AMD Smarter Choice

Climbing to new heights of manufacturing productivity

AMD 64 Opteron™

Trek Bikes maximizes the use of lean manufacturing techniques to ramp up production on the Trek Madone road bike

THE CHALLENGE

- Leverage the success Lance Armstrong and the Discovery Channel Pro Cycling Team have had with the Madone racing bike by manufacturing it for the broader road-bike market
- Produce more than twice as many Madone road models to provide consumers with more purchasing options
- Manufacture greater numbers of Madone road models using the same production capacity and personnel

THE SOLUTION

- Employ a leaner approach to manufacturing through the use of SolidWorks® 3D CAD software powered by AMD Opteron™ processors
- Implement advanced molding methods developed with SolidWorks 3D CAD software on AMD processor-based workstations into full production
- Create molds, tooling, and fixtures in parallel with product design using SolidWorks 3D CAD software as the collaborative development platform

THE IMPACT

- More than doubled throughput from nine to 20 models
- Shortened manufacturing time by 20 percent despite increased throughput
- Eliminated secondary machining steps, cut material usage
- Accelerated time-to-market

Just as Lance Armstrong used the *Col de la Madone* — a mountain in Menton, France, featuring a 12-km climb from sea level to 927 meters — to gauge his physical readiness to compete in the *Tour de France*, Trek Bikes approached the ambitious production of the 2007 Madone road bike as the ultimate test of its lean manufacturing processes. Armstrong rode the Trek Madone, which Trek named after Armstrong's mountain training ground, to win the last three of his seven consecutive *Tour de France* victories. Trek has produced Madone bicycles for the Discovery Channel Pro Cycling Team and the consumer road market since Armstrong first rode a Madone in 2003.

With the newest version of the Madone, Trek sought to capitalize on the success Armstrong and the Discovery Channel Pro Cycling Team have had by expanding the Madone road line, increasing the range of purchasing options, and broadening its appeal in the consumer road market, according to Product Manager Tyler Pilger. "Trek continues to produce the best-in-class, OCLV carbon road bike with the Madone, but we now offer 20 different models, with varying price points and specifications, instead of the traditional nine models," Pilger explains. "The challenge our designers, engineers, and manufacturing specialists faced was to produce more than twice the number of Madone models in a more tightly compressed period of time."

"The work on the Madone represents the most intense development and production effort, in terms of the numbers involved, that we have undertaken at Trek," says Michael Sagan, Trek Product Development Technology Lead. "To meet our objectives, we needed a single design and manufacturing platform that we could count on. By using SolidWorks 3D CAD software on AMD Opteron™ processor-based workstations to drive product design and tooling development, we achieved our ambitious goals and cut 20 percent of the time from the manufacturing cycle, even with the higher volumes. AMD and SolidWorks technologies touched this project at every point of the process, from concept to commercial availability."

Cutting-edge composite molding technology

Production of the 2007 Madone began with research completed by Trek's Advanced Concepts Group (ACG). Operating as on offline, research-and-development,

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manufacturing skunk works, ACG used SolidWorks CAD and COSMOSWorks® analysis software on AMD processor-based computers to develop an entirely new carbon-fiber molding process that supports a faster, more accurate, and more cost-effective approach to manufacturing bicycle frames. In essence, this new molding methodology enables Trek to create all of the tolerance-critical interface areas on the frame, such as the area where the headset bearings interface with the fork, through the actual molding process rather than through a less-controlled, secondary machining step, according to Jim Colegrove, Composites Manufacturing Engineer for Trek ACG.

"The approach we have developed is unique in our industry," Colegrove explains. "By molding the critical tolerance areas, we not only have a higher degree of precision, which translates into greater accuracy and better quality, but we also save time and money and minimize scrap, waste, and material usage. We used to mold the individual pieces and create the interface areas by using a lot of sacrificial material and highly specialized machining. Now, we are molding exactly to size and minimizing specialty manufacturing needs by creating critical high-tolerance areas in the tool. When the frame comes out of the mold, it is essentially finished, aside from the removal of a small amount of flash material around the parting lines."

