

The Aviation Consumer[®]



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EDITOR

Paul Bertorelli

MANAGING EDITOR

Jeff Van West

CONTRIBUTING EDITORS

Jonathan Doolittle

Rick Durden

Larry Anglisano

SUBSCRIPTION DEPARTMENT

P.O. Box 420235

Palm Coast, FL 32112-0235

800-829-9081

www.aviationconsumer.com/cs

FOR CANADA

Subscription Services

Box 7820 STN Main

London, ON N6W 1S1

Canada

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FIRST WORD

SO LONG TO THE HSI NEEDLE

It wasn't so long ago that an HSI was standard state-of-the-art for a well-equipped IFR-capable cockpit. Even when Garmin's GNS430 and 530 took over the world as the go-to navigation boxes, you still needed the mechanical needles to fly an approach.

As we report on page 18 of this issue, those days aren't just behind but are rapidly receding. While we weren't looking—and it seems like we're *always* looking—the market hit an inflection point for glass panel upgrades. We've hit the perfect mix of price, capability, demand and customer preference to ignite a downturn in the desirability of mechanical needles in legacy airplanes.

And while that trend was sneaking up on us, so was another one: the ability to construct a new-age glass panel for an older airplane that doesn't require mechanical backup of any kind. That means no mechanical pitot-static and no spinning mass gyro. Frankly, I didn't expect to see this so soon, but as I noted in my blog on Avweb (www.avweb.com/blogs), Aspen is much further along in this direction than most of us realize.

I was out in Albuquerque last month visiting Aspen and flew with company founder Peter Lyons, who, along with a partner, bought our Mooney 231 three years ago. It's a personal airplane for him, not a company ride, but he's fitted it out with a three-display Aspen system with dual ADAHRs, so the only backup required is a mechanical attitude indicator operated by the airplane's vacuum system. Lyons told me that Aspen is well on the way to FAA approval to certify these systems with no steam gauges at all. They're working on a means to get around the single-point failure of the pitot-static source, which is the FAA's reason for not approving it now.

Once that's tidied up and owners run the numbers on it versus mechanical backups or upgrades, many will have second thoughts about retaining much



less installing any kind of mechanical gyro or HSI; the justification and cost/benefit just won't be there. This has wider implications than might be obvious at first. It's going to put a lot of used gyros on the market which will tank their value. In fact, Lyons told me the stuff he removed from our airplane will be difficult to sell and he doesn't miss the irony that the success of Aspen's remarkable Evolution products made it so. And it didn't take very long. By the time you read this, there will be close to 4000 Aspen systems flying, although not all are the two- and three-display versions.

Marketwise, this puts the aggregate of owners in a peculiar place. Support for mechanical HSIs will be available for awhile, but the expiration date on some of these instruments will loom into view eventually. So if you're thinking about buying a bargain mechanical HSI, you need to go into the deal with clear eyes. Even if you get the unit for a song, the complex installation will cost just as much as it always did.

The other side of the squeeze play involves the declining value of airframes. If you take a pass on the HSI in favor of glass, you could easily spend one third to half (or more) of the value of airplane on the upgrade. You'll have a more capable panel by far, but also one that won't return much of what you put into it when you sell it. That requires some clear eyes going into the glass upgrade, too.

So what has always been true remains true. If you've dreamed of glass, think about buying an airplane that already has it or looks close to what you want. This is probably the smartest buy you can make in the current market.—Paul Bertorelli

LEDs Reconsidered

Your recent article titled, "LED Landing Lights: Worth the Expense," was a disturbing article to me. In it, the author suggests to consumers that they can simply replace their current landing lights with LED lights without any additional approval. This could not be further from the truth. In order to install any component, light bulb or otherwise, on a U.S. registered certificated aircraft, it must be shown that the part, when installed on the given aircraft, still meets the requirements of FAR 23.

Someone must do the testing to prove that this is the case. If the aircraft manufacturer does the testing, then the LED landing light would be listed as an alternate part in the IPC. In this case, the owner would be able to install the bulb.

The LED manufacturer could also attain an STC, listing the aircraft as an approved installation. Without one of these two items, any installation of a part number other than the one listed in the IPC is unapproved and technically unairworthy.

Your article does a disservice to your readers who trust what you print. Many will now install these bulbs with no approval. Some will face FAA ramp check problems, others will face issues with their IAs at annual. Some may even go unnoticed. Nevertheless, this article has served only to move people further away from safe and legal and should be retracted.

Jason A. Archambeault, IA
Via e-mail

Obviously, we disagree on this issue since we can find no clear directive requiring approval for lightbulbs. The GE4509, the industry standard, is neither STCd nor

PMA'd and has no approvals of any kind. In some aircraft, it doesn't even appear on the equipment list. We think owners should use good judgment on this. If they deem the LED to be a safe and adequate replacement, we view it as an owner-supplied part. If they prefer to toe the imaginary line we think you're drawing, that's their business. As you noted in a subsequent e-mail, even IAs don't agree on this.

I'm tearing out what's left of my hair. Trying to get info on the Teledyne Alphabeam LED light. No luck, not even from Teledyne or Aircraft Spruce, the only one advertising it.

We just put two Whelen lamps in the first of our fleet of B arons. Works well, but per the STC, can't be installed

closer than 24 inches from the flux gate. We have 17 inches in the left wing position.

Since the Teledyne is scheduled to be PMA'd, thought this might solve the issue. What info can you share with us? Even Teledyne seems confused.

Ray Benischek
Via e-mail

Teledyne tells us they have now obtained a PMA for the Alphabeam are are ready to market it. For more information or questions, contact Shannon Giddens at 310-577-3882.

Cessna Oops

Your Cessna 172 article in the October 2010 issue on page 26 states in error that the 170A was ragwing. It was the 1947 170 dash nothing that had a fabric wing. The 1949 170A was all metal with small chord flaps and the 170B had large chord flaps after Cessna engineered the military L-19 with "paralift" flaps.

James Hays
Brownwood, Texas

Fuel Feedback

I have enjoyed reading your articles on leaded aviation fuel. They have always been well written and it is nice to see someone with your level of influence in the aviation community talking about the issue. I am sure you get lots of e-mail from people suggesting various technical solutions to the problem, but I think the main problem is the level of uncertainty surrounding the issue.

My solution to the problem would be for the EPA and FAA to jointly announce that lead would be banned 15 years from today. To prevent a problem from occurring 15 years from now, I would encourage people to switch over by putting 20 cents per gallon tax on leaded fuel and increasing the tax 20 cents each year. This would create a clear economic incentive for the industry to switch over.

Unfortunately, none of the aviation groups would ever support either of these ideas. They appear to be happy with the current state of uncertainty about the future. Please don't let this issue die.

Ryan Turner
Via e-mail

I have noted the unleaded avgas discussion carried in your recent issues with considerable concern. Swift and

continued on page 32

AIRCRAFT UPGRADES

LED Landing Lights: Worth the Expense

These products have multiplied and improved since we last examined them. Top picks are AeroLED's SunSpot and Whelen Parmetheus.

by Paul Benetti

In case you haven't noticed, the latest aircraft bulb—once the darling of the green energy field—has a lot to be displaced by cheaper, brighter and more efficient light emitting diode technology. The same has happened in automotive lighting and many new light sport aircraft have LED tail and landing lights. Legally certified aircraft would probably have more LED technology installed if the FAA had worked so hard to chill the market by raising an onerous certification hurdle. Nonetheless, a few handy companies have started LED products—landing and taxi lights, and tail lights in the interim. The market has actually expanded slightly since we last examined these products a year-and-a-half ago. Moreover, we expect to see more products for the certified market during the next couple of years, mirroring the emerging trend in all segments of the lighting market. For this report, we tried seven LED products, all but one being picked as a landing or taxi light. Our impression is that the companies have improved the performance of LEDs to the extent that they're no longer just novelties. However, they remain expensive—some as much as 20 times more than an incandescent bulb installed for the same ap-

lication. However, even at those prices, a LED landing light might make sense for some owners.

LED TECH
Recent breakthroughs in LED manufacturing have brought prices down, improved efficiency and output and also increased the range of colors the lamps can output. Unfortunately, the industry standard GE 4509 PAR is that the vast majority of airplanes have as landing lights. It's neither the most durable nor best bulb going. (PAR refers to parabolic



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CHECKLISTS

- + Overall, the lamps have improved noticeably since we tried them last.
- + It's better to think of them as incandescent lights that double as landing lights rather than as expensive bulbs.
- For owners who don't fly much, we would say skip the expense of LEDs.

CONTACT US

Editorial Office
941-929-1693
E-mail: avconsumer@comcast.net

Subscription Department
P.O. Box 420235
Palm Coast, FL 32142-0235
800-829-9081

Online Customer Service:
www.aviationconsumer.com/cs

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Spot or Spider? Apples vs. Oranges

While both are satellite trackers, they're not in the same league when it comes to price and performance. Spot is far cheaper, but Spider works better.

by Paul Bertorelli



If the basic idea behind the ELT—you crash, it tells the world where you are—was laudable, the performance of this technology has been anything but. Even the new-generation of 406 MHz ELTs haven't proved much better and are hardly flying off the shelves. From this conundrum emerges a

niche market for portable satellite vehicle tracking devices and personal messengers. This technology has been around for awhile in the transportation industry, but lately it has made inroads into the sporting and outdoor markets with a device called the Spot Satellite GPS Messenger, which recently introduced its second generation model. Another company, the New Zealand-based Spidertracks, has been marketing its own satellite tracker called the Spider S3.

Although these devices use different satellite systems—the Spot

uses the low-earth orbit Globalstar system, the Spider uses the 66-satellite Iridium communications network—the two gadgets work on the same principle. They rely on GPS to establish an accurate position, then communicate this through the commercial satellite networks to either rescue agencies or to public or private view Web tracking, or both, customizable by the user.

The concept is fundamentally different than an ELT, which activates only after the crash, and then none too reliably, and then transmits a distress signal to a dedicated satellite network. Satellite trackers, on the other hand, lay down a path of electronic bread crumbs in near real time, providing searchers with accurate position datums from which to begin looking for a downed aircraft.

Furthermore, unlike an ELT, whose signal is trackable only by government agencies, a satellite tracker's data can be constantly monitored by people with a greater interest—family, friends and business associates. Think of it as do-it-yourself SAR.

The purveyors of these gadgets are careful not to call them beacons, but satellite trackers or messengers. Nor do they necessarily claim they'll function as an ELT does,

Spot, upper image, is a truly portable device, powered by three lithium batteries. Spider S3, lower, requires ship's power between 10 and 32 volts. SOS button can instantly notify emergency services and speeds position update rate.



nominally activating during or after a crash and remaining on. What they do claim is that this inexpensive technology will reliably track vehicle or personal movements and relay that data to interested parties.

SPOT

The Spot messenger first appeared in aviation markets in 2008, when Spot International sponsored a promotional deal at EAA AirVenture. The original sold for \$169.95, plus the cost of the satellite tracking service. Last fall, the company introduced a follow-on model, the Spot 2, which is smaller and equipped with a redesigned button set.











Overall size is 2.2 by 3.6 inches by 1 inch thick—about the size of a cigarette pack. It's available in silver or bright orange and consistent with its sport/recreation use, the company says it's waterproof to a depth of 1 meter, although it doesn't float. Price is the same as the original, although you can find it discounted for as little as \$120.

The Spot is powered by three lithium AAA batteries which the company says will last about seven days for normal, always-on tracking and about six days in SOS mode. Battery life is said to be three months for powered-up standby mode.

The Spot has only five controls: a help assist button, a check-in/OK button, a custom message key, a track progress button and an SOS button. Once the unit has found itself via GPS, pushing the track progress button will send a waypoint every 10 minutes for 24 hours until cancelled. These waypoints are viewable in the personal account section of Spot's Web site and are plotted as numbered waypoints with lat/long data and time, but no speed or vector information. The Web and tracking maps can be publicly viewable. Confirming the Spot's initial position with the Google satellite view, we found it to be accurate within about 10 feet.

