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The Aviation Consumer

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AUTONOMY IS THE NEW PARACHUTE

If the FAA gives it the nod, autonomy could help sell some airplanes. More on that in a minute. As Cirrus and other manufacturers have proven, whole airplane parachutes are deal-closing accessories, especially for new pilots and skeptical passengers. This when-all-else-fails backstop has even trickled down to unsuspecting backwoods utility taildraggers, with Cubcrafters recently introducing a BRS (Ballistic Recovery System) option for its Carbon Cub and Sport Cub models. The BRS will add roughly 40 pounds to the airframe, while tacking on $14,000 to the price. It's also available for retrofit.

Cubcrafters' John Whitish told me old-school Cub pilots generally dismiss the idea of whole-airplane parachutes, but says there are plenty of potential buyers that walk away because it didn't have one.

It's easy to see why stick and rudder types shrug off whole-airplane parachutes, preferring to bravely ride the sucker to a smoking hole or hopefully, a successful landing. Deploy one and you'll likely trash the airframe, but for the believers, that's a reasonable compromise for the hope of walking away from the thing only rattled by the drama.

Now for the gentler and smarter electronic version, called eSafe. It's an independent fly-by-wire standby autonomous flight control and autoland system, which takes command of the aircraft should you become incapacitated or manually engage it because you've lost control. The computer calculates direct routing with an appropriate approach profile to the nearest suitable airfield or landing area, transmits an emergency squawk code from its own transponder and flies a stabilized approach and landing, even navigating around weather (based on ground radar and ADS-B) and lowering the flaps and landing gear.

It's not Cirrus, but Diamond Aircraft taking the lead and is flying the eSafe system in its DA42 Twin Star. Diamond CEO Christian Dries told me the system will come in several iterations, with the first version the most basic for the sake of easier regulatory approval. This means the pilot or passenger can activate and deactivate eSafe on their own. Dries mentioned the possibility of using smartwatch technology for inputting the pilot's biometric data.

He also made it clear that the system is almost totally independent from the existing avionics, sourcing Garmin's G1000 (standard on the DA42 and other Diamond models) only for airspeed and other basic flight data, including fuel quantity status. This could make eSafe easier to certify, while avoiding the hassles of a closed architecture. eSafe uses its own database provided by Jeppesen or equivalent provider, its own autopilot servos and weighs under 50 pounds.

The first version of eSafe will fly an appropriate approach to landing and chops the engine power on rollout to a stop. It doesn't require a published approach or forward visibility, but does require GPS position. Stable directional control on landing is possible because of the system's yaw damper computer, although future enhancements could include automatic braking and taxiing.

In the event of a single engine failure in the DA42, Dries said the eSafe system can, under normal circumstances, successfully maneuver the aircraft for a normal landing. In this situation, he concedes that the system is a good match for Diamond airframes because the yaw characteristics are relatively mild. "After an engine failure, Garmin's GFC700 yaw damper can keep the aircraft straight and level until eSafe takes over," he said.

Dries is perhaps too optimistic of earning across-the-board regulatory approval—including retrofits—within 24 months, while believing the market will tolerate a 10 percent price premium (above the cost of a new Diamond) for a first-gen eSafe option. How much extra might you pay to carry around this level of autonomous backup?—*Larry Anglisano*

SUN VISOR FEEDBACK

I read with a great deal of interest your article on aftermarket visors in the February 2016 issue of *Aviation Consumer.*

I've been a fan of Rosen visors, and for every aircraft I've purchased, I've changed out the factory visors for the Rosen products.

There's one anomaly for these visors and it may also be true for some of their competitors. The corner edges of the visors offer no protection against accidentally making contact with the inside of the windscreen while positioning the visor. One of my aircraft (in a flying club) had a nice symmetrical arc embedded into the windscreen from a careless moment by one of the pilots. I raised this issue with Rosen a few years back and my concern seemed to be dismissed.

Some type of corner protector on the visor would completely eliminate this risk of trashing a windscreen. Additionally, in another one of the clubs I belonged to, a pilot left the aircraft uncovered on a warm sunny day. The aircraft was completely locked and unventilated. The interior heat must have been fairly high as both Rosen visors sagged down from their stowed horizontal position. So precautions about high-heat environments should be stated to alert the aircraft owner of the issue.

Rosen wouldn't help support the replacement visor plastics and we had to do it at full cost.

Nevertheless, I'm generally happy with the products I've purchased from Rosen.

Tom Engleman
Nevada City, California

ELECTRONIC ATTITUDE GYROS FOR BACKUP

Larry Anglisano's commentary on the ridiculous regulatory snag that's unraveling with the idea of using electronic attitude gyros for backup (February 2016 issue of *Aviation Consumer*) is spot on. I am one of those buyers he mentioned who tried to have an L-3 unit installed to back up the OEM glass in our company's early-generation Cirrus, but after a month of dealing with its FSDO, my shop is ready to give up.

The problem it is running into relates to the way the original type certificate is written and specifically, the equipment list, which calls out for the three backup round-gauge instruments in the subpanel. The shop was told a field approval would likely have to be reviewed on a level higher than the FSDO, which could take forever.

We even considered the Sandia SAI-340 instrument, but there is also the concern about the single-point failure of the pitot source input. Any idea what's being done to make this technology available for backup?

Ernie Clark
via email

Sandia Aerospace's Barry LeBlanc offers the following update: Our largest customer base—owners of round-gauge instrument panels—can have the SAI-340 installed as a primary attitude instrument and signed off as a minor alteration with a logbook entry.

For field approvals in applications supplementing an Aspen EFD1000 primary flight display, shops have been questioned about the SAI-340's attitude aiding (via pitot input). The instrument utilizes air-data input to help refine the attitude solution during specific operational maneuvers. The SAI-340 is certified to support a degraded mode to address its operation where air-data aiding has been lost. If the external air-data source becomes unavailable (plugged pitot static port, or similar fault), the unit will enter the Degraded Mode automatically. Operation in this Degraded Mode does not imply that attitude availability from the SAI-340 has been lost. During this Degraded Mode, attitude information is always available to the pilot—it is never removed or made unavailable.

For interfaces that include the Garmin G500/600 PFD as primary, FAA field approval will also be required, perhaps until Garmin recognizes the SAI-340 in its STC. There are now a dozen or more signed field approvals from the Philadelphia, Pennsylvania, Minneapolis, Minnesota, Seattle, Washington and Juneau, Alaska, FAA FSDOs.

We are still baffled as to why one FSDO accepts the retrofit, while another rejects it—including one that required a flight test. During the SAI-340 TSO process, we logged more than 40 hours of documented (video) flight testing, which is on file with the Fort Worth, Texas, ACO.

I think there needs to be more FAA internal education on how a TSO is applied for and issued. Still, I believe there are a lot of well-educated FAA Avionics inspectors that have worked their way from the hangar to their present position. These are the inspectors that have a grip on FSDO-level field approvals and should be sourced for electronic attitude instrument approvals whenever possible.

ZAON TRAFFIC UNIT

I'm looking to upgrade the software in my Zaon XRX portable traffic receiver. Is there anyone who can help?

Bruce McGree
via email

Zaon left the industry abruptly, leaving plenty of systems in the field needing support. Any engineers up to the task?

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Electric Aircraft: Are They For Real?

Yes, but battery limitations and immature hybrid technology may keep them from being a disruptive market force for as long as a decade. Carbon emission rules will force the issue.

by Paul Bertorelli

In 2015, somewhere in an airless office tasked with keeping track of such things, a dot was placed on a spreadsheet graph. It represents year one of the next big thing in aviation: electric airplanes. The graph will march forward from there, rising gently into the future. Or so it is hoped.

Never mind that you can't readily buy an electric airplane right now and you'll have a time even finding one to fly, as I did last summer. It took a trip to Slovenia to experience the tingle of raw voltage coursing into a brushless DC motor at the touch of button.

Electrics will get bigger in 2016, but probably no more accessible. It's not for lack of trying. Above and below the surface, there's semi-furious developmental work to bring electric airplanes to market, driven by a mix of a parallel market push in the automotive world, a war on noise and emissions, demand for drones and the faint outlines of an energy transition away from oil and toward electricity for everything.

Yet, are any of these electric airplane proposals for real? Or are they just vanity projects with all the credibility of flying cars? In this article, we'll examine those questions and explore the daunting challenges electric airplane manufacturers face in bringing these airplanes to market.

Several things appear certain. The electrics we're seeing now are more certification ice breakers than products with market legs. And because limitations on battery energy density won't significantly improve for quite some time, there's a tilt toward serial hybrid power systems. Physics being physics, these are likely to be slower and will carry less than equivalent gasoline models, but they should cost less to operate. It's anyone's guess if they'll be cheaper to buy, but unless they're a lot cheaper, they'll struggle to be market disruptive for the foreseeable future.

The barriers electric airplanes face to achieve market acceptance are both technical and regulatory, but everyone I spoke to for this article placed the regulatory challenge as by far the most difficult. That, combined with immature technology, means that even the most ambitious electric aircraft projects are less swing-for-the-fences and more on-base bunts.

PROCESS, NOT PRODUCT

"What's most interesting is the process, not the determination to come up with a product. But if you never have a product, you never learn the process," says Nicolas Chabbert of Daher, which is partnering with Airbus in the aggressive $55 million E-fan project to bring to market first a certified pure-electric trainer and then a four-place hybrid-drive aircraft before 2020. The E-Fan 2.0 trainer, which, through a subsidiary calledv-

E-volo's VC-200 Volocopter, above, uses distributed electrical power to rethink the basic concept of the helicopter.

The Airbus E-fan 2.0, right, aims to be a mass-produced EV trainer. Propulsion is via two ducted fans driven by the powerful brushless DC motors being developed by Siemens, lower photo.

VoltAir, Airbus plans to certify by next year, is aimed at the European training market. The E-fan 4.0 is a four-place trainer/personal aircraft for the North American market to be built in the U.S. and in service by 2020.

Besides VoltAir, Airbus has nine other developmental partners, including European general aviation stalwarts Daher and Diamond Aircraft and Siemens, the German electrical conglomerate. But the Airbus entry shouldn't be viewed as a giant aerospace consortium seeking gold in general aviation, but rather a logical first step toward developing a commercial hybrid electric aircraft under a conceptual project called E-Thrust. Airbus has partnered with Rolls Royce and Siemens and set a 2050 timeframe for a marketable hybrid-electric airliner. The relatively modest E-fan project opens the path toward that development.

There are other such projects, including a serial hybrid being developed by Pipistrel Aircraft in Slovenia and Diamond Aircraft has its own hybrid project perking. Again, both are more certification proof-of-concept vehicles to give regulators grist than they are marketable products.

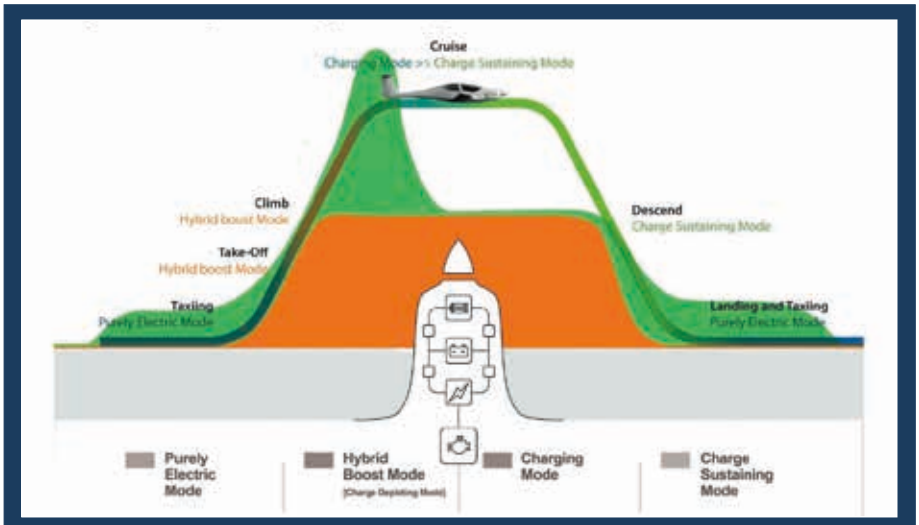
But will the regulators come around? They are and they will, according to GAMA's Greg Bowles, an engineer who works in GAMA's Brussels office. He says European regulators have committed to having rules in place by late 2016—part of the CS23 revision—that would allow the certification of electrics to begin, including hybrids. He says these new regulations are more streamlined than legacy rules, which don't address electrics anyway.

"The good thing about the European proposal is that it doesn't require independently certified propulsion," Bowles says. "Today, you have to get a type certificate for the engine and then a certificate for the airframe. This would allow you to approve the propulsion with the airframe in one step." Unfortunately, the FAA has been neither as flexible nor as timely as European regulators and lags in electric aircraft regulation development. The long-awaited FAR Part 23 revision is supposed to address this and the hope is that a draft will appear in early 2016.

WHY DO THIS?

Rules or no rules, electric airplane development is being pushed along by broader trends in the world economy that favor decentralized or so-called distributed electric power. The wider use of electricity in everything from cars to industrial tools to medical devices is pervasive. "Distributed power" means power that's generated at or near the point of use and for airplanes, that opens up new design possibilities.

"Where's the practicality? What can we do with this?" says Christian Dries of Diamond Aircraft, who's about to fly its third-generation electric airplane. "This technology will allow us to develop airplanes that are slightly different from everything we know now. For example, tilt-rotor airplanes that will have the possibility of vertical takeoff, but can also fly at very high speed," Dries adds. Diamond's current project, a hybrid based on the DA40 airframe with a pair of canard-mounted electric motors is a vivid example. Dries hopes the airplane will fly later this year. An even more dramatic example is the Volocopter, a complete rethinking of the helicopter by the German-based start-up e-volo GmBH. In place of a main and tail rotor, it has distributed power in the form of 18 motors mounted on a circular array. The Volocopter has flown unmanned and e-volo founder



HYPSTAIR HYBRID CYCLE

In a project co-funded by the European Union, Pipistrel is developing a hybrid drive using a small turbocharged engine driving a generator and about 100 kg (220 pounds) of batteries in the wings. The graphic above shows the proposed hybrid cycle. The aircraft can take off on battery power alone, battery-boosted hybrid power or engine power alone. Typically, it would use engine power boosted by the batteries for maximum performance.

By the top of the climb, the batteries are depleted and the hydrocarbon engine provides both cruise power and battery recharging. The system also has recuperative charging through the propeller during descent. The chart at left shows the weight penalty against the gasoline version of the same aircraft, the Pipistrel Panthera. There's an additional penalty: At the mid-altitudes, the hybrid model will have only about 100 HP available compared to 195 HP for the Lycoming IO-540V version. That means slower cruise and climb for the hybrid, although it regains some advantage because turbocharging allows operation at higher altitudes.

