Integration of Industry 4.0 in Education Programs of German Universities of Applied Science

Prof. Dr.-Ing. Rainer Würslin
Agenda

» The University of Applied Sciences Esslingen
» The German Education- and Study-System
» Industry 4.0
» Education Requirements and Solutions for Industry 4.0
Location

Europe

Germany

Baden-Wuerttemberg

Esslingen

Goeppingen
City Campus

» Automotive Engineering
» Basic Sciences
» Building Services, Energy and Environmental Engineering
» Mechanical Engineering
» Natural Sciences

approx. 2300 students

Hilltop Campus

» Graduate School
» Information Technology
» Management
» Social Work, Health and Nursing

approx. 2300 students

Göppingen Campus

» Engineering Management
» Mechatronics and Electrical Engineering

approx. 1200 students
Study Program in Mechatronics

Master Programs
duration 3 semesters

Bachelor Thesis

Semester 7

Specialization
Semester 4 and 6
(Sem. 5 company internship)

- Software and Nets
- Components of Automation
- El. Power Systems and Renewable Energy
- El. Drives and Automotive Electronics
- Sensors and E-Mobility

Study Programs
Semester 3 to 6

- Mechatronics / Automation
- Mechatronics / Electrical Engineering
- Mechatronics / Precision-Engineering

Fundamentals in Mechatronics
(Mechanics, Electrical Engineering, Informatics, Mathematics, Physics....)

Cooperative Programs with Industry
- MechatronikPlus (apprenticeship + study)
- MechatronikCom (study + orientation to company)
The German Education- and Study-System
From Secondary School into the Job

Jobs in Trade, Industry and Commerce

Dual System (2-3,5 years)
  - Training-on-the-job in a company/organisation

Advanced Vocational School (1 year)

Vocational Gymnasium (3 years)

Secondary General School

Intermediate School

General Academic School

University of Applied Sciences

University of Sciences
Different Kinds of Universities in Germany

**University of Cooperative Education (Duale Hochschule)**
- small classes
- fixed timetables
- oriented to practical experience
- students are employees of the companies

- practical training:
  - half the time in company

- degrees:
  - bachelor of engineering
  - master of engineering

**University of Applied Sciences (Fach-Hochschule)**
- small group classes per semester
- fixed timetables
- students start with practical experience
- theory and practical education

- practical training:
  - labs and projects during the study
  - 1 Sem. industrial internship
  - thesis 6 month in industry

- degrees:
  - bachelor of engineering
  - master of engineering
  - PhD possible in cooperation

**University of Sciences (Universität)**
- big classes into the first semesters
- liberal structure of study program
- academic education with theoretical emphasis

- practical training:
  - labs during the study
  - 12 weeks industrial internship

- degrees:
  - bachelor of science
  - master of science
  - PhD
Features of the University of Applied Sciences program

» Focus on Bachelor- and Master Programs of **Engineering**
» Professors with industrial experience
» Additional lecturers from industry

» Institutes of applied research and Steinbeis-Centers
» Students starts with industrial experience
» Students gets international experience

» Practical internship 100 days in industry
» Final thesis in industry (6 month)
» Good job prospects for students
Industry 4.0
From Industry 1.0 to Industry 4.0

First Industrial Revolution
through the introduction of mechanical production facilities with the help of water and steam power

First mechanical loom, 1784

Second Industrial Revolution
through the introduction of a division of labor and mass production with the help of electrical energy

First assembly line, Cincinnati slaughterhouses, 1870

Third Industrial Revolution
through the use of electronic and IT systems that further automate production

First programmable logic controller (PLC), Modicon 084, 1969

Fourth Industrial Revolution
through the use of cyber-physical systems

Degree of complexity

Source: DFKI (2011)

Time

1800 1900 2000 Today
Some facts to Industry 4.0

» Movement toward
  » Internet of things and services into production
  » Cyber Physical Production Systems (CPS)
  » Smart Factories

» The goals of production are:
  » controlled by the product
  » self-organizing
  » flexible

» Obstacles:
  » increasing number of variants
  » shorter development- and sales times
  » Individualisation of products
Cyber Physical Systems (CPS)

Structure

Cyberspace

- data processing

Physical system

- e.g.: monitoring/control/application, etc..
- e.g.: actuator/sensor/embedded system

Features

- adaptable
- reliable
- autonomous
- usability
- safe & secure
- efficient
- accessible

Reference IAO
Smart factory: organizes itself

Cyber-physical systems (e.g., machinery, equipment)
- have an identity
- communicate with each other and with the surrounding environment
- configure itself (Plug and Produce)
- store information

- decentralized self-organization

New large order, we need an additional shift next Saturday

I can work this Saturday

I have short term home to my sick child. Who can make my orders

Magazine is empty. Please fill it

My capacity is fully booked until Friday

I must be on goods output in 2 hours

Quelle: VDI / Fraunhofer IAO
Areas of action

» Norms and Standards

» Revolution of ICT in manufacturing - an infrastructure for information, production and communication technology

» Safety and Security

» Human-machine interaction (HMI)
   » Operational work organization and job design
   » Qualification, education and further education

» Legal Framework

» Preliminary recommendations for the implementation of dual strategy
Education Requirements for Industry 4.0
Requirement profiles for developers for Industry 4.0

» Knowledge topics:
  » for norms and standards in communication technology
  » for a new production logistics and production infrastructure
  » Topics for Safety and Security
  » Specialists for human-machine interaction
  » Modeling of technical systems using information technology
    » interaction between the real and digital world
    » model-based, mechatronic engineering
    » adapting development (Delta Engineering) in contrast to full development
Requirement profiles for operators for Industry 4.0

» Augmented Operator
  » Control and monitoring of manufacturing processes with the help of virtual production systems
  » Influencing production targets
    (Situational and context-dependent)
  » Operation of IT-based assistance systems
  » Remote Maintenance and remote control of production lines
companies in future will be education-partners of universities
  » compressed undergraduate study program
    + supplemented by business practice
    + depth studies
  » Knowledge not only in engineering, also in not technical skills
Increasingly interdisciplinary skills are required
New approaches to work-related knowledge and skills acquisition
Development of digital learning techniques and digital Media (e-learning)
Demographic change and heterogeneous requirements of learners require new approaches in didactics
Our way: in the faculty mechatronics

**Semester 7**

**Specialization**
Semester 4 and 6 (Sem. 5 company internship)

- Software and Nets
- Components of Automation
- El. Power Systems and Renewable Energy
- El. Drives and Automotive Electronics
- Sensorics
- E-Mobility

**Study Programs**
Semester 3 to 6

- Mechatronics / Automation
- Mechatronics / Electrical Engineering
- Mechatronics / Precision Engineering

**1st Study Part**
Semester 1 and 2

**Fundamentals in Mechatronics**
(Mechanics, Electrical Engineering, Informatics, Mathematics, Physics,...)

**Cooperative Programs with Industry**
- MechatronikPlus (apprenticeship + study)
- MechatronikCom (study + orientation to company)

**Master Programs**
Duration 3 semesters

**Bachelor Thesis**
Education in Industry 4.0 in the Automation Lab
Thank you for your attention