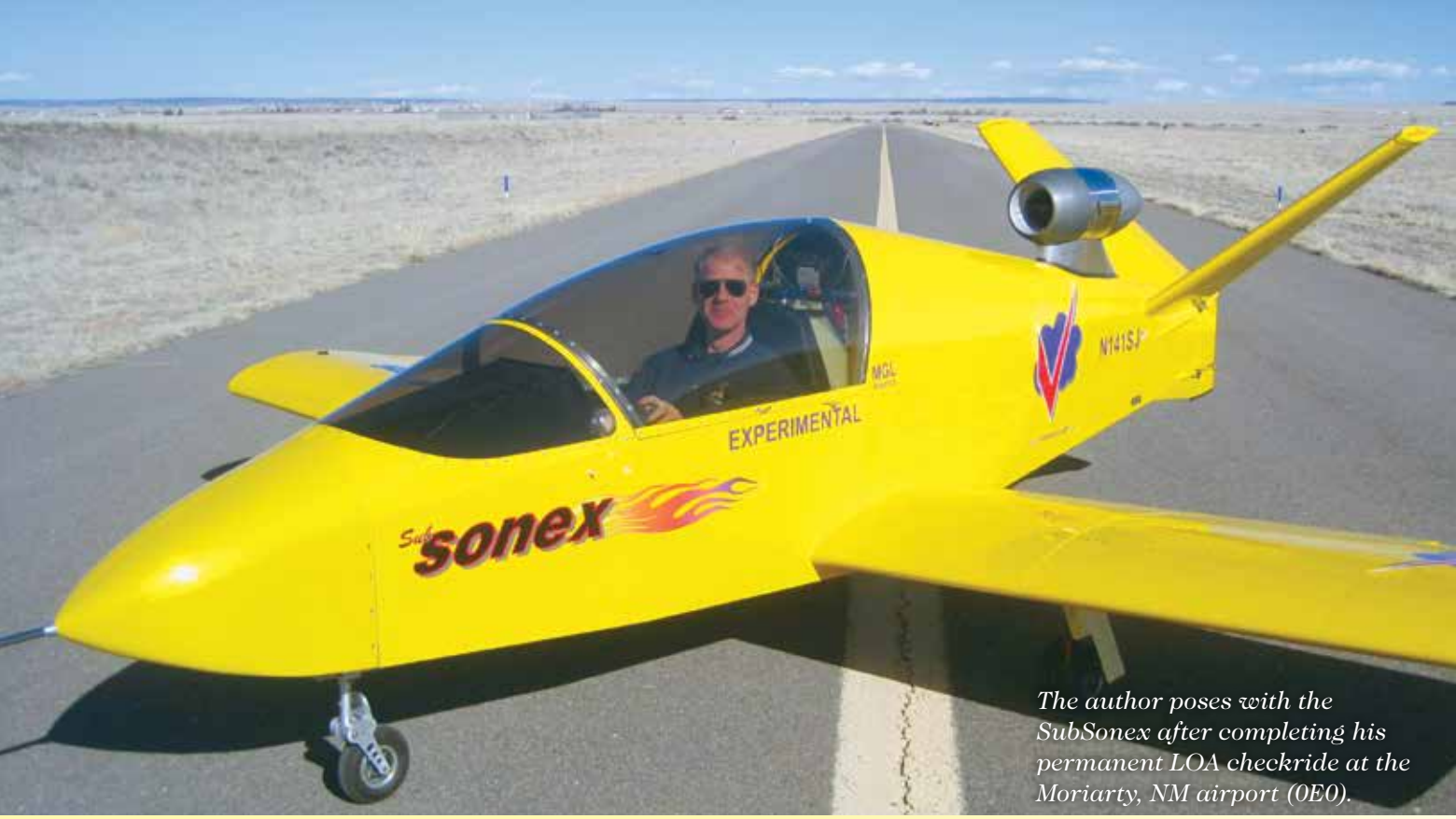
