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Vol.5 No.9 | September 2016

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PHOTOGRAPHY BY **DEKEVIN THORNTON**

GOING SubSonex

Having a blast in Sonex's microjet

BY MATTHEW MCDANIEL

Matthew McDaniel poses with the SubSonex after completing his permanent LOA checkride at the Moriarty, New Mexico, airport (0E0).

Fun is the primary mission of all Sonex aircraft, and it's apparent in every aspect of their machines and their corporate culture.

So, how does one go about learning to pilot a jet that requires FAA authorization to fly, but doesn't have an instructor's seat or a simulator?

BOB CARLTON COMES SCREAMING down the air show line at nearly 300 mph. The high pitch of the tiny PBS TJ100 jet engine, combined with the vivid canary yellow paint scheme, make the entrance of the JSX-2 SubSonex very hard to ignore. Not that anyone at the air show would want to. Like microjet air show routines of the past, the SubSonex act is both a crowd-pleaser and an attention-grabber. Yet, this little jet is no one-trick pony, and its presence on the air show circuit, while exciting, is not what it was designed for. The JSX-2 could easily be the everyman's jet, and I was lucky enough to learn why in the most fun way possible—through firsthand experience studying and flying it.

SPIRITED PERFORMANCE

The density altitude is a whopping 7,000 feet at the runway. While the takeoff roll of the SubSonex is correspondingly long, that is immediately forgotten as the tiny landing gear break free from the runway surface. Even at this altitude, the JSX-2's performance is so far removed from most aircraft in this weight class that I can't help but smile. I quickly get back to business and retract the gear as the airspeed rapidly accelerates toward the maximum gear speed of 125 mph. The gear stows within seconds, and 500 feet AGL passes as I reduce the thrust to climb power (98 percent) and arm the engine's automatic protection computer (more on that later). Climbing at 150 to 160 indicated, I reach maneuvering altitude after only three climbing legs around the airport's perimeter. The altimeter now reads 9,500 feet MSL (density altitude of around 10,500 feet), but I'm only 3,000 or so feet above New Mexico's high desert terrain. As I level off, I wonder to myself what the SubSonex's performance must be like when operating out of Sonex's home airport of Oshkosh, Wisconsin, in the dead of winter. I'm sure what I just experienced would seem positively anemic in comparison.

PHOTOGRAPHY COURTESY OF **MATTHEW MCDANIEL**

If I crane my head around and look over my shoulders, I can see all the way around to the tip of each ruddervator. Yet, I'm still required to do clearing turns before I can begin my stall series, so I do. I'm about halfway through my permanent letter of authorization (LOA) checkride in the SubSonex, and while I am utterly alone in the roomy cockpit, I know I'm being monitored. One video camera records my view inside and outside the cockpit, including the instrument panel and controls, while another uses a wide-angle lens to capture the entire right profile of the diminutive JSX-2, as seen from the right wingtip. On the ground, the DPE monitors my radio calls and waits abeam the runway's touchdown zone (binoculars in hand) to assess my approaches, my go-around, and my ability to land the aircraft precisely. At this point, I have a grand total of two flights and 2 hours of SubSonex experience.

MICROSTEPS TO MICROJETS

Tiny jets have been around for decades. In fact, a fascinating array of them have popped up at AirVenture over the years. However, until recently, flying examples have been essentially limited to novelty air show acts and one-off aircraft originally designed with piston powerplants. The jet engines they used were mostly converted auxiliary power units (APUs) or upscaled RC model aircraft engines. While the former suffered from poor power-to-weight ratios and high fuel consumption, the latter lacked reliability and operational convenience. Additionally, with airframes initially designed without consideration of turbine power, the systems, aerodynamics, and performance limitations can easily negate any advantages that a jet engine (of any variety) might offer. Thus, the microjet that offered any real level of practicality remained elusive.

Then, in 2008, a Czech company with decades of experience building military-grade APUs introduced something different, something game-changing. The PBS TJ100 turbojet engine was a modern, clean-sheet design with exceptional thrust-to-weight ratio and fuel economy. Unlike earlier microjet engines, it incorporated computerized digital control, an integrated starter/generator, recirculating lubrication, and spark ignition. All of which contributed to ease of operation, along with reliable and predictable performance. People noticed. Soon, the TJ100 became very desirable for both small manned aircraft and drone applications. Previously built microjets that struggled with engine reliability for years quietly began to convert to PBS engines. While other applications that had been waiting for just such an engine began to move beyond imaginations and into reality.

