
AGENDA

DAY 1

- 08:45 – 09:00 Arrival
- 09:00 – 09:15 Welcome Speeches
- 09:15 – 09:25 Welcome and introduction
- 09:25 – 10:15 Presentation of Fraunhofer
- 10:15 – 11:20 Industry 4.0
- 11:20 – 11:30 Break
- 11:30 – 12:30 Smart Data for Smart Factories
- 12:30 – 13:30 Lunch break
- 13:30 – 14:30 Smart Production
- 14:30 – 15:30 **Smart Maintenance**
- 15:30 – 15:45 Break
- 15:55 – 17:00 Workshop part 1: Description of own production & maintenance
- 17:00 – 17:30 The path to Smart Production and Smart Maintenance
- 17:30 – 18:00 Summary/ Feedback of the participants to the 1st day

SMART MAINTENANCE

Michael Wolny

Gwangju, 6. November 2018

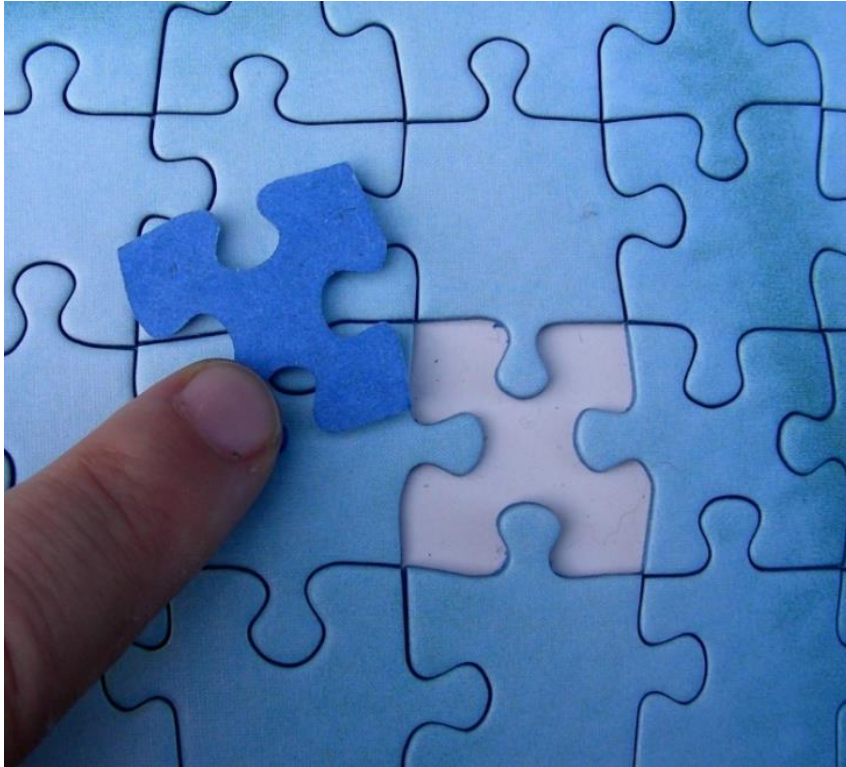


AGENDA – SMART MAINTENANCE



- Classification of Maintenance into the Fraunhofer Layer Model
- Central Elements of Smart Maintenance
- Smart Maintenance at IML (presentation of current projects)
- Changes in Maintenance Requirements for Industry 4.0
- Changing Business Models in Industry 4.0
- The Importance of Change Management in the Implementation of Smart Maintenance

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Fraunhofer's contribution for developing Industrie 4.0 innovations

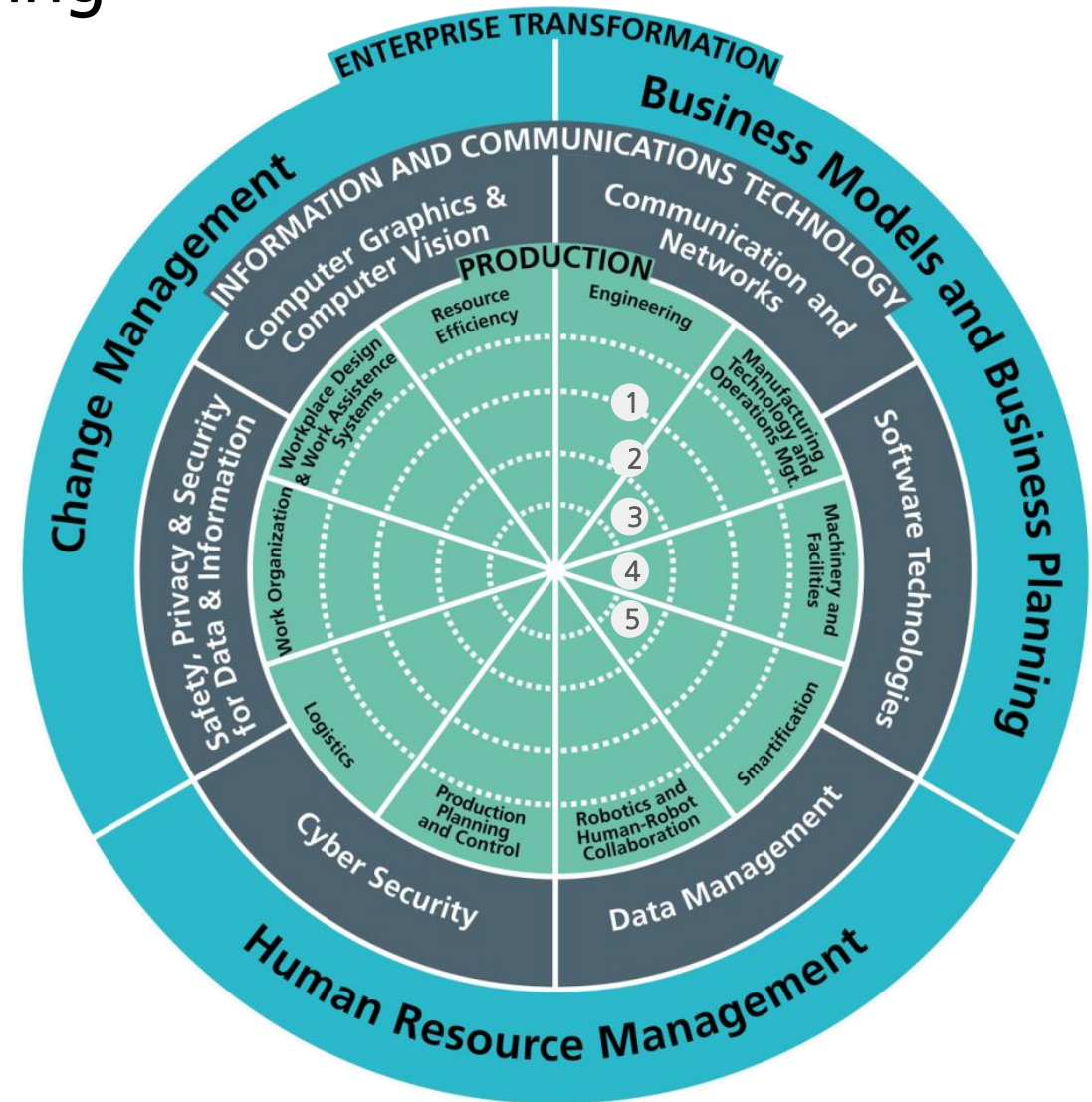
LAYERS:

- ENTERPRISE TRANSFORMATION
- INFORMATION AND COMMUNICATIONS TECHNOLOGY
- PRODUCTION

Functional Areas:

1. Data recording and processing
2. Assistance Systems
3. Interconnectedness and integration
4. Decentralization, service orientation and transformation ability
5. Selforganizing and autonomy

Fraunhofer Layer Model of Industrie 4.0 Value Creation (as of June 10th, 2017)



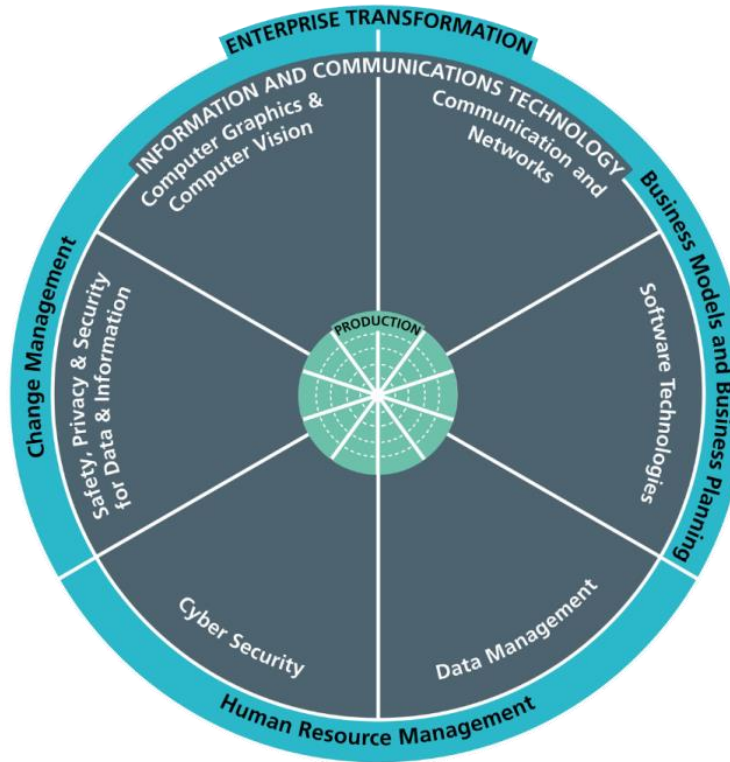
In reference to Neugebauer, Reimund; Hippmann, Sophie; Leis, Miriam; Landherr, Martin (2016): Industrie 4.0 - From the perspective of applied research. 49th CIRP Conference on Manufacturing Systems (CIRP-CMS 2016). Available online at www.sciencedirect.com

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Enterprise Transformation



Information & Communication Technology



The diagram is a circular representation of digital transformation domains. It features a central point with five concentric dashed circles labeled 1, 2, 3, 4, and 5. Ten radial lines divide the circle into ten equal segments. Each segment is labeled with a number (1-10) and a domain name. The domains are: 1. INFORMATION AND COMMUNICATIONS TECHNOLOGY (Production, Resource Efficiency), 2. Communication and Engineering, 3. Business Models and Networks, 4. Manufacturing Technology and Operations Management, 5. Software Technologies (Machinery and Facilities), 6. Smartification, 7. Robotics and Human-Robot Collaboration, 8. Data Management, 9. Human Resource Management, 10. Cyber Security (Production Planning and Control). A blue outer ring contains labels for each domain: Change Management, Computer Graphics & Computer Vision, Workplace Design and Work Assistance Systems, Work Organization, Logistics, Cyber Security, Production Planning and Control, Robotics and Human-Robot Collaboration, Data Management, Smartification, Manufacturing Technology and Operations Management, Business Models and Networks, Communication and Engineering, and INFORMATION AND COMMUNICATIONS TECHNOLOGY.

