Digital Manufacturing of Composites
Marcus Kremers - CTO
Driven by a strong vision and entrepreneurial spirit

>20 years of composite heritage

- Technology leader in advanced composites
- Provider of automation solutions for composites
- Legacy in Aerospace, Marine and Oil & Gas
- 150 + employees
Parts manufacturing
Automation solutions
Composite Manufacturing **Know-How**

Know-how of Composite Manufacturing

- Part manufacturing
- Automated *processes*
- Digital manufacturing

**Scalability**
The Fieldlab Digital Factory for Composites

Airborne
Composites and Automation

SIEMENS
Automation and Digitalisation

KUKA
Robotics
Experience and Collaboration Centre
Exploring Digital Factory concepts
Focus on Composites
Led and funded by private companies
To create business opportunities
Supported by Public Private Partnerships for projects
To build a vibrant and international ecosystem
Composite

Stacking of plies into a composite laminate with different angles of the fibre reinforcement
Composites to make the world a **better** place

- Lightweight
- Durability
- Performance
- Eco footprint
- Low maintenance
- Tailored design
- Recycling
- LCA
Composites in Aerospace

50% composite

20% lower fuel
Composites in Automotive

- 20% lighter
- Lower fuel consumption
- Longer range
Composites in Infrastructure

- Longer lifetime
- Easier installation
- Re-use
- Less foundations
The Great Cost challenge of composites

Cost

1. Automation

2. Digitalisation

3. Holistic approach
Automation Building Blocks
Automated Laminating Cell

Functionality
Laminating cell for thermoset prepreg
Combines three functions:
• Automated tape laying
• Cutting of laminate into shape
• Pick & place for offloading of laminate

Specifications
• Tape width 150 mm / 6”
• Lay down rate 300 lm/hr (45 m^2/h)
• Variable angle cutting, on-the-fly
• Laminate cutting 30 m/min
• Pick & Place cycle 10 seconds
• Automated tool change < 1 minute
End-to-end automation: Thermoplastic Composite Pipes

- In-situ consolidation
- End-to-end automation
- Digital manufacturing concepts:
  - Process Data driven quality assurance
  - Model-based, adaptive process control
Digital manufacturing – what is it?

- Digital Twin:
  “A *living, integrated* digital representation of the physical world that can *predict*”
Digital manufacturing – what is it?

- Digital Twin in our manufacturing “world”:
  - **Model** that fully describes the manufacturing process, updated with real-time data.
  - It can **predict** the output **quality** and **advise** how to adapt or improve.

- Manufacturing process becomes:
  - **Predictable**: manufacturing processes can be designed up-front, with much less trial-and-error.
  - **Understandable**: it becomes clear what drives the quality of the process. Problems can be quickly resolved.
  - **Adaptable**: when input changes (for example material, environment, design), the process can be adapted to give the same quality.

- Removes the ‘Black Magic’ of composites.
Manufacturing Digital Twin

- Physical line
- Simulated Controls
- Process model
- 3D Visualisation
- Quality
Digital twin modes

- **Virtual** → Quality
- **Replay** → Quality
- **Live Copy** → Quality, advise
- **Autonomous** → Quality, control
How can a digital twin be used?

- Integrated simulation up-front (CAD + programming + process)
- Operator training
- Assistant for operators and engineers during production
- Problem solving during production issues
- Optimisation of production without need for trials or standstill
- Offline testing and debugging of new hardware / software
- Trend analysis, machine learning
Product Digital Twin

Shared Digital Twin environment
Product and Manufacturing Digital Twin

- Physical line
- Simulated Controls
- 3D Visualisation
- Process model

Input material data → Output quality data

Data flow:
- Physical line to Simulated Controls
- Simulated Controls to 3D Visualisation
- 3D Visualisation to Process model
- Process model to Output quality data
High Volume Thermoplastic Composite Line

- End-to-end automation, digital manufacturing
- 1 minute cycle time, 1.5 million parts / year
- Full quality inspection at incoming material and outgoing product
  - Adaptive control and self-learning possible
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