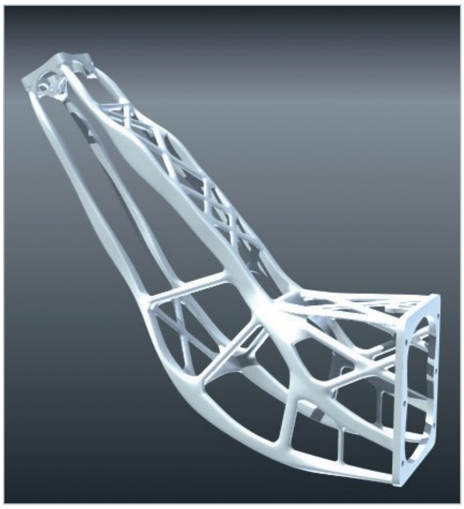
Topologically Optimized and 3D Printed Component on its Way into Space:

OptiStruct and Altair ProductDesign help RUAG Space Switzerland Zurich to design and optimize one of the longest component ever manufactured by industrial 3D printing for use in space.



Together ahead. RUAG

Key Highlights

Industry
Space

Challenge
The creation of cost effective, lighter and stiffer components for space applications

Solution
OptiStruct, solidThinking Evolve, ProductDesign, Industrial 3D printing

Benefits
- half the weight
- cheaper launch
- increased stiffness
- reduced stress
- minimum lead time

Challenge

Weight reduction is a decisive factor in the space industry, since the lighter a satellite is, the less it costs to send it into space. At the same time the component has to perform under extremely harsh conditions in space and during the launch procedure and therefore it does not only have to be light but also extremely stiff. The requirement for ever lighter components has pushed the space industry to look for ways to save material and weight at every opportunity. As a result manufacturers are investigating the potential impact that new design techniques and manufacturing methods could have on the weight of their products. One such technology which is causing a stir in the industry is the rise of Additive Manufacturing (AM).

RUAG Space is Europe's leading equipment supplier to the space industry. With 1,150 employees worldwide in RUAG Space and a further 8,000 worldwide in the entire RUAG Group, RUAG Space Division recorded total sales of around 248,6 million Euro in 2013. The company develops a wide range of products for the space industry including launcher structures and separation mechanisms, satellite structures, mechanisms and mechanical equipment, digital electronics for satellites and launch vehicles, satellite communications equipment and instruments. Since 2013, RUAG Space has been conducting intensive research and development work to investigate how to 'print' its components using an AM process. Making a 3D print involves building up layers of metal powder and joining them together to form the desired shape in an automated process called Direct Metal Laser Sintering (DMLS).

Keywords: Aerospace, Optimization, Design, OptiStruct, Evolve, ProductDesign, Additive Manufacturing

RUAG Success Story

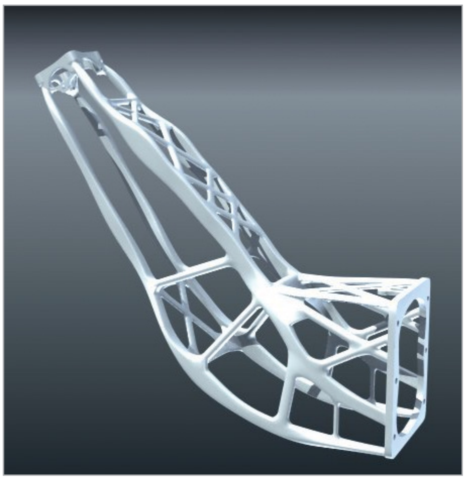
"Our goal is to equip one of the future Sentinel-1 satellites with antenna support components that have been manufactured using an industrial 3D printer. 3D printing has enormous potential for our business, and we are currently in the process of developing further space applications. Again we will use the Altair products within the design and optimization process to guarantee a component layout that is suitable for 3D printing. In the future it will be possible to create entire satellite structures using a 3D printer. This means that electrical harnesses, reflectors, heating pipes, and other assemblies that today still have to be manufactured individually could then be integrated directly into the structural elements."

