Robust optimization and control for improved system performance
The dyn Team

~ 20 Dr.-Ing. candidates, 1 PostDoc
~ 2 technicians, 2 (part-time) secretaries
~ 15 student assistants
DYN@TUDO: Areas of Research

Process Control Methods & Applications

Logic Controllers & Hybrid Systems

Modeling, optimization, and optimal operation of continuous and batch processes

Control and operation of processes with discrete decisions

Process Design and Biological Systems

Production Planning and Scheduling

Dortmund Process Dynamics & Operations Group
Optimization of Plant Performance by Control

Approach:
• Use measured data to improve the performance of processes on the basis of mathematical models

Implementations:
• Distillation column with reaction (pilot plant)
• Chromatographic separations (SMB, CAEC) (pilot plants)
• Polymerization reactors (pilot and industrial scale)
• Chlorine production (for Thyssen-Krupp Uhde)

ERC Advanced Investigator Grant MOBOCON – Model-based optimizing control – from a vision to industrial reality
• Focus on robustification, interaction with the operators
Projects with Industry (1): Process Control

- Model-based control of complex emulsion polymerisation processes (BASF)
- Realization of Advanced Control at a polymerization reactor (with Evonik Industries)
- EU STREP EMBOCON (Embedded Optimization (a.o. with BASF)
- EU STREP CAEC (Continuous Annular Chromatography)
- EU IP F3 Fast Flexible Future Factory
  - Modeling and control structure design for Arkema, Evonik, Procter&Gamble
  - Process and control development of continuous acrylate polymerization with Rhodia and BASF
  - Leader of the WP “Process Operation”
Projects with Industry (2): Scheduling

- Coordination of scheduling systems (with ABB Ladenburg)
- Fast scheduling using timed-automata models (Tool TAOpt)
  - Industrial case study: SABIC warehouse pallet mover control
- Optimal operation of a sugar plant (study for Invensys/Suiker Unie)
- Production planning for future flexible plants (F3 MES)
- Risk-averse medium-term planning of an industrial batch process
EU Project Multiform (just finished)

- Coordinated by TU Dortmund / DYN (S. Engell, Chr. Sonntag)
- Design support for complex controlled systems using different model formalisms and computer tools
  - Tool transformations via the Compositional Interchange Format
  - Tools for logic controller specification and verification (DC/FT)
  - Improvement of analysis tools (SpaceEx (Grenoble), Uppaal (Aalborg), Arcade (RWTH Aachen))
  - Design framework (ESI, TUDO)
  - 4 case studies, thereof 3 industrial
- Spin-off company euTeXoo (Chr. Sonntag)
- Follow-up project with PSE Ltd. on Modelica-gPROMS transformation of models
Cooperation Potential

- **Domain knowledge:**
  - All kinds of processes where energy is transferred (heating, cooling, power generation) and/or where substances are changed, mixed or shaped (chemical, biological, metallurgical, food)

- **Methods:**
  - Dynamic optimization, monitoring and control of industrial processes
  - Systems design and validation, tool integration
  - Optimization methods (memetic algorithms)
  - Planning and scheduling methods (fast, online)
  - Optimization and decision-making under uncertainty (multi-stage MPC)

- **More than 50 PhD graduates**
  - The majority work in an around the chemical industry
  - Several leaders of control and optimization groups
  - 5 faculty members at foreign universities
  - 2 full professors at German universities
Interests in Other Applications

- Modeling, monitoring, and control of bioreactors (fermentations, production of active ingredients)
- Water purification and distribution (drinkable and irrigation), flow optimization, storage management under uncertainty
- Food industries
- Temperature and ventilation control of buildings
- Smart grids, production and demand management under uncertainty, combined power and heat generation
- Planning of agricultural production under uncertainty

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Interests in EU Calls: ICT

- **From analysing to controlling behaviour of Systems of Systems (SoS) (ICT-2013.3.4) (STREP, 15.1.2013)**
  
  Analysing and modelling SoS with possibly emergent behaviour and their control, and validating new SoS engineering approaches in industry-driven case studies of real applications, such as distributed energy systems and grids, *multi-site industrial production*, or automated transportation. Generic aspects of the approaches should be stressed, basic concepts elaborated and open research issues identified.

- **ICT for water resources management (ICT-2013.6.3) (STREP, 16.4.2013)**

- **Smart Energy Grids (ICT-2013.6.1) (STREP, 16.4.2013)**

Interests in EU Calls: Other

- **KBBE:**
  - Development and industrial application of sensors for food processing operations (KBBBE-2013.2.3-01)
  - Saving water and energy for resource-efficient food processing (KBBE-2013.2.5-02)

- **Energy:**
  - Development and validation of methods and tools for network integration of distributed renewable resources (ENERGY 2013.7.1.1) (4.12.2012)

- **Energy-efficient buildings:**
  - Integrated control systems and methodologies to monitor and improve building energy performance (EeB.NMP.2013-4) (4.12.2012)