"Complicated interactions and conflicting performance criteria are common with composite components, but HEEDS MDO was able to find high-performing designs that intuition and experience alone could not."

– Jessie Tan, Assistant Principal Engineer, Singapore Technologies Aerospace

ST Aerospace Achieves up to 12% Mass Reduction in Composite Aircraft Design

ST Aerospace is a global company with more than 7,000 employees around the world and a global customer base that includes the world's advanced military forces, major airlines and leading freight carriers. ST Aerospace is a leading independent, third-party aviation Maintenance, Repair and Overhaul (MRO) company with an annual capacity of more than eight million man hours and extensive capabilities in engineering and development, engines, aircraft components repair and spares.

The Challenge

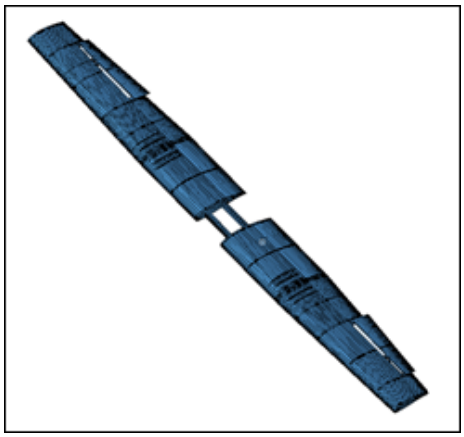
ST Aerospace needed to design composite aircraft structural components to minimize mass and increase performance. The engineers at ST Aerospace initially conducted manual optimization using their experience and intuition to guide the design process, but were not able to discover a satisfactory solution using this method alone.

There is a complex relationship between the components in aircraft structures and the effect on their performance. This is compounded by the large number of design variables and load cases typical when designing these structures, with competing performance goals further complicating the design process. These characteristics make it very difficult to design efficient aircraft structures using a manual process. So, ST Aerospace approached the Red Cedar Technology consulting team for help in optimizing the mass and performance of an aircraft tail, wings and fuselage.

How HEEDS MDO Contributed to ST Aerospace's Success

Red Cedar Technology consultants used HEEDS MDO optimization to complete the design of the structural components. The optimization efforts focused on varying the number of plies, the orientation of the plies, and the materials used, so that the mass of the structural components was minimized while performance constraints were met, including material failure, buckling, stiffness, and manufacturing criteria in the design.

The optimization studies contained not only a large number of strongly coupled variables, but also mixed types of variables. Both discrete (material properties) and continuous (integer number of plies and ply orientations) variables were present. To search this complex design space, the SHERPA algorithm was used. SHERPA is a proprietary hybrid and adaptive search strategy available only in HEEDS MDO.



Wing Optimization: 12% Mass Savings

Tail Optimization: 3% Mass Savings

Wing optimization

There were more than 80 design variables for the optimization of the wing. By reducing the number of plies in certain regions and increasing the number of plies in other regions, HEEDS MDO was able to optimize the interactions of the many components in the wing, which could not be easily ascertained during the manual design process. HEEDS MDO found a design that reduced the mass in the wing by 12% while ensuring the performance constraints were met.

Tail optimization

The starting design for the tail from the manual design process was an infeasible design. The tail optimization included 12 design variables in total. HEEDS MDO was able to find a design that reduced the mass in the tail by 3% while ensuring the constraints were met.

Fuselage optimization

There were more than 120 design variables for the optimization of the fuselage. HEEDS was able to discover a design that reduced the mass in the fuselage by 9% while ensuring the constraints were met.

With more than 20 load cases present in designing the fuselage, over 35% of the designs evaluated during the optimization were found to be infeasible, a testament to the difficult design landscapes typical of these types of composite problems.

ST Aerospace becomes a HEEDS MDO Customer

Following the success of HEEDS MDO in optimizing these composite aircraft structural components, ST Aerospace became the first HEEDS MDO customer in Singapore in 2011, purchasing a perpetual license of the technology. This was due, in part, to the successful manufacturing and prototype performance of the lightweight structural components designed by HEEDS MDO. Jessie Tan, Assistant Principal Engineer at ST Aerospace, said, "Since we have integrated HEEDS MDO into our design process at ST-Aerospace, we have seen improved performance and decreased mass in our aerospace structural components. Complicated interactions and conflicting performance criteria are common with composite components, but HEEDS MDO is able to find high performing designs that intuition and experience alone cannot."