GASOLINE VS. HYBRID DRIVE

	LYC IO-540	HYPSTAIR HYBRID
DRY WEIGHT	190 KG	160 KG
BATTERIES	N/A	100 KG
ACCESSORIES	20 KG	15 KG
FLUIDS	6 KG	5 KG
START BATTERY	11 KG	N/A
TOTAL INSTALLED WEIGHT	227 KG	280 KG
CRUISE	198 KTS	177 KTS

Cruise for Lycoming version is at 8000 feet; Hypstair at 15,000 feet. Climb rates with battery depleted aren't available

Stephan Wolf told me that it will fly manned early in 2016. The Volocopter leverages distributed electrical power to a logical maximum in that instead of complex mechanical linkages requiring skilled pilot input, the aircraft is stabilized by software controlling the motors, including the ability to automatically compensate for failed motors without action by the pilot. There's only one problem: On a full battery charge, the Volocopter has an endurance of only 20 minutes.

TILT TOWARD HYBRID

Everyone I spoke to building or considering pure electric airplanes offered some version of this observation from e-volo's Wolf: "If you would have asked me five years ago when we started this project, I would not have said battery energy would be the bottleneck. I still wouldn't say that now because five years ago, I thought the same thing."

While pure electrics (EVs) can fly fine, they can't do it for very long and this sharply limits their practicality. "People thought that airplanes would go the same way cars are going, which is EV first, then hybrid then back to EVs as batteries got cheaper," says Embry Riddle's Pat Anderson, who's working on a number of electric aircraft projects at ERAU, including a research EV. "But I really think aerospace is going to play out the opposite. It will be EV followed by faster, which is going to be hybrid. If you look around, that's what's happening," Anderson says.

And indeed it is. E-volo's Wolf says they're exploring a hybrid design, Diamond is on its second-generation hybrid and Airbus and Pipistrel are throwing serious money at serial hybrid designs of their own.

This leads to a design road fork. Hybrids can be viewed as range extenders or power boosters. The range extender concept has a small motor with a generator to supplement batteries, which are the prime mover. That's the thinking behind PC Aero's Elektra designs. They're battery operated airplanes with solar panel range extenders. The power-booster hybrid has a larger hydrocarbon motor and batteries sufficient only for bursts of high power for takeoff, climb or hovering.

Diamond's hybrid, for instance, uses an Austro diesel to drive a generator to power the two electric motors and charge the batteries, of which it has a lot: 440 pounds (200 kg) occupying the entire backseat of the airplane. That means it's a two-place airplane, but one that will cruise at about 120 knots for up to 10 hours, burning less than 2 GPH, the company claims. Dries concedes that this design will be slower than even a diesel-powered DA40 and will carry less payload. But it might have longer endurance and lower overall operating costs, perhaps because the engine can be operated on condition, without a specific overhaul cycle. Diamond's hybrid could also have terrific takeoff performance at any density altitude since 300 kWh can be applied to those two motors on the nose. Dries sees an additional selling point: The electric power provides a secondary power source for emergency use, something that may appeal to buyers.

HYPSTAIR

Pipistrel is pursuing a similar strategy with its hybrid project. Although the system will fit into its yet-to-be-certified Panthera airframe, it's intended to be a generic hybrid drive proof-of-concept for any single-engine aircraft and is being developed under an EU co-funded project called Hypstair. The architecture of this system is similar in concept to the Diamond proposal, although

it has a single electric motor and a smaller gasoline hydrocarbon motor which appears to be a Rotax turbocharged 914 with 115 HP. The graphic on the opposite page shows the proposed hybrid cycle. One of the system's design points is a haptic power control and a fully integrated electronic cockpit.

This system, too, will be a certification guinea pig, but judging by the claimed performance specs, it might be competitive as a marketable aircraft. Because the Panthera will be offered as both a gasoline version and an electric hybrid, Pipistrel has published performance specs for both. The hybrid claims a 177-knot cruise speed at 15,000 feet against 198 knots for the gasoline version at 8000 feet. The two have identical range at a 155-knot cruise, but the hybrid version's useful load is less; 915 pounds versus 1100 pounds for the gasoline version.

Sales points? Lower noise and emissions, mainly. But like the Diamond example, the Panthera hybrid could apply all of its battery power to takeoff and climb and produce impressive performance in high density altitude conditions. It similarly has the option of charged batteries as a secondary power source for emergencies. In Slovenia last June, Pipistrel's Vid Plavik told me the hybrid version might get you from A to B on 15 percent less fuel. But none of that's proven yet. We'll judge them seriously when they fly.

E-FANS

If any of these ideas deserve the award for rapid industrialization, it would be the Airbus E-Fan project. Its subsidiary, VoltAir, intends to have the E-Fan 2.0 electric trainer in service by next year and the E-Fan 4.0 four-place hybrid before 2020. VoltAir has already built a factory for the 2.0 in France. The 4.0 will be built in the U.S. and is intended for the North American market.

The 2.0 is similar in concept to Pipistrel's Alpha Electro, in that it's an EV with an hour of endurance and 30 minutes of reserve. Rather than conventional props, it has a pair of ducted fans and a novel chain-drive system to the wheels for taxiing. One executive familiar with the project told me that Airbus understands building the airplane won't be enough. It will also have to provide training and support

Diamond Aircraft CEO Christian Dries says electric aircraft will look different and he's about to deliver on the claim with this certifiable twin-motor hybrid drive airplane based on the Diamond DA40.

doctrine, maintenance and battery exchange protocol. Airbus envisions a volume market in the European training market and insists it's serious about being in GA. In a carefully vetted answer to e-mail queries, Airbus senior VP Ken McKenzie offered this reply: "We believe the larger focus of an innovation project like the E-Fan is not necessarily to make an aircraft that's cheaper to produce, operate and maintain than an aircraft with a combustion engine, but rather to develop innovative, eco-friendly propulsion and lightweight material solutions, with the goal of bringing them to market quickly as more stringent carbon emissions regulations come into effect."

THE LONG TERM

The pure electrics—EVs—put designers in a box. For the time being, they struggle to fly for an hour, which may or may not make them marketable enough to even sustain the developmental effort. The long-promised better batteries aren't around the corner. Hybrids look a little better, but they give up performance and payload against internal combustion aircraft. Hybrids also need better, lighter batteries. The entire industry is at such early-stage development that aerodynamics haven't caught up with power technology.

"Improving the aerodynamics is a much faster way to get improved performance than improving the specific energy of batteries, without question," says Embry Riddle's Pat Anderson. That means high-aspect ratio wings

Pipistrel's Alpha Electro, lower photo, is nearing the ready-for-sale finish line. After Siemens balked on providing the motor, the company says it has a new supplier. The Electro, which we flew last summer, has quick-change battery packs, top photo. See the August 2015 Aviation Consumer *for a review of the Alpha Electro.*

The Eternal Overpromise

WHERE ARE THE BATTERIES?

Everyone we speak to in the electric aircraft field decries the lack of progress in battery capacity. We asked Jeff Chamberlain, head of the Argonne Collaborative Center for Energy Storage Science, a leading battery research center, why this is so.

Electric aircraft manufacturers had expected battery energy density to be higher than it is now. Why isn't it higher?

It's a very difficult problem of physics and chemistry. You want to pack in as much energy as possible and allow it to be pulled in and out of that material. So the bottom line is, we need to design a battery pack that allows us to move energy in and out of that material so we can store more energy in it. It's just a very difficult problem.

We've seen 5 to 7 percent increases in energy density a year. Is that the limit?

Yes, the sevenish percent improvement a year will absolutely continue. In lithium ion we can, at least theoretically, possibly double or triple energy density and have a concomitant decrease in cost. That's going to persist for quite awhile. You do hear in the media about all these breakthroughs and that's a combination of snake-oil salesmen and entrepreneurs and the media is complicit in this. Sometimes a report is turned into a catchphrase and that causes a bit of overpromising.

Where do you think the cost per watt hour will go with lithium ion?

In 2004, the cost was around $1600 per kilowatt hour, this it at the pack level. Ten years later, at the end of 2014, we were down to $350 to $400 per kilowatt hour. We believe that with manufacturing process improvements and materials innovations, we can get down to between $125 and $150 per kilowatt hour.

Parity with oil, with oil at about $30 per barrel, would be about $100 per kilowatt hour. I've seen projections for less than $100 per kilowatt hour for lithium ion. Our models are a little more conservative than that.

What will drive future development? Will it be grid and vehicle batteries?

What will drive it is what I have in my hand. Handheld devices. What's interesting is that although we are focused on some big-picture problems for the taxpayer, what still drives it is the handheld device. The things we invent still land in handheld devices because of the urgent market need there. And then they make their way into cars. Just now we're starting to see vehicle makers adopt chemistry concurrent with handheld devices. But I predict it will still be handheld devices driving because these guys are under enormous pressure to develop new products in ways that vehicle manufacturers aren't.

How about ultra capacitors and fuel cells? Will these become competitive with batteries?

Yes and no. Super capacitors are great. They do high power with thousands and thousands of cycles. But the problem with them is they just don't store energy well. We can't conceive of an ultra capacitor reaching anything close to the energy densities we see in lithium ion today. So you wouldn't see the volume and in the vehicle world, volume is king. In aviation, maybe mass is king.

Fuel cells are well-functioning devices. Maybe you could put one at the base of a solar tower to electrolyze water to create hydrogen that you could then use in a fuel cell. The device works really well, but the problem is hydrogen production, transportation and storage. With electricity, there are already networks. For hydrogen, that network doesn't exist. On top of that, if fuel cells achieved volume, the price of platinum would rise because there's just not enough of it for catalysts. We're working on that.

We've heard a lot about lithium air and, lately, lithium sulfur as the new miracle chemistries. What's your take on these?

Our portfolio at Argonne has lithium sulfur and lithium oxygen in it, but it's a small piece. Even though there are great discoveries going on with lithium oxygen, we are, at a minimum, a decade away from a viable prototype, let alone commercialization, which might be 20 years away. We're further along in lithium sulfur, but we're still five to 10 years away from a viable prototype, in my opinion, and another five to 10 years for commercialization. And by that I mean reversible batteries that you can recharge, so called secondary batteries. There are primary batteries for lithium oxygen that are out there, but they're one use and then you throw them away.

So it sounds like if we want better batteries for aircraft, we need to be patient.

Yes, but maybe not quite as patient as you think. I'm often asked what comes after lithium ion and the answer is lithium ion. We are changing the chemistry inside lithium ion cells in order to get to two to three times the energy density while we're working on the brass ring of lithium sulfur and lithium oxygen. Even with lithium ion, from what I see from our friends at Embry Riddle and elsewhere, electric flight is not more than five or 10 years away.

Argonne Lab's Jeff Chamberlain, left in left photo. Lithium air research in IBM's Battery 500 project is still years from practical products.

with long spans, low drag and light airframes. Anderson says that last item can be a problem:

"You really chase your tail on what the mission is. If you're talking about a flight school, if you can exchange the battery packs and you have a durable airplane that's not too light for its use, that might be a durable option. At Embry Riddle, durability is number one for us," Anderson adds.

Research on dramatically more efficient airframes is underway, but most of it is theoretical. NASA researcher Mark Moore is well known in the electric aircraft community and has been working on a project intended to reduce required propulsion energy by a factor of five. "One part of the efficiency improvement is the ability to decrease the size of the wing because the tight aero-propulsive coupling of the propulsion to the wing lets us achieve a dramatically higher maximum coefficient of lift," Moore told me in an e-mail. "In essence, we're able to size the wing to the high-speed cruise condition instead of the takeoff and landing condition," he adds.

This produces some pretty weird ideas, not the least of which is the Greased Lightning research aircraft, powered by 10 electric motors. The LEAPTech project, with up to 18 motors on a single wing, will test how efficient tight integration of distributed power propulsers can actually be. While manufacturers are happy to see this research, they also groan a little at the prospect of manufacturing such complex things profitably.

EVs are unquestionably the most efficient form of electric flight, potentially offering the lowest cost per knot of speed and the fewest emissions with the least noise. Hybrids are more practical, but are also more complex, requiring a hydrocarbon engine, a generator, inverters, batteries and an electric motor. Initially, that complexity represents a tradeoff in reliability and performance against the gasoline engines that other than early adopters might not find attractive. Battery safety is also a worry, given the susceptibility of lithium ion to thermal runaway. Argonne Lab's Jeff Chamberlain says the industry has made great strides in reducing thermal risks.

CONCLUSION

To answer the headline query, are these things real? The answer is that when an aerospace giant like Airbus decides to invest $55 million in little airplane development, it's real, even if that's coffee money for a $66 billion company. Other projects, although on a smaller scale, look just as serious.

Two visions of an electric future. Top, Airbus E-Thrust concept, a hybrid electric airliner driven by ducted fans. NASA is experimenting with multiple propulsers on a single wing in the Greased Lightning research vehicle, lower photo.

But investing, designing and building is one thing, certifying and selling something else. The selling part is the largest unknown. When I visited Pipistrel last summer, the company said its Alpha Electro EV had generated more interest than any airplane intro in the company's history.

I suspect Airbus will find similar initial traction for its E-fans, mainly in Europe where noise and low-emissions and efficiency drive the market. Given the cost of fuel in the U.S., I'm not convinced there's a meaningful market for two-place electric trainers here yet because there's not much of *any* market for new two-place trainers.

The Airbus E-fan 4.0 is intended as a North American product so it will presumably compete against other four-place gasoline aircraft. Given the performance it's likely to have, my guess is it will be in the Cessna 172 space. Making it faster will require a larger hydrocarbon engine, tanking its emissions, economy and payload. Like hybrid cars, hybrid airplanes may have minimal advantages over traditional gasoline engines and that could evaporate if their hydrocarbon engines aren't economical.

Taking Airbus at its word that it will stick to the plan and deliver, this airplane will undoubtedly be the most interesting product introduction in decades and its technology integration and sheer innovation may actually generate excitement in general aviation. But excitement isn't always the same as sales. What Airbus will have to prove is that an electric airplane that's more complex and with unproven technology will sell against venerable gasoline models. In a market notoriously fickle and conservative, will it be enough just that the airplanes are electric and are incrementally more efficient? And will the combination of low noise and emissions sweeten the deal for buyers? Carbon emission regulations will play a role. But these don't yet exist in the U.S. market.

There are always early adopters, but my guess is none of these products will be disruptive for quite some time. I think they'll trace the same general pattern that diesels did; the sales curve will rise measurably but modestly. I thought GAMA's Greg Bowles had as good a take as any on the electric aircraft industry: "Personally, I think it's very real. But I don't want to ever oversell it."

