Energy Efficiency in Manufacturing

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2018-10-15, Auckland

Saarland University | Chair of Automation and Energy Systems

- Saarbrücken, located in the heart of Europe
  - Two hours by train to Paris and Frankfurt
  - 200 000 inhabitants

- Saarland University
  - 18 000 students (17% international)
  - 279 professors, 1 300 academic staff

- Chair of Automation and Energy Systems
  - Head: Prof. Dr.-Ing. Georg Frey
  - Staff: 1 postdoc, 15 PhD candidates, 1 technician, 1 secretary

AES Research Focus

The focus of our research is on the development of methods to provide reliable automation and energy systems

Conceptual design and analysis of networked automation systems, the so-called C³ systems (Communication, Computation, Control), whose complex time behavior imposes special requirements on their design and specification as well as on modeling and simulation.

Model-based design and automation of energy systems. In particular, the integration of renewable generators and the associated challenges for efficient operation.

AES Research Topics (Selection)

ERACS
modeling and verification of reconfigurable discrete event control systems

Functional Safety
verification and validation of safety controllers

Compressed Air
simulation based design and operation of compressed air stations

BROS
browser-based reconfigurable orthopedic surgery

AutoIBN & AutoIBN2
energy-efficiency in automated installations

EULE
energy efficiency and multiobjective optimization of public properties by building automation

EHSTEG
model-based analysis and design of waste heat recovery processes

DES
distributed energy systems

MOC²IES
model-based configuration and control of isolated energy systems

MOCES
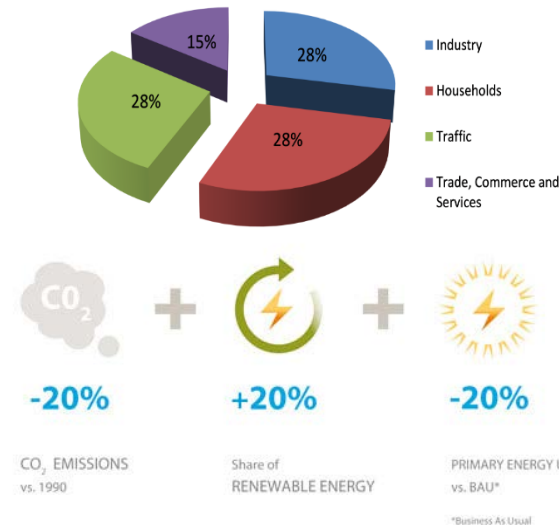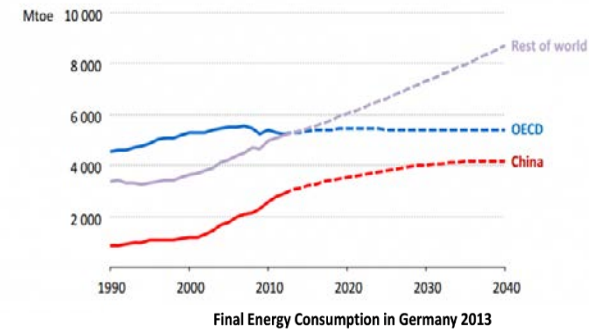modeling of complex energy systems

Federal Ministry for Economic Affairs and Energy

MITTELSTAND GLOBAL
ENERGY SOLUTIONS
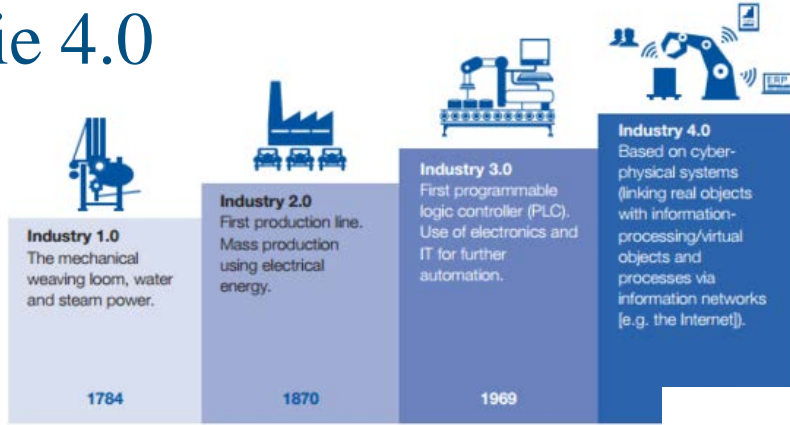MADE IN GERMANY

energie waechter

Motivation

- Energy consumption gets more attention because of rising energy prices and awareness of our environment

