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The Aviation Consumer®

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The Aviation Consumer

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A Little Respect

Many years ago, a wise aviator heard me comment that the airplane we were standing next to wasn't cool. He quietly told me that any airplane that gets a person into the air and back down again safely is very cool because what's truly matters is being able to rise off the ground and fly.

It took years for that to sink in because I was terribly guilty of all sorts of aviation snobbery. Along with many of my fellow pilots, I looked down my nose at airplanes that I didn't consider to be fast enough for their power, or didn't meet some undefined aesthetic standard or, heavens, had a nosewheel. As with most of the pilots I knew, I was guilty of aviation snobbery.

At a time when the cost of maintaining our aviation habit continues to rise at a multiple of inflation, aviation forums are wall-to-wall with pilots agonizing over the high price of flying, and my email box always seems to have a letter from a reader asking how to reduce costs, airplane snobbery is an expensive luxury—one that probably needs to go.

It's a hard habit to break, but if a pilot can ignore airplane snob appeal, she or he may well find some bargains in the used airplane world.

After a few hours of research into the *Aircraft Bluebook*, I've come to the conclusion that the more serious form of aviation snobbery is the willingness to pay extra for an airplane with a tailwheel, even though I love the things. For example, a 1970 Cessna 180 is valued at $77,000; a 1970 182, with a bigger, more comfortable cabin, but a nosewheel, comes in at $44,000. In the two-place world, the 1947 tailwheel airplanes generally run in the $19,000-$21,000 range, with the exception of the Cessna 120/14 at $15,750. An Ercoupe of the same vintage is valued at $15,000. If you want to go faster in a newer two-place airplane, a 1972 Grumman TR2 is $14,250. A 1956 Cessna 170B runs about $25,000—a one-year newer 172 is valued at $17,000.

I fully agree that the average tailwheel airplane is more capable of rough field operations than nosewheel airplanes; yet virtually every nosewheel airplane on the market does just fine on the vast majority of grass runways in this country. To add to that, I can't help but notice that many tailwheel pilots I know almost never go into rough fields—it's akin to the masses of SUVs on our highways that have never been off road. Why pay extra for something you never use?

On top of that, your chances of tearing up your airplane go up dramatically if it's got the steering wheel in the back, which also means you're going to pay more for insurance (and maybe even have a prohibition in the policy against using unpaved runways). So, you can pay less for a nosewheel airplane, be able to fly it on windy days when you'd leave the tailwheel machine in the hangar and pay less for insurance. Somehow snobbery seems counterproductive.

The other form of snobbery that is costing pilots money is that of deciding that an airplane doesn't meet some intangible level of coolness. What pops immediately to mind is the Beech Musketeer/Sundowner/Sierra series. They are known for not being very fast, yet what is often ignored is how big and comfortable the cabins are and how nicely they handle—pure Beechcraft. As for speed, on the typical $100-hamburger run, a Sundowner will be entering the pattern as the American General Tiger, with the same engine, is taxiing in. Because the Beech is in the air slightly longer on that flight, it will probably burn a gallon or two more avgas. However, for the price difference between $47,000 for a 1979 Tiger and $34,000 for a 1979 Sundowner, the Beech pilot can afford to buy a lot of gas.

Perhaps it's time to give a little more respect to the airplanes that don't cost as much as the ones that have snob appeal. —*Rick Durden*

BRS Retrofit

I own a Peterson Katmai conversion of a Cessna 182P. While this letter references your recent (September 2013 issue) article about BRS retrofits for Cessna 172s, 182s and LSAs, I would like to compliment your staff on the comprehensive and accurate article about the Katmai/King Katmai in the January 2013 issue.

Renting Cirrus airplanes, my wife and I grew accustomed to having an airframe parachute. Thus, when I bought my Katmai, I elected to install a BRS airframe parachute. My reasons were similar to those cited in your article: to mitigate the risk—or, more accurately, reduce the consequences of losing one's bet with the risk of flying over harsh terrain or in IMC and, of course, a spouse who strongly desired the extra safety feature.

As noted in your January article, the Katmai/King Katmai aircraft are very capable airplanes for back-country flying, so a BRS seems particularly valuable for an aircraft that would spend much of its time flying over terrain that most of the rest of us flight plan *around*.

Kevin Moore
Via email

Avidyne Product Delay

In the August 2013 issue you had a fantastic article about Avidyne and the continual delays of their product release. I asked Avidyne for a refund of my deposit and was told that they would hold my money for one year from the date of the deposit.

Shame on me for not reading the agreement carefully enough, but the sales rep at Avidyne told me that I could get my money back within the first year.

What kind of company is Avidyne that it refuses to refund a customer's money when they continue to delay the product release and have now changed their support agreements?

Robert Gaynor
Via email

FIRST WORD

I enjoyed the First Word column in the September issue and your observations regarding the drop in airplanes flying in to AirVenture. As someone in his forties, I am often the youngest airplane owner around on the tie-downs at AirVenture or at fly-ins. People who are not baby boomers came up after the big stock market and housing rise before 2008. For us, it is a struggle to own an airplane.

Obviously fuel is a major expense, but if you're like me and live in a decent-sized community, hangar expense is terribly high. With the recent budget restraints in our county, they doubled our rents, but grandfathered in the old timers on the airport. We younger renters are paying three times what we did 10 years ago.

As airline service has improved and prices dropped from the 1970s and 1980s, most young people would rather go commercial when just to get a VFR private ticket runs close to $10,000. When the boomers get too old to fly, the pilot numbers are going to fall through the floor, and the cost of flying will really take off as FBOs and maintenance shops look to squeeze money from a much smaller pie.

Scott Haufe
Via email

iPAD AND FOREFLIGHT

Aviation Consumer has been heralding the iPad and ForeFlight for several years. I bought them, based on your recommendations.

My iPad mini was delivered at 10:00 AM. From then until 4:25 PM, I wrestled with Apple, ForeFlight and even my bank.

Once unboxed, you must set up the unit. After some frustration and a 45-minute call to Apple support, I learned you cannot set up the iPad without a wireless connection. I finally did get ForeFlight downloaded and set up with a Bad Elf Pro GPS via Bluetooth.

My first planned flight involved transitioning New York City airspace. After departure, I noticed that there was no airplane icon registering on the map. With another pilot in the other seat, I checked all the setting and device menus—all were correctly set and each showed the Bad Elf as connected and working, but no in-flight airplane icon on the map.

The next day (a Sunday morning), I emailed ForeFlight a description of the problem and three screen shots. I received a reply just before 1:00 PM that day. It suggested downloading a free "GPS Data" app from iTunes. It fixed the problem.

Since then, the iPad mini and ForeFlight combo have work flawlessly. The iPad is the perfect size for use in my Tiger, however, be warned, it's not all roses, especially getting it up and running.

Bob Reed
Via email

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Bendix King KSN770: Powerful, Hybrid FMS

Bendix King's long-awaited multifunction navigator has a flexible feature set, VGA screen and an open architecture. Expect a learning curve.

by Larry Anglisano

Five years. That's how long the market has been waiting for Bendix King's KSN770 GPS navigator. In the avionics world, a lot can change in five years, and that's exactly what happened while the KSN770 was stalled in a lengthy R&D phase.

Touchscreen, ADS-B, advances in electronic charting and Garmin's GTN-series navigators were a few notable changes that made the original KSN770 product nearly obsolete before it was even brought to market. Worse, the delay—and the absence of a fresh product line—created rumors that Honeywell was abandoning the GA avionics market.

Ultimately, it was a partnership with Aspen Avionics—a dynamic company that has a knack for developing and certifying successful products in minimal time—that pulled the KSN770 from the ashes of avionics extinction.

The collaboration between Bendix King and Aspen produced a product that we might expect. The KSN770 has a modern feature set and generous input/output capability that's packaged in the robust hardware that Bendix King is known for. It's also designed for future growth—that's signature Aspen, in our view.

We recently visited Bendix King's flight operations center in Albuquerque, NM, where we flew with the KSN770 and Bendix King chief test pilot Doug Hawley. As we go to press, the unit is expected to earn STC and TSO certification any day.

CHECKLIST

- Screen quality is excellent and data never appears crowded.
- Liberal interface plays well with a variety of digital and analog systems.
- Interactive voice call outs could step the interface up a notch. It's missing.

A STEP-UP HYBRID

If you're familiar with the Bendix King KMD540 MFD—the display that was part of the company's Integrated Hazard Avoidance System (IHAS) suite—then you'll recognize the KSN770 safety navigator, as it's called, as a follow-on product.

Like the old KMD display, the bezel design of the new KSN770 has a rugged feel, although we're not so sure how the joystick and cursor control device (CCD) will hold up in the hands of ham-fisted users, or in turbulence, for that matter. It protrudes from the lower right corner of the bezel, seemingly making it vulnerable to breakage. On the other hand, it's a convenient way of entering data into the KSN770 FMS.

If you're familiar with the Aspen Evolution PFD and MFD products, it might be obvious that Aspen had their hands in the user interface. That's because the onscreen labels, soft keys and even some of the menu structure resembles that of the Aspen Evolution. We think that's a good thing and so might owners of existing Evolution PFDs. In our estimation, the Aspen feature set is highly regarded for simplicity and ease of

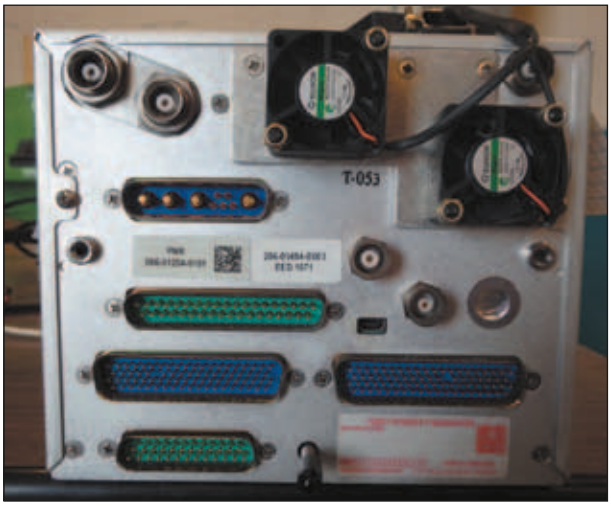
The KSN770 uses a combination of hard keys, resistive touchscreen and a joystick. It has a crisp VGA screen that performed well when splashed with bright desert sun. That's advisory terrain data overlaid on the map page, left.

use. That isn't to say the KSN770 will be an easy transition for everyone—especially those coming from Garmin's GNS530/430 products. The KSN770 user interface is quite different.

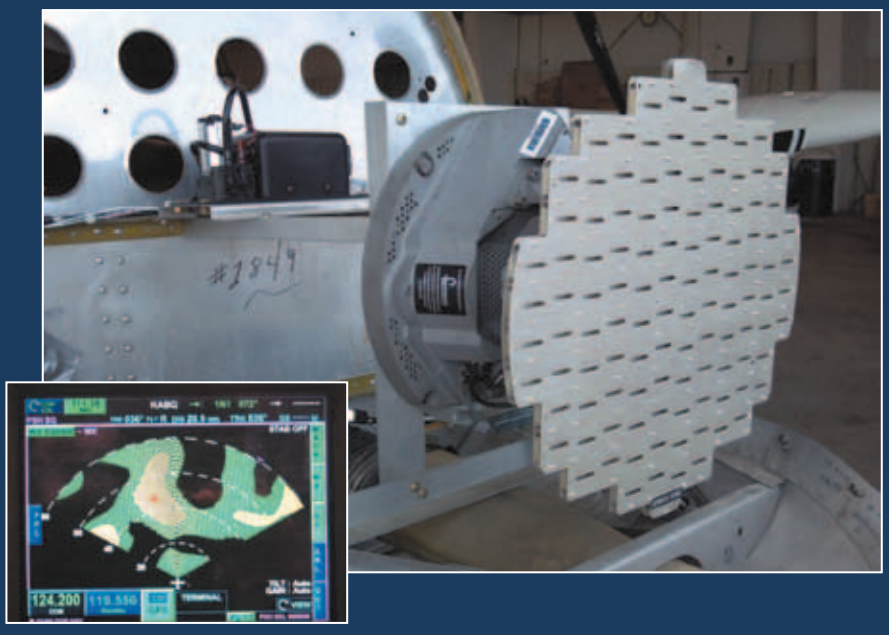
The 10-pound KSN770 stands 5.25 inches high in the radio stack, which is roughly 0.75 inches taller than a Garmin GNS530. This is important because the target audience for KSN770 retrofits may be, in part, owners looking to upgrade from the GNS530. It's simple—less reworking of the radio stack means lower labor costs. This can't be said for the GTN750, at 7 inches tall.

The screen is a 5.7-inch active matrix LCD with a 640 by 480 pixel count. That's full VGA, and it strutted its stuff as we flew around the desert in the Cessna 182S. Sunlight is not a problem for this display, nor is heat. The unit monitors dual cooling fans that are mounted on the rear of the chassis. Should one or both fail, the unit flags a FAN FAIL message on the display—warning of pending overheating.

Bendix King believes that many pilots aren't entirely sold on a total touch interface, so they designed



The look of open architecture, right. In Bendix King tradition, the chassis and connectors on the KSN770 are sturdy. Those are two cooling fans on the upper right area of the chassis, while the various connectors support healthy amounts of digital and analog data.



The KSN770 can interface with Honeywell digital weather radar systems, including the RDR2000/2100 and RDS84 vertical profile models. The interface plays on a dedicated radar page, with the ability to overlay active flight plan data on the weather returns. The RDR2000 and 2100 radar sensor systems are still in production and are available in various configurations, depending on the size of the array.

the KSN770 with a combination of touch and hard buttons and knobs. This hybrid interface brings the best of both worlds.

For example, tuning the radio frequencies can be accomplished with an onscreen keypad or you can twist, turn and tune with a familiar concentric knob. Pushing it in activates the nav window for channeling nav frequencies, while the frequency transfer soft key makes the frequency active.

Speaking of radios, the onboard comm transceiver transmits 10 watts of power, and there's an optional 16-watt version for jet applications.

We're surprised the unit doesn't have a discrete audio output channel for voice callouts and warnings. We think this could enhance the automation and should be present in a unit with this level of complexity.

HOT KEYS, SOFT KEYS

Part of the hybrid feature set includes an intuitive structure of hot and soft keys, while the eight-position joystick knob is intended as the primary way of entering data.

Entering a waypoint identifier, for example, functions as you would expect it to. The left and right action of the joystick advances the cursor to the next available character in the identifier field, while turning it changes the selection of letters and numbers of the identifier field.

