Industrie 4.0

The Aachen Approach

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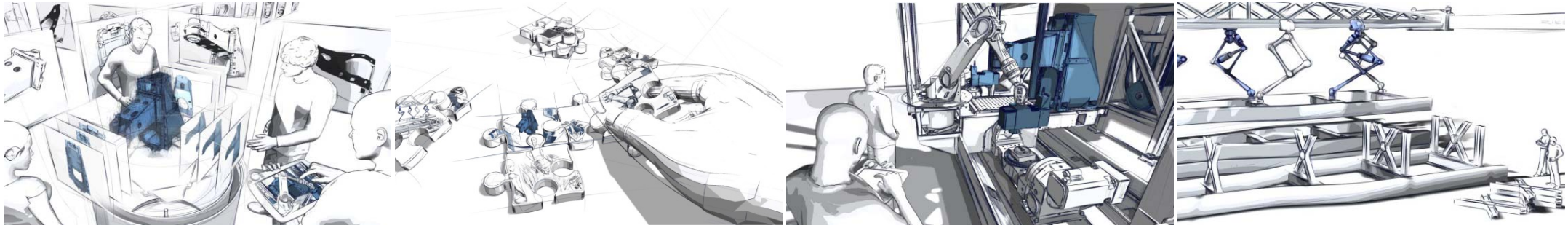

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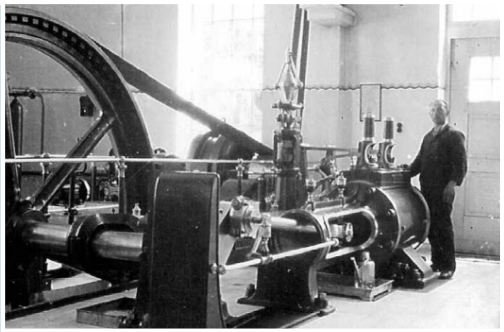
Paradigm shifts lead to the announced „fourth industrial (r)evolution“



1712: Steam engine

1st industrial revolution

by introducing mechanical manufacturing facilities

End of 18th century

Industrialization

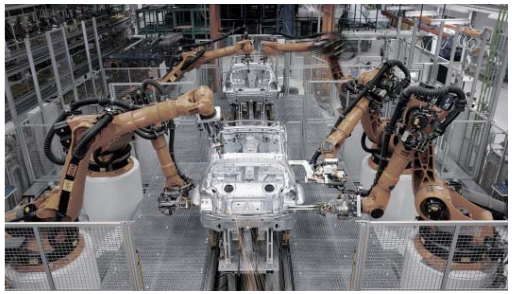
1913: Assembly-line production

2nd industrial revolution

by introducing mass production based on the division of labor (Fordism, Taylorism)

Begin of 20th century

Rationalization



1969: PLC
1973: Six-axis robots

3rd industrial revolution

by applying electronics and IT to extended production automation

Begin of the 1970's

Computerization/ automation

1985: Breakthrough of CIM

Integration of production

Integration concepts regarding information processing in manufacturing companies unifies production planning and control supported by CAD/CAM/CAQ

Begin of the 1980's

Integration concept inspired by business informatics

Source: DFKI (2011); Adomeit (2008); Gaswerk Augsburg; KUKA; reddinpartners, Siemens

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Development during the last decades – Requirements for Industrie 4.0

Availability of computer hardware | **Progress in digitalization** | **Availability of Networks**

CIM
ERP Data
PPS System
Programming
Logical Data Model
Embedded Systems
Condition Monitoring
B2B
Supply Chain
Client/Server
VIBN
Storage Capacity
B2C
Intranets
Database organization
Web 2.0
Software
Digital Factory
Fieldbus
ZigBee
Bluetooth
PLM
Virtualization
Mobile M2M Communication

VISION

4th industrial revolution

through consistent, intelligent networking in manufacturing

Industrie 4.0

Today

Intelligent networking in production – from CIM to Industrie 4.0 & Smart Service World

- „Fusion of virtual und physical world“ towards „Internet of things and services“
- „Merging technical processes with business processes“

