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Jet Blast
John Corneal's SubSonex

Classic Upgrade
Basler's BT-67

Endless Summer
A day in the life at Spruce Creek

Integrated Circuits
Inside the high-tech Berkut

HIS SLEEK FIGHTER-IN-WAITING ESCHEWS the traditional "any color you want as long as it's white" look of most composite canards in favor of a bold three-tone blue and gray camouflage. The paint scheme was inspired by a U.S. Navy F-16 aggressor aircraft painted in former East bloc colors that plays the bad guy in air combat training. In this case, the striking color scheme does the opposite of hiding the airplane — it demands attention.

"I'll watch the parents dragging their kids up and down the flightline and ... they're saying things like, you know, 'One more row of airplanes, then we'll go for ice cream,'" said the airplane's owner, Bill O'Neil, EAA 367019. "Then, when they're about three planes away from this one it changes — the kids are now pulling the parents ... and they jump up and down like, 'This is my favorite!'"

Even more surprising than the unusual paint scheme is the fact that the paint is not the most unusual thing about the *Ultra Raptor*. It's loaded with a stupefying collection of gadgets and features that combine to make it the most high-tech homebuilt around. To understand the airplane, though, first you need to know a little more about the builder.

Bill's self-diagnosed "aviation disease" started when he was about 4 years old.

"I would beg my parents to take me to th airport just to watch, hear, and smell airplanes," he said. "That smell of avgas and je fuel sealed the deal on my love of aviation for life." He went to college at Embry-Ridd Aeronautical University's Prescott, Arizona campus and, after graduation, spent some time at Northrop working on the B-2 Spirit stealth bomber. From there, he went on to work as a project facilitator at NASA's Dryden Flight Research Center at Edwards Air Force Base in California.

During his time at NASA, working on projects like the Grumman X-29 with its forward-swept wings and the General Dynamics F-16XL with its cranked arrow delta, Bill learned a number of lessons that he believes made him a better builder.

"Working with amazingly talented peopl at NASA, I learned many of the constructio principles and the build ethics that remain today," he said. When asked to sum up the philosophy he developed there, he said, sim ply and without missing a beat, "Good enough really just isn't."

Bill's first build project was a Pitts S-1, but then he decided he wanted something a little faster with longer legs.

"When I was looking for my next adventure, if you will, from the Pitts moving on I narrowed it down [to] the Berkut, a Glasair II, and the Lancair 360," he said. "And I wen on a trek to the Lancair factory, visited then but I didn't get to fly in a Lancair. I drove up north to Arlington and visited the Glasair factory, and got a ride in a Glasair II that pretty much sealed the deal."

As for the Berkut, it lost out to the Glasai at that point because the company didn't have full kits available yet. In addition, Bill had never worked with composites before, so the idea of Glasair's builder and community support really appealed to him. He sold the Pitts and started in on a Glasair IIS-RG in 1996 and finished it in time to take it to EAA AirVenture Oshkosh in 2001.

"It was the first airplane I flew to AirVenture. Thanks to what I learned from my NASA friends, I was awarded the Outstanding Workmanship Award," he said. "Of course I felt my Glasair was the best airplane on Earth but after seeing all the Lindy-level quality airplanes I was truly humbled."

Sadly, Bill's prized Glasair was lost a few years later in a forced landing after an

PHOTOGRAPHY BY **JACK FLEET**

Bill "Outlaw" O'Neil (L) and Bruce "Mogas" Marboe can't help but feel like fighter jocks when flying Bill's striking "aggressor" Berkut.

engine failure shortly after takeoff. The landing in an alfalfa field went well, but the rollout into a pair of trees did not. There were no serious injuries, but the airplane was a write-off. Perhaps worse than the damage to the airplane was the blow to Bill's motivation; at the time, he didn't think he'd build again.

Luckily, Uncle Nat had something to say about that. Uncle Nat was a real uncle, but not Bill's. Bill's longtime friend Rob Wilson, EAA 1133294, of Boise, Idaho, is married to Donna, EAA 1133295, Nat's niece. To the rest of the world, Nat was Nathaniel J. Adams, call sign "Blackie," a highly decorated naval aviator who flew F6F Hellcats in World War II. During the war, Nat was a force to be reckoned with, and that hadn't changed 60 years later when the whole gang got together, not long after the forced landing.

