HEXAGON | MSC Software

Case study

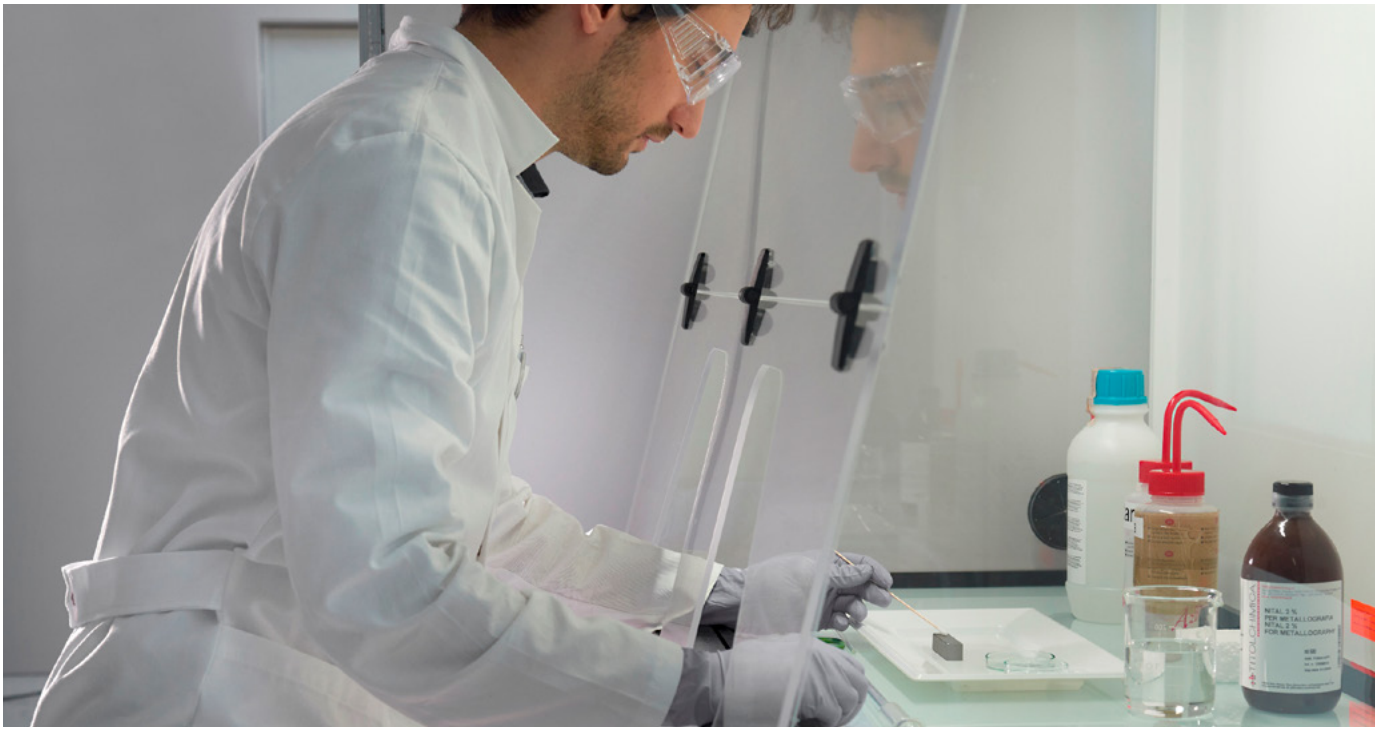
Milan-based manufacturer steps ahead of the competition by putting high heel designs through their paces with simulation software

Simulation software ensures shoe heels don't break under pressure

With Marc, Tacchificio Villa Cortese can perform structural analysis of a heel design at the beginning of a project. In this way the company can identify which combination of geometries and materials will deliver the optimal balance between style and functionality without going to the expense of producing unworkable prototypes.

High heels are a physics-defying choice of elegance over comfort, so it is important they don't trip up their wearers by snapping or cracking unexpectedly. They also need to be fashionable or even avant-garde, especially when they are being produced for the world's leading shoe brands. And increasingly they have to meet customer demand for heels made with environmentally sustainable materials.

Faced with a growing range of design challenges, Milan-based Tacchificio Villa Cortese, which manufactures heels for some of the biggest names in shoes, decided to enhance its craftmanship with the latest in design simulation software from MSC Software.



The R & D division applies a combination of simulation software, laboratory tools for the characterisation of materials, and physical tests to get the best possible results.

Tacchificio Villa Cortese is a family run business that has been producing high heels for world-leading shoe brands since 1961. It started off specialising in wooden heels, but today it also applies its skill to new materials that allow more intricate styles. One of Tacchificio Villa Cortese's imperatives when working on new designs is to evaluate what is wearable and durable.

"We need to understand why shoes break, so, as designers, we can push materials to their limits to make more intricate heels, both higher and thinner, with confidence that they are ready to wear, and will last," says Davide Carminati, R&D manager, Tacchificio Villa Cortese.

The reasons heels break include the impact of a static load when the wearer is standing still; damage from metal inserts that intensify stress on the plastic component of the heel and material fatigue due to viscoelastic effects.

Traditionally, manufacturers explored the viability of heel designs by creating several physical prototypes, fitting them to shoes and asking a person to try them out, before developing physical-mechanical tests. The process, however, is expensive. It is also slow; a disadvantage in a market driven by the tight deadlines imposed by fashion seasons. In addition, physical trial and error limits designers' insight into which materials and structures work and why, so Tacchificio Villa Cortese turned to Marc, the structural simulation software from MSC Software.