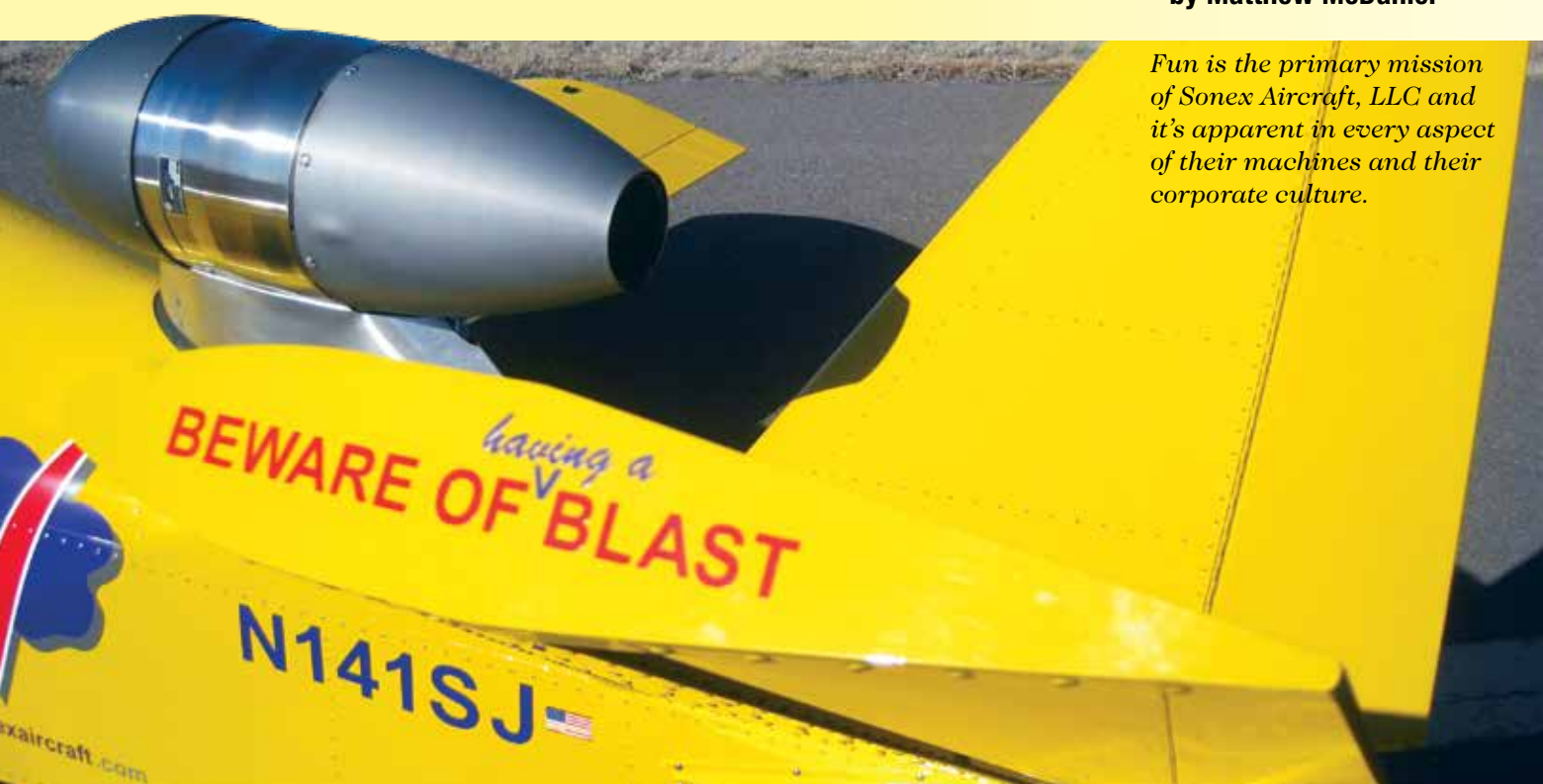