Need to hone basic stick and rudder skills? Primary training at Jack Brown's is accomplished in the school's fleet of 100-HP Piper J-3 Cubs on Aqua 1500 floats. That's a glassy water approach over the LVR in the left photo.

Seaplane Ratings: Jack Brown's Approach

Yes, it's a ratings mill. For more confidence, competence and fun, plan on spending more time and money than the advertised training package prescribes.

by Larry Anglisano

Engage fellow aviators about earning a seaplane rating and it's likely the name Jack Brown's Seaplane Base will enter the conversation. That's because Brown's, located in Winter Haven, Florida, has trained nearly 20,000 pilots since 1963. That's impressive longevity in a niche market.

FLIGHT TRAINING

On the other hand, Florida is particularly favorable for float flying and the abundance of fresh-water lakes in the surrounding Winter Haven area makes training at Brown's seaplane base even more inviting.

Still, with an alumni count of those proportions, I've always wondered how intensive the program really is. Moreover, given the nature of seaplane flying, anytime you introduce words like fun, laid back and easy into a flight training curriculum, it's easy to set false expectations about the experience and the outcome. How proficient might I be with a freshly signed ticket in hand?

To find out, I slapped my money on Brown's counter and enrolled in its SES, or single-engine seaplane course. My takeaway: It's fun, stressful, rewarding and relatively expensive. No, the rating is not a gimme. Expect to work hard to earn it, and get back as much as you put in.

REALISTIC EXPECTATIONS

Brown's offers two options for SES training at the private or commercial pilot level. Either curriculum includes 1.5 hours of ground instruction, five hours of dual instruction in one of Brown's 100-HP Piper J-3 Cubs, plus a checkride, which is administered by company principle and FAA designated examiner Jon Brown or his brother Chuck Brown. The course has a flat-rate fee of $1400, which also includes the examiner fees.

The school says it takes two full days to complete the course. But, that doesn't mean every pilot will complete the course in two days, or pass the checkride after the initial five hours of dual. While the staff initially offers the caveat that it could take longer (based on pilot proficiency and weather delays), I don't think this point is made strongly enough when signing up.

Brown's instructors, on the other hand, make it clear that many students require far more dual instruction than the five-hour minimum and speak up early if they feel that a student will need more time.

You'll make it a lot easier on yourself and the staff if you show up current, prepared and with your credentials and logbook in good order. This includes having a current medical certificate, your pilot certificate and a valid FAA FTN number. You'll also need to comply with the school's TSA-governed identification polices. Bring a U.S. passport or birth certificate. Foreign pilots seeking the rating must meet foreign pilot flight hour requirements and could require a letter from the FAA for foreign license conversion. Basically, don't expect to show up without completing FAA paperwork.

Brown's will provide you with a 30-page course guide ahead of time. It's extensive, and while the material is covered in the initial ground school portion, pre-study is essential. For starters, you'll want to be familiar with FAR 91.115—the regulation covering right-of-way rules for water operations.

As you would expect, when a seaplane touches the water it must comply with nautical rules, so you'll need to be familiar with water navigational aids, plus the procedures for anchoring, beaching, docking and ramping the seaplane. There's also the three main ways of taxiing and turning the seaplane when it's on the

water: idle, plow and step. You might have to sail the seaplane, should the winds be too strong to move it under its own power.

My point is that a student with even minimal seaplane experience will have an advantage over one with none. I showed up with a few hours of dual instruction flying a float-equipped Super Cub. This experience made the initial transition to the J-3—and recognizing the feel of the floats transitioning from displacement to the step—quite easy. I also arrived current in little airplanes, which helps.

An asset was a diverse class. This included Jessica Koss, a CFI and professional pilot at Garmin, a Boeing 737 airline captain, plus the new owner of a float-equipped Piper Super Cruiser. Sharing moral support helped tame the edge when we felt overwhelmed.

THINGS THAT KILL

My instructor, Ben Shipps, made it clear from the beginning that I wouldn't be expected to perform like a seasoned pro on the checkride. That's just impossible after five or so hours of dual. But what is expected is demonstrating solid decision-making skills. This includes showing healthy amounts of respect for situations that have killed far too many seaplane pilots and their passengers. The list includes, but isn't limited to, botching the landing in glassy, mirror-like water conditions (due to the absence of depth perception as the seaplane approaches the water), rough water operations, plus operating in and out of confined areas surrounded by terrain and obstacles.

As simple as it may be, you'll want to be familiar with the J-3 Cub. Want to try your hands at propping while balancing on the deck of the float? You won't get to—it's too risky for Brown's insurance policy.

My instructor spent a lot of time covering what to look for while preflighting the seaplane, which requires having a solid knowledge of the float's structural design and limitations, while understanding buoyancy theory. This is emphasized on the oral portion of the checkride.

Brown's Cubs have battery-powered intercoms with old-school (uncomfortable) headsets. Spoiled by years of wearing your fancy Bose ANRs? Leave them at home—the provided phones are hardwired in place.

For advanced training, Brown's uses its Maule M-7-235, top, billed at $350 per one-hour minimum. Chief instructor Ben Shipps covered a lot of material in ground school, middle. For good reason, emphasis is placed on respecting rough water, bottom.

The aircraft sits on Aqua model 1500 oversized floats, limited to a max wave height of 18 inches. With rigging, these add 250 pounds to the J-3.

With my instructor and me (each weighing 170 pounds) and a fuel tank filled to its maximum 12 gallon capacity, the aircraft was 80 pounds below the 1420-pound gross weight. Since the Cub is flown solo from the back seat, that's where the student sits, positioned next to the water rudder handle.

The school is fine with students attaching action cameras to the aircraft, and maintenance folks helped me temporarily route my AV cabling for the video chase to this story. But, I was told to turn it all off when I strapped in for the checkride—I get it.

TIME TO FLY

You'll generally fly in 1.5- to 2.0-hour blocks, depending on the conditions. Brown's will likely park the Cubs when the wind blows over 20 knots. Since you'll likely never climb above 800 feet (level-off cruise altitude is 500 feet AGL), the ceiling is rarely an issue, while two miles is the required forward visibility.

You'll first learn to maneuver the seaplane on the water, and to not

SES INITIAL: SHOULDN'T THIS BE EASIER?

Since a good teacher is always learning, I set out to do just that when I immersed myself in Jack Brown's initial seaplane training course. I've been instructing part and full time for over 10 years, so I guess I was due for a good lesson. Hopefully the following can help your transition.

If you want to prepare for this course ahead of time, my advice is to do your homework before arriving. If possible, show up current, read Brown's course guide, study the various maneuvers and be ready with questions (Brown's instructors love addressing students' questions, which is a positive trait).

Like any type of flying, come armed with a positive attitude, a willingness to learn and be prepared to be challenged. But at the same time, have fun. Understand it can be overwhelming and exhilarating, with a little bout of frustration mixed in to play with the emotions.

Approaching the ground school portion requires a focused mindset. I set out for an early meeting with Brown's chief instructor (also my ground school instructor), Ben Shipps, armed with a large iced tea and an open mind. After a two-hour discussion of plow turns, hydrodynamics, float construction and more, it was time to fly.

If you want to prepare for the course by brushing up on your flying skills ahead of time, I suggest tightening up your crosswind landing and takeoff technique, while paying close attention to wind direction and speed and how it affects the aircraft. This is front and center when it comes to seaplane flying. Flying efficient and square traffic patterns is also an essential habit to perfect. Used to flying big airplanes? It will pay to get some time in a small one, that could speed your transition to the Cub.

Shipps concluded our initial meeting by saying "I love the question 'why'," in a way that was obvious he wanted to be asked it—and often. This stuck with me throughout my training the next couple of days. It also led me to the conclusion that you should approach the seaplane rating asking the question "why?" as often as you can. Since this training offers plenty of opportunity to do so, I walked away a better pilot and teacher. You can too, with some preparation, patience and an open mind.

Contributor Jessica Koss is an active CFI and a pilot at Garmin International.

hit anything after the ground crew pushes the seaplane off the ramp. Just like taxiing back in and when docking, there is always an audience watching.

Brown's places appropriate emphasis on good habits for safeguarding the equipment—which could ultimately save you money if you're training in or operating, your own seaplane. Water operations are harsh on propellers, the engine and airframe.

Plow turning on the water is perhaps the most harsh, since the nose is pitched up significantly under power, reducing engine cooling, forward visibility and increasing water splash through the propeller. You'll learn to do it, but only as a last resort for when the winds are too strong to turn the seaplane in the direction you need to go while water taxiing.

Idle taxiing using the water rudders is generally the preferred method of getting around, since there's limited prop spray, efficient engine cooling and good forward visibility.

Following water taxi and takeoff instruction, you'll perform airwork to get the feel for the aircraft. The J-3 with big Aqua 1500s is docile, with no bad habits in the stall, while 60 MPH is the magic pitch speed during an engine failure.

My instructor rode me hard when it came to maintaining consistent stick and rudder coordination, and stressed the importance of flying square traffic patterns during takeoffs and landings. As a result, I went home with better flying habits and with a sharp eye for reading winds.

Given the constantly changing environment of water operations, you'll be expected to always know the wind direction and speed, while being able to accurately read its many signatures on the lake water. These conditions are directly proportional to how you manipulate the seaplane in the water and which takeoff and landing procedures you execute. There is a lot at stake.

For example, you might get away with improperly positioning the ailerons in a landplane, but the penance for committing that sin in a seaplane could be a nasty flipover you never saw coming.

Step taxiing is the seaplane equivalent to cruising across the water in a boat at high speed. It's the fastest way to get around and you might never get used to the centrifugal forces induced while step turning, convinced the seaplane is going to roll over. Of course, turning at high speed from downwind to upwind in strong winds is what capsizing is made of.

There is no room for sloppy checklist habits in a seaplane and the one that will be forever engraved in your noodle is the pre-takeoff/step taxi CARS acronym—carburetor heat, area clear, water rudders and stick back. You'll quickly learn there is no tolerance for getting lazy with stick position in both pitch and roll axis. Noseovers (catching the tips of the floats in the water) and capsizing are bad days in a seaplane.

BRING ON THE BOSS

When both you and your instructor agree you are ready to face the checkride with Boss-Man Brown (Humble Master Pilot award recipient Jon Brown is indeed the boss and I guarantee you won't have to be reminded of this fact as you anticipate the ride), it's time to show him how

to fly a seaplane. But don't rush it.

After logging a total of 5.6 hours of dual instruction, I lacked the confidence (and, in my estimation, the polish) required to successfully perform as PIC under pressure on the checkride. While my instructor was convinced I was being too tough on myself and suggested that one more hour of dual would have me ready, I hit the road to the hotel.

What I needed was a personal debrief, contrasting my day's performance in the airplane with the way certain procedures are instructed in the manual. Turns out, that was a good call.

The next morning I brought my A-game to the cockpit and somehow, performing all of the procedures and maneuvers that were overwhelming the prior day came naturally. With a total of 7.3 hours of dual instruction, my logbook was endorsed as competent to pass the SES practical test. I admit to some tension.

Before we began, Brown made it clear that the oral questioning and the practical testing would not include any training or advice on his part. I would be PIC, and should he have to take over the controls for any reason (other than a real emergency), it would be an immediate fail, with credit for any successful maneuvers performed. That's a required standard for any checkride.

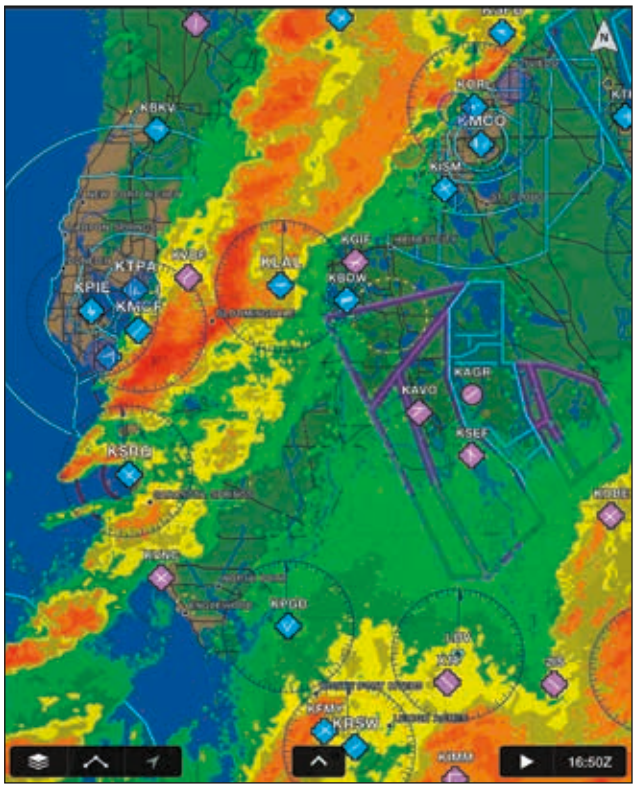
Brown shotgunned questions—good ones—about all the stuff that can kill a seaplane pilot. Poor retention of his course manual will show, and he'll be making notes of it.

As Shipps put it early on, "Mr. Brown has administered nearly 20,000 checkrides. You will not be able to BS this man." True statement.

Once you complete a weight and balance report to prove the aircraft is below gross weight and within C.G. limits, you'll demonstrate a thorough preflight inspection. Yes, maintenance folks are watching from a distance.

After push-off and while water taxiing, you'll execute the method of takeoff which best suits the conditions. Now is not the time to depart the water in the wrong wind direction.

With a taxiway that connects to Winter Haven's Gilbert Airport, you can bring your own aircraft and park on Brown's ramp, top photo. Add a weather delay buffer to your training schedule. My flying was stalled for nearly two days—the bottom Nexrad shot part of the reason.



If you don't anticipate a simulated engine failure, you shouldn't be on the ride. I was relieved we addressed that bit right away, and even more relieved to gracefully stuff it into the water, deadstick.

After nearly eight landings, it was time to demonstrate docking and ramping. Back in the office, Brown offered meaningful explanation to each of the questions I bungled and bumbled. He also offered sound advice for avoiding a litigious outcome while mixing it up with careless boaters and agitated homeowners on the water. Not everyone thinks seaplane traffic is cool, so he reminded me I was now an ambassador and an official seaplane pilot.

DOWN TO BUSINESS

Scheduling your training slot requires a $300 deposit, deducted from the $1400 course fee, which includes five hours of dual. Each additional hour is billed at $185 per.

Brown's five-hour dual instruction is mostly in line with the other curriculums I looked at, but its pricing certainly is not the least expensive. But, they aren't the most expensive, either.

