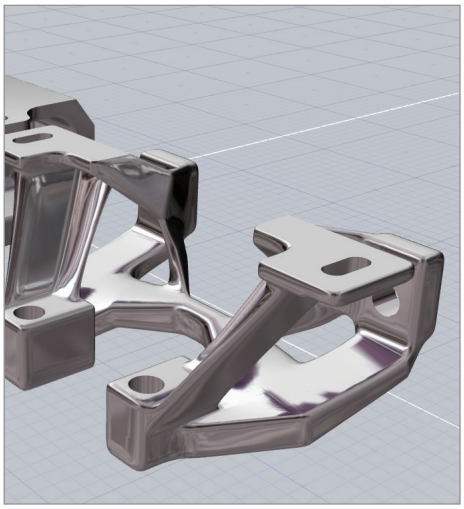
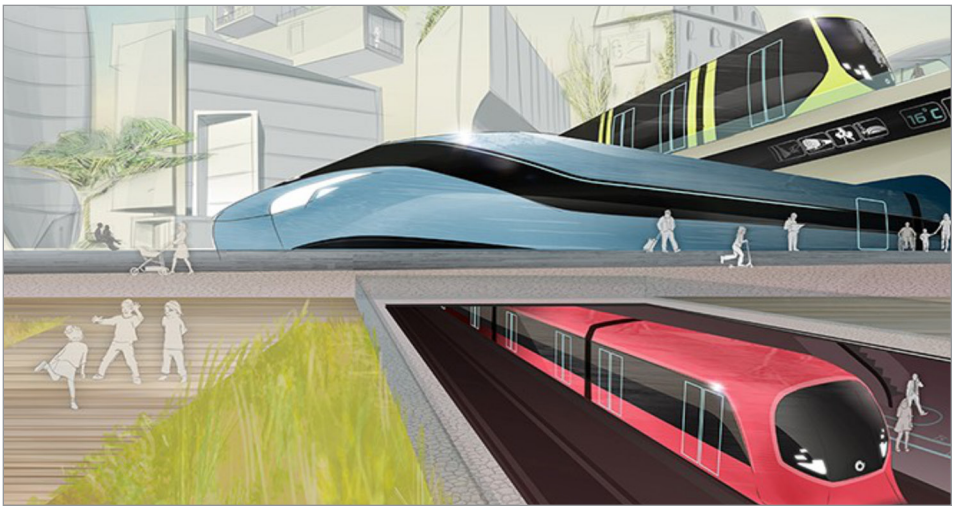
Using Topology Optimization with solidThinking Inspire for Improved Casted Rail Components





ALSTOM

Key Highlights

Industry
Transportation/Railway

Challenge
Optimization of an existing component design to be manufactured with casting or alternatively with AM technologies.

Altair Solution
Simulation driven design approach with solidThinking Inspire for topology optimization, Evolve for shape refinements and HyperWorks for FE analysis.

Benefits
- Reduced development time
- Improved components in terms of less weight and increased stiffness
- Detailed insights into new production options with additive manufacturing

When Alstom, Spain, wanted to improve the design of an existing cast part, the company employed HyperWorks as well as solidThinking Inspire and Evolve in the design and optimization of casted rail components and parts designed for additive manufacturing. Currently this part is used in Alstom's Metropolis units in the train bogies to support the anti-roll system. It turned out that the first design of the part seemed much too strong for the occurring workloads, and the finite element (FE) model revealed that the safety factor was also a little too high.

As a first step an analysis with solidThinking Inspire® was carried out, providing the same results. To improve the overall design while at the same time optimizing material usage, the optimization options were extended by increasing the design volume of the part, followed by a topology optimization.

As a result of several iterations with Inspire, a customized solution was found, the exterior shape was refined and fixed with solidThinking Evolve®. The final geometry was then again verified with a detailed FE analysis. For the next step, which was already in progress, the team began preparing and analyzing the part to be additively manufactured. For this Alstom collaborated with local 3D printing companies.

Company profile

As a promoter of sustainable mobility, Alstom develops and markets systems, equipment and services for the railway sector. Alstom manages the widest range of solutions in the market – from high-speed trains to metros and tramways – customized services (maintenance, modernisation,...) and infrastructure and signalling solutions. Alstom is a world leader in integrated railway systems.

Keywords: Lightweight Design, Optimization, Additive Manufacturing

ALSTOM Success Story

"We are very satisfied with the results achieved since we have realized better designs and could fulfill all structural requirements in a shorter term. Currently HyperWorks is our main tool for structural studies as well as the development of the best possible solutions, and we plan on using it for a long time."