Classification of Smart Maintenance into the Fraunhofer Layer Model

3rd Layer Production

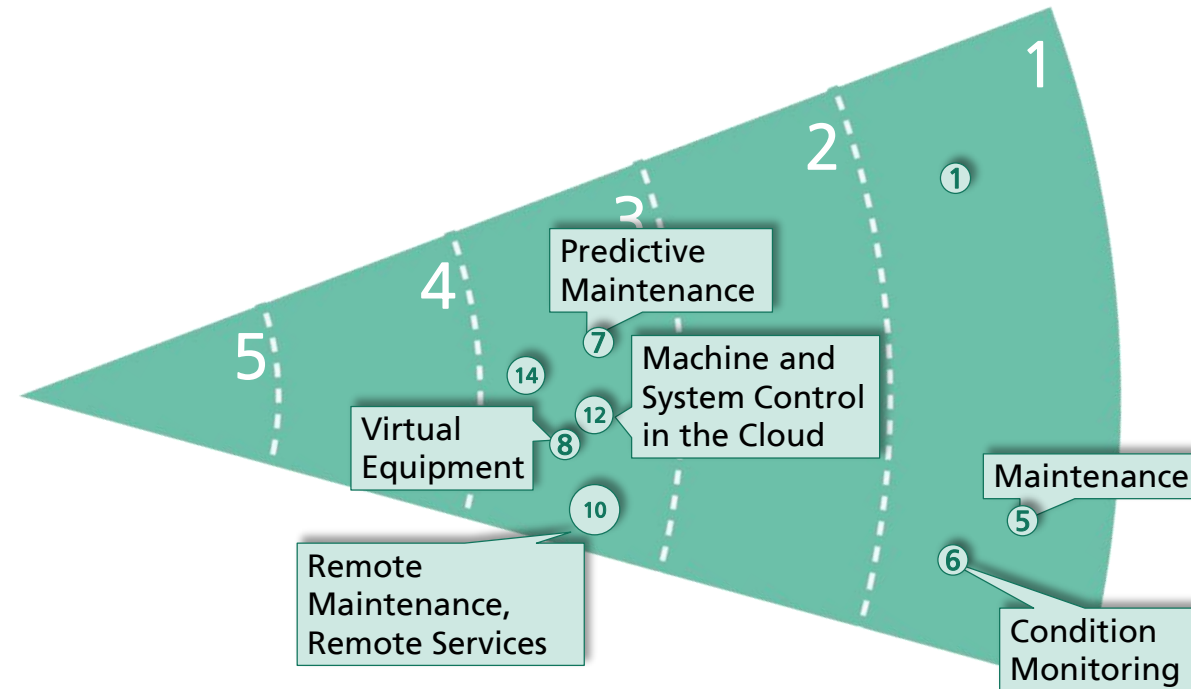
LAYERS:

● PRODUCTION

Machinery and Facilities

Functional Areas:

1. Data recording and processing
2. Assistance Systems
3. Interconnectedness and integration
4. Decentralization, service orientation and transformation ability
5. Selforganizing and autonomy



Classification of Smart Maintenance into the Fraunhofer Layer Model

3rd Layer Production

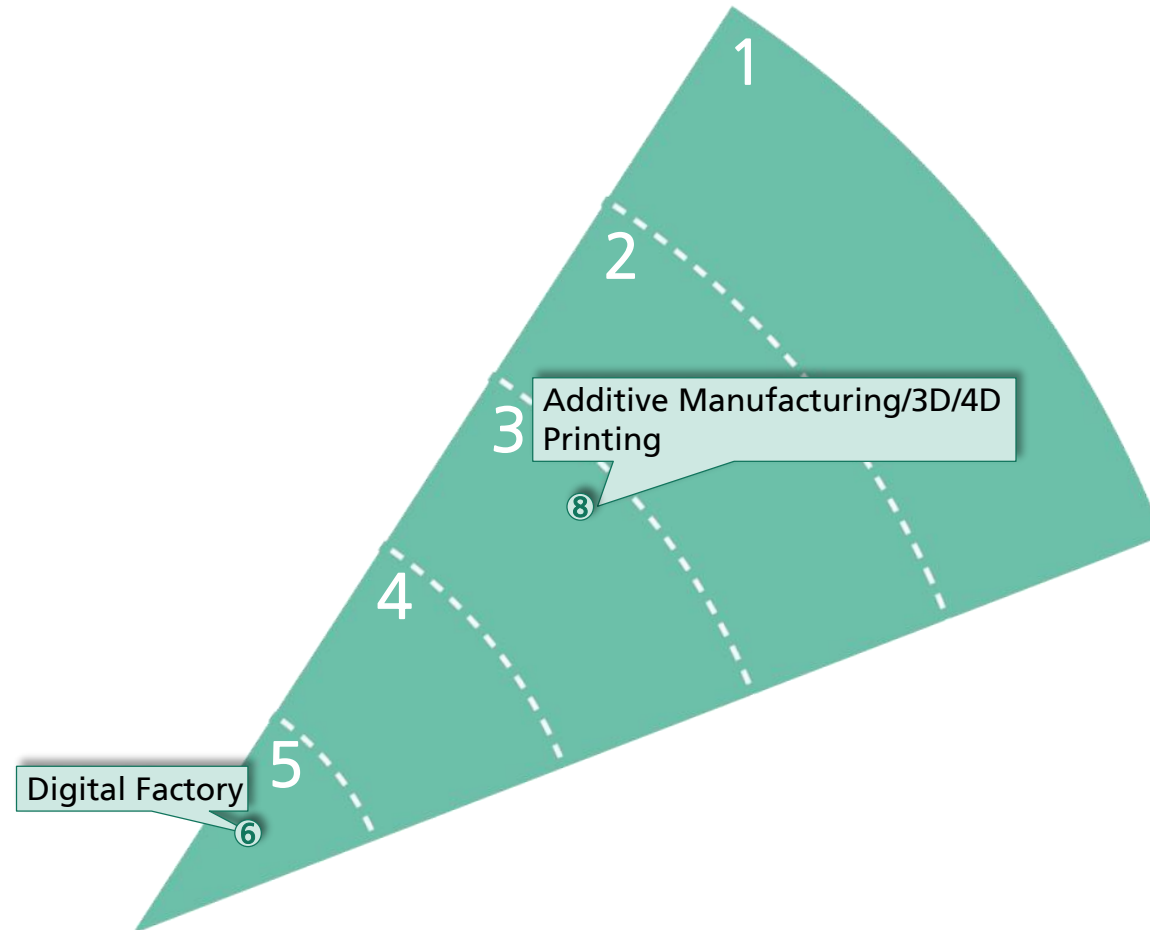
LAYERS:

● PRODUCTION

Manufacturing Technology and Operations Mgt.

Functional Areas:

1. Data recording and processing
2. Assistance Systems
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Classification of Smart Maintenance into the Fraunhofer Layer Model

3rd Layer Production

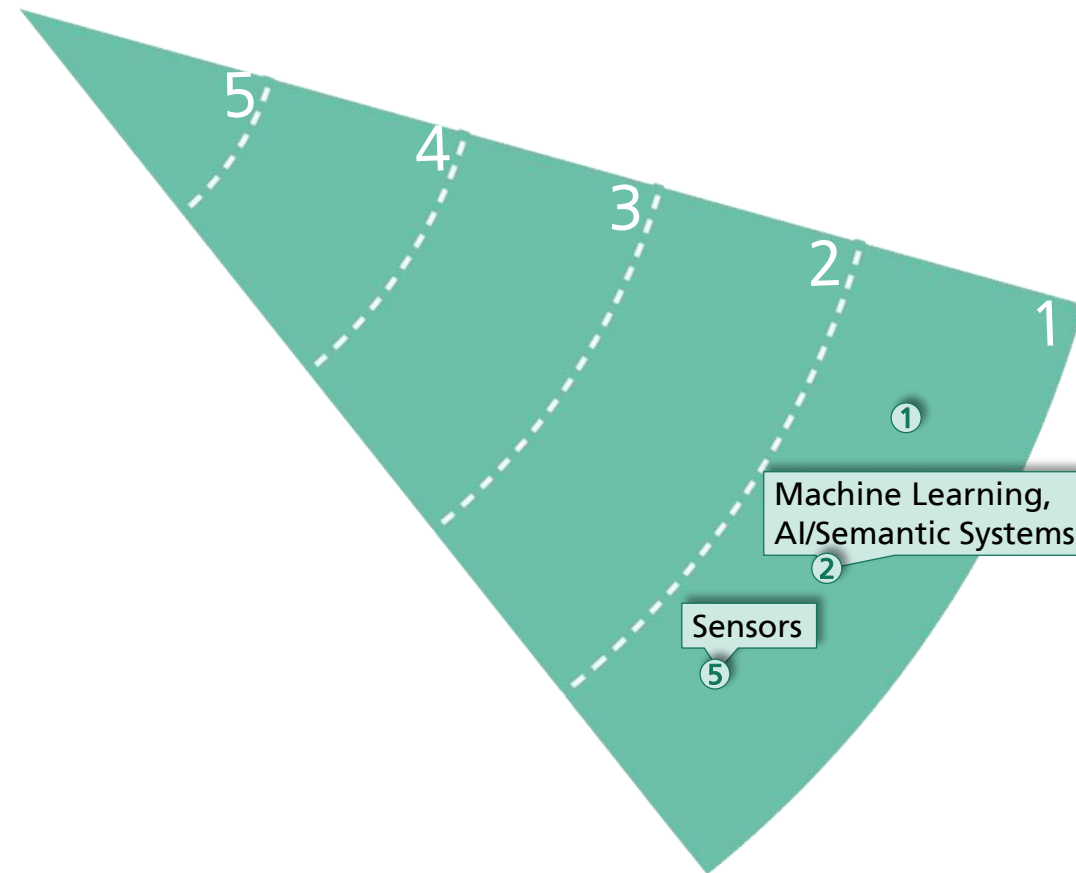
LAYERS:

● PRODUCTION

Smartification

Functional Areas:

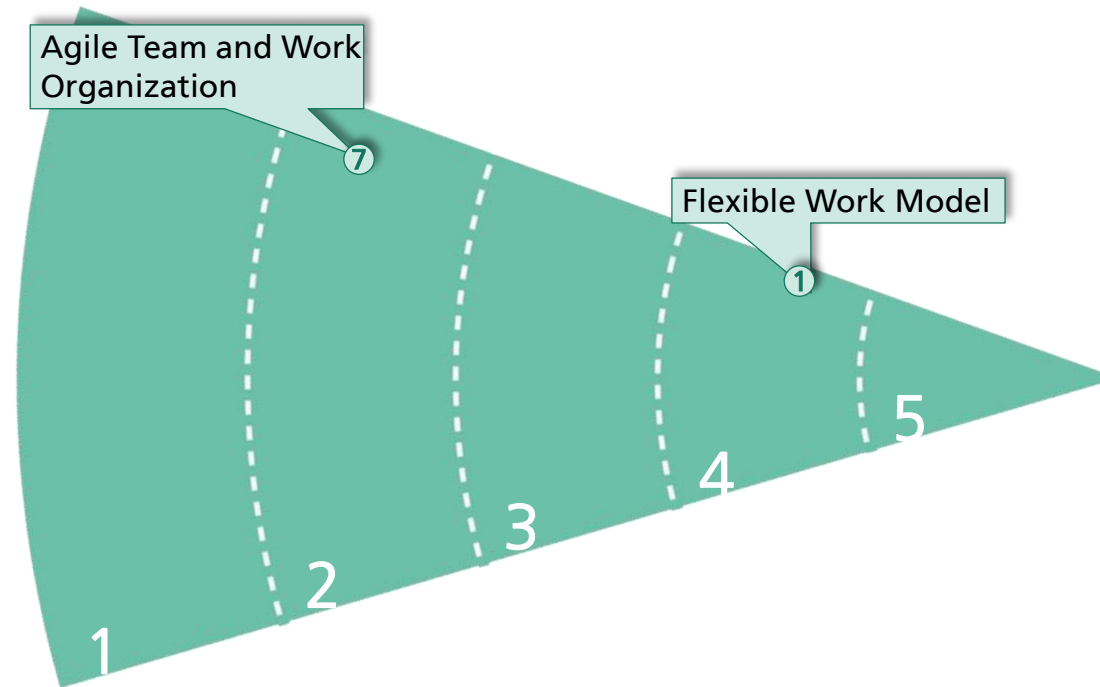
1. Data recording and processing
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Classification of Smart Maintenance into the Fraunhofer Layer Model

