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The Aviation Consumer

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Shop and Owner: Fragile Relationship

That's one of the many things I learned over the 25 years working at several aircraft maintenance shops. As explained in the article on page 12, money matters can turn a healthy working relationship into a hostile separation. When this happens, the customer and the shop will lose. That's why it's the responsibility of the owner and the shop to keep this uncomfortable part of the work on the rails. With some rare exceptions, it's also a reason why an owner shouldn't take the aircraft without paying the invoice.

Both of these rules were broken when a friend recently brought his airplane to an avionics shop for autopilot work. There was a long history of favorable dealings on both ends of the counter. In other words, both the shop and the owner were assets to one another. But that unraveled when the shop's owner asked for payment. Insulted by his arrogant tone—and feeling like a deadbeat—my friend assured the shop's owner that he would put a check in the mail when he got home, as he's done countless times in the past. These payment terms were acceptable for previous work, so why was this time any different?

On the way home (he didn't pay the bill before leaving) my friend discovered the autopilot wasn't fixed. Not only was he insulted by the way payment terms were handled, but now he's angry at the unresolved autopilot problem. Back at the shop, the shop's owner is angry for not getting paid and has little motivation to work with the customer again, except perhaps to collect on an old invoice. The autopilot problem was ultimately resolved, but my friend has vowed to never do business with the shop again. In a 30-second exchange over money, a 10-year relationship was foiled because payment terms weren't clarified ahead of time. Who was in the wrong? You can make your own judgment, but there are lessons to be learned by this falling out.

The service department at my local car dealership stays in business because they don't fork over the keys until the owner pays the bill. It's an understood policy reinforced by a sign on the wall that states these terms. If this policy doesn't exist on the wall of your aircraft shop, ask what the standard payment terms are—after you offer to pay the bill. Your willingness to pay could earn you better service in the future, instead of looking for a new shop.

STEPPING UP

When I began evaluating avionics for *Aviation Consumer* somewhere around 1995, Garmin hadn't conquered the world, Bendix/King was the king of the avionics world, Narco was a close second and a retrofit glass cockpit consisted of the stark Argus 5000 moving map display. I forget the price of aviation fuel, but you can bet it was more palatable than it is now. Back then, this magazine's hard-hitting, give-it-to-them-straight reporting style was a perfect fit for my straightforward approach to helping consumers make the right buying decisions, while ignoring the marketing hype and ad propaganda found in other venues. Month after month, year after year, I remained committed to this cause.

As I take command of *Aviation Consumer* as editor, I'm more driven and focused than ever. There's a lot to cover, to include the evolving aircraft refurbishment market, plus advances in avionics, engines and alternative fuel, to name just a few topics.

Rick Durden, my valued colleague, will remain aboard as Senior Editor, while also covering industry news and features for sister publication *AVweb.com*. I'm also joined by a variety of expert contributors; some have written in these pages for even longer than I have.

I know you'll find value and education in our coverage and invite you to share in my enthusiasm for making you the most savvy and informed aviation consumer possible.—*Larry Anglisano*

PILOT LIFE INSURANCE

Regarding the life insurance for pilots article (January 2014 *Aviation Consumer*), I think you should know that The Pilot Insurance Center (PIC) is not all rosy. I was coming up on retirement and wanted to use life insurance as a financial tool. My bankrupt airline no longer allowed me to take a lump sum, and the annuity that I was given was taken at 100 percent, leaving my wife with nothing if I died. The insurance would fill in the gap.

PIC said the ideal weight for my height to qualify for the Preferred rate was 196 pounds. Since I was then 220, I told them I would contact them when I reached my goal (they said I would never get there). I didn't think I was going to grow any taller, so I gave it a go.

A year later and under my doctor's prescribed plan, I was down to 195 pounds. I called PIC, was quoted the preferred rate and a nurse was sent to the house for a physical. She took my history, checked my weight and drew blood. I waited five weeks and was told that the nurse missed something and would have to come back. She took my blood and history again. I was a pound lighter, but she didn't take my weight.

Ultimately, I was told by PIC that since the nurse didn't take my weight during the last visit, the company went back to my private doctor records and determined that since I hadn't been at 196 pounds for more than a year, they denied me the preferred rates, but would be happy to insure me for a much higher premium. I found PIC to be less than upfront with information and they did not stick to their word.

Tom Woodward
Granbury, TX

PIC's Bill Fanning responds: "After having been declined for coverage by another insurance company, Mr. Woodward applied with us and was offered a policy at Preferred Rates. He chose not to accept the coverage. Most every insurance company requires any weight loss over 25 pounds to be sustained over a 12-month period. There are many factors that are taken into consideration. In this case, there were other factors which we can not legally discuss with outside parties."

LAKE AMPHIBIAN

I just read with great enjoyment your Used Aircraft Guide on the Lake Amphibian in the January 2014 issue. On the whole, the article was informative and accurate and I particularly liked your comments about the need for Lake-specific training.

The contact info that you published about the Lake Amphibian Flyers Club is old information dating back to 2009. Since that time we have been in Wellington, Florida, and the correct phone number is 561-948-1262. The website is www.lakeflyers.com. The two engineers that created the Lake were Herb Linblad and David Thurston (not David Thrust).

The comment attributed to me about not needing ballast with four passengers is only partially correct. It is a borderline situation and depending on the actual passenger weights, aft ballast may be required. Your point was well made, however, that it is not a load-and-go airplane. Front or rear ballast can be required depending on loading and careful consideration of CG loading is imperative.

Marc Rodstein
Lake Amphibian Flyers Club

XAVION BEEFS

I bought the Xavion app six months ago. Only after I made the non-refundable purchase did I find out that the iPad cannot be mounted at an angle to the airplane's line of flight to use its internal GPS for AHRS (an important part of the emergency landing function of Xavion), and it will not perform its takeoff recording function unless it is running as the primary app on takeoff. My iPad is mounted to the left and slightly above the panel, facing me, which places it at an angle to the centerline of the airplane. I run ForeFlight on takeoff because of the complex airspace in Chicago. As a result, Xavion is effectively useless for me. Those limitations should have been disclosed before I spent $100 on the app. Your Xavion article (December 2013) should have noted these points.

Henry Fiorentini
Via email

Reader Fiorentini provided us with a 13-page email chain he exchanged with Xavion's developer, Austin Meyer. In it, Meyer explained that if an iPad is mounted in a landscape orientation, an external GPS source such as the Sagetech Clarity, is necessary for attitude information. That's because the iPad is acting as an artificial horizon when using its internal GPS and needs to be panel-mounted the way avionics should be: pointing ahead. The takeoff recording function only works when the app is running as the primary app.

Still, we stand behind our review. Our flights were made in a complex airspace area (Denver). We had Xavion running in the foreground as its takeoff recording recording feature also gives a warning if a takeoff is attempted on a runway that

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CHECKLIST

- There's a wide variety of autopilot models to choose from.
- Digital AHRS improves autopilot reliability and performance.
- Even an entry-level autopilot upgrade is a major investment.

Retrofit Autopilots: You'll Pay For Precision

A rate-based S-Tec may be a cost-effective solution, but Avidyne's DFC90 and Bendix King KFC225 attitude-based models easily outperform it.

by Larry Anglisano

Proposals for new autopilot upgrades can be shocking. Even entry-level wing-leveling systems start at $10,000, not including installation. But that won't buy much. Higher-end models with add-on options can easily snowball a project to $40,000. That's roughly the cost of an average engine replacement—or an average Skyhawk.

For years, S-Tec (now Cobham Avionics) has dominated the autopilot retrofit market with thousands of STC approvals, from Cessna 150s to Beech 1900s. But S-Tec isn't the only game in town.

Century and Bendix King still build autopilots, too. There's also Avidyne's DFC90. It's a drop-in, AHRS-based solution for replacing and increasing the performance of existing S-Tec systems.

Here's a look at the current retrofit autopilot market that's trending toward digital interfaces, increased reliability and higher costs.

STABILITY MATTERS

Since pilots buy autopilots to fly the aircraft more smoothly and with more accuracy than a human, it's easy to have unrealistic expectations on what a modern system can do and how well it might perform.

Rather than an automatic pilot, the better description is flight control system. That's because what we're really asking the system to do is maintain aircraft stability, particularly when turbulence and out-of-trim conditions depart the airframe from the intended roll-and-pitch axis.

In addition, we expect full-featured systems to precisely fly all segments of an instrument approach, including course reversals and holding patterns, following the lead of integrated GPS navigators and FMS systems.

Attitude-based systems do all of that more precisely than a rate-based system. It's all about the precision and stability of the reference source that feeds the autopilot computer. An attitude-based autopilot computer receives roll and pitch signals from a compatible attitude gyro (or digital AHRS, in a PFD-equipped aircraft). A rate-based autopilot works by reference from a rate gyro inside an electric turn coordinator, arguably a less stable reference, especially in turbulence as the turn coordinator bounces.

As we reported in the instrument upkeep article in the January 2013 issue of *Aviation Consumer*, PFD systems equipped with non-spinning, electronic gyros have become the preferred sources for driving autopilots. They're more precise, reliable and promise a longer life. You'll still need a backup attitude gyro, but it doesn't need to have the outputs for driving the autopilot. The AHRS does

Avidyne's DFC90 digital autopilot computer, top photo, takes an input from Avidyne's Entegra or Aspen's PFD. It's designed to drive S-Tec servos, while utilizing the existing wiring.

The Century 4000, top photo, and the Century Triden autopilot, middle, differ by the mounting configuration of the control head. The S-Tec 30 integrated autopilot and turn coordinator, bottom photo, saves the most panel space.

that when connected to a digital gyro emulator/converter (Garmin's GAD43 or Aspen's EA100).

While arguably less precise than attitude-based autopilots, rate-based models are notoriously easier to install, cheaper to purchase and might require less upkeep than attitude-based models. But there's a performance tradeoff, especially when installed in quicker airframes. A lower-end rate-based model may be an acceptable match for an Archer, but not enough autopilot for a speedier Malibu, for example.

BENDIX KING KFC225

Once the leader of the autopilot market, Bendix King introduced the KFC225 for new production Beech Bonanzas and Barons. The all-digital, attitude-based KFC225 was intended as a modern replacement for the venerable KFC200/150. Bendix King made significant improvements when designing the KFC225, eliminating the heavy KC295 remote flight guidance computer in favor of a flat-pack, self-contained computer/controller that mounts in the radio stack. It reengineered the KS270-series mechanical servo actuators to an improved servo speed control, or tach feedback, design. Plus, it added an integrated altitude preselect and vertical speed function, eliminating the remote KAS270 altitude selector system. There's also voice prompting and an optional yaw damper that still requires a separate yaw rate gyro.

The KFC225 went out of production during Bendix King's hiatus from the market, but it's back in the lineup with an interface that's based around Garmin's G500/600 and Aspen's Evolution PFD. When the KFC225 was introduced, the STC included the KCS55A mechanical HSI system and the KI256 flight director gyro. Now, the installation approval is blanketed under Garmin and Aspen STCs. But that doesn't make the KFC225 a player in all aircraft, although Bendix King says the STC list is expected to grow. For now, it's available for the Beech Baron and Bonanza series, Cessna 421 and 414, Piper Navajo Chieftain and the newer GippsAero G8. Bendix King says the system will be approved for the Cessna 210 series and the Piper PA46 Malibu Mirage in mid 2014.

Pricing for the KFC225 starts at $28,000, but that doesn't include an Aspen or Garmin PFD or a gyro emulator. Aspen's single-screen Evolution PFD is roughly $15,000 installed, while a G500 might easily top $20,000. You could install the system with the KI256 flight director gyro, priced at $20,000, and the KCS55A slaved compass system with HSI for $17,000, but we can't see why anyone would do that. If you have an existing KFC200, a KFC225 could be an easier retrofit than starting from scratch, since some of the existing servo mounts and other supporting hardware might be utilized.

CENTURY

Forget the rumors that Century isn't making autopilots any more. There are four current-production models in the Century lineup and all are compatible with Aspen's EA100 autopilot gyro emulator (it can also replace the 52D-series attitude gyro in vintage CII, III and IV autopilots).

Century's Alan Flewitt says the company holds more autopilot STCs

DIGITIZED FLIGHT CONTROL

While Honeywell's KFC225 is a digital autopilot, it was born in the era of the KI256 spinning attitude gyro, an analog pitch and roll source. Despite some reliability issues early on, the KFC225 and KI256 did a stellar job of flying all of the aircraft for which it was approved. But drop an AHRS-based (attitude heading reference system) digital gyro emulator in the mix (Garmin's GAD43 or Aspen's EA100) and the KFC225 becomes nearly a complete digital system, with a level of performance and reliability no rate-based system can touch. While the GAD43 and EA100 are digital-to-analog converters, receiving digital pitch, roll and yaw data in, and then outputting analog data to the autopilot, sourcing a digital reference has safety and maintenance advantages.

Because an autopilot that's driven by a failed mechanical gyro will likely remain engaged—flying erroneous pitch and roll commands—digital gyro emulators have built-in health monitoring algorithms that will immediately disengage the autopilot if an AHRS fault is detected. Through software, digital gyro emulators make calibration and configuration easier and more precise, allowing technicians to precisely set autopilot bank angles and flight director command bar voltages without having to perform time-consuming spinning gyro alignments. That means less down time.

(over 1600 approvals) than any other autopilot manufacturer. It also offers field and factory support for vintage systems from its headquarters in Mineral Wells, Texas.

The expandable C2000 autopilot remains the company's top selling system, available in a basic single axis or up to a three-axis configuration that Century calls the "Total Solution" model. It has roll, pitch, flight director and yaw damper.

In the basic roll configuration, the C2000 has heading hold/select, VOR, localizer and back course intercept and track. When interfaced with an HSI, the system is designed to intercept a course at shallow angles, but when equipped with a traditional CDI there's an automatic 45-degree course intercept function. With GPS steering, a $2854 option, the system will intercept a GPS course and approach at any angle.

The pitch expansion option adds altitude hold, attitude command, glideslope capturing and tracking, control wheel steering and pitch trim prompting. Altitude hold systems that have trim prompting warn the pilot when the aircraft is out of trim so they can manually trim the pitch axis. Automatic electric pitch trim, requiring an additional trim servo, takes care of that chore automatically.