The author poses with the SubSonex after completing his permanent LOA checkride at the Moriarty, NM airport (0E0).

Microjet Fu

Flying the SubSone

by Matthew McDaniel



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

The altimeter reads 9,500 MSL, but I'm only 3,000 feet or so above New Mexico's high-desert terrain. If I crane my head over my shoulders, I can see the tips of my aircraft's ruddervators. Yet, I'm still required to do clearing turns before beginning my maneuvers, so I do. I'm about halfway through my Permanent Letter of Authorization (LOA) checkride in the SubSonex microjet, and while I'm alone in the solitary cockpit, I'm still 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 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 to assess my ability to land the aircraft precisely.

un

x, With a Bonus!

Microsteps To Microjets

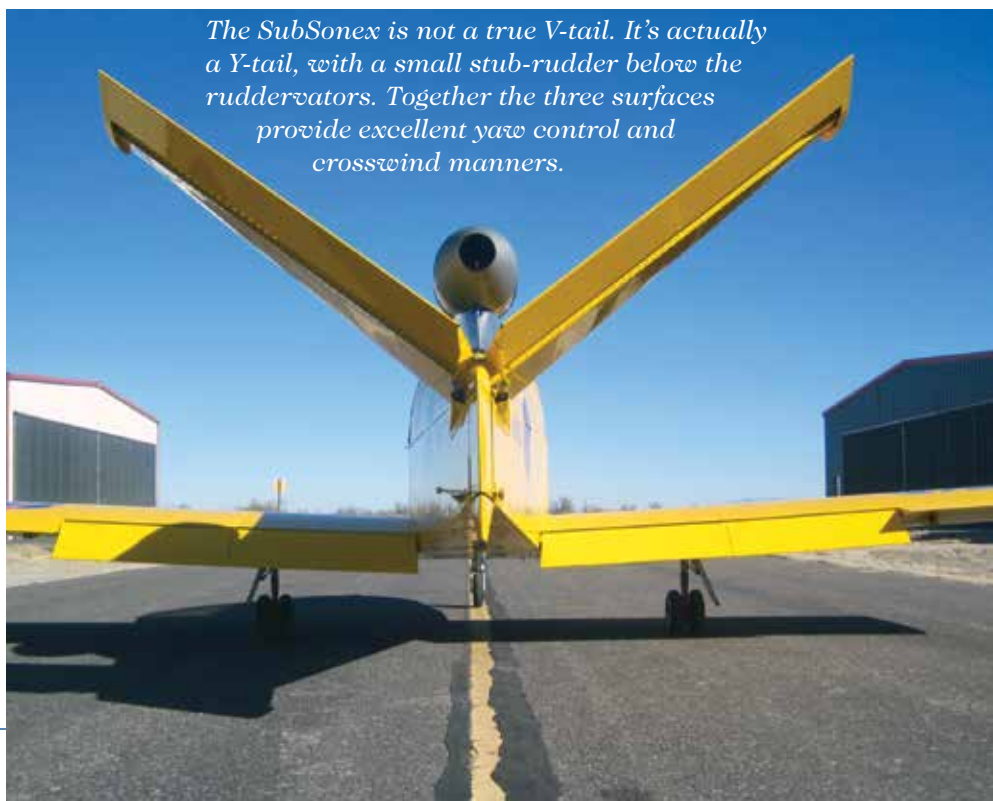
Tiny jets have been around for decades. Until recently, however, flying examples have been essentially limited to novelty airshow acts and one-off aircraft that were originally designed for piston-power. Their jet engines were mostly converted Auxiliary Power Units (APU's) or up-scaled RC-model engines. While the former suffered from poor power-to-weight ratio and high fuel consumption, the latter lacked reliability and operational convenience.

Then, in 2008, a Czech company with decades of experience building military-grade APU's introduced something different, something game-changing. The PBS TJ-100 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. People noticed. Soon, the TJ-100 became very desirable for small manned aircraft and drones. Previously-built microjets, struggling with engine reliability for years, began to convert to PBS engines. Other applications that had been waiting for just such an engine began to move from imagination into reality.