The joystick also serves double duty for push/select functions. During our trials, we had the tendency to either push it too lightly or too quickly, but once you get a feel for it, it works. The cursor control device, or CCD, comes from jet FMS systems, so it's natural for Bendix King to include one on the KSN770, which was born from the company's Apex FMS.

You could also enter data in a QWERTY pop-up window. The screen is resistive. Putting pressure on the surface with your finger or an object commands a given function. Bendix King says the touchscreen will easily work with gloves.

The hot keys are right out of Aspen's Evolution flight displays. Hot keys sit along the right side of the screen and are aligned with and displayed adjacent to their corresponding soft key.

When configuring the map, hot keys and the corresponding soft keys are used to turn on and off various information overlays for each map. The best way to grasp the concept is to understand that hot means active, so the hot keys activate a function and turn green to indicate that the function is active.

CHOOSE YOUR MAP

Bendix King says the KSN770 was designed for both VFR and IFR missions, allowing flexible map display configurations. You can configure it for single-screen or split-screen view, add a single thumbnail view of traffic, for example, or two thumbnails for displaying both traffic and terrain. You can also select the view on each map screen—either a 360-degree or arc view.

The map can be configured for VFR or IFR (low or high airways) while traffic, terrain and weather—including XM data from Aspen's EWR50 datalink receiver can be overlaid on each. The unit also interfaces with the L-3 WX500 stormscope.

Changing the map range is accomplished with dedicated soft keys on the upper left of the bezel. There's also a map panning mode that's controlled with the joystick. You can't perform a two-finger pinch zoom, as you can with Garmin's GTN navigators, or as we've grown accustomed to with tablets.

Georeferenced NACO charts—including taxi diagrams—are provided by Seattle Avionics. The chart display is accessed by pressing the MFD soft key and then toggling to the first page in the View menu, and then pressing the Charts hot key. The List hot key brings up a menu of available terminal procedure for a given airfield. The SEL, for select, hot key enables the chart viewing mode, where you can manipulate the chart by panning and zooming using the joystick or by using the touchscreen. The orientation of the chart is adjustable and there's a day and night mode—either black text

on a white background or white on black.

The TAWS view displays either advisory terrain data or enhanced ground proximity warning system (EGPWS). This includes the Bendix King KGP560 EGPWS and KMH880—which has TAS traffic and EGPWS in a single box.

Speaking of traffic, the unit can display a variety of TCAS, TAS and TIS systems, including Garmin's GTX330/33 and Avidyne TAS. Traffic can displayed on a dedicated traffic page, in a thumbnail, and as a pop-up during traffic alert conditions.

FMS NAVIGATION

At the core of the KSN770 is Honeywell's WAAS-enabled GPS. As noted, the FMS trickled down from the Honeywell Epic/Apex GUI. The FMS is, of course, driven by a subscription-based database obtained via download from Honeywell's Wingman data services division. Data is loaded into the unit via the USB port on the front bezel.

VFR pilots will find that single-point navigation is simple, especially with the Direct key on the bezel. Here you can select airports and navaids using the QWERTY keypad or by scrolling with the joystick.

In true FMS function, you can create and load an entire flight from departure to approach. First, insert the starting waypoint (which defaults to a nearest list) and destination. This builds a basic flight plan. The Procedure hot key advances to a drop-down menu of available departure, arrival and approach procedures. For a departure, select the runway, the published procedure and desired transition. From there, it's back into the Procedure menu to select the desired approach and or arrival, with desired transitions.

The flight plan window has a drag bar that you slide with a finger to view the waypoints in the flight plan (or use the joystick). The flight plan waypoints are also identified on the map screen, so you can watch the construction of the route.

Course and VDI information for GPS and raw nav data is displayed on a healthy variety of navigational indicators, including PFDs, analog HSIs and traditional indicators with OBS Resolver circuitry. A CDI hot key switches the course output from GPS and nav. In addition to displaying onscreen mode annunciation for approaches, the unit will output the data for display on a PFD. The current navigation source is displayed next to the radio tuning and display window at all times to provide an indication of the navigation source that's being displayed. The system automatically switches the CDI from GPS to VLOC when an ILS approach procedure is active in the flight plan.

The system accepts a variety of analog and digital heading inputs, including the AHRS reference from Aspen's Evolution and bootstrap synchro from the KCS55A HSI system. Heading input is required for computing GPS roll steering and for moving-map overlay of weather and traffic systems that require a heading reference.

The system is compatible with a variety of autopilot systems, but you'll need to verify full compatibility with your system. During our flight trials, the KSN770 was interfaced with the rate-based Bendix King KAP140 and performed flawlessly on RNAV LPV, LNAV+V and ILS-coupled approaches.

BACK IN THE GAME

The KSN770 has a list price of $13,995 and the KSN765 (a version that doesn't have a comm or nav radio) is $12,995.

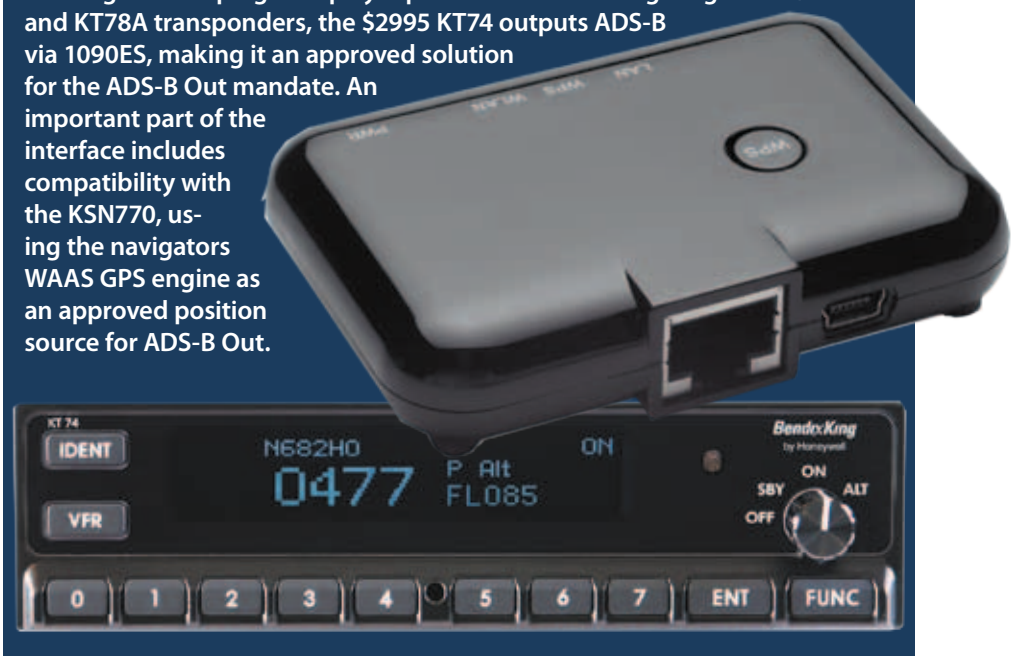
Based on our evaluation, we have no doubt that the capable KSN770 can appeal to buyers looking for an alternative to Garmin's GTN navigators. We applaud the open architecture design that makes it easier to interface the unit with vintage and newer products.

Will the KSN770 put Bendix King back in the retrofit market as the player it once was? That's possible, as long as a skeptical dealer network can recognize the product as one that's equal to or better than Garmin's offering. In some ways, we think it is. Contact www.bendixking.com, 855-250-7027.

WHAT ABOUT ADS-B?

Don't count on it in the initial release. Bendix King says the KSN770 won't display UAT ADS-B weather and traffic, but that it's planning on a future interface that will enable ADS-B input. Since Aspen Avionics had their hands in the design of the KSN770, it's logical that Aspen's line of recently introduced ADS-B receivers will eventually play with the KSN770, including Aspen's EGC50 WiFi ADS-B unit. The KSN770 is currently fully compatible with the Aspen EWR50 XM satellite weather receiver. You can, however, initially use the KSN770 for ADS-B Out, since it's designed to drive the recently introduced KT74 digital Mode S ADS-B transponder.

Designed as a plug-and-play replacement for existing King KT76A/C and KT78A transponders, the $2995 KT74 outputs ADS-B via 1090ES, making it an approved solution for the ADS-B Out mandate. An important part of the interface includes compatibility with the KSN770, using the navigators WAAS GPS engine as an approved position source for ADS-B Out.



Redbird's Redhawk: Like New at a Used Price

Redbird wants to reset trainer aircraft economics by refitting older Skyhawks with a Centurion diesel. At higher TBRs, the numbers pencil out.

by Paul Bertorelli

For at least two decades, the airframe manufacturers have relegated new trainers to the "why bother?" category. The market is so moribund that the last truly consequential trainer, other than LSAs, was Diamond's DA20 Katana, a 1995 intro that was a lukewarm seller at best. Sooner or later, this was going to be fixed and in Redbird's new Redhawk Skyhawk diesel conversion, maybe later has actually arrived, at least as an incremental step forward.

Redbird, which invented the inexpensive, motion-based simulator market, unveiled the Redhawk at AirVenture in July. Although it doesn't qualify as a new airframe or

AIRCRAFT FLIGHT REVIEW

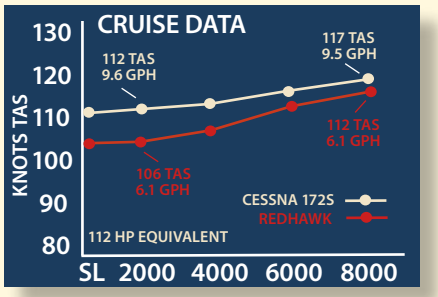
even a new idea, its execution can be called innovative: a remanufactured Cessna 172 fitted with a Centurion 2.0 diesel (now Continental, formerly Thielert), fresh paint and upholstery and a not-that-modest glass panel that isn't a Garmin G1000. Redbird hasn't promised a final price, but the target is under $200,000. When we visited Redbird's San Marcos, Texas, headquarters in August, the company was tooling up for serial production and thinks the market might support as many as 30 Redhawks in 2014, a bold start indeed.

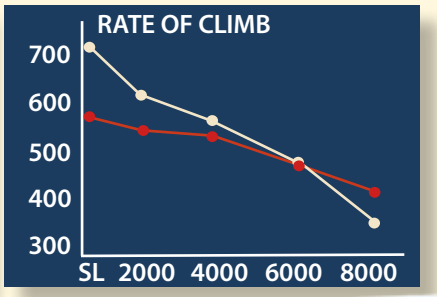
For a company that professes no interest in becoming an aircraft manufacturer, and Redbird says it doesn't, the Redhawk project is a substantial investment. At AirVenture and again at San Marcos, Redbird's Roger Sharp said, "Look, we wouldn't be doing this if someone else would build this airplane or one like it." The most obvious "someone" is Cessna, which has a half-million dollar 182 diesel, the JTA, but no diesel trainer. Cessna proposed its own Centurion Skyhawk in 2007, but pulled back when Thielert ran into trouble. Redbird is convinced they're missing a market.

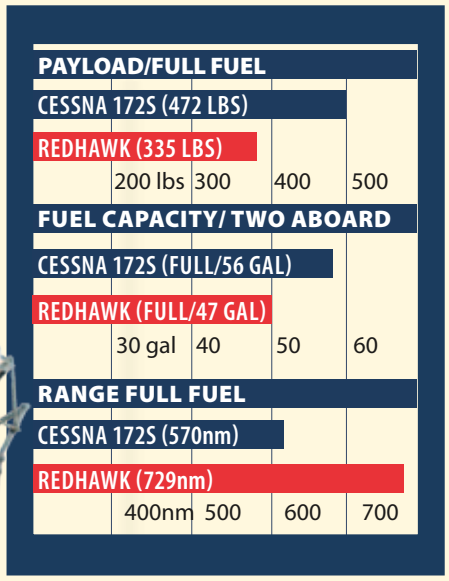
OUT OLD, IN NEW

Converting a Skyhawk to a diesel and flogging it as a trainer isn't original to Redbird. Before it was bought from Continental, Thielert developed the conversion STC and there are a handful knocking around Europe as trainers and personal

SKYHAWK VS. REDHAWK







ENGINE SPECS		
	IO-330-L2A	CENTURION
HP	160	135
TORQUE	350 FT/LBS	302 FT/LBS
WEIGHT	268 LBS	295 LBS*
BSFC	.45 LB/HR	.36 LB/HR

*DRY WEIGHT, PLUS INSTALLATION WEIGHT

aircraft. But the world didn't exactly explode with woozy desire for Jet A Skyhawks. What's different this time is a confluence of factors, including Continental's injection of capital and developmental energy into the diesel market with its purchase of Thielert, Redbird's we'll-try-anything ethos and a growing consensus that Cessna has lost interest in selling airplanes. Also, there's a fat supply of Skyhawks suitable for conversion and the airplane lends itself to more than just a cosmetic makeover.

And the Redhawk certainly isn't lipstick on a geriatric pig. Sharp told us the airplanes will be disassembled and stripped and critical parts inspected, replaced or upgraded. None of the original wiring or lighting will remain; in fact, not much of anything original will remain, other than the base airframe, which will get a dose of anti-corrosion treatment.

The engine is the major cost hit,

CHECKLIST

- ✚ Redhawk looks, feels, flies and smells like a new airplane.
- ✚ Aspen/Garmin panel makes for a modern cockpit, without overkill.
- ~ Engine economics depend on regionally variable fuel prices. Longer TBRs will make them more competitive.

The Redhawk is nicely turned out in Aspen glass driven by a pair of Garmin GNS430s, right. New interior and upholstery are part of the package.

which Continental will supply in a kit costing $56,000 and that will require another $12,000 to $14,000 for 160 hours of labor.

The rest of the project is straightforward refurbishment, such as metal repair and upgrades, paint, upholstery and rewiring, skillsets that are all available at the San Marcos airport, according to Sharp.

There's no STC to convert older Skyhawks to Garmin's popular G1000 glass and developing one for a project like this is a non-starter. So the Redhawks are likely to have an evolving suite of off-the-shelf gear from Aspen, Garmin, Bendix/King, S-TEC and other minor manufacturers. The airplane we flew had a pair of Garmin GNS430s, a two-screen Aspen setup, a Garmin GTX330 transponder and a KAP140 autopilot.