MORE DETAIL

Spot's OK/custom message function allows you to send a routine how-goes-it update to your account, which can also include a pre-programmed personal SMS text message, say something like "Landing in 10 minutes." Pressing the OK

SPECIFICATIONS	SPOT	SPIDER
RETAIL COST	\$169.95 (\$120 DISCOUNTED)	\$995 (S3) \$1795 (S2)
POWER OPTIONS	3 AAA LITHIUM BATTERIES	10-32V SHIP'S POWER ONLY
SIZE	2.5 X 3.6 X 1	3.5 X 4.2 X 1
SATELLITE SYSTEM	GLOBALSTAR	IRIDIUM
REPORTING FREQUENCY	10 MINUTES	1-2 MINUTES
REPORT DATA	LAT/LONG, TIME, DATE	LAT/LONG, TIME, DATE, TRACK, SPEED, ALTITUDE
WATERPROOF?	YES, 1 METER DEPTH	S2 IS WATERPROOF, RUGGEDIZED; NOT INTENDED FOR OUTDOOR OR PORTABLE USE
OPERATING TEMPERATURE	-22F TO 140F	-13F TO 158F
DATA PLAN COSTS	\$99.99 YR/BASIC \$49.99 YR/TRACK PROGRESS \$12.95/YR RESCUE BENEFIT	\$120 YR/ 4 HRS PER MONTH \$180 YR/8 HRS \$300 YR/10 HRS \$540 YR/20 HRS \$600 YR/30 HRS
PROS AND CONS	<ul style="list-style-type: none">  SMALL, LIGHT, PORTABLE  INEXPENSIVE TO BUY AND OPERATE  SIMPLE OPERATION WITH LONG BATTERY LIFE  POSITION REPORTS HAVE LIMITED INFORMATION  RESPONSE SKETCHY AT TIMES 	<ul style="list-style-type: none">  ROBUST, RELIABLE TRACKING  SIMPLE, FLEXIBLE OPERATING MODES  DETAILED AND FREQUENT POSITION REPORTING  NO PRACTICAL PORTABLE OPERATION MODE  MORE EXPENSIVE TO BUY AND OPERATE

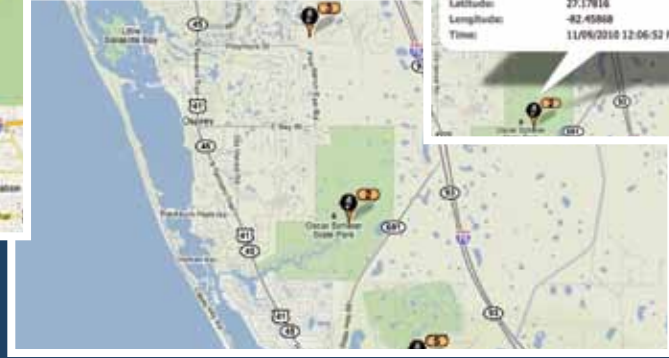
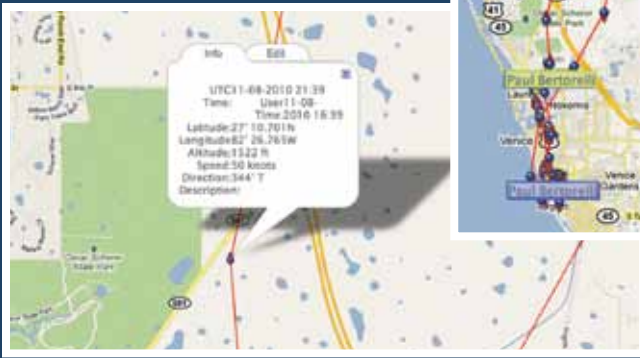
button e-mails that message to your selected contact list, along with the time and your position.

(You can't change that message in the field, unless you have access to your account via the Web.) Simply pushing the button sends the message on its way, sent three times during a 20-minute period. You can send the OK/custom message during routine track progress and it will go out immediately.

The Spot has two dedicated buttons that live under protective covers. The Help/Assist is a sort of non-emergency option that, when activated, will send a pre-programmed I-need-help message to the sources of your choice. These

can be the same list of contacts you use for the track progress messages or you can arrange for them to go to service providers offering roadside or other assistance. The message is sent every five minutes for an hour until canceled, which can be done at any time.

On the right side of the unit, also under a protective cover, is the SOS button. Pushing this one immediately sends a distress message to the GEOS International Emergency Rescue Coordination Center, which then notifies local responders. The message is sent with pre-programmed and position data every five minutes until it's cancelled or the batteries die. Both the SOS and



TRACKS COMPARED

Images above illustrate typical tracking performance on a short flight. Both trackers were placed on the glareshield of a Piper Cub, with the Spider powered by a portable 12-volt battery pack. Spot has its own internal lithium batteries.

Spider, left image, reports a position every 2 minutes, with lat/long., speed, track, time and altitude, as shown in the detail balloon viewable on the Spidertrack Web site. At 50 knots, the position reports are only 1.5 miles apart, a dense and detailed bread crumb track. (Inset detail show the entire track.)

The right image shows comparable Spot performance. It's critical that the Spot's combined GPS and satellite have a good view of the sky. When it slipped out of place on the Cub's downtube mount, tracking suffered. Even under ideal circumstances, some position reports were missed, but generally, we found them to be available on the promised 10-minute intervals. In the Cub, that made the reports 8 miles apart. In a 150-knot airplane, they would be 25 miles apart. Note that position reporting provides only lat/long. and time and date. No track or altitude data is provided.

assist messages are sent whether the Spot has GPS position data or not. GEOS monitoring is provided in the basic service plan, so the last thing you want to do is a push-to-test to see if it works. For an additional \$12.95 a year, you can buy a GEOS member benefit to cover up to \$100,000 in SAR expenses.

SPIDERTRACKS

In principle, the Spider S3 performs similarly to the Spot, but it's more expensive to buy and operate and based more on the commercial vehicle tracking model than the sport or recreation model Spot is built on. Its tracking is also more robust and data rich and, at least according to our brief tests, less likely to fade.

The device itself is larger, measuring roughly 4 inches by 3 inches in a trapezoidal, low-profile shape.

No batteries, though, only ship's power through an accessory plug (10 to 32 volts), so if you're thinking of this unit doubling for outdoor or sport use without power available, it won't do that. No external antenna is required; all you need do is place it where it has a clear view of the sky.

The Spider's operating mode is simpler than the Spot: You simply plug it in, wait for it find the GPS and Iridium satellites and then tracking starts. There are actually two versions of the hardware, the S3, which is a consumer-grade perch-on-the-glareshield design and the S2, a ruggedized, waterproof version designed for commercial use. The S3 sells for \$995, the S2 for \$1795.

The S3's interface is simpler than the Spot. It has only three buttons—no on/off switch—you just plug it in and it fires up. Once it finds itself, it reports a single position datapoint. Pushing a button labeled "watch" starts the track mode, which reports additional positions after the device moves at at least 40 knots. It will then report position every two minutes. The datapoints are more detailed than Spot's, offering lat/long, time, speed, track and altitude. In our view, the additional

data could be a meaningful plus for SAR responders. The Spider paints quite a detailed picture of your movements, with position reports at closer intervals than Spot's.

If the Website doesn't receive good data for a period of 15 minutes, it will alert your contact list. If the contacts don't respond after another 15 minutes, a so-called second tier alert will be sent that can—but doesn't have to—go to your designated rescue services. All of this can be customized on the Web interface, including the tracking interval, which can be as little as one minute. Spidertracks views the monitor mode as something to be used only when flying in hazardous areas, but we suspect most users would want it on all the time, since detailed breadcrumb tracking is what makes a satellite tracker superior to an ELT.

The system can be configured to send custom messages—you program these on the Web site—corresponding to "mark" button pushes. One for takeoff time, say, two for an enroute check, three for landing and so on. These can be set up to be sent automatically at certain speed thresholds, say 60 knots to indicate takeoff or under 30 to indicate

CONTACTS

Spot LLC
 866-651-7768
 www.findmespot.com

Spidertracks
 720-287-0054
 www.spidertracks.com

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Kitfox LSA: Taildragger or Trike?

You can buy it in either version. Because of its performance, long pedigree and build quality, this LSA is a top value.

by Paul Bertorelli

We're running out of ways to explain why what was supposed to be the shining salvation of aviation—the light sport aircraft industry—has thus far failed to deliver a three-run homer. Would-be buyers continue to complain that no one has produced a decent \$40,000 LSA, but someone has produced a good one for a little more than twice that: The Kitfox.

As a kit company, Kitfox has been around since the early 1980s in various iterations and its basic design idea has evolved through a number of variants and one European knockoff.

And the big idea? A conventional welded-tube structure covered with fabric and with expansive clear plastic doors, a glass roof and a huge baggage compartment. As if there weren't a long enough list of signa-

ture features, the design is unique for its use of full-span flaperons in place of conventional ailerons. On the experimental side, the formula has proven successful enough to have put about 5000 kits into the field.

PRICE POINT

Last year, with little fanfare, Kitfox announced an LSA version of the airplane, available as either a taildragger or as a tricycle gear airplane. If you can't decide which you prefer, Kitfox owner John McBean says the designs can be swapped back and forth without undue effort, although it's not something an owner would be likely to do on a whim. (It takes a half day or so.)

McBean's idea was to produce a U.S.-made LSA at a price point around \$100,000, thus the base

price for the Kitfox LSA is \$83,500, equipped with just a radio and a portable GPS. But these days, nothing is shipped in minimal mode so typically, the Kitfox will invoice at about \$100,000, equipped with a Dynon Skyview EFIS, a Garmin SL40 navcomm and a transponder. For basic LSA training and flying, we consider this lavishly equipped.

Engine choice for now is the popular 100-HP Rotax 912, but McBean says the company is looking at Lycoming's new IO-233. The problem will be weight. At 170 pounds installed, the Rotax brings the Kitfox LSA in under 800 pounds,

CHECKLIST

-  The Kitfox design follows one of the most successful and established experimental designs.
-  Performance is excellent. Choice of taildragger or trike is a plus.
-  The company is geared for small production, thus appears to be financially stable.
-  Flaperons and heavy tail take some getting used to.



The Kitfox's long-span flaperons give aggressive roll response, top. The panel has plenty of room for glass suites like the Dynon Skyview, middle photo. Seats don't adjust, but rudders do, lower photo.

making it one of the lighter products on the market.

To hit the price point, the Kitfox is constructed like an experimental aircraft because it essentially is. Although it meets the 1320-pound LSA weight requirement, the Kitfox has essentially the same structure as the well-regarded kit aircraft. Extensive use of fabric helps keep the weight

down, as do the clear plastic doors and skylight.

There are some minor differences, such as carb heat for the Rotax, which is not used in the experimental version.

FLYING IT

Although it's available in both taildragger and trike versions, we

flew only the taildragger, since we tilt toward conventional gear for this class of airplane. There's not much difference in performance between the two, although the handling is quite different.

Getting into the Kitfox is the usual butt-first-drag-the-legs-over-the-stick suppository type insertion.

The inflexible and overweight will struggle a bit, but we find this to be true of all LSAs to some degree. The Kitfox's gear legs are further forward than they are on a Cub, but the doors are wider so it's an even trade. Once inside, the contoured seats are comfortable. They don't slide for adjustment, but the rudder pedals do, using a lever mounted on the center cockpit tunnel, far forward. But do remember to adjust the pedals before securing your seatbelt, otherwise you can't reach the rudder lever.

Everything is about where you expect it to be in the airplane. The engine controls are mounted center console low, with all the electrics on small rocker switches on the pilot's side. With the Dynon Skyview on the left, the right side of the panel is wide open for another EFIS, map or GPS.

Trim is electric only, on the center console, and the motor is quick moving. All it takes is a stab to trim off control pressure. We would prefer a coolie hat trim on the stick, but the center console location works fine and simplifies wiring. The flaps—well, flaperons—are located on a lever between the two seats and are easily reachable. The Kitfox is somewhat

unique among LSAs in having push-pull tubes rather than cables for the ailerons and elevator and this is quite noticeable in precision of movement. The rudder has conventional cables.

Rather than a moving trim surface, the Kitfox trim system changes the angle of attack of the horizontal stabilizer through a jackscrew arrangement, rather like the Mooney M20 series.

The Kitfox has 6.00 X 6 tires rather than the 5.00 X 5 used on most LSAs, better to suit its intended function as a backcountry flier. Ground handling is conventional, although we found that straightening the airplane out after a brake-assisted turn is a practiced art. Demonstration pilot Paul Leadbrand says leading the ground turn cures that, but we never mastered it. Visibility over the center of the nose is blocked, but you can peek around the side of the glareshield to get a good view forward, so aggressive S-turns are an option, not a requirement.

If there was any surprise in flying the Kitfox, it was on takeoff. With the gear mounted forward, the airplane is quite heavy on the tail—you can't easily lift it off the ground as you can a Cub or a Champ, if you can lift it at all. This means that on the takeoff roll, it takes considerable forward stick to lift the tail and hold it up. If you're prepared for that, it's okay. But the surprise came when we picked up enough speed for the flaperons to bite—and that's not very fast.

They have so much roll moment that it's possible to lift a wing during the takeoff roll and we did, imparting an unintended turn. In fact, we noticed that even experienced Kitfox pilots tend to walk the wheels a little because lacking any noticeable dead neutral, the slightest stick movement imparts rolling moment.

However, in climb and cruise flight, this is less noticeable, but the airplane wants a delicate, two-finger touch on the stick. It rolls quickly and easily. Pitch forces aren't as light as we expected, certainly not quite as feathery as Cessna's Skycatcher or the Piper Sport. Little in the way of right rudder is required for climb, merely resting a foot on the pedal is sufficient.

With only a degree of dihedral, the airplane is close to neutrally stable in roll and will diverge slowly if displaced from level. Pitch is another story; if displaced, the Kitfox aggres-

sively seeks the trimmed airspeed, damping phugoids in two cycles. Stalls are nothing to speak about; the usual burbling with no fall off and, if held in the stall aggressively, the Kitfox falls into the parachute mode most LSAs seem to have.

Climb and cruise performance are excellent. We found that Kitfox happily bolted up to

pattern altitude by the turn to downwind and cruised at about 120 knots indicated at around 5000 RPM indicated for the Rotax 912. Fuel consumption is typically 4 to 5 gallons with a

27-gallon capacity. Baggage capacity is a generous 150 pounds in a large area behind the seats, so the Kitfox can live it up its reputation for a backwoods airborne camper.

For as tricky as it was to learn the takeoff, landing the Kitfox is easier than with other taildraggers we've flown. We surmise there are several reasons for this. One, the gear legs are stiff enough not to impart much bounce, so when you stick the airplane on, it seems to stay stuck.

Second, and unlike older taildraggers, the Kitfox is not very draggy and will float if you approach fast; it won't give up flying all at once, so you can finesse the speed as you feel for the runway. Last, there are simply no sight picture issues in this airplane. Everywhere you look, you get good visual cues and with side-by-side seating, both pilots see more or less the same thing.

