FUTURE WORK LAB

Innovation Lab for Work, People and Technology at Fraunhofer Stuttgart

Dipl.-Kfm. Thilo Zimmermann (IPA), Helmut Zaiser, M.A. (IAO)
Qualisys - Stuttgart, November 25, 2016
Research partners in the FUTURE WORK LAB
Fraunhofer IAO and Fraunhofer IPA as well as University Stuttgart

Fraunhofer Institute for Industrial Engineering IAO

Institut of Human Factors and Technology Management IAT, Universität Stuttgart

Foundation: IAO 1981
IAT 1991

Head of Institute:
Prof. Dr.-Ing. Wilhelm Bauer

Financials and staff (2014):
34,3 Mio. € turn-over, of which 35% for industry
600 staff members

Fraunhofer Institute for Manufacturing technology and Automation IPA

Institut for Industrial Manufacturing and Management IFF, Universität Stuttgart

Foundation: IPA1955
IFF 1935

Head of Institute:
Prof. Dr.-Ing. Thomas Bauernhansl

Financials and staff (2014):
60,3 Mio. € turn-over, of which 35% for industry mandates
1000 staff members

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Fraunhofer IAO and IPA – active in the Industry 4.0
History of Production
Managing the increasing complexity

According to Yoram Koren: The Global Manufacturing Revolution; Source: Ford, beetleworld.net, bmw.de, dw.de

"People can have the Model T in any colour - so long as it's black"
Henry Ford (1913)

1850
1913
1955
1980
2000

Mass Production
Customized Mass Production
Globalization
Regionalization
Complexity
Personalization
Manual Production
The 4th industrial revolution in production

- 1st Industrial Revolution (18 Cent.): Mechanical production machines
- 2nd Industrial Revolution (19 Cent.): Electrification
- 3rd Industrial Revolution (20 Cent.): Automation
- 4th Industrial Revolution (21 Cent.): Intercommunication

Cyber-physical systems (CPS)
Cyber-Physical Systems are almost everywhere
... and are going to take over the factory
The principles of the network economy change everything
Internet technology meets production IT

Production IT

Computer
Integrated
Manufacturing

Digital Product Lifecycle Management
Digital Factory
Digital Factory Operation

Embedded Systems → Cyber-physical systems

IT

World Wide Web
service orientation
"Internet of Things"
Web 2.0
"Cloud" orientation
"App" orientation

1990 2000 2012

INDUSTRIE 4.0

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The Age of Interconnection
Everything that can be connected, will be connected in future

Zahl der vernetzten Maschinen
Mit dem Internet verbundene Geräte

6,3 Mrd. Smartphones
350 Mio. Tablets
15 Mrd. Maschinen

2010 → 2020
9,4 Mrd. Smartphones
950 Mio. Tablets
3,1 Mrd. PCs
1 Mrd. PCs
1,2 Mrd. Maschinen

Quelle: Bitkom, Strategy&, PWC und Roland Berger, 2015

Smartphone as companion through life
Robots as collaboration partner
Business Transformation

Digitalization of value chains and new business models

Economically
- Digital business models
- Open Innovation
- Global Value Chain
- Sharing Economy

Examples
- Collaboration Platforms
- Customer Experience Centers
- Co-Working Centers
- Bike / Car sharing

Bildquelle: ubicentrex, Dassault
Human and Society

A high diversity arises

- Individualization through new values and life styles
- Aging Population in the course of demographic change
- Establishment of the „Digital Natives“ in the workforce
- New health consciousness with regard to physical and psychological health
- Social and cultural diversity has chances and potential for conflict

The differences between life worlds of younger and older generations are in respect to former times...

<table>
<thead>
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<th>Größer</th>
<th>Kleiner</th>
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<td>9</td>
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</tbody>
</table>

Quelle: Jacobs Krönung-Studie, Institut für Demoskopie Allensbach (2013); Basis: Bundesrepublik Deutschland, Bevölkerung ab 14 Jahre, in Prozent, Nicht dargestellt: Unentschieden, keine Angabe

Foreign population in Germany with regard to region of origin (as of 31.12.2013)

Migration to and from Germany 2013(!):
- Immigration → 1.226.493
- Emigration ← 797.886

Quellen: Statista-Dossier »Bevölkerung in Deutschland I«; Mediendienst Integration, 2014
What is typical of today’s production in Germany?

