CONBILITY®
producing sustainability

CONBILITY GmbH

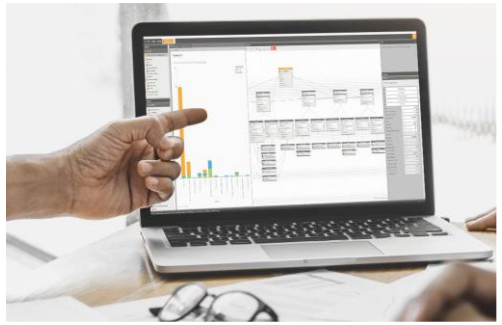
Technology Partner for Advanced Composite Material Series Production

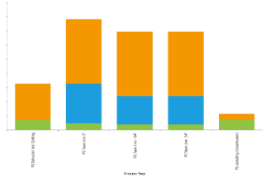
- *Turnkey Machines & Modular Production Systems for Advanced Composite Materials*
- *End-to-End Engineering: Design, Prototyping & Testing of Advanced Composite Material Parts*
- *Technology Evaluation, Cost & CO_2 Benchmarking*

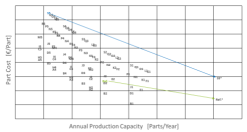
Conbility´s Portfolio

Technology Evaluation

- Process Chain Modelling and Evaluation
- Cost and Carbon Footprint Assessment
- Design of production Scenarios



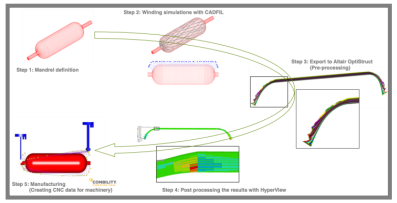


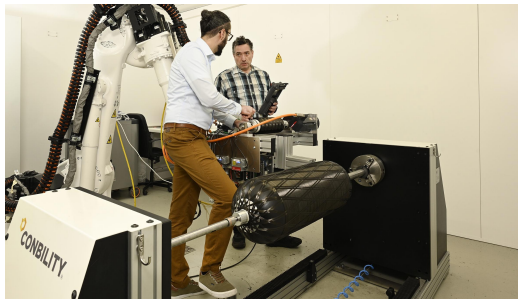


One Stop Shop Services

… related to Winding and Placement of Tapes, Prepregs, Towpregs and Dry-Fiber:

- Prototyping
- Manufacturing Services
- Product Design
- Part Testing





Composite Production Machines

… for Winding and Placement of Tapes, Prepregs, Towpregs and Dry-Fiber:

- Single Applicators, Winding Axis, etc.
- Turnkey Production Machines (Series Production or R&D)

Anchored in a Leading R&D Ecosystem – From Idea to Implementation

Located at RWTH Aachen University

- One of the world's top engineering universities with strong focus on advanced materials and production technologies

Direct access to high-end R&D infrastructure and complementary expertise

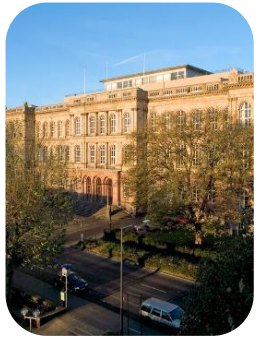
- Fast and flexible use of testing labs, pilot lines, and simulation tools

Strong ties with our sister company AZL Aachen GmbH

- Experts in composite design, production technologies, and market strategies
- Joint execution of cutting-edge component and process development projects

Part of the international AZL Lightweight Network

- Accelerated innovation through collaboration with OEMs, Tier-1s, material and equipment suppliers



47.078 Students in Total

557 Professors

14.150 International Students

10.272 Staff

25.913 Engineering Students

1,192 Billion € Financial Vol. Total

7.133 Graduates

10.233 Publications

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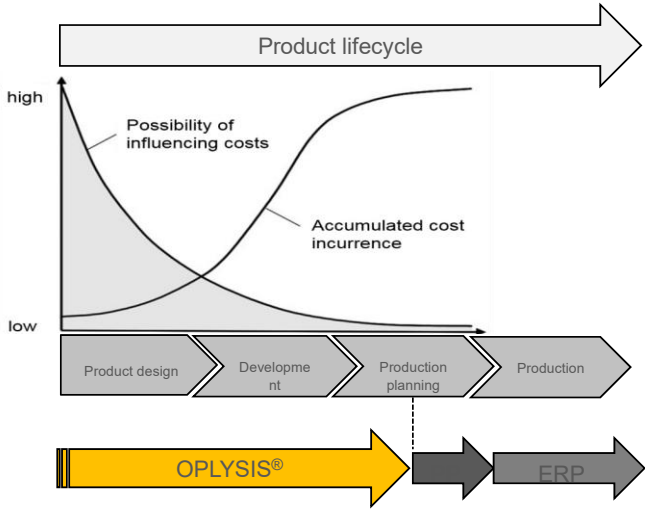
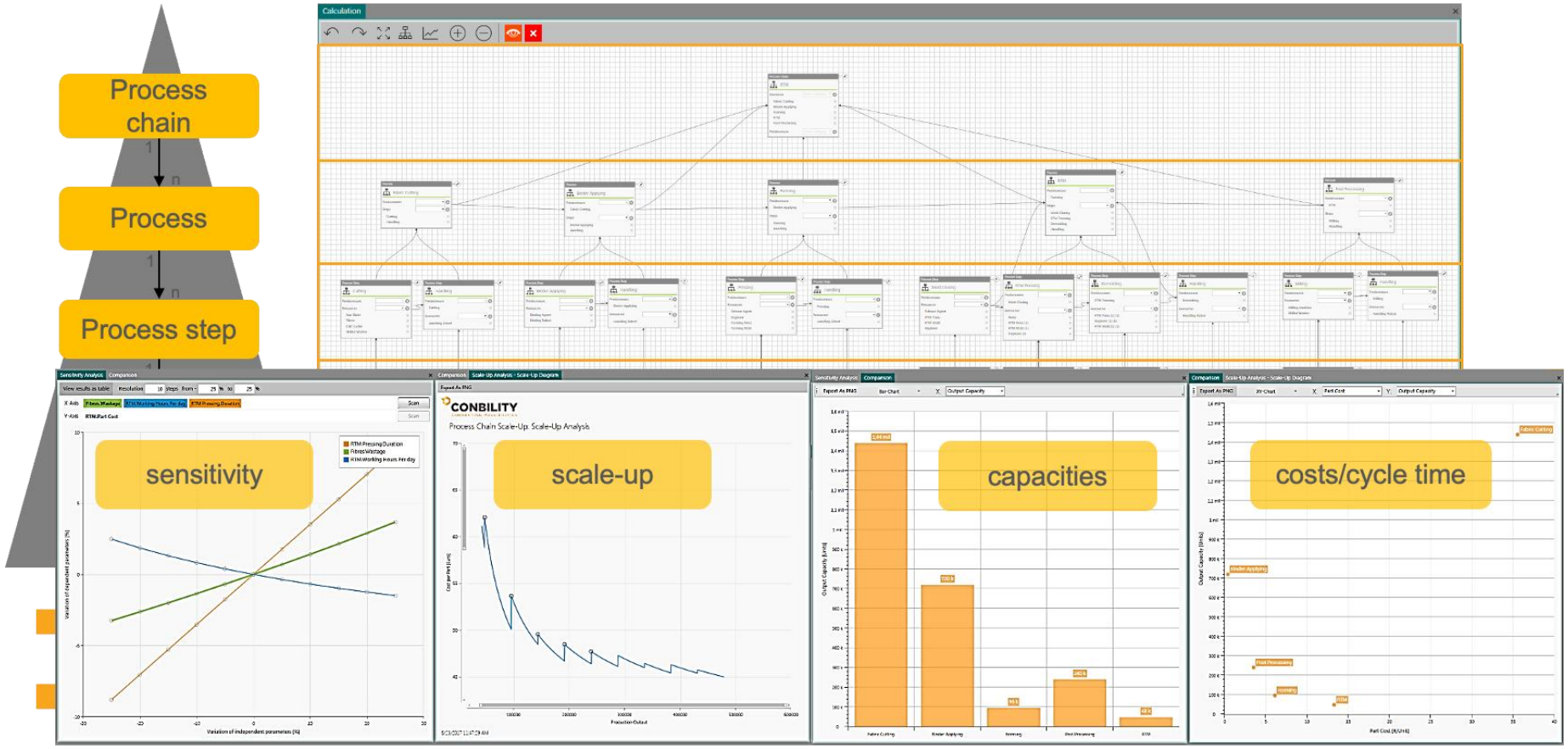
Technology Evaluation

Software and Services for Evaluating Production Technologies

Software OPLYSIS-eco® - Design and Evaluate Production Scenarios by Drag&Drop

OPLYSIS helps to directly evaluate the impact of product design on manufacturing costs & CO_2-footprint and facilitates simultaneous optimization



