CONBILITY®
producing sustainability

Conbility GmbH

Advanced Machine Systems for Composite Production

Conbility – Profile

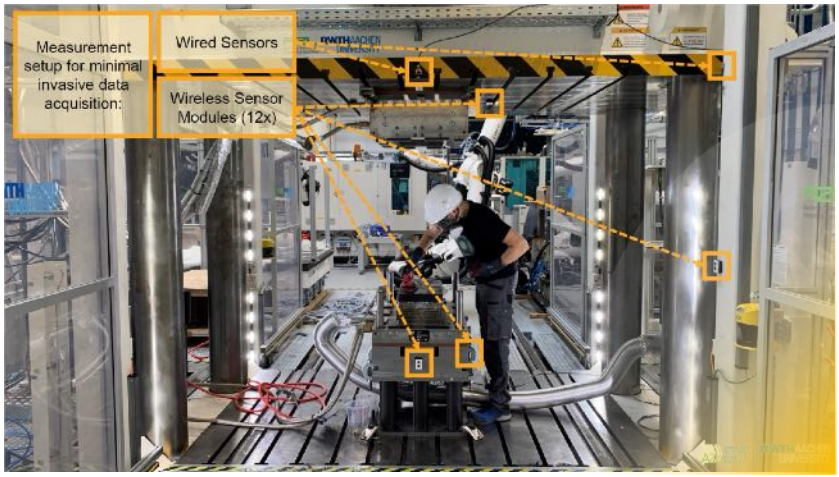
- **Founded 2015 in Aachen**
- **Location since 2019: Technology Parc TPH, Herzogenrath**
- **Strong Background in:**
  - Production Technology and Material Science
  - Development of Special Purpose Machines
  - Laser Processing Technology
- **Portfolio:**
  - Tape/ Fiber Placement Machines for Composite Production
  - Software for Cost and Eco Assessment
  - Technology Evaluation
  - Digital Transformation

Conbility – Premium Partner of the AZL-Network

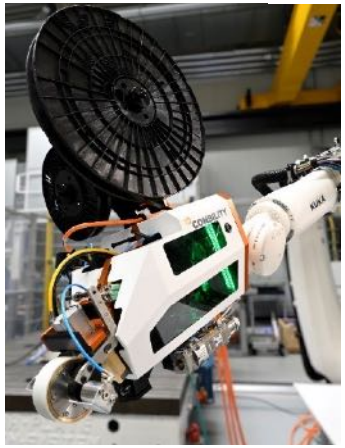
- Process Chains for Hybrid Composite Materials
- Plastic Material- and Processing Technology
- Production Technologies
- Machine Tools and Production Metrology
- Laser Technology
- Automotive Science and Engineering
- Fiber- and Textile Technology
- Welding and Bonding Technology
- Structural Mechanics and Lightweight Design

Conbility – Fields of Activity

Digital Transformation

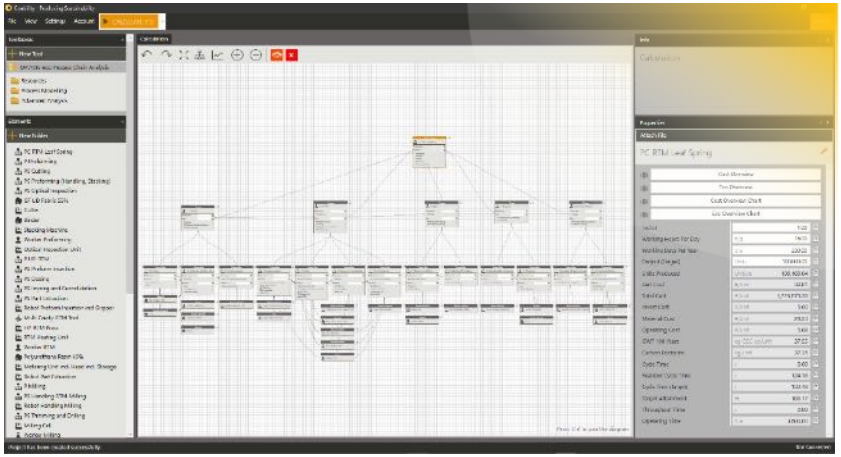


Tape Placement Machines

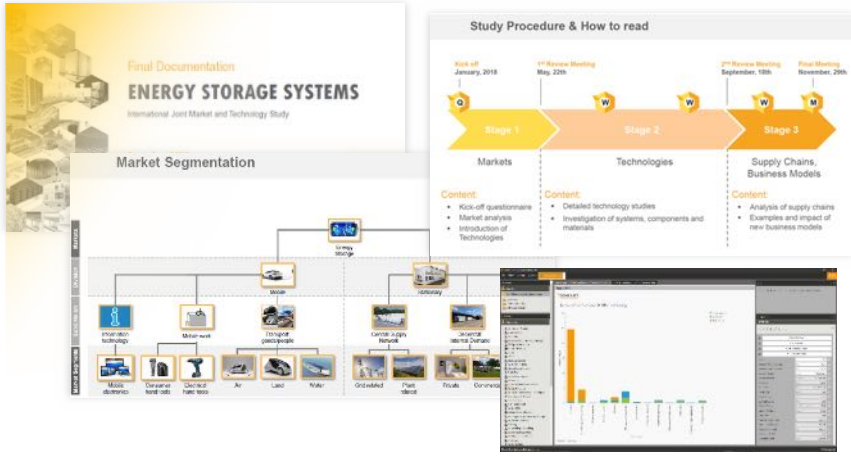


3D Tape Placement Applicator

2D Tape Placement Machine at Conbility



Software for cost and eco assessment



Technology Evaluation

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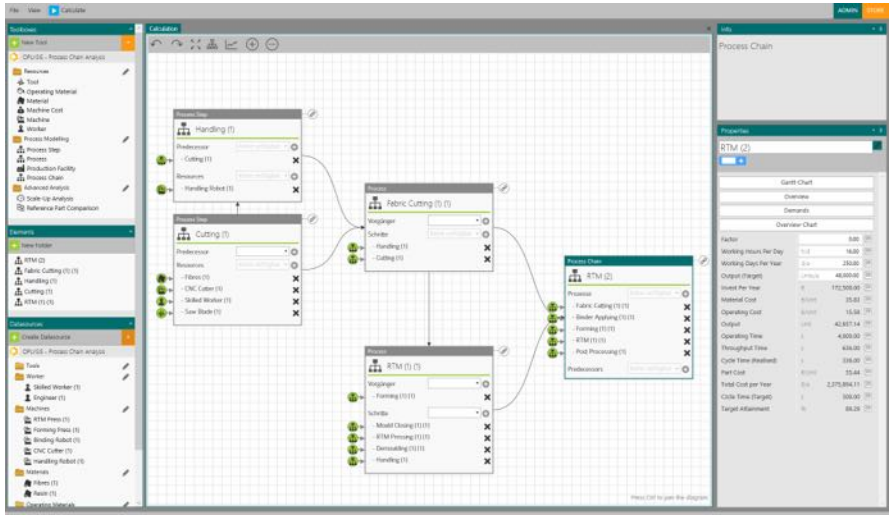
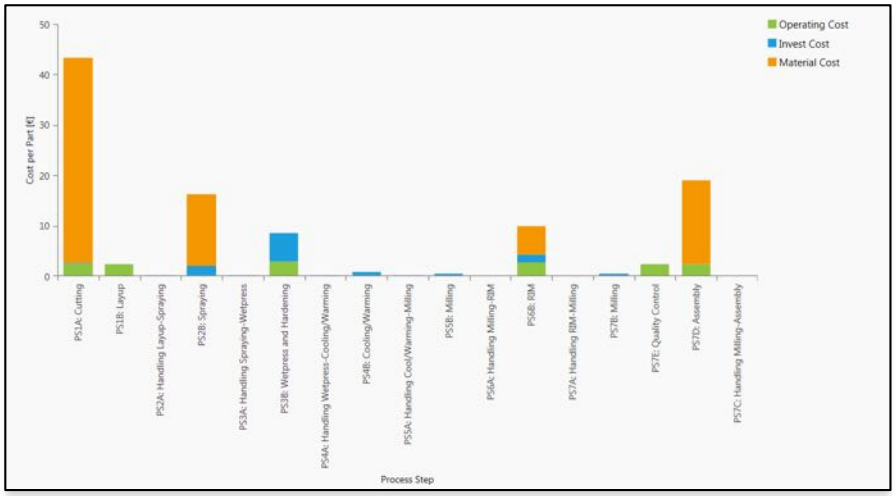
Software for Costing and CO_2 Footprint Analysis,

Advisory Services

OPLYSIS® - Calculate Product Costs and Production Capacities

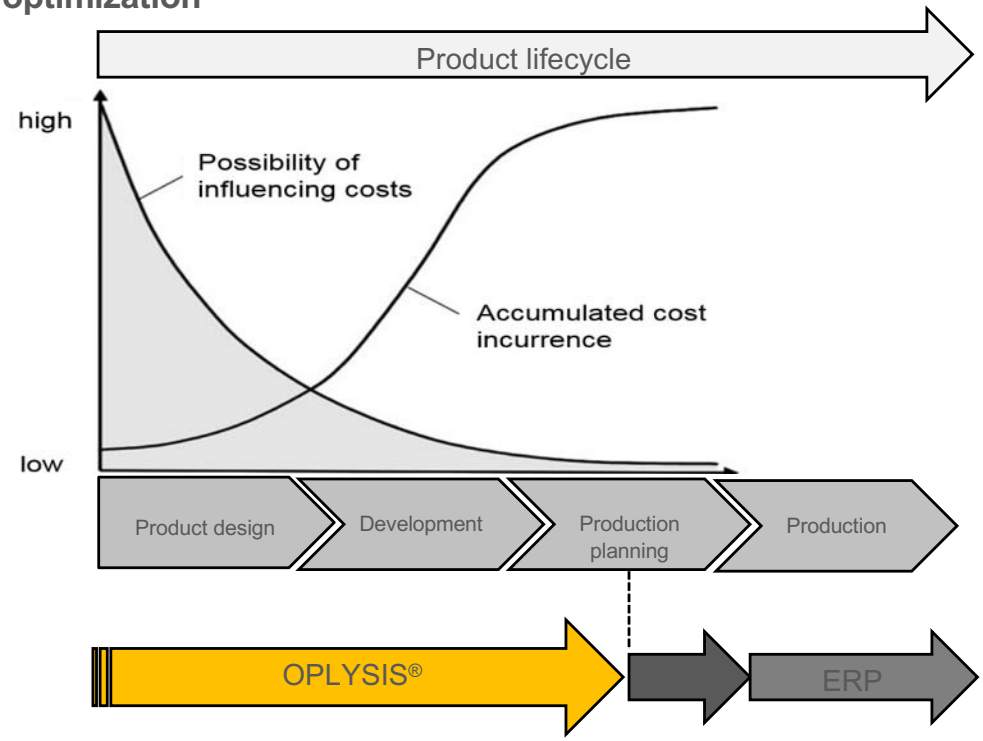




- **Costing Software** for calculating product costs and capacities of serial production scenarios
- **Drag&Drop Workspace** for easy and transparent modelling of production sequences
- **Branch- and Technology Independent** by using basic elements of Activity Based Costing methodology
- **Expressive** by providing cost structures and cycle times for every process stage
- **Fast** by adding and linking calculation elements by drag&drop
- **Easy-to-use** by guided input for the required information
- **Reliable** by using standard calculation routines and visual representations of interdependencies
- **Inspiring** by facilitating real-time modification and substitution of process sequences
- **Affordable** by flexible subscription model on monthly basis

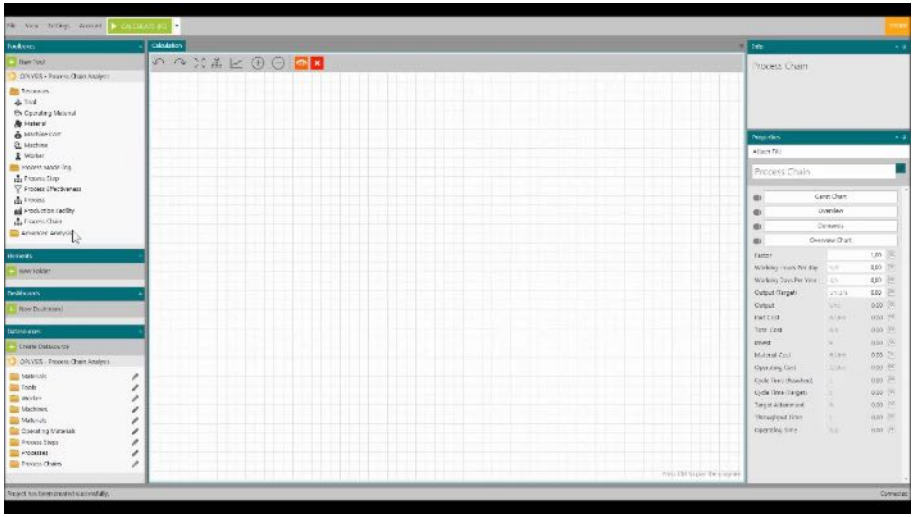
OPLYSIS® - A Concurrent Engineering Tool to save Costs and Time

