Digitization: Transition from Computer Aided Manufacturing to Human Aided Automation

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Composites Convention 2019
Stade, 12th of June 2019

DLR – German Aerospace Center

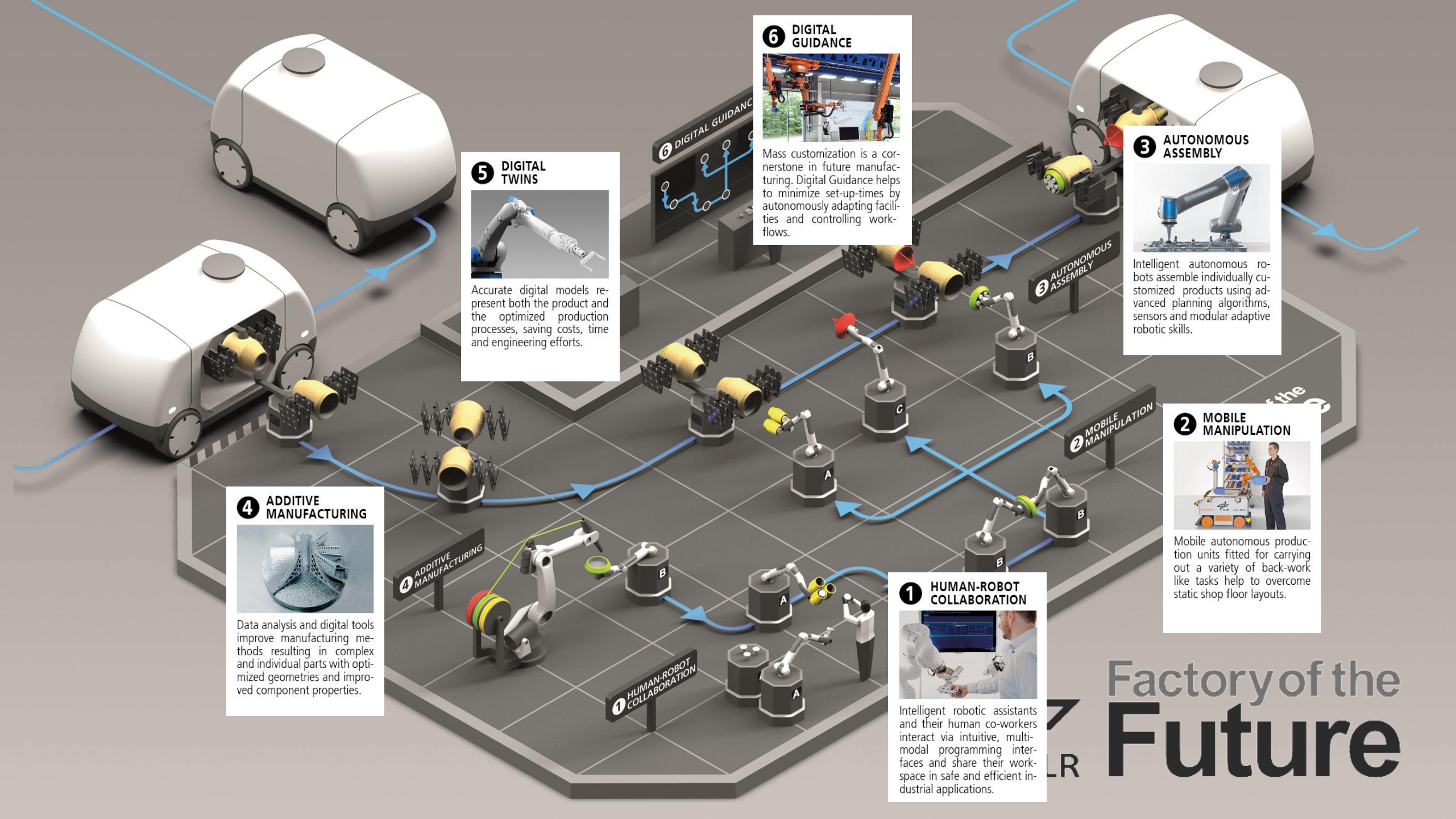
Tasks

- Research Institution
- Space Agency
- Project Management Agency

Research Areas and Cross-link-fields

- Aerospace
- Space Research and Technology
- Energy
- Transport
- Security
- Digitization (e.g. „Factory of the Future“, „Condition Monitoring“)

Motivated by the Digitization Initiative of the German Government



6 DIGITAL GUIDANCE

Mass customization is a cornerstone in future manufacturing. Digital Guidance helps to minimize set-up-times by autonomously adapting facilities and controlling workflows.

5 DIGITAL TWINS

Accurate digital models represent both the product and the optimized production processes, saving costs, time and engineering efforts.

3 AUTONOMOUS ASSEMBLY

Intelligent autonomous robots assemble individually customized products using advanced planning algorithms, sensors and modular adaptive robotic skills.