If there's a downside to installing the C2000, it's the amount of radio stack space that's required to accommodate the 2.25-inch-tall control head. Century's solution to this is the $20,000 C4000 and $16,500 Triden systems. These are similar to the C2000 (using the same model servos) but have different control heads (the C4000 uses a Dzus rail mount while the Triden fits in a 3-inch ATI cutout). While these systems currently have limited STC approvals, adding an aircraft on a case-by-case basis could be easy.

Flewitt says since the C2000, Triden and C4000 all fly exactly the same way, the FAA doesn't require demonstration flight testing for approval. That saves a huge amount of time in the approval process. While the STC list is growing, current applications include the Cessna 182 and 421, Beech Bonanza and Piper Comanche.

Both the C4000 and Triden systems have, in our view, busy displays. There are no fewer than 20 mode annunciators in the C4000. But then again, it has a lot of modes, including integral GPS steering, vertical speed select and hold, plus glideslope capturing (from either above or below the glideslope—a useful feature that many systems don't have).

COBHAM S-TEC

S-Tec's entry-level model is the $9793 System 20. It's esssentially a wing leveling and nav tracking system that's integrated into a turn coordinator/controller, with optional heading command (requiring a compatible directional gyro, HSI or PFD). There's also an optional $2300 ST-901 GPSS system. S-Tec offers an upgrade for adding altitude hold to the system, requiring a pitch computer, pitch servo and pressure transducer. This makes it the System 30 with trim prompting.

Other basic models include the panel-mounted System 40 and 50, using a separate turn coordinator and controller. These systems are nearly identical to the System 20 and 30, except for mounting (none will support automatic trim). The way we see it, there's little advantage buying the two-piece 40 or 50 system unless you want localizer backcourse tracking, a function that's lacking in the 40 and 50. On the other hand, the

AUTOPILOT SYSTEMS COMPARED

SYSTEM	FLIGHT AXIS	THEORY	MOUNTING	MAJOR FUNCTIONS	PRICE
S-TEC 20 S-TEC 30	ROLL ROLL,PITCH	RATE-BASED	TURN COORD	NAV TRACK, ENROUTE/ LOC APPROACH ONLY	$9783 $15,589
S-TEC 40 S-TEC 50	ROLL ROLL, PITCH	RATE-BASED	PANEL CUTOUT	NAV TRACK, ENROUTE/ LOC APPROACH ONLY	$9994 $16,014
S-TEC 55X	ROLL,PITCH, TRIM	RATE-BASED	RADIO STACK	GS CAPTURE/TRACK, VERTICAL SPEED COMMAND	$24,867
S-TEC 60-2	ROLL, PITCH, TRIM	RATE-BASED	PANEL CUTOUT	GS CAPTURE/TRACK, PITCH COMMAND	$21,436
S-TEC 60PSS	PITCH, TRIM	PRESSURE	PANEL CUTOUT	STANDALONE ALT HOLD, GS CAPTURE,VS COMMD.	$12,556
S-TEC 30ALT	PITCH	PRESSURE	PANEL SWITCH	STANDALONE ALT HOLD,TRIM PROMPT	$8345
BENDIX/KING KFC225	ROLL,PITCH, TRIM,YAW	ATTITUDE	RADIO STACK	ALT PRESELECT,GS CAPTURE,VOICE PROMPT	$30,000
CENTURY 2000	ROLL, EXPANDABLE PITCH	ATTITUDE	RADIO STACK	ATTITUDE BASED COMPATIBLE WITH ASPEN	$13,298
CENTURYTRIDEN	ROLL, PITCH, TRIM, YAW	ATTITUDE	PANEL CUTOUT	INSTRUMENT CUTOUT CONTROLLER, LCD	$14,439
CENTURY 4000	ROLL, PITCH, TRIM, YAW	ATTITUDE	RADIO STACK	DZUS-MOUNT LED CONTROLLER, GPSS	$19,995
AVIDYNE DFC90	ROLL, PITCH, TRIM	ATTITUDE	RADIO STACK	ENVELOPE PROTECTION, DRIVES S-TEC SERVOS	$9990

System 50 is all self-contained, with a pitch computer built into the console. The System Thirty requires the installation of a remote pitch computer—increasing the labor effort.

STEC's flagship retrofit system is the 55X, with self-contained computer/controller. It has vertical speed command, nav tracking and glideslope capturing, GPSS and it supports automatic electric pitch trim (a $5500 option). There's also the optional SA-200 altitude preselect/alerter with voice callouts. At $11,733, it includes a new United Instruments encoding altimeter. The $5710 ST-360 alerter is available, with less automation and more complex feature set.

The System 60-2 is aimed at larger aircraft and has remote pitch and roll guidance computers. It has many of the features of the 55X, less GPSS.

For add-on altitude hold, there's the PSS (pitch stabilization system). It supports automatic pitch trim and has glideslope capturing. The System Thirty Alt is also a stand-alone altitude hold system, less autotrim and glideslope interface.

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AVIDYNE DFC90

Avidyne's DFC90 plug-and-play retrofit autopilot is designed to drive S-Tec servo actuators, while plugging into an existing S-Tec 55X mounting rack and wiring harness. What's compelling about a DFC90 upgrade is transitioning from the S-Tec's analog, rate-based concept to a digital attitude-based platform. It interfaces with the AHRS in Avidyne's Entegra or Aspen's Evolution PFD. This means earlier Cirrus models, to name one high-performance application, will benefit from the DFC90.

If you've flown a Cirrus that's equipped with an S-Tec 55, you might have noticed sloppy approach coupling and tracking, especially in strong winds. The DFC90 solves these issues, based on our evaluation. It also steps the interface up a few notches, with airspeed hold that's commanded on the airspeed bug of the PFD. Unlike the 55X, the DFC90 doesn't require manual arming of its GPSS mode. It automatically engages GPSS mode when you're tracking a GPS course. There's also a fully functional flight director.

The other draw is envelope protection, including a straight-and-level mode that recovers from unusual attitudes (recovering to wings-level from 60 degrees of bank and 30 degrees of pitch). The DFC won't let the aircraft get too slow or too fast, pitching up or down accordingly.

We like the DFC90s ergonomic design, with mode logic designed for an easy transition from a 55X. But don't expect a while-you-wait drop-in installation. Most existing Entegra and Evolution PFD systems will need to be upgraded—running anywhere from $3500-$6000—on top of the $9990 cost for the autopilot computer. Installation might cost $1500 to $2000, including flight testing.

Avidyne recently added STC approval for the DFC90 and Aspen Evolution combination for a wide variety of Beech Bonanza applications, as well as approval for some models of the Cessna 182.

CHOOSE CAREFULLY

The key is selecting the proper autopilot for your mission and airframe. Since an autopilot will likely expand your mission, consider one with advanced approach capability, especially if instrument flying is your plan. For higher-end aircraft, accept that pricier, higher-end autopilots will be better suited than entry-level models. This includes models with autotrim, yaw damper and attitude-based control logic.

For tighter budgets and lighter airframes, the S-Tec 20 is our top pick if you can live without altitude hold. You can always upgrade later by adding the additional components. The Avidyne DFC90/Aspen Evolution combination wins for performance. With a growing STC list, it could be the easiest way to advanced functionality at a lower cost.

Turbochargers: Care and Feeding

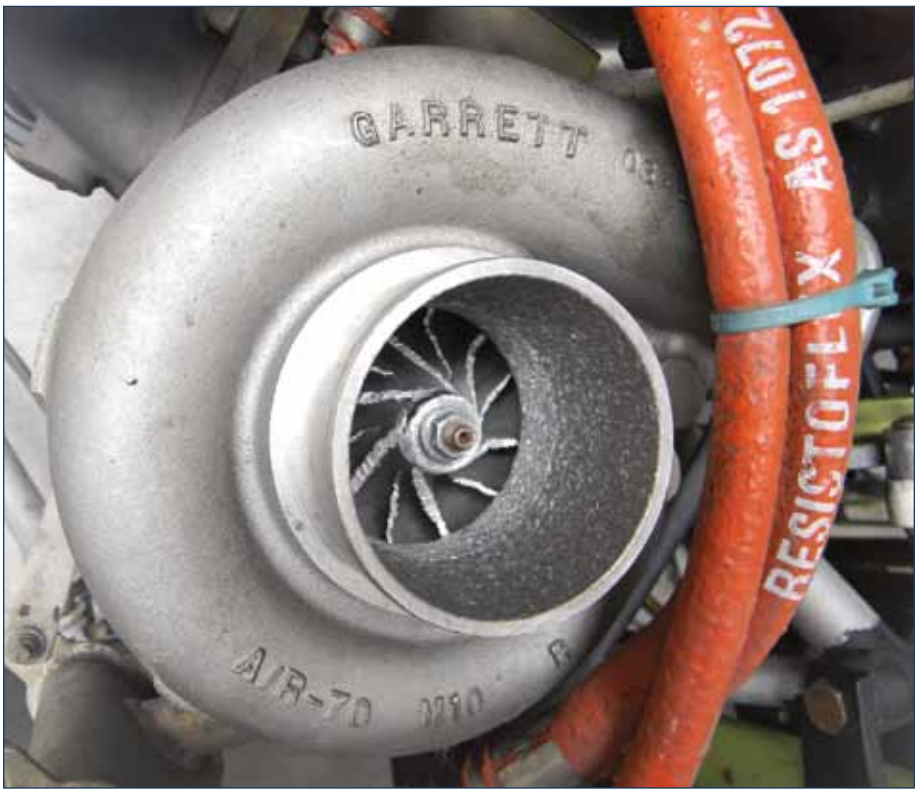
Careful engine operation and preventive maintenance should allow a turbo to last well over 1000 hours. Good troubleshooting keeps costs under control.

by Rick Durden

We admit it. We like turbochargers, turbocharging systems and the airplanes that wrap around them. More than just a tool for flying in mountainous regions—turbos provide the vertical agility for dealing with weather necessary in an airplane that is a vehicle for serious transportation. In the flat lands of the Midwest and Great Lakes, turbocharging often means going versus remaining parked when there is ice in the clouds. When going the distance, getting up to the high teens or low 20s means far more speed and efficiency than a normally aspirated airplane and the ability to select the best altitudes for the winds.

Our research indicates that the additional hourly cost of turbocharging is on the order of $25 per turbo, or a little more than 10 percent of the hourly cost of operating a high-performance single. Most of that is to allow for overhaul of the turbo at about 1200 hours—the rest for the more rigorous inspections required of the exhaust system and periodic adjustments to the full turbo system.

When correctly set up, operated properly and appropriately maintained, the systems tend to be reliable. The bottom line we got from pilots, mechanics and overhaulers is that your turbo system will thrive if you treat your engine well with regular oil changes and gentle power changes. The turbo itself will probably need to be overhauled at somewhere between 1000 and 1500 hours of operation, and the most likely problem you'll experience is induction leaks—however, troubleshooting has to be done carefully to avoid throwing money at what may be minor problems.



Foreign object damage to the compressor side of a turbo—overhaul required.

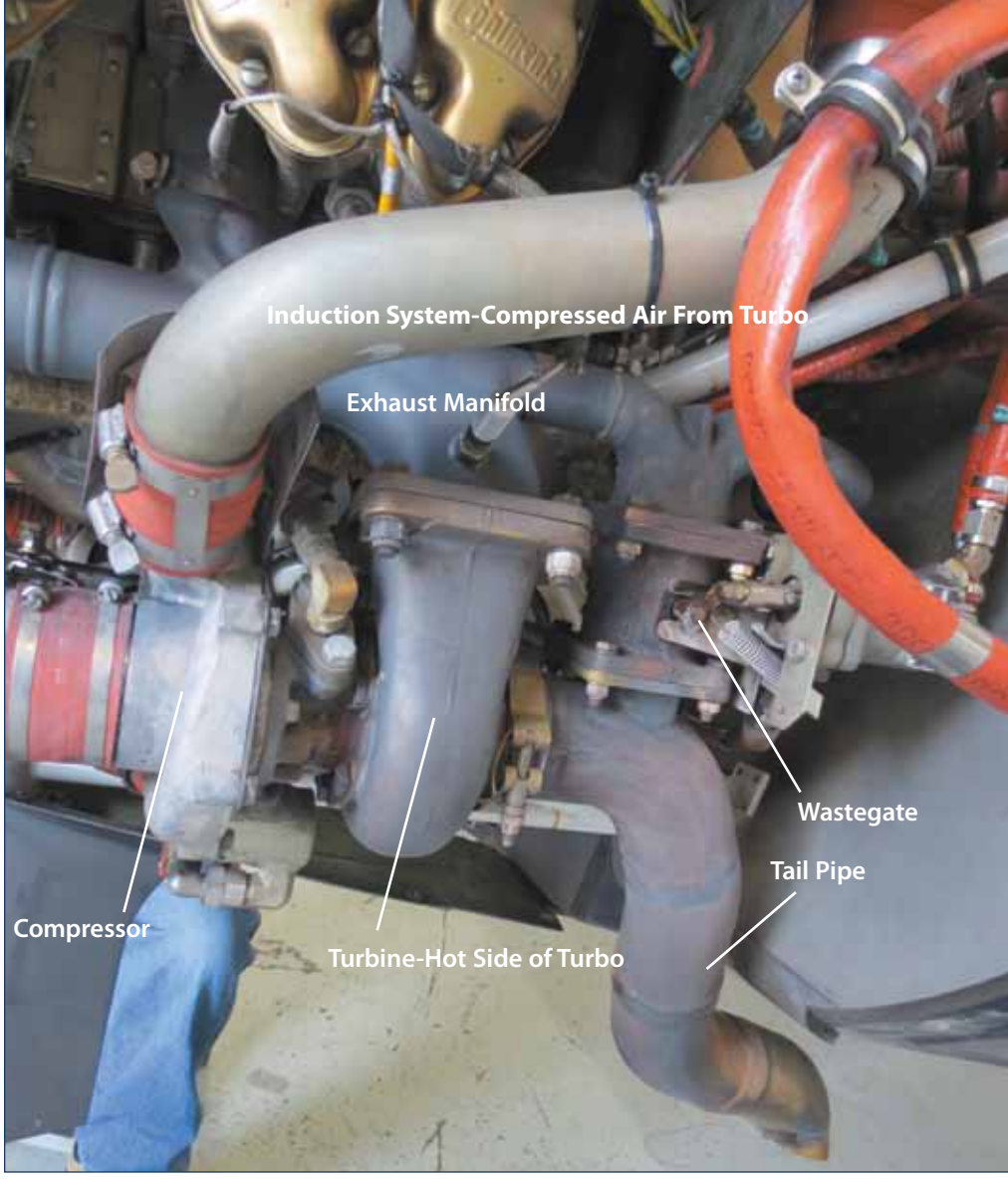
CHECKLIST

- Most "turbo" problems are due to something other than the turbo.
- While reliable overall, plan on overhauling a turbo once before TBO.
- Hasty troubleshooting can cause a minor problem to be expensive.

