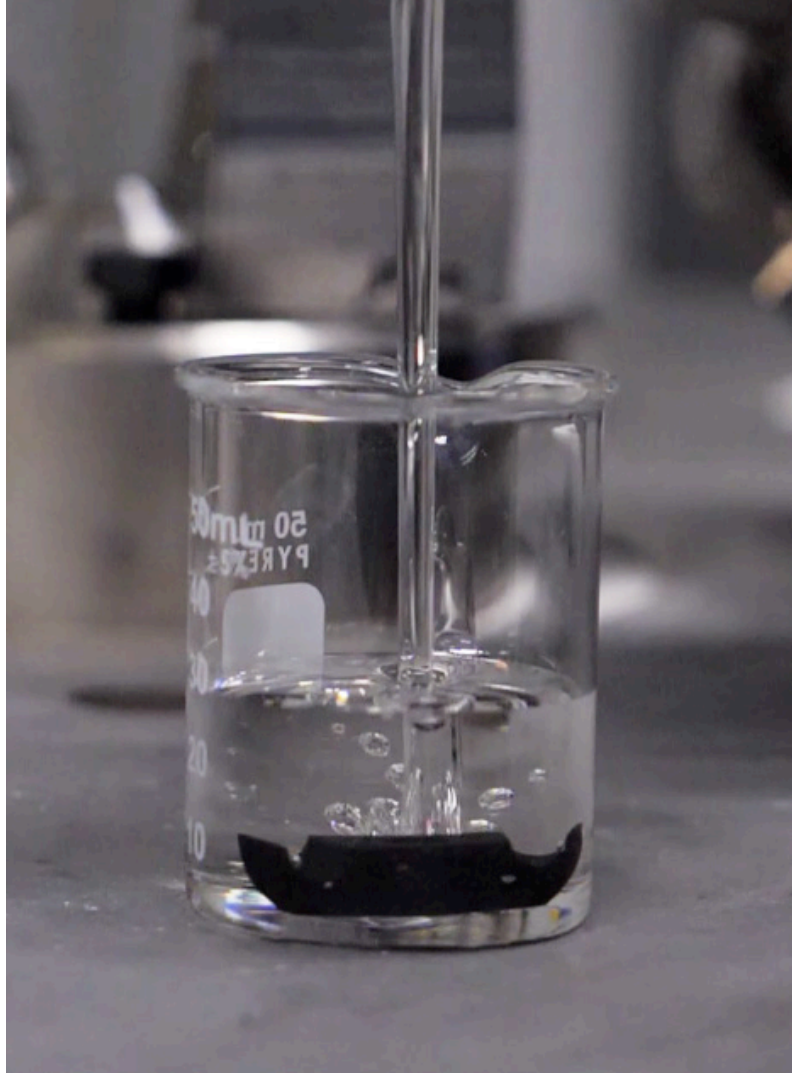




Additive solutions for U.S. Air Force sustainment challenges

Using the Stratasys Origin[®] One, the team was awarded first place for an optimized version of the traditional C3175-9J hydraulic line clamp used in F-16 aircraft that meets stringent aerospace flight criteria.





Final clamp revision with a printed-on elastomer tether for ease of installation.

Ongoing sustainment for aging aircraft components

The U.S. Air Force increasingly faces sustainment challenges, including cost, speed, and supply chain agility, when using traditional manufacturing methods to maintain aging aircraft components. The department often seeks innovative engineering solutions to keep aircraft aloft and to modernize the fleet. In 2020, they hosted an open competition to quickly find new and creative 3D printing solutions for the C3175 family of hydraulic line clamps. Thousands of these clamps are used in the Air Force's F-16 aircraft, in areas like landing gear cavities, and they frequently fail after extended exposure to vibration, chemicals in the environment, and heat cycling. Historically, these clamps have been injection molded or CNC machined from a phenolic material that off-gases toxic formaldehyde.

nTopology and Stress Engineering Services reached out to Origin (which was acquired by Stratasys in 2021) to collaborate on a new design and manufacturing solution for the C3175-9J clamp. The team aimed to leverage Origin One's P3™ technology, [nTopology's](#) topology optimization algorithms, and [Stress Engineering Services'](#) design and analysis expertise. It took just two weeks while performing daily design iterations, prototyping, and testing replacement designs to land on a new, 3D printed solution that meets stringent airworthiness requirements, weighs less and is more efficient to manufacture.

