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The Aviation Consumer®

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The Aviation Consumer

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HOW WILL YOU FLY WITHOUT ADS-B?

You can skirt the airspace, of course, but for many that won't be practical. For these operators the FAA has a new "statement of policy for authorizations to operators of aircraft that are not equipped with ADS-B Out equipment." More on that in a minute. I can see the panic building, even with new products that make for easier compliance. As an example a reader recently asked for my advice for fitting avionics in his recently purchased Archer. Since the airplane needed an IFR GPS, a transponder and an ADS-B Out upgrade to satisfy the mandate (six months away, as I type), we concluded that Garmin's new GTX375 is a logical choice. As we reported in the May 2019 issue of *Aviation Consumer*, this latest all-in-one navigator makes sense for federated panels because it works with a good variety of third-party accessories. In this Archer, the 375 can drive the existing King HSI, it can connect to the existing autopilot, plus it has a built-in 1090ES ADS-B transponder to replace the King KT76A, and most important—it satisfies the mandate. Although hardly a slap and go, the installation won't require lots of radio stack rejiggering because it's nearly the same height as the King KLN-series GPS that it will replace. Doing some back-of-the-napkin math, also figuring some other work that needed to be done, I sent him to a few well-respected avionics shops for proposals to compare with my notes. He came back with bad news: None of the shops could touch the installation for at least six months or more.

I'm hearing this more and more lately and at this point a six-month shop backlog is sounding pretty good. Another reader with a Baron told me his busy shop couldn't install a new Garmin package until next February—after the ADS-B Out mandate hits. The Archer owner has a major trip to take through plenty of ADS-B airspace, and the Baron owner bases his airplane at an airport inside Class B airspace. Realistically, neither are easily going anywhere without finding shops who can do the work before the mandate hits. This got me thinking about all of the pilots with noncompliant aircraft who will try and thread the way through ADS-B airspace without having the complying onboard gear. I did some digging and turns out the FAA already thought about all of this and has published guidance for getting through the FAR 91.225-defined airspace without the equipment.

It states that requests for ATC authorized deviations from the ADS-B Out equipage requirements must be made to the ATC facility having jurisdiction over the airspace, and within specific time periods. There are a couple of scenarios. If you have an ADS-B Out system installed but it's not functioning properly, you can request to fly to the destination airport (including any intermediate stops) or to proceed to a place where the repairs can be made—or both. This request can be made at any time. If the aircraft isn't equipped, the deviation request must be made at least one hour before the proposed operation. The FAA says aircraft operators may request to deviate from the ADS-B rule on a case-by-case basis, and that the ATC facility with jurisdiction over the airspace has discretionary authority to determine whether it can accommodate or deny the request. In other words, don't always count on a free pass. Moreover, don't plan on placing your deviation request by telephone—the FAA won't accept such calls. As of April 2019, the FAA was developing a website to be used for the deviation request. If your system fails in flight, a controller can issue the authorization to proceed through the airspace. I suspect you'll get an official letter, sort of like when your Mode C reporter fails.

If you haven't equipped for ADS-B yet and plan to fly in 91.225 airspace the obvious advice is to get on a shop's schedule ASAP. Despite the buzz on some internet forums, the FAA says it will not extend the equipage deadline and the drop-dead date is still Jan. 1, 2020. We're preparing an update to our ADS-B buyer's guide if you're still undecided on which system to buy.

If you still need a thorough lesson on ADS-B technology in general, John Ferrara sent me his book *The ADS-B Guide*. It's over 260 pages on everything you might want to know about ADS-B. It's written in simple language, it costs $36 including shipping and is available at www.ads-bman.com. *—Larry Anglisano*

SKYBEACON VALIDATION

I read your field report on the uAvionix skyBeacon installation and fly-off in the May 2019 *Aviation Consumer*. Incidentally, I had an A&P/IA install a skyBeacon in my 28-volt Cessna 172N and directly after the installation found that the unit won't validate with the FAA's radar inside the Mode-C veil, required for the FAA rebate.

I have been troubleshooting this problem with uAvionix and was told the problem is because my unit shipped without the newest firmware update. Buyers need to make sure their skyBeacon has current firmware. Since mine was out of date, this mistake is costing me lots of money and time to fix on my own because I have to fly for an hour back to the shop.

Bill DuBois
via email

We asked uAvionix about this and were told that it released a skyBeacon firmware field update in March 2019 and the company has been shipping new units with that updated firmware in place since the February 2019 timeframe. There isn't firmware specific for 24-volt aircraft, but the updated firmware resolves a compatibility issue uAvionix observed when installed on 24-volt aircraft. The company also issued a service bulletin for the requirement and posted it on the company website.

Worth mentioning is the current STC installation manual requires verification of the skyBeacon firmware version prior to installation to ensure equipment has the most up-to-date software. This is true of any avionics installation and it's up to the installer to verify that the equipment complies with any outstanding service bulletins and other published guidance before releasing the aircraft for service.

In the June 2019 *Aviation Consumer* article on the skyBeacon ADS-B flight test, Rick Durden states in part you have to make a 30-minute flight in "rule" airspace where ADS-B Out will be required next year and obtain a report from the FAA confirming that your system meets FAA-defined performance specs. This is to collect the FAA's installation rebate.

But what if the rebate is not available or you don't want it? Do you still have to fly in ADS-B airspace for 30 minutes as he describes?

George Stobaugh
via email

You should follow the guidance in the ADS-B system's approved installation manual. If it prescribes a flight test (or any means of testing), comply with the manual. Still, we think it's a good idea to validate a new installation for two reasons. First, unless the shop has the appropriate test equipment to make certain the system works properly, it could be the only way you know if the system meets the ADS-B performance specs. Second, the flight test enables you to print an ADS-B performance report to keep with the aircraft records, proving that the system meets the 2020 mandate. In our experience, some tweaking might be required and the flight test is an easy way to discover it.

VORTEX GENERATORS OR STOL KIT?

After reading the VG article in the April 2019 *Aviation Consumer*, I thought I would offer feedback.

When operating our 182Q Skylane out of Marlboro Airport (9B1) in Massachusetts, we purchased a Horton STOL kit to better cope with its 1570-foot (tree-obstructed) runway and have been delighted with the aircraft's significantly improved lower-speed handling.

We later installed VGs and found that only area of improvement was a considerably better ride in turbulence, and perhaps slightly lower stall speeds. In fact, the price we paid for the mod was not worth the 6-knot loss in cruise speed. After flying with the VGs for two years we actually removed them.

Dick Bicknell
Port Orange, Florida

JUPITER BIKE

Since I am in the market for a folding e-bike, I read with great interest your article in the June 2019 *Aviation Consumer* on the two latest e-bikes from Jupiter Bike. It was a great article, but why didn't you include a comparison with other folding e-bikes? Is that something I can expect in an upcoming issue of the magazine?

George Edmundson
via email

Contributor Phil Lightstone had actually purchased the latest V2.0 (and rode the Discovery) so we ran his field report since these bikes were extremely popular at this year's Sun 'n Fun. Still, we're preparing a roundup of folding bicycles, but not limited to e-bikes although we'll look at other electric models in that article.

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On The Cover: That's a Decathlon doing what it was intended to do—aerobatics. But like other aerobatic cruisers, the Decathlon can also serve as a go-places airplane. We scanned the market for aerobatic cruisers for the in-depth article starting on page 10 of this issue.

The basic SkyView HDX retrofit for the Skyhawk couldn't be cleaner. Those are custom panels fabricated and finished by Thrustflight in Texas. That's a Garmin GMA340 audio panel, SL30 nav-comm and GTN650 in the main stack. The Dynon ADS-B transponder is mounted remotely.

SkyView In A Skyhawk: Big Work, But Worth It

Installing a Dynon Certified SkyView HDX system in a flying club Cessna was both more trouble—and more beneficial—than originally planned.

by Jeff Van West

Dynon's STC'd version of the SkyView HDX system was introduced a couple of years ago (we covered it in the September 2017 *Aviation Consumer*), but it hasn't been retrofitted in large numbers. Part of that is because the STC has been limited to Cessna Skyhawk models (at press time Dynon earned an STC for some Beech Bonanza models), plus Dynon hasn't established a large installation network.

Dynon's battle for certified dollars got harder this year when Garmin announced the G3X Touch system, which would be the closest competitor to a SkyView HDX and available for almost 500 certified aircraft models.

That's too bad, because SkyView HDX offers a boggling feature set for the dollar and an installation option that lets you get involved at a level only homebuilders used to experience.

We just completed a basic SkyView install in my Maine-based flying club's 172, and if you're considering this major retrofit, this field report is for you. There are lessons.

SHOULD WE DO THIS?

Our club's flagship 172N got a serious IFR panel upgrade back in 2000 or so. The avionics included an Apollo MX20 MFD, GX60 GPS/Comm and S-TEC autopilot with altitude hold. There was an Insight GEM engine monitor and the airplane also had some serious mods that made it a keeper—STOL kit, 180-HP engine and beefy 182 control yokes.

But the avionics were showing their age. Buttons on the radios and transponder were wearing out from sheer hours of use. Display streaks on the MFD made you think it had been left out in the rain. The GPS database could no longer be updated with all modern approach fixes. The autopilot ready light no longer lit. The engine monitor sort-of told you the EGTs and CHTs if you brought your reading glasses and the sun wasn't too bright.

It's a club, so some folks suggested letting things break and making it a VFR-only airplane. Or at most keeping it a round-gauge machine with minimal updates. They were in the minority, however, so in late spring 2017, our club approved an upgrade to dual Garmin G5s, a new GTN650 navigator and GTX345 ADS-B transponder from Garmin. We started raising the roughly $32,000, but postponed the purchase until after Oshkosh—just in case.

ENTER SKYVIEW

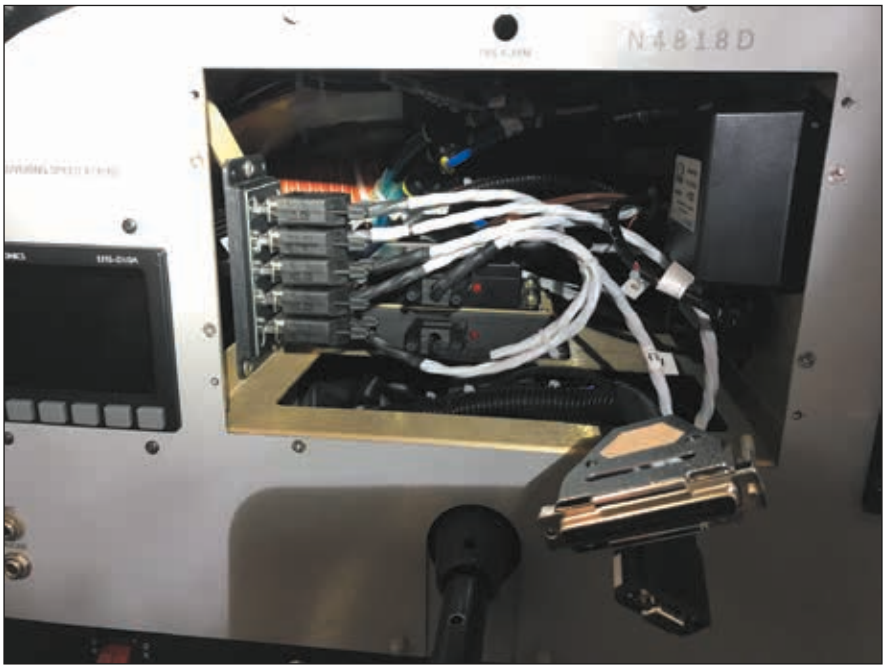
Then Dynon Avionics upset the cart by announcing the SkyView HDX touchscreen system would be available for the Cessna 172. The core install centered around a 10-inch touchscreen with synthetic vision. The screen could be split three ways for PFD, MFD and engine instruments. A second 7-inch screen on the right side was optional. The backup Dynon D10A electronic AI with airspeed and altitude tapes was standard. So was a real two-axis autopilot with approach capability and an emergency "straight-and-level" button.

I got my eyes on the system at AirVenture (I was at the show working with sister publication *AVweb*) and asked more questions. How about

CHECKLIST

- ✚ The SkyView Certified HDX is a complete interface with a generous feature set.
- ✚ The system is highly configurable and the hardware is robust.
- ~ There's a huge learning curve for first-time installers. That means downtime.

That's the mounting rack, sensors and connector network for the HDX display, top. The system uses external mechanical control heads for autopilot input, middle. At roughly 2 inches deep, the Dynon display and control bezel feels solid and fits well on the panel, bottom.