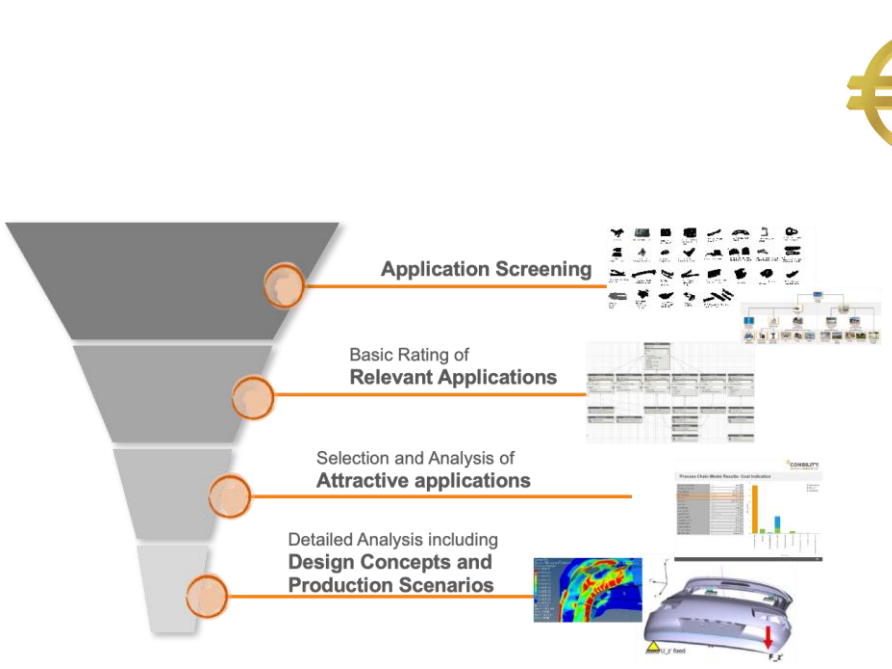


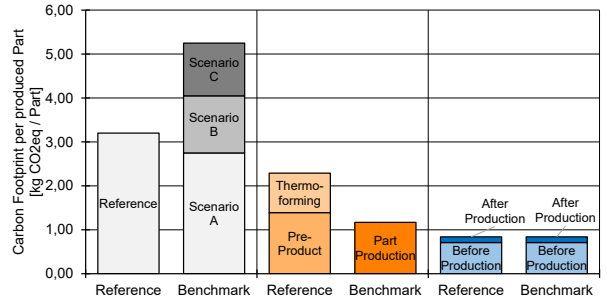
LINK: Experience Useability

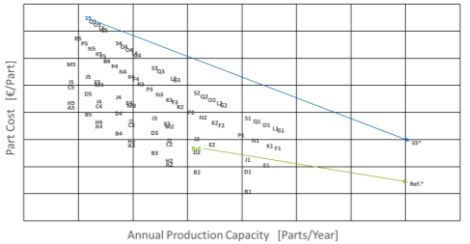
Service Technology Evaluation – Industry and Technology Independent rating of KPIs of production strategies and processes

- Utilizing broad understanding and up-to-date knowledge of technologies to **identify and understand manufacturing technologies**
- Provide **transparent and interactive insights by setting up models of process chains** with our software OPLYSIS-eco

- Evaluation and **benchmarking of material-, process- and product-characteristics on all relevant KPIs of production strategies** incl. use-phase and recycling processes.
- Provide **insights on process optimization**, and offer recommendations for **improving production efficiency and sustainability**







exemplary clients

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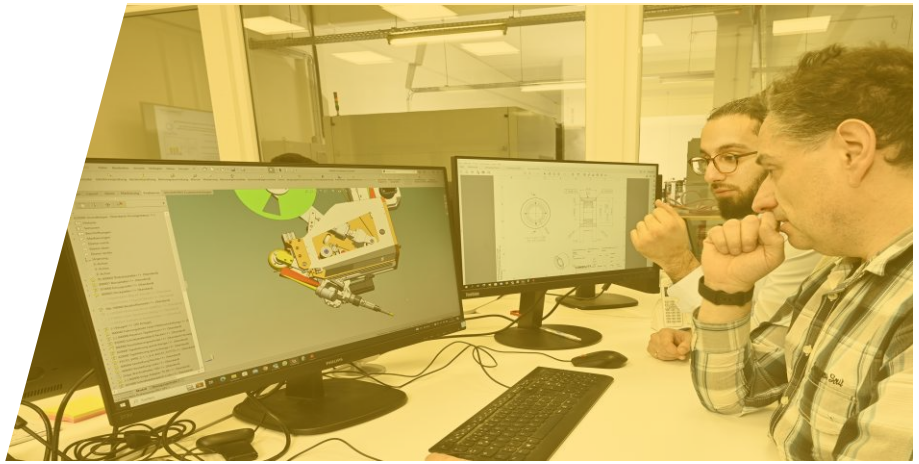
Production Systems



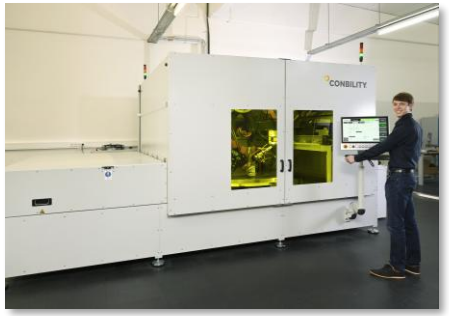
Winding and Placement of Tapes, Prepregs, Towpregs and Dry-Fiber

Additive Manufacturing

Stationary and Deployable

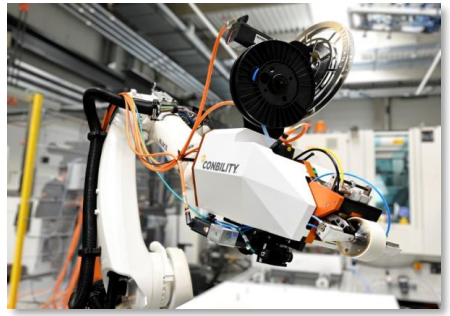
Advanced Composite Materials Production Systems – Portfolio Thermoset & Thermoplastic

2D Placement



- High-throughput application with **up to 6 spools** in parallel
- **Tailored-blanks / Preforms** made from dry-fiber, thermoset/thermoplastic tapes and towpregs
- Lamination/consolidation by **laser** (closed-loop temperature control) and **IR**
- Heated **turning table**

3D Applicators



- Up to **4 spools** in parallel
- Versatile application: **placement and winding**
- **Broad-range of materials**: dry-fiber, thermoset/thermoplastic tapes and towpregs
- **Easy installation** into existing robot-systems
- All **process parameters closed-loop controlled**

Cell-Upgrades

- Reliable **upgrading of existing infrastructure** from one source
- Upgrading **winding/placement** applicator
- Planning, delivery and installation of **sub-systems** (heating/turning-tables, winding axes, laser-safety enclosures,…)
- **Turn-Key and certified** commissioning incl. all software, control and hardware tasks

Turn-Key Cells

- Turn-Key Cells for **winding** and/or **placement** incl. **3D-Printing**
- Configurations for **institutes, industrial tech-centers and manufacturing**
- Starting from 270 k€, <10 months delivery
- **On-floor installation** and flexibly **rearrangeable/ deployable containerized setups** available

Production Lines

- Turn-Key production lines for **24/7 serial production**
- For **preform** and **component manufacturing**
- **Upstream and downstream processes** e.g. automatic material exchange, quality assessment, assembly, forming, finishing…
- **One-Stop-Shop:** From identifying best-suited technologies, evaluation to integration of (linked) cells

Production Systems – Technologies and Markets

Conbility Machine Systems:

Applications:

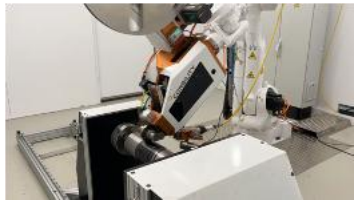
THERMOSET-FRP:

…for high-speed towpreg winding

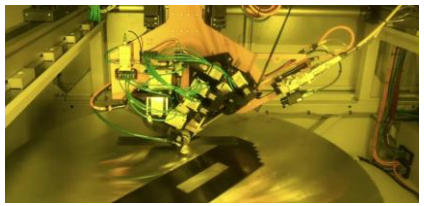
…for conventional towpreg winding

…for prepreg-/ dry-fiber placement

THERMOPLASTIC-FRP:



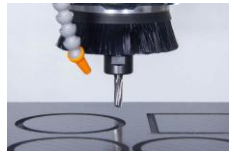
…for laser-assisted thermoplastic tape winding

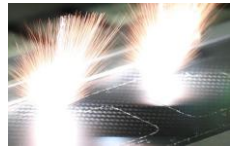


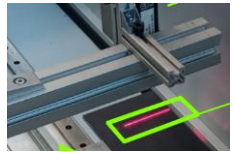
…for laser-assisted thermoplastic tape placement

+

Post-Processing & QS:







Exempl. Parts:

Hydrogen pressure vessels

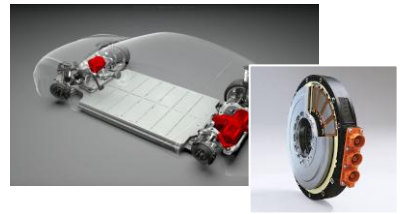
Rotor sleeves, slit pipes for water pumps, tubes

Structural parts

Local reinforcements of injection molded parts

Exempl. Markets:

H2-based E-Mobility

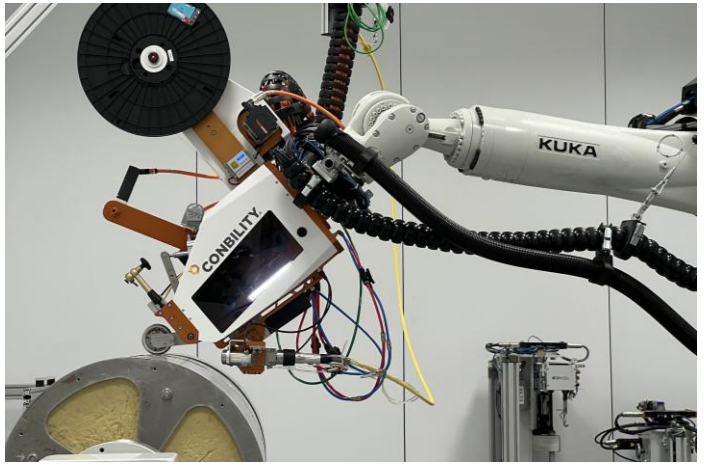


E-Motor drives for E-Mobility

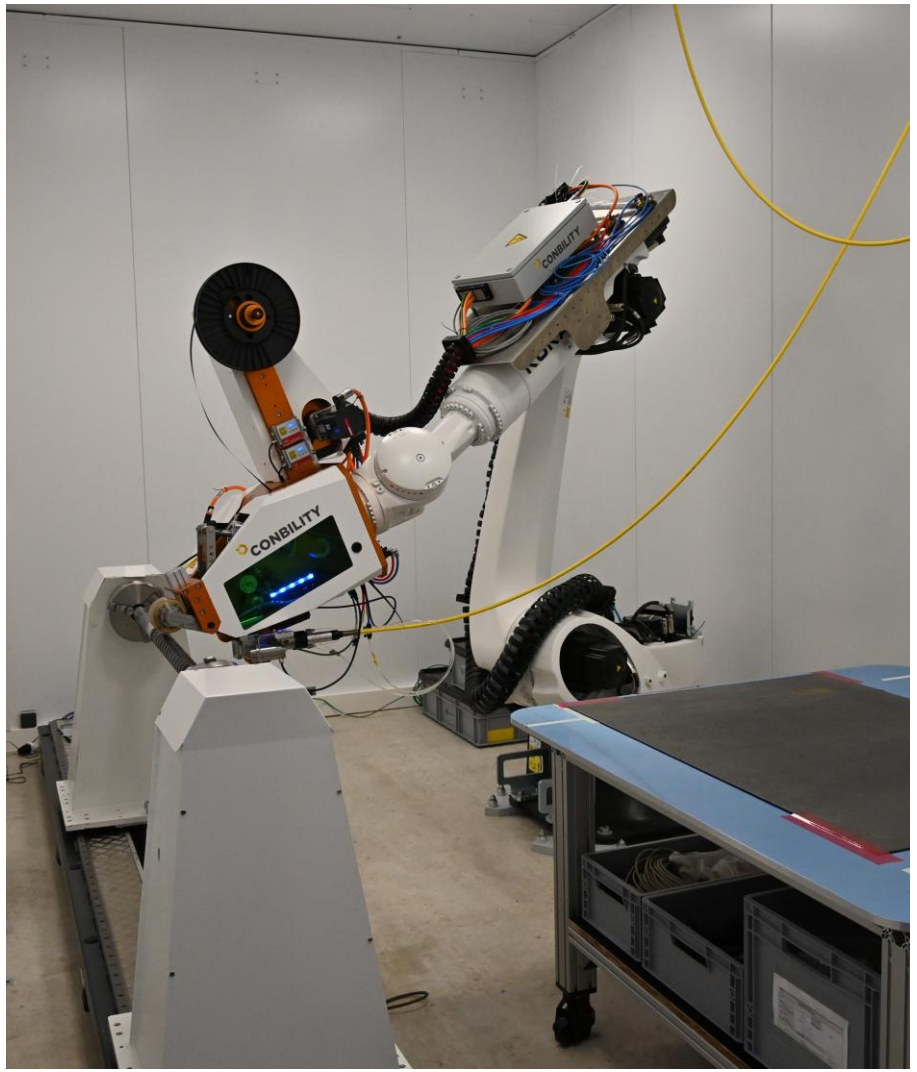
E-Motoren (sonstige), Pumpen

Structural parts (Aerospace, Automotive)

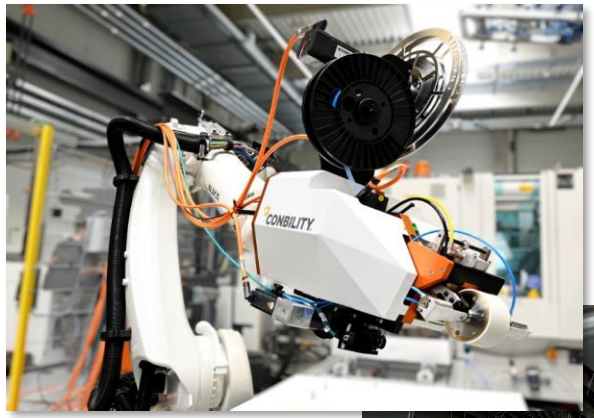
Example „Cell-Upgrades”: Integration laser-processing into non-laser R&D-cell, TITK Rudolstadt, Thüringen

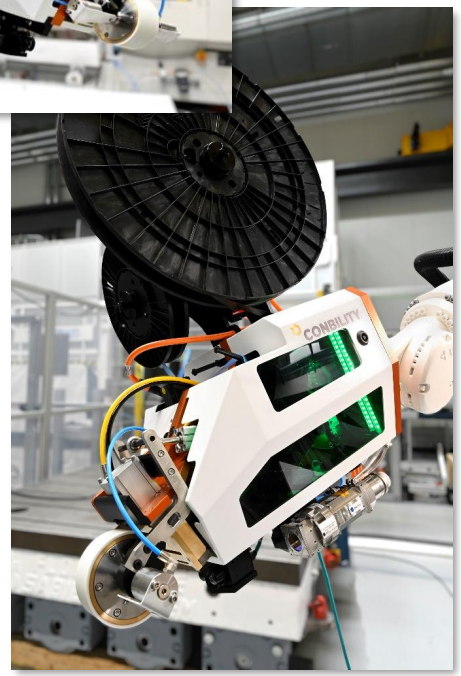


Example „Turn-Key Cell”: Flexible Cell for laser-assisted Winding and Placement at FIBRE, Bremen



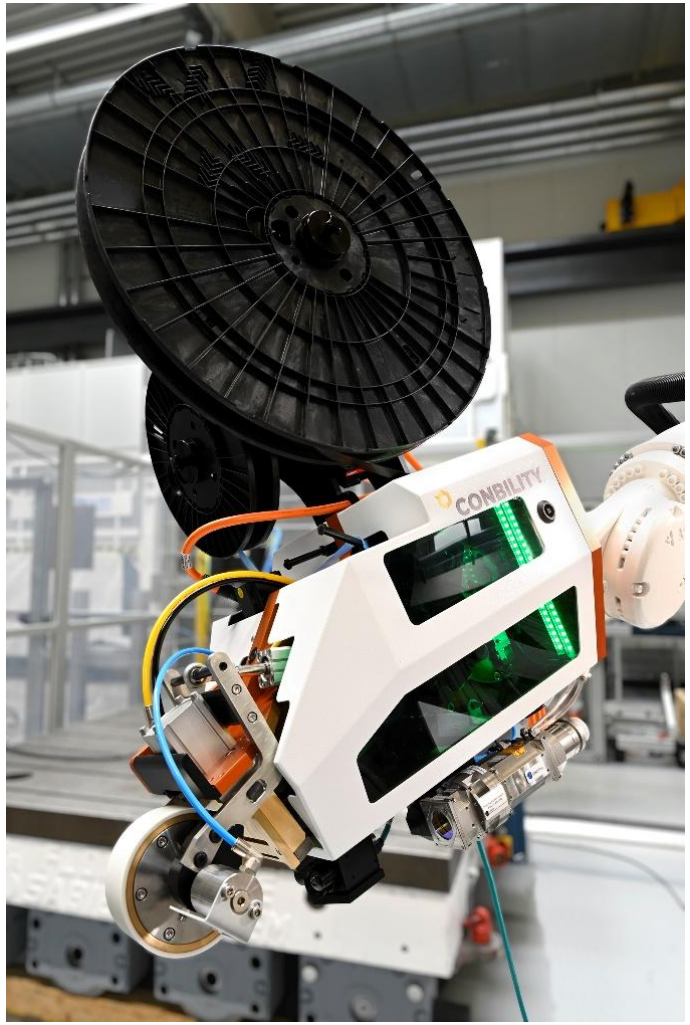
3D-Multi-Technology-Tape Placement and -Winding Applicator

