IoT and Industry 4.0 in aR&D and Education
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School of Engineering - Facts and Figures

- 14 Institutes
  e.g. Automation, Business Engineering, Computer Sciences,…

- ~1’700 students in 2015
  ~150 in Systems Engineering
  ~480 in Computer Science & Engineering

- Projects
  50 new aR&D p.a., 50 Service
  150 on-going aR&D p.a., 75 Service
  Volume direct CHF ~22M, Volume CTI*/Industry CHF ~16M

- Staff
  ~280 people in research and teaching
  ~130 full-time equivalents in aR&D projects

*CTI: Commission for Technology and Innovation – National Funding Source
Content

- Reviewing IoT & Industry 4.0
- Consequences of industrial revolutions
- Approaching digitization for SME‘s
- Competence Center for Industry 4.0
- Presentation of an applied research and development project
  - Value adding services through IoT
- Continuing education and degree courses
  - CAS certificate of advanced studies in Industry 4.0
Reviewing industrial revolutions

- **1\textsuperscript{st} industrial revolution**
  - by the end of 18\textsuperscript{th} century
  - Enabler: water and steam power to run production processes

- **2\textsuperscript{nd} industrial revolution**
  - by the beginning of 20\textsuperscript{th} century
  - Enabler: electrical power, telephones and globalization.
  - Assembly lines in factories for mass production were introduced
Reviewing industrial revolutions

- **3rd industrial revolution** by the mid and end of 20\textsuperscript{th} century
  - Enabler: electronics and communication technologies, e.g. programmable logic controller in assembly lines

- **4th industrial revolution** transition starts today
  - Enabler: digital connection of production systems by means of internet of things, cyber physical systems and digital cloud services
Perspective on products and productions

Variations per product

Variety of products

Increasing complexities

Model T
{standardized components, no or little variations}

1850

1913

1955

2000

2015

Handicrafts
{unique}

Configuring Online-tool

Rapid Manufacturing

VW Beetle

Variations per product
Tendencies regarding complexities for industrial products and services

**Globalizing tendencies**
- more stakeholder
- increasing requirements
- division of labor and specialization of labor
- increasing networks and network densities
- distributed product life-cycles

**Customizing tendencies**
- reduction of innovation cycles
- changes in timing and content of product life-cycle stages
- enhancing features and components

**Miniaturizing tendencies**
- disappearing system borders
- resource efficiency and including sustainability
Approaching digitization for enterprises (SME’s)

Does it make sense for my business?
• Business case

What are my benefits of digitization?
• Own needs

What are the benefits for my customers, e.g. b2b partners?
• Customer needs

Common expectation
“Step towards digitization is a chance to maintain competitive - if not a necessary step!”
Approaching digitization for enterprises (SME’s)

When the business case is suitable for digitization the next step should focus on business processes. Important aspects are...

- **Standards**
  - Standardized interfaces, communication layer and protocols must be defined

- **System models and systems understanding**
  - For machines and humans it is necessary to understand its opposite
  - An appropriate system model is required

- **Systems engineering**
  - SME’s typically providing a specialization in a certain field, e.g. mechanical engineering. Challenges of digitization are composed of different disciplines and therefore a systems engineering approach is recommended
Approaching digitization for enterprises (SME’s)

Involved employees are challenged

Changes towards digitization are driven by qualified staff. Especially a certain level of knowledge and skills…

- Good interdisciplinary knowledge of modern technology
- A sense for business cases, knowing customer needs
- Capability of designing and developing systems and models
- Communication skills
- Team player
- …

… systems engineering!
Center of Competence for Industry 4.0

- Automatic Control and Cyber Physical Systems
  *Institute of Automation*

- Big Data
  *Institute of 4D-Technologies*

- Sensor and Actor Systems
  *Institute of Microelectronics*

- Resource Efficiency
  *Center of Resource Efficiency*

- Applied Management and Business Processes
  *Institute of Business Engineering*

- Additive Manufacturing, 3D-Printing and Scanning
  *Institute of Product and Production Engineering*

- Internet of Things
  *Institute of Mobile and Distributed Systems*
Remote Monitoring of Production Lines

- A project together with LCA Automation AG
- Development of a new system to remotely diagnose production lines
- Software is analyzing sensor data (vibrations, temperature, electrical current, video feed, etc.) to detect irregularities and send alarms
- Sensor data can be viewed online over the web. This enables a location-independent diagnosis and fast customer support
**Center of Competence for Industry 4.0**
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Introducing the implementation partner LCA

