



# AEROBATIC AVIONICS

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## *Needs, Wants and Weight*

S T O R Y   B Y   S C O T T   M .   S P A N G L E R

*A*ir shows and fly-ins are one of the few places where curious cockpit peepers can get close to airplanes. Back in the day, cool airplanes had a knob-studded stack of radios and colorful, complex attitude and horizontal situation indicators that dominated orderly fields of instrument circles. Today, it's the number and size of screens staring back with dark, empty eyes.

If the airplane is flying, its ability to twist, turn and tumble rules cool. Surprised to find few symbols of cockpit coolness in these airplanes, the curious brand them bipolar.

"The guys that are yankin' and bankin' are going to have minimal stuff in there," said Stu

Horn, president of Aviat Aircraft, which manufactures the latest iteration of the iconic Pitts Special, the two-seat S-2C aerobatic biplane. "When you're doing loops and rolls, you don't need a GPS."

In serious aerobatic machines, "minimal stuff" means day-VFR instrumentation and avionics to satisfy today's communication, navigation and surveillance requirements.

According to Horn, in the S-2C, the Electronics International engine monitor is gaining popularity over its heavier analog predecessors. A comm, altitude-reporting transponder, and handheld GPS meet most CNS requirements.

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*LEFT: The panel of aerobatic pilot Sean Tucker's Challenger III is elegantly simple. The airspeed indicator is over the altimeter, the Garmin Area 560 GPS is over the Dynon Avionics EFIS D10A, and the Becker ATC4401 Mode C transponder is over the Becker AR4201 comm. To the right is the Electronics International MVP-50 engine analyzer.* Photo by Brian Norris, Team Oracle

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Aviat also makes the Eagle, a kit-built tandem aerobatic biplane, and sells plans and components for two single-seaters: the Pitts S-1T (also built, on-demand, in a certificated version) and the S-1-11B, the 300-hp Super Stinker.

“If builders ask, Aviat will recommend instruments and avionics,” Horn said. “But, they don’t ask.”

Curtis Pitts first flew his eponymous Special in 1944. It weighed approximately 500 pounds. With 65-horses behind the prop, it had to be light. If something wasn’t absolutely necessary, it wasn’t on the little biplane. Among competitive aerobats, this ideology has persisted as engines grew more powerful, because every extra ounce hobbles horsepower’s ability to overcome gravity and drag.

Balancing a good power-weight ratio is the strength to withstand the force of gravity multiplied.

“All American Champion Aircraft are efficient, eco-

nomical travelers with lights and strobes,” said Jerry Mehlhaff, owner.

Most are rated +5g and -2g, good for everyday loops, rolls and spins. Powered by a 180-hp engine with inverted systems, the Super Decathlon is ACA’s all-out aerobat, good to +6g and -5g.

The load an airplane bears affects all of its parts. Wires and connectors are especially vulnerable to g-force strains, if they are not securely bundled with limited slack and affixed, as appropriate to the structure. ACA closely spaces cable ties on all of its airplanes to make the bundle stiffer. It uses an approach fast stack hub to give avionic connections screw-down security.

Connected to this standard infrastructure is, essentially, a custom avionics installation limited by the customer’s wants, needs and pocketbook.

“We’ve gone to extremes, with the Aspen Pro PFD, JPI 930 engine monitor, and Garmin 530 with a glideslope,” Mehlhaff said. “Customers serious about aerobatics, however, order light: day-VFR with a comm, transponder and portable GPS. Garmin’s 696 in a panel mount is popular. Beyond their 13-pound burden, vacuum gyro systems self-destruct. You might get a hundred hours before you need to rebuild them.

“More expensive electric gyros are just as vulnerable to g-forces. Solid-state avionics, such as Aspen Avionics’ 2.3-pound EFD 1000 and Pro, are immune to gravity, but a hammerhead sometimes confuses it.”

Mehlhaff guessed that the computer doesn’t comprehend a vertical line with increasing altitude and decreasing speed, a no-speed 180-degree pivot, and an altitude loss with increasing speed on another vertical line, “but it comes right back.”

“Aspen units are popular with the aerobic community, even though we do not certify or test them for aerobatics,” said Brad Hayden, vice president of marketing for Aspen Avionics. “But, working with Southeast Aero, the U.S. distributor of Extra aerobatic aircraft, we updated the software for aerobatics because they would fly some whacky maneuvers, a knife-edge ILS or something, that could roll the unit. They had (company) competitions to try and roll software 2.0, but it’s been bullet proof.”

According to Doug Vayda, chief pilot and director of sales at Southeast Aero in St. Augustine, Fla., “Walter Extra designed his 200- and 300-series airplanes as thoroughbred competition aircraft. When it came to weight, he was focused on ounces. When these hardcore, steel and composite aerobats came to America, pilots found out that they were pretty fast and pretty easy to travel with.”

Going places called for a GPS, and dual nav/comms



Photo courtesy of Extra Aircraft

Stacked in the Extra 330LT’s carbon fiber panel are dual Aspen EFD1000s, an Electronics International MVP-50 engine monitor and Garmin’s GNS430 and GTX330, all good to  $\pm 10g$ .