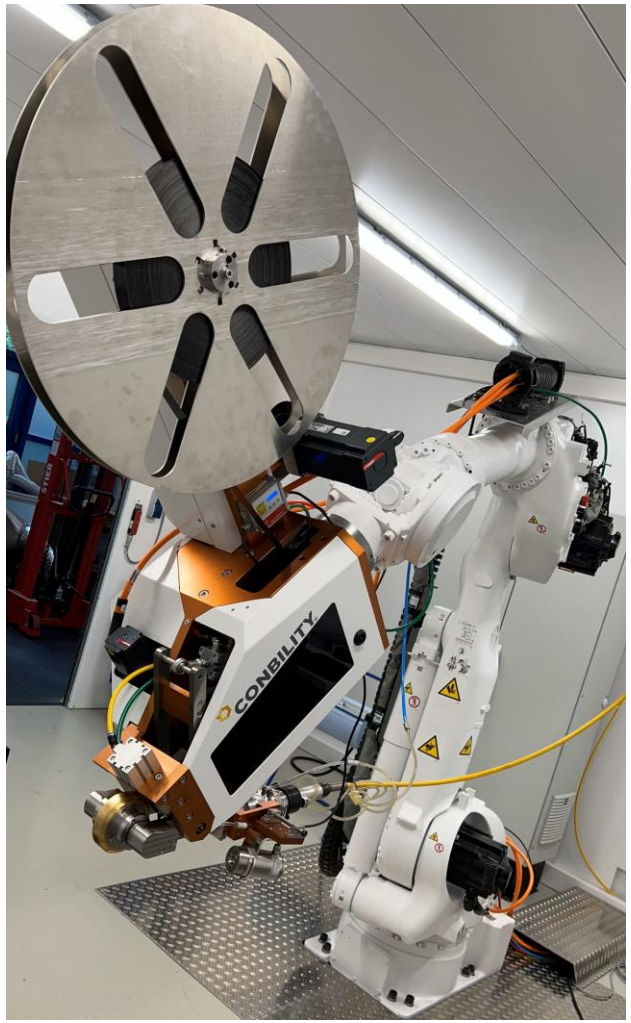


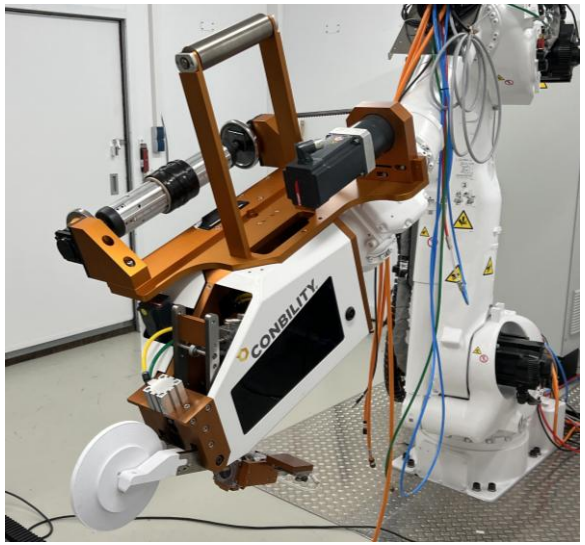


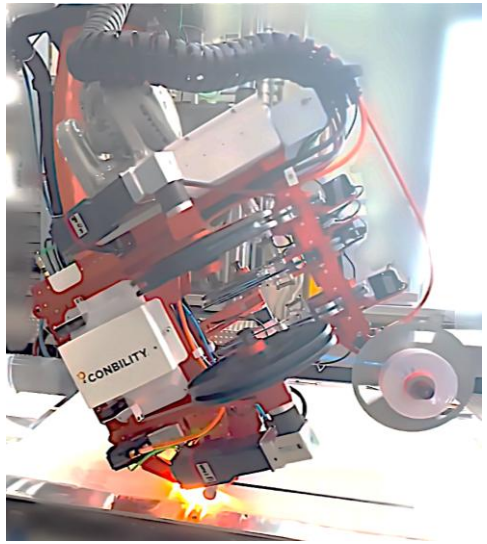
- **Application**
  - 3D-Placement or winding of tapes: **dry-fiber** (epoxy / thermoplastic binder), **prepreg tapes** (thermoplastic / thermoset resins)
  - **Preforms** for liquid composite moulding
  - **Prepreg-layups** for autotoclave or press moulding
  - **In-situ consolidated parts** for thermoplastic tapes
- **Advantages**
  - Maximum flexibility: Modular platform design - easily adaptable modules for feeding, guiding, heating and consolidating materials
  - Fast and easy material rigging and maintenance: Open architecture for reaching and exchanging all parts within seconds
  - Reliable setup and operation of process by closed-loop control of all quality-sensitive parameters
  - User friendly operation of high-performing control system by Conbility´s HMI
- **Technical Information**
  - Up to 4 spools (1/8” - 2”); up to 1.000 N tape tension and compaction force; closed-loop temperature control +-3K; cooled roller; +- 1 mm add/cutting tolerance

Multi-Technology-Tape Placement and Winding Applicator - Configurations





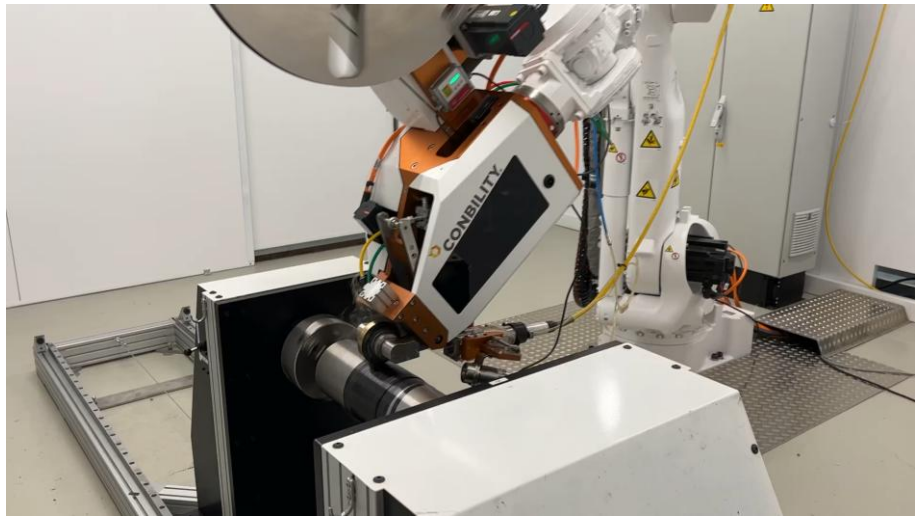


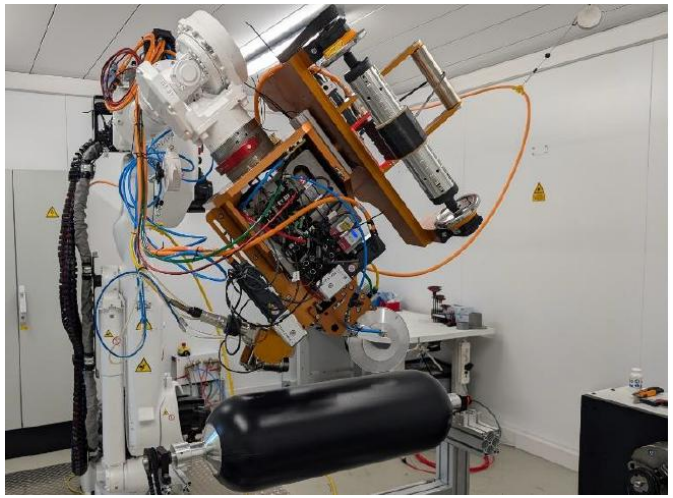


- Rovings
- Dry-Fiber Bands
- Towpregs
- Prepregs (backingpaper)
- Tapes

- Haefner
- Card Board
- Up to 4 spools (quick exchange)

(Laser-assisted) Thermoplast and Thermoset Winding @Conbility´s Technical Center

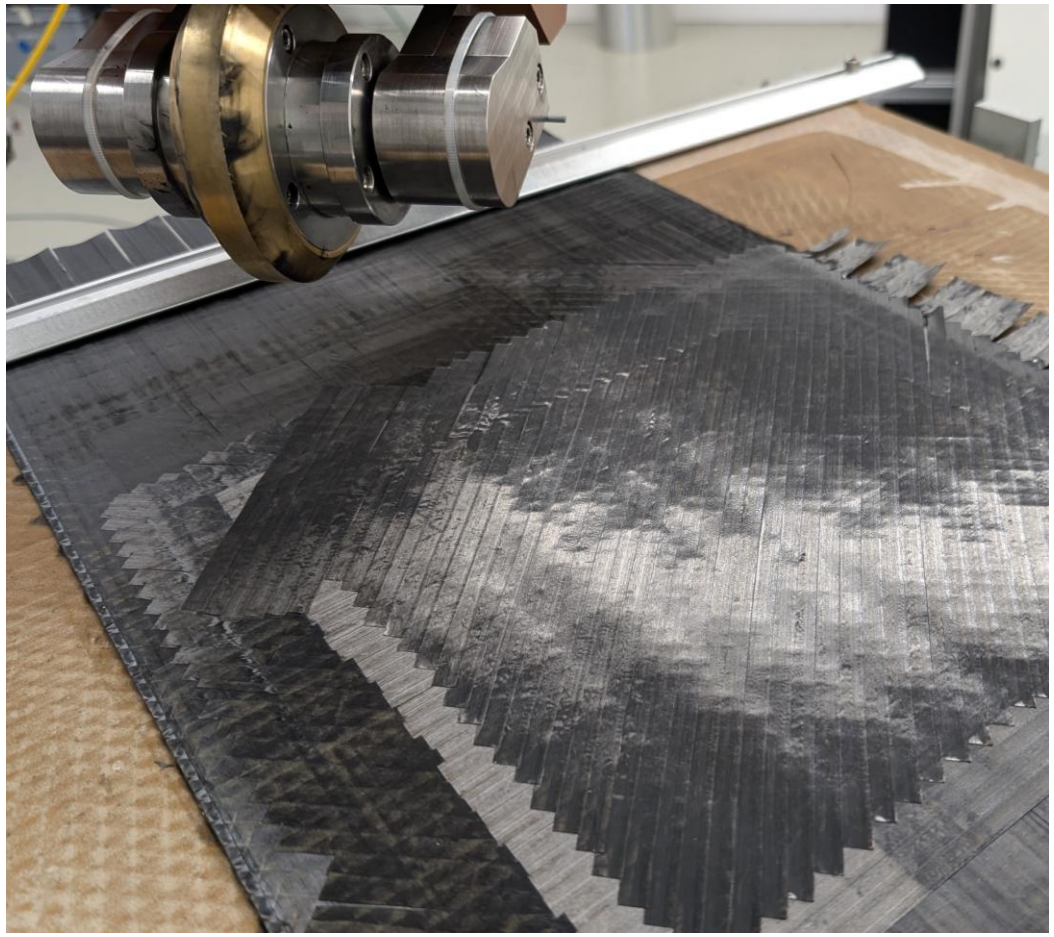




Exemplary Applications

- Winding of thermoplastic tapes with in-situ consolidation
- Winding of thermoset towpregs, also with high-speed >8 m/sec
- Rotor sleeve manufacturing
- Direct wrapping of rotors
- Hydrogen pressure vessels
- Hydrogen pipelines (electrolysers, flow lines)
- Lightweight flow lines
- Pipes (full composite, wrapped liners, TCPs)
- Hydraulic cylinders (full composite, metal wrapping)
- Structural elements, struts