3rd Layer Production

Work Organization



Functional Areas:

1. Data recording and processing
2. Assistance Systems
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5. Selforganizing and autonomy

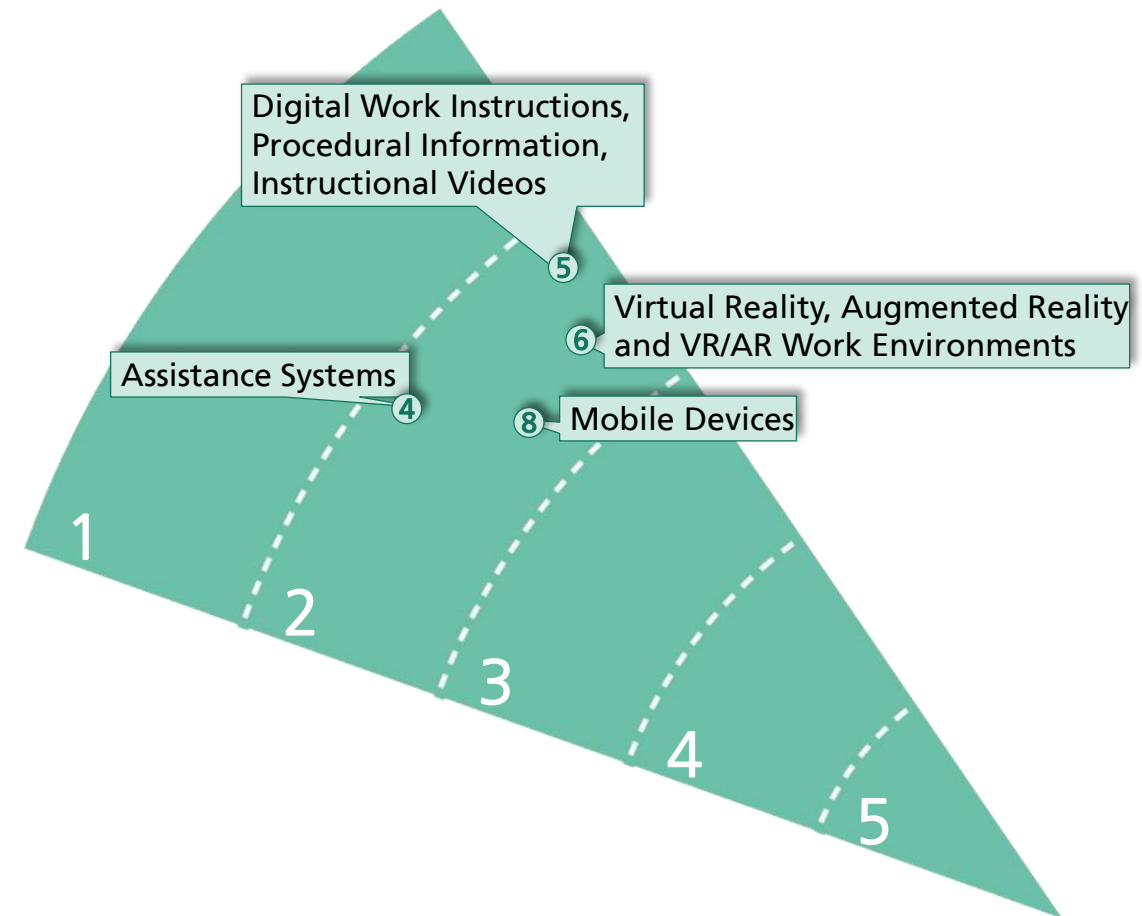
Fraunhofer Layer Model of Industrie 4.0 Value Creation (as of June 10th, 2017)

3rd Layer Production

LAYERS:

● PRODUCTION

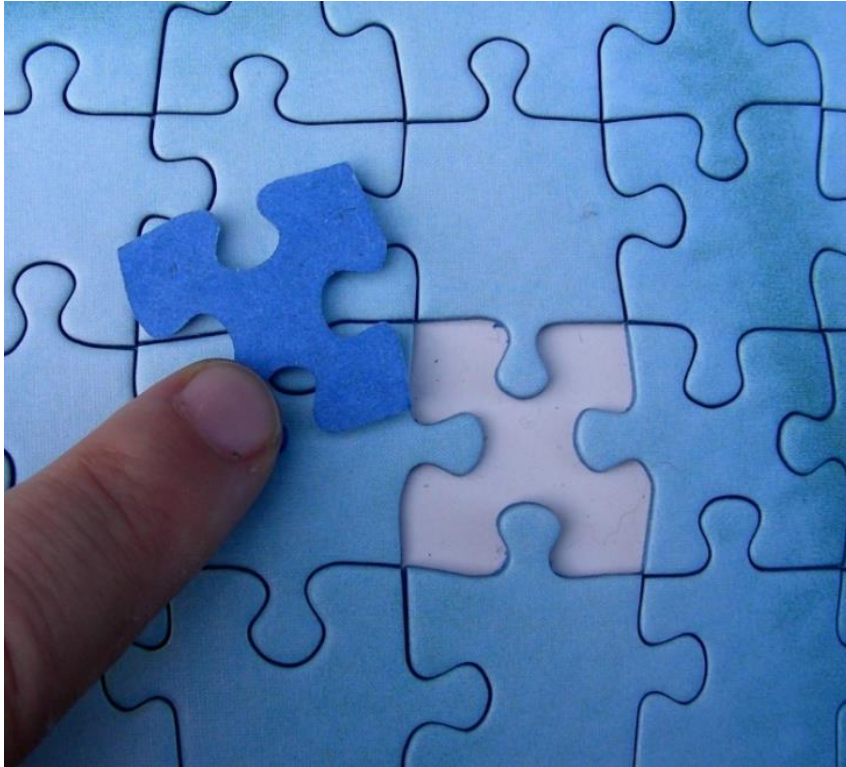
Workplace Design and Work Assistance Systems



Functional Areas:

1. Data recording and processing
2. Assistance Systems
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AGENDA – SMART MAINTENANCE



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CENTRAL ELEMENTS OF SMART MAINTENANCE

DEFINITIONS

Why do we need smart maintenance in the age of industry 4.0? Let's ask differently: Who is responsible for ensuring the functionality of the cyber-physical systems of industry 4.0?

The maintenance!

It is the task of the maintenance to ensure that the potentials of the new concepts and technologies can be realized and are available for the Smart Factory.

Therefore a further development of the maintenance towards a Smart Maintenance is absolutely necessary!

CENTRAL ELEMENTS OF SMART MAINTENANCE

DEFINITIONS

"Some maintenance measures, especially the planning and preparation of maintenance activities, will be technologically supported, but the operational part of maintenance will remain in its classical meaning.

"The maintenance of industry 4.0 not only creates the basis for its successful existence - it can and must also participate in the technological progress of the Smart Factory. The aim is to avoid unplanned disruptions through planned maintenance measures. For conventional maintenance, this means further developing Smart Maintenance into a proactive and condition-dependent maintenance system.

[ACATECH 2015]

"In order for maintenance to keep pace with the development of industry 4.0 in the management of technical assets, it is not only necessary to further develop technology to smart maintenance on an operational basis, but above all to have a strategic understanding of management that brings together the central elements of smart maintenance - " human beings ", " sensor technology ", " data management " and " assistance systems " - in an integrative view.

[BÄRENFÄNGER-WOJCIECHOWSKI 2017]

" Means a comprehensive concept for the inspection, maintenance, repair and improvement of technical systems, characterized by intelligent sensor/actuator combinations, a high degree of networking and anticipatory software components".

[AUSTERJOST & ANLAHR 2014]

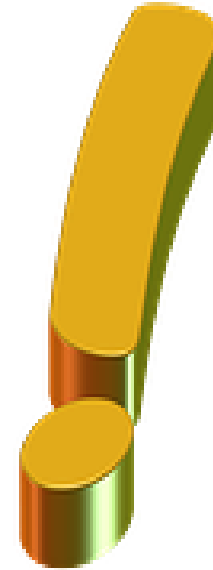
"The target must be the development, implementation and permanent improvement of the effectiveness of the asset management system in order to increase the value added contribution of maintenance, taking into account the interests of stakeholders. Now that value creation is a consequence of interlinked processes and maintenance has to be positioned as a co-designer of corporate value creation, it is necessary to adapt its range of tasks and thus embed the maintenance strategy dynamically and learning oriented into the management instruments of maintenance. In particular, the target and controlling system, the maintenance strategy and prevention must be designed in the context of the competence development of the maintenance and production employees as the key performers of value creation".

[BIEDERMANN 2016]

Central Elements of Smart Maintenance

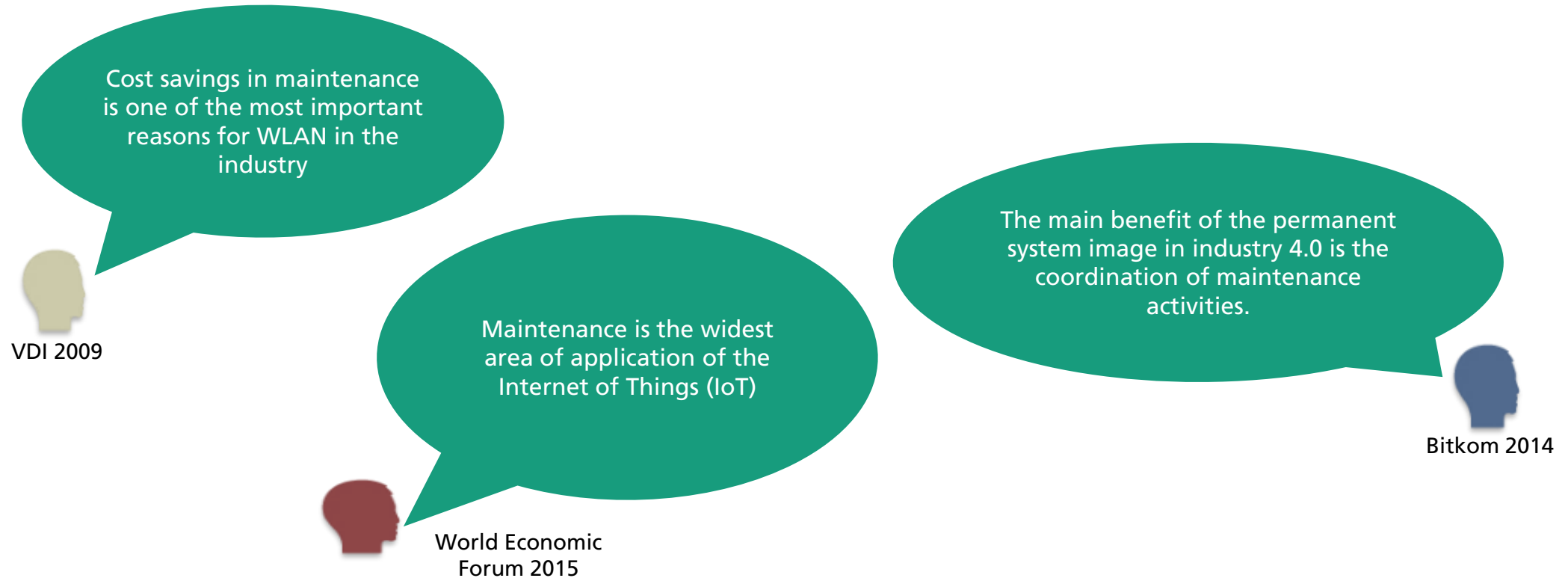
Smart Maintenance - Definitions

Or to put it simply:
Smart maintenance is "smart" when it efficiently ensures the availability of machines and systems in the Smart Factory of Industry 4.0.



