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The Aviation Consumer®

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The Aviation Consumer

EDITOR
Larry Anglisano

SENIOR EDITOR
Rick Durden

CONTRIBUTING EDITOR
Jim Cavanagh
Paul Robichaux

EDITOR AT LARGE
Paul Bertorelli

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

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

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FIRST WORD

DO MANUFACTURERS HAVE GOOD-FAITH OBLIGATIONS?

In the product warranty article in the April 2019 *Aviation Consumer* we described reader Joel Rosenlicht's unfortunate experience with the Rolls-Royce 250-B17F turboprop engine in his Silver Eagle-converted Cessna P210. To recap, Rosenlicht flew the converted airplane for nearly 11 years and 1000 hours before the original Roll-Royce engine began making metal. When the engine was removed for evaluation, Griggs Aviation opened the gearbox (one of the engine's chip detectors flagged metal in that location) and found a half-inch polishing stone with gouges in its side. Assumably the stone was used during the manufacturing process for the gears—and accidentally left inside of the gearbox when the engine was assembled. Call it luck (I'm not sure if it's the good or bad kind), but that stone must have parked itself in a benign location within the gearbox for the years Rosenlicht flew the aircraft.

Although Rolls Royce provided some components for the gearbox (in the article we incorrectly said the company provided an entire gearbox), Rosenlicht was left with a bill north of $70,000 for the remainder of the engine work, plus freight charges and months of downtime. He made an insurance claim because his policy (through Alliance) covered damage from foreign object damage. While it looked like the insurance company would pay the claim, it was ultimately denied, presumably because the polishing stone wasn't sucked into the engine while the aircraft was in service. If the aircraft crashed because of engine failure, it would have been a different story. Additionally, Rosenlicht told me his policy won't be renewed (he was a clean customer for over 30 years) because the company isn't insuring Silver Eagle-modded Centurions moving forward.

Shortly after we ran the article I got a letter from Bob Mittelstaedt who did a Silver Eagle conversion on his P210 in 2007. Eleven years and 900 hours later the engine gear case began leaking oil from a boss on the left side of the case used to mount the engine to the airframe. According to Mittelstaedt, it was determined that the depth of the bolt hole in the boss was .15 inches short of spec, which caused a crack at the bottom of the bolt hole that penetrated the case. The bolt was never touched after the original installation and the engine was never removed from the aircraft.

"It was way out of warranty, but Rolls was not willing to do anything—not even a discount on the $43,000 (not counting removal, installation and testing) it charges for a new gear case," Mittelstaedt said. He spent $69,062 to troubleshoot, remove the engine, send it out to change the gear case (with mandatory upgrades) and reinstall the engine. In both of these cases, the Rolls-Royce engines were clearly out of the original warranty and Rolls had no legal obligation to cover the repairs. But is it reasonable to expect a manufacturer to step up and fully make good on repairs that are the result of manufacturing defects? Some argue that it should. Rosenlicht pointed out that in the auto industry, as one example, manufacturers often cover defects through recalls (although Nissan left me high and dry when the transmission in my Xterra roached after its fluid mixed with engine coolant, the result of a faulty OEM radiator). I think part of the problem in aviation is that companies simply don't have the money to be handing out replacement engines outside of the warranty period, although it might be argued that Rolls-Royce has resources to do so, or perhaps not.

To find out, we reached out to Rolls-Royce for comment on these Silver Eagle engine issues and to date it has ignored us—not something I would expect from a company of its caliber, which damages its customer service even further. I have to assume that Silver Eagle Cessna conversions are small potatoes in Rolls-Royce's world, but for the buyers like Rosenlicht and Mittelstaedt who shelled out real money to retrofit Rolls Royce turbine engines (ones with perceived better reliability than the piston engines they replaced) it's a stinging ownership experience.

As Mittelstaedt put it: "It's still a fantastic airplane, but Rolls Royce has lost their luster with me by failing to accept any responsibility at all, even though they did not have legal responsibility. That's not the way great companies treat customers who spend a lot of money with them." —*Larry Anglisano*

ENGINE STORAGE 101

As a longtime subscriber to *Aviation Consumer*, I usually find something real-world-valuable in every issue. Rarely do I read an article that is as divorced from reality as the long-term engine storage tips article in the April 2019 issue.

I would guess that I'm not the only reader who is not in the aviation business. My plane is an avocation, one that I love, but that often must take a back seat to work, family, travel and other commitments. Here in Southwest Florida, it often seems that great flying weather occurs on non-flying days, and days that I've scheduled to get up in the air have clouds and thunderstorms building by 10 a.m. The end result is that, while I try to fly at least weekly, there are multiple occasions each year where the aircraft sits idle for at least 30 days.

If I had the time to pull the plugs, oil the cylinders, change the oil and desiccant the exhaust, and then do it all again in reverse, don't you think I'd be flying instead? Unless I know that I'm going to be gone for multiple months, there is no practical way I could follow your advice. I'm pretty sure I'm not alone. For me the only real-world takeaway from this article is a healthy dosing of extra guilt.

Don Scattergood
Placida, Florida

While we realize that it simply isn't always practical to follow the engine manufacturers' service letters that detail the proper storage techniques for engines that slumber beyond 30 days, our hope was to save at least some owners some grief and money should they neglect an engine for longer periods of time. These are engines that sit for a longer duration than yours.

HOW MUCH FOR A BARON INSPECTION?

I provided owner feedback for the Beech Baron 55 report in the March 2019 *Aviation Consumer* and stated that the annual inspection completed by Master Aviation in Connecticut was $47,000. That's an accurate figure, but deserves further explanation because it was more than an annual inspection, and further detail might help potential Baron owners realize that the bar for a prepurchase inspection will likely be significantly different than for an in-service annual maintenance event.

In reality, we asked the shop for a mechanical restoration that would bring our 1978 Baron to its original operating condition. We fixed things that were otherwise passable, or deferrable, because we would be flying our families in this airplane. The props had about 200 hours since their last overhaul, but that had been 17 years prior. As it turned out that was a good suggestion as one of the hubs was no longer salvageable. That was $17,000 of the bill. Master subsequently removed and sent out one of the props for free the following year for wicking oil along a bristle that had somehow been under a seal. The defect list grew to a whopping 60 items, including all of the typical annual inspection items to address.

There was the overhaul of a slipping starter adapter, we addressed the aging engine mounts, replaced two cylinders, accomplished the wing spar AD, replaced the exhaust system for each engine, refurbished the prop electric de-icing system, replaced parts for and re-rigged the landing gear, repaired the original fuel quantity indicator system, plus a multitude of smaller defects which soon came to the surface and added to the invoice.

All of this work was coordinated and accomplished in an exceptional manner. We have gone back to Master Aviation for two additional annuals since and each time the cost was much lower and reduced from the prior year. We expect the annual to be in the $8000 to $10,000 range this year. The plane continues to fly defect free and my partner and I are happy campers.

Ross Detwiler
via email

GARMIN AND YOUR PRIVACY

I read the Garmin D2 Delta PX wrist-based pulse oximeter article in the April 2019 issue and wonder if you can comment about a user's medical data privacy as it relates to the data captured by the watch. Garmin's Connect website implied that if the watch owner opted in to typical Garmin Connect features, information such as heartbeat, pulse ox and similar data may be submitted to Garmin where it is stored and presumably available for analytics within the company.

Jim Meade
via email

Garmin reiterated that the watch isn't a medical device, and users can choose to upload the data, or not. It also said it processes aggregated user data for research and development purposes.

On The Cover: Paul Pelletier, an A&P mechanic at Learn2Fly CT in Connecticut, prepares a uAvionix skyBeacon ADS-B Out/wingtip lighting system for installation on a Piper Cherokee. We followed along with the installation for a field report to see how long this budget-based retrofit really takes.

CONTACT US

Editorial Office
860-614-1987 (EDITORIAL ONLY)
Email: consumereditor@hotmail.com

Subscription Department
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Big Sandy, TX 75755-8535
800-829-9081

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The ADS-B Out-equipped skyBeacon, main image, has the same footprint as many externally mounted OEM position light housings.

SkyBeacon Retrofits: Two Upgrades in One

uAvionix says its skyBeacon ADS-B/lighting device is a no-install solution. Don't take that literally, but it's still the simplest solution on the market.

by Larry Anglisano

Let's be realistic—when it comes to avionics installations there isn't much that can be done in an hour, except getting the aircraft in the hangar and the toolbox rolled out. But since its introduction a couple of years ago, it's been said that the now STC-approved and TSO-certified uAvionix skyBeacon wingtip ADS-B Out/LED lighting device is the one-hour ticket to complying with the 2020 mandate. The company even advertises the product as a "no install" solution.

To see just how long a mandate-compliant skyBeacon install really takes, we spent some time on the shop floor—with labor timer running—and followed along with a skyBeacon project. Spoiler alert: It wasn't a one-hour deal.

IS IT APPROVED?

For this field report, we found the poster child for a budget ADS-B upgrade—a basic Piper PA28-151 equipped with vintage avionics and serving hard duty on the flight line at Learn2Fly CT at Windham Airport in Eastern Connecticut.

The first step in any skyBeacon installation is ensuring the device will fit on the existing left wingtip. To review, the skyBeacon is equipped with both LED position lamps (red) and also LED anti-collision lights, which don't have to be hooked up. The device is designed to bolt on in the location previously occupied by the OEM lamp assembly. This is external mounting, and wingtips with lights enclosed inside the fairing won't work in the current configuration. Not sure? Start with the STC and its approved model list, or AML.

At press time the TSO'd skyBeacon has an AML-STC that encompasses 272 aircraft models and our PA28-151 test bed is one of them.

Still, we hear from potential skyBeacon buyers with aircraft that are not on the AML who report their shop won't tackle the installation for lack of an STC. According to uAvionix, this isn't a deal breaker and the approval should be straightforward when following the FAA's ADS-B Out installation policy memo. It's worth a read by linking to it at tinyurl.com/yxfqxhk3.

Ryan Braun at uAvionix told us both the industry and the FAA have been trying to get the word out on this alternate means of approving installations of qualifying ADS-B Out equipment. Specifically, the guidance allows for the installation of TSO'd and previously STC'd systems on other aircraft models (ones that aren't on an AML-STC) without further data approval—or at least the data an installer would have to reference with a traditional FAA field approval. This is important, especially in the case of a skyBeacon install on an airplane that's not covered by the current uAvionix AML.

According to Braun, the FAA has issued a blanket approval and only wants the installer to submit a completed and signed FAA Form 337, and uAvionix has samples on its website.

Why wouldn't an aircraft be included on the skyBeacon's STC model list? Consider a Piper PA32,

CHECKLIST

- ➕ Many skyBeacon installs can be accomplished in under two hours.
- ➕ The integrated LED lighting makes the upgrade a good value.
- ~ If the aircraft doesn't have anti-collision lighting, installing wiring and the switch increases the price.

In our Piper installation, it was out with the original position lamp and Whelan Xenon anti-collision lamps, top, and on with the all-in-one skyBeacon, bottom, which bolted in place without having to drill the wingtip. The existing position light and anti-collision light switches, bottom, were used.

as one example. The Saratoga isn't included on the AML because most newer models have wingtip lighting with forward position and strobe lights, and a rear position light. The company didn't add these aircraft to the STC because the skyBeacon doesn't integrate a rear position light. On the other hand, some tapered-wing PA32 models do have forward position and strobe lights, so the skyBeacon would be a good fit, just as it was on our PA28-151. Let's look at the installation on it.

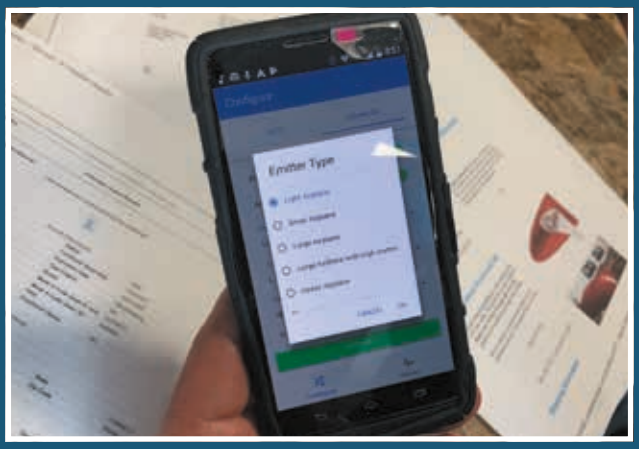
WHAT'S PACKED INSIDE?

By nature of its design, the skyBeacon has to be mounted as far outboard as possible, parallel to the vertical and horizontal centerlines of the aircraft and at least 3 feet from the transponder antenna. The fin on the bottom of the electronics housing must point downward when mounted on the wingtip. A peek inside the device reveals why the installation is critical.

In addition to the 978 MHz ADS-B Out transmitter and LED lighting, there's a WAAS GPS/SBAS receiver and a barometric pressure sensor with an altitude encoder. The altitude encoder isn't a replacement for the primary Mode C altitude reporter, but instead it ensures that the skyBeacon always has access to timely pressure altitude data to transmit over ADS-B, regardless of the radar coverage environment.

