



## Facts

### Challenge

Sustainability and cost impact on manufacturing of aerospace parts across the supply chain.

### Solution

Use of DMLS to allow the use of different materials, optimised design and more energy efficient processes under consideration of a holistic analysis that included sourcing of raw material.

### Results

- Optimised: improved part design requiring less raw material
- Sustainable: lower energy consumption over the product lifecycle, resulting in a reduced CO<sub>2</sub> site footprint
- Based on partnership: unique cooperation and continuous improvement of outcomes



*Graphic of the conventional design of the assessed steel cast bracket (left) and titanium bracket with optimised topology made by using DMLS technology (Source: EADS)*

## Light, Cost and Resource Effective – Researching Sustainability of Direct Metal Laser Sintering (DMLS)



e-Manufacturing Solutions

# Joint EADS Innovation Works (IW) and EOS study demonstrates savings potential for manufacturing in the aerospace industry

## Short profile

EADS is a global leader in aerospace, defence and related services. In 2011, the Group – comprising Airbus, Astrium, Cassidian and Eurocopter – generated revenues of € 49.1 billion and employed a workforce of over 133,000.

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Over the last 40 years aviation's challenge has shifted from getting airborne, easily and safely, to providing a more sustainable and cost-efficient flying experience. Where Daedalus and Icarus used nothing more than feathers and wax to realize the dream of flight, the design and construction of modern aircraft requires highly developed methods and technologies to meet its challenges.

EADS IW, EADS' Research and Technology organisation, is always investigating new ways for improving manufacturing processes. One of the most recent target areas in this field is the use of Direct Metal Laser Sintering (DMLS), a technology that has been used by EADS IW to research the benefits of optimised design and general production sustainability, by using DMLS to manufacture demonstrators of aerospace parts, including an Airbus nacelle hinge bracket.

## Challenge

Set forth in the EADS vision 2020 is the group's desire to be geared-up for the challenges of the 21st century. With the challenge of the environment being a key driver, sustainability and a reduction in costs of the group's manufacturing operations and operational phase of its products underlies the group's research. EADS IW as a customer and EOS as a technology supplier for DMLS solutions

created a lifecycle cooperation in order to gain a better understanding of particular industry requirements and get an overview of the EOS technology's performance in the areas of quality, sustainability and environmental criteria.

As quality, costs and environmental effects play a major role in the decision-making process for design and manufacturing

solutions, EADS IW defined new Technology Readiness Level (TRL) criteria focusing on sustainability. Indeed, aerospace Research and Technology (R&T) at EADS must pass nine TRL processes before a technology can be qualified for use in production. For each TRL review, a technology's level of maturity is evaluated in terms of performance, engineering, manufacturing, operational readiness, as well as value and risk. For each of these criteria, new components must out-perform existing ones.

The results were expected to show reduced CO<sub>2</sub> emissions and higher energy and raw material efficiency as well as optimised recycling. When analysing energy consumption, the company's investigation must include not only the production phase, but also aspects such as the sourcing and transportation of raw materials, argon consumption for the atomization process of the metal powder material, and the overall



*Further example of improved part design: prototype of a topology optimised Airbus A380 bracket made of stainless steel powder produced via DMLS with conventional bracket behind (Source: EADS).*

waste produced during the atomization process.

### Solution

A Streamline Life Cycle Assessment (SLCA) performed by EADS IW highlighted, amongst other things, the potential cost and sustainability benefits of DMLS technology during the operational phase in the re-design of Airbus A320 nacelle hinge brackets. EADS IW's data was backed-up by test results from EOS, and in an additional step, by test results from a raw material (powder) supplier – a truly unique approach. Together the companies enriched the lifecycle information: the new brackets were to be lighter in order to significantly reduce energy consumption over their lifetime.

In the first step, cast steel nacelle hinge brackets were compared to an additively manufactured (AM) one with optimised titanium design by measuring the energy consumption over the whole lifecycle. The technology turned out to be a good fit for the design optimization of the nacelle hinge brackets as for this application the operational phase is typically 100 times more important than the static phases (e.g. manufacturing of the part). By using the optimised design, energy consumption over the whole lifecycle (including manufacturing and

operational phase) of the brackets was lowered by almost 40 %, despite the fact that during the manufacturing phase the EOS technology uses significantly more energy.

In the next step, these 'static phases' were evaluated. The manufacturing process of one part was compared for the EADS application in titanium with optimised design, built with rapid investment casting and on an EOS platform. The energy consumption for the production of the bracket, including raw material production, manufacturing process and end-of-life is slightly smaller when moving from rapid investment casting to the EOS platform. The advantage of the EOS technology: the process itself uses only the material that is really needed to build the application. Thus the consumption of raw material can be reduced by up to 75 %.

### Results

It is important to note that this study focused on a one-part comparison between the DMLS and a rapid investment casting manufacturing process and that the question of scalability is yet to be addressed. However, by working together with partners over the whole lifecycle the study produced some impressive upshots: the optimised design of

the engine cowl hinge allowed EADS and EOS to demonstrate the potential to reduce weight per plane by approximately 10 kg – a noteworthy figure in aviation where every kilo counts. CO<sub>2</sub> emissions of the door hinges were reduced by almost 40 % over the whole lifecycle by optimising the design, and consumption of raw materials was reduced by 25 % compared to rapid investment casting.

"DMLS has demonstrated a number of benefits, as it can support the optimisation of design and enable subsequent manufacture in low volume production. In general, the joint study revealed that DMLS has the potential to build light, sustainable parts with due regard for the company's CO<sub>2</sub> footprint," says Jon Meyer at EADS IW. "A key driver of the study was the integrated and transparent cooperation between customer and supplier with an open approach that saw an unprecedented level of information sharing. This transparent collaboration has set the standard for future studies involving the introduction and adoption of new technologies and processes. Even after the first positive results were evident, neither of the parties settled for the outcome, but continued to investigate options for further improvement."

Part of the project's success was due to their continued striving towards further improvements, evidenced in the swapping of the EOSINT M 270 for an EOSINT M 280 using titanium instead of steel, which led to additional CO<sub>2</sub> savings. DMLS has the potential to help make future aircraft lighter, leading to savings in resources which help to meet sustainability goals without compromising on safety."

*"We see several advantages in the use of DMLS, mainly concerning freedom of design and ecological aspects. We can optimize structures and integrate dedicated functionality and DMLS can significantly reduce sites' CO<sub>2</sub> footprints as our study with EOS demonstrated."*

*"Considering ecology and design taken together, optimised structures can also result in reduced CO<sub>2</sub> emissions due to weight reduction.*

*I see tremendous potential in DMLS technology for future aircraft generations, when it comes to both development and manufacturing.*

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