Cozy Mk IV

BY ED KOLANO

PHOTOS BY JIM KOEPNICK

Dear Mr. Cox,

Quite a few months ago Ed Kolano described some odd behavior for the four-place canard airplane. As a builder of another four-place canard, the Cozy Mark IV, I read the article with great interest. Of course I was deeply concerned over Mr. Kolano's comments. One could get the idea that all canards had these problems. Recently another Cozy builder commented that he could find no such behavior in his three-place Cozy. I think readers of Sport Aviation would enjoy and benefit from an article on the handling qualities demonstrated by the Cozy. While I can't speak for Nat Puffer, I am sure his plans-built Cozy would be available for Mr. 'olano to fly. (excerpt)

Sincerely, Joe Lane EAA #10819

So I called Nat Puffer, designer of the Cozy series of plans-built airplanes and president of Co-Z Development Corporation. We discussed the roll reversal issue and as happens when two airplane people begin talking about airplanes, we also discussed several other aeronautical matters. By the end of our conversation, the gracious Mr. Puffer invited me to fly his airplane not only to explore this roll reversal phenomenon but also to perform the flying qualities review for Sport Aviation.

The subject airplane, N14CZ, is the company conformity prototype built by Mr. Puffer in 1990. Having proved the plans, he offered them for sale in 1991, and sales have been steady ever since. This airplane has had a few minor changes incorporated over the years — like electric elevator trim and nosewheel extension/retraction — but it is essentially the same machine. Basically a Long-EZ plumped to fit four, the Mark IV continues to hold its own market niche in an industry where new designs seem to be rolling out of hangars at an ever increasing rate.

All Aboard

Cozys are normally parked with their noses resting on the ground. With the original retract mechanism, the procedure was to lift the nose, crank the nosewheel down and climb aboard using a small step protruding from the lower left side of the fuselage. From there it's onto the seat, then feed your legs into the rudder pedal tunnel. Not a particularly graceful entry. N14CZ has an electric nose gear mechanism which allows the passenger and pilot to enter the cockpit with the plane's nose still on the ground, then flip a switch which lowers the nose gear and raises the airplane's nose. A more civil process.

In keeping with EZ-type tradition, each rudder pedal only moves forward to independently deflect the same-side rudder outward and actuate the same-side wheel brake. Good thing because a one-forward/ one-back rudder pedal arrangement would pose a clearance problem with the pilot's knees positioned just below the lower instrument panel edge.

Each pilot has a short control stick mounted on an outboard sill. Stick travel is 4" longitudinally and 3" laterally. Rudder pedals are also installed on both sides. Primary engine controls are located on a console between the pilots. Although the carb heat, throttle and mixture levers are next to each other and operate identically, their different sizes allow selection by feel without confusion.

Taxiing is also EZ-traditional using differential braking to swing the castoring nosewheel in the desired direction. The airplane's nose tends to drift downwind during crosswind taxi, but an occasional brake tap keeps the plane tracking on centerline. Pedal force remains light whether making aggressive turns or just nudging the nose a few degrees left or right. The large canopy is hinged along the right side, held open or closed with a gas spring. A strong wind from the right, however, can overpower the spring and lower the canopy unless some occupant dedicates a supporting hand.

The Mark IV, like its canard brethren, is not a STOL airplane, but it's no slouch either. Power is delivered from a Lycoming O-360-A1A, 180 horsepower engine turning a 3-blade, fixed pitch, wood Performance Propeller. Using the recommended technique of holding the plane on the runway until 80 mph, then pulling it off takes 18 seconds at 2250' density altitude with a 15 knot wind 20° from the left of runway heading. With no propwash over the rudders, they start to become effective about four seconds after brake release during this wind condition. The tactile demarcation between full rudder and wheel brake actuation is a bit nebulous from the right seat, but this is only a factor during the initial portion of the takeoff roll. Approaching rotation speed the rudders become quite powerful. The airplane's sensitivity to pedal displacement combined with low pedal forces in this speed range mandates a light touch to avoid overcontrolling the plane directionally.

