FLYING QUALITIES REPORT

BERKUT

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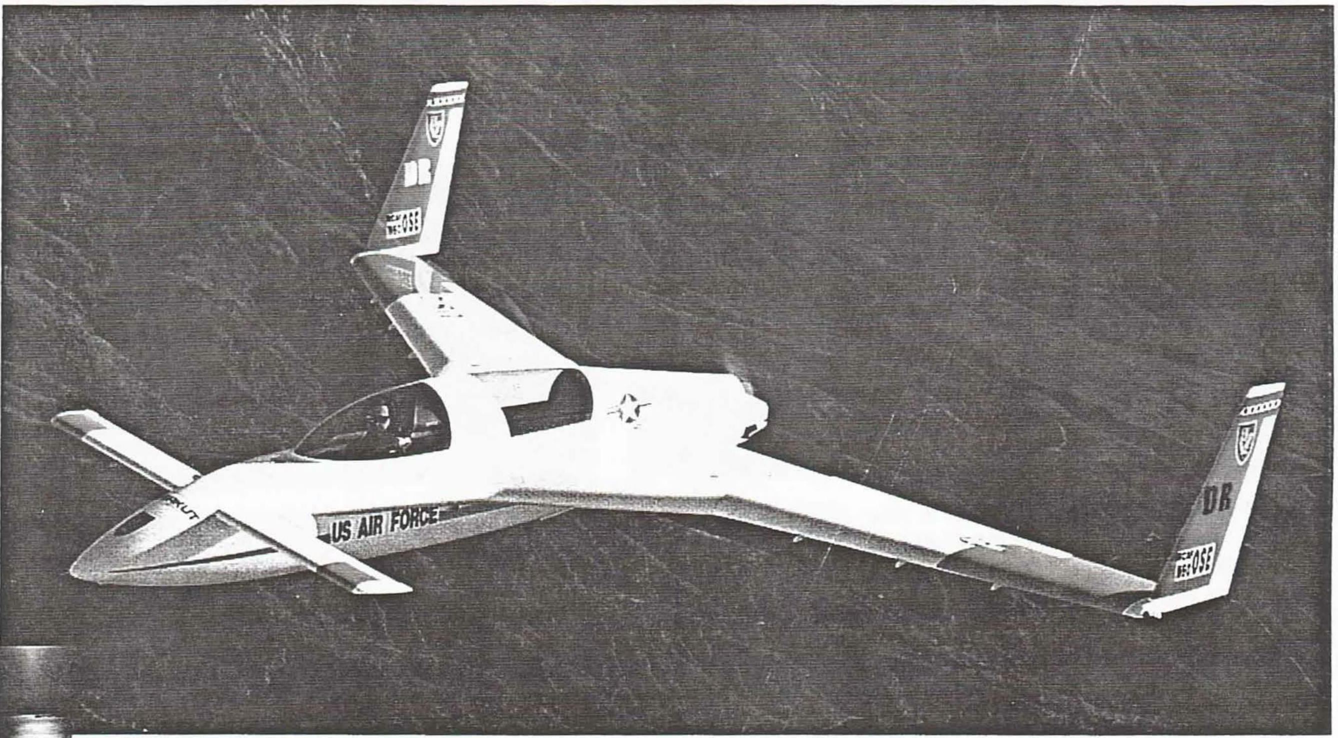


