Flexible Parametric CAD Models for Web-based Low-Noise Wing Design (SIMDAT)

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

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UTP for design

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The pursuit of low noise civil aircraft has become a major driving force for technology innovation in the aerospace design process. Design of low noise aircraft is a complex process involving many disciplines and seamless collaboration between disciplines is the key to the success of such process. Data lies at the heart of the collaboration scenario where computational modelling and simulations are essential to delivering low-cost, high-performance products. The EC-funded SIMDAT project focuses on the use of advanced Grid technology to promote collaboration in four application areas. In the aerospace application area, the design of a low-noise wing is chosen as the test bed for available and emerging Grid technologies.

SIMDAT Aerospace – DataGrid for Aerospace Design

The SIMDAT aerospace data grid aims to provide a distributed, collaborative infrastructure and tools to support design of complex aerospace systems, using the design of a low-noise, high-lift wing as an exemplar. The project involves three main partners, each specialising in different disciplines. Grid technologies, and Web Service access to proprietary analysis capabilities in particular, provides an ideal vehicle for seamless collaboration towards common targets. Figure 1 shows the architecture of the application scenario, in which the main partners and their area of expertise are illustrated.

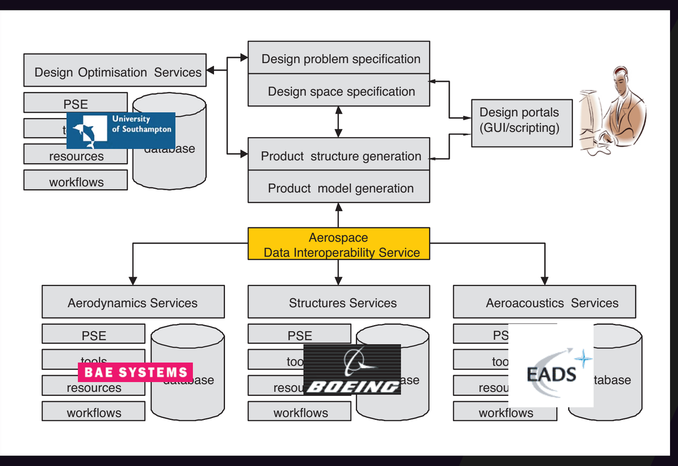

Figure 1: SIMDAT Aerospace Scenario (Boeing may join phase II)

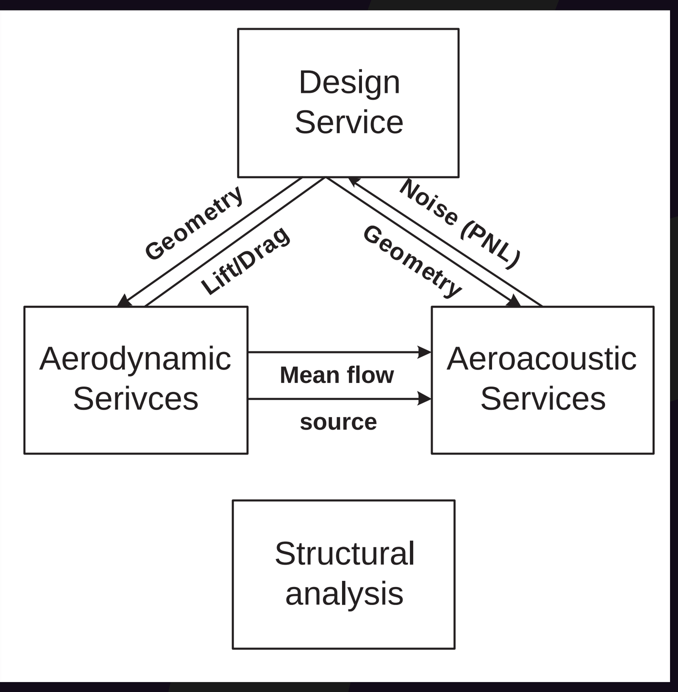

Figure 2: Dataflow for SIMDAT Aerospace Application

Services and Dataflow

SIMDAT Aerospace will primarily contain three services: Design Services for producing the geometry definition for analysis based on input from designers; Aerodynamic Services for mean flow analysis using CFD; Aeroacoustic Analysis for predicting the noise levels for the configuration. Structural analysis may also be introduced as a constraint in the design process. The data flow between services is illustrated in Figure 2. The geometry is defined in CATIA V5 as a parametric model, which, based on the input variables provided by designers will produce the geometry file. The geometry files in IGES format will then be passed to a mesh generation Web service to generate the mesh for mean flow CFD analysis and acoustic analysis. The parametric definition of the model will allow designers to modify the design easily and study the tradeoffs between different choices. And after the whole dataflow has been automated and validated, the parametric definition of the model will allow it to be coupled with optimisers to explore the design space in order to locate near optimum solutions. Reliable, fault-tolerant and secure data exchange and service invocations are the key to providing a collaborative process across institutional boundaries.

