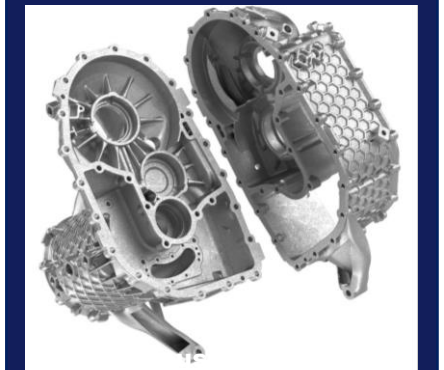
SLM SOLUTIONS

CASE STUDIES

May 2022

Advantages of AM

Enhanced Performance



A highly integrated final E-drive unit and gearbox in one main housing along with Internal coolant channel

Measurements: 590x560x367mm
Material: AlSi10Mg (Aluminium)
Machine: SLM® NXG XII 600

Traditional Manufacturing

1. Inability to optimize topology resulting in increased weight of component
2. Requirement of multiple parts for various functionalities, limiting enhancement in component performance.
3. Increased work steps causing higher labor costs.

Additive Manufacturing

1. Optimized topology & functional integration enabled **weight reduction of ~10%**.
2. The use of lattice structures in the design resulted in **rigidity increasing by 100%**.
3. Installation work **reduced by around 40 work steps**.

Source: Prototype for small-series production: electric drive housing from a 3D printer – Porsche Press Release

Advantages of AM

Decentralized Manufacturing

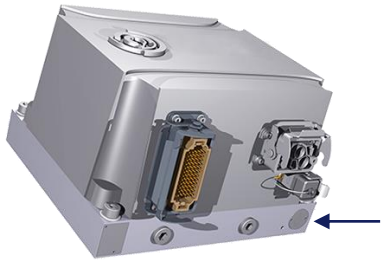
Metroflexx Brake panel

An integrated brake control system that features a service brake, emergency brake, and wheel slide protection. The pneumatic base plate acts as a manifold with many internal channels to direct air to other systems in the transit vehicle.

Measurements:
275x320x39 mm
Material: AlSi10Mg (Aluminium)
Machine: SLM®800

Traditional Manufacturing

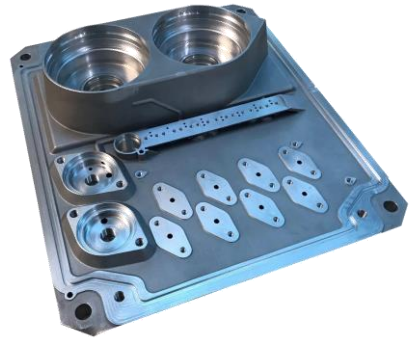
1. Pneumatic channels are machined into solid aluminum plates which are then sandwiched together.
2. Assembly requires multiple fasteners and gaskets which add to assembly time and can be potential sources for air leaks.
3. Component manufactured in France and shipped for use in the USA resulting in long lead times.



Metroflexx Pneumatic Base Plate

Additive Manufacturing

1. Design optimization contribution to significant weight reduction. **Weight reduction of 5 kg (from 7kg to 2kg)**
2. Additive Manufacturing enables for **32 parts to be combined in 1**
3. Decentralized manufacturing leading to **reduction in lead times by 70%**.



Source: SLM
Note: Based on case study with Wabtec Corporation, for more info click here.

Advantages of AM

Faster production times

Main Fitting

Main fitting component of a nose landing gear for a Bizjet

Measurements:
455x295x805 mm
Material: Titanium
Machine: SLM®800

Traditional Manufacturing

1. Length of production was a few months due to several manufacturing steps required in the process.
2. Significant carbon footprint due to the weight of the component
3. Component manufactured by assembling several parts.

Additive Manufacturing

1. Time taken to produce the main fitting **reduced from a few months to a few days** using the SLM® 800.
2. Additive manufacturing process as a whole, including optimized design resulting in **decreased carbon footprint**.
3. Component manufactured **as a single part.**

Main Fitting*

* Image is only illustrative and not the additively manufactured part.