ADS-B In and Out via a 1090ES transponder, so we could fly into Canada (for now) and what about Wi-Fi for connecting to iPads, and backup batteries for those displays? Standard. Full engine monitoring? Yep, that's included with all the probes and sensors. The total system price was slightly more than we were already going to spend. The SkyView Certified was a no-brainer.

The suggested GPS navigator was an Avidyne IFD540 or 440, but we went with the Garmin GTN650 we chose initially because its simple interface suggested a lower training barrier. In a club with about 60 pilots, that's a big deal. However, we went for just the one 10-inch screen. This investment was already looking to be enough to spend on an aging Skyhawk.

SCHEDULE CAREFULLY

As Dynon got its certification ducks in a row, we secured a spot with Thrustflight, a Dynon Certified install center in Addison, Texas, for the install. At the time, this was the closest approved shop to our club's base in Maine. Air Plains Services in Wellington, Kansas, has since been added to list. Still, no problem; we found members interested in the flight time. The plan was to bring it over in October of 2017, and the budget was now $45,000 all told.

That didn't happen because it took Dynon into spring of 2018 to get STC approval for our Skyhawk. Our peak flying season is in the summer, so we planned to fly the airplane to Texas in the fall of 2018. Thrustflight kept a spot reserved for us. Meanwhile the heading indicator failed, making the airplane VFR only. The transponder failed, and we had to get a used unit.

Then Dynon offered a new way to get the install done: Have your local IA do the job by adding their name to your STC. Our IA had put an older SkyView in a Glastar, so as great as Thrustflight had been up to that point, we switched plans to go local. However, Thrustflight was still happy to answer questions and sell us custom panels, precut for the install we planned. That's commendable from a shop that just lost a $45,000 job.

Then we lost an airplane in a landing accident (no injuries) and the install had to be pushed to winter of 2018. That meant we had to compete with annuals already scheduled for the same time, which meant the airplane went in and out of the IA's hangar and sat sometimes for weeks at a time. This is the reality of handing a project of this size to a small shop and you need to expect it take longer than planned, which includes post-installation tweaking and bug-chasing.

It was April of 2019—months after we dropped it off—when we got our airplane out of the shop and ready for its shakedown flights.

AVIONICS OVERHAUL, SANS EXPERT

I could regale you with details of the install missteps and near disasters as our IA and our member-helpers figured out as we went. Better that I sum them up as points learned.

Because virtually the entire panel came out, we took the opportunity

System configuration and calibration take sizable amounts of time, but Dynon makes it as easy as possible. That's the new circuit breaker panel in the bottom photo.

and replaced all the lower circuit breakers and many switches at the same time. This was a good call as it let us clean up that section (and rewire the electrical bus), and organize where new breakers and switches from the SkyView system would go. This is an important part of the planning.

For example, the autopilot servos have a switch, but we wanted that left on at all times because the emergency straight-and-level button wouldn't work with it off. We kept it away from master switches and gave it a red cover for visibility (it's not yet installed in the photo below).

SkyView's engine monitoring added items like carb air temp and fuel flow, which we never had before. All these sensors went in before the main panel, as did the new autopilot servos and cables.

Dynon has served homebuilders—read "amateurs"—for years, and their documentation shows it. But there were only a few places where a call or email to their responsive customer service was needed. That said, most technical answers were by folks used to experimentals. Sometimes the answer/advice was incorrect for a certified install. Dynon is still growing up in this respect, and as more models are added to the STC, the challenges will continue. Garmin spent years developing a vast engineering database from all of its STC work. Dynon has some catching up to do.

For now, some creativity was required. Dynon supplied mounts for some of the equipment, and it's cleverly designed so parts can stack up, attaching to the part below. However, custom mounts had to be made for the magnetometer in the wing and the critical ADAHRS (an old radio rack sufficed for the latter). Both work great now.

Designing our own install also let us put it all together with maintenance in mind, such as making connecting cables just a bit longer than necessary. This paid off during the debug phase.

As will likely be the case for many installs, the Dynon wasn't the only equipment installed. Our IA could legally put in and sign off on any radio we wanted, but you can only order your own Garmin GTN650 for an experimental aircraft. Certified installs must go through a Garmin installation center. We had bought one for our RV-12 eLSA, planning to do IFR training, so we just used that one for the Cessna—again a bad idea. There's more than the physical install.

Garmin paperwork is designed for only the illuminati to handle correctly. By the time we got it all straightened out and working, it would have been better to complete the install sans Garmin parts and then bring it to an avionics shop (and Garmin dealer) for those final pieces.

Once the parts were in the plane, the setup was shockingly simple and supremely satisfying. We did our own compass swings, AoA calibration and autopilot tuning. These are critical steps traditionally left to the avionics shop, so don't try this at home unless you know what you're doing. The autopilot tuning is a tinker's dream. Want the AP to bank less in a turn or more? Capture more aggressively? Allow less deviation in turbulence, or more? You can adjust all of that. Much of this is done using on-screen directions that walk you through the process step-by-step. What isn't is well documented in the installation guide.

To be clear: Our IA had to inspect and sign off on all this work, but we've been partners throughout this project. Sort of like the owner-assisted annual from Hell.

We also created an engine instrument layout that worked well for a wide range of experience levels and mirrored much of how it displayed in our RV. Because we do a lot of training, we customized the bigger engine instrumentation layout to better

serve students learning what all that data means.

Not to say we didn't run into problems. Certain sensors and items got configured wrong at the start and it took backtracking to find the issues. A few of the multitude of wires didn't get connected until the lack of function was discovered in flight testing. The squawk list grew.

Somewhere a decision was made to keep a few older cables for the transponder and nav radios as they were working fine. Do not do this. They all got replaced later. Likewise, the system failed its pitot-static certification because the old tubing had tiny cracks that the analog system didn't mind, but made the SkyView's brain see red. Replace every old cable and tube while everything is still apart.

There were also a few items we wanted to connect, but couldn't. Unlike the Garmin G3X Touch system, the Dynon backup AI in the certified install can't be connected to the GTN navigator. Nor can it connect to a magnetometer or GPS, so it has no heading or ground track on it. We're admittedly tempted to connect some of these on the grounds of safety, but we haven't yet (don't tell anyone).

SKYVIEW IN THE REAL WORLD

Because we have an RV-12 with a non-touchscreen SkyView, many pilots knew the basics. This meant our checkout process was just ground orientation for pilots already checked out in the RV and the pre-Dynon 172. Most pilots were comfortable flying it after that hour or so on ground power. That included learning the GTN, which was completely new to all of them. We recommended people take a buddy or club instructor on a first flight. We also required a fight with an instructor before anyone exercised IFR privileges in the airplane.

The touchscreen HDX is actually easier than the older button-only SkyView because you just touch what you want on screen and get on-screen buttons. In fact, I find it quicker to control the autopilot from the touchscreen than from the dedicated buttons sitting immediately to the right.

At least that's true in smooth air. With turbulence, the buttons work better, so it's great to have both. The install also includes dedicated heading, baro, and altitude bug knobs. The HDX has places to brace your fingers, and knobs and buttons for functions you might otherwise do via the touchscreen. It's similar to Avidyne's hybrid-touch approach that way and really makes a great combination approach.

The Skyhawk now has unusual attitude recovery thanks to the integrated digital autopilot. The middle photo is the old panel—capable, but dated and failing. It's now all electric, finally free of the vacuum system, bottom.

We retained the SL30 navcomm from the previous panel. It plays perfectly with the SkyView, even exchanging frequencies and control between the displays. We chose to set up that radio as navcomm number one and make the GTN number two. The SL40 in our RV is the only radio so both planes now have the SL controlled from the SkyView display, which we hope offers some consistency. This essentially gave us two touchscreen-controlled radios; the SL30 from the SkyView and the GTN from its own touchscreen.

We showed pilots how to put a six-pack of instruments up for the round-dial holdouts. Some folk do prefer to fly this way. The SkyView HDX that's part of the certified install is dirt-simple to use. Even folks who struggled a bit with the classic SkyView in the RV seemed to pick up the HDX user interface right away.

There are a few items on the display that took adjustment. Instrument approaches with vertical guidance require looking in two places on the display. This isn't a big deal, but a focused view like Garmin offers would be nice. We're also based on

The system has screen recording and that's a capture in cruise flight. Notice the logical layout of engine data.

the coast and an approach over the water shows as blue sky over blue ocean. Whoops. Again, there's a grid to show which is the earth below, but it's a surprise when you first see it.

Night flight was also a bit of a surprise. The displays are easy enough to read, but the SkyView HDX and D10A (backup AI) don't dim at the same rate. There's also no spillover light for other switches the way the old post lights used to offer. We may add some glareshield lights just for more ambient cockpit lighting.

During calibration of our stock (read: ancient) Cessna fuel senders, we had to give up and just edit the voltages for certain gallon amounts to yield a gauge that even remotely worked. The addition of the fuel totalizer was fantastic, however. It's been accurate to a tenth of a gallon between refuelings.

Dynon has a great feature where it compares what the totalizer thinks is on board to the gauge readings on the ground and alerts you if they don't match. With so many people using the airplanes and forgetting to tell the computer they added fuel, that's a big win.

The new system also uncovered a mechanical issue. Our old engine monitor hinted that CHTs were a bit high, but it was hard to tell for sure. SkyView showed CHTs reaching into the low- or mid-400s during climbout. It also showed for the first time that full-power fuel flow was a bit lower than it should be. Now that's getting addressed by our mechanic and could end up giving us a couple hundred hours more of engine life than we otherwise would have seen.

HITS AND MISSES

Now that the bugs are mostly squashed and the member checkouts are mostly done, things are generally working well. The final cost, including the GTN650 and labor from a few expert shops to do the things we didn't get right the first time, was about $42,000. That doesn't include the time volunteered by club members.

The takeaway there is the cost of doing it locally was a wash—or more if you include our personal time. The plane came out 35 pounds lighter when we reweighed it.

Display failure on our single-screen system would take out our primary flight instruments, moving map and all engine gauges. The flight instruments are on the backup and the GTN and iPad have a map, but we have no backup for the engine instruments. Make that display failure happen in the clouds and we lose vertical nav for approaches.

Dynon's user design is also busier than Brand G when you cram it all in one 10-inch display. If you have the budget, get two screens. If you really have the budget, get two ADAHRS as well. The GTN sends flight plan information to the SkyView, no problem, but won't accept it from the SkyView. The iPad can send a flight plan to the SkyView, but that can't continue to the GTN. Sure, we could buy a Flight Stream 510 for the GTN, but don't you think we've spent enough already? If you go Avidyne, everything plays together.

GPS location and the ADAHRS data flow to the iPad, but weather and traffic don't, which was a disappointing discovery. We didn't read the fine print on that. We're told that should be updated in the next SkyView software update.

About halfway through our install, Garmin announced the G3X touch was now available for almost every sub-6000-pound airplane known to man. Would we have gone that route if we had the option?

I'll admit I like the Garmin equipment better. The only big oversight I see on the G3X system is the lack of battery backup, but that can be added aftermarket. I would miss the extensive customization that's simple with the SkyView. Customizing Garmin equipment requires knowing the secret handshake. And maybe wouldn't even be legal if you did know how to do it.

However, the same level of capability as we have in our Skyhawk would be at least $5000 more in hardware alone going the full Garmin route. My gut feeling is it would be an additional $5000 delta in labor, but that would depend on your deal with your shop. Is a Garmin system $10,000 better? Personally, I'm not sure—but I am sure our club as a whole would say, "No." At least so far.

As for whether the club would say the money was well spent on our Cessna, I think the answer would be mixed. The pilots who've flown the plane love it. The pilots who prefer VFR days and round gauges might feel otherwise.

There's universal agreement the plane looks better on the inside. It's more impressive to potential members and the family of existing ones. The new install has unleashed a backlog of pilots looking to add an instrument rating, which is good for those pilots and the club.

So you could say the Dynon Certified SkyView install has at least a little something for everyone.

What's It Really Weigh?

Don't shortchange major installations by not generating an accurate weight and balance report. Putting it on the scales is worth the effort.

by Larry Anglisano

Part of the sales pitch for investing in a modern all-glass upgrade like the Dynon SkyView or Garmin G3X Touch system is the ultimate weight savings that tags along with the project. Sure, yanking out the vacuum system and the round-gauge gyros in favor of electronic instruments generally will yield a sizable weight savings. But just because the new weight and balance report shows more useful load doesn't necessarily mean the numbers are accurate. In fact, that new report can be grossly inaccurate.

Unless the aircraft has never been modified (which is highly unlikely for older models), there is a good chance there are at least some discrepancies in its weight and balance data. A common phrase written in aircraft maintenance logbooks after the job is done is "negligible change to weight and balance." That may be a true statement from a regulatory standpoint because in general, if the item installed or removed was under one pound many installers won't generate a new weight and balance report.