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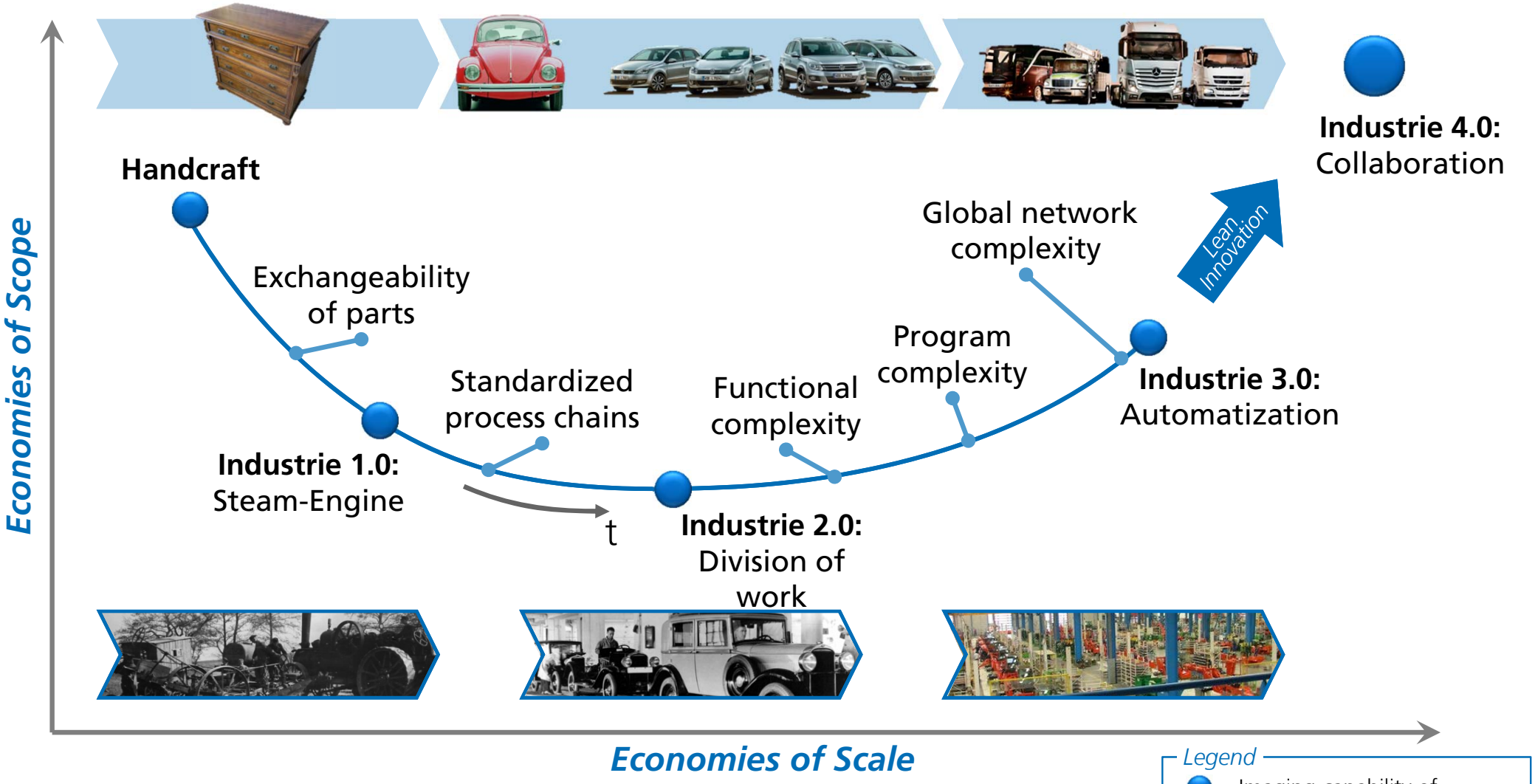
Industrie 4.0 makes global network complexity manageable and enables the realization of economies of scale and scope



Source Pictures: mvc-brenig.de; thedetroitbureau.com; vertikal.net; wikimedia.org; pagenstecher.de; daimler.com; pillenstein.de