In one category, the Kitfox blows away everything: cockpit visibility. With a large windshield, two clear doors and a giant skylight that extends back over the baggage compartment, this thing is like flying in a fishbowl. But alas, fishbowls heat up so in a Florida summer, bring a hat and suntan lotion. Thankfully, the airplane has good ventilation through panel-mounted eyeball vents and you can also fly with the doors open. Gas shocks hold the doors open.

CONCLUSION

As LSAs go, the Kitfox holds its own in terms of overall performance, comfort

KITFOX: NO NEWCOMER

The Kitfox design has been around long enough to pre-date the great surge in experimental designs that occurred during the early 1990s. It first appeared at Oshkosh in 1984 (before Cessna had exited

the piston market) and has been a strong seller, with some 5000 examples flying across at least 10 different model iterations.

The company was started in Boise, Idaho, as Denney Aircraft and the design and rights were later acquired by Skystar Aircraft, which sold the design as the Skystar Kitfox and developed new versions of the aircraft for the kit market, selling as many as 30 to 40 kits a month during the heyday.

Current owner John McBean worked for Skystar in sales and as demo pilot. The company re-

mained viable until 1999, went through a bankruptcy and emerged reformed after an employee buyout in 2000. It went under again and didn't operate from October 2005 to April of 2006. It was then acquired by John McBean and his wife Debra and resumed operations in large industrial hangars at the Homedale, Idaho, Airport, west of Boise.

Currently, Kitfox employs 10 people, mostly plying the new kit and support business for the existing fleet of Kitfox aircraft and building the LSA version. McBean told us that the company is well-positioned to produce a low-cost LSA both because of its long kit experience and polished production methods and because the company is not leveraged. It currently has no debt obligations. Although debt-free operation can sometimes hobble growth, like most companies, Kitfox is in holding mode, waiting for more favorable economic conditions. It seems well-prepared to do that.



and practicality. At about \$100,000, it's higher on the value line than many other LSAs we've flown. With the welded steel structure and quality fabric work, the workmanship on the airplane is excellent. You won't find any paint goobers or sloppy welds.

As for the flaperons, we're neutral. We like the idea well enough, but we would be just as happy with conventional ailerons that would be less alive during the takeoff roll. On the other hand, if you plan to do a lot of backcountry flying—as many Kitfox owners do—the flaperons offer an extra measure of slow speed roll control for a pilot who's accustomed to them.

Which version to pick, taildragger or trike? We're strongly biased toward the taildragger because we think it's better looking and because LSA flying is more about the fun and

the challenge of pure airmanship and less about transportation. For our money, there's no better way to do that than in a taildragger.

AC TV



For a video demonstration of Kitfox LSA, log on to www.avweb.com and select the video index. Scroll down to the Kitfox flight trial. You can hear a podcast on training in the Kitfox LSA at <http://snipurl.com/1f5o5u>.



Paperless Cockpit Redux: iPad a Best Bet For Now

No, the iPad doesn't do it all and isn't for everyone. But for the fat middle of the user bell curve, it delivers the most utility and best experience.

by Jeff Van West

Before the fan-boy and anti-fan emails start pouring in, let's get one thing clear: We're pegging the iPad as the best bet for *most* pilots for replacing paper charts and approach plates in the cockpit. This is not a surprise with a device designed for reading stuff comfortably.

We've said before and we're saying again: If you want advanced functions—GPS navigation, TAWS, on-board weather, or even some kinds of interactive documents—then the iPad may let you down. Most importantly, it may let you down unexpectedly, as with the iPad's GPS that works great, except when it doesn't. There are at least two external GPS units for the iPad, but we haven't tested them.

If your needs extend to those other functions, there are other more

robust and versatile options. There are also cheaper options if your budget can't justify an iPad. And even using the iPad, there are several options for view charts that offer different capabilities and cost.

IPAD SWEET SPOT

What the iPad does well it does phenomenally well. The physical device is simple to use: A button to

For viewing digital versions of what we used to lug along as paper, the iPad simply does it best.

turn on, a tap to launch your chart reader, and a suite of taps, flicks and pinches to select, scroll and zoom. We've watched pilots who we know

It's bigger, but no more awkward than holding a book of approach charts. We'd still recommend a kneeboard to rest it on or a mount.

struggle with navigating even a Garmin GPSMAP 496 whip through the iPad with ease.

The screen is also super-sharp and color. Anyone with enough vision to fly can read an approach plate when it fills the screen. Most eyes can even read it at half that size, as happens in the split-screen mode some apps offer. With the 9.5 by 7.5-inch iPad in a grippy sleeve on our lap or in one of several kneeboard and mounting solutions, it's easy enough to use in the cockpit.

The screen has a significant glare in the daytime and can be too bright at night (although switching to an inverse view helps). If we could wave a magic wand, we'd want an iPad that was just a bit smaller. The touchscreen is also limited when it comes to jotting down information. Freehand writing with your finger is possible, but neither comfortable nor clean. Don't count on the battery life; we've found 24-volt to USB power adaptors for under \$5.

While you can pay to play at \$499 for a 16GB unit, we think you want to go at least to the \$629 16G/3G model to get the internal GPS (or look at one of the external GPSs that connect). Even the mediocre internal GPS will almost always place you on a chart close enough to get you in the right part of the sectional chart or the airport diagram. The GPS also makes preflight planning much easier, as the radar or METARs you're reviewing on the ground are relative to your location. In our testing of the iPad, its utility for flight planning in the FBO, particularly for weather, was a huge plus. There are

cool tricks these apps can play, too. Enter your clearance with airways "ENE V3 CON ..." and the app decodes it into waypoints to put into the GPS. The other great plus about the iPad is that download manage-

ment is built in through WiFi. Tell the app to update your charts before you go to bed and it does the rest—no datacards, no website downloads.

How much you want to lean on the iPad GPS in flight will probably influence your app choice. We still think the two contenders worth trying are ForeFlight and WingX, at least for North American flying (try Air Navigation Pro for some European charts). No other apps but none have the utility and reliability of these two, as we see it.

Our testing supports ForeFlight being easier to use than WingX, and it clearly excels on preflight weather (including international weather), integrating this weather over a map, but not the scanned charts. ForeFlight offers sectional and en route charts, with your route and position shown. You can easily pinch to zoom and scroll. ForeFlight just improved their system to allow rubberbanding and editing of routes right on the screen, as well as a much-needed direct-to-function.

WingX is designed more like a portable aviation GPS, with a data-derived moving map capable of showing terrain and customizable

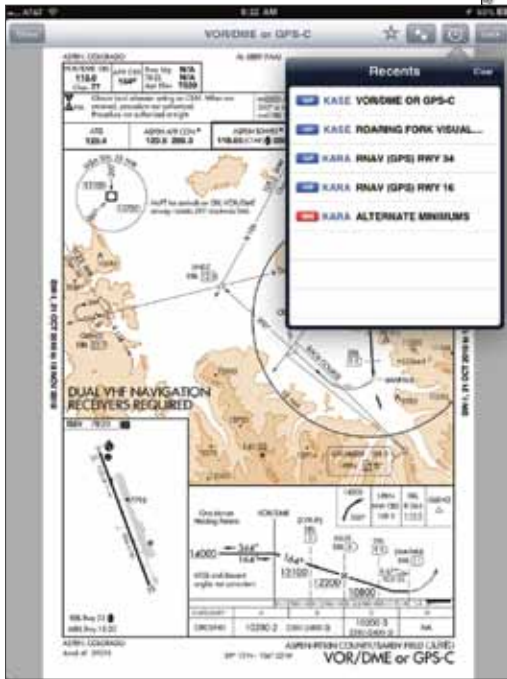


to show only the items you want. It just added scanned charts and pinch to zoom. It also has a clever split-screen setup to show an airport diagram or approach and a chart simultaneously (ForeFlight lacks a quick toggle between these views). WingX is better at getting information off the map for points

not in your flight plan. It can also give you detailed information on items like airspace directly rather than zooming in to read it off the chart. The split screen showing your position on the map and the approach plate simultaneously is a plus.

We tended to prefer ForeFlight in the FBO, but WingX in the air, particularly in aircraft that have no other GPS. (Even a so-so GPS is better than none at all.) That said, the

A crisp, color touch-sensitive screen is just the easiest way to navigate charts. WingX's split screen (above) lets you see a map and chart simultaneously. ForeFlight (below) lets sectional or en route charts act as your moving map. Both platforms access approaches by selecting an airport and getting onto the airport information page, but from there each program differs.



	SIZE AND WEIGHT	APPROACH CHARTS	GEOREFERENCED?	SECTIONAL/ EN ROUTE	OTHER DOCS	GPS POSITION	PREFLIGHT TOOLS	COCKPIT WEATHER	WI-FI UPDATES	PRICE
iPad/ForeFlight	7.25 X 8.25 X 0.5 1.6 LBS	NACO	⊖ ¹	⊕	⊕ ³	⊕	⊕	⊖	⊕	\$629 + \$79/YEAR
iPad/WingX	7.25 X 8.25 X 0.5 1.6 LBS	NACO	⊕	⊕	⊕	⊕ ²	⊕	⊖	⊕	\$629 + \$99/YEAR
iPad/PDFPlates/ SkySectionals	7.25 X 8.25 X 0.5 1.6 LBS	NACO	⊖	⊘	⊕	⊖	⊖	⊖	⊖	\$629 + \$0 OR MORE ⁴
iPad /JeppMobile	7.25 X 8.25 X 0.5 1.6 LBS	JEPP	⊖	⊖	⊕	⊖	⊖	⊖	⊕	\$629 + JEPP SUBSCRIPTION
KindleDX/ Airbrief	10.4 X 7.2 X 0.4 1.2 LBS	NACO	⊖	⊖	⊕	⊖	⊖	⊖	⊖	\$375 + \$99/YEAR
Sony PRS-900/ ReaderPlates	7.9 X 5 X 0.4 0.8 LBS	NACO	⊖	⊖	⊕	⊖	⊖	⊖	⊖	\$250 + \$99/YEAR
ChartCase	10.3 X 6.6 X 0.7 2.6 LBS	NACO	⊕	⊕	⊘	⊕	⊕	⊕	⊕	\$1195+ \$399/YEAR
SkyPad ²	9.8 X 7.2 X 1.1 2.6 LBS	NACO OR ⁶ EUROPEAN	⊕	⊕	⊘	⊕	⊕	⊕	⊕	\$895+ \$299/YEAR
Jepp Nav Suite	VARIABLES WITH HARDWARE	JEPP	⊕	⊘	⊘	⊕	⊕	⊕	⊕	HARDWARE+ ⁵ \$1058/YEAR
SOLID FX FX8	7.6 X 5.9 X 0.4 0.8 LBS	JEPP	⊖	⊖	⊕	⊖	⊖	⊖	⊖	\$1195 + JEPP SUBSCRIPTION
GPSMAP 696	5.7 X 7.7 X 2 2.2 LBS	NACO	⊕	⊘	⊖	⊕	⊖	⊕	⊖	\$2999+ \$799/YEAR
AV80R Ace	4.8 X 7.6 X 1.1 1.3 LBS	NACO OR EUROPEAN	⊕	⊕	⊘	⊕	⊖	⊕	⊘	\$1799 + \$399/YEAR
Quadra	4.25" X 3" X .5" 0.4 LBS	NACO	⊕	⊕	⊖	⊕	⊘	⊕	⊕	\$595+ \$260/YEAR

1 - May add as feature when coupled to external GPS receiver. 2 - When iPad GPS is locked on. 3 - Custom docs can be attached to specific airports. 4 - Varies widely with area covered. 5 - Hardware not included. 6 - European coverage TBA. Also note that some subscriptions cover Alaska and/or the Caribbean. Aspirin not included when trying to puzzle all this out.

apps are constantly being improved. ForeFlight has a three-month trial plan for \$24.99 or a year for \$74.99; WingX requires you try the full year at \$99.95. We know several pilots who pay for both, to get the best of each. Both systems offer bonus data, such as AOPA airport information, current fuel prices and more. WingX offers georeferenced approach charts (the aircraft's position on the approach), but that's an extra \$199/year.

These aren't the only two options. Beacon by Zivosity has promise (and has sectional and en route charts), FlightPrep has iCharts (approach, sectional, en route and TAC, but no GPS support) and Garmin's terrific PilotMyCast will be released for the iPad and will have approach charts.

If you have a Jeppesen digital chart subscription, you can download a free iPad reader for your Jepp plates on your iPad. But that's all it does: display approach and airport charts.

CHEAPER READERS

You can shave some cash by still using the iPad but rolling your own charts. PDFPlates.com offers whole sections of the country in PDF format for donation. PDFs of sectionals or en route charts can be had from SkySectionals.com as one-time purchases or by subscription. But we think the management of these solutions is penny-wise, pound-foolish given the ease and value of something like ForeFlight.

We've looked Sony and Kindle solutions in the past (see March

2009, August 2009 and March 2010). PDFPlates offers files (free or for donation) that work on KindleDX and Kindle2 as well as the Sony digital readers. Readerplates.com offers files for the Sony readers and KindleDX for \$9.99/month. Airbrief.com costs \$9.99/month for the KindleDX and Kindle.

While these readers have the advantage of running for days between charges, we can't recommend investing. In less than 12 months we've gone from searching for the right kind of plate reader to something that only does approach charts not being worth the trouble, unless you already own the hardware.

If you already own an iPhone or Android, you might consider WingX or ForeFlight on the smaller screen.

It's harder to read, but you get most of the iPad features without the hardware investment.