The problem with that is a bunch of so-called negligible weight and balance changes end up being a significant change to the report over time. We've also found that some reports have mathematical errors, which carry on over the years.

The other thing that many installers don't account for is the weight of old wiring and install hardware. Fill a rubbish barrel with removed wiring bundles from a typical aging piston single or twin and you'll find that the barrel weighs several pounds more than it did before the job started.

Many techs that we talked with have discovered equipment that was installed and removed from some aircraft without being documented at all. "I worked a Piper Dakota that once had a new stack of radios installed but the shop never updated the weight and balance at all," one tech told us. He had just installed a big-screen PFD and two Garmin navigators. He's correct in pointing out that calculating a new report for his latest work would be pointless. After all, you need to start a revision with accurate basic empty weight and reference datum figures. In this case and many others like it, the only way to do that is to have the aircraft weighed.

SPECIALTY EQUIPMENT

While a competent mechanic can handle the task of weighing an aircraft, many shops can't justify the purchase and calibration costs of the scales. The shops we spoke with admitted that it's easier for them to subcontract the work, or send the owner to have it accomplished.

While aircraft weighing is specialty work, the process is easier than you might think if you find the right shop. That includes using a weighing service that has certified and calibrated scales that are designed specifically for weighing aircraft. Larry Jackson of Jackson Aircraft Weighing Systems in Florida (a leading provider of aircraft scales) pointed out that non-aviation scales like those used in the racing world, as one example, aren't made to the specs of aircraft scales, especially when it comes to calibration points.

Modern scales generally consist of multiple platforms with wireless transmitters and can include a combination of sensors, including jack stand load cells and platform scales.

On average, expect to pay around $250-$300 for a single-engine piston, $350-$400 for a piston twin and close to $1000 or more to weigh a turboprop or small jet. The process generally takes a couple of hours, including the final paperwork.

The service will add to the final invoice, but weighing the airplane with calibrated aviation scales as shown in the photo here might be the only way to get an accurate weight and balance report.

Aerobatic Cruisers: All-Purpose Fun

You fly for the pure enjoyment of it and to get places efficiently. Why not do it in a plane that kicks the fun up a notch? But do a careful prebuy.

by Rick Durden

I'm bored!

Admit it. You've made the statement loud and clear on more than one of those flights where you are following the magenta line in good weather and waiting for your destination to appear over the horizon. Sure, every once in a while, you'll do a steep turn or wander off course a bit to look at something interesting—but, deep inside, you know that's not enough. You live in the third dimension—there's got to be more to getting from one place to another in an airplane than droning along waiting . . . and waiting. Flying is supposed to be fun.

Why not roll the airplane? Or loop it? Or fly upside down for a while? Anything to break up the monotony.

Well, first of all, you're in a normal category airplane and you're smart enough not to do something as incredibly stupid as aerobatics in an airplane that's not built for them.

And second of all . . . maybe there is no second at all. You fly most of your trips by yourself, right? Why not own an airplane that you can use to go places and do some akro on the way? And, what better way to enjoy a gorgeous evening than a few loops and rolls as the sun heads for the horizon? That sure beats yet another session of touch and goes in the pattern.

THE MARKET

A we researched this article, we were pleasantly surprised to find that during the heady aviation days of the 1960s and 70s, aircraft manufacturers spent the money to certify a wide variety of airplanes in the acrobatic category—capable of withstanding six positive and three negative Gs. There is a mix of two-place airplanes with power ranging from modest to Yeah Baby as well as two four-place "family" airplanes.

From the standpoint of space, we're limiting this article to production airplanes, while pointing out that every aerobatic instructor and pilot we interviewed spoke highly of the Van's RV line of homebuilts for the ability to smoke along in cruise and nicely fly what interviewes referred to as "gentleman's" and "lady's" aerobatics.

CAUTIONS

The unanimous consensus among those we interviewed for this article is that every aerobatic airplane they have flown has blown through redline more than once and otherwise been overstressed by student screwups—despite the instructor's best efforts. (It's also why they are adamant against doing akro in normal category airplanes.)

That means, in our firm opinion, that anyone considering purchase of an aerobatic airplane have a careful prebuy examination performed by someone who knows the type. We also think that the inspection should be approached with the mindset that the airplane has been overstressed (and tailwheel airplanes groundlooped at least once) and the examiner is looking to find out what the effect has been, whether repairs are (or were) needed and whether repairs were done properly.

As part of the prebuy, carefully check to see if there are any STCs or mods to the airplane that disqualify it for aerobatic flight. That could include an engine or STOL mod. Further, some aerobatic airplanes are the subject of requirements for mods to maintain their aerobatic certification.

That being said, there are a lot of aerobatic airplanes in beautiful condition out there—we've talked with some happy recent buyers. We recommend a patient search.

As a final preliminary remark,

Patty Wagstaff and aerobatic student Anna Cutright in front of Ms. Wagstaff's 8KCAB Super Decathlon.

Above, Cessna A152 Aerobats. The one on the right, nicknamed "Orville," was used by the late William Kershner in his Ace Aerobatic school. It is now displayed in the Smithsonian Institution. The one on the left, "Wilbur," is still used by Ace Aerobatic School, now run by Dr. Catherine Cavagnaro. Below, Dr. Cavagnaro's Aerobatic Bonanza.

you're going to need parachutes unless you are only going to do aerobatics solo and are nuts. Figure in the cost of chutes in your airplane search as well as their weight when looking at useful load of the aircraft you're considering.

CESSNA AEROBAT

The Rodney Dangerfield of aerobatic airplanes, but we, frankly, love it. For the 1970 model year, Cessna made the already strong 150 almost bulletproof by adding stringers, nearly doubling the number of rivets and using wing struts from the 182.

Power was not increased when the structural changes were made so the complaint is that Aerobat pilots spend half of their lives climbing for altitude. That's not entirely true, but because one has to dive for the entry speed for most maneuvers, Aerobat pilots learn energy management early on.

With well-harmonized controls, Aerobats will do lovely, positive-G aerobatics, but their pilots have to work to make it happen. For example, rolls require that the control yoke be turned completely upside down to get full aileron deflection.

Dr. Catherine Cavagnaro uses an Aerobat in her Ace Aerobatic school in Sewanee, Tennessee, for aerobatic, spin and upset recovery training. She does so because the yoke and side-by-side seating give a more realistic depiction of what is involved in recovery from an unusual attitude in most airplanes.

Dr. Cavagnaro and others told us that the Aerobat particularly shines in snap rolls and spins—although, as with all aerobatic airplanes, entering a snap roll too fast is likely to result in structural damage. The wing sweep that begins just outboard of the wing struts helps cause the Aerobat to enter snaps and spins—and recover—more crisply than the Citabria and Decathlon.

We used VRef as guidance for prices for this article. For the Aerobat A150K-M, prices ranged from a low of $20,000 to a high of $27,000—assuming an airframe in good shape with a mid-time engine and decent avionics. Overall, Aerobats commanded about a $5000 premium over 150s of the same year. For the A152 "no letter" through the B model, prices started at $34,000 and topped out at $45,000 with a $5000 to $7000 premium over straight 152s.

Owners advised us that an Aerobat must have the rudder stop AD complied with to maintain their certification. We also learned from the Cessna 150/152 Club that parts are getting hard to find, notably wing struts.

During a prebuy exam, check for corrosion as well as whether the vertical stabilizer is indeed vertical. We heard some unpleasant stories of bent vertical stabilizers and twisted empennages, probably due to snap rolls entered too fast.

Interior refurbishment costs more than a stock 150/152 because, as with the Citabria/Decathlon, the seat cushions are separate from the seats so that they can be easily removed when wearing parachutes.

One owner told us that he was able to find an Aerobat that had never been a flight school airplane, so it wasn't abused. However, it had been parked outside in the Southern California sun for 15 years so that its paint had faded—making it an "Uglybat."

CITABRIA

Trying to keep up with the number of different Citabria models that have been offered over the years is more than a small challenge. Boiled down to the essence, all models start with the number "7" and are followed by two or three letters.

The lowest-power Citabrias of which we are aware have 100 HP, while the highest have 180 HP up front (there are only few 180-HP Citabrias in the field). All are fabric-covered, and have fixed-pitch props; some have wing flaps, the others don't and all are aerobatic, have tandem seating, are soloed from the front and use a stick rather than a yoke. The 7KCAB model has an inverted fuel and oil system.

Flying from the front seat gives the Citabria surprisingly good visibility for a tailwheel bird. From a ground handling perspective, we

AEROBATIC CRUISER ACCIDENTS: RLOC AND LOW FLYING

In talking with insurance agents about insuring aerobatic aircraft we learned that the rates tend to be similar to insuring high-performance cars. If you want a 700+HP Dodge Hellcat, plan on paying through the nose. If you're driving a used Miata that will scoot along nicely and corner as if it's on rails, the premium isn't going to cause nosebleed. If you are buying a Pitts Special, plan on writing a pretty big insurance check; if your acquisition is a Citabria, Decathlon or Cessna Aerobat, the fact that the airplane is aerobatic isn't going to bump the premium noticeably.

We've found that aircraft insurance rates track accident rates pretty closely—insurance underwriters track accidents carefully because they've got to accurately analyze risk or they're going to be out of a job when their company rolls inverted and pulls.

For this article we went into NTSB reports and tracked the 100 most recent accidents (except for the Great Lakes where we only found 87). We were looking for red flags for prospective owners.

After burying ourselves in bent airplane numbers we came to a few conclusions. First, even with aerobatics involved, the highest risk of tearing up your airplane is on landing, particularly loss of control during rollout (runway loss of control—RLOC). If you're flying a tailwheel airplane your risk of RLOC is two to three times what it is for a nosewheel airplane even though tailwheel pilots possess the magic macho mojo of aviation. They still wreck airplanes on landing at something over twice the rate of nosewheel pilots.

The second conclusion is that doing aerobatics isn't a terribly high-risk endeavor unless you start down low, then it is a very risky undertaking—pun intended. Once some pilots get into an aerobatic airplane we can't help but think that a switch flips somewhere in the primitive recesses of the brain that causes too many of them to go into "Hold my beer and watch this!" mode. Stupid pilot tricks looked to us to make up on the order of 10%-25% of the accidents we surveyed.

With that as general background, here's our take on accidents on some of the aerobatic airplanes on the used market.

• Cessna 150/152 Aerobat

There were 16 Aerobat accidents, most of which were fatal, involving low flight. A few pilots hit obstructions while making a low pass, but most were stalling in a pull up from a low pass or doing aerobatics at low altitude. One pilot was reported to have a habit of doing rolls shortly after takeoff. He tried it one too many times. Another decided to buzz his friends and do a roll. The nose dropped when the airplane was inverted and it impacted the ground with the wings vertical.

• Citabria/Decathlon

In our accident review, we lumped the Citabria and Decathlon together, largely because their similarities outweigh their differences. We've long considered the Citabria/Decathlon to be the standard by which tailwheel ground handling is measured. That was reflected in the fact that of the 100 most recent accidents, 30 involved RLOC, a fairly low rate for airplanes with the steering wheel on the back end.

Where our eyes were opened was the number of accidents related to pilots shutting off the "this may not be a good idea" part of their brains—25 out of 100. There were eight stall/spin accidents, all during what is euphemistically called "maneuvering" flight—read messing around down low. To top that, there were 18 crashes arising out of flying low in general—five doing aerobatics and tying the record for low flying; the rest were flying low and smacked into something. One person put two 11-year-olds in the back seat, then flew low and hit power lines, killing everyone.

• Aerobatic Musketeer and Bonanza

We found no accidents involving aerobatics, low flying or stalls while maneuvering in the aerobatic versions of the Musketeer and Bonanza. We also noted that their rate of RLOC was 25%, consistent with our observations about the good ground handling of both types.

• Great Lakes

We did not see evidence of significant pilot foolishness in Great Lakes accidents. What we did see was that well over half of the accidents were RLOC, partially, we think, due to poor visibility with the airplane in three-point configuration. That was consistent with the more than 10 of 87 accidents also involving hitting something on final, on the ground, on rollout or taxiing into another airplane.

• Pitts Special

The good news is, of the 100 most recent Pitts wrecks, only 30 involved RLOC, the same as the Citabria. The bad news is that 12 pilots ran their airplanes out of fuel; there were eight inflight and six on-the-ground collisions—probably due to poor visibility—and four crashed after stalling at low altitude.

The further bad news was seven pilots died trying to do low-altitude aerobatics and six spun in after appearing to start plenty high. Half of those aircraft were loaded out of CG aft and over gross. Significantly, there were four structural failure events; only one was fatal.