A light stick pull — less than 5 lbs. — rotates the airplane at 80 mph. As soon as it is airborne its roll sensitivity becomes apparent. Lateral stick forces are low, and airplane response to small displacements is lively. Fortunately the learning curve here is steep, and you quickly adapt.

Back to the no-slouch department. With two pilots, half fuel (26 gallons) and a forward center of gravity, the Mark IV shows a timed climb rate of 1125 fpm through a mean 5250' density altitude. And this rate reflects a cruise climb airspeed of 120 knots. At this speed the canard is just below the horizon. Neck-stretching helps a little, but an occasional belly check is a better idea for ensuring a clear sky ahead

It's A Cruiser

Setting 2450 rpm for level flight at 7000' density altitude, the needle points to 150 knots. The label above the trim switch reads, "STRONG Elevator Pitch Trim." No disagreement here. Probably a little too sensitive as anything other than a momentary actuation is immediately felt and is probably more trim than the pilot wanted.

The field of view in level flight is good considering the pilot's eyes are only a few inches above the side canopy sill. Over the nose the look-down is about 5°. The canard fills approximately 5° of forward vertical view out to 30° either side of the nose. Peering over the canopy sill, the side-ward/downward view is excellent as is the panoramic view above the horizon. Looking aft, the pilot can see to within 20°-30° of straight back on his side. Naturally the aft view is not as generous when looking cross-cockpit.

A comfortable cruiser, the Mark IV appears to be suited for the 1000 mile range claimed. The side stick and throttle seem to be located right where a pilot's hands naturally rest. Turbulence is passed on to the occupants mostly as heave — vertical accelerations versus pitch up or down.

Control stick forces are generally low for the maneuvers typical of a cruising airplane. Lateral breakout force — minimum stick force needed to cause a roll rate — is very low in roll at less than 1 lb. Breakout in pitch is noticeably higher in the 3-4 lb. range. There appears to be friction in both systems. In pitch the friction results are hardly noticeable with less than 1°/sec residual pitch rate when the stick is displaced and allowed to re-center on its own. In roll the stick returns only to within 1/2" of its pre-displaced position. The result is a residual, hands-free roll rate in excess of 10°/sec. Roll control system bearings are the same used on the Long-EZ, and Mr. Puffer reports some builders are opting for bearings with less friction. A partial consolation for this residual roll rate is it is immediately recognized and remedied with stick placement experimentation which takes longer to explain than accomplish.

Back to the pitch axis. The Mark IV exhibits a trim speed band in excess of 50 knots. After slowing from the cruise speed of 150 knots to as slow as 110 knots using only back stick, the airplane maintains the slower speed hands-off without re-trimming. Any slower and the pilot must hold back stick or re-trim. On the fast side the trim speed band extends to 160 knots. Flying faster than this requires a push on the stick or re-trimming. Red line airspeed is 190 knots.

On the one hand this large trim

speed band means the pilot can adjust his airspeed without having to trim. On the other it means the pilot is deprived of a stick force cue to a changed airspeed. Mr. Puffer says he never noticed this characteristic or whether it was also apparent with the previous mechanical trim system.

Level 30° bank angle turns can be accomplished without any pull on the stick. A 45° bank takes about 5-6 lbs. of pull.

Pitch axis dynamics are well behaved. Aggressive pitch changes can be accomplished without persistent pitch oscillations, meaning the plane's short period is deadbeat. The plane's response to aggressive stick pulls or pushes is not abrupt which might be considered appropriate for a cruiser. Long term pitch oscillations are positively damped. That is, if the airspeed is changed, by a gust for instance, the airplane eventually returns to its original airspeed.

Maximum average roll rate during 30° to 30° bank-to-bank rolls ranges from 35°/sec. to 45°/sec. with rudder coordination producing the faster rates. Rolls requiring outboard lateral stick are affected by the cockpit wall. Full outboard stick displacement cannot be achieved using a normal stick grasp, because the pilot's hand contacts the cockpit wall. The penalty is about 10°/sec. in average roll rate. Mr. Puffer says the upholstery on the wall is thicker than it should be in N14CZ.