The skyBeacon monitors the transponder's Mode C replies to determine the aircraft pressure altitude (from the transponder's altitude encoder). You will find areas that do not have radar coverage, however, meaning there is no guarantee that your transponder will be transmitting that data. Further, pressure altitude is an important piece of data carried by ADS-B, and is only allowed to have a latency of up to two seconds. Since most secondary surveillance radar systems do not interrogate at that high of a frequency, it is rare that you will have fresh enough data from the transponder. The obvious solution is to add an altitude source to the ADS-B system, but unfortunately, there is a requirement in AC 20-165B that specifies that the same altitude source must be used for both the transponder Mode C reply and the ADS-B broadcast.

Interestingly, the skyBeacon's integrated altitude encoder doesn't plumb into the aircraft's static system as a traditional encoder does. Instead, it functions using a software algorithm. In essence, the internal encoder acts as a slave, automatically calibrating, or technically achieving "correspondence" with, the primary aircraft encoder at all times. uAvionix calls this Constant Calibration, and in the end it lowers



Clockwise from upper left: The wingtip on our Piper was an aftermarket Knots2U piece that was previously drilled to accommodate the OEM lighting fixtures for both position light and anti-collision light. The skyBeacon bolted on without any need for modification, but there was a gap on the front corner of the skyBeacon that needed to be filled. The heat shrink you see over the wiring protects the quick-disconnects, which allow the wingtip to be removed without having to cut the skyBeacon's wiring during inspections and maintenance.

Once the wires were connected, mounting the skyBeacon using the provided high-quality hardware took no more than five minutes. It took longer to program the device using the app-based uAvionix installation configuration utility. It works on iOS and Android devices and uses a Wi-Fi connection for communicating.

both the cost of installation and long-term maintenance efforts.

The device also has uAvionix's patented Power Transcoder, which ensures the correct synchronization of data elements between the secondary surveillance radar (SSR) replies and ADS-B transmissions. Those elements include Mode A squawk and transponder IDENT status. The Power Transcoder also works to calibrate the altitude encoder.

INSTALLING IT

Once you've determined that a skyBeacon will fit the wingtip, the first step in the physical installation is gaining access to the existing position and anti-collision (if equipped) lamp assembly by removing the left wingtip.

Since our installation included connecting the skyBeacon's anti-collision lighting, part of the task was modifying the wiring of the existing Whelan Xenon high-voltage anti-collision lighting system. This original Whelan system utilizes a remote-mounted power pack that converts 12 volts of DC power input to over 450 volts of power output to drive the strobes.

The Piper had an OEM rocker switch that turns the anti-collision lights on and off and we simply used the existing switch, the existing circuit protection and the existing strobe wiring (after bypassing the Whelan power supply). This yielded 12 volts of DC power input to the skyBeacon's strobe circuit.

Obviously you'll want to verify that you do indeed have 12 volts of power input after the wiring change before connecting the strobes. Connecting 450-plus volts to the device will certainly induce a smoke show.

When connecting the skyBeacon's anti-collision lighting, the electrical installation consists of three wires. The red wire connects with the power wire coming from the aircraft's existing position light circuit breaker, the yellow wire connects with the aircraft's anti-collision power wire (after bypassing any high-voltage power supply) and the black wire connects with aircraft

YouTube See a video of the skyBeacon install at http://tinyurl.com/j95ht2a.

ground. The skyBeacon may be grounded to the aircraft structure via the mounting screws, but we suggest finding a solid ground, and it will be required when mounting the device on composite structures.

Worth mentioning is if the aircraft doesn't have an existing anti-collision lighting system, the installer will need to install a command switch, circuit breaker and route a power wire out to the left wingtip. This will obviously add to the cost and effort of the project.

The installation kit includes mostly everything that's required, including three 6-32-inch button-head machine screws for securing the device to the existing nut plates in the end of the wing. Two O-rings per screw must be used between the mounting screw and skyBeacon assembly.

For a variety of Cessna applications where the skyBeacon might not be a direct bolt-on, uAvionix offers a wingtip adapter. It's priced at $100 and is covered by the STC. It works on the Cessna 150/152, older 172C models, 182, 185 and some 206 models.

Once the wires are connected and secured and the skyBeacon is mounted, simply reinstall the wingtip. The physical installation on our Piper example was accomplished in around 1.5 hours, plus roughly one hour to make the changes to the Whelan strobe power pack wiring. If there wasn't strobe interconnect, the physical install could easily be accomplished in an hour or less. But that's not the end of the job.

CONFIGURATION, SETUP

As with any ADS-B Out system the skyBeacon needs to be programmed and configured. For this process, the device has built-in Wi-Fi for a secure connection with an iOS or Android smartphone or tablet. The Wi-Fi is intended for ground configuration only and it automatically disables after five minutes (from power-up) or when the aircraft is airborne. When you connect the installer utility app, the automatic shutdown is overridden so you can take your time entering the critical installation data. The uAvionix skyBeacon Installer app is downloaded from the Apple App Store and from Google Play.

In combination with a Whelan LED rotating beacon, the LED skyBeacon brought impressive exterior lighting to the Piper.

We found the configuration process to be reasonably straightforward and launching the skyBeacon installer guides you through the programming process. Still, you'll need to have some aircraft-specific data on hand for verification, including the ICAO number. This is a 24-bit number issued to the aircraft by the registration authority of the aircraft. These addresses are generally written as a 6-digit hexadecimal number. There's also the emitter type (light, small or large aircraft, etc.), which assists ATC with tracking.

You'll also enter the call sign, plus the aircraft's Vso number in knots. This V-speed allows the skyBeacon to automatically switch between airborne and ground modes and is set to the aircraft's stall speed. If the aircraft has ADS-B In equipment, you enter which frequency (978 MHz, for example) it uses.

There's also the option of configuring Anonymous Mode. When you set it, this enables the skyBeacon to transmit a self-assigned or random ICAO and non-identifying call sign when the squawk code matches the defined VFR squawk code. The manual says you aren't eligible to receive ATC services when programmed for anonymity. Other configuration items include the aircraft's length and width (in meters), the GPS antenna offset and a transponder monitor threshold. The configuration also has a setting that turns the position and anti-collision lighting on or off.

UP AND RUNNING

All told, this installation was accomplished in around four hours. Half of that was the physical installation, including the programming, and the rest was completing the FAA Form 337 (which has to be signed by an IA), the flight manual supplement, instructions for continued airworthiness, a brief flight test and modifying the aircraft checklist to ensure the pilot turns the navigation light switch on after every startup. If not, the skyBeacon won't turn on.

At a typical shop labor rate of $100 per hour, and the cost of the skyBeacon at $1850, we easily declare the strobe-equipped install a solid value. Deduct the FAA's $500 equipage rebate from the invoice and we think a skyBeacon ADS-B Out/lighting upgrade is a no-brainer for basic airplanes.

Our thanks to Paul Pelletier, an A&P at Learn2Fly CT at the Windham Airport (IJD) in Connecticut, for accommodating this field report.

Dynon D3 Pocket Panel: Touchscreen, Compact

It's not a primary instrument, but it's reliable and affordable enough for a belt-and-suspender backup to glass and round-dial instruments.

by Paul Robichaux

If you gathered 100 pilots in a room and asked for a show of hands who likes their aircraft's vacuum system, you probably wouldn't see any. Yet the lowly and disrespected vacuum pump soldiers on for plenty of instrument panels not converted to all electric.

For portable backup, Dynon's Pocket Panel portable EFIS series has historically been a decent seller, but the much improved current-gen model D3 EFIS has plenty of competition from app-based backups and AHRS-equipped portable ADS-B. I've been flying with the latest Pocket Panel in my Piper Cherokee Six and prepared this field report.

STANDALONE BACKUP

The idea behind Dynon's latest D3 is the same as the earlier D1 and D2 models: packaging backup attitude data into a completely portable, battery-powered, GPS-equipped instrument. Of course with no required connection to the aircraft, and with a couple of mounting options, the D3 can easily be moved between aircraft (provided you've charged it) and serve as backup for electrical and vacuum system failures. Since the D3 is a portable device with no certification, it can't legally be used as a standalone primary instrument in certified aircraft.

The D3 essentially uses the same AHRS as Dynon's panel-mount avionics, but it's mated to a different display and supplemented by GPS data instead of being connected to the aircraft pitot/static system.

On the D3, Dynon says it dispensed of the bezel controls in favor of touchscreen because it recognizes that pilots live in a touchscreen-driven world. It also added synthetic vision—something most every buyer might expect in any EFIS display.

CHECKLIST

- ➕ An inexpensive safety backup for legacy vacuum instruments.
- ➕ Stone simple to use, and its portability means you can use it in multiple aircraft.
- ~ Since it lacks a TSO and it isn't covered under NORSEE guidance, it's for backup use only.

Moreover, the current D3 portable further improves on previous Dynon Pocket Panel models by providing a brighter display (twice as bright as the D2), an integrated G meter and the terrain-only synthetic vision feature at a slightly lower price point than its predecessors. At press time, the D3 is street priced around $879.

RIGHT SIZE, BETTER DISPLAY

At 3.5 by 3.25 by 1.0 inches, the D3 is a relatively small chassis, which makes it work well for hanging from a RAM suction mount. But the D3 isn't waterproof, so use caution in seaplane applications.

Getting rid of function keys means there is more room for the color touchscreen, and the unit has just a single small button for power. Touch the menu icon on the upper left corner of the screen to access most controls and settings, which Dynon kept shallow to provide a straightforward feature set. Swipe left and right on the main display to choose between various displays.

There is a jack for connecting an included external GPS antenna, and also a charging port on the left side of the case. The device uses newer USB-C input for charging the Li-ion battery, and the D3 includes a USB-C charging cable that plugs into the included 12-volt lighter adapter or the included wall charger. There are also two mounting options:

The Dynon D3 Pocket Panel in the lead image is doing just what Dynon intends: backing up the round-gauge instruments in our Cherokee Six test bed.

a RAM suction cup, and a "pinch mount" intended for mounting in an empty 3 1/8-inch panel cutout. There's a printed quick-start card, but you must download the clearly written and easily understood user manual from Dynon's website. Dynon recommends that you check for software updates when you first get the unit. That's important because our demo had the original version 1.0 firmware, not the February 2019 revision, but it was easy to download it to a USB stick and plug it in to the unit using the included USB-C adapter.

Recharging takes about six hours and depending on the setting for screen brightness, that yields about six hours of endurance.

The D3 displays what you'd expect to see on a modern EFIS: aircraft attitude provided by the AHRS (pitch, roll, turn rate and slip/skid), plus GPS-derived groundspeed, altitude, vertical speed and ground track. Attitude integrity depends on having a GPS fix, so there's also a GPS signal strength indicator, and you'll see the familiar red X symbology if the GPS signal degrades enough.

FLYING WITH IT

The standard I use when looking at a new gadgets is whether I can figure out the basics without having to read the manual. That normally doesn't apply to the latest aviation gadgets, but in this case the D3 passes this with flying colors. It begins with the power button on the front of the bezel. When you press it, the D3 powers up and displays a short summary page, which you dismiss by touching the screen. After a few seconds the EFIS display appears and you're ready to fly (although you should align the unit before takeoff). The display has a small icon in the upper left corner (three parallel lines, nicknamed the "hamburger menu"). Touch that and you'll have access to a small settings interface that lets you align the unit, adjust screen brightness and change between unit systems (knots/MPH/KMH).

The alignment procedure is straightforward: The normal EFIS display appears with a set of arrows that let you adjust roll and pitch indications to match the true pitch.

The latest D3 Pocket Panel loses its bezel keys in favor of a touch-screen. Simply swipe the screen to move between menu options, top. That's the power key in the lower right corner of the bezel. At 1 inch deep, the chassis is sized for portability.

The Piper PA-32 sits nose high on the ground, so I had to align the unit to zero the pitch indication. Alignment settings are preserved when the unit's powered off.

In flight, the unit simply works. You can swipe between the EFIS and G meter pages, and you can use the hamburger menu to adjust display brightness, although I found that the display "auto" mode works well. Speaking of the display, the color LCD touchscreen is clear, bright and easy to read, although I didn't find the fonts and graphics to be as crisp as the Garmin G5, the Aspen Evolution or even current-generation panel-mount navigators.

The screen is a bit shinier than I would like, but Dynon includes a matte-finish screen protector in the box that you should plan on applying to both reduce glare and protect the screen against scratches.

I evaluated the D3 on both local and cross-country flight in various conditions, including day and night VFR and IFR. In all cases, it worked flawlessly. The GPS-derived speed and altitude agreed within a few percent with my panel-mounted Avidyne IFD540 GPS navigator, even without an external antenna, plus the pitch and roll attitude indications were solid and stable. This is in sharp contrast to my tests a few months ago with a Stratux-based ADS-B unit feeding data to an EFB app on my iPad, which was so jittery as to be unusable. If you've

That's the D3 in the pinch panel mount in the main image to the left. It's secure and easy to remove and reinstall. The bottom image is the D3 secured to a RAM window suction mount. The big display in the photo is Dynon's SkyView Touch PFD.

flown with other EFIS instruments, you can adapt to the D3's display pretty much instantly. If you're used to traditional round gauges, you should plan on practicing with the D3 to get used to the differences it will impose on your scan. It will probably feel unnatural to focus on the single instrument at first, and that's not a good match for using the D3 in a backup situation. Dynon takes pains to say that the GPS-derived track, airspeed and vertical speed are advisory only and not meant to replace your magnetic compass and pitot/static instruments, so it's a good idea to get used to including all of them in your modified scan.

