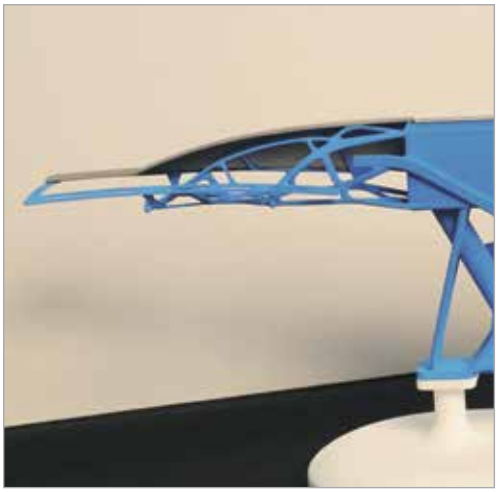
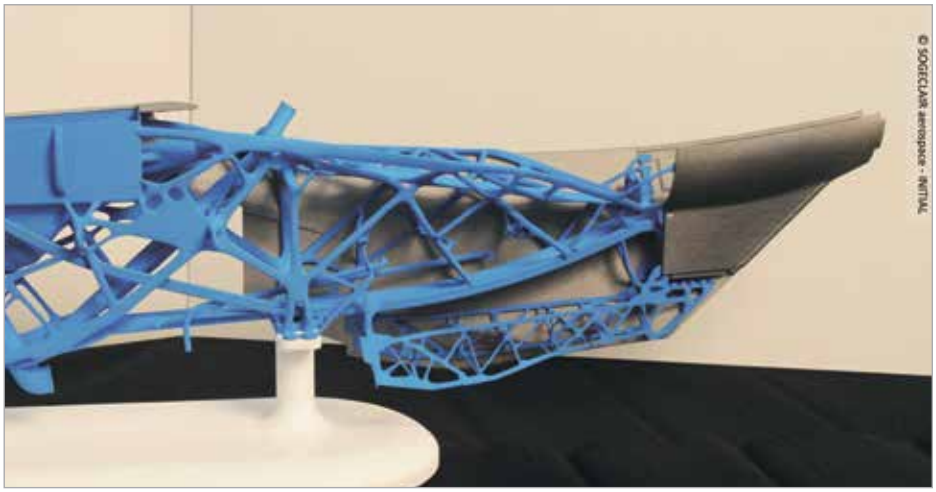
SOGECLAIR Aerospace Employs HyperWorks to Optimize Additively Manufactured Aircraft Components Topology optimization of a large aeronautic engine pylon structure, for which a 1/8 scale model was 3D printed





Key Highlights

Industry Aerospace

Challenge Find new development and manufacturing approach to reduce weight while ensuring safety.

Altair Solution A CAE-driven design process combining topology optimization using OptiStruct and Additive Layer Manufacturing (ALM).

Benefits

- Design freedom combining optimization and additive manufacturing
- Maximize weight-saving of parts while maintaining the part's stiffness
- Reducing the overall number of system parts leading to reduced assembly time

The aerospace industry has long been a trendsetter in early adoption of new technologies as it strives to meet the challenges posed by regulatory and safety standards, high manufacturing and operational costs, and global competition. In recent years, reducing aircraft weight for improved performance and reduced fuel costs has been a primary focus of aerospace engineering efforts. SOGECLAIR aerospace, a major supplier for the aerospace industry, recently explored a new concept for an engine pylon, a critical component that holds an aircraft engine to the wing or fuselage. Their innovative approach combined topology optimization using OptiStruct, part of Altair Engineering's HyperWorks software suite, and Additive Layer Manufacturing (ALM), also known as 3D printing.
The project resulted in a 20% reduction in weight, a 97% reduction in the number of components and a structure as strong as the traditional one.

About SOGECLAIR aerospace

SOGECLAIR aerospace, part of the SOGECLAIR S.A. group, is a major engineering partner and prime contractor for the aerospace industry. With offices in France, Spain, the United Kingdom, Germany, Tunisia, and Canada, and a team of nearly 1,250 staff, SOGECLAIR aerospace is attentive to its customers and their technological and strategic expectations. Consultancy and management services are provided in configuration management, aero structures, systems installation, aircraft interiors, manufacturing engineering, and equipment. SOGECLAIR aerospace's activities extend from the research & development phase up to the supply of the products.

SOGECLAIR aerospace has chosen to put innovation at the heart of their corporate culture. The company's Innovation Centre, active since 2009, encourages and facilitates innovation and development into new engineering approaches and solutions.