The place hosts an atmosphere that's genuine with no pretentions. That's worth a lot, as was the additional ground schooling given for gratis. Brown's will instruct in a customer's aircraft if there is an instructor qualified to fly it and sets pricing based on each situation.

If I had a nit to pick, it would be the inability to rent Brown's J-3 once you have your temporary ticket and fresh FR. But as the sidebar on the following page warns, that's not easy anywhere. Still, it's tough to walk away without proving to yourself that you can fly a seaplane on your own, but Brown and your instructor know you can.

Contact www.brownsseaplanebase.com, 863-956-2243.

SEAPLANE RENTALS: GOOD LUCK WITH THAT

With fresh seaplane rating in hand and your chest puffed out with seaplane pilot ego, thoughts turn to actually renting a seaplane to feed your new addiction. Unfortunately, that could be a pipe dream. The buzz-killing reality is that seaplane rentals are few and far between. After surviving the initial training and seeing your instructor (and the examiner) hover centimeters from your controls, you should know why.

Several operations told us insurance matters are the major obstacles in the way of solo seaplane rentals. According to one school, its insurer is well aware of the risks inherent with water operations and gets heartburn at the thought of a five-hour seaplane pilot going it alone. Additionally, it's too risky for the school to jeopardize the flow of training revenue should a renter break its one-and-only seaplane.

When we asked Jack Brown's Seaplane Base's Pat Owens if the school would rent us one of its J-3s on floats, we could hear her laughter echo across the Sunshine State. "Nobody can afford to pay for that kind of insurance," she told us.

Of course, Brown's isn't the only school where you can earn the SES rating, but it's a firm believer that its fleet of simple J-3s—with oversized Aqua 1500 floats—are more forgiving seaplane trainers than others.

During our research, we learned that Adventure Seaplanes (with locations in Lake Wales, Florida, and Lino Lakes, Minnesota) has available for training and solo rental a Cessna 172L on Baumann 2550 floats, a STOL-equipped Cessna 180 on Aerocet 3500L floats, plus a Cessna 185 on PK3500C floats.

The 172 rents for $250 per hour, or $2500 for a 20-hour block. The 180 is $300 per hour, or $6000 for a 20-hour block. Adventure Seaplanes requires a minimum of 25 hours of seaplane experience and at least 400 hours of land airplane time before it will hand over the keys. It also has a DeHavilland DHC-2 Beaver available for dual instruction for $600 per hour.

In general, the company requires 200 to 400 hours of total time, plus a 10-hour rating with a successful completion of the checkride. If you already have the rating, you can accomplish a checkout in the model you are going to fly solo.

We asked our go-to guy, Jon Doolittle at Sutton James Insurance in Hartford, Connecticut, for his take on the state of insuring seaplanes for rent.

"In the insurance business, not too many of the underwriters really understand seaplanes, particularly when it comes to substantiating logged flight experience," he said. Don't assume your current renter's insurance (or non-owner coverage) policy covers you on floats.

Derek DeRuiter at Northwoods Aviation in Cadlilac, Michigan, told us he will rent the float-equipped Super Cub on his FBO line for solo, but requires the renter have a minimum of 15 hours of seaplane time and the renter must provide the insurance. DeRuiter says Epic Insurance (www.epicinsurancesolutions.com) is a good source.

"My advice for someone serious about gaining experience flying seaplanes after they earn the rating is to go buy something simple—perhaps a Champ—put on some floats, self-insure it (buy liability insurance, not hull) and step up to something bigger when you reach 100 hours of experience," Doolittle suggested.

Aside from the chart below, float-maker Wipair, Inc has a good seaplane school finder search engine on its website, www.wipare.com. Some training providers offer skiplane flying when the surrounding water freezes.

SELECT SEAPLANE TRAINING SCHOOLS COMPARED

SCHOOL	LOCATION	BASIC COST	AIRCRAFT	CONTACT
Adventure Seaplane Base	Florida, Minnesota	$1500* plus examiner	Cessna *172, 180, 185, DeHavilland Beaver	www.adventureseaplanes.com, 612-868-4243
Airlink	Maine	$1825 includes examiner	Cessna 172	www.airlinkconnection.com, 207-859-0109
Chesapeake Seaplanes	Maryland	$925 plus examiner	Taylorcraft BCS12D	www.chesapeakeseaplanes.com, 301-872-4055
Foothill Aviation	California	$2500 includes examiner	Super Cub, Stinson 108	www.foothillaviation.com, 408-375-8935
Island Seaplane Service	Hawaii	$2520 plus examiner	Cessna U206	www.islandseaplane.com, 808-836-6273
Jones Brothers Air and Seaplane Adventures	Florida	$1700 plus examiner	Husky A-1B, Cessna 185	www.jonesairandsea.com, 352-508-1800
Kenmore Air Harbor	Washington	$1695 plus examiner	Super Cub	www.kenmoreairharbor.com, 800-543-9595
Northwoods Aviation	Michigan	$1245 includes examiner	Super Cub	www.northwoodsaviation.com, 231-775-6641

BendixKing KSN770: Slowly Maturing

It has a powerful and logical FMS, plus it's priced well below the competition. The tradeoff is limited ADS-B display and non-existent wireless connectivity.

by Larry Anglisano

One unfortunate reality of long certification delays is taking a hit in market credibility. That's how it went with Bendix King's KSN770 retrofit GPS. It's no secret that Bendix King left the market wondering about its ability to earn FAA certification on a product that should have been released years before its time, especially when a certification-savvy Aspen Avionics had its hands in the architecture.

Still, when we flew with the KSN770 in late 2013, we found a fully functional and capable navigator, seemingly catering to what's left of King Radio loyalists. It has robust controls, has a bright VGA display and it has a rich feature set that's compatible with a generous list of LRUs, including weather radar and TAWS-B terrain. Who knows why certification dragged on as long as it did?

To see what improvements and tweaks BendixKing has built into the system since our flight trial (you can read that in the October 2013 issue of *Aviation Consumer*), we put our hands on a fresh KSN770, putting a sharp eye on the functions that should matter in the current market, including ADS-B and third-party compatibility.

QUALIFYING ONE

When we reviewed the KSN770 a few years ago, we struggled to define its dominant buyer, especially in a market dominated by Garmin. Since then, Avidyne has come on strong—and out of the ashes of certification delays itself—with its IFD540 and IFD440 navigators. This increased competition isn't making things easier on the KSN770, especially since Avidyne's systems are slide-in replacements for Garmin GNS navigators, or can be installed fresh.

On the other hand, the ship weather radar-capable KSN770 could have appeal to owners with panels still equipped with early 2000s-vintage Honeywell IHAS equipment. This includes the KMD540/740 MFD, KX155A navcom and KLN89B/KLN94-series standalone GPS navigators, plus the RDR2000-series radar.

For buyers only needing a GPS navigator/MFD, BendixKing offers the $11,500 KSN765, which doesn't have VHF comm or nav functions.

The other draw is the KSN770's hybrid feature set, which has been approved upon. Onscreen touch-command lables were enlarged and the resistive touchscreen was improved for fingering in gloves, and with the gentle tap of a fingernail.

With a bright 5.7-inch diagonal VGA screen, the KSN770 might also

The multi-window KSN770, left, is considered a hybrid system since the user interface has both touchscreen and hard controls. The lower right rotary knob functions as a joystick/cursor control. The left knob tunes the comm radio frequencies.

CHECKLIST

- The KSN770 is $5000 less than Garmin's GTN750 and Avidyne's IFD540.
- Hybrid feature set and a bright display caters to a wide variety of users.
- After all this time it doesn't display ADS-B weather and true ADS-B traffic symbols. That's in the works.

That's an entire BendixKing stack (several vintages worth) in that Beechcraft panel, top. The transponder at the bottom and KMD250 MFD to the left of the radio stack get WAAS GPS position input from the KSN770. Onscreen georeferenced electronic charting, bottom, is provided by Seattle Avionics.

appeal to aging eyes. But, size isn't the only matter, although the KSN is easier to wedge in a panel than Garmin's GTN750. ADS-B and wireless connectivity top the list of buyer deman—technology in which Garmin has clearly taken the lead.

Since many major retrofits also include ADS-B add-ons, cross-brand compatibility and FIS-B weather overlay ability is a major consideration. In this department, we think the KSN770 still has lots of growing to do. Let's iron that out.

IT CAN'T DO THAT YET?

BendixKing had an ADS-B solution early on with its KT74 1090ES transponder, a unit built by Trig Avionics. But like many non-GPS-equipped ADS-B transponders, the KT74 requires an external GPS WAAS position to complete the interface, and the KSN770 completes the chain. Its GPS engine is an ADS-B mandate-compliant certified position source for both the KT74 and Trig's TT31 transponder.

The KSN770 is also supposed to feed GPS position to BendixKing's KGX130 UAT ADS-B transceiver, but we've heard of difficulties getting it to work in the field. One buyer told us his shop ended up installing the GPS-equipped flagship KGX150 UAT system (which requires the installation of an additional GPS antenna) as a last resort. BendixKing picked up the tab. As we go to press, it's unclear whether that was a shop learning curve or a hardware problem, but we commend BendixKing for stepping up with a hardware upgrade to get the aircraft off the hangar floor.

BendixKing's non-GPS KGX130 and KGX150 UAT transceivers are built by FreeFlight Systems, which FreeFlight sells as the RANGR series. FreeFlight also makes the Wi-Fi adapter, which BendixKing sells as the KGX150—the same nomenclature as the UAT box. This module is intended to transmit ADS-B data from the ADS-B receiver to an iPad or Android tablet.

That's precisely what you'll have to do in a KSN770 interface because the KSN770 isn't yet approved to display ADS-B FIS-B weather data. That requires a separate TSO process, which we're told is in the works.

If you have the KGX-series ADS-B transceiver and the Wi-Fi module, you can send the weather and traffic data to your iPad that's running ForeFlight's Mobil navigation app, in addition to Wing X Pro for iPad, plus ADS-B View, which is FreeFlight's own app. There is also the Seattle Avionics FlyQ EFB, plus iFly GPS by Adventure Pilot.

One caveat: While FreeFlight told us the KGX hardware is fully functional with ForeFlight (it should know—it builds the hardware), ForeFlight wants readers to know that it has not tested the BendixKing hardware with its app. As far as we know, the only difference between the BendixKing and Freeflight units is the logo.

Displaying onscreen ADS-B traffic should be easy these days and the KSN770 will do it, but it won't paint the targets in true ADS-B symbology. What you'll see is a traffic target that's coded in familiar TCAS-like circles and triangles. We don't necessarily see this as a hands-down deal breaker, but buyers jumping feet-first into the world of ADS-B will likely expect to see a more complete onscreen ADS-B interface, in our view. That also includes FIS-B weather graphics, also missing. Until that's resolved, users will have to settle for fee-based SiriusXM weather display, which the KSN770 nicely supports.

The KSN will send mandate-approved WAAS GPS position to the BendixKing KT74 extended squitter transponder, right.

The KGX150 UAT transceiver, top, and the Wi-Fi module, bottom, are made by FreeFlight Systems. This combo enables ADS-B weather and traffic on popular tablet apps, but not on the KSN's MFD. You can't send flight plan data into the KSN, either.

The KSN is compatible with the L-3 Skywatch active TAS and TCAS processors, plus the KGP560 TAWS-B terrain processor.

SOLID FMS FUNCTIONS

The FMS inside the KSN770 trickled down from Honeywell's big-airplane Epic/Apex GUI, which is to say it's capable, but not too advanced for inexperienced users. BendixKing pitches the KSN770 to both VFR and IFR missions and we think it strikes a good balance.

Single-point navigation is accomplished with an onscreen QWERTY keypad or you can scroll the database with the rotary joystick/cursor control device on the lower left bezel. We liked the split-screen feature set when we originally flew with the unit and like it even more now that BendixKing has tweaked the software some before it earned certification.

In true FMS logic, IFR users can create an entire flight plan from departure to approach, while accessing NACO-based electronic charting (including taxi diagrams, arrival and a departure procedures) provided by Seattle Avionics. Annual data subscriptions are $299 and are transferred to the KSN770 via thumb drive.

We particularly like the ability to enter customized holding patterns, which can output to autopilots with digital steering. This trickles down from the Apex suite.

A huge dollar-saver during installation is the KSN770's ability to interface with vintage King OBS indicators and mechanical HSIs. This means if you have an existing KX155 navcom, for example, you won't have to spend big for a new indicator.

As for PFDs (primary flight displays), the KSN is only compatible with Aspen's 1000-series Evolution. BendixKing used to make the KFD840 PFD, but that was dropped.

The KSN770 comes standard with a 10-watt comm radio (and full VHF nav), but a 16-watt version is available for jets. You can tune the radio frequencies with a concentric knob on the lower left bezel or with the onscreen keypad.

We originally dinged the KSN770 for not having interactive discrete audio callouts, but it hasn't been added. We also hoped for external air/data computer input for onscreen wind data in real time, but it won't do that, either.

A TEMPTING BUY-IN

The KSN770 navigator is convincing from a price standpoint, compared to other retrofit navigators. It's also an alternative for users who don't jive with Garmin's operating logic, including KSN770 buyer Paul Werbin, a loyal BendixKing owner and an active CFI with a variety of Silver Crown avionics in his Beechcraft.

"One of my main reasons for going with the BendixKing navigator is the company's track record for designing a feature set that seems logical. I teach in an airplane that has a Garmin GTN750 and I find myself asking why they put certain menus where they did," Werbin told us.

But he also admits that since there is so much packed inside of the KSN770, there is no way to keep the logic simple. We concur. Make no mistake, as logical as the KSN770 is, it's packed layers deep with data.

There is also the KSN770's tempting price point. At $11,995, it's substantially cheaper than Garmin's $16,900 flagship GTN750 and also Avidyne's $17,595 IFD540. To sweeten the deal, BendixKing offers a generous trade-in allowance for removed vintage BendixKing avionics—"Rewarding buyers for their brand loyalty," the company told us. That means adding additional systems and accessories to the interface could yield a sizable cost savings compared to the competition, even after considering labor costs.

"The trade-in of my old equipment, plus the ability to use my old King OBS indicators saved me a lot of money. I got the KSN770, the KT74 ADS-B transponder, the KGX UAT ADS-B In receiver and Wi-Fi adapter, plus a new 406 MHz ELT system installed for $23,000. That is what I was quoted for Garmin's GTN750 navigator alone, including installation," Werbin told us.

But that cost savings didn't come without bumps in the road. Since there are very few completed KSN770 field installations, we got the idea his shop dealt with the learning curve that tags along with early adoptions. All indications are that BendixKing worked hard to resolve installation

continued on page 32

Discount Fuel Cards: Best for Jet Fuel

Fuel cards issued by discounters offer substantial savings for jet fuel buyers. Most have no annual fee. For avgas users, discount card options are limited.

by Rick Durden

Even with fuel prices at historic lows in the aviation world, pilots are constantly looking to save when they top off. Various apps keep us apprised of current pump prices, so we can plan our stops. But, what if there were a way to get a discount from the retail price when we taxi up to an FBO?