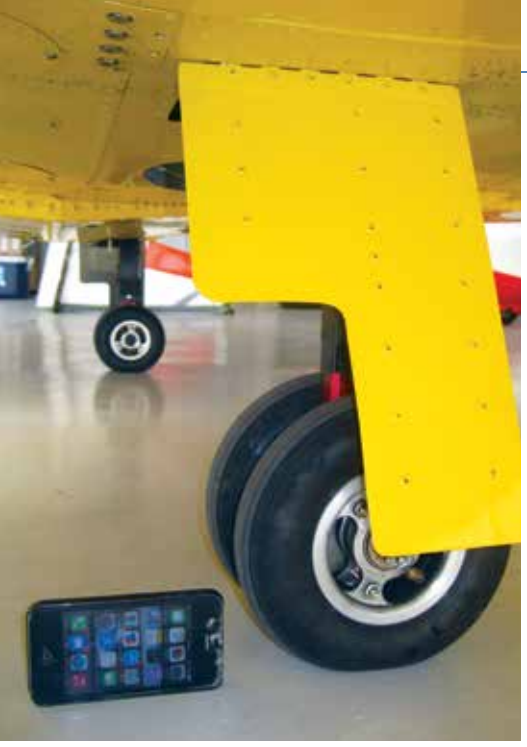
Jet Gliders: An Oxymoron Or Soul Mates

An early adopter, Bob Carlton of Desert Aerospace, engineered the installation of a TJ-100 onto the top of his Salto aerobatic glider. He'd been performing airshows in sailplanes for many years and had previously installed retractable RC-jet engines, attempting to eliminate towplanes. That proved only marginally successful. But, when he burst onto the airshow 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 he'd go on to convert a two-seat motorglider (a Comp-Test TST-14 Bonus) from piston power to a retractable TJ-100 engine. The conversion created a self-launching training glider that didn't suffer from the anemic climb performance plaguing nearly all self-launching gliders (especially at the high density altitudes common at many popular gliderports). With the cooperation of both PBS and Comp-Test, the engine installation included computer components and software developed to make it as pilot-error resistant as possible. For example, safeguards ensure the engine cannot be retracted/stowed until the full shut-down sequence is complete, including a two-minute cool-down, even if the pylon switch is selected to DOWN with the engine running.

The newly-christened TST-14J BonusJet motor glider has become



The SubSonex is not a true V-tail. It's actually a Y-tail, with a small stub-rudder below the ruddervators. Together the three surfaces provide excellent yaw control and crosswind manners.



For size perspective, the author placed his iPhone4® next to the SubSonex's main gear. Each tire is inflated to 75-psi and is about the size of a breakfast waffle. Though short-stroked, the struts provide sufficient shock adsorption for landing.

DATA CHART – All Speeds in IAS		
	Comp-Test TST-14J BonusJet	**Sonex JSX-2 SubSonex**
Engine	PBS TJ-100 Turbojet, 247 lbs. Takeoff Thrust, Standard Exhaust Engine Weight: 44 lbs. including operating fluids Engine Thrust-to-Weight Ratio: 5.61:1	PBS TJ-100 Turbojet, 247 lbs. Takeoff Thrust, Bifurcated Exhaust Engine Weight: 44 lbs. including operating fluids Engine Thrust-to-Weight Ratio: 5.61:1
Wingspan	55.8 feet	18 feet
Length	27.1 feet	16 feet, 6 inches
Height	3.9 feet	5 feet, 1 inches
Wing Area	130.2 ft.²	60 ft.²
Max Gross Weight	1,234 lbs.	1,000 lbs. (Utility) 900 lbs. (Aerobatic)
Useful Load	453 lbs.	~500 lbs.
Wing Loading (1g)	9.48 lbs./ft.²	16.67 lbs./ft.² (Utility) 15 lbs./ft.² (Aerobatic)
Aircraft Thrust-to-Weight Ratio (Takeoff Thrust @ MGW)	1:4.99	1:4.05 (Utility) 1:3.64 (Aerobatic)
Fuel Capacity (usable)	24.0 gal.	39.5 gal.
Fuel Burn	30-32 gph @ Max Takeoff Thrust 15-16 gph @ Max Cruise Thrust	30-32 gph @ Max Takeoff Thrust 15-16 gph @ Max Cruise Thrust
Brakes	Berringer disc brake on single main wheel gear	Dual-disc brakes on each main gear
Landing Gear	Single main wheel, nose wheel for normal loaded configuration, tail wheel for resting condition (unloaded).	Retractable Tricycle: Dual-tire mains, single-tire nose
Cockpit Flight Controls	Dual center control sticks, left hand thrust & spoiler levers	Right hand side-stick, left hand thrust & flap levers
Minimum Controllable Airspeed	45-50 kts.	~60-70 mph (depending on configuration)
Stall Speeds	38 kts.	~56 (Vso), ~65 (Vs) mph
Maneuvering Speed (Va)	81 kts. @MGW	157 mph @MGW
Max Gear Speeds (Vlo & Vle)	N/A	125 mph
Max Flaps Speed (Vfe)	No Flaps. Spoilers may be deployed up to Vne (111 kts.)	125 mph
Cruise Climb Speed	60-65 kts.	150 mph
Cruise Speed	50-60 kts. (thermalling) 57 kts. (best glide speed) 46 kts. (minimum sink speed)	200-250 mph based on altitude (Typically 225 mph at 14,000')
Never Exceed Speed (Vne)	111 kts.	287 mph (250 Kts) Mach 0.386 (@ 10,000')
Final Approach (Vref)-Full Flaps	60-65 kts. (w/ spoilers extended)	85-90 mph
Takeoff Distance (@ MGW)	~500' @ S.L.	~1,000' @ S.L.
Landing Distance (@ MGW)	~1,000' @ S.L.	~1,500' @S.L.