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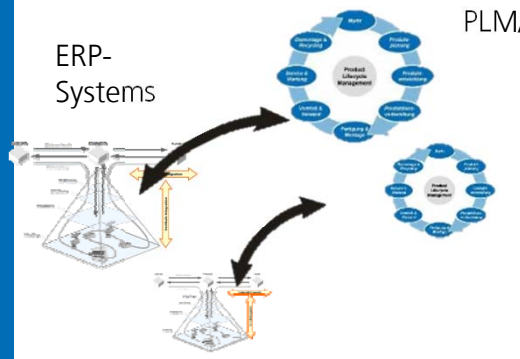
Industrie 4.0 –
The Aachen Approach

Single Source of Truth

ERP-Systems

PLM/Engineering-Systems



IT-Globalisation

- Big Data
- Assessing and Storage in the cloud
- Data mining, safety, security
- High Speed Computing

Local data storage

Cooperation

- Business Communities
- Social Communities

Automation

- Cognitive System

- Adaptation by sensors
- Intuitivity, reliability
- IT-Openness
- Cost-efficiency
- Robustness

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Industrie 4.0 –
The Aachen Approach

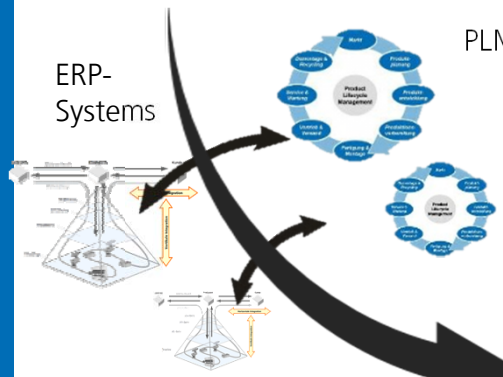
cyber

physical

Single Source of Truth

ERP-Systems

PLM/Engineering-Systems



IT-Globalisation

- Big Data
- Assessing and Storage in the cloud
- Data mining, safety, security
- High Speed Computing

Local data storage

4th Industrial revolution

Collaboration
Productivity
- Human/Human
- Human/Machine
- Machine/Machine

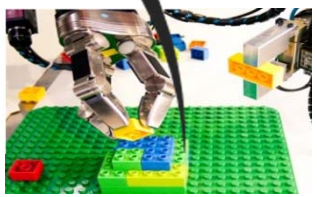
Cooperation

- Business Communities
- Social Communities

Automation

- Cognitive System

- Adaptation by sensors
- Intuitivity, reliability
- IT-Openness
- Cost-efficiency
- Robustness