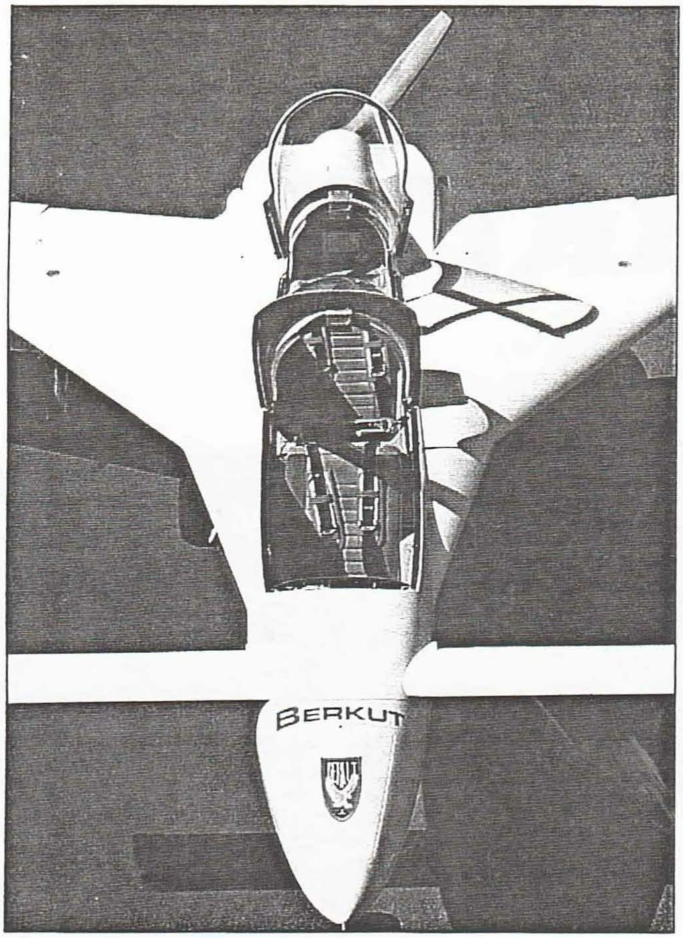
The Berkut is back after a couple of years out of the public eye. Designer Dave Ronneberg kept his crew, vendors and customer base intact through the dissolution of Experimental Aircraft, Inc. and subsequent rebirth of Renaissance Composites, Inc. Although their new Berkut sports a list of improvements, the revision responsible for the most Pavlovian customer response is the installation of the Lycoming IO-540, 260 horsepower engine. Turning a Klaus Savier two-blade, fixed pitch (110") propeller, this powerplant seems a better match for the basic airframe than the original 180 horsepower engine.

Other improvements fall into the pilot preference category. For instance, instead of the awkward hop-up-to-the-canopy-rail cockpit entrance, you just step into the cockpit while the nose is on the ground with the nosewheel retracted. Then flip the landing gear switch from "Kneel" to "Down" to extend the nosewheel after the occupants are aboard. The process is reversed before climbing out. Slick. A clear window in the center pedestal allows the pilot to ensure the castoring nosewheel is straight prior to lowering the nose; damage will occur otherwise. The landing brake is now electrically operated instead of the Wheaties-required mechanical lever on the prototype. There's an improved canopy latching system and lighter lateral (aileron) control feel as well.

The front seat is still cozy, but not confining for an FAA-standard adult. Sills on both sides of the pilot serve as arm rests, although the one on the right must be shared with circuit breakers set nearly flush with the surface. The left sill contains a sectional-size compartment. Baggage locations include the hollow inboard portion, the wings/strakes accessible by the rear seater, a shelf behind the rear seater's head and an overnight bag compartment in the nose.

Baggage is probably not the Berkut pilot's concern. Although the company advertises a 1,500 mile range, the airplane is better suited for fun flying than coast-to-coast journeys. The 30° reclined seat is not adjustable so the right side stick and left throttle are always ergonomically friendly. Adjusting the rudder pedals requires hand tools. While this wrench-turning and cushion-stuffing is an inconvenience to accommodate pilots of different sizes, it also implies a custom fit situation which just adds to the fighter pilot feeling.

The side stick has a fore and aft



travel of about 4", and 45° side to side. The landing brake is a forward-hinged flat panel which extends from the plane's belly under the rear seater's feet. The brake is extended, via a stick-mounted switch, during taxi to help keep pebbles kicked up by the nosewheel out of those intakes. It's also used to add drag in the landing pattern. That's right to add drag. Because the rudders deflect outboard only, the pedals can be independently displaced an estimated 8" when maximum braking is applied. There is no separate toe or heel brake pedal. Brakes are applied by continuing to displace the rudder pedals after full rudder deflection is achieved.

Directional control on the ground is accomplished through differential braking and works well enough to keep the nosewheel within a foot of the taxiway centerline. The brakes are surprisingly effective at maneuvering the airplane through tight turns. Pivot turns are possible, but power must be used to prevent slowing to a halt.

Another nice feature of the Berkut's directional control system is the clear tactile demarcation between full rudder and the beginning of braking. The pilot can easily feel a brake come into play, and does not have to rely on an airplane swerve to let him know. Brake sensitivity is also good, allowing fine modulation without guesswork, and braking effort is fairly light for taxiing tasks with no more than 25 lbs. necessary.

