AIR ACCIDENT CASE HISTORY

Piper Navajo Tree Strike

THIS CASE FOCUSED ON DELIVERING A BETTER UNDERSTANDING OF THE EVENTS WHICH FOLLOWED A TREE STRIKE, PARTIAL WING LOSS AND SUBSEQUENT GROUND IMPACT RESULTING IN A TOTAL LOSS

THIS BULLETIN SHOWS HOW THE J2 AAI CAPABILITY IS ABLE TO SUPPORT AND BETTER EXPLAIN THE EVIDENCIAL TRAIL AND PROVIDE FURTHER INSIGHT INTO CONTROLLABILITY OF THE AIRCRAFT.

Discovery

- Flight physics based aircraft model enabled j2 to look at rates of change.
- The scenario builder allowed a better understanding of aircraft behaviour following the partial wing loss and understanding exactly what happens to the aircraft following such an event
- 3-D Visualisation enables views from all angles of the dynamic behaviour of the aircraft
- Direct model to SIM means experienced pilot input can be obtained without the need for flight test
- Obtain and present all the necessary aero engineering data using the j2 Universal Tool-Kit

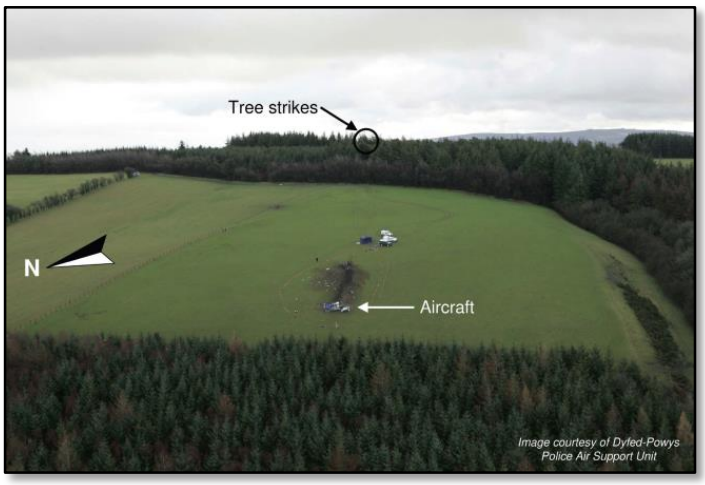
CONCLUSIONS

- The accelerated roll rate was caused by deployment of the right aileron.
- This was most likely caused by inertial forces resulting from the initial roll to the left.
- The speed of roll was not recoverable using normal pilot inputs and control surface authority.
- It was possible to predict the distance to first strike on ground to +/- 0.5m
- The aircraft model build and analytical workshop was completed inside of 3 weeks from a position of no data.
- No writing of code was required
- This study was completed with no OEM involvement or OEM data being available.

In this case j2 were tasked to examine the available information and determine those events and actions that supported the trail of evidence at this accident. The evidence trail showed that following a tree strike and loss of approximately 1/3rd of the left wing the aircraft then lost control and struck the ground. The evidence showed the right wing tip weight as the first point of contact with the ground.

High Fidelity Model Build

A high fidelity math model of a Piper Navajo was constructed using the j2 Universal Tool-Kit. This model was further qualified using j2 flight to match against flight test data obtained from published data from University of Tennessee. The model was deemed to be a level 6 fidelity dynamic model (FAA. 2011. CFR Title 14 Part 60 Flight Simulation Training Device Initial and Continuing Qualification and Use Appendix B. sl.: Federal Aviation Authority, 2011. p. 149.)



A series of dynamic scenarios where constructed to match altitude, flight path, airspeed and weather/wind conditions as reported. j2 Universal Tool-Kit was used to introduce a point force acting on the leading edge of the wing as it struck the tree and the instantaneous loss of 1/3rd of the outboard left wing. The j2 Universal Tool-Kit then automatically calculates the resulting changes in aerodynamic forces.

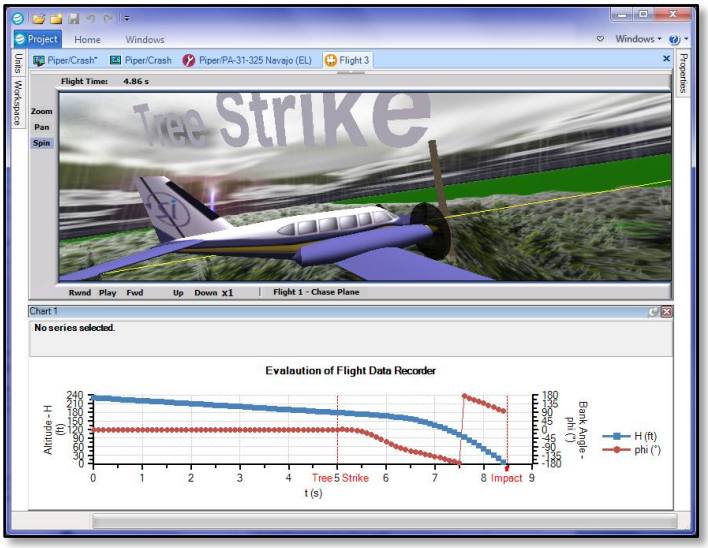
Two scenarios were constructed using the j2 software, 1) all control surfaces remained neutral after wing loss and 2) control surfaces were floating (cables severed) and would have acted according to aerodynamic forces and principles.

These two cases were then 'flown' in the software and the flight physics data extracted to provide a greater insight and reach a conclusion on the most likely scenario.

AIR ACCIDENT CASE HISTORY

The Tree Strike Scenario

The tree strike event caused the aircraft to yaw and roll to the left. As in scenario 1, if control surfaces remained neutral the aircraft continued to roll and hit the ground left wing, engine nose.
This did not tally with the evidence – right wing hit first.



The j2 Universal Tool-Kit was used to adjust and run numerous cases looking at different inertia's, tree strike forces producing a greater yaw and roll rate but it was not possible to reach a meaningful conclusion that followed the laws of physics and remained within the achievable limits for this aircraft.

We then examined case 2 where the control surfaces now floated and were under the influence of the aircraft orientation and inertial forces caused by the yaw and role initiation.

J2 Universal Tool-Kit offers a unique capability to use flight physics to reproduce any event, examine a timeline of the aircraft behaviour and alter the rates of change of deployment of control surfaces. In this case we examined the excitement of the right aileron resulting from the roll to the left. At a positive deflection (down) of 4 degrees the analysis showed this was sufficient to accelerate the initial roll rate and this caused the aircraft to roll over the top and resulted in the right wing to impacting the ground first.

The j2 Universal Tool-Kit was then able to examine if there was enough control authority to recover from the partial wing loss. Given the rapid onset of the yaw and roll it was deemed not possible to prevent the roll and impact with the ground through Pilot input.

The unique capability of the j2 Universal Tool-Kit was also able to predict the distance from the tree strike to the predicted first ground contact, being 185m which was within 0.5m of the actual measured distance of 185.5m. This provided a further degree of confidence that the flight physics model was proving to be highly accurate with respect to modelling rates of change in yaw and roll and aerodynamic behaviour on an uncontrolled descent flight path.

The conclusion was that this accident did not offer any chance of recovery and it was the excitement of the right aileron caused by the initial roll rate which accelerated the roll causing a complete over the top roll of the aircraft.

More Information

For further information contact

j2 Aircraft Dynamics

John Jeffery, MSc.

T: (00 44)7973 717311

E: john.jeffery@j2aircraft.com