Evaluating the Influence of SHM on Damage Tolerant Aircraft Structures Considering Fatigue

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First patents concerning the integration of Structural Health Monitoring (SHM) capabilities into aircraft have been granted over 70 years ago [1]. Since then, numerous potential applications of SHM along the entire aircraft lifecycle have been identified in scientific literature. However, the application of this technology in commercial aviation is currently limited to field studies carried out primarily within aging fleets. Aside from recent advances in sensor technology, growing research effort has been committed to identify and quantify promising business cases for SHM [2]. Even though numerous individual applications have been investigated with regard to their lifecycle cost impact, current studies yield varying results. In order to facilitate the integration of SHM in commercial aviation we plan to put forward an integrated analysis framework for SHM technologies covering the entire aircraft lifecycle including design, operation and retirement. As part of this framework we introduce an evaluation approach expanding [3] to identify the impact of SHM on aircraft structural design considering structural weight, risk of structural failure and inspection efforts, as depicted in Figure 1. The proposed methodology is limited to damage tolerant structures prone to fatigue and considers only component sizing rather than the redesign of structures. By using the established relation between structural dimensions, weight, inspection effort and probability of failure, the approach is calibrated with inspection intervals provided by the manufacturer as well as information from aircraft fatigue tests. Subsequently, the influence of aircraft Operations Monitoring (OM) and SHM can be analyzed using an ideal sensor system (no false alarms) as well as real sensor system (possible false alarms). Finally, a case study is presented demonstrating the suggested methodology utilizing a commercial narrow-body passenger aircraft. Employing the methodology within our integrated analysis framework a better understanding with regard to sensor performance requirements and the impact of SHM on operational aspects can be developed.

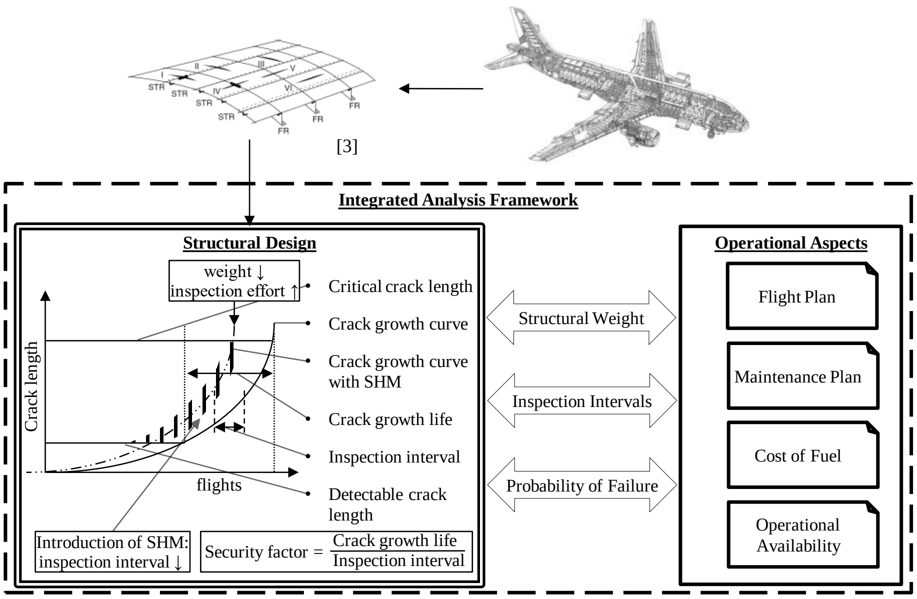

Figure 1. Schematic representation of design evaluation approach within integrated analysis framework.

Literature
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