

# Introduction to “Industrie 4.0”

## Facing the Smart Future – The German Perspective

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Director – INC Invention Center

CEO – KEX Knowledge Exchange AG

# A lot of talking has been done

# Industrie 4.0





# Berlin, Germany





# Paris, France

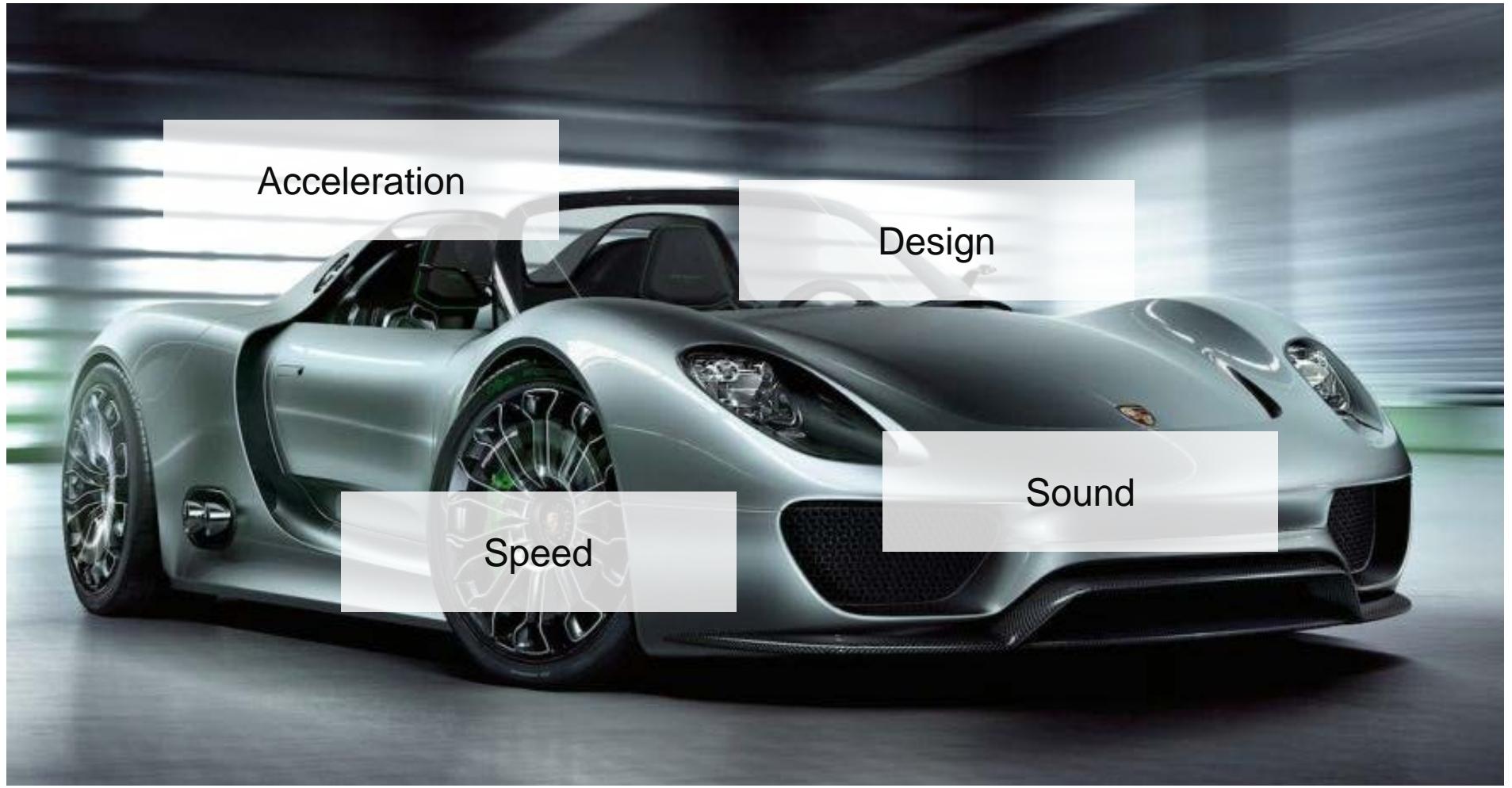




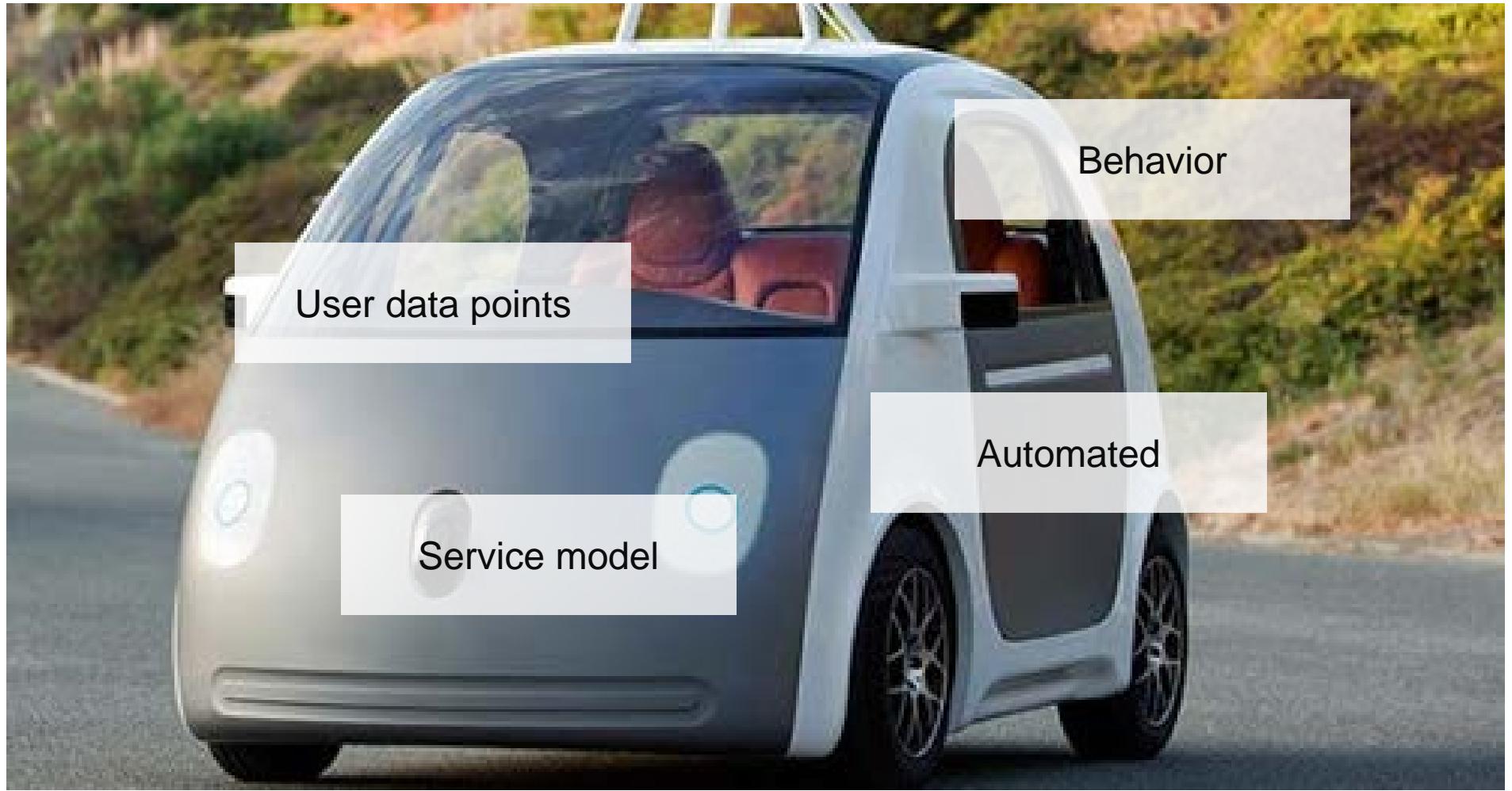
# Self organizing systems – Industrie 4.0



# Traditional markets



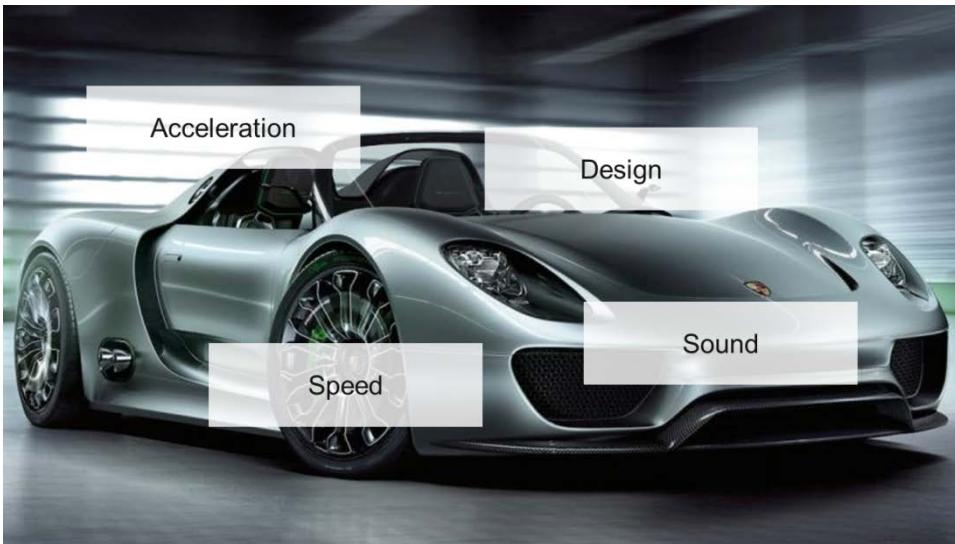
# New competitors with different understanding of the market



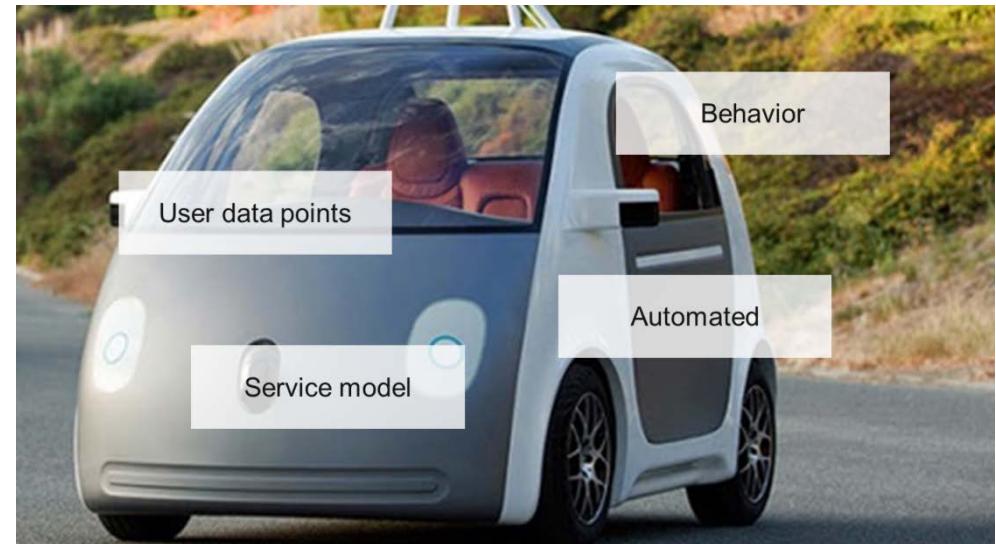
# Value: Growth & Revenue

## Adopt or die

Traditional innovation patterns



Innovation patterns from digital players



Current and new competitors are driving the market and will change the game of innovation patterns. There is no way not to adapt. European companies will invest 140 billion Euro annually in internet applications.

