TESTING ORNITHOPTER C-GPTR
By
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C-GPTR Test Pilot from Spring 1995 until August 10 2001

ORNITHOPTER C-GPTR.....1996 TESTS

The question we are asking ourselves, is not [as in most test flying programs] "How well does it fly and perform it's intended task?" but rather "Will it fly at all?"

On Oct 3/96,the testing began. Our objective for this, our first test, was to determine whether PTR would actually move forward under its own power. We didn't know, the computer simulations were for the level cruise condition and the model, being hand-launched into cruising flight, never went through an 'accelerate to take-off' stage. We had previously conducted static engine run-up and flapping tests at UTIAS with PTR firmly tied down and so.....we simply didn't know whether the wing design would produce enough static thrust to start moving....if it didn't, a new wing would have to be designed and built [a major project]....but if it did, we could go on.....to the runway .....to the sky ????

Too windy to do the test outside, PTR was pushed to the back of the hangar, turned around and pointed towards the hangar doors [left open .... just in case..] I climbed into the cockpit, closed the canopy and suddenly ...silence.....with my helmet on and the canopy closed, I can no longer hear the chatter outside.....and I am in my own little world.....

" .....The lab crew are tapping on the canopy.....turn the radio on, they are calling out the start-up checklist.....seat-belt and shoulder harnesses on ?..... yes [and TIGHT.....I remember the static tests and being tossed around as the fuselage pitched and plunged] .....fuel on, throttle set, choke set....." They wheel up the external battery for starting and plug it into the connection on the side of the fuselage [too heavy to be carried on board, it means that the engine cannot be re-started in the air.....another item for the 'ongoing issue' list]....the green light glows....."....clutch?...no, it's still unserviceable.....ballistic chute?..no,not for this test.....ignition switch on, brakes set, controls free and functioning ...CLEAR THE WINGS.....starting....." I look out at the left wing, slowly it moves down then half-way up and quickly, the engine starts, the wings settle into idle flapping frequency 0.5 hertz and everyone is beaming. Flapping always has this effect on us.

Now I must wait while the engine warms up and the lab crew set up the data acquisition system and cameras... ..the instruments are fluctuating wildly, the result of the varying loads imposed during each flapping cycle, every reading must be averaged.....I'm being bounced around a little even at this low flapping frequency....I ride the rhythm....up and forward, down with a 'thunk' and back, up and forward.....The signal to GO jolts me out of my daydreaming. We hope [and the calculations predict] that PTR will start to move at approximately 0.7 hertz flapping frequency. " At last ! here we go.....throttle forward slowly....radio the flapping frequency to the lab crew.....0.55 hz, 0.6.....0.7....still not moving.....certainly being tossed around now...quite difficult to keep the stick centred.... must constantly correct....instruments really fluctuating too.....0.75....still nothing.....0.8..., Ah ! we're moving.....keep straight....nosewheel steering much too sensitive...darting off in one direction then the other ....very twitchy....."

As I am bounced around, the joystick goes with me causing control inputs that I did not intend, but this is the nature of ornithopters and one must constantly correct for it. ".....actually going quite fast now....surprising ! ... flapping frequency 0.9....maintain 0.8....." After flapping our way along the length of the hangar, I throttled back to idle and, amid popping flashbulbs and cheering lab crew, PTR rolled to a triumphant stop twenty feet from the hangar doors.

We were distinctly pleased with ourselves and PTR following this episode and immediately made plans to start testing on the runway at the first sign of good weather. With no ailerons and a large average dihedral [taken over the whole flapping cycle] , PTR has no cross-wind capability and is definitely a no-wind aircraft. All the testing is carried out at dawn [we call it 'dawn patrol'].

The next day was calm and we met at the hangar at 5 a.m. As soon as it was light enough to see, PTR was pushed out to the runway. Our objective for the day was to conduct low-speed runs to check all systems and ground handling.

One car, carrying the Chief Field Engineer who is in radio contact with me and a second engineer with the video camera, drives in front of PTR and the chase car, carrying the rest of the engineers, drives behind.

Two runs at 15 mph, using the full 7000' of runway yielded the following results:

[1] - Once every second, the fuselage pitches from [what is normally considered to be] an extreme 'climb' atitude to an extreme 'dive' attitude and the wings flap from far above the horizon to far below [coming within 16" of the ground]. - This completely destroys a pilot's normal visual references of aircraft attitude....[pilot's use the position of the nose or instrument panel and wingtips in relation to the horizon in order to detemine the attitude of the aircraft eg. cruise, pitch up/down, banked]. - The interesting result is that it is difficult to determine whether PTR is on the ground or 2 feet above it or if one wheel is lifting etc.