2 MOBILE MANIPULATION

Mobile autonomous production units fitted for carrying out a variety of back-work like tasks help to overcome static shop floor layouts.

4 ADDITIVE MANUFACTURING

Data analysis and digital tools improve manufacturing methods resulting in complex and individual parts with optimized geometries and improved component properties.

1 HUMAN-ROBOT COLLABORATION

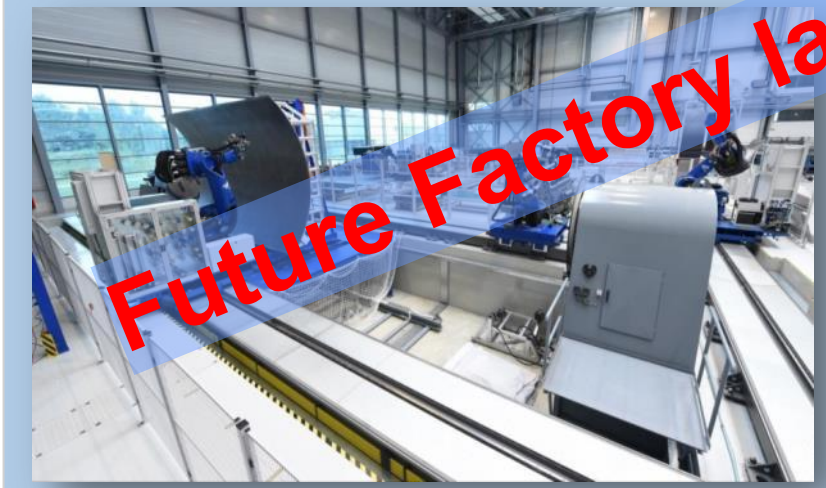
Intelligent robotic assistants and their human co-workers interact via intuitive, multimodal programming interfaces and share their workspace in safe and efficient industrial applications.

Factory of the Future

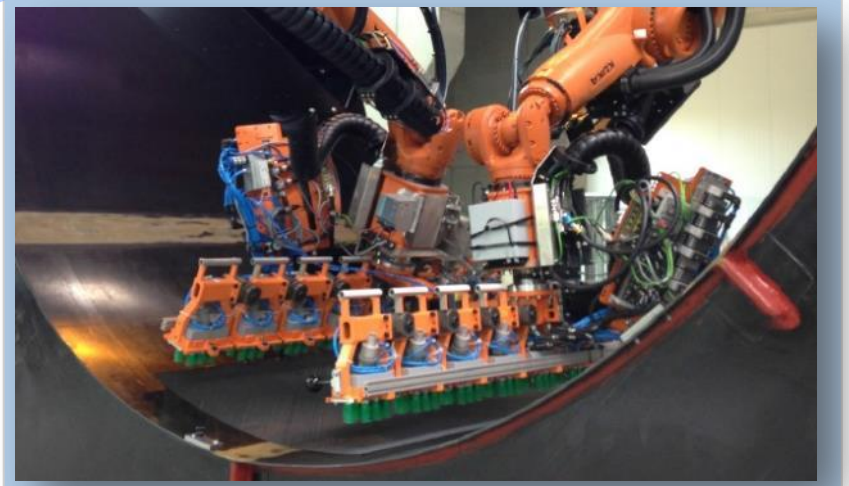
The DLR Center for Lightweight Production Technology (ZLP)

Objectives: Maximum floor-to-floor efficiency by high placement rate and robust placement devices
Placement rate: > 100 kg/h → industrial scale up to TRL 6

Stade
Multi-robot automated fiber placement
Autoclave technology
Fully automated preforming and RTM



Augsburg
Robot based dry placement of multi-axial fabrics
Vacuum infusion (VARI, VAP), oven curing



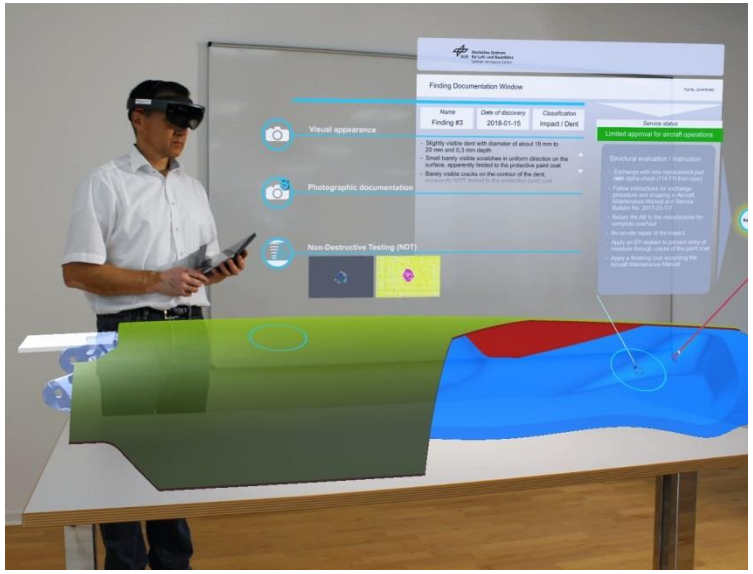
Future Factory labs for Composites

Strategic research-field “Zukunftsfabrik 2030 für den Multimaterialleichtbau”