TABLET SOLUTIONS

There are Window-based computers that can fold up such that they are a tablet you can hold in your lap or in a mount, which we reviewed in our April 2010 issue. Our top picks were Flight Prep's Chart Case and the Voyager Skypad2. AnywhereMap's Duo is also a contender.

Tablets are similar to the iPad in that they have touch-sensitive screens, but they often also offer a stylus for better writing. They connect via Bluetooth or cable to an external—and reliable—GPS, as well as an optional XM receiver or even Zoon traffic sensor. The result is more like a portable MFD than a simple chart reader. As it's a full-up computer with a fold-away keyboard, it can also be used for e-mail, document management and anything else you might need on the road.

We found the tablet solutions have more powerful viewing options. For example, you can customize split screen views more completely than on iPad apps.

If you want approach plates and sectional/en route charts but also want datalink weather and powerful flight planning tools, then these devices might be a better bet. They will cost you more than the iPad, however, running \$895-1796 for the devices plus \$299-350/year for the data subscriptions, or more with XM weather. These things are also heavier than an iPad, and consist of several pieces with power cables or batteries to recharge.

JEPPESEN USERS

The tablet computer is also the hardware end of Jeppesen's paperless solution for GA: FliteDeck. We'd give Jeppesen's FliteDeck software a seven on a scale of one to 10 for overall usability. It's a powerful moving map and display system. It shows all the Jeppesen approach charts your subscription covers, as well as en route maps that are similar too, but not exactly the same as Jeppesen low or high charts. It also has a VFR view that is similar to a sectional and the Jepp textual information you'd get with an paper subscription.

The learning curve is a bit steep

for the software, and you still have the cockpit clutter of a separate GPS and power supply, but the system does work as described. XM weather is available if you get the receiver. Jeppesen doesn't offer the hardware, so you're on your own to put that together as well. Jeppesen, and several other vendors for that matter, also offer higher-end EFBs aimed at corporate and commercial aviation.

If you just need Jeppesen approach charts, try the SOLIDFX FX8. The reader is similar to the Sony or Kindle in screen technology and battery life, but the similarities stop there. The software to organize and display the plates is exceptional. The FX8 requires a stylus (no touch sensitivity) but that lets you write down notes with near pen accuracy and fill out forms. Jeff McDonald of SOLIDFX says some of their clients use the FX8 for document management more than as a chart reader. The FX8 is also the perfect size, in our view, at 7.6 by 5.9 inches. There is a bigger FX10 version. The FX8 is \$1195, plus whatever subscription you choose for the Jeppesen approach charts.

Looking at the FX8 on our chart to the left, it clearly lacks extras that other solutions offer. We think that's mostly a limitation of the iRex reader SOLIDFX uses. We'd like to see SOLIDFX offer an iPad solution themselves that took their clever organization to a more versatile platform.

AVIATION GPSS

If our top-pick iPad is the chart reader that makes a pass at being a GPS, then we have to look at real aviation GPS units that also show charts. We think three rate: the Garmin GPSMAP 696 (October 2010), the Honeywell AV8OR Ace (October 2009) and the Anywhere-Map Quadra (June 2010).

The least capable as a chart reader is the GPSMAP 696, showing only approach charts (soon to be georeferenced) and an en-route-

chart-style moving map. Both the AV8OR Ace and the Quadra show georeferenced approach, sectional and en route charts. The Ace is bigger (seven-inch screen) and can show the whole chart at once. The Quadra is smaller (4.3-inch screen) and requires scrolling, but the screen is quite sharp. The Quadra also has WiFi data download.

The Garmin is a pricey \$2999 plus \$700/year for full data. The Ace is less at \$1799/year, plus \$399/year for U.S. data and \$799 for European data. (You read that right. European charts and approach diagrams.) The Quadra is a bargain \$595, plus \$260/year for the data subscriptions.

IPAD FAN CLUB?

It somewhat pains us to feel we're joining the iPad brigade, but when the mission is viewing digital versions of what we used to lug along as paper, the iPad simply does it best. WiFi/3G and the (mediocre) GPS take it a step beyond paper into a real preflight and cockpit tool.

The next generation iPad or Android tablet might have the horsepower to drive a real GPS and datalink weather (XM or ADS-B). Until then, we think most pilots won't regret for a moment buying an iPad and tossing the paper in the recycle bin.

CONTACTS

AnywhereMap 800-292-1160 www.anywheremap.com	Jeppesen-Sanderson 866-498-0213 jeppdirect.jeppesen.com
Bendix/King by Honeywell 800-601-3099 www.bendixking.com/av8or	PDF Plates 540-200-8620 www.pdfplates.com
Flight Prep (ChartCase) 800-996-4360 www.flightprep.com	Seattle Avionics (Skypad) 425-806-0249 www.seattleavionics.com
ForeFlight team@foreflight.com www.foreflight.com	SOLIDFX 508-316-8078 www.solidfx.com
Garmin International 800-800-1020 www.garmin.com	WingX 866-42-WINGX www.hiltonsoftware.com



Sunglasses For Pilots: Oakley, Vedalo Tops

Wrapping Oakleys were our overall favorites, even though Vedalo clearly offers the most advanced lens and Mile High wins for the maximum value.

by Larry Anglisano

Reviewing sunglasses is like reviewing clothing: It's grossly subjective and one size never fits all. But there are some important qualities to look for when choosing sunglasses for the cockpit. Special-purpose sunglasses aren't cheap but the price tag isn't a reliable predictor for performance.

While sunglasses are an important part of pilot ego, we think they're also a critical tool. In addition to protection from both visibly blinding and damaging UV sunlight, they should reduce eye fatigue, aid the eyes in transitioning from daylight to darkness and add clarity for effectively spotting traffic. They must also be comfortable under headsets for hours at a time and work well with modern cockpit glass displays. And they have to look good.

Here are our finds on what retailers know are top sellers and some of the up-and-coming brands trying to find a niche in the market. Obviously, we couldn't cover every model, so if a certain pair works well for you in the cockpit, let us know.

YOU'RE SO VAIN

Call us narcissists (after all, we are pilots just like you) but style was high on our list of criteria and it's where the testing got difficult. Style is subjective and one personality might like an athletic wrap-style frame while another might dig a square frame.

A smaller face is going to look like a beetle while wearing a huge pair of classic Ray Ban aviators. And, the temple frame design on some models isn't going to fit every nose comfort-

Wrapping shades, like these Oakley M-frames, make a big difference in cutting out side glare or reflection off the inside of the glasses when the sun is behind you.

ably. Ray Ban, Oakley and Randolph Engineering offer their models in different sizes, just like shoes. Most of the so-called off-brands are one-size fits all.

As the comparison chart shows, comfort is a major category in which we judged, which includes wearing headsets and ball caps. The ability to easily remove and reinstall the glasses from the clamping of headphone ear cups is important. As a rule, glasses with grippy rubber earpieces will be a challenge. We also have yet to find a pair that's terrific while flying up in the teens with an oxygen cannula piped into our honker.

NAMES YOU KNOW

The brands most familiar in our test samples were Oakley, Ray Ban and Serengeti. Despite a table stacked with more sunglasses than we knew what to do with, we were drawn to familiar name brands first.

Originally founded by Bausch and Lomb, Ray Ban is the most recognizable name in glasses with an earned reputation for quality. The signature Ray Ban look is the green or brown G-15 series lenses in the familiar black wire frame. Polarized lenses are a poor choice for aircraft, but the model 3393s with non-polarized brown lenses performed well in the glass-endowed, four-screen cockpit of a new Pilatus. The color did a good job of enhancing cloud definition while still reducing overall light and glare. The Pilatus driver told us they aren't too dark as to make the transition back to all those cockpit screens and map/menu viewing any problem at all.

The shape is a bit of a wrap-around to keep outside glare in check. Comfort is good, although the temples do hook around the ear at about 30 degrees but are still comfortably wearable on usual 1000-mile, Bose-wearing hauls in the PC-12NG. They also proved to be reasonably good outside the aircraft while riding dirt bikes in the woods given their shatterproof build.

There were two pairs of Oakleys

MODEL	LENS TINT	LENS TYPE	FRAME STYLE	COMFORT	PRICE	COMMENTS
Ray Ban Aviator RB3026	green	glass	aviator	~	\$139	timeless aviator styling, durable, good lens performance
Ray Ban RB3390	brown	glass	rimless rectangular	~	\$139	brown lenses work well for outside/inside transition
Oakley TightRope	smoked or black	Plutonite	rectangular	~	\$120	excellent lens performance, uncomfortable after a few hours
Oakley M-Frame Hybrid S	smoked or black	Plutonite	full wrapping	+	\$120	rugged frame, near-perfect lens performance, serious comfort, RX capable
Serengeti 5222 Aviator	red (light-adjusting)	photocromatic glass	aviator	~	\$170	performed well with glass displays, nose/ear grip not ideal
Mile High Chocks	yellow, beige, grey and black	polycarb	full wrapping	+	\$82	versatile for sport use, durable, easily interchangeable lenses
Mile High Soarer	yellow, beige, grey and black	polycarb	partial wrapping	+	\$97	comfortable, less-aggressive look compared to full-wrapping frame
Mile High Aviate	yellow, beige, grey and black	polycarb	flip up/rectangular	~	\$77	flip up, RX capable, big with a somewhat "old-fogy" look
VedaloHD Azzuro2	copper-rose	polymer	rectangular	+	\$249	excellent performer in all lighting, unisex design, RX capable, featherweight, pricey
VedaloHD Argento2	smoke	polymer	rimless aviator	+	\$249	more traditional aviator styling, RX capable, pricey
Ra Vision Gear	gray or brown	Trivex (plastic)	rimless	~	\$289	durable, bendable frame for custom fit, celebrity priced
Randolph Concorde	gray	polycarb	aviator	~	\$99	good nose grip, proven mil-spec engineering standards

in our test group, the Oakley M-Frame Hybrid S wraps and the more traditional Tightrope model with polished black frame and black Iridium lens. The M-Frame was a recommendation of and top choice for several of our U.S. Marine contacts flying missions in the Middle East. They're also a top choice for athletes and available in interchangeable lenses and prescription.

The M-Frames offer full coverage with full-wrap, smoked HD Optics shatterproof lenses that perform flawlessly in most all lighting conditions. We've worn them in the dark of night (don't ask why) and were able to navigate both skies and roadways. Oakley calls the lens technology 'XYZ Optics' that enhances clar-

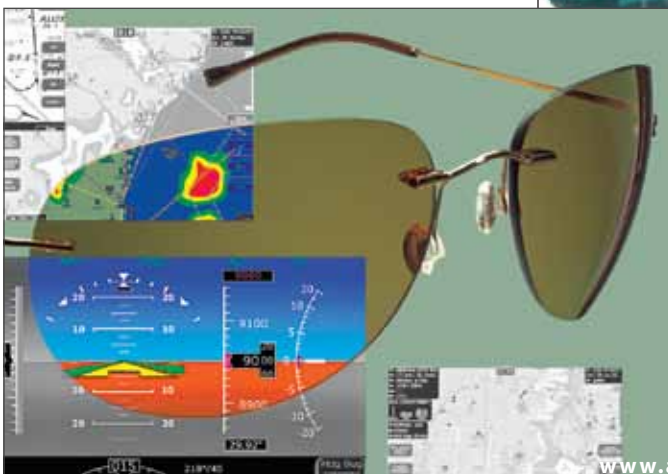
ity at all angles and when viewing cockpit displays from an angle, and they stand up to this claim.

They're also extremely durable with a solid and rugged feel that fits well with headsets and flight helmets. But don't try to take them off when clamped with headsets—the rubbery grip on the temple frames really hold them into place. The Unobtanium nosebombs and earsocks are designed for comfort and increased grip with perspiration.

We sweat a lot in the cockpit and the M-Frames never nose-slide.

The Tightropes are a more traditional frame and lens design that performed almost as well as the wraps, with less side eye coverage. They weren't as comfortable, either.

The Vedalos look sharp and wear well, as the better half of our cockpit demonstrates. The company's claim of enhanced LCD readability proved true, but the screws in the lenses can be distracting.





All Mile High glasses come with four lenses, but only the amber and grey are suitable for the cockpit.

They began to hurt our noses after a couple of hours mainly due to weight. But the smoked lens was flawless, just like the wraps.

SERENGETI AND RANDOLPH

We tested the Serengeti 5222 with non-polarized photochromatic, Drivers Radiant red-tint lenses. Flying in an Avidyne Entegra-equipped Cirrus SR22, some lenses struggled to effectively eyeball those big screens. The Serengeti large-frame aviators had no trouble. They closely resemble Ray Bans in look and quality build.

The photochromatic (self-adjusting) glass lenses have a potential pitfall in failing to get dark enough or not darkening fast enough. In our testing, the 5222s darkened to a point of being more than adequate in direct and bright sun. In low light, they were comfortable enough to wear inside a dimly lit hangar. But

the feel of the Serengeti's substantial frame was heavy and can be fatiguing after a couple hours. We wished they had better grip, too, when the sweat

started pouring. In their defense, the ones we tested were big but are available as "Small Aviators" for smaller faces. Before dropping \$170 try the Serengetis on for size.

Some manufacturers claim to supply military fighter jocks, but Randolph is the real deal. In 1982, became the prime contractor for aviation flight glasses for the U.S. DoD and a lead vendor to various government agencies. Their consumer gear is still mil-spec.

