

## Pushing the edge in a niche market

Femap and NX Nastran are instrumental in creating super-light recumbent bicycles

### Business initiatives

New product development

### Business challenges

Reduce weight of existing bicycles to create a super-light product line

Accommodate the widest possible range of riders

### Keys to success

Easy-to-use preprocessor

Accurate solver

Integrated nonlinear analysis functionality

### Results

A thorough understanding of material performance

More accurate physical prototypes; more focused testing

Up to 4.5 kilogram weight reductions on bikes

Bikes can support heavier riders

New models ready for production sooner

### CHALLENGE B.V.

#### Intelligent design on wheels

Paul Voerman, president and founder of Challenge, has been involved with recumbent bicycles for nearly 20 years and remembers their embarrassing early days. "The first recumbents looked like office chairs on wheels held together with garden fencing," he says. "Passers-by would stop and stare." People still stop and stare at recumbent bikes today, but for a completely different reason. In this niche of the bicycle market, innovation is unrelenting. These bikes have become works of engineering art featuring lightweight construction, intelligent design, dazzling paint jobs and a super comfortable ride.

Challenge's product line includes recumbent bikes designed for racing, commuting and touring as well as a new recumbent tricycle. There are quite a few models in each category and they attract buyers from all over the world. The company's current design effort is not aimed at adding new models to the product line (with the exception of the recent tricycle) but at revising popular models to create a new super-light (SL) category. The original Fujin model, for example, which weighs 15 kilograms, is now available in two SL versions: the Fujin SL weighing 9.5 kilograms and the Fujin SL II that tips the scales at only 8 kilograms, without the addition of exotic components.

#### Weight-loss challenges

Reducing the weight of the bikes is limited to some extent by the need to accommodate a range of riders. As it is, lightweight recumbents typically impose an upper limit on the amount weight they can carry (rider and gear). Ideally that number will not be so low that it rules out too many prospective buyers. Finding that balance – a super-lightweight product that is also strong enough to accommodate



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most of the target market – is the challenge facing Voerman and his colleagues. “With our super-light bikes, we are pushing the limits of the material,” Voerman explains. “We really have to know what we are doing.”

Finite element analysis (FEA) plays a critical role in this effort, allowing Challenge’s bike designers to virtually push the materials (typically aluminum and magnesium) to their upper limits and visualize what happens, before building prototypes. The company uses the Femap™ and NX™ Nastran® finite element analysis (FEA) solution from Siemens PLM Software. This solution was chosen because of accuracy, user-friendliness and affordability as well as the availability of integrated nonlinear analysis functionality.

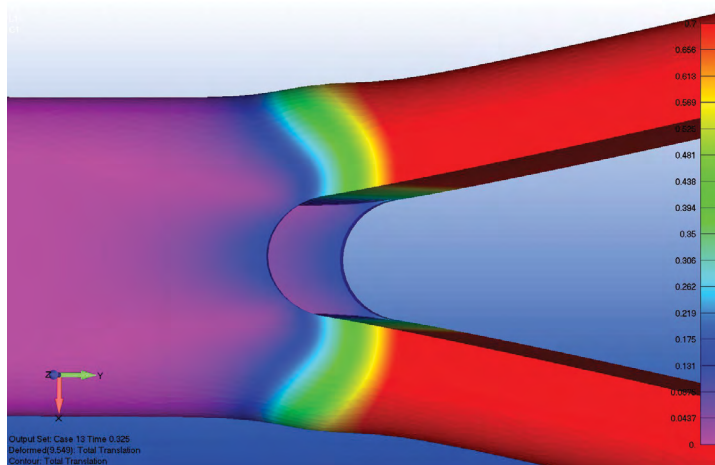
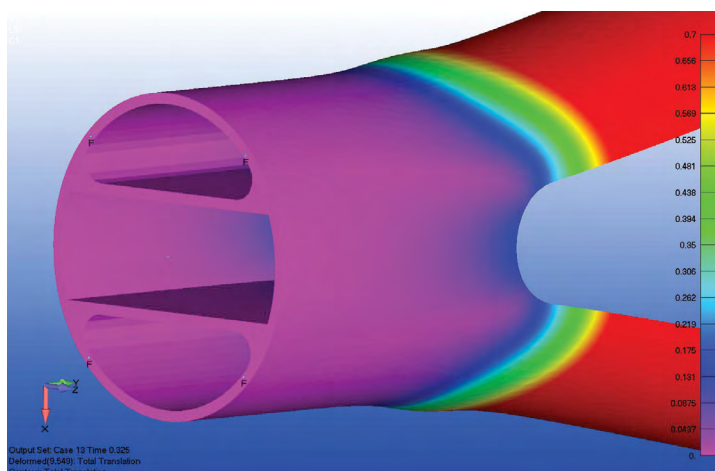
Voerman compares the selection of the FEA system to buying a car. “Prior to purchasing Femap and NX Nastran, I had used other FEA programs that were too expensive or hard to use,” he says. “It’s like buying a car. You need one that rides comfortably and you need a reliable engine. Femap is like the comfortable ride because it is easy to use and NX Nastran is the reliable engine because it gives accurate answers. You also want a dealer where you know the support will be good. We were already using Solid Edge® software as our CAD system, so we knew Siemens PLM Software was a very reliable company.”

