Trends in the manufacturing of Composite Aerospace Components and resulting demands for Machining Technologies

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DLR – German Aerospace Center

Tasks

- Research Institution
- Space Agency
- Project Management Agency

Research Areas and Cross-link-fields

- Aerospace
- Space Research and Technology
- Energy
- Transport
- Security
- Digitization (e.g. „Factory of the Future“, „Condition Monitoring“)

Motivated by the Digitization Initiative of the German Government
DLR – German Aerospace Center
Sites and Staff

- Approx. 8,500 employees
- 42 Institutes and Institutions
- 20 Sites
Trends in the manufacturing of Composite Aerospace Components and resulting demands for Machining Technologies

Jan Stüve
28th of November 2019
The R&D-environment of the CFK-Valley Stade
Trend No. 1 in the manufacturing of Composite Aerospace Components

Digitization

Source: https://www.alexanderthamm.com/de/artikel/digitalisierung-des-mittelstands/
Mass customization is a cornerstone in future manufacturing. Digital Guidance helps to minimize set-up times by autonomously adapting facilities and controlling workflows.

Accurate digital models represent both the product and the optimized production processes, saving costs, time, and engineering efforts.

Intelligent autonomous robots assemble individually customized products using advanced planning algorithms, sensors, and modular adaptive robotic skills.

Mobile autonomous production units fitted for carrying out a variety of back-work-like tasks help to overcome static shop floor layouts.

Intelligent robotic assistants and their human co-workers interact via intuitive, multimodal programming interfaces and share their workspace in safe and efficient industrial applications.
Future Factory for Composites

How does it look like?
Smart machine control for Multi-Head Automated Fiber Placement
Digital twins as enabler for efficient composite processing

- The Virtual Autoclave – a digital twin of the real process

Simulation of heat flow inside the autoclave
Human Aided Automation by Virtual and Augmented Reality

- Reinvolve Human into Automation
- Smart Remote Maintenance
  - VR-login for service provider
  - AR for on-site worker
- Process Monitoring
  - Process data displayed in the right context
- Collaborative Troubleshooting
  - Multi User VR/AR
- „Replay“ as process documentation
  - Review process as happened
  - Walk through instead of one-perspective video
Trend No. 2 in the manufacturing of Composite Aerospace Components

Netshape production of integral components
Fully automated textile preforming and RTM-production

1. textile storage
2. textile cutting
3. textile handling
4. draping
5. compressing
6. trimming to net shape
7. loading/10. demoulding
8. isothermal 2C injection
9. curing
10. demoulding
Example for application of netshape composite production: Competitive Composite Rib - LOCOMACHS

Global Wing Box Design Modification

The research leading to these results has received funding from the European Union’s Seventh Framework Programme (FP7/2007-2013) under grant agreement n°314003.
Example for application of netshape composite production: Competitive Composite Rib - LOCOMACHS

Detailed Rib Design Modification

- Tolerance compensation option at joint to upper cover
- Composite adapted web reinforcement
- Reduced complexity at joint to lower cover
- Integration of rib post on one side
- Stringer with local grow outs (Duck Feet) required

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Example for application of netshape composite production: Competitive Composite Rib - LOCOMACHS

Geometrical Accuracy and Weight

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Weight Saving of more than 40%

Deformation in mm

Geometrical accuracy requirements of flanges met

Global geometrical accuracy requirements met

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Production Cost Estimation

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Production Cost Estimation

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Trend No. 3 in the manufacturing of Composite Aerospace Components

Dustless assembly
Carbon Fiber Reinforced Thermoplastic (CFRT) material for aerospace components

Faster processing of components and weldability for assembly without riveting

Automated Fiber Placement of CFRT using HUMM3-Flashlamp

Induction welding of PEEK-CFRT as an example
Use Carbon Fiber Reinforced Thermoplastic (CFRT) material for aerospace components

Current product developments: Rear pressure bulkhead made of CFRT in automated production

Realized by DLR Center for Lightweight-Production-Technology Augsburg and Premium Aerotec GmbH, Augsburg

Automation in composite production is needed to enable rate and constancy of quality.

Digitization enables smart processing and the creation of digital Life-Data-Sheets.

Netshape production avoids post processing and reduces waste.

Thermoplastic composites enable joining without riveting.
Thank you for your attention!