CENTRAL ELEMENTS OF SMART MAINTENANCE

SMART MAINTENANCE AS A DRIVER OF INDUSTRY 4.0



Smart maintenance is not just any part of industry 4.0!
As a driver, it will make industry 4.0 possible in many cases

CENTRAL ELEMENTS OF SMART MAINTENANCE

EXPERT OPINION:



Prof. Dr. Henning Kagermann

- President of the German Academy of Engineering Sciences (Acatech)
- Former Spokesman of the Executive Board of SAP AG

"In the factories, maintenance tasks will become more important because the more complex systems become, the worse the consequences will be. "There will tend to be a shift to more demanding activities and higher qualifications..."

Süddeutsche Zeitung from 09./10. January 2016



Prof. Dr. Siegfried Russwurm

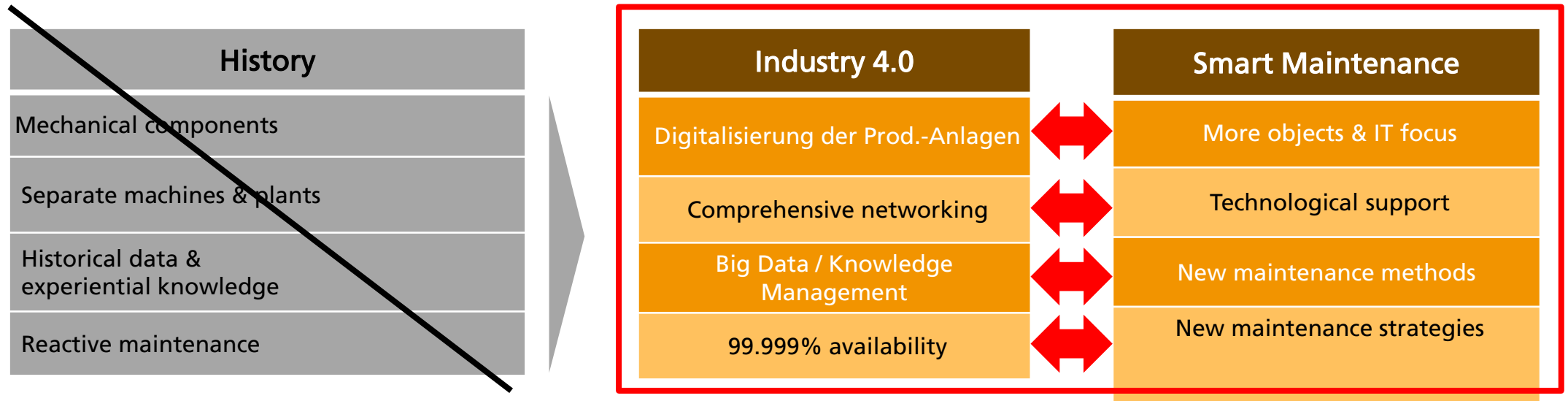
- Former member of the Managing Board of Siemens AG, Chief Technologist of the Group,
- Member of the Steering Committee of the Platform Industry 4.0

"Fixing failures and malfunctions will continue to be important [in industry 4.0] and may even become more important in complex solutions. And here we cannot do without the human being."

VDI News of 13 November 2015

CENTRAL ELEMENTS OF SMART MAINTENANCE

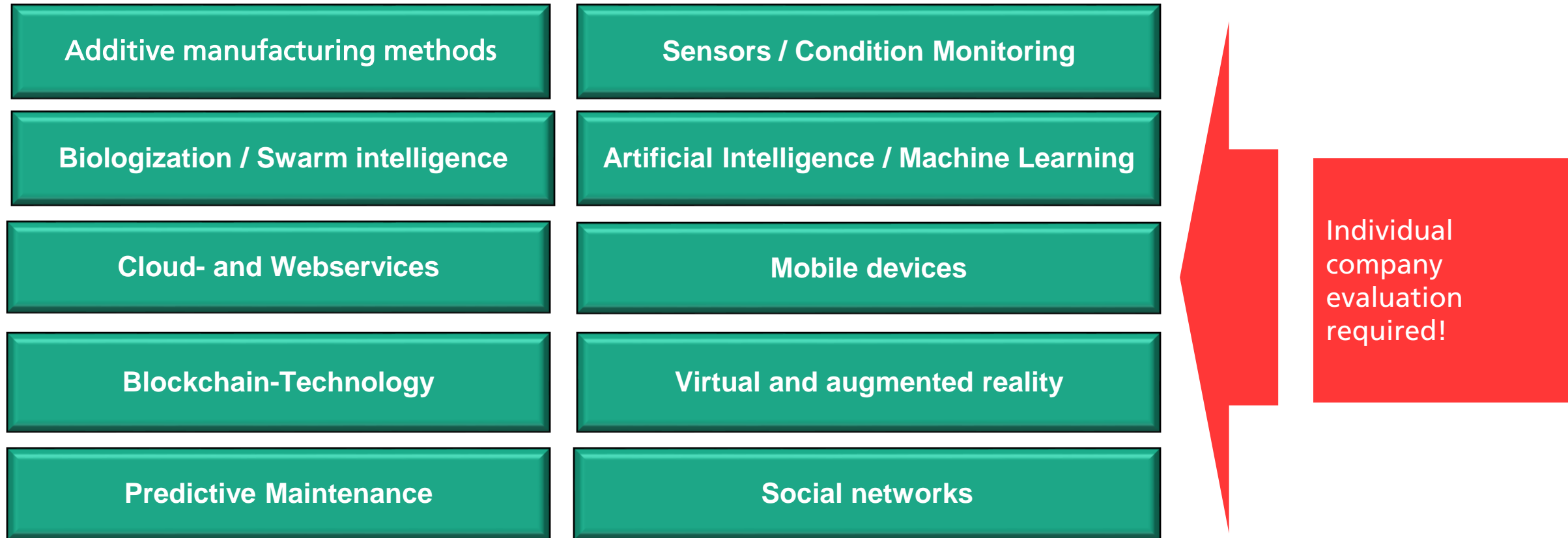
WHY DOES THE SMART FACTORY NEED SMART MAINTENANCE?



For the Smart Factories of industry 4.0 to become reality, maintenance must develop further into Smart Maintenance.

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE



Central Elements of Smart Maintenance

Possible Elements of a Smart Maintenance

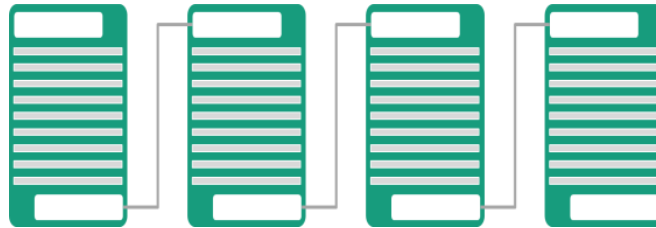


3D printing based services

- Establishment of 3D printing services to optimize spare parts management
- Secure digital order processing for the productive use of 3D printing in value chains
- Development of platforms for collaborative 3D printing services in the maintenance area

Central Elements of Smart Maintenance

Possible Elements of a Smart Maintenance



```
# Basic chain parameters
chain-protocol = multichain          # Chain protocol: multichain (permissions, native assets) or bitcoin
chain-description = MultiChain BlogOnBlockchain # Chain description, embedded in genesis block coinbase, max 256 chars.
root-stream-name = root              # Root stream name, blank means no root stream.
root-stream-open = true              # Allow anyone to publish in root stream
chain-is-testnet = false             # Content of the 'testnet' field of API responses, for compatibility.
target-block-time = 15               # Target time between blocks (transaction confirmation delay), seconds. (5 - 86400)
maximum-block-size = 8388608         # Maximum block size in bytes. (1000 - 10000000000)
```

Blockchain Technology

- Potentials for optimizing data management and data exchange
- Development of blockchain technology as a cost-efficient and secure solution to interface problems

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE



	Monday, 12.01		Tuesday, 13.01		Wednesday, 14.01		Thursday, 15.01	
Worker	8:00	14:00	8:00	14:00	8:00	14:00	8:00	14:00
Mr. Maier								
Mr. Schneider								
Mrs. Sonntag								

Webservices

Use of social networks in the company

- Employee groups are responsible for coordinating short-term work assignments at a given date

Web service

- Groups of people vote on appointments

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE

I can work this Saturday.

I'm afraid Saturday doesn't work.

