Additive Manufacturing – Hype meets reality

March 23rd, 2016

Joachim Zettler – Airbus Apworks GmbH
Hype? Time for gaining trust
Hype meets reality.

Introduction to APWorks
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.
Airbus APWorks

Founded in 2013

100% subsidiary of Airbus Group

A perfectly harmonized triad for 3D printing

Our customers:
We are globally operating and have a global customer base. Ranging from aerospace, automotive, oil&gas to robotics and mechanical engineering, there is nearly no industry we do not offer specific solutions for.
Airbus APWorks

Founded in 2013

100% subsidiary of Airbus Group

A perfectly harmonized triad for 3D printing

Where we are:
Located near Munich, Germany, at the Ludwig Bölkow Campus, which pools high technology initiatives together, APWorks is situated in close proximity to AIRBUS Group divisions and other high tech companies such as IABG, EOS and Siemens.
This setup allows easy access and interchange on the latest technologies and trends in the fast growing additive manufacturing business.
Additive Manufacturing

APWORKS OFFER

AM Design

Process & Post Process

AM Value Chain

End of Part’s Life

Quality Assurance
Additive Manufacturing

AM Design
- Build design & preparation
- Detailed design, optimization
- Process selection
- Part concept

Process & Post Process
- Material production & qualification
- ALM process
- Heat & pressure treatment
- Machining of interfaces
- Surface treatment

Repair

End of Part’s Life

AM Value Chain

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

Quality Assurance
Design:
Part optimization.
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 loop of Topology optimization if required
5. Further FE analysis
ALM value chain in more detail
Detailed design, optimization, design for manufacture (DFM)

Design for manufacture
Application of design rules (design for manufacture)
Structure efficiency
Structure simulation
Aerodynamic efficiency
Flow simulation
Cooling efficiency
Thermal simulation
RF simulation
Antenna pattern distortion

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

Design rules to applied on their own or in conjunction with optimisation
Materials:
Scalmalloy®.
ALM value chain in more detail

Scalmalloy®

<table>
<thead>
<tr>
<th>Typical Values</th>
<th>Scalmalloy®</th>
<th>AISi10Mg</th>
<th>TiAl6V4</th>
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<tbody>
<tr>
<td>0.2% Offset Strength (MPa)</td>
<td>450</td>
<td>210</td>
<td>860</td>
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<tr>
<td>Tensile Strength (Mpa)</td>
<td>490</td>
<td>350</td>
<td>910</td>
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<tr>
<td>Specific Strength</td>
<td>184</td>
<td>129</td>
<td>205</td>
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<tr>
<td>Elongation (%)</td>
<td>8</td>
<td>3</td>
<td>10</td>
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<tr>
<td>Vickers Hardness HV0,3</td>
<td>177</td>
<td>119</td>
<td>320</td>
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<tr>
<td>Fatigue Limit 3E7 cycles (MPa)</td>
<td>300</td>
<td>97</td>
<td>600</td>
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<tr>
<td>Density (g/cm³)</td>
<td>2.67</td>
<td>2.70</td>
<td>4.43</td>
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Boosts the possibilities of Additive Manufacturing

- Impressive mechanical and thermal properties
  - Higher strength
  - Reduced wall thickness
  - Higher thermal conductivity
  - Outstanding level of ductility

- Only available through APWorks, making us a sought-after partner

- Potential to become future industry standard material

Scalmalloy® ALM parts have properties in the range of high strength 5XX Al-Alloys
ALM value chain in more detail
Process & Postprocess

MATERIALS & MACHINES

Available Metallic Materials:
• Titanium (Ti6Al4V)
• Steel (1.2709)
• Aluminum (Scalmalloy®)
• Inconel 625

Additive Industries MetalFAB 1

EOS M290 X 2

EOS M400
### Special solutions for different industries

<table>
<thead>
<tr>
<th>Industry</th>
<th>Robotics</th>
<th>Mechanical engineering</th>
<th>Automotive</th>
<th>Medical</th>
<th>Aerospace</th>
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<tr>
<td>Lightweight</td>
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<td>Functional</td>
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<td>Integration</td>
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<td>Customization</td>
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<td>Lead time</td>
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<td>Certification &amp; Qualification</td>
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Solutions for General Mechanical Engineering

Functional integration
Heat exchanger demonstrator
Combining lightweight and functional integration
Heat exchanger demonstrator
Combining lightweight and functional integration

- Heat exchange surface: 48 700 mm²
- Minimal pressure loss
- Extraordinary thermal performance
- Very large surface area
- No support structure needed for printing
- Scalable design
- Wall thickness 1mm, diameter channels 3mm
Additive Manufacturing – Hype meets reality

Solutions for New Products

APWORKS
Optimized bionic frame

0-45km/h in 3s

80 km/h Top Speed

32kg total weight

DMLS out of Scalmalloy

40% weight reduction

6kg weight of frame structure

Additive Manufacturing – Hype meets reality
Use Cases - Stem

- Weight saving
- Homogenized stress distribution
- Increased stiffness

Material: 6XX Al

Material: Scalmalloy®

272 g → 198 g
Use Case – Bionic frame

Material: Scalmalloy®

6kg Weight of the Frame Structure
Bionic Frame
40% Weight Reduction
Bionic partition - Largest aircraft part ever manufactured with AM

- First test flight 2016
- Saves up to 465,000 metric tones CO2
- 45% Weight Saving
Thank you