Digitization: Transition from Computer Aided Manufacturing to Human Aided Automation

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Motivated by the Digitization Initiative of the German Government
Mass customization is a cornerstone in future manufacturing. Digital Guidance helps to minimize set-up times by autonomously adapting facilities and controlling workflows.

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

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

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

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

Accurate digital models represent both the product and the optimized production processes, saving costs, time and engineering efforts.
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 \( \rightarrow \) 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
Digital Twins of machines

• The Virtual Autoclave

Measurement of temperature distribution using thermography
Flexible autonomous production, placement and assembly robot (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?

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

**Manufacture** of substructures:

Individual correction of process- and material tolerances

- Production and assembly conform
- Design with weighted tolerance windows

**Assembly** of substructures:

Usage of elasticity and plasticity for gap avoidance

- Interactive correction of processes
- Interactive Joining of substructures

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

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

**Learning aptitude**

- Individual analysis of sustainability and productivity
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

• Collaborative 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!