



Real-Life Stories

Shaping Composite Wings

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An aircraft's structure is the result of numerous assembled parts, such as the engines, fuselage, wings, tail, landing gear, just to name a few. Many of these components are made of titanium, advanced aluminum alloys and composites. In recent years, in order to achieve greater fuel efficiency and reduce operational cost, aircraft manufacturers have placed greater focus toward applying carbon fiber reinforced plastics (CFRP), a light, durable and corrosion-free material, into aircraft designs.

In the case of the Airbus A350, both the fuselage and wing structures are made primarily of CFRP. According to Airbus, approximately 70 percent of the A350 airframe is made of composite material structures, titanium and advanced aluminum alloys. Composites alone account for 53 percent.

The manufacturing process of a CFRP wing panel typically involves multiple steps – molding, tape layup, stringer integration, vacuum bagging, curing, non-destructive inspection, machining and assembly, and painting. Machining tools play a key role towards the end of the manufacturing process. With safety in jeopardy, precision and quality are utmost critical.

Located in Ankara, Turkey, the TUSAS-Turkish Aerospace Industries (TAI) has been manufacturing the A350 aileron spars, a.k.a. the backbone of the aileron, since 2012. TAI specializes in the design, development, manufacturing and integration of space systems throughout Turkey. Its Ankara production plant covers approximately 5 million square meters with an industrial facility of 230,000 square meters. The site is equipped with some of the most advanced, high technology machinery that enables parts manufacturing, aircraft assembly, flight tests and delivery for the military and commercial aviation markets.



Z-shape spars that TAI has been manufacturing since 2008.

The composite wing spar that TAI produces measure 5.5m in length and 0.5m in width. Four of the Z-shaped spars make up one set of ailerons. A total of 64 sets of ailerons are manufactured per year. A profile tolerance of $\pm 0.5\text{mm}$ around the entire edge of the part is required. The Z spars are produced in a sophisticated five-axis FOG precision milling machine.

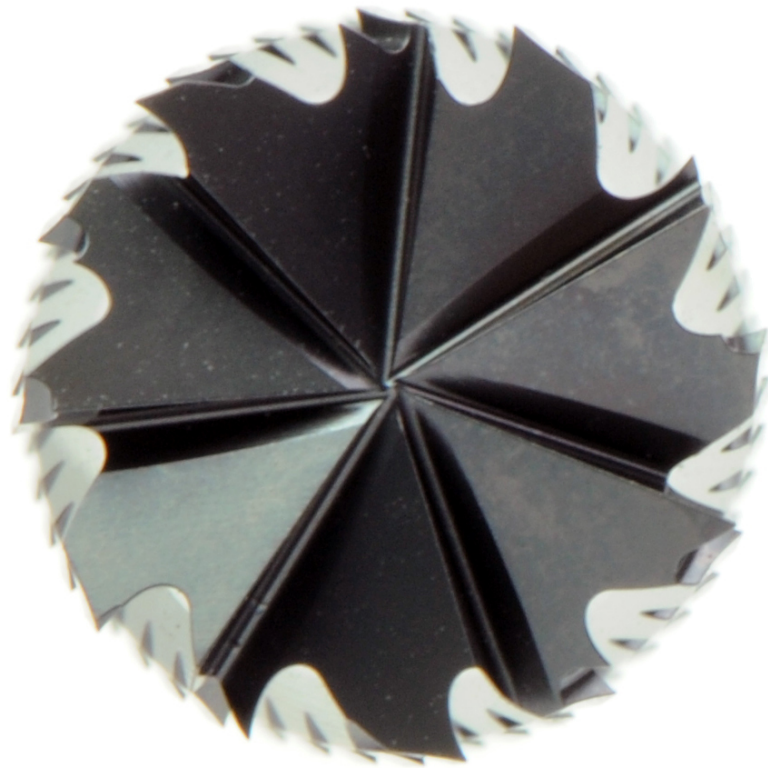
Throughout the manufacturing process, TAI had experienced delamination and uncut fibers at the cutting edge, which is unacceptable for the part. Delamination is the splitting of a laminate into layers and can occur at a single hole edge or at both hole openings during milling. A diamond coated 12.7mm diameter compression router was used for the roughing operation with unsatisfactory tool life.



The Z spars are produced in a sophisticated five-axis FOG precision milling machine.

After attending a machining and training conference offered by OSG Turkey, TAI witnessed the performance of OSG's EXOPRO® AERO-BNC router versus other manufacturers' routers.

The EXOPRO® AERO-BNC is a patented diamond coated fine nicked router designed to excel in high feed CFRP roughing and finishing, and it can be applied to both thick and thin laminates. With extremely low cutting forces and flute management, tool life can be greatly extended.



The end cut of OSG's EXOPRO® AERO-BNC router.

"The OSG nicked router is very special since it has all the versatile characteristics," said Onur Bahtiyar, NC Engineering Leader at TAI. "Its ability to side mill and slot, as well as having multiple cutting edges on the flute length is unlike the compression style tool. OSG's diamond coating is also the best I have seen."

Running the EXOPRO® AERO-BNC at the same slot milling cutting condition of S 6,000 rpm, Vf 1,250mmpm with flood coolant and shrink fit holder (short and long type), no delamination and uncut fibers are observed after machining unlike what was seen previously.

"Switching to OSG's nicked router enabled us to improve surface quality," said Bahtiyar. "The elimination of delamination is providing us a cost savings of \$21,363 per year."

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