University of Stuttgart
Institute of Industrial Automation
and Software Engineering

Research and Teaching at IAS

2018

Prof. Dr.-Ing. Michael Weyrich

History

since 2013

Institute of Industrial Automation
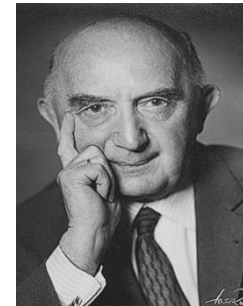and Software Engineering

Professor M. Weyrich

1995 – 2015

Institute of Industrial Automation
and Software Engineering

Professor P. Göhner

1970 – 1995

Institute of Control Systems
Engineering and Process
Automation

Professor R. Lauber

1935 – 1970

Institute of Electrical
Installations

Professor A. Leonhard

Institute of Industrial Automation and Software Engineering (IAS)

Faculty of Computer Science, Electrical Engineering and Information Technology of the University of Stuttgart

Research and teaching at the Institute focuses on the topic of **Software Systems for Automation Engineering**.

We see ourselves as a **bridgehead to Product and Plant Automation** in the research disciplines of **Information Technology, Software Technology and Electronics**.

Prof Weyrich was appointed to the University of Stuttgart in April 2013.

Universität Stuttgart

Information about IAS

- Institute members
  - Head of institute: 1
  - Research staff: 15
  - Faculty support staff: 5
  - Apprentices: 2

- PhD graduates per annum: ~2

- Undergraduate Projects and Diploma-/Master Theses per annum: ~90

- Exams per annum: >>1000

- Publications per annum: 20-25

- Student Assistants per annum: 40-50

Lectures at the Institute

- Industrial Automation I (German)
- Industrial Automation II (German)
- Technologies and Methodologies of Software Systems I (German)
- Technologies and Methodologies of Software Systems II (German)
- Software Engineering for Real-Time Systems
- Industrial Automation Systems
- Introduction to Computer Science II (German)
- Lecture Series: Software and Automation
- Reliability and Safety of Automation Systems (German)
- Software Engineering Internship
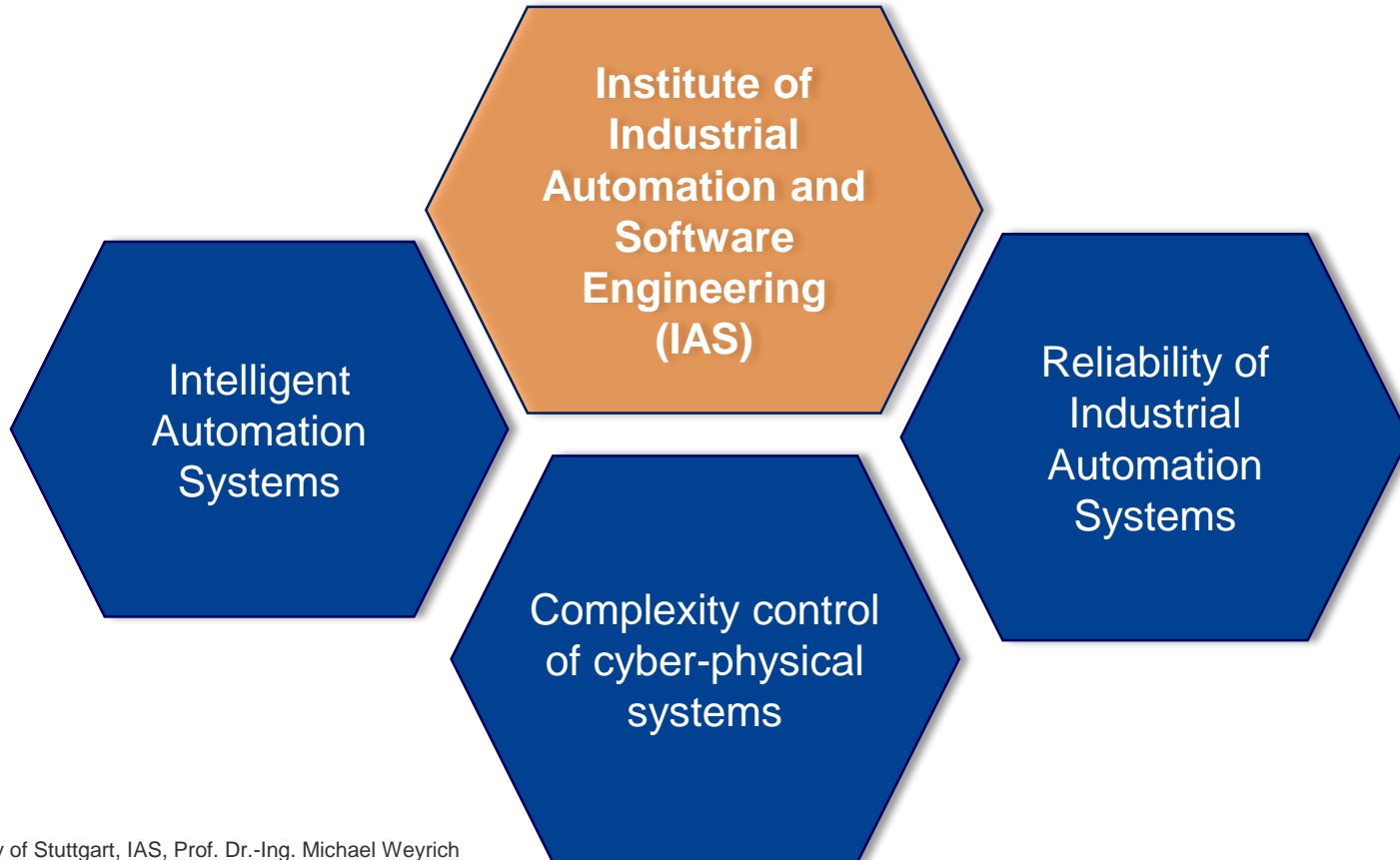- Industrial Automation Internship

