APWORKS

by Airbus Group

Additive Manufacturing applications in Aerospace, Automotive, Robotics and beyond

JGIF 2015

Tokio, 9th of November 2015

Joachim Zettler – Airbus Apworks GmbH

Airbus APWorks

Founded in 2013

100% **subsidiary of Airbus Group**

A perfectly harmonized triad for 3D printing

Design	Materials	Serial production
		

Who we are:

Founded in 2013 as a 100% subsidiary of Airbus Group, APWorks is familiar with modern manufacturing processes, including proven concepts and lightweight design from the aerospace technology. With a high focus on design, materials and serial production, APWorks optimizes parts for weight, structure, cooling and RF efficiency. Working in close cooperation with Airbus, we develop high quality materials, and advanced qualification processes for serial production.

Our aim:

Making innovative and high quality aerospace concepts accessible for customers across all industries.

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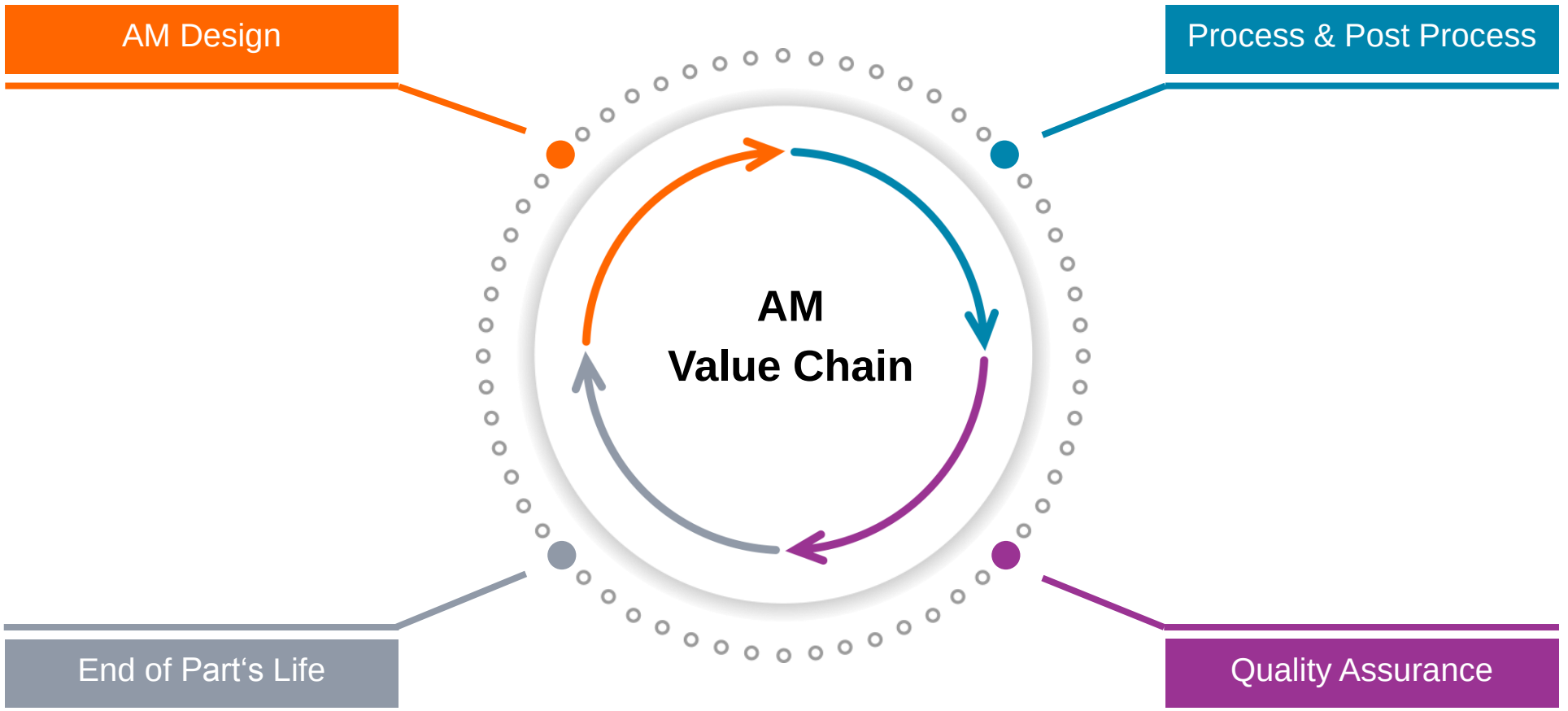
Additive Manufacturing