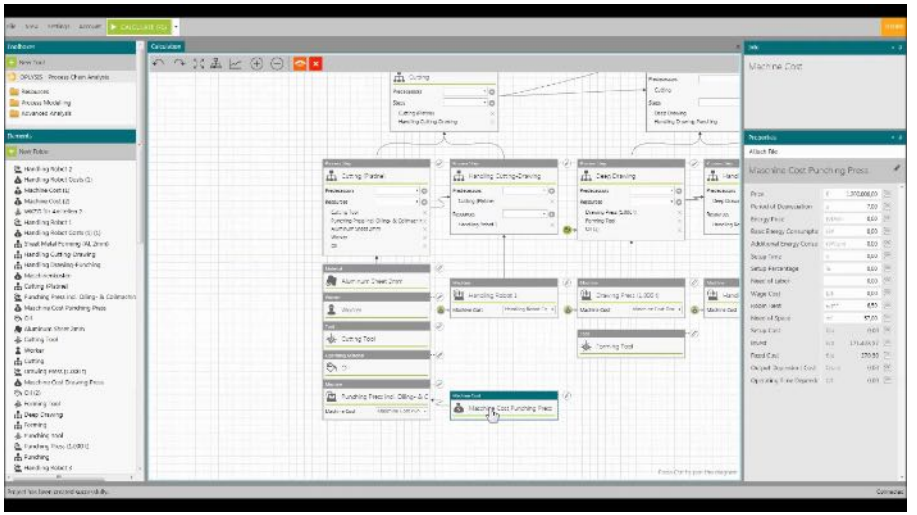
OPLYSIS helps to directly evaluate the impact of product design on the manufacturing costs and facilitates simultaneous optimization



OPLYSIS enables early

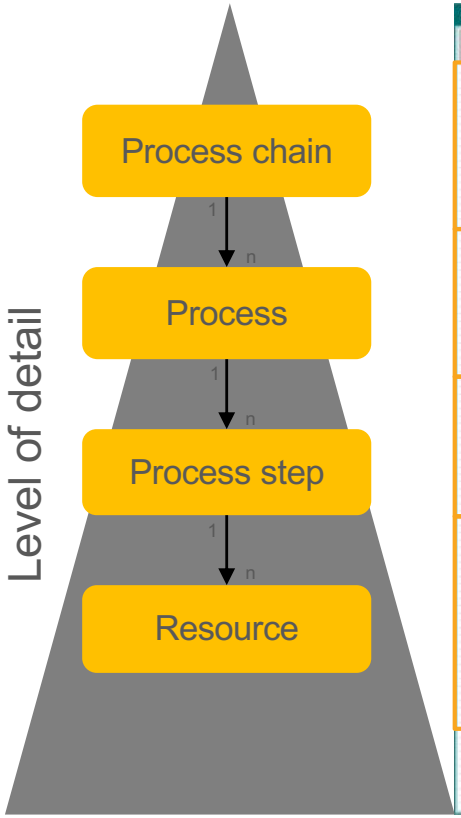
- Assessment of invest and production cost
- Identification of cost drivers and bottlenecks
- Effects analysis of different production scenarios or alternative resources (materials, machines, technologies, etc.)

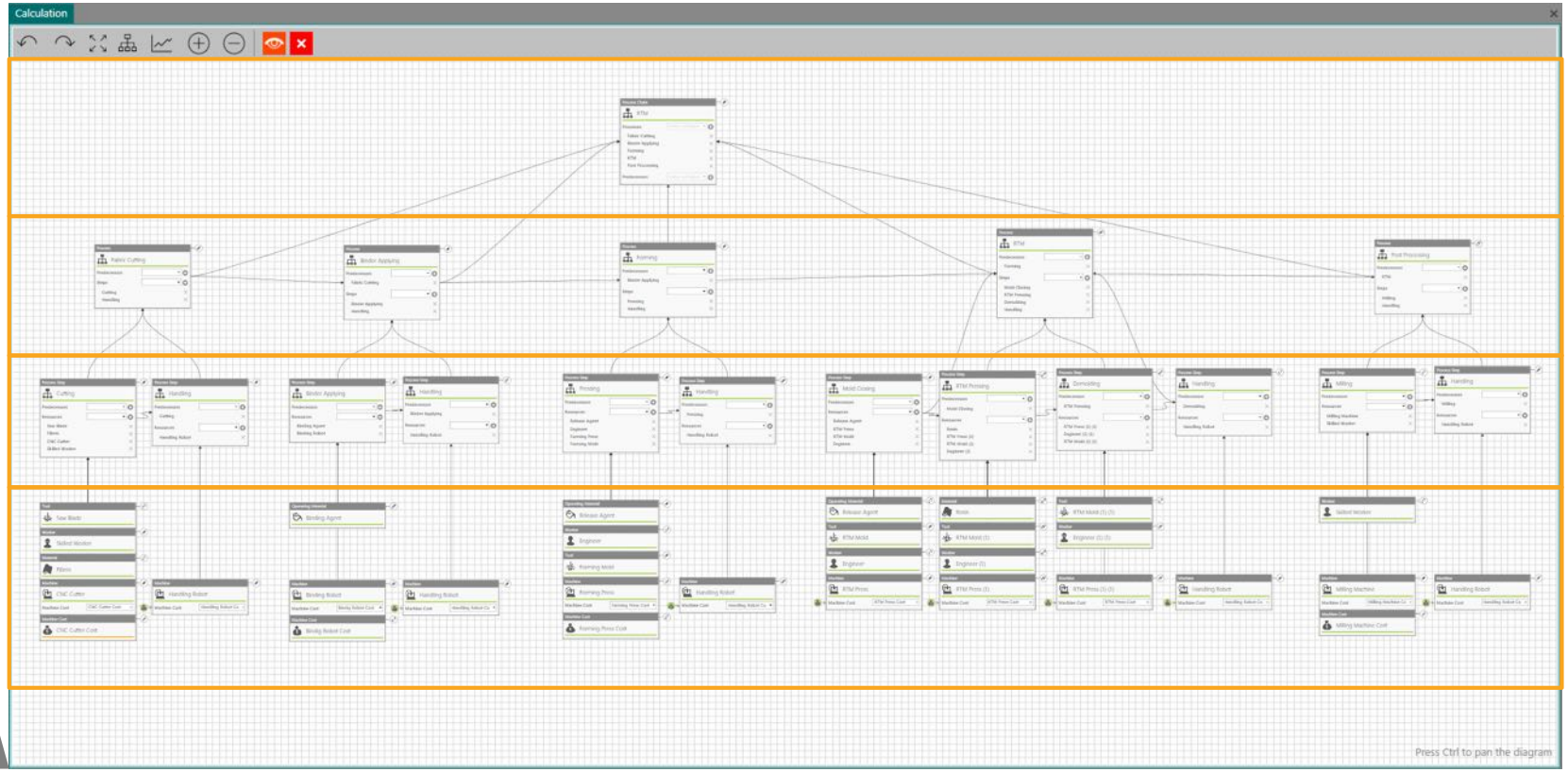




https://www.youtube.com/channel/UC6bsSogrG-vdZrKHSVW6NkQ

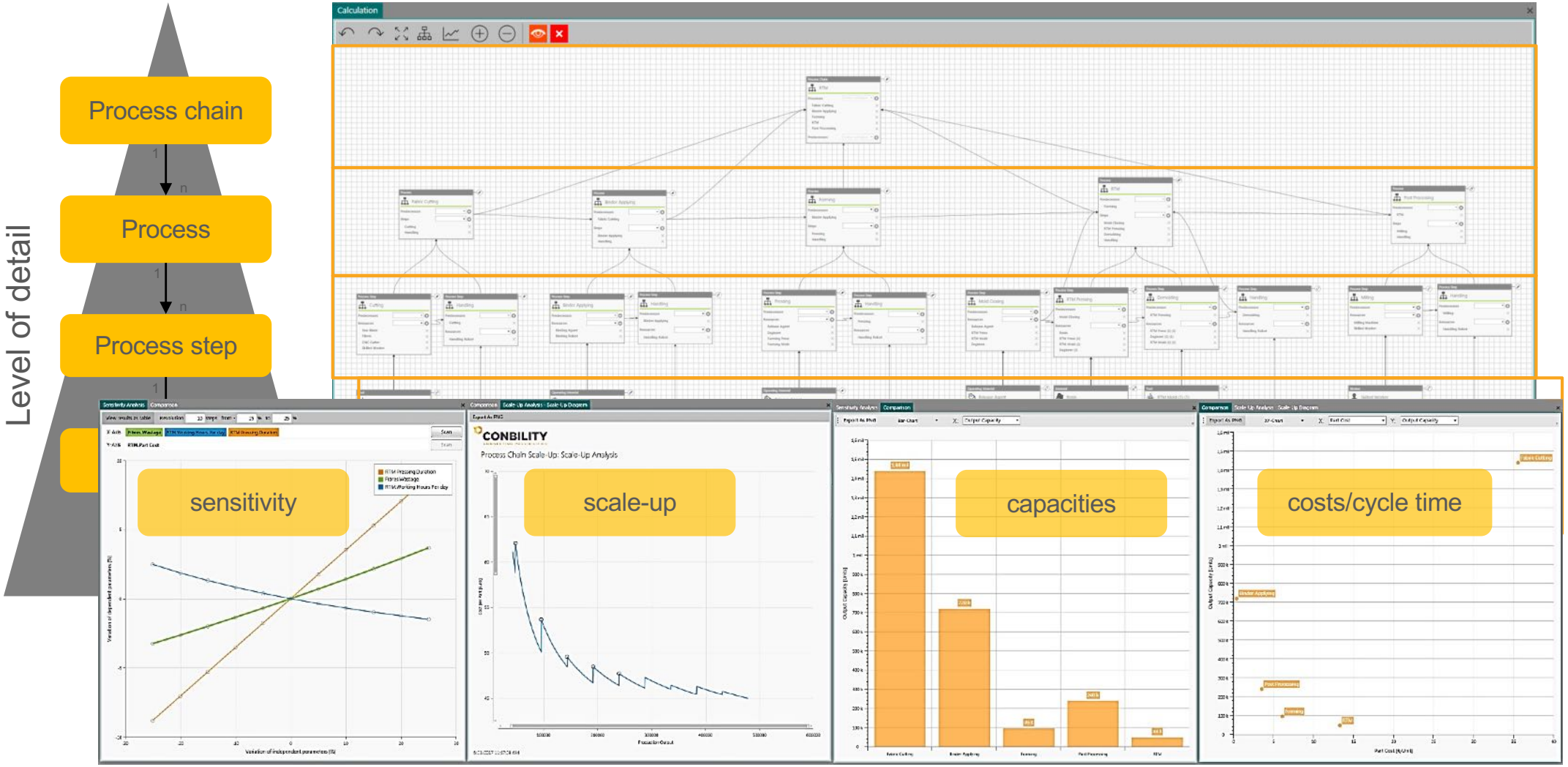
Transparent process flow on different levels of detail