"I was attending the Reno Air Races, retelling my incident over and over," Bill recounted. "Uncle Nat listened to my story, then — with a hand on my shoulder — leaned in and asked, 'Okay, when are you starting the next airplane?' Still sore from the crash and my spirits crushed from losing my beautiful Glasair, I said, 'I don't know if I can or even want to.' His hand on my shoulder squeezed a bit harder, and he then asked again with a bit more force, 'When are you going to start the next airplane?' So it didn't take long to ... determine that I just needed to quit feeling sorry for myself and get on with building again."

That proved to be powerful inspiration, and was all Bill needed to get started on the next project — an airplane that would be dedicated to Uncle Nat. It was time to give the Berkut another look.

Most people look at the Berkut and assume it's a Rutan design. Those people are wrong, at least technically, but they're easily forgiven. It's obviously a similar airplane, but with many major changes, including retractable main gear, individual canopies, and a wider cockpit with more headroom. It was developed by Dave Ronneberg, EAA 296648, and the prototype first flew on July 11, 1991. With the required 40 hours flown off, Dave brought the airplane to Oshkosh just a few weeks later.

RETT BROCK

In an article in *EAA Sport Aviation* ("Berkut," December 1991), Dave unabashedly acknowledged the airplane's lineage.

"We've made a lot of modifications, the canopy, the landing gear, the wiring, the engine installation, but the essential airplane that Burt Rutan designed has not been altered in the Berkut," he was quoted as saying. "I still think the Long-EZ is one of the finest airplanes I've ever flown or worked on ... I think the Berkut is a good extrapolation of the Long-EZ, however, and I'm proud of it."

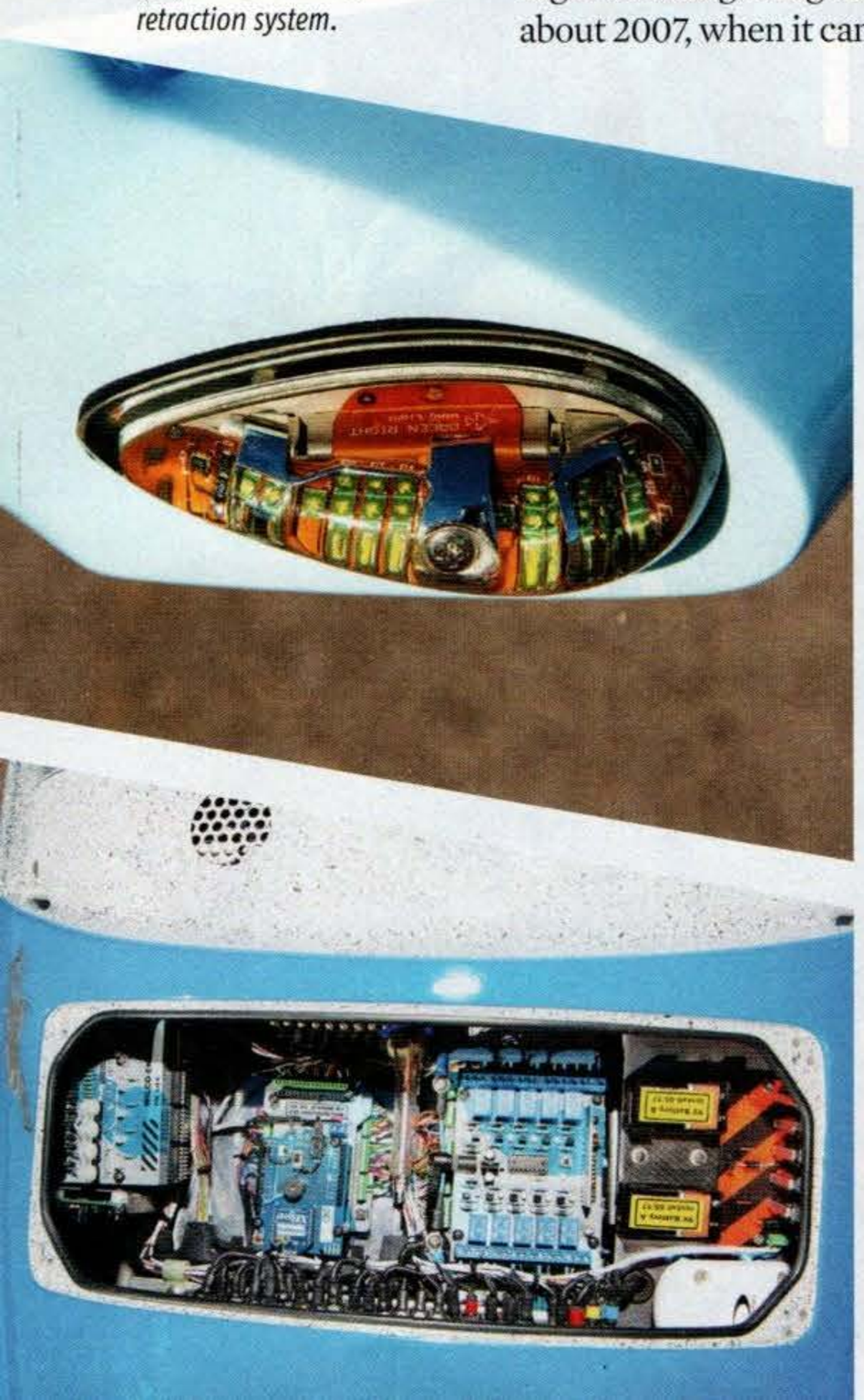
The Berkut, named for a type of golden eagle with a 9-foot wingspan found in Kazakhstan and Iran, was sold as a kit on and off for years, with the rights changing hands several times amid lawsuits and bankruptcies. It's estimated that 75 kits were sold, and that somewhere around 20 of the airplanes are completed and flying. One of those kits had been started, and all the pieces were there, but there was one problem: it wasn't for sale.