APWORKS OFFER



Additive Manufacturing

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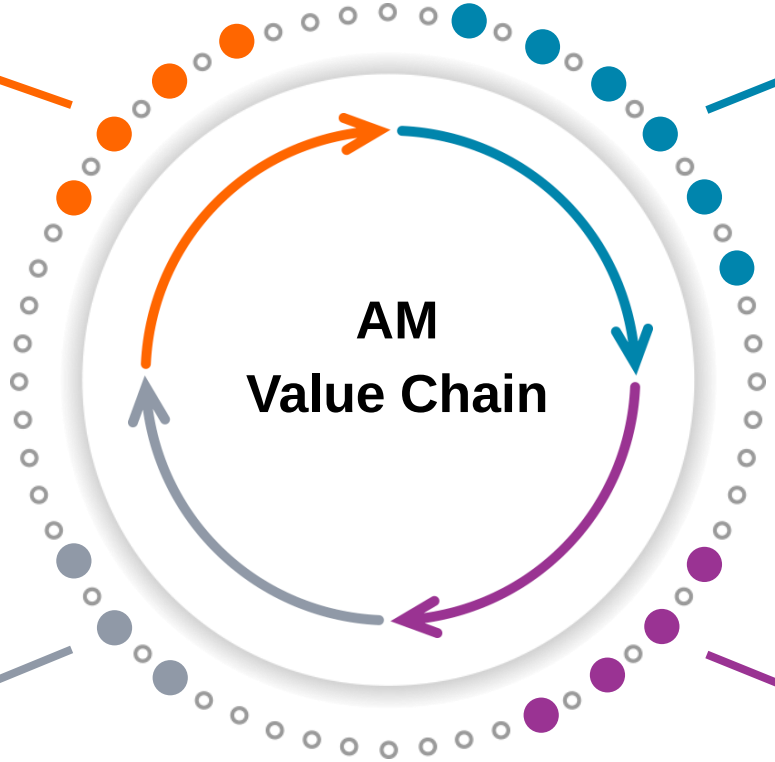
AM Design

Build design & preparation
Detailed design, optimization
Process selection
Part concept

Process & Post Process

Material prodcuction & qualification
ALM process
Heat & pressure treatment
Machining of interfaces
Surface treatment



End of Part‘s Life

Repair

Quality Assurance

Destructive testing
NDT (non-destructive testing)
Metrology
Validation on testing

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Additive Manufacturing

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AM Design

Process & Post Process

APWorks controls each phase of the AM value chain with customized services generating superior results:

- Concept Development & Consulting
- From prototyping to large scale part production
- Powder Sales of high quality Aluminum powder
- System integrator