TURBO SYSTEMS 101

Turbosuperchargers (a supercharger spun by a turbine in the exhaust stream), the technical term for what we call turbochargers or turbos—have been used in airplanes for an astonishingly long time. In 1920, an Army test pilot climbed to over 33,000 feet in a LePere biplane powered by a Liberty engine equipped with a General Electric turbocharger. Cessna brought turbochargers to general aviation in a big way, starting in 1962 with the model 320.

There is now one supplier of turbos for general aviation, Hartzell. It took over Kelly Aerospace, which had acquired the Garrett and Rajay line of turbos and developed a bad reputation for quality control. In interviews over the last year, Hartzell reps said that the company is addressing the quality control issue. Our conversations with mechanics and Gary Main of Main Turbo, one of the largest turbo overhaulers in the country, have elicited comments that they are



Wastegate and one of two turbochargers on a Cessna 400.

watching to see if Hartzell does turn things around—it's too soon to tell.

A turbocharger is nothing more than an air pump. One half is a turbine that lives in the horrendous environment of the exhaust system, its wheel being spun by the hot exhaust gases. The turbine wheel shaft extends through the center housing to the cold side, where it spins the pump that compresses ambient intake air and forces it into the induction system at higher pressure, allowing more power to be developed. To do its job, the turbo can spin at over 100,000 RPM.

TWO SYSTEM FLAVORS

Depending on the system, the engine either can develop sea level manifold pressure up to a defined altitude—a turbonormalized engine—or it can develop higher-than-ambient manifold pressure at sea level and continue to do so up to the altitude at which the system simply can't compress the ambient air enough and manifold pressure starts to drop—the critical altitude.

A waste gate—a butterfly valve in the exhaust pipe upstream of the turbo—routes air either down the remainder of the tailpipe or diverts it into the turbo, or some mixture of the two. When open, all the exhaust goes out the tailpipe; when closed, it all goes into the turbo.

Some wastegates are fixed—the pilot controls power with the throttle; some are manual—there is a second control in addition to the throttle, that the pilot must use in setting power. However, most are automatic—a controller senses the pressure of the air in the upper deck of the induction system, just upstream of the throttle body, and uses engine oil pressure to set the position of the valve in the wastegate to maintain the manifold pressure the pilot has commanded with the throttle. Properly adjusted, an automatic system requires no action by the pilot during a climb or descent—which is not the case with a fixed or a manual wastegate.

Turbo system problems are challenging to troubleshoot (see the sidebar on page 10). That's because there is no instrumentation that directly reads out conditions within the components of the system—such things as RPM of the turbo or position of the wastegate valve.

When you discover that your system can't make the promised manifold pressure at altitude, it doesn't mean it's time for a $2000 turbo overhaul. According to Scott Utz, Director of Maintenance at Arapahoe Aero on Denver's Centennial Airport, turbos hold up quite well—most of the time the problem will be something other than the turbo. One of the most common is simply a leak or leaks in the induction system. It's not difficult to check out and fix. Another common problem is an alternate air door that doesn't completely close—another easy fix.

ROUTINE MAINTENANCE

Utz pointed out that routine, preventive maintenance that keeps the engine happy is good for the turbo system as well. Keeping the air filter clean is good in general—on a turbo something as basic as a dirty filter means less air into the compressor, resulting in lower manifold pressure at altitude.

Even with the impressive metallurgy and high-temp alloys used in their manufacture, the environment in which wastegates live mean that they sometimes fail. According to Utz, the valve may warp or the shaft become loose and the wastegate can develop a mind of its own. Mike Busch, whose Savvy Aircraft Maintenance Management company manages over 500 general aviation airplanes, told us that wastegates can also get sticky as lubricating oil cokes around moving parts. Both he and Utz said that wastegates may have to be pulled and repaired or overhauled from time to time. Depending on the installation, that can run from $500 to $1400.

FOD happens. If a chunk of some-

TURBO TROUBLESHOOTING

According to Mike Busch, whose company is in the business of providing maintenance management to general aviation aircraft owners, there are generally five things that can go wrong with a turbo system: problems with the turbocharger, controller or wastegate, or leaks in the induction or exhaust systems. Most initially manifest as a loss of manifold pressure at altitude or premature bootstrapping (loss of manifold pressure control because the wastegate is fully closed).

There may be an underlying problem with the engine itself—such as a cylinder or ignition issue—however, most of those problems can be diagnosed with a good engine monitor. We wouldn't own a turbocharged airplane without an engine monitor that can record and download engine data.

Step one when noticing a problem is to document the details precisely when you notice them—manifold pressure behavior, power setting, altitude, temperature and airspeed, at the least.

However, if the problem is a sudden loss of manifold pressure in flight, don't mess around—assume that it is an exhaust system leak and that you have hot gases spewing inside the cowling and a serious fire risk. Reduce power and land as soon as practical. Don't assume it's a minor problem. Fires due to exhaust system failures have killed too many pilots and passengers.

The next step is consultation with your mechanic and, if the problem wasn't an exhaust system blowout, do a critical altitude check—see if engine will develop the manifold pressures at the benchmark altitudes called out in the Service Manual for the airplane. If the engine doesn't make power and starts to bootstrap at an unexpectedly low altitude, the problem is most likely to be an induction system leak.

An induction system leak may also show up as higher than normal manifold pressure when idling on the ground. A visual inspection may disclose the leak or it may be necessary to pressurize the system with shop air and spray it with soapy water and look for bubbles.

An exhaust leak is less likely than an induction leak—assuming the exhaust system has been maintained carefully and inspected every 50 hours. They also tend to be easier to find on a visual inspection of the exhaust system, as they leave noticeable stains.

Wastegates can get sticky due to accumulations of lead, carbon and sulfur or coked oil. If manifold pressure seems to vary randomly, especially with power, altitude or speed changes, it may be the wastegate is going. Removing the wastegate and applying a source of adjustable air pressure can detect if the wastegate is closing smoothly as pressure builds toward 50 PSI and the spring drives it toward the open position as pressure is reduced. If it doesn't, it's probably time for an overhaul.

Controller problems are rare. On a twin, swap controllers and see if the problem changes engines. Otherwise, the poppet valve may have sludge that can be blown out with shop air in to the oil return port. Make sure the upper deck reference line has no liquid in it. If there is any, purge it and then clean the controller's aneroid chamber.

The turbo itself can go, although it's usually not high on the probability list. If it's the problem, it's usually obvious. FOD is easy to identify; blades rubbing on the housing on the hot side can be seen when the exhaust pipe is pulled for routine maintenance. Also, a worn-out center section usually shows up with oil leaking into the compressor and processing through the induction plumbing and engine or into the turbine, resulting in oily deposits in the tailpipe and on the belly. Nevertheless, oil in the turbo may be due to a bad check valve in the supply or return lines—inspect that first. The turbo itself may be fine.

thing comes through the engine, or if something comes apart, an exhaust valve, for example, and it goes through the turbine side of the turbocharger, the turbo is most likely finished. The same is true if something resistant to contact processes through the compressor side—see the photo on page 8.

Otherwise, turbos do wear out and lubrication lines get plugged with coked oil—the result of the heat and speed at which the wheels are turning. The question becomes, when overhaul or inspect and replace as necessary (IRAN). Realistically, IRAN is rarely the right answer for a turbo. Unless it's very low time, repair is seldom possible because of the effects of heat on the components, according to Gary Main.

Depending on the model of the turbocharger, overhaul will run $2000 to $2200. Gary Main told us that if you give his shop a little advance notice, his folks can have your turbo overhauled and on its way back to you in a week. If time is tighter, overhaul exchange turbos are about 10 percent more expensive.

OPERATION

The good news is that the same principals you apply in carefully operating your engine will pay dividends for turbo longevity—no rapid power changes, allow the oil to warm up prior to takeoff and change the oil on a schedule that reflects hours of operation as well as calendar time.

The bad news is that there are a couple of misconceptions about turbo system operations among pilots, and they may be reducing turbocharger life.

First, our research found that a lot of pilots assume that the turbo is not spinning during low-power operation, such as on landing or during taxi. That is incorrect—there is always some exhaust gas going to the turbo; an automatic system closes the wastegate on engine start, so all the exhaust gases are routed into the turbine.

Second, a surprising number of pilots did not know their airplane had limits on allowable manifold pressure above a certain altitude. Most know about critical altitude—the highest altitude at which the turbo will allow the engine to produce rated manifold pressure. However,

Removing the connection to the induction system allows visual inspection of compressor. The oil supply routes into the center of the turbo. A heat shield surrounds the turbine on this installation.

at some point above critical altitude, the pilot must comply with a table that shows the maximum allowable manifold pressure and reduce power accordingly.

For example, a Cessna 414A has published maximum manifold pressures for all altitudes above 20,000 feet. That's because the turbine blades are spinning so fast and get so hot that they stretch—it's called blade creep—and, if the maximum manifold pressure for the altitude is exceeded, there's a high risk they will rub against the housing, causing rapid erosion. We're reminded of an acquaintance who set an altitude record in a turbocharged Cessna Skymaster by ignoring the maximum manifold pressure table and then couldn't understand why he had to replace both turbos a few months later.

OVERSHOOT

Because oil pressure controls the wastegate on automatic system, it's not unusual for the manifold pressure to overshoot—exceed redline—on the first takeoff of the day if the oil is still cold. The system is just sluggish. There is a popoff valve that should open to stop the manifold pressure from exceeding more than a few inches above redline and damaging the engine. It's not a good idea to rely on the popoff valve—monitor manifold pressure on takeoff and stop it at redline if it shows any evidence of going over.

Properly adjusted, with warm oil, the controller will hold manifold pressure at redline at full throttle. With a fixed or manual wastegate, the pilot has to set power—and because it takes a few moments for the turbo to spin up from its relatively low RPM during taxi and runup, the manifold pressure will lag behind throttle movement. Experienced pilots learn to stop throttle movement at some point below the target manifold pressure. Overshoot increases with takeoff elevation—we've seen it exceed 15 inches of manifold pressure on a takeoff from Leadville, Colorado, in a Turbo Arrow.

In cruise, back off a bit from a power setting that generates maximum Turbine Inlet Temperaure (TIT). Turbo overhaulers and mechanics told us to back off at least 20 degrees to extend the life of the system, be it lean or rich of peak.

If possible, make gradual power reductions in descent. We're still not convinced that shock cooling is real. However, Gary Main of Main Turbo and the mechanics we spoke with said that they are convinced that rapid cooling hurts turbos.

On approach, keep in mind that once the power comes back a ways, the wastegate will be closed and all exhaust gases are exiting through the turbo. Gary Main told us that the turbo has to have time to spin down and cool off prior to shutdown.

At shutdown, the oil flow ends and a hot turbo will coke the oil in the unit, eventually plugging oil galleys and leading to turbo failure. Gary Main gave us the example of a freight outfit that uses Navajo Chieftains and that goes through turbos at low time. He commented that they seem to carry high power until close to the runway, then chop the throttles, land, taxi a very short distance and shut down.

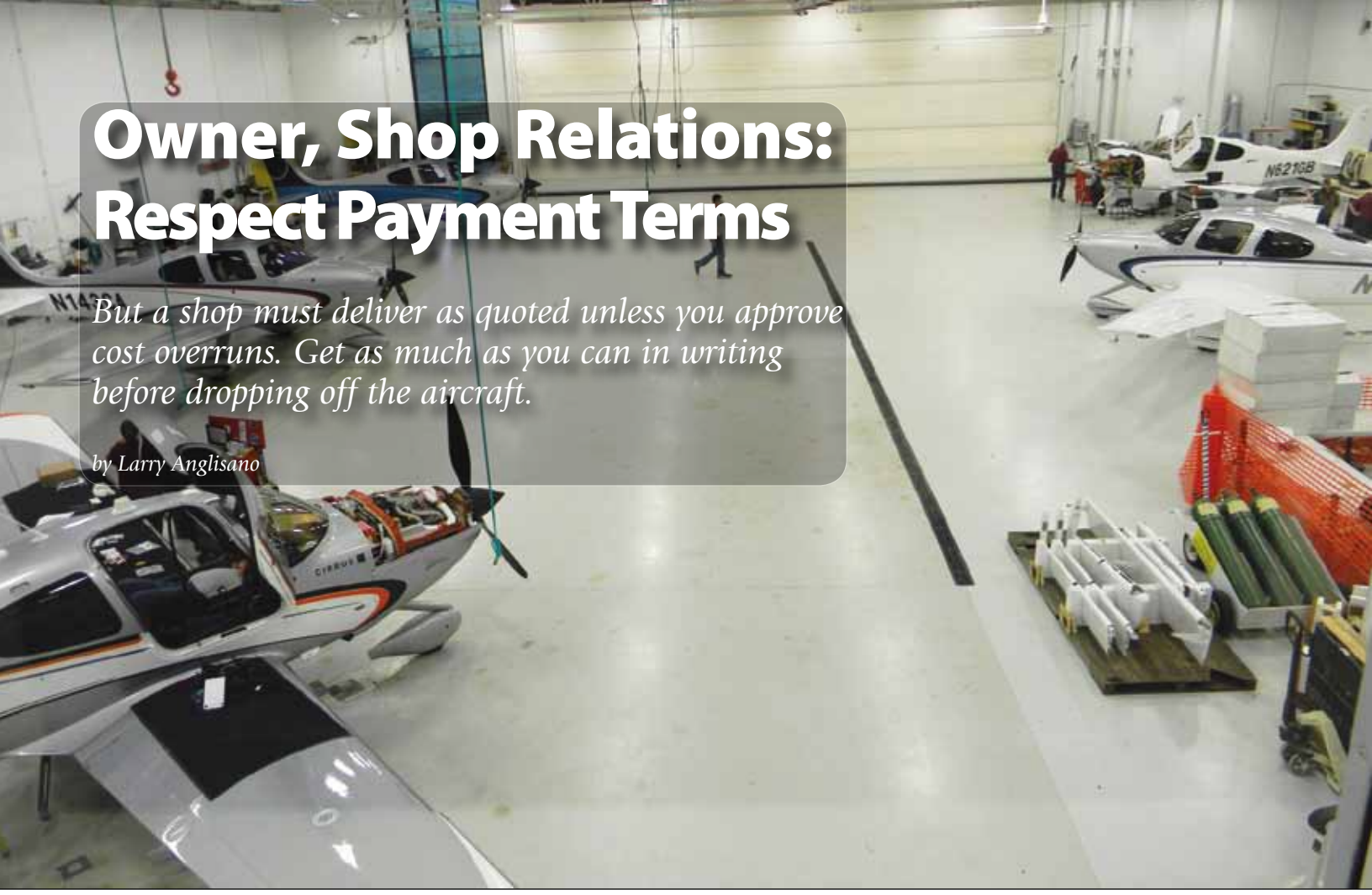
Many POHs call for a five-minute idle spooldown time after reaching parking. The purpose is to cool off the turbo. However, research performed on a Cessna Skymaster and, more recently by GAMI, produced the not surprising information that the turbo is the coolest it is going to get just after touchdown on landing—unless there's been a high-power approach and chopped throttle.