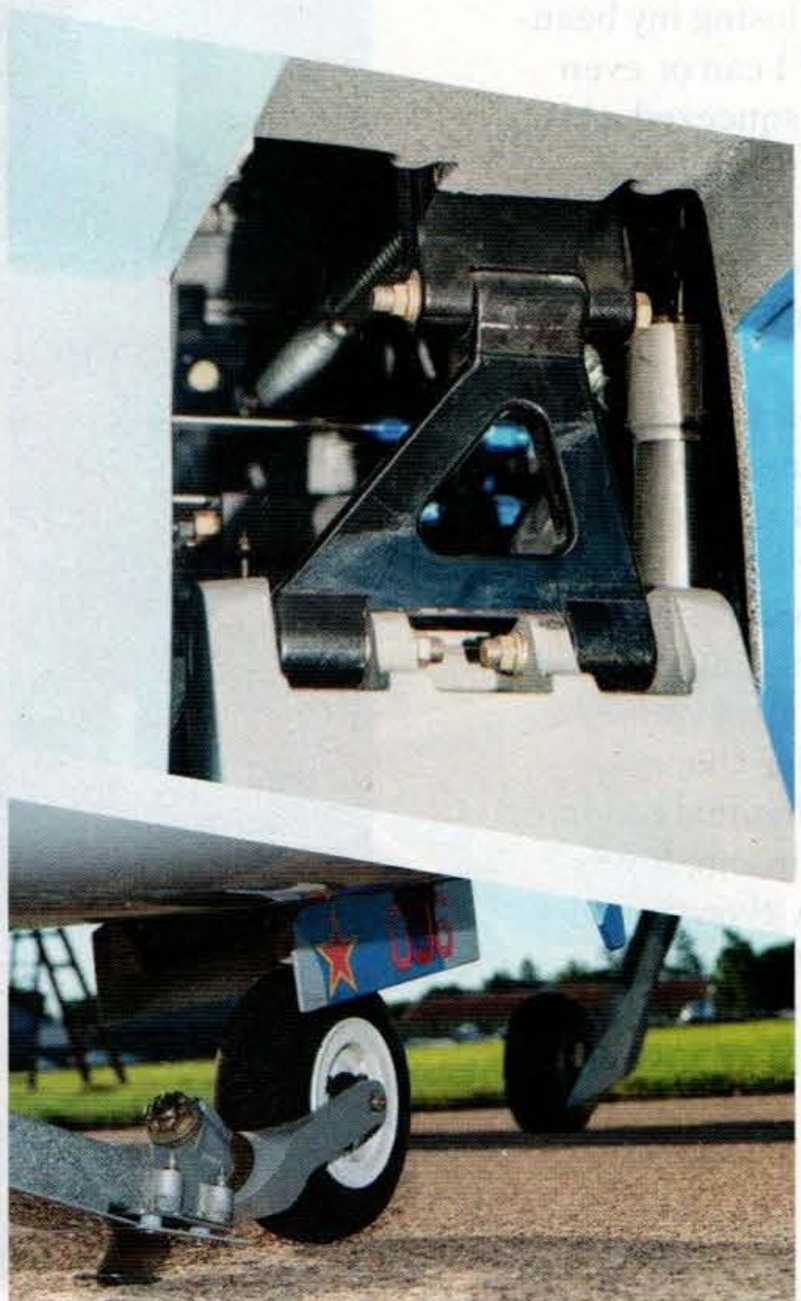
"He wasn't really openly going to sell his airplane," Bill said. "I talked to him, convinced him that I would finish it. I had built a Glasair and got a workmanship award. I promise you I'll get it done. I won't be one of these guys that just lets it sit, so he agreed to sell it to me."