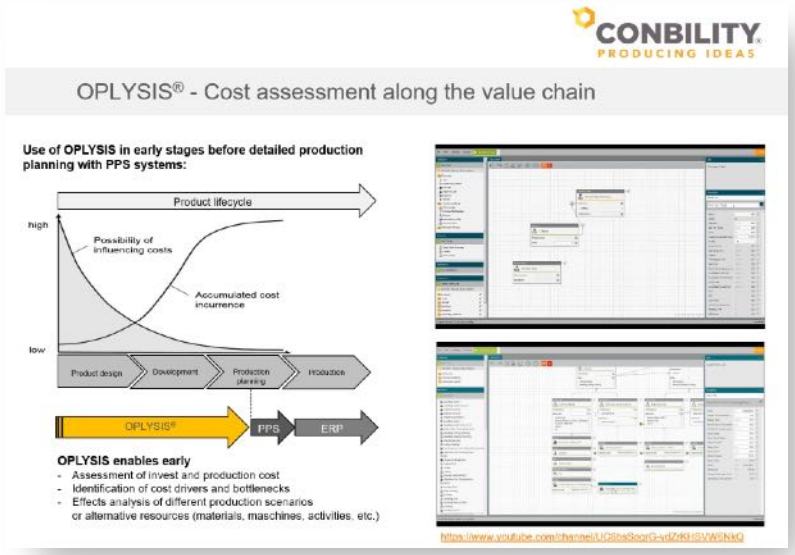


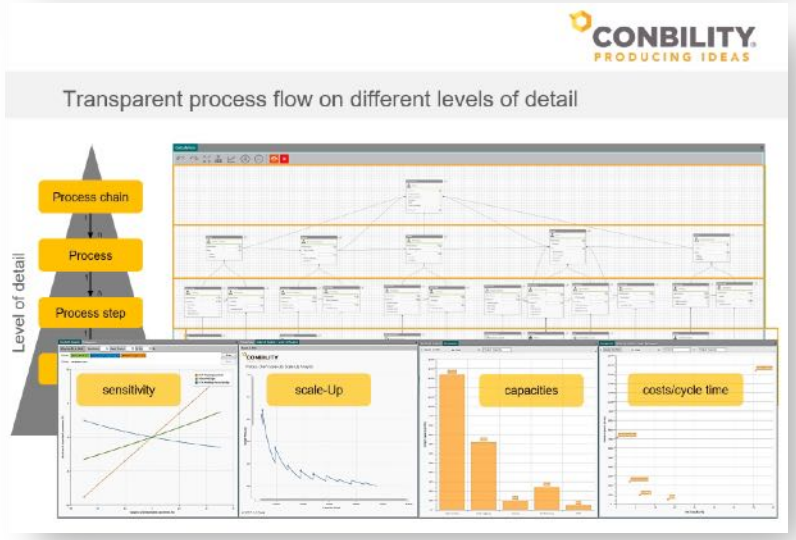
- Calculation of material, operating and invest cost on every level of detail
- Calculation of cycle and throughput time and output per year in consideration of i.e. scrap and resource availability

Transparent process flow on different levels of detail



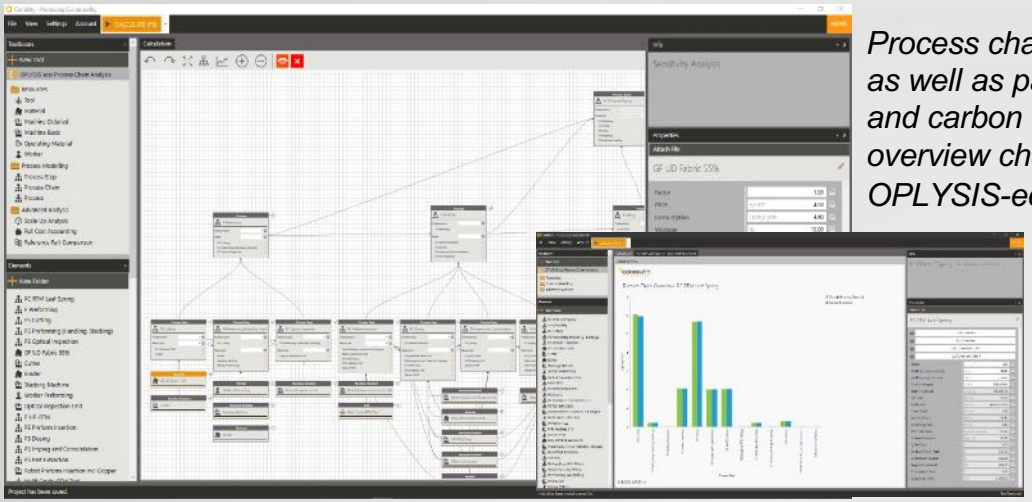
Our Products and Services





- **Product: Process Costing Software „OPLYSIS“**
  - Intuitive Drag&Drop Workspace
  - Advanced Analyses (Sensitivities, Scale-up, Capacities)
  - Assessment of Invest and Production cost
  - Identification of Cost Drivers and Bottlenecks
  - Effective Analysis of different Production Scenarios
- **Advisory: Modelling and Analysis with our Team**
  - Modelling of your existing Production or of different Production Scenarios
  - Support in Production Planning
  - Identification of Cost Drivers and Bottlenecks before Start of Production
  - Technology Consulting

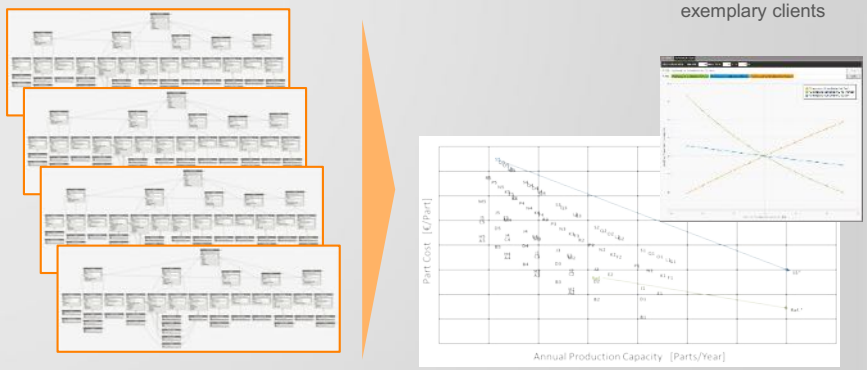
Production Cost and Carbon Footprint Assessment using OPYLSIS-eco



Process chain model as well as part cost and carbon footprint overview chart in OPLYSIS-eco

exemplary clients

- Integrated software for **simultaneous calculation carbon footprint, product cost and production capacities** of production scenarios
- **Drag&drop workspace** for easy, intuitive and transparent modelling of production scenarios
- **Branch- and technology independent** by using basic process chain elements suitable for any production scenario
- **Efficient analysis** of key performance drivers with **sensitivity analysis** and **scale-up analysis**
- **Inspiring** by facilitating real-time modification and substitution of process sequences



Easily derive multiple production scenarios by parameter variations and sensitivity analysis

What we offer:

- OPLYSIS-eco software license
- Benchmarking of Material and Process Technologies as an Individual Service

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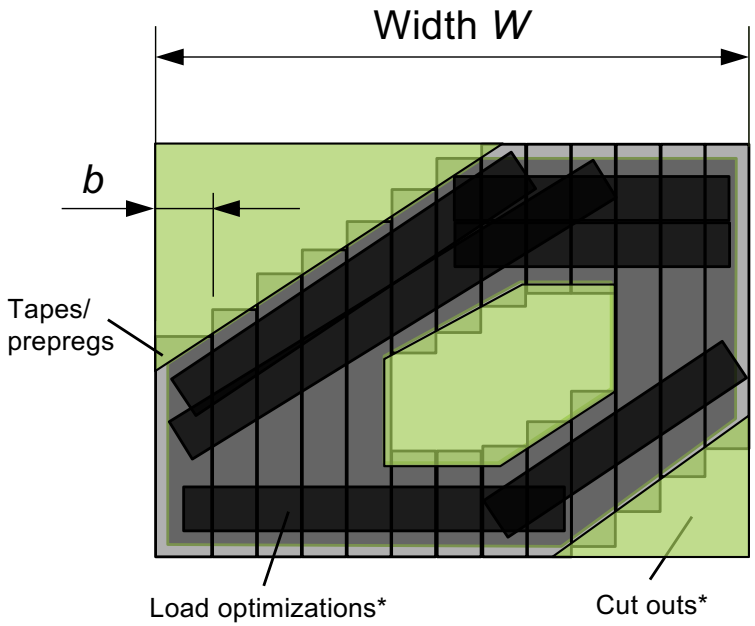
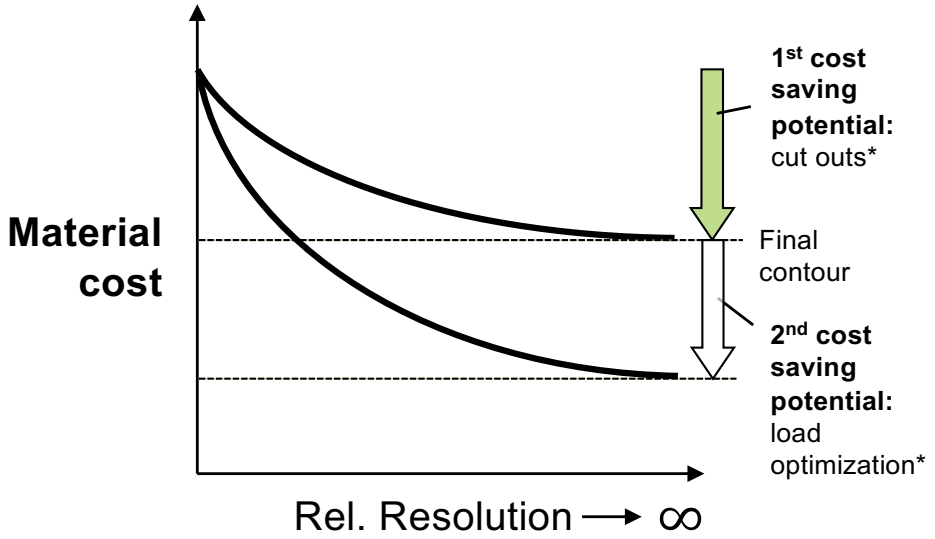
Tape Placement Systems

Double Belt Press Systems

Laser-assisted Tape Placement
Motivation



Tailored composite blank



$$Rel.Resolution = \frac{W}{b}$$

* depends on the product design and mechanical requirements

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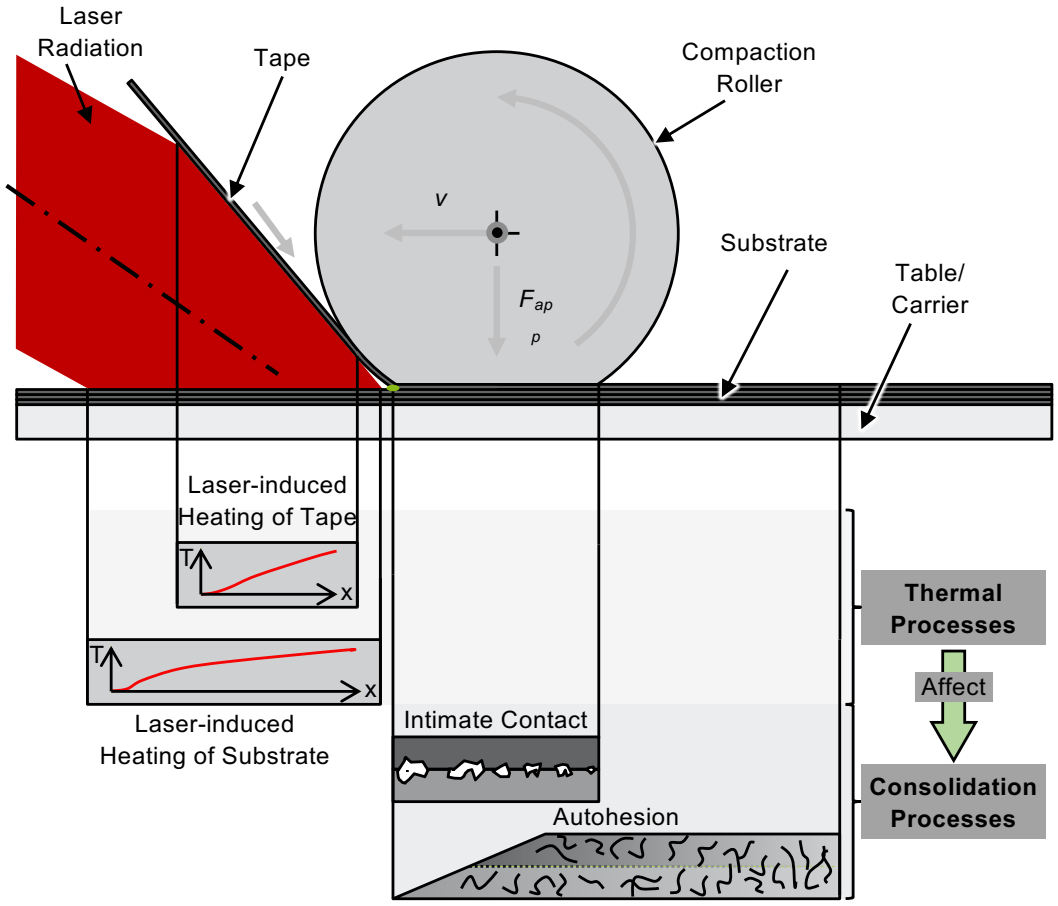
Laser-assisted Tape Placement with in-situ Consolidation
Process Principle and Advantages