The radio operator/ engineer, we decided, has to give me a running commentary and over the last 4 years, we have developed a 'rapid radio code' since this no time for embellishments.

[2]- The nosewheel 'hopped'

[3]- The brakes didn't work

[4]- The nosewheel steering was too sensitve

[5]- The nosewheel steering must be disconnected from the rudder [my request]

[6]- The flapping freq' indicator is unreliable.

After these 2 runs, testing was ended for the day and we took the laptop computer and cameras back to UTIAS to download the data.

Oct 6 was the next calm day and we met at dawn. Our little convoy trooped out to the runway with the intention of conducting acceleration tests [gradually increasing the speed on each run to determine if PTR is in fact, able to accelerate to the 50 mph predicted lift-off speed] and associated ground manoeuvring tests. This information, we hoped would enable us to begin to work out a ' take-off technique for ornithopters.'

On the first 2 runs, PTR accelerated readily to 20 mph [the goal for these 2 runs], it is surprisingly zippy. However, the nosewheel hop was still present [this is partially due to the pitching of the fuselage] and the nosewheel steering was rapidly becoming unmanageable. I realised that it would have to be re-designed before attempting the higher speeds.

We decided to try one more run for the day, at 25 mph. Half-way along the runway, sensing that all was not well with PTR, I throttled back and stopped. The outer 4 feet of the right wing had completely disintegrated.

So ended our first year of testing. The winter was spent repairing the damage, re-designing and planning for the following Spring.

ORNITHOPTER TESTS.....1997/ 98/ 99

It was Aug/ 97 before we were back out on the runway. The wingtip disintegration and other problems of 1996 had resulted in 11 months of research, data analysis, re-design and re-building. PTR now stood resplendent with:

--- new wing outer panels.
--- new main landing gear [wider to help with the cross-wind problem and higher - the wingtips had been coming alarmingly close to the ground]
--- re-inforced nose-gear strut [to withstand the pounding it receives]
--- new nose-wheel steering assembly [now disconnected from the rudder and the stick and connected to the foot pedals--back to steering with my feet]
--- new disc brakes to replace the original drum brakes.
--- new stage '0' chain [to replace the original belt which had been slipping , causing intermittent flapping, however, using a chain means no clutch--it was removed-- and no airborne re-start--still an ongoing issue]
--- new flapping freq' indicator and a repaired tail-cam' system.

We were optimistic as 'dawn patrol' began once more !
During 1997, we continued acceleration tests and achieved a maximum speed of 40 mph for the year.

However, as the speed increased, the bouncing started. We discovered that one cannot take-off in an ornithopter by holding the stick centrally, accelerating to lift-off speed, then rotating because it starts to bounce [we call it 'boinging mode'] at speeds above 30 mph.This must be suppressed to allow the take-off run to continue.

We started a long series of tests, experimenting with different stick positions. Too much 'stick forward' resulted in wheelbarrowing with nosewheel damage. Too much 'stick back' caused severe bouncing and the test would have to be ended.

Various other problems arose. PTR took to shedding the stage '0' chain, once actually depositing it on the runway through an inspection hole. The nosewheel steering was still very twitchy and the brakes, flapping freq' indicator and tail-cam were not functioning.

The testing continued until Sept 16. The last run of the day was 'lively', flattening the nosewheel and shearing rivets all along the fuselage. We ended testing for the year and retreated back to UTIAS for the winter to make the necessary modifications and repairs.

A computer take-off simulation was written, which showed the stick position to be critical

[a deflection of 1/2 degree resulted in a bounce - on the simulation- to 90 feet !] and precise stick/elevator positions would have to be held accurately [to within 1/2 degree] at different points during the take-off run.

It was decided that a 'stick/elevator position indicator' was needed, to enable me to determine the exact postion [in degrees] of the elevator and one was designed, built and installed on the instrument panel...A lovely instrument...the centre of my universe !....it consists of a vertical column of coloured L.E.D's....green for various,defined degrees of stick forward/elevator down....red for stick back/elevator up...and yellow for neutral. Now, I could accurately place the stick in any desired position and radio the lab crew that I was holding "..1 green...2 red etc ." However, maintaining that position while being tossed around , is another matter and one still has to constantly correct.

Testing resumed at dawn on Sept 19 1998.The speed was increased on each run in our effort to attain the 50 mph predicted take-off speed. Very quickly, 46 mph was reached. It was at this point that we ran into the 'boing barrier'. No matter what we did, at 46 mph PTR would start to bounce wildly and acceleration would cease.