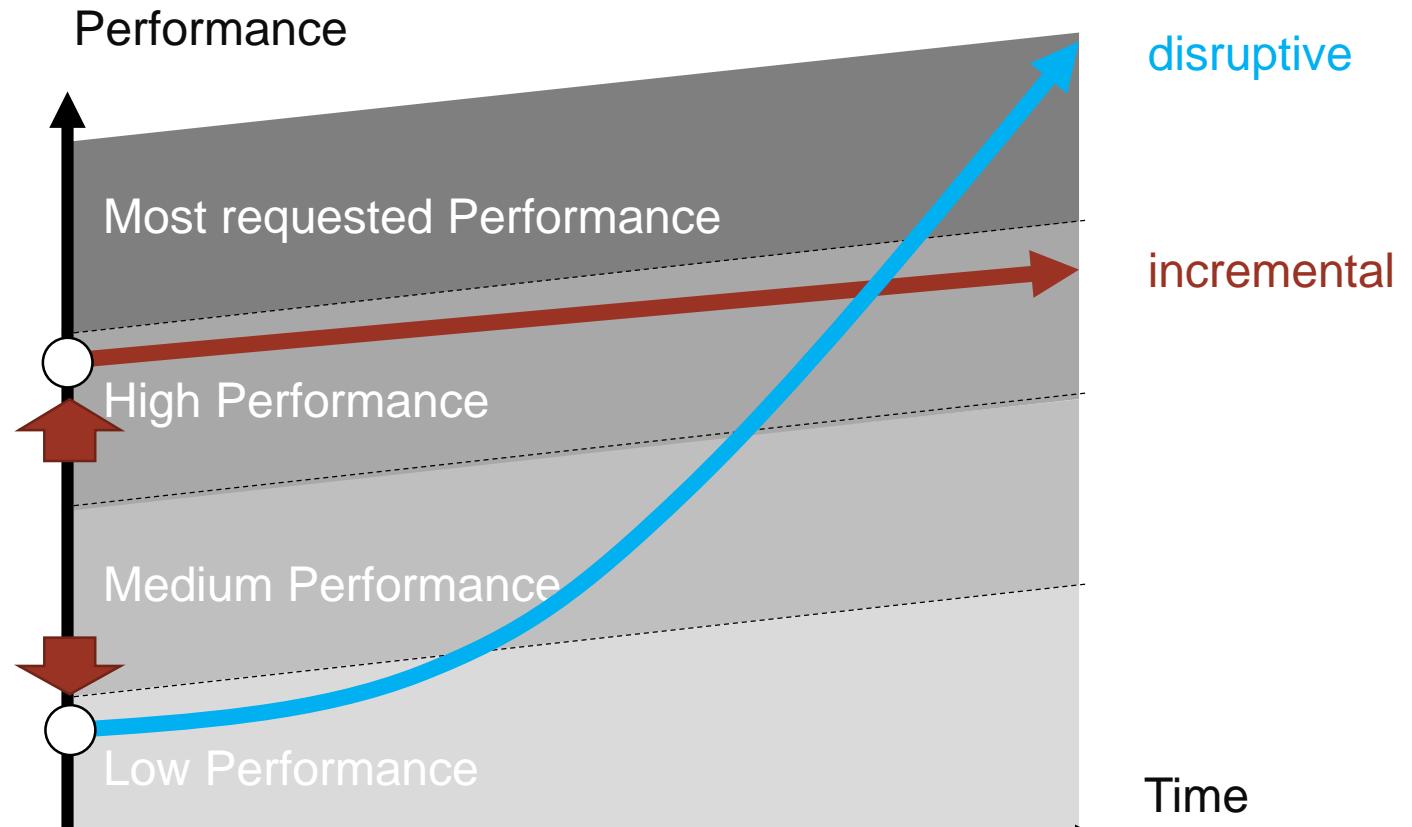
# New competitors with different understanding of the market



# Innovators dilemma



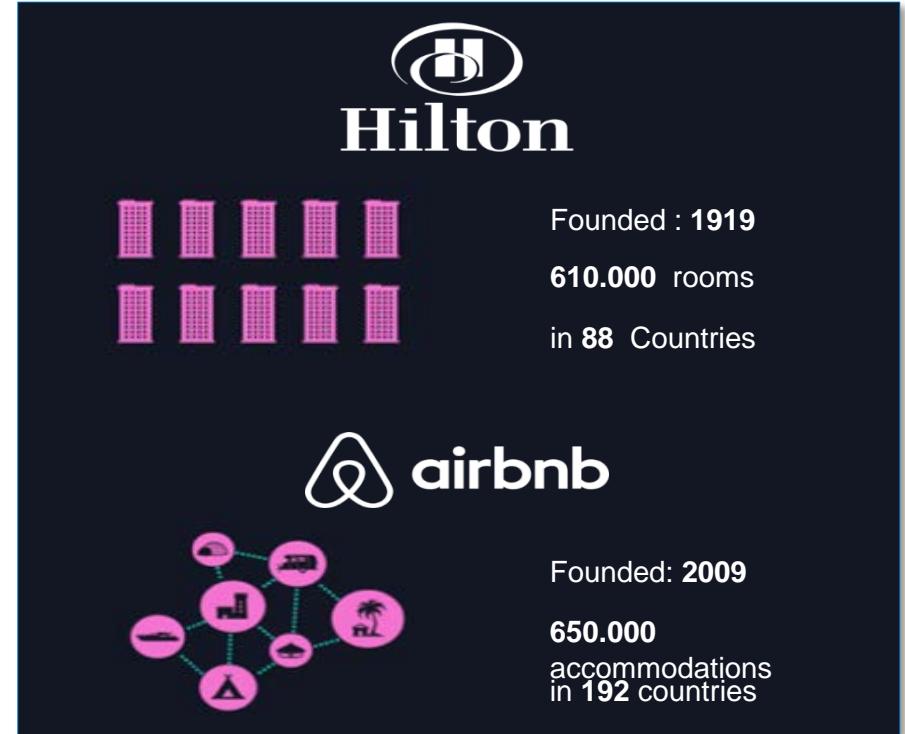
Vacuum tube  
radio(RCA)



Transistor  
radio (Sony)

# Value: Growth & Revenue

## Differentiate



Digital products, and services through new business models will enable companies to create unique selling proposition and differentiate in competition. Flexible production with lower complexity costs will differentiate the market players.

## Growth



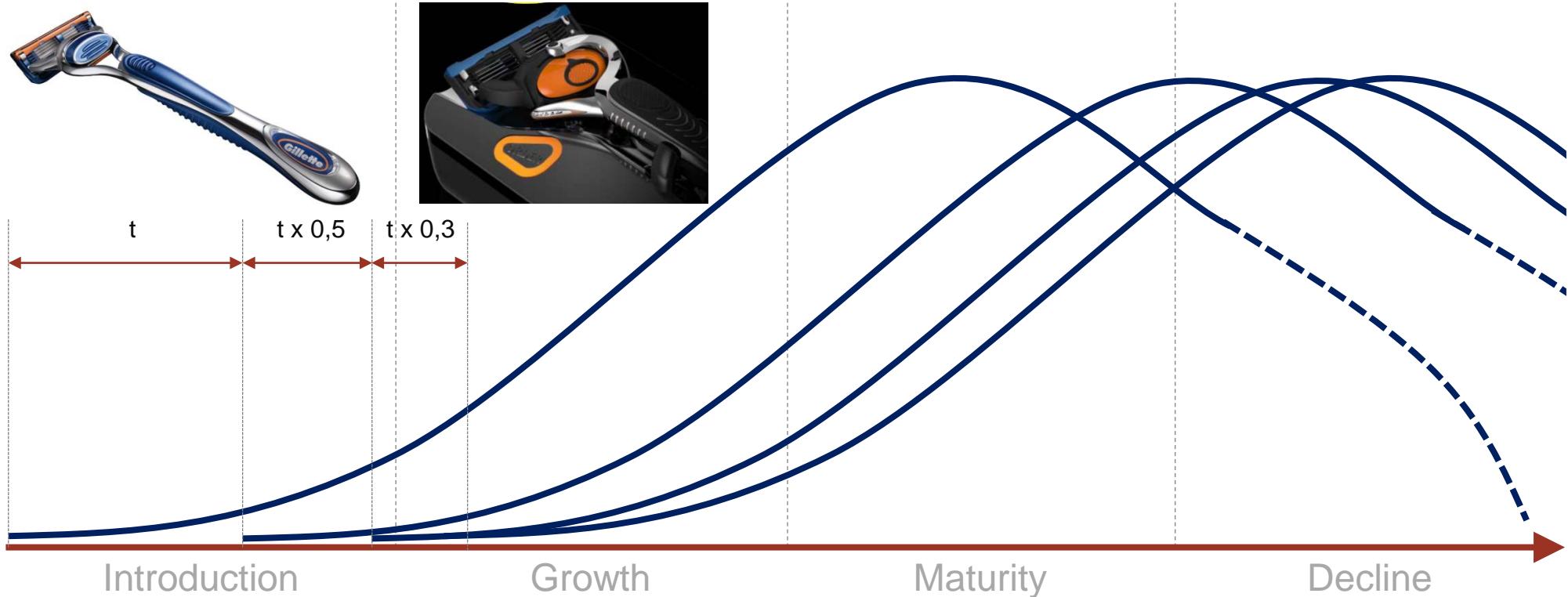
Digitized products and services generate approximately an additional € 110 billion per year for European industry.

Over 80% of the companies will have digitalized their value chains in the next 5 years.

Companies can most likely only drive growth and further revenue if they create digitalized products and adapt to digital supply chains.

# Value: Growth & Revenue

## Lifecycle



Lifecycles of current products will be extended by services and new business models in the first step. However, digitalized products, services and business models will also result in quicker product lifecycles. Updates have to be implemented in shorter time.

# Value: Productivity & Efficiency

## Margins

						
Inventory costs	Manufacturing costs	Labor costs	Logistics costs	Quality costs	Flexibility	Time
30-50% 	10-20% 	10-30% 	20-30% 	10-20% 	20-30% 	20-30 % 
Inventory cost reduction due to minimization of minimum inventory level through real time information over the whole supply chain and production.	Manufacturing cost reduction due to real time optimization of production KPI and improvement of planning quality as well as machine utilization.	Labor cost improvement by leveraging flexibility of labor in production and higher degree of automation.	Logistics cost reduction over the whole supply chain due to better automation and material flow harmonization.	Quality cost reduction due to real time data availability to optimize quality issues.	Improvement of flexibility due to higher planning quality, forecasting capability and agile company processes.	Faster value generation due to agile organization and collaboration as well as steering the value chain based on data transparency.

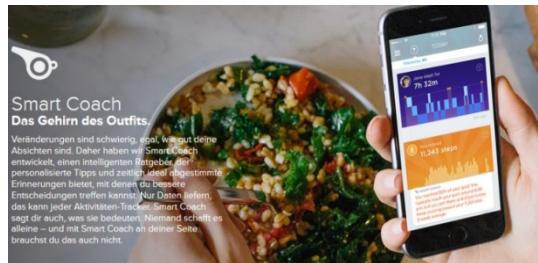
Companies will gain in average up to 20% total productivity and address more individual products with lower complexity costs through smart production and smart networks.  
Especially early movers will be able to create market barriers.

# Value: Individualization & Flexibility

## Vital analysis



## Food / Fitness Coach



Pyramide of needs, Maslow

## Geo-Tracking



## Community



Quelle: jawbone

# Industrie 4.0 – the digitalization of manufacturing – is a global trend

## Engineering excellence

### Bringing engineering excellence to the digital world

Visionary concepts integrating technology, society, and industry in the digital world



### Bringing digital innovation to the physical world

Start-ups for the Internet of Things and a renaissance of manufacturing

## Ability to scale

### Innovation through adoption

Massive build-up of smart factories and very large OEMs building up business through own demand



### Pragmatic adoption of potentials and long-term strategy

Use of existing technologies and strategic development of selected key technologies

## Radical innovation

## Speed

# Opportunity and risks of »Industrie 4.0«

## Specific German view

Opportunity	Risks
<p><b>Company oriented</b></p> <ul style="list-style-type: none"><li>■ Resilience of production processes</li><li>■ Efficient production of individualized products (flexibility vs. automatization)</li></ul>  <p><b>Macro-economic oriented</b></p> <ul style="list-style-type: none"><li>■ Empowerment of skilled work force, e.g. production planning, decision making and safety</li><li>■ Leveraging of German production competencies</li><li>■ Finding answers for demographic change</li><li>■ Differentiation potential by label »Industrie 4.0«, esp. machine building industry</li></ul>	<p><b>Company oriented</b></p> <ul style="list-style-type: none"><li>■ Data security</li><li>■ New disruptive business models<ul style="list-style-type: none"><li>– Data are the new capital assets</li><li>– Erosion of core competencies</li><li>– (Global) competitors from new market arenas</li></ul></li></ul> <p><b>Macro-economic oriented</b></p> <ul style="list-style-type: none"><li>■ Protection of data privacy</li><li>■ Low technical acceptance (»Technikakzeptanz«)</li></ul>

# The development of Industrie 4.0 (I/II)



Initial study on potentials and strategic recommendations for engaging in a broad, society-encompassing, definition of Industrie 4.0



Platform pooling experts from the traditionally distinct industry associations of machine tool manufacturers, the electronics sector and the ICT sector; Chaired by Ministry of Research and Education and Ministry of Commerce



Theses on predicted developments in Industrie 4.0 on the whole ecosystem of production: Human, Technology, Organization

# The development of Industrie 4.0 (II/II)



Several high-profile consortial research grants are given to develop use-cases and testbeds



Get new technology first

The 2015 Hannover Messe offered several expositions of possibilities of Industrie 4.0 in production environments



The implementation strategy of Industrie 4.0 specifies target areas for R&D, reference architectures for Industrie 4.0 systems and components, and an agenda for industrial security in the context of Industrie 4.0

# Identified key research and development areas



- Horizontal integration between companies along value chains („value networks“)
- End-to-end digital engineering across the product lifecycle
- Vertical integration of a company's IT systems and production infrastructure
- Cross-cutting technology fields
  - Networks
  - Data analysis
  - Sensors/actors
  - Safety and security
  - Semantics and ontologies

# Adoption of Industrie 4.0

## Key players and best practices

### Key players (Examples)



**SIEMENS**



**FESTO**



**BOSCH**



**PTC®**



...



### Best practices (Examples)



**nobilia®**



...

# Research projects on Industrie 4.0

## Ongoing research activities (selection)

Federally funded projects (Avg: ~1M EUR)  
for developing...

- ...standards for tool management
- ...“plug-and-play” for machines
- ...self-documenting production system setups
- ...flexible autonomous material flow systems
- ...security frameworks for production systems
- ...demonstrators for prototyping and testing Industrie 4.0 solutions in a production setting
- ...business model templates for Industrie 4.0 solutions
- ...

