

Ornithopter Report for 8 July 2006



Hello Everyone;

We have been runway testing once again. Recall that testing last year was curtailed because of problems with the jet-boost engine. At first this was due to electromagnetic interference: the main engine's ignition scrambling the jet's electronic control unit. Measures were taken to correct this, both by us and AMT Netherlands (the engine's manufacturer). However, after this was dealt with a new problem occurred, where the engine's glow plug simply wouldn't ignite. A big clue was that the RPM wasn't being displayed on the EDT (Electronic Data Terminal), and it turned out that the RPM sensor was damaged. AMT sent us a new one, and the problem was solved. A run-up on 8 June showed no problems with both engines, and the aircraft was then on standby for runway testing.

The weather was suitable on Saturday, 8 July, and the team met early in the morning. The first run was at 9:00 and 50 mph was reached with the wings flapping at 0.8 Hz. There were a couple of brief liftoffs, but nothing close to sustained flight. Essentially, this was a repeat of the last run from 2005. The second run was at 9:10 and 51 mph was reached with 1.0 Hz flapping. Again, brief liftoffs were attained, but longer and higher. Runs 3 and 4 (9:20 and 9:38) were virtually identical, with slightly above 50 mph being reached with flapping between 1.05 and 1.1 Hz. Some very large hops were attained, but the engine was throttled back before the hopping continued. The final run was at 10:16, and the wings were given maximum throttle (1.0 Hz). The aircraft then lifted off and stayed off of the runway for a sustained flight of 14 seconds. The height was above one meter and the distance covered was about a third of a kilometer. After about 10 seconds of straight and level flight (amazing looking by the way), a cross wind caused the right wing to begin lifting and the aircraft began to experience roll divergence. Jack Sanderson then throttled back and brought it down, but its roll angle by that time was large enough that it touched the left wing tip and spun around to collapse the nose gear. Jack was fine and the damage isn't drastic, so the team was in a celebratory mood while walking the aircraft back to the hangar.

The important thing to remember is that the aircraft needed the jet boost to stay aloft. It wasn't a pure flapping-wing flight. We had known that the wing was marginal because it was trying to fly a 770 lb aircraft, whereas it was designed for a 600 lb aircraft. Ornithopter wings are not happy operating at off-design conditions. What we learned is that the wing is actually slightly sub-marginal (not unexpected) and the jet boost was needed. Of course, in all fairness I should say that the jet alone could not have even come close to sustaining the

aircraft; the flapping still did most of the work. So, we can say that it was a jet-assisted ornithopter that sustained level flight.

Also, it would have been great if Jack had been able to fly the length of the runway and then grease it in for a smooth landing. However, what we learned is that aileron-less roll-yaw coupling is not adequate if one is trying to follow a given cross-wind path (along the runway). A direct means of roll control is needed for any future ornithopter.

These caveats aside, a lot was learned. For the first time, Jack was able to exercise the aircraft's capabilities to its limits without any of the usual show-stopping failures occurring (which have aggravated me throughout the program). I had always felt that even if the aircraft didn't fly but got a fair chance and did its best, then I can live with that. In fact the situation is much better. Jack said that once the aircraft was in the air (and before the roll divergence), the ride was surprisingly smooth and stable. This is an important finding for future ornithopter design. Also, any concerns about the effect of the wing's unsteady wake on the tail were unfounded. This is clearly a viable design path for future ornithopters.

Speaking of the future, it would be nice if sufficient funding were found so that a new wing, optimized for the actual aircraft weight, could be built. However, even if that doesn't happen, I feel like a very important accomplishment has been realized, and I can go into retirement feeling good about that. The present action item is to fix the Bird so that it can go on display in the Toronto Aerospace Museum. Are we happy? Absolutely.