Technology Strategy Board
Driving Innovation

Innovation **results**

AN R&D CASE STUDY

Redesigned airline buckle to save energy

The Technology Strategy Board funded the SAVING project to look at ways in which Additive Manufacturing techniques could be used to reduce carbon emissions. The Direct Metal Laser Sintering process (see box, right) is inherently energy intensive, but can be used to create parts that are much lighter than their conventional counterparts. The environmental benefits of the process are, therefore, derived from the use of DMLS products, not from their production.

This was the principle that inspired Crucible Industrial Design, one of the SAVING project partners, to look at the design of a new seat buckle for commercial passenger jets, as small savings on the individual parts would be multiplied many hundreds of times on a large plane.

The project also served as a demonstration of the DMLS design principles that had been developed earlier in the programme.

Direct Metal Laser Sintering (DMLS) is an Additive Manufacturing (AM) process whereby fully dense metal parts can be built in a variety of materials directly from 3D Computer Aided Design (CAD) models. Due to the unique method of construction complex part geometry can be built simply and quickly without tooling. Each part is built in a series of horizontal layers from bottom to top by fusing together metal powder with a high power laser beam. To maintain dimensional stability parts are built attached to a metallic platform with a custom support structure that is later removed. Careful design of each part can minimise the size of the support structure and considerably reduces post-processing time. Materials commercially available include Aluminium, Stainless Steel and Alloys of Titanium, Nickel and Cobalt Chrome.

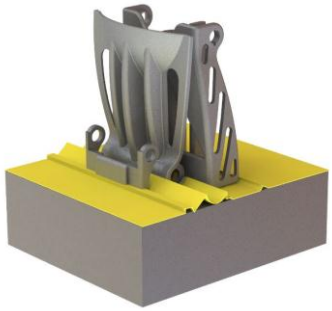
Design and manufacture

The project began with an analysis of the conventional seat buckle, and a decision to maintain a conventional structure, so that the results could be compared on a 'like for like' basis.

Crucible's initial design work focussed on developing a buckle that could withstand considerable shock loads whilst minimising material volume.

Once a design had been produced that passed FEA testing, attention turned to optimising the buckle for DMLS production. One of Crucible's main objectives for the project was to show that parts could be made with little or no support structure, if the parts were oriented correctly and designed to work with the process.
The main issue that Crucible had to consider was minimising the number of downward facing horizontal surfaces, as these always require supports. This can be achieved by a combination of part orientation and component design. The result was a set of parts that could be 'grown' from the DMLS platform with almost no support structures.

DMLS parts are removed from the platform by wire erosion. The path used by the process can also be used to create some of the finer points of the part geometry.



A unique feature of AM processes is the ability to build an assembly of parts. Crucible fully exploited this ability by building the sliding clamp that locks the belt in place as part of the main body, increasing strength and eliminating assembly time.

The results

The finished DMLS buckle, produced in titanium, weighed 70 grams. A conventional steel buckle weighs 155 grams, creating a saving of 85 grams per buckle.

An Airbus A380 configured for all economy seating has 853 seat buckles, which would result in a possible weight saving of 72.5 kg. Research by Helms and Lambrecht* has shown that a saving of 1 kg can save 45,000 litres of fuel over the life of a large passenger plane. The titanium buckle could, therefore, save up to 3.3million litres of fuel.
This could equate to a saving of over £2m on fuel, whilst the cost of equipping an 'all economy' A380 with titanium buckles would be approximately £165,000.

This project has demonstrated that it is possible to design complex DMLS parts that can be made with minimum waste, and that the long term use of lightweight DMLS parts can make a significant impact on CO2 emissions.

Project TP14/SMP/6/I/BA036D

Project Partners
Plunkett Associates, Crucible Industrial Design, EOS, 3T RPD, Simpleware, Delcam, University of Exeter

Project Website
www.manufacturingthefuture.co.uk

Technology Strategy Board investment:
£735,080

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£1,456,211

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Technology Strategy Board
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Collaborative research and development projects are one of the tools that the Technology Strategy Board uses to drive innovation in the UK. The Technology Strategy Board is a business-led executive non-departmental public body, established by the Government. Its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve the quality of life. It is sponsored by the Department for Business, Innovation and Skills (BIS).

Tel: **01793 442700 www.innovateuk.org**

*Helm H. and Lambrecht U. The Potential Contribution of Light Weighting to Reduce Transport Energy Consumption. IJLCA. July 2006