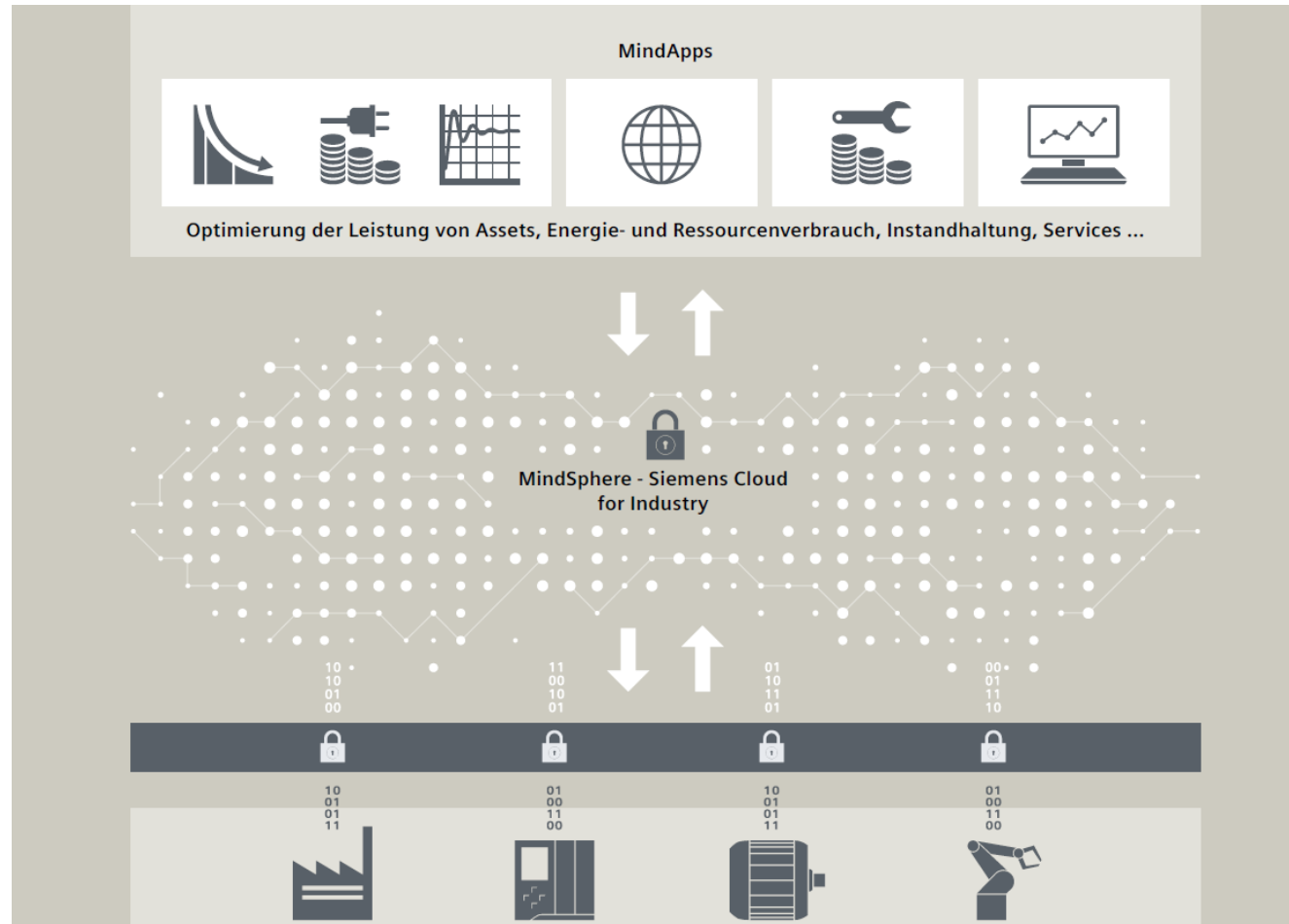
Implementation: <https://www.vote2work.com/>

Mobile devices

- Use of mobile technologies for interdisciplinary coordination of orders
- Better alignment and time management of available resources

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE



Cloud Technologies

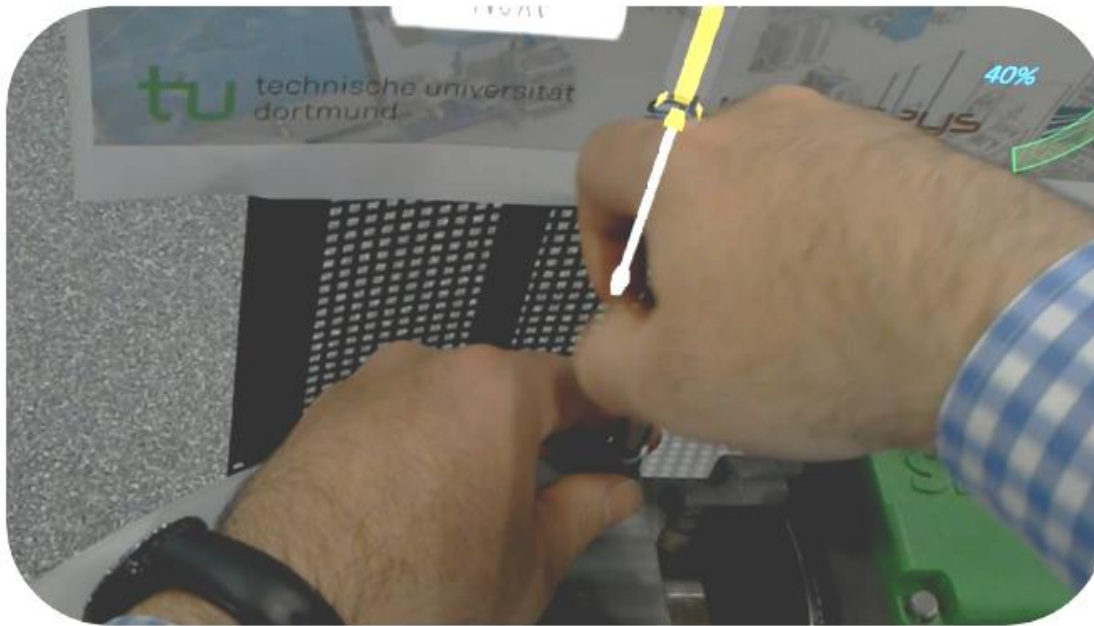
Availability-oriented maintenance

- Preparation of a production and maintenance plan on the basis of central questions, e.g.
- How much remaining use is possible?
- How much residual usage do I need?

Example Siemens-MindSphere

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE

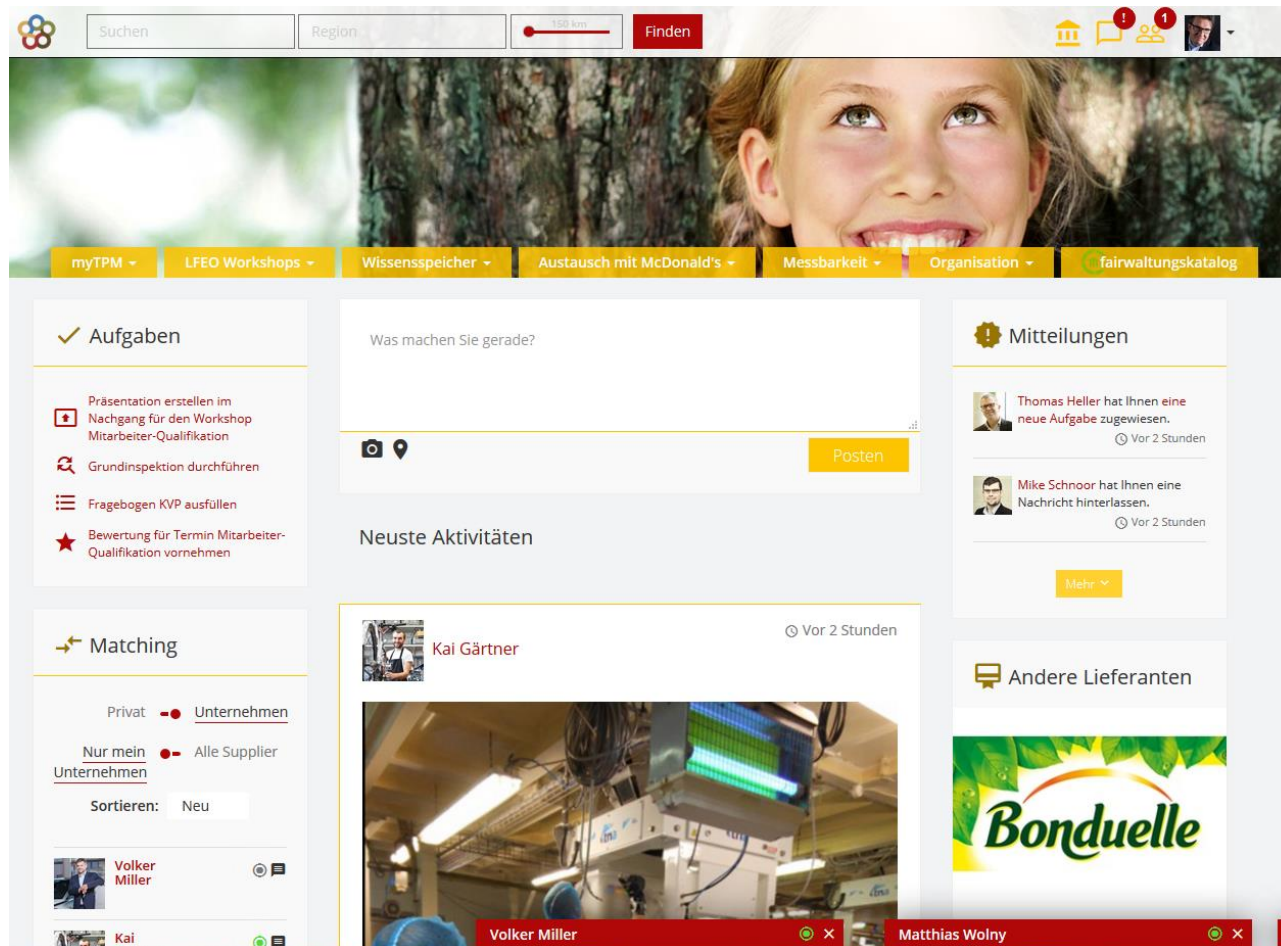


Augmented Reality

- Augmented Reality-Escape Games for professional training in the context of smart maintenance across learning fields
- Projection of "step-by-step" instructions into the field of view of the maintenance technician in real time

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE



Social Networks

- Internal company social networks as a central component of knowledge management in Smart Maintenance
- Overview of current events within the company
- Messenger for internal company communication

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE

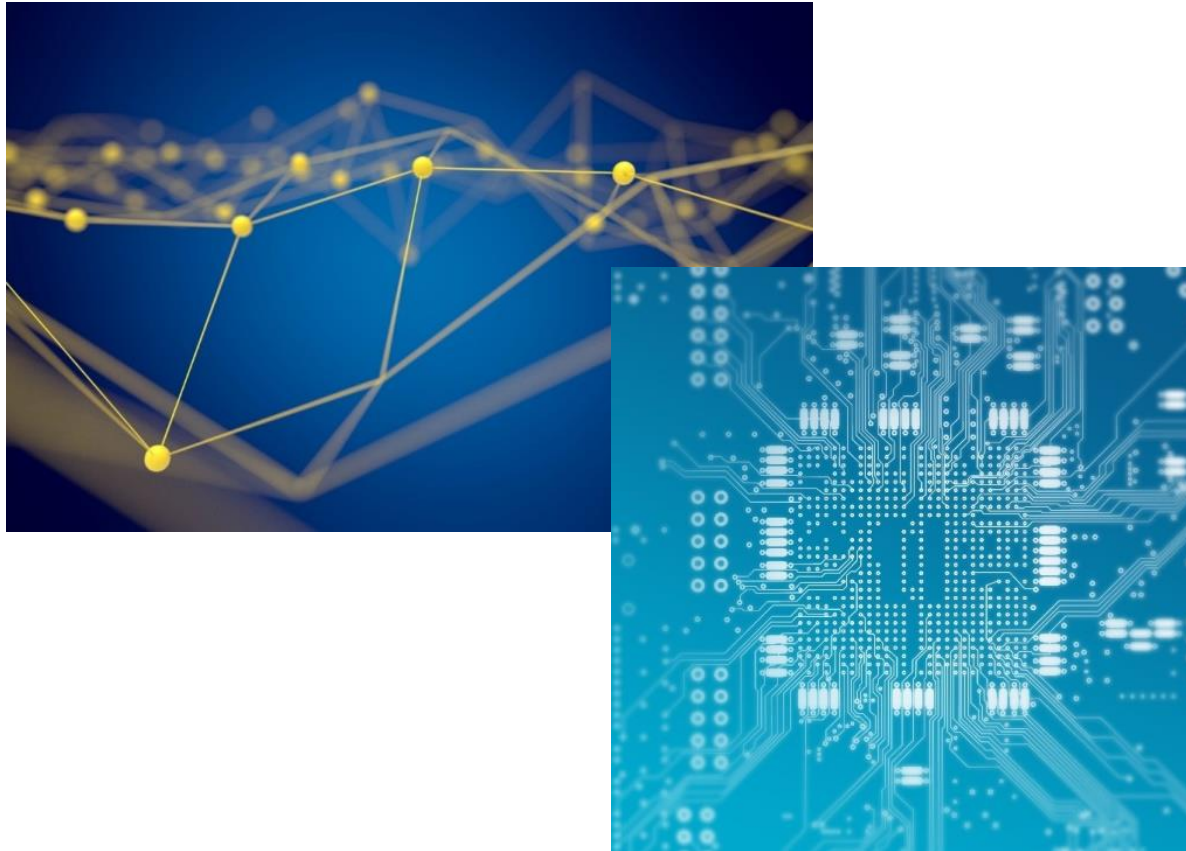


Biologization

- Current technology trend
- Simulation of the cycles existing in nature
- For improved and more sustainable management of the limited resources available