the go-to aircraft for TJ-100 dual instruction. In the process, it has helped create a whole new kind of jet pilot; the jet-glider pilot. Having a glider rating (or any glider experience at all) before flying the BonusJet is not necessary. Takeoffs are relatively conventional and are quick enough to prevent sloppy piloting from developing into real control issues. You're airborne by 50 KIAS and climbing at a very conventional-feeling pitch attitude and vertical speed. Like all gliders, the TST-14 is a rudder-loving aircraft. Pilots quickly learn the meaning of adverse-yaw, if they insist on leading turns with aileron rather than rudder. The yaw-string on each canopy can resemble a windshield wiper as pilots comically wallow around the yaw axis, getting the feel for when to use rudder and how much. Yet, the BonusJet has overall docile handling, in both jet-powered and powerless soaring modes.

Intentionally shutting down your only jet engine in flight feels strange, but the fun is seeing it retract into the fuselage via the rearview mirror, followed by the serene silence of soaring flight (minus the fear of "landing out", should lift prove elusive). The TJ-100 can be extended, started, and warmed-up in less than two minutes. At best-glide speed, the TST-14 loses less than 300-feet of altitude in two minutes!

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.

Back at the airport, the TST-14J does things foreign to traditional glider pilots, such as go-arounds and touch-and-goes! It is necessary to practice landing with power, as the TJ-100's 36 lbs. of residual idle thrust discourage landing in a 1,200-lb. aircraft with 56 feet of wingspan, although spoilers address that issue adequately. If desired, power-off landings are an option (with engine stowed or extended). Either way, flying the TST-14 will make you a better pilot, forcing you to use good crosswind technique and manage your energy state, improving your traditional twin-and-turbine flying.

Those that come into the BonusJet course with an existing Glider Rating can opt for a checkride to receive a permanent Letter of Authorization (LOA) for the BonusJet. The LOA is essentially the same as a jet-aircraft Type Rating, in that it appears on your pilot Certificate by aircraft type. It's unlikely you'll ever earn a "Type Rating/LOA" any cheaper or quicker than in the BonusJet. In fact, if you already operate a small jet, a checkride in the BonusJet can satisfy your annual FAR 61.58 requirement, at a fraction of the cost of doing it in your Citation or Phenom!

When A Dual Checkout Isn't An Option

With the PBS TJ-100's 247 lbs. of thrust propelling the project, Sonex Aircraft moved its SubSonex single-seat microjet design from the prototype stage (as the JSX-1) into a production configuration (the JSX-2), then onto the airshow circuit (flown by Bob Carlton) and into the hands of customers. As of this writing, Sonex had two factory-demonstrator JSX-2's flying; Carlton's airshow steed (Serial #001) based in Moriarty, NM, and Serial #002, based at the Sonex factory in Oshkosh, WI. The first customer-assembled JSX-2 SubSonex (#003) has been completed and has begun its flight test program, while at least a half-dozen more are in various stages of construction.

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 simulator? It's not as tough or scary as one might imagine. While many builders will elect to hire

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.

an appropriately-rated pilot to flight test their SubSonex, simply to protect their investment, transitioning into the SubSonex is enjoyable, educational, and relatively stress-free, especially for pilots accustomed to operating complex/high-performance aircraft.

First, complete Sonex's T-Flight Training Program in the two-seat Sonex Sport Trainer, to get the feel for the flight controls and sample the airfoil characteristics. Second, log some dual instruction in a two-seat TJ-100 powered aircraft, to experience the engine operating principles and techniques. Currently, the best option is Bob Carlton's TST-14 BonusJet glider course in NM, although other options may become available in time.

