Real-time benefit assessment in production of fiber reinforced polymers (FRPs)

Implementation of Industry 4.0 in benefit assessment

Dr. Philipp Hilmer; Ali Al-Lami, Manuel Buggisch
8th EASN-CEAS International Workshop on Manufacturing for Growth & Innovation
EFFICOMP Session, Glasgow

6th September 2018
Table of contents

• Introduction
  • Motivation
  • Concept of the smart-work-station (SWS)
• Realization of SWS
  • Data collection in SWS
  • Data processing by SWS
• Eco-efficiency assessment model (EEAM)
  • Process modeling in EEAM
  • Process assessment by EEAM
• Implementation of SWS
• Outlook
Motivation 1

Benefit assessment

- Economic
- Quality
- Ecological
- Social
- Time to market

FRP

Dr. Philipp Hilmer; Ali Al-Lami

6th September 2018
Motivation 2

Design | Manufacturing | Assembly | Operation | End-of-Life
Motivation 3

- Conventional data collection
  - Time consuming
  - Offline data processing /assessment
  - Dedicated collector
  - Dependent quality
  - FRP production has in general a low degree of automation (DoA)
  - High DoA is a prerequisite of digitalization in data collection

- SWS
  - Automated, sensor-based
  - Real-time data processing
  - Real-time impact assessment
  - Process automation is not a prerequisite
  - Product and process independent

Framework adopted from ISO-14040
Concept of the smart-work-station (SWS)

- Elementary flow definition
  - Fiber
  - Matrix
  - Core material
  - Ancillaries
  - Labor
  - Electricity
  - Equipment
- Initial data
  - What
  - How much
  - When
  - Where
- Regardless of DoA

Concept of SWS: example of preforming with various DoA
Data collection in SWS

- Sensors
  - Visual recognition
  - Infrared (IR) camera
  - Integrated scales
  - Electricity meter
- Technology independent
- Product independent

1- Mold dedicated scale:
   - How many workers
   - How long
   - Where
   - When

2- Integrated digital scales:
   - How much material
   - Where
   - When

3- Optical detection:
   - What material
   - Where
   - When

4- Electricity meter:
   - Which equipment
   - How long
   - When
   - How much energy

5- IR-Camera:
   - How many workers
   - How long
   - Where
   - When

Sensors of SWS: example of preforming with various DoA
Data processing by SWS

- Visual recognition
  - Elementary flows (~350)
  - Pictures
  - QR-Codes
  - Database (DB)
  - Machine learning
  - Recognition
- IR-Camera
  - Work duration
  - Labor count
  - Where
  - Which activity
- Product independent

Work time per activity (NACOR)

Optical recognition
Process modeling in EEAM

- Production of FRP
  - Manufacturing
  - Assembly
  - Quality assurance

- Process
  - Unit processes
  - Elementary flows
  - Intermediate flows

Model example: Multi-material process

Multi-Material leading edge (LE)
Process assessment by EEAM

- Aspects
  - Economic
  - Ecological
  - Time to market
  - Resources
- Key result indicators (KRI)
  - kg CO₂
  - €
  - hh:mm
  - kg waste/material
  - kW

Real-time benefit assessment: SWS & EEAM
Implementation of SWS

- Aerospace industry
  - Project NACOR: Preforming and Assembly
  - Preforming of spars with high DoA
- Energy
  - Project SmartBlades2: Manufacturing of a 20m rotor-blade
Outlook

- SWS development
  - Material DB enhancement
  - Stability
  - User interface
- SWS implementation
  - Further projects: EFFICOMP
  - Further unit processes
  - Other techniques
  - More structures
  - External partners
- SWS-based design to cost (DTC)
  - Parametrization of SWS results
  - Assessment-based estimation
  - Reliable estimation results
Thank you for your attention!

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)
German Aerospace Center
Institute of Composite Structures and Adaptive Systems | FA-FVT |
Lilienthalplatz 7 | 38108 Braunschweig | Germany

Dr. Philipp Hilmer
Tel. +49 531 295 2318
Philipp.hilmer@dlr.de
www.DLR.de
Literatures