Flexible Parametric CAD Models as Services

The design of a flexible parametric wing model is the first task of the project at Southampton. The wing geometry can be parameterised in various ways, from a more mathematical definition to a more engineering intuitive way based on geometric parameters such as leading-edge radius, maximum thickness, etc. Here the airfoil section of the wing is modelled using Non-Uniform Rational B-Splines (NURBS) and the locations of the control points are used as design variables, however, to better control the range of the design space and reduce the probabilities of producing unrealistic geometries, non-dimensional parameters are used in the definition of the control points as shown in Figure 3. This will lead to uniform ranges for all the design variables from 0 to 1 and eliminate the need to constrain the relative location of control points, as is the case when absolute coordinates are used. 13 Control points will be used in the definition of one airfoil section and there will be 20 design variables in total for the airfoil section. The profile shapes and locations for the flap will also be parameterised, while the shape of the fuselage will be fixed in the problem. An illustration of the final shape that will be designed is given in Figure 4.

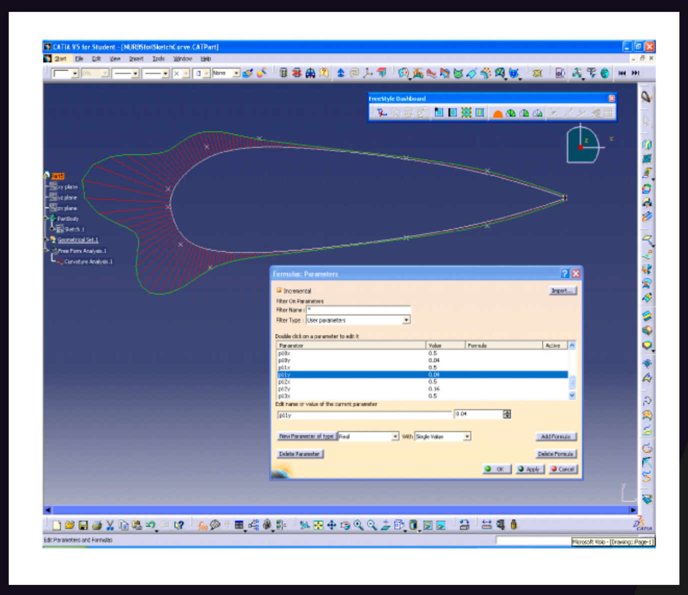

Figure 3: NURBS Parameterisation of Airfoil Sections

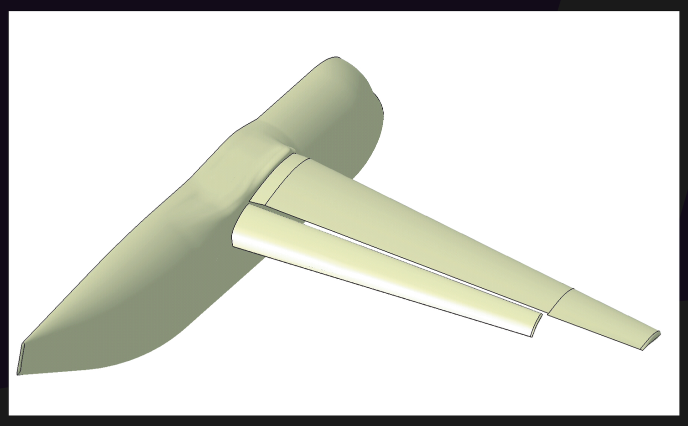

Figure 4: Aircraft Wing Geometry (to be parameterized)

With the tools and technologies being developed, design and analysis services will be composed together to form a task specific workflow that can be used in the design process. Working in a collaborative way, design teams will be able draw on expertise from various partners and deliver better designs faster.

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