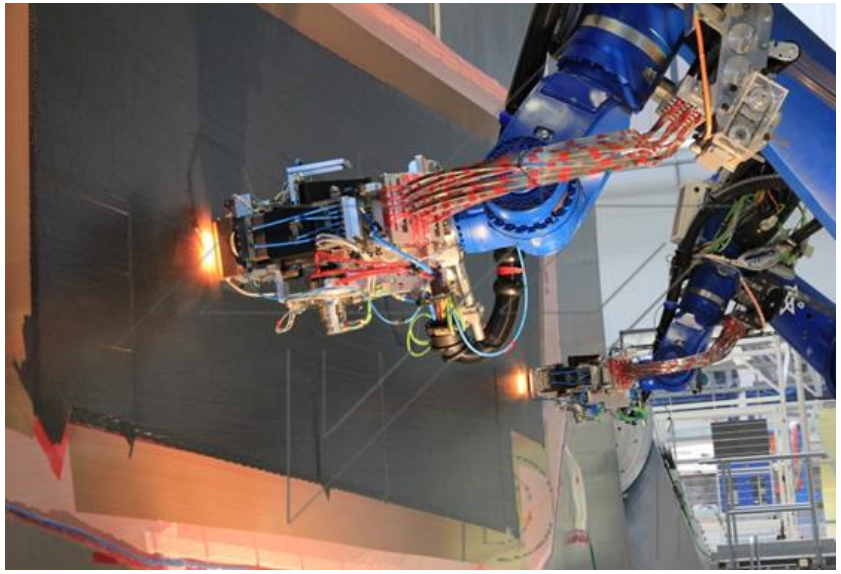
Institute of Composite Structures and Adaptive Systems

Since 2016

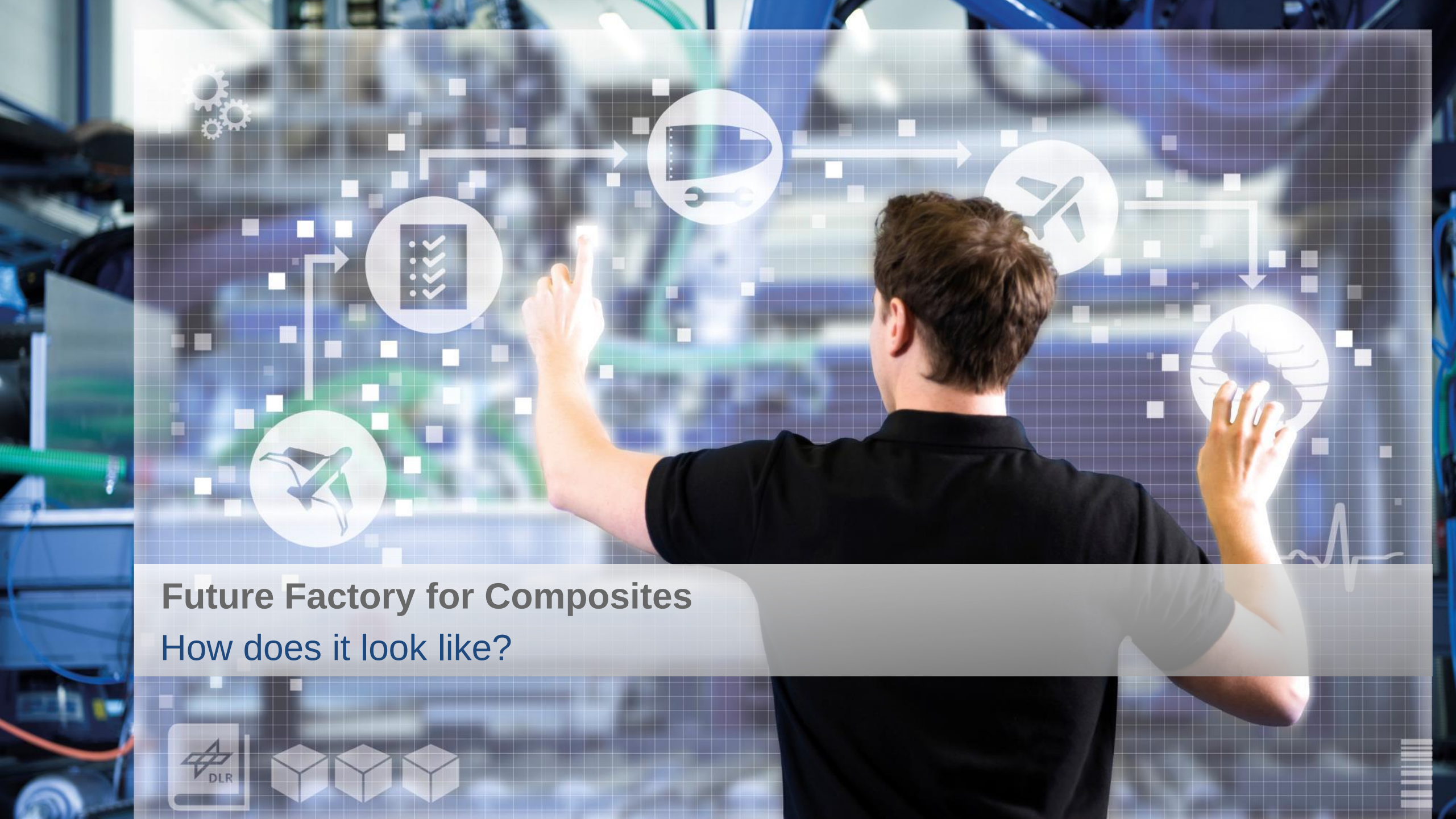
DLR Manufacturing Competence for Industry 4.0