Bill started working on the airplane in 2005, along with his friend and build partner Bruce Marboe, EAA 1162698. Bruce's call sign is "Mogas," as in, as soon as they land, Bruce says, "Let's put mogas in it and go again!" Bill was glad for the composite experience he gained from building the Glasair instead of starting with a project as challenging as the Berkut.

"I'm psyched now that I didn't try to tackle it," he said. "Because even with all of my previous airplane experience it's an extremely difficult airplane to build. I don't believe I would have been able to finish it. I really don't." Bill and Bruce worked on the airplane, getting the major structure together and getting the airplane on its gear, that sort of thing. Then, in about 2007, when it came time to install the canopies, they hit a snag.

With the Ultra Raptor, *it's not the devil but the delight that's in the details. Two onboard computers control everything from the wonderfully complex lighting system to the laser-guided – yes, really – nose gear retraction system.*





"They didn't work properly," Bill wrote in the project's extensive documentation, spiral bound into a hefty volume titled *The Big Book* "Each canopy was aided by a pair of gas-charged struts mounted on either side of the canopy rails. If you didn't apply perfect pressure on both sides of the canopy while openi them, it would jam. Also, you had to be carefu when closing the canopies as the gas struts would resist the closing until just past halfwa then they would accelerate and slam down."

So they decided to use electric actuator instead. That's when Bill's college friend Rob Wilson came along to help figure out how to control the actuators. They started with momentary toggle switches and then went to a system of relays, but both of thos solutions were pretty dated. Then an electr cal engineer wandered in, as they do, apparently, and suggested he use a hobby circuit board, which would be small, cheap and efficient, and could ultimately be used for other applications in the airplane as we Rob didn't know how to work with the boards, nor did he know how to write the C++ code that would eventually be needed. As Bill said later, Rob was "undaunted and oblivious" and from that day forward became an integral part of the team.