Courses for Degree Programmes

- B. Sc. Elektrotechnik und Informationstechnik
- B. Sc. Mechatronik
- B. Sc. Medizintechnik
- B. Sc. Erneuerbare Energien
- B. Sc. Technische Kybernetik
- B. Sc. Technikpädagogik
- B. Sc. Informatik

- M. Sc. Elektrotechnik und Informationstechnik
- M. Sc. Mechatronik
- M. Sc. Medizintechnik
- M. Sc. Information Technology
- M. Sc. Nachhaltige Elektrische Energieversorgung
- M. Sc. Technikpädagogik
- M. Sc. Verkehrsingenieurwesen

Research at IAS

The research of Automation Technology is based on applications in the manufacturing industry, automotive and urban life.

Institute of Industrial Automation and Software Engineering (IAS)

Intelligent Automation Systems

Complexity control of cyber-physical systems

Reliability of Industrial Automation Systems

Research area: Intelligent Automation Systems

Intelligent automation systems offer opportunities in the area of optimization, flexibility and networked information management.

- Autonomous integration of automation components (Self-X)

- Optimization of automation systems based on process data (Machine Learning, Big Data, Data Analytics)

- Distributed control methods for coordination

- Assistance systems to support the engineering process
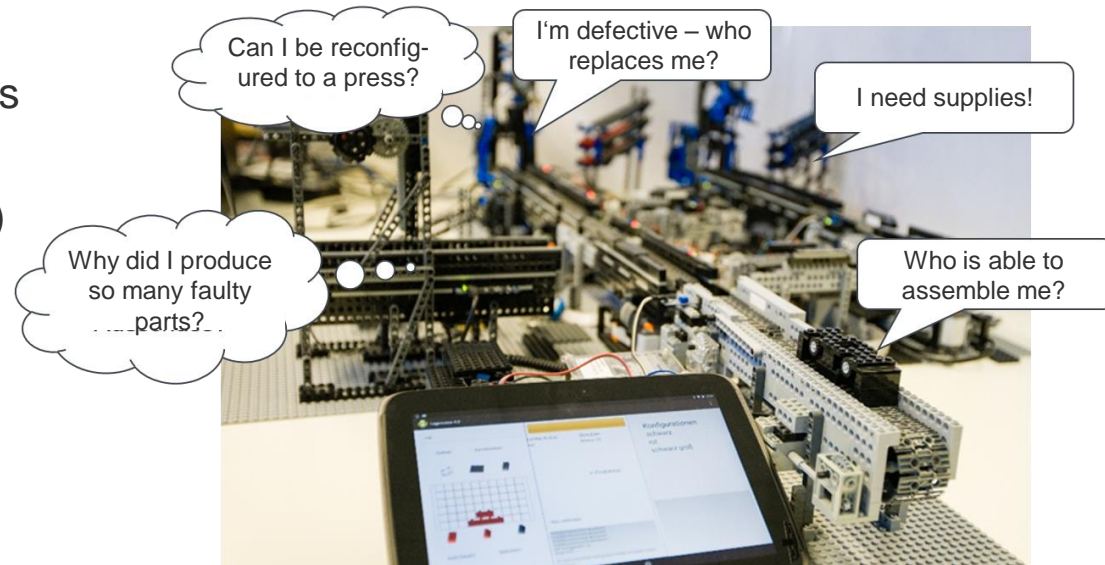
Research area: Complexity control of cyber-physical systems

Digital twins, networking and cooperation enable novel engineering and work processes. At the same time, the complexity of cyber-physical systems is increasing due to software and IT.

- Model-driven development of distributed plant controls

- Model-based test of dynamically changing software and hardware systems

- Digital twin and its applications

- Human-machine cooperation in a hybrid reality

Research area: Reliability of Industrial Automation Systems

The quality of automated systems in terms of improving reliability and availability is a key issue in automation.

- Assessment and evaluation of the reliability of automated systems in the Internet of Things

- Fault management and automatic reconfiguration to increase availability

- Test of automated systems and anomaly detection

Cyber Security

Valuation

Reliability

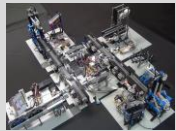Availability
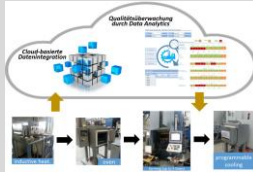
Test
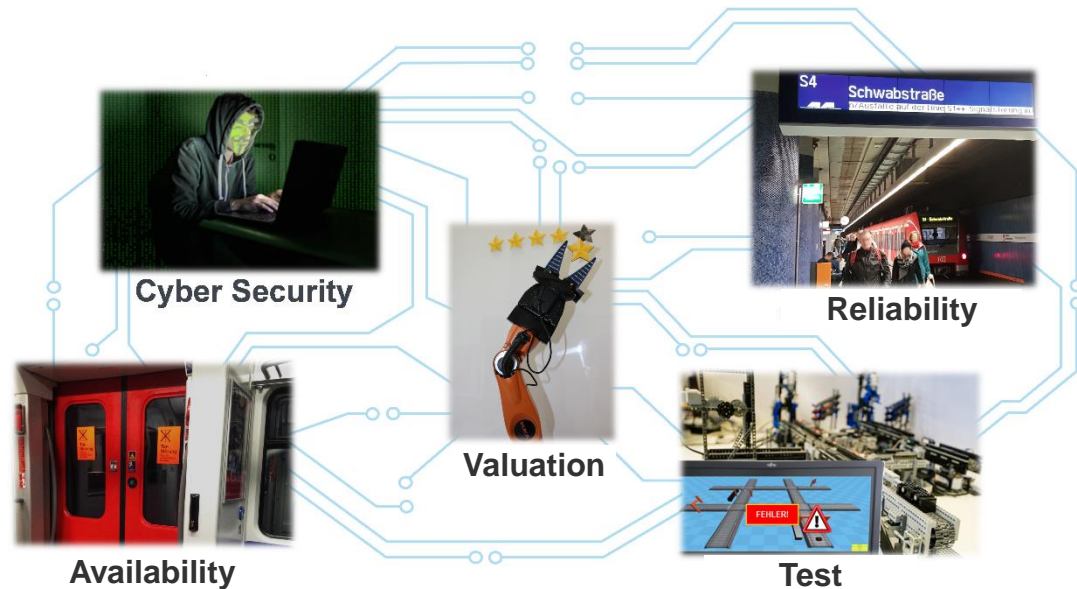
Model processes at IAS