Juan Manuel Romero
Structures and calculation lead engineer
Alstom, Barcelona

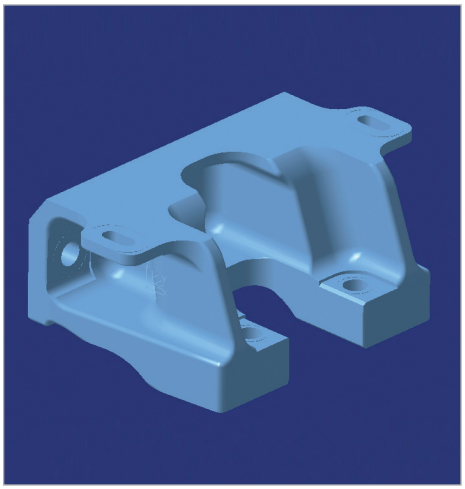
It recorded sales of €6.9 billion and booked €10.6 billion of orders in the 2015/16 fiscal year. Headquartered in France, Alstom is present in over 60 countries and employs 31,000 people today.

The project described in this case study was carried out by the Bodyshell and Calculation department in Barcelona, which is regularly designing and verifying the different train structures Alstom develops and is consulted by other Alstom departments for technical questions.

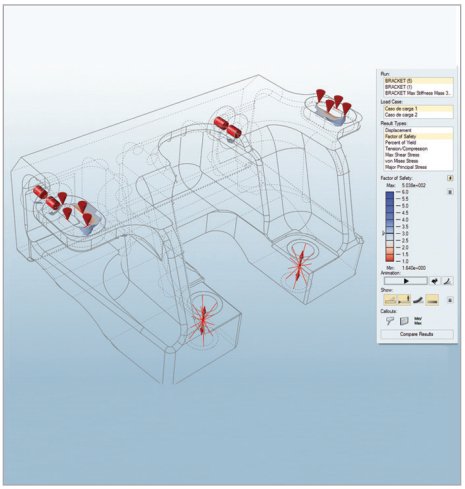
Lead for the project was Juan Manuel Romero a structures and calculation lead engineer at Alstom, Barcelona.

Challenges

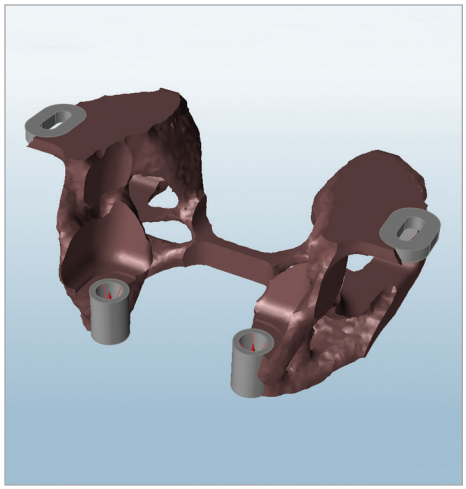
In every industry development engineers drive for the best manufacturing and development processes in order to create the finest possible products. When searching for the perfect structural design solutions, they have to consider technical and economical aspects. Simulation enables them to achieve their goal and supports them in the entire product creation process. At Alstom in Barcelona the engineers usually receive several inputs, (strength, volume constraints, thermal, and others...) to study the geometry, the material, and the fixation. After that they check the solution they came up with and generate a graphical representation. Usually the Alstom engineers handle several simulations per week, helping them to overcome any development obstacles that might occur. To address these challenges Alstom has to use sophisticated



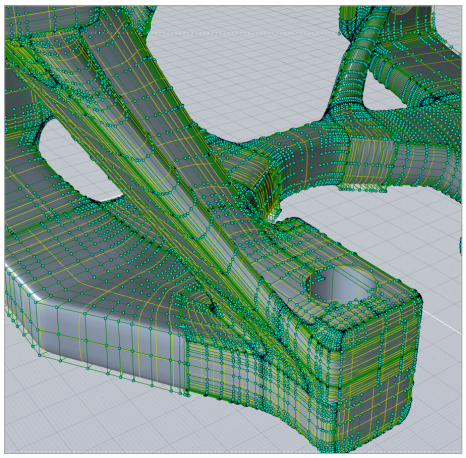
Model of the cast part supporting the anti roll system



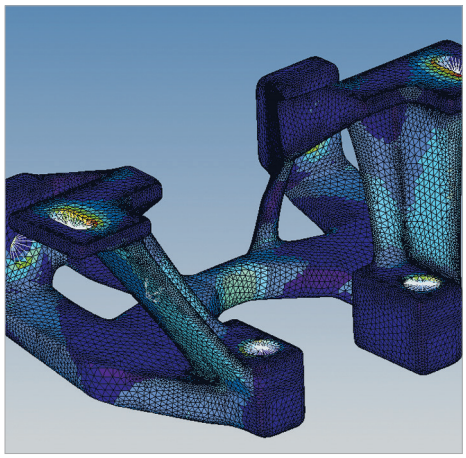
Defining supports and loads prior to the analysis with solidThinking Inspire®



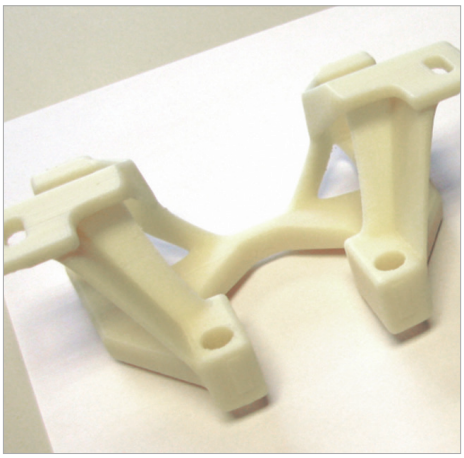
Result of the topology optimization with solidThinking Inspire®



Refinement of the geometry in solidThinking Evolve®



The final geometry was verified with a detailed FEM analysis using HyperWorks®



Model of the 3D printed version of the anti roll system support

software tools allowing them to handle all related development tasks and to support the product creation process as a whole.