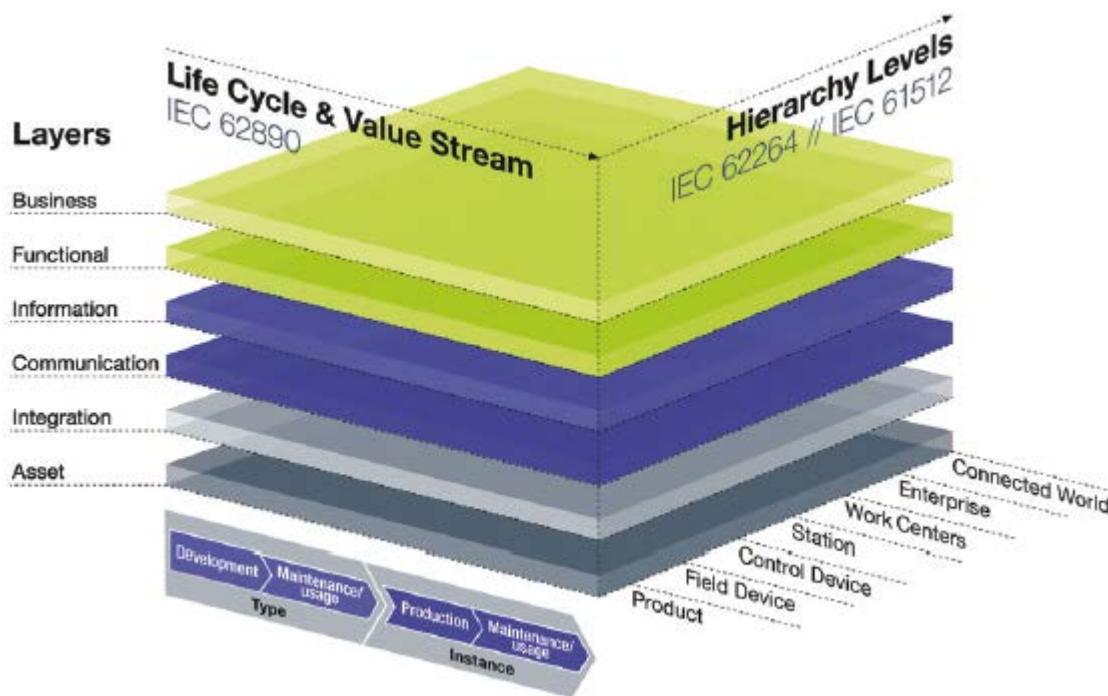


**KARIS PRO**



...

# Reference architecture model Industrie 4.0 (RAMI 4.0)

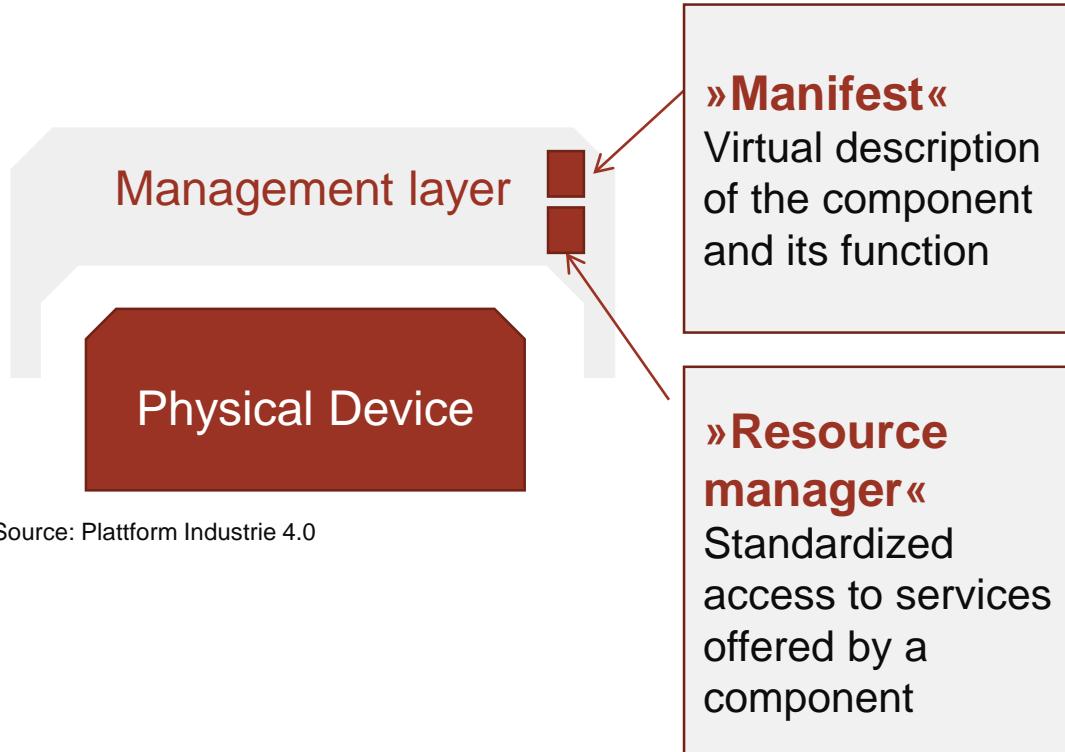


Source: Plattform Industrie 4.0

## Goals and structure

- To discuss and plan architectures of Industrie 4.0 systems
- Driver for standardization
- Structured consideration of adaptability of existing standards

# Reference model for Industrie 4.0 components



## Goals and structure

- To **ensure interoperability** between components, and between Industrie 4.0 systems and human operators, **basic component designs are specified**
- Emphasis on **describing function** of component within larger system and **providing access to component services**
- Term **»Industrie 4.0 component«** defined for compliant components

Definition of »Industrie 4.0«  
Lack of common understanding

Industrial Internet

Smart Services

Internet of Services

Cyber-Physical Systems

Smart Production

Internet of Things

**Industrie 4.0**

Digitalization

Factories of  
the Future

Smart Cities

Smart Products

Smart Manufacturing

Smart Factory

Smart Home

# Definition Industrie 4.0



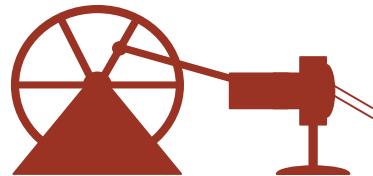
## Platform Industrie 4.0:

„The Term Industrie 4.0 stands for the fourth industrial revolution. Best understood as **a new level of organization and control** over the entire value chain of the **life cycle of products**, it is geared towards increasingly individualized customer requirements. (...) The basis for the fourth industrial revolution is the **availability of all relevant information** in real time by **connecting all instances** involved in the value chain. The ability to derive the optimal value-added flow at any time from the data is also vital. The connection of people, things and systems creates dynamic, self-organizing, real-time optimized value-added connections within and across companies. (...)"