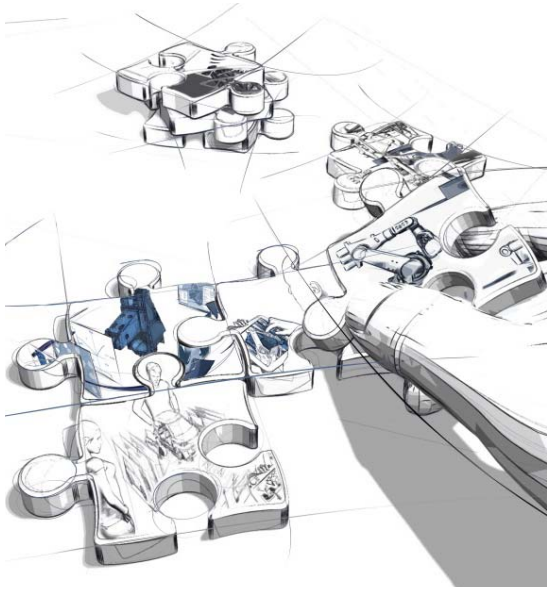


software

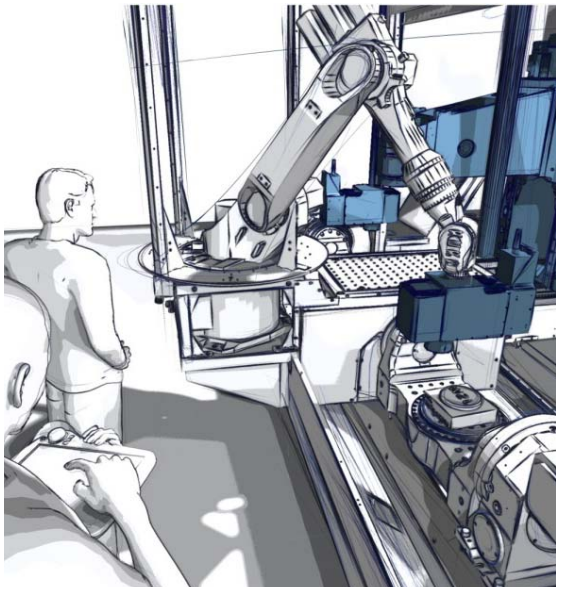
hardware

Industrie 4.0

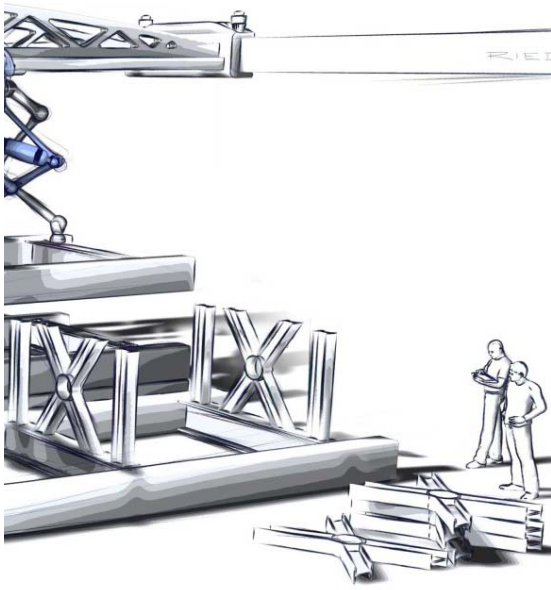
Virtualization and Cross-Linking



Globalization and Complexity



Digital Production



Cyber Physical Production Systems

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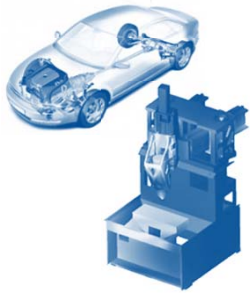
Industrie 4.0 –
Virtualization and Cross-linking



Real world

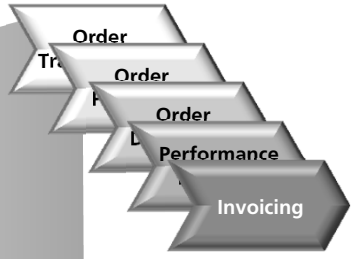
Virtual world

Fusion

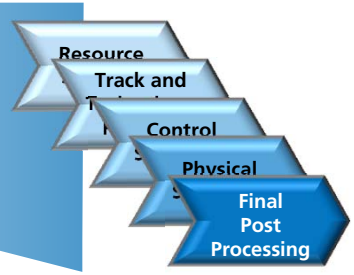
Industrie 4.0

Internet of Things

Business processes



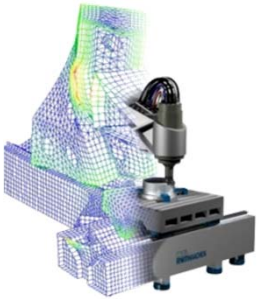
Technical processes



Semantics,
System understanding

Virtualization

Cross-linking



Finite-Element-Models

State Models

Data Models

Analytical Models

CAx-Chains

PLM/PDM

Clouds

Mobile Devices

Ubiquitous Computing

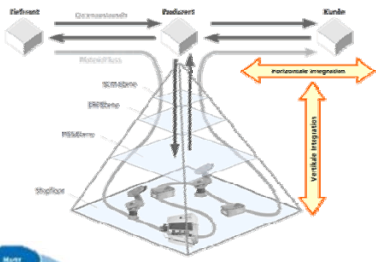


Image sources: Daimler, Chiron, WZL

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Industrie 4.0 –
Cyber Physical Systems

Cyber-Physical-Systems (CPS) are systems with embedded software, integrated for example in:

- equipment,
- buildings,
- transportation means,
- medical processes
- logistic processes
- or **Production Systems (CPPS)**

Cyber-Physical Production Systeme (CPPS) …

- …**gather data** with production-integrated sensors and metrology systems **in real-time,**
- …**record** and analyse data for the **creation of models,**
- …**interact actively** with actors of the physical and digital world as well as with **human**
- …are connected via digital **communication interfaces** with theirselves and with the **Internet of Things**.