MOUNTING MATTERS

The mounting location of the Pocket Panel matters more than you might suspect at first. The unit has an alignment procedure to adjust pitch and roll, meaning that you don't have to have perfect alignment in those axes. Dynon's documentation says the unit can be adjusted +/- 6 degrees for roll and +/- 30 degrees for pitch.

Yaw alignment, however is more important: The unit must be aligned so that the display is parallel with the wingtip-to-wingtip line. Using the pinch mount to put the unit flat on the panel is ideal for this, assuming you have an empty hole in the panel. If not, wherever you mount the unit must be a location that keeps the display in that position. If you angle the unit to face your seating position, you'll see that the attitude, turn rate and skid ball data all degrade and will read incorrectly. On my first flight, I was surprised by this since I hadn't carefully read the operation manual and didn't know to expect that degradation.

My Cherokee Six didn't have any open slots in the panel, so I used the RAM suction cup mount to secure it to the left side of the windscreen, near where the glareshield and windscreen meet. In that position, I got a strong GPS signal from the D3's internal antenna, and my eyeballs had a good line of sight to the unit. Plan on spending a couple of hours moving the unit around until you find the ideal position that works for you—and the device's performance.

THE SAFETY TRADEOFF

Dynon liberally use phrases such as "supplement your unreliable legacy instrumentation" and "portable" to reinforce the point that the D3 isn't for primary use. Most buyers will turn on and align the D3 when starting the airplane and use it as a secondary instrument unless the primary instruments fail. My trial proved that the D3 can be used to maintain controlled flight to an uneventful landing.

For less than $900, you can purchase what amounts to an insurance policy to protect you against the risk of a vacuum failure. The Dynon Pocket Panel doesn't do everything a permanently mounted and certified EFIS does, but it's priced at about one-third of the typical budget EFIS.

For pilots who already have glass cockpits, or who are completely proficient at partial-panel flying in hard IFR, this might not be a necessary investment. However, the low cost and improved safety benefits make the D3 well worth considering for the rest of us.

Contact www.dynonavionics.com, 425-402-0433.

The ATP Rating: Expensive Training

Getting the multi-engine airplane ATP is a complex, dollar-intensive process. Go into it with open eyes and serious determination.

by Rick Durden

It's aviation's Everest: the highest rating, the toughest to obtain and necessary to have to fly in the Part 121 airline world, and even in some portions of the Part 135 air taxi world. In reality, if you want to fly for a living, the chances are almost unity that you'll need to hold an Airline Transport Pilot (ATP) rating to do so. Even in the corporate world, operating under Part 91, insurers want the pilots who haul mega-buck executives around to hold aviation's Ph.D.

Because of space and complexity, this article is limited to the ATP for airplanes. We'll start out by noting that there is a big difference between the single- and the multi-engine ATP. The single-engine version is plenty tough to obtain, with a minimum age requirement of 23, minimum experience of 1500 hours of flying time, a tough written exam and a practical test that requires demonstrating a serious ability to fly precisely.

As there are no single-engine Part 135 or 121 operations that require an ATP, what was once a rating obtained by pilots who had taken the ATP written, weren't in a financial position to take the multi-engine ATP checkride within 24 months and didn't want to have to take the written again, is now a rating almost no one pursues unless flying a single under circumstances where insurance requires an ATP.

Prior to taking the written exam, an ATP applicant must complete an ATP Certification Training Program that includes six hours in at least a Level C full-motion simulator.

MULTI-ENGINE ATP

The multi-engine ATP requirements are complex—they are summarized in the sidebar on the following page. They reflect a desire by Congress and the FAA that all pilots flying in a multi-crew environment in larger jets have training specifically for that environment before flying passengers. The manner in which that desire was implemented was to require that someone working on the ATP rating must first complete an FAA-approved ATP Certification Training Program (CTP) involving a specified number of hours in a full-motion flight simulator and classroom training before even being allowed to take the written exam. Once those two hurdles have been cleared, and the applicant meets the age and experience requirements, he or she may take the checkride.

As we researched this article we learned that the current realities in the world of professional aviation are that regional and cargo airlines are paying the freight to put new hires through much of their ATP training. Because the FARs require that a first officer not only have an ATP, but also a type rating for the aircraft being operated, most new hires at regionals and smaller cargo operators take a combined ATP and type rating checkride.

GETTING THE ATP: FIGURING OUT THE REQUIREMENTS

Attempting to sort through the complexities of the multi-engine ATP eligibility requirements in FAR Part 61 can be frustrating enough to cause a pilot to want to stick his head in the oven and turn on the gas. At first blush it appears that an applicant has to be 23 years old, have 1500 hours of flight time and be of good moral character—unless it's the second full moon of the month and then she only needs 1000 hours of flying time and can be 21 years old, if she has a degree in understanding aviation legalese issued by a four-year college.

OK. It's not quite that bad, but it can take some parsing of the language to understand. Because of the credit given by the FAA for graduation from aviation programs offered by institutions of higher learning, we think that any young person who has not yet attended college and wants to fly for a living—even if he or she hasn't even obtained a private ticket—should understand the ATP eligibility requirements before making the decision whether, and where, to attend college. The credit the FAA gives for pilots who graduate from qualifying programs can potentially get them into an airline pilot slot in a big hurry.

So, we'll break down the requirements to see where the FAA gives credit for certain military experience or college education and turning what were once hard-and-fast requirements into flexible ones.

There are two requirements that are fixed—the applicant has to read, speak, write and understand English (after years of giving this a nod and wink, it's being taken seriously) and has to be of good moral character. The FAA doesn't say how to prove one's moral character, although, in practice, the FAA assumes the applicant meets the requirement. However, if the applicant has a history of conviction of a crime, usually a felony involving moral turpitude, she or he may find that the FAA says she or he cannot ever hold an ATP. We've seen two cases in which an FAA inspector figured out that applicants had forged entries in their logbooks and disqualified them from ever obtaining an ATP.

• Age: To hold an unrestricted ATP you have to be 23 years of age. There is a restricted ATP that allows a pilot to fly as first officer, not captain. The minimum age is 21 and the required aeronautical experience is set out in Part 61.160.

• Training Requirements: Prior to taking the knowledge exam (written) an applicant must complete an ATP-Certification Training Program offered by an FAA-approved training facility. The applicant must show the graduation certificate to take the written.

• Aeronautical Experience, Unrestricted ATP: This is where things get interesting. The basic requirements are 1500 total hours of pilot time; 500 hours of cross-country time; 100 hours of night time; 50 hours in the class (multi-engine) of airplane for the rating sought (25 hours in a full flight simulator can be credited toward the 50); 75 hours of instrument time (there are specific credits for simulator time); and 250 hours of PIC (with credit for SIC time) including: 100 hours of cross-country time and 25 hours of night time. The experience requirement is further broken down with credits and/or limits for simulator time, night takeoffs and landings, specified SIC time and time as a flight engineer.

• Aeronautical Experience, Restricted ATP: Here is where going to the right school or flying for the military can bootstrap a pilot into the ATP with significantly less flying time than 1500 hours.

Military: A U.S. military pilot or former military pilot who graduated from U.S. Armed Forces undergraduate pilot training school and received a rating qualification as a military pilot may obtain a restricted ATP with 750 hours of total flying time.

Higher Education 1: A bachelor of aviation degree graduate (usually a four-year degree) of a college or university approved by the FAA and whose training program meets FAA requirements may obtain a restricted ATP with 1000 hours total flight time.

Higher Education 2: An associate of aviation degree graduate (usually a two-year degree) of a college or university approved by the FAA and whose training program meets FAA requirements may obtain a restricted ATP with 1250 hours of flight time.

Short on cross-country time? A pilot with 1500 hours total time and at least 200 hours of cross-country time, but less than the 500 hours required for an unrestricted ATP, may obtain a restricted ATP.

• Turning a restricted ATP into an unrestricted ATP: Once you have a restricted ATP, all you have to do to have the restriction removed is meet the unrestricted age requirement and aeronautical experience requirements of an unrestricted ATP and provide "satisfactory evidence" to the FAA of having done so.

Yes, figuring out the eligibility requirements for the ATP takes a little effort. However, if you're in high school and want to fly professionally, taking the time to understand the requirements for a restricted ATP may mean that the college degree you decide to obtain may allow you to pick up your ATP with 1000 hours of flight time rather than 1500. In our opinion, that's worth taking the time to understand how the system works.

If you want to make a living flying jets, top right, plan on getting an ATP and on spending time in simulators (lower right) at any time of the day or night.

Company-paid ATP training is not the case with the larger, legacy airlines—they still have the luxury of hiring pilots holding ATPs.

Nevertheless, the airlines that are doing ATP training look first at applicants who have an ATP, then at those who have passed the written (which means they've completed the expensive ATP-CTP) and then at those who have completed at least some of the work toward the rating—they have done their homework and are ready to take the written exam once they complete the ATP-CTP course.

We also found that military pilots seeking to go to the airlines were shooting for the legacy carriers and thus were getting the ATP on their own.

If you're doing the ATP on your own, here's what's involved.

ATP-CTP

The ATP Certification Training Program must be administered by an entity that has received FAA approval for the program.

We'll emphasize this right here—pay attention—while you have to complete the ATP-CTP prior to being able to take the ATP written, the ATP-CTP does *not* prepare you for the written exam. We thank Sporty's Eric Radtke for bringing this into focus for us. He said that Sporty's has found that there is a fair amount of misinformation about the ATP-CTP floating around—more than a few of his company's customers had to be told that the ATP-CTP is not ATP written prep. In checking websites of various training organizations, we were pleased to see that this fact is set out—none were hiding the ball.

The good news is that once you successfully complete the ATP-CTP you never have to take it again, even if you delay taking the ATP checkride for years.

The FAA requires that an ATP-CTP include a minimum of 30 hours of classroom instruction and 10 hours of simulator time, with at least six hours of that in a Level C or higher full flight simulator for a multi-engine jet with a max takeoff weight of at least 40,000 pounds.

The classroom instruction must include high-altitude aerodynamics, meteorology, air carrier operations, crew resource management and safety culture. Students must then get at least a score of 70 percent on a written examination.

SIMULATOR TRAINING

The simulator training requirement does not pertain to a particular type of jet, but introduces the student to large jet operations and requires training in low-energy states/stalls, upset recovery, adverse weather, flight management systems and automation. There is no checkride—if the student has passed the written exam and completes the 10 hours of simulator training, she or he is entitled to an ATP-CTP course completion certificate.

Perhaps because most pilots seeking an ATP are doing so as airline new hires, we found a limited number of training providers offering the ATP-CTP outside of structured college degree courses or contracts with airlines. We note that CAE Simuflite and FlightSafety International also offer ATP-CTP courses; however, they are only offered for crews of two, so you'll need a friend to sign up with you.

During our review of ATP-CTP courses, we observed that all courses also included one of the realities of flying professionally—your simulator time may be at any hour of the day or night. Sims run 24 hours a day, so your time in the box may start at 2 a.m.

Sporty's (www.sportys.com) charges $4595 and teams with ABX Air, a Part 142 training academy in Wilmington, Ohio. The course lasts five days—Monday through Friday. There are usually two classes per month with a maximum class size of six people. Payment in advance is required and there is no refund for canceling within 30 days of your class date. That is a reality in the simulator training world.

As with all of the companies we surveyed, some sort of financing is available. By paying with PayPal you can spread your payments over six months with no interest.

ATP (Airline Transport Professionals) (www.atpflightschool.com) offers its ATP-CTP for $4895. It's a seven-day class held at its Dallas-area training facility. The program includes 30 hours of classroom time, four hours in a fixed-base flight training device and six hours in a full-motion simulator. Written

Even if you prefer self-study, you're going to need 30 hours of classroom time as part of the ATP-CTP (top). For written test prep we recommend using one of the big dogs in the test prep field, King Schools (middle), Sheppard Air (bottom left) or Gleim (bottom right).

test preparation is available for an additional $200.

THE WRITTEN

The multi-engine ATP written (ATM) is unique among FAA knowledge tests in that a passing score is good for 60 months. That means that those who take the ATP-CTP and ATM as part of a college program have plenty of time to build up the required hours for taking the ATP checkride.

By the time someone has gotten to the position of prepping for the ATM we think that he or she is probably an old hand at taking FAA exams. Nevertheless, there is enough beyond the instrument and commercial writtens in the ATM, notably high-altitude aerodynamics and weather and flight planning for jets, that we recommend shelling out for one of the commercially available written test prep courses.

Sheppard Air (www.sheppardair.com) offers its test prep software for $85, with a money-back guarantee. It's a pure written test prep—you study ATM questions and answers. That's it; there's no coursework, just the questions and answers. Sheppard offers 24-hour-a-day customer service by phone, so you can get help anytime as you study. In our research for this article a number of the people we spoke with recommended having completed the Sheppard's test prep before attending an ATP-CTP and then taking the written in the next day or so.

For $279, King Schools (www.kingschools.com) offers an online or DVD video ATM course with interactive test prep and unlimited random tests. It is a full ATP course, not just test prep. Running time for all of the videos is approximately 11.5 hours. The interactive test prep allows the student to identify and concentrate on weak areas.