"All we need for training in this airplane is heading track and altitude hold. We're not trying to make it a good personal airplane," Sharp said. Redbird CEO Jerry Gregoire told us several times that he tilts toward Bendix/King as a principle avionics vendor, but it's difficult to see how this will happen. Sharp said the airplane needs a simple GPS mapcomm and a second digital radio, products that Bendix/King doesn't have in its catalog or announced. The perennially delayed KSN 770 exceeds Sharp's design brief and deliveries are still un-

Continental delivers the Centurion as an install kit, left, complete with engine mount. Operation and run-up is automated through a pair of test switches, lower left. Engine power instruments, top, tell the tale. At 98 percent or 132 HP and 6.8 GPH, the BSFC is 0.35 lbs./HP/hr.

certain. For the time being, we suspect Redhawks will be primarily Garmin and Aspen equipped.

Redbird has acquired hangar space adjacent to its Skyport facility and when we visited, had bought its second conversion airplane—a 1981 P-model Skyhawk—with the goal of developing serial production methods in the coming year. Sharp believes the supply of suitable Skyhawks is more than ample to support modest volumes of conversions, but estimates good ones will cost about $40,000.

BUSINESS CASE

For flight schools hoping to turn a profit, aircraft operating costs are critical and factors like fuel cost spikes, a bad month of maintenance or unflyable weather, can turn a barely black P&L blood red. Few flight schools have headroom to raise rental prices. The typical G1000 Skyhawk rents for $155—what Redbird charges at its Skyport—but we've seen them as high as $170. Higher than that, we're told by flight schools, and the customers look elsewhere.

The Redhawk addresses this on two fronts: It's cheaper to buy by at least 40 percent—assuming Redhawk hits its numbers—and, on paper, it's cheaper to operate.

For argument's sake, assume that both airplanes are new, glass-panel equipped with autopilots. Redbird is aware that ownership of flight school aircraft is hardly monolithic. Some schools own their own assets, but many depend on non-bank financing and/or leaseback relationships. So even though training is the target market, who is actually buying this airplane? One avenue that Sharp says Redbird will pursue is to sell the airplane to institutional leasing companies that then lease them to schools for either a flat monthly or an hourly arrangement. One company they've been talking to is Brown Aviation Lease, which already has such programs in the field, although they declined to give us even blue-sky numbers on how the Redhawk might be structured.

But it's easy to pencil some numbers. On a $364,000 new 172 financed over 10 years with 25 percent down, the monthly nut would be $3030 at 6 percent. For a $200,000 Redhawk—same terms—it comes to $1665 or $1365 less a month. See the sidebar on page 11 for sample operating costs. If the operating numbers we discuss in the sidebar are accurate, 100 hours a month in the gasoline Skyhawk would cost $9630 and, at $155 an hour rental, would take in $15,500. (We haven't included insurance costs here, which should be equivalent for both aircraft.)

For the diesel, revenue is the same on monthly expenses of $7965 or about 17 percent lower. The diesel's economics look even better when TBRs rise to 2000 or 2400 hours and if Continental can rid the Centurion of the 600-hour gearbox replacement requirement. Higher avgas prices position the diesel even more favorably.

EQUIVALENT PERFORMANCE?

In a word, no. The diesel Redhawk doesn't do what the gasoline Skyhawk does. At a glance, it carries 100 pounds less, climbs slower at low altitude and cruises slower at modest power settings, but can go nearly as fast as the Skyhawk or maybe a bit faster at higher altitudes and higher power settings. Whatever the mode, the Redhawk does what the Skyhawk does on 20 to 40 percent less fuel.

Let's consider a typical training mission. The S-model Skyhawk used

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for the initial conversion has a typical empty weight of 1642 pounds against a 2450-pound gross for a useful load of 808 pounds. With the Centurion conversion, the empty rises to 1746 pounds for a useful load of 704 pounds.

Although the tankage doesn't change, to stay within wing-loading limits with heavier Jet A, the Centurion conversion's capacity is given as 47.6 gallons with 44.6 usable instead of the stocker's 56 gallons. So with full fuel, the Redhawk has 385 pounds left for people and stuff—a two-person airplane, plus bags. The avgas Skyhawk, at 472 pounds with full fuel, does better, but it's still not a three-person airplane with full tanks. Thanks to its miserly fuel burn, with equivalent range fuel, the Redhawk diesel narrows its weight disadvantage, but it doesn't close it. However, earlier model 172s have higher useful loads and will do better.

There are two ways to examine cruise figures. The Centurion is a 135-HP powerplant, versus 160 HP for the Lycoming IO-360-L2A in the stock airplane. If equivalent power output is compared, they're close. Seventy percent in the gas model at 4000 feet is 112 HP, where the Skyhawk will cruise at 115 knots true on 9.6 GPH. The equivalent power for the Centurion is about 83 percent, where we recorded 110 knots on 6.1 GPH.

For a training aircraft, we doubt if the speed will matter as much as the fuel burn will. We would expect the Redhawk to spend its days grinding along at 65 percent power, burning about 5.5 GPH.

Where the diesel's performance noticeably lags is in climb rate. Taking off from San Marcos on a 90-degree day, the Redhawk posted better climb numbers than its POH suggested, but these were hardly stellar. At low altitude, the avgas Skyhawk bolts up to pattern altitude at 700-plus FPM, the diesellags that at 600 FPM. It's the difference between turning into the downwind 100 feet below pattern altitude and reaching it by the mid-downwind. Roger Sharp suggests that training doctrine for the Redhawk may have to be modified accordingly.

FLYABILITY

Sharp says he also looks forward to

continued on page 32

THE NUMBER CRUNCH

With the Centurion and Lycoming in a like airframe, it ought to be easy to run the numbers and get a credible operating cost comparison, right? Not exactly. It depends on what assumptions you're willing to accept about gas prices and fuel consumption, plus a slew of other variables including where in the world the airplane is operated.

Because the Centurion replacement/overhaul costs almost twice as much as the Lycoming and has a 500-hour shorter TBR, its economics aren't slam dunk for the U.S. market.

The chart below shows how the Centurion's short, expensive overhaul cycle rules the economics. Best case, with $6.10 avgas and $5 Jet A, the Centurion enjoys a $4 to $6 per hour lower operating cost than the Lycoming, but with real-world Jet A prices in the U.S. averaging $5.53, the margin is likely to be half that.

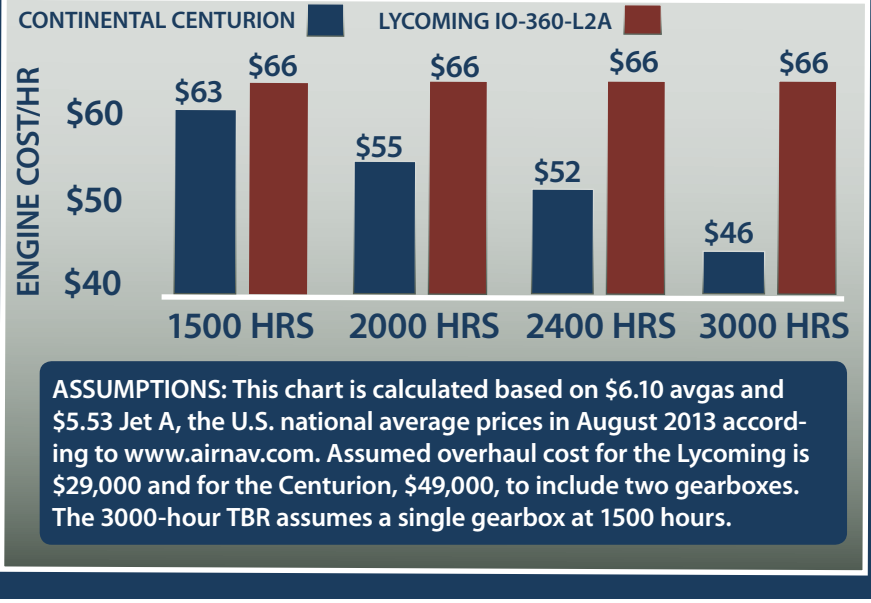
We're assuming similar dispatch reliability between the two engines, but we added $4000 worth of unscheduled maintenance for the Lycoming. Redbird told us it's had cylinder issues with its Lycoming 172s, but other operators we've contacted haven't voiced similar complaints.

When Continental extends the gearbox replacement requirement and reaches a 2000-hour TBR, the cost Delta is an impressive $11 an hour in favor of the diesel. And Continental wants to push the engine TBR to 3000 hours with 1500-hour gearboxes, in which case the engine's economics enter another realm.

The picture is less rosy if we use the August 2013 U.S. national average price for Jet A of $5.53 or plug in a slightly lower avgas price. In that case, the diesel has only a $3 advantage over the diesel or it runs about even. A few grand worth of cylinder work on the Lycoming increases the spread, however.

Of course, one diesel selling point is fuel availablity. If aviation gasoline isn't available, Jet A becomes the only choice. Further, in Europe, where avgas is north of $10, the diesel is dramatically cheaper.

When Continental purchased Thielert in July, it acknowledged that eliminating or extending the gearbox replacement cycle and extending TBRs to 2000 or 2400 hours were priorities. The economics show why they need to be. The Centurion is clearly competitive in some regions now, but only with the higher cycle limits will they become true world beaters.



ASSUMPTIONS: This chart is calculated based on $6.10 avgas and $5.53 Jet A, the U.S. national average prices in August 2013 according to www.airnav.com. Assumed overhaul cost for the Lycoming is $29,000 and for the Centurion, $49,000, to include two gearboxes. The 3000-hour TBR assumes a single gearbox at 1500 hours.

David Clark DC Pro-X: Supra-Aural Comfort

David Clark focuses on comfort and performance with a new noise-canceling headset. It has a compact frame and advanced electronics.

by Larry Anglisano

David Clark has a lot to prove with the new DC Pro-X noise-canceling headset. Not only does the mid-priced ANR headset market offer a healthy variety of good-performing models—including the Lightspeed Sierra and Telex Stratus 30XT, to name a couple—but the company's X11 model was a disappointing performer, based on our evaluation and feedback from other users.

The DC Pro-X is a completely redesigned model that resembles previous David Clark models only by its signature green earphones and familiar headband. Based on our recent evaluation, we're pleased with the DC Pro-X performance, comfort and features.

CLAMPING CONTROL

As with all of our headset evaluations, we had several pilots fly with the unit so we can get a feel for how it performs on different heads and in different aircraft.

The DC Pro-X has a supra-aural design, which means the ear cups rest on the ears, rather than fully enclosing the ears. While a supra-aural design isn't a cure-all for the pain caused by some large over-the-ear models, the leatherette ear seals have slow-recovery memory foam that's effective at reducing clamping pressure.

It also helps that the DC Pro-X weighs only 7.5 ounces and has an adjustable magnesium alloy headband. The band includes an adjustable stirrup-design suspension, which allows the user to fine-tune the fit. David Clark says the swivel hinge stirrup on the headband disperses clamping pressure, rather than creating pressure points. The bottom of the headband is surrounded by a breathable and vented leatherette pad. All of our testers raved about the DC Pro-X comfort and noted that the unit is comfortable to wear with sunglasses and with ball caps.

CHECKLIST

- Finally, a David Clark model with extended-wear comfort.
- Audio quality and noise-canceling performance is impressive.
- The supra-aural design makes it a player in jet cockpits.

The supra-aural design requires precise positioning of the ear cup over the ear canal. If it's not positioned properly, you'll struggle with hearing the phone audio. It's easy, however, to find the sweet spot once the headband and ear cups are properly adjusted to your head. David Clark suggests wearing the headset so the head pad lightly touches the top of the head.

The M-55 electret microphone succeeded in reducing ambient noise in all of our test aircraft—including singles and piston twins—that were equipped with newer and vintage audio systems. The adjustable microphone boom is rigid enough to remain in place precisely and easy to adjust so the microphone sits at an appropriate distance from the lips—avoiding clipping or over-modulating.

The headset collapses to save space during storage (it's compact enough to stuff into a map pocket). The collapsible design also makes it easy to store the unit in the included headset bag or for tossing into a small flight bag.

HYBRID ENC

The DC Pro-X electronic noise-canceling circuity (ENC) is a feed-forward/feedback design, where two miniature microphones are installed on the unit's ear dome. A microphone is located on the exterior of the dome while a second microphone is installed internally, near

There's no mistaking the new DC Pro-X as a David Clark headset. It has a sturdy headband and flexible mic boom found on previous models, but the small footprint and leatherette ear seals contribute to a higher level of comfort no other Clark model has delivered.

the speaker. The exterior microphone registers the unwanted noise before it makes it to the human ear canal. Each microphone outputs to individual inversion circuits, where the signals are converted to an antinoise signal. David Clark calls this Hybrid ENC, a design that ultimately results in 30 dB of noise-canceling performance.

The ENC circuitry is powered by two AA batteries. David Clark said that the expected battery life is up to 50 hours, and the company is working on a panel interface for connecting the unit to ship's power. In our evaluation, we found that low battery power resulted in deteriorated noise-canceling performance, evident by a rumbling noise in the noise-canceling circuitry.

Speaking of dead batteries, the unit has a failsafe mode that allows the unit to work in a passive state. David Clark calls this dual voice coil technology, which is a failsafe design that allows audio to bypass the noise-canceling circuitry in case of battery failure. There's a passive version of the headset—the DC Pro—that we didn't evaluate.

The DC Pro-X has an automatic shutoff feature that powers the unit down after 5 minutes when it isn't connected to live audio jacks. The automatic shutoff can be disabled via a switch inside the control module.

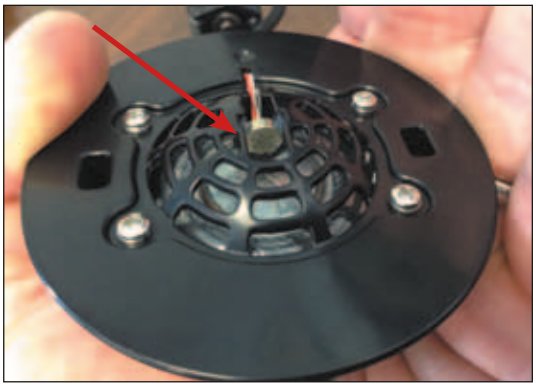
CONTROL SET

The DC Pro-X has a simple control module that also houses the two AA batteries. We were afraid of breaking the swivel battery cover each time we changed the batteries—it seemed fragile enough to snap off. The battery compartment also houses a stereo/mono slide switch and the automatic shutoff switch.

We think the simple user controls are logically and easily positioned for single-handed operation. There's a simple pushbutton power switch at the top of the module that pulses a green annunciator when the unit is on, and it pulses red to indicate low battery power. When the unit is initializing, the button pulses yellow.