POWER

Takeoff with half fuel and two pilots takes about 15 seconds at a density altitude of 1,600 feet. There is no swerve with full power application, since there's no vertical tail to catch the prop swirl. Rudders become effective for directional control around 40 knots. Pilots of conventional airplanes should remember not to press on both pedals, since both rudders can be deflected simultaneously, adding drag.

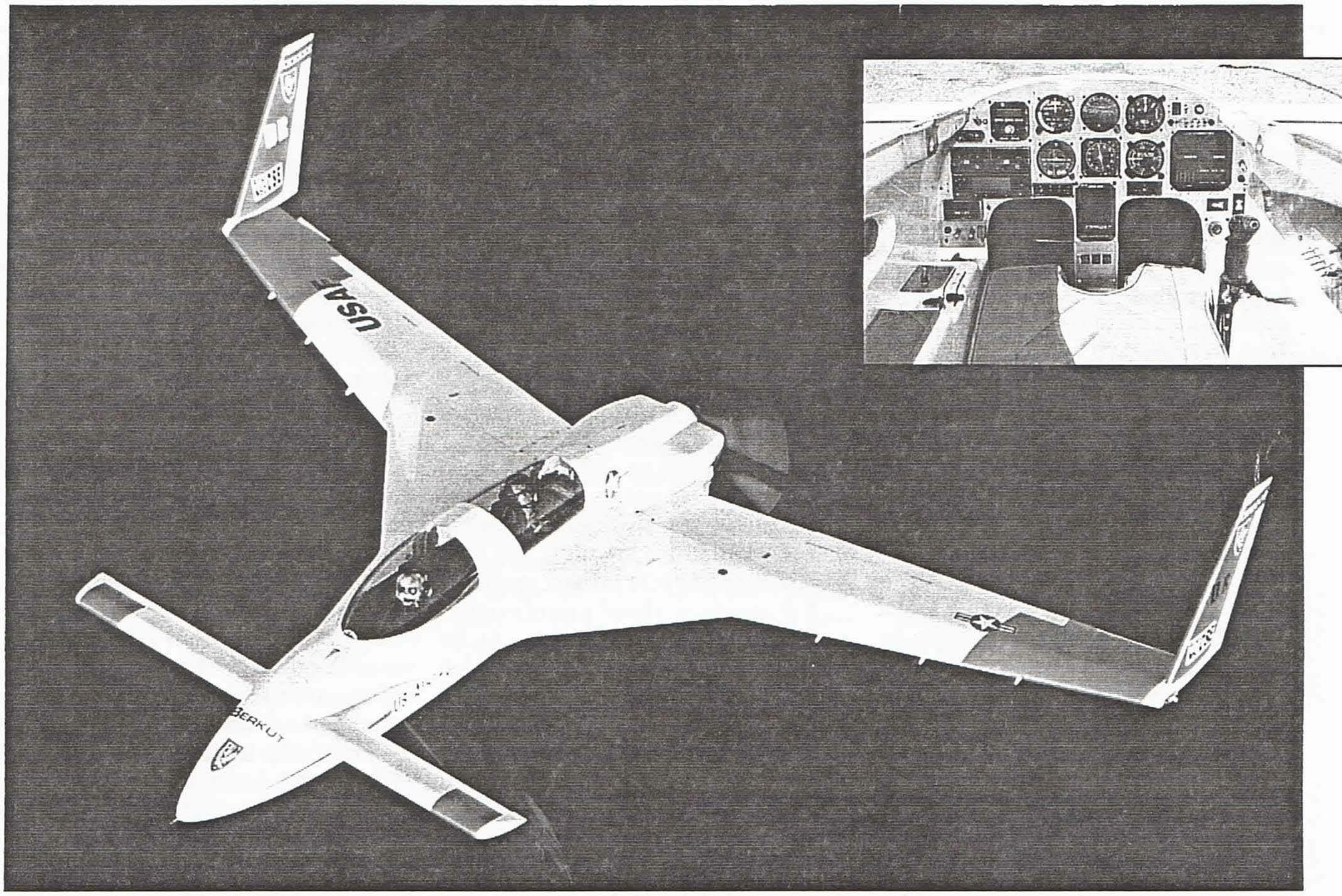
A 5 lb. pull unsticks the nosewheel passing 70 knots. While the trim setting determines the stick pull required, this setting allows a light rotation force and easy capture of the takeoff pitch attitude. As the main wheels lift, the slight disharmony between pitch and roll stick forces becomes apparent. The light roll forces and responsive roll result means tiny inadvertent lateral stick displacements while holding back stick can easily occur. Aware of this lateral PIO possibility, it's not difficult to avoid.