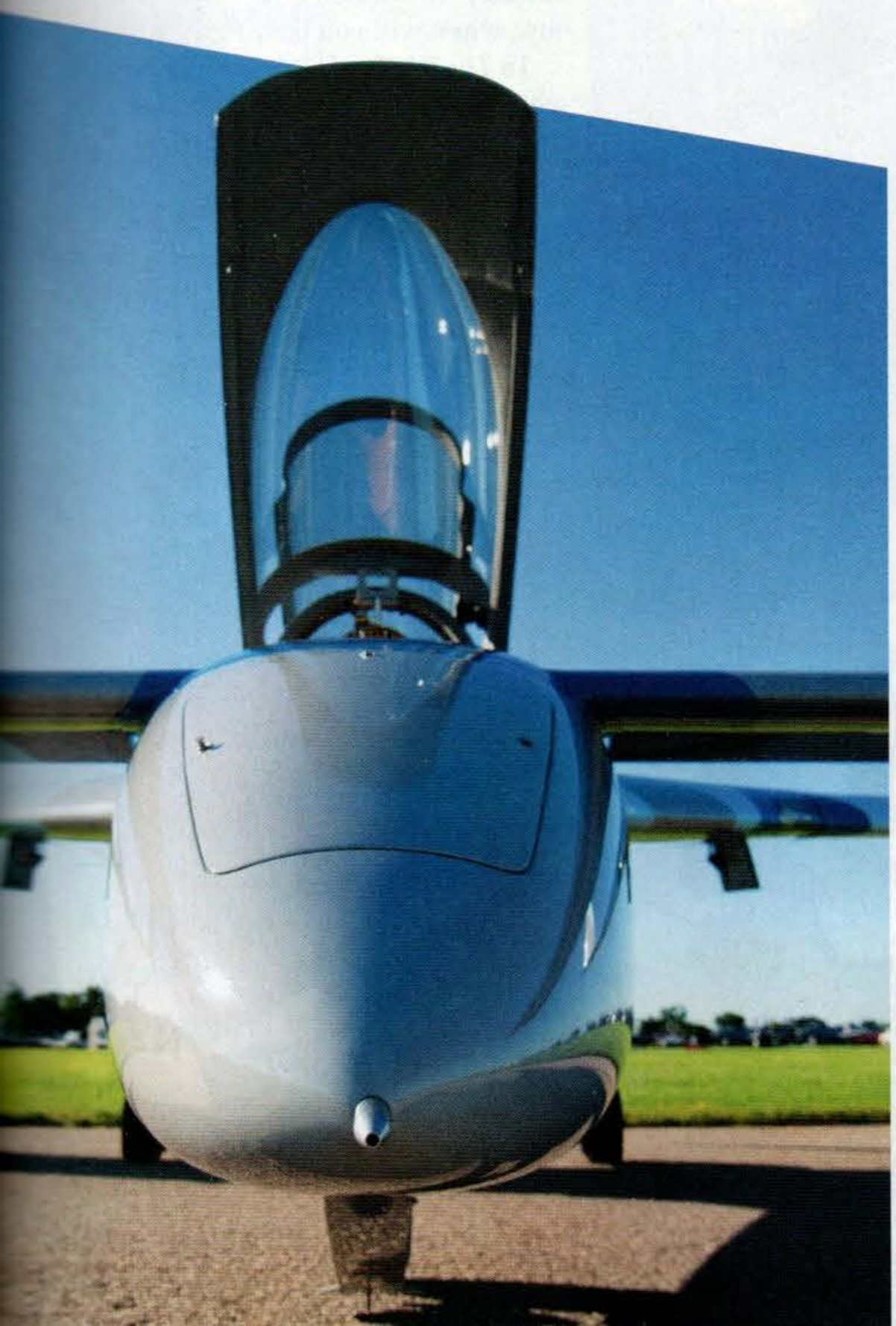
As the project progressed, the solution fo raising and lowering the canopies evolved into a series of high-tech refinements that range from ingenious to hilarious. There ar not one but two onboard computers, Arduin Mega 2560s, which each weigh a little more than an ounce and are about the size of a deck of cards. The computers are named *Nomad* and *The Other*, inspired by a classic *Star Trek* episode ("The Changeling," season two, episode 32). The computers control things like the air show smoke system, the temperature-sensing automatic cowl fan, a cockpit courtesy lights along with several other custom lighting features, including an automated light show that can be triggered when the airplane is on the ground. The computers are also responsible for the playback of a series of audio checklists, with bot Rob and his wife stepping into the Majel Barrett role as the voice of the computer.

The audio checklists start with the preflight. The computers cycle the lights, exten and retract the speed brake, and even move the elevator through full travel using the tri mechanism — the Berkut doesn't have a

PHOTOGRAPHY BY **BRETT BR**

-parate tab for pitch trim, it just cycles the elevator itself. -cidentally, the computers also control the trim rate based on -e aircraft's speed, as the airplane is extremely sensitive to pitch -anges at higher airspeeds. Some builders add a rotary potenti--meter to slow the rate, but that just adds an additional control to -e panel, one that's easy to forget, so in the case of the *Ultra* -ptor, the computer slows the trim rate down when the airplane -flying faster than 100 knots. *Nomad* also handles another safety -ature — automatic gear extension. When the airspeed falls -low a set value, the computer checks to see if the gear is down. -it isn't, the pilot is alerted, and if he doesn't do anything, the -ar is extended automatically. This, like all of the computer-con--rolled features of the airplane, can be overridden by the pilot at -y time, and the onboard computers are not required for flight. But they do make it more fun.

