EXCELLENCE IN SCIENCE

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Benchmarking of triaxial and damage models for composites:

The World-Wide Failure Exercises (WWFE-II &III)

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Hosted at Faculty of Engineering and *Physical Sciences*, University of Surrey, UK.

Introduction: In the mid 1960s researchers at Farnborough perfected carbon fibres and were the first to optimise them for mass production. However, initial attempts to introduce carbon fibre composites into aircraft (e.g. engine compressor blades) were unsuccessful as failure criteria were immature and composites were vulnerable to damage from bird impact . By 2011, composites have received widespread recognition, with some commercial aircraft using up to 50% of composites by weight. Multi-axial loads are often encountered and therefore mature theories needed.

How mature are failure theories?: Traditionally, design is made through a lengthy, expensive and sub-optimal 'make and test' procedure. The lack of validated design tools has led to either conservative or catastrophically under-designed components. Composite structures are set to be key enablers in the delivery of cheaper, greener transportation and energy generation. To achieve the requisite goals, a step change is needed in the availability and reliability of design tools within the industrial knowledge base. Previous attempts have shown a lack of maturity.

The World-Wide Failure Exercise (WWFE): An international activity, known as the World-Wide Failure Exercise (WWFE) is underway. Its aim is to assess the state-of-the-art and maturity of world-wide expertise and to distil its best facets in a form that will increase confidence in the reliance of computer modelling by industry and academia. Co-organisers are Prof M J Hinton (QinetiQ) and Prof P A Smith (University of Surrey).

Details of activities: Originators of unique theories were invited to participate by agreeing to submit two papers (1) describing a blind prediction of their theory and (2) commenting and improving the accuracy of the blind prediction against test data. Some 25 groups from 13 countries took part in two exercises (WWFE-II and WWFE-III). They were given a well-defined set of challenging problems to solve in order to stretch their models and their ability to accurately predict all forms of damage and failure under complex conditions. By a careful assessment of all models and their correlations with experiments, common successes/gaps are identified and recommendations made on how best to advance the science, engineering and technology so as to benefit academia and industry. Results are to be published in 2 books.

1911: HM Balloon Factory at Farnborough is renamed HM Aircraft Factory.

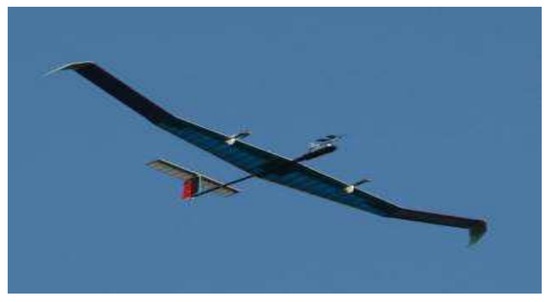
1963: Carbon Fibre is developed at Farnborough.

QinetiQ was formed in 2001 from a large UK government agency.

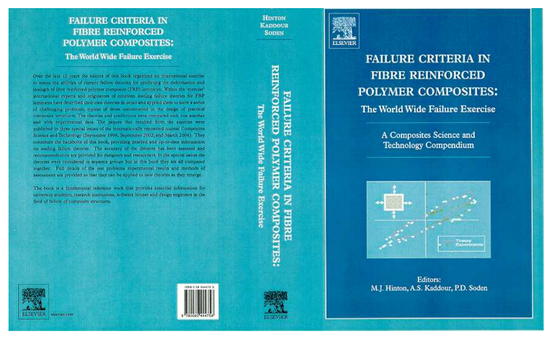
QinetiQ floated in LSE in 2006.

QinetiQ is a commercial company that offers technical, information and managed services to civil and defence customers.

QinetiQ operates within UK and international markets.



The first in the world, Zephyr developed by QinetiQ to operate at 60,000 feet and is an "eternal" solar powered vehicle. Composites are used to reduce weight.



1st WWFE was completed in 2004

Carbon fibre and glass fibre composites extensively used in large scale structures

UNIVERSITY OF SURREY

QinetiQ

My Industry Fellowship…

has provided me with a platform to lead 25 world-wide renowned groups/individuals, who have established themselves as pioneers and originators of methodologies for strength analysis of lightweight fibre composites. With their generous contributions (papers), it was possible to set up a process for 'distilling' their knowledge/expertise in a form that can firmly steer future directions for scientists, researchers and design engineers. The Fellowship and the WWFE are destined to serve as a smart bridge between Universities, research centers, software houses and industry.