Even with the cruise prop, acceleration is brisk. The 200 knot limit on the landing gear allows enough time to raise them without concern. There is virtually no pitch change when raising the gear. Three green lights indicate all up.

Averaging a 1,500 fpm climb rate at the best rate of speed of 120 knots, the field of view (FOV) is restricted. The combination of canard and nose-up pitch attitude pretty much hide what's in front. A faster cruise-climb should help the FOV. Once level, the FOV improves and the canard doesn't seem as intrusive.

Although the Berkut is a comfortable cruiser, it takes discipline to remain straight and level in this airplane. It'll do it, but the pilot may not want to. Yank it around the sky. Figuratively obliterate clouds and fancied ground targets. Wipe your brow with your imaginary silk scarf, and continue on your way.

There's plenty of power for level-flight acceleration: From 70 kts., the speed doubles in 21 seconds, almost



triples to 200 kts. in less than a minute, and it's still accelerating.

The cruising numbers at a 5,000' density altitude are 20" manifold pressure, 2,600 rpm with the engine leaned yielding an indicated cruise speed of 190 kts. There is a perceptible high frequency buzz from the engine which can only be felt through the pilot's arms resting on the unpadded sills.

PITCH

A stick pull or push of 2-3 lbs. is sufficient to start the nose moving up or down. This breakout force is high enough to preclude inadvertent control inputs without making small intentional inputs cumbersome.

The static stability gradient is shallow. Flying 30 kts. slower than the 190 kt. trim speed takes only a 4 lb. pull. A 5 lb. push holds 30 kts. faster than trim speed. Trimming the airplane works like this. Actuate the switch on the top of the stick. This operates an electric motor which adjusts the centering spring which repositions the stick and therefore the elevator. Still, trimming the airplane is not as time consuming as this gradient and trim system might suggest.

Expect substantial stick forces when maneuvering. With an average stick-force-per-G gradient of about 6 lbs./G, the Berkut is slightly more demanding but in the ballpark with tactical military jets. The ergonomics of a small displacement side stick, however, make those forces seem higher. The force remains low enough for one-handed frolicking, and the gradient helps to discourage higher G than necessary.

When the stick is pulled or pushed, the initial motion of the airplane is quick. It doesn't feel overly sensitive, due to the stick force required, but the initial pitch acceleration is impressive. Continued pitching brings the stick-force-per-G into the picture. The result is an airplane which allows the pilot to make immediate small pitch attitude changes while offering some protection from too much response because of the forces involved. Dynamically, the airplane settles down after just one small pitch oscillation following an abrupt pull or push on the stick. This is the airplane's short period which appears to have a fairly high frequency and heavy damping.

There are no pitch surprises when adding or reducing power. Pulling the throttle to idle from the cruise setting drops the nose slowly (4 lb. pull to hold altitude). A full throttle application raises the nose, requiring an initial 5 lb. push to remain level.

ROLL

A lateral stick force of less than 2 lbs., starts the airplane rolling. It's more sensitive in roll than pitch with seemingly small stick displacements eliciting comparatively high initial roll rates. The stick returns exactly to its zero roll rate position when released, so there is no hunting to achieve a steady bank angle. Once the bank angle is established, the airplane tends to remain there on its own — neutral spiral stability.

There is no obvious adverse yaw during cruise conditions. This is good because the rudders are very effective and over-coordinating is easy to do. Using only aileron for cruising turns works nicely with low stick forces generating reasonable roll rates.

Similar to the pitch case, the initial roll response is followed by a less aggressive continued roll. The initial airplane roll response might be a little on the sensitive side, but most of the roll rate comes from the first half stick displacement. The second half improves the roll performance, but only marginally. An aerodynamic phenomenon called roll damping is a contributor.