LCA automation
partner in automated manufacturing

Industry 4.0 at LCA Automation AG
Introducing the implementation partner LCA

Factory Automation

LCA provides highest expertise in the designing and realizing of automated assembly systems. Features are latest state-of-the-art HMI solutions, 100% data tracking and database interfaces. All processes are fully monitored and meet the highest quality, traceability and productivity requirements.
Introducing the implementation partner LCA

Over 150 build systems, distributed all over the world

Brazil, China, Germany, France, Mexico, Russia, USA, …
Introducing the Problem

- Providing a maximum level of reliability, availability and process security
- Preventing unplanned down-times, e.g. due to wear or aging
- Omitted maintenance work
- Maintenance schedules are not up to date
Introducing the Problem

- State and condition of machine is unknown
- Exact data is often missing
Goal of Project

Real time remote monitoring and remote maintenance of automated assembly lines by means of Internet of Things and Industry 4.0

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Goal of Project

Real time remote monitoring and remote maintenance of automated assembly lines by means of Internet of Things and Industry 4.0

- Value adding service through IoT and remote monitoring of production lines
- Higher efficiency in service and maintenance
- Data to optimize products
- Maximum of productivity and reduction of unplanned down-times
- Lean administration
Monitoring system

Important requirements

- Using available data from programmable logic controller
- System must be an add-on solution and removeable
- Sensors
  - mainly low-cost standardized sensors
  - advanced sensors, only if necessary
- User Interface must be widely available, independent of operating system and easy to use
Remote monitoring interface
Remote monitoring interface

Production Data
- Operation Time: 23.34 h
- Production Time: 18.32 h
- Downtime: 5.12 h
- Total Parts: 6231
- Parts / h: 332.2
- Total OK: 6159
- OK / h: 337.9

Stücklisten
- Prüfplan_3D.PDF

Info
This module handles the profile shell and joints it on the shaft. The joining axe (Axis 1) operates under a high load and is in a critical operation. The positioning axe (Axis 2) operates at high speed and low load.
Remote monitoring interface
Remote monitoring interface
Background technology for accessing the data

- Tool - LabVIEW-Software
- Object oriented design of controller interface
- Platform-thinking applied, to easily introduce new modules
Background technology for accessing the data
Analyzing the data

Model based approach

Data → Model → Result
Analyzing the data

Statistics based approach

- Control-chart analysis
- Estimation of current state based on statically limits of observed data
Ongoing processes

Identified issues in this project

- Quality of data
- Amount of data
- Security issues in IT-networks
- Performance limits through HW

General issues regarding remote condition monitoring and maintenance

- Technology acceptance, especially cultural change
- Legal issue
  - Data authority and access to internal data for 3rd parties
Value adding technologies for maintenance reasons

Remote support - live!
Conclusions

- The goal “developing a platform-based technology for remote condition monitoring and maintenance” is achieved.
- I4.0 Competence Center is the partner for digitization.
- Digitization is a step with high potential – especially for small and medium sized enterprises.
- **Systems Engineering for competitiveness!**
Project funded by the Commission for Technology and Innovation (CTI)

- For longer term research collaborations (e.g. 2 years) on institute level with the goal of developing and/or improving a product, production or service
- Open to Swiss industry
- Requires submitting a proposal
  - Innovative product
  - Business plan & strategy
  - Clear aR&D need
- Start upon selection
- CTI finances aR&D at FHNW, industry invests the same in labor and a contribution in “cash” (regular conditions)
Student Projects

- For exploratory projects and prototyping
- Open to national and international institutions and industry
- Start is twice a year (Master Thesis more flexible)
- Up to 7 students for semester projects 1&2 and 3&4 (180hrs p. semester and student)
- 2 students for semester project 5 and Bachelor Thesis (180/360hrs p. semester and student)
- Industry fee of CHF 1’500.– per selected project
1st Swiss certificate in the field of Industry 4.0
CAS certificate of advanced studies in Industry 4.0

- **New business models**
  Digitizing, Internet of Things (IoT) and artificial intelligence enabling disruptive new products and business models

- **Optimizing business processes**
  Approaches for better cooperation of human, technologies and organization.

- **Automatization and cyber-physical systems (CPS)**
  CPS features, importance of modeling, robotics and assisting systems, standards, interfaces and interaction

- **Distributed computing**
  User- and licensing concepts for cloud-computing services, Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES), Smart Data, Process-Mining, Business Analytics, IT-security

- **Change to digital**
  Change management for the challenges of digitization