We're only aware of one discount program for avgas—which may be a good thing, because it means retail prices aren't bumped up to accommodate discounting—but many are available for those who burn jet fuel. The programs are generically referred to as fuel cards, and are so ingrained that in the turbine world you're costing yourself at least a dollar a gallon if you're not using a fuel card each time you buy jet fuel.

AVGAS DISCOUNTS

Associated with the website, Airnav.com, the AirBoss fuel card program offers discounts on avgas for a membership price of $39 per year—for an extra $40, it includes jet fuel. To join, you must first be a registered user of Airnav.com (free) and then spend about a minute entering the data and credit card information requested by AirBoss.

To find out whether an FBO is participating in the AirBoss program and the fuel discount, simply do a search for fuel prices on AirNav. In addition to the retail fuel prices that pop up, you'll see any AirBoss discount that exists. To take advantage of the discount, you must present your AirBoss card when paying for your fuel. The AirBoss card is not a credit card, although AirBoss does offer an AirBoss-branded Visa card.

The AirBoss card is not valid at your home airport.

AirBoss advertises discounts of from five cents to $1.50 per gallon with an average of 19 cents. We spent some time doing fuel price searches for various locations across the country and observed that for every 10 FBOs listed, one or two would show as participating in the AirBoss program. In our search, the discounts were on the order of 25 cents per gallon.

If your airplane burns jet fuel, it's worth your time to have a wallet-full of fuel cards and use JetfuelX to know which one to use when you fill up.

AirBoss suggests that if you burn 1000 gallons of fuel per year, the program pays for itself—if those 1000 gallons are bought away from home.

We looked at a number of bank credit cards that give money back on purchases and at AOPA's branded credit card that provides one percent cash back on avgas purchases. In general, if you make significant avgas purchases away from home, the AirBoss program is a better deal than the cash back credit cards.

JET FUEL DISCOUNTS

Due to the voracious feeding habits of turbine engines, the retail jet fuel market is a story of countervailing powers—FBOs who may have a monopoly on various airports versus entities that buy fuel in vast quantities and have the clout to negotiate contracts for reduced prices. What started with airlines setting up contract pricing evolved into companies that issued what are effectively credit cards to turbine aircraft owners. The card companies offered discounts of as much as 25 percent on jet fuel to card holders and then went out to FBOs to negotiate discounts in excess of that amount so that the card company could make a profit on each fuel sale.

That evolved to the current situation where each card company has a proprietary list of FBOs that give a discount to it, and it shares the list, and discount rate, with its card holders. In turn, the cardholders go to those FBOs and buy fuel in return for the discount—which is usually run automatically when the card is used on the purchase. The card-holding owners get a discount they could not otherwise have negotiated.

THERE'S NO FREE LUNCH

FBOs are not run by half-wits—they know they have to jump on the discounting/contract fuel bandwagon or lose customers in droves. They jumped on the bandwagon, but also raised their retail prices on jet fuel. That way they don't get taken to the cleaners by putting fuel into the wing at a price below break-even. Nevertheless, owners are happy because they are getting a nice discount over the posted retail price and the card companies are making money.

The problem is obvious—as a turbine owner, if you aren't using a fuel card to buy jet fuel, you're paying the inflated price the FBO created to protect itself from the discounters. In our survey of fuel cards and pilots who use them, paying retail versus using a card accepted by that FBO can mean a price differential of as much as three dollars a gallon.

We were told that in some cases an FBO will pass on its discounted jet fuel rates to a customer who does not have the appropriate fuel card if the customer asks—don't count on it. We were also told that you are more likely to be able to negotiate a jet fuel price discount with your home FBO, although it may not be greater than the FBO offers to the fuel card it accepts.

That means that if you are buying jet fuel on a regular basis, don't plan on paying cash or using a bank-issued credit card.

All of the fuel cards we surveyed bill you directly, so the purchase is just a matter of presenting your card. Some of the card companies advertise services that allow you to track fuel use by airplane, which is of value if you own more than one.

For international operations, we definitely recommend using fuel cards, not only for lower prices, but for support should there be a dispute with the FBO after the fact. The fuel card company should act on your behalf and have enough leverage to be effective with the FBO. We were told that bank card and oil company credit card providers were not as effective in negotiating with an FBO on issues that arose after the sale.

How do you get the least expensive fuel on a trip? Fuel discount cards, especially for jet fuel, can add to the challenge. The ForeFlight Mobil app can lead you to fuel providers that best suit your credit cards.

In our survey, we looked at the following—in no particular order—jet fuel cards:

UVair (www.uvair.com) offers acceptance at over 5000 outlets worldwide and online fuel pricing.

U.S. Bank Multi Service Aviation Card (www.usbank.com) is a bank card that offers to "leverage discount fuel contracts" and is "accepted at locations around the world."

The **Avfuel Pro Card** (www.avfuel.com) advertises access to over 3000 fuel locations worldwide and contract fuel discounts.

The **WorldFuel AVCARD** (www.wfscorp.com) offers a discount program and acceptance at over 7600 locations.

The **Corporate Aircraft Association** (www.corpaa.us) offers its members heavily discounted fuel prices—we were told as much as $3 per gallon, however, membership is $500 per year. One pilot told us he recouped the fee with his first fill up.

The **Epic Card** (www.epicaviationllc.com) does not disclose how many FBOs it has contracted with for discounts but says it operates internationally.

AEG Fuels Carnet Card (www.aegfuels.com) offers discounts at more than 2000 locations.

BRINGING THEM TOGETHER

Now that you have your stack of fuel cards, how do you assure you get the best deal? We received estimates of 10 to 20 minutes of time spent by pilots logging on to their card websites to get pricing information and making a decision as to where to buy fuel for each flight. For those who do have more than one fuel card, we recommend the free service offered to ForeFlight subscribers—JetFuelX—designed to manage fuel cards.

When you sign up for JetFuelX you provide the website with the fuel cards you use Once that's done you simply type in your destination and JetFuelX tells you which FBO at that airport and five nearby airports, has the best fuel deal for you based on the card discounts you have. The application is optimized for computer, tablet or smartphone.

CONCLUSION

In the world of buying jet fuel, the reality of powerful jet fuel discounters means that an individual who doesn't carry a pocketful of fuel cards is going to pay the inflated retail prices. Juggling the cards can be time-consuming, however, our survey indicates the cards and time spent are worth it. We do recommend, that if you are a ForeFlight user, you use JetFuelX to help you apply the cards most effectively.

Electronic Pilot Logs: We Favor EFB Integration

We were impressed by the high quality of all of the electronic logbook apps we reviewed. In a tight race, we lean toward ForeFlight, Garmin and Safelog.

by Rick Durden

Electronic pilot logbooks have become ubiquitous in the last few years. We've been impressed that a lot of skull sweat has gone into making them easy to use as well as a safe place to keep something very important to you—your history as a pilot. We looked at a representative sampling and liked what we saw.

Picking a favorite proved almost impossible—especially as the type of flying a pilot does varies widely and whether a pilot wants to share details of flights on social media also varies and some of the programs have a focus on professional versus recreational pilots or at pilots who have a desire to share their flying with others. While we lean toward the logbooks offered by ForeFlight, Garmin and Safelog, we aren't tilting too far in any direction. We think all are satisfactory and we're glad that many have free introductory periods so that pilots can take their time picking out what's right for them.

Here's what we looked at, in no particular order:

ForeFlight (www.foreflight.com) has included a pilot logbook in its new Basic Plus ($99.99 annually) and Pro Plus ($199.99 annually) Electronic Flight Bag apps.

It advertises storage on its secure cloud server. We like that ForeFlight provides videos to help introduce a user to the logbook portion of the app.

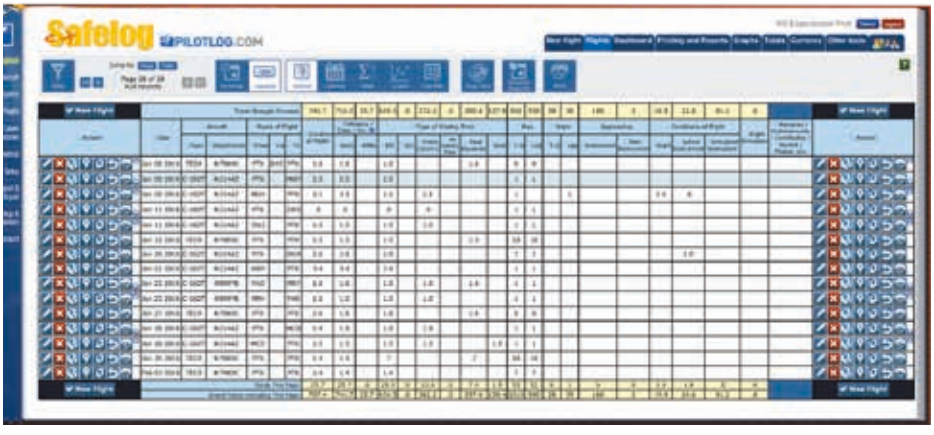
As with any of the electronic pilot logbook apps, a high-time pilot is going to spend some time inputting historical data into the app. ForeFlight, as does most of the other providers, addresses the issue directly and gives guidance an options for the process, including importing flight time spreadsheets as well as from other electronic logbook apps.

Once set up, ForeFlight creates a draft logbook entry for each flight you make—you can accept it or tailor it as needed. By using the settings menu, the user can add or subtract data fields for each flight entry to track conditions or equipment important to the user such as retractable gear. The app is set up to allow electronic signature by the flight instructor for flight training. There is a library of instructor endorsements—each can be tailored by the instructor (something of significant importance to instructors). Once the endorsement is created and the instructor signs the logbook, the endorsement cannot be changed by student.

The logbook app automatically tracks currency for takeoffs and landings—and will separate touch and goes from full-stop landings—and instruments, including approaches and holds. Currency status as of the moment can be determined at a glance and the date when currency for a selected operation expires is also shown.

The logbook also tracks your pilot certificates and ratings. We noted a few small problems with the area—it doesn't have a way of showing type ratings, and the CFI ratings on it have land and sea limitations—something the real ratings don't have.

Safelog (www.safelog.com) is a sophisticated system that works on just about any platform on the market as well as on the web. Logbook data syncs between all platforms you use and you can access your logbook anywhere you can get an Internet



Excel Pilot Logbook, upper left, allows the user to flight time in a number of formats. Safelog, lower left, can present a display that effectively mimics a paper logbook, and is customizable.

connection with any browser. Safelog points out that you can access your entire logbook on a mobile device—something few other providers accommodate. For $45.99 per year (the annual price goes down with multi-year subscriptions), we found Safelog to be very user friendly, an assessment shared by users who reported on it in various aviation forums. It offers a transition service to get data from other programs and provided what we felt were clear instructions about bringing in your data.

It does not automatically record flights, however, we do not consider that a drawback as the apps that do record the time the airplane is in flight rather than the FAA-defined flight time.

We liked the logbook display and the numerous ways your historical flight data can be presented and printed out—including as a complete, hard copy logbook with an embossed cover. It's easy to display flight data by aircraft type, N number, airports and on Google Maps. In addition, there is a troubleshooter that detects logbook issues—it can catch mistakes you make while inputting data.

The software allows you to fill out an FAA form 8710 checkride application and will import the flight time automatically from your stored data. In addition, if you want someone else to see your logbook, such as a CFI, examiner or when applying for a job, you can give permission (and withdraw it) for a specific individual to see your electronic logbook. We consider this to be one of the better programs for a professional pilot or someone who flies a great deal or in a number of different types of aircraft.

MyFlightbook (www.myflightbook.com) is a free online pilot's logbook. It is not as sophisticated as other apps we reviewed, although we found it more than adequate for the task. It included properties that could be added for a particular flight that ran the gamut of aviation operations from skiplane takeoffs to aerial refueling, yet we could not figure out how to add aircraft category and class information. However, we liked that when you entered the N number of a new aircraft, it identified the aircraft by category and class. MyFlightbook is set up to access your logbook

ELECTRONIC LOGBOOK LEGALITIES

FAR 61.51 sets out the regulations for logging flight time. It does not specify the type of logbook that a pilot must use—only that it is in a "manner acceptable to the Administrator." Before we go any further, we'll state unequivocally: Electronic logbooks are acceptable to the Administrator.

We'll also quickly digress to point out that the FAA defines "flight time" in Part 1.1, *General Definitions* as "Pilot time that commences when an aircraft moves under its own power for the purpose of flight and ends when the aircraft comes to rest after landing." So, if you start up and sit there idling while you fiddle with things and play with the glass panel while the Hobbs runs, you can't log it as flight time. It also means that you don't have to limit the flight time you log to the time while the aircraft is not touching the ground.

The FAA requires that pilots be able to prove they meet the requirements of the FARs for recency of experience in takeoffs and landings and instrument flight. Pilots also have to prove that they have received the proper endorsements for such things as flight reviews, operating high-performance and complex aircraft, airplanes with tailwheels and pressurized aircraft that have a service ceiling above 25,000 feet. A logbook, be it paper or electronic, is the easiest method of being able to show such proof.

In addition, flight schools and FBOs that rent airplanes usually want to see evidence that you have the flight experience that you claim—and they can demand that evidence in whatever form they wish, almost invariably a pilot logbook, paper or electronic.

Insurance companies ask that you fill out an application that calls for a breakdown of your flying time. If you have an accident, the company may demand proof that you actually had that level of experience when you filled out the form. Your logbook is the evidence the company will require. A word to the wise—insurance companies base their decisions as to whether they will insure you and the premium they charge on the experience and flight time you set out on the application. If you exaggerate—and then have an accident and can't prove that you had the claimed time—you could (although it's rare) be leaving yourself open for the company to deny coverage.

As with compliance with most of the FARs, you are on your honor when you record your flight time in a logbook, be it paper or electronic. Because logbook FAR compliance is on the honor system, the FAA comes down particularly hard when it finds a pilot has falsified his or her logbook, be it paper or electronic. We are aware of cases in which pilots have had all of their certificates revoked for falsifying their logbooks. We are also aware of the FAA denying a pilot's application for an ATP rating on the grounds that he didn't meet the good moral character requirement of FAR 61.153(c) because he'd previously had a violation for logbook falsification.

We do not think that the chances of falsification are any better or worse based on whether a pilot uses a paper or electronic logbook. The issue is not the method of recording flight time, it's the person doing the recording, in our opinion.