We tested the RE Concorde model, an aviator design with grey, non-polarized lenses. The Concorde's skull model temples fit well and were easy to take on and off without removing the headsets. We especially liked the positive fit and grab-on feel of the silicone nose pads. We've used Randolph models on the fire-arms range and they proved rugged enough for this harsh environment as they are for the cockpit.

MILE HIGH

Our first reaction to the Mile High Chocks was to compare them to the rugged Oakley M-Frames. The Chocks, a close copy of the Oakley wraps, just felt too light. It turns out this is one of their strong points.

The other novel thing about the Mile Highs was the ability to easily swap out four sets of included lenses. Off into a dark grey sky? Snap in the yellow impact-conforming lenses. Bright sun? Install the smoked ones. There are three styles of frames to choose from. There are partially wrapping Soarers and

the full-wrapping Chocks. There is also the squarish, flip-up style Aviates that let you to snap in prescription lenses behind the colored ones.

Outside the cockpit windows, we found the light-enhancing yellow lenses definitely brightened dark skies—in some conditions you would swear it's sunny. But with eyes inside the cockpit, the yellow lenses are just too bright. The amber lenses, however, were a perfect match for partial sun and worked well inside the cockpit. The smoked lenses? Not so good. We wished for more bright-sun shielding as well.

Interestingly, we found the MH Chocks our hands-down favorite for sports. The frames are light enough where you don't know you are wearing them, the interchangeable lenses were extremely useful for playing under the changeable and often grey skies of New England, and they can take a beating. However, one of our test samples showed up with a scraped lens, so perhaps they aren't as scratch-coated as claimed. Still, they're the kind of glasses you can toss in your backpack, glove box or unorganized flight bag where they'll get beat up but can easily survive. For under \$100, they're a real value.

VEDALO, RA VISION

The Italian-produced VedaloHD Signature Series models surprised us with quality, performance and obvious metrosexual styling. Perhaps the most feminine-styled glasses in our group, we forked them over to our female tester and pointed the airplane eastbound into morning sun. Our typically outspoken and critical copilot gave the VedaloHD Azzuro's high marks for comfort and performance commenting that she forgot they were on her head when clamped with headsets. They are also available with prescription lenses.

Vedalo is no sissy in sunglasses design. The lenses are impact, chemical and atmospheric-agent resistant, incorporate Vedalo's NXT technology and are designed for the cockpit. The non-polarized HDL-3C lenses don't use a tint or a coating. They have a filtering process impregnated directly into the lens the company claims results in increased color sensitivity and improved chromatic contrast. They are intended for reading LCD displays and instrumentation within

CONTACTS

Mile High
www.mile-highglassesusa.com
630-479-7449

Oakley
www.oakley.com
800-403-7449

Ra Vision Gear
www.ravisiongear.com
800-718-7992

Randolph Engineering
www.randolphusa.com
781-961-6070

Ray Ban
www.ray-ban.com
866-472-9226

Serengeti
www.serengeti-eyewear.com
800-423-3537

VedaloHd
www.vedalohd.com
800-801-4523

HOW WE TESTED, HOW YOU MIGHT CHOOSE

While our rigorous criteria for testing aviation sunglasses came naturally, it also required some thinking outside of the box. We used our test samples at the crack of dawn on our daily cycling workout, while running, on the golf course, while shooting firearms and archery, while ripping down the mountain on a snowboard, in our vehicles, on our motorcycles, and, of course, in various airplanes and helicopters both at work and on our own time. We also didn't look at the selling price of any models until we were done with the assessments.

Recognizing that flying companions also need quality sunglasses, we solicited the help of non-pilots. Our flying companions aren't shy in speaking up when sunglasses begin to hurt their temples and ears an hour into a trip.

And then there was the drop test. Inevitably, all sunglasses suffer the dreaded pavement strike during preflight or maintenance.



The samples that didn't get this treatment in the course of normal events got dropped from chest-high onto the ramp. Sparing our budget, all survived and

we consider every model worthy of typical abuse.

We gathered what real-world testimonials we could from active pilots who fly with some of the models we tested. Incidentally, Ray Ban and Serengeti seem to be the most popular brands among the pros.

Any brand worth trying should block UVA and UVB light, and all our test models do. Another concern is shatter-resistant lenses.

While glass lenses are highly scratch resistant, they aren't what you want on your face if they shatter. Polycarb is virtually shatterproof, but not the best optical quality. Several of the custom lens material from Oakley or Vedalo claim they can do both, but we didn't break a bunch of lenses to find out.

When you're looking at tint, know that NASA tests show amber or green lenses that block blue light may improve your ability to see traffic, but may tint colors in your cockpit displays. Make sure you try any sunglasses in your cockpit with your own displays and portable devices. If you're having an issue, a middle ground may be a gray-green lens such as you'll find in Randolph glasses.



a cloud deck without the need for backing them off your eyes. Speaking of backing, aerobatic legend Sean Tucker testifies that the Vedalos are the best he's used.

The rimless Ra Vision's are designed to be adjusted to fit an individual face. The drill is to bend the frames for personal fit and comfort. Ra claims the glasses were designed to be worn with headsets and flight helmets, and we were able to bend them to our liking (mostly). When our heads were loaded down with headsets and a ball cap, the Ra's were almost too flexible, bowing out when we wanted them to be flush with our skull. But they were extremely lightweight and durable. A tad punchy at the end of this review, we tried to snap the titanium frames in half but couldn't do it.

With choices of grey or brown non-polarized lenses, the Ra Vision optics are supposedly optimized for moving-fast, looking at flight instruments and gauges or through a

windshield. Ra lenses are company-specific Trivex. We didn't have any complaints when using the grey lenses and the contoured design offered good side coverage. The styling was also a hit with the females in our test group.

OUR FAVORITES

All of the sunglasses in our trial performed well. Frame style fit and comfort is another story, and we stress that buying from a local retailer or online from someone who will accept returns if they don't fit well is imperative. Our thanks to Sporty's Pilot Shop for doing exactly that with several of the brands we tested. Vedalo offers a 30-day money-back guarantee. Ra Vision offers refund for one year.

Overall, we liked the Oakley M-Frame Hybrid wraps best in nearly every category we tested. They're rugged, sturdy and have high-quality smoked lenses that function flawlessly in nearly every lighting condition

we looked at. If a full wrap design is too aggressive for your style, the Oakley Tight Ropes have lenses that are nearly identical performers but have traditional frames that sacrifice some long-term comfort.

Our testers were also impressed with the VedaloHDs. If enhancing and massaging LCD color avionics displays is high on your list, these lenses are worth trying. We're of two minds on the \$250 price tag. We didn't feel they were exceptionally better than glasses that cost half as much, but if you've just spent \$80,000 on a new glass panel, the difference in cost here is practically a rounding error. And they really do make the LCD displays shine.

For all-purpose models for both cockpit and sporting activities, Mile High wins hands down. In our view, they represent real value with four sets of interchangeable lenses that you'll make use of. In fact, we found them so versatile, we're actually keeping them.



The Century NSD360A was installed on many craft as a bargain HSI. Most units, like this one, weren't even slaved to a remote compass. While finicky to maintain and not cheap to fix, the system is still a bargain when it comes to owning an HSI.

When Analog HSIs Die: Repair May Be Best

Retrofit glass is a tempting solution, but some conventional systems are worth maintaining if bottom-line cost matters more than top-drawer capability.

by Larry Anglisano

Here's the common scenario: An owner plans to finally make the plunge to a glass PFD as soon as the aircraft's Jurassic-age analog heading system finally

quits. Then it does quit and the dream of adding glass to the six-pack shrivels to budget-stressed reality.

Even bottom-line pricing for even entry-level flight display retrofits is far more than it will cost to overhaul or even replace the existing 30-year-old mechanical HSI. While it's likely not how you want to spend upgrade money, in some cases it does make sense to repair the dinosaur or upgrade to newer—but still analog—system.

TWO GOOD HSIS

We think there are two analog HSI systems worthy of keeping, or even installing in the right circumstances: the Century NSD360A and the Bendix/King KCS55A.

The NSD360A is a non-slaved (which means you need to correct for gyro precession as you would a plain-vanilla DG), vacuum-driven and self-contained model that's found in various flavors. The double-edged sword with these is that the low entry cost comes with limited life between overhauls and a complicated design of finicky belts, gears and meter movements. A complete overhaul of this unit from a top-drawer instrument lab is just shy of \$3000.

There's also a slaved version of the instrument that's driven by a magnetic heading flux sensor and slaving amplifier. Unfortunately, that adds the potential for slaving component failure. Doing a partial repair to these instruments is money wasted. A real overhaul is usually what it takes for another couple of years' worth of service.

Bendix/King's once flagship, all-electric KCS55A system is far more failure resistant. But when the system does fail, get ready for an impressive shop bill. That's because there are two high-priced components: the KI525A HSI and KG102A remote electric heading gyro. An overhaul or exchange of either one is several grand. Some earlier KG102A gyros aren't worthy of exchange or overhaul due to parts obsolescence, so your only choice could be a new or salvaged one.

Heading failures aren't always related to component failures, either. The wiring harness for this system is complex and there are numerous junctions and interconnects littered throughout the airframe. That's why installation of this desirable system, even a good used system, is a major project. You can find complete KCS55As for about \$2500 (see sidebar), so getting used parts to replace isn't the issue. But there may be some serious shop time to track down a fault in the wiring.

CHECKLIST



Parts are available for mechanical systems and prices have been driven down by glass panels.



Upgrading to an electronic HSI is easily twice the cost of fixing the existing device, and ...



... working removed parts won't fetch much on the used market if you do upgrade.

The takeaway here is that if you have one of these two systems, repair or replacement is an option that makes sense. No shop in their right mind would attempt doing any kind of billable repair to old Narco models like the DGO series and later HSI100. In our view, these should have been in the rubbish barrel years ago.

PRICE GLASS ANYWAY

No matter what model HSI you have, you owe it to the airplane to at least price the Aspen EFD1000. If you do any kind of IFR flying, don't even consider the entry-level Pilot model from Aspen. Roughly \$7000 gets you into the world of glass, but this display doesn't have an electronic CDI presentation. It does overlay GPS course data on top of a digital directional display but there's no glideslope, flags or autopilot interface. We know a Mooney owner who chose the Pilot model and just months out of the shop has buyer's remorse. Upgrade is possible but expensive.

A complete single-screen Aspen Pro PFD project can better \$14,000, depending on the interface and aircraft. We've always viewed this as a solid value given the huge leap in capability and relative ease of installation. But it's still a big job that's double the cost of repairing a KCS55A or NSD360A.

Upping the ante is Garmin's G500/600 retrofit PFD/MFD. This means serious amounts of panel modification/replacement to make that big screen fit and more remote boxes. Garmin's G500 is a lower-end version of the G600, with functions like Synthetic Vision, charts and autopilot gyro emulator as à la carte options. A typical G500 install might be double the price of an Aspen EFD1000 Pro.

STANDALONE E-HSI OPTIONS

Before you give up on glass, consider going halfway there with a standalone Electronic HSI (EHSI).

EHSIs aren't really standalone because they still need a heading system. This can be an easy install or a budget-buster. The Honeywell KI825 ESHI can drop into an existing KCS55A installation, replacing the KI525A and using the existing remote KG102A gyro and magnetic flux gate. The KI825 has a rugged

PSST ... WANT A USED KCS55A?

Aspen's EFD1000 retrofit PFD has been an industry changer on many fronts. Part of that includes stealing the pole position for the most desirable HSI upgrade/replacement on the market. For years the Bendix/King KCS55A was front and center setting the benchmark for which all other systems were measured.

With the huge success of the Aspen, the used market has become saturated with removed KCS55As that are getting tossed on the surplus equipment shelves. Hunt the pages of eBay, Controller or used avionics wholesale houses and you'll find plenty of removed KCS55As for \$2000-3000, sometimes less if they have an "as removed, as is" status.

But that's where the bargain ends. Install costs could double the cost of the used pieces. There's the KI525A HSI instrument, the KG102A remote gyro, the KMT112 magnetic flux sensor and the KA51 slaving control/meter which mounts on the instrument panel. There's serious disassembly required to install all these components in most aircraft and install prices reflect this. Does this game make sense? We think so. The system has proven itself rugged and reliable. If you can score a later-model system with the important service mods and higher serial numbers (mainly for the gyro) it will likely serve you well. Just be ready for pricey trips to the shop when the components break.

If you have a standalone IFR GPS and nav/com, you'll need a switching relay and mode annunciator panel to properly display and share the navigational data on the HSI. Sometimes you get lucky and the removed system has this already, but it must match the GPS in your airplane. Used relays and annunciators run for around \$600.

Support for the KCS55A is guaranteed and plentiful. While some repairs can be made to these systems on the shop level, many will require a trip to Honeywell in Olathe, Kansas, for service. That's \$275 minimum to evaluate the unit, with average repair costs being \$3876 for the KG102A HSI and \$1672 for the KI524A gyro. That said, we've been impressed at the high level of support from Honeywell. Turnaround times aren't bad and shop interaction is positive with seemingly skilled techs.

If your plans include a PFD upgrade and the aircraft has a working KCS55A you won't need anymore, we think it's worth keeping as a secondary system. It makes a fine system for a right seater and for backing up the glass. Besides, it's likely worth more to the aircraft than to your shop on trade in.





Two tempting options that we'd avoid. While the Aspen system model is our top pick to upgrade from a mechanical HSI, the entry-level Pilot model (top left) lacks even a CDI needle. Go for the Pro model. The Honeywell KI825 (bottom left) has a checkered record for reliability.



that wasn't rugged enough. The 3305 has a projection lamp replacement interval which isn't a big deal, except removing the unit from the aircraft to saddle up to the repair bench opens a can of worms. This disturbs those finicky connectors that can make an otherwise functional system nearly useless.