- Industry sector accounts for approximately one third of the final energy consumption in Germany

- Energy becomes to a more and more important cost factor

Final Energy Consumption in Germany 2013

- Industry 28%
- Households 28%
- Traffic 28%
- Trade, Commerce and Services 15%

-20% CO₂ EMISSIONS vs. 1990

+20% Share of RENEWABLE ENERGY

-20% PRIMARY ENERGY USE vs. BAU*

*Business As Usual

Industie 4.0

Industry 1.0
The mechanical weaving loom, water and steam power.
1784

Industry 2.0
First production line. Mass production using electrical energy.
1870

Industry 3.0
First programmable logic controller (PLC). Use of electronics and IT for further automation.
1969

Industry 4.0
Based on cyber-physical systems (linking real objects with information-processing/virtual objects and processes via information networks [e.g. the Internet]).

Industrie 4.0

INTERNET of THINGS

Health

Energy

Mobility

Industry 4.0

Security

Communication

Source:
www.industry40wood.com,www.mhlnews.com,www.imi.kit.edu, www.slideshare.net

Industrie 4.0 and Energiewende

- The vision Industrie 4.0 will change the German manufacturing systems. Smart Factories provide Cyber Physical Systems (CPS) that combine the virtual and physical world.

- Completely new manufacturing processes and energy management systems will lead to an efficient production in terms of energy and resources in the future.

- Energiewende demands for intelligent distribution networks of Energy that leads to Cyber Physical Systems again

- Energiewende can only be successful if energy production and demand can be balanced. Either by storage (expensive) or intelligent Demand Side Management → Industrie 4.0

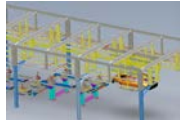# Key Research Topics in AutoIBN

Automated Wheel Adaption System — Automated wheel adaption to determine the rear axle geometry in the assembly line.

Assembly Worker Assistance Systems — Innovative Human Robot Concepts for the automation of production and testing processes in the continuous assembly line

Virtual Plant Engineering — Advanced plant design and virtual commissioning along with efficient plant planning and production design.

Energy Efficient Production Facilities — Energy efficient operations for production facilities with variable operating modes.

Research & Test Environment — Research scenarios are set up and integrated in a model factory for validation.
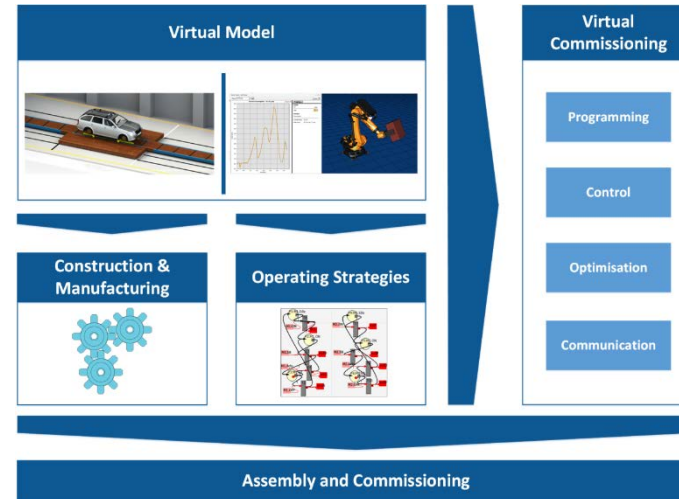
AutoIBN: Energy Efficiency

Motivation

- Energy optimization takes advantages of switching components into energy efficient modes

