

MARKFORGED

INNOVATING CONTINUOUS CARBON FIBER 3D PRINTING
TECHNOLOGY WITH SOLIDWORKS SOLUTIONS



Markforged chose the SOLIDWORKS 3D design environment to develop the continuous carbon fiber 3D printing systems that are disrupting the market by providing fast access to accurate plastic parts with the strength of metal.

Challenge:

Establish and grow a 3D printer manufacturing company by inventing and innovating a disruptive continuous carbon fiber 3D printing technology, which rapidly produces high-strength, production-quality parts that are stronger and more cost-effective than metal parts at low volumes.

Solution:

Implement SOLIDWORKS design, SOLIDWORKS Premium design and analysis, and SOLIDWORKS PDM product data management software solutions.

Benefits:

- Invented continuous carbon fiber 3D printing technology
- Cut hardware development time to less than six months
- Improved 3D printing accuracy to within 50 microns
- Realized explosive growth in its first four years

Like many innovators, Markforged founder and CEO Greg Mark took his inspiration for the world's first continuous carbon fiber 3D printer from necessity. His experience producing carbon fiber wings for race cars compelled him to seek a better method for producing carbon fiber composites. Combined with the need of engineers to quickly obtain high-strength parts, this necessity provided the inspiration to merge carbon-fiber production and 3D printing technology, and Markforged was born.

The company has disrupted the status quo in the 3D printing industry by offering access to end-use, production-quality parts having the same strength as metal. While other 3D printers produce fragile replicas of designs that are primarily used for prototyping, Markforged printers generate precision parts that are as strong as metal more affordably at low volumes.

To quickly develop its breakthrough technology, efficiently design new products, and successfully grow the company, Markforged needed a robust 3D development platform. The company chose SOLIDWORKS®, acquiring SOLIDWORKS design and SOLIDWORKS Premium design and analysis software, and more recently implementing the SOLIDWORKS PDM product data management (PDM) system.

"Buying SOLIDWORKS was a no-brainer," Mark stresses. "We picked SOLIDWORKS because we believed it would provide the greatest return on investment. We're saving time and money using SOLIDWORKS and realizing faster times-to-market. Because the software is easy to use and taught at many universities, it's easy to add engineers and immediately have them up and running, and contributing.

"SOLIDWORKS is a great CAD package because it makes us fast," Mark adds. "The world moves fast, and we have to move faster to stay ahead of the competition. SOLIDWORKS is a key differentiator because we can maintain the speed that is critical to our success as the company grows."



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— Greg Mark, Founder and CEO

ACCELERATING DEVELOPMENT OF A PRINTER THAT PRINTS ITSELF

Using SOLIDWORKS, Markforged cut its new product development cycles to less than six months—much faster than the typical one-year or year-and-a-half development cycles for most technical hardware products. "In our market, it's all about speed—about efficiently getting to the right design," Mark explains. "It's not just about designing quickly, but about making prototypes, refining the design, and making modifications without burning time or money. SOLIDWORKS gives us unbelievable speed, precise accuracy, and a stable development platform for making design changes. In short, SOLIDWORKS helps us reach the optimal design in less time."

"SOLIDWORKS supports our iterative workflow," notes Senior Mechanical Engineer Bennett Wilson. "We do a lot of inventing and prototyping, and often may iterate on a part five times in a single day. SOLIDWORKS fits well with our approach. We've actually printed parts designed in SOLIDWORKS on one of our 3D printers for use on another 3D printer, a case in which the 3D printer prints parts of itself."



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SAVING TIME AND MONEY, IMPROVING PERFORMANCE WITH SIMULATION

In addition to using SOLIDWORKS 3D design capabilities, Markforged leverages the simulation tools in SOLIDWORKS Premium software not only to validate designs but also to optimize design performance. For example, during development of the Mark X, the company's largest, most advanced 3D printer, with accuracy of within 50 microns, engineers needed to double the size of the printer's build platform, maintain its strength, and avoid displacement—while reducing weight.

"The build platform on the Mark X is twice the size of our previous designs but has to be much stiffer, with deflection of less than three microns under load," Wilson recalls. "We ran displacement analyses in SOLIDWORKS Premium on the design using different pocketing schemes to reduce weight until we found the best combination of stiffness and weight. We were able to gain this insight in minutes versus hours and produce a build platform that is twice as big and twice as stiff, yet weighs about the same as previous versions."

RAMPING UP DEVELOPMENT WITH PDM

Markforged implemented the SOLIDWORKS PDM system in 2016 to support, manage, and maintain the company's rapid development pace in the midst of explosive growth. As the organization and its engineering staff grows, SOLIDWORKS PDM software provides the revision controls, formalized workflows, and data management tools that the company needs to support a larger, more collaborative approach to development.

"SOLIDWORKS PDM is an invaluable tool for us," Wilson says. "As the number of products and engineers continues to grow, it's too easy to have the wrong version of something land in the wrong person's hands. SOLIDWORKS PDM ensures that we're always working on the right version and can collaborate more frequently and effectively."

The innovation cycle at Markforged hasn't slowed down. Next up for Markforged is its Metal X for 3D printing of metal parts, a new process and printer design made accessible to many of its customers through yet another rapid hardware development cycle.

Focus on Markforged
VAR: CADD Edge, Marlborough, MA, USA

Headquarters: 10 Fawcett Street
Cambridge, MA 02138
USA
Phone: +1 617 666 1935

For more information
www.markforged.com



With SOLIDWORKS design and simulation tools, Markforged has compressed its development cycles down to less than six months while simultaneously increasing the accuracy of 3D-printed parts to within 50 microns.

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