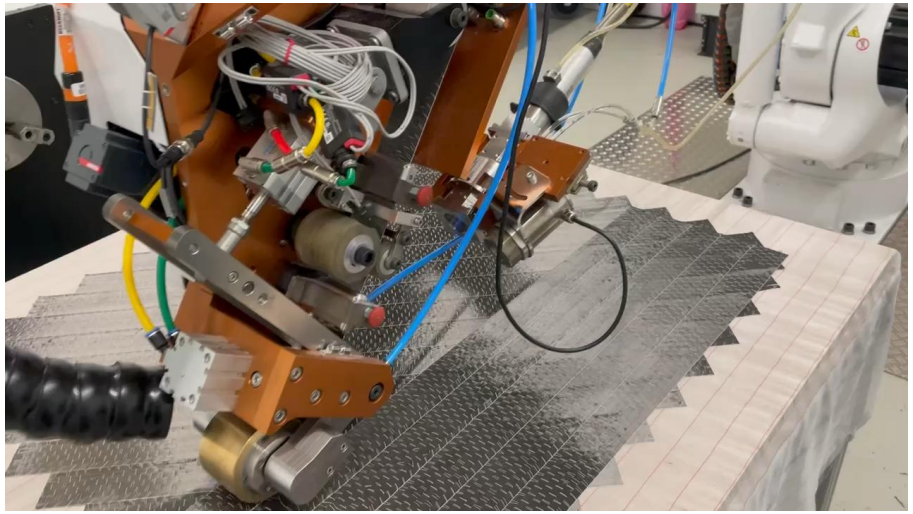
Laser-assisted Thermoplast Placement @Conbility´s Technical Center

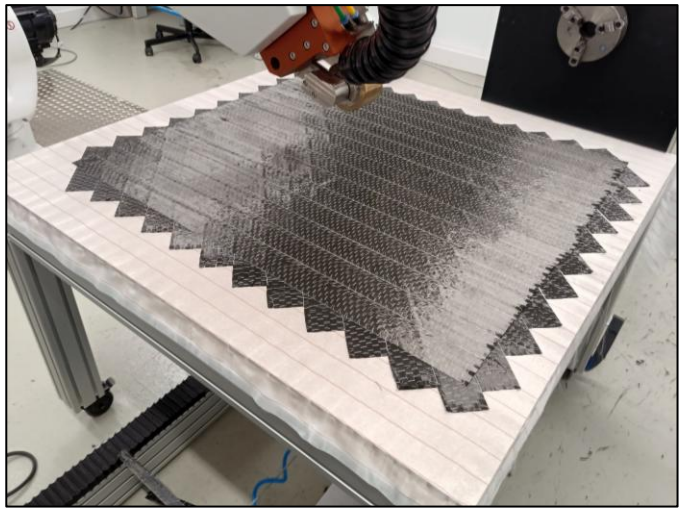


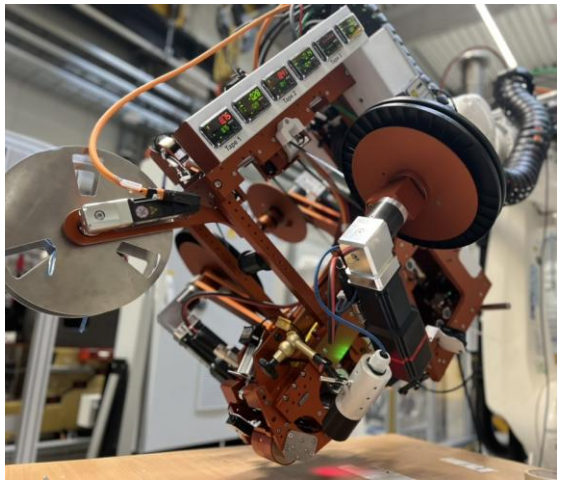
Exemplary Applications

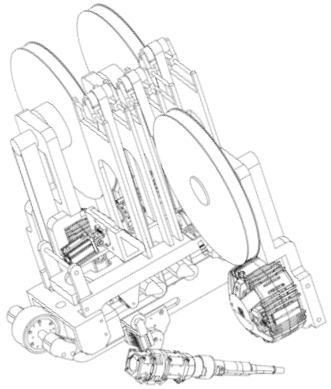
- Manufacturing of high performance lightweight 3D structures
- Manufacturing of 2D laminates (e.g. for material development/characterisation, further processing by stamp forming)
- Local reinforcing of plastic, composite and metal structures
- Local reinforcing of organosheets, cross-plies or other semi-finished products

Dry Fibre Placement @Conbility´s Technical Center



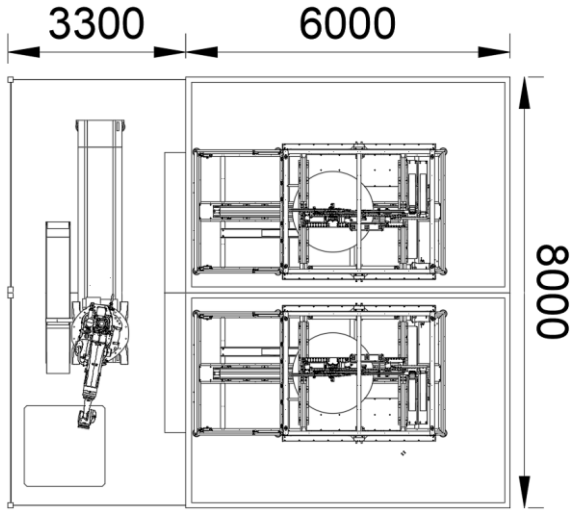


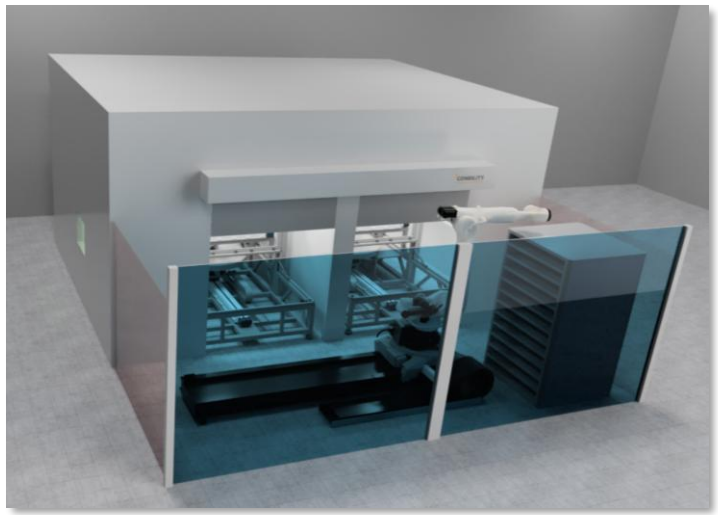




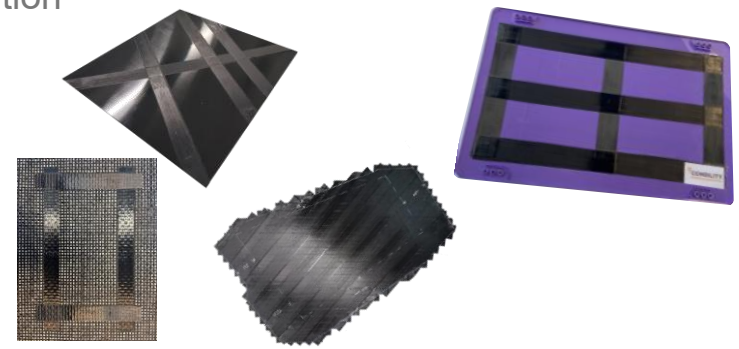
Exemplary applications

Deployable Manufacturing Cell for flat and slightly curved Parts and Preforms





- **Application**
  - dry-fiber (epoxy / thermoplastic binder), prepreg (thermoplastic / thermoset resins
  - Preforms/Tailored Blanks, e.g. for liquid composite moulding, stamp moulding, injection moulding
  - In-situ consolidation for thermoplastic tapes
- **Technical Information**
  - Easy installation and re-location capabilities
  - Fast placement tailored blanks up to 1 m/s
  - Fully automated loading/unloading
  - High availability
  - No post-consolidation needed for thermoplastic in-situ consolidation



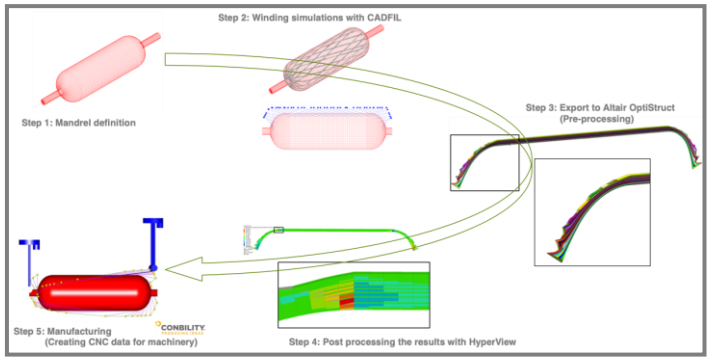
Deployable Modular Manufacturing Cell for Winding, 3D Placement and 3D-Printing