*When cross-country capabilities are more important than weight, American Champion combined a JPI 930 engine monitor, Aspen EFD1000, with Garmin 347 audio panel, GNS430W and GTX327 transponder.*

made operating in Class B airspace easier. Then came gyros.

According to Vayda, “Extras are day-VFR birds, but a DG is easier to follow than whiskey compass aerobically stirred and shaken. An attitude indicator is insurance against unforecast weather.”

Extra mounted electric gyros on plates for easy removal before aerobatics. In Extra’s latest and greatest, “Aspen glass is standard in every 330LT,” Vayda said. “Customers wanted autopilots, but without an HSI you can’t have GPSS. So, we searched for an HSI that could handle aerobatics.

No electro-mechanical unit was up to the Extra’s  $\pm 10g$  capabilities, and there was no place to securely mount the heavy slaving unit. Glass was the only answer, but the Extra’s rapid—and often concurrent—changes in altitude, airspeed and attitude overwhelmed the software.

Southeast Aero talked to all the glass manufacturers, and Aspen invested a year in STCing its unit for the Extra.

“Keeping the boxes where they belonged was another challenge,” Vayda said.

Using a standard tray and making sure the Allen head is extra tight doesn’t work at  $\pm 10g$ . Southeast Aero designed new trays to close tolerances, and Extra

is using a lot of Southeast’s R&D in its new line.

Since the Pitts Special first flew, aerobatics in America has changed with the airplanes. Pilots not interested in competing or performing were drawn to the horsepower, handling and aerobatic abilities.

“They often exercise them in positive-g maneuvers,” Vayda said. “Negative g is a learned tolerance. After trying it once, these pilots would think, ‘Okay, that’s no fun.’ And, that would be the last time they’d do that.”

On deliveries through 2012, Vayda noted, 40 percent will be gyro-free Extras going to hard-core aerobats. The rest will carry Aspen glass. Of the total, 90 percent will have a nav/comm with GPS and a Mode-S transponder for traffic reporting. Roughly half will have XM weather and a nice stereo intercom so they can listen to XM Radio or their iPod.

The iPad electronic flight bag is the newest addition; Southeast Aero installed mounts for them in the last two Extras it sold.

Air-show mounts are hybrids, reliable day-VFR cross-country travelers and serious aerobatic machines that fly maneuvers seemingly beyond any airplane’s capabilities. One such machine is the Challenger III, a custom-designed, purpose-built biplane for Sean

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Tucker, leader of Team Oracle. Now in its first full season, it's powered by an IO-540 pumped up to almost 400-hp. Empty, it weighs 1,225 pounds. During every practice session and every performance, Tucker multiplies this figure 10 times positive and seven times negative.

"Weight is important to Tucker," said Brian Norris, an A&P-IA who's been his operations manager and ferry pilot for 21 years. "Over the years, every time we wanted to add something, Tucker would ask what does it weigh, and I'd say it was negligible. He some-

how decided that 'negligible' equaled 8 ounces, so we saved more than two negligibles with the Dynon Avionics EFIS D10A. It's in the airplane because this is our living. We can't look outside and say the weather is bad, let's not fly today. We have to get to the next show."

In designing the panel, they had to balance weight, what Tucker needs to perform and what Norris requires to get to the next show safely. With its myriad capabilities, the Dynon weighed less than 2 pounds. Still, Norris had to sell it to Tucker. Norris made a pile of instruments the Dynon replaced and itemized its important performance capabilities, such as computing den-

sity altitude, a critical factor in every performance. And, its integral altitude encoder talks to the 250-watt Becker ATC4401 Mode-C transponder (1.65 pounds). It's paired with the Becker AR4201, a 1.48-pound, 760-channel flip-flop comm with a 20-channel memory.

Economics sealed the deal. In marginal VFR weather, Tucker could make his own way to the practice area instead of following a Piper Seneca, the team's parts truck whose operating cost is nearly \$300 an hour. The Dynon talks to the Garmin touch-screen Area 560 GPS mounted above it. Not counting the removable XM weather antenna, the GPS weighs 9.5 ounces.

On the panel's right side is the Electronics International MVP-50 engine analyzer, "an awesome unit that saves a lot of weight," Norris said. Wanting nothing more than the blinking red light, Tucker turns off the woman who alerts the pilot to things beyond their limits. Norris turns on the voice for his three-hour cross-country legs, made possible with a removable ferry tank, because it really gets his attention.

"In any Challenger, there are two things that will never go high-tech: the altimeter and airspeed indicator," Norris said.

Needles moving across a dial tell a more complete story than numbers on a screen. With a single glance, Tucker verifies every maneuver's specific entry speed and altitude, and their trends.

"Everything on the panel has a purpose specific to our mission," Norris said.

And, shouldn't that be the basis for all panel improvements? And, in doing so, doesn't it diagnose the bipolar nature of what makes an airplane cool? □

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