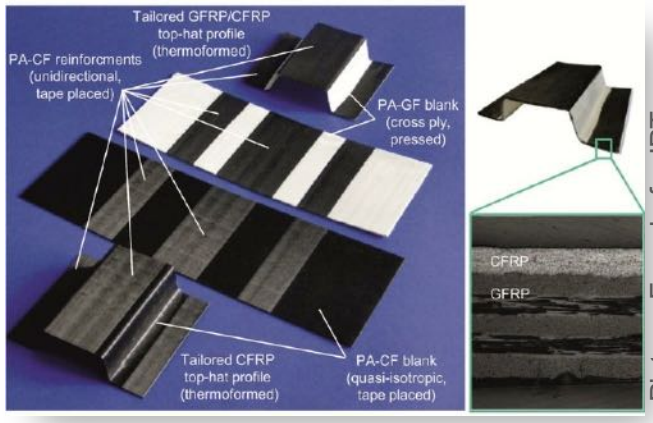


Advantages

- **Energy-efficient heating of process zone due to usage of laser radiation**
- **Precisely and fast controllable laser-induced heating**
  - Closed-loop control of laser power
  - Avoidance of over-heating
- **No post-consolidation processes**
  - Energy efficient and resource efficient
  - Cost efficient (process and investment costs)
- **High flexibility**
  - Thickness variations within a laminate
  - Usage of different tape materials within a laminate
  - Production of tailored 2D composite sheets
  - Final local reinforcements of parts or organic sheets
- **Advantages for subsequent thermoforming**
  - Better stability for handling operations
  - Strong laminate fixation during injection molding
  - Faster and more homogeneous heating before thermoforming due to complete contact of the tape surfaces

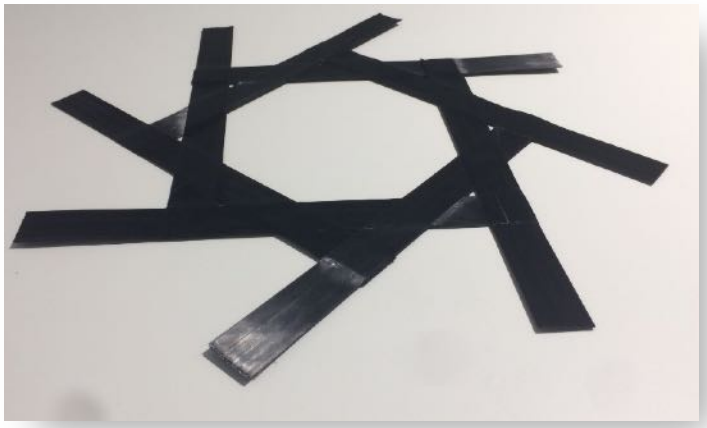
Exemplary Addressed Product Categories

Load- and cost optimized multi-material combinations



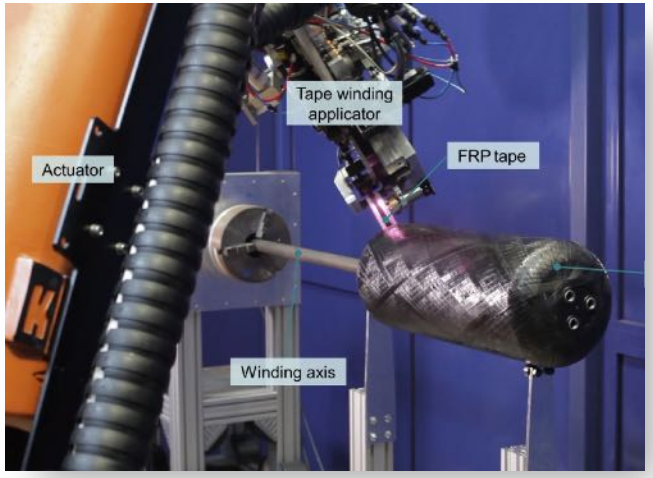
Picture: Fraunhofer IPT, Aachen

Tailored Composite Blanks



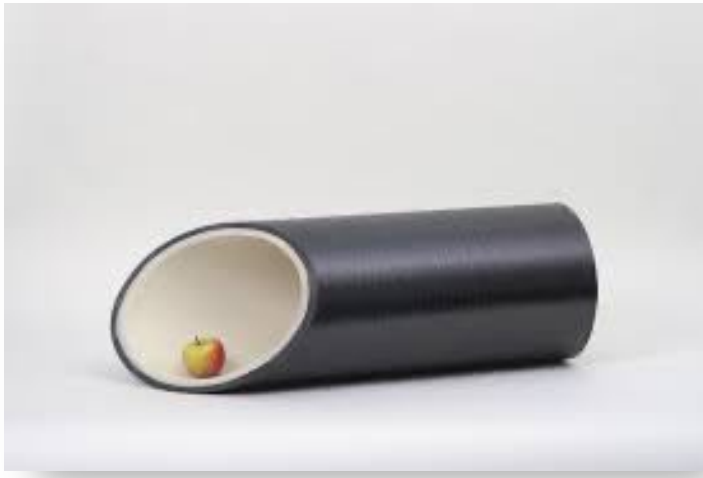
Picture: Aachen Center for integrative Lightweight Production (AZL)

Composite vessels



Picture: Fraunhofer IPT, Aachen

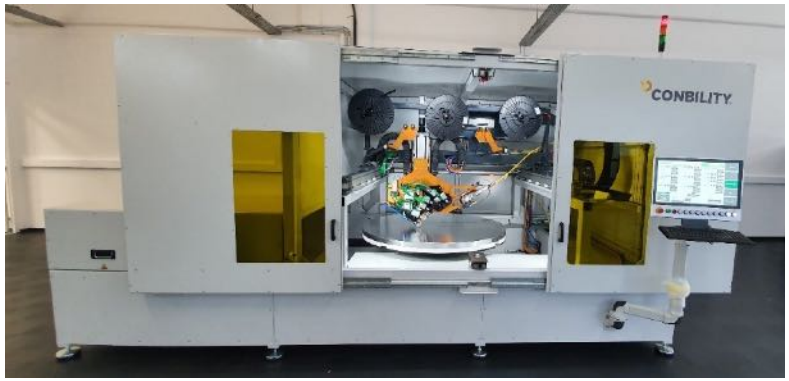
Composite pipes



Picture: Fraunhofer IPT, Aachen

Our Standard Tape Placement and Winding Systems

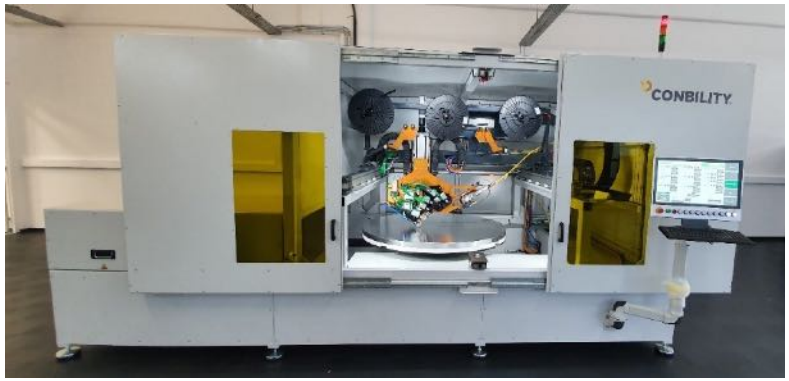
- 2D Tape Placement Machine



- 3D Tape Placement Head „Multi-Material-Head“

Our Standard Tape Placement and Winding Systems

- **2D Tape Placement Machine**



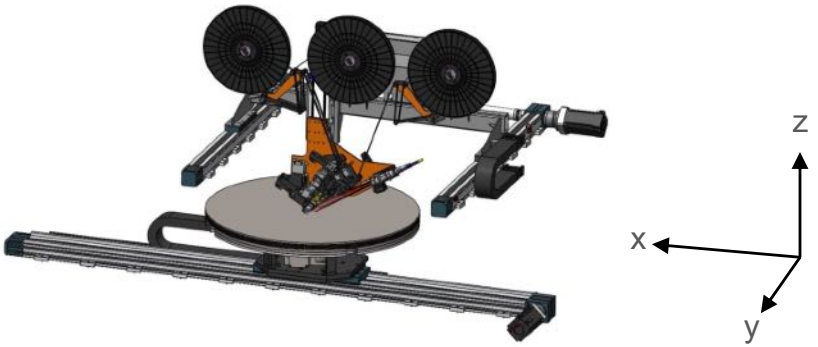
- **3D Tape Placement Head „Multi-Material-Head“**

2D Tape Placement Machine

Laser-assisted Tape Placement with in-situ Consolidation

Laser-safe and Key-ready Maschine for laser-assisted Tape Placement with in-situ Consolidation

PrePro 2D for laser-assisted tape placement:



Video:

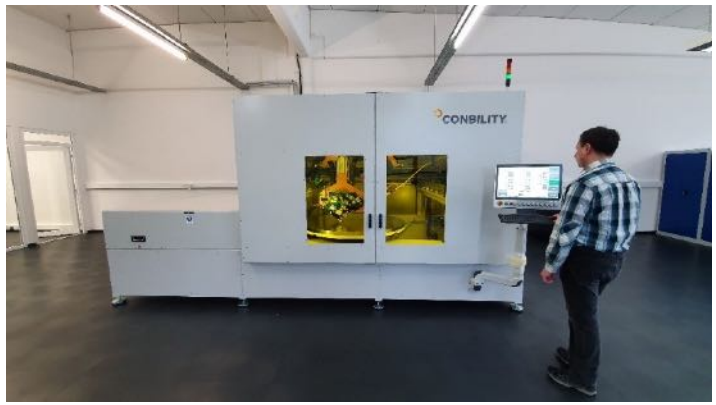
YouTube Video:

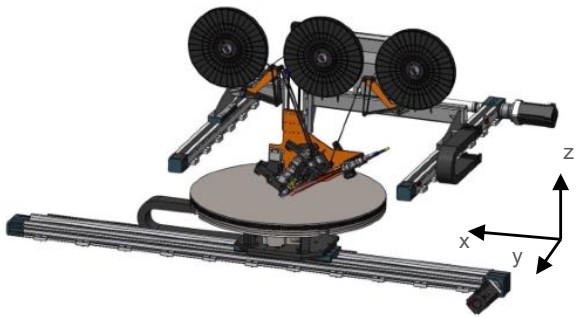
https://youtu.be/Q_pKDH006xo

System Properties

- Table size: up to Ø 2 m
- Multiple tapes possible
- Process speed: up to 1 m/s

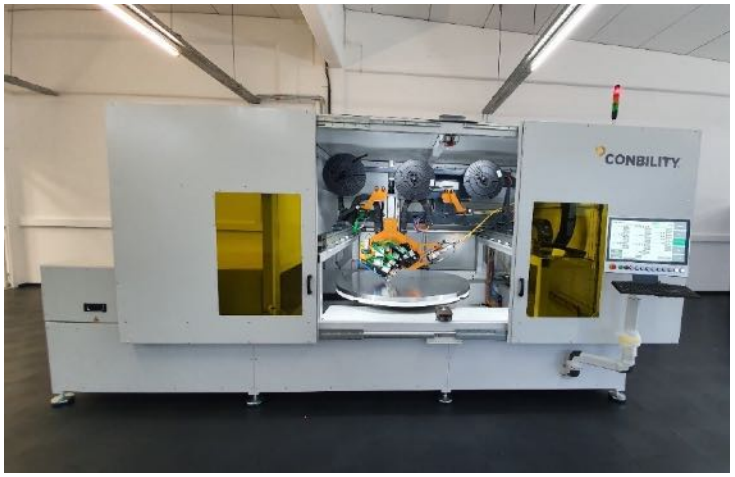
Machine Characteristics

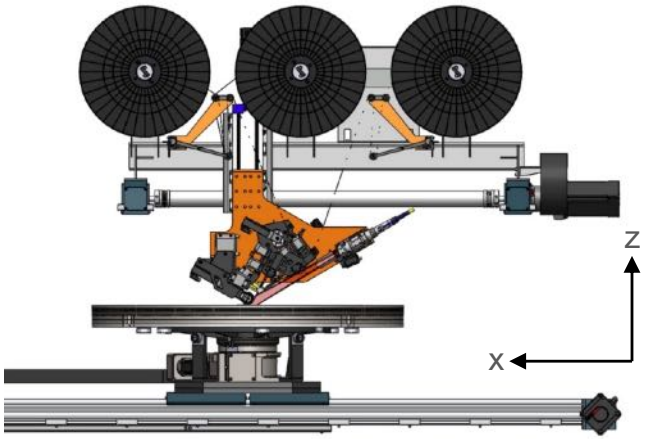




- ***Plug&Produce Production Machine*** for manufacturing tailored composite blanks by automated thermoplastic tape laying
- **Small footprint** of 5 x 2.5 x 2.5 m^3
- **Flexible arrange- and reconfigurable on the shop-floor** by low weight of 3.2 t, moveable by forklift
- **Integrable into fully automated production lines** by automated unloading mechanism
- **Direct further processing of laminates in thermoforming** by using in-situ consolidation (no additional costly, energy-consuming and space-demanding consolidation step needed)
- **High cost- and material efficiency** by independent cut and add on-the-fly for each tape
- **High productivity** by consolidation of tapes with up to 1 m/s and simultaneous placement of three tapes in parallel
- **Highest standard for the laminate quality** by using aerospace proven laser heating
- **Prevention of over-heating** by temperature-control in the process zone
- **Flexible adaptable of tape material** by exchangeable modules to cover tape widths from 6 to 25 mm, thickness up to 0.3 mm
- **Full control and documentation of all relevant process parameters** by user-friendly HMI and machine control