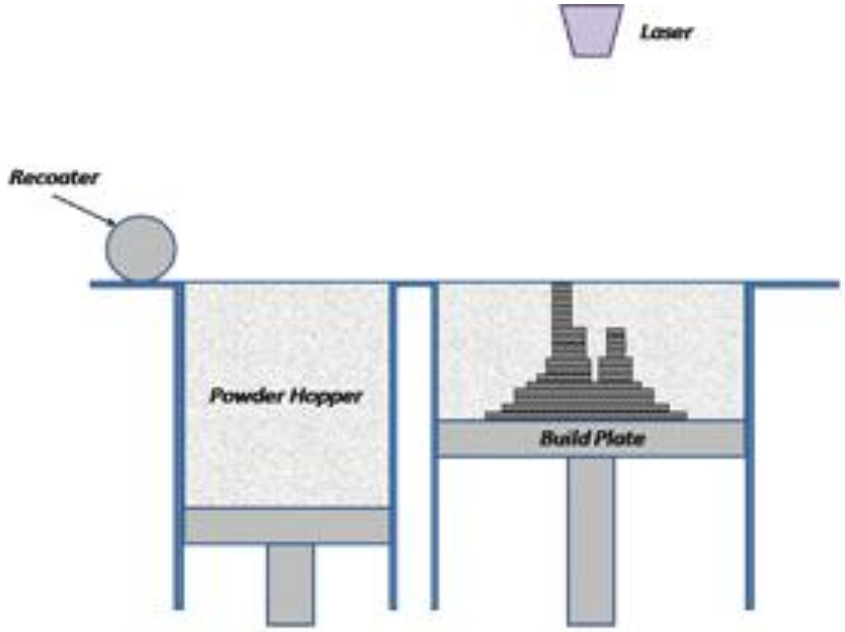
End of Part‘s Life

Quality Assurance

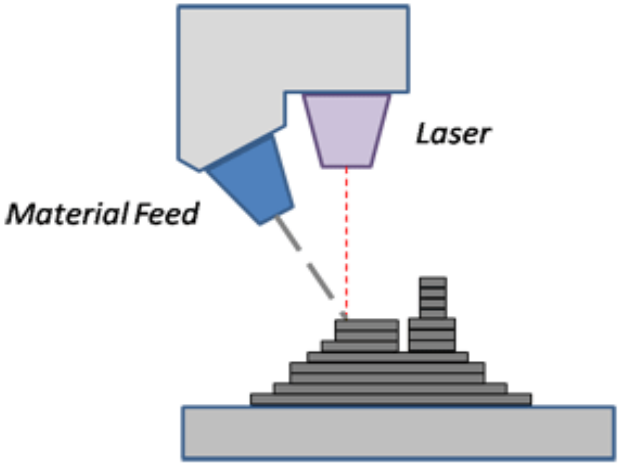
Re-cap: ALM Deposition Process Types

Additive Manufacturing Processes

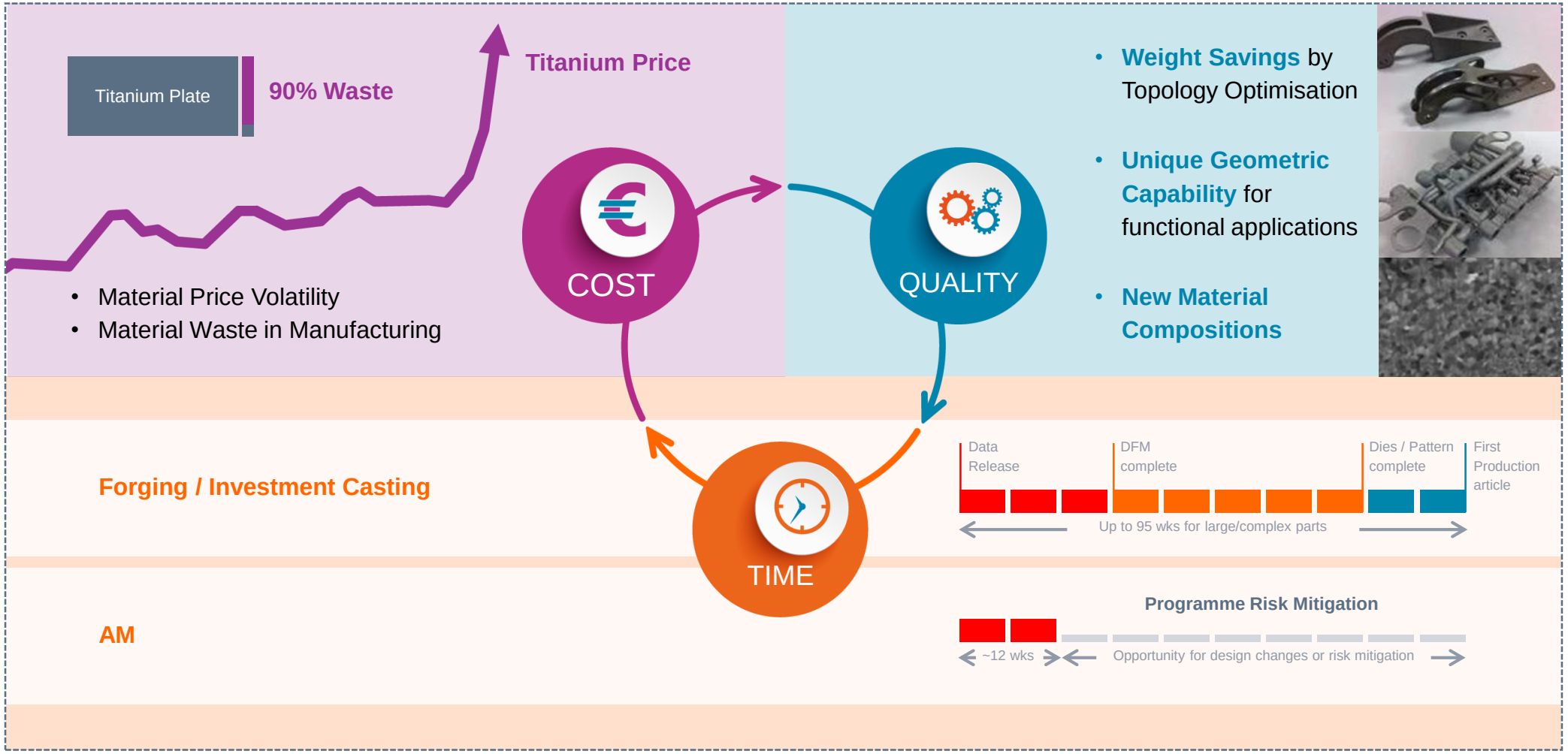
Powder Bed



Directed Deposition

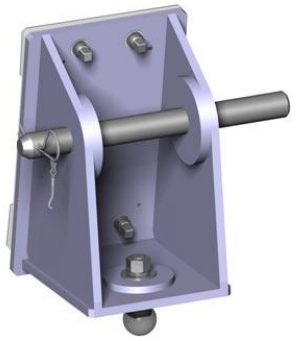


Motivation for Technology Adoption



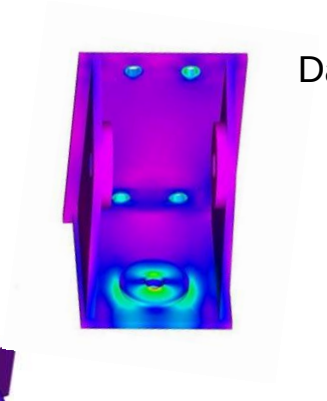
ALM value chain in more detail
Design optimization