CENTRAL ELEMENTS OF SMART MAINTENANCE

POSSIBLE ELEMENTS OF A SMART MAINTENANCE



Artificial Intelligence

- Analysis of production and manufacturing data to predict possible machine failures and malfunctions
- Identification and initiation of the ideal maintenance time for the machine

CENTRAL ELEMENTS OF SMART MAINTENANCE

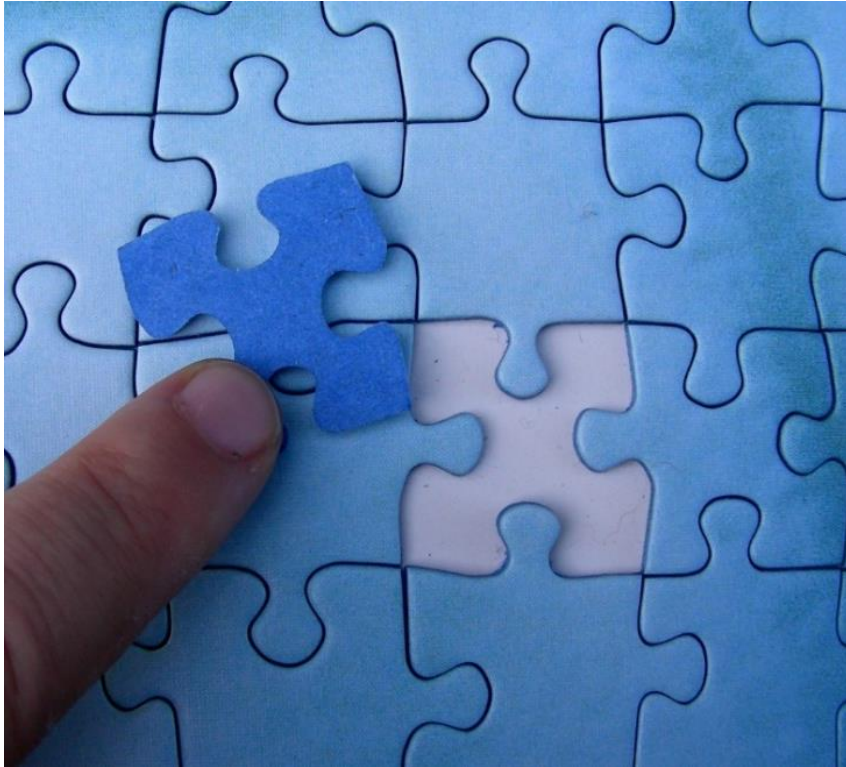
POSSIBLE ELEMENTS OF A SMART MAINTENANCE



Predictive Maintenance

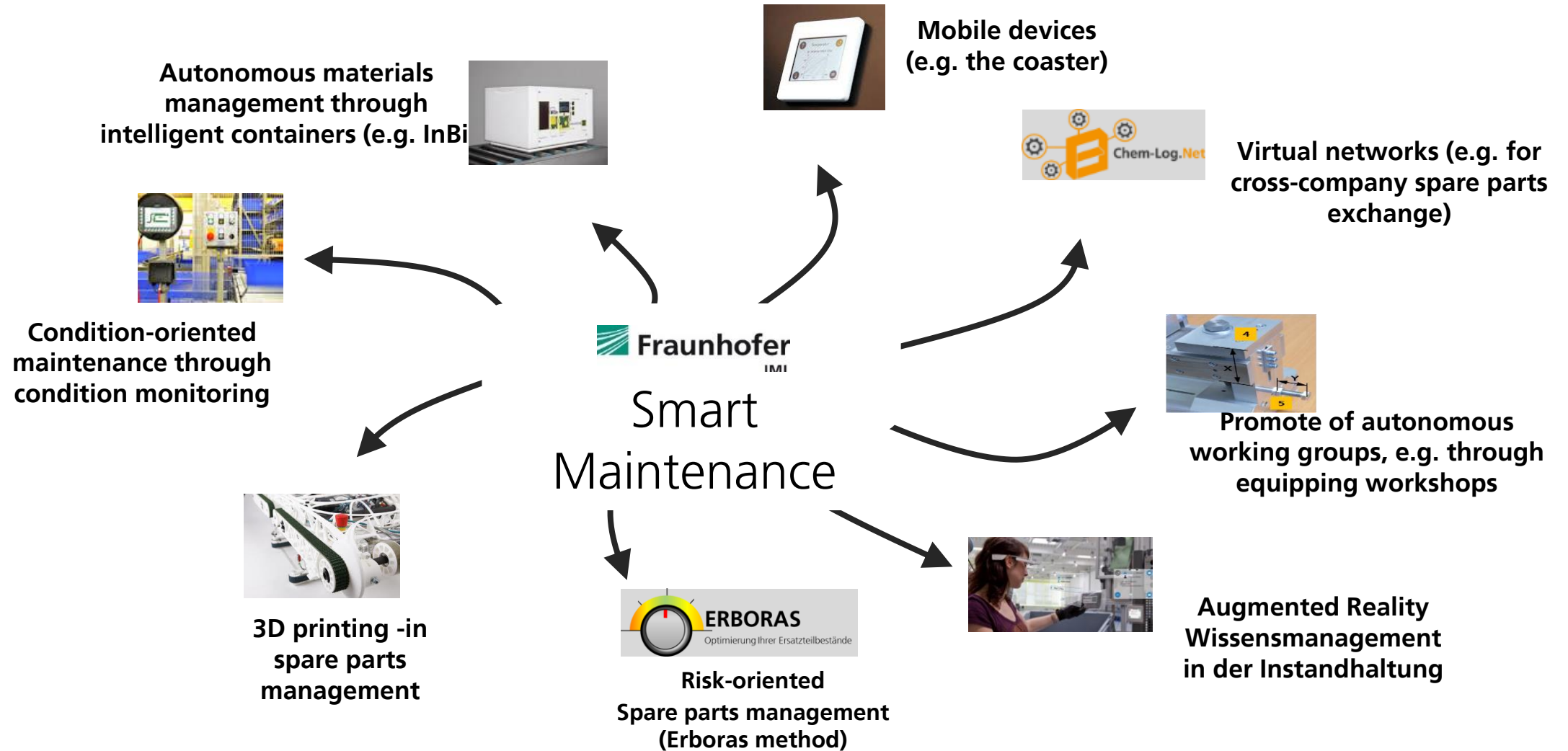
- Increased efficiency through networking of existing systems and intelligent use of data
- Productivity increase, inventory and cost reduction
- Early detection of potential system failures
- Detection of power losses
- Simulation of scenarios for decision making
- Improvement of the coordination and control of maintenance and production

AGENDA – SMART MAINTENANCE



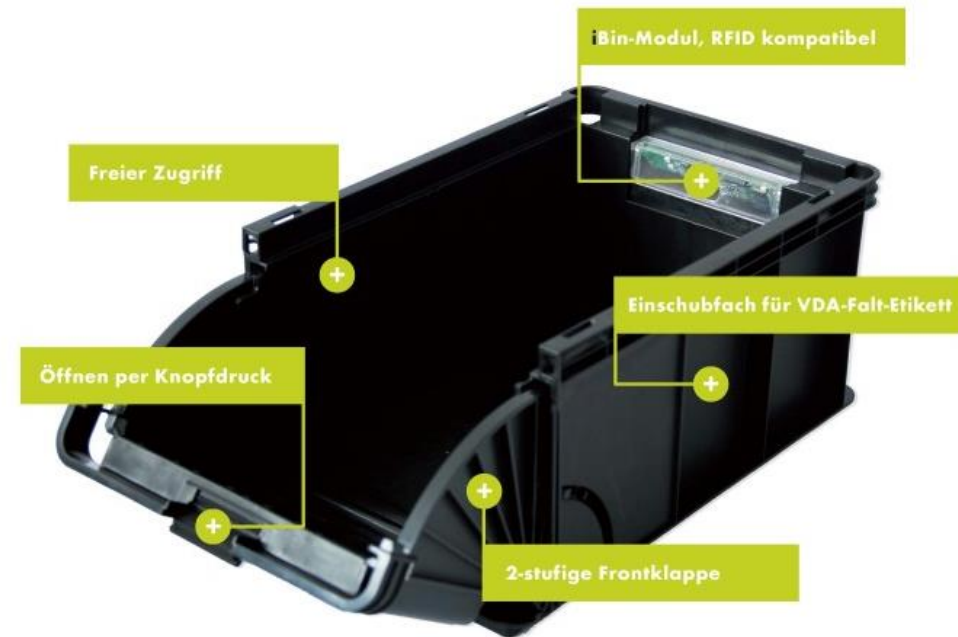
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SMART MAINTENANCE AT FRAUNHOFER IML



SMART MAINTENANCE AT IML

EXAMPLE: INBIN



SMART MAINTENANCE AT IML

INDUSTRY SCENARIO 4.0: COASTER OF THE FRAUNHOFER IML - HUMAN-MACHINE-INTERFACE



SMART MAINTENANCE AT IML

NETWORKS IN INDUSTRY 4.0: EXAMPLE MAINTENANCE AND SPARE PARTS MANAGEMENT



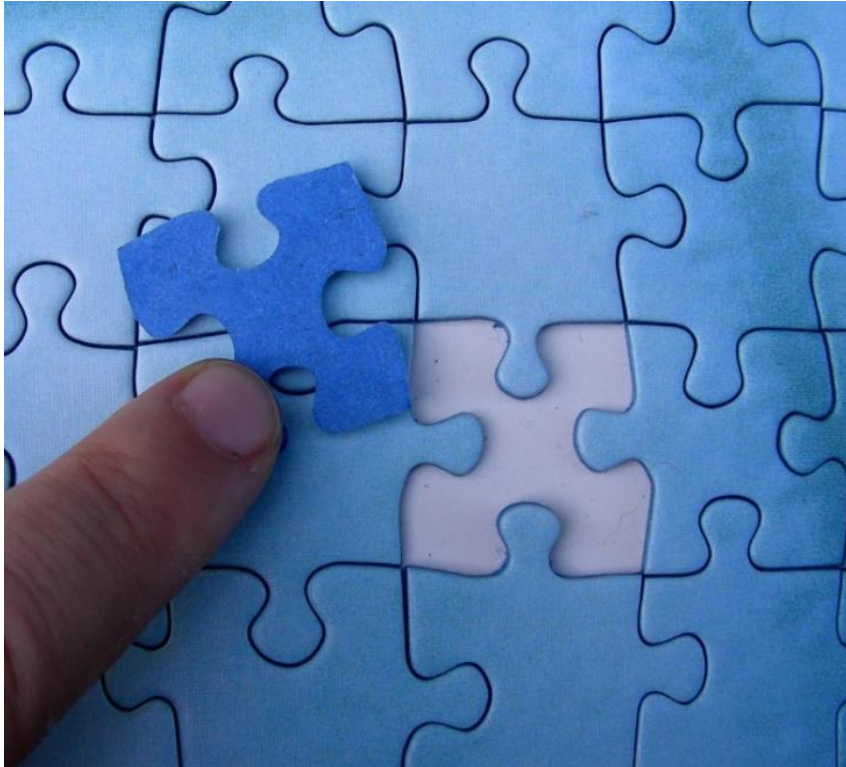
SMART MAINTENANCE AT IML

THE ROLE OF THE HUMANS



Quelle: Fraunhofer IML, 2014.

