

INTEGRATIVE PRODUCTION CONCEPTS FOR HIGH-WAGE COUNTRIES

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Abstract

The production location Germany is in competition with other international locations for global companies. To reduce unemployment in Germany, the production sector has to grow stronger. Therefore, production technologies have to be developed which allow a profitable production in the high-wage country of Germany. To achieve this goal, the Cluster of Excellence “Integrative Production Technology for High-Wage Countries” was founded at RWTH Aachen University. Consequently, the aim of the cluster is to keep the production and the development of production technologies in high-wage countries. Within this Cluster, the Institut für Textiltechnik der RWTH Aachen (ITA) is involved in several subprojects which use synergies of different areas of production, including plastics, machine tools and textiles.

Problems of producing companies in high-wage countries

Producing companies face a number of problems in high-wage countries.

- Mass-market
- High wage
- Rising variance of products
- Time-to-market

The result of those problems is that a large number of producing companies migrate to low-wage countries in order to reduce their production costs. Thus, 40% of the German companies are planning investments in foreign countries. Figure 1 shows the foreign countries that German companies are investing in.

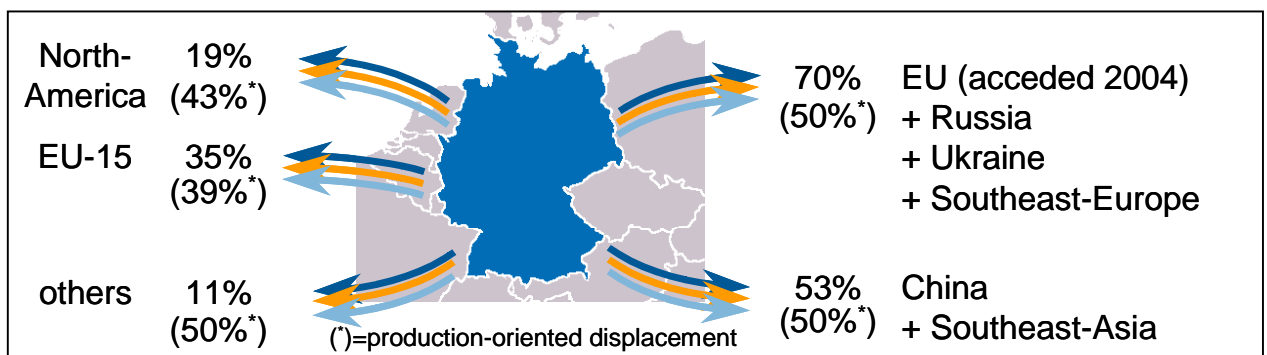


Figure 1: Investments in foreign countries [Source: DIHK]

Cluster of Excellence „Integrative production technology for high-wage countries”

The Cluster of Excellence “Integrative production technology for high-wage countries” unites the institutes of RWTH Aachen university dealing with production engineering. The task within the cluster is to investigate the conditions, methods and arrangements that allow a successful and economic production in high-wage countries. In order to do that, a holistic production theory is needed. This theory is to be supported by the research objectives of the cluster. The objectives are met by an interdisciplinary approach for coherent, comprehensive description and explanation models, composition methods and tools as well as key technologies for integrative product development chains.

Production technology is characterised by two dilemmas of “scale and scope” as well as “planning and value orientation”. The scale of production technology is described by critical masses, standards, maximum rates, controlled single processes and high synchronisation. The scope means one-piece-flow, versatile, dynamic processes, limited capacity and low synchronisation. This first dilemma “scale and scope” is shown on the left side of Figure 2. Planning orientation consists of a high planning complexity for the optimisation of value-adding processes, modelling and simulation as well as knowledge and information management. On the other hand, a value orientation is determined by focusing on processes adding value, minimising of production planning, work preparation, management, transport and storing as well as standardising methods of operation. The dilemma of “planning and value orientation” is shown on the right side of Figure 2.

