Integrative Production Technology for High-Wage Countries

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- Institut für Textiltechnik of RWTH Aachen University
- The Cluster of Excellence
- Industrial Cooperation - The Manutex Initiative
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RWTH Aachen University

Aachen - in the heart of Europe, close to
- Düsseldorf
- Cologne
- Belgium
- The Netherlands
- Paris

- founded in 1870 by industrial initiative
- 31,500 students in 106 courses of study
- 450 chairs
- 4400 assistant lecturers (mostly PhD positions)
- 2500 non-academic members of staff
- 650 apprentices
- 650 Mio. € total budget incl. affiliated institutes
- thereof 30 % third party funding
Faculties and Interdisciplinary Research at RWTH Aachen

- RWTH Aachen University is a multi-discipline university with the focus on engineering and natural sciences.
- The ITA cooperates with all faculties.
- Cross-cutting issues are transferred by forums from RWTH University.
- The ITA is active in all forums.
- Prof. Gries coordinates the interdisciplinary research at RWTH.

Mathematics, informatics and natural sciences
Architecture
Construction engineering
Mechanical engineering
Mining, metallurgy and geo science
Electrical engineering and communication technology
Philosophy
Economics
Medical science
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ITA within RWTH Aachen University

RWTH Aachen University is worldwide leading in:
- Production technology
- Automotive technology
- Polymer research and development

ITA is service provider for:
- Fibre processing
- Yarn production
- Textile fabric production
- Product development
- Production technologies
Introduction ITA – Research fields

<table>
<thead>
<tr>
<th>Fibre Production</th>
<th>Fibre Processing</th>
<th>Fabric Production</th>
<th>Composites</th>
<th>Joining</th>
<th>Finishing</th>
</tr>
</thead>
</table>

Focuses:
- 75 % Product development
- 75 % Production technology development

Technical width:
- Textile chain
- From polymer
- to the textile product
- Simulation and construction

Technical depth:
- Process and machine
- Material and tools
- Handling and logistics, Recycling
- Measurement and test engineering, Quality assurance

Functional, economical and ecological solutions for

- Medical Technology
- Civil Engineering
- Smart Textiles
- Energy
- Nonwovens
- Automotive
Introduction ITA – Research fields

Simulation
Production technology
Product development

Fibre Production Fiber Processing Fabric Production Composites Joining Finishing

Functional, economical and ecological solutions for

Medical Technology Civil Engineering Smart Textiles Energy Nonwovens Automotive
Our Performance

<table>
<thead>
<tr>
<th>Innovation process</th>
<th>Process- and quality Improvement</th>
<th>Textile prototyping</th>
<th>Qualification</th>
<th>Special topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature and patent research</td>
<td>Friction and wear</td>
<td>Textile rapid prototyping</td>
<td>Training and personal education</td>
<td>Energy efficiency</td>
</tr>
<tr>
<td>Product innovation workshop</td>
<td>Scanning electron micrograph</td>
<td>Composite prototyping</td>
<td></td>
<td>Material efficiency</td>
</tr>
<tr>
<td>Concept study</td>
<td>High-speed-video camera (HSV)</td>
<td>Textile prototyping</td>
<td></td>
<td>Nine step tool</td>
</tr>
<tr>
<td>Prototyping</td>
<td>Particle image velocimetry (PIV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement consultancy</td>
<td>Laser doppler anemometry (LDA)</td>
<td></td>
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<tr>
<td>Implementation</td>
<td></td>
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</tbody>
</table>

| Machine- and process simulation                                                   |                                                            |                                                 |                                     |                                  |
| Machine simulation                                                                |                                                            |                                                 |                                     |                                  |
| Process simulation                                                                |                                                            |                                                 |                                     |                                  |
| Textile simulation                                                                |                                                            |                                                 |                                     |                                  |
| Fluid simulation                                                                  |                                                            |                                                 |                                     |                                  |
| Neuronal nets                                                                     |                                                            |                                                 |                                     |                                  |
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Cluster of Excellence – Integrative Production Technology for High-Wage Countries

Focus on:
- Material Science and
- Production Technology

Cooperation:
- 19 professors of RWTH Aachen
- Fraunhofer USA

Funding volume:
- 39 Mio. € in 5 years
Organisational Structure of the Cluster of Excellence

Scientific Board
Industrial Advisory Board (IAB)
Scientific Advisory Board (SAB)

Steering Committee
Brecher, Bleck, Hirt, Michaeli, Schmitt, Schuh, Schulz

Project Management
CEO: Prof. C. Brecher
COO: Dr. Lutz Oliver Schapp
CFO: S. Hartmeyer

ICD A Coordinator: Prof. Schuh
ICD B Coordinator: Prof. Schulz
ICD C Coordinator: Prof. Hirt
ICD D Coordinator: Prof. Schmitt