Gleim's (www.gleimaviation.com) online ATM course is priced at $109.95. The average course length is 35 hours. For those who complete the course, Gleim guarantees passing the ATM the first time or the course price is refunded.

For $74.95 ASA (www.asa2fly) offers its test prep bundle—its test prep book and software download (with 24 months of access). It is a test prep course, not an ATP training course; however, the test prep materials include explanations for correct and incorrect test answers and references for further study.

Sporty's is a reseller for ASA's ATM test prep materials. It also offers training for the practical test in a Piper Aztec for $2452 plus a $25 package of materials needed for flight training in the Aztec. We were told that for pilots who are multi-engine and instrument current the course is popular for those who want to take Sporty's ATP-CTP followed immediately by the ATM and then the flight test.

CONCLUSION

The multi-engine ATP requires the serious application of cash and hard work. In the aviation world where everything always seems hideously expensive, we were pleased to find that ground school and written test prep courses were so reasonably priced.

We also recommend that anyone thinking of college and a professional flying career look hard at attending an FAA-approved two- or four-year college and getting an aviation degree that allows obtaining an ATP with fewer than 1500 hours total time.

Garmin's Full Circle: Two New Panel GPSs

We thought we were done with standalone panel-mount GPS, but in the GPS 175 and GNX 375, Garmin sees a market opening.

by Paul Bertorelli

In the 30 years of its existence, Garmin has proven good at a lot of things, but its mastery of expanding niches into full-blown, must-have products is one reason it's a $3 billion company. This spring, Garmin resurrected something we thought we'd never see again: the standalone panel-mount GPS. And not just one, but two, one of which represents a new product category.

At the Aircraft Electronics Association show in Palm Springs, Garmin unwrapped the GPS 175, an old-school standalone IFR navigator with LPV approach capability and a companion product that's something we weren't sure was even possible, never mind that anyone would want. The GNX 375 combines the standalone GPS navigator with ADS-B In and Out in the form of a Mode-S transponder. It's essentially Garmin's hot-selling GTX 345 1090ES transponder mashed together with the navigator. Neither of these units have comm capability, however, so they're not a straight-up replacement for the GTN-series mapcomms nor a new-age GNS 430/530.

SCOURING THE MARKET

You may have noticed that avionics sales have been on a tear recently, with growth into the double digits and eight straight quarters of in-the-black performance, according to AEA. Much of this growth has been driven by ADS-B because as owners haul their airplanes into the shop, they're doing while-I'm-here upgrades, to include electronic gyros, mapcomms, transponders and so forth.

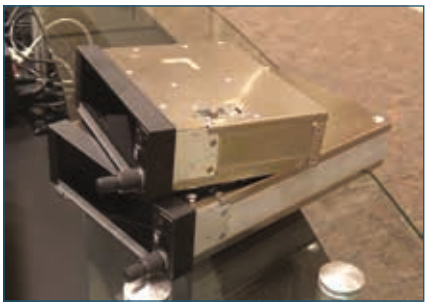
But Garmin, and probably the shop network that sells their products, discovered a certain resistance among buyers who have modest or older airplanes that have good comms, but who might nibble on a new, color touchscreen navigator at the right price. And at $4995 retail, that's what the GPS 175 is. Dare we say it, but it's a modernized throwback to Garmin's original approach-capable navigator of 25 years ago, the GPS 155/165.

In a market where a $10K box ain't no big deal, the GPS 175's price will likely get people through the door. And here's something interesting: It has the same price tag as the GPS 155 did, but if inflation is considered, that older box would sell for about $8200 in 2019 dollars.

Is Garmin going all consumer electronics on price and volume? Perhaps, but we suspect they've set the price to find a broad market to sustain sales when the ADS-B sugar bubble pops by about mid-2020 or beyond. The GTN 650 and 750 were brisk sellers, but nothing like the GNS 430 and 530, thousands of which are still in the field. Moreover, shops say some owners balked at the expense of rearranging the panel to shoehorn in the larger GTN 750.

It's obvious from the photos that the GPS 175 and GNX 375 share the GTN design architecture and the easy way to describe them is as GTN navigators with the comm sections removed. If there's canniness to this,

The GNX 375, below, and GPS 175 have identical interfaces. Both will display ADS-B traffic, left, but the 375 is distinguished by transponder controls.



With an onboard transponder, the GNX 375, left, bottom box, is deeper than the GPS 175.

it's that Garmin sees the size of these new boxes as a critical market driver. Both are the standard 6.25-inch rack width and 2 inches high, or the size of older navcomms like the BendixKing KX155, which is still flying in many aircraft.

The GPS 175 isn't pin-for-pin on the older navigators it's designed to replace; it's a little too complex for that. But it will fit in place of a GPS 155, the old UPSAT GX50/55 and the BendixKing KLN 89/90/94 navigators. As shown in the photo at upper left, the 175 is shallow—only 6.58 inches from the panel face to the rear of the connector backshell. That means it ought to fit into anything without doing major mechanical and electrical violence behind the panel. With that in mind, Garmin also made sure the 175 will work with just about every indicator and autopilot still out there, from old Cessna 300-series autopilots right through the GFC 500. And yes to the BendixKing KI 204/209 and even—gasp—old Narco VOA needles. More modern EFIS gear is

HOW GARMIN TOOK OVER THE WORLD

With the introduction of the GPS 175 and the upscale GNX 375, Garmin has done two things: invented a new product category and come full circle as an avionics company over the course of a quarter century. Oh, and it has left the competition for dead. How did this happen? It hardly seems possible that we once wrote a headline—in 1998—complaining of too many choices in the GPS panel-mount market with too little value.

Two years earlier, we reported on *seven* GPS panel products from *five* manufacturers. Two decades later, those manufacturers are gone and one is a shadow of what it once was. Garmin did it with an unending parade of new products—some just competent, some spectacular—but mainly because the competition was somnambulant.

Consider the market state in mid-1994. Garmin introduced the GPS 155/165 IFR-capable GPS navigators and were the first to gain approach approval. But BendixKing, IIMorrow, Trimble, ARNAV, Northstar and Magellan had credible navigators, even if Garmin bested them on capability.

We assumed the point-counterpoint of competition would distill the best products and consumers would be the winners. It wasn't to be. Trimble, ARNAV, Northstar and Magellan never developed serious follow-on products, either for lack of will or a belief that the market wasn't worth the investment. In 1994, BendixKing still owned the avionics market with the vaunted Silver Crown products. Garmin had no navcomms and a limited GPS panel-mount line. But it was a company on the move. In 1998, Garmin unveiled the seminal GNS 430, the world's first color mapcomm—a word we had to invent to describe it. It wasn't cheap, either. At $9995, it was the equivalent of $15,500 in 2019 dollars.

The new GPS 175 costs a third of that. Despite the GNS's high price, the market lost its mind and the 430, and the follow-on 530, fell into a bottomless pit of demand. BendixKing responded respectably with the KLN89B and the KLN94, but compared to Garmin's sales, these were lesser players. And while it did develop some large-screen displays—the KMD 555 and 850—these were never mainstreamers.

Serious competition came from UPSAT, the former IIMorrow bought by the package company to develop tracking technology for its trucks. In 2003, it introduced the CNX80, an FMS-style integrated navigator that we thought bested Garmin's GNS 530. Garmin thought so, too, so it bought UPSAT, renamed the CNX80 as the GNS 480 and soon killed it.

In 2004, the battle over integration was joined and won by, surprise, Garmin. BendixKing and Avidyne both attempted integration with modular systems that could or had to use others' navigators. But that same year, Garmin's G1000 appeared as the new King Dog of integrated avionics and soon became the de facto standard OEM panel.

Avidyne actually had a simpler, easier-to-use EFIS in the Entegra—or so we thought in a head-to-head review—but Garmin simply overwhelmed it with marketing and support horsepower.

The panel GPS market languished until Garmin introduced the GTN line in 2011. Sales wise, these weren't as spectacular as the GNS boxes had been, but they were the only new mapcomms around until Avidyne introduced the IFD line, which still gives Garmin some competition.

Because their high price and large size crowded the GTNs—at least the 750—out of many panels, Garmin found an opening: owners with good radios who needed approach-capable GPS and/or mandate-compliant ADS-B. While sales success isn't a given, it sure looks like just as it did with the GNS series and the G1000, Garmin hit the market with the right product at the right time.

also supported, including the Aspen EFDs and Sandel EHSIs.

The interface is straight out of the GTN playbook. It's a color touch-screen display measuring 4.8 inches on the diagonal and has pinch scrolling and scaling. That's a little tight on a screen that small, but it's doable. The 175 has keys and commands identical to the GTN series and has the look and feel of Garmin's Pilot tablet app.

Speaking of that, both boxes have Garmin's Connext network that uses Bluetooth to talk to peripherals, including Garmin's 796/795/660 aera portables and the FltPlan Go app through a tablet. That means you can dump a flight plan from the tablet to the navigator easily. That applies to updating the database with the tablet, too, using Garmin's Flight Stream 510 in the 175's memory slot.

TRAFFIC AND WEATHER

As ADS-B reaches its crescendo, Garmin addressed that in two ways. First, the 175 will talk to the GTX 345 1090ES transponders or the GDL 88 UAT box, displaying both traffic and weather from those devices. That includes Garmin's TargetTrend, which plots vector lines for nearby traffic to help with avoiding when seeing isn't working.

For owners who don't yet have ADS-B—quite a few, still—the GNX 375 is simply the 175 with the transponder tacked on the back. That makes it deeper—10.85 inches to the connectors—but everything else is identical to the 175. The transponder is essentially Garmin's GTX 345, which has proven a killer app in the avionics market thanks to the combination of a good price and reliable installations and interface.

At $7995, the GNX 375 is likely to attract owners who want updated GPS navigation and who've been dragging their feet on ADS-B, or so Garmin believes. Garmin said both of these products were expected to be available in April and as an additional pot sweetener, it's allowing dealers to sell the GPS 175 over the counter so owners can buy it directly and have a local A&P install it. Shops might not like that, but a sale is a sale, and it shows Garmin is ready to compete with Dynon, who's doing the same thing with a full-up EFIS system.

ON THE HORIZON

MGF HUD: Credible Contender

This HUD is easy to use and works well, but do light airplane drivers really want the capability? MGF aims to find out.

by Paul Bertorelli

The head-up display or HUD is all but standard equipment in airliners and business jets, but it has proven a resilient non-starter in light aircraft general aviation. We would guess this is because pilots don't see a burning need for HUDs and, thus far, none have worked very well.

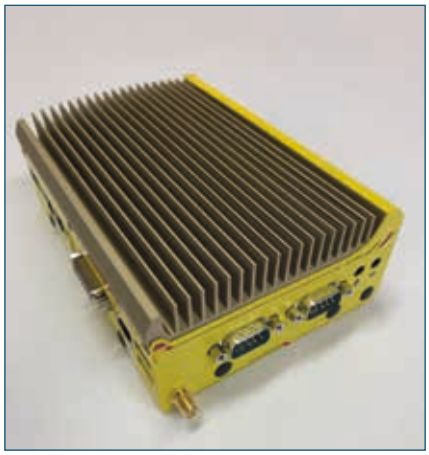
MGF—MyGoFlight Products—hopes to reset that clock with its SkyDisplay HUD aimed dead center at the light aircraft and small turbine market. It's intended as an affordable option, but at $25,000 installed, some might argue the point.

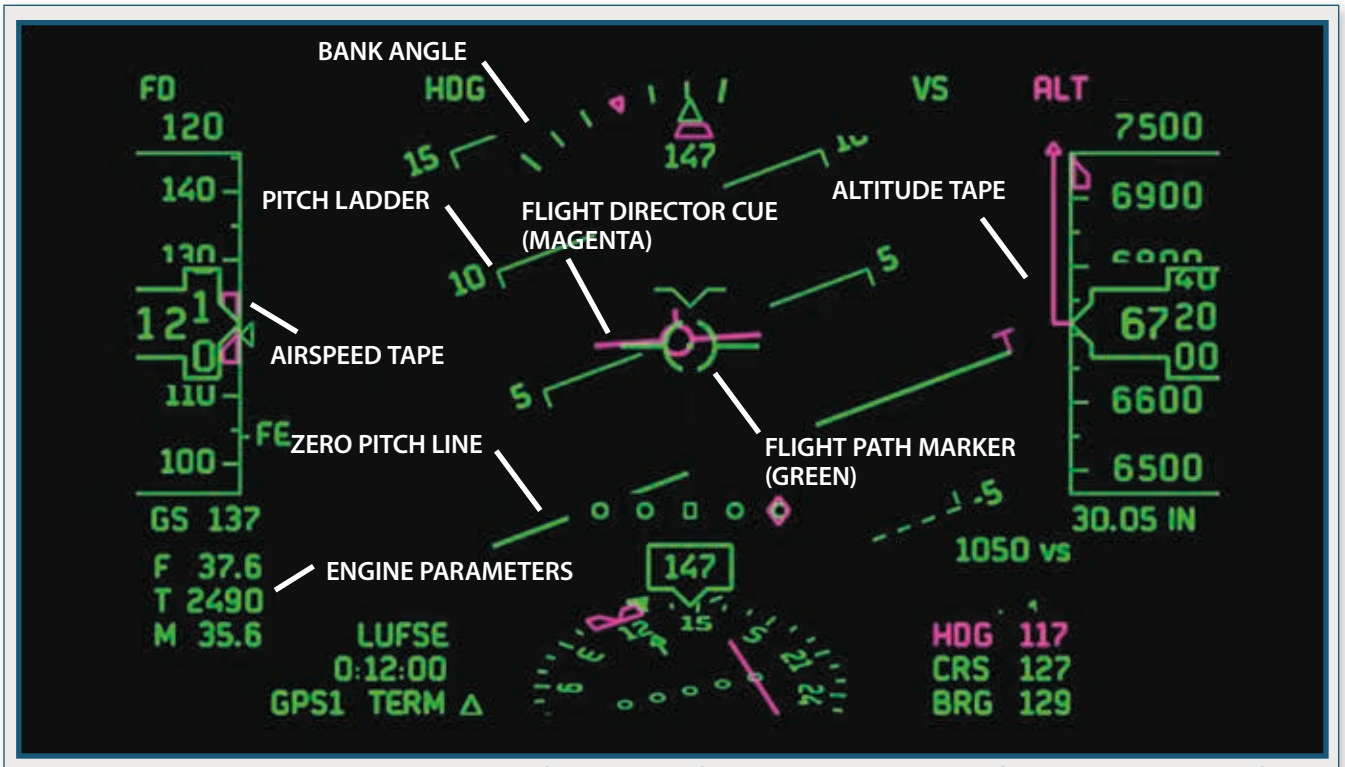
We recently flew the SkyDisplay in a Cirrus SR22 with MGF owner Charlie Schneider and conclude if any light plane drivers really want a HUD and if MGF gets past the certification hurdles, the SkyDisplay is a functional if not perfect device.