Roll damping shows up much more graphically in the abruptness of the roll response. For example, it takes very little time for the airplane to achieve its final roll rate following aileron deflection. Likewise, it stops rolling almost immediately once the stick input (and aileron deflection) is removed. It might even be too abrupt. With such an abrupt roll behavior accurate bank angle captures are easy, but this comes at the expense of pilot comfort (see the accompanying article, **Roll Damping**).

Average roll rates are impressive. Expect 90°/sec.-100°/sec. using full stick and full pedal. A full-stick effort is in the 15 lb. range which is easily accomplished with one hand. The average roll rate drops to 50°/sec. if coordinating rudder is not used.

YAW

Pedal forces are light throughout the operating envelope. A 5 lb. push generates a yaw rate, and the ensuing sideslip (relative wind from the left or right of the plane's nose) is very effective at rolling the airplane (this is called the dihedral effect). Because it takes just a little sideslip to generate a substantial rolling moment, there is no uncomfortable sideforce throwing the pilot against the side of the cockpit.

The combination of light pedal forces and aggressive dihedral effect can lead to over-coordinating. Of course, when the best roll performance is sought, this can be exploited as illustrated in the previous section.

There is another dynamic airplane response to sideslip called the Dutch roll which is a yaw/roll oscillation. In the Berkut the Dutch roll is very lightly damped as indicated by at least 6 or 7 nose swings and bank angle changes once a sideslip is created. These oscillations are more roll than yaw, and each cycle takes 3 seconds.

Fortunately, these coordination and Dutch roll annoyances can be avoided by minimal rudder use which works out nicely for cross country flying. When aggressive rudder use is desired, suppression of the Dutch roll can be fairly easily accomplished with a well-timed rudder deflection.

With the power and trim set for cruising conditions the 1 G stall characteristics are classic canard. All controls continue to function as expected during a slow deceleration. Airplane response is progressively more sluggish and adverse yaw is more pronounced as the speed slows. Neither rudder nor aileron inputs are needed to maintain wings-level in smooth air.

At 70 kts. a stick pull of 10-12 lbs. places the airplane about 12° nose-up. At 65 kts. the plane begins a pitch bobble of 3°-4° every 1.5 seconds as the canard loses lift then recovers when the nose drops. With 20 lbs. of back stick, 62 kts. is indicated and the pitch excursions are about 5°. Further back stick, up to 35-40 lbs. full aft limit, doesn't slow the airplane any further. It settles into a steady 62 kt. minimum airspeed climb of a couple of hundred feet per minute, and the pitch bobble decreases to an almost imperceptible level. Pitch attitude here is about 10° nose-up.

Recovery is immediate with aft stick relaxation, and can be accomplished with little or no altitude lost without adding power.

LANDING PATTERN CONDITIONS

Landing gear extension speed is 200 kts. Lowering the gear at 150 kts., the mains lock down 5 seconds after the switch is thrown but the nose gear takes 16 seconds at this speed. There's a small nose-down pitch "bump" which accompanies gear extension and is countered with less than 5 lbs. of stick pull to hold altitude.

The Berkut is a clean airplane, aerodynamically speaking, even with the gear down. Extending the landing brake (6 seconds) adds drag which helps the power-to-airspeed connection. It also inhibits engine cooling, but not until 15 minutes or so have passed. With the brake deployed a trace of a high frequency buzz can be detected in the cockpit.

A level, 90 kt. pattern speed takes 16" manifold pressure and 1,750 rpm. The canard is slightly below the horizon here, obstructing the forward/downward view.

Adverse yaw is the first big change noticed from the cruise situation. A rapid 1/3-1/2 lateral stick displacement swings the nose 5°-6° the wrong way. Coordination is easier than the cruise case, and roll starts and stops are much less abrupt.

There isn't much change in the stick feel in pitch with 2 lbs. needed to move the nose. The lateral stick forces lighten considerably. As little as 1/2 lb. starts the Berkut rolling. This small force displaces the stick 1/2"-3/4" and results in a 3°/sec.-4°/sec. roll rate. After that there's a "feel bump" of 2 lbs. or so which begins the real stick force increase. Full lateral stick displacements can still be tirelessly performed one-handed.