1

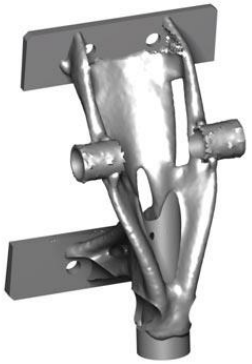


Existing design

2

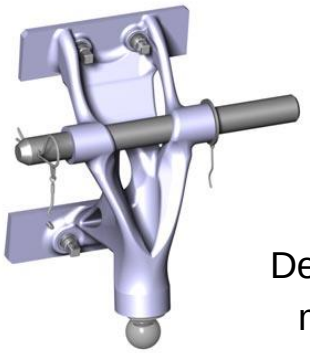


Data used to create optimized design interpretation



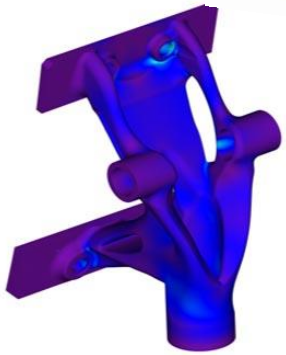
3

Design interpretation modelled as solid



4

Further FE analysis



Further loop of Topology optimization if required

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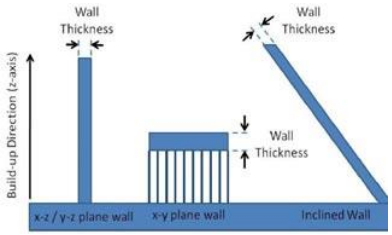
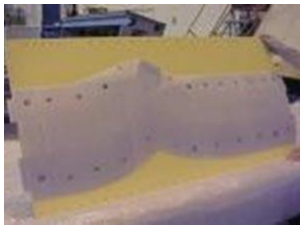
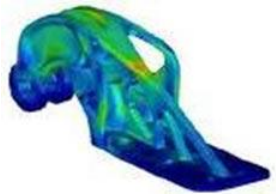
ALM value chain in more detail

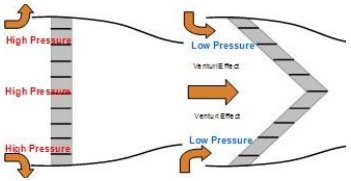
Detailed design, optimization, design for manufacture (DFM)

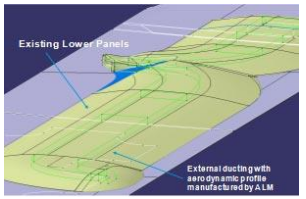


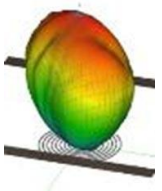


Although not yet applied to ALM applications; AGI has capability for RF simulation









Design for manufacture

Structure efficiency

Aerodynamic efficiency

Cooling efficiency

antenna pattern distortion

Application of design rules (design for manufacture)	Structure simulation	Flow simulation	Thermal simulation	RF simulation

Design rules to applied on their own or in conjunction with optimisation

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ALM value chain in more detail
Scalmalloy®

Typical Values	Scalmalloy®	AlSi10Mg	TiAl6V4
0.2% Offset Strength (MPa)	450	210	860
Tensile Strength (Mpa)	490	350	910
Specific Strength	184	129	205
Elongation (%)	8	3	10
Vickers Hardness HV0,3	177	119	320
Fatigue Limit 3E7 cycles (MPa)	300	97	600
Density (g/cm^3)	2.67	2.70	4.43

Scalmalloy® ALM parts have properties in the range of high strength 5XX Al-Alloys

ALM value chain in more detail
Process & Postprocess

MATERIALS & MACHINES

EOS M280

SLM 125 HL

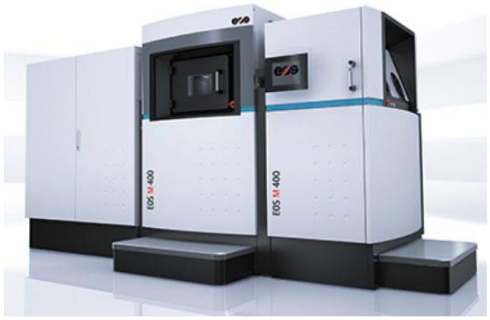
ARCAM A2 EBM

EOS M290

EOS M270

Available Metallic Materials:

- Titanium (TI6AI4V)
- Stainless Steel (316, 17-4, 15-5)
- Aluminum (AISi10Mg, **Scalmalloy**, Silmagal)
- Cobalt Chrome
- Inconel



EOS M400 (08/15)

