Case Study: **Composites Technology Research Malaysia Sdn Bhd (CTRM)**

**Optimising Design for a Flipper for Airplane Components in Production**

**Industry Challenge**

Composites Technology Research Malaysia Sdn Bhd (CTRM) is part of the global supply chain in Composites Aero structures for major commercial and military aircraft manufacturers in the world. The company plays a strategic role in the Aerospace and Composites industries and has also diversified its business into composites aircraft interiors, aircraft seats and transportations.

As part of the production process, the company is required to run thorough physical tests on each of the components that it manufactures to ensure that they meet the stringent standards. This is especially true in the case of components made of composite materials. In order to guarantee that the testing process is extremely meticulous and accurate, each component needs to undergo the required scans/tests from all possible angles. This means that each component needs to be flipped over by 180 degrees, rotated etc. to ensure that each portion of this component is accessible to the scanning machines and also to guarantee that all data and measurements are physically captured and recorded.

Flipping these components can be quite a challenging process, especially since some of them such as the aircraft fan cowl can weigh upwards of 70 kilograms. Flipping these is not easy even if there are 5 persons deployed to physically flip each part.

Doing it manually can damage the product since there is a possibility that it might get dropped or might touch or scratch some surface thereby damaging the part. Since these parts are not ergonomically designed to be held or flipped, they can be quite unwieldy. Yet, testing and certification of each component before it is sent to the OEM is extremely important.

The company was keen to mechanise the process by designing a “flipper” device that could be used to physically flip the components as required for testing.
The team first attempted to build a flipper device using a generic open source software to design it. While the software had only some basic functionalities to enable the design concept, it fell short on several counts. Therefore, the initial version was designed based on the open source software and hand calculations. It had four pneumatic actuators for flipping, two motors for up-down sliding, two counter-balancers at both sides of the flipper to reduce actuator load, and four magnetic clamps. The design had several issues and was not optimal. It had too many actuators, making it costly to fabricate. It also had unnecessary redundant motors, which not only raised the cost, but threw up issues around asynchronous motion.

For the next iteration, the load from Adams was analysed using Patran and MSC Nastran to calculate the various stresses as well as reserve factors for all the stresses. There were four types of stressors - Tensile, Compressive, Local buckling and Crippling - that needed to be analysed, and each of them had a pass/fail test. Using inputs from this analysis, the third concept was developed with variations such as a flipping pivot line close to the Centre of Gravity (CG) of the part in order to reduce the movement of the arm and provide greater support. This also helped to improve stability and avoid use of magnetic clamps. The team also used hinges to further improve the design.

For the second iteration, the load from Adams was analysed using Patran and MSC Nastran to calculate the various stresses as well as reserve factors for all the stresses. There were four types of stressors - Tensile, Compressive, Local buckling and Crippling - that needed to be analysed, and each of them had a pass/fail test. Using inputs from this analysis, the third concept was developed with variations such as a flipping pivot line close to the Centre of Gravity (CG) of the part in order to reduce the movement of the arm and provide greater support. This also helped to improve stability and avoid use of magnetic clamps. The team also used hinges to further improve the design.

The second concept was a definite improvement over the first one on many counts. Instead of two motors in the first design, the redundancy had been eliminated in the second concept, with only one motor for up-down sliding with the gearbox. Also, the second concept had only two pneumatic actuators for flipping.

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