Anyone who has attended the big aviation shows will know MGF as a purveyor of flight bags, GPS and camera mounts and other such gadgets. Because the company designs and builds at least some of its own products, it has developed a cottage industry industrial base that Schneider told us he applied to creating the SkyDisplay.

HUDs are simple in concept, but not so simple to engineer and install. They're basically an optical projector that displays an informationally compressed flight data display on a glass screen called a combiner. The idea is that the pilot can look through the display and see critical data such as attitude and airspeed while avoiding the distraction of looking down at the panel. The display has to be engineered in such a way that the data appears

The MGF HUD, bottom photo, mounts to the cabin ceiling just aft of the windshield line. The data crunching is done by a two-pound computer, top, that lives behind the panel. All of the hardware is commercial off-the-shelf product adapted for aviation use.





Photographing a HUD in action is harder than finding black holes and Leprechauns. The above image is a computer-generated frame from our trial flight in the SR22. It depicts industry-standard symbology that allows the use of only two colors, green and magenta. In flight, the above imagery is superimposed on what the pilot sees through the windshield.

The basic functionality is similar to the pilot's primary flight display, but with information compressed into a smaller image. Central to the HUD's appeal are the flight path marker and the flight director cue. The flight path marker depicts where the aircraft flight vector is headed, while the flight director cue indicates what the autopilot is commanding, whether it's flying the airplane or not.

The pitch ladder is a direct indication of pitch up or down and the zero pitch line indicates level flight. Heading is shown in three formats: the HSI at the bottom of the page and in digital repeaters above the HSI and under the bank angle indication.

almost at infinity, so as to be an aid, not a distraction.

MGF's iteration of this technology uses commercial off-the-shelf hardware from the automotive industry for the projector and a purpose-built, cabin ceiling-mounted bracket to tie the projector and combiner together. MGF sources the components offshore, makes some of its own parts and assembles the HUD at its Denver headquarters.

Schneider told us each aircraft will require a dedicated bracket and the company plans to provide these for popular models, although the full model list isn't fleshed out yet. He says the first approvals are expected this summer. The HUD is attached through posts bonded to the cabin ceiling via a mounting bracket.

In the legacy SR22 we flew, the airplane's Avidyne Entegra and Garmin 430s provided the data, which is crunched by a computer that's mounted behind the panel. The SkyDisplay uses ARINC 429 data from the navigators and serial data between the PFD and the autopilot so it can tell what the flight director is commanding. The refresh rate, says Schneider, is 16 MHz, so there's no noticeable latency in the display.

Schneider says he doesn't know if all avionics manufacturers will allow access to their high-speed bus data, but he believes SkyDisplay will function adequately with slower data MGF can access from newer navigators, such as Garmin's GTN series and the just-announced GPS 175.

In flying it, we adapted quickly, although it takes discipline to actually use the data effectively. On a couple of approaches, keeping the flight director cue inside—or at least near—the flight path marker kept the airplane on rails to DA or MDA. Once the runway looms up through the clag, you can flip the combiner up and complete the landing visually. Or use it as a reference all the way to the runway. Call us old school, but we would do the former. Using it for landing and takeoff, while possibly of some benefit, tends to encourage obsessing over data at the expense of having a feel for the airplane, which we think is something desirable in a light piston aircraft. Heavier and faster aircraft are different and more likely to benefit from disciplined use of a HUD.

That said, MGF might find some traction among owners who fly serious IFR, especially at night, and from pilots who just like gadgets. The device performs as claimed, but we doubt if it will rise to the must-have equipment category.

YouTube See a video of the HUD in action at http://tinyurl.com/j95ht2a.

Tire Retreads: Strong, Cheaper

The airline industry long ago recognized that retreaded tires are a substantial cost savings over new tires. The same can be said for GA ops.

by Jim Cavanagh

Included on the FAA-approved Owner Maintenance List is tire replacement. With basic tools and a couple of specialty items that many of us have already, changing your tires can be a relatively quick and easy thing to do. In addition to saving the labor costs, you can save even more by replacing tires with retreads.

Retreads aren't just for the 18-wheel trailer trucks. These days they can be a high-quality option for light aircraft that results in a sizable value if you understand the technology and buy from the right sources. Here's an overview.

LIVING A TOUGH LIFE

Aircraft tires are highly engineered and are remarkably strong for their size. They often go from 0 MPH to 80 or more MPH in an instant without distorting enough to come off of the rim, plus they have to hold pressure at these high speeds. If the airplane is a little cockeyed on landing, the tires sustain tremendous side loads, far greater than ever expected of an auto tire. The tires have to be balanced to eliminate wobble, which can be quite pronounced at landing speeds and can transfer vibration to the airframe, creating shaky rollouts. There's plenty of engineering involved. The tires are designed by computer for different loads and speeds, and the tread design is optimized for landing on the different surfaces we see in our operations.

And they must be as small and as light as possible because they induce drag on a fixed-gear airplane and occupy space and add weight to retracts. Tires are a combination of rubber, steel and cloth, all built into a design that creates a stable and strong unit.

How a tire wears depends on a multitude of factors, including the basic rubber formulation and hardness, the speed of the touchdown, temperature and the load on the tire.

If you haven't shopped for new aircraft tires, you'll find that compared to auto, truck and SUV tires, they may seem a bit pricey for their small size. There are sizable differences. While it's tempting to compare aircraft tires with car or truck tires, the comparison is flawed. The applications are very different and so aircraft tire design is rather different from vehicle tire design. An important consideration in tire design is heat dissipation.

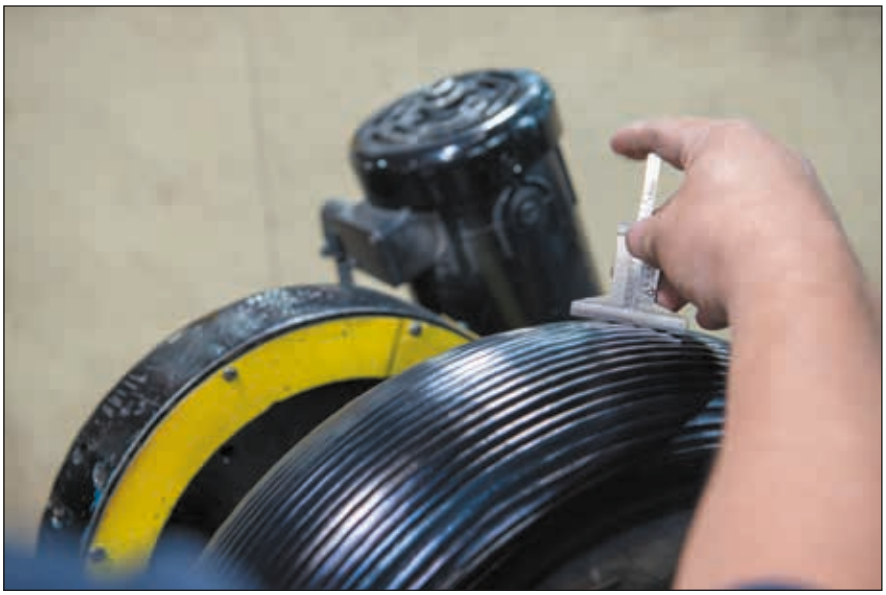
Most of the heat is generated in a tire by the flexing of the tread as it contacts the ground and again when it rolls off contact with the ground. Car tires are designed to run for hours without overheating and one way that's done is by limiting the deflection to only about 17 percent.

Aircraft tires don't need to run for hours. In fact, they only have to handle a taxi to takeoff followed by the takeoff roll, or a landing roll followed by a taxi back to parking. In both cases, they have sufficient time to cool before they're called upon to perform again. Aircraft tires aren't designed to handle a maximum-braking-effort abort. If you abort a takeoff and use maximum brak-

CHECKLIST

- There is a definite cost savings—nearly half—comparing retreads with factory-new tires.
- It can be argued that retreads might be more durable than new tires.
- Retreading is environmentally friendly, conserving far more oil than building a new tire.

A tech at Desser Tire and Rubber Company works on fresh retreads in the main image. The company's Monster series aircraft tire is the thickest in the industry, for around $100.



That's a retread in the Shearography Measuring System machine in the top photo, and a check of new rubber depth gauge in the middle. The tire at the bottom is ultimately rejected during the weathering check portion of inspection.

ing effort, most tire manufacturers recommend a tire inspection and, for heavier aircraft, a mandatory tire change.

Tubeless tires are also almost universal for cars but not widely used in airplanes. That's because a tubeless tire requires an airtight wheel. Most light aircraft wheels consist of two halves that bolt together and few are designed to be airtight. Tubeless tires show up on a wider variety of aircraft than radials—King Airs, Conquests and Aerostars, for example.

IT'S ABOUT THE SAVINGS

Tire retreading is such a big industry there's an entire organization (TRIB, for Tire Retread and Repair Information Bureau) dedicated to the cause. The website, www.retread.org, is a good source of reference.

According to TRIB, a retreaded tire generally sells for between 30 and 50 percent less than comparable new tires. Additionally, retread folks claim that not only are retreads no worse than new tires, they may actually have a few advantages. Every retread candidate is carefully inspected and only the best carcasses are chosen.

And, some studies have found that the stretching of inflation increases the tensile strength of the nylon plies, so a used carcass is actually stronger than a new one. It's easy to argue that retreads may be better than bottom-feeding the new tire market.

For instance, a value tire like a lower-end McCreary or the house brand at Aircraft Spruce (to name just one supplier) is easier on the checkbook in the short term, and if you do the exchange yourself it may seem like a smoking good deal, but in the long term this tire might not last nearly as many cycles (think landings) as a more expensive tire—say a Michelin or Goodyear Flight Special or Flight Custom, for example.

And don't just go by the brand. Based on my experience swapping my own rubber, within their lines most companies have both a premium and an economy tire. We'll look at new tires in a separate article. For now, we'll concentrate on retreads.

There is a wide range of pricing for new tires—anywhere from $85 to $300 per tire—so changing all three could get a bit pricey. Add tubes and labor to the project and you will see this firsthand, plus how quickly the invoice will grow.

That's the fresh Desser Monster model retread sidewall and tread pattern shown here.

Retread tires, on the other hand, are priced at roughly half the cost of a new tire.

I know that owners with high-end aircraft or perhaps a show-plane may scoff at retreads. Still, in all fairness this process—retreading or recapping as some call it—has been around nearly as long as we have had tires and it has proven to be an effective economy.

Moreover, major airlines and commercial operations often depend on retreads to reduce this consistent maintenance cost. In general for airline ops, a good core can be retreaded up to 10 times at a fraction of the cost of a whole new tire.

In fact, a couple of airlines have maintenance contracts with tire companies to provide and replace tires at regular intervals and they work with dispatchers to organize the downtime without involving regular crew. The old tires are removed, processed, retreaded and reinstalled in cycles. I was told that as many as 95 percent of all tires used by the airlines are retreads.

During my research I spoke with Jose Murillo of Desser Tire and Rubber. Desser has been in the tire business since 1920. The company has a long history selling new and used tires and a number of other rubber products. Around 20 years ago, Desser began to focus on aircraft tires—both new and retreads—in hopes of becoming a diverse market leader.

Since reliable distribution is critical in the tire replacement business, a warehouse was opened in Memphis, Tennessee, in 1989 to serve the eastern and southern parts of the country. Murillo told us that Desser sells over 100,000 tires a year to pilots in 85 countries. The company has been highly visible in *Trade-A-Plane* for years and has earned a good reputation among shops.