# But...

# Industrial Revolutions at ThyssenKrupp: Steam hammer „Fritz“ (1861)

Power machines



1<sup>st</sup> Industrial  
Revolution



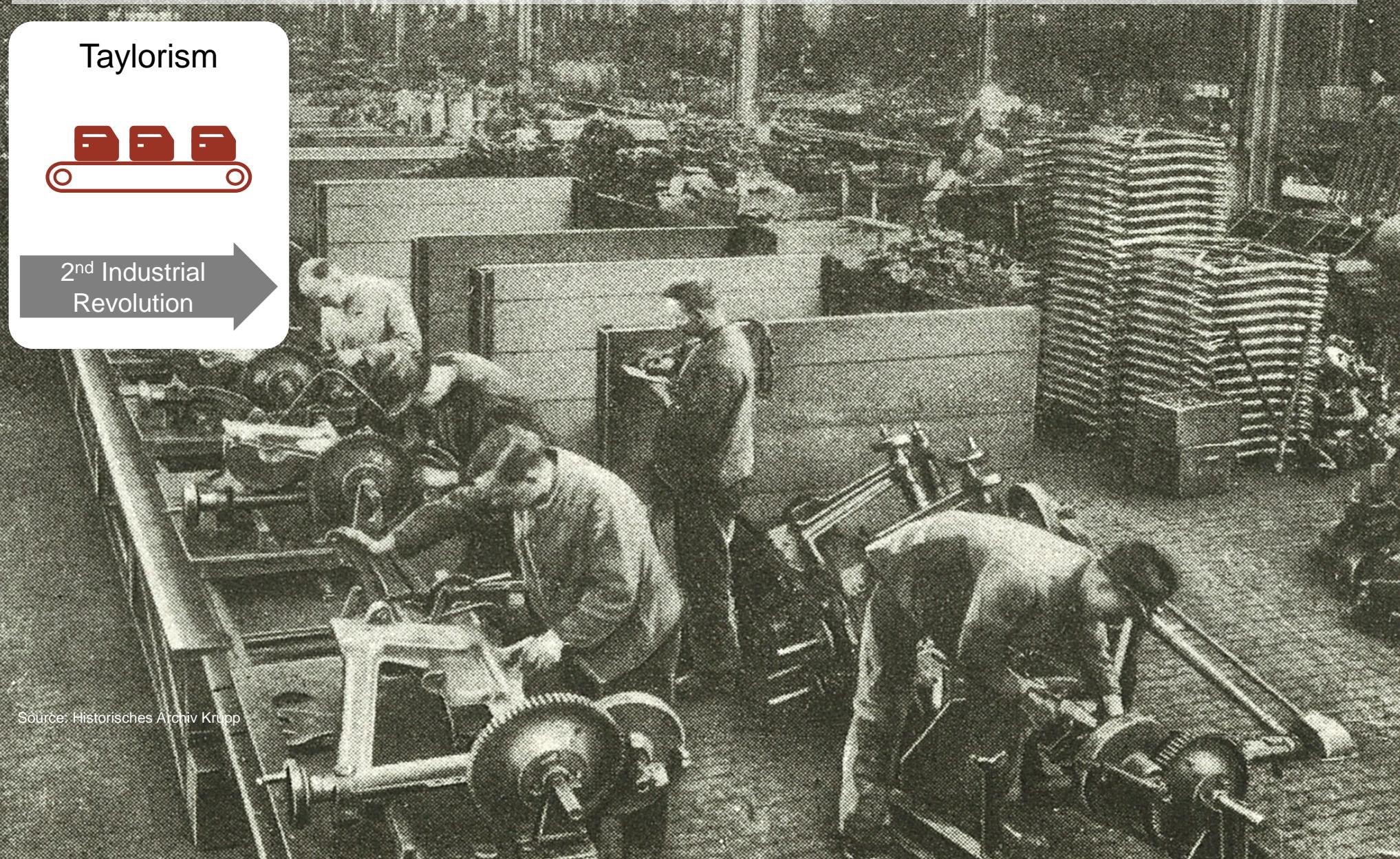
Source: Historisches Archiv Krupp

# Industrial Revolutions at ThyssenKrupp: Grass mower assembly in the agricultural machinery plant (1930s)

Taylorism



2<sup>nd</sup> Industrial  
Revolution



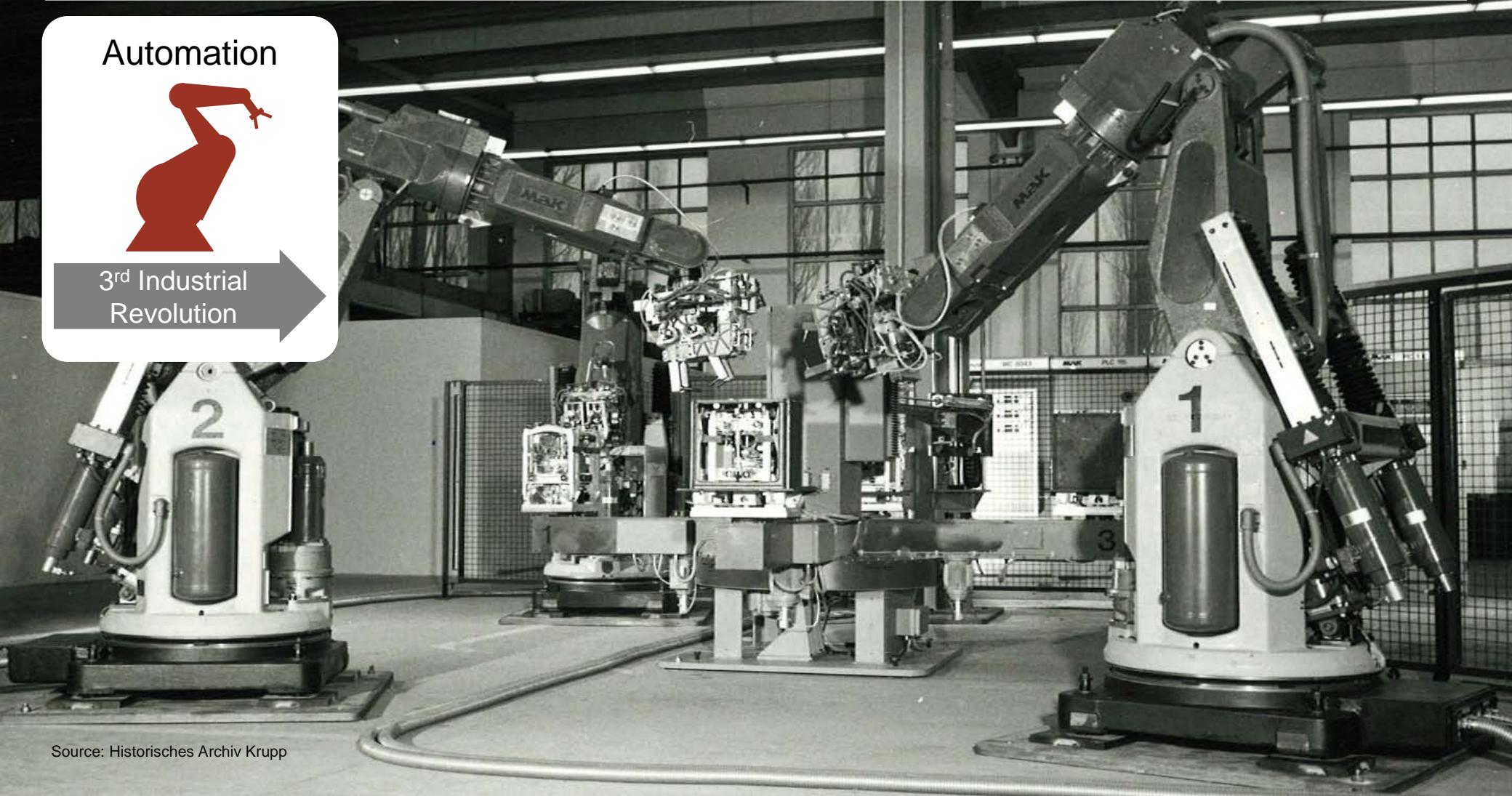
Source: Historisches Archiv Krupp

# Industrial Revolutions at ThyssenKrupp: Automated production line with three „MaK“ industrial robots (1989)

Automation



3<sup>rd</sup> Industrial  
Revolution



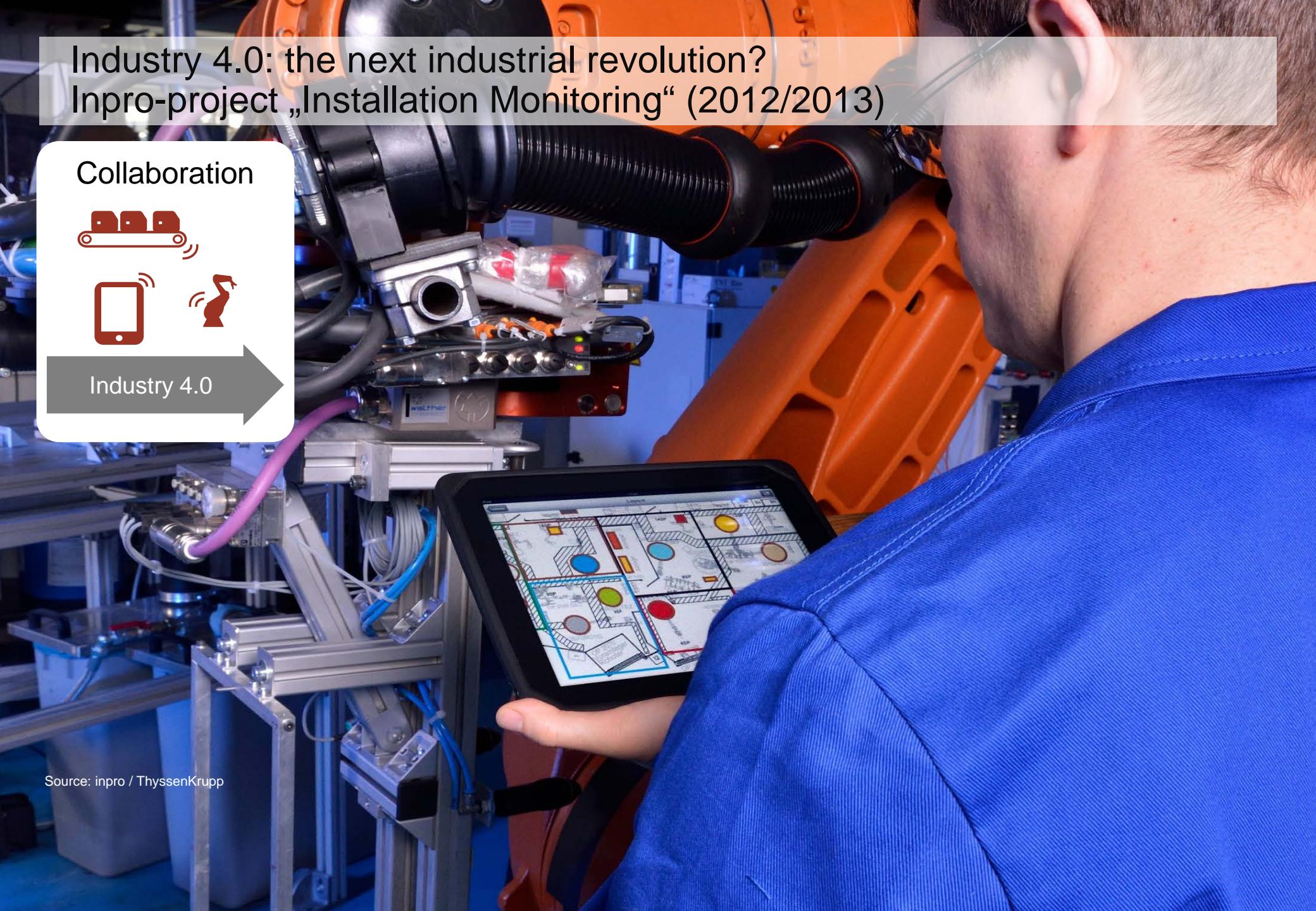
Source: Historisches Archiv Krupp

# Industry 4.0: the next industrial revolution? Inpro-project „Installation Monitoring“ (2012/2013)

Collaboration



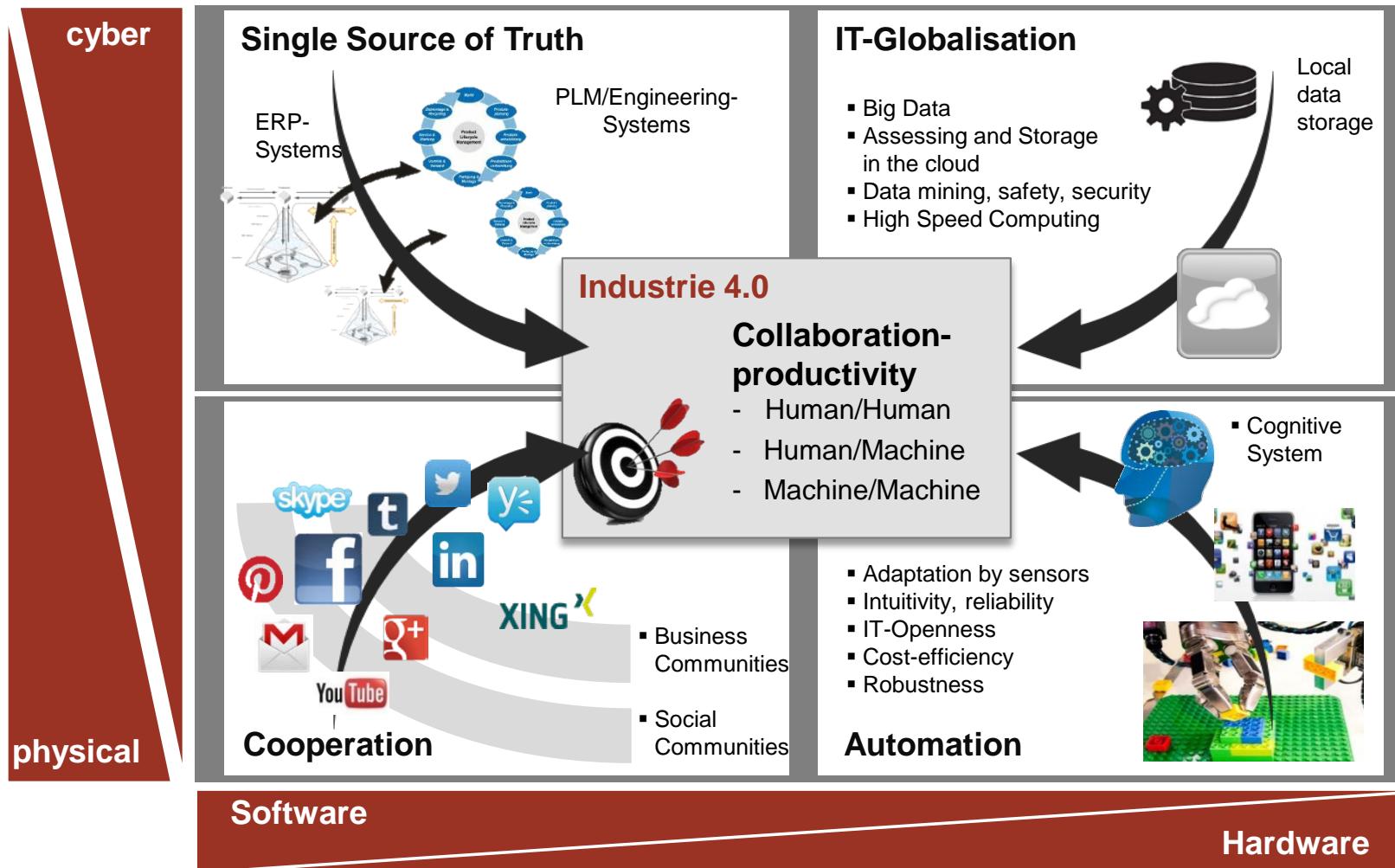
Industry 4.0



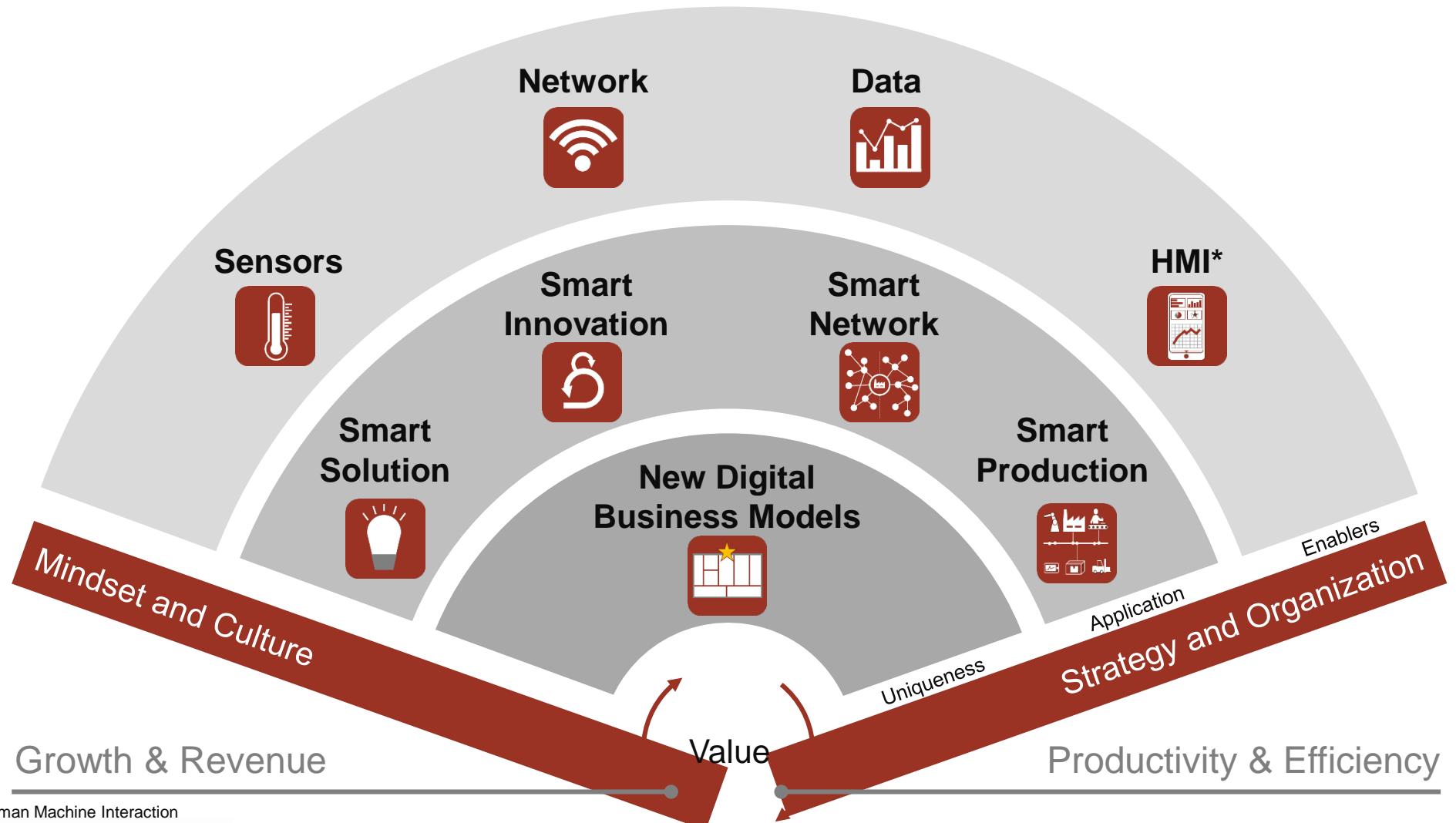
Source: inpro / ThyssenKrupp

# **Revolutions have never been predicted in advance!**

# Drivers of the 4<sup>th</sup> industrial revolution

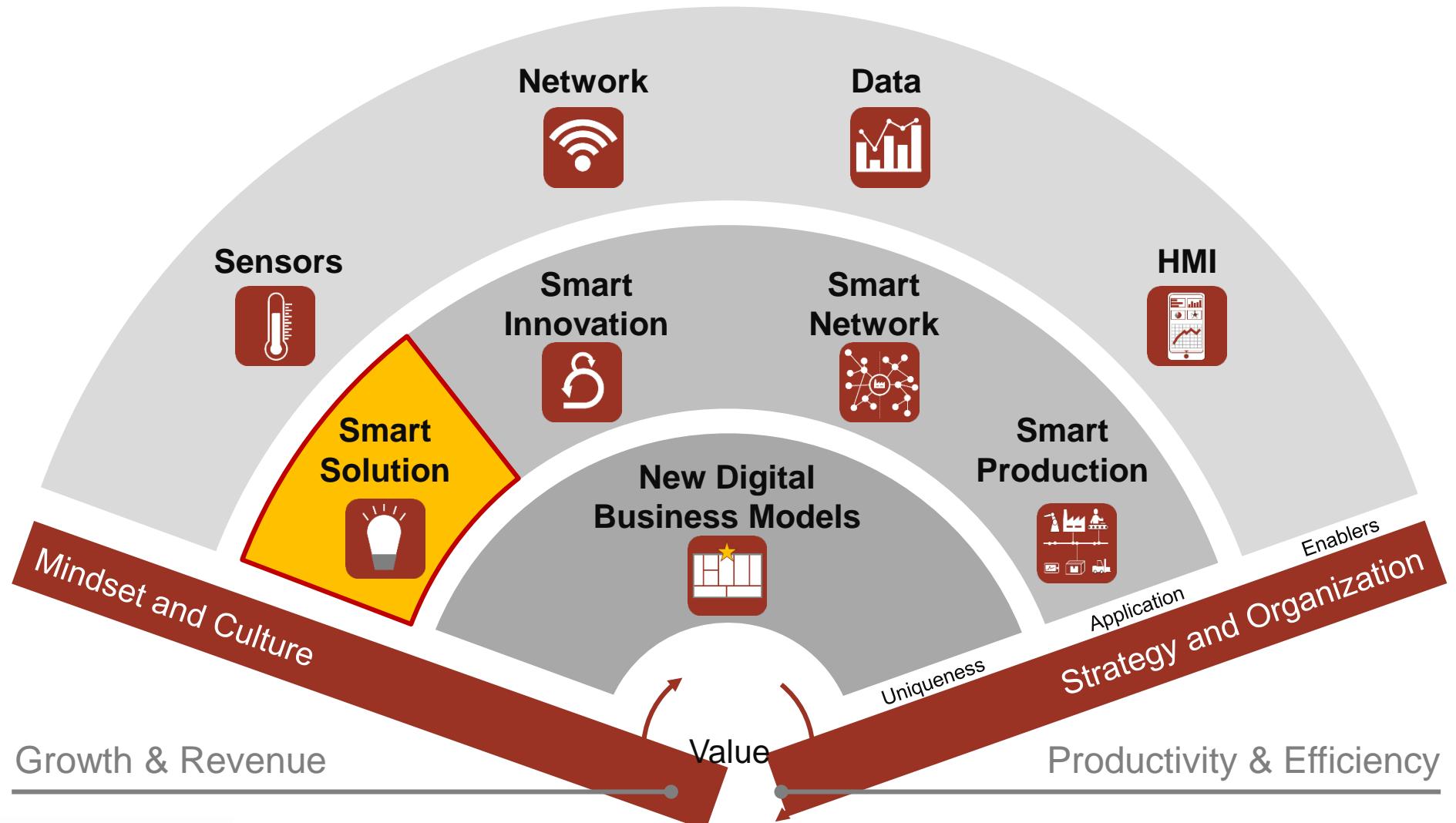


# Smart i4.0 Navigator



\*Human Machine Interaction

