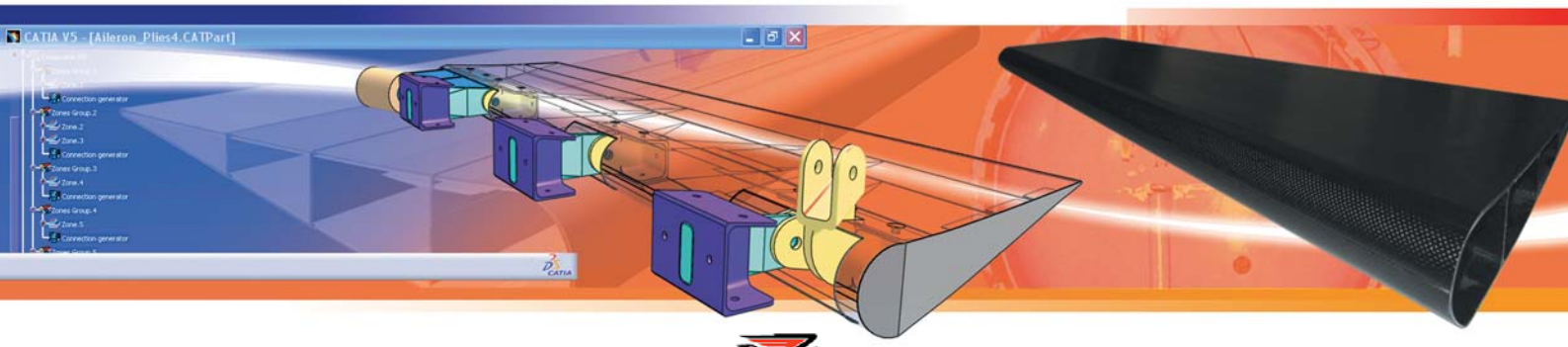
ACT Aerospace

Cuts detailed design time 90% with CATIA for Composites



Overview

Challenge

When ACT Aerospace used manual methods for detailed composite design, issues such as wrinkling and warping during layup required design changes that lengthened cycle times.

Solution

ACT Aerospace chose CATIA Composites Engineering to generate ply patterns, simulate lay up, evaluate producibility, and optimize design and material usage. CATIA also generates computerized numeric control (CNC) programs for creating layup tools.

Benefits

ACT Aerospace has reduced the time required for detailed design and prototyping by 90% and reduced material usage more than 15% through increased precision.

"We have reduced the lead time required to produce the detailed design and lay up the first prototype from a month or two to three to five days, depending on the complexity of the part."

Andy Hill, General Manager,
ACT Aerospace

Composite detailed design presents challenges

ACT Aerospace of Gunnison, Utah, USA, is a leading provider of composite parts for aerospace and medical applications. After 24 years in business, ACT Aerospace has more than 50 employees and serves about 50 customers.

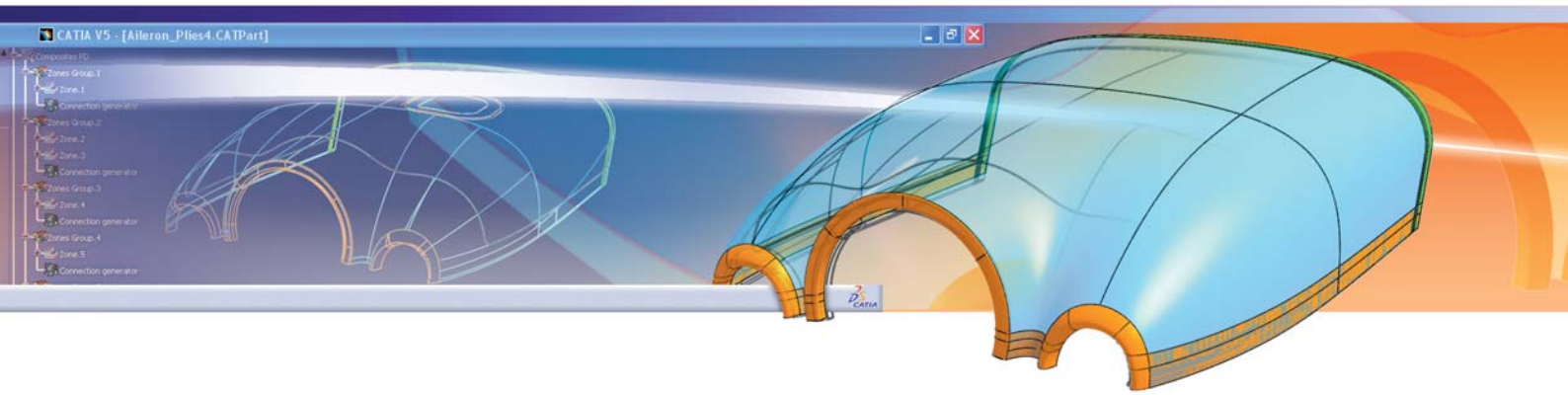
ACT Aerospace's customers typically provide 3D geometry of the tool surface and a 2D ply layout that has been engineered to meet structural requirements at critical cross-sections. ACT Aerospace's engineers then define the detailed 3D ply layout, build the tool, cut the plies and lay up the parts to meet the customer's requirements.