Volume controls for the left and right earphones are linear, and an audible beep represents the gain level when changing volume. Since these volume controls are only usable when the unit is powered, the system defaults to maximum volume when passive.

The rest-on-ear supra-aural cups on the DC Pro-X make the headset sunglasses-friendly, top photo. The feed-forward/feed-back noise-cancelling circuitry uses dual noise-sampling microphones that are mounted in each ear cup, middle photo. The control module, bottom photo, has good ergonomics but a fragile battery lid.



As we would expect from a headset in this price category, the DC Pro-X comes standard with wireless Bluetooth that's controlled with a single Bluetooth button on the control module. When you hold the button for a couple of seconds, the key pulses yellow during pairing—a process that was seamless with both Android and Apple devices we used. Once the device is paired with the headset, the key pulses blue. If the device is paired but not connected, the key pulses green. Weak batteries will hinder Bluetooth performance, as we discovered on one flight.

Whether using the Bluetooth function for making cell phone calls or for listening to music, the headset has impressive features. For instance, when the headset is plugged into the aircraft intercom, you'll hear sidetone (that's the sound of your own voice as you speak on the phone). If there's chatter on the aircraft radio or the intercom, the cell phone receiver audio is muted. To answer a call, simply press the Bluetooth button on the control module.

When connected to a smartphone while listening to music, the music audio will mute with aircraft radio activity and then gradually fade back in when communication is completed. That's a nice touch.

MISSION-CAPABLE

"I like these better than the Bose A20 headset—especially the price." That's what a flight instructor said after he took the DC Pro-X on a three-hour training flight in a Piper Arrow. As he put it, the headset has good audio and a lot of high-end features. Best of all, it's comfortable.

The DC Pro-X has a street price of around $650—not a bargain, but still fair, in our view. On the other hand, we think the model can serve a broad mission profile. It's a solution for quieter turbine cockpits due to its supra-aural design, while offering enough protection in louder piston cabins, too. Contact: www.DavidClark.com, 800-900-3434.

Akro for Under $100K: Wide Variety; Use Caution

$100,000 will buy a lot of used, factory-built, aerobatic airplane—from a Cessna Aerobat through a Pitts S2-B—but do a careful pre-buy exam.

by Rick Durden

There has long been a subset of pilots with a certain sense of adventure and the burning desire to own an aerobatic airplane. While most lust after an aerial hotrod such as one of the Extra 300 series or a Sukhoi Su-29, economic reality means putting something a little less impressive into the hangar.

In this article, we'll take a look at what's available in the world of used, production aerobatic airplanes for under $100,000. While that isn't chump change, it's still less than the price of most new LSAs—and it provides a pleasantly large selection.

CAVEATS

We can't cover every type of airplane that can legally fly aerobatics and is priced under $100,000 and still do justice to those out there in reasonable numbers. Accordingly, we're going to skip over the warbirds and some of the 1940s airplanes that are probably legal for aerobatics because of the certification standards of the time.

We're also repeating what we've often said about the damfoolishness of doing aerobatics in a normal category airplane: Every year, a certain number of pilots kill themselves by botching aerobatic maneuvers in a normal category airplane. While the certification design load requirements for a normal category airplane are higher than the G-loads seen in basic loops and rolls, there is absolutely no margin for a mistake. We've seen too many accident reports where pilots have removed the wings of normal category airplanes during aerobatics.

CESSNA AEROBAT

In 1970, Cessna beefed up the structure of its popular 150 trainer with additional stringers, nearly doubling the number of rivets and using heavier wing struts to strengthen an already sturdy airframe. The Aerobat never got much respect because it wasn't especially macho and it had a nosewheel. Get over that, however, and it's more than adequate for basic, positive-G aerobatics.

The Aerobat's obvious weakness is lack of power. It loses altitude diving for entry speeds and clawing back up for the next try is leisurely, to say the least. Energy management is something Aerobat pilots learn early.

The controls are well-harmonized. Rolling maneuvers require some coordination, as the yoke has to be turned upside down to get full aileron deflection.

Anyone who learns to do clean aerobatics in an Aerobat will have little trouble stepping into an airplane with a stick. An Aerobat teaches good habits simply because they're essential to complete maneuvers with any grace.

Where the Aerobat shines is in snap rolls and spins. Due to the sweep of the wing at the strut attach point, the effect of yawing the airplane as it's stalled is magnified slightly. The airplane enters snaps and spins smartly. It recovers from snaps and spins more crisply than its competition.

Prices, according to Vref, are about $19,000 retail for the 1970 Cessna 150 Aerobat and escalate to $43,000

7KCAB Citabria (above right), has a 150-HP engine with inverted fuel and oil systems and good handling in the air and on the ground. Cessna Aerobat cushions, both back and seat, can be removed or installed in seconds to accommodate parachutes (below right).

for the 1986 A152. The 150 Aerobat seems to command about $5000 more on the retail market over the non-aerobatic 150—for the 152, the premium for the Aerobat is as high as $9500.

CITABRIA

There have been, and are, many models of the Citabria, an outgrowth of the Aeronca C-3, K and Champion line. All start with the number "7" and are followed by a series of letters. In general, the lower-powered models have 100-HP Continental or 115- or 118-HP Lycoming engines and a choice of flapped or no-flap wings, while the bigger engine versions have either 150 or 160 HP.

All have fixed-pitch propellers. The 7KCAB has no flaps, 150 HP and was the only version with an inverted fuel and oil system. As with the Aerobat, the lower-powered versions take their time getting to altitude and sacrifice speed and altitude in each maneuver. The Citabria has a stick and a tailwheel, both aesthetic essentials in the world of aerobatics, although the tailwheel means a higher landing accident and insurance rate.

All are soloed from the front seat, which is a plus for visibility. Unfortunately, the Citabria doesn't have well-harmonized controls, most noticeable of which are the far too heavy ailerons. Spades, which reduce aileron forces and improve roll rate, are worth the price on a used airplane and worth retrofitting if not already installed.

The bigger engine Citabias cruise at an honest 110 knots on about 7 gallons per hour and get into and out of small strips nicely. Flying aerobatics, then slipping down final over the trees into a grass strip on a summer evening in these airplanes is the sort of thing that inspires poets.

The Citabria and Decathlon share one highly desirable trait: They're among the most docile of tailwheel airplanes on the ground.

Either airplane does excellent wheel or full-stall landings, and both are good choices for a tailwheel airplane checkout. For the person seeking an all-around airplane, it's difficult to go wrong with a Citabria or Decathlon.

7KCABs were built from 1967 through 1977 and range in value from $24,000 to $34,000. The 150- and 160-HP GCBCs (wing flaps, no inverted fuel system) start at a low of $25,500 and exceed our $100,000 limit with the 2010 model year. Small-engine Citabrias can be had for as low as $22,250, with the 2010 model valued at $94,000.

DECATHLON

The Decathlon developed from the 150-HP 7KCAB Citabria, keeping the same power with an inverted fuel and oil system, while adding a constant speed propeller, symmetrical airfoil and a shorter wingspan.

The result was a very good, intermediate-level akro machine. With plus 6 and minus 5 G load redlines, it will do all positive and negative akro reasonably well. As with the Citabria, the Decathlon's ailerons are too heavy for its elevator and rudder; spades are essential.

In 1980, the Super Decathlon was introduced. It is a 180-HP version that addressed many of the complaints of those who wanted more from the 150-HP version. Most recently, American Champion introduced the 210-HP Xtreme Decathlon at a price point well above our arbitrary limit.

All of the Citabrias and Decathlons must be loaded carefully. Two adults with parachutes often means that no more than about half fuel can be carried.

150-HP Decathlons are valued at $28,000 for the 1971 model, through $63,000 for the last year of production, 1994. Super Decathlon values start at $71,000 and go up past our $100,000 limit with the 2004 model.

CAUTION: WOOD SPARS

The wood wing spar Citabrias and Decathlons are the subject of AD2000-25-02R1 regarding repetitive inspection of the spars. If there is damage, the spar must be replaced.

PRE-BUY FOR AKRO: TAKE EXTRA CARE

A raw fact of life to be accepted and internalized when purchasing any aerobatic airplane is that it has almost certainly has been abused—not necessarily intentionally—so it's a matter of investigating to find out how badly. Keeping this in mind may keep you from making an expensive mistake.

The first step to take when even considering the purchase of an aerobatic airplane is to join the International Aerobatic Club (www.iac.org) and take advantage of its technical staff to find out as much as you can about the type of airplane you want to buy.

We regularly warn readers to be wary of airplanes offered for sale with a "fresh annual" or "fresh overhaul." As bluntly as we can put it—they are classic traps for suckers. Too often the work was either pencil-whipped or de minimis. This is of even greater concern for an aerobatic airplane because undone or poor maintenance can kill you in a hurry.

When you think you have found an airplane that fits the bill and you've made a deal that is subject to a satisfactory pre-purchase exam, have the exam done by a maintenance technician who knows the type well. Do it even if it means buying him or her an airline ticket to get to the airplane. We're not kidding or trying to pad the pockets of A & Ps.

Start with the engine and prop. The gyroscopic forces of aerobatics can do all sorts of damage to the prop itself, the moving parts of the engine and the engine mounts. That means getting an oil analysis to look for evidence of high wear, borescoping all the cylinders and generally looking for evidence of damage. Figure on about 500 hours between prop overhauls for an airplane regularly flying akro.

The competition aerobatic system rewards progressively higher G maneuvers as the level of competition goes up—effectively reducing the real-life TBO of the engine. Some airshow performers overhaul their engine after each season or every other season. If the airplane is used for Unlimited aerobatic competition or air shows, figure on a 500-hour TBO.

Next, go over the structure in detail looking at the condition of the ribs—no cracks, and spars—no cracks, wrinkles or signs of overload. Leading edges should not be buckled or broken at any point. Rivets should line up, show no evidence of smoking and should be tight enough that you cannot insert an index card under any of them.

Rib nails should be firmly in place, with no evidence that any rib is sawing on the spar. Look for cracks in the paint and/or fabric as evidence that the structure has flexed. The inspection for corrosion should be extra thorough. If it exists, find it. Otherwise, in a high-G environment, it will find you.

For an aerobatic airplane, we consider any service bulletin affecting the structure to be mandatory, not optional.

Take a hard look at the restraint system. Exposure to sun weakens belts. Being barfed on means acid has been applied. In our opinion, what might be ordinary wear in a Normal category airplane calls for replacement in an aerobatic airplane. We also feel that the useful life of an aerobatic restraint system is 10 years.

If the airplane has quick-release doors, have someone hold each one while you pull the release to make sure they work properly and easily. They are supposed to be checked annually—in our experience, they aren't and we've run across too many that were inordinately hard to release.

When you fly the airplane, make sure the gyroscopic instruments work properly. Akro can eat gyros—and you may really need that turn and bank gyro when you're headed back to the airport, into a setting sun on a hazy evening.

This means a new set of all-aluminum wings—$25,000 for a Citabria, $29,000 for a Decathlon—before installation cost.

American Champion's website (www.americanchampionaircraft.com) does a superb job, in our opinion, of providing technical support, with Service Letters, on the spar inspection and wing replacement.

BEECH MUSKETEER

During two years of the production run of Beech's entry-level four-place machine, the Musketeer/Sierra, there was an aerobatic version. The 1969 B 23, now valued at $24,000, and the 1970 C 23, valued at $25,000, are worth serious consideration if you want nearly the ultimate flexibility in a personal airplane.

The Musketeer has a rightful reputation for not being a speed demon. However, it has a large, comfortable cabin, carries a decent load and has the lovely, smooth, solid handling common to the Beechcraft line. As with other four-place airplanes that have aerobatic capabilities, the Musketeer's rear seats cannot be occupied for it to be in the Aerobatic category.

Without an inverted fuel and oil system, only positive-G maneuvers are approved, and the 180-HP Lycoming up front gives it enough power to fly them reasonably well. We note that William K. Kershner, the well-known aviation writer and educator, started his Ace Aerobatic School (which eventually became Sewanne Aerobatic School), with a Beech Aerobatic Musketeer, giving aerobatic and spin training to hundreds of pilots.

AEROBATIC BONANZA

In the late 1960s, Beechcraft was approached by Lufthansa and the air forces of Mexico and Iran to create a training aircraft that would have the capabilities of the T-34 Mentor, but with side-by-side seating. The result was the E33C and F33C Bonanzas, built for the 1968 through 1970 model years. Apparently, only one went directly to a private buyer in the U.S.

Many of the aerobatic Bonanzas have found their way back to the U.S. from their original overseas owners. To retain their aerobatic certification, they have to have an aerobatic kit installed. It involves a

tail beef up and installation of large, triangular "stall strips," as are on the A36 Bonanza, for aileron control at high angles of attack.

Not surprisingly, the aerobatic Bonanzas fly much like the big-engine T-34s—with controls nicely harmonized in all axes and a heavy enough and linear stick-force-per-G to discourage overloading the clean airframe. The airplane does pick up speed in a dive and 285-HP helps make for great, sweeping loops and barrel rolls, although the roofline does require some leaning forward for the pilot to pick out reference points in those maneuvers.

Values for the 1968 and 1969 E33C are $80,000 and $85,000, respectively, with the 1970 F33C coming in at $90,000.

GREAT LAKES

In the mid-1970s, the Great Lakes design was resurrected and put into production. The company has changed hands a few times since then, and the Great Lakes is currently being built by Waco Aircraft in Battle Creek, Michigan.

The airplane is a tandem, two-seat biplane with a 180-HP Lycoming AEIO-360 (although some have 200 HP) and an inverted fuel and oil system. The open cockpit Lakes is, simply put, hugely fun to fly. It's larger than the Pitts and more draggy so vertical maneuvers are limited. Inverted work is as good as the Decathlon, and snap rolls are great fun. With the swept upper wing, it "unhooks" and "rehooks" cleanly. Ground handling is every bit as good as the Citabria and Decathlon.

A pre-purchase should concentrate on corrosion, engine condition, mounts and propeller condition. Prices run between $40,000 and $70,000.

PITTS SPECIAL

The vast majority of single-place Pitts Specials were homebuilt, however, there were, and are, production versions of the S1-S and S1-T. The two-place versions, S2-A -B and -C, are all factory-made airplanes. The S1-S and S2-C are still coming off of Aviat's production line in Afton, Wyoming, with Aviat providing support for the older models.