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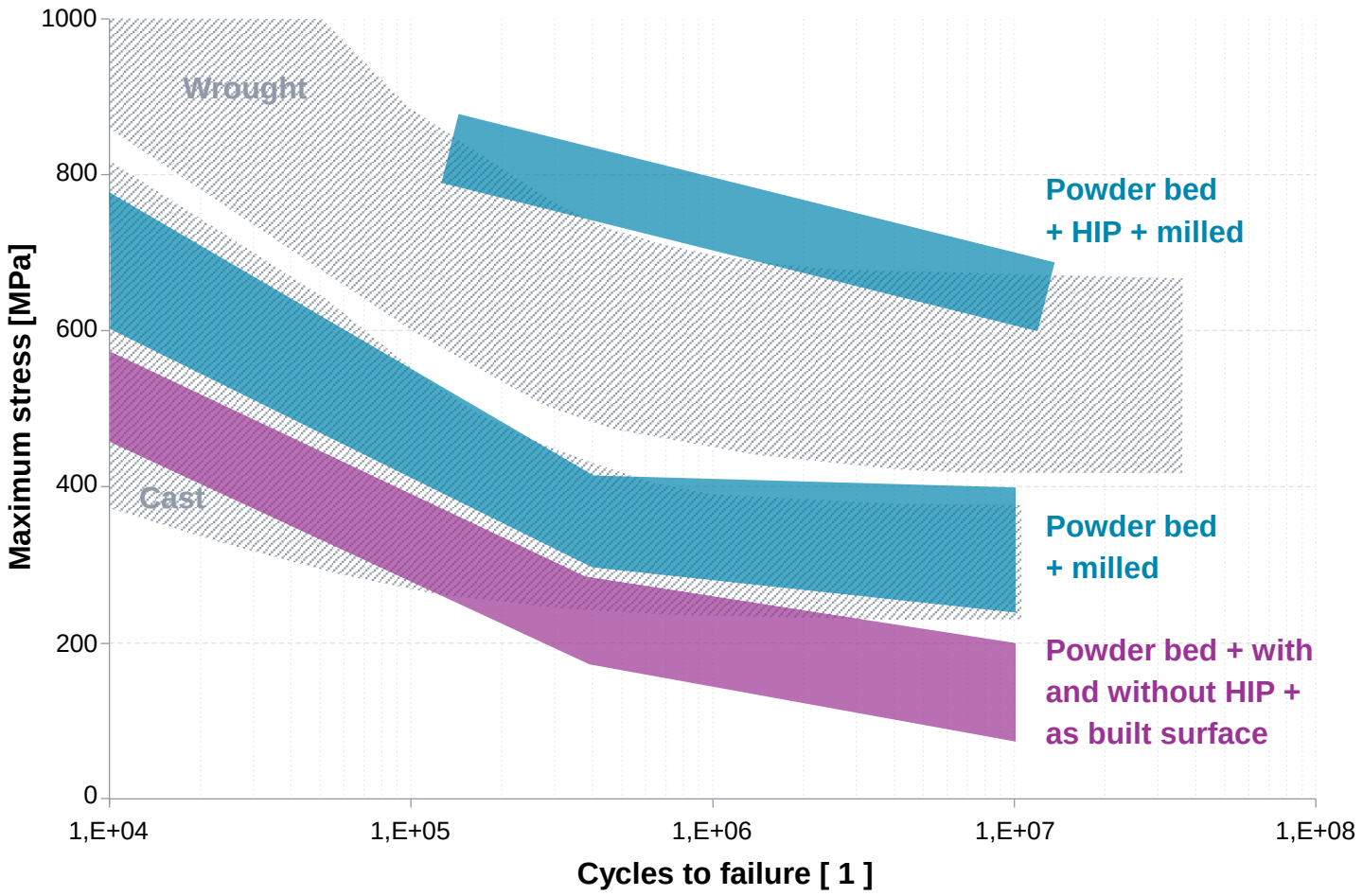
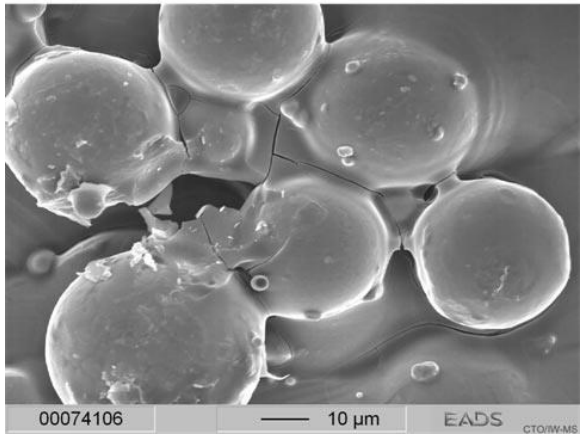
ALM value chain in more detail

Influence of surface roughness on fatigue data (Ti6Al4V, schematic)





- **Surface roughness strongly influences fatigue life**
- **Fatigue of specimens with as built surface not improved by HIP**

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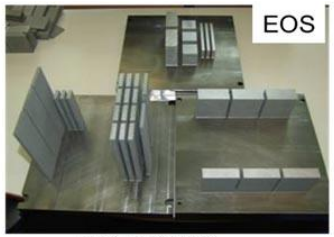
ALM value chain in more detail
Destructive testing

Testing of inbuild traveler samples

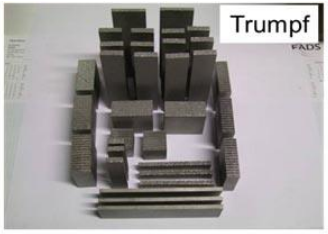
Analysis of traveler samples

- Static/dynamic tensile
- Fatigue crack propagation
- Fracture toughness, J_{IC}, etc.
- Corrosion (salt spray, SCC etc.)
- Fracture analysis (SEM, XPS, XRD etc.)
- AFGROW, DoE, ANOVA etc

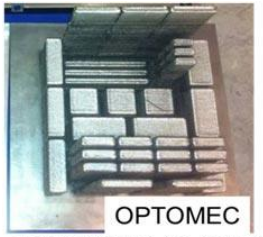
Cross reference against extensive APWorks database