All Citabria models, top, are fabric, but some have no flaps. For going places, find a 180-HP version. In our opinion, the smooth-handling aerobatic Musketeer, bottom, is substantially undervalued.

much prefer the models with toe brakes over the early versions with heel brakes.

The flight controls are not well-harmonized. The elevators and rudder are "just right," while the ailerons are way too heavy and the roll rate slow. We consider spades, which look like small shovels and are attached to the ailerons to reduce control forces, to be a nearly essential mod.

It takes work and finesse to do precise aerobatics in a Citabria. However, as with the Cessna Aerobat, learning in one means that when you step into a more capable akro machine that you'll be amazed how easy it is to nail the maneuvers you've struggled to master.

Citabria cruise speeds are proportional to engine size. The big engine ones will cruise 110 knots on 7 GPH. We consider the more powerful Citabrias to be very good backcountry airplanes—making them the utility infielders of general aviation.

The big shortcoming of many Citabrias (and Decathlons) is useful load. With two beefy Americans and parachutes, it may not be possible to carry more than a gallon or two of avgas. In the aerobatic world we simply are not willing to fly over gross.

We strongly recommend that adequate useful load be high on your list of must-haves when searching for an akro cruiser.

Prebuy considerations are the usual concerns about corrosion and structural integrity for an airplane that has probably been overstressed at least once. Because the airplanes are fabric covered, we are of the opinion that their hangaring is a must.

Prices for Citabrias are all over the chart. In general, the older, lower-powered ones are the least expensive, with prices starting as low as $19,000. Prices climb steadily with power and youth, with new production model prices in the $170,000 range.

DECATHLON

In the early 1970s the 150-HP 8KCAB Decathlon emerged from the chrysalis of the 150-HP 7KCAB Citabria with the same fuselage and powerplant, but a shorter, symmetrical airfoil wing and a constant-speed prop. Stressed for +6 and -5 Gs, the Decathlon proved to be a big step up in aerobatic capability over the Citabria although it still had the lousy, heavy ailerons of the marque. In 1980 power was boosted to 180 HP in the Super Decathlon, but useful load suffered. A few years ago American Champion came out with the 210-HP Extreme Decathlon with a number of modifications, including far lighter and delightfully effective ailerons.

Three-time national aerobatic champion Patty Wagstaff owns a Super Decathlon she uses for aerobatic instruction and as a personal traveling airplane. She told us that she can rely on the airplane to do a solid 120 knots for four hours and that she has flown hers from Anchorage to the lower 48. She recommended a careful prebuy as the airplanes can be subject to abuse.

Wagstaff also noted that wood-spar Citabrias and Decathlons are subject to an AD requiring repetitive inspection and replacement with aluminum wings if there is damage—a fix that runs in the $40,000 range.

While the 150-HP Decathlon doesn't have the vertical ability of the higher-horsepower versions, we consider it an excellent performer and we've happily used one for solo travel. Plus, with everything tied down, it's a blast to break up the en route time by periodically pointing the wheels at the sky.

Our review of prices showed a range from $24,000 for an early 150-HP version through $289,900 for a brand-new Extreme.

AEROBATIC MUSKETEER

For some two years of the production of its entry-level four-place airplane, the Musketeer/Sierra, Beech built an aerobatic version. The 1969 B23, now valued at $21,500 and the 1970 C23, valued at $22,500, are aerobatic with only two of the four seats occupied.

The Musketeer series has long had a reputation for a large, comfortable cabin, excellent handling and painfully slow cruise speeds. Yet, with a 180-HP engine, it does most acceptable aerobatics without requiring periods of climbing following maneuvers.

The late William Kershner, a well-known aviation writer, thought so well of the aerobatic Musketeer that used one to start the Ace Aerobatic School where he gave, and wrote about, spin and aerobatic training.

AEROBATIC BONANZA

For three years Beech made an aerobatic version of the 33 series Bonanza for Lufthansa and the Mexican air force. All but one of the E33C and F33C Bonanzas were exported.

The pilot of this two-seat Pitts, top, is keeping the runway in sight on final via a steep forward slip. The Great Lakes Sport Trainer, bottom, is a currently produced classic that started production in 1929.

Over the years many of them were bought by private owners in the States. In researching this article we learned that some of them have been modified with inverted fuel and oil systems, making them very capable aerobatic cruisers.

To maintain aerobatic certification each must have had Beech's retrofit aerobatic kit installed, beefing up the tail and adding stall strips improving aileron control at high angles of attack.

Owner Dr. Catherine Cavagnaro told us that she cruises her aerobatic Bo at 160 knots while burning 12 GPH. She characterizes the airplane as "not nimble" in comparison with two-place akro birds. We've also seen handling comparisons to the sister production airplane, the T-34 Mentor.

The clean airframe picks up speed rapidly in a dive but the comparatively heavy pitch forces help prevent loading too many Gs inadvertently.

Our scan revealed prices from a low of $73,000 to a high of $85,000.

GREAT LAKES

The 1929 Great Lakes Sport Trainer went out of production during the Depression but was resurrected with a horizontally opposed engine in the 1970s. It is now built by Waco Aircraft of Battle Creek, Michigan. New prices start at $265,000.

It's a two-place, tandem, open-cockpit biplane with a 180-HP Lycoming turning a constant-speed prop. It is not a fast airplane—cruise ranges between 100 and 110 knots, depending on whom you believe. It can get chilly in the winter, yet we know a few folks who only want to fly airplanes open to the breeze when traveling.

With an inverted fuel and oil system, the Great Lakes is often compared to the 7KCAB Citabria in handling and performance, although the Lakes is lighter in roll. The swept upper wing gives it a sharp, clean entry and exit to snap rolls and spins.

Ground handling is demanding as three-point visibility is poor.

We found prices all over the place for the line—from $50,000 up—and largely dependent on condition of the fabric (recovering four wings is expensive) and engine.

PITTS SPECIAL

While there were a few production single-place Pitts Specials, we looked at the two-place S2 line. The S2-A has a 200-HP engine while a 260-HP Lycoming powers the S-2B and S-2C.

All have impressive vertical ability and such responsive controls that akro seemingly only demands that the pilot think about a maneuver to perform it.

The airplanes require training to land successfully because they go where the pilot demands, immediately, and it seemingly takes a while for most pilots to decide where they want the airplane to go. It is blind in three-point attitude and we've noted that most Pitts pilots fly final in a forward slip so that they can see the runway.

On a prebuy exam look for slop in the control system as bearings wear out and make sure inspection holes have been cut in the underside of the wings—that indicates the owner has probably been looking at the structure.

Look to see that the nose bowl and spinner line up. If not, the engine mounts are probably worn out and the alternator can be pushed into the nose bowl and the exhaust can hit the front of the firewall.

Cruise speeds are on the order of 150 knots, but there is little space for baggage and there's no heater. Nevertheless, we like it for weekend trips. Prices for the S2-A range from $60,000 to $70,000, with the S2-B starting as low as $60,000 and going into six figures. The S2-C starts at $80,000 and goes up.

CONCLUSION

We like traveling in little airplanes that can be maintained at any shop in the country. We purely enjoy de-stressing after a rough day at work by caging our eyeballs with 30 minutes of akro.

To be able to do both in the same airplane is, to us, the definition of an all-purpose flying machine.

Editor's Choice Awards: Garmin An Easy Win

Garmin has expanded the STC list for its retrofit autopilots, earned widespread approval for the G3X Touch and now has new navigators.

In each July issue of *Aviation Consumer* we pick 12 products, services or companies that were standouts over the past editorial year. You know, the best of the best. We don't take our Editor's Choice Gear of the Year awards lightly, but when we looked back at what Garmin has accomplished recently, we knew we had our winner.

The Aviation Consumer PRODUCT OF THE YEAR

Perhaps what impressed us the most about Garmin this past editorial year was its ability to earn a wide variety of STC approvals. This includes expanding the GFC500 budget-based autopilot, a system that not long ago was limited to experimental aircraft. At press time Garmin announced a new STC for installation of the system in Mooney M20J/K/M/R/S models, in addition to the Beech Bonanza 36 series.

As we reported in the June 2019 *Aviation Consumer*, Garmin also earned an STC for installation of the G3X Touch integrated avionics suite in over 500 aircraft models, is nearly completed with the G5000 integrated avionics suite for Cessna Citation XL/XLS jets (the system was recently certified for Beechjet models), plus Garmin designed and earned a TSO and STC for a new series of standalone GPS navigators. This is the GPS175 and the GNX375—a navigator with built-in mandate-compliant ADS-B Out.

For all of these accomplishments in a short amount of time, we offer credit where it's due and tip the editorial hat to Garmin.

EASIEST ADS-B INSTALL: UAVIONIX SKYBEACON

For the second year in a row the editor's choice for a budget ADS-B Out solution goes to uAvionix and the skyBeacon wingtip LED position/strobe system with integral ADS-B Out transmitter. As we reported in the May 2019 *Aviation Consumer* field report (we actually installed a skyBeacon in a Cherokee), many installations might not be completed in under one hour, but some might and the rest can likely be accomplished in a few hours, with paperwork and flight testing. The skyBeacon is currently priced at $1850 and you can learn more by visiting www.uavionix.com.

BEST LED LANDING LIGHT: AEROLED SUNSPOT

As aviation gadgets go, LED landing lights are only expensive when compared to old-school incandescents. While they may cost $600 or more, there's value in performance of seeing better for landing and taxiing, plus improved conspicuity by leaving the LED lights on all the time.

The AeoLED Sunspot was our top pick in our LED performance shootout in the March 2019 *Aviation Consumer*. At $349, the we think the 1030-L-A is a high-value combination of price and performance. Visit www.aeroleds.com.

BEST NEW AIRCRAFT ACCESSORY: JET SHADES

The Jet Shades product is a direct result of company founder Kevin Duggan trying to solve the nagging problem of excess heat in the cabin of his Eclipse Jet. Tired of sticking random things in the windows and trying automotive shades, he developed the Jet Shades. These are made of optical-quality polycarbonate material that's virtually unbreakable and shatterproof, block 99.9 percent

of infrared light, over 44 percent of solar energy and can reduce 70 percent of glare.

What's unique about the Jet Shades is they are custom fitted and can be left in during flight, and easily removed for night ops. We tried a set in the cockpit and the rear cabin of a Pilatus PC-12 and in the sun-splashed cabin of a Diamond DA40 and found them to be excellent performers, while Duggan and his team couldn't be easier to work with when it comes to tweaking the fit.

The Rhode Island-based company is constantly improving the product and offering more applications—from small piston singles to jets. Since the Jet Shades are a removable accessory, there's no FAA approval required. Those are the shades fitted in a Cirrus SR22 at the top of the page. Contact www.jet-shades.com.

FAVORITE IFR HOOD: VIBAN

When it comes to IFR training hoods, also known as view limiting devices, you should choose for personal comfort and compatibility with eyeglasses and hats.

Our market scan in the March 2019 *Aviation Consumer* proved there's plenty of variability in fit, form and comfort. Of the hood design, our top choice is the $39.95 hybrid-design ViBAN. It has good durability and comfort plus it's easy to put on and take off. Depending on the type of glasses you wear, you might make it work with them. Contact www.viban.com.

MOST ADVANCED AUDIO PANEL: PS ENGINEERING PMA450B

Tennessee-based PS Engineering has never been a company to let its products go stale and the PMA450B audio control panel is proof. The flagship panel is the result of nearly 34 years of PS Engineering designing nothing else but aircraft audio systems.

In fact, the PMA450B is perhaps the most feature-rich panel we've used, with a highly configurable UI that caters to a wide variety of users. It has dimensional audio, which digitally processes incoming radio signals at user-defined locations in the headsets, Bluetooth for streaming to multiple devices, interfaces for action cam audio streaming and a variety of other advanced features—including a programmable aural warning system—that leaves room for the typical buyer to grow in to. It's $2595, and done right the install won't be inexpensive, but we still think it's a good value and the most feature-rich audio panel on the market. Contact www.ps-engineering.com.

BEST VFR REFRESHER COURSE: SPORTY'S RUSTY PILOT

Among a handful of interactive pilot refresher courses for VFR flying, we favor the Sporty's Rusty Pilot program. What we like best is the course is a good way to hone rusty radio communications skills. After trying a handful of courses, we think the $99 price is fair, it's accessible in app and desktop format and we like the excellent support provided by Sporty's. You can read the report in the December 2018 *Aviation Consumer* and visit www.sportys.com.

FAVORITE AIRCRAFT WASH: FLEET WASH

In an exhausting trial for the August 2018 *Aviation Consumer*, we gathered a few dirty airplanes and took out the buckets and hoses to test a handful of popular aircraft wash products and found that the Fleet Wash from Arrow-Magnolia was a hands-down favorite. We particularly like that it's easy to work with and has deep-cleaning qualities.