Advantages of AM

Improving functionality

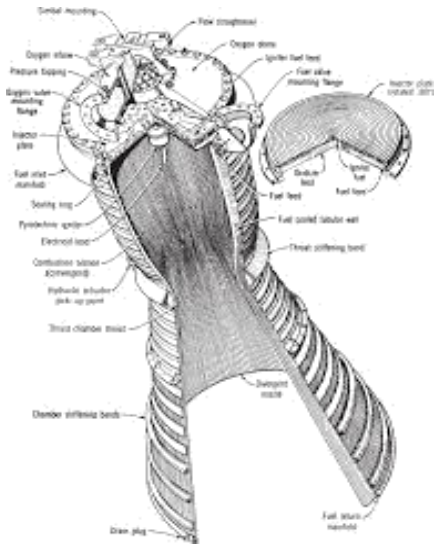
Monolithic Thrust Chamber

Core element of a liquid-propellant rocket engine.

Measurements:
228X194X310mm
Material: IN718 (Nickel Superalloy)
Machine: SLM® 280

Traditional Manufacturing

1. Time consuming and cost intensive process to produce
2. Increased risk of human error due to requirement of multiple parts for single component.
3. Essential cooling structure manufactured separately



Additive Manufacturing

1. Production time decreased from **~6 months to <5 days**
2. Entire component printed, without needing multiple parts – **significantly improving reliability.**
3. Innovative lattice structure enabling an **integrated cooling function** which also resulted in **increased stability.**

Source: SLM; NASA; G. P. Sutton, History of Liquid Propellant Rocket Engines, AIAA, Reston, VA, 2006.

Advantages of AM

High precision hybrid manufacturing

Grooving component used in metal cutting

This component performs an essential service in the production of parts for the aerospace, energy and electronics industry, to name a few

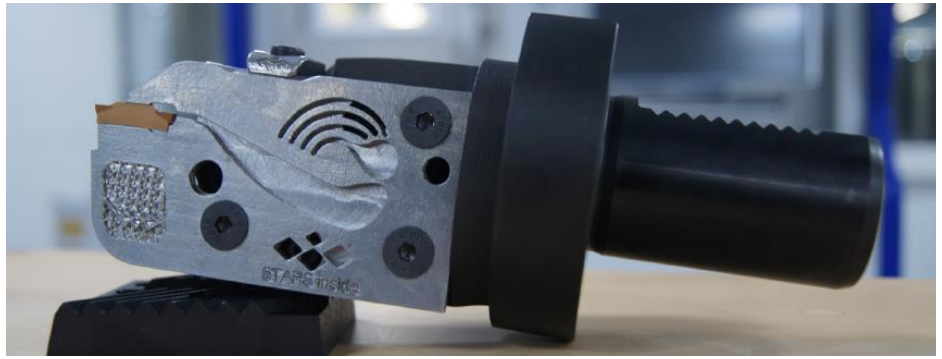
Material: 16MnCr5 (case hardening steel)
Machine: SLM® 280 Twin.

Traditional Manufacturing

1. Ineffective geometric shape of cooling channel with complex shapes unable to be produced.
2. Ineffective cooling leads to shorter life of product for end-users.
3. Increased weight of component → environmentally unfavorable.

Additive Manufacturing

1. **Complex star-shaped cooling channel** produced over a traditionally manufactured component.
2. Enhanced cooling functionality **increases life of product**, thereby **reducing total costs for customers**.
3. Weight of component **reduced by 45%**.