The SN3500 is far more rugged and capable. It has an impressive reversionary attitude function that's driven by that solid-state AHARS. A remote AHARS is connected to a panel-mounted switch that toggles between EHSI and attitude while retaining the heading display. This is an excellent way to back up a failed primary horizon gyro or for full-time display. A new installation should be compared closely with an Aspen, which, admittedly, does far more.

The SN3500 would be a better option if it was more price competitive. The unit is \$11,419,

with an extra \$980 for reversionary attitude system, and \$4495 for the AHARS that drives it. That puts the system at almost \$17,000 without the install costs. So it could be right if you

feel, easy feature-set and good display. If only it was reliable.

We've heard from a handful of KI825 owners who constantly battle failures of these units. Repair is pricey and awkward, and one operator stocks several spares on the shelf because failure, he says, is guaranteed.

Sandel SN-series EHSIs are a better bet, and can also utilize the KCS55A gyro and flux gate. We would avoid the first-gen SN3305. It had growing pains and install hardware

The Sandel SN3500 is a terrific unit, with an option to function as backup attitude, but installed costs can rival the more capable and complete Aspen install.

just needed to replace the HSI portion of a KCS55A, but we think the Aspen is a better value overall.

"MINOR" FIXES

An important point to remember with any mechanical HSI system is that regular maintenance is required. But that isn't always a big deal, nor does it mean that a major component of your HSI system is toast. It could just be a calibration problem.

Maybe you've grown accustomed to compensating for that 10-degrees worth of error or the classic fist pound on the instrument panel to make the glideslope needle come into view on an approach. The good news is that minor issues like these can be addressed without shot-gunning major components. Consider the heading alignment procedure for the KCS55A. Essentially, this is a



glorified compass swing but requires specialized skills and equipment. First, there's the remote flux valve that's adjusted to remove large amounts of heading error. Then, fine tuning of the panel-mounted slaving meter to tweak out small amounts of remaining heading error. Similar procedures are required of a slaved NSD360A system.

It's not uncommon for heading error to show its head after annual inspection or other maintenance where the flux might have been disturbed. If this is the case, get ready for some shop time to get the system back within specs.

CONCLUSION

Given the age of the average HSI system, we think it's a smart idea to plan for repair or upgrade in the maintenance budget. The system will fail at some point and even the cheapest fix will run several grand.

The success of the Aspen Pro model speaks for itself. It seamlessly displays full-stack navigational data on a single screen, and is an easy step into glass and GPSS steering for your autopilot. However, budget nearly always drives the decision and we think investing \$6000-7000 on a well-maintained Bendix/King KCS55A install is a viable option.

Going glass instead of staying analog has one extra advantage: It may nip buyer remorse in the bud, which is what you might have when you reluctantly spend money on old, yet proven reliable, technology.

Larry Anglisano is Aviation Consumer's avionics editor.

CONTACTS

Aspen Avionics
www.aspenavionics.com
888-992-7736

Bendix-King by Honeywell
www.bendixking.com
877-712-2386

Sandel Avionics
www.sandel.com
760-727-4900

Spot or Spider?

(continued from page 6)

landing. The Spider has an external keypad, but it's for extended functions related to alerts, monitoring and pre-programmed text messages, not discrete messages on the fly. Although it wasn't available when we tested the Spider, the company does plan to offer a text messaging system which would connect the unit to a smartphone through Bluetooth.

WEB SITES

Managing tracking and alerts for both devices is done through dedicated Web sites. We found that both sites were generally logical and easy to use, but we had some trouble initially registering to the Spot due to a phone number format not explained on the site. It took a call to customer service to get that sorted out.

Similarly, the Spidertracks site was not yet fully functional when we tried the unit, although it was straightforward enough to get the device operating and to see its tracking results on the Google maps the system uses. The instruction sheet with the Spider is somewhat confusing and it took a call to the company to sort out some questions. Here, Spot is better because it has a U.S.-based support line and also a series of short technical videos explaining the product's principle features.

COMPARING THEM

The graphic on page 6 shows how the two compared on a couple of short test flights. As you can see, they are somewhat comparable, however, given its more frequent position reporting, the Spider paints a much more detailed picture of the aircraft's track, offering more data than the Spot does.

Moreover, the Spot proved, well, spotty at times. It would seem to track well, then skip a few beats, and pick it up again. It appears to be quite sensitive to the antenna's view of the sky. We had it attached to a downtube in Cub and vibration caused it point inside the aircraft rather than outward toward the windshield. This caused it to stop tracking. As for the Web interface and notifications to your contact

list, again, the two are functionally comparable. We found that the primary messages went to our designated list as they were supposed to and anyone we thought remotely interested in the peripatetic albeit short-range wanderings of a J-3 Cub could log in and find out more than they ever wanted to know.

Purchase and operating cost is the major point of departure here. At nearly \$1000, the Spider is more expensive by a factor of about six. Its complex, multi-tiered data plan based on the Iridium system does give you some flexibility in what you pay. For example, let's say you use the Spider eight hours a month. The basic fee—called the Regular Flyer—is \$15 a month, plus \$4.50 an hour for every hour you go over that. All but the most basic plans require a one-year contract, so figure \$180 a year.

Spot's basic plan is \$99.99 a year or \$199.98 for two years. (Whatever happened to the volume discount?)

If you add the track progress feature, it's another \$49.99 a year and the GEOS insurance (\$12.95), you're up to about \$160 a year—\$20 cheaper than Spider.

So what's the value equation here? Here it is, in our view: With its two-minute report rate, in a 150-knot airplane, the Spider's maximum circle of probability is 5 miles, which is how far you'll fly between reports. With the Spot, on the other hand, it could be as much as 25 miles, but it could be a lot more if it misses a report or two. It could also be less, depending on when your imaginary crash occurs.

The Spider gives the advantage of a more complete position report. On the other hand, it costs a lot more and you can't take it hiking or fishing with you, unless you're fishing from a boat with an electrical system.

Given these factors, we think the two are close to being comparable values. The Spot isn't as robust, but it costs a lot less and you can use it as a multi-purpose sports/recreation backup plan, in addition to being an aircraft safety enhancer. If all your outdoor activities are limited to the cockpit of a fast airplane and you're obsessive about having razor-sharp SAR tracking, the Spider is the better choice.

How the Jet Guys Did It (A New Fuel, That Is)

While developers of 100LL replacements struggle to find interest, the alternative jet fuel market sailed through its approvals. Here's why.



Money talks, goes the standard street wisdom, and [expletive of choice] walks. That more than anything describes the state of play when comparing the alternative jet fuel industry to the rather more stalled effort to find an unleaded replacement for 100LL.

This should be no surprise. Thanks to serious industry support from the military, turbine engine manufacturers, the airlines and even the FAA, the alternative jet fuel industry is on a virtual gallop to have in place the regulatory approval standards to allow use of bio-derived or synthetic jet fuels by next year or at least 2012. The economics remain untested so far, but the regulatory hurdles haven't proven as difficult or at least as time-consuming as they have for finding a 100LL replacement. Is there a lesson here?

BIG MONEY

Two forces are pushing the alternative jet fuel market—petroleum price volatility and related worries about peak oil and concern about emissions, mostly carbon dioxide.

National security concerns—an always-reliable means of priming the money pump—are a third factor, thus the U.S. Air Force's interest in alternative fuels has lent a credibility and urgency to the project that has no current equivalent on the aviation gasoline side.

Further, the Energy Independence and Security Act of 2007 requires

Two forces are pushing alternative jet fuels: price volatility and worry about carbon emissions.

federal agencies to buy only fuel that has equivalent or lower life cycle carbon emissions as current petroleum fuels. The Air Force is hoping bio-based or synthetic fuels will help with that and the airlines are equally concerned about carbon footprints.

To make all this happen—which it has with remarkable speed—the industry formed the Commercial Aviation Alternative Fuels Initiative (CAAFI), a working group consisting of FAA staff and representatives from the engine and commercial aircraft manufacturers, with help from

the budding alternative fuels segment. On the avgas side, the rough equivalent of this is the Coordinating Research Council, a non-profit council composed of petroleum and automotive technical representatives. The CRC has had a standing committee examining avgas replacements for years, but it hasn't produced much of substance. Its recent report was largely a summary of past findings and a restatement of the challenge.

Neither CRC nor CAAFI are actually responsible for developing fuels, but rather greasing the skids to get consensus specifications developed and approved so industry can attract capital to produce the fuels.

However, there are key differences between these two groups. CAAFI has the imprimatur of existing legislation, a strong push from monied defense interests and high horsepower influence of companies like Pratt & Whitney, GE, American Airlines and Boeing, whose lunch accounts exceed the entire R&D budgets of Lycoming and Continental combined. It's not that these companies contribute funds directly, but in kind, through staff time and resources. The

airlines alone represent a powerful interest block, says Rich Altman, CAAFI's executive director.

CRC, on the other hand, has worked uncertainly against no stated date or regulatory hardpoint for the elimination of lead in avgas. Efforts to eliminate lead have been on-again, off-again, so there's simply been no urgency. Although some military drones use avgas, compared to jet fuel, there's little military interest in it and in contrast to jet fuel, the piston engine bio- and alternative fuels market is a flyspeck. CAAFI lists some 37 companies in the alternative jet fuel market and the field is relatively rich with research dollars.

On the avgas side, only Swift Enterprises has a high profile project, but at least one other company is exploring the field. Given that aircraft piston fuel demand is in decline, attracting investors will be a challenge.

RESULTS

And what has CAAFI's high-profile work accomplished? A lot, actually. Although it formed only in 2006, CAAFI has overseen the development of a new jet fuel spec, ASTM D7566, which approves jet fuels derived from synthetically processed hydrocarbons. Still on the table before ASTM is an annex to this specification for fuel made from bio sources such as cellulosic plant matter—so-called hydrotreated renewable jet fuel or HRJ. But CAAFI expects that approval sometime in 2011, which will remove any serious regulatory barriers to using alternative jet fuel.

And this isn't just a lab experiment, either. The turbine world has ambitious plans for alternative jet fuels. By 2017, the Air Force would like to have half of its jet fuel derived from synthetic or bio sources. Some of this may be HRJ, which a number of companies are pursuing. But synthetic paraffinic kerosene (SPK) refined through the Fischer-Tropsch process the German military used during World War II is also a possibility. The Air Force is well along with extensive testing in this arena.

None of these processes are ready to be fielded on an industrial scale yet, but CAAFI's Altman told us that once the ASTM approvals are in place, they may become economically practical more rapidly than many people realize.

On the HRJ side, says Altman, the economics are determined almost entirely by cost of the biomass feedstock—harvesting it and delivering it for processing.

Two business models have been proposed: One would consist of standalone refineries dedicated to biofuel production similar to the ethanol economy; the other would comprise "bolt-on" additions to conventional petroleum refineries in which the synthetic output would be just another refinery stream for blending.

For the scales envisioned to meet the Air Force's ambitious goals, Altman thinks both government seed money and large investment by the private sector will be needed to get HRJ and syn fuels launched. But before that can happen, the ASTM approvals have to be in place.

If this sounds like a familiar refrain, it ought to. On the avgas side, the very same struggle is underway to develop a 100LL drop-in replacement. The fact that CAAFI's success was driven in part by an airline industry saying in unison, "we want this stuff" hasn't been lost on Lycoming's Michael Kraft. He's been arguing for a year that no one will invest in bringing a replacement avgas to market until and unless there's a clear, unambiguous demand for it. For jet fuel, the airlines (and the military) did that, but piston GA is still arguing about octane. The two apparent leading contenders for replacing avgas—Swift Fuel and General Aviation Modification Inc.'s G100UL are now before the ASTM for consideration.

Altman concedes that the ASTM process is time consuming and can be tricky, requiring unanimous consensus for everything. Conflict of interest is always a possibility because ASTM committees are often composed of technical people from companies who are asked to approve products that might be competitive with their own. That was true for the jet fuel specs, but Altman says the airlines had enough clout to force



Biomass derived from algae, top photo, may prove an economic source for HRJ fuels. Camelinea, a non-food crop, lower photo, is another source.

ASTM to confine objections to the purely technical, not the potentially competitive, which is what it's supposed to do.

But ultimately, demand more than anything else, says Altman, made the jet fuel specs happen quickly if not painlessly. "You have to have a strong, focused buyers group willing to act together," he says. "The airlines have done a terrific job of that. It's something you wouldn't have expected, but they've made a very determined play and it made a huge difference."

Maybe if consumers of avgas for piston engines do the same, we'll see similar results.

Robinson R22

A helicopter that's fun to fly and economical, yet can earn its keep as a workhorse.



Dateline 1991: The aircraft economic climate was stronger than in the current world, and Frank Robinson's tiny two-place piston helicopter outsold every manufacturer of general aviation aircraft in the U.S.

That's impressive since fixed-wing operations outnumber rotor ops at most GA airports. Helicopters can easily clobber the average operating budget and have limited mission profiles. They aren't exactly simple to pilot, either. But the R22 is more than an entry-level and lower-cost machine. It's versatile and up for the challenge to support numerous mission profiles including airborne law enforcement, aerial photography and personal travel missions.

The pint-sized machine found a huge market because it did what no other helicopter could do: it offered a relatively cheap means of getting into the world of rotors. It has enough performance to serve personal and commercial applications

at acquisition and operating costs that beat anything the turbine chopper market can offer. To date, more than 3600 R22s have been delivered to more than 60 countries. In the personal helicopter market, this is saying something.