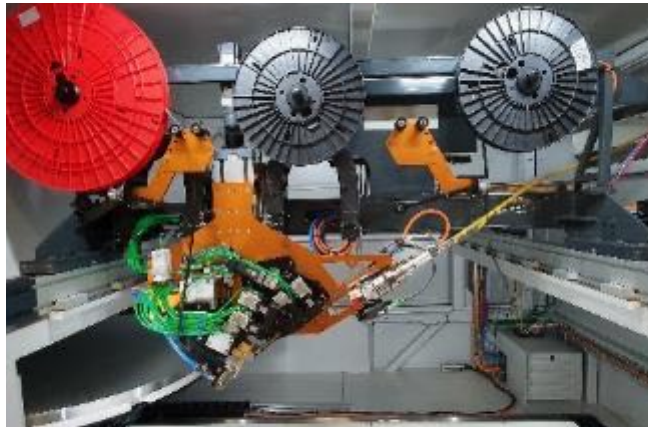
Main Specifications





- **General Specifications:**
  - Machine dimensions: 5 m x 2,5 m, weight: 3,7 tons, (approx.)
  - Laser safety class 1 (laser safe stand alone machine system)
  - Process: laser-assisted tape placement with in-situ consolidation
  - Free choice of tape (fiber) directions
  - Variation of different thicknesses within a laminate
  - No post-processing for consolidation
- **3 x Spool Applicator:**
  - Tape width: standard 25 mm (3x)
  - Tape thickness: <0,3 mm, minimum length <95 mm (tape 1+3), <112 mm (tape 2)
  - Translational Z-axis for applicator movement (vertical direction / blank thickness): 100 mm
  - Translational Y-axis for applicator movement: TCP on complete table surface
  - Automatic pneumatic cutting unit for „cut-and-add-on-the-fly“
  - Exchangeable cooled compaction roller units: 1x rigid surface and 1x elastomer surface
  - Adjustable consolidation force up to approx. 500 N
- **Rotary Table with integrated Heating Functionality:**
  - Table diameter: 1,500 mm, alternative 2,000 mm
  - Max. heating temperature table: 200 °C
  - Rotary table (+/- 90°) and translational X-axis for table movement
  - Max. speed in X-direction: 1m/s (typical process speed for PA-tape: 850 mm/s with laser)
- **Laser System:**
  - 4 kW high power diode laser incl. cooling, optical fiber and processing optics
- **Control System:**
  - Beckhoff industrial control system including HMI based on TwinCat 3.1 and G-code
  - Controlable process parameters: speed, laser power (temperature), compaction pressure
  - Recording of process parameters, IR-camera for monitoring of process zone and temp. control

Configurable and Scalable Machine Setup



System Properties

- Heating table: Ø 1,5 m (scalable up to 2m)
- 3-spool-applicator (scalable)
- Integrated 4 kW Laser system (scalable)
- Process speed: up to 1 m/s

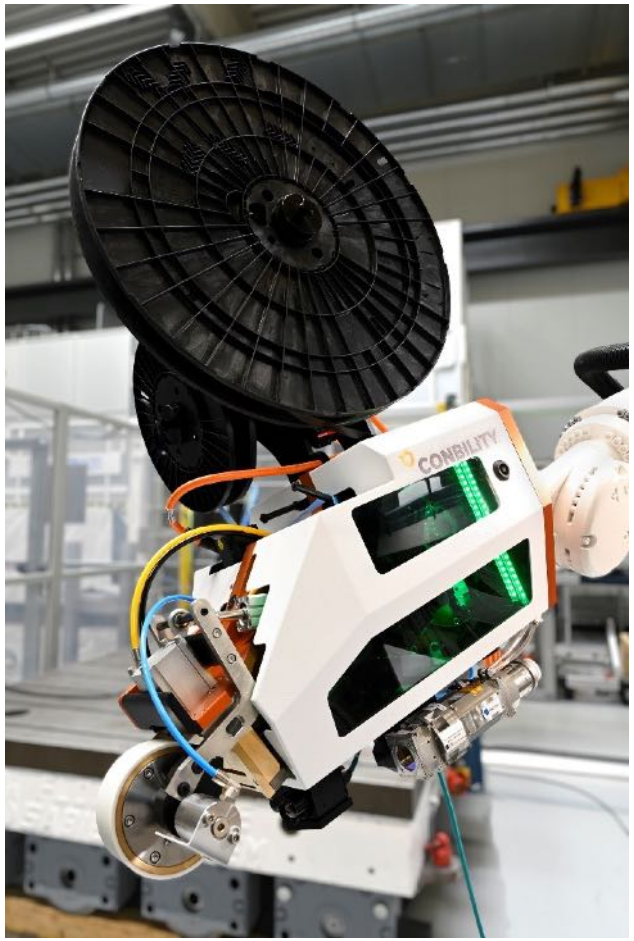
Our Standard Tape Placement and Winding Systems

- 2D Tape Placement Machine

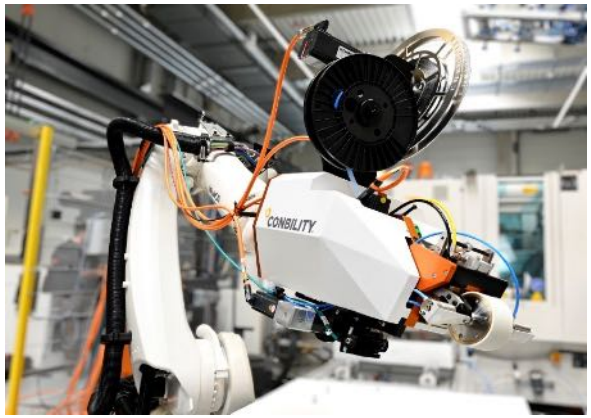
- 3D Tape Placement Head „Multi-Material-Head“

3D-Multi-Technology-Tape Placement Unit

Compact and configurable placement system for automated 3D layup of rovings, prepregs and towpregs



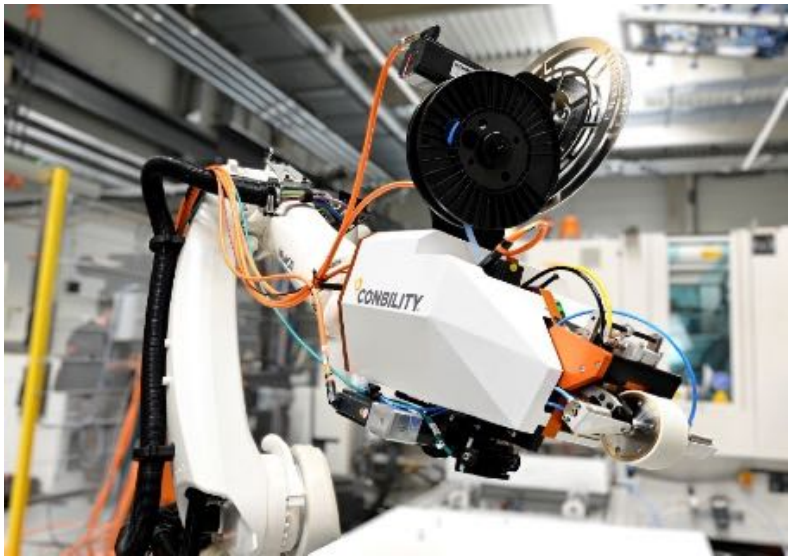
Properties of the system:

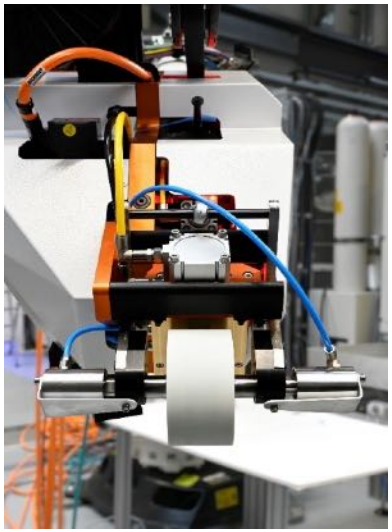


- One investment for the processing of 3 different materials:
  - Thermoplastic CFRP and GFRP Tapes
  - Thermoset CFRP and GFRP Prepregs
  - Dry Fiber Rovings
- Suitable for placement and winding operations
- Single tows/ tapes with width up to 50 mm
- Tape tension control
- Infrared heater to increase tack of resin
- Prepared for integration (plug-in) of a high-power diode laser system, e.g. 4 kW: mechanical interface for the optical systems, control system preparation
- BECKHOFF-based decentral control system communicating with robot control system, including process parameter close-loop-control and HMI
- Can be mounted to a standard robot and is compatible to standard robotic control systems, e.g. KUKA

Conbility´s Tape Processing Applicator – Main Characteristics

- **Closed-loop control of**
  - laser power for defined temperatures in process zone (high-speed pyrometer for control, high-resolution thermal camera for quality and process monitoring),
  - tape tension,
  - Consolidation force pressure roller.
- **Modular and Reconfigurable**
  - **Scalable tape widths**, e.g. 6 mm, 12 mm, 25 mm up to 50 mm within the standard 50 mm tape processing applicator
  - **Additional upgrade of max. tape width up to 100 mm** for the tape processing applicator available
  - All parts (rollers, bearings, guidings, etc.) capable for **heavy-duty operation**, easily exchangeable for maintenance **and adaption for special purposes** (e.g. special fibre materials like ceramics)
  - Upgradeable for **dry-fiber placement and prepreg placement** with alternative resins as addition to thermoplastic tapes (**thermoset prepreg**, also with tension-controlled unwinding of backing paper)
  - **Reconfigurable** for e.g. multiple tapes, optimizations for vessel winding and special tasks like ring winding
  - **Flexible platform** for reliable and robust processing conditions