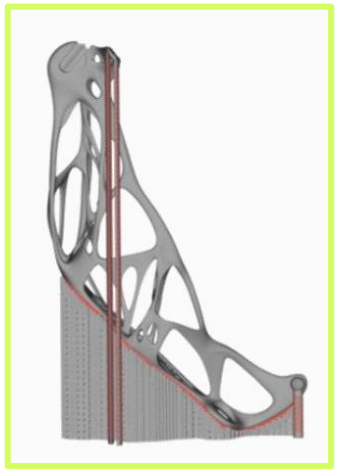
SLM Solutions' **Open Architecture** enables Burgmaier to realize the benefits of AM using its innovative case-hardening steel 16MnCr5 material

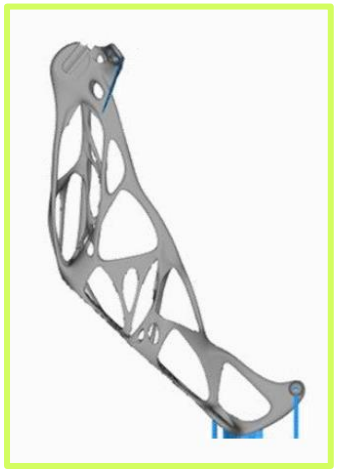
Source: SLM

Advantages of AM

Minimized post-processing costs

By harnessing the power of **Free Float**, customers can reduce post-processing costs by **up to 94%**





	Without Free Float	With Free Float
Material [1]	Inconel 718	Inconel 718
Supports	Block Supports up to 45°	Flat sections + connections
Support Volume	59,588 mm^3	767 mm^3 **-99%**
Post Processing Time (hh:mm)	01:30	00:05 **-94%**

SLM produced the part[2] using Inconel 718, a nickel-based superalloy extensively used in the energy & space industries.

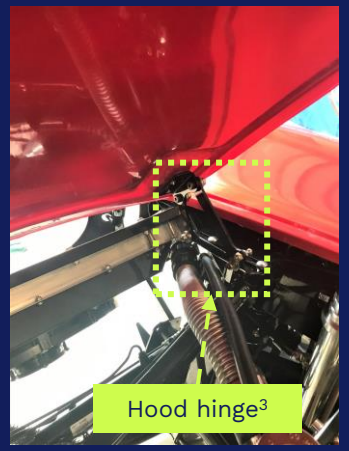
Inconel is a robust material but also results in high post-processing costs.

With SLM® **FREE FLOAT -**
Robustness of material? ***YES***
High post processing costs? ***NO***

1. Original part manufactured using Aluminium. Additively manufactured part produced using IN718 (Nickel-based superalloy). SLM Solutions computed material and labor requirements if original part was manufactured with IN718. Comparative figures based on this study.
2. Part by Lighthinge (EDAG, voestalpine, simufact)

Advantages of AM

Increased precision, decreased post-processing



Lightweight hood hinge[2]

Additively manufactured Lightweight hood hinge with integrated pedestrian protection

Material: IN718 (Nickel Superalloy)[1]
Machine: SLM® 280 Twin

Traditional Manufacturing

1. Component weight resulting in larger carbon footprint.
2. Several individual parts required for the component – resulting in high assembly and tooling costs.
3. Inability to add new functionalities without compromising on quality or cost.

Additive Manufacturing

1. Weight of component **lowered by approx. 50%**.
2. Number of parts **decreased from approx. 40 to 2**.
3. Post processing costs **can be reduced significantly.**
4. **Complexity for free**

1. Original part manufactured using Aluminium. Additively manufactured part produced using IN718 (Nickel-based superalloy). SLM Solutions computed material and labor requirements if original part was manufactured with IN718. Comparative figures based on this study.
2. Part by Lighthinge (EDAG, voestalpine, simufact)
3. Image is only illustrative and not the additively manufactured part.

Advantages of AM

Significant weight reduction

Gooseneck bracket

Structural component from Krueger flap actuating mechanism for airplanes.

Measurements:
93X220X136mm
Material: Ti6Al4V Titanium
Machine: SLM® 280 Twin

Traditional Manufacturing

1. Increased weight of component leading to high fuel consumption.
2. High buy-to-fly[1] ratio resulting in wastage.
3. Long Multiple parts required for single component leading to higher labor costs.
4. production time.

Additive Manufacturing

1. Weight of component **down by 31%**.
2. Buy-to-fly ratio **decreased from 17x to 1.5x,** significantly reducing wastage.
3. Production time **decreased by over 40%**.

Source: SLM
Note: 1. Ratio between weight of raw material purchased and weight of final part.