reTHINK: „CFRP – Recycling and Sustainability“
Near-Net-Shape fabrication-technologies for CFRP

16.11.2016 @ JEC Asia
SUNTEC International Convention & Exhibition Centre,
1 Raffles Boulevard, Suntec City,
Singapur 039593

18.11.2016 @ KMITL
King Mongkut’s Institute of Technology Ladkrabang,
Central Library 5th floor, Chalongkrung Road,
Ladkrabang District, Bangkok 10520

21.11.2016 @ UCSI
UCSI University, North Wing Campus, Taman Taynton View Cheras,
Lot 12734 Jalan Choo Lip Kung, 56000 Kuala Lumpur
AGENDA

- Motivation for Near-Net-Shape fabrication
- Resource efficient production technologies
  - Automated Tape Laying (ATL)
  - Automated Fibre Placement (AFP)
- Forming simulation
- Challenges
- Conclusion
Motivation for Near-Net-Shape fabrication

- Resulting scrap with different fabrication technologies
- Quasi-isotropic layup: [0/90/+45/-45]s

→ Tape width has an influence on the resulting scrap

Source: automobilemag.com

ATL, 50 mm width: 15.84%
AFP, 6.35 mm width: 4.04%
Conventional: 41.01%
Automated Tape Laying – Fiberforge RELAY®2000
Specifications

- 2D-layup, any fibre orientation possible
- Max. layup size: 2 m x 2 m
- UD-Tape width: 50-150 mm (infinitely variable)
- Ultrasonic spot welding
- Combination of any fibre and thermoplastic matrix (e.g. PP, PA6, PEEK)
- Little scrap through tailored layup
- Integration in automated process chain possible
Automated Tape Laying – Fiberforge RELAY®2000

Process chain
Automated Tape Laying – Fiberforge RELAY®2000

Example parts

- MAI Plast demonstrator (PA6/CF)
- Truck service hatch (PA6/CF)
- Forming demonstrator (PPS/CF, Premium Aerotec GmbH)
Automated Fibre Placement – Coriolis Composites

Specifications

- Manufacturer: Coriolis Composites
- Feasible structure size: length 7 m, diameter 3 m
- End effector: laying head with 8 x ¼” tows
- Near-net-shape, material efficient, composite lightweight structures
- Multi-material applications:
  - Thermoplastic prepreg systems (e.g. PA, PPS, PEEK)
  - Thermoset prepreg systems
  - Dry-fiber placement (binder yarn)
Automated Fibre Placement – Coriolis Composites

Process chain

2.5D - Fibre placement

3D - Fibre placement

Autoclave curing

Forming and consolidation

Final 3D-Part
Automated Fibre Placement – Coriolis Composites
Concept for series production and realization

- LuFo IV Projects Azur/AZIMUT/RoCK
- A350-1000 Door Surround Structure (DSS) in cooperation with AEROTEC

Goals:
- Substitution of Ti-parts with CFRP
- Increased performance
- Significant cost reduction
- Weight reduction
- Development in respect to time schedule
Automated Fiber Placement – Coriolis Composites

**AFP process for curved frames: the result**

- 85% CFRP
- Weight- and cost savings
- JEC Innovation Award 2016
Combination of ATL and AFP
Thermoplastic MAI Plast (key project MAI Carbon Cluster)

- Development of cost-efficient technologies for automated processing of thermoplastic high-performance fibre reinforced composites for high volume production
- Realization load-path optimized, locally reinforced semi-finished products
- Combination of ATL and AFP technologies for efficient manufacturing
- Demonstration of an efficient process chain for direct in-mould forming and functionalization of TAFP preforms

Automated Fibre Placement
Load-path optimized local reinforcements

Fiberforge RELAY® Automated Tape Laying
Highly productive, tailored performing

Load-path optimized, generic skin structure
How to generate the flat layup contour of a 3D-part?
The “missing link”

http://steamregister.com
Forming Simulation

Generating a Near-Net-Shape layup

Forming simulation (AniForm)

Definition of the part boundary

Back-forming and contour creation

Layup pattern for the ATL-process

Final part with less scrap
## Challenges

### ATL/AFP + Forming
- Fibre orientation
- Wrinkles
- Gaps
- Surface quality

### AFP
- Path programming
- Gaps/Overlaps
- Collision analysis

### Simulation
- Material characterisation
- Shear rate and temperature dependency
- Computational effort

Source: Zenker, T., et al., ECCM17, 2016
Conclusion

- Near-Net-Shape fabrication can reduce up to 40% of scrap during production.
- Automated Tape Laying and Automated Fibre Placement are suitable technologies to produce Near-Net-Shape preforms highly automated.
- As a result higher sustainability and lower costs can be achieved.
- Forming simulation can be used to replace expensive trial and error experiments for generating the contour and improve the part quality.

Source: http://www.aniform.com
Near-Net-Shape fabrication-technologies for CFRP

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