Roll response is crisp, allowing accurate bank angle capture. There is little adverse yaw, and heading rollouts without coordinating rudder are sufficiently predictable and accurate for VFR flying.

The airplane's Dutch roll is fairly lightly damped. Momentarily stomping on a rudder causes the plane's nose to swing through the relative wind 5 or 6 times before re-aligning. Each of these oscillations takes 1.8 sec., and the airplane rolls as it yaws in equal proportion. The oscillation can be stopped anytime with an intuitive rudder input, and anything short of rudder pedal stomping is not likely to cause this Dutch roll response. Another way: If you fly the airplane the way most pilots do, the Dutch roll oscillation does not interfere with the flying task at hand.

Stalling The Little Wing Only

The high angle of attack testing history of the Mark IV is a fascinating story involving canard airfoil section and span, lower winglets for the wing tips and an in-flight center of gravity adjustment test apparatus. Beyond the educational value of tailoring the airplanets configuration to produce the desired canard stall characteristics, it shows Mr. Puffer's conscientious pursuit of engineered safety for his airplane.

The results of these efforts can be readily observed. With the airplane trimmed for the normal cruise flight condition and the throttle then set to

idle, the Mark IV's canard stalls without any indication of a main wing stall. Stick pull force increases steadily as the airspeed decreases below 110 knots, reaching 15-20 lbs. at 60 knots. Throughout the deceleration, elevator, aileron and rudders continue to function as they should. Slower airspeeds are accompanied by obvious increases in adverse yaw, and the airplane's sensitivity to rudder pedal force seems to increase. Either aileron or rudder deflection excites the Dutch roll during the stall approach.

At 60 knots the nose is near the horizon as the plane begins to oscillate in pitch. Full aft stick (20-25 lbs.) has the pitch bobble settling into a 3°-4° pitch oscillation with each cycle taking about one second. The rate of descent here is in excess of 800 fpm. Aileron deflection rolls the plane, but it also initiates a pitch-roll-yaw oscillation as the Dutch roll and stalling canard pitch oscillation combine. This does not feel threatening, and the rudders can still effectively arrest the Dutch roll. Recovery is as simple as relaxing the back stick.

One Down and Locked

Lowering the nose gear from a trimmed level flight condition of 115 knots (VLE = 120) causes no immediate pitch response. Back stick is eventually needed as the airspeed decays, but it takes 30 seconds to lose just 5 knots in level flight. This aerodynamic cleanliness is one reason the Mark IV comes with a belly-mounted speed brake. Its use is optional, and was not used during the evaluation. Another drag-producing option is simultaneous deflection of both rudders.

Slowing to the recommended approach speed of 80 knots requires either a large power reduction or patience. Once there, 1700 rpm sustains level flight (still at 7000' DA). The only difference in the field of view is pitch attitude related. The nose is just above the horizon, ~~so~~ the canard obscures the horizon to 30° either side of the nose.

There isn't much change in normal handling qualities from the cruise condition. Roll response is not as crisp and actually feels like a better match with the still light lateral stick forces. Friction in the roll control system is still apparent from the residual roll rates. Adverse yaw is just enough to encourage proper rudder coordination with 1/2 lateral stick generating 3°-4° of yaw.

Pitch response is also a bit more sluggish just as in most airplanes flown at landing pattern speeds. There is still a trim speed band extending from 70 to 110 knots. At 65 knots back stick is required.

The acceptability of a large trim speed band under landing conditions is less ambiguous than the cruise case. Pilots rely on stick force cues as continual feedback for a variety of airplane flight situations, including drifting off speed on final approach. Without a pull force needed to fly slower or push force to fly faster, airspeed deviations can go unnoticed unless a diligent airspeed indicator scan is maintained. The closer the airplane is to landing, however, the more the pilot's attention is directed outside the cockpit. Mark IV pilots must keep a close eye on airspeed in the landing pattern.