Desser gets its cores from airports, mechanics, owners and wherever else it can find them. But it can't take just any tire. The core has to be good, with no tread or belt punctures, no sidewall punctures, no torn or ragged belts, no damaged beads, and it must be evenly worn. Desser prefers to buy its cores in numbers on pallets, but the company also has a group of owners who send their tires in for the retread process.

THE RETREAD PROCESS

When a core comes in it gets cleaned and visually inspected. The tire gets spread open so that a close inspection can be taken of the inside. If it's good so far, the tire is then put through a Shearography machine, which determines if any belts have moved or slipped.

Causes for rejection include any worn core layers, weather checking and sidewall damage. Once approved, the core, or carcass, is put on a machine that shaves it to a consistent roundness.

Starting with a good, perfectly round core, and the tire put in a mold with a new rubber compound where lettering and tread grooves are formed, the tire is cooked. This bonds the new rubber to the prepared core. The length of this process depends on the size of the tire.

For the new tread, a high-performance rubber compound is used, and Murillo told us that the retread tire should actually get considerably longer life than OEM tires. The number of grooves in the tire depends on its type and part number.

Out of the mold, a tire is trimmed, visually inspected, balanced and put through the Shearography machine again to check for thorough bonding, ensuring there are no gaps or bubbles. Then it is checked for leaks and painted. The name of the retreader is generally imprinted on the side of the tire.

HOW MUCH SAVINGS?

If a tire has enough tread remaining but is damaged, a repair might be made. Desser said it's able to repair some tires through its sister company Aero Wheel and Brake Service. This is an FAA repair station and is able to issue an FAA Form 8130-3 for every repaired tired it sends out, going as far as snapping a photo of the tire and the paperwork before shipping it out.

I present this overview of the retread process to make the point that aircraft retreads are not cheap repairs; rather they are fully certified, well-built products with decades of experience in both commercial and GA operations. Think about it—when was the last time you ever saw a "road gator" thrown casing laying alongside a runway? It just doesn't happen.

As for bottom-line savings, I checked the prices on Desser-supplied factory-new tires. Using the ubiquitous 6.00 by 6, 6-ply tire as a sample I found that a Michelin Air was $185, a Superhawk (Specialty Tires of America) was $232 and a Goodyear Flight Custom III was $228.43.

Comparable retreads from Desser range from $90 to $103, and the company offers their "Monster" tire, which has a thick 11/32-inch tread thickness—the thickest in the industry—priced from $92 to $104. This shows that retreads are about half the price of new tires.

Desser also sells tailwheel tires, a newly approved retread process for a new smooth Tundra tire for Piper Cub drivers who want to land on sandbars or unimproved surfaces in rough terrain. Tires of all sizes and for nearly all aircraft uses can be found on its website, www.desser.com.

Murillo told us that growing numbers of buyers are having a couple of sets of tires retreaded so that they can remove a set and send it in for retreading while they run on the second set. Four cycles with two sets offers a lot of extended life for the investment. For comparison shopping, Desser will quote a price for retreading your tires when you call.

Our special thanks to Jose Murillo at Dresser Tire for providing the photos for this article.

Piper's New Trainer: New Glass and Engine

Starting at $259,000 the three-seat Piper 100-series sports a Continental IO-370 and Garmin G3X Touch avionics.

by Larry Anglisano

On an otherwise underwhelming first day at the Sun 'n Fun fly-in this past April, Piper surprised the press by unveiling its new 100-series trainer—the Pilot 100 and Pilot 100i.

At first blush these airplanes resemble Piper's venerable PA-28 Archer, which isn't necessarily a bad thing in the training environment for which they're aimed. But a closer look reveals sizable differences compared to the current $369,000 Archer TX.

Price aside (the VFR-only Pilot 100 is $259,000 and the IFR-equiped 100i is $289,000), the models have new avionics, a new Continental engine and a three-place cabin configured with an observer station.

Forget about LSAs, at least for the training environment, suggests Piper president Simon Caldecott, who thinks light sport-derived trainers are misplaced in the training environment.

But the familiar and reliable-dispatch PA-28 airframe is a different story. It retains Archer styling (less the third window—it's gone on the Pilot) and the student-friendly airframe design that mechanics know how to wrench.

ENTER CONTINENTAL

While the Textron Cessna Skyhawk has slumped, Piper has achieved sizable success selling both the Warrior and Archer in the training market, and the new Pilot series is aimed at small flight schools that

The Piper Pilot 100i, lead photo, is based on the familiar Archer airframe but that's where the similarities end.

The Pilot 100i model comes with Garmin's G3X Touch integrated avionics and a center stack suited for instrument flying. It includes the GFC500 autopilot, G5 EFIS backup and Garmin's newly introduced GNX375 WAAS IFR navigator with ADS-B In and Out.

want a new glass cockpit airplane that's engined to stand the test of time between overhauls.

The Continental Prime certified engine series was introduced in 2017, and the Prime nomenclature simply represents a new name for Continental's line of components.

The IO-370-D3A Prime to be used on the Pilot 100 makes 180 HP at 2700 RPM. The TBO is 2200 hours. Piper's Caldecott pointed out that the company thought long and hard for over three years about which engine and avionics it would use in the trainer, which had to be priced well south of $300,000—a price that might be the sweet spot for healthy flight schools. "There is nobody else there at that price point," Caldecott said.

He also reiterated that fuel injection is standard on the new 100-series aircraft, but optional on the Archer. In our view, every buyer might fully expect fuel injection as standard. The IO-370 engine is mated to a Sensenich two-blade fixed prop.

GARMIN G3X TOUCH

While Garmin was showing off the once-experimental but now STC'd G3X Touch integrated avionics retrofit in a Grumman Tiger at the show, Piper had the suite lit up in the Pilot 100i on display. The basic model 100 is equipped with VFR-limited avionics, including a Garmin GTR225 comm radio and GTX335R transponder with ADS-B In and Out.

But the $259,000 Pilot 100 still gets the G3X Touch with a 10.6-inch PFD/MFD with electronic charting, synthetic vision and no autopilot. For an additional $9500, schools can equip the Pilot with a third observation seat and a GMA245R remote audio panel with Bluetooth.

The premium for the IFR-capable gear in the Pilot 100i boosts the price to $289,000. It includes the Garmin GFC500 autopilot with ESP envelope protection, a GTR225 secondary comm radio and a GMA245R remote audio control panel with Bluetooth. For backup, the suite includes the Garmin G5 EFIS.

VERSUS CIRRUS, FOR HALF THE PRICE

Selecting the Continental for the Pilot 100 is somewhat opposite of what Cirrus did in 2017 when it re-engined its SR20 with a Lycoming IO-390, ditching the Continental IO-360ES. At Sun 'n Fun, Cirrus told us sales of the G1000 NXi Perspective-equipped SR20 are at a record high in the training market. We flew the re-engined SR20 for a report in the June 2017 *Aviation Consumer* and found it smooth-running and efficient, burning 8.5 GPH.

But schools will pay a hefty premium for a Cirrus. The 2019 Cirrus SR20 is priced starting at $454,900 with 10-inch displays. The Premium package is priced at $554,900 with 12-inch displays and a 4-in-1 standby EFIS system.

EXPECT LOW VOLUME

Don't expect Piper to crank out hundreds of Pilot trainers any time soon, even though Piper has made modern improvements to its production line. This includes upgraded machinery, while converting to the 3D plastic printing process. Trimming the production costs simply lowered the cost of the airplane, Piper said.

Caldecott reiterated that production will be initially limited to 25 Pilots per year, while it continues building Archers for larger flight schools. Deliveries of the Pilot, certified under Part 23, are expected in the first half of 2020.

Cessna 182 Skylane:

From early straight-tails to G1000 models, the market is littered with fixed-gear Skylanes at a variety of price points.

CHECKLIST

- Just about any Skylane can haul an impressive load.
- You would be hard-pressed to find a shop that can't work on a Cessna 182.
- Expect speed? You won't find it in a 182. Later turbo models will only cruise in the mid-150-knot range.

It's easy to see why the venerable Cessna 182 Skylane is an easy choice for a wide variety of missions. From the oldest Skylane to the current all-glass model that flirts with $500,000, a 182 has good hauling capability, good dispatch reliability and a relatively comfortable cabin, plus maintenance shops know how to work on it. That covers a lot of bases.

Except for its intolerance for mismanagement on and around the runway—giving it a not so respectful ranking in the NTSB reports—we suspect buyers are comfortable with long-term Skylane ownership. For many, it's as far up the pecking order as they'll go in their flying careers.

These days, you can buy a 182 with a full G1000 glass panel and a luxe interior for a price in the high $300Ks. A big investment, to be sure, but far less money (and far less speed) than a new Cirrus SR22, as one example.

MODEL HISTORY

Wind the clock back to 1956 to reach the beginning of the 182 evolutionary history. The fact that it looks like a giant Skyhawk which itself looks like an inflated 150 shows that Cessna just did what it does best: It built on its experience with previous designs and scaled them up. The 182 evolved from the 180 taildragger, so Cessna added the tri-gear, redesigned and relocated the exhaust and reworked the fuel vent system. Wet wings were used to hold fuel.

With the new gear, the 182 developed a nose-heavy tendency and Cessna never did sort this out.

Even new ones require deft trimming or the lazy pilot risks smashing the nosegear into the runway and crow hopping down the strip. It's not unusual to see an older 182 with repaired gear and firewall due to a nose prang.

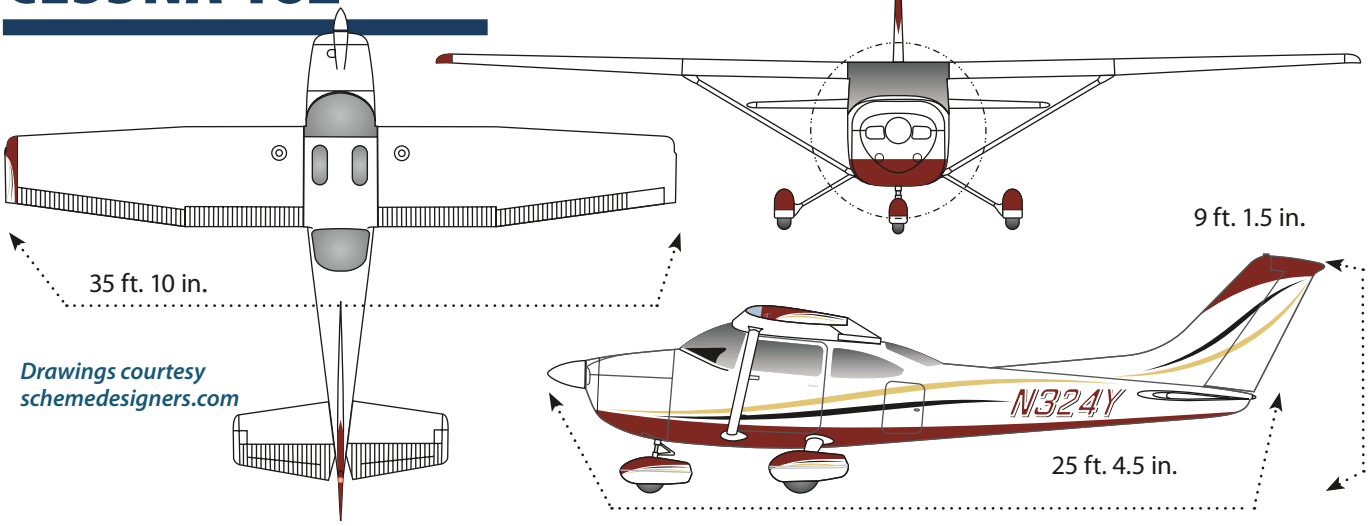
Skylanes are prized for short and rough airfield operation and deservedly so.

When the airplane appeared in 1956, the average price was just under $17,000. That's equivalent to about $158,000 in 2019 dollars. Obviously, given the price of the new 182T, aircraft prices have far outstripped inflation.

In the first 182s, power was provided by a 230-HP Continental O-470-L, an engine that proved to be such a worthy choice that some variant of it was retained until the airplane went out of production in 1986. The engine remains easily overhaulable, for prices under $30,000.