PB/LB IW-UK
3 batches needed

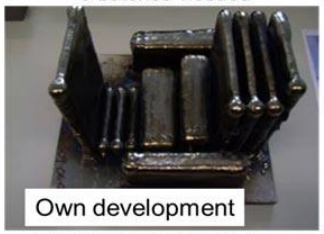


PB/LB ONERA (@ POLYSHAPE)
6 batches needed



PF/LB ONERA (@ ARTS)
1 batch

PB/EB IW-UK 1 batch

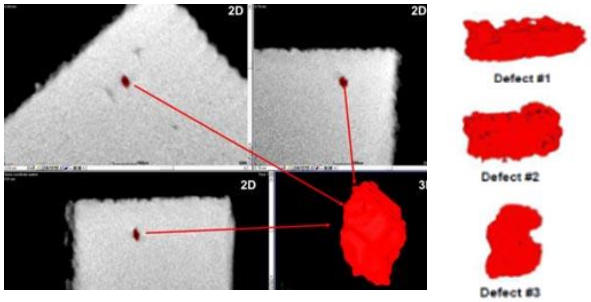


WF/PS IW-F @ NTiC 1 batch

WF/LB IW-G 1 batch

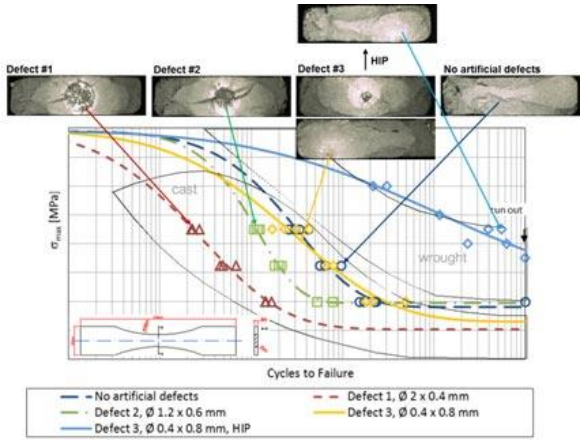
ALM value chain in more detail
Non-Destructive Testing

Detection & characterization of flaws



µCT testing of a cube:
Detection & characterization of voids (Voxel size: 46 µm)

Analysis in reference to effects of defects catalogue



Residual Stress Measurements

- X-ray diffraction (XRD) with portable system
- Destructive hole drilling method

Defect characterization: (µ-) Computed Tomography

Defects: Ultrasonic

Defects: X-Ray

Residual stress

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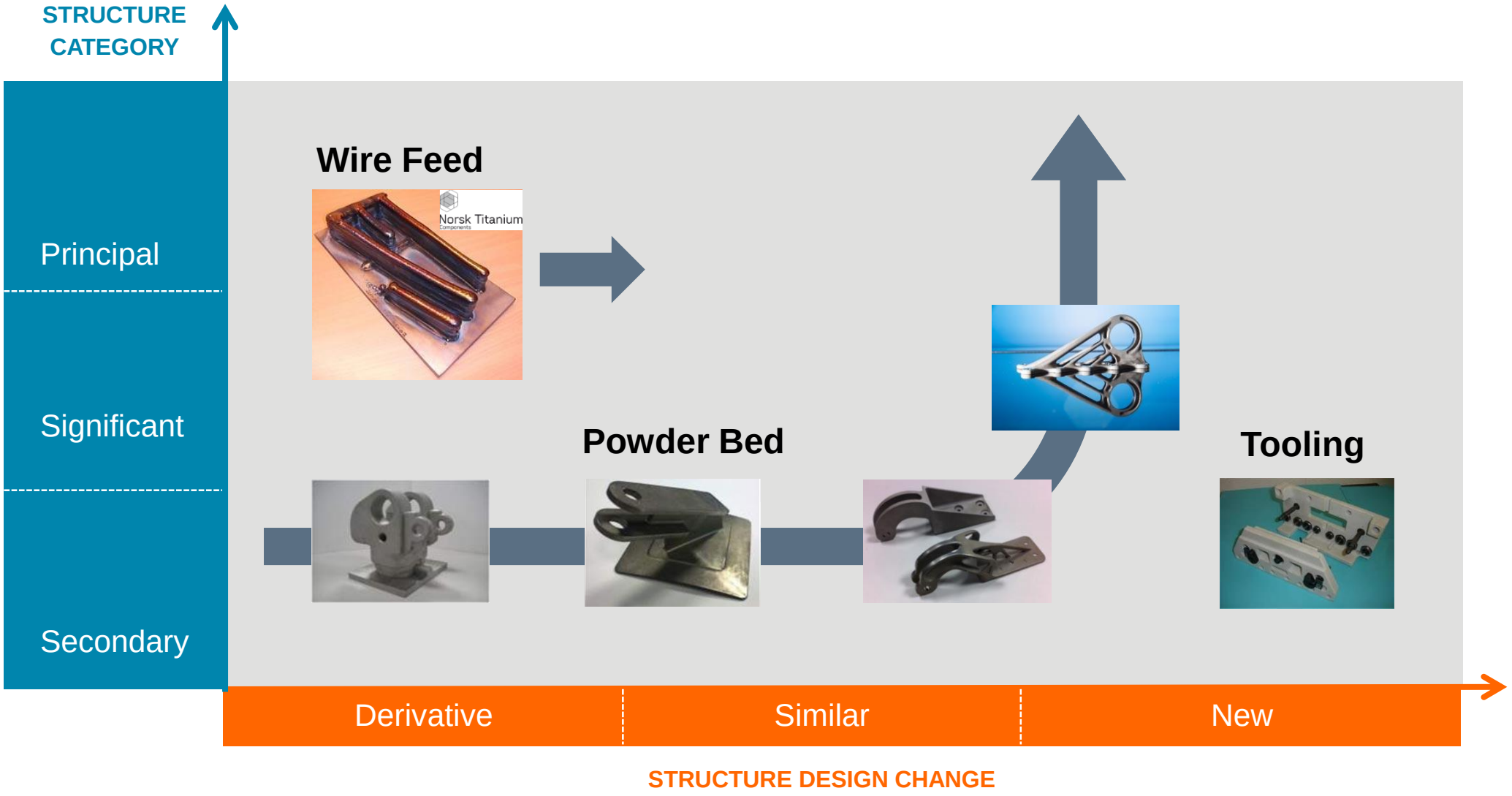
Application Selection Strategy