Digital Tools for complex decision making processes



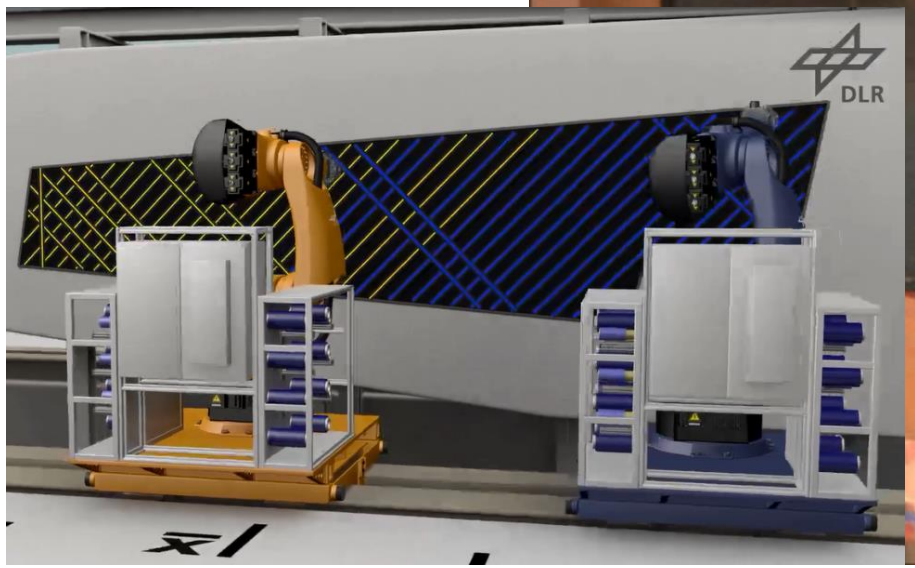
Design4Production: Integration of Design and Machine Control

