

## Session Number 2: Aerospace Structural Crashworthiness

### Advanced Restraints for Accident Survivability – The Relationship Between Impact Loads and Injury Mechanisms

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#### Abstract

Aircraft safety regulations radically changed in 1988 with the adoption of dynamic structural requirements and Anthropomorphic Test Dummy (ATD) injury limit criteria. [1] The presentation will provide an overview of modern restraints and the seat system compliance methods that have evolved. Satisfying the requirement for head impact protection has been one of the dominant challenges for the industry. The presentation will briefly address designs that currently satisfy the HIC requirement and those planned for the future. For example, although passenger airbags in commercial aircraft are still considered a new concept, they have been in service since 2001 and are certified on aircraft ranging from the smallest General Aviation (GA) to the largest transports, including the upcoming A380. Figures 1 and 2 show a frontal airbag for the cockpit of a small aircraft, and a side airbag for a premium class passenger seat respectively.

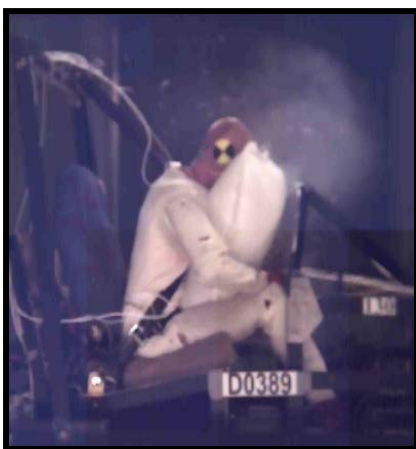


Figure 1: GA Airbag



Figure 2: Side Airbag, Transport A/C

The presentation will focus on conclusions regarding the means to evaluate and compare the relative benefit of seating and restraint systems in aircraft. Previous collaborative research between Am Safe and Cranfield Impact Centre (CIC) will be referenced as the basis for current work. [2] Finite Element (FE) models were used to simulate the human skull and brain response from dynamic sled tests. The indirect measure of injury potential for the ATD (HIC), were compared with measures of direct response (skull fracture and brain tissue pressure). An FE simulation of a sled test conducted according to the Federal Aviation Regulation 25.562 impact criteria is shown in figure 3.

Determining the method to conduct meaningful evaluation and comparison of seat and restraint system design required an understanding of the aircraft crash environment. The presentation provides results of a literature study conducted in this regard. The conclusions of the literature study established the need to further understand injury mechanisms in the thoracic region and how they are related to either contact or accelerative based loading. Specifically cardiac/major vessel injury is of interest.

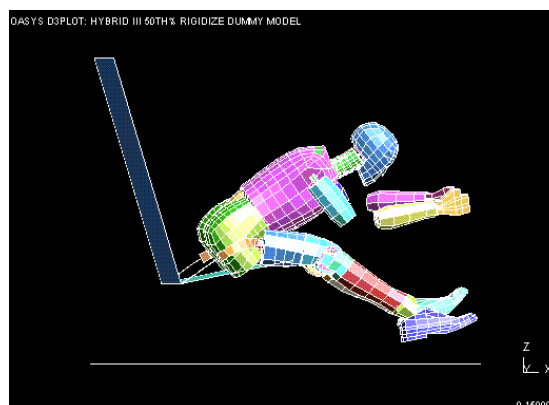


Figure 3: Simulation of 16 G Impact

The ability of modern restraint systems to distribute loads into the body have made the injury resulting from accelerative affects one of the most pertinent for the progression of vehicle crashworthiness. Findings from a study specific to cardiac injury and aneurysm/pseudo-aneurysm to the aorta and other major vessels are presented. Although there are elements which can be associated with the loading typical of aircraft versus automotive impacts, the injury mechanisms clearly result from a combination of affects. Knowledge is thus applicable to all forms of transport vehicles. The lack of understanding of the threshold of injury for deceleration based trauma to the heart and aorta is critical to the advancement of crashworthy design for all manner of passenger seating systems.

## References

- [1] *Code of Federal Regulations, Part 25*, United States Federal Aviation Regulations, [www.faa.gov](http://www.faa.gov).
- [2] Barth T. H., Hashemi S. M. R., Walton A. C., *Modelling of Direct Head Impact Injury Mechanisms Applied to Transport Aircraft: Are Long Pitch Seats Safe?*, Proceedings of the Fourth Triennial International Aircraft Fire and Cabin Safety Research Conference, Lisbon Portugal, November 2004.