Michael Pavloff
Chief Technical Officer at RUAG Space

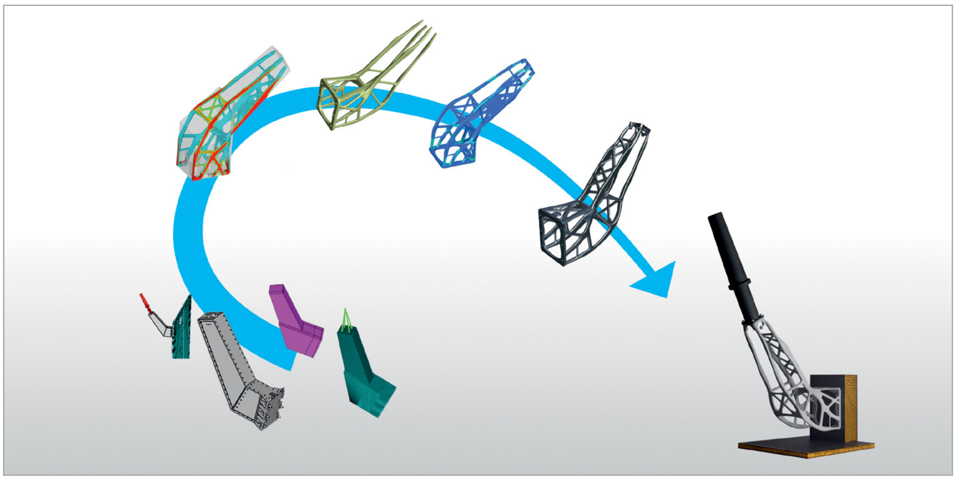
The goal of the engineers was to take full advantage of the design freedom Additive Manufacturing offers and to create an aluminum component that would be significantly stiffer while at the same time lighter than the original design. In addition, RUAG's engineers also wanted to cut down design and development time to get results and the final component faster.

The first step in this project was to identify those components that could feasibly be additively manufactured. This was done by identifying those components that would be suitable for Additive Manufacturing. RUAG's engineers then had to set up a development process and identify suitable materials for the Additive Manufacturing technology. Next, the team had to identify experienced and reliable development and manufacturing partners, which could support them in the design, optimization and manufacturing of the component. Lastly the RUAG engineers had set up a validation and testing process that guaranteed the quality of the additively manufactured part. An antenna support arm was selected as a component that could be manufactured additively and had a high weight saving potential. This component formed the basis of this study.

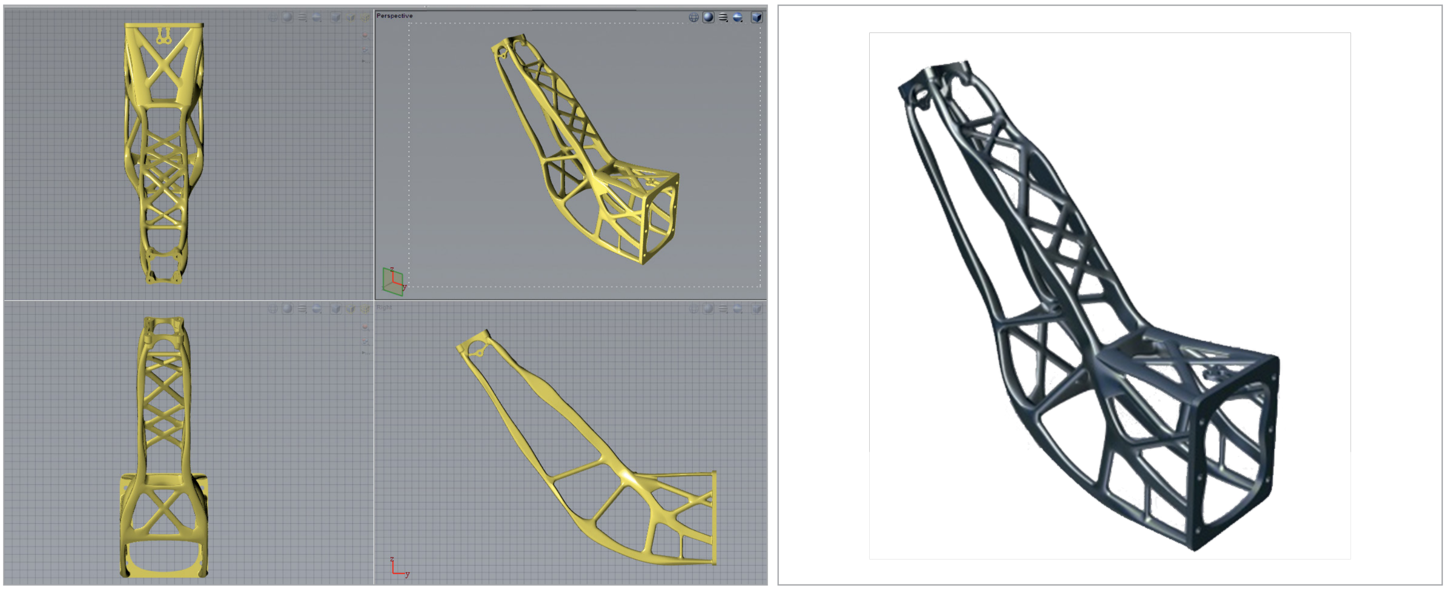
RUAG selected Altair's product development division, Altair ProductDesign, to support the design for 3D printing process due to the company's expertise in developing and utilizing optimization techniques. Optimization methods allow manufacturers to save weight by identifying where material is required in a structure and where it can



Final design of antenna bracket.