The model processes are used to represent special automation technology and to demonstrate the capabilities of software systems.

Intelligent Automation Systems

- Production Process Chain
- Data Analytics in Manufacturing
- Industry 4.0 Assembly plant
- Automated Crane
- IoT scenario: Mountain Hut

Complexity control of CPS

- AutoSAR
- eProduction-System
- Modular Production System
- Driving simulator

Reliability of Automation Systems

- TestIAS with Virtual Reality
- Automated Bottling Plant
- Assistance system Test case prioritization
- Smartphone-based Fault Diagnosis
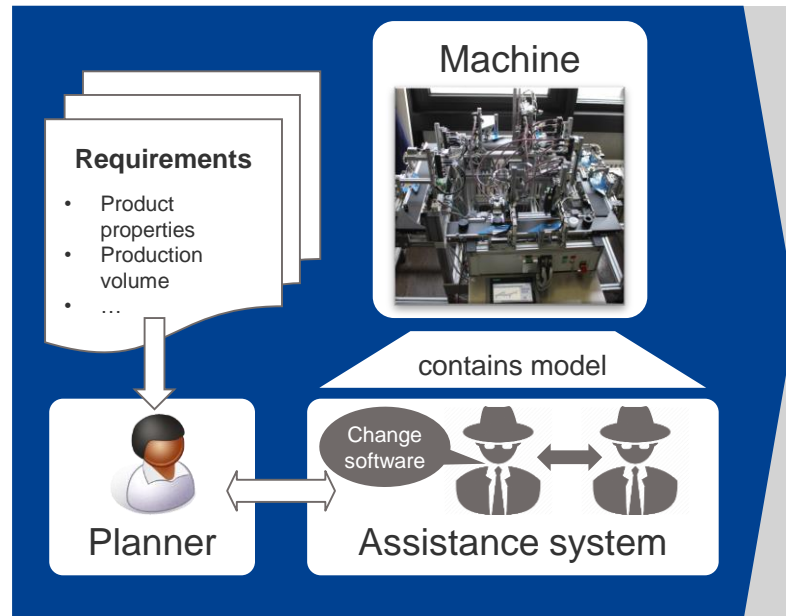
DFG-Project FlexA

Flexibility of assembly and handling machines using multi-agent systems

Requirements:

- Methodical support of the planner in the flexibility process
- Generation and evaluation of adaptation options based on given requirements

Core technologies:

- Product-, process-, resource-model of the machine
- Agent-based assistance system

Approach

- Description of the machine using a model, agents represent components of the machine
- Automated evaluation of production requests
- Generation and evaluation of adaptation options using the model of the machine

