A More Efficient Way to Make Aircraft Parts

If you're in manufacturing, you're probably familiar with cost-saving initiatives. Whether they're periodic Kaizen events or an everyday management expectation, you know the pursuit of lower cost is never-ending. But making real improvements can be challenging. Once the low-effort savings are achieved, new ideas to make the operation more efficient might seem elusive.

That's where new technology, or a new way of doing things can help. A case in point is Piper Aircraft. The company turned to 3D printing technology to reduce lead time and material waste to make aluminum components. 3D printing is an additive technology that creates things by building them layer upon layer, using material only where it's needed. Contrast that with subtractive manufacturing, where a part is made by cutting, milling and shaping the raw material, a lot of which ends up as waste.

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>
> Jacob Allenbaugh
> **Piper Aircraft**

A formed aluminum window pan shown on top of the FDM hydroform tool.

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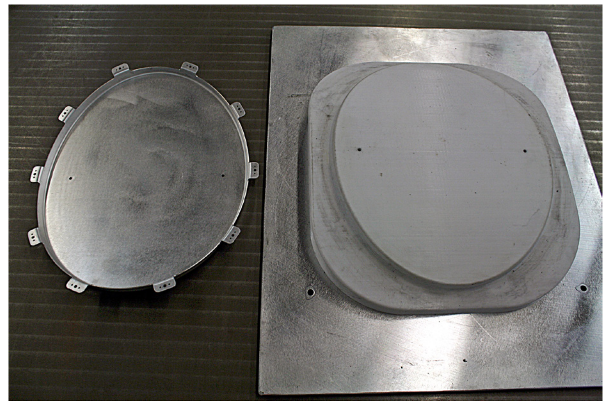
Piper uses hydroforming to produce hundreds of structural aircraft parts such as the inner frames, gussets, brackets and skins. In the past, the company machined aluminum form tools for use in hydroforming machines to make these parts. Machining the geometrically complex tools was expensive due to the amount of CNC programming time required for every part. The high cost of machine time and skilled CNC operators coupled with considerable material waste involved in machining added even more cost.

Fred Jones, lead tool designer for Piper, had the idea of using FDM (fused deposition modeling) tools instead of the machined aluminum tools. He determined that FDM polycarbonate (PC) could withstand hydroforming pressures ranging from 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 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 36 by 24 inches build envelope and also provides a high level of accuracy,” Denino said.

Since then, Piper has produced hydroforming form tools along with route and drill fixtures using their Fortus 3D printer. 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



This aluminum part (left) was formed using the 3D printed FDM tool (right).

forming, the route and drill fixtures are used as a guide for routing and drilling operations that finish the part.

Piper achieved substantial lead time savings using FDM form tools. “I can program an FDM 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 doesn’t 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 it may be possible to build a more efficient aircraft by moving to more complex and organically shaped parts using FDM form tooling.

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Other manufacturers see results similar to Piper's. Pryer Technology Group (PTG) is a supplier of hydroform presses. PTG evaluated FDM hydroform tools as an alternative to traditional form tools for one-off components to replace damaged or corroded sections of an aircraft frame. The corroded frame was digitally scanned and a CAD model of the repaired part and desired tool was created.

PTG's results affirmed the capability of FDM thermoplastics as an alternative to traditional tooling. FDM tooling withstood multiple uses up to 10,000 psi. PTG also noted that the FDM thermoplastic afforded a natural lubricity and vented air from blind recesses, negating the need for vent holes.

These are just two examples of how 3D printing helps reduce cost and improve efficiency. Buying a 3D printer to reduce cost might seem counterintuitive. But there are plenty of examples of companies that have justified the purchase based on the rapid return on investment. There's only so much low-hanging fruit on the cost-savings tree. More substantial and long-term savings might require a change in technology, as Piper and PTG have shown. Thanks to 3D printing, that technology is ready and available.

How did FDM Technology compare to traditional production methods for Piper Aircraft?

Method	Time
CNC Machined Tooling	14 days
FDM Tooling	4.5 days
Savings	9.5 days (68%)

How did FDM Technology compare to traditional production methods for Pryer Technology Group?

Method	Time	Cost
CNC Machined Tooling	5 days	$1,500
FDM Tooling	1 day	$450
Savings	4 days (80%)	$1,050 (70%)

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