AIR ACCIDENT CASE HISTORY

Piper Navajo Tree Strike

DISCOVERY

- j2 used a Flight Physics based aircraft model to look at rates of change.
- The scenario builder provided a deeper understanding of the aircraft behaviour following the partial wing loss, and what happens to the aircraft following such an event.
- 3-D visualisation provides views of the dynamic behaviour of the aircraft from various angles.
- Direct model to SIM means we can leverage experienced pilots, and there is no need for a flight test.
- Using the j2 software, it is possible to back-out and present the necessary engineering data.

CONCLUSIONS

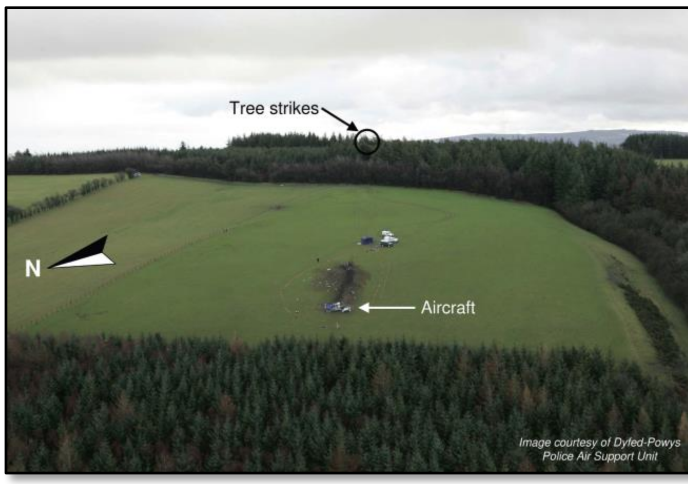
- The accelerated roll rate was caused by a slight right aileron deployment.
- The aileron deployment was likely caused by inertial forces resulting from the initial yaw and roll to the left.
- The speed of the roll was not recoverable using normal pilot inputs and control surface authority.
- It was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

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 OF THE AIRCRAFT. IT WAS HOPED THIS WORK WOULD PROVIDE ADDITIONAL INSIGHT INTO THE EVIDENCE TRAIL AND CONTROLLABILITY OF THE AIRCRAFT DURING THE EVENT.

In this case, j2 was tasked with examining the available information to determine which events and actions supported the evidence trail for the accident. The evidence revealed that after a tree strike, the subject aircraft lost approximately ⅓rd of the left wing, lost control, and struck the ground. The right wing aileron balance was the first point of contact with the ground.

High Fidelity Model Build

The j2 Universal Tool-Kit was used to construct a high fidelity model of the Piper Navajo. Published flight data points from the University of Tennessee were used to further qualify the model. The model was determined 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 based on the reported altitude, flight path, airspeed and wind/weather conditions. The j2 software was used to introduce a point force acting on the leading edge of the wing as it struck the tree, resulting in the instantaneous loss of ⅓rd of the outboard left wing. The software automatically calculated the resulting changes in aerodynamic characteristics.

Two scenarios were constructed using the j2 software, 1) one in which control surfaces remained neutral after wing loss, and 2) one in which control surfaces were floating (cables severed) and acted according to inertial and aerodynamic forces and principles. Both scenarios were then simulated in the software, and the flight physics data was extracted and used to develop a conclusion about which scenario was most likely.

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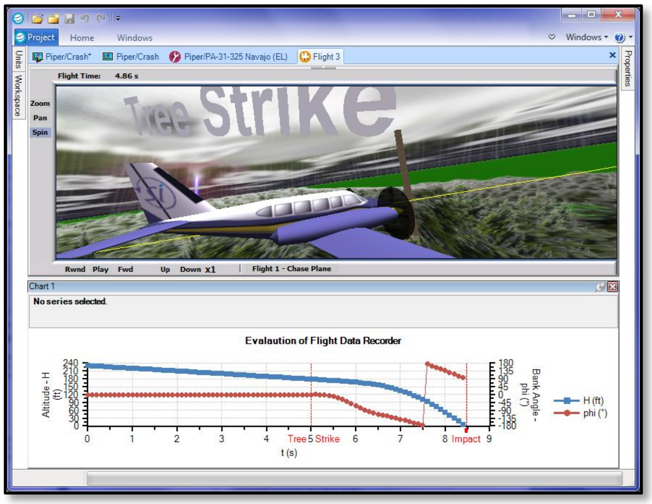
The Tree Strike Scenario

The tree strike event caused the aircraft to yaw and roll to the left. If control surfaces remained neutral, the aircraft continued to roll and hit the ground with the left wing, then left engine and finally nose. However, this did not tally with the evidence, which clearly showed that the right wing of the aircraft hit first.

j2 used the software to run numerous scenarios, looking at different inertias and tree strike forces that would produce a greater yaw and roll rate. However, it was not possible to create a reasonable scenario that was consistent with the laws of physics and did not run counter to the achievable limits for the aircraft.



j2 then analysed the alternate scenario, where the control surfaces were floating and under the influence of the aircraft orientation and the inertial forces caused by the initiation of the yaw and roll. The j2 software allowed the team to use flight physics to reproduce the event, alter the rates of change and control surface deployment, and evaluate the timeline of aircraft behaviour. In this case, we examined the excitement of the right aileron resulting from the roll to the left. A brief positive deflection of 4 degrees was sufficient to accelerate the initial roll rate, causing the aircraft to roll over the top, and allowing the right wing to impact the ground first.

The j2 software then provided insights into whether there was sufficient control of the aircraft for the pilot to recover from the wing loss. Given the rapid onset of the yaw and roll, it was determined that pilot input would not have prevented the roll-over and impact with the ground.

The software was also able to predict the distance from the tree strike to first ground contact within 0.5m of the actual 185.5m. This high level of accuracy served to validate the flight physics model with respect to demonstrating the rates of change in yaw and roll, and the aerodynamic behaviour during the uncontrolled descent on the flight path.

Ultimately, it was concluded that there was no possibility of recovery during the events of this accident. It was the excitement of the right aileron caused by the initial roll rate which accelerated the roll and caused a complete over-the-top roll of the aircraft.

More Information

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