Fortunately, a stick force cue emerges just prior to the canard stall. A small pull force is needed as the airplane reaches 65 knots. The stick force increases to 15-20 lbs. at the first sign of canard stall — a 2°-3° pitch bobble at the same frequency as the cruise

condition. Continued pull to full aft stick (20-25 lbs.) has little effect on airspeed which varies from 60 to 63 knots on the indicator during the pitch oscillation. With full aft stick held, the airplane's average pitch attitude varies a couple of degrees. At 60 knots the nose wanders down until the airspeed increases to 63 knots, then the nose wanders back up, and the cycle repeats with the pitch bobble continuing throughout the slower average pitch attitude oscillation.

As in the cruise case, the landing condition "stall" never feels threatening. Aileron and rudder deflections elicit similar responses to their cruise situation counterparts. Rudder deflection shows a strong dihedral effect here by rolling the airplane.

Recovery can be accomplished traditionally by relaxing the back stick and lowering the nose, but there's a more interesting technique. Add power while holding the back stick, and the plane climbs and accelerates. There is no evidence of a pitch-up to a more dangerous situation. After establishing a climb and gaining a few knots, you can relax the back stick and fly away.

Answer The Question

Average full-stick roll rates in the landing condition are almost as fast as when cruising if coordinating rudder is used. Expect 35°/sec.-40°/sec. with the faster rates occurring during right rolls.

Without rudder coordination, the average rate drops to around 22°/sec. From a starting condition of 30° right-wing-down, full left stick rolls the plane left-wing-down. The roll rate diminishes almost to a stop around the wings-level attitude, then increases again through 30° left-wing-down. The hesitation accounts for the slower average roll rate. This characteristic would probably go unnoticed during normal landing pattern maneuvering, because there is usually no call for a full-stick roll through such a large bank angle change. In fact, full stick is not normally needed at anytime in the Mark IV during landing. Add the fact that most pilots naturally coordinate aileron inputs with rudder inputs, and it becomes easy to understand why this phenomenon might never be detected in the course of normal flying.

The Mark IV exhibits the same Dutch-roll/roll mode coupling as the airplane described in the article which generated Mr. Lane's interest. The difference is the Mark IV does not reverse its roll direction. Its roll rate slows almost to a stop before re-accelerating, but the plane never rolls right with left stick maintained.

Real World Landing

As mentioned, airspeed control on final approach requires a continual check of the airspeed indicator. Keeping the speed within a few knots of the target airspeed can be accomplished using this technique even on a gusty day.

The view over the nose is fine even into the flare. During the flare the disharmony in the control stick is evident. A pull of 7-9 lbs. is needed to establish the touch down pitch attitude, but less than 1 lb. of lateral stick force causes the plane to roll. It is easy to inadvertently rock the wings slightly as stick pull is increased. This seems to be more of a look-good-from-the-ramp concern than a safety issue. Even with the tiny roll-ratcheting, the plane doesn't stray from the runway centerline enough to worry about.

Getting the proper pitch attitude for touch down is not difficult. The canard provides a good peripheral pitch and roll attitude indicator when the pilot's attention is directed toward the far end of the runway.

The nosewheel does not plummet to the runway once the mains touch, so there's no critical stick dancing required. With all three wheels on the runway the airplane tracks straight with normal rudder applications. Normal, that is, except for the fact that both pedals must be displaced simultaneously to apply the wheel brakes. The transition from full rudder to wheel brake is a soft one. It may be easier to detect with experience in the airplane, but there's a range of uncertainty when feeling for the brakes the first time.

As a plans-only airplane, it would seem builders who want to tailor control stick harmony and outboard lateral stick clearance and control system friction can. Whether the longitudinal control system friction or the electric elevator trim is the culprit behind the large trim speed band is unknown, but these are good places for the builder to begin looking if so inclined.

The Cozy Mark IV has a boxy fuselage and does not have gullwing doors or retractable main gear. But looks can be deceiving. It is comfortable and boasts impressive performance numbers. It has benign stall characteristics and positive dynamic stability. And it is easy to fly.

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