Solution

To handle their simulation tasks, Alstom Barcelona applies HyperWorks for meshing tasks and to perform static FE analyses. For optimization and design tasks the engineers rely on solidThinking's products, in particular Inspire and Evolve. These tools allow them to address issues such as material questions, geometrical derogations, and adjustments between the industrial processes and the designs.

Before the engineers started with the re-design of a part used in Alstom's Metropolis units in the train bogies to support the anti-roll system, the existing design had been analyzed. Since the FEM model showed that the safety factor was a little too high, an analysis with solidThinking Inspire® was carried out, providing the same result. With the aim to improve the overall design while optimizing material usage, the design volume of the part was increased in order to extend the optimization options. For the subsequent topology optimization the engineers first created a design space, then applied loads and other boundary conditions, and finally ran the optimization based on this input. Following several iterations with Inspire, in which the design space was changed and the team applied various different load cases and boundary conditions, a customized solution was developed. Finally the exterior shape was refined and fixed with solidThinking Evolve®, and the compliance of this final geometry was verified again with a detailed FEM analysis.

With the HyperWorks and solidThinking solutions Alstom has received very good results. The use of Altair's solutions allows the engineers to complete the process and support structural tests. With their simulation driven design approach, which is enabled and supported by solidThinking Inspire and the HyperWorks products, the engineers could drastically change the way products are developed. As a result, better products are developed in much shorter development circles. Additionally, the redesign of the part resulted in overall weight savings of about 70 percent. Alstom has been working with Altair and solidThinking products for 4-5 years, having established a development process for structural optimization and simulation using Altair products exclusively. The engineers at Alstom have a profound expertise in structural design and are combining simulation, tests, and the expected behavior in most of the situations to achieve the best possible result.

Benefits

The usage of Altair's solutions in the development processes at Alstom resulted in better, stiffer, and lighter products. Depending on the manufacturing method weight savings of up to 70 percent have been reached. In addition to improving the design of an existing cast part by making it stiffer and lighter, the software also enabled Alstom's engineers to study the benefits of additive manufacturing, offering them new expertise in this area and the ability to implement this manufacturing method as soon as it's approved for series production.

Visit the HyperWorks library of

Success Stories

at www.altairhyperworks.com

About Altair

Altair is focused on the development and broad application of simulation technology to synthesize and optimize designs, processes and decisions for improved business performance. Privately held with more than 2,000 employees, Altair is headquartered in Troy, Michigan, USA and operates more than 45 offices throughout 22 countries. Today, Altair serves more than 5,000 corporate clients across broad industry segments.

To learn more, please visit **www.altair.com**

About Altair HyperWorks®

Altair® HyperWorks® is the most comprehensive, open architecture CAE simulation platform in the industry, offering the best technologies to design and optimize high performance, weight efficient and innovative products. HyperWorks includes best-in-class modeling, linear and nonlinear analyses, structural and system-level optimization, fluid and multi-body dynamics simulation, electromagnetic compatibility (EMC), multiphysics analysis, model-based development, and data management solutions.

www.altairhyperworks.com

About solidThinking

solidThinking creates, develops, and markets technology that helps our user community bring the most desirable products to their customers faster. solidThinking was started in 1991 to meet the needs of Italian industrial designers, and acquired by Altair in 2008. Our offering has now been expanded to assist product development for designers, engineers, architects, and scientists. solidThinking software is sold and supported by a global network of distribution partners and is also available as part of the Altair HyperWorks suite.

www.solidthinking.com

Altair

Altair Engineering, Inc., World Headquarters: 1820 E. Big Beaver Rd., Troy, MI 48083-2031 USA
Phone: +1.248.614.2400 • Fax: +1.248.614.2411 • www.altair.com • info@altair.com

Altair®, HyperWorks®, RADIOSS®, HyperMesh®, BatchMesher™, HyperView®, HyperCrash®, HyperGraph®, HyperGraph®3D, HyperView Player®, OptiStruct®, HyperStudy®, HyperStudy®DSS, MotionView®, MotionSolve®, Altair Data Manager™, HyperWorks Process Manager™, HyperForm®, HyperXtrude®, GridWorks™, PBS Professional®, and e-Compute™ are trademarks of Altair Engineering, Inc. All other trademarks or servicemarks are the property of their respective owners.