The turbo then heats up during taxi in. The conclusions were that—unless you approach at high power, chop the throttle and then taxi a very short distance—by the time you reach parking, the turbo has spooled down to an RPM suitable for shutdown, and it's not going to cool off any further. Don't keep idling.

CONCLUSION

After 50 years in general aviation airplanes, we believe turbochargers have proven their worth and reliability for pilots who want to use their airplanes for more than just recreation. The operating cost delta over normally aspirated engines is about 15 percent.

They don't require any extraordinary care beyond what you would do to properly operate the engine. However, when there is a problem, failing to carefully troubleshoot it can send costs skyrocketing if a mechanic just starts replacing parts. And—despite rugged design and impressive metallurgy in construction, conservatively figure that you'll need to overhaul your turbo once in between engine overhauls.



Owner, Shop Relations: Respect Payment Terms

But a shop must deliver as quoted unless you approve cost overruns. Get as much as you can in writing before dropping off the aircraft.

by Larry Anglisano

It can be said that a skilled and reliable aircraft maintenance shop is an aircraft owner's biggest asset. For a shop, a loyal and fast-paying customer keeps the doors open. That's why it's important for the owner and the shop to keep this valued partnership healthy.

Unfortunately, this isn't always easy. Money collection issues, blown schedules and cost overruns are just a few of the things that can send an otherwise healthy working relationship off the rails.

Whether you're looking for a new shop to wrench your aircraft or already have a shop that you are happy with, here are some insider tips to preserve a positive and lasting relationship with a maintenance provider.

OWNER-ASSIST

Perhaps the closest working relationship is an owner-assisted project. While there are several benefits, not all shops are welcoming. You'll need to ask about the shop labor rate for such work.

Bill Foley, who's been doing owner-assisted annuals on his Bonanza for over 10 years, has a cooperative shop. Still, he does the right thing so the shop can still make a profit. He's also careful that the aircraft doesn't tie up space on the shop floor any longer than it would take the shop to complete the work on its own.

AIRCRAFT OWNERSHIP

"I open the aircraft, the IA inspects the plane and we go over his discrepancy list. I usually have several items of my own that I want done. We reach an agreement on which items I will do and which will be done by one of the shop mechanics. While there is some cost savings, it's important to remember that the shop is in business to make money, so there must be some added monetary benefit to them. In my case, I pay the full price of a normal inspection, even though I do the grunt work, including full lubrication of the airframe, plus ground runs and flight testing. I also buy all of my parts from the shop," Foley told us.

Perhaps as important as the savings is the knowledge that's gained. "The early annual inspections that I participated in gave me the added practical experience that I needed to complete my A&P rating. During the period between annuals I can now perform and sign off other needed maintenance work that comes up between inspections," noted Foley.

QUOTES AND PROPOSALS

In our view, major work should never be accomplished without a written price quotation. Don't confuse a job proposal with a price quotation. Some proposals are an outline of the job, but might not be a firm price quotation. Are there hidden costs, including freight charges to order equipment? Freight charges can add hundreds of dollars to a project.

Consider even a minor avionics upgrade. While it's easy to e-mail photos of the instrument panel so the shop knows what it has to work with, this might not be enough information for the shop to issue a firm quote. With avionics work, repairing existing wiring and replacing supporting accessories add to the bottom line. The competitive nature

of aftermarket upgrades often means low-balled price quotes to get the customer in the door. Once the project is underway, you could discover that the project requires more labor and equipment than anticipated. Avoid this trap by bringing the aircraft to the shop during the quotation stage.

Once the shop evaluates it, they should be able to provide an accurate quotation. Even then, there could be other variables that the shop won't see until it disassembles the panel, engine or opens the airframe. Still, good shops might build that variable into the quote. Major projects can snowball once the job gets started. While this generally isn't the fault of the shop, it still has to get your approval for cost overruns. A simple call or text is all takes to keep you informed. In our estimation, you aren't obligated to pay for work you didn't approve.

FLIGHT TESTING

Whether it's an engine replacement or major avionics retrofit, some maintenance work will require flight testing. Shop hangar-keepers insurance policies may not cover flight testing. A shop that doesn't have proper insurance in place (or doesn't advise you that they'll be flying the aircraft without you onboard) has no business flying your aircraft, no matter the experience level of its pilot.

If you offer up the aircraft for the shop to fly without you being present—or if they hire a pilot to fly it on your behalf—you need to make certain the pilot meets the minimum requirements in your insurance policy.

It's your responsibility to provide the shop with a certificate of insurance, which describes the coverage in effect and also includes the shop and the pilot as additional named insureds under the liability coverage. The coverage should include a waiver of subrogation with respect to physical damage to the airplane. This waiver is a promise from the owner and from his insurer not to come after the shop for damage that they cause to the airplane while doing the test flight. If the pilot doesn't meet the minimum requirements, neither the shop nor the owner will be covered for the test flight.

The other consideration for flight testing is a financial one. It's a reason why you'll want to handle money matters well in advance of picking up the aircraft. Consider the following scenario. You arrive at the shop at the end of the project to pay the invoice and also perform a flight test with a shop representative. A dispute over the amount of the invoice results in an argument between you and the shop. Maintenance flight testing is stressful and risky. You don't need the distraction of financial disagreements when your mind should be focused on flying the aircraft. Ask them how much money you owe before you show up at the shop to pick up the aircraft. Good shops will beat you to the punch. Better shops keep you informed along the way.

Engine swaps, upper right photo, usually mean sizable amounts of downtime. Pressuring the shop to get the airplane ready for a trip stresses the relationship. Money disputes can spill into the cockpit on a post-maintenance flight test. Work out the finances well in advance.

HANDLING THE MONEY

An uncomfortable part of the owner/shop relationship is dealing with money. It doesn't have to be awkward if you recognize that the shop is simply there to make a living.

While there might be a certain level of camaraderie that exists

MAINTENANCE SHOP CHECKLIST

- ✔ Always get a written price quotation for major work.
- ✔ Be sure the shop evaluates the plane before quoting.
- ✔ Meet as much of the shop staff as possible.
- ✔ Abide by predetermined payment terms and milestones.
- ✔ You must authorize cost overruns ahead of completion.
- ✔ Ask the shop if it will fly your aircraft. Is it insured?
- ✔ Address invoice matters well in advance of flight test.
- ✔ Remove accessories when leaving aircraft at the shop.
- ✔ Walk around the aircraft with the shop at dropoff.
- ✔ Avoid scheduling important trips around maintenance.
- ✔ Leave the pilot ego at home, but bring your checkbook.

MECHANIC'S LIEN: VARIES BY STATE

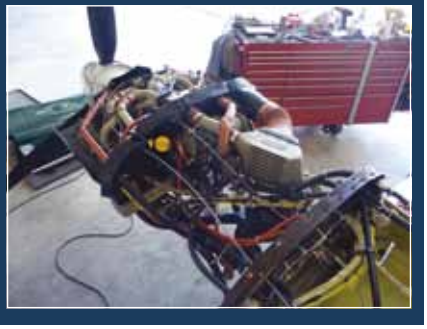
If the shop and owner both do their part, the topic of a mechanic's lien should never come up. But what happens if the relationship melts down and the aircraft owner refuses to pay the invoice? Can the shop go fetch the aircraft and bury it in its maintenance hangar until the owner pays up? In many juristictions, that's considered theft.

The laws vary from state to state, but the rule of thumb is once the mechanic lets go of the aircraft, he or she can't go back and grab it. In many cases, there is what's called a possessory lien. While the mechanic has possession of the aircraft, he might be able to hang on to it until the outstanding invoice is paid in full. Some mechanics think they can hold aircraft logbooks as collateral against an unpaid invoice, but in most states, this is illegal. Since aircraft logbooks might represent up to 30 percent of the aircraft's value, you need to be careful about leaving them with the shop. Consider bringing them to the shop at the time of pickup so the shop can endorse them while you wait.

The other course of action a mechanic can take is file a lien on the aircraft with the FAA. On the other hand, the FAA will only record the lien if it's legal and effective in the state for which it's taken out. The bottom line is that a mechanic must comply with state law in any action it takes against a customer aircraft.

When it comes to getting paid, mechanics have sizable amounts of ammunition when the aircraft is in their possession, but once they let the aircraft go, it will take a trip to court to legally collect a debt. That will be expensive for both sides. In general, the party that has possession of the aircraft has the advantage. Avoid this situation entirely by making sure you understand the terms of the work to be performed.

Last, there has to be some common ground. Shops need to learn not to release an aircraft without first getting paid. We knew a shop owner who would threaten to remove avionics from the aircraft if its owner didn't pay the bill promptly. In some states, that's considered theft and could land guys like him in jail.



during a large project, the shop isn't there to be your friend and it certainly isn't in the business of loaning you money. Think about the number of retail businesses that will allow you to leave with a product or service without paying on the spot. There aren't many, but there seems to be an assumption among some aircraft owners that it's acceptable to send payment after leaving with the aircraft (unless the shop agrees).

We talked with a few shop managers, including Joel Glover, the director of maintenance at Advanced Aircraft in Lancaster, Pennsylvania, to get a feel for how they handle payment at the end of a project.

"There are select regular customers that don't use credit cards but instead, send payment immediately after flying the aircraft home. These customers have proven themselves. But for others that I don't know as well, payment at the time of pickup is absolutely mandatory," Glover said.

Cathy Rudd, a principal at Treasure Coast Avionics in Fort Pierce, Florida, enforces payment at pickup.

"We use the car dealer rules when it comes to payment. At a dealer, you can't pick up your car without paying the bill. We're no different than any other service business. We have employees to pay, utility bills and equipment calibration bills that need to be paid. For the most part, our good customers understand that and respect the policy," Rudd told us.

During larger projects that might last longer than anticipated, don't be surprised if your shop calls looking for payment along the way, especially if you make the decision to add more equipment than what was quoted.

Still, payment milestones should be spelled out in the original quotation. For example, a shop might require a certain amount of money to secure a spot on its schedule and then require another deposit when the job commences. If you agree to these terms, the shop expects you to follow through, just as you expect it to complete the project on time.

If you plan to pay with a credit card, you should speak up before the job begins. While most shops honor major credit cards, some might charge an additional convenience fee to cover the banking costs associated with credit card merchant accounts.

We heard from one owner who refuses to do business with his avionics shop again because it charged him several hundred dollars in credit card fees—and didn't tell him about it—while running his card. He was on vacation while the shop completed the project and the shop owner demanded his credit card number for payment. A business can't charge your credit card without your consent. This likely violates the merchant/bank agreement. When offering up your credit card number for payment, ask the shop when and how much money they will debit the card.

Many avionics projects include the removal of equipment. While some of this equipment may be old or even inoperative, it's still your equipment and it should be returned to you, unless the quotation includes the shop taking it in trade. But this must be stated in the quote.

COMMUNICATION IS KEY

Good communication really is the key to an effective and healthy long-term working relationship. We're not just talking about discussing payment terms and scheduling. You should be an active part of the project.

While scheduling a project or regular maintenance might be convenient for you while you're away on business or pleasure, it might not be convenient for the shop. Be sure you are reachable if the shop needs to discuss something with you. Last, show your appreciation at the end of the job by saying thanks—after you pay your bill.

Aftermarket Parts: Knots 2U Fiberglass

Fiberglass replacement parts can be a better alternative to OEM metal and plastic, but getting the right fit and finish requires skill and effort.

by Jim Cavanaugh

Whether a part on your aircraft is damaged or worn, it's logical to look to the aftermarket for a replacement. While the buying decision might be based on the high price of OEM replacements, there are many benefits to aftermarket replacements. For one, the part could be made from more serviceable material, including fiberglass. This could also yield a weight-saving advantage.

Still, there are some caveats. Not all replacement parts will easily bolt on. There's fit and finish considerations, plus you'll want to source aftermarket parts from a reliable and experienced manufacturer, while ensuring the part has proper FAA certification. You could end up spending more money if your shop has to modify the part to make it fit or obtain FAA approval to put it on.

One company, Knots 2U—the maker of speed and efficiency mods—is ramping up production of replacement fiberglass parts. I recently visited with Knots 2U for a firsthand look at the manufacturing process. In this article I'll explain what it takes to install these parts.

CHECKLIST

- Knots 2U offers approved fiberglass replacements for less than OEM parts.
- Plastic parts might cost less, but fiberglass is more durable and serviceable.
- Unless you're a do-it-yourselfer, installation costs can add up.

HISTORY

Burlington, Wisconsin-based Knots 2U has been around for over 30 years. It's had a hand in increasing both the top and low-end speeds of a number of models, starting with Jim Bradshaw's work on his Piper Twin Comanche.

Tricky little airflow management items sped up the airplane an additional 20 MPH. Since then—and with much success—the company began carving a niche for themselves in the speed business. Jim Bradshaw passed away much too early, but his desire for speed lives on in the company he founded.

The company has grown into a business known in aviation circles for producing some of the highest quality fiberglass in the industry. Knots 2U's fabrication shop not only produces parts for themselves, but is also a supplier to several OEMs.

Having a capable crew, it was only natural that the company began manufacturing and certifying replacement parts, using a combination of fiberglass, plastic and aluminum.

In December 2011, it purchased Globe Fiberglass of Lakeland, Florida. The purchase added over 320

Don't expect to slap on most aftermarket replacement parts right out of the box. Fitting and finishing is tedious work.