Identifying successful designs early

With Marc, Tacchificio Villa Cortese can perform structural analyses of a heel design at the beginning of a project. In this way the company can identify which combination of geometries and materials will deliver the optimal balance between style and functionality without going to the expense of producing unworkable prototypes. Marc also makes it possible for designers to explore the feasibility of geometries that stray from the tried and tested.

"Traditional, manual testing means prototypes have to be physically manufactured first, but testing on a computer screen with the Marc software means designs can be tweaked to balance craft and science, giving us confidence in the quality before a single piece is made," says Davide Carminati. "This also gives us more flexibility to experiment more, and to make better products."

Marc is a nonlinear finite element analysis software which works by simulating how complex materials such as plastics behave and interact under large deformations and strains. Using Marc's automatic two-dimensional and three-dimensional remeshing, the heel maker is able to analyse structures as they undergo substantial distortions and understand how cracks propagate. Marc also helps mechanically validate new materials, including recycled, hybrid materials formed from waste and renewable sources and bio-based and biodegradable substances. It does this

through the use of a digital twin that allows designers to virtually test the materials' behaviour.

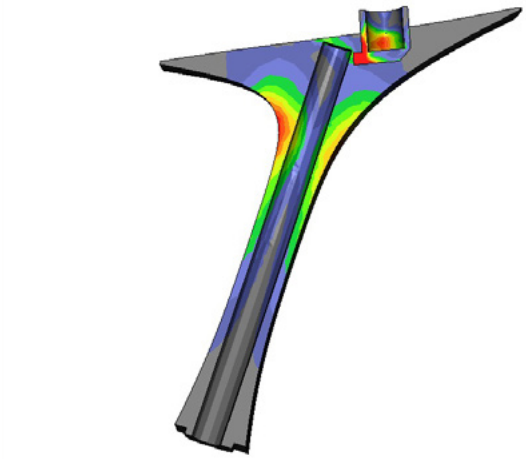
Tacchificio Villa Cortese's physical tests include mechanical lateral impact resistance and fatigue, which are evaluated by an external certifier for ISO regulation, with designers able to work directly on the Computer Aided Design (CAD) file to make preliminary assessments based on the geometry. As well as simulating heel use during regular walking, the company plans to carry out tests on the effects of impact, and one-off stresses such as stumbling and ankle sprains. The results of the analysis are used to rectify or rework the CAD model if necessary, which is then sent to the customer for approval, with a detailed analysis report. If requested, an additive manufacturing prototype is also produced and delivered with the geometry.

Completed heels ready to be assembled to the shoe.

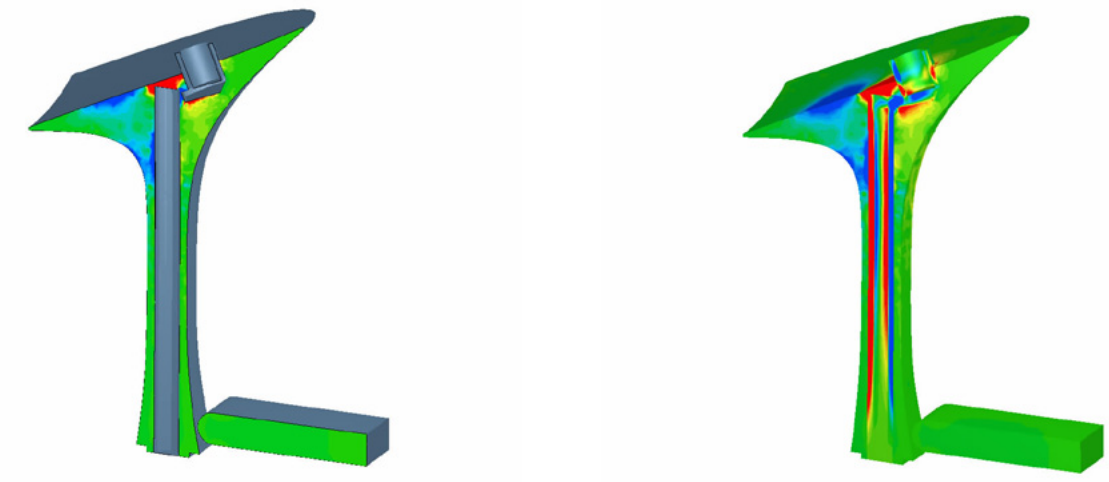
The fastest route to optimisation

The time saved is considerable. Typically, it takes almost five and a half hours to run a full physical fatigue test on a single heel and at least three tests need to be carried out, bringing the total time up to around 17 hours. Furthermore, creating moulds for sample production takes at least four hours, and uses 15kg of raw metal on average. "And, of course, this is all wasted if the tests are unsuccessful," says Davide Carminati.

In contrast, simulating the static equivalent of a fatigue test on a moderately complex model, generally takes around 30 - 45 minutes. Even when a simulation takes longer, it is still the most effective use of resources. "The real advantage is evaluating problems early on, which avoids the need to perform further tests on more variants," says Davide Carminati. "Even if an optimisation analysis takes a full day, we can avoid tests with specific moulds or specific inserts, which would take more time and resources, and could still be unsuccessful."



Stress analysis in Marc software.



Impact analysis in Marc software. The heel of the shoe is made of an exterior, connection and spine which is impacted by a blunt object. The stress contours are shown with and without the spine.

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