Multi-Level Evolutionary Optimization Applied to Wing Conceptual Design

Evolutionary Optimization Group

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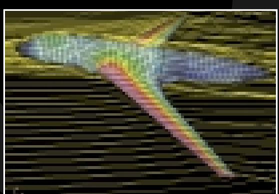
Optimization tools used in aircraft conceptual design are usually based upon empirical models. The speed of the empirical models allows large areas of the design space to be rapidly searched, promising designs being identified for further evaluation using more sophisticated tools. However, empirical extrapolation from previous designs can be unreliable, resulting in the erroneous evaluation of novel designs. More sophisticated methods, such as finite element analysis and computational fluid dynamics (CFD), cope better with novel designs. However, they are too computationally costly to directly replace the empirical models.



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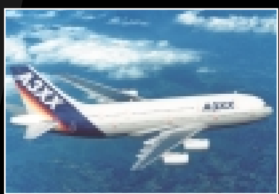
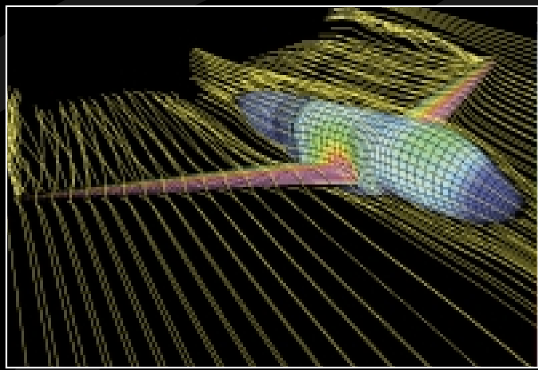
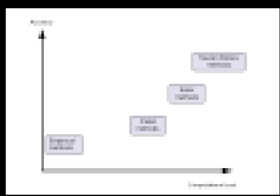
The Evolutionary Optimization Group of the Computational and Engineering Design Centre is therefore investigating the potential for stochastic optimization methods to be used to integrate both simple and sophisticated models in the same algorithm. Such a multi-level optimization might combine the rapid search of simple models with the flexibility of the sophisticated analyses. The project is focused on the conceptual design of wings for very large commercial aircraft such as the 650 seat Airbus Industrie A3XX.



Wing design involves many disciplines, including aerodynamics, structures and aeroelasticity, with each discipline making use of several different levels of analysis.



For example the following figure illustrates the approximate relative computational cost and accuracy of methods for estimating wing drag.



The aim of the research will be to develop multi-disciplinary, multi-level optimization algorithms which synthesise results from several such methods. Mechanisms for the optimal allocation of computational effort between the analysis methods will also be explored.

Many stochastic optimization methods, such as genetic algorthms, act upon populations of individual designs. They are therefore particularly suited to the implementation of schemes for the allocation of design evaluations between analysis methods. This also facilitates the distribution of computation among networks of workstations running in parallel. An important aspect of the project will therefore be the integration of such distributed analyses into the global optimization process.

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This article may be found at http://www.soton.ac.uk/~gmr2/wing.html

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