### Better prototypes, more focused testing

As an example of how Challenge uses the software, Voerman points to a new suspension component that would have been impossible to create without FEA. The part had to be light and reliable, and due to where it was placed on the frame, there were size and shape constraints to work around. Using the nonlinear analysis capability of NX Nastran, Voerman and his colleagues fine-tuned the design over the course of two weeks to achieve optimal weight and strength.

“We could see the stress moving as we changed the design,” Voerman says. “Without FEA, this part would have failed or been too heavy. We would not have reached an optimal design.”

In another example, Voerman used simulation to decide whether or not to continue with what initially looked like a better production method for the rear forks. One of the company’s trademarks is the split-tube rear fork. It had been producing the forks by splitting the tube and then welding in a plate. A Chinese company suggested extruding the tubes with the plates already in place. Since this would eliminate the labor involved in welding in plates, it would be less expensive. So Voerman went ahead and purchased the necessary molds. Many of the forks produced this way came back with a wrinkle in the tube near one of the bends. “We wasted 70 percent of that



**Solutions/Services**

Femap  
www.siemens.com/plm/femap  
Solid Edge  
www.siemens.com/solidedge  
NX Nastran  
www.siemens.com/nx

**Client's primary business**

Challenge b.v. makes recumbent bicycles for racing, commuting and touring.  
www.challengebikes.com

**Client location**

Apeldoorn  
Netherlands

**Partner**

**Bosch Engineering**

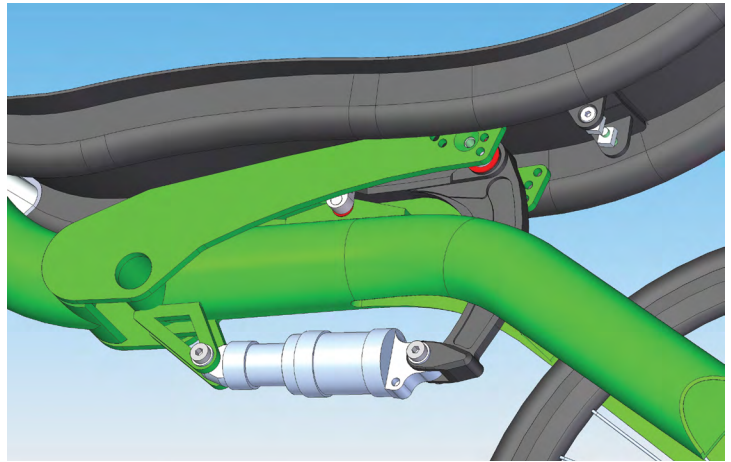
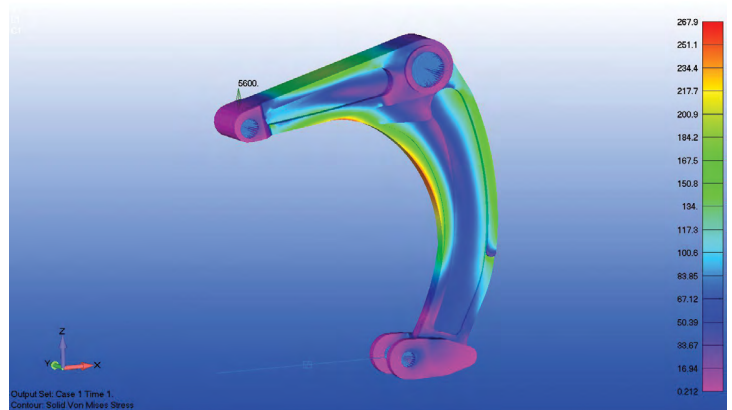
***"Femap and NX Nastran let us indulge our creativity without fear that the ideas will lead the company down the wrong road."***

Paul Voerman  
President  
Challenge b.v.

production run," he says. He performed a nonlinear analysis that predicted that exact flaw. "Seeing that, we decided not to purchase any more of these forks," Voerman adds. "And next time we will do a simulation before we buy molds."

Although the company still makes and tests physical prototypes of new models, new bikes are much farther along when they reach the prototype stage than they were pre-FEA. "In software, we can see where the problem areas are before building prototypes," Voerman says. "We are more sure of the prototypes we build and we know what areas to focus on when testing them." In situations where Challenge is pushing the upper limits of the materials, such as with the SL line, FEA helps get bikes into production quicker. The company now has five SL models available, and Voerman is happy to say that even though the total weight of the bikes is going down, the weight limit on rider and gear is going up. The 9.5 kilogram Fujin SL, for example, recommends a 105-kilogram upper limit on rider and gear weight. "Our goal is the standard 125 kg limit on the 8 kg model," Voerman adds. "I am sure this is possible by fine-tuning the design with FEA."

Voerman likes the recumbent business because "you can be creative in it," he says. That's another reason he appreciates FEA. "Femap and NX Nastran let us indulge our creativity without fear that the ideas will lead the company down the wrong road," Voerman adds. "If we have an idea, such as a new type of tube, we can sketch it up very quickly in Solid Edge, put some force on it, and see if it's worth pursuing. In an innovative field such as ours, FEA is a critical tool."



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