# Smart i4.0 Navigator



# Smart Solution: Smart Product

## Sense Condition



»Individualized Treatment based on Client Data«



## Connect Network



## Visualize & Adopt



## Analyze & Predict

Source: <http://www.kwipped.com/rentals/medical/infusion-pumps/250>

Connected and aware infusion pumps foster safety, security and on-time personal assistance along with cost reduction for logistics. Market growth of >30% per year expected.

# Smart Solution: Smart Service

## Sense Condition



»Further services based on customer behavior«



## Visualize & Adopt



## Connect Network

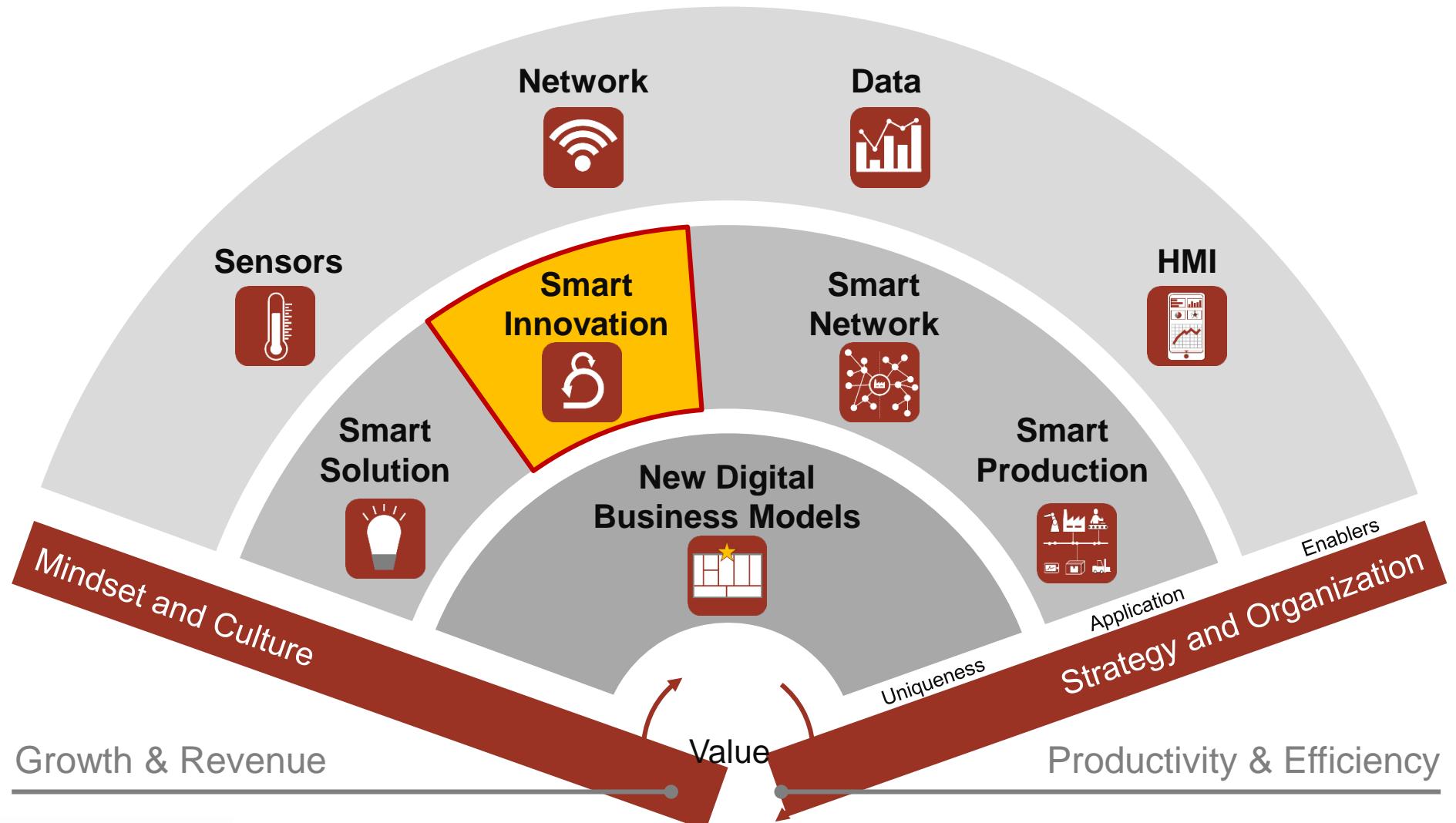


## Analyze & Predict

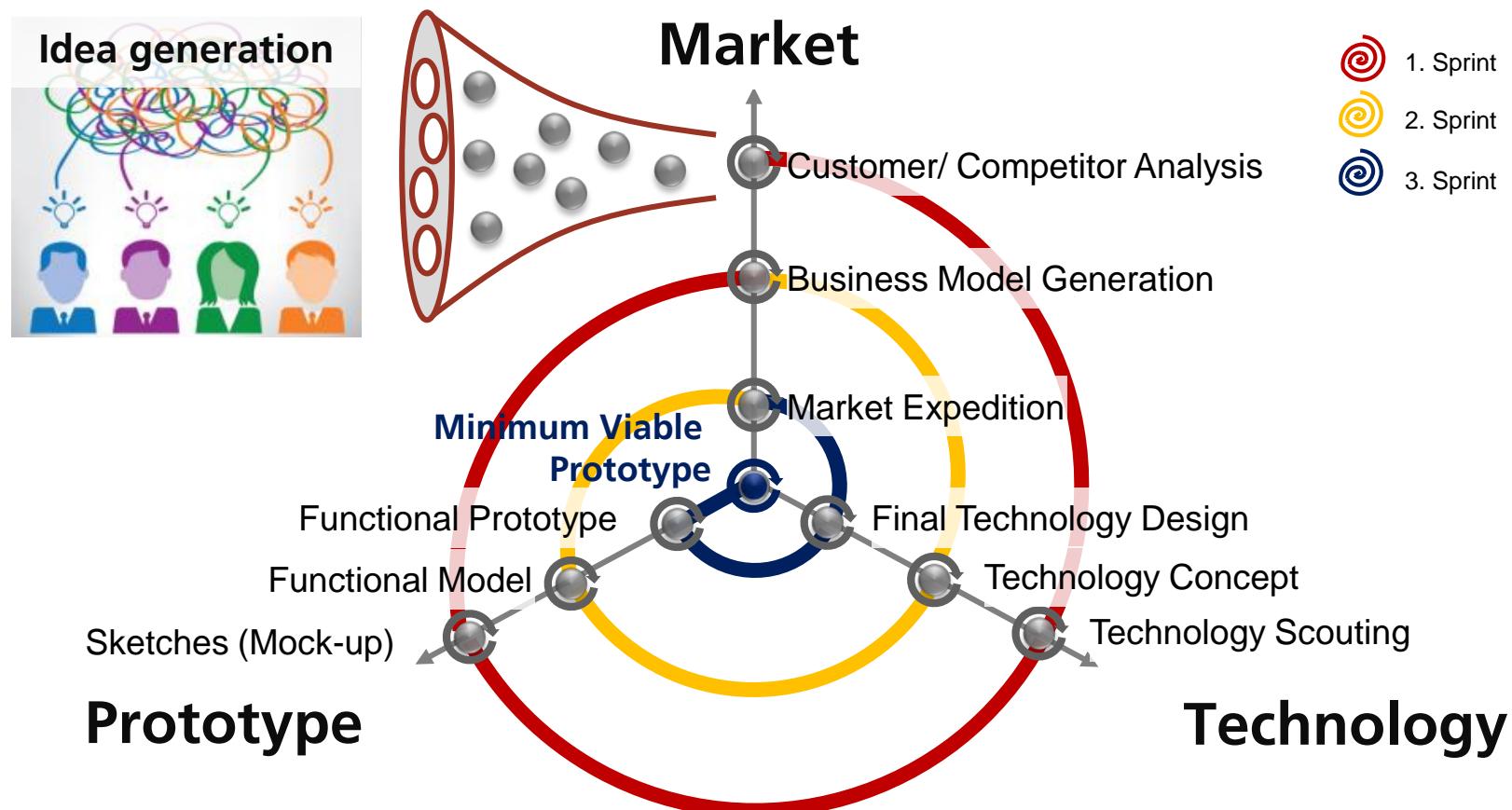
Source: [http://www.cisco.com/c/dam/en\\_us/about/ac79/docs/ps/motm/Connected-Public-Lighting\\_Philips\\_Cisco.pdf](http://www.cisco.com/c/dam/en_us/about/ac79/docs/ps/motm/Connected-Public-Lighting_Philips_Cisco.pdf)

Lightening OEM opens up new revenue stream by offering extended services to local authority by adapting light intensity to regulate traffic flow based on traffic and weather conditions.

