More than 3D Printing

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Airbus APWorks

The Light Rider – Representing our daily business
“It is all about generating added value to products and economic value to the customer”
Overview

1. Design for Additive Manufacturing
2. Material specifically developed for AM
3. Production of aerospace parts
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1. Design for Additive Manufacturing
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MYTHS OF ADDITIVE MANUFACTURING

Overview

- Support structures
- Heat distortions
- Process simulations
MYTH BUSTING
Support structures I

Myth:
Support structure function:
\Connect and hold part to build plate for angles lower than 45° to avoid “sinking” in the powder bed

Truth:
Main role of support structures:
\Transferring the (excess) heat to the build plate

→ Minimize distortions
→ Avoid vaporizations
→ Minimize agglomerates attached to the surface
MYTH BUSTING
Support structures II

Myth:
Support structures highly deteriorate surface quality on connection surfaces

Truth:
- Roughness of downskin connection surfaces might even be better than without supports
- Challenge: find the best support structure geometry for your part

MYTH BUSTING
Support structures III

Myth:
Support structures highly increase costs of the part

Truth:
Adequate orientation / geometry most important:
→ Minimize support volume
→ Support structure geometry for powder removal
→ Minimize connecting elements
→ Make functional areas free of support structures
MYTH BUSTING
Support structures III

Different orientations & support structure setups for the same part on Magics.

- Hatching exposure time
- Post contours exposure time
- Support structure exposure time
- Recoating time

Original part
Run time: 32.4 hrs.

Optimized support part
Run time: 25.2 hrs.

- Hatching exposure time: 46%
- Post contours exposure time: 27%
- Support structure exposure time: 58%
- Recoating time: 5%
MYTH BUSTING
Heat distortions

Myth:
Process related heat distortions do not allow the manufacturing of complex geometries

Truth:
Solutions:

\ Optimize the design for the AM process

\ Optimize the support structures

\ Optimize process parameters
MYTH BUSTING
Process simulations

Myth:
Process simulations are not accurate enough yet to be useful for Additive Manufacturing.

Truth:
State-of-the-Art:
\Process simulations can be calibrated for many materials and parameter sets
\They can identify areas prone to deformations

⇒ Geometry /orientation / support structures can be adapted

Process simulation of a reverted “V” shape with Autodesk (Netfabb package).
Displacement on Y axis.
“Pulling effect” can easily be spotted on the geometry (red circle).
DESIGN FOR ADDITIVE MANUFACTURING
Part Design Workflow

- Topology/thermal optimization or CFD simulation
- Orientation definition & part redesign
- Design verification (CSM/CFD/heat analysis)
- Support structure generation
- Print process
- Post processing & Quality assurance
DESIGN FOR ADDITIVE MANUFACTURING
Optimization of part design

Need of knowledge of:

- The AM production process, its capabilities and limitations
- Sensibilities to process / heat related deformations
- Support structures
- Process simulations

In order to improve:

- Overall quality (minimized distortions, better accuracy & surface quality on specific areas)
- Print time (less print time due to optimized support / orientation)
- Postprocessing time (no / few supports, all easily accessible)
Get a part that is “designed for AM” and not a part that “has to be adapted for AM”
DESIGN FOR ADDITIVE MANUFACTURING
Geometry example – VW Caddy

http://www.apworks.de/en/3i-print/
An efficient design for AM:

- Optimized design (wall thickness, overhang angle,...)
- Minimized support structures
- Easy access of supports for removal
DESIGN FOR ADDITIVE MANUFACTURING
Geometry example – VW Caddy

An efficient design for AM:

- Inner lattice for stiffening
- Optimized lattice orientation for printability

→ Resulting in:

- Printability without any irremovable support
- Minimized print time
- Minimized post processing time
- Optimized surface quality

Previous lattice orientation (left) and improved lattice for AM (right) for CSI Caddy part.
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"Combining the benefits of metallic 3D printing with new materials can greatly expand the possibilities for modern components"
Scalmalloy® unites the best of both "worlds"
Ductile as titanium and light as aluminum

<table>
<thead>
<tr>
<th>Property</th>
<th>AISi10Mg</th>
<th>Scalmalloy®</th>
<th>Ti6Al4V</th>
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<tr>
<td>0.2% Offset Strength (MPa)</td>
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<td>Tensile Strength (MPa)</td>
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<td>Specific Strength</td>
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<td>Elongation at Break (%)</td>
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<td>Vickers Hardness HVO,3</td>
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<tr>
<td>Density (g/cm³)</td>
<td>2.67</td>
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<td>4.41</td>
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</tbody>
</table>
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Success Story
Bionic Partition - Aerospace Industry

BACKGROUND

TARGET/CHALLENGES:
- Design and production of weight optimized partition at highest stress levels
- Including cutout for emergency stretcher access/fold down seat for cabin attendants

CURRENT PROCESS:
- Honeycomb Structure out of a multiple material mix

APWORKS SOLUTION:
- Topology Optimization/ Bionic structures
- 3D Printing of final part design out of Scalmalloy® and Titanium
- Collaboration between Airbus, Autodesk and APWORKS

CUSTOMER BENEFIT:
- 45% weight saving
- Installation in existing aircraft cabins possible
- Easy replacement of individual parts (modular design)

Saves up to **465,000** metric tons of CO₂ emissions per year per aircraft (example: A320)
**Success Story**

**Passenger Aircraft Armrest - Aerospace Industry**

**BACKGROUND**

**TARGET/CHALLENGES:**
- Design and production of a printable weight optimized passenger aircraft armrest

**CURRENT PROCESS:**
- Conventional machining of 2.000 series aluminum alloy

**APWORKS SOLUTION:**
- Topology optimization
- Design based on bionic structures
- Finite-Element-Analysis
- 3D Printing of final part design out of Scalmalloy® (aluminum powder)

**CUSTOMER BENEFIT:**
- 44% weight saving
- Increased stiffness while achieving a homogenized stress distribution
- CO₂ savings of 13.2t per year (A320)
- 4.2t kerosene savings per year (A320)

**CUSTOMER PART**

**Lifecycle cost savings of**

1.580 € per armrest (A320)

# 240 per aircraft (example: A320)
Success Story
Scalmalloy® Satellite Panel

BACKGROUND

TARGET/CHALLENGES:
- Reduction of development cycle time
- Lightweight design

CURRENT PROCESS:
- Assembly of machined parts

APWORKS SOLUTION:
- Optimization of existing design
- Manufacturing of compact designs with Scalmalloy®
- Part integration

CUSTOMER BENEFIT:
- Significant reduction of development cycle time (optimization + manufacturing in 3 months)
- 15% weight saving
- Less assembly time (part integration 10 -> 5)
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