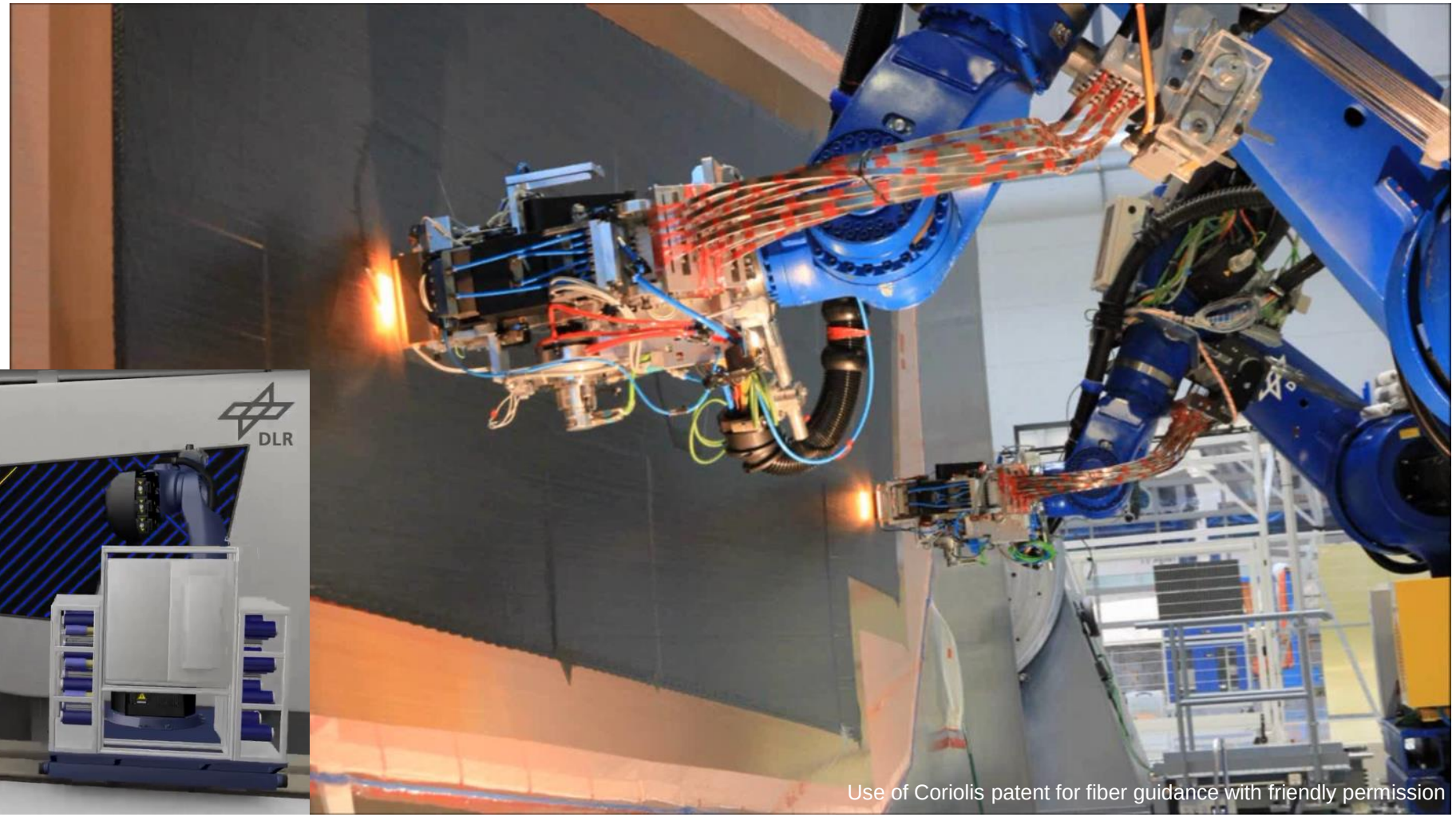


Future Factory for Composites

How does it look like?