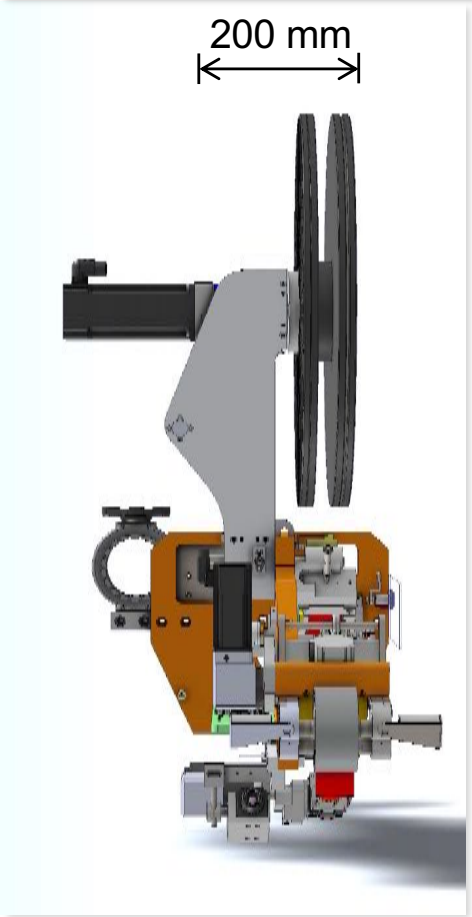




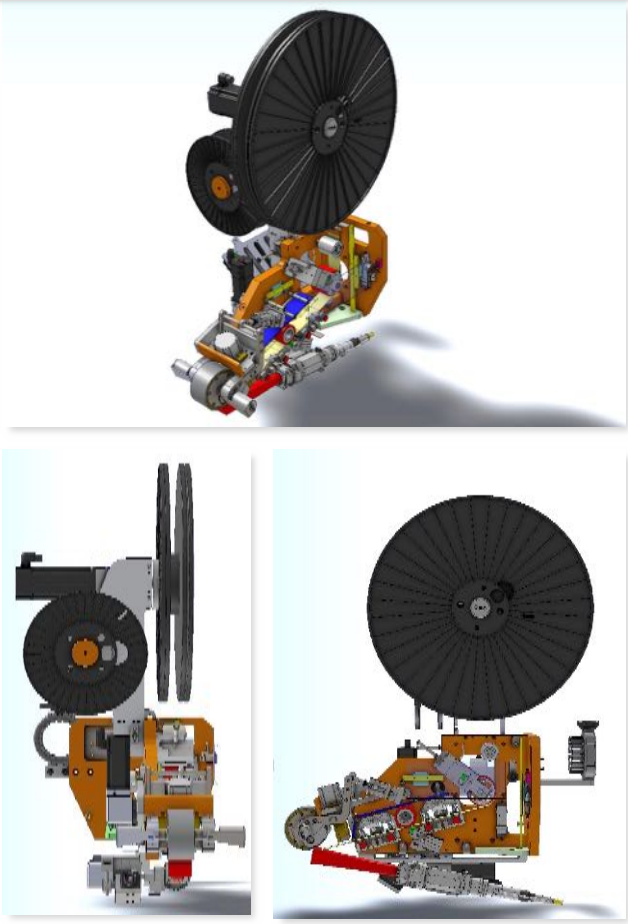
Conbility´s Tape Processing Applicator – Additional Features

- **Adjustable Laser-inclination** (defines distribution of laser power incoming tape/substrate) via servo motor during process
- **Scalable in width** according to client´s demand (e.g. 90° gear for spool drive, compact roller, compact robot interface, positioning of pyrometer/IR-camera)
- 78 kg weight
- **Beckhoff Industrial PC-based** control
- **Laserline high-power diode laser**, 24/7 capable
- **Fluid-cooled laser homogenization optic** with high working distance (low contamination potential) incl. easily exchangeable protection glass

Latest generation of Conbility's industrial-grade product



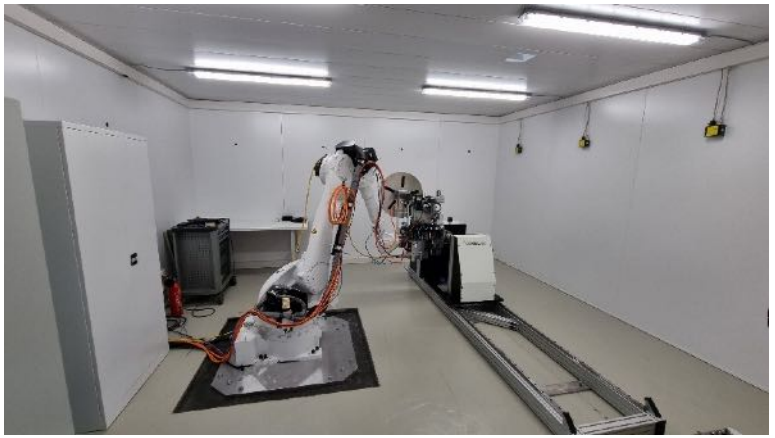
Configuration for tape processing, max. tape width 50 mm



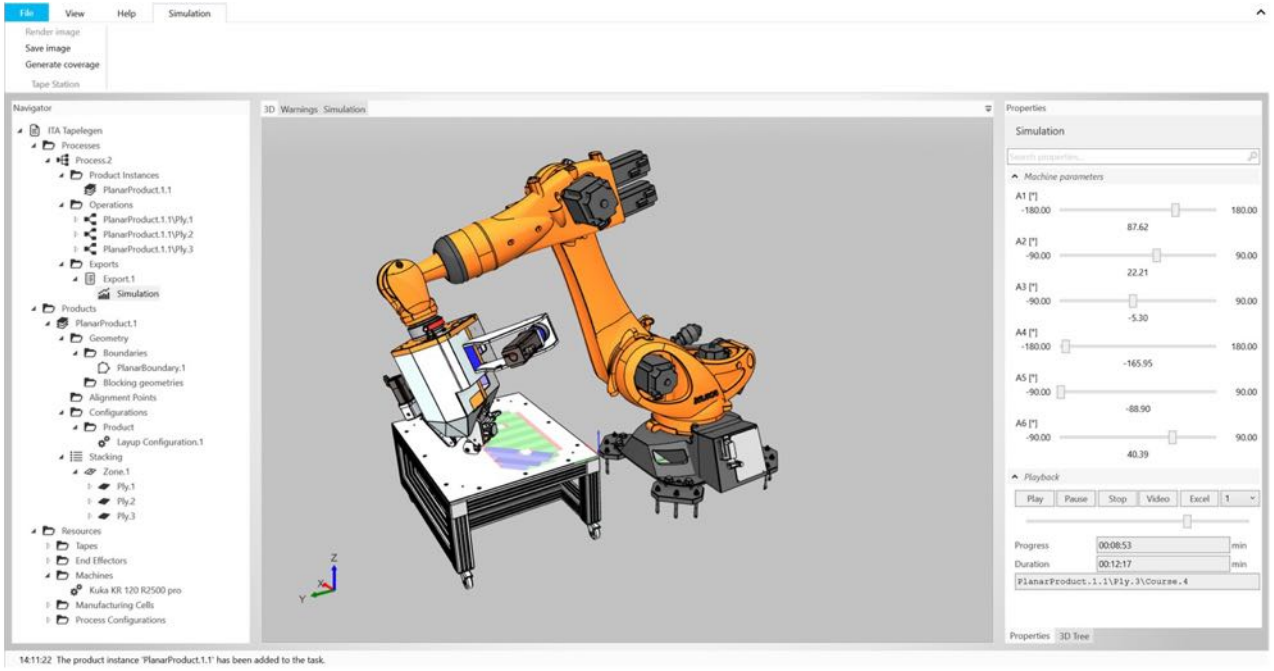
Configuration with backing-paper unwinding upgrade

Conbility – Reference Tape Winding Cell

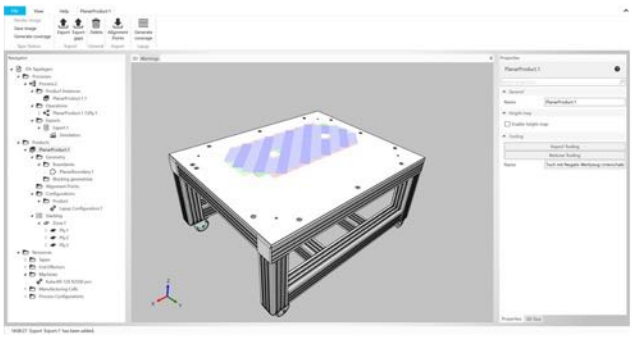
Laser-safe Winding Cell for thermoset towpreg winding and thermoplastic tape winding at Conbility´s technical center in Herzogenrath, Germany



CAD-CAM



simulation of created programs



generating of layup

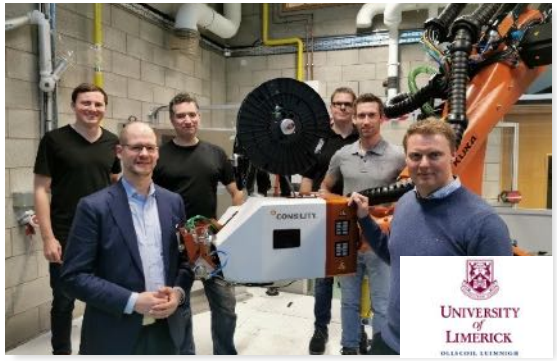
post-processing

Conbility – References Tape Processing Systems

- AIMEN Centro Aplicaciones Láser, O Porriño - Pontevedra, Spain

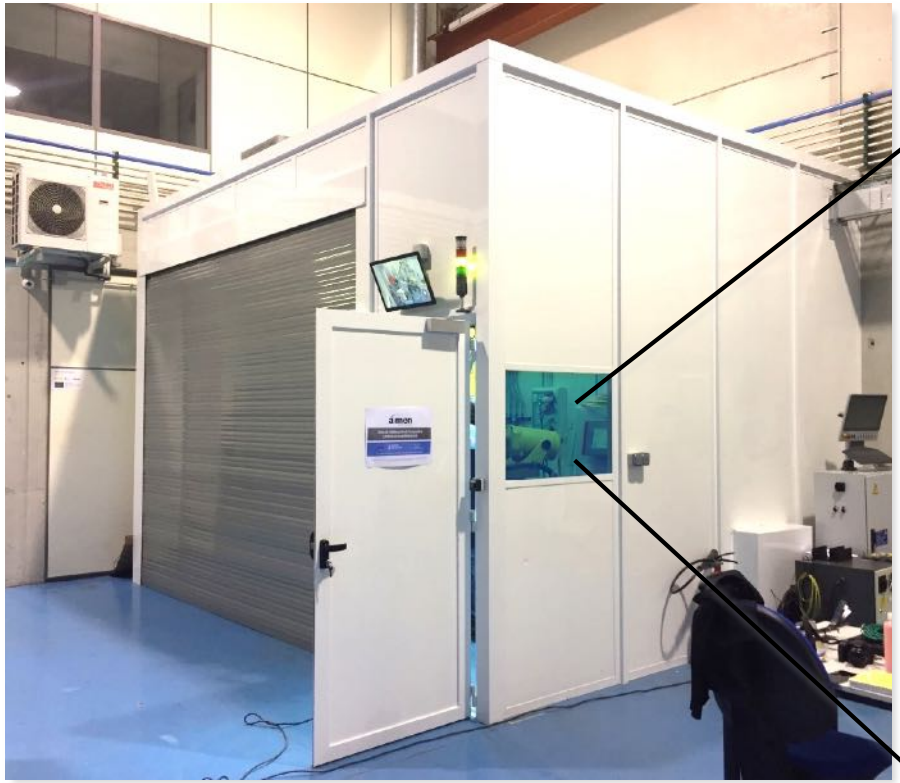
- Bilsing Automation Tic. Ltd. Sti.- Bursa, Türkey