# Smart i4.0 Navigator

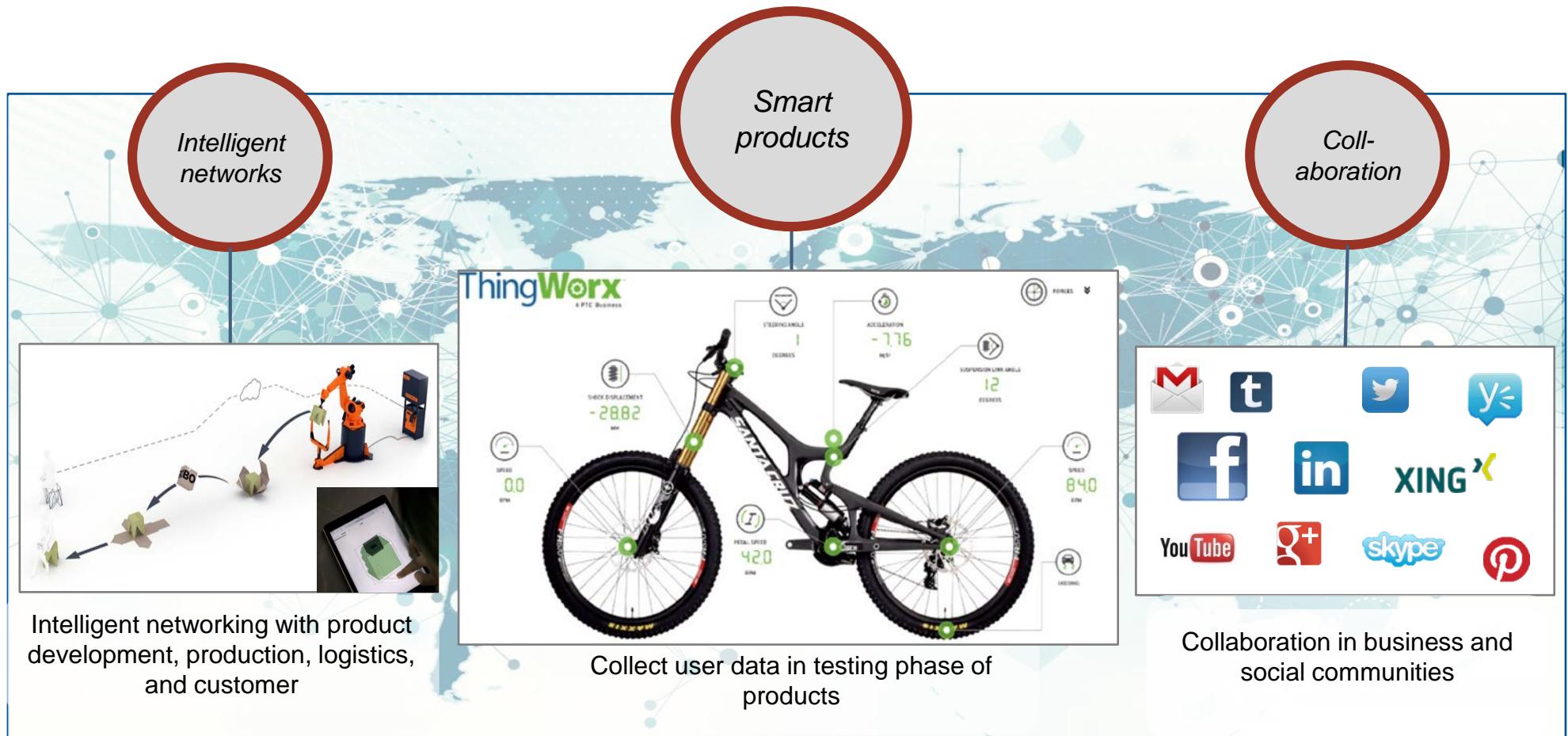


# Smart Innovation: Accelerate with Agility



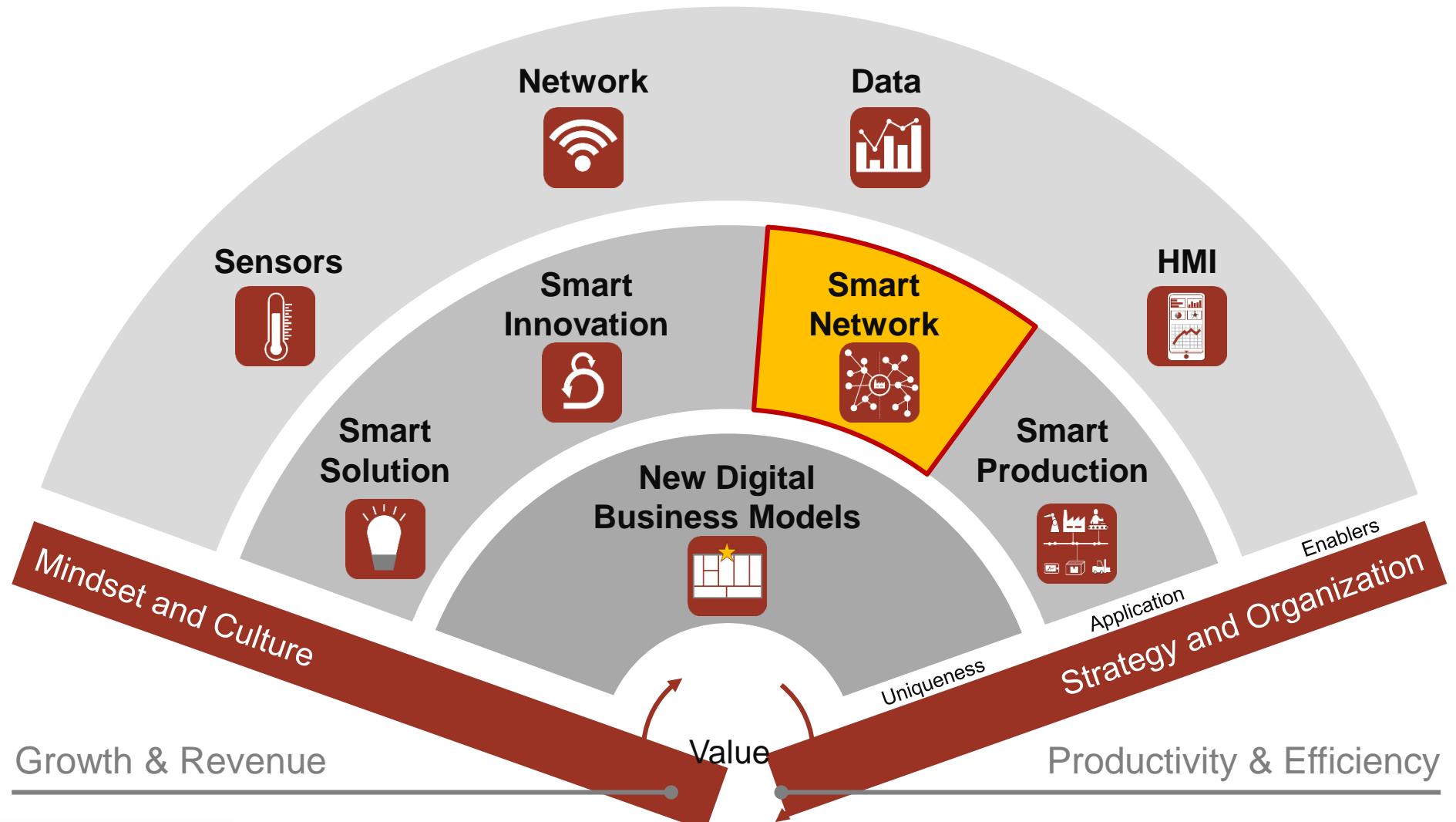
Leverage radical/ disruptive innovations by early user experience in fuzzy front end and agile development teams. Improve development time -50% and costs -30% as well as flexibility.

# Smart Innovation: Data driven Engineering



Create user data driven products and technologies with open innovation using disruptive networks. Improve customer individualization and explore the unexpected.

# Smart i4.0 Navigator



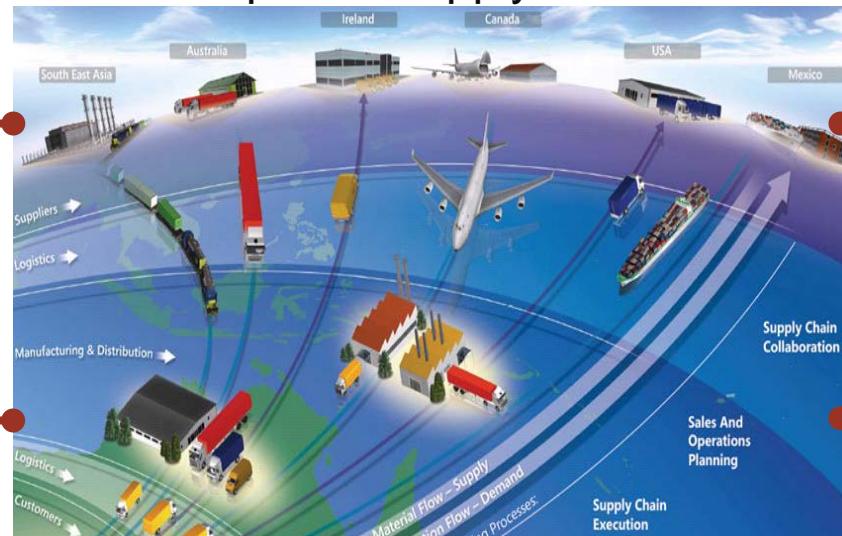


# Smart Networks: Transparent Logistics

## Sense Condition



»Allocation of transport operations  
to free capacity based on  
transparent supply chains«



## Connect Network



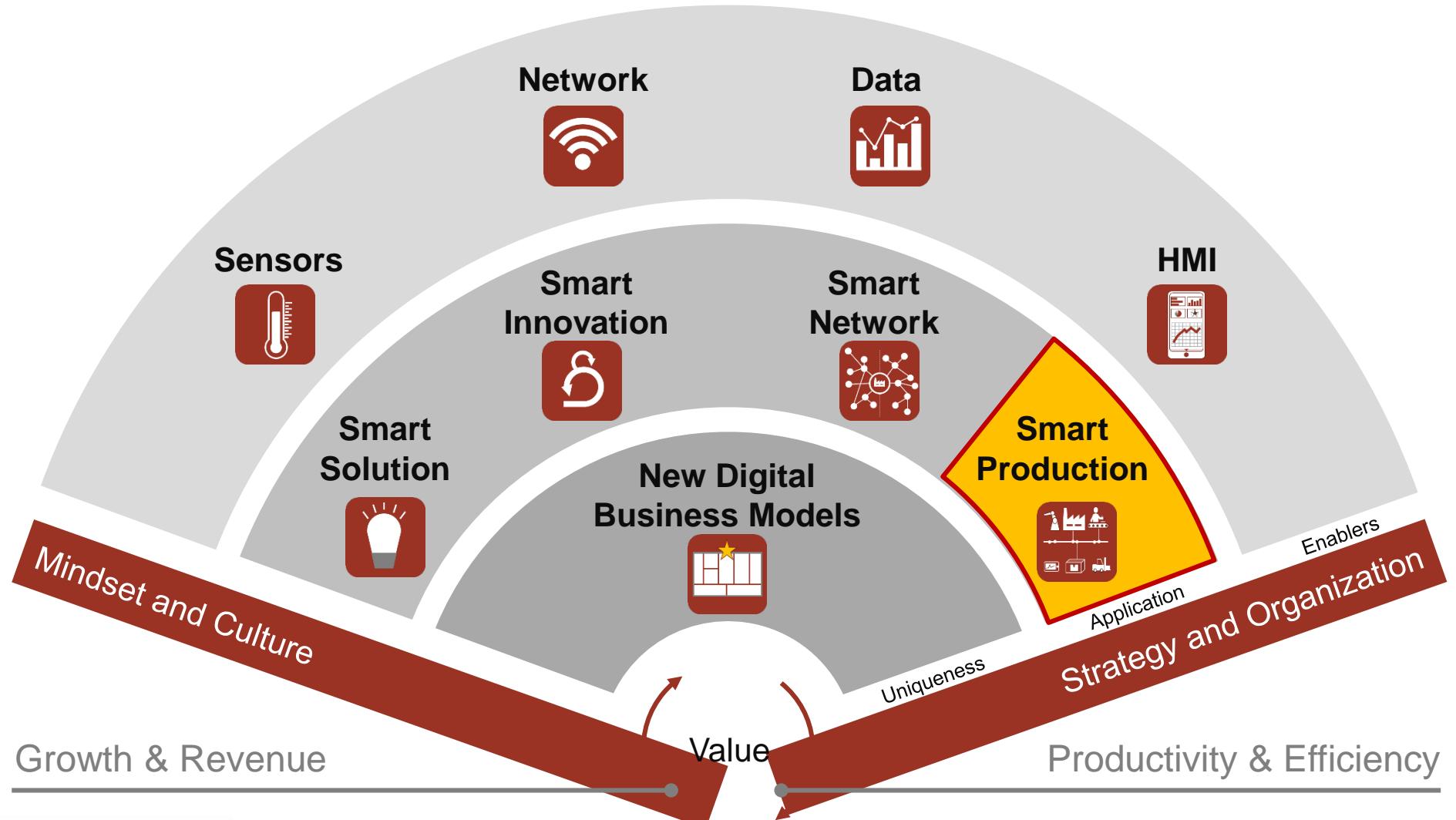
## Visualize & Adopt

## Analyze & Predict

Source: [http://www.cisco.com/c/dam/en\\_us/about/ac79/docs/ps/motm/Connected-Public-Lighting\\_Philips\\_Cisco.pdf](http://www.cisco.com/c/dam/en_us/about/ac79/docs/ps/motm/Connected-Public-Lighting_Philips_Cisco.pdf)

All supply chain participants and third party logistics offer their capacities transparently.  
Transportation can be allocated to free capacities based on transparent data.

# Smart i4.0 Navigator





# Smart Production: Operational Excellence

**Sense  
Condition**



*»Real time lean production  
for injection molding«*



**Connect  
Network**



**Visualize  
& Adopt**

**Analyze  
& Predict**

Source: [http://www.industrieanzeiger.de/image/image\\_gallery?img\\_id=37373606](http://www.industrieanzeiger.de/image/image_gallery?img_id=37373606)

Production technologies are equipped with sensors, real time production performance KPI can be analyzed. Real time lean production steering and planning possible. Return on Invest < 1 year.