The STC'd AeroVent system from Knots 2U, left and inset, is a way to replace broken plastic side pillar trim while improving the cabin airflow system on a wide variety of Cessna models. It adapts to the existing duct work and uses aluminum swiveling air vents, but costs a whopping $1400.

new items to its already large inventory of parts. It included the materials, plugs, molds and most importantly, the paperwork that had been developed over the past 30 years. That has huge value because the FAA approval process is a long and challenging one that ultimately is passed along to the consumer. It also allows Knots 2U to bring new replacement parts to market more quickly.

GLOBE'S PROBLEMS

When it was announced that Knots 2U had purchased Globe, there was some head-shaking throughout the industry. Globe had a bit of a reputation. Its parts generally looked good, but proper fit was a crapshoot. Sometimes a part fit, sometimes it didn't. Globe always made good on a bad part, but sending out ill-fitting parts slowed down projects.

About a dozen or more years ago, I was rebuilding a Piper Tomahawk. I opted to use Globe as I was a devoted fiberglass guy, knowing that the parts would be mostly indestructable, while also repairable. I had only had marginal luck repairing plastic parts with ABS cement, since most parts were drawn to such thinness, there was no real substance. I was surprised when the first part, a front door post and side panel, came nowhere close to fitting. Parts were either too wide, too tight, or the angles or curves were off. The rigidity of the fiberglass did not allow for any flex. Thinking it was an aberration, I tried the next part and found the same thing.

In all out of seven parts, I was able to use four of them (and this was after modification). Even then the parts did not fit as I would have liked. I learned the real downside of fiberglass parts: If they are not built correctly, they can never be right.

In talking with John Bailey, owner of Knots 2U, about the Globe interior part problem, he relayed the story from Globe. According to lore, Globe PMA'd a series of interior parts for the Piper Tomahawk as well as several Piper PA-28 and PA-32 models, but soon realized the fiberglass layup called out in the original drawings was simply too rigid and needed to be revised. Attempts were made to change the layup formula, but the FAA dug in their heels and wanted a complete substantiation report before the changes could be made. Globe quickly shelved the product line and only produced an occasional part.

With the Globe purchase, Bailey and crew also inherited a handful of the Globe problems. Having perfected their methods for producing fiberglass parts, Knots 2U knew they had their work cut out for them. Developing a proper part isn't as cut and dried. Certain things have to be done.

First, they had to separate the wheat from the chaff, as they say. Containers of molds, OEM original parts, plugs and fixtures made their way to Wisconsin. Current production molds were separated from the out-of-production tooling and plugs, plus thousands of items had to be sorted and shelved. The most important thing Knots 2U bought, though, were the volumes of approved drawings and data.

One of the first updates Knots 2U made was to upgrade to new standard resin to replace the old out-of-date resin used by Globe. While it was a high-quality resin back in the day, it had to be replaced by new and much improved formulas. To do this, Knots 2U had to get approval from the FAA before any changes to the resin or layup could be made. This meant hundreds of engineering hours and drawing revisions.

COSMETICS MATTER

At some point everyone has to stand back and take a long look at the replacement parts they buy for their airplane, particularly when it comes to fairings, fillets, wing tips, interior parts and other cosmetic pieces that are the finishing touches to any project. If the finishing touches suck, then the entire project sucks. This is the ultimate testament about any replacement part you buy for your airplane. How can you be sure it will fit? How do you know you are getting your money's worth? How do you avoid hours and hours of fitting and modifying an aftermarket part to replace an original OEM part? This aspect of refurbishing an airplane is the so-called leap of faith an owner or mechanic has to take when choosing a supplier.

In my estimation, buying an aftermarket part instead of OEM replacements is a smart decision. Most of the time, aftermarket parts are half to one-third of the price of factory replacement parts and in many instances a higher quality. But when you shop the aftermarket, you have decisions to make. You or your mechanic will have to fit the part.

This means drilling holes and trimming the component on your own. In addition, you will have to paint it. Both ABS plastic and fiberglass parts require painting for "finish out" and UV stabilization.

Aftermarket cosmetic parts will often be plastic, like the original, or fiberglass. Both have their long and their short suits. Plastic will come in different shades of white, off-white or black and fiberglass will come either primed or gel coated. What's the difference between plastic and fiberglass? It's all about cost and durability. Plastic is usually cheaper and fiberglass is more durable.

The differences in prices are in the actual making of the part. Both plastic and fiberglass parts have to start with a plug, from which is made a mold. Plastic parts, usually ABS or Kydex, can be fabricated using either male or female molds, while fiberglass molds are usually female. When making a part, heat and vacuum is used for the plastic parts, while fiberglass parts are laid up by hand, with some vacuum bagging. Many of the parts have to be mated and seamed. All of them have to be finish-trimmed, inspected and labeled. After the initial prep, plastic parts can be built rather inexpensively and quickly, as a number of molds can be fitted into the vacuum machine and in just seconds, several parts can be formed, awaiting final trim to size. Fiberglass parts involve sizable amounts of labor to hand lay-up the part in a mold—one at a time.

IMPROVING QUALITY

So far, Knots 2U has been able to rework about 90 percent of the Globe fiberglass parts for fit, finish and aircraft eligibility. On parts where fit was an issue, molds have been reworked or completely replaced. Aircraft eligibility has been updated on many parts. In some cases, parts were incorrectly approved for models they did not fit; in other cases, models were added to the eligibility list. Bailey states they still get some poor fitting issues, but they are becoming few and far between.

The resin used is stable at different

Tech Corner

HOLE-MATCHING 101

You have received your parts, you have stuck them on the airplane and the fit is pretty good. Now you have to get the holes in the correct places—a daunting task. An incorrect hole ruins the part, or in the case of fiberglass, requires a repair. A hole that is off center, too big or has ratty edges can negate the expense of trying to make the airplane pretty. Your first thought is probably, "Why did I get involved in this?"

Approach it with patience and planning. The best way to locate holes is to use the old part, but to do this, you have to be willing to sacrifice it. Always make reference marks on the part and on the surface. Cut out any sections where there are holes and securely tape the part in place. Because the thickness of the part may cause some error towards the ends, start by drilling small holes and enlarge them after ensuring they are correctly located.

If you are not fastening to a structural part, you can simply drill through the new part wherever it is aesthetically pleasing to your eye, and drill through the aluminum at the same time, or mark the structure and drill later; you don't have to match the holes. Look at your old installation and see if this is what the factory might have done. The critical holes are where there are receivers for the fasteners, and even then, if the new hole is off a smidgeon, there are ways to allow for it and still have a nice finished product. The secret is having sharp tools and a relaxed approach.

First, fit the part. The manufacturers are often conservative and a part may be a bit oversized in the areas where it can be trimmed. If a tip fits over an elevator end lengthwise, then it may be slightly wider and gradually tapered, for example.

A window trim or a part with a lot of curve and little access often requires making reference lines on the old part and then cutting the section with the holes out and overlaying it on the new part. Do small holes first and check these with a small bit to see that they match the receiving hole. The easiest holes are control surface tips.

Trace the edge of the old part onto the paint or to a piece of masking tape. Your goal is to install the piece so it's snug, while removing any material that crosses the reference line. If the part is plastic, the extra can be scraped off with a utility knife held perpendicular to the part and dragged down the edge, creating little plastic pigtails. If the part is fiberglass, then a belt sander or sandpaper with a block of wood will get the job done. The trick is to always sand to the outside of your reference line. Once you have matched the line all the way around, you are ready to locate holes.

First, establish a reference line for the old part. Come out from this with a wider piece of masking tape and draw a parallel line. Using a square, mark the hole centers from the reference line and note the distance to the center. My trick is to tape an aluminum yard stick to match the wing contour and tape it securely. Using the carpenter's square, I slide it along the straight edge. If you go to the first and last holes and establish a distance, use this to align the ruler to set the square to that depth. Done correctly, it should be perfect for marking.

Before you actually start marking, secure the new part in its exact location on the top and bottom of the surface. Don't handhold the part for measuring. Movement creates error. By starting with a small bit, there's room to drill a larger hole or elongate it. Unibits are great for "moving" holes and for giving a good, smooth cut.

If the hole ends up larger than intended, use a Tinnerman washer. These are countersunk, Stainless steel washers that accept a countersunk screw and provide an attractive finish. The fact that it covers your blunder—nobody has to know.

PARTS PRICING COMPARED

OEM PART NUMBER	DESCRIPTION	KNOTS 2U FIBERGLASS	OEM PRICE PLASTIC	TEXAS AERO PLASTIC
0531012-2	CESSNA 172 DORSAL SADDLE	$106	$220	$84
0430004-10	CESSNA 152 ELEVATOR TIP	$119	$437	$73
0430011-2	CESSNA 150 RUDDER CAP	$119	$426	$98
0723200-5	CESSNA WING TIP	$294	$725	$284
35115-0	PIPER PA-28 WING TIP	$311	$1075	$321
99621-00	PIPER PA32 FWD DORSAL	$206	$291	$146

Plastic parts will average out to be less expensive, but fiberglass parts are far more durable, do not change dimensionally or get brittle over time. They're also more easily repaired. One solution is to put the fiberglass parts in areas of sun, heat and physical contact, where things wear out. Save some money and use plastic in areas that are more benign—like the interior.

temperatures and is flexible enough to allow some bending without cracking. The controlled manufacturing environment ensures stability of the plugs and molds as they are being developed, built and stored. K2U's record of few warranty claims is a testament to its efficiency.

Of the 18 employees, 14 of them are involved in manufacturing. Common parts are typically in stock for immediate shipment. The next most common group of parts are built and kept in the mold until an order comes in, or until time allows staff to pull and finish the part for inventory. The least common parts are made to order, a process that can take from just a few days to a couple of weeks, depending on the complexity of the part.

A 10,000 square-foot-building—equipped a state-of-the-art climate control system—was recently added to ensure an optimal manufacturing environment. Office space, inspections, assembly of parts (including wing tips with light lenses and their popular AeroVent door posts) fill the old building, along with an inventory of numerous parts provided by other vendors, including those sourced from Texas Aero Plastics.

Knots 2U markets products from a number of vendors to enable a buyer to purchase a complete replacement-part assembly. For example, if an owner wants a wing tip with nav and recognition lights with newer LED parts, the company can ship it in a ready-to-install state (including paint). As the sidebar on page 18 describes, it isn't always this easy. Many parts will need to be fitted and finished. This creates additional expense and downtime.

One of the newer projects the company is creating is a website for owners interested in speed increases. Whether you are a Reno Racer or you just want to beat the Bonanza a couple of hangars down, this site will be an open discussion of any and all parts, philosophies and techniques used to speed up an airplane. Competitors are asked to participate, and racers, endurance guys and aerodynamic engineers are slated to provide material.

The speed mod business is pretty competitive, but most players have the same goal. Bailey is hoping that anyone with anything to say about speed or efficiency will contribute and that owners and aspiring racers will get involved. This site should be launched in early 2014. While the Globe transition is keeping the company busy, it continues an effort that's focused in the speed business.

OEM SURPLUS

A final note on sourcing parts. As impressed as we were with Knots 2U and its fiberglass production, it isn't the only replacement part option. Aside from a variety of plastic replacement parts vendors (some offering certified parts, others not), there's also discounted OEM parts. One respected source, Preferred Airparts, buys surplus OEM inventory in addition to parting out used aircraft. We talked with a few shops that source parts from Preferred and all had good things to say about the company's supply of surplus Cessna parts.

Last, no matter which replacement part you buy, someone needs to sign off the installation. If you want to manufacture your own part, consider that there are structural and burn specifications that need to be met. That could squash the idea.

CONTACT

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Shell's Unleaded Avgas: A Major Weighs In

The company predicts a two- to three-year approval cycle for a fuel it says has been under development for a decade.

by Paul Bertorelli

While the long-awaited unleaded replacement for 100LL might not quite be ready for the fuel farm, as of early December 2013, it looked to be at least hovering over the horizon. Shell surprised the industry with a late-in-the-year announcement that it has developed an unleaded 100-octane fuel that it intends to submit to the FAA's fuel approval process.

Shell becomes the first major oil company to submit a candidate fuel, joining two other fuels to be submitted by General Aviation Modifications, Inc. and Swift Fuel, both of whom are well along in their testing of 100LL replacements. Shell's surprise announcement was believed to be timed to coincide with ASTM International's meeting in Tampa in early December.

The company claims its new fuel has been under development for 10 years, including test-cell research, but with minimal flying. Lycoming and Piper announced that they're cooperating with Shell, which expects to certify its fuel within two to three years.

WHAT IS IT?

At the ASTM meeting in Tampa, Shell was cagey about the details of its new avgas, but Tim Shea, the company's VP for aviation fuel development, told us that its fuel will be aviation-alkylate based with a blend of aromatic hydrocarbons. Conceptually, this makes it similar to GAMI's G100UL, but a departure from Swift Fuel's candidate, which

FUTURE FUELS

is a binary blend of chemicals not related to traditional avgas.

Heretofore, avgas has been composed of what refiners call aviation alkylate, a blend of branched-chain hydrocarbons consisting of isomers of isooctane. Of themselves, these have high octane and good anti-knock characteristics.

But to achieve octanes of 100 and higher, refiners add a small dose of tetraethyl lead to meet the requirements of ASTM fuel spec D-910. In reality, most run-of-the-refinery avgas has motor octane values above 100.

Tetraethyl lead was banned from automotive fuels during the 1980s and there's pressure to remove it from aviation fuels to achieve new, more stringent air-quality standards. Shea explained that in place of lead as an octane enhancer, Shell is using an aviation-alkylate base with a blend of aromatic compounds to deliver a fuel with performance characteristics almost identical to 100LL.

"In our formulation direction,

Shell's Tim Shea, right: "Our plan is to make this fuel, once approved, widely available on a global basis."

One of Shell's challenges will be to deliver a fuel that drops into existing tankage at a price close to current 100LL.

we started with what aviation gasoline looks like and then removed the lead. From there, the question was how do we maintain D-910's physical properties while achieving the MON requirement for high-octane fuel? It's fair to say it's alkylate-based in its approach," Shea said.

"A lot of the chemistry has been around, but what we've figured out is how to make the chemistry work in an aviation fuel. A lot of the existing molecules that people are well aware of struggle...with the low-temperature properties of the fuel," Shea explained.

Indeed, the two other candidate fuels, Swift Fuel and GAMI's G100, also rely on high aromatic content for octane and there are concerns that these fuels won't perform as well as 100LL in cold starting.

"What drove aviation fuel development was volatility as much as octane," says BP's Alasdair Clark, whose company is watching the Shell project closely. At the ASTM meeting, he declined to say if BP will submit its own fuel and no one else we spoke to offered any clues, either.