Keywords: Optimization, additive manufacturing

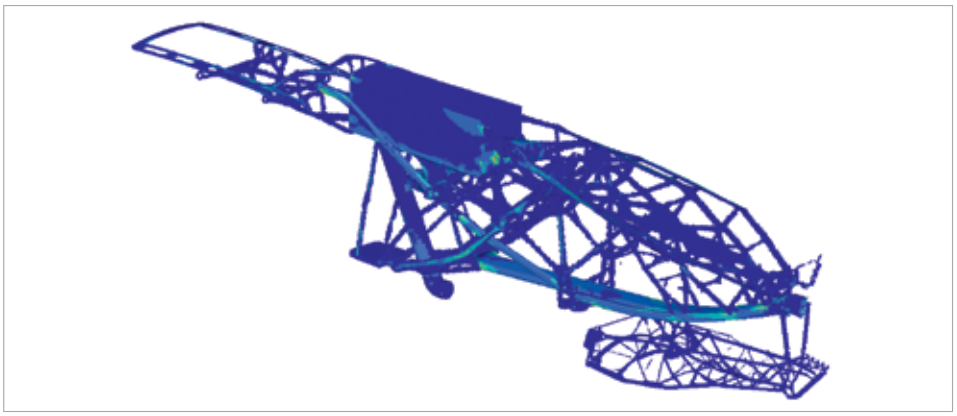
SOGECLAIR Success Story

"HyperWorks allows us to explore non-intuitive optimal solutions and achieve significant weight savings for different parts either for aircrafts or satellites. The ability to reduce weight while maintaining stiffness is vital, since this contributes directly to the aircraft's performance in terms of fuel consumption and payload. Without HyperWorks, and in particular OptiStruct, we would have not been able to fully benefit from the advantages ALM offers. The symbiosis of optimization and additive manufacturing gives us a lot more design freedom than we ever had in the past with traditional development and manufacturing methods."

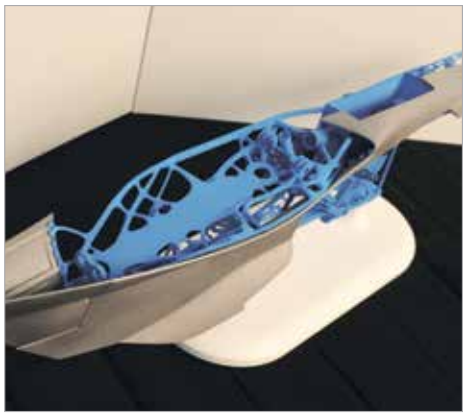
Abdelkader Salim,
Engineer in the Innovation Department
SOGECLAIR aerospace

Technologies offer new possibilities

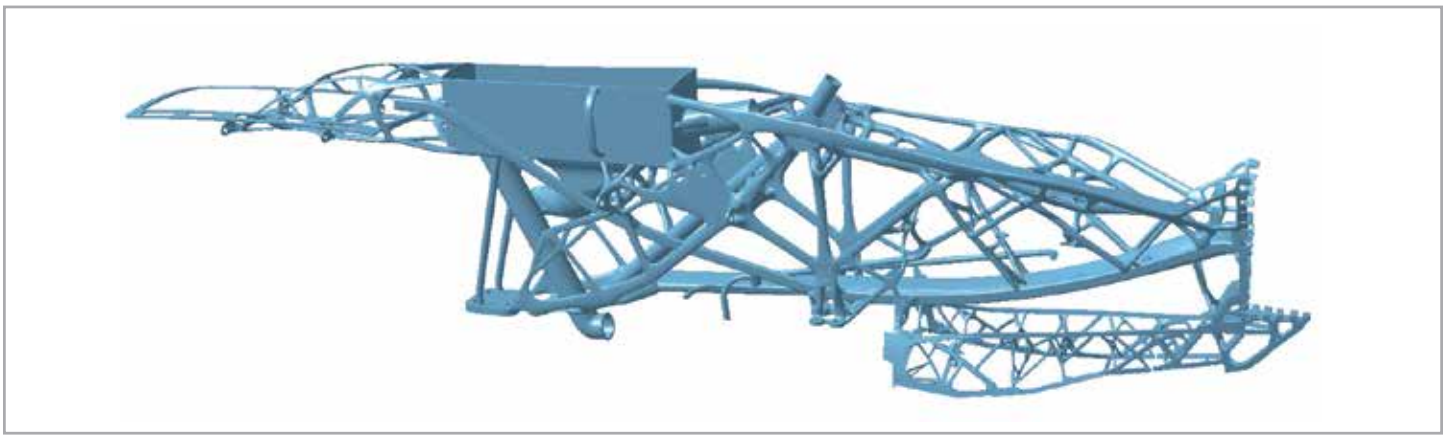
Reducing weight while ensuring safety, reducing fuel consumption, and increasing payload is the major goal in the aircraft industry today. Design, development, and manufacturing challenges are complex. Topology optimization is used in the concept phase of the design process and optimizes material layout within a given design space, for a given set of loads and boundary conditions, so that the resulting layout meets a prescribed set of performance targets. This replaces time-consuming, costly design iterations, saving time and money while improving performance. SOGECLAIR aerospace engineers use Altair Engineering's HyperWorks software suite for their casting simulation and optimization tasks. HyperMesh and HyperView serve as their pre- and post-processor, while OptiStruct, an FEA solver, handles optimization. OptiStruct uses a general approach of a multiple constrained optimization problem. It offers a number of different methods to account for manufacturability when performing topology optimization such as the minimum member size control to avoid mesh dependent results, which could be also used to control the degree of simplicity of the solution. Additive Layer Manufacturing, better known as 3D printing, uses lasers or electron beams to fix layers of powdered material into a digital mould. ALM eliminates many conventional constraints from the manufacturing process and enables the production of complex, precisely designed shapes. It allows the integration of functions within the component, contributing to a reduction in the number of parts required and assembly time. ALM is often more efficient than production methods such as