Single-place birds have either 180 or 200 HP up front. The S2-A has a 200-HP Lycoming, while the S2-B and -C have a 260-HP Lycoming, giving them impressive vertical ability and cruise speeds upward of 150 knots. All have full inverted systems.

A Pitts is about as small a biplane as can be imagined to carry one or two people, fuel and a large engine. They are exceedingly clean and, to put it mildly, go like crazy. Even with higher-performing machines in the competition world, a Pitts still can win at almost all levels in competition except Unlimited.

The controls are well harmonized, although quite a bit of nose-down trim is required for inverted flight. For one who came up in akro flying an Aerobat or Citabria, the overwhelming feeling is it's only necessary to think about a maneuver to fly it. Most of those pilots overcontrol a Pitts the first time out.

The airplanes are initially hard to land because they go precisely where the pilot tells them to—immediately. Once that's figured out, they're not bad. That said, it's utterly essential to get a good checkout before you fly the airplane home, or you run a significant risk of tearing it up on your first couple of landings.

In addition to the standard aerobatic pre-purchase checklist, look for slop in the control system. It often just requires an adjustment, but bearings can be worn out. Make sure the inspection holes have been cut in the underside of the wings, an indication that the owner has been looking at the structure. Look to see if the spinner and nose bowl line up. If not, the bushings on the engine

The venerable, delightful Great Lakes is still in production (top). Aerobatic Bonanzas combine graceful akro with superb cross-country speed (middle). Little-known Aerobatic Musketeer is surprisingly inexpensive (bottom).

continued on page 32

ECI Cylinder Failures: Owners Under the Gun

A massive AD would remove 30,000 Titan cylinders from the field. But owners and shops question whether the FAA has proven a real risk exists.

by Paul Bertorelli

A new engine is only as good as the cylinders the shop or owner picks and cylinders have, episodically, proved problematic. As we go to press in early September, this is indeed the case with an extensive manufacturing run of Engine Components International cylinders that the FAA proposes to remove from service via a massive AD. At issue are about 30,000 ECI cylinders for Continental O-520- and O-550-series engines manufactured between 2002 and 2012. According to the FAA's proposed rulemaking notice for the AD, more than 30 of these cylinders have suffered head-to-barrel separations due to two unique types of cracking. Although the FAA can't explain the reason for these failures, it wants the affected cylinders removed from service via a complex, hour-based metric that it estimates would cost owners as much as $82.6 million, making the proposed AD one of the largest on record.

Not surprisingly, ECI is opposing the AD as being far too broad and unsupported by accurate data. It says the FAA has overestimated the number of true head/barrel separations and it believes the ones that have occurred were due to severe overheating caused by pilots mismanaging leaning. In response to the FAA's shotgun approach, ECI would like to stick with a 2008 bulletin it issued against a smaller population of cylinders requiring inspection at 50-hour intervals and removal at TBO.

As of press time in early September, the FAA's docket for the proposed AD remained open and was gathering overwhelmingly negative comments.

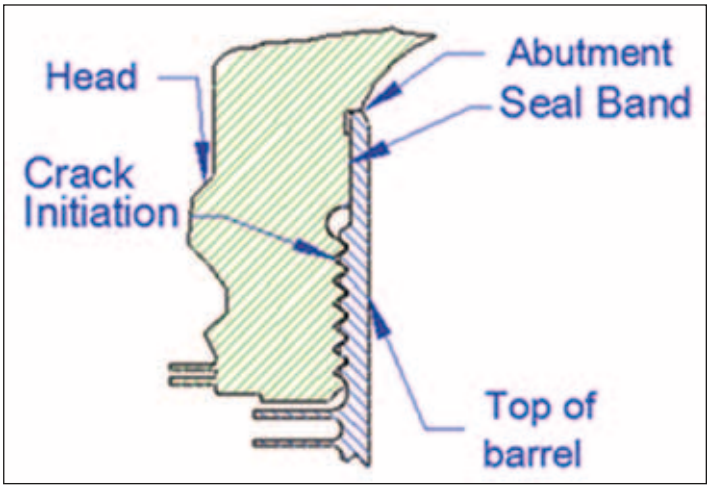
BACKGROUND

Problems with ECI cylinders date as far back as 2004, but the incidents that led to the AD proposal result from what the FAA says are multiple reports of cylinder failures.

Technically, these cylinders are identified under the Airmotive Engineering Corp. flag, the ECI sister entity that owns the approved parts manufacturing authority. These cylinders are marketed by ECI under the Titan brand name.

The FAA has been somewhat vague about how many failures have occurred and, in any case, ECI doesn't agree that all of the cylinders the FAA has flagged qualify as head/barrel separations. The FAA claims more than 30 and possibly as many as 39

Cylinders mate to heads, left and below, via an interference shrink or seal band. As shown in the drawing below, if the fit is lost or the band fails, aluminum threads in the head aren't capable of carrying combustion loads, resulting in head/barrel separation.



head/barrel failures, while ECI counters it has verified 19 head/barrel separations since about 2002. When we visited ECI's San Antonio, Texas, factory in August, we were told that the company hasn't examined all of the cylinders that the FAA claimed failed, if these are even available for analysis.

The proposed AD names two failure modes, although neither it nor the docket filed in support of the NPRM offers an explanation or mechanism for the failures. One type of separation, says the NPRM, is a shrink-band failure, while the other is cracking in the dome of the cylinder head above the combustion chamber.

Aircraft cylinders of the type in question consist of two components, a finned steel barrel and an aluminum head. The load surface—the part that actually carries the stress of containing combustion pressures—is called the shrink band and cylinder assemblies are held together via a precision interference fit between band surfaces on both parts. Threads on both the barrel and the head serve only as a means of assembling the two parts; they're not intended to carry combustion loads, since threads in the aluminum head lack the yield strength.

Prior to assembly, the head is heated and screwed onto the barrel while hot, driving the expanded shrink band into an interference fit on the barrel. If the band fails, either due to cracking or loss of interference, all of the combustion loads are transferred to the uppermost thread in the assembly. It's likely to fail, resulting in head/barrel separation.

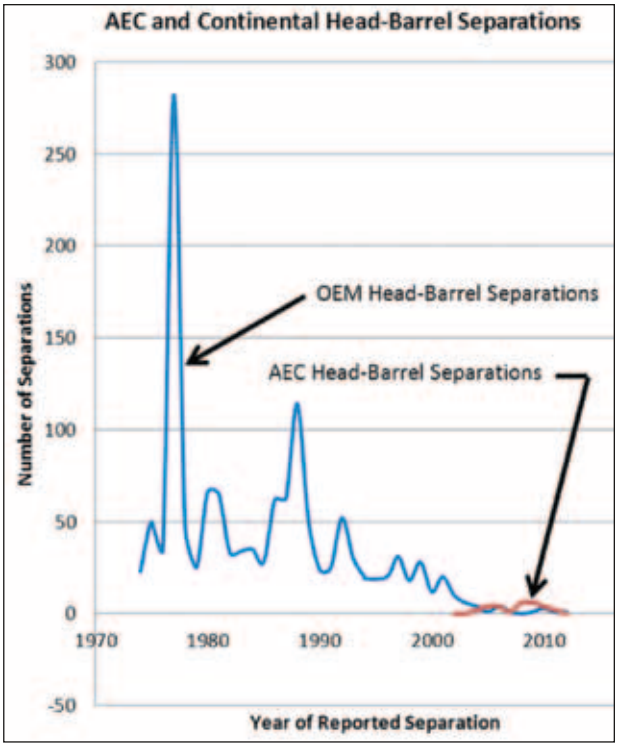
ECI concedes that it has had issues with head/barrel separations in the past, due either to a slightly out-of-tolerance shrink band fit or improper heating during assembly. But Ty Stoller, who is president of ECI's parent, Danbury Aerospace, told us those issues have been addressed and don't have any bearing on the 30,000 cylinders the FAA has named in its recent NPRM.

Although the dome cracking is a fundamentally different process, ECI and the FAA still consider these to be head/barrel separations. ECI has identified one other mode of separation which it calls a "slip off." They showed us one cylinder which appeared to have an intact shrink band, but little evidence of thread damage. ECI doesn't have an explanation for this type of failure.

NO AGREEMENT

ECI and the FAA don't agree on the actual number of separations that have occurred in the identified cylinder population. We're told that most of the data for both ECI's and the FAA's analysis comes from service difficulty reports (SDRs) which are problematical on several counts. They don't necessarily sweep up all the cylinder failures and many that are identified may not be accurately reported as head/barrel separations.

When we asked if ECI's research had also included a look at Continental OEM head/barrel separations during a comparable period, ECI told us that it found 21, a number comparable to ECI's failures, if you accept 19 as an accurate claim. However, Continental's failures are among a much larger population of cylinders—about five times larger, according to Continental's estimates of its cylinder production.



According to ECI's research of SDR data, above, head/barrel separations were much more numerous than they are now. Continental head/barrel separations have declined steadily. Red trace compares ECI incidents.

Jimmy Tubbs, ECI's vice president of engineering, concedes that Continental cylinders have had a lower rate of failure. "There's no question they've done well with their cylinders," Tubbs said of Continental's OEM cylinders.

Asked why this is so, Tubbs explained that ECI believes Continental cylinders are more likely to be installed in newer or more sophisticated aircraft equipped with electronic engine monitoring equipment that makes it less likely that a pilot would inadvertently overtemp the cylinders. "We've seen some of the older, single-probe CHTs that haven't been calibrated in years and can be 50 degrees in error," Stoller told us.

ECI argues that all of the failures it has seen are due to overheated cylinders caused by improper leaning or poor baffling and not detectable problems in manufacturing quality. When we visited ECI, the company showed us a couple of cylinders with signs of thermal stress and possibly detonation. ECI is arguing for a requirement for datalogging digital engine monitors as both a safety-of-flight instrument and a means for tracking engine health.

LOW NUMBERS, LOW RISK?

The FAA's NPRM docket doesn't offer much in the way of risk analysis to back up its claims of a safety issue requiring the removal of 30,000 cylinders. But it's not hard to run some basic numbers. Accepting the FAA's higher failure numbers, the percentage of cylinders that have had head/barrel separations is 0.116 percent. At ECI's lower number, it's 0.06 percent. On a per-engine basis, 30,000 cylinders represents 5000 engines for a per-engine failure rate of one in 263 engines using ECI's figures or one 147 engines using the FAA's higher claims. However, the affected engine population might be larger, since not

WHAT THE AD PROPOSES

The FAA's proposed AD against ECI cylinders indentifies two groups of cylinders defined by serial number ranges. One group (A) is in SN 1 though 33696, the second (B) runs from 33697 through 61176.

The proposed AD would require removing Group A cylinders from service within 25 operating hours if, on the effective date of the AD, the cylinder had fewer than 500 hours, or more than 1000 hours. Group B cylinders would have to be removed from service within 25 operating hours if, on the effective date of the AD, the cylinders have 1000 or more operating hours.

The AD would also require repetitive visual inspections, compression tests, and leak checks for cracks, for Group A cylinder assemblies with between 500 and 1000 hours and for Group B cylinders with fewer than 1000 hours, until they are removed from service, which the AD eventually requires.

The AD would also prohibit installing affected cylinders onto to any engine and would require reporting to the FAA all removed cylinders.

Note that the serial numbers suggest the affected population is larger than 30,000, but other cylinder types not subject to the AD are in the serial number range. In the affected range are about 10,000 cylinders that are already under an inspection requirement under ECI's MSB 06-2 mandatory service bulletin issued in 2006 after manufacturing defects were identified and later corrected. The FAA's new NPRM expands the range of cylinders to be identified, inspected and eventually removed.

all cylinders will be installed in a complete set.

Furthermore, says ECI, a head/barrel separation doesn't necessarily result in a catastrophic engine failure because with five remaining good cylinders, the engine should continue to produce usable power for an emergency landing. ECI also claims there have been no accidents or injuries as a result of head/barrel separations. (We're unable to confirm this independently and a sweep of the NTSB records as far back as 1995 revealed just a handful of accidents related to head/barrel separations for both Lycoming and Continental engines. If head/barrel separations are more numerous, they don't seem to cause many accidents.)

ECI also challenges the FAA's claims on predicting future failures in the affected cylinder population. ECI told us to support the AD's breadth, the FAA appears to have used two statistical models, one called Weibull and the other Crow-AMSAA. Taken together, the two models predicted 15 to 35 head-barrel separations between 2011 and 2013 in the two cylinder populations. But ECI says there have been no separations during that period and none in ECI cylinders manufactured since 2008.

WHAT SHOPS SAY

We canvassed six respected engine shops about their experiences with ECI cylinders. Although reaction to the AD was mixed, none of these shops reported any head/barrel separations in ECI cylinders. Two shops, Penn Yan Aero in Penn Yan, New York, and Poplar Grove Airmotive in Popular Grove, Illinois, told us they've stopped recommending ECI cylinders because of a perceived higher rate of cracking not related to head/barrel separations. But Penn Yan's Bill Middlebrook said he thought the proposed AD was far too broad and an FAA overreach.

"It appears to us to be excessive and over burdensome on aircraft owners, ECI and the industry as a whole. It is already having an effect on our business in that we are flooded with panicked customers who may or may not have ECI product on their engines," Middlebrook said.

Zephyr Engine's Herman Vollrath echoed the sentiment, but in descriptive prose too harsh to print. Only one shop, Certified Engines in Opa-Locka, Florida, thought the AD was justified. Said Certified's Allen Weiss, "Are the cylinders unsafe? I don't know about that word, but we've seen plenty of cracking of cylinders outside the applicable serial numbers," he adds. Weiss says Certified has had "moderate success" with the ECI Titan line, with issues no different than other shops may have experienced. When asked if the AD is justified, Weiss said: "My answer is yes. I wish it was no. This could potentially put them out of business and that's very bad for our industry. I want them to win their appeal because I need them to stay afloat. On the other hand, safety has got to be number one."