When they get in the airplane, passengers are given a prere--corded briefing that plays over Harold Faltermeyer's "Top Gun -anthem," a song instantly recognizable to generations of pilots. -nd that song is just one of the more than 2,000 tracks available -n a system Bill and Rob call Raptor Radio. Like other aspects -f the project, this one evolved over time. They didn't set out to -uild a 200-knot iPod — the only reason they built audio



capability into the system was for some basic annunciations. Then came the checklists and the briefings, with the music being thrown into the mix simply because they could. Raptor Radio has multiple channels, each featuring music and movie lines, with names like *Classic Rock*, *The Blues*, *The Island*, and one called *Hop 19*, which is strictly music and dialogue from *Top Gun*. *Retro Raptor* rounds things out with a collection of big band favorites interspersed with old time radio programs and vintage commercials.

One of Bill's favorite features is the automated squat system. The Berkut, like other similar canards, is usually parked with the nose gear partially retracted because, without the weight of a pilot, the nose gets light and there's a risk of the airplane tipping back. The nose gear is driven by a jackscrew, and in most Berkuts, the squat is controlled by a momentary toggle switch in the cockpit. You press and hold, and then when the nose is at the right height, you let go. If you inadvertently retract the nose gear all the way, there is a small rubber bumper that the nose will rest on, but that puts the skin of the gear doors just 3/16 of an inch off the ground.

The Berkut's cockpit is clean and surprisingly simple, given all the high-tech upgrades made to the airplane. The nose gear retraction system will lower the nose to a height of six inches by default (R), and must be overridden in order to lower it all the way as in some other canards (L.)

"ANYTHING WORTH DOING IS WORTH OVERDOING."

"So, in a flat hangar that's swept and there's no little rocks or anything, no problem," he said. "But you go to a ramp somewhere in Idaho, and the ramp's uneven or who knows what's out there, you're gonna squat it right down onto something." So, when the *Ultra Raptor* squats, it stops when the nose is 6 inches off the ground. That's low enough to make it easy to get in and out of the airplane, and to eliminate any risk of it tipping, but high enough so that there's no risk of damaging the bottom skin. But how does the airplane know when it's at exactly 6 inches? A timer? They tried six of them, with complicated permutations to change the retraction rate depending on whether or not someone was in the cockpit. The next thing they tried was sonar, which worked fine until the system would get distracted by wind noise. That's when they decided to use lasers.

"Just a short span laser range finder," Bill said. "And it works absolutely flawlessly. Doesn't matter if I'm in it or not, it goes to the set position."

And, of course, all of the not-quite-figurative bells and whistles of the *Ultra Raptor*, the myriad features driven in part by the 17,000-plus lines of code Rob has written over the last 10 years, can all be controlled with a smartphone app.

"A few observers may view some of this aircraft's features as superfluous fluff," Ro wrote in *The Big Book*. "And we would like agree! Our paramount goal is always safet but a little functional showmanship mixed in never hurts! Like a good party, things m have gotten just slightly out of control."

"It's just crazy fun. It's hard to really expla Bill said. "By the time I taxi out and the check lists are done, I'm at the end of the runway, I' ready to go. I close the canopy and the throttl comes forward, we lift off the ground, and th where it's just, like, this is just pure joy."

The airplane first flew in 2012, but it co tinues to evolve, perhaps even more than typical "never finished" homebuilt.

As for why they did it, Bill cites two ad tional sources of inspiration alongside Un Nat. First, his grandfather, who said, "Anything worth doing is worth overdoing Second, he quotes Rob's father, whose insight should be embraced by any home-builder: "If you don't have time to do it rig now, when will you have time to do it over

In *The Big Book*, Bill summed up the "why question" by saying, "We have simply endeavored to do Berkut 036 right."

Mission accomplished. EAA

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AIRCRAFT DATA

AIRCRAFT MAKE & MODEL: Berkut
CERTIFICATION: Experimental amateur-built

LENGTH: 18 feet, 6 inches
WINGSPAN: 26 feet, 8 inches
HEIGHT: 7 feet, 6 inches

MAXIMUM GROSS WEIGHT: 2,200 pounds
EMPTY WEIGHT: 1,150 pounds
FUEL CAPACITY: 55 gallons
SEATS: 2

POWERPLANT MAKE & MODEL: Lycoming IO-360-C1A
HORSEPOWER: 200
PROPELLER: Prince carbon composite
CRUISE SPEED/FUEL CONSUMPTION: 195 knots/10 gph
WING LOADING: 18.1 pounds/square foot

V_{NE}: 304 knots
V_{SO}: 60 knots

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