The best-known example is Bob Carlton's engineering feat of strapping a TJ100 to the top of his Salto aerobatic glider. He'd been performing air shows in sailplanes for many years and had previously installed retractable RC jet engines, in an attempt to eliminate his need for towplanes. That proved only marginally successful. But, when he burst onto the air show scene in May 2008, with his self-launching Super Salto Jet Sailplane act, he knew he'd finally found the right engine. What he didn't know is that it would be so successful that he'd soon go on to form Desert Aerospace and convert a conventional two-seat motorglider (a Comp-TeST TST-14 Bonus) from piston power to a retractable TJ100 engine, or that he'd be called upon to be test pilot, and eventually air show pilot, for Sonex's ambitious microjet project.

Sonex Aircraft founder and legendary sport plane designer John Monnett set about designing a completely new Sonex. His design would revolve around PBS turbojet power and be optimized to take full advantage of it. By this time, Carlton had likely logged more TJ100 flight time than any other pilot. That, plus his experience converting and flying PBS powered gliders made him uniquely qualified to help John and Sonex on the SubSonex project. Together, Carlton and the Sonex team got their microjet design into the air as the prototype JSX-1, into a production configuration (the JSX-2), onto the air show circuit, and into the hands of their customers. As of this writing, Sonex has two factory demonstrator JSX-2s flying: Bob's air show steed (serial No. 001) based in Moriarty, New Mexico, and serial No. 002, based at the Sonex factory in Oshkosh, Wisconsin. The first customer assembled JSX-2 (No. 003) has been completed, and began its flight-test program, while at least a half-dozen more are in various stages of construction.

THE WHOLE KIT AND CABOODLE

The SubSonex is sold only in quick-build and ultra-quick-build options, which ship with fully completed fuselage and wings; pre-installed canopy; pre-molded fuel cell, interior, and trim pieces; complete landing gear system; and even completed wiring harnesses. Recently, Sonex lowered the price of the JSX-2 airframe kit significantly, while also introducing purchasing options to help spread out the initial costs. The most significant of which is allowing the engine (the most expensive component)to be purchased separately, so its cost can be deferred until the builder is ready for engine installation late in the build process. In reality, small quick-build kits such as the SubSonex leave relatively little work for the builder compared to traditional kits and a tiny fraction of the work required during a plans-built aircraft project. SubSonex kits can include almost everything for a flyable aircraft (minus paint and avionics), even a custom trailer for transporting or storing the aircraft. As with any aircraft, though, buyers have a choice of optional equipment to personalize their jet, not the least of which is the well-proven, lifesaving technology of a BRS ballistic parachute recovery system.

Like the Cirrus Vision SF50, the SubSonex is not a true V-tail. It's actually a Y-tail, with a small stub-rudder below the ruddervators. The SF50 is an X-tail design with two small dorsal fins and control surfaces.

WHEN A DUAL CHECKOUT ISN'T AN OPTION

So, how does one go about learning to pilot a jet that requires FAA authorization to fly, but doesn't have an instructor's seat or a simulator? It's not as tough (or scary) as one might imagine. I'd bet that many builders will elect to hire an appropriately rated pilot to flight test their SubSonex after completion, simply to protect their investment. Still, transitioning into the SubSonex is enjoyable, educational, and relatively stress-free.

First, complete Sonex's T-Flight Transition Training Program in a nosewheel version of the two-seat Sonex Sport Trainer to get a feel for the flight controls and sample the airfoil characteristics common to all Sonex aircraft. Second, log some dual instruction in a two-seat TJ100-powered aircraft to experience the engine operating principals and techniques. Currently, the best option for this is Bob Carlton's TST-14 BonusJet glider course in New Mexico, although other options will inevitably become available in time. After a quick flight with a designated pilot examiner (DPE) in the engine training aircraft (in which a full blown LOA checkride may be an option, but is not required), you can receive a temporary (30-day) LOA to fly your SubSonex and practice for your permanent LOA checkride to your heart's content. Thereafter, you'll be off flying your own jet, and that will have you grinning from ear to ear.

PILOT IN COMMAND: LOGGING JET TIME

As sole occupant, and by default, sole manipulator of the controls, you'll be logging jet pilot-in-command time even before becoming officially rated in the SubSonex. While I had thousands of turbine hours going in, the BonusJet glider and the JSX-2 were the first single-engine jets I'd ever flown. Even so, with focused studies prior to arrival in New Mexico and the training received there, I encountered no real surprises in either aircraft.