# Smart Production: Operational Excellence

**Sense  
Condition**



»Operational Excellence  
in Logistics«



**Connect  
Network**



**Visualize  
& Adopt**



**Analyze  
& Predict**

Source: [http://www.industrieanzeiger.de/image/image\\_gallery?img\\_id=37373606](http://www.industrieanzeiger.de/image/image_gallery?img_id=37373606)

Up to 80% cost improvement due to reduced warehouse capacity (inventory) and simple logistics. Return on Invest < 1 year.

# Smart Production: Dezentralized Production

## Sense Condition



»Automated real-time configuration of machine control«



## Connect Network



## Visualize & Adopt

## Analyze & Predict

Source

Based on analysis of the production variables of machines patterns for rapid configuration of the machines can be derived. ROI <2 year.



# Smart Production: Dezentralized Production

## Sense Condition



»Forecast quality issues  
and prevent downtimes«



## Connect Network

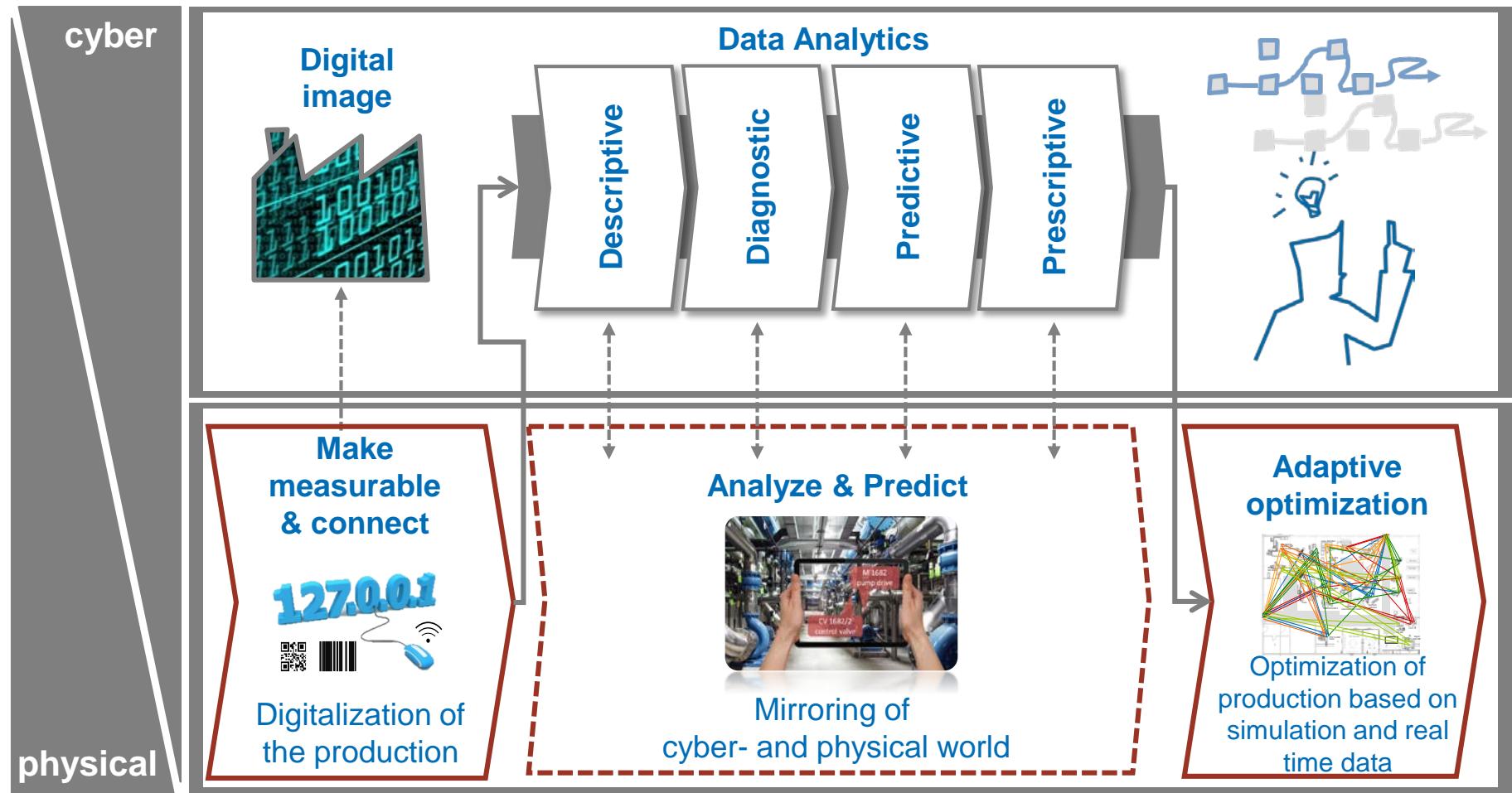


## Visualize & Adopt

## Analyze & Predict

Production performance and FMEA can be done with real time data measurement. This will enable a better forecast ability for production performance and failure prevention.

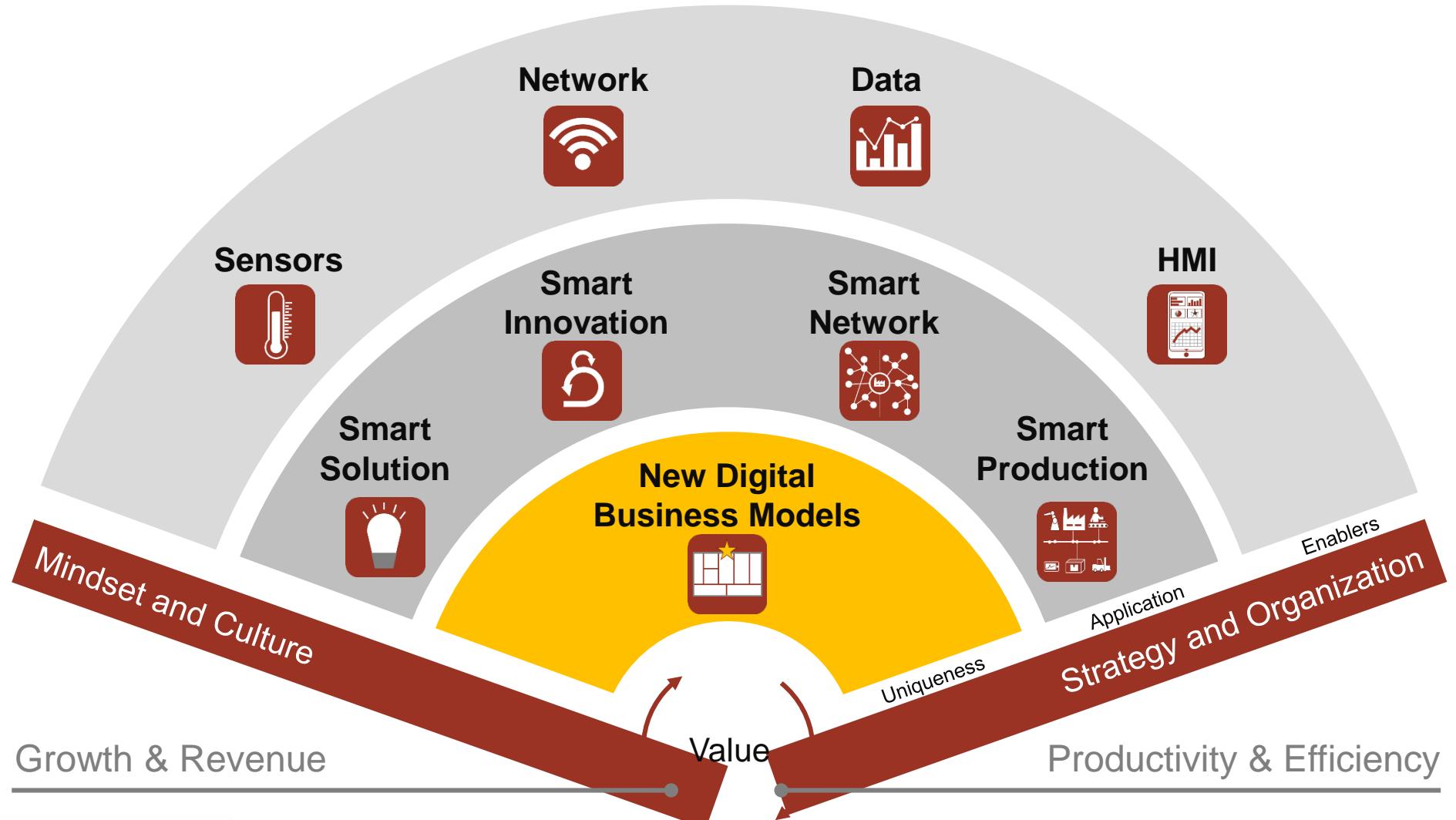
# Three main steps to a digital production



Aim of building up a Industry 4.0 infrastructure is to gain better knowledge of the production

# Smart i4.0 Navigator

## Management Perspective



# Smart Solution: Smart Service

## Sense Condition



»Predictive maintenance and advanced services«



## Connect Network



## Visualize & Adopt

## Analyze & Predict

Source: [http://www.cisco.com/c/dam/en\\_us/about/ac79/docs/ps/motm/Connected-Public-Lighting\\_Philips\\_Cisco.pdf](http://www.cisco.com/c/dam/en_us/about/ac79/docs/ps/motm/Connected-Public-Lighting_Philips_Cisco.pdf)

Jet engine manufacturer globally equip their turbo machines with sensors and analyze the usage data in order to realizes repair and maintenance services in advance.

# On demand delivery of plates



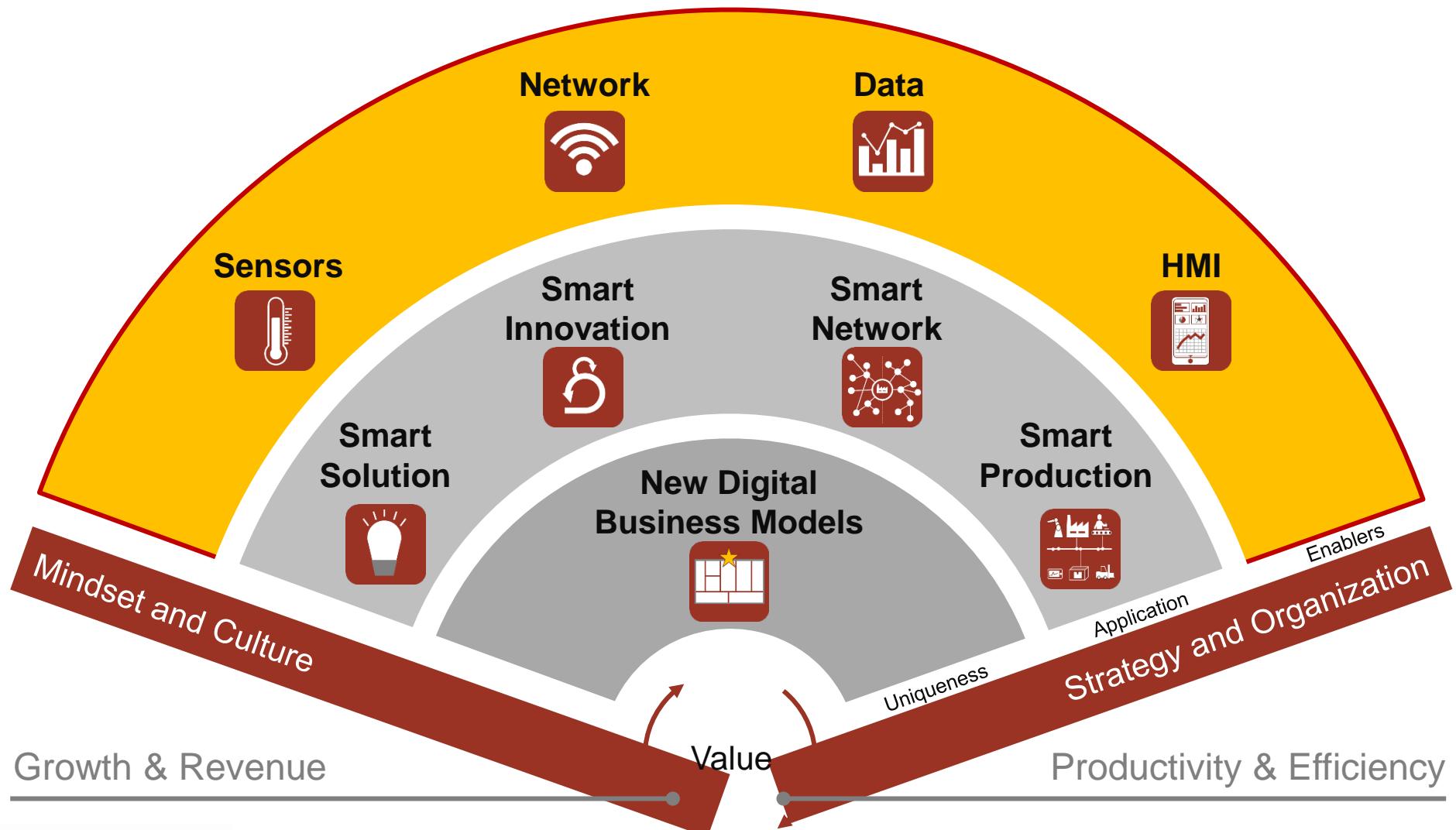
**02 - NUR EIN KNOPFDRUCK**  
für neue Klingen

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Registriere Dein Gerät zunächst mit Lieferanschrift im Shop von Perfect Shave. Drücke den Order-Button, bis der blaue Ring um den Knopf anfängt langsam zu blinken. Der Knopf muss ca. drei Sekunden gedrückt werden.