Finding a suitable material

For the clamp halves, the team selected an innovative, flame-retardant material from Henkel that could meet the Air Force's stringent flight requirements and had passed UL 94 V-0 (burning stops within 10 seconds). LOCTITE® 3955, a flame, smoke, toxicity (FST) rated photopolymer material, is flame-retardant, extremely chemically resistant and can also handle wide low and high temperature ranges. LOCTITE 3955 avoids the stress relaxation behavior inherent in thermoplastic materials.

The team used advanced software on the Origin One to print in two different materials, the stiff, flame retardant material and a flexible elastomer, LOCTITE IND402, which acted as a tether to connect the two clamp halves. This simplified downstream assembly for the aircraft technicians, making it easier to install the clamps in the field. Each assembly was serialized during print for part inventory, traceability, and part provenance.

Using the Origin One platform reduces the high cost of tooling for low-volume or custom production and provides the flexibility to change part designs quickly and cost-effectively. Quality can be kept high, and costs can be brought down. For this application, Stratasys Origin One is capable of producing 54 clamp halves in 24 minutes. 1,296 clamp halves can be printed using one printer in a single day. Post-processing a printed batch can be completed in roughly 20 minutes.

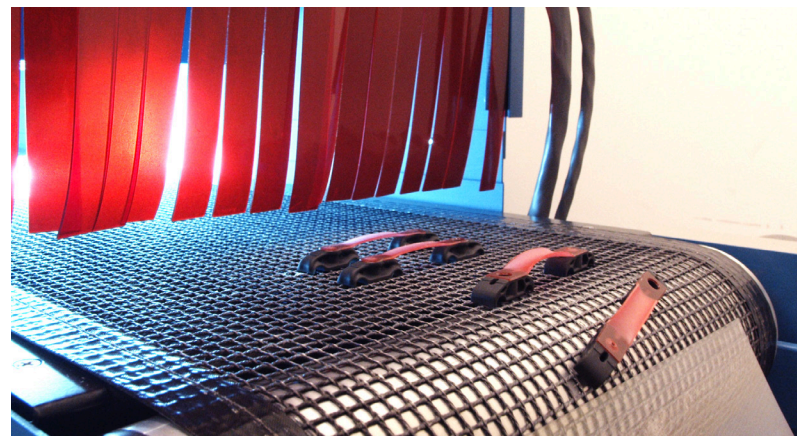
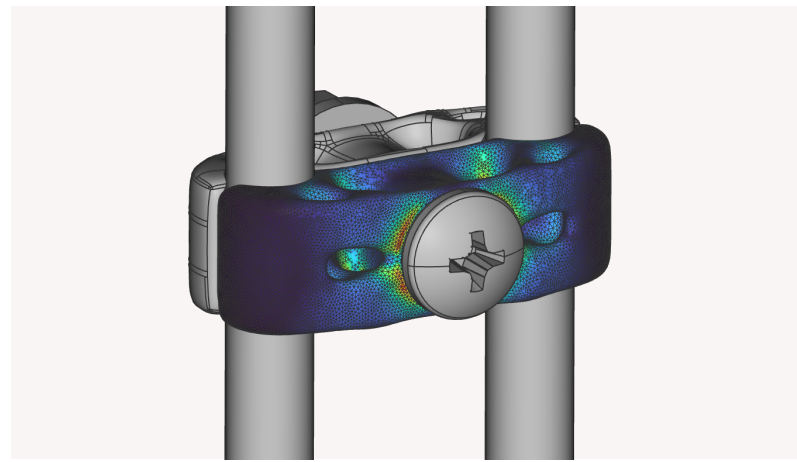
A winning final product

In an exciting climatic event, the RSO-hosted Advanced Manufacturing Olympics, the Origin, nTop and Stress team took first prize in the challenge and beat out stiff competition from expert teams and OEMs across the U.S.

Ultimately, the team printed over 400 different parts, as well as custom test fixtures for internal functional testing. 100 tests looked at installation, tubing retention, temperature effects tolerances, inertial loads, and handling loads. The final, optimized clamp design for the C3175-9J employed on F-16 aircraft doubled the strength of the original part while weighing less.

Next-level part production

The Stratasys Origin One is a transformative 3D printer enabling mass production of end-use parts in a diverse range of high-performance materials. Manufacturers can achieve industry-leading accuracy, consistency, detail and mechanical properties with Programmable PhotoPolymerization P3™ technology. High throughput, combined with best-in-class repeatability, helps expand production without delays, for faster launch times and flexibility in response to shifts in demand, while maintaining minimal inventory. Take on the most demanding applications today.





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