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PREDICTION OF AIRCRAFT STRUCTURAL RESPONSE DURING DITCHING: AN OVERVIEW OF THE SMAES PROJECT

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The focus of the Smart Aircraft in Emergency Situations (SMAES) project is the development of tools to support the design and entry into service of safer aircraft. A set of advanced simulation techniques are being developed to allow more cost effective design methods for ditching and the integration of safety into advanced structural concepts. Of particular interest for future aircraft designs is the effective use of new materials, such as carbon-fibre composites. New design tools are required in order to allow effective use of these materials while maintaining safety. These tools will also support the continuing requirement for designs which provide a greater level of passenger protection.

Ditching can be defined as a controlled emergency landing of an aircraft on water. It is assumed that the pilot has sufficient control to perform a landing close to the instructions in the flight manual. The overall ditching process can be considered in four phases, figure 1.

1. The approach phase before contact with water that sets up the impact conditions.
2. The impact phase consisting of the initial impact with the water
3. The landing phase where the aircraft slows to rest.
4. The floatation phase when the occupants evacuate the aircraft.

The focus of the SMAES project is the impact and landing phases that are characterised high hydrodynamic loads on the aircraft structure and high-speed water flow around the aircraft. As an aircraft structure is not rigid under these conditions, both the behaviour of the fluid and structure is complex and non-linear.

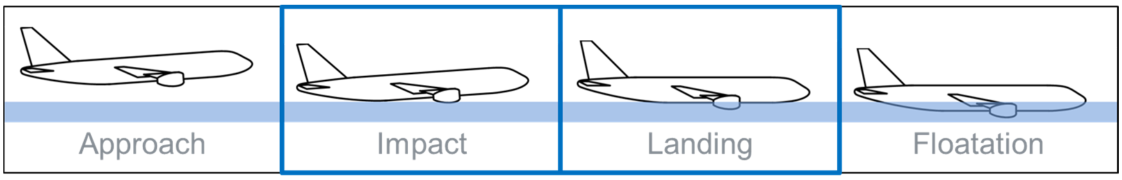

Figure 1: Phases of Ditching

This paper presents the context and objectives of SMAES, identifies the key technical challenges and describes the planned demonstration cases. The project covers two main research areas: numerical prediction of the ditching loads; and predictive aircraft models that incorporate non-linear dynamic structural behaviour and are coupled with the hydrodynamic models. The final coupled fluid-structure tools will be demonstrated on metallic, composite and composite-metallic hybrid structures.

Within SMAES, two main approaches to the prediction of ditching loads have been developed. The first approach uses semi-analytical methods, where the modified Wagner method and the Modified Logvinovich Method (MLM) are being extended. The second approach is the use of detailed numerical fluid models that can be coupled with deformable structural models. Under SMAES both meshless (SPH) and Coupled Euler-Lagrange approaches are being used. An important challenge for the prediction of ditching loads is the inclusion of effects resulting from high velocity water flow on the airframe loads. These effects include cavitation, aeration and suction.

Reliable and predictive aircraft models for structural behaviour and rupture under dynamic fluid loads are required. A particular challenge is the need to extract detailed structural response, such as rupture, as well as overall aircraft dynamics from the modelling process. An additional requirement for the structural models is that they must be suitable for coupling with the fluid load models.

These activities are supported by an intensive experimental campaign. A new experimental facility is being commissioned at INSEAN to allow guided impact tests of structural components at 30-50m/s into water. These experiments are designed to be representative of the conditions experienced during ditching, and avoid the scaling problems inherent in model tests. In addition the experimental campaign includes a number of impact tests in support of the demonstration cases along with characterisation of specific materials used in the experiments.

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Project Consortium

Aircraft Manufacturers	**Software Companies**	**Research Organisations**	**Universities**
Dassault Aviation (France)	ESI (France)	DLR (Germany)	Cranfield University *Coordinator* (United Kingdom)
Airbus Military (Spain)	Altair Engineering (France)	ONERA (France)	University of East Anglia (United Kingdom)
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