Structural Design for Military Airframes

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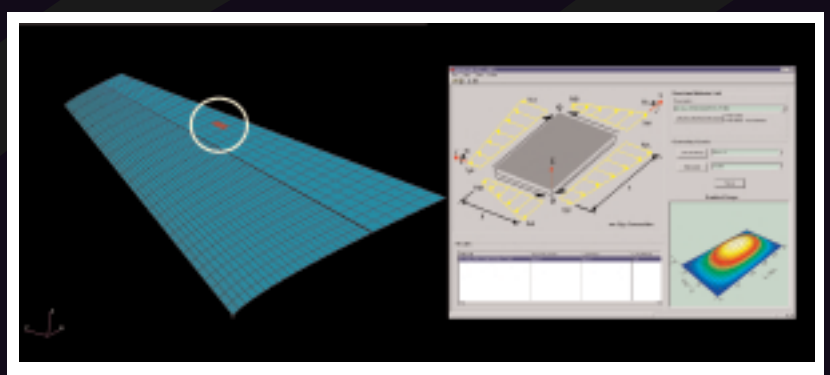
CEDC UTP for design



Scenario

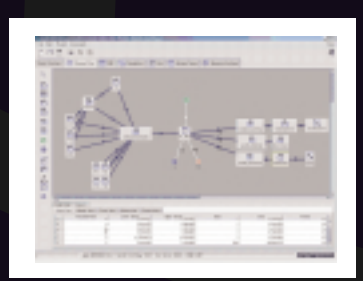
A fundamental activity within the aerospace industry is the pursuit of minimum mass airframes that meet all necessary design criteria. ECLIPSE is a BAE SYSTEMS code used for this purpose, sizing aircraft structures for minimum mass that meet design criteria such as strength and stiffness. It is a world class capability that has been developed over the past 30 years. Recent developments in integration and optimisation techniques offer the ability to replicate and enhance the capability offered by ECLIPSE whilst addressing future support and maintenance issues that it may face.

Current System

ECLIPSE uses a NASTRAN finite element model together with a control deck to define the structure and how it is optimised. An initial minimum size model is evaluated in NASTRAN and resized in ECLIPSE such that it meets all of the design criteria. The process is repeated until convergence criteria are satisfied and the structural mass has been minimised.

Recent Developments

BAE Systems has been investing in integration and optimisation technology for Multidisciplinary Optimisation (MDO). In addition it has standardised many of its structural analysis calculations in the Computer Integrated Standards (CITS) package. It is these technologies that offer the potential to replicate the ECLIPSE process in a more modular and flexible system. Such a system would allow standard techniques for resizing structure to be reused for other problems (e.g. topological optimisation.) Linking CITS calculations to optimisers would also enhance the company's ability to systematically search for the best solution to structural design problems.



Evolutionary Structural Optimisation

Many structural design problems relate to how material is distributed throughout a design space. Using the strength resizing capability of ECLIPSE it is possible to size regions of material in a structure to give a more even stress distribution. Areas of relatively low stress in a structure can then be removed to increase the efficiency of the structure and decrease its mass. Hence, there is a common strength resizing method that could be shared between an ECLIPSE replacement and a topological optimisation capability. A method was tested using ECLIPSE and routines developed for inclusion in CITS.

Laminate layup using CITS

ECLIPSE currently uses a Sequential Linear Programming (SLP) technique to resize laminates for strength and stability. More recent methods include using genetic algorithms, which also allow the stacking sequence and more advanced design rules to be incorporated into the optimisation process. A method was demonstrated using CITS calculations coupled to a genetic algorithm and gives similar or better results to ECLIPSE solutions for the same problem.

Proposed System

Design solutions will increasingly need to be found using multidisciplinary approaches. These will incorporate analyses at many levels of detail using tools from different phases of the design lifecycle. Future capability such as an ECLIPSE replacement will need to take these factors into account and be flexible enough to maintain and develop this capability and hence the company's competitive edge. Such a system is likely to use existing methods, methods being investigated, reusable modules based on CITS and integrated using recently acquired MDO technology.

Further Work

Once a strategy for developing an ECLIPSE replacement demonstrator has been agreed then key components will be developed and a system demonstrated.

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