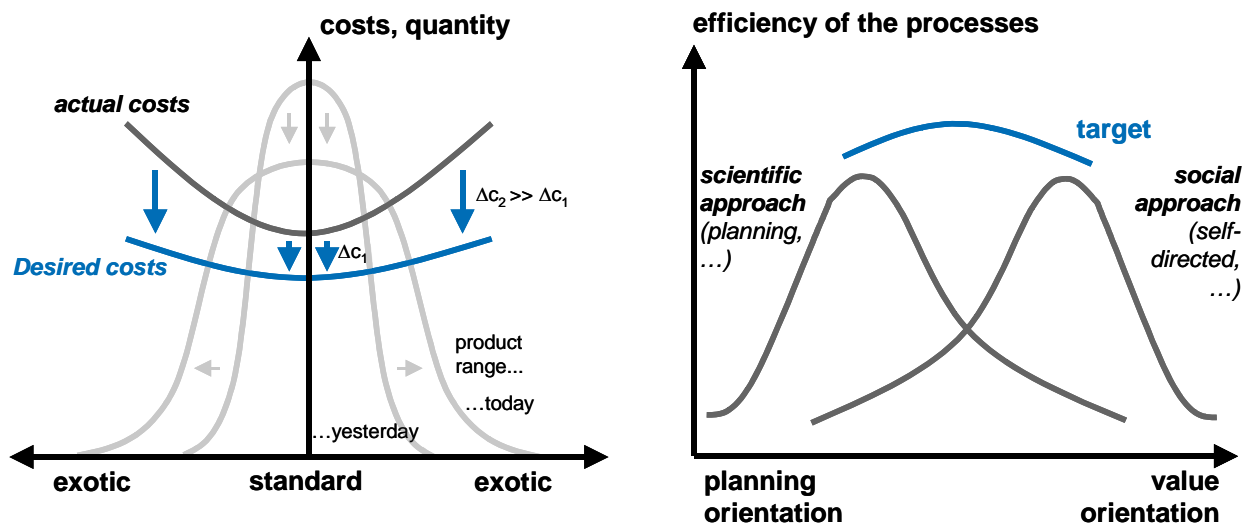


Figure 2: Dilemma “scale vs. scope” and dilemma “planning vs. value orientation” [Source: RWTH Aachen University]

The vision of the Cluster of Excellence is to dissolve the polylemma of production technology within the next 20 years. The first step is to significantly reduce the two dilemmas, as is seen in Figure 3.

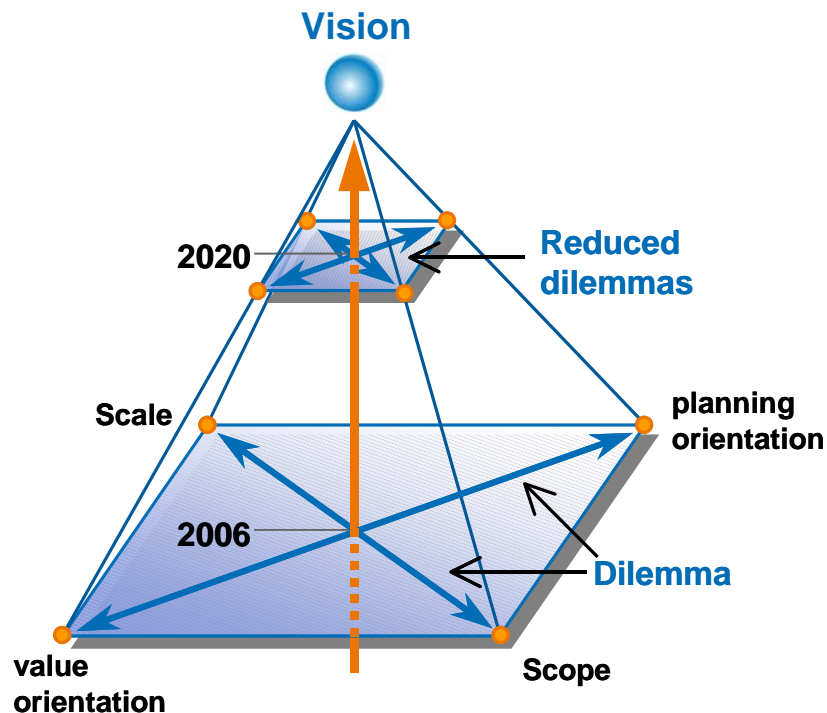


Figure 3: Vision of the Cluster of Excellence [Source: RWTH Aachen University]

Fields of work within the Cluster of Excellence

In order to reduce the dilemmas of production technology, four fields of research were defined:

- Individualised production
- Virtual production systems
- Hybrid production systems
- Self-optimising production systems.

