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MDO SYSTEMS FOR AERONAUTICAL APPLICATIONS

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ABSTRACT

In order to satisfy the industry needs of reducing development costs and time to market, the new trends within the design process are driven by the integration between disciplines and by using automated design procedures. Multidisciplinary analysis are mainly characterised by the design of accurate interfaces between disciplines. It has to be remind that the accuracy of the algorithms used in separate disciplines can not be preserved in the overall simulation process without taking care of the development of accurate coupling procedures. A classical example of multidisciplinary application is the study of fluid-structure interactions. In this case, the interaction between disciplines can be summarised as follows: the loads provided by the fluid are transferred to the structure which in turn transfers displacements and displacements velocities to the fluid. Then, not only the forces have to be preserved through the coupling procedure but above all the energy. In the case these properties are not satisfied, instabilities in the simulation can appear without being supported by any physical meaning. Both for static and dynamic simulations, an iterative process takes place during which the fluid and the structure are exchanging information through suitable interfaces.

By another hand, Multidisciplinary Design Optimisation (MDO) will provide designers with a new array tools and approaches that will take them closer to that elusive goal, an "optimum airplane". Mathematical tools, such as sensitivity analysis, modelling methods and optimisation solvers, provide a mechanism by which this working together can be accomplished. The result is a process that can both reduce the design cost and flow-time, and improve the quality of the aerospace systems. MDO means among others

- automatic overall process management and monitoring,
- automatic generation of models related to different disciplines,
- geometry parametrisation and its relationship with the CAD model,
- capability of executing single discipline solvers on heterogeneous platforms,
- efficient and robust optimisation strategy,
- accurate definition of the mutidisciplinary optimisation problem, including objective function and constraints

A large amount of resources needs to be involved in order to design an efficient and useful tool. In addition, it requires the set up of working groups and/or the education of

a new generation of engineers, thinking on a multidisciplinary basis. Figures 1 to 3 illustrates an example of computation of the static aeroelastic deformation of an aircraft at cruise condition (M=0.8, Cl=0.45). In the present exercise, an Euler solver was coupled with a generic computational structural mechanics tool. The system is able to provide not only the surface deformation and the related aerodynamic characteristics, but also the structural responses of the aircraft components. References 1 to 3 describe a MDO system designed for the solution of aero-structural problems.
Future works will deal with the extension of the tools in order to take into account other disciplines like acoustics, ...

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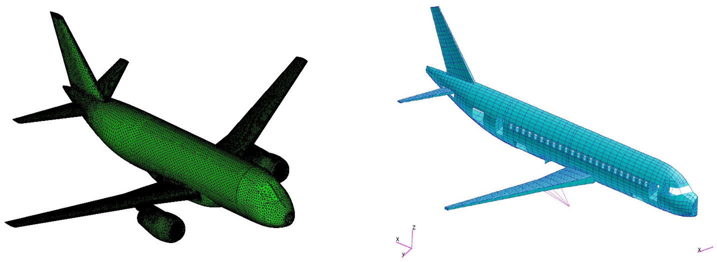

Figure 1:CFD and FE structural aircraft models

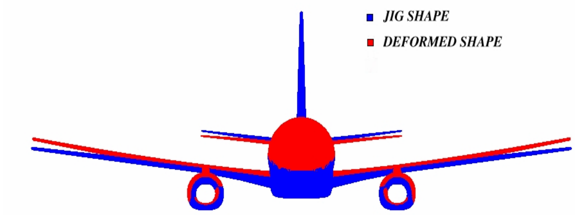

Figure 2: Static eroelastic deformation at cruise condition

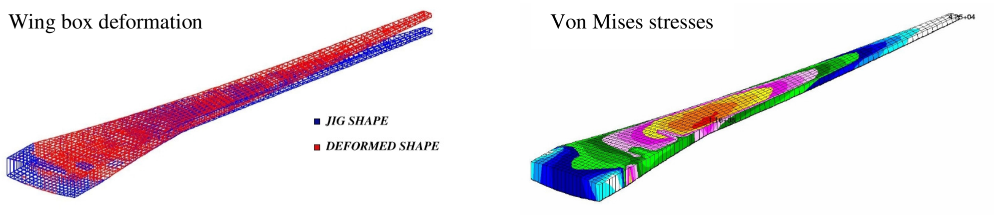

Figure 3:Wing structural responses