Three different nosewheel dampers were tried, in an effort to reduce the pitching of the fuselage. Finally, new calculations showed that PTR would have to be firmly held on the ground until 50 mph then abruptly pulled off, to an altitude that would avoid re-contacting the ground. This is not easy, since the lift varies dramatically during the flapping cycle, increasing on the downstroke. When in the air, PTR will follow an oscillating flightpath [up and down 10 feet approx, once every second].

On Nov 8, we decided to try this technique, I held the stick forward at 2 green and.....PTR accelerated right through 46 mph, finally reaching 51 mph...the fastest yet and sufficient for an intended lift-off !

Thouroughly pleased, we launched into the next test with the objective of conducting a fully controlled take-off run, up to and including an intentional lift-off at the predicted lift-off speed.

At 50 mph, I brought the stick back firmly and we rose into the air ....our first intentional lift-off...but I had no time to savour this feat....since it was immediately followed by three ungainly bounces, one of which sheared off the nose-wheel...then surprisingly, we lifted off again, in a truly magnificent 'airliner' type take-off before finally screeching and grinding to a stop, in a shower of sparks on the sheared-off nosewheel strut.

The damage to the forward fuselage was significant and so, having achieved what we believe to be a 'first' for piloted ornithopters and with me beginning to feel like a 'grizzled veteran' , we went into our usual winters hibernation of research and rebuild.

1999 started with PTR being given a 'special certificate of airworthiness', by Transport Canada-Air , It gave me quite a feeling of accomplishment when I saw that I was named as being the only pilot allowed to fly it.

The goal for 1999 was to finally achieve sustained flight. We started in August. The modifications to PTR had drastically increased the gross wt, and the predicted lift-off speed

had to be increased to 57 mph to achieve sustained flight. We spent Aug and Sept practicing lift-offs and working out several problems while waiting for the perfect weather for 'the flight'

On Oct 15, the wind was calm...and we met at dawn.....we didn't know if PTR would reach 57 mph and I wondered what would happen if it did....the pitching and heaving of the fuselage become increasingly severe at speeds above 40mph...and it becomes increasingly difficult to control.

"....All is ready...the ballistic chute is armed for this test...there's the signal to GO.....throttle forward....stick 2 green....initial pitching quite heavy.....20 mph....30 mph...flapping freq 1.0...increase to 1.1...40 mph...increase flapping freq to 1.2....50 mph...being bounced severely now...hard jolts....very difficult to control....52 mph....56mph ...never been this fast before...1 more second, then I'll lift-off....what's this ??...rolling rapidly from side to side....something's happened...no word from lab crew....throttle back ..wait and see.....we're veering off to the right...have to fly it back to the centre line...increase throttle...rudder....its not responding.....we're going over.....inverted now...we're down.....stopped....it's still flapping...even upside down...turn the engine off....the lab crew are radioing...are you o'k,are you o'k....yes ....cockpit crushed though...can't get out....petrol is leaking... puddle's quite large.....wait for lab crew...don't make a spark.....

And so, at 56 mph, on the point of lift-off, we had suffered a major structural failure. The right vertical struts buckled and snapped in half, the right wing 'cracked the whip' and partially disintegrated. The left wing was still flapping and producing lift, strong lift which caused PTR to roll rapidly inverted. The whole episode, from when the struts failed to when I was hanging upside down from my seatbelt took 5 seconds....the lab crew had no time to warn me.

EPILOGUE

We have now looked at the crash video many times over and have determined the cause of the failure. PTR has been stripped and inspected.

We are continuing with 'Project Ornithopter' and the rebuild has started. This winters hibernation will be busier than previous ones but already it's March and in September, we will again, 'meet at dawn'

2001 UPDATE

PTR was rebuilt and we started testing again in 2001

On Aug 10 2001, I resigned as PTR's test pilot in order to work full time on my own ornithopter design 'Nightingale'

Biography: I was born and grew up in Welwyn Garden City, Hertfordshire.England.
I am married and live with my husband, John and dog, Angus on a wild 50 acres in the Ontario [Canada] countryside

Pilot Qualifications: Commercial Pilot Licence with single and multi-engine, land,sea,multi-IFR and flying instructors ratings.

Memberships: Society Of Experimental Test Pilots [AM]
British Women Pilots Association

This article is dedicated to my twin brother PATRICK JONES who died suddenly on December 31 1997....' Like me, he always dreamed of flying....'