What we do consider to be more of an issue is the loss of the record itself. Pilots have lost their paper logbooks or had them stolen. We have a certain degree of unease with the long-term viability of electronic methods of storage as we've seen companies go out of business and records lost when servers were shut down.

No matter what type of logbook you use, we strongly recommend that you back it up in a secure manner. After all, it is the history of some of the most important events in your life.

SELECT ELECTRONIC LOGBOOKS COMPARED

PROGRAM	PRICE	COMMENTS
EXCEL PILOT LOGBOOK	$39 ONE-TIME FEE	Downloadable spreadsheet. Highly customizable data presentation.
FOREFLIGHT	STARTS AT $99.99 ANNUALLY	Logbook comes as a part of the ForeFlight EFB app. Automatic flight time recording.
GARMIN PILOT	$74.99 ANNUALLY	Logbook is included as part of the Garmin EFB. Can integrate with panel avionics.
LOGBOOK PRO	STARTS AT $69.95 PLUS ANNUAL FEE	Downloadable, highly customizable software. Links to all portable devices for extra fee.
LOG TEN PRO X	STARTS AT $56.66 ANNUALLY	Apple only. Changes configuration as a pilot's career advances.
MYFLIGHTBOOK	FREE	Can upload imagery from flights. Designed for easily sharing flights on social media.
SAFELOG	$45.99 ANNUALLY	Probably the most sophisticated program. Allows sharing data with specified persons.

from anywhere you can get on the Internet and it does track your currency and medical status. There are customizable queries for looking at your flight time and you can download your logbook into a spreadsheet.

We liked that it is easy to upload imagery you captured during a flight to your logbook. That nicely supports a major feature of the software: It is designed to be easy to share details of your flights on Facebook and Twitter.

Although a number of pilots on various aviation forums spoke well of MyFlightbook, we did not find it to be as user friendly as some of the other apps.

Garmin Pilot (www.buy.garmin.com) The popular Garmin Pilot EFB app includes a pilot logbook with automatic entry of flight time and day/night conditions. With cockpit connectivity provided by Garmin's Connext, Garmin Pilot and the electronic logbook can receive information on the flight from panel-mounted avionics and portable devices. At $74.99 for an annual subscription, we consider the price to be quite competitive.

The settings section allow you to set up detailed preferences for the logbook, something we feel is essential in a logbook app—and it allows you to put in a default taxi time for the automatic logging function as otherwise the time recorded starts with the takeoff roll and stops during the landing roll. Endorsements may be tailored by the instructor, but start out with what is considered standard FAA language. The app tracks your currency in areas that you can select and includes color-coded markers to quickly let you know if you are current in that particular area.

Excel Pilot Logbook (www.excelpilotlogbook.com) For a one-time download fee of $39, we like the Excel Pilot Logbook. It is essentially a spreadsheet that displays in logbook format and is compatible with Windows and Mac computers as well as Apple and Android devices. To use multiple devices, it is necessary to keep the spreadsheet in an app that allows you to sync files to your computer such as Google Drive or Dropbox. As this is not a web-based app, you'll need to back it up as you would with anything on your computer—the makers recommend Dropbox. As with its competitors, the software provides flight hour summaries, currency monitoring and graphic display of your flight data. We also like that the pilot logbook display can mimic a paper logbook with the advantage of being able to customize the columns to track specific types of flight time, an advantage for those who fly multiple types of airplanes. In addition, the log will track crew duty time for Part 135 and 121 pilots.

We did not see any indication that the software had provisions for endorsements, a shortcoming, in our opinion. The website has a basic set of FAQs and how to guide to get you running.

Log Ten Pro X (www.coradine.com) This app for Apple devices works for pilots of all experience, but seems to be targeted at newer pilots aiming for a job in aviation—it's free for your first 40 hours of flight time—and it tracks crew duty time. It allows you to select one of a number of configurations that best suits the type of flying you do—although you can choose to fully customize a configuration of data. As you progress in your aviation career, it's easy to update the configuration of the logbook so the data fields most pertinent to you are displayed.

The system syncs between all of your iOS and Mac devices via iCloud. The website contains a number of brief videos that help explain operation of the app. While the app does not automatically record flying time, the "Fly Now" feature allows you to use your iPhone to tell it that you are getting ready for brake release and it will start a new logbook entry with the time and location using the phone's GPS and its database of airports. After landing, another tap causes it to enter the end time and location. The logbook entry is made automatically, although you can input additional details. The app is set up to accept endorsements and print customized reports and create an FAA 8710 form. We did find pricing a little confusing—a one-time fee of $99.99 if you're just going to use it on a Mac or an annual fee starting at $56.66 to use it on all of your iOS devices.

Logbook Pro (www.nc-software.com) has been providing logbook software for 18 years. For $69.99 for the standard software—with free lifetime updates—the program is highly customizable both for logbook columns for flight data but also for tracking currency.

Syncing with portable devices requires purchasing an annual subscription, something also required for cloud backup of your data. The program will also import an airline pilot's schedule and trip data from various airline scheduling programs.

CONCLUSION

As we said at the beginning, we lean slightly toward ForeFlight and Garmin—because of overall value for the price; the logbooks are part of the EFBs—and Safelog because of its sophistication. Nevertheless, overall, we think there is a plethora of riches available to pilots in the world of electronic logbooks.

Certified PreOwned: Price-Setting Revisited

A sales dealer offers an inside look at the unique process of setting the price of a preowned aircraft.

by Fred Ahles

The January 2016 issue of *Aviation Consumer* included an excellent overview on the merits of manufacturer-sponsored certified preowned (CPO) aircraft sales programs. While this growing market trend is attracting a great deal of buyer interest (especially for Mooney models), there is still some confusion on how resale pricing is determined, how much more buyers will pay for these top-of-the-food-chain machines and whether that increment is really worth it.

In this short follow-up, I'll offer an insider's perspective on how we—a CPO Mooney dealer—determine what you'll really pay and why there might be sizable discrepancies with pricing publications.

BRIDGING THE PRICE GAP

It's important for manufacturers and dealers to understand and support the used market because it affects the credibility of the brand. In Mooney Aircraft's case, if an individual wants to purchase an aircraft, but can't justify (or can't afford) a brand-new one, a range of pre-owned choices still keep buyers in the Mooney family.

In the used market, you will see a huge disparity in equipment, hours of operation, maintenance and damage history, cosmetics and a host of other factors which affect the price of an aircraft. Simply put, a certified preowned program ensures that discriminating buyers have access to aircraft that have had superb care and are in superior condition, but there is a narrow supply chain.

Consider that in late January, there were about 154 Mooney Acclaims, Ovations and other models on the market, but just four that meet the stringent criteria required of a CPO aircraft.

As an example, let's revisit the numbers on the late-model Mooney Acclaim, N189FA, which appeared in the previous article. This 2008 Acclaim Type S qualifies for the Mooney CPO program and is on the market for $499,000, but *Aircraft Bluebook* suggests an average retail price of $365,000. Why the attention-getting price gap? The bulk of it is attributed to routine adjustment, not CPO status.

2008 MOONEY ACCLAIM TYPE S (CPO PREMIUM $21,660)

AIRCRAFT BLUEBOOK AVERAGE RETAIL AND ADJUSTMENTS	COMMENTS
*$365,000	**Aircraft Bluebook* published average price
$15,400	Low airframe hours (add 4.3% for low usage)
$2900	Low time engine
$20,000	Air conditioning retrofit
$20,000	Type S model (not shown in *Aircraft Bluebook*)
$10,000	G1000 SVT synthetic vision (not shown in *Aircraft Bluebook*)
$30,000	WAAS upgrade (not standard until model year 2009)
$2000	Jeppesen electronic charts
$12,000	310-HP engine modification (not shown in *Aircraft Bluebook*)
$36,500	Prime condition price adjustment
$513,840	Predicted retail price
*$499,000	*Dealer asking price

First, *Aircraft BlueBook* represents an average retail price of preowned aircraft. Average airframe hours are used to compute base average and half-time engine hours is assumed. So, if a plane has more or fewer airframe or engine hours, the value needs to be adjusted.

Additionally, the price guide doesn't take into account much of the equipment installed in the aircraft—a factor which greatly affects the price. The chart below shows the *Aircraft Bluebook* average value and the appraisal adjustments made to the Mooney Acclaim.

Notice that *Aircraft Bluebook* allows the appraiser to add between 5 to 25 percent for what's known as a "prime condition adjustment," which is normally about 10 percent above *Bluebook*. While the size of that adjustment varies from airplane to airplane due to dozens of factors unique to each aircraft, this aircraft is arguably the top prime condition aircraft on the market today and offers the advantages of the Mooney CPO, which no other Acclaim on the market at this time does. That CPO status results in a $21,660 price premium.

The CPO value-added factors, which represent the price increment above, includes 27 points of inspection, repair and refurbishment of the engine, avionics, airframe, interior and exterior. Additionally, the aircraft is in close-to-new cosmetic condition, it has no damage history, it has always been hangared, has complete logs, a fresh annual inspection and all maintenance done at a Mooney Service Center. Many of these factors aren't found in the *Bluebook*.

Other items which add value to this Acclaim example include the following equipment: Garmin GFC-700 autopilot, WX500 Stormscope, Skywatch active traffic system and a 406 MHz ELT.

Bottom line: You'll pay a premium for CPO aircraft because they are in superior condition, which some buyers want, and many do not need. A reputable dealer will walk you through an appraisal in detail, explaining the unique factors that drive the asking price of an airplane.

Fred Ahles is the president of Premier Aircraft Sales in Fort Lauderdale, Florida.

Piper Super Cub:

Put on floats, tundra tires and snow skis, the PA-18 Super Cub is easy to fly and holds value in a soft market.

The development of Piper's Super Cub is as much a story of survival as it is progress. While the role of the original J-3 was mainly for training, Piper had to bring more utility to the table than the Cubby's 75 MPH cruise speed, 200-mile range and 450 FPM climb performance. Enter the refined PA-18 Super Cub, a design that's still being tweaked some 66 years later through several so-called Cub clones, which includes nicely executed models from Cub Crafters and American Legend Aircraft, to name a couple.

Still, there's no arguing that a real-deal PA-18 can hold its own in the outback as a get-down-to-business workhorse as much as it can satisfy the appetite of weekend warriors showboating at their lakehouses, ski cabins and backcountry landing strips. And a good Super Cub isn't a bad investment, either, hanging on to its value in a market where some other utility machines take it on the chin. Tricked out with engine mods and aesthetic improvements, it's not uncommon for a Super Cub to sell well north of $125,000, and much more when rebuilt to new standards,

Because it's so versatile, delightfully fun to fly, not terribly expensive to operate and possessed of what can only be called the Cub cachet, a PA-18 holds its value better than almost any other airplane.

In the air, the Super Cub flies like a Cub. That's good and bad.

In the hands of a pilot who's aware of its limits, a Super Cub can do about anything, except go fast. Being comfortable in one might require some aftermarket tweaking, too.

Because there are so many modifications to PA-18s, legal and otherwise, and because a significant proportion have been worked hard and put away wet, so to speak, finding a good one requires the willingness to do homework and have a pre-purchase inspection performed by someone who knows the marque.

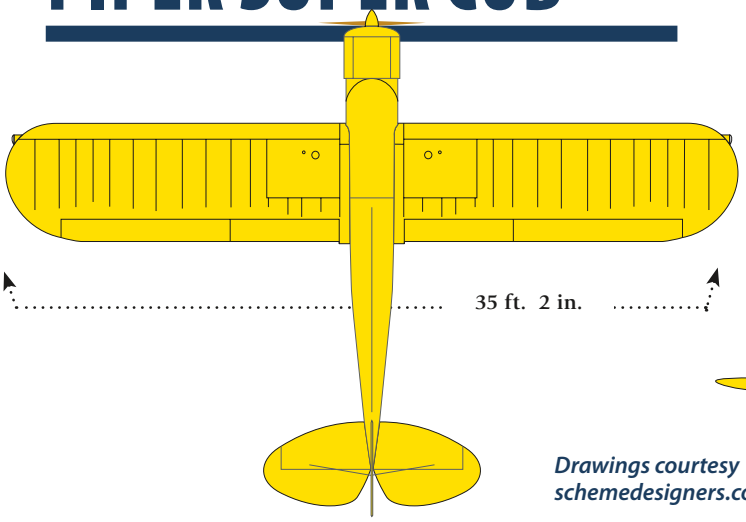
MODEL ORIGINS

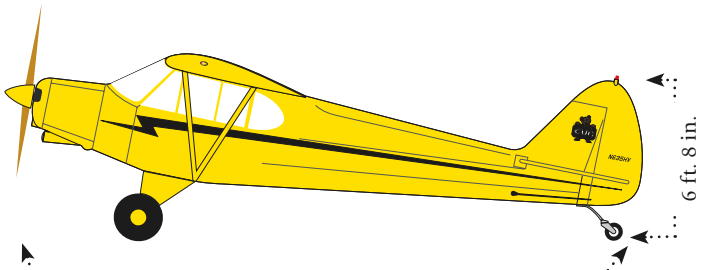
The Super Cub's family tree grew from the 1935 E-2 Cub, which, once the cockpit was enclosed and a slightly larger engine installed, became the J-2 and in 1937, the J-3 Cub. Mimicking the yellow-and-black paint scheme to compete with the popular Aeronca C-3 and with more room and better performance, the Cub sold in droves, reaching its production peak in 1946.

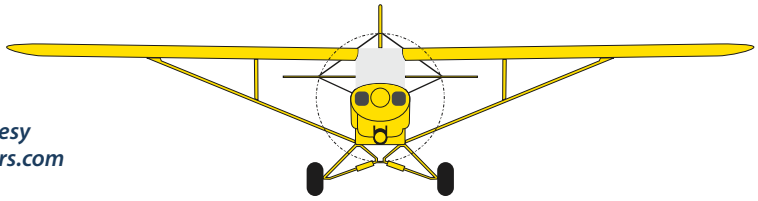
In 1948, it was spruced up and renamed the PA-11. The PA-18 Su-

For work or play, the landscape in the main photo is where a Super Cub shines. That's a rebuilt PA-18A, initially designed as an agricultural sprayer/duster.