The optimization result represents the ideal geometry and is very close to the final structure of the additively manufactured part



3D printed 1/8 scale model to evaluate the overall product creation process



Final refined geometry of the engine pylon based on the optimization results and ready for the additive layer manufacturing. Compared to the traditional development and manufacturing methods, a weight saving of about 20 percent can be achieved.

forging or casting because it reduces the waste and consumption of raw materials, especially for small series or spare parts and, in addition, it enables a higher design freedom compared to many of the traditional manufacturing methods.

To fully benefit from the advantages of ALM, it is important to structurally optimize the components that are about to be printed. Manufacturing constraints must also be considered and integrated in order to create a manufacturable design.

Creating an optimized engine pylon

An engine pylon has a complex architecture to help it fulfil multiple functions. Meant to hold an aircraft engine to the wing or fuselage, a pylon also plays a critical role in the aircraft's structural, aerodynamic, and systems (hydraulic, electric, etc.) requirements. In addition, it is designed to prevent a fire in the engine area from spreading to the wing. With the need to integrate today's ever bigger, more powerful, and hotter aircraft engines into the aircraft structure, conventional design and manufacturing approaches are stretched to their limits. Thus, SOGECLAIR aerospace sought a technological breakthrough in order to achieve the desired goals. Typically, an optimized component needs less material and is as stiff as a traditionally designed component, due to the fact that material is placed only where needed. With the flexibility and advantages of Additive Layer Manufacturing, the complex design of an optimized part now becomes manufacturable. The first step in the development process of the new engine pylon was a feasibility study of the objectives to determine if an efficient solution is possible. OptiStruct was used to run an optimization based on the available design space, the applied loads, and other boundary conditions. Optimization constraints were complemented by the manufacturing constraints associated with additive manufacturing. The resulting design was then refined within a CAD tool and the final design was again numerically verified with OptiStruct.

By following this optimization driven design process, the engineers could reach a structurally yet lighter design a lot faster than with a traditional design process. In contrast to the existing conventional pylon design, the optimization driven process allowed a design that integrated system elements (mainly fluid pipes) into the pylon architecture, making those elements part of the structural system and contributing to the overall strength. One objective of this project was to demonstrate the numerical feasibility of topology optimization of a large (5 m length, 0.8 m width and more than 1 m in height) and highly complex architecture design of an aeronautical structure. The obtained results show that a significant weight saving of more than 20% can be achieved even in a heavily constrained structure (in terms of stresses, dimensions, interfaces, systems, etc.). In addition, the overall number of system parts was reduced by 97%, providing even more savings in time and costs.

Streamlined development with HyperWorks

HyperWorks offers SOGECLAIR aerospace an innovative, streamlined development environment with more design freedom, faster development cycles, and lower costs. The software enables the engineers to maximize weight-saving of parts while taking into account both the part's requirements (stiffness, strength, bolt loading, etc.) and the constraints of the proposed manufacturing process. Topology optimization with OptiStruct makes exploration of innovative concepts possible at the earliest stages of design, again saving time and leading to improved performance. Except for geometric reconstruction done in a CAD tool, the HyperWorks suite covers the entire optimization process within one simulation environment, boosting engineers' efficiency and expertise.

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About Altair

Altair is focused on the development and broad application of simulation technology to synthesize and optimize designs, processes and decisions for improved business performance. Privately held with more than 2,600 employees, Altair is headquartered in Troy, Michigan, USA and operates more than 45 offices throughout 24 countries. Today, Altair serves more than 5,000 corporate clients across broad industry segments. To learn more, please visit www.altair.com.

About HyperWorks®

Performance Simulation Technology

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

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