APPLICATION CUSTOMER STORY:

Piper Aircraft

Piper Reduces the Cost and Lead time of Hydroforming Tooling for Aircraft Development

"I can program an FDM part in 10 minutes while a typical CNC program takes four hours to write."

– Jacob Allenbaugh, Manufacturing Engineer, Piper Aircraft

SITUATION

Piper Aircraft designs and manufactures efficient single-engine and twin-engine trainer, personal and business aircraft.

Piper uses hydroforming to produce hundreds of aluminum aircraft structural components such as the inner frame, gussets, brackets, skins, etc. In the past, the company machined aluminum form tools for use in hydroforming machines. Machining geometrically complex form tools was expensive due to the amount of time required for programming every part, the high cost of machine time and skilled labor for computer numerical control (CNC) machines, and the considerable material waste involved in machining.

HOW DID FDM COMPARE TO TRADITIONAL METHODS FOR PIPER AIRCRAFT?

METHOD	TIME
CNC Machined Tooling	14 days
FDM Tooling	4.5 days
SAVINGS	9.5 days (68%)

SOLUTION

Fred Jones, lead tool designer for Piper, had the idea of using Fused Deposition Modeling

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Aluminum window pan shown on top of FDM tool.

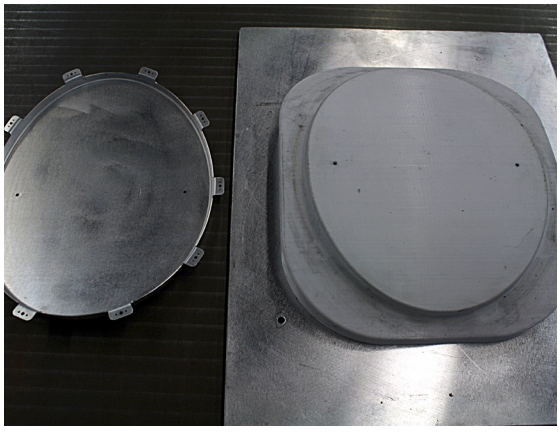
(FDM®) tools. FDM technology is an additive manufacturing process that builds plastic parts layer by layer, using data from CAD files. He determined that FDM polycarbonate (PC) could withstand hydroforming pressures ranging from 20,600 to 41,300 kPa (3,000 to 6,000 psi), suitable for forming all of the structural parts produced by Piper. For hydroforming applications involving higher pressures, ULTEM™ 9085 resin hydroforming tools can withstand up to 69,000 kPa (10,000 psi).

Together, Jones and manufacturing engineer Jacob Allenbaugh worked with Vince Denino, account manager for Prototyping Solutions, Birmingham, Alabama, to determine the right FDM machine for the company. “We recommended the Fortus 900mc because it provides a large 91 cm (36 inches) x 61 cm (24 inches) x 91 cm (36 inches) build envelope and also provides a high level of accuracy,” Denino said.

Piper has already produced dozens of hydroforming form tools along with route and drill fixtures with their Fortus machine. During hydroforming, the sheet metal is pressed against the form tool to force it to take its final shape. Piper makes the PC form tools slightly larger than aluminum tools because the PC has slightly greater deflection than aluminum. After forming, the route and drill fixtures are then used as a guide for routing and drilling operations that finish the part.

RESULTS

Piper has achieved substantial lead time savings by using FDM form tools. “I can program an FDM



Aluminum window pan (left) and FDM tool.

Piper Aircraft

part in 10 minutes while a typical CNC program takes four hours to write," Allenbaugh said. "The FDM machine can be much faster than a CNC machine and does not require an operator in attendance. Material waste with FDM is much less than CNC machining because the FDM support material is typically less than 20% of the total."

FDM also offers the potential for future design improvements in structural parts. The CNC machining process inherently limits the geometries that can be machined onto form tools which in turn constrains the geometry of the finished parts. Allenbaugh believes that it may be possible to build a more efficient aircraft by moving to more complex and organically shaped parts that will be built with FDM form tooling.

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