11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

SHAPING OF AIRCRAFT AND HELICOPTER CONFIGURATIONS WITH CAD

Arno Ronzheimer [1]

[1] Institute of Aerodynamics and Flow Technology, DLR,
Lilienthalplatz 7, D-38108 Braunschweig, Arno.Ronzheimer@dlr.de

Key Words: *Virtual Product, CAD, Parameterization, Lofting*.

With today's simulation techniques it is possible to develop a competitive and complex technical product almost completely virtually starting from first pre-design concepts to the detailed programming of the numerical controlled machine to launch manufacturing, [1]. Especially in the early design phases it is highly desirable to gain as much knowledge as possible of the product under development to mitigate the risk of unfeasible designs and to fulfill the top level requirement, [2]. As mainly simulations are used to gather a reliable and comprehensive knowledge the simulation fidelity becomes essential.

In industrial aircraft design, Navier Stokes solvers have become the state of the art in fluid flow simulation and, in combination with advanced meshing tools, particularly based on unstructured methods, nearly no limitations regarding the complexity of the underlying geometry exist. The challenge today in simulation based design or even in simulation based optimization in the context of virtual product development is to bring a first concept roughly sketched on a sheet of paper into a parametrically controllable variable geometry ready for CFD simulation.

Fortunately, today nearly all established CFD grid generation software systems are able to process CAD data and therefore the most obvious and reasonable work around is to rely on high end computer aided design software for geometry generation. A viable method to create a parametric model of an aircraft is to reuse an existing model or parts of it by adapting relevant design parameters. This was already presented in [3] for airfoils and wing type geometries and can be accomplished quite easily also by a non-experienced designer. However, since the use of parametric CAD systems in pre-design is still a novel technique, eligible parametrically variable CAD parts are still rare in design offices and the delegation construction work to an experienced CAD designer with little knowledge in aerodynamics may lead to more or less improper designs, as shown in Figure 1.

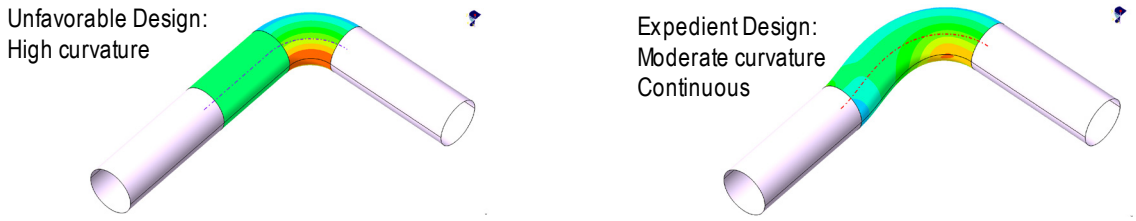

Figure 1: Different joint designs between two perpendicular pipes with curvature analyses

Ideally, an aerodynamics engineer also has reasonable skills in computer aided design to model surfaces, which incorporate his knowledge about fluid dynamics. Over the past number of years high end CAD systems have become very user friendly and intuitive even in freeform design. For generation of surfaces in aircraft design the preferred function is the loft function named "Multi-sections surface" in CATIA V5, [4]. About 90% of the wetted aircraft skin

area is lofted and the main design work is to prepare a wireframe to supply the loft function with section-, guide- and spine curves as shown in Figure 2.