Multi-Head Automated Fiber Placement

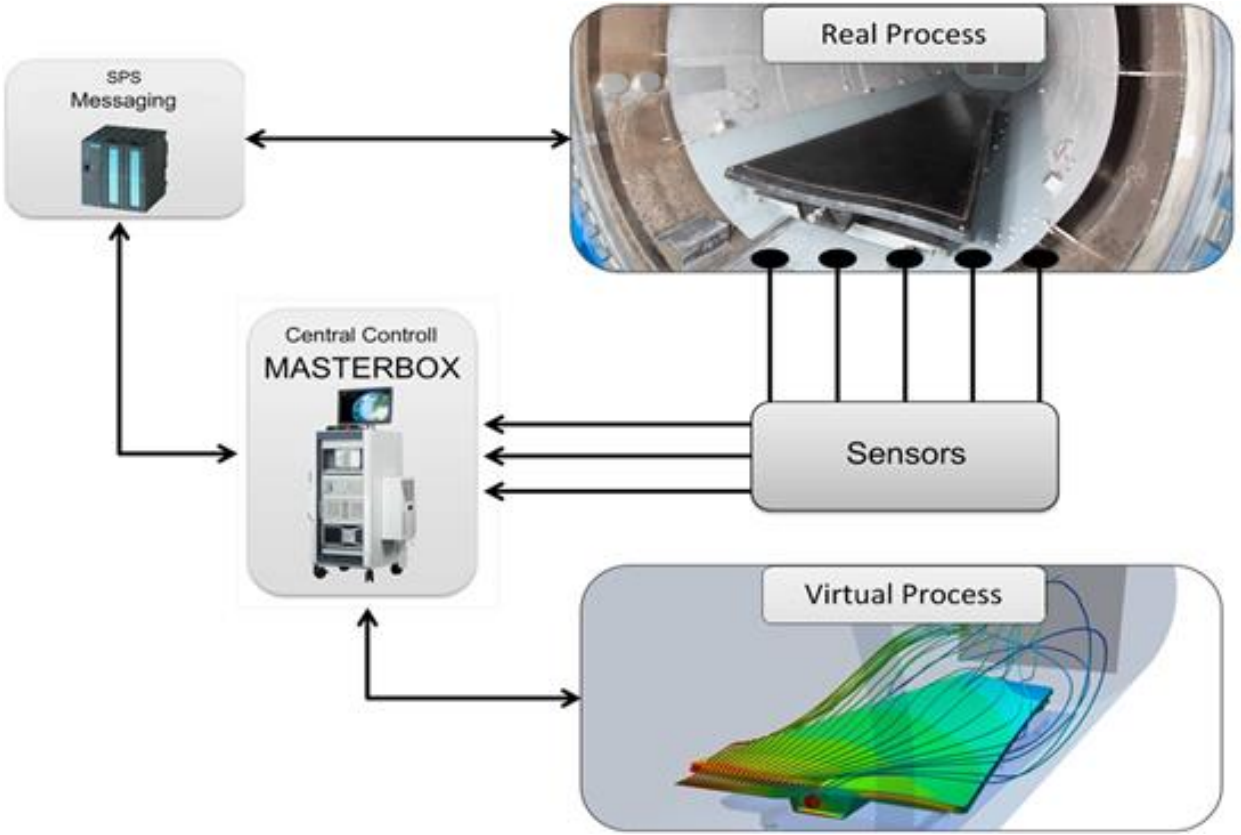




Use of Coriolis patent for fiber guidance with friendly permission

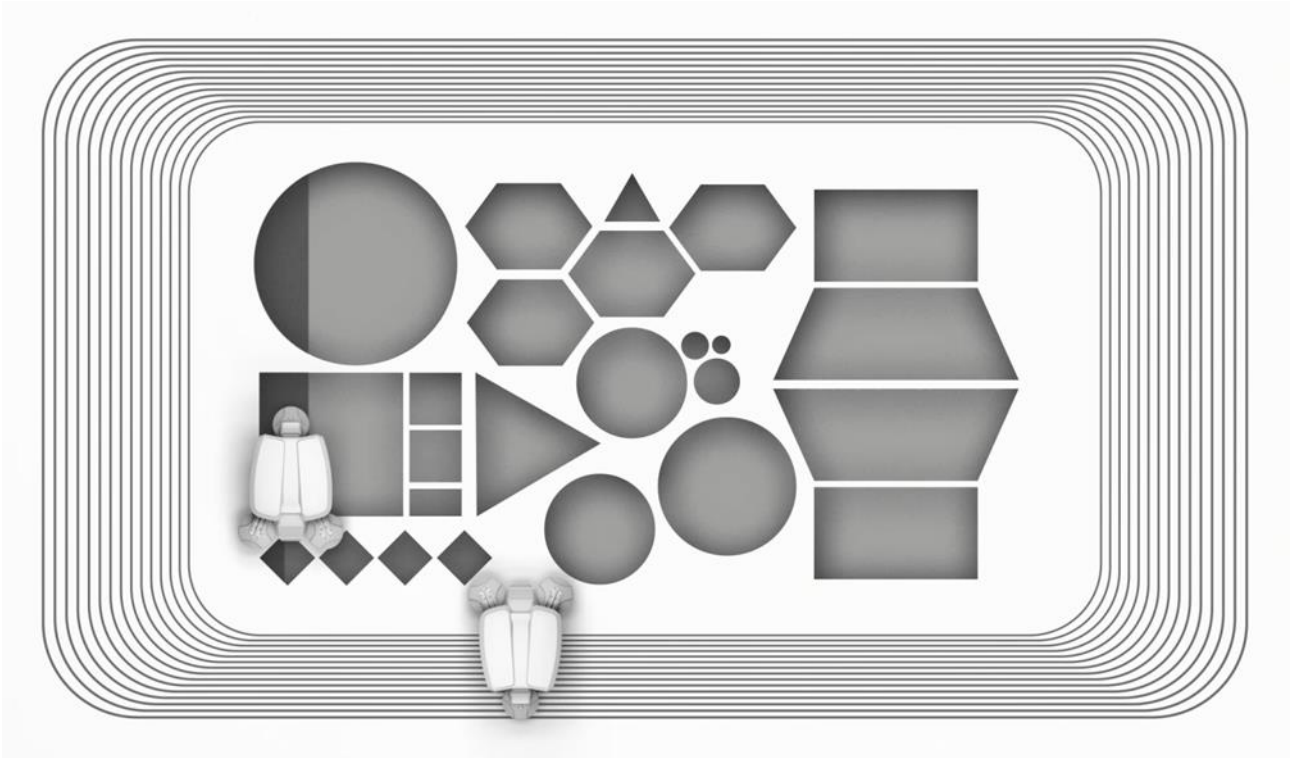
Digital Twins of machines

- The Virtual Autoclave



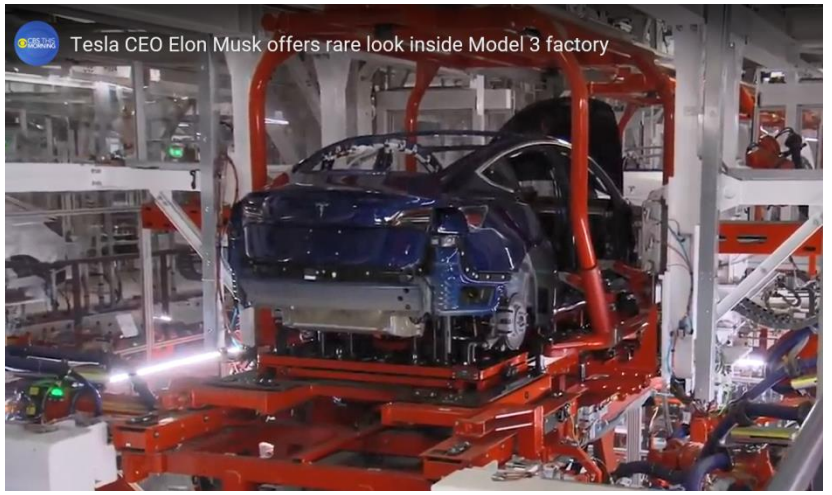
Measurement of temperature distribution using thermography

Flexible autonomous production, placement and assembly robot (Flappybot)



Flappybot

Over-automation: “Production Hell”

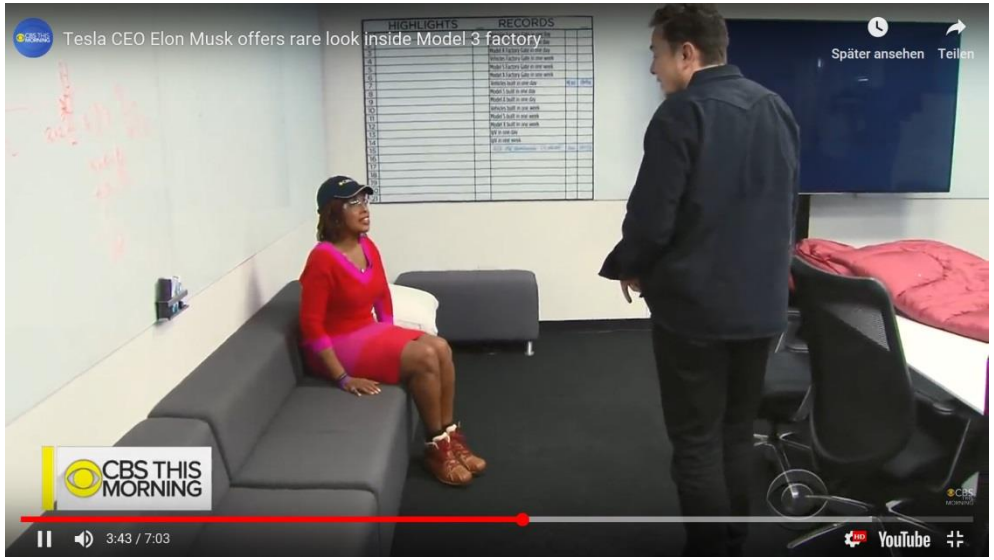


Elon Musk:

- Too many robots in the production process of the Model 3 led to
- "crazy, complex network of conveyor belts“.
- Robots slowed down production
- Start using more humans in the factory, to speed up production

Short way out:

- Take personally control over production line
- Sleep at the factory to keep it running



Learning element for Industry 4.0:

- **Where are human skills indispensable?**

Source: https://www.theinquirer.net/inquirer/news/3030277/elon-musk-admits-too-much-automation-is-slowing-tesla-model-3-production

Why does Human Aided Automation work for Composite Production?

