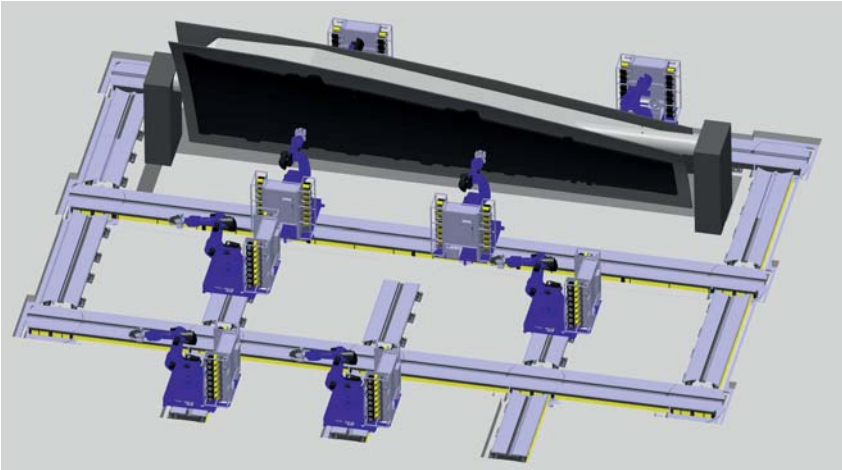
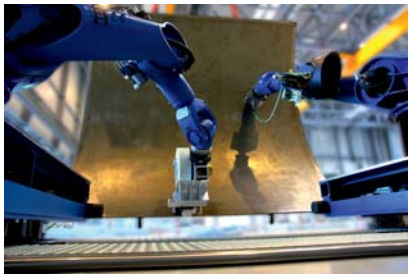
Center for Lightweight-Production-Technology (ZLP)

GroFi - Large-Scale Parts in Fiber Placement Technology



CAD model of GroFi



Simultaneously operating robots

GroFi Platform

Demands of high productivity for large aircraft parts out of CFRP

The demands of more lightweight aircrafts due to fuel saving reasons has led to a change in material used for most, also large scaled aircraft structural parts like fuselages, wings and empennages. Compared to metallic materials, carbon fiber reinforced plastics (CFRP) offer higher weight reduction potential while keeping the mechanical performances at the same level or even increasing them. Manufacturing these parts out of CFRP and in higher quantities than what is possible now, an increase of process effectivity as well as process stability and flexibility is required. These demands, especially high productivity and flexibility, cannot be achieved by existing systems. Due to their weight and size, single lay-up unit platforms that are used nowadays, are inflexible and ineffective.

Multi lay-up approach

Therefore, the aim of the GroFi platform is to demonstrate high productivity on an industrial scale with its multi lay-up approach. With the combination of Automated Fiber Placement (AFP) and Automated Tape Laying (ATL) of several lay-up units operating simultaneously at one multi-cavity tool, the following targets can be achieved:

- 150 kg/h fiber mass throughput with each GroFi platform
- Production of aircraft certified structures
- 8 simultaneously coordinated operating robot units lay-up in a multi-cavity tool
- Online path control, online correction and online quality control
- Holistic process consideration and automation
- Quality assurance and quality monitoring during the process with sensor systems

Rail system enables an autonomous movement of the robots

Eight robots are located on a rail system, which is separated in a maintenance and process loop. Rotary stations allow an autonomous movement of the robots alongside the entire platform, including automatical transfer between segments and loops. The additional capability of the robots to transfer process-related tasks and therefore replace other lay-up units results into an extremely flexible and effective system. A comprehensive understanding of the behavior of the entire system is required to develop future technologies.

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
German Aerospace Center

Institute of Composite Structures and
Adaptive Systems
Ottenbecker Damm 12
D - 21684 Stade

Contact: Dipl.-Ing. Dirk Röstermundt
Telephone: +49 (0) 531 295-2351 / 3704
Telefax: +49 (0) 531 295-3702
E-mail: dirk.roestermundt@dlr.de

Contact: Dipl.-Ing. Christian Krombholz
Telephone: +49 (0) 531 295-3712
Telefax: +49 (0) 531 295-3702
E-mail: christian.krombholz@dlr.de
www.dlr.de/fa

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Lay-up unit

GroFi Team: Top row (left to right): Dirk Röstermundt, Christian Ückert, Sebastian Rosskamp, Marcus Perner Bottom Row (left to right): Matthias Bock, Chinh Nguyen, Christian Krombholz

Therefore, to get the best possible product quality, key aspects in GroFi need to be determined and analyzed. Some of them are:

- Material science
- Dynamic effects of the platform
- Sensor technology
- Imperfection management

Material science

Understanding the behavior of the material during the lay-up process is one way to get high product quality and high effectiveness at the same time. Therefore, process parameters like compaction force, compaction time, heating temperature and interaction between different materials need to be known and evaluated before handling the materials. Furthermore, the challenges of double curved part geometry and high fiber mass throughput can be met by using Automated Fiber Placement and Automated Tape Laying simultaneously.

Dynamic effects of the platform

Vibrations and dynamic behavior between components, especially caused by the lay-up units need to be clarified. For this purpose, measurement data recorded at defined move scenarios during the process point out the need for action. Based on these results, concepts for vibration isolation and damping can be developed. Furthermore, this knowledge can be used for optimization of almost every aspect, beginning from construction to path programming.

Sensor technology for high quality and effectiveness

To ensure high laminate quality, several sensor technologies are integrated at the platform and at the lay-up units. An edge-detection system is used to handle gaps and overlaps of nearby material courses through an online path correction.
Another system used to to increase the quality is a force and torque sensor. Therefore, an online compaction control for best lay-up and tack results becomes possible.
Additionally, a quality assurance system controls and monitors the quality of laid-up material and allows measures within a developed imperfection management.

Imperfection management

Tolerance and imperfection management need to be established to improve production speed without any compromise in quality. Acceptable tolerances for every single path will be calculated according to the tracked position of earlier paths in the process to guide the machine on future paths. Furthermore, imperfections are detected and their impact on the integrity of the part is calculated using advanced FEM-Models. Thus, continuous quality assurance is possible.

Contacts and information

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German Aerospace Center

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Contact: Dipl.-Ing. Dirk Röstermundt
Telephone: +49 (0) 531 295-2351 / 3704
Telefax: +49 (0) 531 295-3702
E-mail: dirk.roestermundt@dlr.de

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Telephone: +49 (0) 531 295-3712
Telefax: +49 (0) 531 295-3702
E-mail: christian.krombholz@dlr.de
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