Design Engineer David Guzik, who served as the chief engineer for the Madone, says that working on the same SolidWorks CAD platform enables Trek design and manufacturing engineers to collaborate and work more closely on creating cutting-edge products and manufacturing processes. "ACG came through with a major breakthrough by getting rid of the need to machine tolerances and developing a method for molding tolerances," Guzik notes. "That capability provides for better alignment and takes costs out of manufacturing. And because we are all working in SolidWorks, three other industrial designers and I were able to collaborate on adding style and shape to the concepts ACG came up with, resulting in the production of a better product faster and more cost-effectively."

Advanced manufacturing concepts save time and money

For the 2007 Madone, Trek was able to deploy the advanced manufacturing techniques developed by ACG very quickly because everyone involved — ACG, designers, engineers, and manufacturing specialists — used SolidWorks software. Frame Engineer Technician Kurt Schubert used SolidWorks software to work with ACG and design engineers on implementing the new molding techniques and setting up all of the production molds and tooling for the Madone. Using SolidWorks software on his AMD Opteron™ processor-based workstation, Schubert could quickly and easily create mold designs directly from imported part models. "With SolidWorks, I can create the molds by bringing the frame parts into an assembly block and just using the cavity function to create the mold shape," Schubert points out. "I also used SolidWorks draft analysis, surfacing, and parting line capabilities to finalize the molds."

While Schubert created the advanced molds required to manufacture the Madone, Product Manufacturing Engineer Mark Wilke used SolidWorks software to develop the preforms and carbon fiber lay-ups that are inserted into the mold. "Using the same CAD platform helps us to work together more closely and automate many functions," Wilke notes. "For example, we used to take physical dimensions directly off the mold to create the preforms. Now, I can bring the mold model into SolidWorks and take the cavity dimensions of the tool right in the CAD system, which is about 10 times easier for creating the preforms. The time savings are pretty significant when you consider it used to take three hours to create a preform for each part."

Developing tooling in parallel with design improves competitiveness

In addition to taking a concurrent approach to molding composite parts, Trek develops tooling and fixtures for other production processes in parallel. Product Development Engineer Chris Pomering, who is responsible for all post-molding manufacturing processes, such as machining, bonding, and

finishing, says that using SolidWorks in parallel with design engineers enabled him to complete almost all of the post-molding tooling for the Madone while the design was still in development. "The old way was to wait until the design was frozen before developing tooling," Pomering explains. "Because we all use SolidWorks, I can take snapshots in time of the design as it is being created, enabling me to consider tooling and manufacturing issues as the design progresses. Working this way, I was able to complete 95 percent of the work on the Madone before the design was frozen, which eliminated a substantial amount of lead time."

TREK

According to OCLV Engineering Manager Chad Manuell, who served as the project manager for the Madone, the efficiencies, integration, and expertise that Trek realized on the manufacture of the Madone translate into more than just time, cost, and material savings and further develop the expertise that the Waterloo, Wisconsin, production facility needs to continue succeeding in the face of stiff overseas competition. "This was the first real big project where we really integrated the different functions and groups using SolidWorks," Manuel stresses. "Everyone knew what we had to do and what had to happen. We did more than meet an ambitious production goal ahead of schedule, reduce scrap, and increase throughput. We learned things that will enable us to push the limits of technology, make us more efficient, and ensure our competitiveness in the global market."

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SolidWorks Corporation, a Dassault Systēmes S.A. (Nasdaq: DASTY, Euronext Paris: #13065, DSY.PA) company, develops and markets software for design, analysis, and product data management. It is the leading supplier of 3D CAD technology, giving teams intuitive, high-performing software that helps them design better products. For the latest news, information, or an online demonstration, visit the company's Web site (www.solidworks.com) or call 1-800-693-9000 (outside of North America, call +1-978-371-5000).

About AMD

AMD (NYSE:AMD) designs and produces innovative microprocessors, Flash memory devices, and low-power processor solutions for the computer, communications, and consumer electronics industries.

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