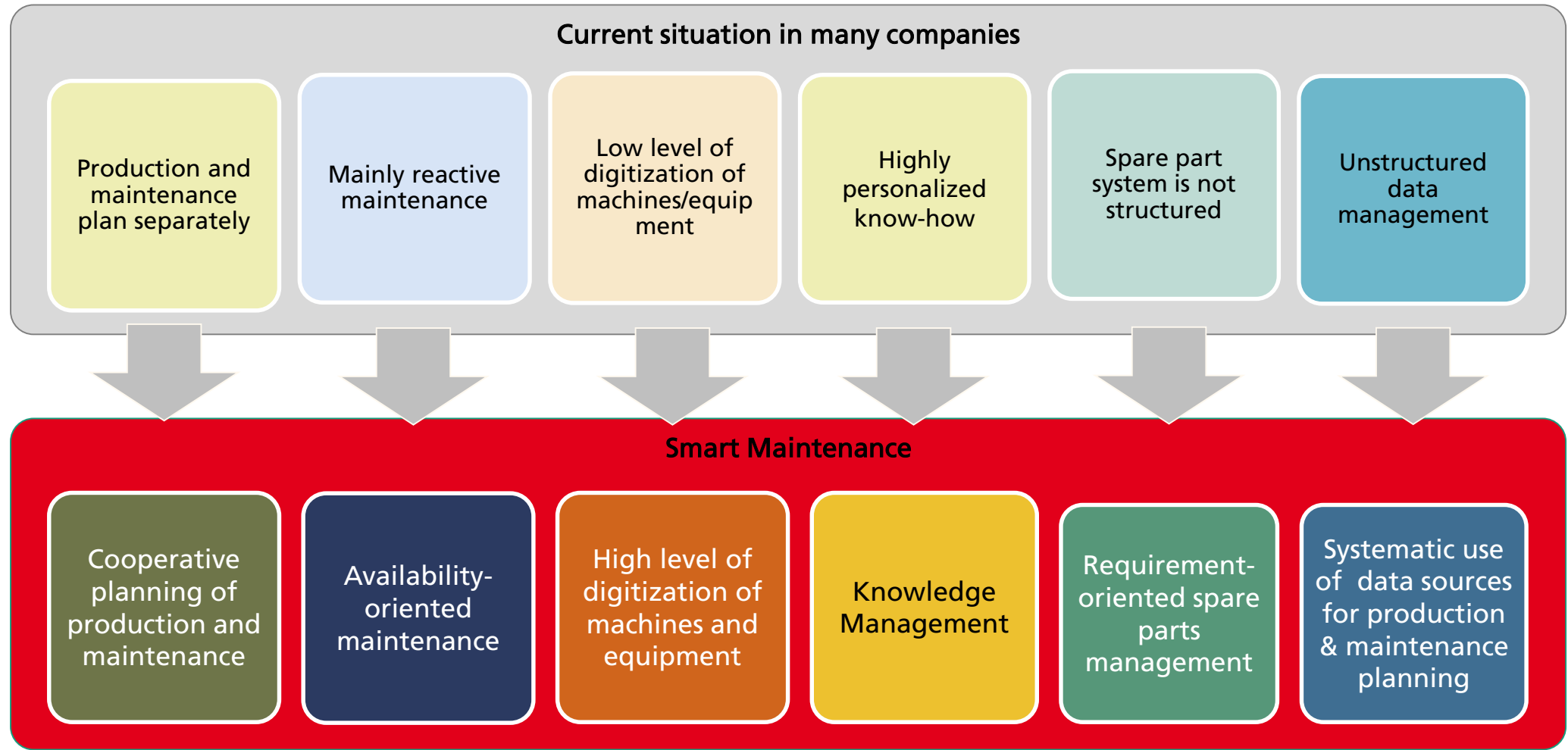
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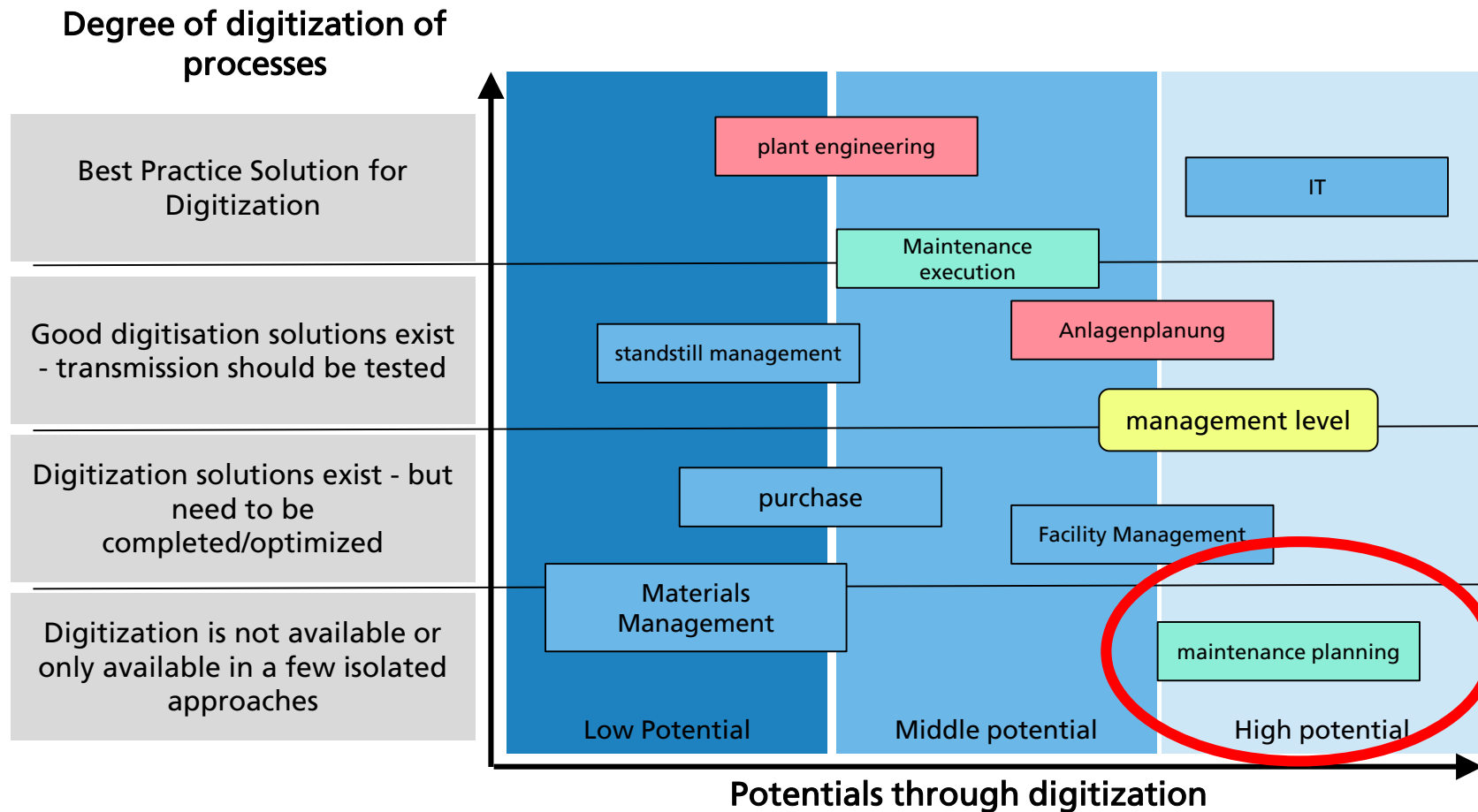
CHANGES IN MAINTENANCE REQUIREMENTS FOR INDUSTRY 4.0

REQUIREMENTS OF A SMART MAINTENANCE



CHANGES IN MAINTENANCE REQUIREMENTS FOR INDUSTRY 4.0

SMART MAINTENANCE IN YOUR COMPANY: WHERE IS THE HIGH POTENTIAL?



CHANGES IN MAINTENANCE REQUIREMENTS FOR INDUSTRY 4.0

WHAT DOES INDUSTRY 4.0 MEAN? CENTRAL REQUIREMENTS FOR SMART MAINTENANCE

Three central requirements for Smart Maintenance can be derived from the target vision of Industry 4.0 and the current situation:

Two out of three plants worldwide are more than 15 years old

1

Equipment of existing plants and machines to realize industry 4.0 capability on the shop floor

70 percent of companies have problems planning maintenance intervals

2

Demand-oriented improvement of availability, flexibility and adaptability in order to achieve production in sync with customer requirements

Annual search effort for information in the industry: 23 million working days

3

Managing technical and conceptual complexity in order to optimise the companies' ability to act

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CHANGING BUSINESS MODELS IN INDUSTRY 4.0

THE DEVELOPMENT OF NEW BUSINESS MODELS REQUIRES SUITABLE METHODS AND APPROACHES

"If I had asked people what they wanted, they would have said faster horses." (Henry Ford)¹

The trick is not to ask customers what their needs are, but to anticipate them.