- University of Limerick - Castletroy, Ireland

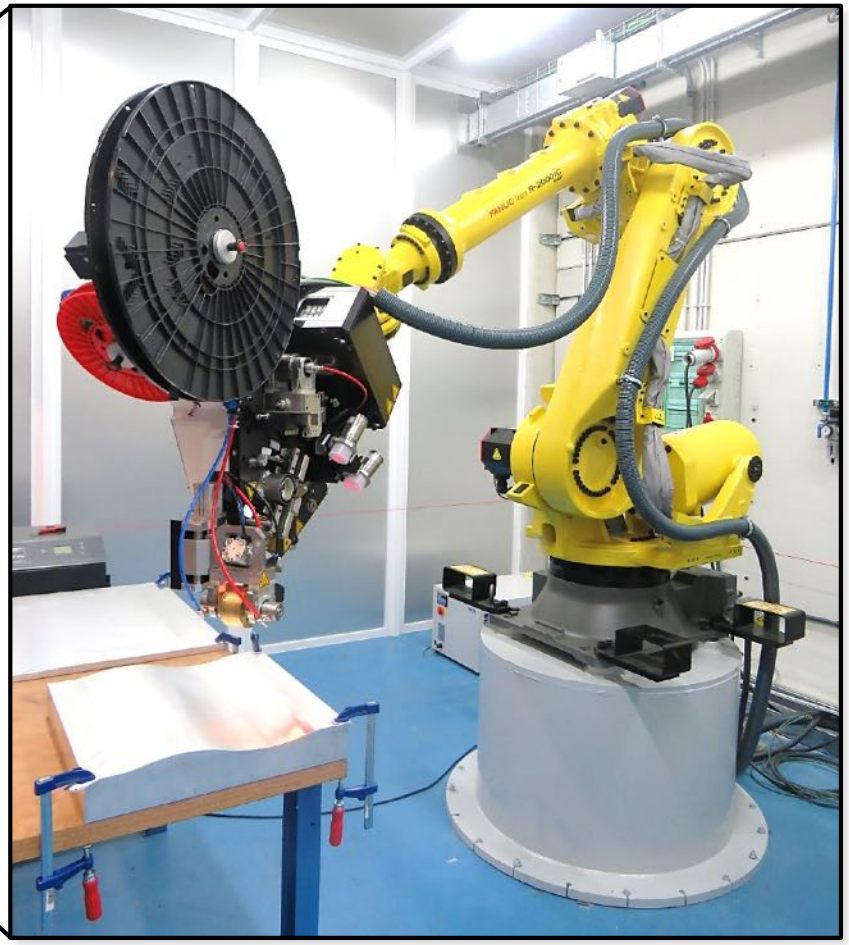


- Institute for Textile Technologies - Aachen, Germany

Exemplary integration @ AIMEN Technology Centre, Spain

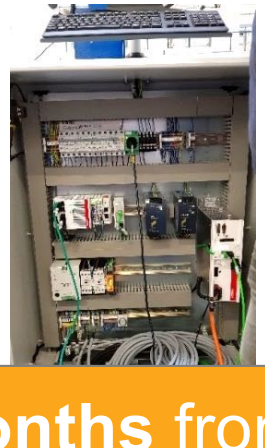


Laser safety cell

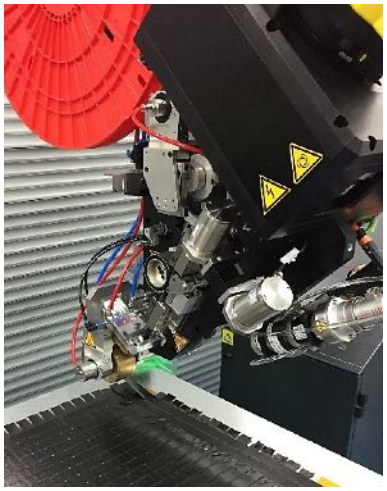


ATL on FANUC robot

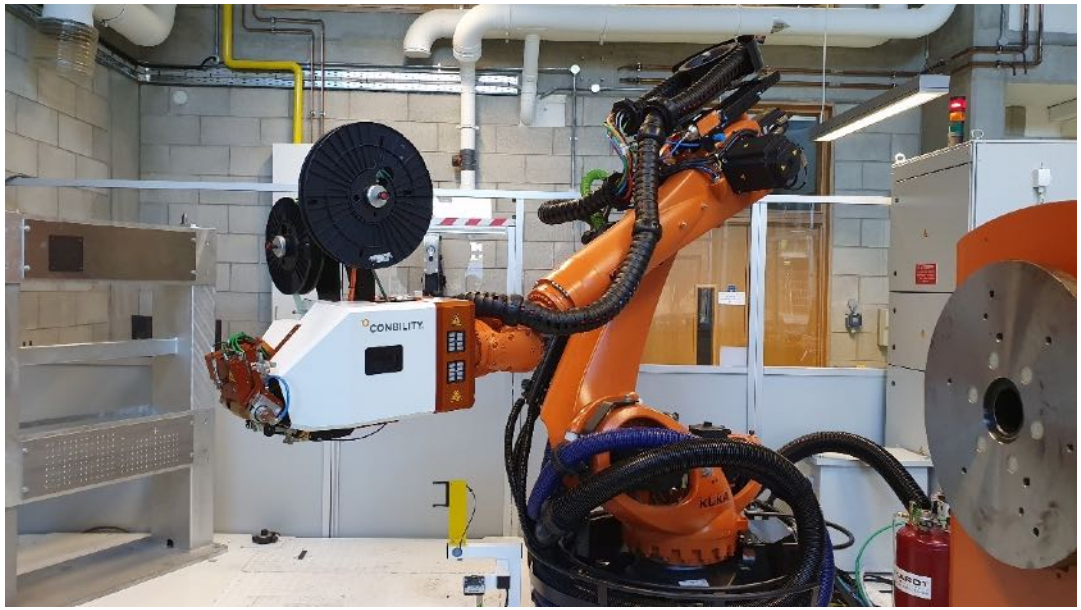
Integration @ AIMEN Technology Centre, Spain



3.5 months from
PO to acceptance



Integration @ Limerick University in Ireland



Our Products and Services (Production Systems)

- **Tape Placement Machine Systems**
  - 2D Tape Placement Machine
  - 3D Tape Placement/ Winding Head („ATP-Head“)
  - Key-ready Manufacturing Cells
    (Customized - Including Robot, Laser Safety Cell, Winding Axis, etc.)

- **Job-order Manufacturing (Job-Shop)**
  - Manufacturing of Test Laminates (2D, 3D) by Tape Placement with in-situ Consolidation
  - Manufacturing of Test- or Prototype-Parts by Tape Placement or Tape Winding (e.g. Tubes, Pipes)
  - Local reinforcement of metal parts or thermoplastic parts (e.g. Injection Molded Parts or „Organo-Sheets“)

CONBILITY®
producing sustainability

Inductive Double Belt Press

Inductive Double Belt Press System

Impregnation example:

PA - GF
- p_H = 20 bar
- t_H = 50 s
- T_H = 300 °C

- Energy- and cost-efficient inductive heating system
- Consolidating and impregnating a wide variety of composite materials
- Highly flexible: all parameters adjustable within minutes (e.g. pressure, temperature, speed)
- Max. Temperature: 300 °C
- Max. Pressure: 24 bar
- Steel belt width: 350 mm (scalable)

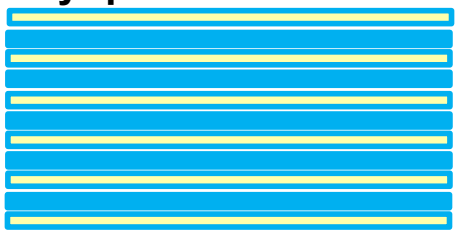
Double Belt Press System

Start-up Video of the HMI

Start-up Video of the Machine

Impregnation Trials – PA6 and Glass Fiber Textile

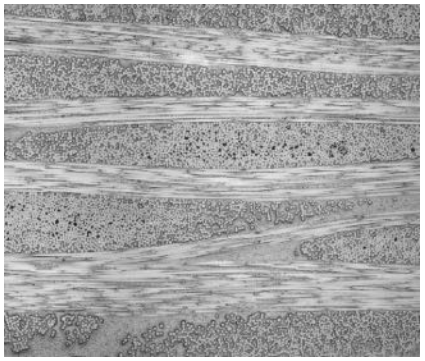
Layup:



Comments:

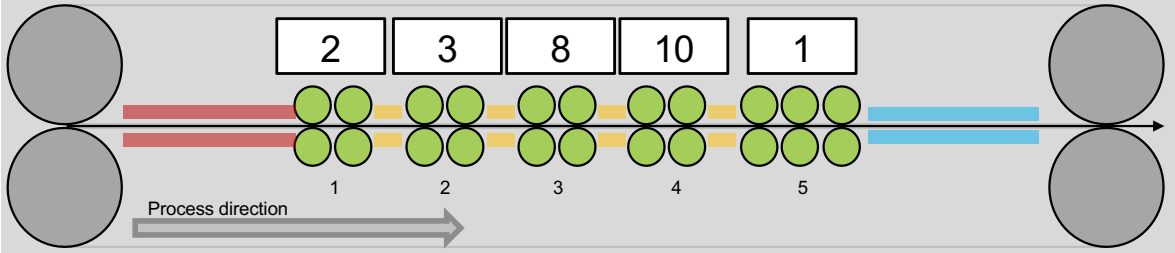
- Processing speed: 500 mm/s
- Glossy and smooth surface without visible voids
- Minimal fiber washing
- Component flat and stiff

Microsection:

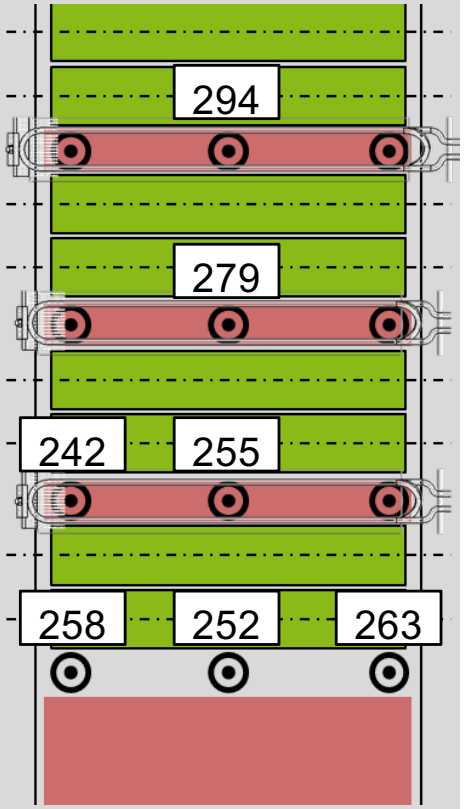


Material right out of the machine (no post-processing done)

Pressure distribution during trials (pressure per cylinder [bar])

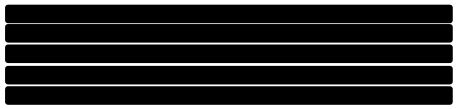


Average temperature measurements

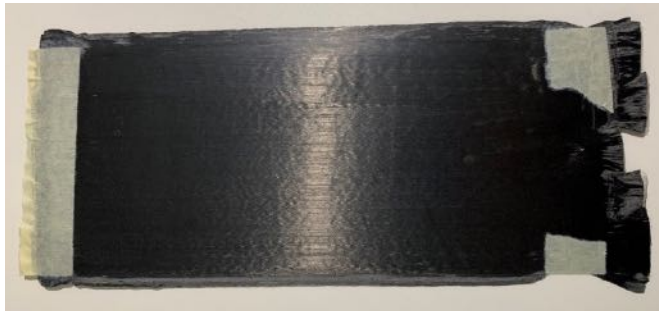


Consolidation Trials – 5 Layer PA12-CF Tape

Layup: Material right out of the machine (no post-processing done)



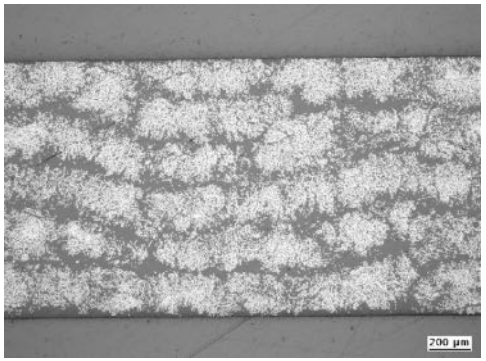
PA 12 – CF Tape



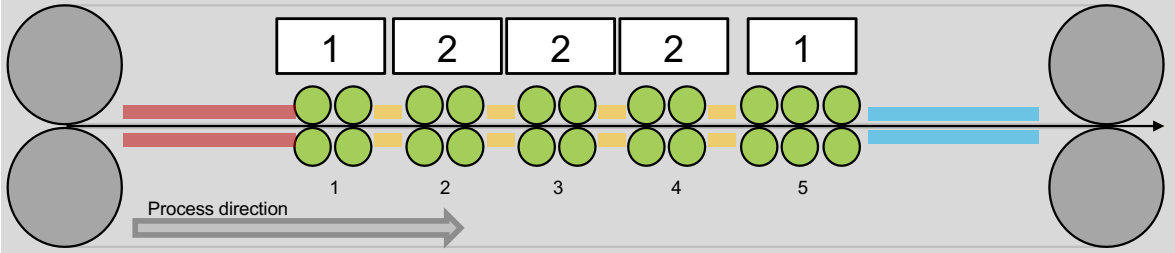
Comments:

- Processing speed: 700 mm/s
- Glossy and smooth surface without visible voids
- Minimal fiber washing
- Component flat and stiff

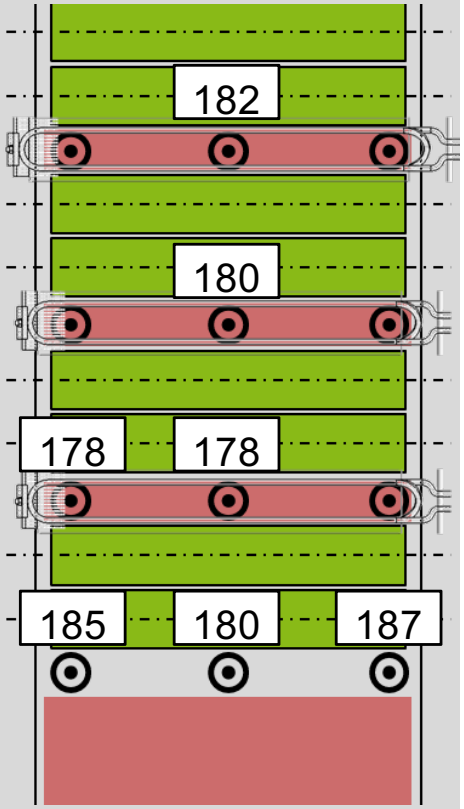
Microsection:



