QUB - Mechanical and Aerospace Engineering PhD Project 2019-2020

Title: A multi-fidelity simulation platform for assessing the damage tolerance of composite aero structures

Project description:

A key concern in the development of composite structures for aircraft is their perceived weaknesses with respect to in service damage. From a regulatory and certification point of view, it is often necessary to demonstrate considerable residual strength in these scenarios. To satisfy these requirements via testing programmes can be extremely costly and even prohibitive. More importantly, such programmes often fail to accurately represent real in-service scenarios. Increasingly, numerical methods combined with advances in computational technology, offer an economical means to better predict composite damage response under complex loading conditions.

Much enabling work has been completed in the domain of composite damage mechanics and failure modelling to estimate composite residual strength, however implementing this efficiently and inexpensively at vehicle/sub-assembly level remains challenging. Previous work has successfully automated the embedding of high-fidelity composite damage models within a low fidelity vehicle model (Figure 1). Whilst this can be sufficient for one-off structural integrity checks, the significant run-times mean it remains infeasible for application to a full design process which would typically require large volumes of analyses. There is a clear need to more efficiently incorporate complex composite damage mechanics in large scale structural design.

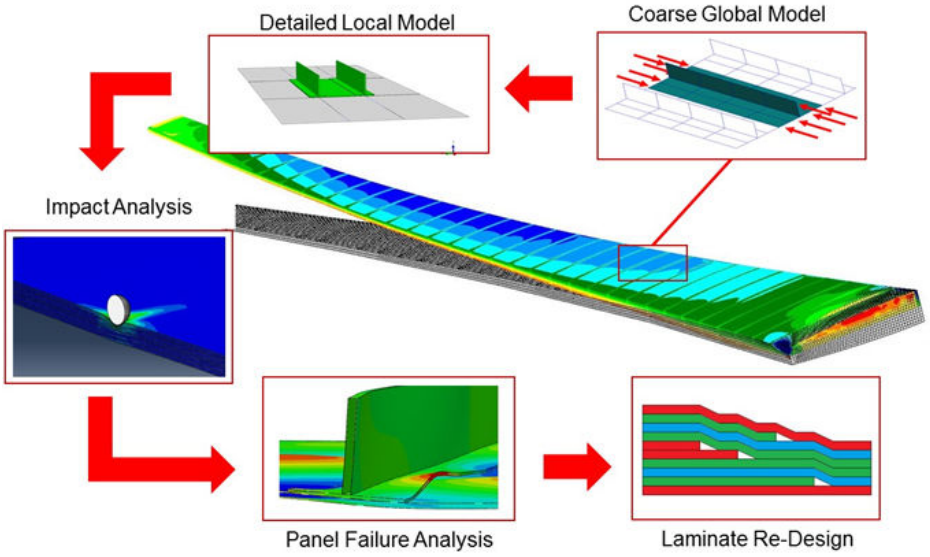

Figure 1 Multi-fidelity Framework embedded detailed composite model in lower fidelity aircraft wing

Aims and Objectives:
This project aims to develop a multi-fidelity simulation platform focussed on the preliminary design stages, which will allow commensurately accurate assessment of composite damage tolerance within the context of the product assembly.

- *Investigate methods for simulating composite damage phenomena on aero structures.*
- *Develop a method for capturing composite residual strength from high-fidelity damage models, in a form suitable for integration with lower fidelity vehicle design/optimisation models.*
- *Develop a modelling strategy that can rapidly integrate local composite residual strength criteria within a vehicle level preliminary design model.*
- *Demonstrate the new framework on exemplar aircraft wing case studies.*

Key skills required for the post: Knowledge of computational analysis methods for structural design (FEA) and an aptitude for programming.	
Key transferable skills that will be developed during the PhD:	
Lead supervisor:	Declan Nolan (d.nolan@qub.ac.uk)
Other supervisor(s):	Damian Quinn (d.quinn@qub.ac.uk)
Guaranteed stipend:	£15,009
Conditional top-up available:	
PhD students in the School have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to in excess of £2,400 per year.	

Queens University Belfast is a diverse and international institution which is strongly committed to equality and diversity, and to selection on merit. Currently women are under-represented in research positions in the School and accordingly applications from women are particularly welcome.