Although Shell's announcement drew encouraging nods from owner groups we spoke to, within the fuels and aircraft certification communities there are open worries about how any new fuel—not just Shell's—will compare to 100LL. ASTM D-910 defines what has become the ideal piston aviation fuel, apart from the toxic characteristics of tetraethyl lead.

But lead is such an effective—and cheap—octane enhancer that replacing it has defied industry efforts for three decades. D-910 also specifies distillation end points that define the volatility of various hydrocarbon components in gasoline. Although D-910 doesn't define these by name, it does specify volume ranges as a means of measuring fuel volatility.

To prove those properties, Shell will undertake an intensive program that will include submission to ASTM International for a new fuel spec. Shea said the new spec will be almost identical to D-910 in performance, but will vary slightly. "In a physical property sense, we are extremely close. We meet all performance criteria and the two that we're off, we're off very slightly," Shea said.

But "very slightly" is a worry for engine makers and airframers. Lycoming's Michael Kraft says that the challenge in certifying the fuel will be to make it close enough to D-910 for the FAA to declare the fuel the technical and regulatory equivalent of 100LL.

Otherwise, the replacement fuel will need to be certified for both engines and airframes and Lycoming and Continental worry about who would do this certification work and who would pay for it. If airframers and engine makers have to fund such work, will they pass these costs on to customers and will customers pay? Shell's fuel, and the fuel approval process in general, isn't far enough advanced to provide a definitive answer.

Kraft said for Lycoming to certify fuel usage on its engines, it will need an ASTM spec for a basis. "We're watching to see what Shell's next step is with regard to ASTM. That will give us something to work with," Kraft said. With an ASTM spec in hand, engine approvals are relatively straightforward for Lycoming, but the issue isn't as simple as that. Hundreds of airframe models will also have to be approved and everyone in the industry is hoping the FAA will declare any new unleaded fuel the equivalent of D-910 avgas, requiring nothing but a POH entry for an approval.

WHAT'S NEXT?

Shell says it will continue its testing, working with Lycoming, Piper and other companies to prove the characteristics of its unleaded fuel. At the ASTM meeting, Shell agreed to establish a task force to pursue a new ASTM spec, which the FAA says it requires within six months of the agency completing its testing.

As for the FAA's role, it established a multi-step testing process called the Piston Aviation Fuels Initiative (PAFI) which envisions accepting up to 10 candidate fuels for initial evaluation, followed by detailed testing of just two fuels that make it through initial screening. The FAA says it's not picking winners or losers, but only has sufficient budget for tests on two fuels.

As of December 2013, it wasn't clear that the FAA will see additional fuel candidate submissions. Chevron, Exxon and ConocoPhillips are players in the avgas market, but sources tell us that they're not sure if these companies will develop their own fuels or look for licensing arrangements with other refiners.

And that might happen. Said Shea: "Our plan is to make this fuel, once approved, widely available on a global basis. Whether that's through Shell refineries or licensing, the plan is to make it available." Shell currently doesn't refine avgas in North America and what branded distribution it has is through exchange arrangements with other refiners. But one Shell executive told us it might consider establishing new refining in North America if the market looks promising.

We're not sure if that will prove to be the case. Avgas volume continues to decline as flying activity decreases. The U.S. Energy Information Administration reports that the avgas market is about 225 million gallons a year and has declined from the last high in 2006 of 276 million gallons.

And what about price? "It's a bit early stage, but our early estimates are that it will be comparable to the

current leaded product," Shea told us. "Historically, if you look where unleaded fuels have come to displace leaded fuel, the cost generally goes up a bit, but it should be within a very reasonable figure," Shea added.

No one knows what "reasonable" means, but the best guesses we could get from industry sources are between 50 cents and $1 more than current avgas prices. But pricing will be determined by how much competition there is to refine the new fuel and what the demand will be. Shea said configuring refineries to make the new fuel is essentially an overnight process, even if the aircraft and airframe approvals to burn it might not be.

GAMI AND SWIFT

Both GAMI and Swift continue their testing toward final approval for their fuels. GAMI's G100UL is similar in concept to Shell's idea, with an aviation-alkylate base and octane enhancement through blended packages of aromatic hydrocarbons.

Swift's fuel is a binary blend of isopentane and mesitylene, derived from an acetone feedstock with a butonal co-product. It has higher heat content than avgas and is about a pound heavier per gallon than avgas.

Both companies are well into testing and last fall, Swift built a pilot plant and blending site for what it hopes will become 100SF fuel. It may need the capacity; the FAA can request up to 10,000 gallons of fuel for testing purposes. Swift is pursuing a new ASTM standard specifically for its fuel.

At GAMI's Ada, Oklahoma, headquarters, the company is continuing work on its efforts to gain STC approval for G100UL. It plans to obtain first an ASTM test spec and then either a new final spec for G100UL or perhaps approval under another new ASTM spec, according to GAMI's Tim Roehl.

He said Embry Riddle Aeronautical University is about halfway through a 150-hour flight test program on a Cessna 182, with no issues so far. As for the impact of Shell's submission, Roehl said, "It's unknown what the impact is going to be. In some ways, it's supportive of our effort. We have said there is a formulation out there that can be made that does provide 100 motor-octane performance, which is what the fleet needs in order to have a one-fuel solution."

AROMATICS IN AVIATION FUEL

by Paul Millner

Modern, high-performance aviation fuels came out of research undertaken by Standard Oil of New Jersey and others in the 1930s and 1940s. They discovered that combining the hydrogen-poor olefinic light gases that were a side product of catalytic cracking with isobutane in an alkylation reaction resulted in very high-octane (close to 100) gasoline blendstocks.

By simply adding up to four grams/gallon of tetraethyl lead (TEL) to enhance octane, the 100/130 green avgas specification could be met. To achieve the even higher performance 115/145 purple avgas, though, even the allowable eight grams/gallon of lead weren't enough. To enhance the blend, aromatics were added.

Aromatics are simply compounds that contain a six-carbon benzene ring. The simplest aromatic is benzene itself, six carbon atoms plus 12 hydrogen atoms or C6H12 and referred to as a C6 aromatic. Although benzene has decent blending octane, it's the most biohazardous of the aromatics and the most aggressive toward fuel system materials.

In the past few decades, benzene in motor gasoline has been significantly limited to reduce both inhalation and skin-contact hazards, as well as limiting tailpipe emissions.

The next heavier aromatic, toluene or C7, is much more benign. In addition to good octane-blending value, it fits nicely within the distillation and specific gravity specification range for avgas. With the advent of 100LL in the 1980s, limited to two grams/gallon of lead, some blenders added toluene to achieve octane performance, especially at refineries whose alkylate quality wasn't spectacular.

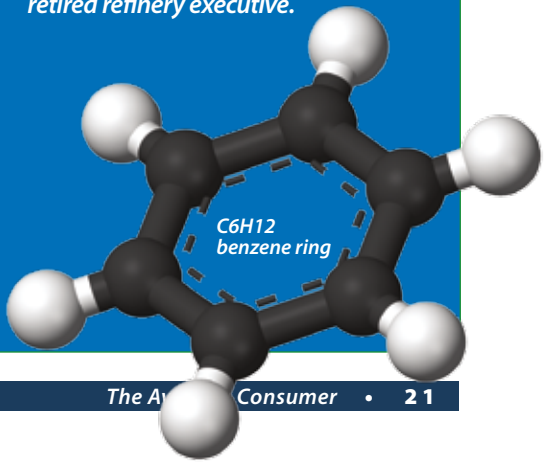
The next heavier aromatic, xylene or C8, comes in three differently shaped isomers and so does the next heavier one, mesitylene or C9. The symmetrical one, 1,3,5 trimethylbenzene, is the most benign C9 and of good octane performance. Historically, little C8 or C9 was included in avgas blends. However, work by Swift Fuels, GAMI and others has demonstrated that tweaking the avgas specification to allow the slightly heavier distillation and specific gravity required to include C8 and C9 aromatics has no discernible adverse effect on engines or performance.

All refineries make at least trace amounts of all the aromatics in normal processing, varying with the content of aromatics and aromatics precursors in the crudes they process. However, only refineries with naphtha reformers—common technology—and aromatics extraction units can make substantial amounts of mostly pure C6, C7 and C8. That capability is common in the Gulf Coast chemical industry.

C9 is more of a specialty chemical, although it can be made from the feedstocks produced by refineries. Due to variations in processing technology and refinery configurations, the composition of these aromatic streams vary from refinery to refinery and from time to time, making predicting their price and availability at all refineries uncertain.

For instance, mixed xylenes are commonly available in a 2:1:1 ratio for meta, ortho and para xylenes, but that can vary significantly depending on processing details. For aviation blending, maximum metaxylene, paraxylene to a freeze point limit and minimum orthoxylene makes the most beneficial impact on the octane blend.

Paul Millner is a Cardinal owner and retired refinery executive.



GPS Plus GLONASS: Reliable Nav for Tablets

Two new WAAS GPS with GLONASS receivers from Bad Elf and Global Navigation Systems make tablet navigation convenient.

by Larry Anglisano

CHECKLIST

- GNS2000 Bluetooth receiver is perfect for dropping in the pocket.
- Bad Elf Lightning fits well when plugged into Apple's Lightning port.
- Bad Elf sucks battery life from an already challenged iOS7 system.

The internal GPS in Apple devices uses so-called Assisted GPS data from cellular towers, but the receiver wasn't designed for aviation. That's why it's not uncommon for an iPad or iPod to struggle with maintaining a GPS signal lock in flight. That makes a remote GPS receiver necessary.

Most Bluetooth GPS receivers are compact enough to toss on top of the glareshield, where it receives the best reception. But it can also become a dangerous projectile in a crash and in turbulence.

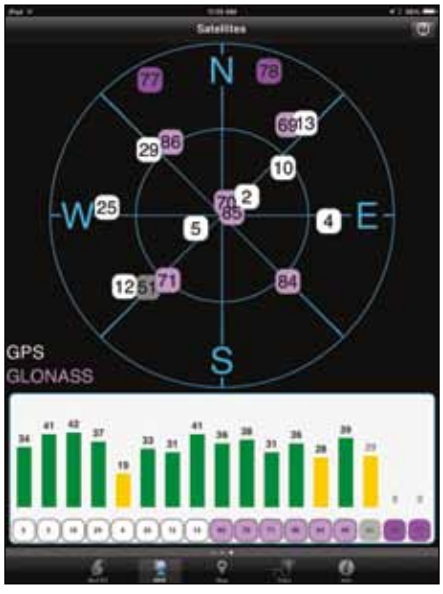
Two new satellite receivers, one from Bad Elf and the other from Global Navigation Systems solve that problem.

WHY GLONASS?

GLONASS (Global Navigation Satellite System) is the Russian satellite navigation constellation that consists of 24 satellites (the same number as the GPS constellation), providing global coverage to GLONASS receivers.

GLONASS isn't new to the aviation world. Garmin's Bluetooth GLO GPS introduced a couple of years ago is a good performer, based on our evaluations. Much of that has to do with it being a dual receiver, using both GLONASS and WAAS GPS. It's claimed that GLONASS results in 20-second faster lock-on performance, compared to WAAS GPS alone. There's also better position update rates (up to 10 times per second).

Obviously, a dual receiver is beneficial inside an aircraft cabin. That's because a receiver mounted down low or obstructed by the instrument panel could lose lock-on.



BAD ELF LIGHTNING

The new Bad Elf GPS for Apple's Lightning Connector is a redesigned version of the previous 30-pin Dock GPS, a receiver that plugs directly into earlier iOS devices. Elf's Brett Hackleman went back to the drawing board when the iPad mini and newer iPhone came along with its miniature Lightning power connector. The only way to make the existing ELF receiver to work was to

There's no shortage of satellites for navigating with a WAAS GPS and GLONASS receiver, left photo. The Bad Elf GPS-1008 for Apple's Lightning connector, above, is a big improvement over the previous pigtail adapter solution. Unfortunately, the new receiver draws from the device's battery power.

The GNS2000 receiver, right, is the perfect size for stashing in a shirt pocket. That's a good solution when yoke-mounting the iPad mini horizontally, bottom.

plug it into the Lightning-to-30-pin adapter. In our trials (*Aviation Consumer*, April 2013), this proved to be an awkward solution for cockpit use because the receiver hung off the tablet, where it got in the way and was susceptible to breakage.

That problem is solved with the $130 GPS-1008 GPS and GLONASS receiver. It's made for plugging directly into the Lightning power port and works with the current iPod Touch, iPhone and iPad.

Previous Elf receivers were solid performers, but the new receiver with both GPS and GLONASS step up performance to an even higher level. Thanks to the 99-channel chipset, it's not uncommon for the receiver to lock on while inside a building without even being close to a window. We used the receiver and an iPhone while biking in the woods and it never lost lock (while a Garmin sports GPS did).

Bad Elf says the receiver has 8-foot accuracy up to 60,000 feet and at speeds up to 1000 mph. During our trials, 12.5-foot accuracy at 5000 feet was the norm. That was in a Cirrus moving along at a more modest 170 MPH. We used the receiver to feed position to the Wing X Pro-7 nav app on the iPad mini that was running iOS-7. Make sure the iPad is charged.

That's because the Elf Lightning gets its power from the iOS device, rather than using a stored charge. This creates another burden load for the battery-life-challenged iOS-7 operating system. Bad Elf says not to expect any more than 4.5 hours of endurance when plugged into a 4G iPod Touch, under continuous navigation. We experience roughly under 10 hours of endurance with the iPad mini. USB power is passed through the Elf Lightning GPS, so the receiver will charge the iOS device when plugged into a power source.

The receiver fits nicely when connected to the Lightning port. During the two-month trial, it was plugged in all of the time and it easily survived our abuse. In fact, it molds so well against the bottom of the iPad and iPhone 5 that it's hardly noticeable. The device comes complete with a USB cable for charging and has a detachable keychain lanyard.

GNS2000

German manufacturer Global Navigation Systems previously offered the GNS5870 GPS receiver, a good performer with impressive battery endurance and GPS receiver performance. The follow-on GNS2000—with a 99-channel GPS WAAS and GLONASS receiver—provides equally impressive battery life. While rated for 10 hours of life, the unit exceeded that over several days of navigating and using Bluetooth connectivity.

The GNS2000 is smaller and thinner than a pack of gum and it easily slides in a shirt pocket (we forgot it was there and almost sent it through the wash). It's also simple to use. It has a single on/off slide switch on the side of the case, next to the Mini-USB socket for attaching the charger. A full charge is achieved within a few hours.