- **Strong Small and Medium-sized companies (SMEs)**
  - Germany: 99% of all companies, 60% of work force

- **Configurated and individualized products**
  - Lot size 1
  - Complex products, processes, and value chains

- **Expensive, but well qualified and productive work force**
  - On all levels of hierarchy
  - Lowest payment level in industry 2,120/month

- **Intelligent Automation**
  - Software drives product innovation

- **Eroding delivery times – rising pressure for higher flexibility**
  - Modular and flexible machine design, down-sizing and low-cost-automation
  - Strong focus on capacity flexibility
  - Flexibility of the supply chain

- **High resilience with strong market volatility**
  - Successful overcoming of the crisis of 2009/2010

- **Strong and growing industrial IT**

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Today about 8 Mio. people work in German manufacturing and guarantee wealth and jobs in volatile times.

Quellen: IW Köln (Productivity), JD Power (Best Cars), IT-Performance TNS Infratest, patents: heise online, Intelligence PIAAC-Test

Pictures: BMW, Trumpf, Stihl, Festo

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Driver of the Transformation of Work

The focal points of work have changed

Human and Society

Future of Work

Technology and Digital Systems

Business and Business models

Socio-Engineering

Socio-Economics
How does work in the industry of the future look like?
In the context of the digital transformation

Future of Work

Flexible employment forms
Mobile interconnected work
On-the-job
Virtual Work Environment
Individualised Work Places

Human
Diversity Society

Leadership

Employment scenarios
Work Task
Activities

Qualification/training
Organisation of Work

Work Environment

Work place
Work equipment// Interfaces

KapaflexCy
Human-Robot-Collaboration

Mobile Devices

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F13
Stuttgart’s Future Work Lab
Unique innovation lab for labour, people and technology

- Exhibition of Industry 4.0 technologies
  - Tangible/living digitalisation and automation
  - Demo centre along the value chain

- Consultancy and Competence or skills centre
  - Permanent event program (seminars, etc.)
  - Learning modules, qualification methods

- Lighthouse of leading research institutions
  - Think Tank: International Benchmarking
  - Embedding of projects and partners

- Early 2017: Opening by Fed. Minister of Research
- Spring 2017: Move to ARENA 2036 building
Demo Center »Future Work with Parcours«
Demonstrations along the in-company value chain
First examples: Work equipment 4.0

Makes live easier – even with heavier things

User

- Manufacturing companies
- Automotive
- Logistics

Benefit

- Exoskeleton for over-head work
- Quantification of effectiveness
- Time and cost savings through prevention of illness / disability
- Gain in staff satisfaction

Manual stand-up work desk, exoskeleton and sensor carpet
Smart Feedback

Example: Motion capturing to feedback reality into the planning models

Technical assistance systems

- Motion analysis expertise
- Humans at their workplace
- med. ergonomics, training avatars
- LEAN & FAST exoskeleton development
First examples: work equipment 4.0
Logistic tasks and fault clearing with data glasses (Itizzimo)

By using mobile devices new possibilities for usage of production data arise

- Yes: 72.7%
- Partly: 19.0%
- No: 8.3%

Winner of German Inno. price 2014

QR-Scanner integrated in smart glasses

Live Support/Interaction and visualised information

Context-based data in close-to real time

Quelle: Itizzimo
Mobility - Mobile devices for manufacturing
Smart, task oriented, and distributed presentation of relevant information

Support at fault analysis by
- Explanation of identified elements
- Visual mapping of identified components to facilities
- Supply of relevant documentation and additional data
- Live remote support
First example: organisation of work 4.0
Systematic control of staff flexibility in manufacturing

Sales order: 50 gear boxes till Monday

Assignment via smart phone

I could work on Saturday!

I can’t on Saturday....

Additional shift on Saturday needed

“Master cockpit”: call for assignments

Winner ROI Industrie 4.0 Award 2014
“Everything as a Service” (XaaS)
Application example: Virtual Fort Knox – Integration platform

Virtual Fort Knox

Private or Public Cloud

Manufacturing Service Switch (ESB++)

mOS

AS1

S1

S2

S3

S4

S5

Robot

Sensor

Product

SOA, WS

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AS  Aggregated Service
IS  Integration Service
CS  Cloud Service
CPS  Cyber-Physical-System
mOS  Manufacturing Operating System
The traditional triangle of work T-O-P

Is still accepted...