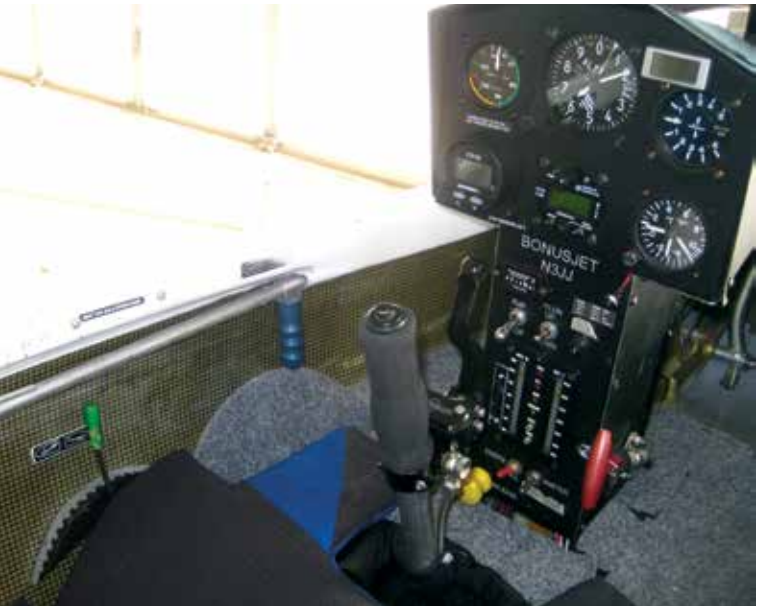
After a flight with a DPE in the engine training aircraft (a full-blown LOA checkride is an option, but is not required), you can receive a temporary (30-day) LOA to fly your SubSonex and practice for your permanent LOA checkride. Thereafter, you'll be off on a quasi fighter-pilot experience that will have you grinning from ear to ear.

Pilot-in-Command: Logging Microjet Time

As sole occupant and, by default, sole manipulator of the controls, you'll be logging microjet PIC time even before becoming officially rated in the SubSonex. While I had thousands of turbine hours going in, the BonusJet and JSX-2 were the first single-engine jets I'd ever flown. Even so, no real surprises were encountered. In fact, the whole process was low-key, relatively stress-free, and great fun.

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 Primary Flight Display (PFD) and Multifunction Display (MFD) will please pilots accustomed to advanced avionics and instrumentation. The controls are light and responsive, which may take a few minutes of adjustment if all your recent experience is in cabin-class twin/turbine aircraft. Fortunately, the side stick is controlled with just the wrist, which helps limit any over-controlling tendency. While ailerons become heavier as airspeed increases, in all fairness that only becomes noticeable within the SubSonex's top-end speed range (200-250 KIAS) and even then the forces remain lighter than any cabin-class aircraft I've flown.

Standard maneuvers, such as steep turns, slow flight, and various types of stalls, offer no significant surprises. Even though the JSX-2 is well-mannered in slow flight, the pilot must be proactive when behind the power curve, recalling that a jet engine's available thrust doesn't change in proportion to its operating speed. For example, reducing RPM just 6%, from max climb (98%) to max cruise (92%), results in a 25% drop in available thrust.



The TST-14J BonusJet panel. The lower console is dedicated to the PBS engine gauges and extension/retraction control. On the upper panel, the fuel gauge and voltmeter were exchanged for units appropriate to the jet engine. The left sidewall houses the thrust lever (black), trim lever (green), and spoiler lever (blue). The hand brake lever on the control stick activates the powerful Berringer disc brake on the main landing gear.

Stalls offer plenty of aerodynamic warning, with no pronounced tendency to drop a wing (even in turning stalls), and yaw control remains excellent.