RECOMMENDATIONS

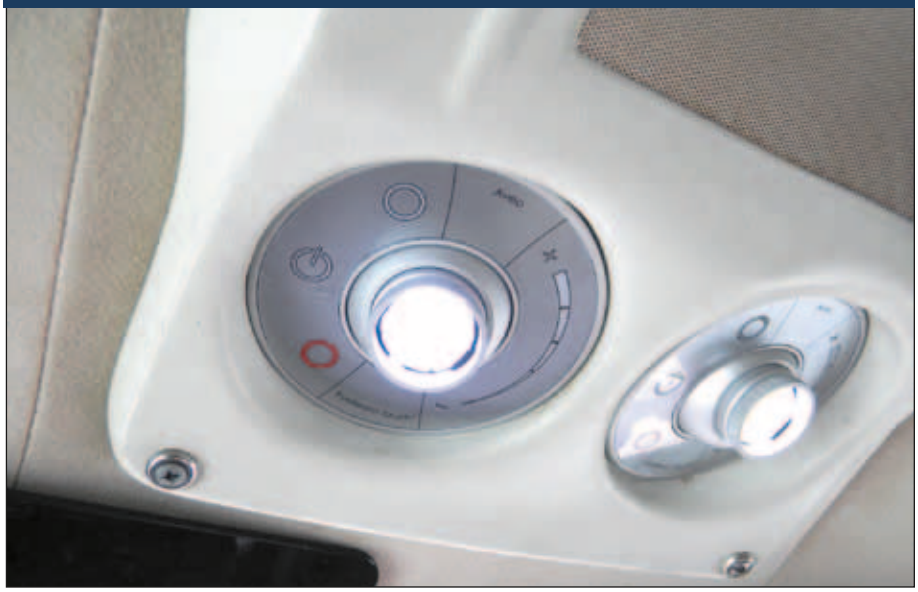
As we go to press in early September, the FAA was at least a month away from closing the comment period on the proposed ECI AD and we can't predict which way it will go. The NPRM has attracted widespread opposition, including from AOPA, EAA and scores of owners and shops.

In the meantime, should you buy ECI cylinders for an overhaul? As recently as 2008, *Aviation Consumer's* cylinder and engine customer satisfaction surveys have revealed favorable results with ECI cylinders. Since then, we haven't seen a notable uptick in complaints about ECI cylinders, so our recommendation is to consult with the overhaul shop before making a decision.

At least two of the shops we interviewed—Zephyr and America's Engines in Tulsa, Oklahoma, both well-known shops—report no problems with ECI cylinders and either use them exclusively or don't steer customers away from them. Although our shop poll didn't reveal a universal ringing endorsement for ECI cylinders, we haven't seen enough convincing data from the FAA (or anyone else) to advise avoiding these cylinders. As for the AD, we're withholding judgment until we've seen more data.

CONTACTS

Engine Components International
800-324-2359
www.eci.aero



The vibration-proof Aveo Eye-Beam Touch overhead swivel lights, left photo, use capacitive sensing touch controls. The white and red LEDs provide plenty of useful lighting and have a linear brightness control.

Cabin Lighting Mods: LED Technology Shines

If you fly at night, effective cabin lighting is essential. We like the Aveo Eyebeam overheads but not the lengthy FAA approval process to install them.

by Larry Anglisano and Dr. Robert M Dodenhoff

You might not think about cabin lighting until you reach for the overhead light switch on a dark night and nothing happens. Maybe you dropped something on the floor or between the seats, or maybe you need to read a paper chart (remember them?).

There's also instrument panel lighting. For many aircraft that still retain the 1970s Royalite plastic overlays, original-equipment panel lighting might be marginal at best—if it even works at all.

Then there's lighting for passenger comfort. Many passengers may be accustomed to high-tech airliner cabin lighting. They won't be impressed when you toss them a Maglite for their in-flight reading enjoyment.

The cabin lighting market for smaller aircraft is stark, mainly due to certification hoops. Still, there are some effective options that can help light up an otherwise dark cabin. Here's an overview of the market that needs more options.

PANEL FIRST

As Dr. Dodenhoff, our resident AME, describes in the sidebar on page 23, your eyeballs are sensitive to any lighting in a dark cabin. Before upgrading the system, you'll want to address the instrument panel first. While some older instrument panels use a single overhead spotlight to illuminate the instruments, there are far better options.

For round-gauge panels, there are several choices. Perhaps the most expensive option is installing internally lighted instruments (they have incandescent lamps that are fixed inside the instrument) or instruments with a lighted bezel (a lighting tray that sits on top of the bezel and shines on the instrument glass). One look at the price of lighted instruments could have you considering other options, especially when upgrading the panel with a PFD—which requires a standby attitude indicator.

Consider Sigma Tek's popular 5000B-series attitude gyro with internal lighting. It has a list price of nearly $1600 (compared to $1200 for a version without lighting).

If you're not about replacing functional instruments just to gain lighting, lighting rings and wedges are the better choice, although not without potentially hefty labor costs. Lighting rings attach to the outer bezel of the instrument and give the appearance of an internally lighted instrument. In some ways, lighting rings might perform better than internally lighted instruments. That's because the ring is designed to direct the light inward, potentially eliminating the parallax and blinding effect created by internal lamps.

Lighting wedges get in the way, however, when it comes time to reinstall instruments during maintenance. That's because the lights are sandwiched between the instrument and the panel, or, if the aircraft has a "false panel" overlay, it's placed over the panel structure and under the overlay.

Nulite Instrument Corporation, makers of the FAA-approved instru-

CHECKLIST

- LED solutions offer more effective light than incandescent bulbs.
- Instrument lighting wedges are a good solution for old panels.
- FAA approval stands in the way of otherwise good lighting solutions.

The Mod1 LED Overhead Console from David Hoffman Products, top photo, is priced at $26 but doesn't include switches or lights. An Air Mod custom interior, center photo, with Osram dimmer-controlled gooseneck reading lamps. Flexible gooseneck lights can also be used to light circuit breaker panels and switches, inset. Light wedges, bottom, provide uniform lighting without blinding.

ment wedges (priced at $76 each), says the product is considered a supplemental light to the original aircraft's approved lighting system and won't require anything other than a logbook entry to be made by a mechanic or certified repair station. Because the lights in the wedges are incandescent, they can often be used with the existing dimming circuit.

Speaking of dimmer circuits, UMA Instruments has a similar lighting concept with their EL-series of lightbezels. The UMA lights, which are available in various colors, eare solid state electroluminescent light strips rather than incandescent bulbs. As a result, they require a DC to AC inverter. Electroluminescent gives more uniform lighting coverage and generates little, if any, heat.

As for avionics lighting, nearly all modern stack-mounted systems have integral lighting, with displays that are controlled by a sphoto-detector for automatic dimming. Some units with color screens allow for contrast and brightness adjustments for ultimate customizing. Radios, including navigational indicators, are commonly wired to an avionics lighting circuit that has a dedicated dimmer.

OVERHEAD OPTIONS

It's a challenge to find a system that has STC and PMA approval for use in certified aircraft. For that reason, it will be up to the installer to determine whether a given product can be signed off with a logbook entry or by field approval. During our research, we found a few products that we think are worth chasing installation approval, if it's required.

Aveo Engineering (the makers of external LED lights) offers several solutions to original-equipment dome lights. The Eyebeam Dome has touch controls with LED lamps that are available in different colors.

For more focused cabin lighting, the Eyebeam Touch has a swiveling enclosure, LED backlighting and capacitive touch controls. There are no mechanical switches to break, and dimming is accomplished with a brightness slider that's also operated via capacitive touch. You can select white or red LED (each housing contains one of each), and the system doesn't require an external power supply (each light operates on 9-to 32-volt input voltage). We think the Eyebeam lights are attractive and add a modern touch to updated interiors, since the units can be ordered in custom colors, however we think the standard anodized black or silver bezels offer a high-end appearance. The Eyebeam NVG is a four-color model—adding green and blue LED lights to the assembly.

Installing the Eyebeam Touch lights isn't necessarily complicated but will likely require sheet metal fabrication for use in headliners that lack a solid mounting structure. The total diameter of the light assembly with the exterior bezel is 3 inches. Aircraft Spruce sells the Eyebeam Touch for $168, and Aveo has a lifetime warranty on the product.

Aveo told us that while the Touch-series products aren't FAA approved, they are currently working with the Orlando, Florida, MIDO to obtain PMA approval. Aveo says FAA field approvals should be successful, as the products have complete DO-160G testing packages from independent EASA aerospace testing labs.

CONTACTS

Aveo Engineering
925-443-9999
www.aveoengineering.com

David Hoffman Products
800-416-8548
www.nulite.net

NuLite Instrument Corporation
800-416-8548
www.nulite.net

UMA, Incorporated
540-879-2040
www.umainstruments.com

Whelen Engineering
860-526-9504
www.whelen.com

Whelen Engineering's 70813 series LED cabin light is designed to replace the common A360 incandescent dome light. It sells for under $200. Whelen says the 70813 is shock and vibration resistant, and the LED lamps are rated for nearly 100,000 hours—more service than any cabin light will likely ever need to provide.

David Hoffman Products in Hot Springs, Idaho, provided the cabin lights for the Rutan Voyager and offers the Mod1 Cockpit Light for the rest of us. His products are standard equipment on the Cessna Corvalis, Lancair Evolution and Diamond models, to name a few. The independent lights are offered in red, green and white LEDs and have swivel-ball positioning.

The Mod1 lights can be installed in the company's Mod 1 Overhead Console housing. The assembly weighs 4 ounces and ships with precut holes with plugs, so you can use all six cutouts or as few as you want. The housing measures roughly 6 inches wide and 9 inches long and mounts in the overhead using four standoffs.

ROLL YOUR OWN LIGHTING

Sometimes a bit of creativity is all it takes to achieve effective lighting, including the use of fiber-optic lighting "ribbons." SPT Superior Panel Technology (www.SPTpanel.com) has the Fibrelite fiber-optic lighting system that can light a large area of the instrument panel (a single LED can illuminate up to three 3 1/8-inch instruments). The lighting ribbon is sandwiched between the panel and the instruments and can be connected to a battery for failsafe operation. A lighting package sells for around $300 and has STC approval. SPT also offers electroluminescent glareshield lighting strips. The strips are 18 inches long and flexible, to accommodate a variety of glareshield shapes.

If you're considering a new interior, include cabin lighting in the planning. Some shops, including Air Mod in Batavia, Ohio, can work creative lighting solutions into the project, to include gooseneck reading and supplemental lighting.

Aveo's Eyebeam Flex is a spinoff on the company's overhead LED lighting products but packaged in a flexible neck with a remotely mounted touch control.

It's important to stress that these kinds of lighting installations could require additional FAA approvals.

A word of caution: some color displays might be too bright for night flying when overhead spot and gooseneck lights shine on the photodetectors. This will send the system into daylight mode, increasing the intensity of the display.

Frankly, we're surprised that upgraded cabin lighting isn't a bigger priority during interior upgrades. On the other hand, it might be, if shops offered more solutions. We suspect many owners don't consider it.

"I couldn't tell you the last time someone asked to have cabin lighting upgraded during an in-house interior project", said Dodd Stretch from Airtex Products in Fallsington, Pennsylvania. According to Stretch, his company usually reinstalls the existing lighting when completing a new interior. He doesn't think the market can even sustain new lighting products. We think it can, if the FAA would ease up on the approval process for installation or more manufacturers would earn STC approval.

NIGHT VISION 101: DIM IS BETTER

Ultra-modern cabin lighting is well and fine but pilots still need to understand the pitfalls of lighting that's either too bright or improperly directed. Pilots are often told to avoid bright lights while flying at night, or at least protect one eye. That's because the eyes' adaptation to darkness is an independent process in each eye. Moreover, night vision can be temporarily impaired if the eyes are exposed to just one second of bright lighting conditions (think twice about turning the overhead spot light on in flight). The exact mechanisms are unclear, but they include a biochemical process.

The retina of the eye contains cells, called rods and cones. The Rods are quite numerous and are found in the periphery of the retina (they also have a high sensitivity to light and are responsible for vision under very dim levels of lighting). The cones are located mainly in the center of the retina and are responsible for distinguishing color.

These receptors, which are stimulated by light, produce signals that are then interpreted as vision. The rods in the eye contain an extremely light-sensitive chemical, called Rhodopsin. A brief exposure to bright light degrades Rhodopsin and the rod is unable to function. As a result, the Rhodopsin needs to regenerate during a long process that can take upwards of 45 minutes of absolute darkness to attain maximum sensitivity after exposure to bright light. This isn't exactly practical or possible in flight—especially sitting in front of bright cockpit screens. Keep in mind that the process of dark adaptation is approximately 80 percent complete after 30 minutes.

Using red lighting in the cockpit helps to preserve night vision, and manufacturers are smart to incorporate them into modern products. The obvious disadvantage, however, is that it's difficult to see red objects. Red light also requires more focusing power of the eye on near objects (the instrument panel, checklists and anything else that requires intense focus). This becomes more of a problem for pilots over the age of 40.

Robert M Dodenhoff, MD, is a senior FAA Aviation Medical Examiner and Assistant Clinical Professor of Medicine. He has an office at Brainard Airport in Hartford, Conn.

Beech 36-Series

Fast, comfortable, well-mannered, six-place traveling machine that's been a market favorite for over four decades.

Since 1968, the 36-series Bonanzas has steadily built a solid record for workmanship, performance, handling and comfort. Prices on the used market reflect the high regard for the airplanes. Easy entry to the rear seats and club seating made them popular with passengers as well as pilots, even though the aft CG limit can make loading a challenge and some turbocharged models are a little light on useful load. Aftermarket mods such as turbonormalizing and tip tanks can turn a 36-series Bonanza into an airplane that can carry four people 1000 NM at 200 knots.

HISTORY

In one form or another, the Bonanza has been in continuous production since 1947, when the first V-tail was built—an astounding fact in itself. The 35 Bonanza was the first high-performance postwar single and was markedly different from the average light airplane of the day. Base price of the first models was $7975 ($33,539 in 2013 dollars).

By 1967, Beech had a gaping hole in its model lineup. Archrival Cessna had been selling its six-place retractable single, the 210, since 1960 and by the end of the 1967 model year had rolled 936 through the factory doors. Cessna also had the 206 for the utility market.

Beech didn't have a truly comparable airplane. The V-tail, S35 Bonanza, introduced in 1964, received a 19-inch cabin stretch that permitted the installation of a fifth and sixth seat. These were called "family" seats, and they really weren't suitable for adults. The company kept working on a true six-place airplane.

The 36 was originally aimed at the utility and charter market that was dominated by Cessna.

For the 1968 model year, Beech introduced a stretched version of the Bonanza, with six seats, a conventional tail like that on the eight-year-old Debonair (redubbed 33 Bonanza that same year) and an aft set of doors. Base price of this first 36 Bonanza was $40,650, which rose to an average of $47,050 equipped ($315,824 in 2013 dollars). That same airplane is now worth an average of $90,000.