Fleet Wash is $30 per gallon and made satisfying amounts of suds—something that's important to us when washing aircraft. It was strong enough to wash away slimy de-icing fluid without leaving behind any film. Best of all, it left a brilliant shine after rinsing and drying. Visit www.arrowmagnolia.com.

BEST PORTABLE POWER SUPPLY: FLIGHT GEAR BATTERY PACK

If you're like us, you need a reliable and powerful charging bank for topping off portable electronics on the fly. We found that the $79.95 Flight Gear backup battery pack (sold by Sporty's) gets the job done.

What we like best are the multiple charging ports—three standard USB-A and one USB-C output/input port—for charging multiple devices at once. With 20,000 mAh of capacity, we've found it tough to run the bank dry. It even has a microprocessor that monitors the battery health of the charged device and shuts

down the charging circuit before it overcharges.

We're told this battery is different than others that resemble it and sold by Amazon because the Flight Gear was tested to ensure it won't interfere with onboard avionics.

MOST ADVANCED TUG: TRACKTECH BY AC AIR

When it comes to modern aircraft tugs, we think Chino, California-based AC Air Technology excels with its line of TrackTech remote-control tugs. The general idea of a remote-control tug (it moves on heavy-duty rubber tracks—yes, like a tank) is having the freedom to walk around the aircraft while inching it into tight spaces without needing a wing walker.

The tugs have a lanyard-equipped remote-control unit with a joystick that moves the tug forward, back, left and right and there's a three-position speed switch for low, medium and fast. There's an even a lighting option for night ops. AC Air has a good website for getting the right tug for your aircraft and it has models for basic piston singles up to jets. Prices start at around $3500. Contact www.acairtechnology.com.

BEST BACKWOODS TURBOPROP: QUEST KODIAK 100

With excellent fit and finish, a refined and sophisticated cabin and modern avionics, the Series II Quest Kodiak 100 is perhaps the most versatile turboprop single we've flown.

Moreover, it was even easier tagging the Kodiak a favorite because the one we flew for our report (September 2018 *Aviation Consumer*) was fitted with big Aerocet amphibious composite floats, adding even more utility, but at a speed penalty. Powered by a 750-HP Pratt PT6A, a Kodiak 100 on wheels does around 183 knots—no speed demon—but the payback is that it's easy to get the airplane in and out of tight places on the water and backwoods runways. If you had $2.15 million (nearly $2.8 million with floats) to spend for a rugged yet refined workhorse, we'd have no problem recommending the Kodiak as the best backwoods utility turboprop. Visit www.questaircraft.com.

BEST PORTABLE EFIS: DYNON D3 POCKET PANEL

Dynon's latest-gen Pocket Panel D3 portable EFIS doesn't do everything a permanently mounted and certified EFIS does, but at just shy of $900 it's priced about one-third of the typical budget EFIS.

For pilots who already have glass cockpits, or who are proficient at partial-panel flying, the D3 could be one of the best investments when it comes to belt-and-suspender portable backup.

The D3 uses the same AHRS as Dynon's panel-mounted avionics, but uses GPS data instead of pitot/static input, plus it has a new touchscreen, synthetic vision and a better UI than its predecessor. Visit www.dynonavionics.com.

PPL Training Courses: Sporty's, MzeroA Top

The Sporty's Learn To Fly course emphasizes decision-making and real-world scenarios, while MzeroA has a unique interactive style.

by Kate O'Connor

CHECKLIST

- Sporty's guarantees students who pass the course will also pass the FAA tests.
- The MzeroA course material is a dynamic and engaging presentation.
- All of the courses require a sizable investment. Be sure the one you choose works on your device.

Learning to fly can be a little like trying to drink out of a firehose, especially for students with no previous exposure to aviation. With all of that new information, terminology and technique to take onboard, the logical starting point is a good virtual ground school.

Thankfully the online course options are getting better all the time, while providing a potentially cheaper and more time-flexible resource for new pilots. For this article we took a look at eight of the top options for online private pilot ground schools.

SPORTY'S LEARN TO FLY

The Sporty's Learn To Fly course covers Private, Recreational and Sport Pilot certificates. It uses a modular format, with each of the six main sections focusing on a different phase of training. The main sections are further divided into short video lessons ranging from one to 30 minutes. Most lessons have an associated review quiz that can be retaken as desired. Students can click on the "Explanation" link in the quizzes to jump directly to the part of the video that addresses each question.

The course videos are professional, well-organized and come with a highly useful search function: Typing a word or phrase into the search bar will pull up a list of any course video in which that word or phrase appears. Students can then click on any of the videos that show up in the search results to jump directly to that lesson. A video training study guide and review notes document can also be downloaded. The guide is a companion to the video lessons and does a good job condensing the information into salient points. Videos do not need to be watched in order.

The course allows students to create study tests. Students can review all questions in a selected category or have the program pick a random selection of questions from the desired categories. The course analytics software tracks answers and provides a display of the percentage of questions answered correctly in each of six categories (Aircraft Performance, Airplane Systems, Aviation Weather, FAA Regulations, Flight Operations and Flight Planning) over all sessions, the past three sessions and the most recent session. Study tests can be saved in progress and previous tests can be reviewed. A "smart" study session option will generate questions from a student's weakest performance areas.

Simulated FAA practice tests are available with similar analytics. Practice tests can also be saved and resumed later. Once a student passes two practice tests with a score of 80% or higher and completes all of the video lessons, Sporty's will provide an endorsement for the FAA written exam or FAA WINGS credit. Other features include an illustrated maneuvers guide with step-by-step videos, the option to share course progress and test scores via special-use email link, access to an online library of FAA books and materials, and an "Ask a CFI" email address for student questions.

Sporty's has integrated CloudAhoy's flight data recording app into the Learn to Fly course. Once a CloudAhoy account is connected, flights logged with CloudAhoy will sync with the Sporty's course. Each maneuver from the flight will be listed and connected to a corresponding maneuver guide. Sporty's also has partnerships with Redbird, integrating its Guided Independent Flight Training (GIFT) simulator program, and with ForeFlight to log the written test endorsement on ForeFlight logbooks.

Overall, it's nearly impossible to find fault with this course. It

Sporty's latest Learn To Fly Course shown here is accessible on a wide variety of devices and has free lifetime updates.

puts worthy focus on aeronautical decision-making and real-world flying scenarios. Some time is spent on cockpit variations—including glass versus round gauges—and other aircraft differences students might encounter during flight training. The video search feature and test/study analytics make it easy to find information, track progress and highlight areas for further study.

The Sporty's course is $199.99 and includes free lifetime course updates. It is accessible via computer, Android and iOS apps and Roku. Videos can be downloaded for offline viewing and progress syncs between platforms. For students who complete the course, Sporty's guarantees passage of written, oral and flight tests. Contact www.sportys.com.

MZEROA PRIVATE PILOT ONLINE GROUND SCHOOL

MzeroA.com's Private Pilot Online Ground School is organized into 15 lessons. Each lesson starts with an overview followed by a series of short videos covering lesson subtopics. Videos vary in length from roughly two to 20 minutes. Most are short and provide a good mix of animation and real-world demonstrations. After watching, the student can mark each subtopic as complete.

Quizzes are available at the end of each lesson and can be retaken, but the questions remain the same—only the answer order differs. Explanations for wrong answers are given after quiz completion. The quizzes are timed but not time limited. Sixty-question practice tests can be generated whenever desired. The website also offers a 12-module Private Pilot Bootcamp. The bootcamp includes longer video lessons and more quizzes, along with a 60-question Bootcamp final exam. MzeroA provides endorsements for the FAA written test after the final exam is passed with a score of 90% or better.

The pricing structure at MzeroA can get a bit complicated. Membership is purchased via monthly subscription with subscription tiers providing access to different features. Members get access to all of the site's 500-plus training videos—not just those for any one certificate or license. The Bronze membership runs $97/month and provides access to the videos; Private, Instrument, Commercial and Fundamentals of Instruction ground schools; written test prep; and a members-only forum. The Silver tier costs $127/month and adds access to both live and archived webinars and workshops. In addition, Gold members ($147/month) get access to live question-and-answer sessions, live mock checkrides, additional flight technique videos and a "pass your checkride or they pay for it" guarantee.

John King at King Schools, top, and Jason Schappert at MzeroA, bottom, put a dynamic human element into their online courses.

Where MzeroA truly excels is in community building and communication. The live mock checkrides, weekly webinar workshops (including an extensive archive of past webinars) and question-and-answer sessions provide excellent information and great opportunities to explore specific topics in detail—all while being able to ask questions pretty much immediately. Students are highly encouraged to reach out with questions throughout the course and the company's Facebook page and YouTube channel are regularly updated, active and well-followed. The biggest drawback of the program is the potential cost. Since it works on monthly subscriptions and some of the highest-value learning opportunities only come with the most expensive membership option, it's possible that a student could end up paying a lot if they don't make progress quickly. FAA WINGS credit can be earned via the webinars. Contact www.mzeroa.com.

GOLD SEAL ONLINE GROUND SCHOOL

The Gold Seal Online Ground School Private Pilot course is divided into six topic sections, each containing between two and 14 lesson modules. The 50-plus modules are aimed at teaching both FAA written exam and checkride knowledge. As part of the course, Gold Seal offers webinars and livestreamed flight lessons.

Each video lesson has a clickable outline and is divided into short segments which makes it easy to stop and restart study. The videos are interactive, with opportunities to click for additional videos and images and drag-and-drop activities. The lesson dashboard allows students to take and save notes, access relevant study resources such as e-books, videos and forms via direct links and tag their progress on the topic as "complete, needs some review or needs lots of review." Lessons do not have

We like that the King Schools course has selectable video lessons—15 in all to choose from.

to be completed in order.

Each lesson also has an associated quiz. Quizzes can be reviewed and retaken, and missed questions can be printed for later study. Students can also select the number of questions in the quiz. Other features include an option for CFIs to sign up for free to monitor student progress, a "Find a CFI" resource, flash cards with answers and answer explanations, and a library of downloadable resources.

Some—not all—lessons can be accessed on an iPad. After a student passes the course final exam with a score of 80% or better, Gold Seal provides certificate of completion and an FAA knowledge test endorsement. The final exam can only be retaken once every 24 hours, while practice exams can be taken as often as desired.

Overall, the Gold Seal course is well organized, easy to use and provides a good variety of study materials. While it could be improved by better access via mobile devices, the focus on interactive learning makes it a strong program. It also provides great value for its $169/year price tag. Gold Seal offers a money back guarantee that students who successfully complete the course will pass their FAA exams. Contact www.goldmethod.com.

KING SCHOOLS

No private pilot course review would be complete without King Schools. The King Schools Private Pilot Ground School and Test Prep Course is organized into 15 topic sections. Each section is divided into subsections containing a series of video lessons. While presented in a logical progression, lessons can be viewed in any order the student wants. After each video, a short review quiz appears. Once the questions have all been answered correctly, the subsection is marked as complete. Video length is typically between one and 10 minutes.

All video lessons and quizzes can be reviewed and retaken. A "Report Card" shows course progress and percentage of correctly answered review questions by topic. Answer explanations are available. The iOS King Schools Companion App allows students to download lessons for offline use. Progress syncs when the device is reconnected to the internet. Other features include unlimited randomly generated private pilot practice tests, phone and email access to pilot and CFI staff for questions, and a graduation certificate.

The course offers an endorsement for the FAA written exam after completion of three practice exams with a score of 70% or higher.

The price is $279 and it comes with a 100% money back guarantee if the student does not pass the FAA written exam. The course can also be bundled with the Private Pilot Practical Test Course (currently available for $398) or in a set with the practical test course and the King Schools Online Library (currently $599). The package deals also include additional pilot skills courses. All courses are lifetime-access with all future updates made available at no additional cost. A notification will appear if the course has been updated since the previous login along with the option to view the changes.

The course makes it easy for the student to pick up where they left off. Progress indicators are clear and the information is presented in an engaging and accessible way. The biggest drawback is cost: It's significantly more expensive than other courses offering similar features. Also, the app is not available for Android users. The Private Pilot Ground School and Test Prep Course includes approximately 15 hours of video material. Contact www.kingschools.com.

ROD MACHADO

Rod Machado's 40-hour Private Pilot eLearning Ground School is divided into 26 interactive video modules. An outline along the side of the video window allows students to navigate easily between topics in a lesson. Each video lesson also has tabs that show relevant notes, a glossary and additional resources related to the topics being covered. Modules can be completed in any order.

