SIMULATION SMOOTHS DESIGN AND BUILD OF AIRCRAFT TOOLING

A fully digital workflow allows engineers at Piper Industrial Manufacturing Co. to simulate forming of sheet metal parts prior to tool build, ensuring accuracy from the start.

BY JONATHAN HILTON AND KEVAN CHISHOLM

Founded in 1937 by William T. Piper, Piper Aircraft long has resided at the forefront of general aviation, producing some of the most reliable and widely used aircraft in the industry. The Vero Beach, FL, company has helped shape the aviation landscape by providing aircraft for personal, training and business use. It revolutionized private aviation with the introduction of the Piper Cub, an aircraft that became synonymous with light aviation, and throughout its history, Piper has developed a range of aircraft known for their durability, versatility and affordability. From the iconic PA-28 Cherokee to the high-performance M-Class series, Piper's commitment to innovation has kept it competitive in an evolving industry.

Key to competitiveness has been the evolution of Piper's manufacturing techniques, from hand-built aircraft in the early days to today's high-precision, technology-driven production methods. A significant shift in recent years involves the way that the firm designs and produces sheet metal forming tools. One of the most transformative advancements: adoption of the AutoForm Forming software suite for tool design and sheet metal-forming simulation, in use at Piper Industrial Manufacturing Co. (Pimco), a Piper subsidiary also operating out of Vero Beach.

From a time-consuming and inexact process that involved machining tools manually, Piper Aircraft and its subsidiary, Pimco, have transitioned to a fully digital workflow that allows engineers to simulate the forming process of sheet metal parts before physically machining any material.

Simulation at Pimco Drives Tooling Success

Pimco provides precision manufacturing solutions for Piper as well as for third-party aerospace and industrial manufacturers, leveraging advanced forming technologies. Equipment employed includes two Flexform fluid-cell presses from Quintus Technologies, and another to be installed by year's end, as Pimco expands its equipment inventory to mirror the growing demand for low-volume, complex sheet metal forming. The company also boasts laser cutting machines, 3D printers and CNC milling machines. With such capabilities, Pimco offers consultation and contract manufacturing, leveraging its expertise in sheet metal forming, tool design and advanced aero-

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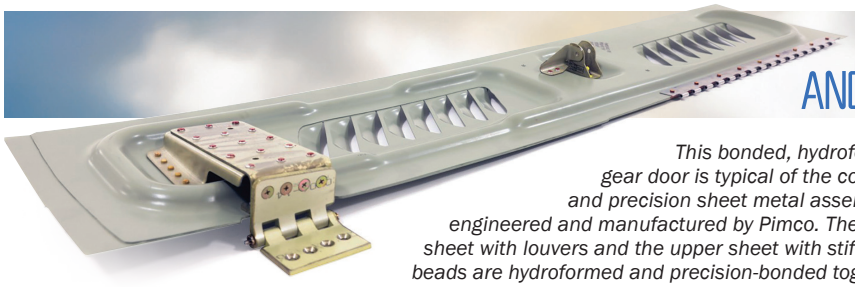

This bonded, hydroformed gear door is typical of the complex and precision sheet metal assemblies engineered and manufactured by Pimco. The lower sheet with louvers and the upper sheet with stiffening beads are hydroformed and precision-bonded together.

space-manufacturing techniques. Simulation prowess adds greatly to the Pimco arsenal.

Greater Efficiency in Tool Build

In the past, forming tools for Piper's aircraft were hand-cut from templates—a process requiring highly skilled personnel to shape tooling manually. This method, while effective, proved time-consuming and often led to inefficiencies, as tools required adjustment and refinement after initial production.

Today, Piper and Pimco have transitioned to a fully digital workflow using AutoForm software, which allows engineers to simulate the forming process of sheet metal parts before physically cutting any material. The process follows these steps:

- CAD design—Engineers design the forming tool in 3D CAD software, ensuring accuracy from the start.
- Digital simulation—Using AutoForm, the entire forming process is simulated, allowing engineers to predict how the sheet metal will behave under pressure. This helps identify potential stamping defects such as wrinkling, thinning or springback before production begins.
- CNC machining—Once simulation validates the digital tool design, Pimco machines the die details with CNC equipment, producing highly accurate forming tools with minimal human intervention.
- Testing and implementation—The newly machined tool is tested with actual sheet metal parts, with any final refinements made before launching full-scale production.

Reducing Multi-Step Forming to a Single Operation

A prime example of simulation success at Piper Aircraft involved redesigning a forming tool for a critical sheet metal component. The part material: 0.8-mm-thick type 2024 annealed aluminum. Previously, this part required multiple forming operations and expensive countermeasures to eliminate wrinkles due to its complex geometry. The process increased production time, cost and risk of variability between batches.

Leveraging AutoForm's simulation capabilities, engineers designed a tool that optimized material flow and eliminated the need for multiple forming operations. This particular project called for reverse engineering a legacy part, and then producing it. Piper's supplier provided the CAD drawing of the legacy part as a starting point, and then Pimco employed the AutoForm Forming suite for simulation, using the AutoForm Incremental module.

One of three high-pressure fluid-forming presses at Pimco. They employ tools produced following rigorous simulation to manufacture a variety of components for Piper aircraft.

AutoForm Forming provides a portfolio of software products for the digital planning and validation of sheet metal processes and parts. AutoForm Incremental simulates sheet metal forming processes in many small steps via the finite-element method. Users can simulate all forming operations—including calculation of springback—beginning with a blank sheet and ending with the finished part.

After simulation and build, Pimco paired the new tool with high-pressure forming via one of the Quintus Flexform presses, designed to apply uniform pressure across the part, allowing it to be formed in a single operation.

The high-pressure Flexform technology proves ideal, says Quintus, for airframe structural components and high-quality engine components, ranging from small shallow parts (typically double curved) to large deep parts. A flexible diaphragm in the fluid-cell press allows most types of forming in block, cavity and expansion dies, and shallow or small tools may be mixed with tall and large tools in a single forming operation. Also, Flexform can perform undercuts, create intricate shapes, and trim and cut.

Within the aerospace industry, using such high-pressure forming typically reduces or eliminates the need for hand correction and intermediate heat treatments, according to Quintus officials, who note that Flexform presses function ideally in prototyping and low-volume production.

Reduced Lead Times, Better Part Quality

The new process employed by Pimco has increased efficiency by reducing tool changeovers and setup times, while also improving part quality—better surface finish and dimensional accuracy—via high-pressure forming. In addition, the process allows for quicker movement of parts from forming to assembly, reducing lead times. Fewer forming operations means less labor and material waste, thus delivering lower production costs.

As Piper Aircraft continues to modernize its production methods, the use of robust simulation software and advanced, economical forming technology ensures that the company remains competitive in a rapidly evolving industry. By embracing digital engineering and automation, Piper not only honors its legacy of quality aircraft manufacturing but also paves the way for more efficient, precise and innovative aviation solutions. **MF**

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