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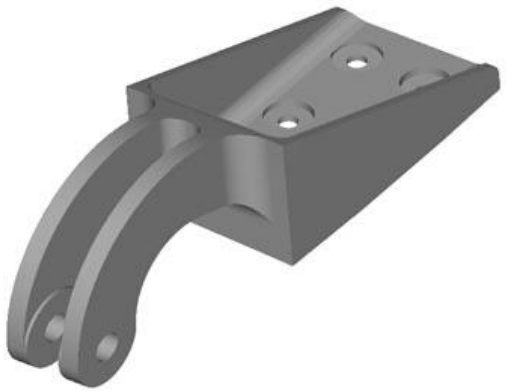
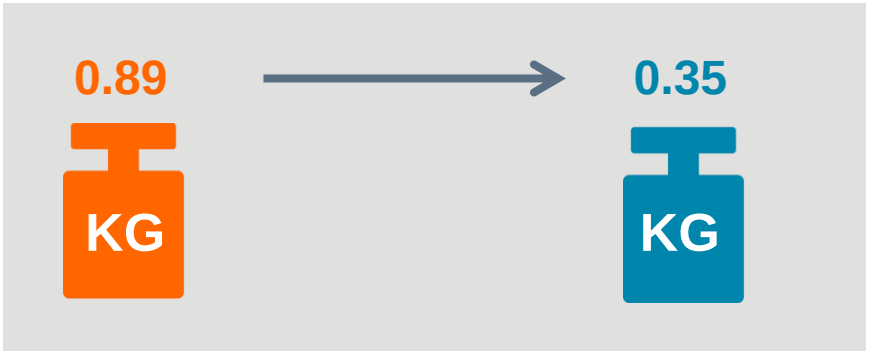
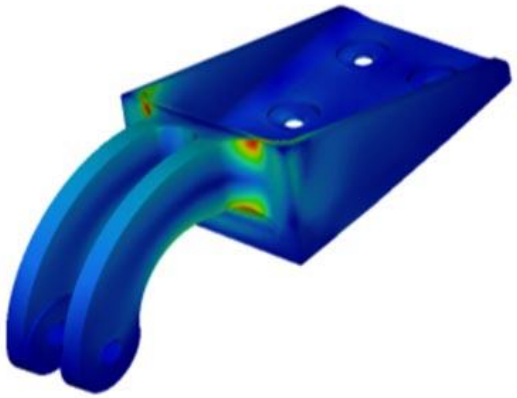
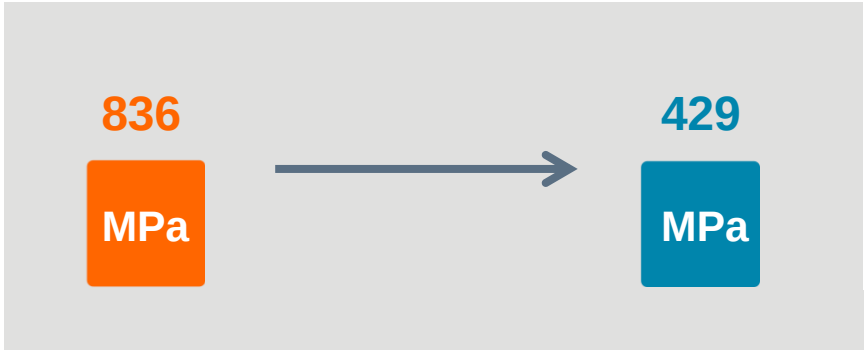
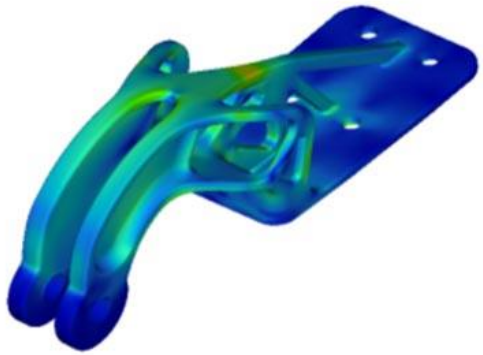
Weight Saving through Design Freedom: ‘Bionic’ Brackets