# Smart i4.0 Navigator

## Management Perspective

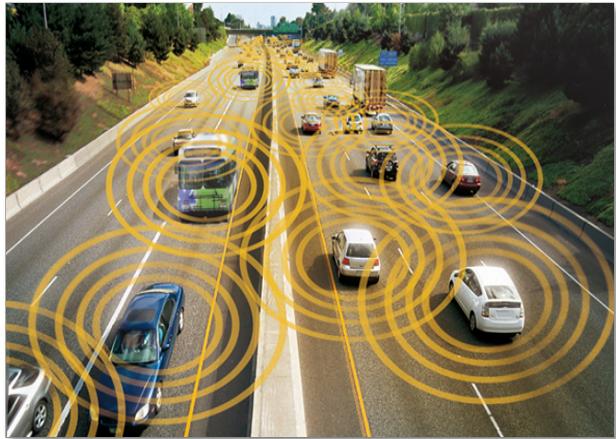


## Sensors ...

- ... become **smaller**
- ... become **cheaper**
- ... become **more versatile**
- ... can **measure more data**
- ... can **interact with each other**



Source: engineersgarage, hyperscan (2014)

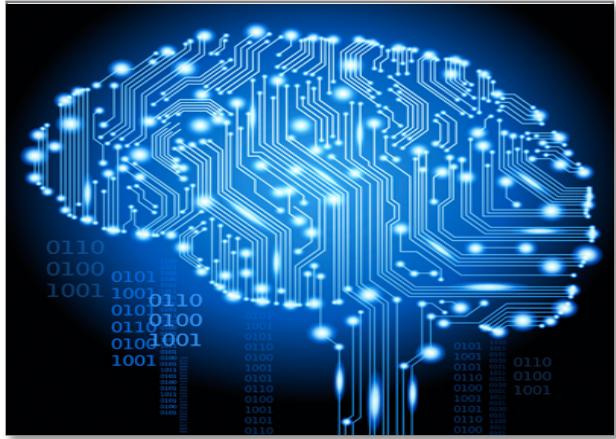


- **Ad-hoc networks:**  
Automated recognition, utilization,  
build-up and re-group of networks
- Significant increased **data transfer rates**
- Increasing **number of network partners**
- Increasing **robustness** of wireless networks
- **Low energy** applications (bluetooth)
- Resources are **on demand** available (cloud)

Source: wired (2012)

## From Big Data to Smart Data

- Linked data from heterogeneous sources
- Descriptive analytics (generation of information)
- Diagnostic analytics (pattern recognition)
- Predictive analytics (prognosis)
- Prescriptive analytics (decision-making)
- Semantic analysis



Source: traffic technologytoday (2010)

# HMI: Collaborative Robotics



Source: Hannover Exhibition

# HMI: Virtual Reality

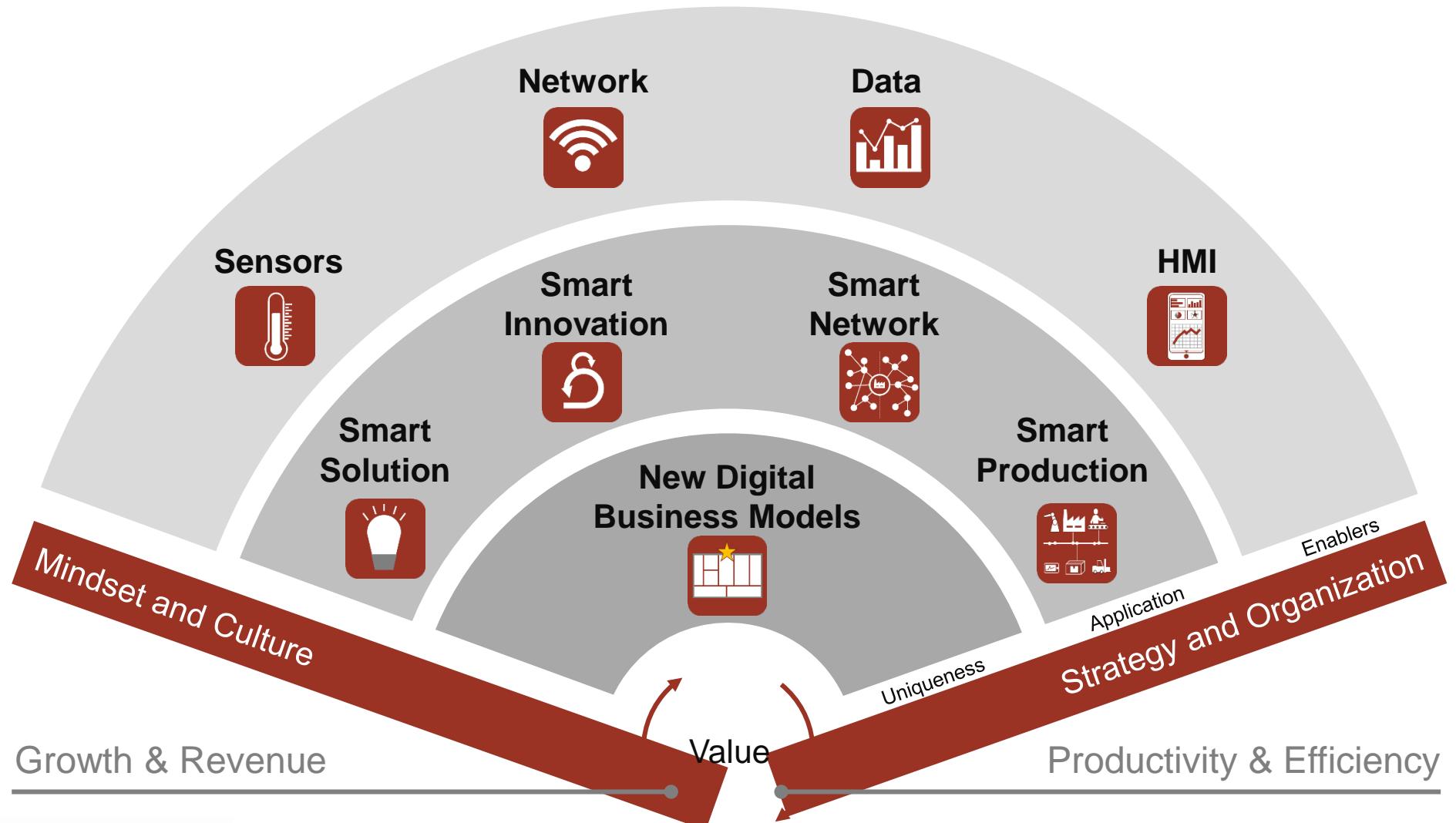


# HMI: Augmented Reality

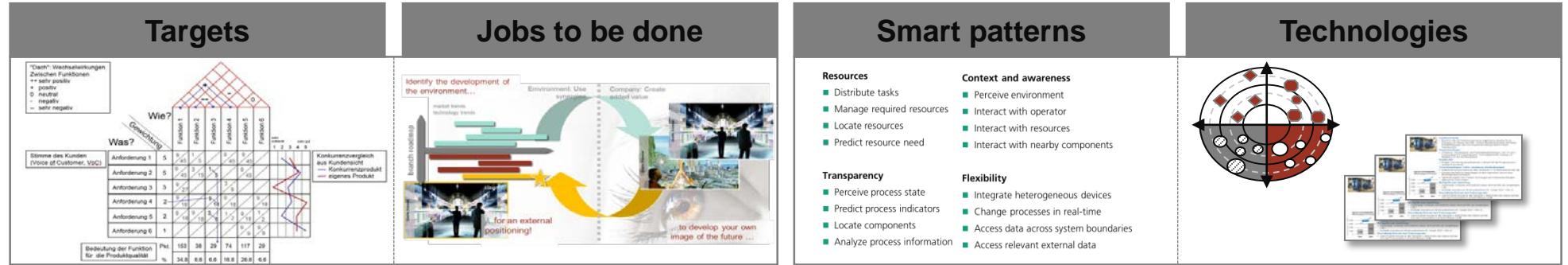


Source: iTIZZIMO

# Smart i4.0 Navigator



# What companies should do?



„Jobs to be done“

Audit situation

Identify solutions

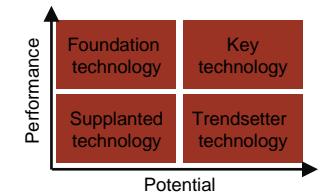
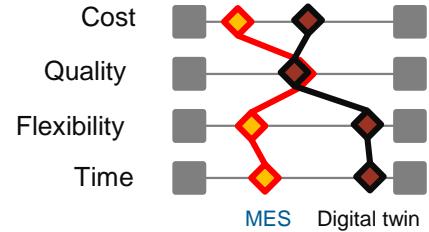
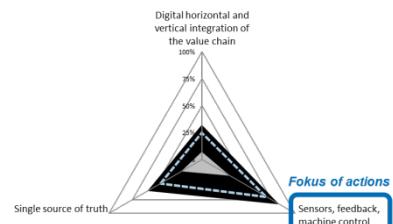
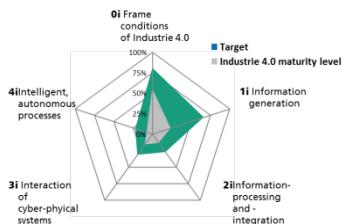
Business case

Value analysis

Fields of observation

Technology assessment

Business case



# What the government should do?

## Ongoing research activities (selection)

Federally funded projects (Avg: ~1M EUR) for developing...

- ...standards for tool management
- ...“plug-and-play” for machines
- ...self-documenting production system setups
- ...flexible autonomous material flow systems
- ...security frameworks for production systems
- ...demonstrators for prototyping and testing Industrie 4.0 solutions in a production setting
- ...business model templates for Industrie 4.0 solutions
- ...



**KARIS PRO**

SmartTool



...

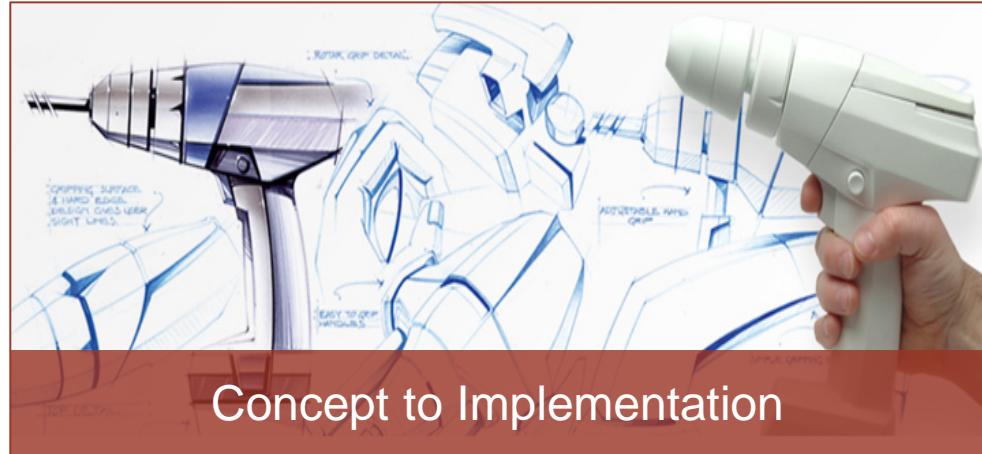
# What have these two pictures in common?



# We support to implement i4.0



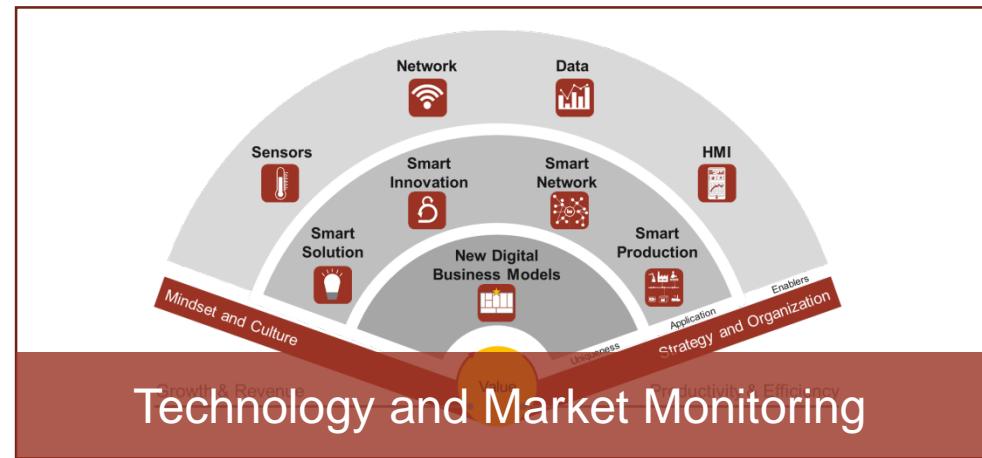
Strategy and Roadmap



Concept to Implementation



Accompany Transformation



Technology and Market Monitoring



A background image shows a man in a dark suit and light blue shirt interacting with a large, glowing blue and white circular interface. The interface has various data points, lines, and a small molecular structure, suggesting a high-tech or scientific theme.

# Feel free to contact us!



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