EVOLUTION OF THE ROBBIE

Observing a keep-it-simple dictum since the first Robinson rolled off the assembly line at the Torrance, California, plant in 1979, the company has hewed to basics, making only incremental improvements and refinements and no drastic model changes. The first R22s had 150-HP Lycoming engines de-rated to 124 HP. When it was introduced, the Robinson engine and airframe had a phenomenal TBO of 2000 hours. That has since been inched to 2200 hours, but there's a catch to this which you'll see in a moment.

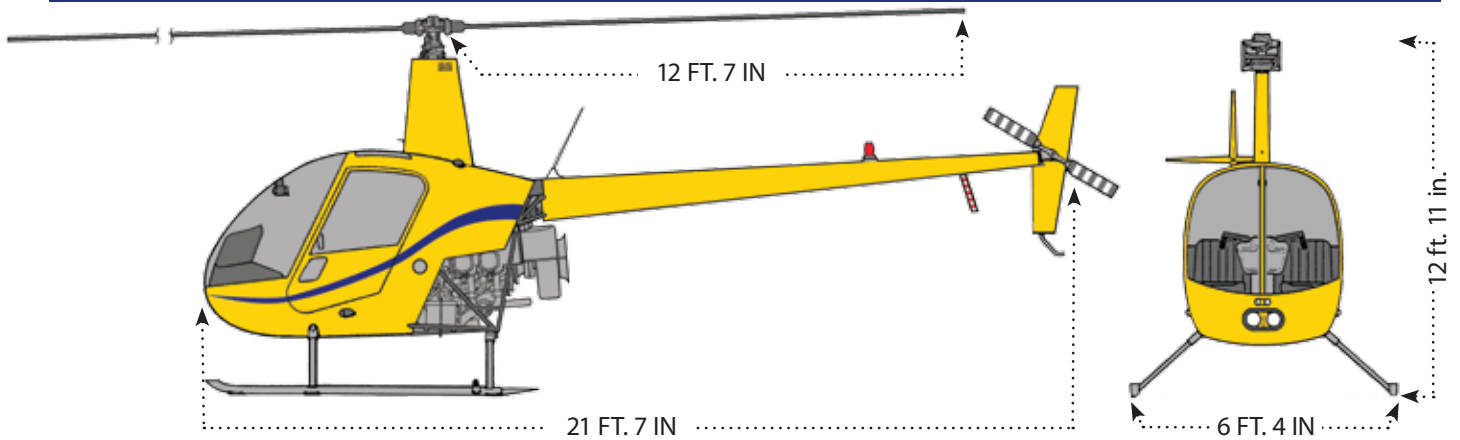
The HP model came along in 1981 with a 160-HP, B2C engine. Although the powerplant was still

de-rated to 124 HP, the pilot could pull the extra power at any time, since there are no artificial stops. And the extra throttle would provide a minimal cushion in high-density altitude situations.

In 1983, the factory pumped out the Alpha instrument trainer, with the gross weight boosted from 1300 to 1370 pounds to lug around all the extra instruments and avionics. It's not uncommon to find Bendix/King KCS55A HSI systems and GNS430W WAAS navigator upgrades in these instrument trainers. At the same time, changes were made in the structure and control system to widen the CG range. The battery was moved from the nose to the engine compartment and the aft main strut was lengthened to give extra clearance for the tail rotor.

In 1985, the Beta model upped the ante in horsepower from 124 HP to 131 HP. And a year later, an amphibious Mariner model was brought out with fixed floats that are attached

ROBINSON R22

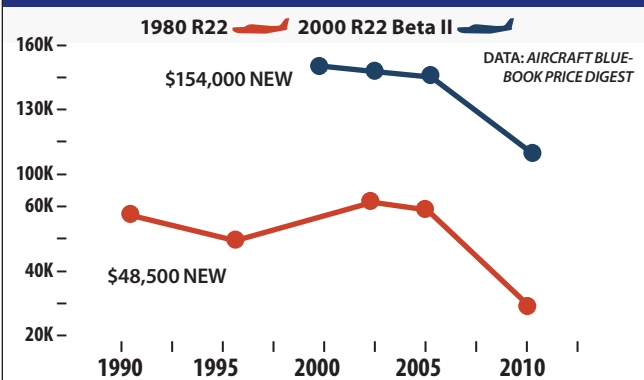


SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL*	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1979 ROBINSON R22	LYC O-320-A2B (124 HP)	2200	\$20,000	19	504 LBS	94 KTS	\$30,000
1981 ROBINSON R22 HP	LYC O-320-B2C (124+ HP)	2200	\$20,000	19	486 LBS	96 KTS	\$36,000
1983 ROBINSON R22 ALPHA	LYC O-320-B2C (124+ HP)	2200	\$20,000	19	546 LBS	96 KTS	\$43,000
1985 ROBINSON R22 BETA	LYC O-320-B2C (124+ HP)	2200	\$20,000	19	546 LBS	96 KTS	\$50,000
1986 ROBINSON R22 MARINER	LYC O-320-B2C (124+ HP)	2200	\$20,000	19	506 LBS	89 KTS	\$57,000
1997 ROBINSON R22 BETA II	LYC O-360-J2A (131 HP)	2200	\$19,000	19	515 LBS	96 KTS	\$100,000
2005 ROBINSON R22 BETA II	LYC O-360-J2A (131 HP)	2200	\$19,000	19	515 LBS	96 KTS	\$140,000

* ENGINE OVERHAUL ONLY

RESALE VALUES



SELECT RECENT ADS

- AD 2007-26-12** BLADE INSPECTION
- AD 2004-19-09** ROTOR REPLACEMENT
- AD 2003-04-04** TAIL ROTOR CONTROL ASSEMBLY
- AD 2000-20-51** YOKE ASSEMBLY
- AD 99-07-17** SPRAG CLUTCH
- AD 99-02-02** FLEX PLATES

SELECT MODEL COMPARISONS

PAYLOAD/FULL FUEL

'98 R22 BETA II	~550
'84 R22 ALPHA	~500
'98 ENSTROM F28F	~700
'81 ENSTROM F28C	~700
'98 SCHWEIZER 300C-269C	~850

CRUISE SPEEDS

'98 R22 BETA II	~85
'84 R22 ALPHA	~85
'98 ENSTROM F28F	~95
'81 ENSTROM F28C	~95
'98 SCHWEIZER 300C-269C	~95

PRICE COMPARISONS

'98 R22 BETA II	(\$105,000)
'84 R22 ALPHA	(\$45,000)
'98 ENSTROM F28F	(\$194,000)
'81 ENSTROM F28C	(\$88,000)
'98 SCHWEIZER 300C-269C	(\$145,000)

to a special skid gear. The entire arrangement can be removed and replaced with the standard skids. The floats aren't the instantly inflatable variety found on other helicopters.

PERFORMANCE, HANDLING

There are no hydraulics in the R22 to dampen sloppy control inputs, so it's easy to get squirrely if you get out of the bubble. The R22 will bust any ego that has only experienced stabilized, turbine rotorcraft. You'll need a delicate touch on the controls, which is the case with most small copters. It's safe to say that if you aren't always actively flying the R22, soon you won't be flying at all.

The R22 is not fast but as helicopters go, but it's no slouch for its power. Max cruise is listed at 102 knots and usual operations in station to station cruise put the needle around 95 knots. Offerings from Schweizer and Enstrom struggle to catch the R22. An experienced instructor told us students usually fly the Robbie around 80 knots. But the speed is there for the taking.

In maximum hovering altitude out of ground effect, the R22 again comes through with respectable numbers. For the R22 Beta, HOGE is 5200 feet, compared with only 2750 feet for the Schweizer 300C. The Enstrom F28F outshines the R22 in this category, however, with a HOGE of 8700 feet. The R22 Beta II model has a max hovering in ground effect altitude of 9400 feet, however.



The rotor blades are a low-inertia design, which means decaying rotor speed can quickly whack an inattentive pilot between the eyes. In the early days of the R22, this was mentioned as the probable cause of airframe breakups as the main rotor blades, in slowing down, struck the airframe. It is also generally cited as making for a more "dramatic" critically timed flare at the bottom of an autorotation. Early on in R22 training, instructors stress the importance of quickly lowering the collective—you have less than two seconds—in a real-deal or simulated loss of engine power. This reaction is also critical in hovering autorotations.

But with bad habits comes good. For example, the mechanical throttle/collective coordination of the R22 is remarkably good at matching engine RPM output to collective movements. Robinson has the ergonomics down, which includes an easy-to-interpret rotor/engine tach gauge. On top of this, Robinson has made standard an electronic throttle governor to hold a constant RPM as the collective is moved up and down. This is something every pilot who has flown turbine helicopters desires, because the nagging concern about maintaining rotor RPM throughout various maneuvers is largely eliminated with the automatic throttle response.

A few training operations we spoke with take the same attitude toward training on the R22 as the factory has aggressively pushed. Robinson is outspoken in addressing any design-related safety issues with a training program that should serve as a model for the industry. The thread is simple: When you pilot an R22 your training has

To the unfamiliar, watching an R22 during autorotation training is like watching someone practice crashing. The descent is steep and the pull-up happens at what looks like the last possible moment.

you understanding and recognizing the machine's limitations and manners. This training campaign seems to have lowered the accident rate. Still, the R22, or any helicopter for that matter, is no place for the uninformed. Nobody has demonstrated an autorotation from higher than 10 feet and slower than 45 knots that hasn't broken metal in the R22.

CREATURE COMFORTS

The one odd and seemingly little-league control arrangement on the Robinson is a teetering handlebar or T-Bar cyclic control. This is mounted on a single control column that feeds up through the floor at the base of the instrument pedestal. When the student has one handle and is resting his hand on his leg for stability, the other handle is teetered rather high for the instructor, who should be ready to take over at any given time. The accident reports are full of days where instructors should have had more caffeine before going flying with newbie students.

The cabin of the R22 requires headsets, but isn't as noisy as you might expect. It's on par with a Cherokee or Skyhawk. You can almost get away with a voice-activated intercom in an R22 (which isn't the case in many helicopters). Of course, there's also the added vibration from all those spinning parts that adds a bit of drama to the environment. For brand new pilots, eyeing those blades as they whirl by the bubble windshield is at first disconcerting. Welcome to the world of helicopters.

The instrument panel in an R22 doesn't get more basic. In most ships, the flight instruments include airspeed, vertical speed, altimeter, engine/rotor tachometer and manifold pressure. Engine instruments include oil pressure and temperature and cylinder head temperature. The cluster is nicely arranged and everything is somewhat easy to access for maintenance. The avionics stack is fairly stark, as these are fair-weather helicopters.

But avionics upgrades are definitely doable. The Robbie has a 14-volt electrical system that can handle a decent suite of electronics. Vibrating airframes tend to eat gyro instruments, and since these instruments are electrically-driven, they are high-price items.

Low operating costs earned the R22 a place in aerial photography, wildlife patrol and other similar roles.

By no means is the R22 intended for rotoring into IMC. You can load all the latest and greatest avionics in but this is a VFR-only machine. Still, it's extremely economical for earning and instrument rating and many flight schools capitalize. It's also well-thought-out for the pilot flying. Robinson has thoughtfully put frequency memory and active/standby switches on the pilot's side cyclic so you don't have to reach for the radio. It adds a big helicopter touch.

NO BIG PILOTS OR HIGH OPS
 Passenger and baggage capacity with a full 30 gallons of fuel is about 310 pounds in a typical modern R22 Beta II. Baggage—and we use that term lightly—is stowed underneath the seats. Plan to travel lightly in these helicopters.



The R22 can be a bit awkward to get in and out of, but it's a comfortable dwelling once you're settled. Crushable seats absorb much of the energy in a crash, which is why you want to be careful in what you store underneath them.

More than one flight school told

us they've added the larger and competitor Schweizer models to their flight lines because the R22 isn't always up to the task when loaded to the max. One instructor's rule of thumb is 240/160, which means a heavyweight in one seat only leaves room for a lightweight in the other.

ACCIDENT SCAN, OR "WHY HELO INSTRUCTORS SEEM SO JUMPY."

There must be a quick fill option at the NTSB for R22 accident reports that types, "The certified flight instructor (CFI) and student pilot undergoing instruction were conducting 180-degree autorotations in a helicopter ..."

Of the accidents we reviewed for this report, 53 percent occurred during training. This isn't a big surprise given the R22's place as the helicopter trainer of choice. What was a surprise was that 55 percent of all the accidents were some kind of loss of control, 35 percent were loss of control that either bent metal (usually the rotorcraft phenomena of dynamic rollover or landing while moving sideways or spinning) and 20 percent were from hard landings. Here's the real kicker, though: Of the 20 percent that were hard landings, *all* of them occurred during instruction. The vast majority of these accidents left the occupants with no or minor injuries.



Photo by Craig Murray

ACCIDENT SUMMARY

35%	GENERAL LOC (35%)
20%	HARD LANDING (20%)
18%	MECHANICAL (18%)
14%	CFIT/COLLISION (14%)
4%	PILOTLESS FLIGHT (4%)
3%	UNKNOWN (3%)
3%	CARB ICE (3%)
2%	MISC PILOT ERROR (2%)
1%	HIGH DEN ALT (1%)

The R22 earned a reputation for accidents that culminated in a Special FAR (SFAR 73) requiring training to fly and instruct in these machines (as well as the R44). That rule was reviewed and

re-extended in 2009 to become SFAR 93-2. In its review, the FAA noted that the combined accident rate of the R22 and R44 was now slightly lower than the average for similar helicopters, which it attributed to the training. But it also noted the R22's rate alone was slightly higher. A reputable flight school should provide training compliant with the SFAR. Robinson itself offers a 3½-day course for \$400.