PIPER SUPER CUB





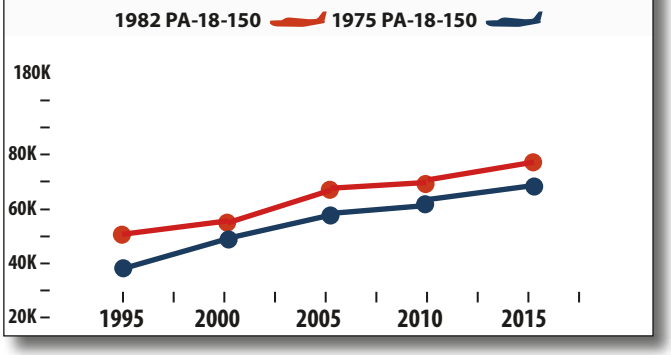


Drawings courtesy schemedesigners.com

PIPER SUPER CUB MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL	CRUISE	TYPICAL RETAIL
1950-1955 PA-18-95	90-HP CONT. C-90-12F	1800	$16,000	18	700	85 KTS	±$37,000
1956-1961 PA-18-95	90-HP CONT. C-90-12F	1800	$16,000	18	700	85 KTS	±$38,500
1950 PA-18-105	115-HP LYC. O-235-C1	2000	$21,000	36	675	96 KTS	$38,500
1951-1952 PA-18-125	125-HP CONT. O-290-D	2000	$17,000	36	655	97 KTS	±$41,000
1952-1954 PA-18-135	135-HP CONT. O-290-D2	1500	$17,000	36	872	95 KTS	±$42,500
1955-1960 PA-18-150	150-HP LYC. O-320-A2A	2000	$21,000	36	804	100 KTS	±$50,000
1961-1978 PA-18-150	150-HP LYC. O-320-A2A	2000	$21,000	36	804	100 KTS	±$65,000
1979-1981 PA-18-150	150-HP LYC. O-320-A2A	2000	$21,000	36	804	100 KTS	± $72,000
1982-1990 PA-18-150	150-HP LYC. O-320-A2A	2000	$21,000	36	804	100 KTS	±$80,000
1991-1994 PA-18-150	150-HP LYC. O-320-A2A	2000	$21,000	36	804	100 KTS	±$94,000

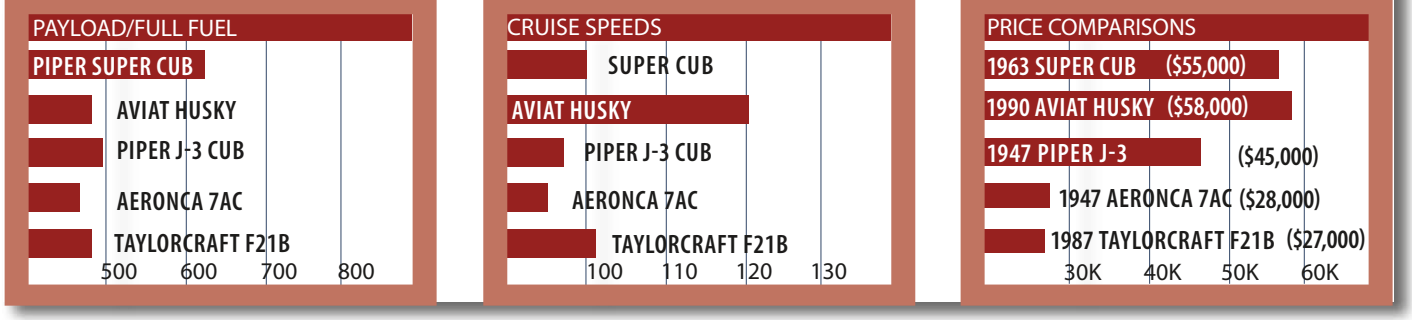
RESALE VALUES



SELECT HISTORICAL ADs

AD 99-01-05	WING STRUT/FORK INSPECTION
AD 85-06-04	FUEL TANK TUBING LEAK
AD 78-10-03	FUEL CAP VENTING MODIFICATION
AD 68-05-01	MUFFLER PRESSURE TEST
AD 62-02-05	RUDDER CABLE ATTACHMENT LUG

SELECT MODEL COMPARISONS



Cub Crafters can rebuild a Super Cub starting at $65,000. The one to the left is decked out with an Oregon Aero leather interior, amphibious floats and a 180-HP engine.

per Cub model appeared in 1950, although the first, the PA-18-95, was little more than a PA-11 with a 90-HP Continental. Coincidentally, the PA-18-105 debuted with a 115-HP Lycoming, flaps, a counterbalanced elevator and other features that separated the Super Cub from its ancestors.

In 1951, the O-235 was replaced with a 125-HP O-290; in 1952, that engine got souped up to 135 HP. Finally, in 1955, the Super Cub got the engine that it really deserved: a 150-HP Lycoming O-320-A2A, which it kept until Piper dropped it from the line in 1994. The Super Cub remained essentially unchanged throughout its production run.

All Super Cubs carry the PA-18 designation. Those originally fitted out as agplanes were called PA-18As; these should be looked on with caution, because of a likely history of hard use and exposure to corrosive chemicals.

Changes and options to the Super Cub were few over the years and came, as in the old VW Beetle, only as necessary improvements. Here's a list of some of the more important functional changes:

In 1961, an optional metal belly pan was made available on all Super Cubs. (Previously, it was supplied only on the cropdusting versions.) The mod also includes a beefed-up lower rear fuselage. The option is a good one, but watch out. Many of the airplanes ordered with it were used as chemical sprayers, and the structure may have suffered corrosion as a result.

About 1965 (even Piper couldn't tell us the exact date), zinc chromate anti-corrosion treatment was added to the wings. If you're considering a mid-60s model, remove an inspection cover and check the color of the metal. Yellowish green is good, anything else is not so good. At the same time, Piper beefed up the fuselages with more 4130 steel and heli-arc welding.

In 1971, Piper switched from Grade-A cotton fabric covering to long-lasting Ceconite. Although cotton shrinks less in cold weather, it has a shorter lifespan, from three to a maximum of 10 years. Ceconite, by contrast, will last 10 years under most conditions and can go much longer than that if pampered.

In 1976, the old visual float fuel gauges were replaced with panel-mounted electric gauges. Although they are neater looking, pilots tell us the old gauges are more accurate and reliable.

In 1977, Piper switched from the old-style DC generator to a 60-amp alternator. The alternator is retrofittable to older models, however, and is a desirable feature for Super Cubs equipped with multiple radios, strobes and other electrical gear.

In 1978, the ailerons were changed from fabric to aluminum. Although cheaper to fabricate, the metal surfaces are not so easily repaired, a problem for bush operations. Like the alternator, the metal ailerons are retrofittable to older airplanes. The year 1978 also saw a switch to more powerful and reliable Cleveland brakes, a partial solution to the Super Cub's long-standing awkward and ineffective heel brakes. These are retrofittable to older aircraft.

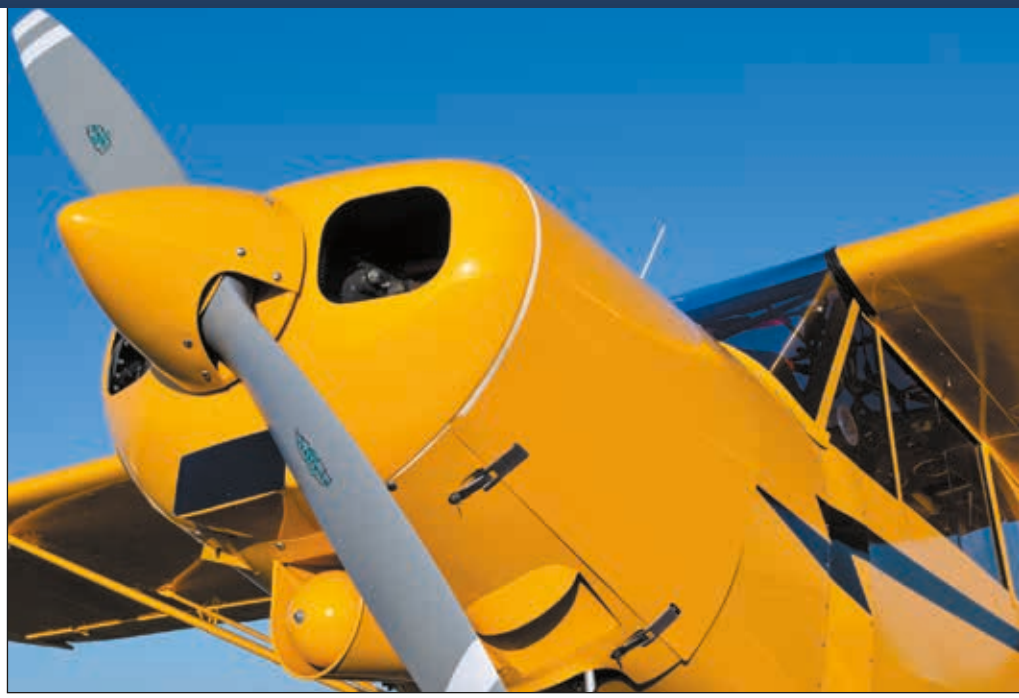
Like many other airplane models, the Super Cub died in the Big Slump

that hit general aviation in the early 1980s. In 1981, Piper sold off the marketing of the Super Cub to a Texas company called Wes-Tex, for which Piper manufactured airplanes to order in lots of 50 or so. That arrangement lasted only two years and production of the PA-18 line ceased altogether in 1983 after a total run of 33 years and 8442 aircraft.

In an attempt to revive the line in 1988, Piper announced that it would resume production of the PA-18, and even offered an innovative new purchase scheme designed to hook into the successful homebuilt industry: A buyer could purchase a Cub kit and build it under factory supervision.

The kit idea really never took off, at least in part because of Piper's financial troubles. The option was dropped after a couple of years and today owner-assembled airplanes are valued at some $12,000 less than their factory-assembled peers.

Production of new Cubs continued, sort of; three were built in 1988, 49 in 1989, seven in 1990, none in 1991 (bankruptcy) and only one in 1992. The line ramped up in 1993; and 108 were built before production was stopped entirely after the 1994 model year. The emergence of New Piper divorced the company entirely from anything to do with new Cubs.



It's easy to tell a Super Cub from a J-3 by its closed cowling, top. With an electrical system, a Super Cub can support panel avionics and instruments, bottom.

MARKET SCAN

Simply put, the Super Cub holds its value extremely well. Scanning values in a recent *Aircraft Bluebook*, we note that even recent models are worth more than their new list price, although inflation isn't figured into the numbers. If a bargain comes on the market, it's wise to check carefully for serious corrosion or other hidden surprises. There are not any inexpensive Super Cubs.

A 1975 model, for example, sold new for $19,700, but in 2011, Bluebook gives the average retail as $65,000, a bit more than it was the last time we reviewed the Super Cub five years ago. Trade-A-Plane shows listings in the 90s, with some asking prices well north of $110,000. Some of these are equipped with color mapcoms and GPS.

For comparison, consider the Aviat Husky, an airplane designed to compete directly with the PA-18, but equipped with 30 more horsepower. A 1989 Husky's average price when new was $63,400 and is now has an *Aircraft Bluebook* value of $56,000. A similar-vintage Super Cub sold new for just over $56,000 and is now worth nearly $80,000, according to the *Bluebook*.

In 1980, we commented on the excellent resale value of the older models and went on to state: "It's not likely that the current production Super Cubs will do as well; the current new price of $30,000 is highly inflated and it's doubtful that a 1980 Super Cub purchased today will ever fetch $30,000 again (assuming reasonable inflation rates)."

Well, guess what? The current value of a 1980 Super Cub is roughly $72,000. Checking the inflation tables, $30,000 in 1980 dollars is about $86,000 in 2016 dollars.

PERFORMANCE

It's not hard to imagine what happens when you put a big engine and a big wing on a light, two-place airplane: STOL performance to burn and this is why people buy Super Cubs. Although bigger, more complex and more expensive aircraft like the Helio Courier have established excellent reputations for STOL performance, if you ask the people who really use them—the bush pilots, the cropdusters, the outback charter pilots—the Super Cub is usually considered the ideal STOL airplane.

One Alaskan bush pilot summed it up this way: "Owning the Super Cub is like owning a vital share in the Alaska bush flying arena, if there is such a thing. Knowing that it is the Super Cub that pioneered true off-airport operations in terribly rough terrain and continues to hold its own as the king of STOL working bush-

It's easy to find action in a Super Cub. We're having too much fun flying one on Edo 89-2000 floats in the top photo. That's reader Gregory West's clean PA-18, bottom. Photo courtesy of Christopher Buff.

planes. That's just my opinion, based mostly on working them and the simple fact that it is the most widely used airplane here when I look around the bush flying community."

It comes from this: Book takeoff roll at gross weight is 200 feet. Heavily overloaded, a Super Cub may grind along for 300 feet before becoming airborne, pilots tell us. Now, with the addition of VGs and progressively larger engines, takeoff rolls in the double digits on calm days are being reported.

Book rate of climb is 960 FPM, although that's at 50 MPH, which generates a climb gradient of some 22 percent. That claim might be viewed with at least a raised eyebrow, given our examination of Super Cub accidents—many involved hitting an obstruction after takeoff or stalling while trying to clear an obstacle. Either that or optimistic pilots are given to try and get more performance out of Super Cubs than was ever built in.

The tradeoff, even with lots of power, is that a Super Cub is not going to get anywhere quickly. Figure on cruise speeds in the 100 to 110 MPH range on 8 to 8.5 GPH.

RANGE/PAYLOAD

Discussing the legal loading of Super Cubs is enough to send working pilots into knee-walking howls of laughter. The PA-18 is probably overloaded more consistently, by bigger margins, than perhaps any other airplane, perhaps other than the Husky, which has the same space and a smaller legal payload.

Yes, we see the ivory-towered safety set waving the index finger at us. However, they overlook the need for a pragmatic approach to professional aviation, particularly in the back country, and probably wouldn't know a Super Cub if it leaked oil on them.

They don't take into account that the 150-HP Super Cub has the same engine as the Cessna Skyhawk had for many years, as well as a bigger wing, but a gross weight of 550 pounds less. "Overload" a Super Cub by 550 pounds and you've still probably got more climb performance than a grossed-out Skyhawk. In these days of marketing hype, the word "Super" can still mean something.

In the context of tailwheel airplanes, with their designed-in instability on the ground, unforgiving nature in crosswinds, poor visibility in three-point attitude and willingness to bounce unless the landing is just right, the Super Cub may be easier to handle than most. It has no built-in bad habits on the ground, although the heel brakes can be challenging to the newcomer. It has very good visibility over the nose from the front seat, from which it is soloed. Not so the back seat.

So long as a pilot is willing to learn how to fly a tailwheel airplane and give it his or her undivided attention on landing and takeoff, the Super Cub is capable of handling strong winds and challenging landing areas safely. That being said, the loss of control accident rate for the Super Cub is awful. The heel brakes come in for some share of the blame, but tailwheel airplanes are more demanding than nosewheel models.

Because many of the Super Cub landing and takeoff accidents we reviewed occurred at off-airport sites and because the PA-18 is so capable, it may be causing pilot egos to write checks their skills can't cash by attempting to operate on strips that are simply too short or too narrow for the pilot to handle.