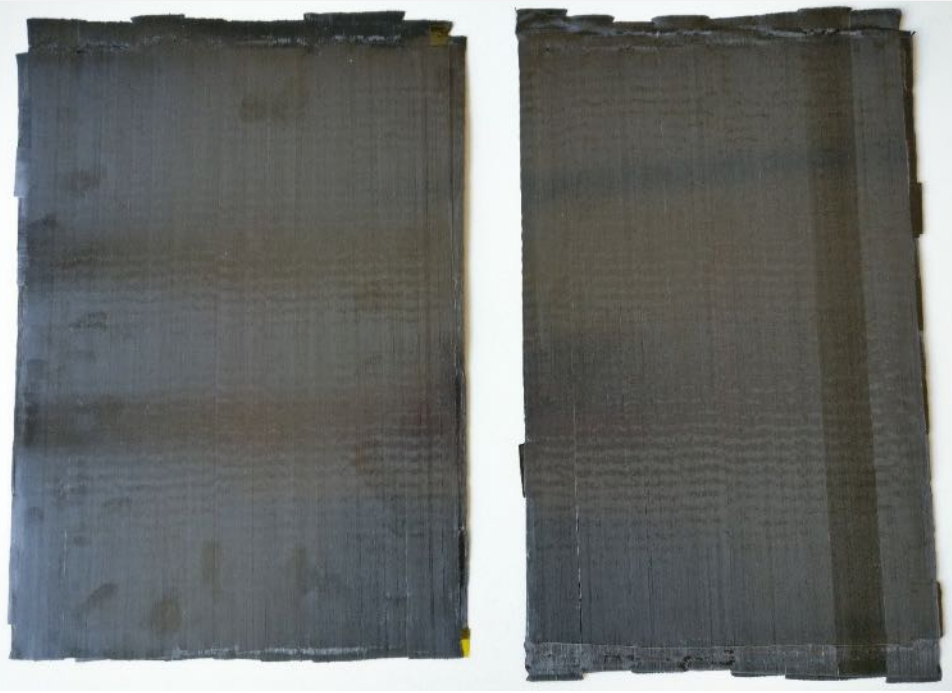
Pressure distribution during trials (pressure per cylinder [bar])



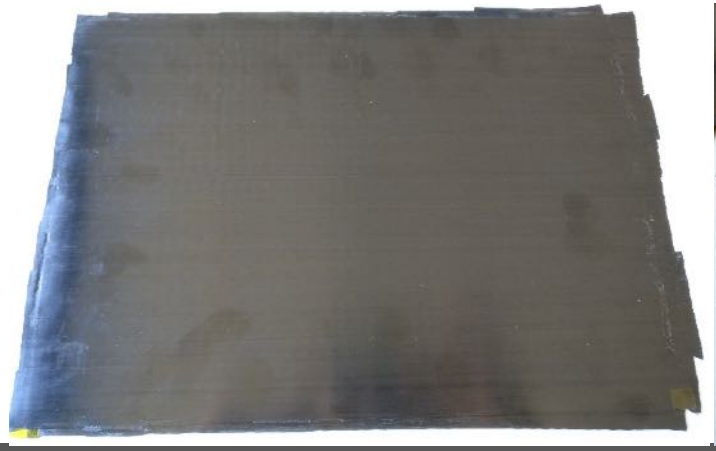
Average temperature measurements [°C]

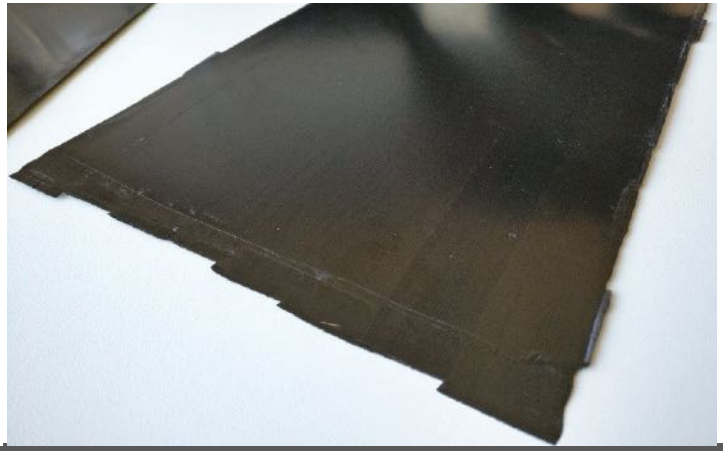


Consolidation trials - CF-PC tape



- Very good consolidation of layers
- Very smooth and glossy surface
- Local thickness variations of 3 tapes are no issue
- No issue with polymer sticking to belts

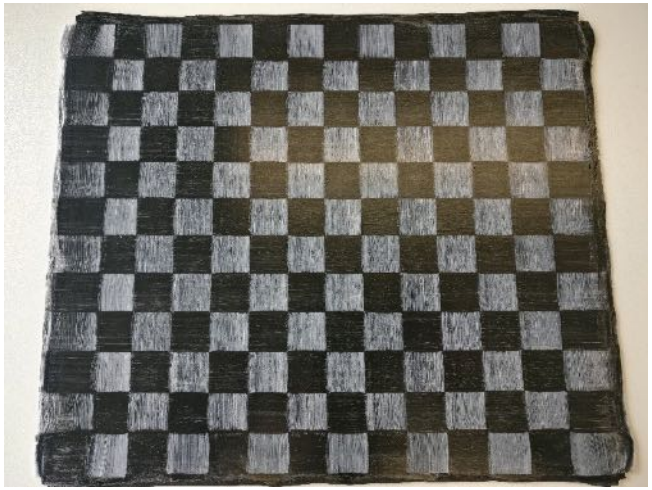


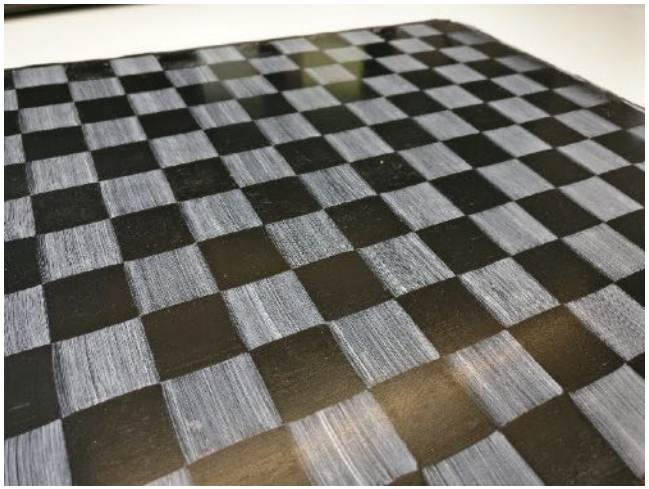


Consolidation trials: Huesker W8SVR

- Very good consolidation of layers
- Only little blurring of checkered pattern
- Higher process speeds possible, but currently limited by:
  - Inhomogeneous inductor temperature of machine width
  - Cooling module length

→ Machine design can easily be adopted for a tailored consolidation line

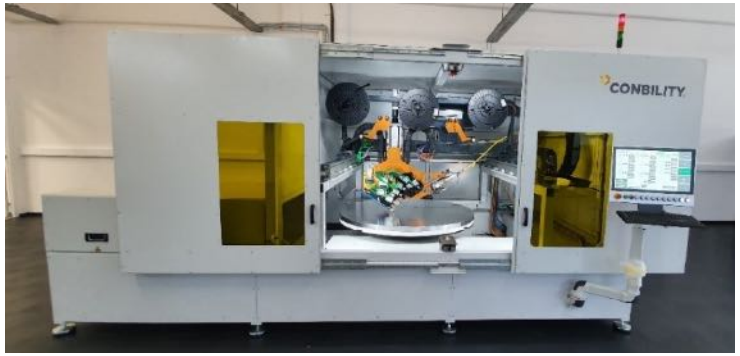




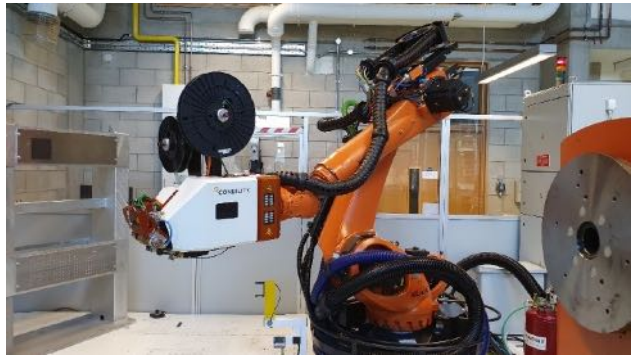
Summary of Conbility´s Machine Portfolio

Energy-efficient Double Belt Press

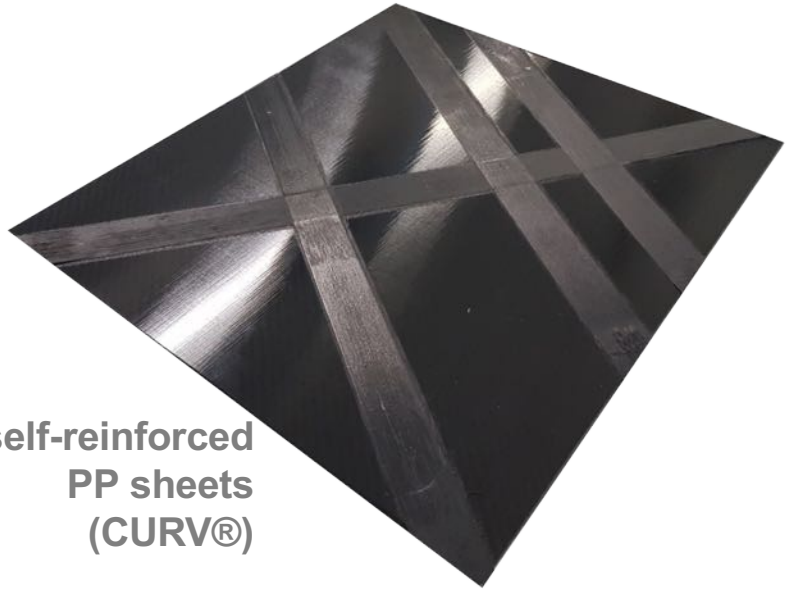
2D Tape Placement Machine with integrated Laser System



3D Tape Placement and Winding Systems

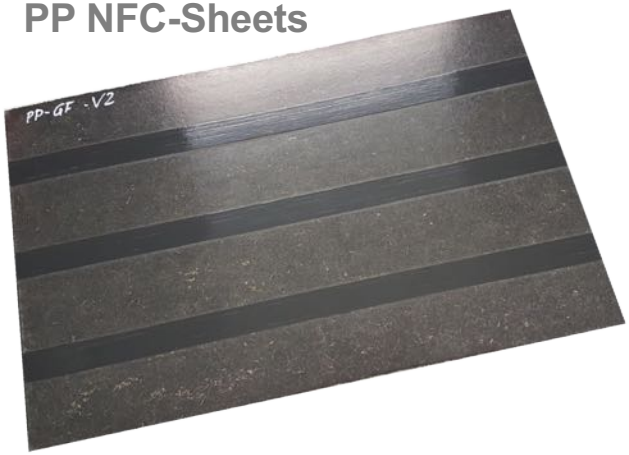


Exemplary Parts: Local Reinforcements and Tailored Blanks



self-reinforced PP sheets (CURV®)

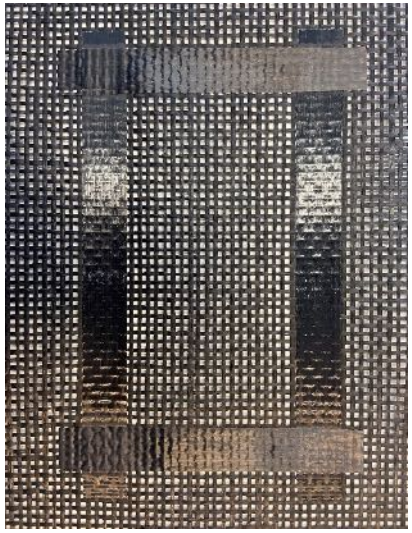
Pre-consolidated Flax-PP NFC-Sheets



Tailored blanks with / without cut outs

thin injection molded parts

DeliComp® Prepregs



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