With its straight tail and windowless back, the original 182 looks like an antique, but Cessna soon sleeked it up with a rakish

CESSNA 182

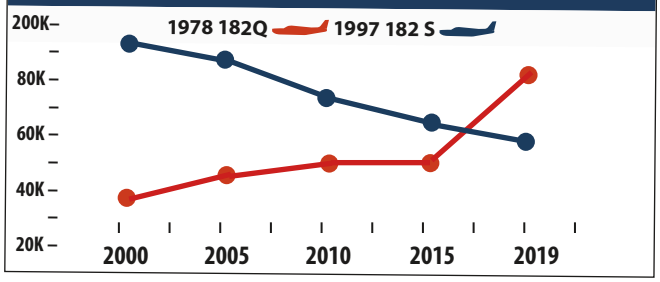


Drawings courtesy schemedesigners.com

CESSNA 182 SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1956-1959 182 A,B	CONT 230-HP O-470-L	1500	$25,000	55	1010	117-120 KTS	±$31,000
1960-1965 182 C-H	CONT 230-HP O-470-L	1500	$25,000	65-84	1090-1190	123 KTS	±$34,000
1966-1969 182 J-M	CONT 230-HP O-470-R	1500	$25,000	65-84	1175	123 KTS	±$41,000
1970-1971 182 N	CONT 230-HP O-470-R	1500	$25,000	65-84	1310	121 KTS	±$44,000
1972-1974 182 P	CONT 230-HP O-470-R	1500	$25,000	61-80	1169	123 KTS	±$46,000
1975-1976 182 PII	CONT 230-HP O-470-S	1500	$25,000	61-80	1169	125 KTS	±$57,000
1977-1980 182 QII	CONT 230-HP O-470-U	2000	$25,000	61-80	1169-1390	121 KTS	±$70,000
1981-1986 182 RII	CONT 230-HP O-470-U	2000	$25,000	92	1373	124 KTS	±$84,000
1981-1985 T-182 RII	LYC 235-HP O-540-L3C5D	2000	$30,000	92	1319	157 KTS	±$85,000
1997-2000 182 S	LYC 230-HP IO-540-AB1A5	2000	$35,000	88	1210	140 KTS	±$140,000
2001-2005 182 T	LYC 230-HP IO-540-AB1A5	2000	$35,000	92	1025	140 KTS	±$160,000
2001-2005 T182 T	LYC 235-HP TIO-540-AK1A	2000	$40,000	92	1025	159 KTS	±$190,000
2006-2009 182 T	LYC 230-HP IO-540-AB1A5	2000	$35,000	92	1130	145 KTS	±$280,000
2006-2009 T182 T	LYC 235-HP TIO-540-AK1A	2000	$40,000	92	1025	159 KTS	±$375,000
2009-2013 182 T	LYC 230-HP IO-540-AB1A5	2000	$35,000	92	1025	159 KTS	±$360,000

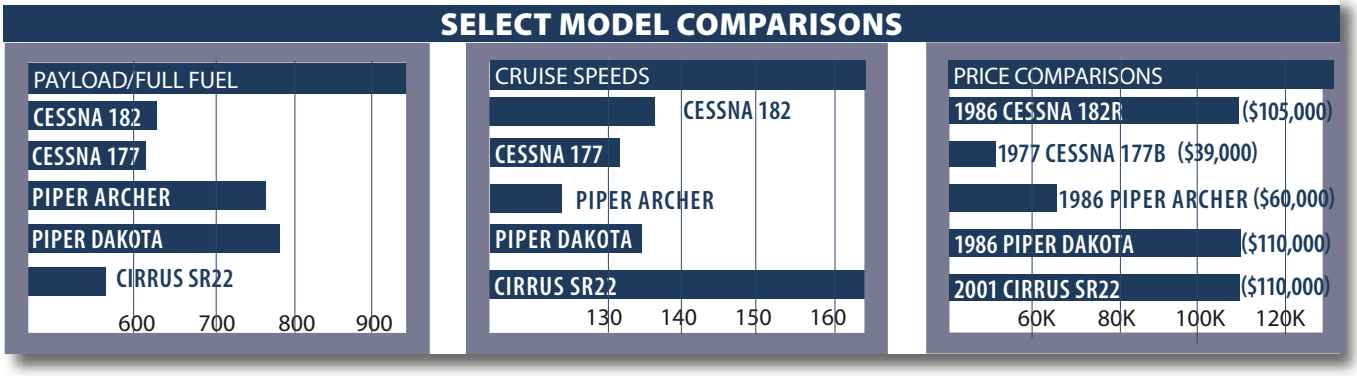
RESALE VALUES



SELECT RECENT ADs (S-MODEL)

AD 08-26-10	ALTERNATE AIR SELECTOR VALVE
AD 07-05-10	SEAT BACK LOCK ASSEMBLIES
AD 04-15-10	BENDIX/KING KAP140 AUTOPILOT
AD 98-16-04	SPAR CAP ANGLE STIFFENER INSPECTION

SELECT MODEL COMPARISONS



That's an early 182S retrofitted with an Aspen PFD and Avidyne GPS, top, and a mid-2000s model with Garmin G1000 glass, bottom.

tailfin and the classic rear window everyone loves. Gross weight was 2550 pounds, compared to the modern Skylane max takeoff weight of 3110 pounds. (More on that later.)

Cessna embarked upon a continuing improvement program, introducing new model designations every couple of years. The 182A saw redesigned gear with a wider track and a lower stance, with the mains 4 inches shorter and the nosegear 2 inches shorter. The 182A got an external baggage door and a 100-pound higher gross weight.

In 1958, the Skylane name was applied—prior to this, the airplane was simply called the 182—and a deluxe version with wheel pants, standard radios and full paint instead of the trim over bare aluminum bettered the basic 182.

The 182B, with cowl flaps, came out in 1959. A swept tail was added in 1960 to make the 182C; it was basically a styling move, since the swept tail degraded spin recovery and reduced rudder power. The gear continued to be a problem, so in 1961, it was lowered again, by another 4 inches, on the 182D.

As it did with other models, Cessna put a rear window (Omni-Vision) on the airplane in 1962, with the 182E. This airplane was a significant upgrade over the earlier 182s and these are often thought of as "modern" Skylanes. The fuselage was widened 4 inches and the cabin floor lowered by nearly one inch to make more interior room.

Electric flaps became standard, the panel layout was updated and the adjustable stabilizer of the original gave way to a trim tab. The gear was beefed up (again) and the gross weight was boosted to 2800 pounds. A different engine variant, the O-470-R, was fitted. The 182E also had a redesigned fuel system, with bladders and the availability of auxiliary fuel, which raised capacity to 84 gallons.

Cessna also made changes that weren't as obvious. To save weight, it used thinner aluminum for the skins and converted from sheet aluminum to roll aluminum, which was cheaper.

That also yielded an airplane with more surface imperfections, which ended the days of polished metal airplanes. Full paint jobs became standard, to hide the dimples. The new airplanes were only 10 pounds heavier than the old ones but performance actually suffered, with reduced climb, takeoff performance and service ceiling.

The 1963 182F sported a thicker, one-piece windshield and back window, a standard T-panel and an increase in horizontal stabilizer span of 10 inches. Flap pre-select also became standard. From the F model forward, until the S arrived in 1997, changes were less dramatic. The G model had an available kiddie seat for the baggage bay, while the 182H got an alternator to replace the generator.

TURBOCHARGING, NEW ERA

The next significant upgrade was with the 1970 182N model. Gross weight was increased to 2950 pounds and the spring-steel gear was swapped for tapered tubular steel legs that allowed more fore-and-aft movement.

Track was widened again, to 13.5 feet, improving ground handling somewhat. In 1972, a leading-edge cuff was added to the wing to improve low-speed handling, resulting in the 182P, a variant that stayed in production through 1976. The dorsal fin was extended and the cowling was shock mounted.

In 1981, the 182R got another gross weight boost to 3100 pounds and an increase in standard fuel capacity, to 88 gallons, stored in wet wings. The bladders, which had been a problem, were dropped in 1978. Cessna also switched over to a 28-volt electrical system. A turbocharged version was added to the line in 1981, the T-182RII, powered by a Lycoming O-540 produc-

Later-model Skylanes (top and bottom photos) come standard with three-blade propellers and stylish interiors, but at a slight weight penalty. The cabin shot at the bottom is in a 2015 model year 182T.

ing 235 HP. Production ended in 1986 with the 182R.

In 1997, when Cessna reentered the market, it introduced a newly retooled Skylane for the next century. The changes were substantial, some cosmetic, some not. The biggest change was dropping the reliable O-470 for a 230-HP Lycoming IO-540-AB1A5; no surprise there, since Cessna and Lycoming share the same parent company, Textron.

But the change improved one thing. The O-470s were quite susceptible to carb icing and the injected Lycoming solved that. But like the O-470, the Lycoming is a bit of a fuel hog.

Further, the Lycs are known for lunching cams at the mid-time point, which the TCM engines don't typically do. Also, the Continental is a smoother-running engine, in our view.

Cosmetically, Cessna did away with the old Royalite instrument panels, replacing them with painted metal. The interior—seats and cabin panels—is much improved, as is the instrumentation. Interior surfaces are now treated with epoxy-based anti-corrosion materials.

The latest 182 also has sealed wet wings, not bladders, making us wonder if owners will encounter leaks as the sealants age, as happens to Mooney owners. To get water out of the system, the airplane has no fewer than 12 separate drains, five on each wing tank and two at the bottom of the cowling. Although gross weight of the airplane is 3100 pounds, its typical empty weight is substantially higher than earlier models so it carries less than, say, an early 1980s RII. Speedwise, the normally aspirated model is respectable, cruising at just under 140 knots on 16 to 17 GPH. One reader told us the turbo 182 is capable of the mid-160s (knots) in the teens.

Maintenance wise, the 182S has proved the target of a number of Cessna service bulletins, with most of the work being covered under warranty. Thus far, we've heard no significant beefs related to unusual maintenance problems. The BendixKing avionics in the new Skylane (172 and 206, too) turned out to be hugely problematic. So much so that Cessna eventually switched to Garmin's G1000 and never looked back.

Cessna teased the market with the $530,000 182 JT-A diesel-engine model, but ultimately put the program on hold indefinitely. Test aircraft have flown with the 227-horsepower SMA SR305 turbocharged engine, but a turbocharger failure (resulting in an off-field landing) seemed to be the beginning of Cessna's FAA certification troubles. Worth noting is this engine has operated pretty well under European approval.

Textron currently offers the G1000-equipped 182T at a base price north of $500,000.

MARKET SURVEY

The market may have been more well delineated when the 182 appeared but it's a jumble now. There are so many used and new airplanes available, it's hard to know what to compare the 182 to. The Skylane still offers lots of interior space and an unusually flexible payload/range combination that explains its enduring appeal.

Late-model Skylanes have depreciated to the point that a 1997 S model can be had for $135,000 or less. That's a good value when you consider that one 10 years older—a lesser airplane, in our view—sells for roughly half that.

For equivalent capability, buyers may or may not favor Cessnas over Pipers. An average-equipped 1979

No pavement? No problem. A Skylane can handle backcountry turf just as well as big-airport pavement.

Skylane will fetch about $71,000 while an early 1980s Piper Dakota has held its value, bringing as much at $110,000, despite the fact the Cessna cost less when new.

Which Skylane model? That depends on your budget. As noted, the latest models have started their depreciation slide and are looking to be better values than ever. These are well-equipped airplanes and are quieter and more comfortable than the earlier Skylanes.

For a real steal, look for 2005 models with G1000 suites for prices in the mid-$170Ks or less. But *caveat emptor*. Some aircraft haven't been upgraded to WAAS (the upgrade cost is staggering), creating several problems, including the ability to shoot a modern GPS approach, plus the ADS-B position source dilemma, since WAAS is required.

If you're going older, most buyers seeking a practical, use-it-often airplane won't want a museum piece, so that argues for a 182E or later. If your budget allows up to $90,000, the 1981 T-182 strikes us as a better combination of speed, value and hauling ability than any other airplane we can think of. You might have to invest in modern avionics, or ones to your liking. This could run an additional $50,000—or more—for a ground-up upgrade.

PERFORMANCE, HANDLING

If fast is your mantra, the Skylane won't be your airplane. Flogged to the limit, these are 135-knot airplanes, but more like 130 knots burning about 12 GPH. Range varies with year and tankage, of course, but typically, you can easily fly 900 still-air miles in the 88-gallon versions. That's more endurance than most owners can muster.

Skylanes are prized for short and rough field ops and deservedly so. Longtime reader David T. Chuljian flogs his L-Model 'Lane into the Idaho outback with good results.

The prop is well clear of the ground and the gear is high enough to keep antennas out of the muck. If need be, the wheelpants can be removed. But still, it ain't no traildragger. The nosegear will take some hits on rough strips.

A late-model 182 will get over a 50-foot obstacle in only 1115 feet; add a third more for safety margin and you're still comfortably under 2000 feet. Initial rate of climb is good, thanks to the high horsepower, but it was better in the early models than the later ones, thanks to significantly higher gross weights.

But later models—the 182P and forward—have greater fuel capacity and higher gross weights and thus offer more loading/range flexibility. This, more than any other factor, makes the Skylane a first choice as a family airplane. It's not much good to blaze along at 160 knots if you can only carry three people.

Although the CG range in the 182 series is adequate, the airplanes tend toward forward CG; ballast or bags in the baggage compartment help. Speaking of which, the baggage compartment is large and easily accessible through an exterior door. (The seals, when old, may leak and should be replaced.)

Handling? We're not talking BMW-like. The 182 is a big, stable airplane and it takes some effort to break it loose from anything other than straight and level. And even if you do, its draggy profile means that speed builds slowly enough that only a somnambulant pilot could lose it in a dive. The Skylane is heavy in pitch, so timely trimming is a must, especially prior to or during the landing flare. Get lazy in the flare and the Skylane can slam the nosegear onto the pavement, buckling the firewall and leading to a huge repair bill. Roll forces in the 182 are nothing unusual; think of a Skyhawk with stiff cables. In a turn,

That's the split rear seat and the baggage area in a 1960s vintage Skylane pictured here.

the Skylane will want to overbank if left alone but so slowly that you should never get behind it.

As far as roll trim goes, fuel load and balance are important in the 182, particularly in airplanes with long-range tanks. The fuel system will self-siphon between tanks if the airplane is not parked on a level surface, so it's possible to have an imbalance that won't improve in flight. Even Cessna's excellent L-R-Both fuel selector won't prevent the tanks from draining at different rates unless a single tank is selected.