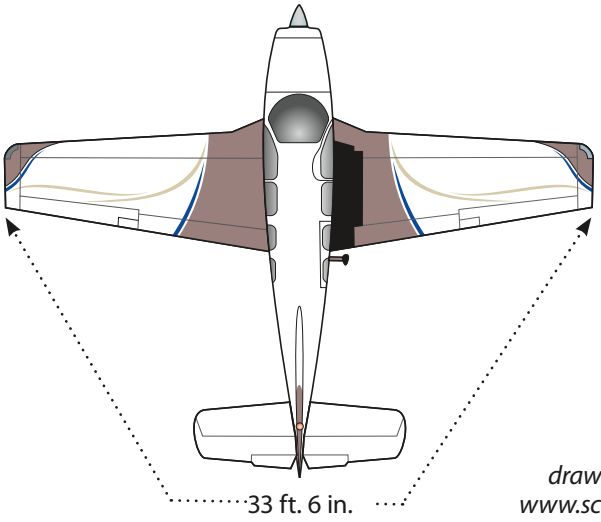
The original 36 was equipped with a six-cylinder Continental IO-520-B engine producing 285 HP and swinging a two-blade prop. It had some limitations compared to the later models: Club seating was not yet available and the standard fuel capacity was only 50 gallons, with 80 optional.

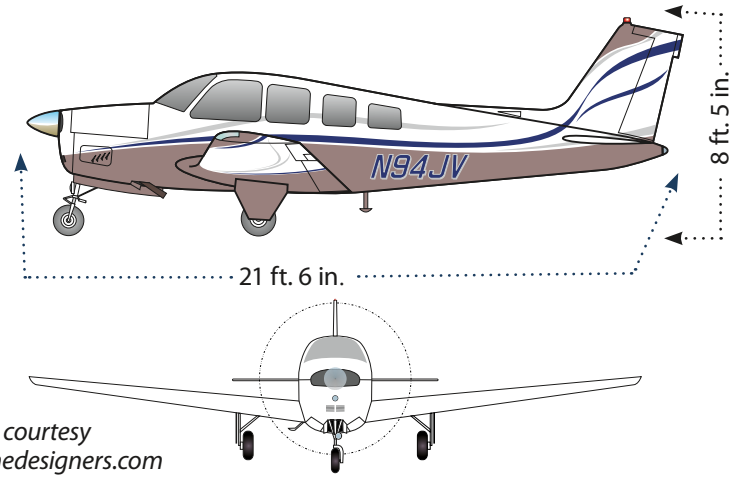
The stretch was accomplished by adding 10 inches to the fuselage of a 33 Bonanza; the 36 was not an all-new airplane. The length was added in such a way that the cabin moved forward, relative to the wing. Empty weight rose only 31 pounds.

The 36 was aimed at the utility and charter market dominated by Cessna, as a good choice for air taxi and cargo hauling. This was in contrast to the V-tail Bonanza, which was sold as an upscale business airplane. The 36 Bonanza could even be flown with the rear doors removed. Of course, the original 36 could be outfitted with options like a more plush interior. In 1970, the A36 debuted with the popular club seating option. The marketing focus changed, positioning the A36 more as a larger version of the other Bonanzas rather than as a utility airplane. Many of the "luxury" options became standard equipment.

In 1973, the fuel system was

BEECHCRAFT BONANZA 36 SERIES



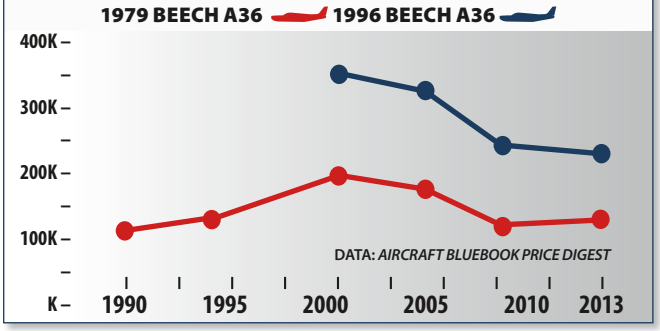


drawings courtesy
www.schemedesigners.com

BEECHCRAFT BONANZA 36-SERIES SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1968 BONANZA 36	285-HP CONTINENTAL IO-520-B	1700	$30,000	50	1620 LBS	170 KTS	±$90,000
1979 BONANZA A36	285-HP CONTINENTAL IO-520-BB	1700	$30,000	74	1405 LBS	168 KTS	±$125,000
1979 BONANZA A36TC	300-HP CONTINENTAL TSIO-520-UB	1600	$35,000	74	1381 LBS	190 KTS	±$125,000
1982 BONANZA A36	285-HP CONTINENTAL IO-520-BB	1700	$30,000	74	1405 LBS	168 KTS	±$140,000
1982 BONANZA B36TC	300-HP CONTINENTAL TSIO-520-UB	1600	$35,000	102	1512 LBS	190 KTS	±$160,000
1996 BONANZA A36	300-HP CONTINENTAL IO-550-B	1700	$33,000	74	1384 LBS	168 KTS	± $225,000
2002 BONANZA B36TC	300-HP CONTINENTAL TSIO-520-UB	1600	$35,000	102	1512 LBS	190 KTS	±$335,000
2006 BONANZA G36	300-HP CONTINENTAL IO-550-B	1700	$33,000	74	1300 LBS	168 KTS	±$300,000
2012 BONANZA G36	300-HP CONTINENTAL IO-550-B	1700	$33,000	74	1300 LBS	168 KTS	±$720,000

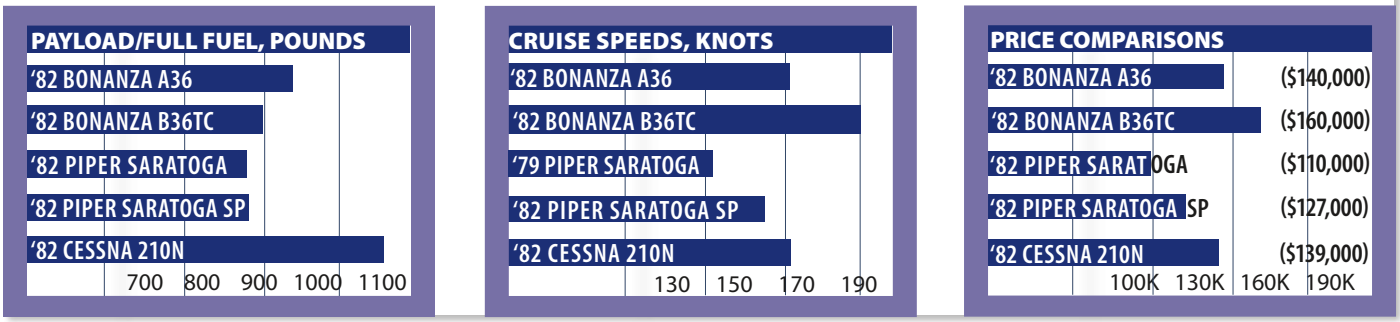
RESALE VALUES



SELECT RECENT ADs

AD 2007-08-08	GEAR UPLOCK ROLLER INSPECTION, REPLACEMENT
AD 2000-08-08	INSPECTION OF V-BAND EXHAUST CLAMPS
AD 97-14-15	INSPECTION OF CABIN DOOR LOCKING HANDLE
AD 97-04-03	INSPECTION OF WING SPAR FOR CRACKING
AD 93-24-03	INSPECTION OF RUDDER FORWARD SPAR ASSEMBLY

SELECT MODEL COMPARISONS



There's plenty of panel space for just about anything desired (above left). Numerous mods are available to enhance the 36-series—this A36 has been turbonormalized and has tip tanks for longer range (below left).

changed. Standard capacity actually went down to only 44 gallons, with a 74-gallon extended range system available. We believe it's highly unlikely that there are any standard-capacity A36s in the fleet. An 80-gallon system was made standard in 1980.

As the years passed, the basic A36 remained largely unchanged, though in keeping with its real-world mission—a personal user's IFR platform—more and more equipment was made standard. By 1976, an autopilot was standard, along with what is now a basic IFR suite.

Responding to the call for turbocharging, Beech introduced the A36TC in 1979. With a 300-HP Continental TSIO-520-UB, equipped with a variable absolute pressure controller that automatically maintained manifold pressure during altitude and temperature changes, the airplane showed a lot of potential. Only 272 were sold in three years, as pilots complained about having only 74 gallons of fuel aboard when the engine wasn't exactly fuel efficient.

In 1982 Beech released the B36TC, which used the Baron 58 wing. It was longer, for better performance at altitude and carried 102 gallons of avgas. The changes punched up range by 50 percent.

The biggest change to the normally aspirated airplane came in 1984, when a 300-HP Continental IO-550 replaced the IO-520. There was an all-new (and very well laid out) instrument panel. Gone was the trademark Bonanza "throwover" control wheel with its massive central column in favor of a pair of ordinary control yokes. With the introduction of this airplane, the base price had roughly quadrupled over the original 36: $160,700 ($361,208 in 2013 dollars) with a current average value of $155,000.

The bigger engine can be retrofitted to older aircraft; a popular mod, judging by our reader feedback. TBO on all of the engines that have gone into the "straight" (non-turbo) 36 Bonanzas is 1700 hours, with the estimated overhaul cost on the 520 currently at $30,000 or so and $33,000 for the 550. An owner opting to switch rather than overhaul not only gets the extra power (for not a lot more fuel burn), but better service reliability as well.

The current G36 (G for Garmin 1000 glass panel) Bonanzas are the only Beech singles still in production; the last F33As were built in 1994.

HANDLING, PERFORMANCE

This is why pilots love Bonanzas. The handling for its intended mission is just about as good as it gets, although the 36 is regarded as more ponderous than the sports-car-like V-tail 35. This is due mostly to the stretched fuselage, although that has its advantages over the 35 when it comes to weight and balance.

The somewhat higher control forces are also a safety feature in that they translate directly to rock-solid stability—desirable in an IFR platform. An airplane with relatively high stick-force-per-G control forces is less likely to depart into a spiral if the pilot has to divert attention for a moment or two from the task of keeping the airplane upright and on course. That's very important in slick, fast singles, as loss of control in IMC causes a significant number of accidents.

Landing is much easier than in some airplanes, although at extreme forward CG loadings (common when flying solo), it requires some determination to raise the nose in the flare and make a smooth landing. We did

Cowling halves open wide for easy access to the engine room, a safety benefit, in our opinion.

notice that fully 18 percent of the most recent 100 accidents involved runway loss of control, most on landing—too much speed on touchdown (overrun) or loss of control on rollout.

One characteristic of the classic V-tail that is blessedly reduced in the 36 is the notorious tendency to Dutch roll in turbulence. The extra length makes for a more comfortable ride.

In keeping with its mission as a serious cross-country machine, performance is respectable. Cruise for the normally aspirated 36 and A36 is about 165 knots, with a 1000 FPM-plus initial climb rate. The A36TC and B36TC will keep up with a Mooney 231 and Cessna T210N, running in the 170-180 knot range in the middle altitudes. Once over 20,000 feet, the longer wing of the B36TC shows itself, making the airplane a few knots faster than the A36TC, with cruise speeds in the area of 190 knots.

Fuel burn for the turbos is high, at least 17-18 GPH, to keep head temps under control.

INTERIOR

The 36 has excellent visibility and is quite comfortable, although headroom and legroom is cramped for taller pilots and passengers. With four aboard, it's a luxury liner, but adding a fifth and sixth person makes things tight. There is a noticeable shortage of baggage space. Some room aft of the third row of seats (watch that CG envelope) was created with the 1979 model. Before that, the only place to stow things was the modest slot between the front seats and the rear-facing center row. There is not enough room to fit six people and six bags on board, a problem for a family that has kids and needs space for stuff.

Up front, the panel is generally well organized, although at the time the earlier 36 Bonanzas were made, Beech was still using the "backwards" or "airline" positioning of the gear and flap switches with gear on the right and flaps on the left. It wasn't "right" or "wrong," but just different. But it has led to many inadvertent gear retractions. Later models have the switches placed as they are in other airplanes.

PAYLOAD

Figure on about 950 pounds in the cabin with full fuel in an A36, but watch the aft CG limit when carrying passengers. The A36TC is not a great load hauler; full fuel cabin load is 700-800 pounds. With six 170-pounders in the cabin, each with 20 pounds of luggage, it is not possible to put any fuel in the tanks and be under gross weight.

The B36TC had a higher empty weight than the A36TC, but gross weight went up by 200 pounds, a net improvement of about one 170-pound passenger. Plan on being able to carry 900 pounds in the cabin with full fuel.

CRASHWORTHINESS, SAFETY

Beech paid attention to crashworthiness and survivability providing a strong "keel" arrangement from the aft end of the cabin to the nose. It's tied into a sturdy rollover structure that provides anchor points for shoulder harnesses for all occupants (four-point style for the front seats). There are openable side windows that function as emergency exits. There is no separate door or exit for the pilot. The fuel tanks are in front of the main spar, which lessens their protection in a crash and means that the center of gravity moves aft as fuel is burned.

The gear is massive. It's the same landing gear used for the Baron, where it has to support far more weight. The military T-34 trainer is basically a Bonanza, and as a result the gear had to be subjected to severe drop tests to satisfy the Pentagon. All that structure underneath the cabin also helps to absorb impact forces in a crash.

Another nice thing about the gear is that it's electromechanical and, if correctly maintained, has proven reliable. Emergency extension is through a simple hand crank located behind the front seats.

The 36 Bonanza also has a simple feature lacking in many aircraft: an easy-to-open "barn door" cowl, making preflight of the engine easy. This is really a safety feature, in our opinion.

The 36 Bonanzas have a much longer CG range than the model 35 series, although not as long as its competitor, the Cessna 210. Both fore and especially aft loading has to be carefully watched. A pilot flying solo with a full fuel load might have difficulty getting the CG aft of the forward limit. Trying to carry six passengers (reduced fuel is necessary)

BEECH 36 WRECKS—A MIXED BAG

In looking back at 100 Beech 36-series NTSB reports, engine-related crashes led the statistics, at 20 percent. As expected, there was a mix of run-of-the-mill engine failures due to catastrophic component failure and sudden stoppage, failed accessories, but far too many that were the result of improper and sloppy maintenance.

The Continental engine in one A36 seized due to oil starvation. The mechanic was blamed for the improper installation of the oil filter. The pilot of a crashed A36TC told investigators that the engine simply blew up during cruise. That's because a connecting rod failed.

Speaking of big bangs, there were several engine failures and subsequent crashes that occurred on maintenance test flights, including one Bonanza that began to shudder and shake violently when its propeller pitch-change pin separated following a reduction in prop speed. The propeller overhaul facility was blamed for that crash.