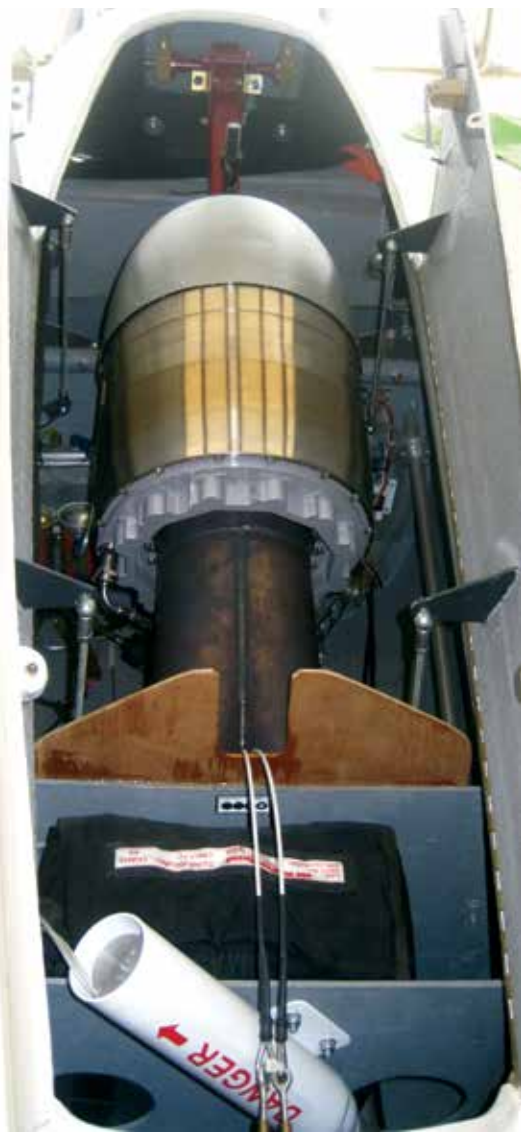
One must account for the turbojet's delayed response time in its lower power range, and the pitch-change induced by the high thrust line during large power changes. Both characteristics are common to the BonusJet trainer as well, and are easily managed with normal anticipation. Otherwise, the SubSonex flies like most any other aircraft in its weight category, with a similar wing loading.

The landing is where the SubSonex differs most for the cabin-class pilot. The TJ-100's residual idle thrust must be considered. With an aerodynamically clean airframe and no windmilling propeller drag, it's necessary to slow the JSX-2 to near final approach speed before leaving pattern altitude (lowering the gear early in the downwind leg helps). Otherwise, the slick little bird accelerates during descent to landing, with little way to mitigate that. 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. Cabin-class pilots will inevitably flare high, as they aren't used to sitting a foot above the runway. 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.

The checkride for the permanent SubSonex LOA is about as straight-forward as any checkride. Because the JSX-2 is intended to be a VFR fun machine, no instrument maneuvers are required. An aborted takeoff must be initiated around 50% 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 of minutes and be ready for clearing turns, steep turns, slow flight, and a stall series. All too soon, it's back 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 no-flap approach is the most difficult. Without flaps to help prevent acceleration, it's critical to plan to remain on-speed. If you do, the longer landing float is manageable and you'll be rewarded with a roll-it-on landing.

As of this writing, eight pilots have added a permanent LOA of "SubSonx" to their 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 allows pilots to act as PIC in any subsequent models deemed a "common type" by the FAA, should evolutionary changes ever lead to a JSX-3 or JSX-4 being introduced.

Want the thrill of flying your own jet, the unadulterated fun of streaking to altitude in a nearly vibrationless airframe, the achievement of earning a jet rating for your pilot certificate, and the pseudo fighter-pilot experience, all while avoiding cabin-class prices? The SubSonex can provide all that, and then some! Plus, with its +6/-3 G airframe strength and crisp control response, the SubSonex offers another piloting option that you won't have in your cabin-class machine: 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. T&T



The fully encloseable engine bay of the BonusJet motor glider houses both the retracted PBS TJ-100 engine (forward) and the BRS ballistic parachute recovery system (aft).

Matthew McDaniel is a Master & Gold Seal CFII, ATP, MEI, AGI, & IGI and Platinum CSIP. In 25 years of flying, he has logged nearly 16,000 hours total, over 5,500 hours of instruction-given, and over 5,000 hours in all models of the Cirrus. As owner of Progressive Aviation Services, LLC (www.progaviation.com), he has specialized in Technically Advanced Aircraft and Glass Cockpit instruction since 2001. Currently, he also flies the Airbus A-320 series for an international airline, holds 8 turbine aircraft type ratings, and has flown over 80 aircraft types. Matt is one of only 25 instructors in the world to have earned the Master CFI designation for 7 consecutive two-year terms. He can be reached at: matt@progaviation.com or 414-339-4990.