In the past, ACT Aerospace's engineers used the trial-and-error or "paper doll" method to develop the detailed design. They generated an initial design in their CAD system and then went out on the manufacturing floor and tried to build it. The complexity of the composite lay up process made it difficult to predict how the materials would conform to the tool's complex surfaces and the shape of the resultant flat patterns.

Lay up of the first prototype often brought to light a number of challenges. Sometimes distortion caused the material to draw away from the mold, resulting in geometrical errors and air bubbles. In other cases, a ply sequence imbalance across a 3D shape generated stresses that caused wrinkling or warping. When faced with these and other issues, ACT Aerospace engineers would re-cut the material and try again. The prototyping process took large amounts of time, consumed substantial amounts of expensive composite materials and sometimes even required modification of the tool shape.

Investing in leading-edge technology

ACT Aerospace management made the decision to invest in leading-edge technology to simulate the lay up process on the computer. "Our current customers and other leading aerospace



"With the tight integration between geometric modeling and definition of the composite lay up provided in CATIA, we can easily make changes to the underlying curvature of the part without moving the geometry back and forth between two different programs."

Justin Mickelsen, Lead CATIA Designer, ACT Aerospace

original equipment manufacturers all use CATIA," said Andy Hill, general manager of ACT Aerospace. "CATIA Composites Engineering integrates advanced geometric modeling with a full range of composite design tools. When you make a change to the CATIA design geometry, the new geometry is automatically applied to the ply layout. With the other leading composite design solution, any change to the design geometry requires starting from scratch by exporting the geometry again."

ACT Aerospace now uses CATIA to automate every aspect of composite design and manufacturing. "We start off by opening up the customer's part in CATIA," said Justin Mickelsen, lead CATIA designer for ACT Aerospace. "Sometimes there are problems, either in the original design or caused by data translation. We use CATIA's advanced surfacing features to heal the model by removing gaps and overlaps. Then we start figuring out the best way to lay up the part to meet the customer's design intent."

ACT Aerospace designers use CATIA Composites Engineering to organize the ply buildup by recording non-geometric information and creating sequence charts, material tables and lay up books. They develop flat patterns and identify areas of high stress that can cause tears, bridging and wrinkles. When the designer finds an issue, CATIA makes it easy to swap ply edges or reroute sets of plies along a preferred path.

Focus on RAND North America

Hill credits RAND North America, ACT Aerospace's Dassault Systèmes value-added reseller, with introducing the company to the technology that has contributed so much to the success of its business.

"RAND North America made a major contribution to our success in composites manufacturing by introducing us to CATIA and the CATIA composites modules and making great efforts to ensure that we took full advantage of their capabilities," Hill said.

"RAND North America has a lot of experience in the aerospace industry and spent the time needed to understand our particular business requirements. They also have a tremendous amount of expertise in Dassault Systèmes software. The toolset they recommended has proven to be an excellent fit to our requirements. A couple of their knowledgeable people spent a week with us making sure that we were able to get everything that we needed out of the tool."

Getting the design right the first time

"The CATIA Composites Design for Manufacturing module provides tools that tell us if the shape of the part is accurate and if the material will stretch or tear," Mickelsen said. "When necessary, we add darts or splices or

make other changes to the ply. Then we re-simulate the lay up to see if we have corrected the issue. These tools make it possible to identify and correct issues on the computer that otherwise would not have been detected until we started laying up parts on the manufacturing floor. Before we get to manufacturing, we are confident that we can easily assemble a part that meets all the customer's requirements."

"Moving from manual methods to CATIA has helped us reduce the time required for detailed design and lay up of the first prototype by 90% or more," Hill said.

