FLAVIIR

INNOVATION THROUGH PARTNERSHIP

THE FLAVIIR PROJECT

The initial, conceptual phase of any design process is, essentially, a highly global search over the space of possible configurations, topologies, shapes and dimensions. The solution chosen to progress to the preliminary design stage is ideally one that satisfies all the constraints specified in the design brief and relevant regulations and optimizes some figure of merit related to performance, cost, revenue or combinations of these. The task of the FLAVIIR team at the Computational Engineering and Design Group of the School of Engineering Sciences at the University of Southampton is to develop a (collection of) computational tool(s) that aid this process in the case of Unmanned Air Vehicle (UAV) design.

With the increased freedom in layout selection possible when designing a UAV concept (compared, for example, to the relatively constrained and mature world of commercial airliner design), comes the significant challenge of building a geometry engine that will provide the variety of airframe models demanded by the highly global nature of the design search. In order to enable multidisciplinary trade-off studies, both an external surface and an internal structure are required – we have developed a single, generic model to supply these, in the form of a parametric geometry residing in a commercial CAD tool (CATIA®). Figures 1 and 2 show a number of instances of the external surface and internal structure of this model.

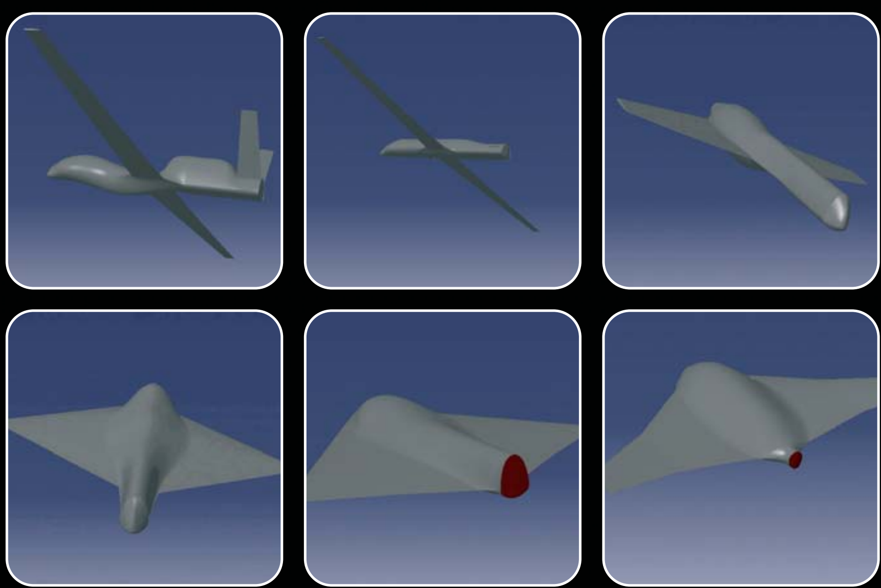

Fig.1 A selection of geometries generated by the geometry service, including a clone of the Global Hawk (top left), morphing into an X-47 clone (bottom centre).

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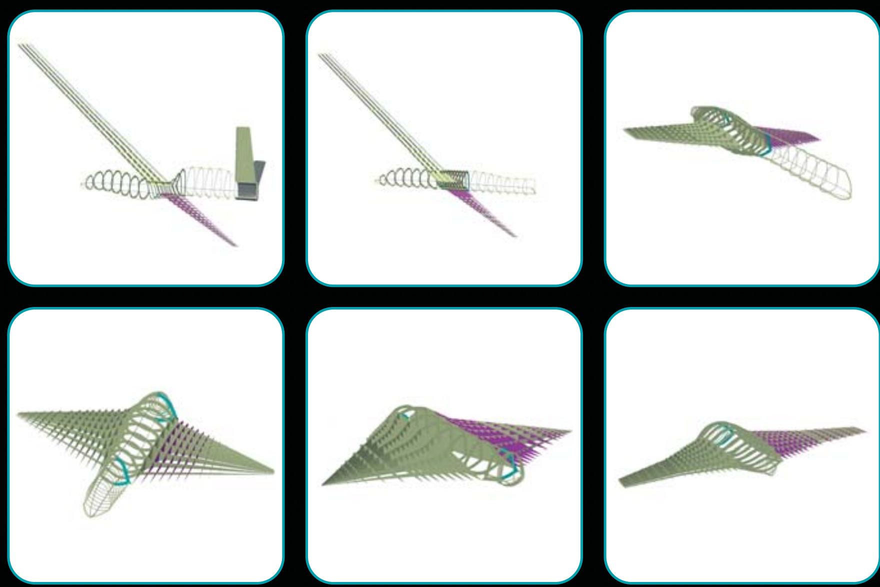

Fig.2 A selection of internal structure models generated by the geometry service of the UAV conceptual design system, corresponding to the external surface geometry sequence shown in Fig. 1.

The internal structures shown in Figure 2 are clearly over-engineered for most mission specifications. This is deliberate, as the approach implemented here is based on the concept of the structural universe of a design. The actual conceptual designs will be subsets of the entities contained in the structural universe (the models depicted in Figure 2 are, in fact, instances of the structrural universe).

A prerequisite of the structural universe approach is modularity, that is, the guarantee that that almost any logical sub-element of the geometry is (or can easily be turned into) a separate entity. Such elements can then be removed from the design, without compromising its suitability for any subsequent (usually automated) analysis. Figure 3 illustrates this feature for a number of examples. For example, it is very easy to create space for various systems that have to be accommodated inside the airframe, such fuel tanks or circulation control channels. Most important, however, is the possibility of removing elements that are `not earning their keep', that is, have been judged to be under-utilized by, say, an automated stress analysis process.

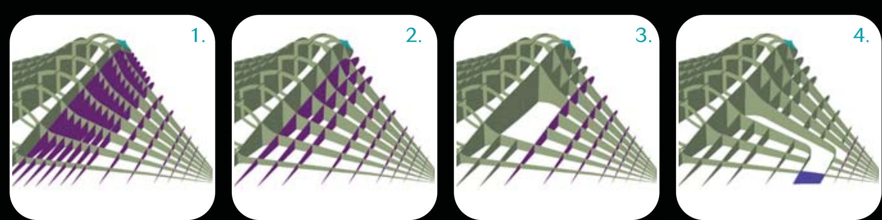

Fig.3 Examples of modularity on a blended wing body instance of the structural geometry. Ribs, spars and parts thereof can be removed or filleted easily to reduce weight in case some elements prove to be unnecessary (2), a fuel tank or other similar system needs to be accommodated (3) or a duct needs to be created for channeling engine bleed air to a circulation control plenum installed on the trailing edge (4).

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