In the air, the Super Cub flies like a Cub. That's good and bad. It does handle as nicely as a Cessna 150, for example, but it's generally easy to fly for a 1930s design, harmonized in pitch and yaw, but ponderous in roll. It's forgiving in all phases of flight except for an uncontrolled stall and there is virtually no stall warning.

Inflight handling does not change much when either floats or skis are swapped for wheels, something that makes it a good airplane for pilots transitioning to floats or skis. Its lack of dihedral means it has no roll stability. Bags of adverse aileron yaw require that a pilot learn to use the rudder, something that is essential when maneuvering because it is vicious in an uncoordinated stall, rolling rapidly and losing 300 to 400 feet of altitude quickly.

This behavior has killed more than a few folks engaged in pursuing wildlife at low altitude and who didn't keep the ball centered when yanking and banking. In Alaska, the resulting low-altitude stall, roll and dive into the ground has gained the appellation, "moose stall." We were told by a number of pilots that the installation of VGs makes an uncoordinated stall much less exciting, taming the roll and nose drop.

Admission should be charged to the comedy routine that is a first timer entering a Super Cub. Once inside, legroom is poor while shoulder and headroom is more than adequate. Stock seats become quite uncomfortable after a couple of hours of flight. Aftermarket seats can improve the situation dramatically. Baggage room is limited to a shoulder-width compartment behind the rear seat. Visibility is perhaps poorer than you'd expect from a tandem high-wing, but you'd be right to expect quite a lot. Noise damping in flight is almost non-existent, so bring a good headset.

MAINTENANCE

Generally, the Super Cub is a rugged and robust airplane that's easy to fix in the field. Annual inspections typically run in the $500 to $700 range, although some get by for next to nothing if the owner does a lot of the work himself. On the other hand, the fabric covering and steel tube fuselage means that the potential for catastrophic annuals is always just around the corner. Corrosion is becoming an increasingly serious concern as the airframes age.

Derek DeRuiter of Northwoods Aviation in Cadillac, Michigan, a company that has long operated Super Cubs on wheels, floats and skis, reported that their Super Cubs are easy to maintain and that switching from wheels to floats takes only three hours compared with more than ten for a Husky. Further, installing wheel skis takes only an hour. He also reported that parts have always been readily available, a definite consideration when purchasing a vintage aircraft.

According to Super Cub mechanical mavens, here are some specific potential trouble spots to look for when considering any used PA-18 for purchase:

· Corrosion in the steel fuselage tubing and wing struts and forks. Particularly check the lower rear tubes, and be extra careful if the plane has done any spraying duty.

· Fatigue cracks in the threaded clevis bolts on the wing struts.

· Worn-out landing gear hinge and shock strut bolts and bushings. The Super Cub gear is likely to have taken a frightful pounding over the years; inspect it closely.

· Worn top rudder hinge bushing, especially on aircraft with rudder-mounted beacons.

· Loose or worn-out elevator trim jackscrew, especially in aircraft used for glider or banner towing.

Another item to consider: Find out the airplane's service history and inspect accordingly. Try to avoid airplanes used for glider or banner towing or cropdusting. If it served as

SUPER CUB WRECKS: HEY! WATCH THIS!

Our review of the 100 most recent Super Cub accidents introduced us to more than the usual stupid pilot tricks we see when we do these reviews for the Used Aircraft Guide. We can't help but wonder if the ability of the airplane to use unimproved airstrips and maneuver well at low speed causes a certain percentage of pilots to shut off their aeronautical brains.

We'll start with the more prosaic accident causes. We saw fewer runway loss of control (RLOC) accidents than we expected, 40. Of those, 13 involved the airplane flipping over in the process. Four botched go-arounds and one hard landing brought the landing-related accident total to 45—a number that is slightly below what we've seen for the Super Cub's peers, the Aviat Husky, American Champion Scout and tailwheel Maules.

We noted that a number of RLOC accidents included the upwind wing being lifted in a crosswind—and two airplanes were flipped by the wind while either stopped or taxiing slowly. Properly positioning the ailerons for the wind is important in a Super Cub.

On the plus side, there were no CFIT or VFR into IMC accidents—something we cannot conveniently recall observing for any other type of airplane. It doesn't mean Super Cub pilots aren't scud-running, but it may mean that the good forward visibility and ability to fly slowly helps them get away with it.

Fourteen accidents involved engine problems of some sort, about half of which were undetermined. Two pilots who flipped their airplanes during botched landings on gravel bars claimed that the engine had lost power leading to a forced landing. We put those in this category although we aren't sure the claims pass the sniff test.

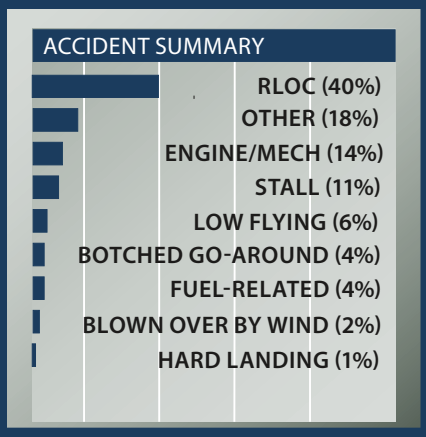
Stalls and low flying combined to lead to 17 accidents. Two involved ranchers who were using their Super Cubs to herd cattle and crashed. Low altitude stalls proved fatal in four accidents. With no camber on the horizontal stabilizer, the Super Cub often rolls rapidly following a cross-control stall—and it can take several hundred feet to recover. In Alaska, those are known as "moose stalls" from fatal low-altitude stall crashes of pilots looking for game. In our review, all of the low-altitude stall/incipient spin crashes also involved severe post-crash fires.

A high proportion of Super Cub accidents involved off-airport operations. Of those, several were due to poor choices of landing sites—deeper snow than expected, rough terrain taking out landing gear or hidden ditches and fences.

Low flying escapades included one pilot who decided to buzz his neighbor's house. He hit the neighbor's potting shed with its right wing and then crashed into his own hangar.

A runway stunt with a motorcycle, Jeep and Super Cub went tragically wrong when the pilot hit the Jeep with his left wing, causing it to swerve. The pilot landed safely; the Jeep hit trees adjacent to the runway, killing both occupants.

Finally, a pilot who had had his medical revoked for repeated DWIs decided to "ski" his Super Cub by dragging the main gear in the water. On the fifth pass he hit a sand bar and flipped the airplane. His first words to his rescuers were, "Don't call the cops."



a bushplane, check the landing gear carefully and double-check the accident history and repair log.

Pipeline patrol is easy on engines but tough on wings because of the constant turbulence at low levels. And remember that tailwheel airplanes such as the Super Cub are likely to have a groundloop history, so check for hidden wingtip damage. There's a significant AD on the wing struts, AD 93-10-6 (this was once two ADs, 77-3-8 and 81-25-5). Part of the AD calls for annual inspections of the struts for corrosion, as well as treatment with a rust inhibitor (linseed oil). The service bulletin the AD specified using a Maule punch tester on the strut; however, some mechanics doubt the effectiveness of this test.

The other part of the AD addresses the lift-strut forks. According to the AD, the original machined-thread forks were prone to fatigue cracking. The fatigue apparently originated at the bottom of the thread grooves, which were very sharp. The problem was exacerbated by people using the struts as steps when getting in and out of the airplane.

The AD calls for Magnaflux inspection of the forks to detect cracks, with the inspection repeated every 500 hours thereafter. If no cracks were found, then the forks could be returned to service if they had less than 2000 hours on them (1000 hours for floatplanes or any airplane that had been on floats at any time in its life).

MODIFICATIONS

"Millions of 'em." That's a good description for the number of mods available for Super Cubs. Owners swear by VGs on the PA-18 for stall speed reduction and improving stall behavior. Safety cables—attached to the landing gear to keep it from collapsing—should a bungee or strut fail, are popular. Shoulder harnesses retrofits are a must, in our opinion. Tundra tires, baggage pods, wider cabins, even nitrous oxide injection is out there for sale. To get feedback from users, we recommend going to www.supercub.org, which has become the de facto place to be for those interested in the Super Cub. The site is a wealth of information for Super Cub owners. Steve Johnson runs www.supercub.org, the website

David Berger's Super Cub sits peacefully after landing by dew ponds on Two Barrows Hill in Exmoor National Park in South West England, top photo. That's PA-18 serial number one, bottom, completely restored to original condition by Roger and Darin Meggers, with Clyde Smith Jr.

for information and conversation on the PA-18.

Cub Crafters builds a "Top Cub" which is modeled on the Super Cub, but certificated under FAR 23. And since our last report, it has introduced the Carbon Cub in the LSA category, with a 180-HP ASTM-approved engine. The airplane stomps the competition at Alaska's STOL contests—but it can't carry 500 pounds of elk meat.

Although it bases the designs of its airplanes on the Super Cub, CubCrafters significantly altered and improved the airframe, so few if any of the parts are interchangeable with a PA-18. However, CubCrafters does specialize in Piper Super Cubs and will completely rebuild them or install many of the numerous available mods.

You can hand over your own Super Cub for rebuild, or Cub Crafters can provide one. As Cub Crafters' John Whitish put it: "Most folks don't want their Cub "as new," they want it better." This might include a 180-HP engine, extended heavy duty landing gear, new avionics and a variety of other modern amenities. For that reason, it's not uncommon for owners to invest $150,000 just in the rebuild. Contact Cub Crafters at www.cubcrafters.com.

OWNER COMMENTS

We operate a Super Cub on floats in the summer and on skis in the winter here in Cadillac, Michigan. The Super Cub performs great with any gear configuration, wheels, floats, amphibious floats, skis and wheel/skis, always having short takeoffs and landings and a good climb rate. We do a great deal of seaplane instruction and students learn to fly the airplane quickly, as it is easy to fly, but challenging to fly well.

It is easy to maintain and it is easy to completely rebuild it to be better than new. There are a huge number of STCs available, with the auto fuel STC being important for float operations.

On the downside, the plane has limited room for people and baggage, and it's hard to get in and out of the cockpit. Cruise speed is slow, especially with a seaplane prop and the cost of buying one is very high, because of the nostalgia of the Super Cub. It will fly into the stall with little warning and you must keep the rudder coordinated.

I enjoy flying both the Super Cub and Husky. They are very similar in design and function. Aviat did a great job with the Husky, improving on the pattern of the Super Cub. In the end, however, I would choose a well-restored and equipped Super Cub over a Husky.

Derek DeRutier, Northwoods Aviation
Cadillac, Michigan

I have owned my more or less stock PA18-150 (G-CUBP, now VH-YUP) since 2002 and flown it just under 900 hours, mainly into short farm fields in SW England and in Australia for the last year. I love this aircraft. Nothing beats loitering in a Cub on a soft, still summer evening with the door open and the wheels kissing the grass at last light.

The aircraft is easy to fly (one of the easiest of the taildraggers), but it is so easy it lulls you into a false sense of security and will bite if you are careless. It slows down very quickly and you can easily get way behind the curve on the landing approach, where you need to be ready with lots of power. It's a stick and rudder aircraft and unless you master the use of rudder input, your passenger is in for an uncomfortable ride. I have Micro Aero VGs and thoroughly recommend them, less for their effect on stall speed than for their effect on aileron authority at low speed.

KSN770

(continued from page 17)

problems. That's reassuring for other buyers.

When the dust settles, there will be some sacrifices. Buyers expecting an all-inclusive and complete ADS-B In and Out solution without having to supplement the interface with a tablet computer won't find it with the KSN770. It's just not there, yet. As we've seen in the past, timing the TSO process is unpredictable.

BendixKing's Roger Dykeman told us the company plans to complete the ADS-B In interface at some point, but couldn't tell us when that would be. The other missing link is a wireless I/O for handing off flight plan data. That exists, to some degree, in the bigger Apex, so it could trickle to the KSN770. We'll keep following the product and report on its status.

Contact www.bendixking.com, 855-250-7027

Piper Super Cub

(continued from page 31)

My 15-year-old son has been flying with me since he could walk and now flies solo in the Super Cub after a few hours of tuition. It's a great teaching aircraft.

The only thing is a Super Cub is slow—really slow. That wasn't such a problem in the UK and Europe. Here in Australia it's more of an issue, especially since the stock seating is not comfortable. An upgrade from Oregon Aero is a good option. One important thing to note: I bought a Gallet helmet at great expense. The front seater, especially, is surrounded by a cage of metal which will bash his head in any kind of accident.

I draw your attention to the FAA study from Alaska (http://tinyurl.com/jbmjkj7), which included the following quote: "Thirty three lives might have been saved through the use of helmets in tandem seat airplanes, such as Super Cubs."

My advice to any Cub pilot, especially ones who are using them for their intended purpose of backcountry aviation, is to invest in a good helmet and use it. It's way cheaper than even a minor head injury.

If you want an opinion on the Legend Cub and Super Cub, contact Dan Compton, who is training ab initio in them here in Australia: http://www.wingsoutwest.com/.

David Berger
via email

Maintenance on a good Super Cub in dry Wyoming is relatively painless and annuals run in the neighborhood of $450 to $650. Being a fabric-covered aircraft leaves the door open for substantial repair in the future. Care and maintenance is reflected in the lifespan of the fabric.

The Lycoming O-320, 150-HP is nearly bulletproof provided it is run on a regular basis and receives scheduled oil changes. It will digest about any fuel you feed it.

We see 106 MPH at 2475 RPM, burning 8 to 8.5 GPH. Admittedly not something that will light your hair on fire, but the Super Cub's beauty is in its slow flight characteristics and its ability to get in and out of short, unimproved strips that would drench the underwear of a pilot flying anything else.

Ray Dennis
Casper, Wyoming

My 1964 Super Cub was totally restored in 2000 with Wipline 2100 amphibs, 160-HP and numerous other mods. The aircraft is low maintenance with 400-plus hours since major overhaul.

It burns about 9 GPH and VGs give it a 28 MPH docile stall. The aircraft works well on the water, getting off in eight to 10 seconds. Insurance runs $2400 a year.

We own four aircraft and the Super Cub is by far the most fun.

Gordon Richardson
Caldwell, Texas

FEEDBACK WANTED

PIPER MALIBU

For the June 2016 issue of *Aviation Consumer*, our Used Aircraft Guide will be on the Socata Piper Malibu. We want to know what it's like to own these big singles, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your airplane to appear in the magazine, send us any photographs (full-size, **high-resolution**) you'd like to share to the email below. We welcome information on mods, support organizations or any other comments. Send correspondence on the Malibu by April 1, 2016, to:

Aviation Consumer
e-mail at:
ConsumerEditor@hotmail.com