Within these fields, various research projects are carried out. A number of institutes are involved in each project.

Individualised production

One of the objectives of the field “individualised production” is to support the development process for individualised products. The flexibility of technology for mass production is to be enhanced. Another part is the optimal adjustment between product structure and production system structure. For individualised products, the productive efficiency has to be increased and at the same time, the costs have to be reduced. Figure 4 shows the elements and models that will be used in this field’s research projects.

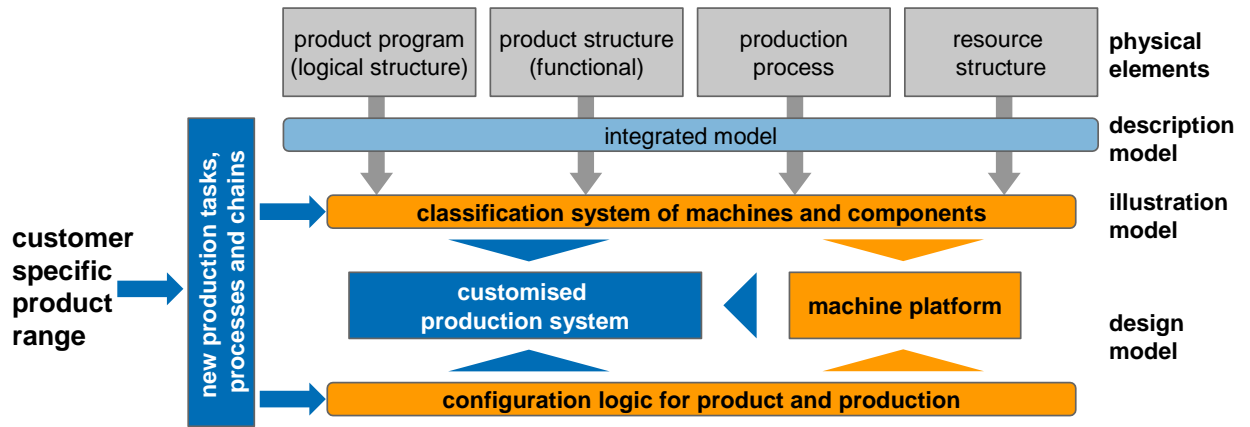


Figure 4: Concepts for individualised products [Source: RWTH Aachen University]

Virtual production systems

The second field are the “virtual production systems”. Research within this field will deal with the question of extension and coupling of models, integrated simulation of material and process, coupling of micro and macro systems as well as prognosis of effective material attributes by means of simulated microstructures. A concept for virtual production systems is shown in Figure 5.

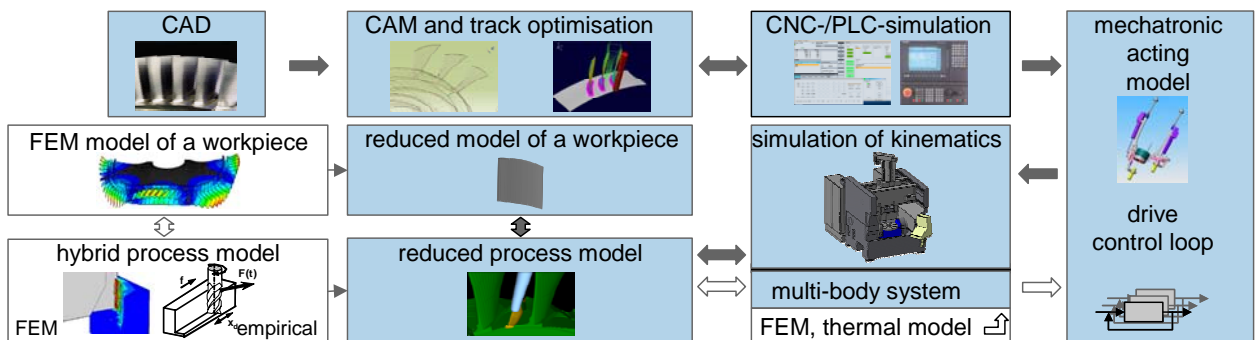


Figure 5: Concept for virtual production systems [Source: RWTH Aachen University]