In Composite Production possible sources of errors are very individual

In case-by-case decisions humans are superior to computers

You can’t step into fully automated processes physically to detect a problem…

… virtually, you can!

Automation suspends humans from interaction, digitization brings humans back to involvement

„*Human Centered Digitization*“ in lightweight construction

Manufactrue of substructures:

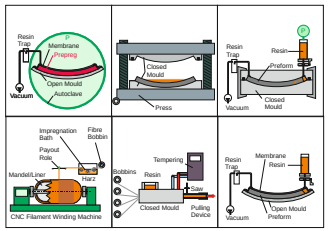
Individual correction of process- and material tolerances

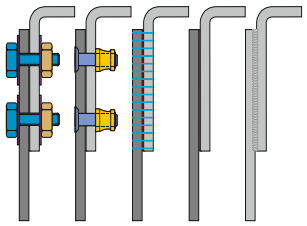
Measurement of:
Fiber angle,
Flow front,
Part thickness,
Curing state,
…

Actuation of:
Forming angles,
Pressures,
Temperatures,
Valves,
…

- Reduced process time
- Minimized scrap rate
- Inherent development
- Relaxation of specifications

production and assembly conform **Design** with weighted tolerance windows



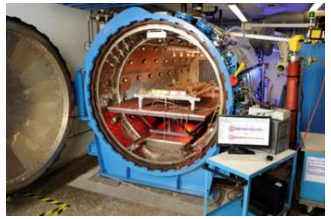


Feed-back

Interactive correction of processes

Interactive Joining of substructures

Feed-back



Individual analysis of sustainability and productivity

Learning aptitude

Assembly of substructures:

Usage of elasticity and plasticity for gap avoidance

Measurement of:
Surfaces,
Clearances,
Joining Forces,
Adhesive Distribution,
…

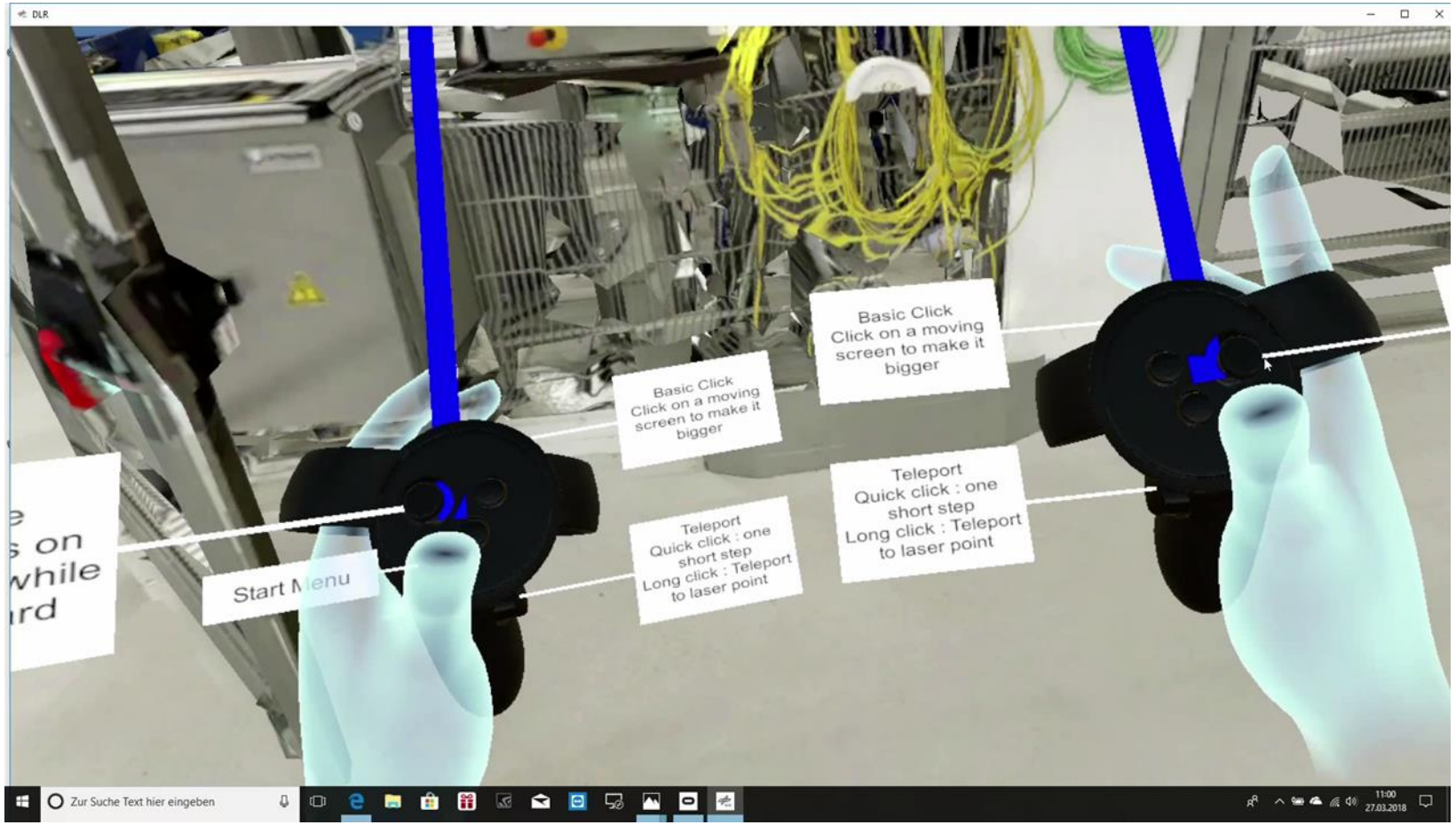
Actuation of:
Treatment,
Positioning,
Compression,
Dwell Time,
…

- Reduced correction efford
- Reduced Lead Times
- Scaling Options
- Adaptability due to Modularity

DLR

HR: Human Aided Automation

- Reinvolve Human into Automation
- Smart Remote Maintenance
  - VR-login for service provider
  - AR for on-site worker
- Process Monitoring
  - Process data displayed in the right context
- Colaborative Troubleshooting
  - Multi User VR/AR
- „Replay“ as process documentation
  - Review process as happened
  - Walk through instead of one-perspective video



Thank you for your attention!