Mechanical problems and collisions with terrain, obstacles and parked aircraft earned third and fourth places, not surprising as the helicopter is a complex machine usually flying in close proximity to the ground. An interesting four percent involved pilots getting out of running aircraft only to have them attempt to fly away, with even less success than the autorotation practices.



The T-bar controls take some getting used to, especially for instructors. Com swap buttons help with the running-out-of-hands problem common in copters. Storage is under the seats, so don't expect much.

Look real hard at the loading weight and temperature when planning run-ons in confined areas. The wreck reports reveal a fair number of R22 missions gone badly at high density altitudes. The Robbie's normally-aspirated Lycoming runs out of steam as the air gets thinner. The rule is to not attempt takeoffs unless you can hover.

OPERATING COSTS

Pilots and operators who responded to our call for feedback almost universally reported the R22 as a reliable and relatively trouble-free machine. As in previous studies, most owners said it was less of a burden than with any other helicopter in their experience, and some readers own both airplanes and the R22. On top of that, the factory is often praised with excelling in customer service and part support.

To say that parts are easily available is not to say they are cheap, any more than with any helicopter. The estimated maintenance cost tally

from \$6 to \$12 an hour, not counting reserve for overhaul. A look at the factory's numbers on the R22 Beta II offers a general summary of what it takes to operate this machine: Insurance for a 200 hours logged helicopter pilot with a clean record is \$8050 per year. Direct operating costs including fuel for \$4.50 low-lead and eight gallons per hour average (8-11 gallons per hour is more realistic), periodic inspections, unscheduled maintenance, parts and labor totals a \$49.98 per hour. Add \$50.98 per hour in anticipation for the big overhaul and you end up with a total operating cost of \$117.06 per hour.

Since helicopters fly low and relatively slow, it's worth comparing the costs per road mile. If one air mile equals one and one half road miles using 110 MPH burning 9.5 gallons per hour, the R22 would cost 75 cents per road mile. The factory skillfully likens this number to operating an expensive automobile. And arriving in your own helicopter is far sexier than arrival in a car.

One experienced owner who uses an R22 for photo missions told us he

counts on paying out roughly twice as much to maintain an R22 as a Cessna 172 he used to use. Still, using that \$117 per hour factory number and it's in the same ballpark as, say, a high-performance fixed wing. Another aerial photographer loves the R22 for its cost. He told us it does nearly everything he needs it to do, if a bit small. Try leasing a Jet Ranger for under \$400 per hour.

AD, SDRS

When we first reviewed the R22, we found that the biggest number of apparent glitches involved worn or failed tail rotor pitch link and teeter hinge bearings, with a dozen instances reported. If that's still a problem, we haven't seen any evidence of it in the Service Difficulty Reports (SDRs). A more recent AD may also be the most onerous. Emergency AD 2004-06-52 requires track and balancing of the main rotors within 10 flight hours if they're older than five years or have 1000 hours time in service. The blades must be replaced if an abnormal increase in vibration occurs within five hours of

the track-and-balance. The AD also requires immediate replacement of certain blades, whose part numbers are given in the AD.

Other ADs of note include 2000-20-51, which requires inspection for yoke cracking; AD 99-07-17 which calls for inspection/replacement of the sprag clutch; AD 99-02-02, requiring inspection and/or replacement of the flexplate; AD 98-21-09 for fuel tank vent check; AD 97-25-05 for carburetor and carb temp gauge replacement and 97-02-14, which requires an improved throttle governor, superseding and supplementing a previous AD on the subject.

A sweep of a couple of years' worth of service difficulty reports revealed no patterns of concern and few issues worth remarking about. There were a couple of incidents involving loose or defective drive belts and comments on sprag clutches. But, as owners insist, the R22 is not a difficult-to-maintain aircraft.

THE BIG OVERHAUL

One unusual aspect of maintaining the R22 involves planning for a complete overhaul of engine, airframe and rotors at 2200 hours or 12 years, whichever comes first. The base price of this overhaul, including the engine, is \$134,000 as of this writing. Naturally, this major overhaul has owners eyeballing the cost of a replacement ship. A new R22 Beta II has a starting price of \$257,000 including basic avionics

and cabin heater. Low-time used machines can be had for around \$150,000.

The factory lists reserve pricing for the big overhaul at \$50.98 per hour. The 2200-hour engine overhaul is \$26,400 and the aircraft overhaul is \$70,000 with 225 man hours of labor at \$70 per hour. When the R22 comes out of this factory overhaul, it is a completely reconditioned machine. Since key components like the main rotor blades have 2200-hour lifetimes, they are replaced. The Lycoming powerplant has a 2200-hour recommended TBO, so Robinson provides an overhauled replacement engine. The interior is replaced, too, and the rotorcraft gets a new paint job. Robinson does both the airframe and engine overhaul, having established an engine overhaul shop at Torrance.

Owners must, however, figure on flying or shipping the R22 to and from Torrance and that's a cost owners gripe about, wishing there were other factory overhaul facilities around the country. For East Coast operators, Northeast Helicopters in Ellington, Connecticut, has been operating a fleet of R22s for years, and has performed enough total overhauls on their and customer ships to be considered as good as the factory, in our view. They're also an extreme-

The R22 has a bit of niche as a toy for the well-heeled. It can't carry much, but it can add air access to places no fixed-wing aircraft could touch.



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ly structured helicopter flight school. Notable West Coast facilities include Civic Helicopters in Carlsbad, California. Of course, you can go to the factory and deal with six to eight

weeks for a factory overhaul. There are about 200 service centers around the world, with over 100 in the U.S.

MODIFICATIONS

Aerial photography really requires a photo door. Tech-Tool Plastics in Texas makes one (www.tech-tool.com). The door is under \$3000 and has a full-view plastic assembly with a vertical sliding window for camera-pointing. Tech-Tool also sells replacement glass for R22.

For making the R22 a heavy lifter, Onboard Systems (www.onboardsystems.com) offers the Talon series certified cargo hook that can lift 400-pound loads. It's designed for easy installation and the total kit only weighs around five pounds.

Simplex Manufacturing (www.simplexmfg.com) makes the Helipod external luggage pod. There's also a similar product for agricultural spraying missions. An autogas STC for the R22 can be purchased from Solatec Corp (www.solatec-corp.com) in New Hampshire.

The owners' group for Robinsons is at www.robinsonhelicopter.org.

OWNER FEEDBACK

I am still the proud owner of R22, Beta II N222JA that I purchased new

in March of 2000. The aircraft is now approaching 1200 hours total time, and it still runs and looks like new.

As a 22,000-hour professional pilot, I enjoy the fact that the thing keeps on working. There are oil changes, spark plugs every couple of years, the 300-hour valve reaming per SB388, exchange the magnetos every 500 hours or four years, the almost rare track-and-balance work, and, of course, annual inspections. The only major issue was when Robinson required all the rotor blades in the field to be upgraded from the original -2 blades to the newer -4 Stainless Steel blades. They sold everyone the new blades for \$4995, instead of the retail price of just over \$20,000, if you responded within the one-year timeframe, and with freight, labor to install and track, I spent a little over \$6500, for the only major maintenance issue in just over a decade of ownership.

Most people say the R22 is one of the most difficult helicopters to fly, because of its sensitivity, low rotor inertia, and some other quirks that are addressed in the SFAR 73 requirements, with which pilots of this bird and the R44 must comply. My opinion is this helicopter is as safe, or even safer, than other machines out there, when properly flown and respected.

I operated this aircraft for over three years, in Denver, Colorado, and encountered no problems in the high-altitude regime. I found it will operate at max gross weight at 9500-foot density altitudes, if flown smoothly and carefully. That to me is an impressive and desirable feature, for what I guess could be called an entry-level machine in the world of helicopters.

My aircraft has every option that Robinson offered in 2000, and my only complaint is the factory-installed attitude indicator option still doesn't function properly even after two overhauls. I would probably leave that one off the list on my

The current panel (top) is more compact and organized than earlier versions (bottom). Many have IFR instruments for training, but the R22 is VFR only. With a view like that, who'd want to go IMC?



Photo by North-Andover Flight Academy

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next bird, to save a little weight and maintenance. Keep in mind, R22s and R44s are not allowed flight in instrument conditions, even though the IFR trainer equipped models can be used to certify a pilot for an instrument ticket.

Factory prices on the R22 have close to doubled since my purchase in March 2000, so I find it better to keep this machine, instead of trading for a newer one. I am facing the 12-year overhaul in about 18 months, and estimate around \$100,000 for a field overhaul, to comply with this requirement, and reset the 12-year/2200-hour clock back to the beginning, on what will likely be a 1400-hour machine at that time.

My insurance has gotten down to around \$4800 annually. When I added my son, they rated him as a student pilot the first year, which upped my annual premium closer to \$8700, for good coverage. Next year I am told the premium will be reduced greatly now that he has a rotorcraft ticket.

After flying more than 50 kinds of aircraft in my flying career, the R22 is definitely at the top of my favorite list.

Jeff Abrams
Ocala, Florida

I have been flying R22s for the last 18 years. For the past 13 years, I have specialized in taking up aerial photographers with my R22 Mariner. I find it to be an excellent platform for photographers and they like it because it is cheaper to rent than other helicopters, and faster than helicopters of comparable size. It is responsive and agile. It does command constant attention to wind speeds and direction, and one must be aware that it has a low inertia rotor system. Things can happen fast with the R22. I compare flying the Robbie to driving a small sports car instead of a full-size car or truck.

Maintenance on the helicopter is easy. As helicopters go, it is inexpensive to operate. Having 2200 hours between overhauls is a plus. I have over 6000 hours and two overhauls on my aircraft with no problems. I find it a reliable, honest machine.

Anne Umphrey
Concord, Massachusetts

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Letters

(continued from page 3)

GAMI both seem to be convinced that they can develop an acceptable 100-octane unleaded fuel while the experts at the big gasoline companies say it is impossible. I believe from an engineering standpoint, Swift and GAMI are likely to succeed, but from a business standpoint, the large oil companies are correct.

Actually, the 100-Octane Coalition had best be very careful about what they wish for. The overriding issue will be price per gallon. Nothing would destroy general aviation faster than a \$2 or \$4 increase in the price of avgas. Folks, even \$2 more per gallon would add about \$16 to the hourly rate for a Cessna 172, for a turbo 210, it would be \$30 per hour and operating a turbo twin like a Seneca II would cost nearly \$40 more per hour than it does now.

Compare that to simply using an unleaded version of our current fuel with an octane rating of about 84 and a price about 20 cents less per gallon than we currently pay. For the 65 percent of the general aviation fleet originally certified for 80/87 or 91/96, using the unleaded version of the current fuel is a no brainer.

Even for the turbo 210 owner, a \$10,000 engine mod with a big inter-cooler and electronic timing ignition would pay for itself in 300 hours. That's based on 94 unleaded saving \$3 per hour while Swift and GAMI fuel adds \$30 per hour. The same math works for the big turbo twins and other 100-octane aircraft. Also note that after the break-even point, the cost of future operations is always much less, resulting in huge savings,

say over 1000 hours. Another issue is fuel compatibility. How, for instance, would Swift or GAMI work with natural rubber fuel line used in a 1938 Cub? How about with various fuel tank sealants? An unleaded version of our current fuel insures compatibility while the legal liability for a high aromatic fuel could be huge.

Also, the ingredients in any new fuel must all be environmentally acceptable. Remember only a few years ago, an oxygenating additive to car gas called MTBE was discontinued because of fuel leaks causing cancer.

The final advantage of using our current fuel without the lead is that we would finally be in compliance with all the other groups where everything from car engines to lawn mowers now run on unleaded.

There is one more risk with Swift or GAMI. The proponents of these fuels assume 100 percent replacement for current 100-octane avgas. In the real world, this is uncertain. Many FBOs have rental fleets of Cessna 150s, 172s and 182s and could decide to carry only 94-octane unleaded. Any competitor renting such aircraft using Swift or GAMI's G100UL would be at a huge economic disadvantage. Thus, at many airports where the FBO has only one fuel storage tank, only 94 unleaded fuel would be available.

Frank Andrews
Everett, Washington

You are assuming your opinions about the cost of Swift fuel and G100UL are fact, but the economics are still unproven. Our research (see the August 2010 issue) suggests that 94UL is not a slam dunk winner on price. It could cost a little more or a little less than leaded avgas.

The reason is that some refiners already

FEEDBACK WANTED

PIPER 140



For the March 2011 issue of *Aviation Consumer*, our Used Aircraft Guide will be on the Piper 140, the precursor to the modern Cherokee line. We want to know what it's like to own these economical airplanes, 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 140 by January 1, 2011, to:

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have in place the alkylate technology to produce such a fuel, but the fact that others don't has an unpredictable effect on competition. Fewer refiners mean less competition and possibly higher prices.

Further, you assume that owners of aircraft requiring 100-octane—and they burn about 60 to 70 percent of all the avgas used—will convert to electronic ignition en masse. Lycoming sees this as unlikely, thus a significant portion of the market will simply not play along.

This could drastically reduce demand, further inching up prices. Furthermore, such a downward spiral would have a devastating effect on small airport FBOs. Also, Continental believes electronic ignition systems can substitute for the octane shortfall of 94UL; Lycoming has pointedly said the opposite. At some point, the market will get its choice.