Approach

- Material flow simulation combined with energy flow in order to improve the interaction between different components of a factory
- Use of extended Petri nets for the discrete-event modeling of the system according to specific energy states and evaluate switching strategies for energy-efficiency operations in a factory model
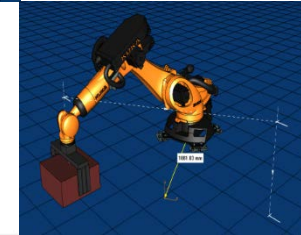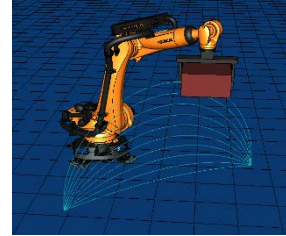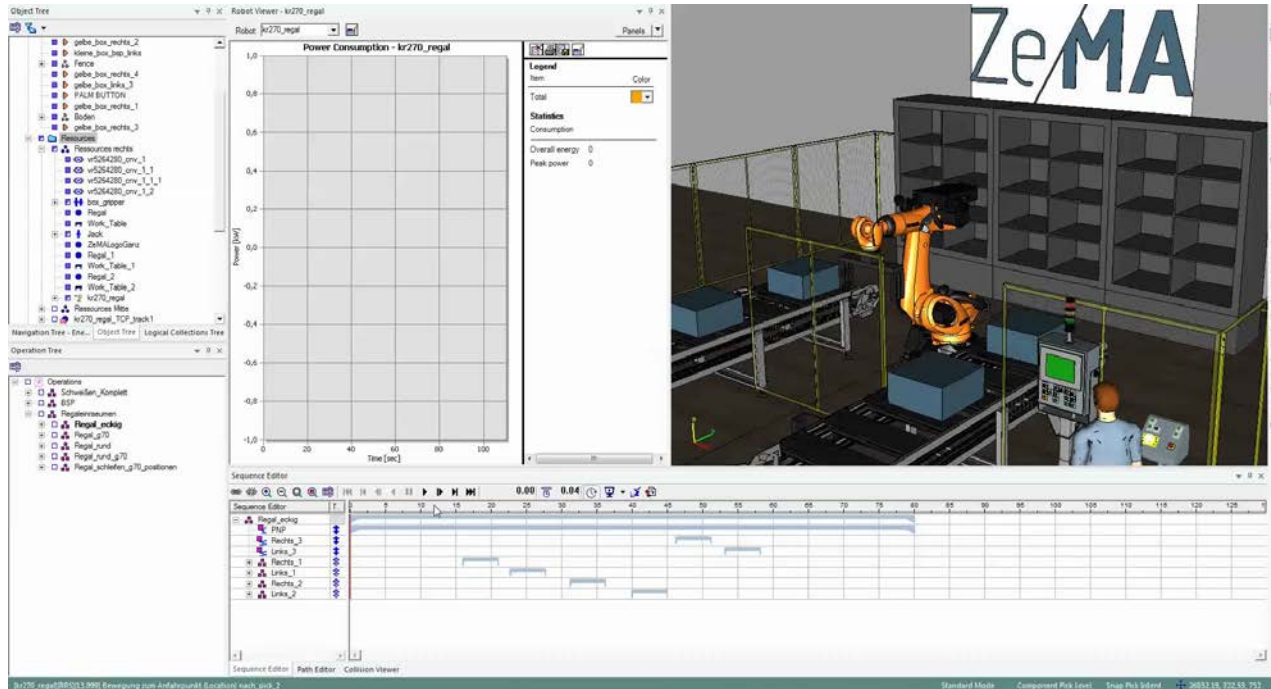
AutoIBN: Energy Efficiency

Motivation

- High degree of automation in the automotive industry. Especially the body in white production uses a huge number of robots. The aim is to increase the energy efficiency of industrial robots.
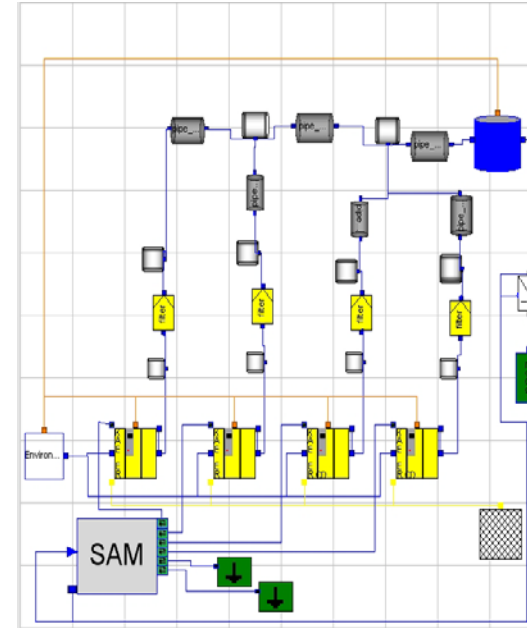
Approach

- Optimized path planning with respect to path and velocity
- Using software tools to show path planning concepts in the virtual plant simulation

AutoIBN: Energy Efficiency

Optimal Control of Compressed Air Supply

Thank you for your attention!

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