- ➢ Decision support and assistance in the flexibility planning process
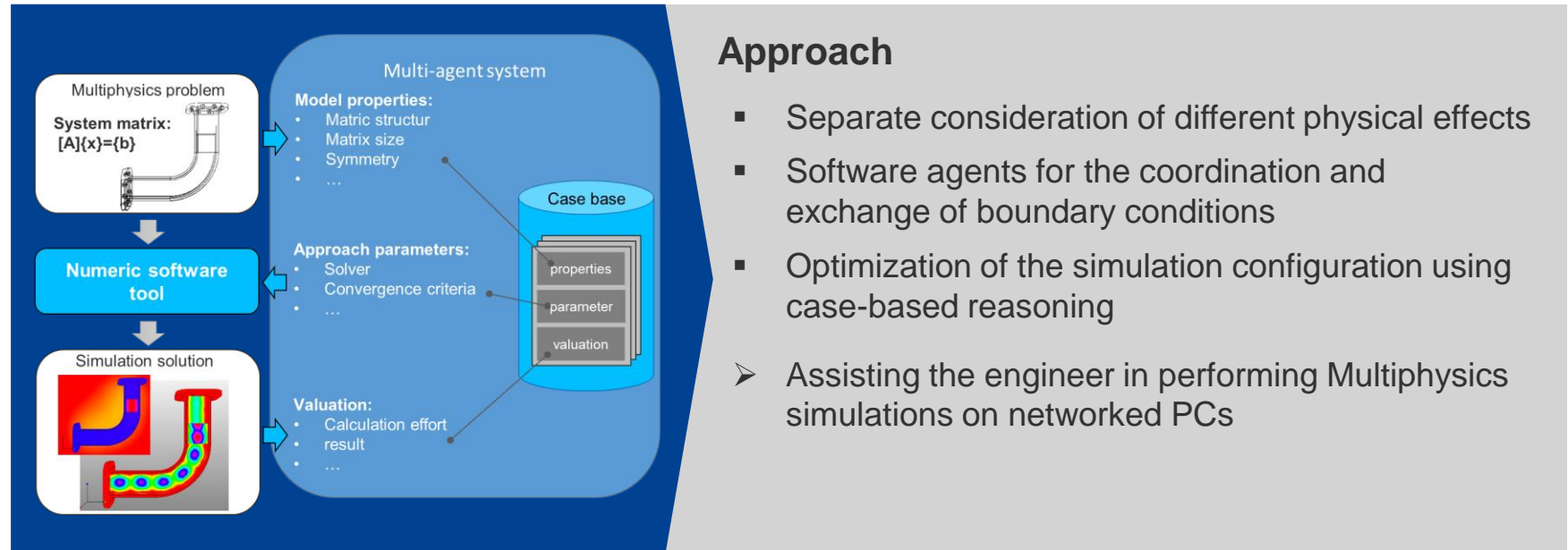
DFG-Project GekoProAg

Decentralized Multiphysics simulation of coupled problems

Requirements:

- Intelligent problem decomposition and cooperation for decentralized simulation
- Improvement of the simulation configuration

Core technologies:

- Software agents
- Simulation
- Case-Based Reasoning

Approach

- Separate consideration of different physical effects
- Software agents for the coordination and exchange of boundary conditions
- Optimization of the simulation configuration using case-based reasoning

➢ Assisting the engineer in performing Multiphysics simulations on networked PCs

DFG-Project DEPIAS

Decentralized self-organized planning of intralogistics systems with the help of agents
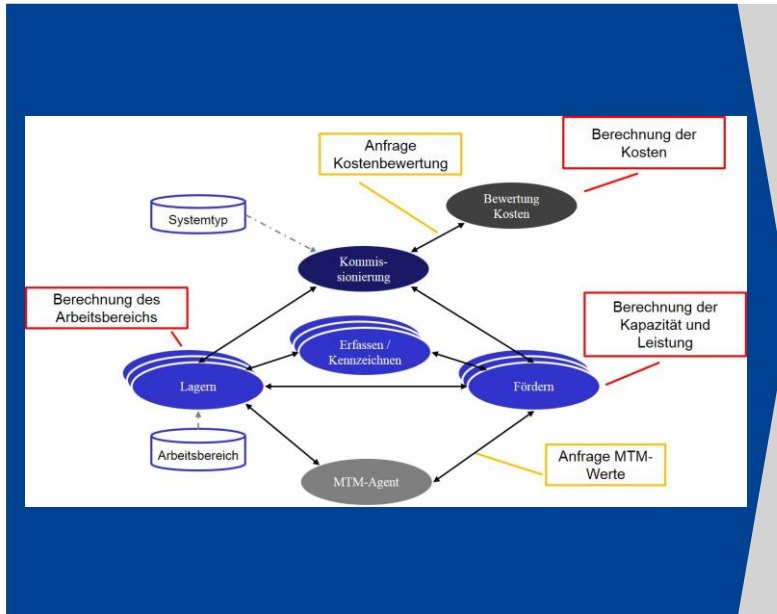
Requirements:

- Support of the planner in the rough planning phase of intralogistics systems

Core technologies:

- Multi-Agent System
- Self-organization

Approach

- Planning of material flow systems is modelled as a dialog-based process and applied to an agent system

- Agents represent resources and try to integrate them into the planned material flow system

- Determination of possible constellations for the material flow system to be planned
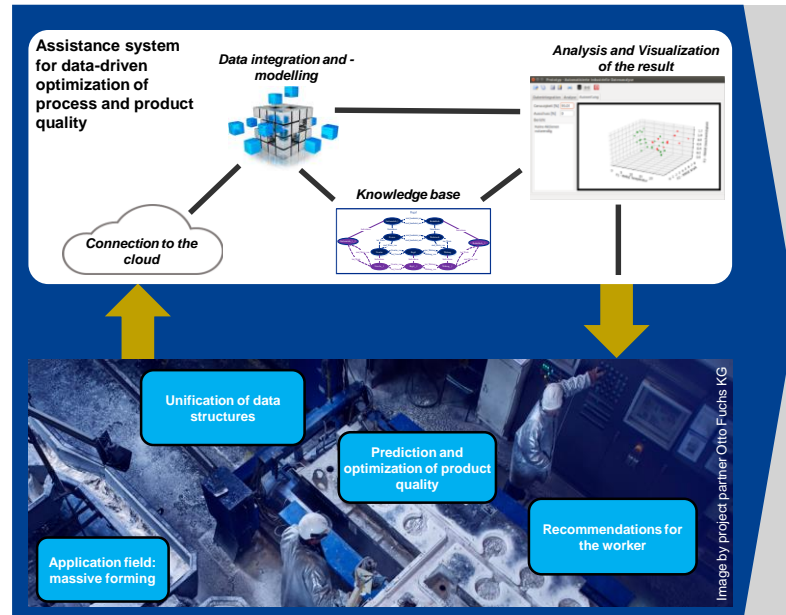
BMWi-Project EMuDig40
Data analytics in quality assurance

Requirements:

- Analysis of process data for compliance with defined quality characteristics
- Real-time recommendations to the worker

Core technologies:

- PLC-based data acquisition
- Feature extraction
- Data Analytics (online/offline)

Motivation

- Sensor data contains information about the plant and process status and can be used to improve the process quality