The JSX-2 cockpit is laid out in a logical, ergonomic fashion that meshes well with its relatively simple operation. All controls fall readily to hand, and the large combination PFD and MFD will please pilots accustomed to advanced avionics and instrumentation, without overwhelming pilots new to glass panels. In fact, the sensitivity and harmony of the flight controls are nearly identical to those of other Sonex piston-engine models (minus the routine need for anti-torque rudder inputs, of course). The exception is the ailerons, which become heavier at high speeds. Yet, in all fairness, that only really becomes noticeable at speeds beyond the capabilities of a piston-engine Sonex (in the 200-250 KIAS range).

Standard maneuvers such as steep turns, slow flight, and various types of stalls offer no significant surprises. Steep turns are your opportunity to wrack the airplane around a little, and it does not disappoint. The JSX-2 is well-mannered in slow flight, but the pilot must be proactive when so far behind the power curve because a jet engine's available thrust does not change in proportion to its operating speed. For example, reducing the TJ100's rpm 2 percent, from max takeoff (100 percent) to max climb (98 percent), results in a 13 percent drop in available thrust. A further rpm reduction of just 6 percent, from max climb (98 percent) to max cruise (92 percent), results in an additional 25 percent drop in available thrust. So, the difference in takeoff thrust (247 pounds) and max cruise thrust (160 pounds) occurs within the upper 8 percent of engine rpm range. While this may

SONEX JSX-2 SUBSONEX

All speeds in mph, IAS.

Engine: PBS TJ100 turbojet
Engine weight: 44 pounds, including operating fluids
Takeoff thrust: 247 pounds
Engine thrust-to-weight ratio: 5.61-to-1
Wingspan: 18 feet
Length: 16 feet 6 inches
Height: 5 feet 1 inch
Wing area: 60 feet squared
Max gross weight: 1,000 pounds (utility), 900 pounds (aerobatic)
Useful load: Approximately 500 pounds, 235 pounds with full fuel
Wing loading (1*g*): 16.67 pounds/foot squared (utility), 15 pounds/foot squared (aerobatic)
Aircraft thrust-to-weight ratio (at takeoff thrust & MGW): 1-to-4.05 (utility), 1-to-3.64 (aerobatic)
Fuel capacity (usable): 39.5 gallons
Fuel burn: 30-32 gph at max takeoff thrust, 15-16 gph at max cruise thrust
Brakes: Dual-disc brakes on each main gear
Landing gear: retractable tricycle: dual-tire mains, single-tire nose
Cockpit flight controls: Right hand side-stick, left hand thrust and flap levers
Minimum controllable airspeed: 60-70 mph depending on configuration
Stall speeds: 56 mph (V_{SO}), 65 mph (V_S)
Maneuvering speed (V_A): 157 mph at MGW
Max gear speeds (V_{LO} and V_{LE}): 125 mph
Max flaps speed (V_{FE}): 125 mph
Cruise climb speed: 150 mph
Cruise speed: 200-250 mph based on altitude (typically 225 at 14,000 feet)
Never exceed speed (V_{NE}): 287 mph (250 knots) or Mach 0.386 (at 10,000 feet)
Final approach (V_{REF}) full flaps: 85-90 mph
Takeoff distance (at MGW): 1,000 feet at sea level
Landing distance (at MGW): 1,500 feet at sea level

The TST-14 BonusJet glider is currently the go-to aircraft for transition training into the SubSonex. Along with their engine commonality, the landing picture on both aircraft is nearly identical.

The author (center) poses with retired ATC specialist and regional airline captain and current BonusJet instructor Billy Hill (right) and retired FAA inspector and current BonusJet/SubSonex DPE Bob O'Haver (left) after his TST-14 BonusJet permanent LOA checkride.

sound alarming to piston pilots, it is pretty typical for turbojet engines and completely manageable with proper training and experience. Best of all, in that same 8 percent rpm drop, fuel flow drops roughly 50 percent. Stalls offer plenty of aerodynamic warning, no pronounced tendency to drop a wing (even in turning stalls), and yaw control remains excellent. One must account for the delayed response time a turbojet has in its lower power range, while the pitch induced by the high thrust line must be compensated for during large power changes. However, both characteristics are common to the BonusJet trainer, as well, and are easily managed with normal anticipation. Otherwise, the SubSonex flies like most any other aircraft in its weight category, with a similar wing loading.