Hybrid production systems

The objective of the field “hybrid production systems” is the development of a method for a systematic design of hybrid processes, production systems and process chains. The procedure to achieve this contains the analysis of existing hybrid processes, the description of physical mechanisms and the development of connection logics. Figure 6 illustrates this procedure.

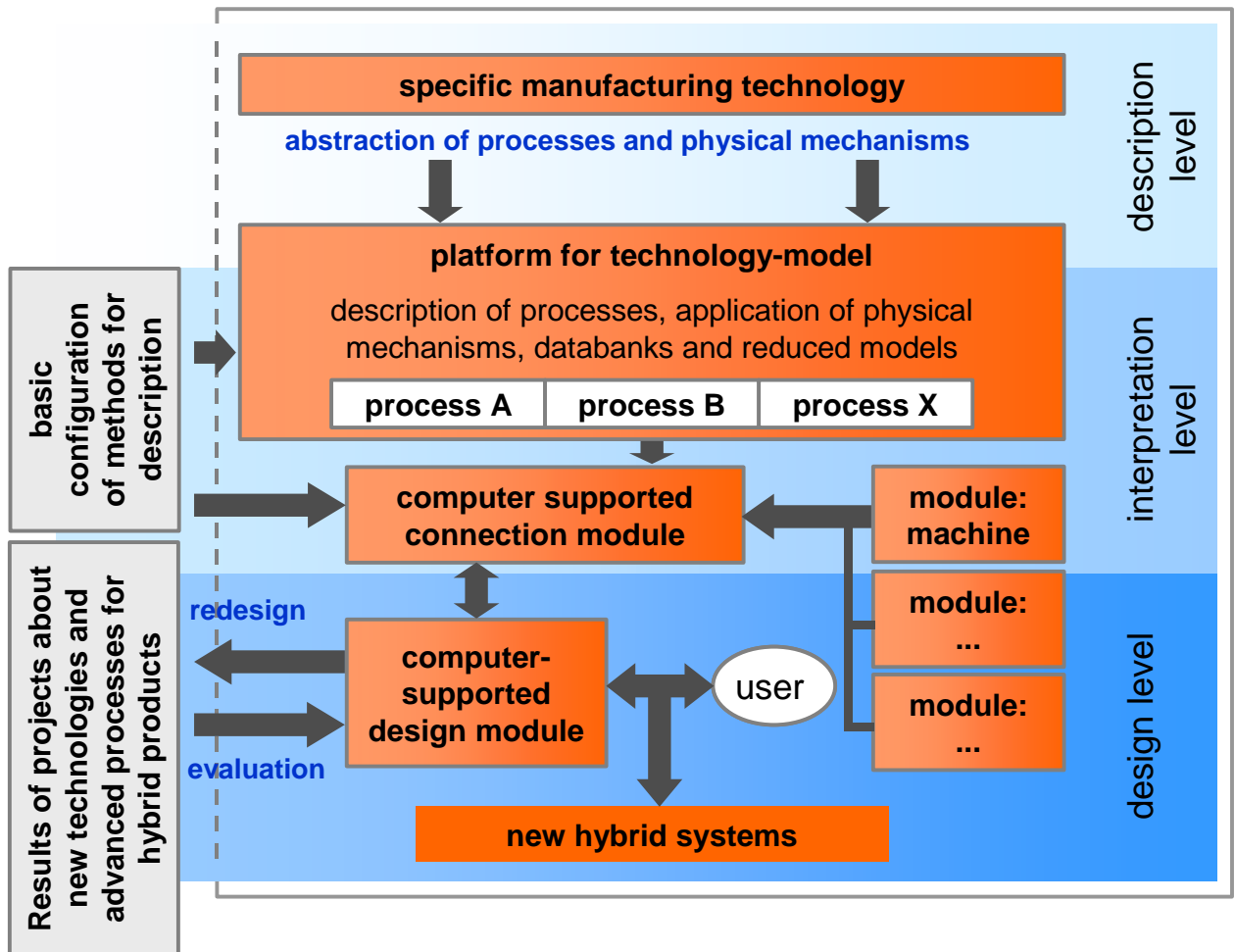


Figure 6: Concept for hybrid production systems [Source: RWTH Aachen University]

Self-optimising production systems

The fourth field is the “self-optimisation of production systems” (see Figure 7). Its research projects