Short interactive review quizzes are given after each topic section in a module followed by a 100-question review quiz at the end of the module. Minimum passing grade on the quizzes is 80%. Quizzes can be reviewed and retaken after completion. If the student exits in the middle of a lesson, they will be asked if they want to pick up where they left off when they next open the module. The course can also be accessed on iPads and Android tablets. Course materials can be downloaded to tablets only for offline use. For computer use, an internet connection is required.

With roughly 1800 review questions and about 40 hours of video, this aptly named course provides one of the most detailed private pilot online ground school experiences we reviewed. Machado's quirky humor keeps otherwise dry material fun and memorable. We would like to see

courses available for download for computer-only users as well.

The price for Rod Machado's 40-hour Private Pilot eLearning Ground School is $279. The course is currently being offered with free copies of Rod Machado's Private Pilot eHandbook and Rod Machado's Private Pilot eWorkbook eBooks, which are great additional resources. Contact www.rodmachado.com.

ASA ONLINE GROUND

The ASA Private Pilot Online Ground School is organized into three stages subdivided into topics. Each of the eleven topics includes a learning objective, written material, a video and a test prep overview. Video length varies between approximately 30 minutes and 1 hour 40 minutes and takes a more traditional lecture format with illustrations, discussion and demonstrations. The test prep overview outlines important information from the lesson. Students can mark each component complete once they have reviewed it. Stages do not need to be completed in order.

Each topic also has an associated study session and quiz. Both are made up of 25 multiple choice questions—quizzes are timed while study sessions are not. Answer explanations are available. Study sessions and quizzes can be retaken and questions vary each time. Scores are recorded and previous results can be viewed. There are also options to chart all recorded scores for comparison and email scores to selected recipients. Students can also make their own custom quizzes from an extensive question bank.

Although ASA says an internet connection is required to access course materials, we were able to download videos for offline viewing. The course is compatible with Android and iOS operating systems and progress will sync between devices. Other features include a great virtual CX-3 flight computer, searchable online FAR/AIM, the ability to follow a specific instructor to access quizzes they have put together and a clickable study guide.

ASA's Private Pilot Online Ground School is a solid, well-organized course with some nice options. It's easy to use, but the video content feels a bit dated. The course costs $179.95 for 24-month access and offers approximately 11 hours of video content. Students are eligible for FAA WINGS credit and an endorsement for the FAA written exam after successful course completion. The written endorsement can be requested after passing two tests with a score of 80% or better. Contact www.asa2fly.com.

GLEIM GROUND SCHOOL

The Gleim Online Ground School: Private Pilot course is broken down into two stages containing 11 units. All units in a stage must be completed—in any order—and an end-of-stage test passed with a score of 70% or higher before the student can move on to the next stage. Units start with a five- to nine-minute audiovisual presentation followed by a written outline reviewing the subjects covered in the presentation. The outlines also include links to more detailed information on individual topics. All units have accompanying quizzes in which wrong answers are noted and automatically marked for review. The same questions are then given again—in a different order—in a study unit test, which must be passed to complete the unit.

Once all of the units in both stages have been completed, an End-Of-Course test becomes available. After passing the test with a with a score of 70% or higher, five additional practice tests are unlocked for further practice.

Other features include a downloadable aviation acronyms sheet and a testing supplement that includes links to relevant FAA publications. Gleim says average course completion time is 35 hours.

The course overall is well-organized and clear, but the design lacks features that might make it more engaging. The biggest issue that we see is that quizzes and tests cannot be retaken or viewed after completion. According to Gleim, the company is working on a significant update to the course, which is expected to be available by the end of the year.

The Gleim Online Ground School: Private Pilot course costs $109.95 for twelve-month access. An additional 12-month course extension can be purchased for half price and course updates are automatically incorporated. There is also a Part 141 version available ($129.95/12 months). Students are eligible for FAA WINGS credit and an endorsement for the FAA written exam after course completion. Gleim offers purchase price refunds for students who successfully complete the course but fail to pass the FAA knowledge test. Contact www.gleimaviation.com.

JEPPESEN

The Jeppesen Private Pilot Online course is composed of three stages subdivided into twelve lessons. Lessons are further ordered into topic sections. Each section includes several short video presentations with follow-up questions. Besides the two end-of-course exams, which can only be taken once the course has been completed, lessons can be viewed in any order.

Each topic section has an associated evaluation test. Once passed, the tests can be reviewed, but not retaken. All lesson evaluations and exams must be passed with scores of 80% or better. The course offers an endorsement certificate upon successful completion. The program tracks and displays both overall curriculum progress and individual lesson progress by percentage. In addition to the end-of-course certificate, course transcripts can be printed at any time.

The course is conducted as a series of lectures with simple videos to illustrate. The in-lesson review questions have a good real-world focus, including things like identifying the correct parts of the airplane in a photo. While the course information is current and well-presented, the format feels dated.

We would also like to see study quizzes that could be retaken. According to Jeppesen, a course redesign is in the works. The release date for that project has not yet been announced. Cost for the course is $239. Contact www.jeppesen.com.

AN EASY WIN

Of the courses we reviewed, our top pick is the $199 Sporty's Learn to Fly Course. Its content is engaging, intuitive, highly portable and provides the greatest number of study options for all aspects of initial training.

MzeroA gets an honorable mention for its unique approach to learning, its robust content and its interactive style.

AeroVonics Gyros: Capable, Inexpensive

With creative, flexible design, these combined displays offer impressive features at low prices. The smaller of the two fits into a standard clock hole.

by Paul Bertorelli

Against an onslaught of inexpensive if not cheap electronic displays, how much longer can conventional iron gyros persist? The latest nail in the coffin comes from a startup called AeroVonics, which unveiled a pair of new instruments at AirVenture last year aimed center-lane at legacy panels.

The company has two models: The diminutive AV-20 that's best thought of as a clock with high-level features and the more sophisticated and flexible AV-30 that mimics the look of a traditional spinning gyro, but overlays a ton of additional flight data. Both are priced as bargain entries.

AV-20

The AV-20 fits into a standard 2.25-inch clock hole. This instrument is available in two versions, the AV-20 at $499 and the AV-20-S at $895. The difference? The AV-20-S has pitot/static input so it can display real airspeed, not GPS-derived groundspeed and it also functions as a capable attitude gyro. The entry-level AV-20 lacks the plumbing input and has no gyro, but it has multilevel clock and timer functions. Both are approved for installation under the FAA's NORSEE rule—non-required safety enhancing equipment. Technically, that means it can't replace a panel clock if the airplane requires one, nor can it provide a legal attitude source backup if one of those is needed.

Not that it couldn't do the job. The AV-20-S's gyro function is one of many features in the instrument, including multiple pages for angle-of-attack indication, G-meter, OAT, true airspeed, bus voltage, density altitude and clock and timer functions. Some of these are paired with audio alerts via tone or chime.

The instrument has a backup battery that will run it for 30 minutes if the ship's voltage fails. That's obviously a pile of functionality in a tiny instrument and as is the way of these things, you can't look at them all at the same time. The AV-20-S has a view toggle to cycle through the AI display, the timers, the AoA and G-meter and so forth. But there's some smarts built into the instrument in the form of customizable alerts that will pop up the AI, the G-meter and the AoA if certain limits are exceeded. The AI pops if the instrument loses bus power, the reasoning being that the primary displays may be dark and you'd need a backup sooner rather than later.

The AV-20-S is big on AoA display and as does Aspen, it derives this data not with a dedicated probe, but in the software by comparing airspeed with accelerometer-derived flight path. As shown in the graphic at right, AoA can be displayed as a hard angle in conjunction with load factor or graphically with a color-coded rising scale. It also lives on the right side of the AI as a tape-type display. If you're a big believer in AoA as a safety factor, the AV-20-S may fill the need.

Given its size, installation is minimally invasive, but there's some wiring and plumbing to do. The rear of the instrument has a pair of standard ¼-inch quick connecting fittings and these will have to be tee'd into the aircraft's system. There's also a DB9 jack for power and ground, the audio alerting and an OAT probe. AeroVonics says it will require about two hours for installation.

AV-30

The more capable AV-30 retails for $1595 and for the higher price, you get a full-featured primary flight display with some planned autopilot functionality. For the time being, AeroVonics is selling only the AV-30-E for experimental aircraft. A certified version with full autopilot integration is planned for early to mid-2020.

In the current version, the AV-30 has a highly customizable attitude indicator display that faithfully mimics a traditional spinning gyro,

Intended as affordable solutions for legacy panels, the AeroVonics AV-30, left in center of panel, can be configured as both a conventional AI (top) and an HSI when connected to a GPS navigator.

2.375 IN. 1.875 IN.

Graphic AoA

Count Up/Down Timer

Combined Load/AoA

Clock/AoA/Voltage

3.375 IN.

The AeroVonics products are nothing if not flexible. The AV-20, upper left, fits into a standard clock hole and can toggle through the displays shown at left. Two versions are available, one with pitot/static input and a less expensive version without. The AV-30, above, mimics an old-school iron gyro look, but with customizable fields to include airspeed, altitude, baro, OAT, nav track and bus voltage. As shown in the photo on the opposite page, the AV-30 can also be configured as a digital DG/HSI when connected to a GPS navigation source.

but overlaid with data such as indicated airspeed, altitude, baro, AoA, OAT and GPS track data. That's a lot of stuff on a single instrument but AeroVonics pulls it off with clean typography. If any of it proves too much for the data-saturated pilot, it can be entirely decluttered.

A word here about the display design. In our view, it's superb. AeroVonics took the trouble to add shading to the pitch ball to give it depth and readability and, frankly, it's a welcome departure from the boring modern EFIS standard. But if you want that, the AV-30 can be set to display it, along with a vintage look that suggests a post-war gyro. AeroVonics reasons that this matches the look of legacy panels where an EFIS might jar. Maybe, but the old airplane will still have an iPad, so the effect may be lost.

The AV-30 incorporates some of the same features found in the AV-20 including probeless AoA, OAT, TAS, Denalt and bus voltage. There are audio alerts for AoA, G and roll limits. The AV-30's backup battery has a claimed two-hour endurance.

Autopilot interface remains a work in progress, according to AeroVonics. An AML-STC certified version *without* autopilot capability will be ready by the end of 2019, with full autopilot and HSI-display integration available sometime in 2020. Autopilot integration will require an AeroVonics-provided adapter box. The company's Bill Shuert told us that it plans to accommodate most popular autopilots.

CONCLUSION

In our view, the Albuquerque-based AeroVonics is a company whose products are worth watching. We didn't have time to try these instruments in an airplane, but have that on the calendar for a future report.

What's most impressive is AeroVonics' integration of safety-related flight data—AoA, G and roll limits—into an instrument that can also nudge the pilot with aural warnings. The artful graphics are a plus.

For more, see www.aerovonics.com.

Got a nice 55 Bonanza? The AV-30 can be configured in vintage mode to suit an older look, right.

Piper J-3 Cub:

You'll pay top dollar for pristine refurbs. Consider an engine upgrade for better performance.

To understand the significance of the J-3 Cub look all the way back to Piper's Lock Haven, Pennsylvania, heyday, where William T. Piper was rightly seen as a visionary. But no one could have imagined how enduring that vision would be, to the extent that over 80 years later, several companies are building brand-new Cub clones that clearly trade on the mystique of the old yellow classic. Two that are front and center in the market are Legend Aircraft and CubCrafters. We think both companies nail the quality and support.

Sad to say, but perhaps the only reason that "Piper Cub" is no longer the standard generic name for every little airplane flying is that the generation that made it so has been displaced by younger folks who simply don't understand the Cub romance and nostalgia.

The reality is that Cubs are becoming a rarity at most airports. And if they are there, they're likely hangared and kept pristine by owners who consider their J-3 a flying pride and joy.

While the 1931 Aeronca C-3 was the first of the relatively inexpensive general aviation airplanes to be a big seller, by taking early advantage of the creation of the small horizontally opposed engine, Aeronca failed to make improvements to it.

For such a small airplane, a Cub has the tendancy to eat up a lot of cash.

So, in the late 1930s, when FDR's Civilian Pilot Training program created a big demand for inexpensive trainers, it was the more advanced Piper Cub that became a mega-seller and brought general aviation to the masses, even if Piper did copy the C-3's paint scheme. Cubs have an almost cult-like following as each year new pilots brought up on the mundane handling of nosewheel trainers discover the pure fun of stick-and-rudder flying in a ragwing airplane.