The simulation driven design process of the antenna bracket leads to: half the weight - reduced stress - increased stiffness - minimum design lead time!



After a first optimized layout had been created with OptiStruct, the engineers used solidThinking Evolve for surface modelling, leading to a lead time reduction and a design freeze after only four weeks

be removed without negatively impacting performance. The technology has a close synergy with AM technology as the manufacturing method allows the creation of shapes that more closely match the ideal material layout identified during the optimization process.

To perform the optimization studies, the combined team deployed Altair's structural solver, OptiStruct, part of the HyperWorks suite of simulation tools. The team identified a 'design space' within OptiStruct and applied the known load cases that the antenna would be subjected to during launch and use in space. Using this information, OptiStruct was able to suggest an ideal, material efficient design that RUAG and Altair could use as a basis for the final design.

For the design after a first optimized layout had been created with OptiStruct, the engineers used solidThinking Evolve, a surface modeling tool from solidThinking, a 100 percent subsidiary of Altair. Thanks to the design freedom Evolve offers, a faster design process compared with traditional CAD tools could be realized. As a result the design freeze could be defined after only four weeks.

After the optimization and design stages of the project, the component was manufactured by RUAG's AM technology provider, EOS. Thanks to the accuracy of OptiStruct, coupled with the abilities of Altair ProductDesign to interpret the optimization results into a feasible part, the final component required very few adjustments to meet EOS' 3D printing requirements.

EOS, the German based technology and market leader in the area of industrial 3D-printing, added its expertise consulted with design for Additive Manufacturing experience and handled the production of the aluminum component by using the system EOS M 400. Some 40 cm long, the antenna support is one of the longest metal component ever produced using DMLS technology. To check that the new support is ready for use in space, it is currently undergoing a battery of intensive qualification tests that are scheduled to be completed by the end of the year.

Benefits

The symbiosis of optimization and Additive Manufacturing enables a new level of lightweight design since this manufacturing process is able to realize structurally efficient components which were not previously possible without a lot of time and effort using traditional production methods. The final design developed by RUAG in conjunction with Altair ProductDesign is much closer to the ideal design proposal coming from the optimization results. Stiffer and lighter components contribute enormously to cut down launching costs for space vehicles and satellites.

For the engineers this new technology offers many advantages including more design freedom, faster design and manufacturing processes and last but not least customized products with a higher performance. Industrial 3D printing for space applications is still in its infancy but the method, especially when combined with topology optimization, will change the way products are developed and produced. Space applications have always been at the forefront of new technology and history shows that applicable technologies were always adopted by other branches quite quickly after having been used successfully in the space industry.

Visit the Altair ProductDesign library of

Success Stories

at www.altairproductdesign.com

About Altair

Altair empowers client innovation and decision-making through technology that optimizes the analysis, management and visualization of business and engineering information. Privately held with more than 2,300 employees, Altair has offices throughout North America, South America, Europe and Asia/Pacific. With a 29-year-plus track record for high-end software and consulting services for engineering, computing and enterprise analytics, Altair consistently delivers a competitive advantage to customers in a broad range of industries. Altair has more than 5,000 corporate clients representing the automotive, aerospace, government and defense, and consumer products verticals. Altair also has a growing client presence in the electronics, architecture engineering and construction, and energy markets.

About HyperWorks®

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

www.altairhyperworks.com

About Altair ProductDesign®

Altair ProductDesign is a global product development consultancy of more than 700 designers, engineers, scientists, and creative thinkers. The organization is best known for its leadership in simulation-driven design to help clients bring innovative, profitable products to market faster.

www.altairproductdesign.com

About EOS

Founded in 1989 and headquartered in Germany, EOS is the technology and market leader for design-driven, integrated e-Manufacturing solutions for Additive Manufacturing (AM), an industrial 3D printing process. EOS offers a modular solution portfolio including systems, software, materials as well as services including specific application consulting.

www.eos.info

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