Personnel
Individual and team

Work 4.0

Technology
Machines and software

Organisation
Structure, space, time
...but in a redefined way!

Many new elements define Work 4.0

- Mixed teams (age, discipline, background)
- Digital, media and communication competence
- Decision and social competence
- Codetermination

- Expert systems (AI)
- Autonomously interacting systems
- New human-technology-interfaces
- Networks of terminals

Providing scopes of action
- Flexible work models
- Use of implicit and expert knowledge
- Demanding tasks
- Complex activities
- Ergonomic work systems

- Agile organization
- Division of labor
- Multiple cooperation
- Management and leadership models
- Global value added
Work design trends are changing

Workplaces will be smart, organisation of work will be digital

- Situation-based forms of organisation
- New forms of interaction
- Physical and digital assistance systems
- Dynamic competence profiles
- Realtime picture of work processes
- Interconnected assisting
- Intuitive
- Context-adaptive
- Strongly increasing possibilities for individualisation
- Predictive and prescriptive recognition of events
Centre for Competence Development and Counselling «Fit for Future Work»

Contents:
- Counselling for and participative conception of work design options
- Counselling for implementation support
- Learning modules for employees
- Planning games make competence-related effects visible
- Physical and digital competence development methods

Particularities:
- Use orientation
- Competences development-oriented
- Open to the integration of partners!

Target groups:
- Employees, companies, and other organisations
Competence development offers for I4.0 solutions

Offers by Fraunhofer IAO and IPA

- Learning modules along Parcours »Today+«, »2025 Technology+« und »2025 Human+«
- Demonstrators for competence development
- Module box with competence development offers for target group-specific learning contents
- Modern learning environment and media
- Face-to-face and Blended Learning
- Competence development for teams and inter-departmental project groups

Complementary external courses

- Complementary fields of knowledge for, e.g., production-related services
Competence management 4.0
Design fields

- Early identification of digital competences
- Digital learning forms
- Design of digital work tasks
- Assistance systems for digital work tasks
Case: Assembly – Learning Codes, Videos, Blended Learning
New I4.0 solution → change of work → design → learning and training

Learning Code

By means of an QR-Code¹) Web sites are called up, which offer two information areas, which include links with more information:

Learning modules:
Video: learn + apply related production technology (supply-/transport systems in automated production)
Video CNC mill-cutting
Blended learning: Enhancing group work

Object-related information
Industrie 4.0-related information

¹) The use of the QR-Code is free. The specifications have been opened by Denso Wave and are available with the International Organisation for Standardisation in Switzerland. In Japan, the US, Australia and Europe the name „QR Code“ is legally protected as an registered trademark of Denso Wave Incorporated. In case of use a corresponding comment should be fixed.

(https://de.wikipedia.org/wiki/QR-Code)
Exporting German trainings to China - the DRAGON project

- Project to building up an online-system with further training offers for blended learning for, at first, production – including the mentioned learning modules – for the needs of the Chinese training and education market

http://www.dragon-training.de/
Idea Center for Labour Research »Work in Progress«

Contents:
- Space for research, innovation, and dialogue
- Current world map of labour research
- Stuttgart Work Conference 2017
- Co-Working Spaces
  - Academic discourse
  - Preparation fellowship programme
  - Factory-oriented Think-Tank
  - Connection to Start-Up Community
- Further development by integration of research projects

Target groups:
- Research, associations, politics, students

Particularities:
- Contact place for labour research
- Direct transfer from science & research to implementation
- Integration of Partners with future project ideas is possible!

Bild: http://www.netzpiiloten.de/
Future Work Lab and ARENA 2036
In 2017 under one roof

- ARENA2036
  “Active Research Environment for the Next Generation of Automobiles”
- Industry and research institutes
- Future Work Lab set-up starting from February 2017
- Grand Opening in May 2017
Automobile OEM, supplier and research institutes from Southern Germany cooperate under one roof.
Lab Tour (90 Minutes)

**Group A**
- Guide: Thilo Zimmermann
- 1. Future Work Lab (40+5 Minutes)
- 2. Immersive Lab (40+5 Minutes)

**Group B**
- Guide: Helmut Zaiser
- 1. Immersive Lab (40+5 Minutes)
- 2. Future Work Lab (40+5 Minutes)
Contact

Future Work Lab

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