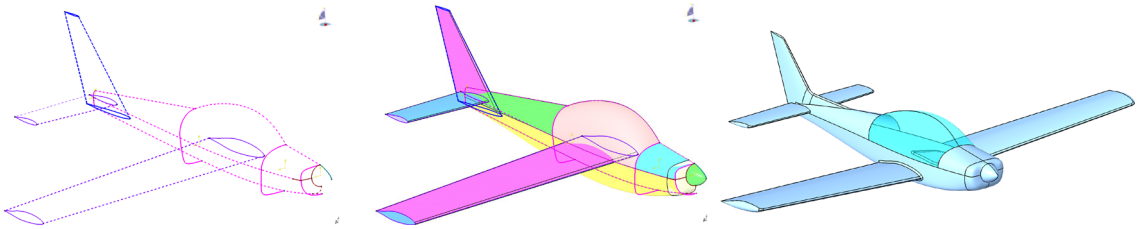

Figure 2: From wireframe via lofting to watertight surface model for CFD mesh

The special purpose of the final paper is to depict ways of generating wireframe curves within computer aided design systems to build up complex mesh-able variable models for CFD. This is shown exemplarily for a helicopter fuselage, created from conical curves, in Figure 3 and Figure 4. The final paper will also focus on nacelles, wings with curved wing tips, and fuselages of fixed wing aircraft.

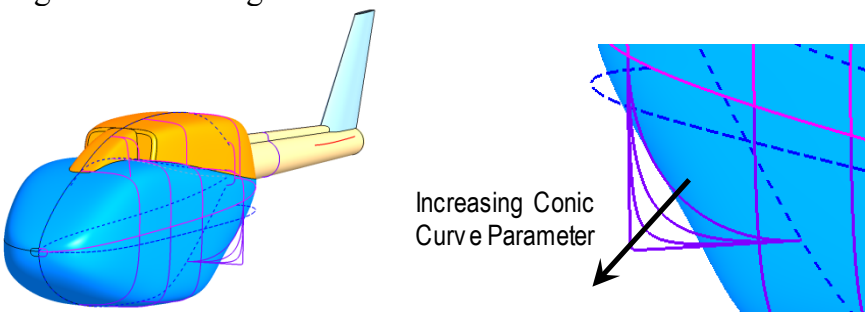

Figure 3: Generic Parametric Helicopter Model with Conical Section Curves

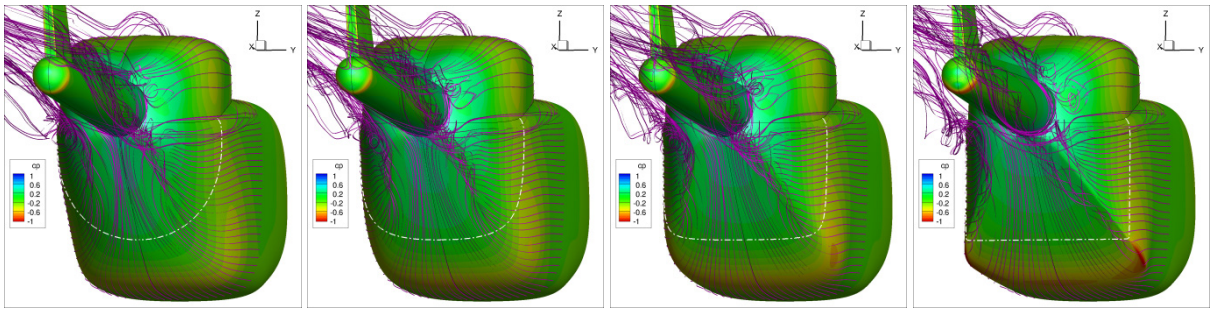

Figure 4: Influence of Conical Curve Parameter on Helicopter Tail-Flow

REFERENCES

[1] Thierry Pardessus: Concurrent Engineering Development and Practices for Aircraft Design at AIRBUS. 24th Congress of International Council of the Aeronautical Sciences, 29 August-3, September 2004, Yokohama, Japan, Paper ICAS 2004-7.7.1.

[2] Hirschel EH.: Towards the virtual product in aircraft design? Proceedings of NDF-2000 Fluid Dynamics with its Challenges in Aerospace Engineering. CNRS, Paris, November, 2000.

[3] Ronzheimer, Arno: Aircraft Geometry Parameterization with High-End CAD-Software for Design Optimization. ECCOMAS 2012, 10.-14. September 2012, Wien, Östereich. ISBN 978-3-9502481-9-7.

[4] www.3ds.com