A Cyber-Physical-System (CPS) is the smallest element of an intelligent object in the architecture of Industrie 4.0

Source: Cluster of Excellence „Integrative Production Technology for High-Wage Countries“, „Cyber-Physical-Systems“ – acatech POSITION/Springer Verlag, Siemens

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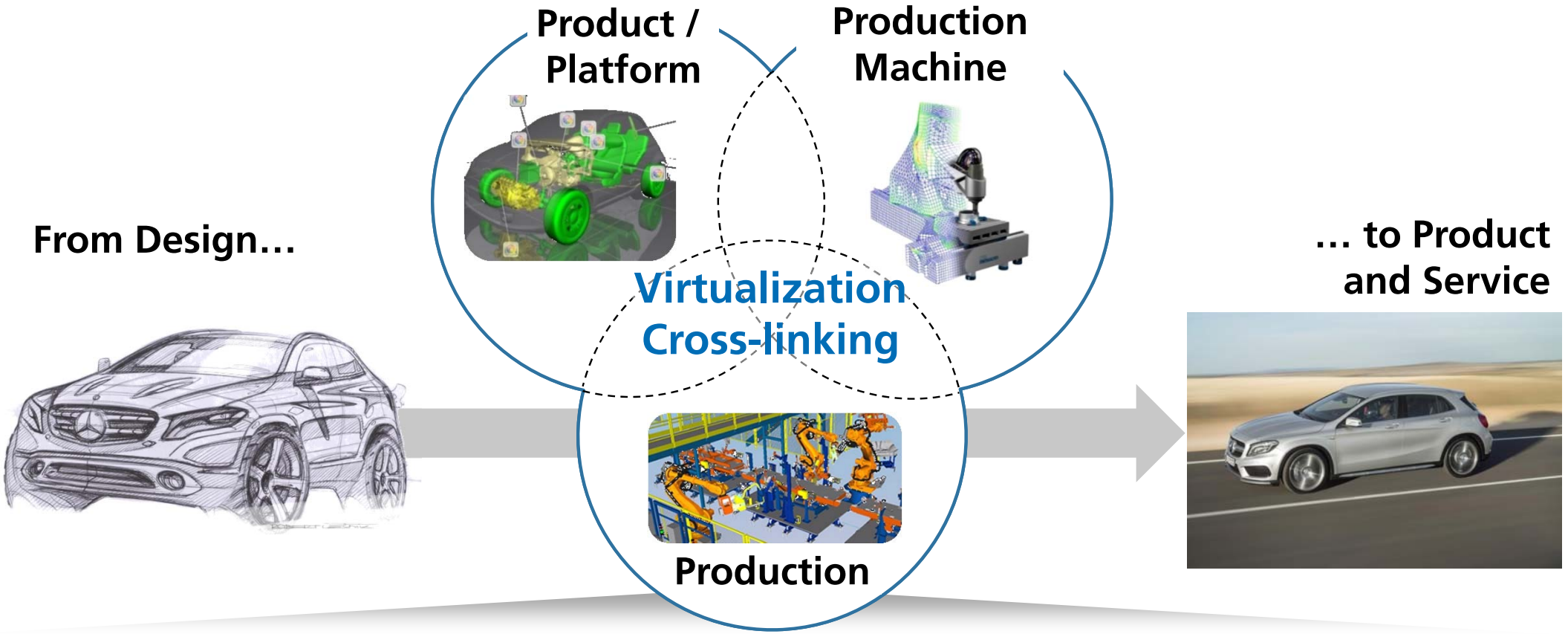
Expectations of Manufacturing Companies towards Industrie 4.0