will deal with a systematic identification of mechanisms for self-optimisation. Methods and concepts for modelling, of cognitive abilities in production systems as well as methods and algorithms for automated rigging, monitoring and controlling of processes are being developed.

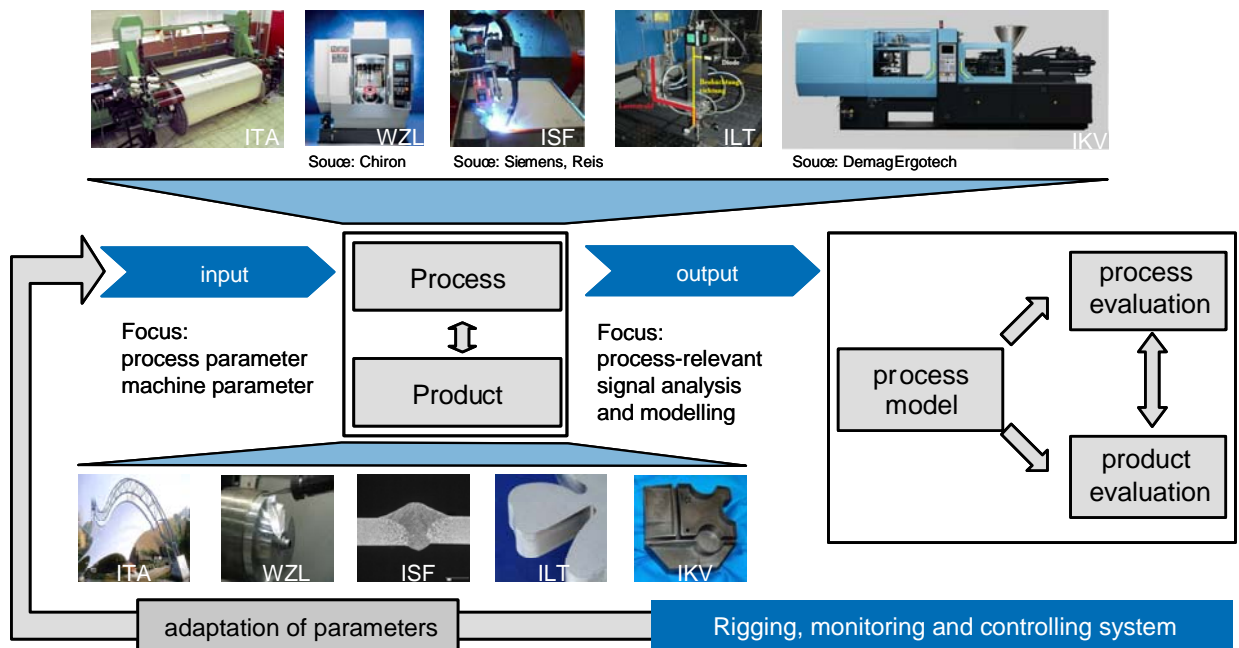


Figure 7: Concept for self-optimising production systems [Source: RWTH Aachen University]

Projects of ITA within the Cluster of Excellence

ITA is working in three research projects within three different research fields of the Cluster of Excellence. Each of the projects is carried out in collaboration with various other institutes.