There are three annunciators on the front of the case, including a battery annunciator that blinks red when the device is charging, a Bluetooth annunciator that's steady blue when connected, or flashing blue when it's not. There's also a green GPS status lamp. You know when the receiver is locked on when the lamp is steady green, or acquiring when it flashes, although you won't see it flash for long.

Signal lock is the fastest we've seen from any receiver. The company says that typical cold and warm startup is around 35 seconds, while hot startup

continued on page 32

TV GLONASS VIDEO

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Pitts Special

Sixty years ago, its vertical ability redefined aerobatics—the marque is alive, well and rewarding skillful pilots.

Until the advent of the Pitts Special, aerobatics was a horizontal affair, even in the hairy-chested, fuel-sucking, 450-HP Boeings and Wacos. Practitioners pirouetted under the stern God of Energy Management—gravity and drag meant vertical maneuvers were brief events.

A small, clean biplane taking advantage of progressively more powerful, and lighter, opposed engines being developed took akro through the roof.

First flown in 1944 (or 1945—sources vary) as a single-seat homebuilt with only a 55-HP engine, the type has developed into today's highly refined and FAA-certified, two-seat, 300-HP aerial hot rod used for advanced training and—at least in lower categories—competitive aerobatics. Many different variants have evolved over the years, including factory-built and experimental versions, but there remain two main types: a single-seater and a two-holer. Today, you can buy a new, factory-built machine from certificate holder Aviat Aircraft, or get the plans and components for a single-seat version (S1-C or S1-SS) from Steen Aero Lab (www.steenaero.com).

Dominant in aerobatic competition during the 1960s and 1970s, the Pitts Special eventually ceded that position to more modern monoplane designs from Extra and Sukhoi. Even Pitts himself saw the monoplane light: Before his death in 2005 at age 89, he designed but never built the Model 13, an enclosed coupe. But the basic biplane design of the Special remains popular as a recreational and training aircraft, and still can be seen strutting its stuff at airshows, fly-ins, pancake breakfasts and in private hangars throughout the world.

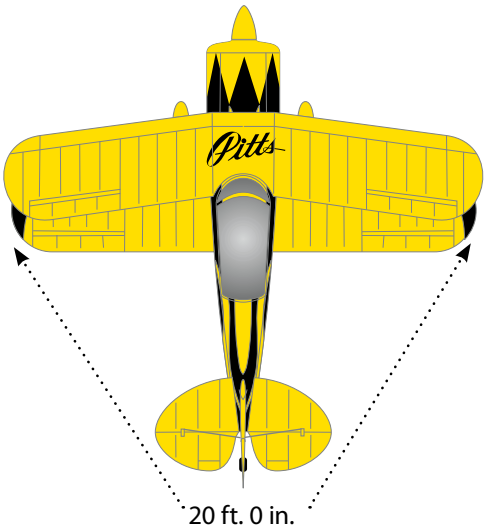
Many variants have evolved over the years, including factory-built and experimental versions.

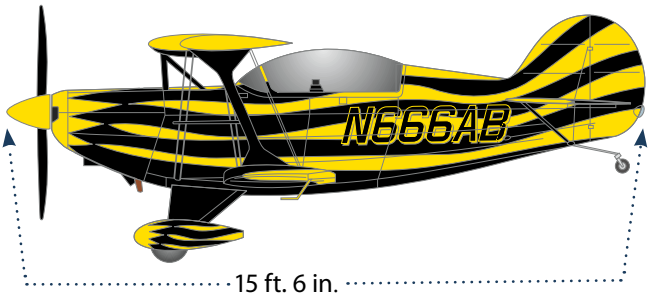
It's not for every pilot, of course. Its small stature, dictated by the need to keep things light and strong, means a short fuselage and stubby, relatively highly loaded wings when compared to most other personal airplanes. All of this results in an airplane responsive to the slightest control input, whether on or off a runway. If you're looking for a one- or two-seat cruiser, look elsewhere. On the other hand, if you're looking for an airborne toy, something to both challenge and perfect your skills, you've come to the right place.

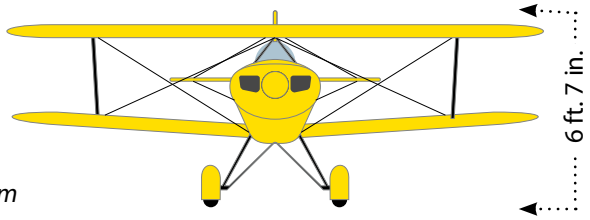
HISTORY

The S-1 (single-seat) and S-2 (tandem seating for two) Pitts Special is the brainchild of Curtis Pitts, a designer and cropduster, who envisioned the airplane as the first specifically designed for aerobat-

PITTS SPECIAL







drawings courtesy
www.schemedesigners.com

PITTS SPECIAL MODEL HISTORY (CERTIFICATED)

MODEL	ENGINE	TBO	OVERHAUL	FUEL	MAXIMUM WEIGHT	V_A	V_{NE}
S-1S	180-HP LYCOMING IO-360-B4A	2000	$28,500	20	1150 LBS	134 KCAS	176 KCAS
S-1T	200-HP LYCOMING AEIO-360-A1D/E	1400	$29,000	20	1150 LBS	134 KCAS	176 KCAS
S-2	180 HP LYCOMING IO-360-B4A	2000	$28,500	24	1500 LBS	134 KCAS	176 KCAS
S-2A	200-HP LYCOMING AEI0-360-A1A/E	1400	$29,000	24	1575 LBS	134 KCAS	176 KCAS
S-2S	260-HP LYCOMING AEIO-540-D4A5	1400	$38,700	35	1575 LBS	134 KCAS	176 KCAS
S-2B	260-HP LYCOMING AEIO-540-D4A5	1400	$38,700	29	1700 LBS	134 KCAS	184 KCAS
S-2C	260-HP LYCOMING AEIO-540-D4A5	1400	$38,700	29	1700 LBS	134 KCAS	184 KCAS

ics, according to the International Council of Air Shows Foundation. From the start, Pitts focused on keeping his creation small and light, something distinctly at odds with the much larger, radial-engined biplanes then popular. By keeping things smaller than the norm, Pitts could incorporate a relatively underpowered flat engine and still obtain excellent performance.

Despite the Special's enduring popularity, Pitts also designed several monoplane types. But the biplane design—affording double the aileron capability in most variants—offered the greatest strength and lift in a smaller package.

EARLY CHAMPIONSHIPS

The first Pitts Special to achieve notoriety was L'il Stinker, flown by aerobatics legend Betty Skelton, to three consecutive U.S. Female Aerobatic Championships, in 1948, 1949 and 1950. At the time, all Pitts Specials were built by Pitts. It wasn't until 1960 that plans were offered.

The first Pitts Special one could build in a garage or hangar was the S-1C, characteristics of which included a flat-bottom wing, bungee-cord landing gear, two ailerons and a single seat. It was powered by pretty much anything its builder wanted to hang on the front, from 85-HP Continentals to 200-HP Lycomings. According to Steen Aero Lab, which also markets S-1 plans and components, the S-1C is the "benchmark" version. "

"Nearly all homebuilt S-1s used S-1C plans for the fuselage and tail, with supplemental wing plan options," according to the company.

Soon, variants began coming out of Pitts' shop, with differences mainly resulting from tinkering with horsepower, fixed or constant-speed props, and flat-bottom or symmetrical wings. Homebuilders also incorporated their own changes, resulting in a wide range of versions—and disagreements between aficionados as to which is which.

These include the S-1D (S-1C with a slightly stretched fuselage and four ailerons), S-1E (a homebuilt), the S-1S (commonly known as the "roundwing" Pitts, it was certified in 1973 and features symmetrical airfoils, four ailerons and a different upper-wing design enabling it to stall first) and the follow-on S-1SS.

FOLLOW-ON DESIGNS

One result of Pitts' refusal to leave well enough alone was the S-1-11B, or Model 11, also known as the Super Stinker. Still a single-seater, it featured a 300-plus-HP Lycoming, four ailerons and a symmetrical airfoil (better for inverted flight than the flat-bottom version), and was available as either a factory-, plans- or kit-built airplane.

The S-1T, a certificated, production version of the S1-S replaced the S-1S in 1981, according to Steen Aero Lab. It came with a 200-HP Lycoming, constant-speed prop and redesigned ailerons. However, there is an S-1T with a 180-HP Lycoming currently available in plans or production form

Panels are basic and functional with such avionics as are installed often mounted low or on the side of the cockpit. No floor means anything dropped disappears and has the potential for jamming controls.

from Aviat, according to its website, www.aviataircraft.com.

There was even an "Ultimate" version, with full-width ailerons.

TWO-SEAT MODEL

Meanwhile, a two-seat model was developed. It sported four ailerons and a symmetrical airfoil. The prototype S-2 had a 180-HP engine; production airplanes, designated S-2A, came with 200 ponies. Soon, the S-2B came on the scene, with 260 HP and featuring improved ailerons and rudder. It was followed by the current production model, the S-2C, tweaked by Aviat VP of Engineering and longtime aerobatic pilot, Ed Saurenmann to make inside and outside aerobatic handling more symmetrical, increase cruise speed and improve handling on landing.

Of all the models and variants developed over the years, many remain available. For example, Aviat Aircraft's website shows that it currently offers plans for the S-1S, S-1T and S-1-11B. The S-2C is in production and it will build the S-1S and S-1T on demand. Aviat also provides parts support for versions no longer in production.

Despite the S-1/S-2's popularity, additional Pitts versions were developed. The Model 12, the last design built and flown by Curtis Pitts, was a slightly larger two-seat biplane specifically designed to use the Russian Vedeneyev M14P/PF radial engine of 360-400 HP. Plans are available from the current owner of the rights to the airplane, Jim Kimball Enterprises (www.jimkimballenterprises.com).

Finally, Steen Aero Lab has been developing the Pitts Model 14 for some years. It was one of Curtis Pitts' last designs and is billed by Steen Aero Lab as "a leading-edge two-place aerobatic biplane." Like the Model 12, it's designed around the 400-HP Vendenyev M14PF nine-cylinder radial.

HANDLING

A Pitts is about as small as a biplane can be and still carry two people, fuel and a large engine. Some owners, however, point out that filling both seats creates weight-and-balance problems, especially if you intend aerobatics. And who wouldn't?

Both basic models are exceedingly clean and, to put it mildly, go like crazy. It's hard to believe that a few years ago these were considered at or near the top in world competition, but are now being used for primary training for those moving up.

The controls are well harmonized. For one who came up in acro flying an Aerobat or Citabria, the overwhelming feeling is it's only necessary to think about a maneuver to fly it. Most of those pilots badly overcontrol a Pitts the first time out. For one accustomed to running out of speed in the vertical almost instantaneously in a Citabria, the Pitts is a revelation.

But for all the delights it brings once airborne, visibility on landing is awful and the airplane is just plain hard to land compared to a Citabria or Extra. We've seen too many NTSB statements for Pitts landing accidents that bluntly say that the probable cause was, "The failure of the pilot to maintain directional control during the landing rollout."

Of course, this should surprise no one: Take a look at the short fuselage, small tailwheel and relatively narrow main gear. Then decide how you'll see the runway in front of the airplane when it's in the three-point position. It's essential to get a good checkout before you fly the airplane home, or you run a significant risk of tearing it up on your first couple of landings. It's also essential to leave at home any tricycle-gear habits and remember to perform S-turns while taxiing.

Anyone moving up to a Pitts also should become proficient in performing forward slips because it is an effective method of keeping the runway clearly in sight on final approach. And, although the S-2C's published "clean" VS1 stall speed is a seemingly benign 56 knots, it's a few knots higher than the VS0 "dirty" stall speed of high-performance singles such as the Bonanza and Cessna Centurion.

Is the Pitts a handful? Those who have fallen in love with it emphatically say, "No!" Pitts guru Budd Davisson, for one, says he can teach anyone to land a Pitts. "The Pitts Special's reputation for being a handful on the ground is grossly exaggerated," he adds. Davisson offers a transition course for aspiring Pitts pilots, estimating around 8-10 hours

A recommended landing technique for the Pitts is to hold the airplane in a forward slip, so the runway can be clearly seen on final. The airplane is so responsive that the slip can be maintained until well into the flare—the airplane is then straightened out, just before touchdown.

stick time for someone with a tailwheel endorsement, but admits the time required can "vary all over the block and is impossible to predict".

MAINTENANCE/INSPECTION

With fixed conventional landing gear and few avionics or instruments, a typical Pitts Special is about as simple as airplanes get. The airframes are fabric-covered steel tubing, with a plywood torque box joining the wing spars.

In addition to the standard aerobatic airplane pre-purchase checklist, look for slop in the control system. It often just requires an adjustment but bearings can be worn out. Any Pitts flown regularly for aerobatics should be inspected frequently. Make sure the inspection holes have been cut in the underside of the wings, indicating someone is looking at the structure.

Once the wings are bolted together, the upper and lower wings form a rigid unit, so an impact to the lower wing may result in damage to the upper. It's essential to inspect each wing. Look to see if the spinner and nose bowl line up. If not, the bushings on the engine mounts are worn and are allowing the engine to sag. While this is initially cosmetic, it can result in the alternator being pushed into the nose bowl and the exhaust hitting the front of the firewall as well as crushing the air box.

According to Budd Davisson, "There's an easy way to tell if a Pitts has been subjected to extremely hard aerobatics outside of its design envelope. The most highly stressed part of the airplane is the anti-drag wire inside the top wing in the first bay outboard of the center section. The back ends of those wires go through the rear spar and come out inside the fabric area either side of the handhold behind the rear spar. If the airplane has been flown too hard, chances are there will be damage where the wire's nut sits on top of the block that's glued to the rear face of the rear spar (just inboard of the root rib)."

The engine and prop might demand some extra inspection time, especially if your mechanic isn't familiar with an aerobatic engine installation. Many Pitts may come with a smoke generator, another oddity for the average mechanic.

Of course, the covering on any fabric airplane should be considered suspect, especially if the example hasn't been hangared. Any ownership budget should set aside some dollars to recover the airplane at the appropriate time.

Finally, and while we're not aware of any systemic corrosion issues with the steel tubing in a Pitts, the prudent purchaser is always on the lookout for related issues.