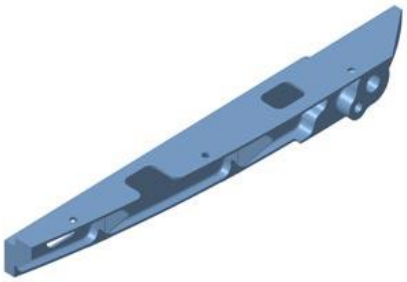








Weight Saving through Design Freedom



255

G

Material: Al2024

142

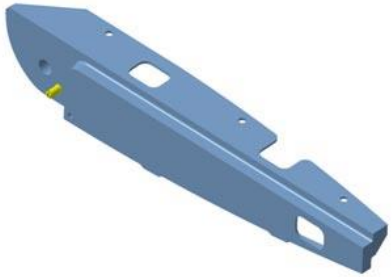
G

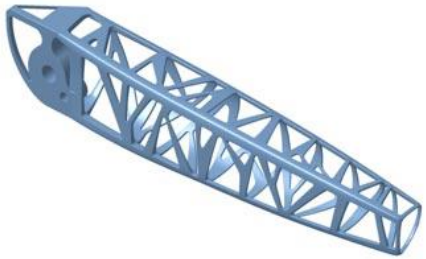
Material: AlMgSc

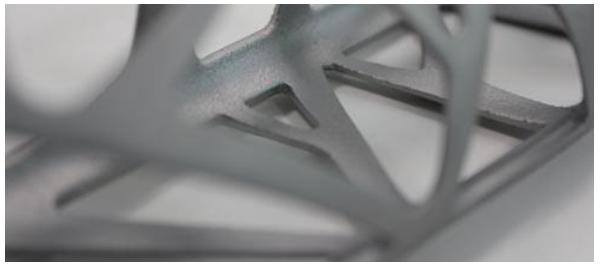
44% Weight saving

Homogenized stress distribution

Increased stiffness







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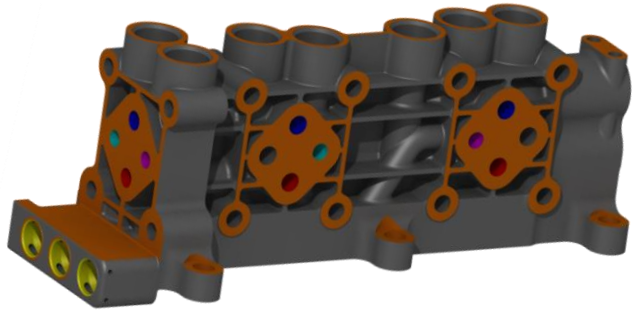
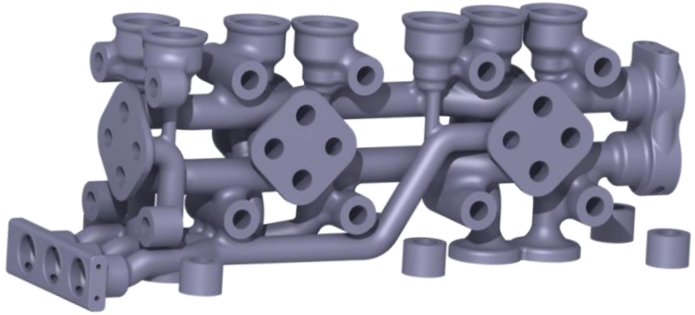
Weight Saving through functional integration





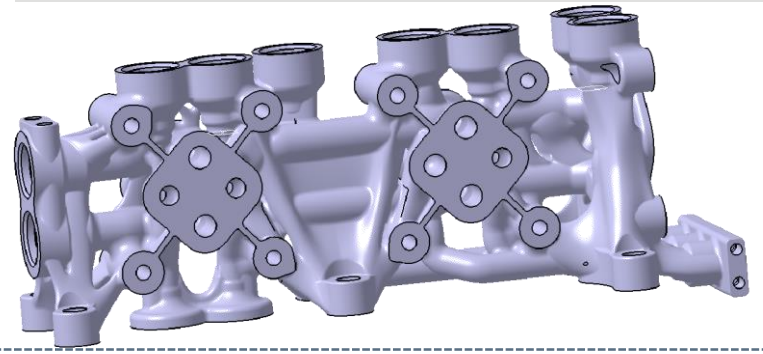
820 G

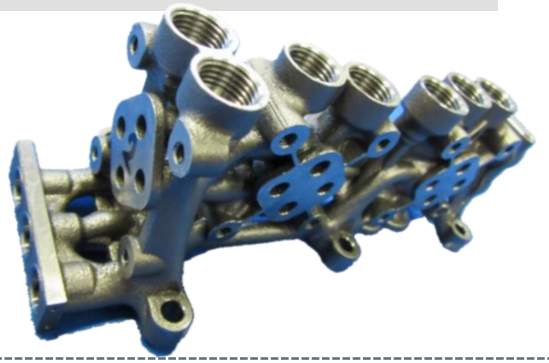
Material: SS

451 G

Material: Ti64

- 45% Weight saving
- 30% decrease in time to market
- More efficient pipe routing





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Thank you for your attention
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