The first of those projects is part of the field “Virtual production systems”. ITA works on a test case called „textile-reinforced con-rod“. The first step is the development of a yarn model and the macro-simulation of the textile structure (see Figure 8). The second step is the simulation of the microstructure of textile reinforced metal and the third step is the deduction of characteristics on the macro-level and the simulation of a coating.

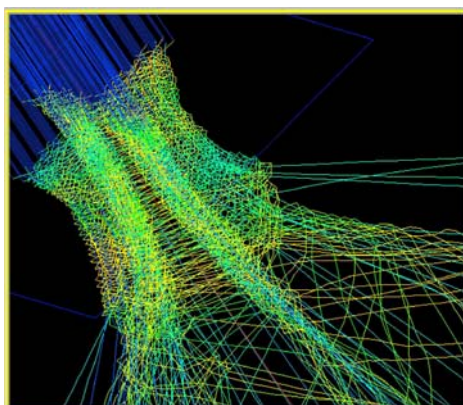


Figure 8: Macro simulation of braiding [Source: ITA]

The second project with participation of ITA deals with the production of a metal-/plastic-component with textile reinforcement. The project is part of the field “Hybrid production systems”. Research is done on the form closure between components, the modification of the plastic characteristics (adaptation of E modulus, homogeneous deformation, lower

shearing force in the area of implementation) and the modification of the metal characteristics (thermal expansion).

The third project, in which ITA is working, is part of the field “Self-optimising production systems”. The project is called “Technology enablers for embedding cognition and self-optimisation into production systems”. ITA is doing research concerning the cognition and self-optimisation of the weaving loom, see Figure 9. The partner institutes are working with similar objectives in different areas, e.g. injection moulding, welding. The results of the research done on model building and self optimisation of the production process are used to enhance the capabilities of this specific process. Furthermore, it is examined whether they could provide an added value that could be transferred to other production processes.

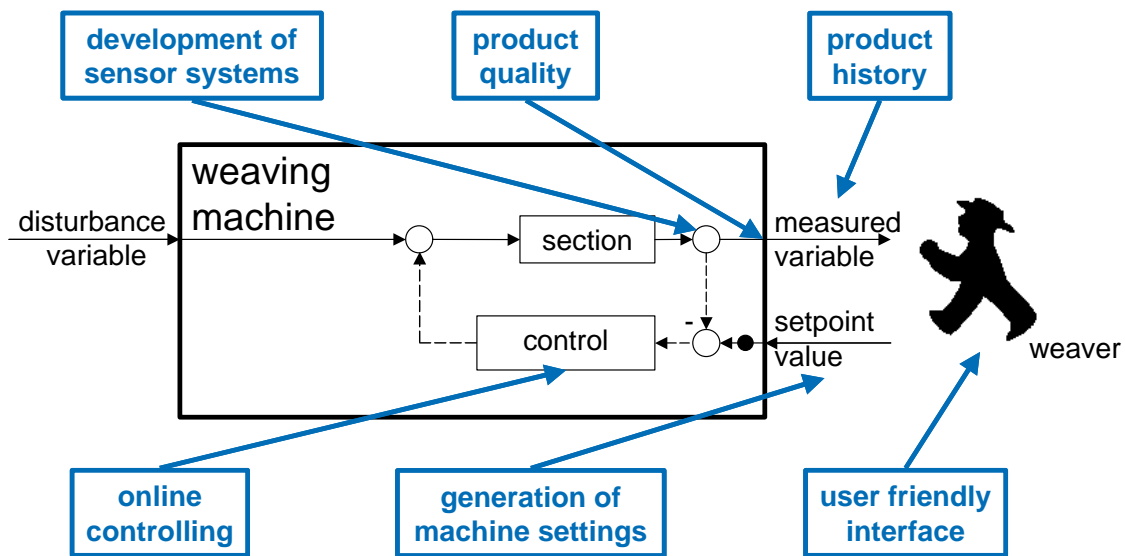


Figure 9: Cognition and self-optimisation at the weaving loom [Source: ITA]

Acknowledgements

The authors would like to thank the German Research Foundation DFG for the support of the depicted research within the Cluster of Excellence "Integrative Production Technology for High-Wage Countries".