First Time Right

Continuous optimization of machining processes

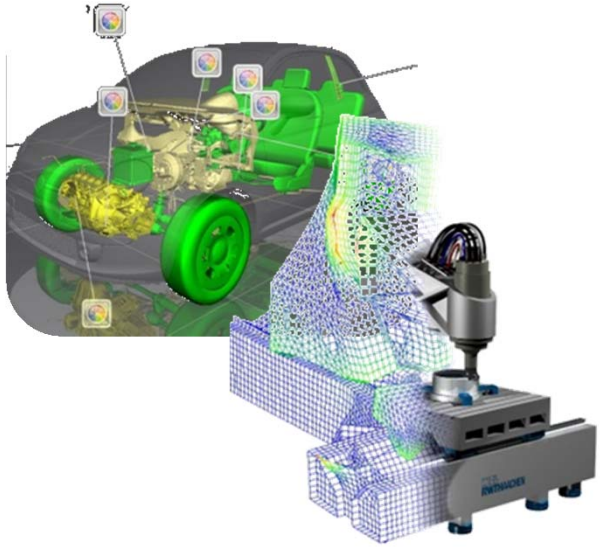
Efficiency down to production batch size 1

Image Sources: Daimler, Siemens PLM, WZL

Overall objectives

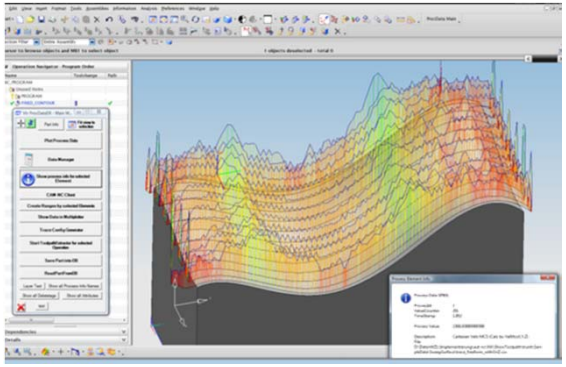
First Time Right

Virtualization of product, production means and production



Continuous optimization of machining processes

Cross-linking of manufacturing resources and information



Efficiency down to production batch size 1

Production control with virtual technologies

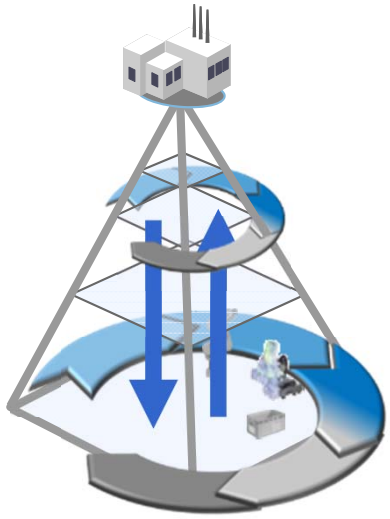


Image Sources: Siemens PLM, Index-Werke, WZL

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Industrie 4.0

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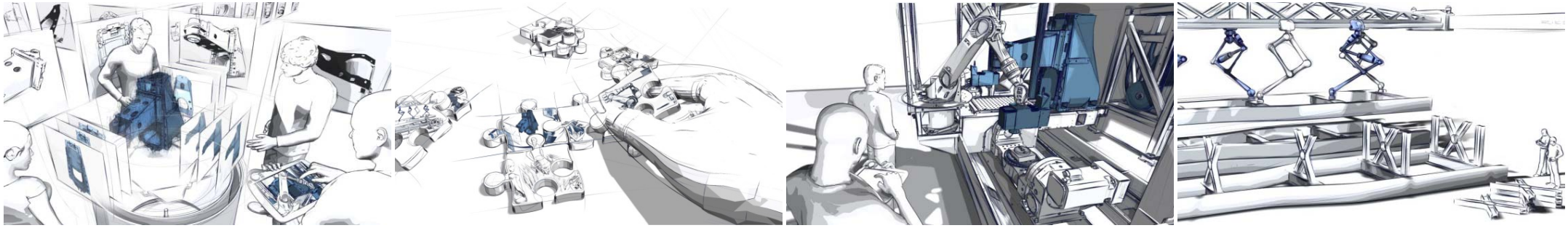

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