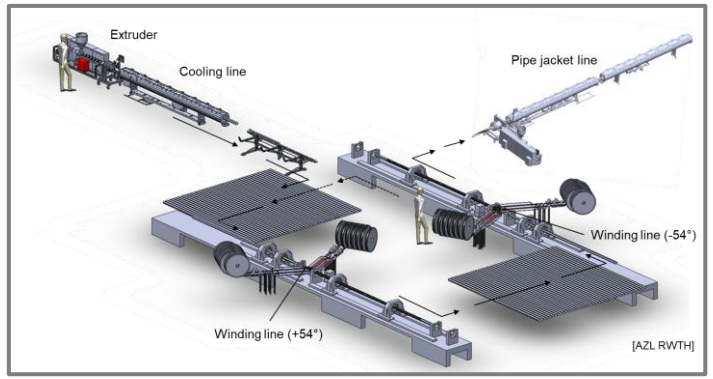
- Reconfigurable:
  - Placement & Winding of continuous fibre composites
  - Additive Manufacturing (w/o reinforcement fibres)
  - Machining
- All elements fully integrated for quick setup and relocation of production
- Modular Control Architecture with Highest Flexibility for System Integration (OPC-UA, ERP, Data Analytics,…)

One Stop Shop Services – R&D and Production

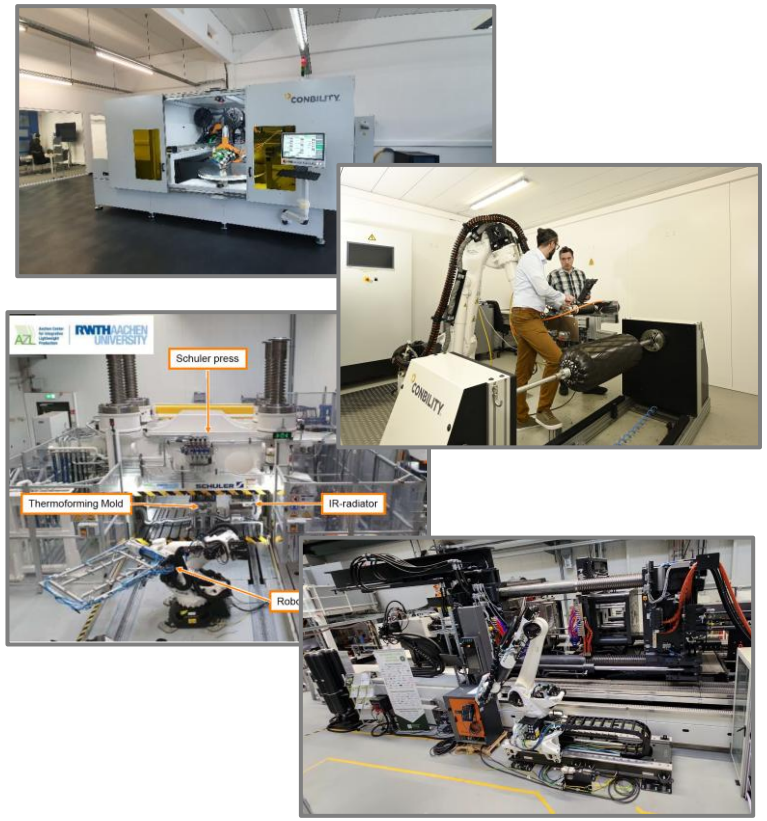
Advanced Composites – R&D, Part Development and Production

Structural Design of Parts and Design of Production Scenarios

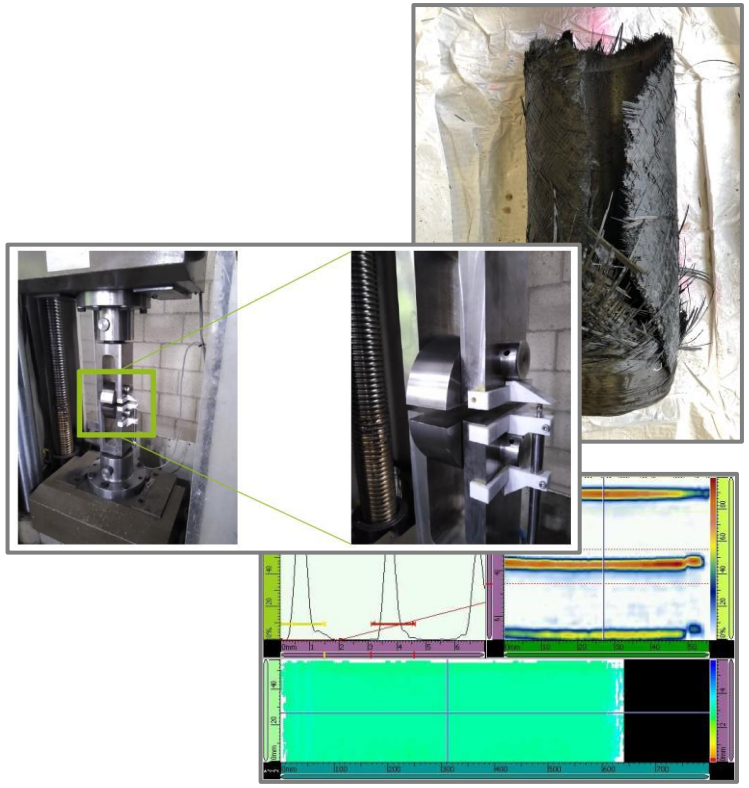




Production and Further Processing of Pipes, Vessels and Laminates



Coupon and part testing (morphologies, thermal/physical analysis, mechanical testing,…)



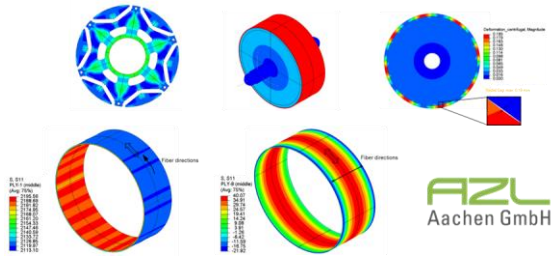
All expertise and infrastructure for design, manufacturing and testing of Conbility´s target components are available in walking distance

Rotor and stator sleeves for e-motors

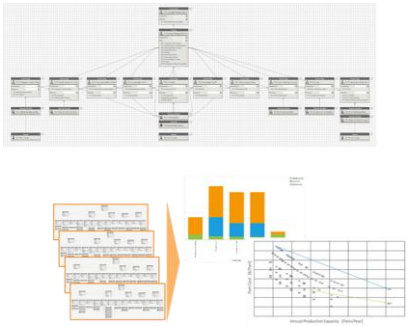
- **CFRP rotor sleeves can be manufactured according to the following principles, available at Conbility:**
  - Thermoset towpreg/prepreg winding (both direct winding or separate rotor sleeve production for subsequent assembly)
  - Thermoplastic tape winding (both direct winding or separate rotor sleeve production for subsequent assembly)
- **<u>For all these combinations / principles we offer:</u>**

Part design (CAD, CAE)

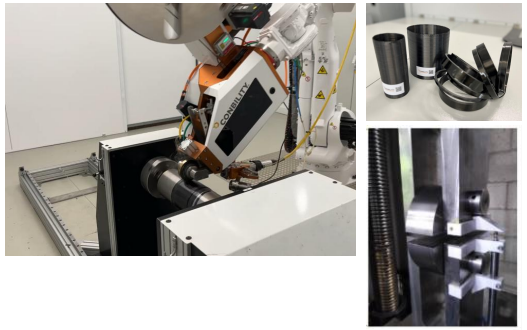
in cooperation with AZL Aachen GmbH



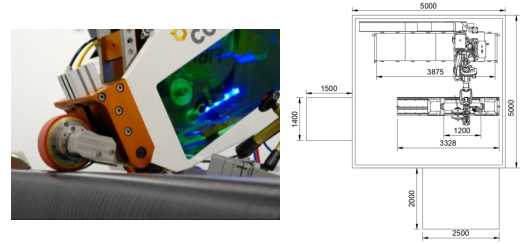
Business Case Assessment



Processing Trials, Prototype Manufacturing and Testing

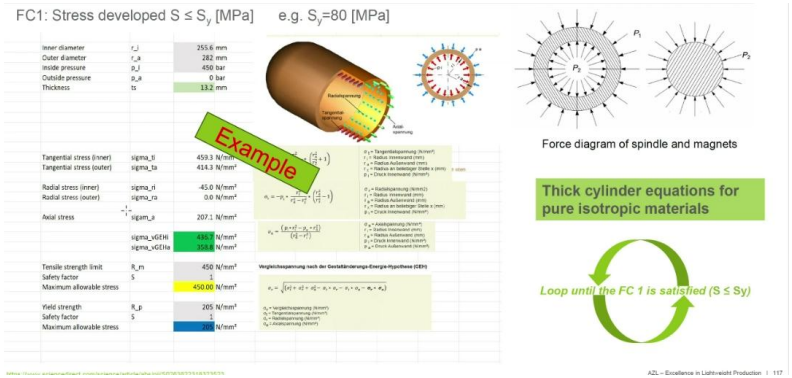


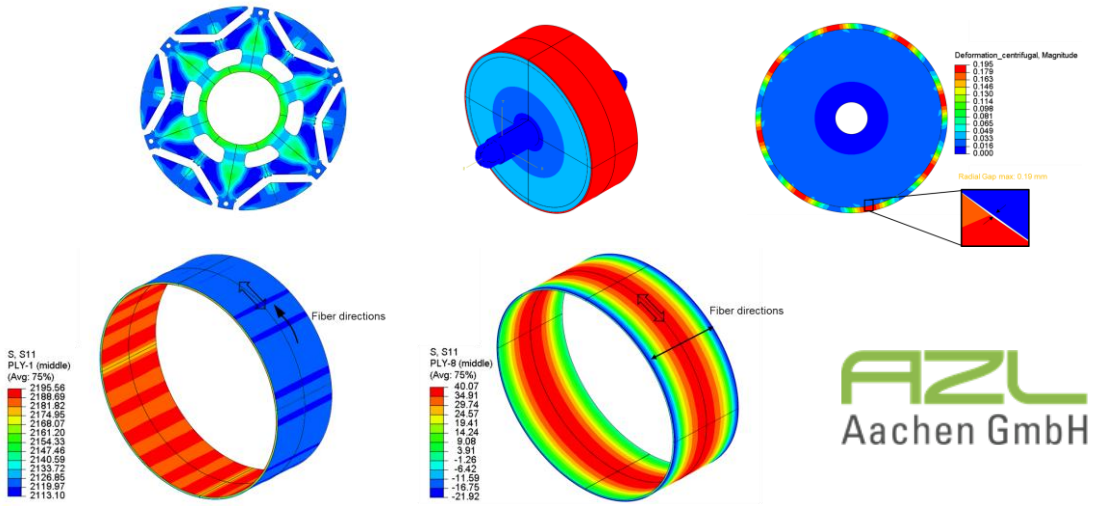
24/7 Turnkey production systems for serial production