ICD A Board
ICD B Board
ICD C Board
ICD D Board

Coordinator Research Area
Board of Speakers

Cross-Sectional Processes
Scientific Coordinator
Prof. Henning

Scientific Coordinator
Cross-Sectional Processes
ICD E Coordinator: Prof. Schuh
ICD E Technology Roadmaps

Coordinator Business Case BC1
Coordinator Business Case BCx

Controlling
Scientific Cooperation
Education and Lifelong Learning
Equal Opportunities and Diversity Management
Knowledge Management
Services, Marketing and Technology Transfer

Speaker
Project A-1

Speaker
Project A-x

Speaker
Project B-1

Speaker
Project B-x

Speaker
Project C-1

Speaker
Project C-x

Speaker
Project D-1

Speaker
Project D-x

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Orientation of the cluster of excellence towards production engineering for high- and low-wage countries

Production technology for premium-sectors (high-wage countries)
- High-End-Production in own country
- Ensuring technological advance

Production technology for medium-class and commodity-sectors (low-wage countries)
- Constant down-sizing of the premium-sector requires focus also on medium-class and commodity
- Ensuring a wide sales volume of production technology

The cluster of excellence focusses on production technology from high-wage countries for production in high- and low-wage countries
Consequences of globalisation for production in high-wage countries

means for companies in high-wage countries...

<table>
<thead>
<tr>
<th>Previous Competition</th>
<th>Globalisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWC</td>
<td>HWC</td>
</tr>
<tr>
<td>LWC</td>
<td>LWC</td>
</tr>
</tbody>
</table>

force to differentiation in mature markets

new markets with new expectations of quality

new competitors with partly different factor costs

increasing individualisation and segmentation

cost pressure and chance to compete using scale effects

Resolving the dilemma between cost pressure and handling diversity and dynamics becomes the central competence for production companies in high-wage countries

and in a second step…

The Dilemma
diversity / cost pressure

**Scope**

**Principle**
- orienting products and production towards best possible compliance of customer preferences

**Advantage**
- high returns because of products fitting customer preferences

**Scale**

**Principle**
- standardisation of product and production

**Advantage**
- Low costs of production i.a. because of great learning effects and optimal levels of technology/automation
The Dilemma
dynamics / cost pressure

**Value-orientation**

**Principle**
- decisions are made synthetical, not hierarchical

**Advantage**
- dynamic adaptation to changing conditions

---

**Planning-orientation**

**Principle**
- decisions are made analytical and hierarchical

**Advantage**
- good synchronisation of all different systems of objectives
Diversity / Dynamics / Cost pressure
The Polylemma of Production

- optimal positioning depends on individual conditions

- Positioning just in the flat is not enough, because requirements due to globalisation are not resolved
  - Scope / Scale: diversity / cost pressure
  - Value / Plan: Dynamics / cost pressure

```
<table>
<thead>
<tr>
<th>company A</th>
<th>company B</th>
<th>company C</th>
</tr>
</thead>
</table>
```

Scope

Planning-orientation

Value-orientation

Scale
Diversity / Dynamics / Cost pressure
The Polylemma of Production

- optimal positioning depends on individual conditions

- Just optimising the position between the poles is not sufficient, since the requirements due to globalisation are not resolved
  - Scope / Scale: diversity / cost pressure
  - Value / Plan: Dynamics / cost pressure
The Polylemma of Production is resolved by addressing the poles simultaneously.

Question: How can products be realised with minimum production costs, which are matching perfectly with customer demands?

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The Polylemma of Production is resolved by addressing the poles simultaneously.

Central fields of action in production engineering

Question:
How can products be realised with minimum production costs, which are matching perfectly with customer demands?

How can a good synchronisation of objectives for all activities be achieved simultaneously achieving high system dynamic?

How can a good synchronisation of objectives for all activities be achieved with simultaneously achieving high system dynamic?

How can products be realised with minimum production costs, which are matching perfectly with customer demands?
The most important resource of a high-wage country is the „Human Resource“

**How can these fields of action concretely be handled?**

- **Innovation und creativity**
- **Large experience**
- **Sense of quality**
- **High employees´ motivation**
- **Availability of highly qualified employees**
- **High productivity of employees**

**Source:** Study „Chancen für den Entwicklungs- und Produktionsstandort Deutschland“ by WZL and Kienbaum Management Consulting, 2006
### Integrative Production Technology for High-Wage Countries