¹<http://www.henry-ford.net/>

CHANGING BUSINESS MODELS IN INDUSTRY 4.0

- Successful business models break rules and offer unique selling points



*The customer wants to listen to the music,
not buy the CD (Apple)*

IT services instead of computer hardware
(IBM)

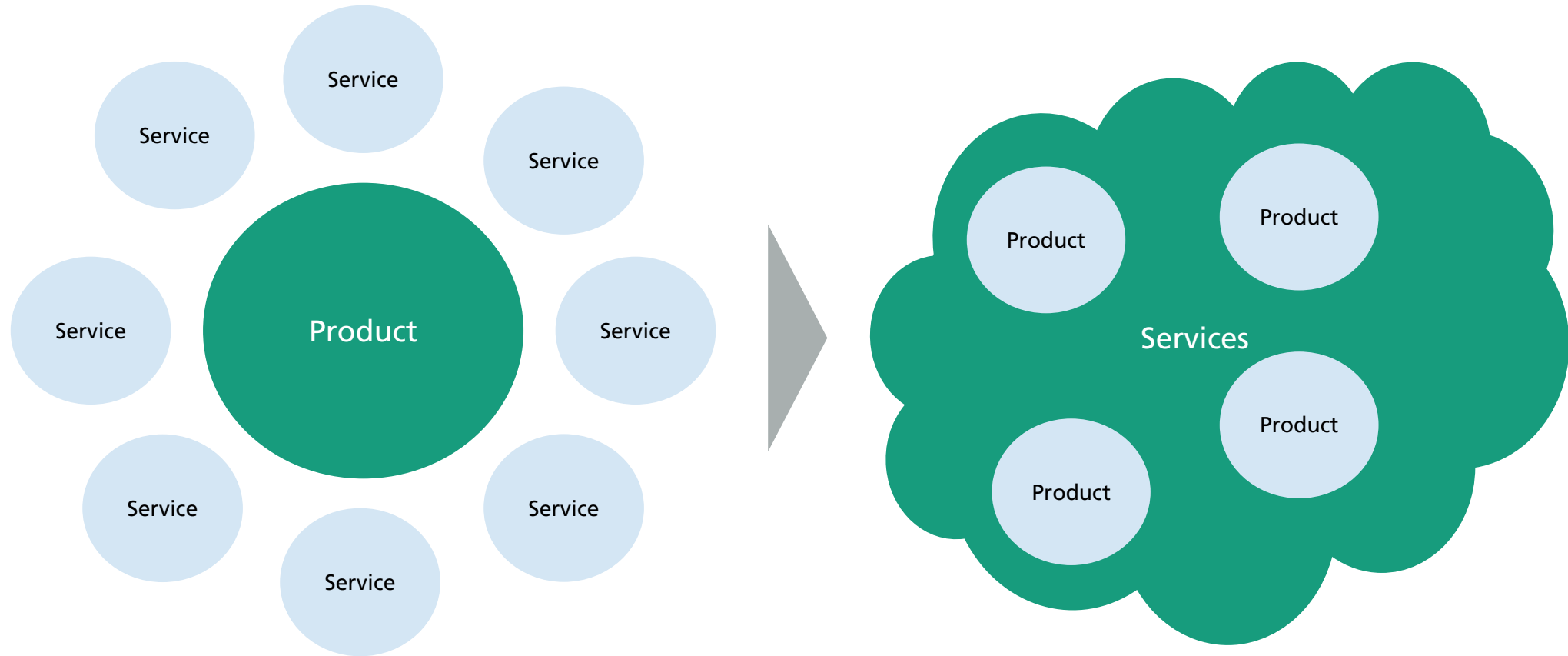


*Thrust hours instead
of turbines (Rolls
Royce)*



CHANGING BUSINESS MODELS IN INDUSTRY 4.0

MANY INDUSTRIES ARE CHANGING FROM PRODUCT TO SERVICE BUSINESS



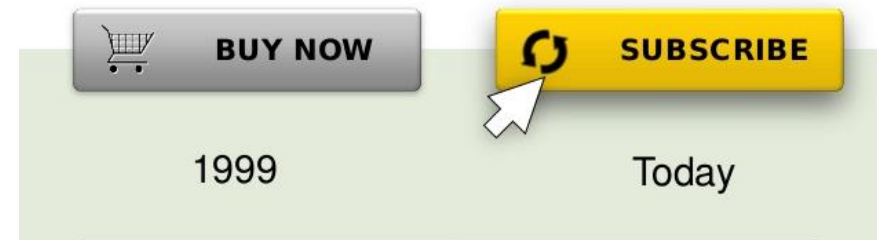
Khanagha et al., 2012.

CHANGING BUSINESS MODELS IN INDUSTRY 4.0

"No APPs - no business" (Hybrid) product/service offerings will be created.



- „Subscription Economy“ - Don't sell the machine, sell the operating hours!
- Make additional sales with digitally enhanced products and intelligent services.
- The margins for these services are often significantly higher than in the old core business.



CHANGING BUSINESS MODELS IN INDUSTRY 4.0

The business models in maintenance will also change.

→ Availability instead of maintenance

→ Availability instead of having a spare part in the warehouse

- ✓ Not the repair or maintenance of a machine is sold, but the availability.
- ✓ The customer does not want the maintenance technician in his plant, but a functioning Production
- ✓ The customer does not want the spare part in his magazine, but a functioning machine
- ✓ This results in increasing maintenance requirements

CHANGING BUSINESS MODELS IN INDUSTRY 4.0

Example from an Fraunhofer IML Project for the development of a new business model by an SME:

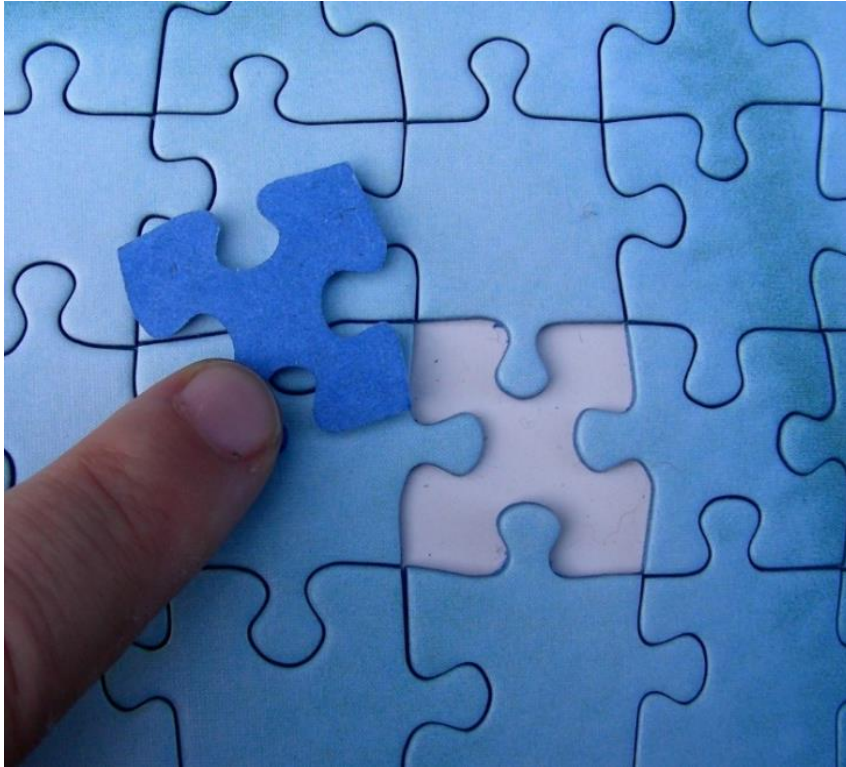
Takeover of spare parts management by a retailer

- **In the past:** The maintenance staff monitored the inventories themselves and reordered them if necessary. The spare parts were delivered by the dealer. The customer accepted the goods and placed them in the warehouse.
- **Today:** The complete supply process is monitored and controlled by the retailer. The only task of the maintenance technician is to digitally record each removal using a mobile device (Smart Phone). In addition to delivery, the retailer also stores the spare parts in the warehouse.



In Germany, spare parts warehouses often still look like this → Potential for a new business model!

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THE IMPORTANCE OF CHANGE MANAGEMENT IN THE IMPLEMENTATION OF SMART MAINTENANCE

The described elements of Smart Maintenance bring changes to the previous working environment of maintenance personnel during their implementation. These changes relate, among other things, to work processes, the use of tools, and possibly also to a change in the business model.



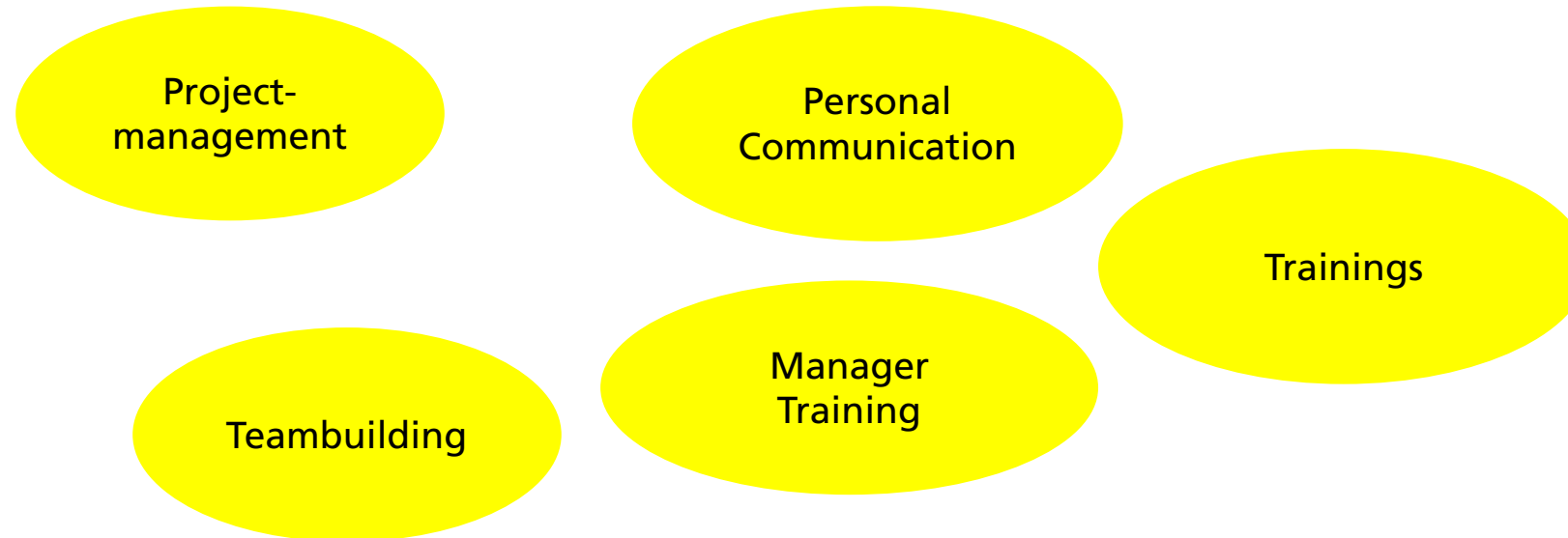
In order to prevent resistance during implementation, elements of change management should be applied.

What is change management?

Change management means profoundly changing structures, processes and behaviours.

THE IMPORTANCE OF CHANGE MANAGEMENT IN THE IMPLEMENTATION OF SMART MAINTENANCE

Which methods in the context of change management have proven to be useful?



THE IMPORTANCE OF CHANGE MANAGEMENT IN THE IMPLEMENTATION OF SMART MAINTENANCE

In the context of maintenance projects, methods in connection with successful project management have proven to be particularly successful, such as

- ✓ The initiation of the project kickoff with the participation of all maintenance stakeholders
- ✓ The collection of requirements for future maintenance concept during the project and their consideration in the maintenance concept
- ✓ The formation of a core team (project team) to assist the project management
- ✓ The transfer of interim results
- ✓ Presentation and coordination of the project results within the core team (Project team)

