DEVELOPMENT OF AN INNOVATIVE COLLABORATIVE FRAMEWORK FOR AIRCRAFT DESIGN

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Abstract: This work concerns the introduction of a new approach to improve the overall aircraft design in a collaborative remote manner. Typical aircraft design approach is the Monolithic Design, where all disciplines are reported into a group or a single person. This approach is difficult to maintain because the single group is unable to monitor the whole process. To improve this method the only possibility is to build a process in which the product is designed thanks to collective efforts of different area of experts introducing the Collaborative Design. The last evolution of this way to proceed is the **Collaborative Remote Design**; the main difference is that the teams can be geographically located in different parts of the world and can communicate and exchange the own tools or results through a remote server connection. In this way is possible to take advantage of the knowledge of several aerospace research centers or companies in each certain discipline. This approach is the base for **MDO** applications within the AGILE (*Aircraft 3rd Generation MDO for Innovative Collaboration of Heterogeneous Teams of Experts*) European Project coordinated by the DLR and funded by EU through the project HORIZON 2020 [1]. There are several **AGILE** project **goals[1]** such as to involve **companies** and **research centers** which will **share** their **best competencies** (tools development), to foster the **Collaborative, Remote and Distribute** design approach, to develop and release advanced **MDO techniques** and so to create an Open MDO Test Suite like a database for the future aircraft design and finally to reduce the design **time** and to increase the **fidelity**. To achieve these goals in terms of Collaborative Remote Design and MDO, the DLR provides two fundamental instruments: **RCE** (*Remote Component Environment*) software and a standard file format called **CPACS** (*Common Parametric Aircraft Configuration Schema*). The first one is open source software useful to help engineers or teams of scientists to manage, run and control complex analyses and simulations and so to create some design chains. The second one is a file based on XML technology containing a parametric description of aircraft configurations in terms of geometry and beyond. The proposal of this work is to create modules usable into RCE software an MDO framework in which the AGILE members, like UNINA, TUDelft, ONERA, BOMBARDIER, ALENIA, DLR, AIRBUS, TsAGI, FOKKER, NLR, CIAM and other partners can use for the Collaborative Remote Design. **Each** partner will have to interface only with **RCE** and the **CPACS** files to reduce time and redundance. The advantage to use a single file format is reduce the number of interconnections among AGILE partners. In particular during this work the developed tools by UNINA are:
VeDSC (**Ve**rtical tail **D**esign **S**tability and **C**ontrol) [2], **FusDes** (**Fus**elage **Des**ign) [3] and **Directional Stability** that perform the directional stability of the whole configuration and of main aircraft components evaluating the interference among these ones; **Zero-Lift-Drag-Coefficient** computes the aircraft zero lift drag coefficient according to semi-empirical approach, **Payload-Range** computes the aircraft payload-range diagram and finally **High-Lift** that computes the aircraft aerodynamic coefficients with high lift devices.
All the modules are algorithms written in ***Python*** language in order to read and write into a generic CPACS aircraft file both results and data. The UNINA methods have been developed in **JAVA** environment and are stored in a executable '.jar' file, which takes advantage of semi-empirical and serialized database, runnable through a simple *Python* command line. Finally these tools are integrating in RCE software and made available for the partners; so is possible to create a workflow in RCE that executes the described steps. In addiction, thanks to the collaboration with the DLR has been developed a turboprop aircraft configuration, similar to the ATR 72, stored in a CPACS file. This kind of approach makes possible the knowledge dissemination and to reduce the overall aircraft design time by the 40-50% overthrowing the production costs.

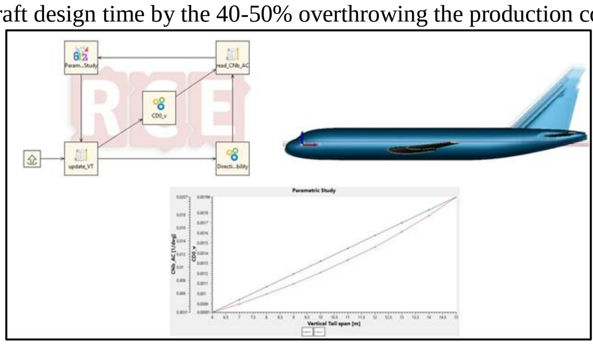

Figure 1: Parametric study on a similar A320 configuration; vertical tail span changing and vertical tail C_{D0} variation.

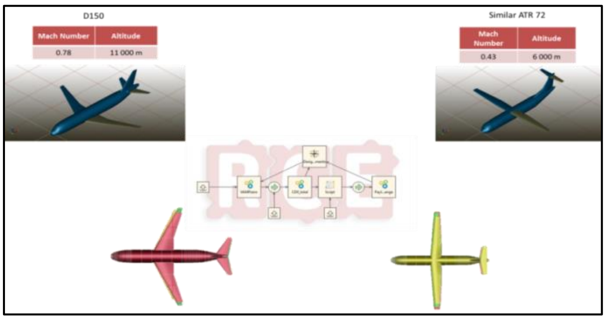

Figure 2: Design of Experiment on a similar A320 and ATR 72 configuration; wing parameter changing.

	Similar A320	*Similar ATR 72*	*DC1*
$CN_{\beta v}$ [1/deg]	0.0050	0.0044	0.0046
CN_{β_fus} [1/deg]	-0.0019	-0.0019	-0.0018
$CN_{\beta w}$ [1/deg]	0.0002	0.0000	0.0002
$CN_{\beta AC}$ [1/deg]	0.0033	0.0025	0.0030

Table 1 : Aircraft 'Directional Stability' results

Reference

[1] AGILE Project : http://www.agile-project.eu/
[2] Della Vecchia P., Nicolosi, F., Ciliberti, D., "Aircraft directional stability prediction method by CFD", 33rd AIAA Applied Aerodynamics Conference, Dallas, Texas, 22-26 June 2015, doi: 10.2514/6.2015-2255.
[3] Nicolosi, F., Della Vecchia, P., Ciliberti, D., Cusati, V., "Fuselage aerodynamic prediction methods", 33rd AIAA Applied Aerodynamics Conference, Dallas, Texas, 22-26 June 2015, doi: 10.2514/6.2015-2257.