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GroFi: Large-scale fiber placement research facility

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Abstract: GroFi is a large research facility operated by the German Aerospace Center's Center for Lightweight-Production-Technology in Stade. A combination of different layup technologies namely (dry) fiber placement and tape laying, allows the development and validation of new production technologies and processes for large-scale composite components. Due to the use of coordinated and simultaneously working layup units a high flexibility of the research platform is achieved. This allows the investigation of new materials, technologies and processes on both, small coupons, but also large components such as wing covers or fuselage skins.

1 Introduction

In order to increase fuel efficiency, the development of light and innovative structural components in the aerospace industry is at all times a fundamental aim which is pushed by the use of fiber reinforced plastics. The demand for a holistic approach in the fields of composites also drives the German Aerospace Center's (DLR) Institute of Composite Structures and Adaptive Systems. The institute closed the gap between basic research and industrial application by opening the Center for Lightweight Production

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Technology (ZLP) in Stade and Augsburg in the year 2010. Its thematic priority is the development of optimized, reliable, productive and, hence, also cost effective production processes.
Currently, fiber placement is the technology predominantly used for the production of large-scale structural components. Thereby, tows or tapes of either prepreg or bindered dry fiber material are laid up in courses on male or female tools.

2 GroFi® - plant concept

New plant concepts have to be developed in order to satisfy the requirements for productive and accurate production technologies especially for aeronautics sector.

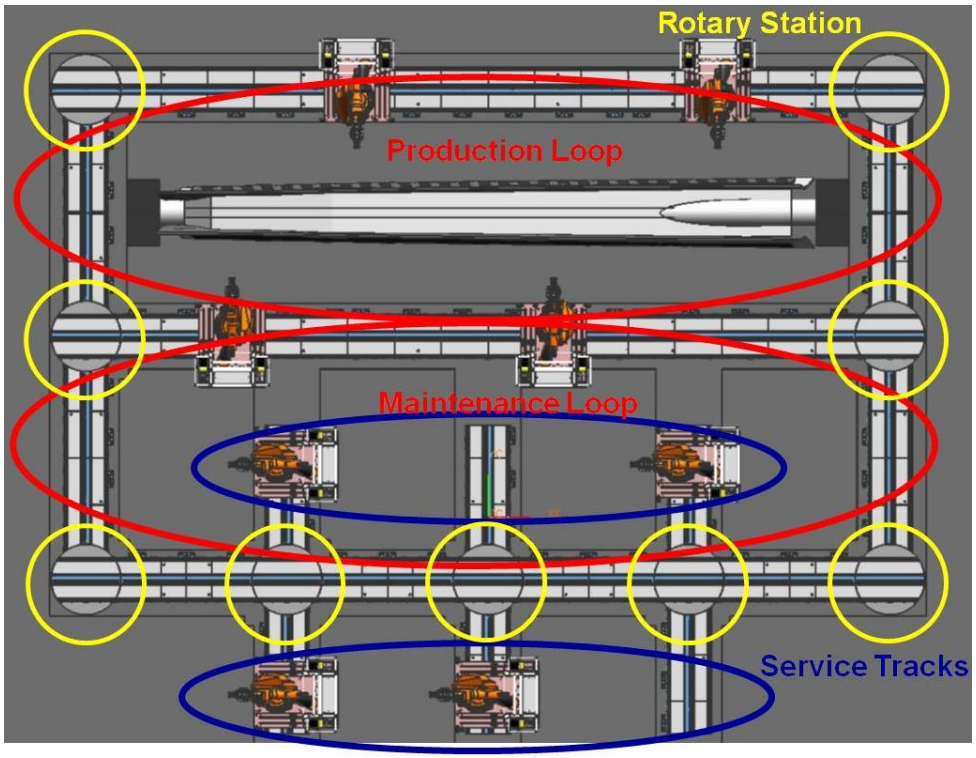

Figure 1: Top view of the GroFi®-plant highlighting production-loop, maintenance-loop, rotary plates and service tracks

The base of the GroFi® project is a fiber placement research facility, invented and co-developed by DLR. This research facility forms an ideal interface, where applied research and development can be tested at full-scale components.