The availability of ply lay up definitions in the CATIA composites module encouraged ACT Aerospace to implement laser projection technology. CATIA exports 3D IGES or STEP files, including hole, splice and marker data for laser projection systems. CATIA automatically accounts for the material thickness and offset due to ply buildup. "We just push a button and CATIA exports all the plies into a folder," Mickelsen said. "Then during lay up, the laser heads project ply data on the lay up tool in the exact location where the material is to be placed."

ACT Aerospace designers also use CATIA to expedite the manufacturing process. They export a 3D representation of how the plies are stacked onto the part onto an engineering drawing. The first page shows the tool without any plies. Each succeeding page adds one more ply onto the tool, until the final page shows the lay up of all the plies. These documents provide additional guidance to the technicians who are laying up the part. "Having a clearer set of layup instructions can result in time savings of 25% or more for complicated parts," said Hank Miller, aerospace layup manager.

"Sometimes we make a late-stage change to the design, such as adding extra plies or removing plies to make the part thicker or thinner," Mickelsen said. "Or the position of a hole changes. We go into CATIA and make the changes and validate their impact on the assembly process. Then we re-generate all of the output for the manufacturing process with the confidence that we are still making a good part. Even when the customer makes a change to the geometry of the part we can import the new geometry and apply it to the existing plies."

Every change requires revisions to and new approvals for several documents, which previously could delay final delivery to customers. "If the engineering can be completed in a few hours, which is now definitely the case, then no deliveries need be delayed," Miller said. "This is without a doubt a major advantage in winning contracts."

"We can save an average of 15-20% on total material usage when exact ply geometry from CATIA is used to create a nesting pattern for our cutter table."

Hank Miller, Aerospace Layup Manager, ACT Aerospace

Reducing material usage

CATIA also helps minimize manufacturing costs. ACT Aerospace normally uses 24-inch-wide rolls of material to produce composite parts. “CATIA helps us keep track of the outside edge when we are designing plies so we can utilize as much of the roll as possible,” Mickelsen said. When ACT Aerospace designers have verified the design, they use CATIA to flatten the finished design into the 2D geometry required by the cutter table. A small shift here or there can allow more plies to be cut from a single piece of material, reducing waste and cutting costs. The designer then exports the geometry in DXF format to the machine control of the cutter table, which nests the plies onto the rolls and generates cutting programs.

“We can save an average of 15-20% on total material usage when exact ply geometry is used to create a nesting pattern for our cutter table,” Miller said.

ACT Aerospace engineers also use the CATIA Advanced Machining module to create computerized numeric control (CNC) toolpaths for producing lay up tools on 5-axis CNC machines. “Our machine shop guys were used to producing their own programs for our older 3-axis machines,” Mickelsen said. “When we got our new 5-axis machines, we were concerned that we would have to pull the programming back to the engineering department.

But CATIA Advanced Machining is so intuitive that operators were soon using it to generate programs for the new machines.” CATIA Composites Design for Manufacturing is used to produce 2D geometry for ACT Aerospace’s CNC fabric cutter.

Although many of ACT Aerospace’s customers provide both the 3D tool design and 2D ply layout, others simply provide the tool surface and the structural design requirements and count on ACT Aerospace to design the ply structure from scratch. ACT Aerospace uses the CATIA Finite Element Model Surface module to generate meshes for MSC/NASTRAN finite element analysis software. ACT Aerospace designers can quickly evaluate new ply configurations, generate a mesh and run stress analysis without leaving the CATIA environment. Engineers also have to meet weight targets, and CATIA provides tools that quickly calculate the weight of any proposed design.

“CATIA gives us a considerable advantage over competitors by enabling us to save time and materials by optimizing the lay up configuration during the design phase,” Hill said.

Focus on **RAND**

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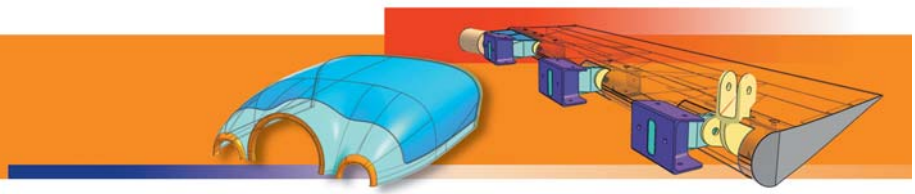

Images courtesy of ACT Aerospace.

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