The NTSB blamed another technician for failing to properly torque and install cotter pins at the number two connecting rod bolts at their attaching point to the crankshaft, which resulted in the separation of the connecting rod in flight and a complete power loss.

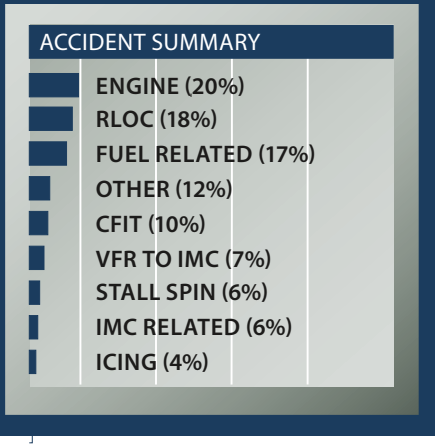
Bonanza pilots also had their share of blame in the NTSB reports we reviewed. That's because RLOC, or runway loss of control, accidents came in second, at 18 percent. Many of these crashes occurred on the takeoff roll, proving that the heavy single demands your full attention once it gets to hauling down the centerline.

Fuel-related crashes came in third, at 17 percent. Many of these were the result of pilots simply mismanaging the fuel in the tanks—especially in models with extended-range tip tanks. But some pilots even have trouble operating the simple left/right selector valve, as was the case with one crashed A36. The surviving passenger in that crash reported that after engine failure at low altitude, the pilot couldn't reach the fuel selector and asked the front seat passenger to handle the chore, but apparently not in time to restart the engine before the resulting crash.

There were, distressingly, some drug/alcohol issues, including a pilot who simply flew his Bonanza into the ground for the purpose of suicide while he was impaired by alcohol. Another pilot found booze and his glass panel G36 Bonanza didn't mix—he crashed it on takeoff. FAA post-mortem tests charted his blood alcohol at 0.365 percent.

Since pilots use their Bonanzas for long-distance travel—and often in the weather—we uncovered the expected crashes where pilots descended below the MDA on an approach and smacked terrain, didn't follow the missed approach procedures and hit something, and others who simply lost control of the aircraft in IMC and hit the ground. Seven percent crashed because they continued VFR into IMC conditions and 4 percent crashed because they continued into icing conditions.

We found no smoking gun among the Beech 36-series wrecks. We did find a remarkable number of fatal crashes—30 in all—often with multiple fatalities. The Beech 36-series may be a trusty, posh traveler but as any aircraft, it demands respect, quality maintenance and proper fuel management.



and any baggage aft of the rear seats may not be possible.

MODS, CLUB

Unlike the V-tail, the 36 Bonanzas being built today are very similar to the first ones off the line: The biggest difference is the engine. As a result, there aren't quite as many mods as for the smaller airplane, though the list is still a healthy one.

As noted above, upgrading the IO-520 to the IO-550 is a popular option when it comes time to overhaul. The STC is available from a wide variety of sources. We have been particularly impressed with Tornado Alley Turbo's (www.taturbo.com) turbonormalization mod for the A36 that adds 400 pounds to the gross weight and makes the airplane capable of carrying four people 1000 miles at 200 knots.

Owners of two-blade props can upgrade to the three-blade airscrew from Hartzell at (www.hartzellprop.com). Also available are various speed mods and even vortex generators.

Approach Aviation (www.approachaviation.com) markets its SmartSpace baggage conversions for pre-1979 airplanes. It gives a much-needed eight cubic feet of baggage area behind the rear seats, with a 70-pound capacity, while retaining the rear hat shelf. Installation is reported to take only a day.

The best source of current information about mods is the American Bonanza Society. It offers service clinics, fly-ins and a good magazine. The ABS is located in Wichita, Kansas (where else?). Find them at (www.bonanza.org). In our opinion, we would not own a Bonanza without being a member of the ABS.

OWNER COMMENTS

We recently acquired our A36 after selling our previous bird, an A35 Bonanza, due to our family having outgrown it. Both aircraft are from the same lineage, and because of that they share the same wonderful flying qualities of which the Bonanza is so well known. But, there is an extra 1000 pounds on the wing in the 36 and you feel it in the controls. In short, flying the A36 is like flying a truck when compared to the A35. While the controls are heavier, they aren't objectionable, and the extra

Clean lines and solid handling have made the 36-series a hit for 45 years.

weight also makes for a much more stable platform. I found that to be the only issue in transitioning from our old Bo.

We routinely true out at 155-160 knots at 10,000 to 11,000 feet. Fuel burn with a stock IO-520 engine at our normal cruise of 20 inches and 2300 RPM averages about 12 GPH. We recently installed GAMIjectors, and that reduced cruise fuel flow to about 10.5 GPH.

Speaking of GAMIjectors, that, in my opinion, is the single best mod any Bonanza owner can do to their aircraft.

The airplanes are solid, reliable machines. For family travel they really have no competition; they are in a class of themselves. They're great to fly, have no nasty handling quirks and are super comfortable for long flights.

Chris Nichols
Via email

I have owned a 1988 B36TC for 14 years. I think it fits the high-performance piston single spot well. I live at 8000 feet in Colorado and often cross the mountains at 13,500 or 14,500 feet, or above, so the turbo engine is useful. It will climb 1000 FPM, even in the teens, and the ceiling is 24,000 feet. Cruise is 170 knots true at a modest power of 28 inches and 2300 RPM at 18 GPH, at 11,500 feet. More power, up to 31 inches at 2400 RPM gives more speed and probably 200 knots true at 20,000 feet.

Pros: interior room and a feel of quality overall. Holds 108 gallons fuel, so range is longer than I can sit. Nice handling in cruise, stronger than some planes, rated utility category.

Cons: the Continental engine, problems with exhaust valves mainly—once had zero compression since the valve face was missing a pie-shaped piece, and had a cracked case.

Two points to know on the B36TC: If not properly rigged and closed, the door can pop open just at lift off. No problem, but the noise is like a firecracker and can scare the pilot into doing something dumb. Do it on purpose on the initial checkout and learn.

It comes new with six seats. If you don't want two people to have to ride backwards, you can turn the middle seats around to face forward. It is easy if you read the pilot manual on how to do it. I removed my rear seats and use that area for baggage room.

Bill Greenwood
Via email

I have a 1976 A-36 Bonanza that I purchased in 2009. I was disappointed with the lack of storage space in

Finding space for baggage can be challenging. This A36 (top), has the rear seats removed and the middle seats facing forward, giving a great deal of baggage space. Pre-1979 models had only a hat shelf aft of the rear seats (middle). SmartSpace baggage conversion (bottom), provides about the same space for pre-1979 airplanes as in later years.

the airplane, as the pre-1979 models were not equipped with a rear baggage compartment.

I had the SmartSpace baggage mod done and have been very happy with the result. The fit and finish are excellent, and it's easy to remove for inspecting the flight controls and avionics in the rear fuselage.

I'm also happy with the other mods to the airplane; the Atlantic Aero engine conversion, tip tanks, turbonormalizing and GAMIjectors.

It's been very reliable—I've only scrubbed a few flights in four years. Operating costs run $150-$175 per hour based on 150-200 hours per year, not including insurance and hangar.

David Crouch
Via email

Our family was growing when aircraft prices plummeted with the stock market, so we took the opportunity to upgrade from a four-place airplane. Our choices were a Piper Lance/Saratoga or a Beech 36/A36. After testing used examples of both aircraft side-by-side at a dealer, the decision was obvious.

The flying qualities and performance of the A36 were nothing short of fantastic.

Transition training was straightforward. I took advantage of personalized training from the American Bonanza Society and highly recommend this approach. With about 1000 hours total time and less than 100 hours in retracts, insurance for the first year was around $3000 for a $1 million smooth policy. It settled to around $2500 as my experience built.

The challenge, we quickly discovered, was baggage space. We could only afford pre-1979 A36 aircraft and, frankly, preferred these due to the increased useful load when compared to later models.

I went to work on creating an STC to expand the baggage capacity of these earlier 36/A36 aircraft so that we could have the same space benefits of the later A36 aircraft. It was a very long, expensive and painful process, but in late 2010 my company, Approach Aviation, was awarded STC SA00304BO for SmartSpace Extended Baggage.

The kit costs $4999 and takes only a day for installation in most cases. Since the cost of a post-1979 A36 is tens of thousands of dollars more than a "baggage-challenged" earlier 36/A36, I think this STC represents an outstanding value in general aviation.

Jeff Simon
Approach Aviation

I purchased a 1999 Bonanza A36TN (Tornado Alley Turbo) approximately five years ago. It is a great traveling machine, especially with the TN conversion and tip tanks. I have 104 usable gallons and at 180 knots, a range of over 1200 NM. I usually fly WOT (wide open throttle) 2300 RPM and LOP (lean of peak), burning 14.8 GPH.

The engine is now 200 hours past TBO and running well. A multi-

The American Bonanza Society provides 36-series care and feeding clinics across the U.S. This one is in Spokane, Washington.

probe engine monitor is a must with the TN, as are GAMIjectors. My CHTs are in the low 300s in winter and low to mid-300s in summer. I try to run at least 60 degrees lean of peak TIT.

My 1999 aircraft with TKS (+100 pounds), air conditioning (+60 pounds) and turbonormalizing (+80 pounds) is heavy at 2810 pounds empty. With full fuel (624 pounds), I have 566 pounds available for people and luggage. So, for long flights it is a good two-person plane, with lots of luggage. Leaving the tip tanks empty, I have four hours of fuel, 720 NM range, and I pick up 180 extra pounds of payload, providing 720 pounds for people and luggage.

The transition from the Cessna 182 was relatively easy; however, there was a definite learning curve when hot and heavy. Fully loaded, my A36TN's gross weight is 4000 pounds. I break ground after using between 1400 and 1900 feet of runway, depending on conditions.

Shops in our area charge anywhere from a low of $2500 to $4000 for annuals on A36TNs. Routine maintenance on the engine and avionics probably adds another $1500-$2500 per year. The aircraft has been extremely reliable and has never let me down on a trip. I attend the ABS (American Bonanza Society) service clinics and take instruction annually from an instructor specializing in A36TNs.

The A36TN is a delight to fly, especially in hard IFR conditions. Controls are on the heavy side, which translates into more stability. I believe TKS is a must-have option in the Northwest due to icing and the fact my aircraft primarily flies in the teens.

Dave Ross
Via email

I purchased my A36 with no hours in type and 500 hours total time. I believe there were three companies willing to insure me. The best deal came from the insurance company that had a relationship with the flight school where I had been flying. The insurance company required an IPC with a specific instructor at the school as my checkout. Insurance was just under $3000, which I hope comes down dramatically since I've logged more than 150 hours in the 10 months since I bought the airplane.

Buying the Bonanza over other planes came down to networking with members of the American Bonanza Society, BeechTalk, CSOBeech, Southeastern Bonanza Society and others, comparing useful load, speed, reports of reliability and durability as well as utility. The extra cost of retractable versus fixed gear became a minor issue when all the other factors were reviewed. I bought the Chevy Suburban of singles. The back doors make flying my dogs and rescued dogs a breeze—I'm a volunteer pilot for Pilots N Paws.

Susan Delgado
Via email

The Aviation Consumer

USED AKRO

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mounts are worn and are allowing the engine to sag. It can result in the alternator being pushed into the nose bowl and the exhaust hitting the front of the firewall as well as crushing the air box.

Prices for the single seaters tend to be between $25,000 and $50,000, depending on condition, age and equipment; figure on $55,000 to $65,000 for an S-2A and from $40,000 to $100,000 for an S-2B.

FINAL THOUGHTS

In buying an aerobatic airplane, keep this in mind: The ragwings should thus be hangared. Storing them outside even in mild climates is a bad idea. Factor that into your buying decision.

Frankly, we like all of them: prices for Aerobats indicate that they have finally gotten the respect they deserve; the Aerobatic Musketeer may be underpriced for its capabilities; Citabrias and Decathlons are the comfortable, reliable old boots of the aerobatic world and, to this day, for the price, there simply isn't anything that compares to a Pitts.

Redhawk

(continued from page 11)

how students will adapt to the airplane's simple operation and single-lever power control. As we've reported previously, the Centurion diesel is car-like in its operation. Although the Redhawk installation, which stems directly from Thielert's original EASA STC, uses a button in lieu of key start, it operates just like the Thielert diesels in Diamond aircraft. With the boost pump running, you merely flip on the engine master, wait for the glow plug annunicators to extinguish and push the start button. In two or three blades, the engine is ticking over. While the Lycoming avgas engine has hot start issues, we've never seen this in the Centurion engines.

The Centurion is equipped with a dual-channel FADEC and throttle by wire to an electronic fuel-injection system. In addition to ship's power from the alternator, the aircraft has a FADEC backup battery. Health checks and pre-takeoff run-up are almost entirely automated. Pushing and holding a Test/Confirm momentary button runs the two FADEC channels through health checks and returns the engine to idle when that's completed.

Unlike the G1000 Skyhawk, engine monitoring isn't tied into the glass, but is presented in two round instruments that are part of the engine package. These display parameters such as oil pressure and temperature, coolant temperature and gearbox temperature in a simple red-yellow-green vertical bar format. Although these instruments look dated by 2013 standards, they're simple and functional.

CONCLUSION

Redbird's short-term plan is to put Redhawk number 1 on its Skyport line and collect data for presentation at its annual training conference in late October. We'll be curious about two things: What kind of block-to-block fuel burns will the Centurion actually deliver in the training environment and how will students take to the simpler single-lever power control and simpler avionics? Both of these strike us as desirable features in a trainer touting itself as state of the art. As for the airplane itself, it presents as new. The upholstery detailing is functional and comfortable, the panel is well designed and it has creature comforts such as vents and visors that are a cut above older training airplanes.

While the performance and load capacity aren't quite up to the avgas model, they appear to be good enough and a worthy tradeoff against the lower operating costs. When and if Continental rids the Centurion of its 600-hour gearbox replacement requirement and pushes the engine TBR to 2000 or 2400 hours, the economics will turn a major competitive corner. Until then, the Redhawk still looks promising, but Redbird will need a year or so of demonstrated real-world data to prove the potential.

FEEDBACK WANTED

LAKE AMPHIBIAN

For the January 2014 issue of *Aviation Consumer,* our Used Aircraft Guide will be on the Lake Amphibian series, the go-anywhere, four-place, mid-wing, water-and-land airplanes. If you've flown or owned one, we want to know about your experience: 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 Lake Amphibian series by November 1, 2013, to:

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