"We're trying to blend the old and the new, applying new FDM technology to the old craftsmanship ways of doing things."

Craig McBurney, Founder and Project Manager, Connecticut Corsair

Connecticut Corsair is restoring the F4U-4 Corsair, an historic aircraft from World War II. When finished, the aircraft will fly again.

CASE STUDY

Restoring an Historical Aircraft to Flying Condition

CONNECTICUT CORSAIR RESTORES A WWII AIRCRAFT USING OLD AND NEW TECHNOLOGY

Twenty years of passion for aviation led Craig McBurney to the F4U-4 Corsair with the hopes of restoring the World War II aircraft to flying condition. The Corsair was the only fighting WWII plane designed and built in Connecticut by one corporation, today's United Technologies Corporation. In May 2005, it was declared the state aircraft by a unanimous vote of the state legislature, and today additive manufacturing technology is bringing it back to life.

McBurney, Founder and Project Manager of Connecticut Corsair, a volunteer organization dedicated to restoring the aircraft, bought the airplane wreckage of a Corsair in 1993. Since most of the functioning components were no longer available, he and his colleagues have been picking up replacement parts from junkyards and warehouses ever since. “Some parts aren’t worth picking up off the ground,” he said, “but we take them anyway because we know we can reproduce them with the help of new technologies such as hydroforming and Fused Deposition Modeling (FDM). We take all the parts we can find.”

The Corsair was a complex aircraft. Not only did it have to be compact enough to fit on an aircraft carrier, but it also had to be strong enough to withstand the forces that accompanied its ability to take off and land in short distances. “There were forces exerted on the Corsair that normally wouldn’t be exerted on a plane,” said McBurney. “The aircraft also flew at top speed, so its outer skin needed to be smooth. We knew it would be difficult to recreate.”

“The Corsair doesn’t lend itself to having parts made from scratch without reference materials,” said McBurney. “There are many different forgings, castings and extrusions. Traditional methods start with an original part and manually copy it in a machine shop or have draftsmen make a sketch of it. People rarely work off a drawing. We have more than 20,000 drawings plus original parts, pictures and manuals.”

The biggest challenge has come from inside the plane. The main beam, called a spar, supported the forces and loads. Angular and geometric, it was the backbone of the plane. “Nothing was straight on it,” said McBurney. “It was all curves and angles. No one has taken on making the main beam like we have. That’s the hardest job. Our hope is that we can make two or three copies and trade them for other parts we don’t have. No one wants to build the whole airplane alone.”

McBurney’s first step was to acquire microfilm drawings of the parts and scan them into the computer. “The SolidWorks CAD software enabled us to model individual components in 3D, assemble them and keep track of them,” he said. “When a drawing was unreadable, we would bring in reverse engineering specialist Mark Bliek of Bolton Works who took a part and created a file for it. Once we had the shape and knew what it was supposed to look like, it just became a matter of making the part.”

That’s where Stratasys came in, using Fused Deposition Modeling technology. During the FDM process, a plastic filament is fed into an extrusion head and heated to a semi-liquid state. Following a toolpath defined by the CAD file, the head deposits the material accurately in layers as fine as 0.005-inch thick. The model is built from the bottom up – one layer at a time.

The Stratasys Fortus 400mc and 900mc products are used for conceptual modeling, functional prototyping, fabrication and assembly tools, and end-use parts. They are ideal for large parts and high volume, providing unprecedented accuracy, stability and durability.

A cutaway of the Corsair engine was on display at The Chester Fair.

The aircraft’s main beam, angular and geometric, is projected on the screen. The main beam made by Stratasys is on the table.

Craig McBurney, founder and project manager of Connecticut Corsair, displayed the aircraft parts at the SolidWorks Product Showcase.

How Does FDM Compare to Traditional Restoration Methods for Corsair?

METHOD	DESIGN TIME
FDM Technology	Less than a day
Traditional Methods	10 days

“Our FDM technology for sheet metal tooling was just the right application for the Corsair,” said Bill Macy, part of the Stratasys Manufacturing Solutions Group. “The airplane has a lot of sheet metal parts. We’ve proven the ability to make sheet metal parts using FDM tools. There also is the added benefit of coordinated tool families, including intensifiers and trim tools.”

In the past, McBurney would have had to copy parts deep inside the airplane by asking the owner of another similar model to take his apart in order to copy the piece. “The answer to that request was usually ‘no,’” he laughed. “Prior to employing FDM technology, we can scan a part without taking it apart. Once we have that file, we print out forming blocks and have the sheet metal parts hydroformed with a Triform Sheet Hydroforming process from Pryer Technology.”

“We used sheet metal analysis software to show we could predict bending performance so the tooling would be built right the first time,” said Macy. McBurney knew that making a steel tool to manufacture tens of thousands of parts would have been cost-prohibitive and unnecessary when only one or two parts were needed. “Although the Corsair project may only need a limited number of parts, we know that FDM tools are capable of producing hundreds of parts,” Macy added. “We have FDM tools that have exceeded the 600 cycle mark and are still producing good parts.”

McBurney began his project in November 2010 and had useable parts to show at the SolidWorks World 2011 conference in January. “It was unheard of in our industry to do that so quickly and so accurately,” he said. “At the conference, we had a steady stream of people from morning to night looking at the plane. Their main questions were, ‘How much will it cost? How long will it take? Where do you get your parts?’”

Restoring Corsair aircraft is not new. Others have been doing it for 30 years, using traditional methods of taking apart old pieces to create new. “True artisans can make a part by hand that looks like a factory part,” said McBurney. “We’re trying to blend the old and the new, applying FDM technology to the old craftsmanship ways of doing things. There is more upfront cost for wooden forming blocks, as we have to hand form metal over the block with hammers and presses. It is labor intensive, and the tools wear out after making a few parts, but once the FDM block is finished, hydroforming is quick and therefore less costly than using an artisan. An artisan might take 10 person-days to create what the Stratasys FDM technology creates in less than one day.”

McBurney and his team are working with mechanical engineering students from Central Connecticut State University to complete the Corsair project. Currently, they have 12 mechanical engineering students who will design a test cell for the Pratt & Whitney Corsair engine. “Our project is a game changer,” said McBurney. “Making main beams for ourselves and others will enable lots of Corsairs to fly again around the world.” He said he believes he could have his Corsair flying in three years, if he finds a title sponsor.

A veteran who served in the U.S. Air Force, McBurney is patriotic and passionate about his cause. “I’ve met lots of WWII veterans who went into combat and didn’t complain, then came back and built our country into what it is today,” he said. “By restoring this aircraft, we’re giving people a sense of the contributions and sacrifices they made for us.”

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