Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: CFDMPS (DEFAINE session) / SYSINT

Corresponding author: Petter Andersson
E-mail of corresponding author: petter.andersson@gknaerospace.com

Type: Oral

Status of corresponding author: Regular

Title
Multidisciplinary design space exploration: An electric fan thruster component design use case

Authors
Petter ANDERSSON[1], Marcus Lejon[2], Saravanan Chidambaranathan[3], Siva Dasari[4], Massimo Panarotto[5], Max Jacobson[6]*

** Corresponding author*
[1] GKN Aerospace Engine System, Dep. of Systems analysis and IP Trollhättan, Sweden, petter.andersson@gknaerospace.com
[2] GKN Aerospace Engine System, Dep. of Product Integration and Simulation Methods Trollhättan, Sweden, marcus.lejon@gknaerospace.com
[3] GKN Aerospace Engine System, Dep. of Research and Technology Bangalore, India, saravanan.c@gknaerospace.com
[4] GKN Aerospace Engine System, Dep. of Automation and Composite Technolgies Methods Trollhättan, Sweden, siva.dasari@gknaerospace.com
[5] Chalmers University of Technology, Industrial and materials science Göteborg, Sweden, massimo.panarotto@chalmers.se
[6] GKN Aerospace Engine System, Dep. of Product Integration and Simulation Methods Trollhättan, Sweden, max.jacobson@gknaerospace.com

Abstract
The aerospace industry strive to explore new and for the commercial aircraft industry, novel technology such as hydrogen hybrid and fully electrical drivelines. Hence there is an increased need for engineering processes that can explore new and novel design in an efficient way. This paper reports on work accomplished in one of the use cases in a European research project, DEFAINE [1]. The project is in its third and final year and result from previous work has been reported in the ICAS conference in Stockholm 2022 [2]. The design space exploration process at GKN Aerospace Engines (GKN AE) is described in a generic form with the phases, “Set up study”, “create context models”, “prepare for analysis”, “run analysis” and “evaluate results”. Different disciplines operates in the phases performing specific task for that area. The effect of the methods and tools developed in the project are demonstrated on a use case targeting Key Performance Indicators (KPI:s) defined by the industry partners included in the project. Here, the prioritized KPI:s include “*design space dimensionality*”, “*Lead-time for design update*”, “*Design point quality*” and “*Design space sampling quality*”.
The use case describes a novel electric aircraft engine with a ducted fan under development at GKN AE [3]. The Design Space Exploration study include objectives and analysis from several disciplines, computational Fluid dynamical (CFD), Strength & Fatigue and producibility that drives cost estimation. The study objective is to investigate the preferred number of vanes or the trade between weight, cost and performance.
To improve the KPI “design space dimensionality”, a highly parametrized cad model has been developed with the ability to include configurational changes in a Design Space Exploration study such as different types of vane fitting solutions and hub designs with an optional stiffness wall. Design automation and parametrization is enabled by applying Knowledge Based Engineering techniques targeting the KPI “*Lead-time for design update*”.

It is evident that in order to perform a more relevant DSE study on a component level there is a need to understand the impact and aspects on an engine level, hence a whole engine model has been included. A whole engine model (WEM) is represented in three different contexts; Model Based System Engineering, Whole Engine Mechanical Model as well as a CFD Whole Engine model where attaching geometry of the component of interest is included to better understand the impact of the design variants. As the number of Fan Outlet Guide Vanes are changed, the position of the interfacing flanges moves and the boundary conditions changes. Hence the requirement to have a WEM to supply the updated boundary conditions. The increased number of designs studied generates a vast amount data that are analyzed and managed using AI technologies within Machine Learning.

The paper conclude that the developed methods and tools within the DEFAINE framework has improved our capability to perform DSE and the results is described in reference to described KPI:s.

References

[1] DEFAINE, "Project overview 19009 DEFAINE," 10 02 2022. [Online]. Available: https://itea4.org/project/defaine.html. [Accessed 22 May 2022].

[2] P. Andersson, M. Lejon, A. Pradas and M. Jacobson, "Demonstrating an approach for multidisciplinary set-based design within an aerospace research project - DEFAINE," in *33RD Congress of the international council of the aeronatical sciences*, Stockholm, 2022.

[3] GKN Aerospace, *GKN AEROSPACE TO LEAD DEVELOPMENT OF ELECTRIC FAN THRUSTER FOR ELECTRIC AIRCRAFT,* Trollhättan: GKN Aerospace, 2021.