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AIRCRAFT DESIGN

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Aircraft design is, as we know, the first fascinating step in the life of an aircraft, where visions are converted into reality. In a practical sense, aircraft design supplies the geometrical description of the aircraft. Traditionally, the output is a three-view drawing and a list of aircraft parameters. Today, the output may also be an electronic 3D model. In the case of civil aircraft, a fuselage cross-section and a cabin layout are provided in addition. In an abstract sense, aircraft design determines the design parameters to ensure that the requirements and constraints are met and design objectives are optimized. The fundamental requirements for civil aviation are payload and range. Many constraints come from certification rules demanding safety. The objectives are often of a financial nature, like lowest operating costs. Aircraft design always strives for the best compromise among conflicting issues.

The design synthesis of an aircraft goes from the conceptual design to the detailed design. Frequently, expert knowledge is needed more than computing power. Typical work involves statistics, the application of inverse methods, and use of optimization algorithms. Proposed designs are analyzed with respect to aerodynamics (drag), structure (mass), performance, stability and control, and aeroelasticity, to name just a few. A modern aircraft is a complex, computer-controlled combination of its structure, engines, and systems. Passengers demand high comfort at low fares, society demands environmentally friendly aircraft, and investors demand a profitable asset.

Overall aircraft design (OAD) comprises all aircraft types in civil and military use, considers all major aircraft components (wing, fuselage, tail, undercarriage) as well as the integration of engines and systems. The aircraft is seen as part of the air transport system and beyond contributing to multimodal transport. Aircraft design applies the different aerospace sciences and considers the aircraft during its whole life cycle. Authors from all economic sectors (private, public, civic, and general public) can submit to this Special Issue (SI). Education and training in aircraft design is considered as important as research in the field.

The design of aircraft and engine components hinges on the use of computer aided design (CAD) models and the subsequent geometry-based analyses for evaluation of the quality of a concept. However, the generation (and variation) of CAD models to include radical or novel design solutions is a resource intense modelling effort. While approaches to automate the generation and variation of CAD models exist, they neglect the capture and representation of the product's design rationale—what the product is supposed to do. The design space exploration approach Function and Geometry Exploration (FGE) aims to support the exploration of more functionally and geometrically different product concepts under consideration of not only geometrical, but also teleological aspects. The FGE approach has been presented and verified in a previous presentation. However, in order to contribute to engineering design practice, a design method needs to be validated through application in industrial practice. Hence, this publication reports from a study where the FGE approach has been applied by a design team of a Swedish aerospace manufacturers in a conceptual product development project. Conceptually different alternatives were identified in order to meet the expected functionality of a guide vane (GV). The FGE was introduced and applied in a series of workshops. Data was collected through participatory observation in the design teams by the researchers, as well as interviews and questionnaires. The results reveal the potential of the FGE approach as a design support to: (1) Represent and capture the design rationale and the design space; (2) capture, integrate and model novel solutions; and (3) provide support for the embodiment of novel concepts that would otherwise remain unexplored. In conclusion, the FGE method supports designers to articulate and link the design rationale, including functional requirements and alternative solutions, to geometrical features of the product concepts. The method supports the exploration of alternative solutions as well as functions. However, scalability and robustness of the generated CAD models remain subject to further research.

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