<table>
<thead>
<tr>
<th>Integrative</th>
<th>Production Technology for High-wage Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>integrated comprehension</strong> of the polylemma of production</td>
<td>„Production technology“: Development of solutions, how production can be optimised under given circumstances</td>
</tr>
<tr>
<td><strong>integrated comprehension</strong> of the concrete research topic</td>
<td>Objective is the advancement of production technology under the circumstances of a high-wage country</td>
</tr>
<tr>
<td><strong>integrated comprehension</strong> of the (scientific) relations</td>
<td>The product can also be (production) technology, which is used in countries with different circumstances</td>
</tr>
<tr>
<td><strong>interdisciplinarity</strong> as a necessary condition for integrated comprehension</td>
<td>Integrativity is central for the future success of high-wage countries</td>
</tr>
</tbody>
</table>

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Cluster of Excellence – Integrative Production Technology for High-Wage Countries

Individualised Production

Question:
How can products be realised with minimum production costs, which are matching perfectly with customer demands?

Virtual Production

Question:
How can a good synchronisation of objectives for all activities be achieved with simultaneously achieving high system dynamic?

Self-Optimising Production

Question:
How can a good synchronisation of objectives for all activities be achieved with simultaneously achieving high system dynamic?

Hybrid Production

Question:
How can products be realised with minimum production costs, which are matching perfectly with customer demands?
Cluster of Excellence – Integrative Production Technology for High-Wage Countries

**Individualised Production**
- Flexible Configuration Logic for Integrative Production Systems
- Manufacturing Technologies for Individualised Production
- Mechatronics-Orientated Modular System
- Networked Models of the Digital Factory
- Platform for Distributed Numerical Simulation
- Virtual Process Chains for Processing of Materials
- Virtual Production Systems

**Self-Optimising Production**
- Cognitive Control Systems
- High-Resolution Supply Chain
- Technology Enablers for Cognition and Self-optimisation
- Assembly Robotics for Self-Optimising Automation
- New Hybrid Manufacturing Technologies
- Hybrid Incremental Sheet Forming System
- Development of Metal/Plastics-Hybrids
- Hybrid Machining Centres
- Functional Surfaces
- Assembly Robotics for Self-Optimising Automation

**Virtual Production**
- Virtual Process Chains for Processing of Materials
- Virtual Production Systems

**Hybrid Production**
- Hybrid Incremental Sheet Forming System
- Development of Metal/Plastics-Hybrids
- Hybrid Machining Centres
- Functional Surfaces
- Assembly Robotics for Self-Optimising Automation

- Motivation
  - Textile-reinforced metals are a material novelty
  - Material behavior can currently not be predicted / simulated

- Objectives
  - Development of a (pre-industrial) software chain for the simulation of component properties of textile-reinforced metals

- Proceeding
  - Material modeling / simulation on micro-, meso- and macroscopic levels
  - Concatenation of the different simulation levels
Project: Cluster of Excellence Production Systems (DFG)


- Motivation
  - Textile reinforced hybrid metal-plastic parts are a new type of material
  - Complex and expensive process chain
- Objective
  - Development and production of 3D textile Preforms for the reinforcement of structural hybrid parts
- Proceeding
  - Modeling, development and production of temperature resistant 3D textile reinforcements
  - Integration of the textile reinforcement into the hybrid process chain

Metallic 3D-spacer warp knit fabric
Subproject: Technology Enablers for Cognition and Self-optimisation

- **Problem:**
  - Non-automated setup of looms

- **Objective:**
  - Automation system for the weaving machine with elements of self-optimisation
  - Developing strategies for a cognitive loom

- **Approach:**
  - Upgrading the smart adjustment tool developed within the scope of the AutoWarp concept
  - Integration of expertise via metamodelling
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Introduction

European Technology Platform for the Future of Textiles and Clothing (Textile ETP)

Chairman – Univ.-Prof. Dr.-Ing. Dipl.-Wirt. Ing. Thomas Gries

Director – Institut für Textiltechnik,

RWTH Aachen University

Germany

thomas.gries@ita.rwth-aachen.de

European Technology Platform for Assuring the future of Manufacturing in Europe (Manufuture)

ManuTEX
The MANUTEX Questionnaire

Stakeholders and Working structure

- The European textile & clothing industry and their representative organisations
- The European textile/clothing machinery industry and their representative organisations
- The European textile & textile machinery research community
- The European Commission & national authorities

- Implementation and coordination: Coordination Committee (representatives of all stakeholder)
- Chairman: Prof. Thomas Gries, Director of the Institut für Textiltechnik (ITA) at the RWTH Aachen University, Germany.
- Website – www.manutex.eu
Research Priorities

MANUTEX
www.manutex.eu

- Advanced Materials
- Innovative Products/Production
- Resource Efficiency
- Intelligent Production
MANUTEX – FP 7 - Nu-Wave Project

Joint Research Strategy Initiative for the Future of the European Textile, Clothing and Machinery Industries

Research Road Map

May 2007

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Thank you for your attention!!!
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