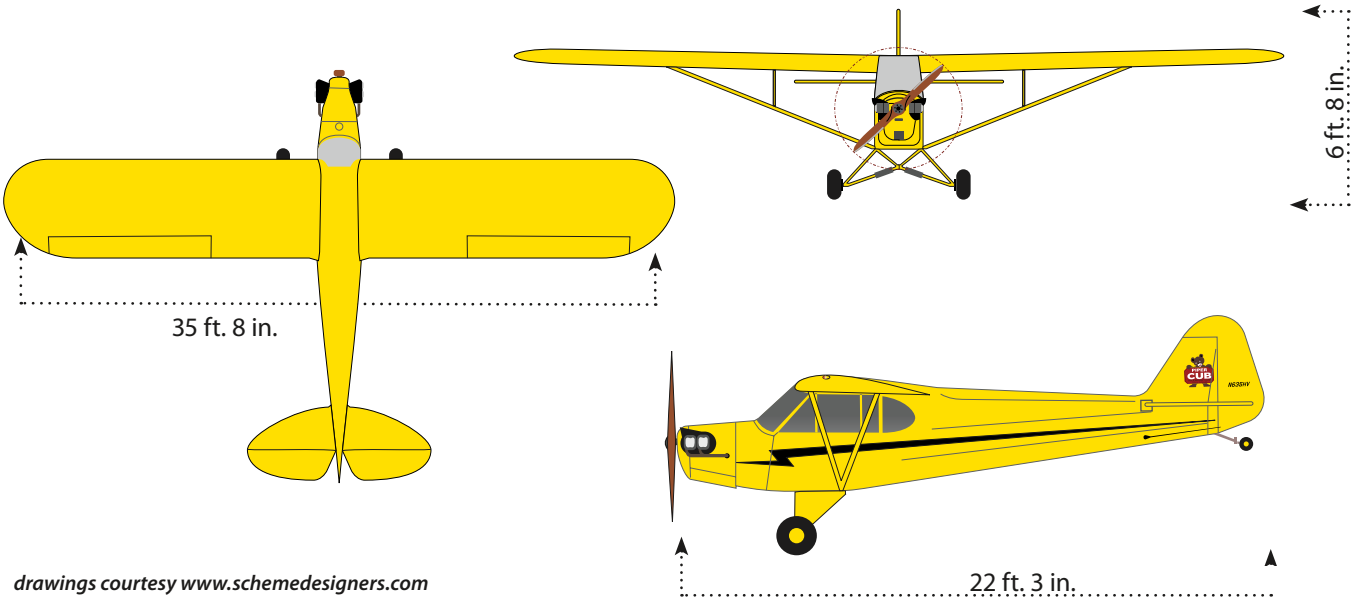
HISTORY LESSON

The first airplane to carry the Cub name wasn't a Piper at all but a Taylor E-2 model, powered by a Salmson radial engine. It first flew in the early 1930s with moderate success in the market.

The J-3 didn't appear until 1937,

It's pretty easy to have lots of fun in a vintage J-3 Cub, the main photo as proof. But as the accident scan suggests, maybe that classic Cub Flying Farmer routine wasn't too far off the mark.

PIPER J-3 CUB

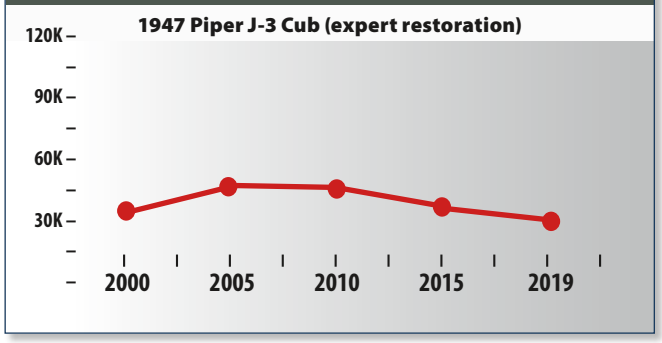


drawings courtesy www.schemedesigners.com

PIPER J-3 MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL	CRUISE	TYPICAL RETAIL
1945 & 1947 PIPER J-3 CUB	65-HP CONT. A-65-8	1800	$13,000	9	540 LBS	76 KTS	±$28,000 (restored)

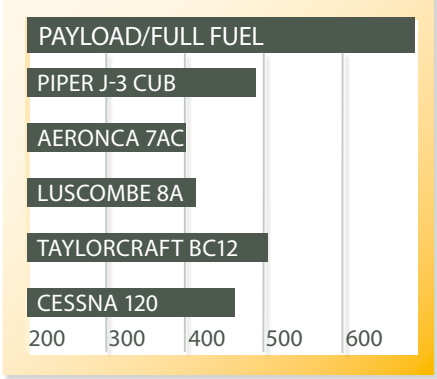
TYPICAL RESALE VALUE

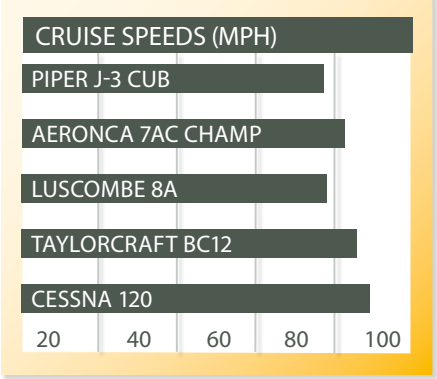


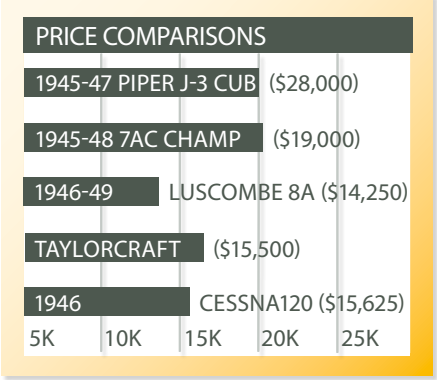
SELECT RECENT ADs

AD 1999-01-05	WING STRUT INSPECTION/ REPLACEMENT
AD 1985-06-04	FUEL TANK MODIFICATION
AD 1978-10-03	FUEL VENT MODIFICATION
AD 1968-05-01	MUFFLER INSPECTION
AD 1958-12-02	AILERON HINGE INSPECTION

SELECT MODEL COMPARISONS







If you've had enough of gee-whiz integrated glass cockpits then flying behind the panel of a vintage J-3 will be refreshingly simple. Think old-fashioned stick-and-rudder flying, top. With doors open and eyes outside, hanging outside at low altitude is a rush. That's a Cubby on floats skimming a lake in the bottom photo.

after William Piper had bought out Taylor, and it was an offshoot of the Taylor design. By modern standards, the first J-3 would have been classified as a sport aircraft, which it in fact is today.

The 1937 J-3 was powered by a 40-HP Continental A-40 and had a 9-gallon fuel capacity. The following year, Piper offered a 50-HP Continental as an option and a year later, in 1939, a steerable tailwheel and a 12-gallon fuel tank became standard.

At that point, the 50-HP Franklin engine appeared as an option, in addition to an engine of similar horsepower made by Lycoming, whose plant was eventually just down the road in Williamsport, Pennsylvania. More than 1300 J-3s were sold in 1939, as the CPT spurred demand and the Depression eased.

1940 saw the evolution of the J-3 into the classic form in which most models survive today, with a 65-Continental up front or, in fewer cases, the Lycoming or Franklin variants. Most had wood props, although over time, most of those have been converted to metal props.

Piper continued to pour Cubs out of its factory until the December 7, 1941, Pearl Harbor attack sent the J-3 into uniform. During the war, Piper built some 5000 L-4 versions of the J-3, slightly modified with olive drab paint jobs, electrical systems and heaters, providing the barest of creature comforts for an airplane known for its spartan appointments.

A Piper publication from the early days of World War II trumpeted the L-4's patriotic versatility: "There is no reason why Piper L-4s couldn't set down American Commandos behind enemy lines. And, when the boys completed their missions of destruction, these planes could get them back with speed and comparative safety."

Piper was ready when the war ended in 1945 and transitioned quickly into building airplanes for thousands of returning vets. The following year, an astounding 6320 Cubs were built, with production reaching 50 a day at one point, or one every 10 minutes.

The market collapsed in 1947 and production plummeted to 720 Cubs—respectable by modern standards but a shock after the previous year. By the end of its production run, 14,125 J-3s had been built. Less than half that many remain flying in the U.S.

MARKET PRICES

Looking at what J-3s sold for when new, some of those old military jocks probably slap their foreheads in regret for not picking up a couple of dozen. In its heyday, the Cub sold new for $1595, or

A typical engine overhaul for a J-3 could run every bit of $16,000, not counting removal and reinstallation and any other work you do when it's down. You check the fuel in a Cub, bottom, the old-fashioned way.

$20,902 in early 2019 dollars. It cost about what the typical car did.

By the 1970s, Cubs were quite a bargain, averaging about $2500 or so. Prices shot up through the 1980s and 1990s, until they began to settle down in the mid-2000s as the prices of other general aviation airplanes stagnated or began to slip. Incidentally, that's about when kit-built Cubs began to appear.

In 2019, a newly restored (a high-quality restoration, that is) showpiece with a zero-time engine and original equipment and instruments can bring $40,000 or more. Even a barely flyable hangar queen will bring a nice piece of change as Cubs have a certain cachet not shared by most of its contemporaries, probably due to the ability to fly with its clamshell doors open—for many, an ideal compromise between open cockpit and closed cabin. It's tough to find anyone who doesn't see the appeal.

A cold-eyed examination of the value of a Cub, based on comparative performance, indicates it's not an especially good deal. Consider that a Taylorcraft of a much newer vintage—say mid-1970s—sells for $10,000 less and an Aeronca Champion (circa late 1940s), which has slightly better performance, for every bit of $4000 to $5000 less. The reality is that no one buys a Cub for what it can do but what it is: a classic with an appeal the others lack.

"Only the Cub can attract the really top dollar," one rebuilder once told us. Simply put, the Cub aura transcends its objective characteristics. Does that mean that it's a good investment airplane? In terms of appreciation in real dollars, no.

However, historically it has held its value much better than its contemporaries and, so long as the buyer doesn't have to undertake a restoration, a Cub should be the best of the 1940s tube and fabric airplanes in terms of bringing the most when it's time to sell.

ENGINES AND PERFORMANCE

Although the 65-HP Continental was the standard Cub engine, many have been refurbished with progressively more powerful engines. There's little difference between the 65- and 75-HP models, but the progressively bigger engines provide extra climb rate, especially for high-attitude or float operations, where the Cub is a marginal performer.

The larger engines may raise a Cub's value by $500 to $1000. But the 65-HP engine is perfectly adequate for most Cub flying and is preferred for ultra-original restorations in which any variation from original configuration is considered a drawback. The Lycoming and Franklin 65s are somewhat rare these days and carry a price penalty of a few thousand dollars. The Lycoming actually puts out something like 50 to 55 HP (with less fuel consumption), while the Franklin suffers from a parts scarcity, we're told.

In a Cub, speed is relative, of course, and a J3 isn't relatively

PIPER J-3 ACCIDENTS: STALLS, RLOC

Having flown J-3s for more years than we like to consider, we were interested to note that only 16 of the 100 most recent prangs involved runway loss of control (RLOC). Because most groundloop events usually involve minor or no damage, they are not required to be reported under the NTSB regs. With heel brakes of varying quality and challenging ground handling, we think the real rate of RLOC events in the J-3 is significantly higher than 16%—and we strongly recommend a careful checkout if you decide to buy what we consider one of the most fun to fly airplanes ever built.

Being able to fly a J-3 with the fold-down door and fold-up window open has been a huge factor in the aircraft's success. It's also, we think, a huge factor in the high percentage of stupid pilot trick accidents—mostly hitting stuff while flying low or pulling up into a stall after a low pass—we observed with Cubs.

There were 20 stall accidents, split about half and half between losing it shortly after takeoff—often over gross and/or in high density altitude ops—and while maneuvering in the weeds.

Normal cruise in a Cub is just about slow flight in anything else, and wrapping the high-drag airframe into a steep turn scrubs speed in a hurry, taking the airplane near stalling angle of attack. While a Cub has a docile stall, doing so when the ball isn't centered is an invitation to a rapid roll-off and steep pitch down that may take more altitude than is available for even the best pilot to recover.

With its low wing loading a J-3 is big-time susceptible to wind gusts and shear. A number of the inflight loss of control accidents as well as hitting obstructions on takeoff or landing and blown go-arounds involved high winds and turbulence. A Cub has a slow roll rate, requiring putting the ailerons and rudder to the stops to keep the airplane pointed where the pilot desires in serious turbulence. Turbulence can also cancel out what little rate of climb the airplane has in high and hot conditions.