Conbility´s offer in the field of rotor/stator sleeves

- **For all these combinations / principles we offer:**
  - **Part design (CAD, CAE) in cooperation with AZL Aachen GmbH**
    - Analytical calculations
    - Detailed 2D or 3D numerical simulations and optimization studies, e.g.
      - performance against static and cyclic loading incl. temperature effects,
      - material evaluation thermoplastic vs. thermoset,
      - pre-tension assessment,
      - air gap optimization,
      - press-fit simulations

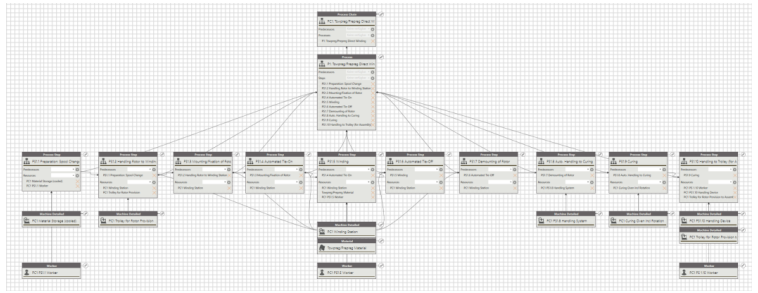


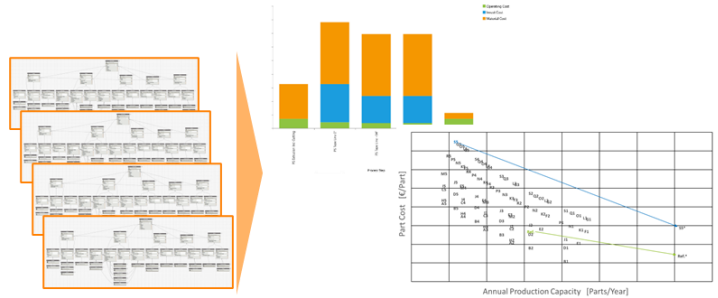


AZL Aachen GmbH

Conbility´s offer in the field of rotor/stator sleeves

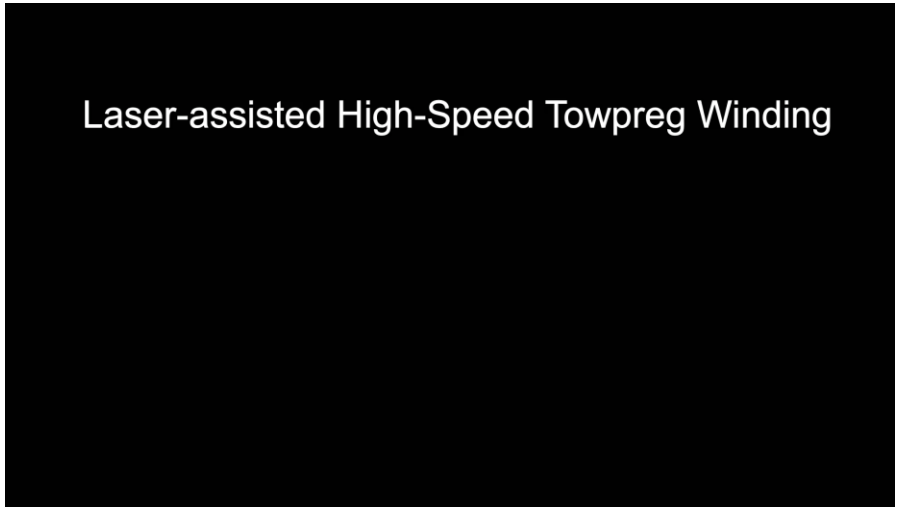
- **For all these combinations / principles we offer:**
  - **Business case assessment**
    - Market screenings, supply chain analysis, regulatory and HSE aspects
    - Process chain modelling with OPLYSIS-eco
    - Part cost assessment and cost benchmarking of different…
      - production principles (direct winding vs. separate winding),
      - materials,
      - winding machine configurations for direct winding (e.g. single rotor winding vs. simultaneous winding of several rotors),
      - machine configurations for separate winding (e.g. pipe manufacturing on single or multiple winding machine,
      - cutting principles/technologies and other post-processing technologies

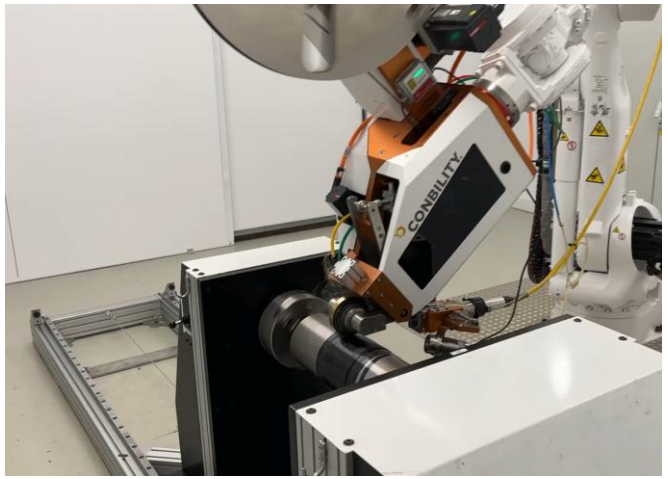


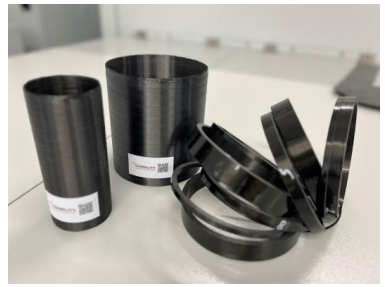


Conbility´s offer in the field of rotor/stator sleeves

- **For all these combinations / principles we offer:**
  - **Processing trials and material investigations**
    - Thermoplastic tape winding (PEEK, LM PAEK, and others)
    - Thermoset prepreg/towpreg winding and curing
    - Post processing (e.g. cutting and/or grinding)
    - incl. analytics (e.g., microscopy)
  - **Prototype manufacturing**
    - Direct winding onto rotors (thermoplastic and thermoset)
      - > 1.000 N tension
      - individual tie-on/-off solutions
    - Separate winding of sleeves for subsequent assembly, including cutting and post processing if required
  - **Testing of prototypes**
    - Split disc testing, Spin testing, Porosity …



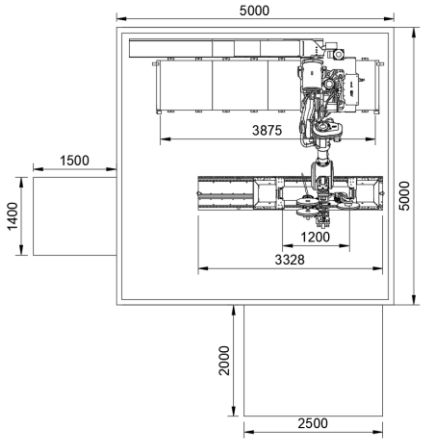


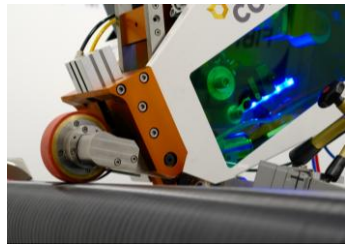


Conbility´s offer in the field of rotor/stator sleeves

- **For all these combinations / principles we offer:**
  - **24/7 Turnkey production systems for serial production of CFRP rotor sleeves**
    - Direct winding systems for thermoplastic tape material: single rotor winding or simultaneous winding of several rotors,
    - Direct winding systems for thermoset prepreg/towpreg material: single rotor winding or simultaneous winding of several rotors,
    - Production system for separate pipe winding and subsequent cutting to sleeve length

- **… and manufacturing services / support with ramp up of production**





Advanced Composites – R&D, Part Development and Production

R&D, Part Development:

Concept Development

Support from idea generation to initial design

Concept Validation

Prototyping and testing to ensure the concept works in practice

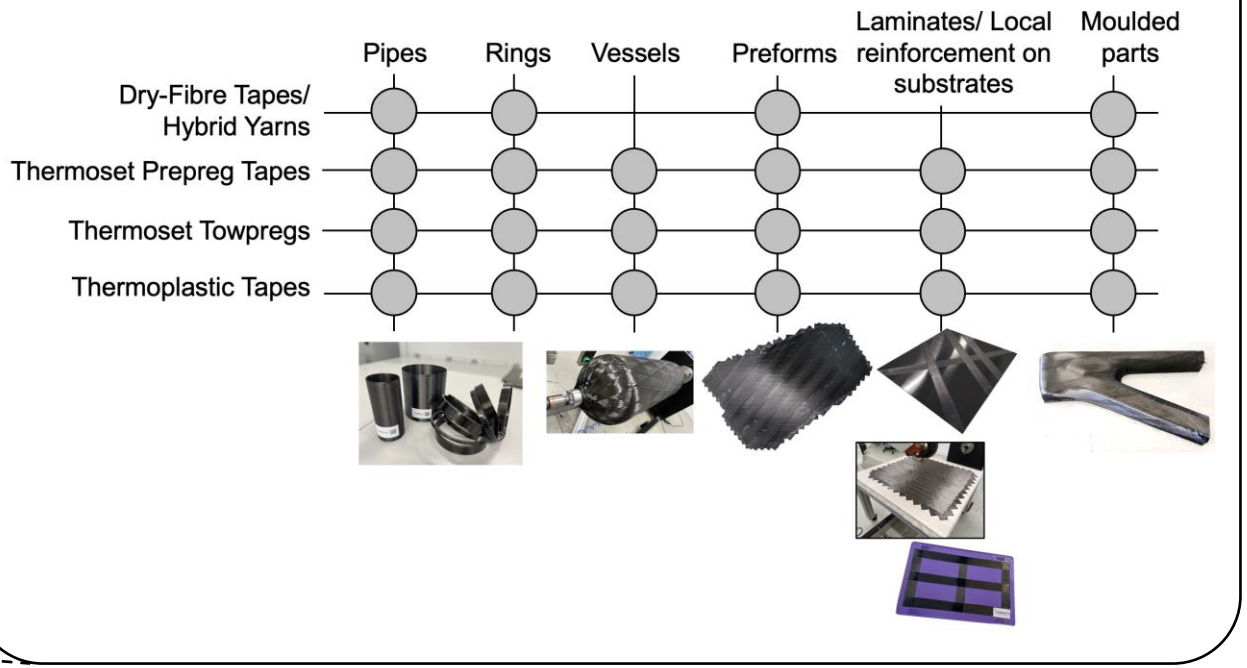
Preparation for Production

Planning for scalability and production efficiency

Production

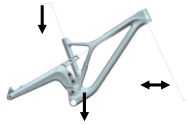
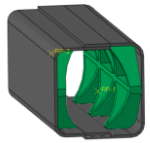
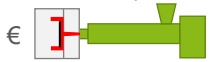
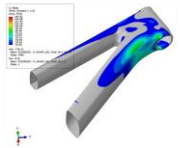
Offering production capabilities for validation and part supply

Production:



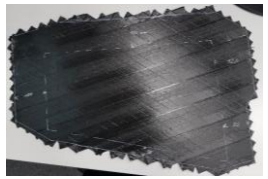
Case Study – High-Volume Bicycle Frame

Bicycle OEM | FRIMO | ANIFORM VIRTUAL FORMING | CONBILITY PRODUCING IDEAS | AZL Aachen GmbH Excellence in Lightweight Production

Specification sheet	Concept design	CAE	Detail CAD	Manufacturing layout	Prototypes
 1. ..... 2. ..... 3. .... Typical requirement studies	 ▪ Material options  ▪ Structural layouts  ▪ Production options & Cost € 	 ■ Mechanical ■ Process ■ Weight optimisation		 ■ Cost analysis ■ CO_2 analysis ■ Facility planning & implementation	 ■ Tape laying ■ Press forming ■ Drape forming ■ Overmoulding ■ Thermoset & thermoplastic & ■ Testing

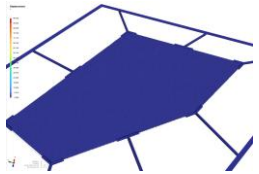
Final Part for Testing: Two shells, joined with a developed welding technology

Tailored Blank Designs



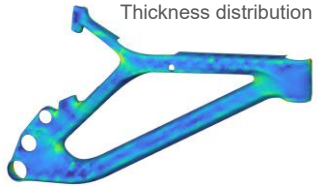
Moulding Studies

Simulation-based optimization

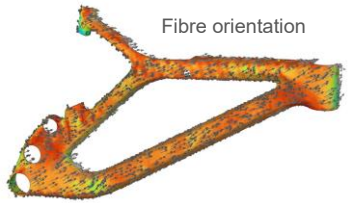


Layup and process optimization

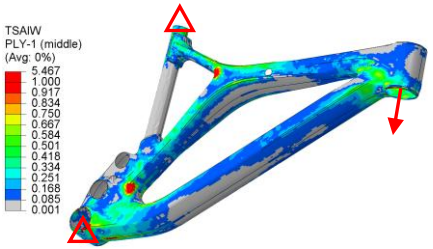
Thickness distribution



Fibre orientation

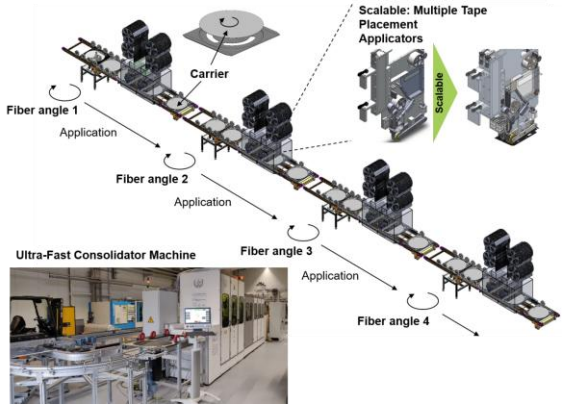


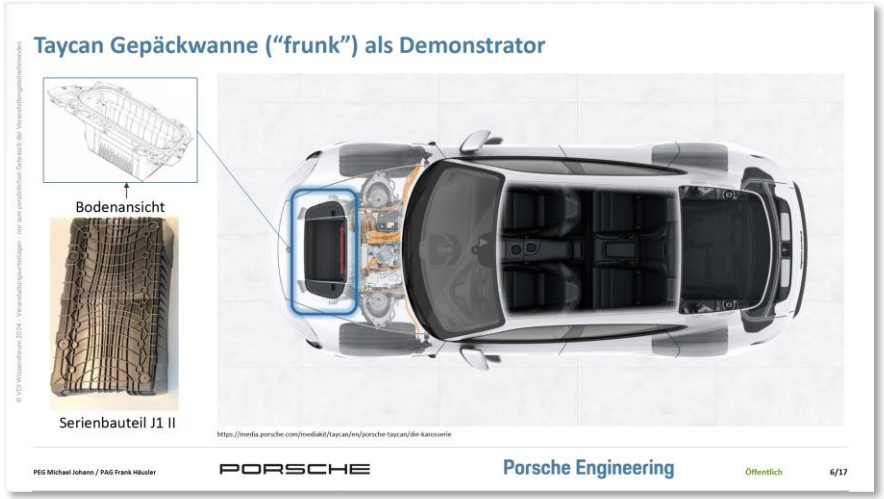
Composites CAE stress analysis

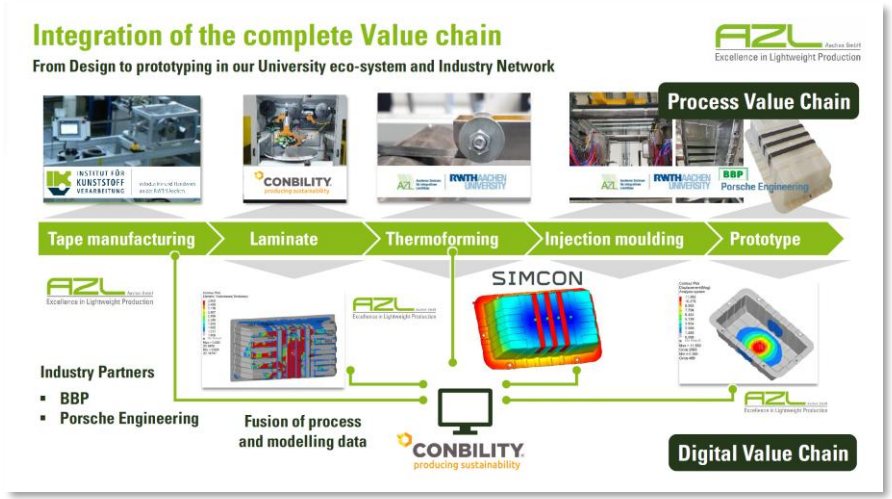


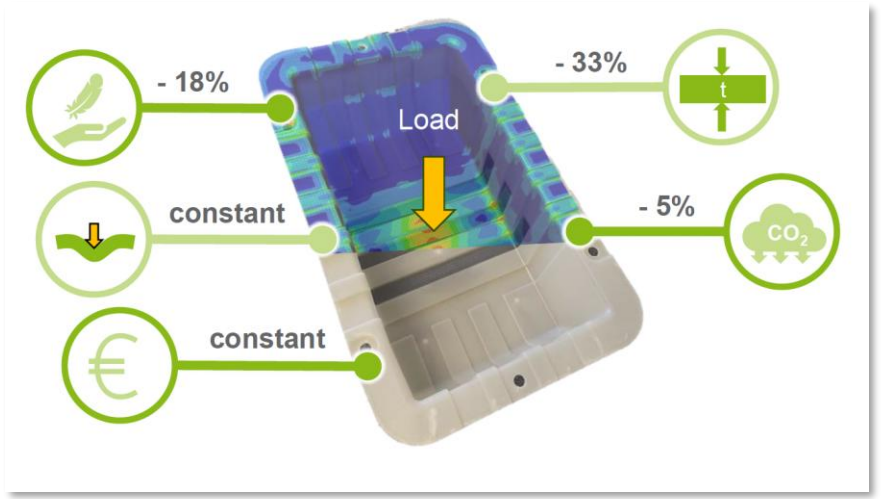
Exemplary Application of Tailored Blanks, Preforms, Local Reinforcement

Ultra-High Volume Upscaling
Solution: 5 Mio./a









Let’s find the best-fit technology for your application…

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www.conbility.com