Transitioning from a Piper or smaller Cessna to a Skylane is a Ralph Kramden experience: You'll definitely feel like a bus driver, albeit a regal one. The seats are high and upright and relatively comfortable. Although visibility is good forward and out the windows, the panel and glareshield are tall, requiring short pilots to use a booster seat. Heating is good for the front-seat passengers, less so for the rear. Wing root vents provide plenty of ventilation but also leak air during the winter, leading some pilots to tape the inlets. Cessna fixed this in the newest Skylanes, which are tight, quiet and warm.

ENGINE, MAINTENANCE

In all of general aviation, there are perhaps a handful of engine-airframe combinations that are nearly perfect. The 182/O-470 pairing is one of them. Four variants of the engine were used: the L, R, S and U. The S (1975-1976) has been the most troublesome because of its revised piston ring configuration, intended to cope with the introduction of low-lead fuel. The U variant (1977-on) is desirable because of a 2000-hour TBO, though earlier engines are upgradeable from their 1500-hour TBO. It's a rare Continental that makes it to TBO without some form of top overhaul but as big displacement engines go, the O-470 is more likely than most to get by without a top.

Because of its high population and simplicity, the O-470 series is relatively inexpensive to overhaul. One persistent weakness of the design, however, is the tendency of the carburetor to ice up. In carb ice conditions, you have to be on your toes in using carb heat—the accident history shows this.

In its singles, Cessna wisely adhered to the KISS theory for the fuel system. But early models still had their problems. The bladder fuel systems found on 1962 to 1977 Skylanes didn't fit well in the wing bays, resulting in the possible formation of a diagonal wrinkle across the bottom of the bladder. Combine that with water leaks due to deteriorated O-rings in the flush fuel caps and you can see the problem; the wrinkle acts as a dam to trap water that the pilot couldn't remove during preflight sumping. On rotation, the water would spill over the wrinkle, reach the fuel pick-up and choke the engine on climbout.

The FAA's response (AD 84-10-01) was to mandate the installation of additional drains and the inspection of the bladders for wrinkles. This is better known as the "rock-and-roll" AD, for it also directed pilots of airplanes not so modified to go out to the wingtip and shake it up and down to get the water to slosh over the wrinkles. This Marx Brothers-like procedure is certain to cause serious doubt in the minds of nervous passengers.

Otherwise, the Skylane is relatively free of serious ADs. A few have cropped up recently, but they're one-time directives. AD 98-1-14 calls for replacement of mufflers; 98-1-1 mandates inspection and possible replacement of the alternate static air valve. Also of note are 97-21-2, inspection of cer-

SMASHED SKYLANES: HARD LANDINGS

Because of some careful engineering, the 182 series airplanes have a long center of gravity range, allowing the pilot much flexibility in loading without going out of the aft limit, as can be a problem with some competitors. The upshot is that when flying alone, or with just one passenger in the other front seat, the airplane is often near the forward CG limit. That has given the airplane an unjustified reputation for being "nose heavy."

When any airplane is loaded near the forward CG limit it takes a focused effort on the part of the pilot to raise the nose and actually stop the descent in the flare and then land on only the main gear. The forward CG limit is usually where a pilot cannot flare the airplane to land—being near it requires really pulling on the yoke to get into touchdown attitude.

Our review of the 100 most recent Cessna 182 accidents indicated that a lot of pilots didn't get the briefing regarding what it takes to flare an airplane loaded well forward—22 of them messed up the flare and hit so hard, or porpoised so badly, that they damaged the airplane. And we mean damaged—the minimum reported was a bent firewall, and several managed to break off one or more gear legs.

When landing a 182 correctly, the nose is up high enough to block visibility directly forward—and it takes a healthy pull to get it there. Not all pilots do it all the time. If you are considering purchase of a 182, assume that there has been damage due to a hard landing, particularly to the firewall—so look for it and ensure that it's been correctly repaired.

There were 16 runway loss of control (RLOC) accidents—not bad for a tricycle-gear airplane, although two involved 182s that had been converted to tailwheel configuration. Combining the RLOC and hard landing numbers for the Skylane gives an overall control issue landing number of 38. We think that's high for a nosewheel airplane.

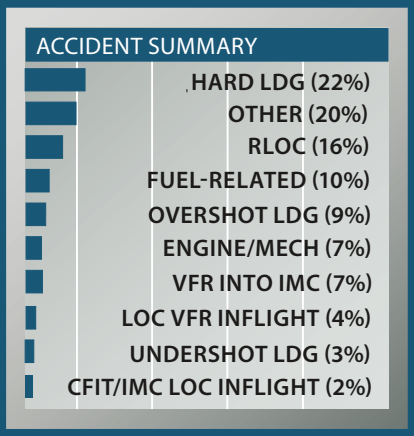
Nine 182 pilots went off the end of a runway, usually after coming down final at the speed of heat and floating down much of the runway before touching down. Three pilots undershot the runway and damaged their airplanes.

While nothing shocks us anymore, we did scratch our heads at the pilot who touched down short of the runway, hit the 6-inch lip of the pavement with the nosewheel, broke it off and then went around. He knew he had a problem so he made the bad decision to land on the grass adjacent to the runway (if you've got a gear problem, put the airplane on pavement—it will slide). Sure enough, the broken nosewheel dug into the turf and flipped the airplane.

A total of 50 landing-related accidents tells us that pilots should get a good checkout in how to correctly land a 182 before heading off solo.

We were impressed by the pilot who landed safely after a goose took out the airplane's windshield.

Modern technology allowed two pilots to hurt themselves: One decided to pick up his iPad while 20 feet up on final instead of flaring. Another flew into ground fog, at night, on long final. He decided to rely on the moving map on his tablet to reach the runway. He crashed a mile short.



tain cylinder installations; 97-15-1, replacement of specified cylinders; and 96-12-22, recurrent inspection of the oil filter adapter.

More recently, Continental had issues with valve lifters coming apart and these impacted some O-470s. We've researched a summary of ADs against the S-model Skylane. Although the number is seemingly large, none are especially onerous.

MODS, CLUBS

The Skylane may hold the record for having the most modifications available and many of them are good. The big-ticket items are engines: replacing the stock O-470 with a Continental O-520 or IO-550, another TCM product with a good reputation. P.Ponk does the 520: Contact pponk.com or 360-629-4812. Peterson Performance Plus (katmai-kenai.com) offers an impressive STOL package, including the full-up King Katmai mod (we covered it in the January 2013 issue of *Aviation Consumer*), plus O-470 engine upgrades.

Air Plains (airplains.com, 800-752-8481) does O-520 and O-550 conversions for the Skylane. For another STOL package, see Sierra Industries at sijet.com. Texas Skyways offers the O-550 upgrade; check them out at txskyways.com or 800-899-7597.

There is the Horton Flight Bonus speed package; contact 800-835-2051 or stolcraft.com. More speed mods are available from Knots2U at knots2u.net or 262-763-5100 and Maple Leaf Aviation at 204-728-7618 or aircraftspeedmods.ca. Met-Co-Aire has drag-reducing wingtips; see metcoaire.com and phone 262-763-5100. If you want to slow down instead of speed up, contact Precise Flight (preciseflight.com or 800-547-2558) for a speedbrake kit. Vortex generators are available from Micro Aerodynamics at 800-677-2370 or microaero.com.

If six hours of endurance isn't enough, see Monarch Air and Development (monarchcaps.com) for aux tanks and improved fuel systems. For more aux tanks, see Flint Aero (flintaero.com and 619-448-1551). Last, don't forget props from Hartzell; three-blade conversions are available. See www.hartzell-

prop.com or 800-942-7767.

There are a couple of Cessna groups, including the Cessna Pilots Association at www.cessna.org, as a source for obtaining information before purchasing a Skylane. These guys have been at it for years and know the brand well. Find more support at the Cessna Owner Organization at 888-692-3776 or www.cessnaowner.org.

OWNER FEEDBACK

There are Cessna 182s; then there are Cessna 182s with STC modifications. They are different airplanes. Mine is a 1980 182Q Skylane II that I've owned for seven years, operating out of a club-owned grass strip. First, I'll tell you what it can do, and you'll think I'm lying. Then I'll tell you about its mods, and perhaps you'll believe.

With moderate loads, it typically takes off in about 400 feet and climbs at a steep deck angle at about 1100 FPM. Taking off from a hard-surface 5500-foot runway, it will be 1000 feet AGL at the other end. It lands in 600 to 800 feet with light to moderate braking. It flies comfortably at 40 knots indicated, with no wing drop in shallow turns. It will cruise at 8500 feet at 143 knots true airspeed, burning only 9.5 GPH. It can fly nine hours, with reserves. I know it's hard to believe.

The mods start with a Texas Skyways O-520 Continental engine with 280 HP and a 2500-hour TBO. This engine will run lean of peak, full throttle, with carb heat and burn only 9.5 GPH. There's a lightweight starter and Tanis engine heater. Then there are two outboard auxiliary fuel tanks, 11.5 gallons each, by Flint. With the mains at 88 gallons, that's 111 gallons useable. Then there is a Horton STOL mod, with leading edge cuffs, fences, gap seals and wingtips. For comfort, there's an Air Mod interior with high-backed adjustable seats and Rosen visors. For safety, new Amsafe airbags are on the front seatbelts. Avionics include a Garmin GTN650, Strikefinder, Garmin 796 with XM Weather, electronic tachometer, JPM engine monitor, Xeon traffic detector and a PS Engineering 8000 audio panel.

On the negative side, this plane had a fresh engine overhaul when I bought it; however, none of the accessories were touched. I have overhauled or replaced just about everything. Useful load is only 1040 pounds. Obviously, it's no more than a two-place airplane if you fill all the tanks, but that's been rare. It has good, but dated, original paint. And it burns 28 GPH on takeoff and initial climb.

I operate the airplane for about $125 an hour, allowing for overhaul, insurance, taxes, annual inspection, repairs and $4.50 fuel. I do fly-outs in the U.S. and Canada with the International Fellowship of Flying Rotarians and fly from my North Carolina foothills home to my second home at 03NC, Pilots Ridge Aero Plantation near Carolina Beach and Wilmington. This is a wonderful airplane.

Rankin A. Whittington
Lenoir, North Carolina

I have a 1998 Cessna 182S model that I purchased in 2015. The airplane was expertly repainted by KD Aviation in Newburgh, New York. The original paint was in fairly good shape, but I was itching for a more modern look and borrowed a factory paint scheme from Cessna's T-series Skylanes.

I had previously owned a Cessna 172, but needed to upgrade as my kids grew and the Skyhawk's useful load didn't. I seriously considered a few Cessna 210s before choosing a 182 and although I do occasionally miss not having six seats, this 182 is sized right for the majority of my mission profiles. This airplane came ADS-B Out compliant via an Avidyne IFD540 and AXP340 transponder. I added ADS-B In capability via a NavWorx MLB100 that feeds both the Aspen evolution MFD and Avidyne IFD540 displays. As you can expect, getting three different vendor products to talk to one another was a challenge. I am mostly—but not fully—satisfied with the end result in that I receive ADS-B traffic and weather on the IFD540, but only traffic without velocity vectors on the Aspen MFD.

As a newbie to glass at the time, I appreciated the inclusion of steam gauges in addition to the glass in

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The Aviation Consumer

Used Cessna 182

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the panel to aid my transition and provide a comforting backup. This was driven home after witnessing red X's on the Aspens after a brief encounter with ice on the pitot tube. Granted it was my fault for being slow on the pitot heat, but I thought it odd at the time that attitude would be so dependent on the pitot static inputs.

With an increased reliance on moving electrons, I had Kelly Aerospace install the STC'd backup alternator. I was very impressed with the quality of the components and the peace of mind afforded by this upgrade. In fact, the backup alternator is capable of 95 amps, which makes it more capable than the stock primary alternator. It's only capable of sourcing 60 amps.

Finally, I contacted Aero Comfort to leather wrap the control yokes and I couldn't be happier with the result. Surprisingly, what could arguably be the least essential upgrade in the airplane ended being among the most satisfying. I swear the airplane is more fun to manually fly now and I am constantly reminded of this when flying rentals and my friends' airplanes without this treatment. I would definitely recommend Aero Comfort to anyone considering this luxury.

In terms of determining the cost of ownership, it's difficult to say. Like many of your readers, I like to upgrade the aircraft in addition to merely maintaining it. Fortunately, I have been blessed in that at least for the time being, I can afford to pursue both. However, scanning through my past annuals I see that the basic annual and the associated maintenance repairs have cost anywhere from $3100 to $3700, and these are New York prices.

Overall, I am very pleased with N182AM. Sure, there are times when I wished for more speed and seats, but I feel this is an airplane I could comfortably grow older with as it teaches me something new each and every flight.

George Scavella
via email

That's George Scavella's 1998 Cessna 182S wearing a modern paint scheme in the photo below. Scavella upgraded from a 172 for more loading and has never looked back.

PILATUS PC-12

It's time again to take a look at the used Pilatus PC12 market for the Aviation Consumer Used Aircraft Guide. We want to know what it's like to own these turboprops, 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 Pilatus by June 1, 2019 to:

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