PRICING/MODIFICATIONS

The *Aircraft Bluebook Digest* doesn't track the Pitts Special, so we searched the old standby, *Trade-A-Plane*, as well as some aircraft sales websites. We were surprised at how few Pitts were on the market. We did see an S-2B with a total time of 655 hours and five hours since major overhaul for an asking price of $89,900. A major overhaul at only 655 hours total time didn't give us any warm fuzzies—we couldn't help but wonder if there is an associated damage history of at least a prop strike.

We saw a 2005 S-2C with 511 hours total time, smoke system and a Garmin 250XL advertised for $198,500. Various versions of the S-1 had asking prices from $18,500 to $31,500.

As a pure sport airplane, Pitts modifications are usually designed to improve some aspect of the type's handling or maintenance. Items like clear, Lexan floor panels, smoke generators, Haigh locking tailwheels (admired by new Pitts pilots, less so by old sticks) and spring steel gear (to replace the older bungee-cord design) are popular mods. Other add-ons or replacements, depending on the aircraft's age, include inverted fuel and oil, electrical systems, Ceconite fabric coverings, seat-bottom parachutes and new, five-point harnesses.

TYPE CLUBS/SUPPORT

We're not aware of a type club devoted to the Pitts Special, unless

PITTS PRANGS: PLAIN VANILLA

When researching the aerobatic-capable, VFR-only Pitts in the NTSB reports, we couldn't find a sort of a pattern of crashes that would have led us to believe the airplane is unsafe or has some hidden defect.

We looked at 20 Pitts wrecks (a few were homebuilts as opposed to factory machines), dating back roughly 10 years and found a mixed bag. Given the aircraft's narrow mission profile, we found mostly a plain-vanilla cross section of crashes that included fuel exhaustion, runway loss of control and some wrecks that were simply the result of poor judgment.

One crash involved a pilot who confessed to consuming alcohol prior to an accident that resulted from aerobatics at low altitude. He was unable to recover from a low-altitude stall before smacking into the terrain. According to the NTSB, his blood alcohol was 0.04 percent. That's enough, according to the FAA, to decrease attention, impair judgment and increase reaction time (none of which are desirable in any aircraft).

There were a handful of RLOC events, for runway loss of control. That's not surprising since Pitts are equipped with conventional landing gear, are short-coupled and are an honest challenge to handle on the ground. A couple of landings-gone-bad involved dual instruction, where the instructor couldn't recover in time and the airplane simply went off the runway and struck something.

We also found some dramatic crashes, including aerobatics-gone-bad. One auger-in began with an intentional spin at 1500 feet AGL and ended with impact in a lake after a recovery at 150 feet. The pilot was found strapped into his seat. He'd had the good sense to wear a parachute, but that may have exhausted his supply of good decisions for the day.

Another Pitts pilot successfully used his 'chute and lived to describe his inability to recover (for reasons unknown) from an intentional inverted flat spin. He landed 50 feet from where the airplane impacted the ground.

A few Pitts pilots had a just a tiny problem with fuel management. According to the NTSB, one pilot ordered fuel but the FBO failed to deliver it. The pilot didn't notice. The engine quit shortly after takeoff. The aircraft nosed over into a canal following the dead-stick landing. Another pilot departed thinking there were 19 gallons of fuel aboard, not realizing that nearly 16 gallons had been used on a previous flight. Things got noticeably quieter 20 minutes after takeoff.

The Pitts is a stunningly capable aerobatic airplane with simple systems. Yet, whether it's being used for something as prosaic as practicing touch and goes or going all out in aerobatics, it demands the pilot's full attention and respect.

you count the various national and international organizations devoted to aerobatics. While not type clubs per se, they are populated with pilots who have flown—and may still fly—the Pitts and have a thing or two to share. We do recommend joining the International Aerobatic Club for information and support on Pitts—its members were extremely helpful in providing information for this article. The local Experimental Aircraft Association chapter may be another great resource, especially for a kit- or plans-built example.

The ultimate aficionado, however, is the aforementioned Budd Davisson, whose Web site (www.airbum.com) includes substantial resources for the pilot merely wanting to learn more about Mr. Pitts' Specials or needing detailed information on which one to choose and how to fly it.

OWNER COMMENTS

I have loved the Pitts for a long time. Once the S-2A came off the assembly line in the early 1970s, it became my airplane of choice for airshows and giving aerobatic instruction. I flew several thousand hours of solo and formation aerobatics in the S-2A. It is still my favorite formation aerobatic airplane—maneuverable, solid and dependable. There are lots of wires and struts on it that you can use as sighting references for precision aerobatics.

The Pitts retains the unequaled romance of flying a biplane and it looks like a bundle of energy when it performs aerobatics. However, it is just hard enough to land well that it keep you on your toes and out of your ego. You cannot grease it on unless you pay total attention on every landing.

The deep fuselage makes it uniquely stable in knife-edge formation and, therefore, in formation slow rolls.

The same deep fuselage creates landing and flight visibility challenges. If you sit too low in your seat, the sides of the fuselage block your peripheral and downward vision. I solved this by using carpet samples for seat cushions. They resisted compression under Gs, so my seating position and sight picture remained steady. When they got a bit worn down, I could just add one more piece of carpet and raise myself up in fractions of inches, which is how you fine tune your position above the cockpit side and below the canopy.

Early on, the practice was to make tight, curving approaches to land, rolling out in the flare. That proved to be a problem should there be any traffic where you had to extend your downwind—so you had to fly level on final for some distance. That doesn't work because the whole airport disappears. There were a number of accidents where a Pitts hit a vehicle or an airplane that had

Inverted spin, smoke on. A Pitts in its natural habitat.

pulled onto the runway and the Pitts pilot simply couldn't see it.

The problem was solved by flying final in a forward slip, with power as needed. That allows you to easily see the entire runway. The airplane is so maneuverable that it can be held in the slip until well into the flare, when it is straightened out and both sides of the runway can easily be seen in your peripheral vision.

If you consider buying one, make sure you have plenty of tailwheel flying time and access to a highly experienced Pitts instructor who can coach you on the fine points.

Debbie Gary
Via email

I've owned and flown several single-seat Pitts Specials and have flown four different S-2As. The handling characteristics are quite similar. There are a bewildering variety of configurations and modifications, so before buying, decide on the mission for the airplane, competition, recreation or instruction and whether transportation is going to play a role.

A Pitts is not for pilots with clumsy feet or who don't have the time or money to fly at least once a week. Most have been through a lot of aerobatics, so a pre-purchase exam by a mechanic who knows them well is needed.

The airplane needs to be hangared to protect it from the elements. It's normal for the whiskey compass not to work very well. With two aboard, an S-2A will not be able to do modern advanced and unlimited aerobatic sequences.

The most useful information one can get is in excerpts from the IAC's *Sport Aerobatics* magazine. I think there are three or four volumes of technical tips reprints from the magazine—they have valuable information on fixing various problems pilots have encountered with Pitts Specials. I highly recommend joining the EAA and IAC and flying and

talking with other aerobatic pilots.

Never, ever be embarrassed about having to make a go around in a Pitts. When I get into a new one, I generally ask for the option, rather than a full stop, during my first 100 landings. It reduces the stress level.

The control cables run under the seat, so on your preflight, make sure there's nothing under there to jam them. Anything you drop in the airplane can come back to haunt you.

Gopal Ramachandran
Via email

Ready, set—roll.

My first aircraft was a Pitts S-2B. Having flown dozens of airplanes, including the Stearman, Citabria, Decathlon, Extra, Sukhoi, T-6 and several WW II fighters in aerobatic flight and competing through Unlimited in both Pitts and Sukhoi, as well as flying 10 years of airshows, I believe the Pitts series of aircraft is the only one that prepares a pilot for all of the others.

The Pitts will teach you faster and make you a more competent pilot for any type of flying you do than any other aircraft.

Simple, rugged construction gives a low operating cost if the operating limits are respected. The dirty little Pitts secret is that a two-seat Pitts is over gross and aft CG with two 180-pound pilots, no matter what the fuel loading. Go to any popular aerobatic flight school and you will see two big pilots, each with 15-pound parachutes, get in a Pitts S-2B with full fuel and go do inverted spins. A 400-pound useful aerobatic load does not go far. Thankfully, a Pitts seems to tolerate any size person that fits inside, albeit with some mushiness in control response.

That caused me to look at an Extra 300L, with its greater than 600-pound useful load, and the Sukhoi 29, with its 950-pound useful load, to be legal with two people aboard.

Flying an S-1T in the Unlimited category, I had to use all the +6 and -4.67 G limits and 203 MPH Vne. I did it many times a flight for hundreds of practice flights with no visible wear on the airframe. The key to longevity for a Pitts is to never snap roll at over 140 MPH.

If you fly frequently and want an economical aerobat that will take you up through learning Unlimited aerobatics, an S-2B with a three-blade MT prop has proven to be the best bang for the buck. Two cautions: Canopies are fragile. The chap who bought my S-2B blew the canopy off on his first flight. Secondly, complete spin training is a requirement—a Pitts is designed to recover almost instantly from any spin, but will also enter a spin quickly when a ham-footed pilot tries to skid around a slow base turn to final.

If you want a low-time S-2B without damage history, be ready to pounce on the first one you find (there's a lot of damage history out there). The resale is quick. The good ones tend to be sold in a week. This is one of the few airplanes that maintains the same level of challenge and enjoyment even after 1000 hours of

A 1974 S-2A. The first S-2As had an open front cockpit that could be covered with an Art Scholl ATC cover to make the airplane single-place. Later, the design went to a canopy that covered both cockpits but acquired a reputation for expensively departing the airplane if not carefully latched.

playing with it.

A new Pitts owner would be wise to fly more than once a week to stay ahead of this thoroughbred, although once acclimatized, it is no harder to fly than anything else. The carbon fiber airplanes will leave it behind in performance, but not fun.

Rick Volker
Via email

I've owned, sort of, two S-2Bs. My current B is a no-damage 1993 model. The first was a 1994 that had been repaired following a landing accident. The only modification on my current airplane is a three-blade MT prop. The two airplanes flew quite differently, I suspect the culprit was rigging.

One important location to check the rigging is in the I-strut connection. If you see a large stack of washers on any of the I-strut connections, you can guess that the rigging has been adjusted there rather than somewhere else. In my aircraft, the rigging problems showed up in spins. Spins to the left would be quite different than spins to the right.

There are two weak spots in the airplane. One is the canopy. When reinstalling it, you have to make sure that the emergency release is fully engaged before flight. The other weak spot is the tailwheel. Two types are available from the factory, and neither is really any better than the other. The three leaf springs that support the tailwheel tend to relax over time and hard landings. As the springs sag, the geometry of the tailwheel will change and it will tend to shimmy.

For positive rolling stability, the tail tailwheel unit should not angled 15-20 degrees off the vertical (top forward) when attached to the leaf springs.

Goodyear Flight Custom III tires on the mains will give you about 450 landings. I wouldn't go cheap on tires, although landing on a flat tire is not a problem. This airplane lands fast because it is not stalled in three-point attitude. It takes a bit of time before most people are able to learn how to land. Takeoff is easy. If you get into trouble, just pull and the plane is flying.

Cross country is a challenge. I go as high as possible—10,000 to 12,000 feet, where it cruises at 145 knots at 11 GPH. If you aren't back on the ground in two hours, you soon will.

Keith Davis
Via email

The Aviation Consumer

GLONASS

(continued from page 23)

is under one second.

The receiver also has a position data logging feature, with a 15-hour internal memory (after which the previous data is overwritten). Using the GNS2000Track application, logged data can be transferred and saved in NMEA or Google Earth (KML) format. The GNS2000 is compatible with Apple iOS and also with Android devices (starting with 2.3 Gingerbread).

We couldn't find any nits with the GNS2000 except for the cost to ship it from Germany. You could, however, buy it through Sears/ePowerBuys for $155. We also found it on Amazon in that price range.

LETTERS

(continued from page 3)

is shorter than the airplane normally uses on takeoff. We are not aware of any aviation apps that provide a warning when running in the background.

We also note that some of Xavion's features require weather information that can be obtained via an ADS-B receiver such as a Sagetech Clarity, including making full use of the runway recording and warning feature—which is disclosed by Xavion—and using such a receiver would, apparently, solve Mr. Fiorentini's angle-mount AHRS issue.

Nevertheless, having received this information from a customer, we agree that Xavion should alert prospective purchasers that the AHRS feature will not work on an angle-mount iPad without input from an external GPS. Also, we were critical of the quality and completeness of the Xavion manual in our review. Mr. Fiorentini's letter causes us to be of the opinion that the manual should make clear that the takeoff recording function does not work unless the app is running as the primary app. We recognize that a lot of pilots know the runways they normally use are plenty long and may chose to have Xavion running in the background on a particular takeoff and not realize they are not getting the benefit of the takeoff recording feature. —Ed.

FROM SLEAZE TO TRUTH

Thank you for Rick Durden's editorial, Full Disclosure (December 2013). He made great points about product and service marketing. Me being an aircraft reseller, his comment about the ratio of sleaze to truth one runs across when in the market for a gently used airplane caught my eye.

Selling an airplane should demand a high level of ethical behavior, regardless of who's selling it. Unfortunately, many pertinent items are overlooked, swept under the carpet or dismissed as a matter of convenience. Occasionally, due to the complexities of any aircraft and its records, some items remain undiscovered. Buyers should be aware that when purchasing used aircraft, flaws will exist and discrepancies will surface after the sale closes.

The philosophy at my company is to disclose known issues on the first phone call with a buyer. Do we know everything about every airplane we sell? Absolutely not—perhaps the first indicator that someone is lying is when they tell you they know everything about the plane. We try to shine light on all facets of an aircraft we represent by providing logs, background reports, dozens of close-up pictures and also video. We travel to see every airplane we represent so that the knowledge we relate about it is first-hand. And finally, we were the first to develop a 90-day or 45-hour breakdown protection policy on every 1976 and later aircraft sold (we call it the FREEdom plan).

Are we perfect? Not by a mile, but building trust with current and future clients has to begin somewhere. I appreciate your great publication.

Chris Kirk
Wild Blue Aircraft Sales
Kansas City, Missouri

FEEDBACK WANTED

PIPER DAKOTA/235

For the May 2014 issue of *Aviation Consumer*, our Used Aircraft Guide will be on the Piper Dakota/Cherokee 235, high-performance four-place single. We want to know what it's like to own these planes, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your airplane to appear in the magazine, send us any photographs you'd care to share. We accept digital photos e-mailed to the address below. We welcome information on mods, support organizations or any other pertinent comments. Please send correspondence on the Dakota/Cherokee 235 by March 1, 2014, to:

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