Bird Strikes and Airframe Design

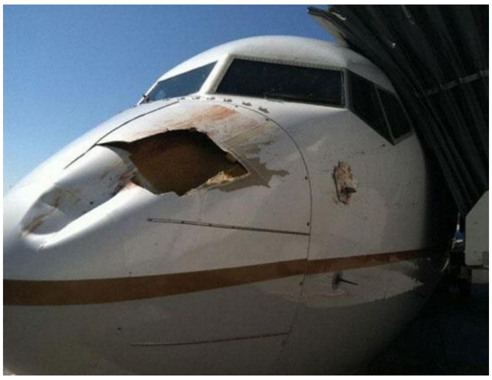
David Coldbeck Spirit Aerosystems

The speaker stepped in at short notice to replace a cancellation, and brought with him a wealth of information on bird strike incidents. In his 40 year or so career he has been involved in civil and military airframe design, and lectured at the University of Glasgow. His presentation, although restricted to coverage of airframe damage (not addressing engine bird ingestion), was a well-planned coverage of the history, the regulation, design, testing and practice used by designers to alleviate the consequences of bird strikes.

His brief history of early day events started with a bird strike recorded by Orville Wright on 7 September 1905 (when the pilot collided with a bird that was being followed), and charted through several milestones to significant commercial airliner events: specifically the loss of a Lockheed Electra on 4 October 1960 at Boston which after losing power from three engines crashed and led to 62 fatalities. On 23 November 1962 a United Airlines Vickers Viscount struck two whistling swans while cruising at 6,000 feet. The impact damage caused a horizontal stabilizer to separate, and led to the death of all 17 occupants.

Mr Coldbeck used these accidents to reference legislation that evolved for civil airliners, citing both US (FAR25) and European (JAR25/CS25) requirements, and in comparison the US regulations were the more stringent. When he cited military practice, UK/European authorities set project-dependent requirements, and contrasted with a simple overall requirement for all US military aircraft. He presented a wealth of historical statistics. Amongst these - the FAA reported 119,917 bird strikes between 1990 and 2011, and the USAF recorded an average annual total of 2,910 bird strikes between 1985 and 2002.

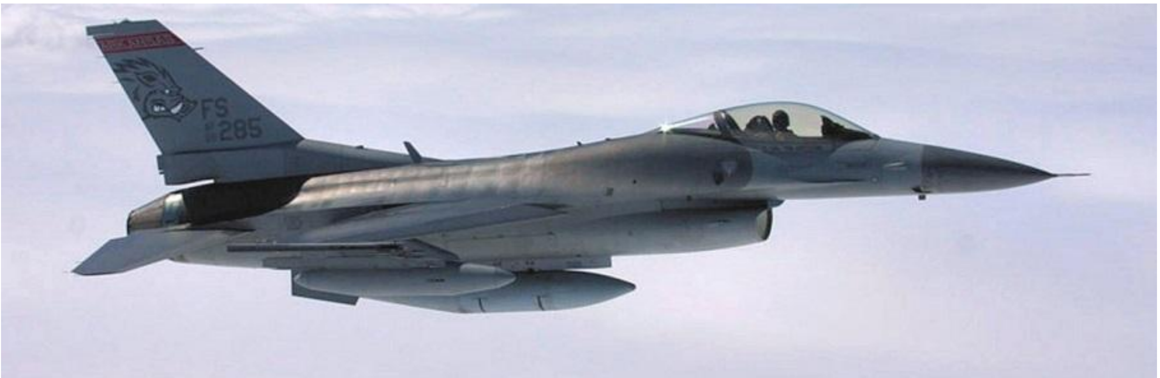
The engineering approach to finding bird strike solutions was categorised under five headings: Analyse – Experiment - Compare existing designs - Guess and test - Non-linear finite-element analysis (NLFEA). He expressed a preference to use all techniques as appropriate, sub-dividing the differing approaches of those who get involved into three categories: mathematical engineers (who model impacts), Empirical engineers (who conduct tests) and 'real' engineers (who combine modelling and testing to validate their solutions). He followed this by presenting several examples, mostly based on personal experience in both civil and military airframe design work in the UK.



Mr Coldbeck stated that it is difficult to prove a value pertinent all aircraft categories, but that bird-strike designed structure on the EAP accounted for 40% of the front fuselage structural mass. Quoting a civil design case he provided an example of how a bird impact can cause an inadequately supported panel to tear across a lateral joint, allowing the carcass to enter the fuselage. Data tables also stressed the kinetic energy of a bird is adequate to even lead to the rupture of an airliner's forward pressure bulkhead.

Pilot vision in the event of a bird strike was also explained. Airliner windscreens use multi-layer transparencies that will deflect the majority of birds, and while penetrations are very rare, the window will 'craze' during a bird strike. Performance trials, conforming to FAR/JAR regulations, have proven to be effective, but the ultimate back-up is that one pilot should retain adequate vision for an aircraft to be landed safely.

In the military sector he cited the case of aircraft with a single-piece canopy, failure of which can leave the pilot fully exposed. The Lockheed-Martin/General Dynamics F-16 has a moulded polycarbonate canopy which deflects (considerably) rather than shatters, and the head-up display is designed to act as shield and to protect against pilot injury.



In reviewing all aspects of bird-strike influence on design, he quoted a well-used stressman's adage "if in doubt – make it stout" to emphasise that it is far from being a guarantee of success when a design is tested.

However, he spoke optimistically of the future, and showed example of a modern airliner wing subjected to tests and the impact being modelled using non-linear finite-element analysis software. The test and the model result correlation was excellent in terms of having identified the failure modes and the extent of the damage very closely. He nevertheless reserved judgement in terms of wide-ranging applications, particular with reference to properties of newer, and emerging, materials and substances.

The vote of thanks from Barry Jacobson expressed particular gratitude for the wide-ranging practical content, and the very informative delivery of the state-of-the-art knowledge in what is still a very little explained area of expertise. About 100 attendees were present.

Mike Hirst