The platform comprises a mold bearing system, which supports tools with up to 20m length and 5.5m width. The two double-sided tool is surrounded by a rail system that is split into two parallel loops, a production and a maintenance loop. Further information is provided in Krombholz et al. (2012), Krombholz et al. (2013) and Krombholz & Bölke (2013).
Up to 8 coordinated industrial robots can produce one or several components simultaneously on the rail system. This robot based multi head layup facility is equipped with both, fiber placement and tape laying units.

Figure 2: GroFi® - research facility for production of large-scale components

Technical data:

- Production of up to 20m x 5.5m part size
- Combined usage of tape laying and fibre placement technology
- Up to 8 layup units (Kuka KR-500-2 with Siemens Control)
- Multihead-approach with up to 8 layup units
- Sensor systems for quality assurance and quality monitoring
- Primarily thermoset prepreg and dry fiber material (thermoplastic also possible)

3 GroFi® - layup units

Fiber placement units (Krombholz & Ucan (2015))

- 2 robot-based fiber placement layup units
- Compact platform size of 2m * 2.5m with all needed equipment
- Layup of 16 x ¼" thermoset prepreg
- Siemens Sinumerik 840D-sl controller
- Integration of sensor systems to assure aerospace quality requirements

Tape laying units

- 2 robot-based tape laying units
- Compact platform size of 2m x 2.5m with all needed equipment
- Layup of up to 150mm width thermoset prepreg (CFRP, GFRP, lightning strike protection)
- Siemens Sinumerik 840D-sl controller
- Integration of sensor systems to assure aerospace quality requirements

Dry fiber placement unit (Krombholz & Kolbe (2015))

- 1 robot-based dry fiber placement unit
- Compact platform size of 2.8m x 2.5m with all needed equipment
- Layup of 16 x ¼" dry fiber placement material (UD-fibers with binder)
- New generation of IR heating device (no laser)
- Siemens Sinumerik 840D-sl controller

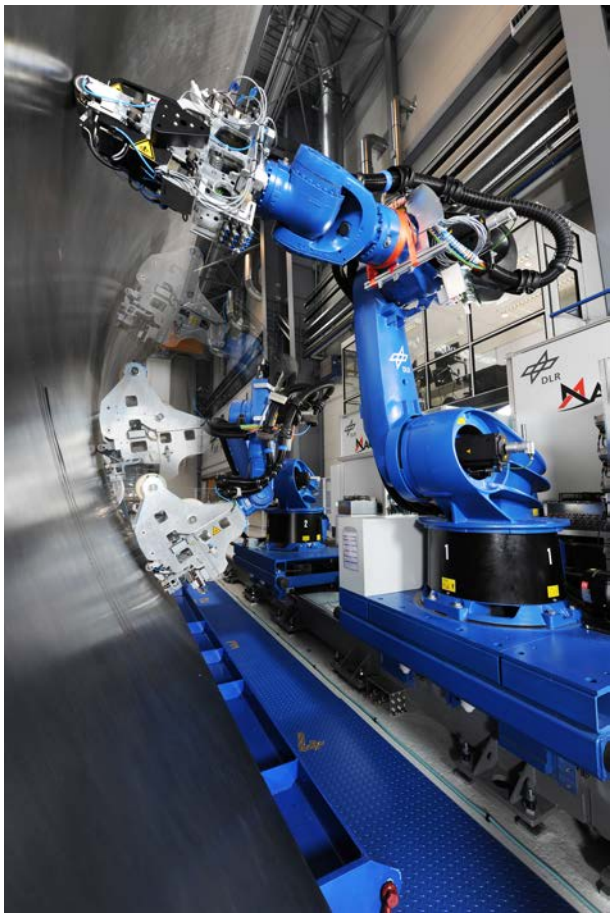

Figure 3: GroFi - realizing a combined usage of fiber placement and tape laying technology

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