Under these flight conditions the Dutch roll is even more lightly damped. A pedal kick (to create sideslip) fires off an oscillation which is much more roll than yaw and persists for at least four complete cycles, each one taking three seconds. Reigning in this oscillation takes a little pedal dancing, increasing the pilot's workload.

Since adverse yaw creates sideslip which causes the Dutch roll to begin, coordination is essential for large or abrupt aileron deflections. Interestingly, if the bank angle change required is not immediate or aggressive — like downwind to base and base to final, small aileron deflections can be used to generate slow roll rates obviating the need for rudder use for the most part.

For more substantial roll rates the minimum answer is rudder coordination, and best roll performance requires over-coordinating and perhaps even leading with rudder. For example a full stick, aileron-only roll averages, at best, 20°/second, but adding full rudder improves the roll rate to 40°/sec.-45°/sec. which is plenty for the landing pattern. Without rudder the Dutch roll can be observed during the roll as a slight roll reversal as the plane proceeds in the desired direction.

In the pitch axis static and dynamic stability characteristics remain positive. Slowing from the 90 knot trim speed to fly at 70 kts. takes a 5-6 lb. stick pull, and 120 kts. requires a 3-4 lb. push. Throughout this range, the rate of descent is not significantly affected by airspeed — a couple of hundred feet per minute at most.

Level 30° and 45° turns can be performed with 4 and 8 lbs. of back stick, respectively. There is still just one pitch overshoot following an abrupt stick input.

The dirty 1 G stall is essentially identical to the clean stall, including airspeeds. Accelerated stalls performed at 90 kts. deliver the airplane to a 50° bank angle with 12-15 lbs. of back stick. The pitch bobble is evident at the same 1.5 sec. interval, and the rate of descent is minimal. Controls operate in their proper sense in all three axes even in the stall, and recovery remains prompt.

LANDING

Although the landing gear is down and the landing brake is extended, the throttle must still be pulled to within 1/4"-1/2" of the idle stop to keep the speed under control. Flying downwind no faster than 90 kts. is important. Once the descending turn to base is begun, a close eye on the airspeed indicator is necessary to avoid getting fast. Target airspeed for base is 80 kts. and final is 70 kts.

Easy turns to base and final make life easier since rudder use is basically optional. Making a line-up correction on final, however, doesn't allow this luxury. Rudder must be used to achieve the roll rate necessary for an expeditious correction. After rolling out on centerline a couple of small pedal inputs are needed to arrest the Dutch roll.

Since the Berkut's descent rate is not appreciably affected by small airspeed changes, it can be aimed at the touchdown point using the control stick. This probably won't work if the speed is allowed to slow excessively. Arriving over the numbers fast means a lot of floating.

Judging the landing pitch attitude is easy, particularly when the canard is used as a reference with the horizon. A 5-7 lb. stick pull rounds out the approach nicely. A good technique seems to be to establish the landing attitude and just wait it out. The airspeed decay and resulting rate of descent change are gentle enough that the airplane just lands when its ready without the bottom dropping out.

The canard is also a good pseudo-peripheral bank angle reference. Making corrections to the centerline once the round-out has begun can be a twitchy affair. Pulling with 5 lbs., it can be a challenge to modulate those tiny roll control stick forces without over controlling. Trimming nose-up during the flare can lower the pull force needed which might improve the pitch-roll harmony, but this technique also minimizes the pitch "feel." If the lateral stick inputs are large or abrupt, the Dutch roll rears up and rudders must be used to calm things back down. On the other hand, as long as the pilot is aware of these handling qualities, he can compensate appropriately. In a low-wind situation, landing the Berkut without any rudder inputs at all is not that difficult and can lighten the workload considerably. Perhaps its landing pattern personality is best expressed by Norm Howell, USAF test pilot, "It's very user friendly once you adapt to it.."

The new Berkut could be the fighter pilot's off-duty flying toy. It would also serve well for active reminiscing by fighter-jock-turned-airline-pilot. Several of its flying qualities resemble those of tactical jets and jet trainers. It has the landing pattern pitch-roll behavior of the T-38, the cruise roll behavior of an F-16, and the slow speed rudder behavior of the A-4 to name a few. Throw in the semi-reclined seats, side stick control, and pointy nose, and the cockpit environment enhances that fighter-like atmosphere. It even has the twin, aft hinged canopies a la F-4. Now, if it only had a gun sight . . . ◆