Approach

- Systematic extraction of unknown relationships and patterns
- Data acquisition and integration, dimension reduction, data analysis, recommendations
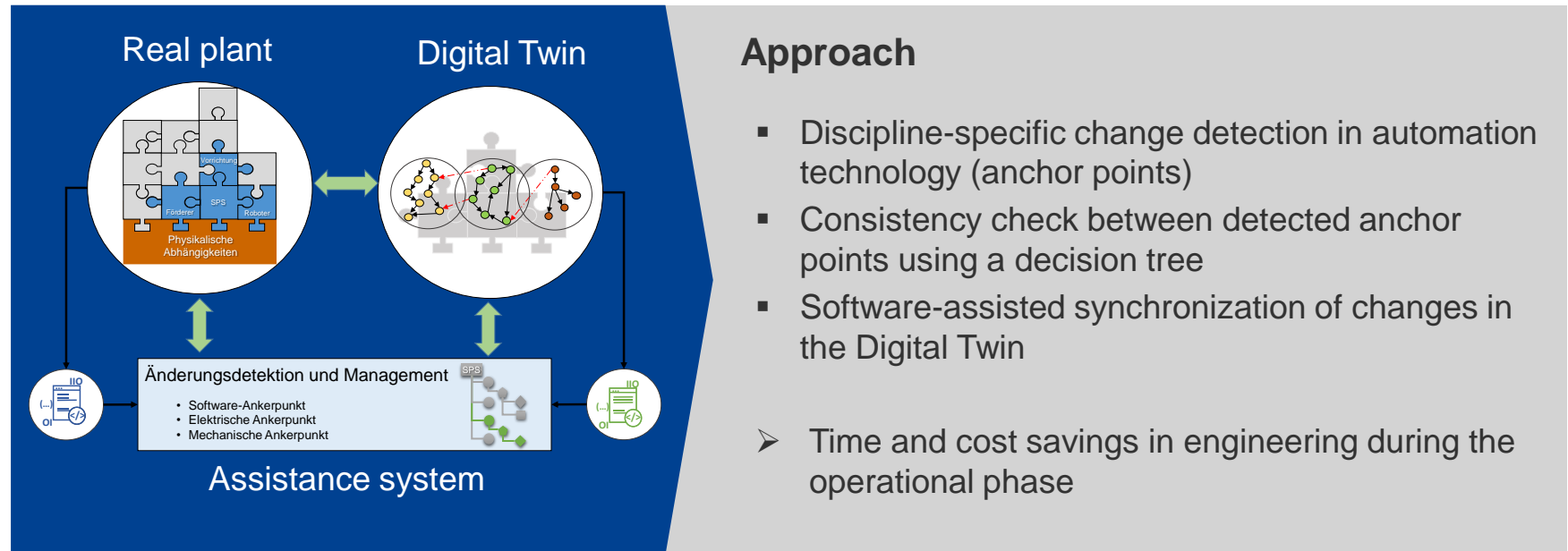- ➤ Data-driven quality optimization

Digital Twin
Synchronization of digital models with the real manufacturing cell

Requirements:

- Cross-domain synchronization of engineering models with a real manufacturing cell in operation

Core technologies:

- Engineering and simulation models
- Robot / PLC code analysis
- Decision Tree in Assistance System

Real plant

Digital Twin

Vorrichtung

Förderer   SPS   Roboter

Physikalische Abhängigkeiten

Änderungsdetektion und Management   SPS

- Software-Ankerpunkt
- Elektrische Ankerpunkt
- Mechanische Ankerpunkt

IIO
(...)
OI

IIO
(...)
OI

Assistance system

Approach

- Discipline-specific change detection in automation technology (anchor points)
- Consistency check between detected anchor points using a decision tree
- Software-assisted synchronization of changes in the Digital Twin

➢ Time and cost savings in engineering during the operational phase

Cooperation with the following companies

- AUDI AG
- Daimler AG
- Deutsche Accumotive GmbH & Co. KG
- Hirschvogel Umformtechnik GmbH
- iss (Innovative Software Services GmbH)
- Robert Bosch GmbH
- Siemens AG
- SMS group GmbH
- Vector Consulting GmbH
- Vector Informatik GmbH
- OTTO FUCHS KG

Maker Space

IAS supports various start-up companies

NAiSE INDOOR NAVIGATION SYSTEMS	Indoor Navigation Systems	Jan. 2017 – Dez. 2017	**EXIST**
tru physics	Simulation und Inbetriebnahme von Robotern in Virtual Reality	Apr. 2014 – März 2015 März 2016 – Feb. 2018	**EXIST** **Junge** Innovatoren
EKU POWER DRIVES	Create technologies that combine power generation with efficient control systems.	Juni 2014 – Mai 2015 Juni 2015 – Mai 2016	**EXIST** **Junge Innovatoren**

Thank you!

Prof. Dr.-Ing. Michael Weyrich

e-mail   michael.weyrich@ias.uni-stuttgart.de

web   www.ias.uni-stuttgart.de

phone   +49 (0) 711 685-67301

fax   +49 (0) 711 685-67302

University of Stuttgart

Institut für Automatisierungstechnik und Softwaresysteme

Pfaffenwaldring 47

70550 Stuttgart