The landing phase is where the SubSonex differs most for the piston/propeller pilot. The TJ100's residual idle thrust (36 pounds) must be considered. With an aerodynamically clean airframe and no windmilling propeller drag, slowing the JSX-2 to near final approach speed before leaving pattern altitude is necessary (lowering the gear early in the downwind leg helps in this endeavor). Otherwise, the slick little bird accelerates during descent to landing with little the pilot can do to mitigate it. The plain flaps effectively lower stall speed, but without significant drag increase (especially at their intermediate settings). While slipping is permitted and effective, it's not an ideal technique due to the indicated airspeed error it can induce (and, I suspect, prolonged slips could induce engine airflow problems due to the small intake size). Better to slow early and maintain speed while descending via flap and power management. Many pilots will inevitably flare high as they aren't used to sitting a foot above the runway at touchdown. Fortunately, this is another area where the BonusJet training correlates directly to the SubSonex, as both aircraft offer nearly identical landing pictures. With proper flare height and speed stable at 85-90 mph on final approach, landings quickly become predictable and consistent in the SubSonex.

While in the pattern, you'll arm and disarm the engine's automatic protection system (known as the PDB—think protection disabled). PBS incorporated computer monitoring into the TJ100 that can induce an automatic shutdown of the engine if operating limitations are exceeded to an extent that major engine damage is likely to occur if operation were to continue. However, having such an auto-shutdown during a critical phase of flight (such as during a takeoff or go-around) would, obviously, be a bad situation. So, the pilot leaves the automatic protections system off until at least 500 feet AGL and selects it off again upon entering the pattern for landing. By doing so, the computer will allow the TJ100 to exceed any limit in favor of continued operation. The rationale being, of course, that a damaged (but running) engine beats an uncommanded engine shutdown at low altitude. It's the best of both worlds really; automatic engine systems monitoring and protection, but with full pilot override capabilities.

UNLEASH YOUR INNER JET PILOT

The checkride to earn your permanent SubSonex LOA is about as straightforward as any checkride you'll ever take. Because the JSX-2 is intended to be a VFR fun machine, no instrument maneuvers are required (even if you hold an instrument rating). An aborted takeoff must be initiated around 50 percent of takeoff speed (about 50 mph). A balked landing (go-around) is required below 100 feet AGL, after crossing the threshold, to ensure you understand the delay associated with jet engine spool up and the pitching moments involved with large power changes. Climbing at 150 mph, you'll reach maneuvering altitude in a couple minutes and be ready for clearing turns, steep turns, slow flight, and a stall series. Return to the airport for the balked landing, a no-flap landing (probably a touch-and-go), and a full-stop landing within a prearranged portion of the touchdown zone. The most difficult approach is the no-flap, as it's important to plan accordingly to remain on-speed. If you do, the longer landing float is manageable, and you'll be rewarded with a roll-it-on landing.

Want the thrill of flying your own jet, the unadulterated fun of streaking to altitude in a nearly vibration-less airframe, the achievement of earning a jet rating for your pilot certificate, and the quasi fighter pilot experience?

As of this writing, eight airmen have added a permanent LOA of "SubSonx" to their pilot certificate (the maximum of seven characters for an aircraft identifier required the elimination of the "e" as the official FAA designation). Earning the SubSonx LOA will allow pilots to act as PIC in any subsequent models deemed by the FAA to be common type (should evolutionary changes ever lead to a JSX-3 or JSX-4 being introduced, for example). While those eight pilots represent only the FAA, Sonex, and Desert Aerospace staff, and three aviation journalists, the first builder to complete a JSX-2 has recently flown his SubSonex on a temporary LOA and is practicing and training toward his permanent LOA checkride.

Want the thrill of flying your own jet, the unadulterated fun of streaking to altitude in a nearly vibration-less airframe, the achievement of earning a jet rating for your pilot certificate, and the quasi fighter pilot experience? Want it all, combined with builder satisfaction that only an EAAer can fully appreciate? The SubSonex is a sport jet that can provide all that and, with its +6/-3*g* airframe strength and crisp control response, also offer one other piloting option to invoke that Top Gun feeling: aerobatics! Regardless of your flight profile, you'll be hard-pressed to wipe the smile off your face at the end of each SubSonex flight. EAA

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