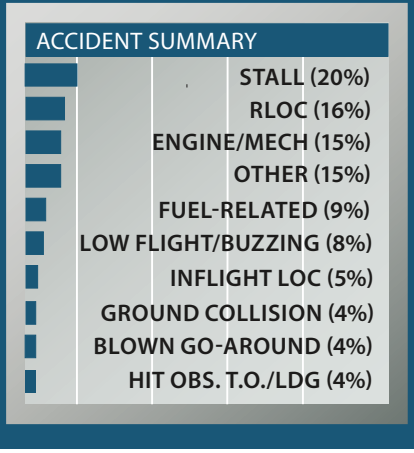
We were, nevertheless, impressed by the pilot who got sideways on landing in gusty winds, went around and flew the airplane into an open hangar, suspending it on a wall, five feet above the floor.

When we do accident sweeps for the Used Aircraft Guide we expect to see, at most, one ground collision. There were four involving J-3s, a very high rate, even for tailwheel birds. Ground visibility is lousy and a pilot has to aggressively look out for other airplanes during ground ops.

Two Cubs were simply blown over when taxiing. Correctly positioning the ailerons and elevator during taxi is not just an academic exercise in a J-3.

The rate of engine stoppages was below what we expect to see—the little Continentals seem to be holding up well over time.

We're used to seeing ground impact accidents involving folks shooting coyotes from a Cub—losing control while chasing critters just seems to be a thing to do. However, one pilot/marksman team flew into the ground because the shooter dropped a shotgun shell and jammed his control stick. The pilot couldn't get enough aft deflection to avoid terra firma.



slow. It's very slow. Typical cruise speed is about 70 MPH with the 65-HP and 75-HP engines, while those sporting the 85-horse mills can streak along at 80 MPH. Then again, Cubs aren't cross-country airplanes. With only 12 gallons aboard, practical unrefueled range is about 150 miles, after which you'll want to get out for a stretch anyway. An *Aviation Consumer* editor once flew a Cub coast-to-coast in nine days, with 42 stops for gas.

The Cub comes into its own not in long-distance cruising but in operations off airports with grass runways. At light weights, on cool days, the Cub is an excellent short-field ship, particularly with the 85- and 90-HP engines. The fat wing delivers stall speeds somewhere around 40 MPH. Heavy or hot, it will still lift off in a short distance, but climbs over nearby obstacles can be unpleasantly sporty, given the airplane's high drag and lack of surplus thrust.

The Cub has a reputation as a docile, easy-to-handle airplane that just about anyone can fly. It's considered a big teddy bear, ever forgiving of ham-fisted pilots. It isn't.

On the runway, the Cub can be a ditch lover and like any other taildragger, it will groundloop if given the chance, although it's considered one of the better-handling taildraggers. For pilots used to toe brakes, the Cub's heel brakes are weak and awkward.

The wing has no dihedral, meaning little roll stability. It has very sluggish ailerons that generate a lot of adverse yaw, thus requiring a good deal of rudder. Even a mild turn will require a healthy stab at the rudder, something most pilots trained on nosegear airplanes have to learn. The stall, if the controls are coordinated, is relatively docile; however, the horizontal stabilizer has no camber, which helps generate a very rapid roll-off and pitch down into an incipient spin at the stall if the ball is not absolutely centered.

That will eat up 300 or 400 feet in a hurry. This characteristic has killed a lot of Cub pilots and passengers who were maneuvering down low. So much so that it is called the "Moose Stall" in Alaska from the number of moose spot-

Going someplace in a Cub? Pack small and light. There's limited storage space behind the aft seat.

ters who have gone to their reward after an uncoordinated stall in a turn a few hundred feet above the trees. Our review of fatal accidents over the last 10 years showed that about half involved low-altitude maneuvering into either a stall or impact with terrain.

With adequate altitude, the Cub is a first-rate spin trainer; it will stall and spin easily compared to later training aircraft such as the Cherokee 140. Conventional anti-spin control inputs will recover it easily.

The soft bungee cord suspension absorbs bounces well and the big rudder gives excellent directional control. However, the Cub can be humbling to land, requiring deft footwork to maintain directional control, especially in all but the lightest crosswinds. The Cub's light wing loading makes it a kite in gusty conditions. With the low landing speed, a 15-knot crosswind can present a major challenge. New Cub owners are well advised to seek competent instruction before soloing.

NO-FRILLS DWELLING

In these used airplane reports we often pay close attention to cabin comfort. For this report on the Cub it's easy: You won't be overly comfy in one. It's loud, the seats are utilitarian at best and getting in and out is, well, an exercise. And yes, you wear the airplane more than you sit in it. But that's part of the Cub experience, we suppose.

Getting into the back seat—from whence you solo—is not so bad but ingressing the front requires some contortions. Once in the back, legroom is acceptable, with the legs extended forward to the rudder pedals and brakes. The front seater is balled up in a painfully cramped seating position that's not comfortable for any length of time.

Baggage room is essentially zip; there's room for perhaps a loaf of bread in the canvas "luggage compartment" behind the rear seat. These days, most J-3 pilots mount a portable GPS somewhere in the cockpit, along with a handheld VHF radio for self-announcing on CTAFs. Beyond that, the instrument panel has the bare necessities. There's a tach, an airspeed indicator, oil pressure gauge and altimeter. The fuel gauge consists of a cork float supporting a vertical a wire that is visible through the windshield.

For such a small, simple airplane, a Cub has the potential to eat up lots of cash. Derek DeRuiter of Northwood's Aviation in Cadillac, Michigan, has, with his father, rebuilt scores of Cubs over the years and offered some comments regarding things to check carefully on any airplane considered for

When converted with a 90-HP engine, a J-3 can make a reasonably good floatplane, but you'll still have to accept some limitations. When searching the market, save some bucks and consider a Champ, bottom, if you can live without the J-3's romantic history.

purchase as an unintended restoration can eat your checkbook.

Fabric condition: Cubs were originally covered with Grade A cotton; it should be avoided unless you are a fanatic for authenticity and willing to pay the price of regular recovering. It lasts maybe eight years if the airplane is hangared. Most Cubs are now covered with Dacron fabrics such as Ceconite. Properly applied and protected from ultraviolet radiation, these fabrics will last as long as you're likely to own the airplane.

Engine condition: TBO of the little Continentals is listed as 1800 hours, but the number is almost irrelevant, since most J-3s aren't flown much and succumb to time and lack of use rather than hours. An engine may have only 600 hours since overhaul, but if the overhaul was in 1979, the engine may or may not be long for this world. Check compression and oil pressure.

Rust: Check the lower rear longerons and the tail post. They do rust; don't buy an airplane without carefully checking this area.

Wing struts and strut forks: Made of the same rust-prone steel as the fuselage tubes, these critical parts have a long history of corrosion problems. A series of ADs applies to this critical area requiring inspection every 100 hours until replacement; make sure that all have been complied with.

Fuel tank and drain: Original Cub fuel tanks were made of lead-coated steel, and they rust out regularly where water collects in the bottom. (Be especially wary of the 1940-45 J-3 and L-4 models, when the factory was skimping on the lead coating.) An AD also requires a new fuel drain. Many, if not most, of these tanks have been replaced by aluminum tanks but check the logs and inspect to be sure.

Wooden wing spars in pre-1946 airplanes: Check for dry rot and cracks.

Landing gear attach fittings: A weak point; check between them for condition, especially if the airplane has been on floats. The landing gear bungees are good for about three years.

Misc: The elevator trim system components wear out; inspect carefully. The rudder and elevator hinges wear out; also check carefully and look closely for corrosion.

Accident Damage: Cubs are subject to all sorts of minor landing and takeoff accidents and their huge wings and light weight make them very prone to wind damage while tied down.

We would suspect that the vast majority of Cubs have been damaged at some time or another and a fair number of those now flying were built from the wreckage of two or three or more and one data plate. Or from a data plate and parts from Univair. That's OK, if the work was done correctly. Only a Cub expert will know, however, so we recommend contacting one of the Cub groups for a list of shops that know the airplane.

We wouldn't be put off by an airplane that has been ground-looped—most have—but make sure damage has been repaired correctly. Again, retain a Cub expert to have a look. It doesn't take long to do a thorough, professional prebuy on a Cub.

SUPPORT

Although Piper has long since stopped making the Cub, finding parts and support to keep one flying is a snap, thanks to a couple of sport aircraft parts houses. In many cases, the replacement parts are vastly superior to the originals; aluminum fuel tanks, for example,

If a Cub clone strikes your interest, Aircraft Bluebook says the average retail price of a 2005 AL11C-100 Legend Cub is $63,000. A 2017 model is $146,000. Both are slightly declining in value.

are lighter and far less prone to corrosion than the originals—not to mention cheaper.

The two big suppliers of Cub parts are Univair and Wag-Aero, both of which stock a complete selection of PMA'd Cub service parts. Wag-Aero Group is in Lyons, Wisconsin, at 800-558-6868 and at www.wagaero.com. Contact Univair Aircraft Corp. at 888-433-5433 and at www.univair.com.

An excellent owner group is the Piper Cub Club, in Hartford, Wisconsin. Its contact is 262-966-7627 and www.cub-club.com.

In addition, there are a couple of excellent websites devoted to the Cub. One is www.j3-cub.com, which features photos, memorabilia and a wealth of Cub knowledge that means a would-be owner is never more than a click away from having questions answered.

Although it's aimed more at Super Cubs, www.supercub.org also includes some information on J-3s. It's rich in photos and Cub lore.

OWNER FEEDBACK

I have owned the same Piper Cub since 1977. Mine is a 1942 L-4 (the military variant of the J-3), which has excellent visibility in turns with the big greenhouse windows across the top and along the sides. I bought it with my father for me to learn to fly some 42 years ago and I have flown it coast-to-coast five times and shipped it to Europe twice while I was stationed there with the Air Force (once to Germany and once to Belgium) because, I really love flying my Cub! I fly my Cub about 15 hours a month as part of my business.

The Cub is an absolute joy to fly. It is slow—really slow—and noisy, but nothing matches flying along in the back seat (you solo from the back) with the breeze blowing in through the door and drifting along like a stately pelican over the trees and countryside. Still, it is a bit too slow for many. Champs and Luscombes will certainly outrun it. But this is not a plane for speed. This is a plane for pure aviation enjoyment. I had a 65-HP engine in it for several years and switched to the Continental 90-HP engine back in 2004. The bigger engine has much better power to get in the air, especially if living out west with high density altitudes or high temperatures. Those aero equations for power versus speed are right and I found that most 65-HP Cubs cruise around 60 to 65 MPH and burn around 4.5 to 5 GPH. My 90-HP Cub cruises around 74 MPH (60 knots) and burns around 5.6 GPH.

Piper J-3 Cub

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Those numbers fit what the Continental engine manuals predict almost exactly. That gives you about two hours of flying (around 120 to 140 miles) with the 65-HP engine and around 1.8 hours in the 90-HP airplane (around the same distance). After that, you really are cutting into any 15-minute reserve fuel remaining.

I have heard guys claim that their Cubs cruise around 90 MPH and I just haven't ever seen one that really flies that fast except in a slight dive. Those big 8x4 tires and wing struts and bungee cords are a lot to drag through the air.

Insurance is about $600 to $800 per year if you have a good bit of tailwheel time. You need to count on hangaring one of these, or any very lightweight fabric plane for that matter.

Parts are plentiful between Univair, Wag-Aero and Aircraft Spruce, to name a few. You can find just about every part you will ever need. The biggest concern (and complaint) to watch when flying a Cub is weight. Most Cubs weigh around 780 to 820 pounds empty. Given that it is a 1220-pound max gross weight plane, that only leaves 440 pounds (or less) for fuel and pilots (forget about bringing stuff). Subtract 72 pounds for 12 gallons of gas and you have 368 pounds remaining. Now if you put an average 190-pound pilot in there, you only have 178 pounds for your passenger—and that is if your Cub weighs 780 pounds empty. Mine (and I expect most others) are really over 800 pounds empty, so with full fuel and me, any passenger I fly needs to be very light.

It's easy to smile when flying a Cub. Amelia is flying a J-3 fitted with snow skis, left.

I have a wind-driven generator between the landing gear legs to power a transceiver, a transponder, altitude encoder and ADS-B In and Out, so I can fly almost anywhere and enjoy experiencing aviation at a pelican's speed and altitude.

With over 6100 hours in everything from fighter jets to gliders, I can't think of an airplane that is as relaxing and enjoyable to fly as the J-3 Cub.

Jon Engle
Charleston, South Carolina

PIPER COMANCHE

It's time again to take a look at the used Piper Comanche market for the *Aviation Consumer* Used Aircraft Guide. We want to know what it's like to own these sturdy singles, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your Comanche to appear in the magazine, send us any photographs (full-size, **high-resolution**) you'd like to share to the email below. We welcome information on mods, support organizations or any other comments. Send correspondence on the Comanche by August 10, 2019, to:

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