

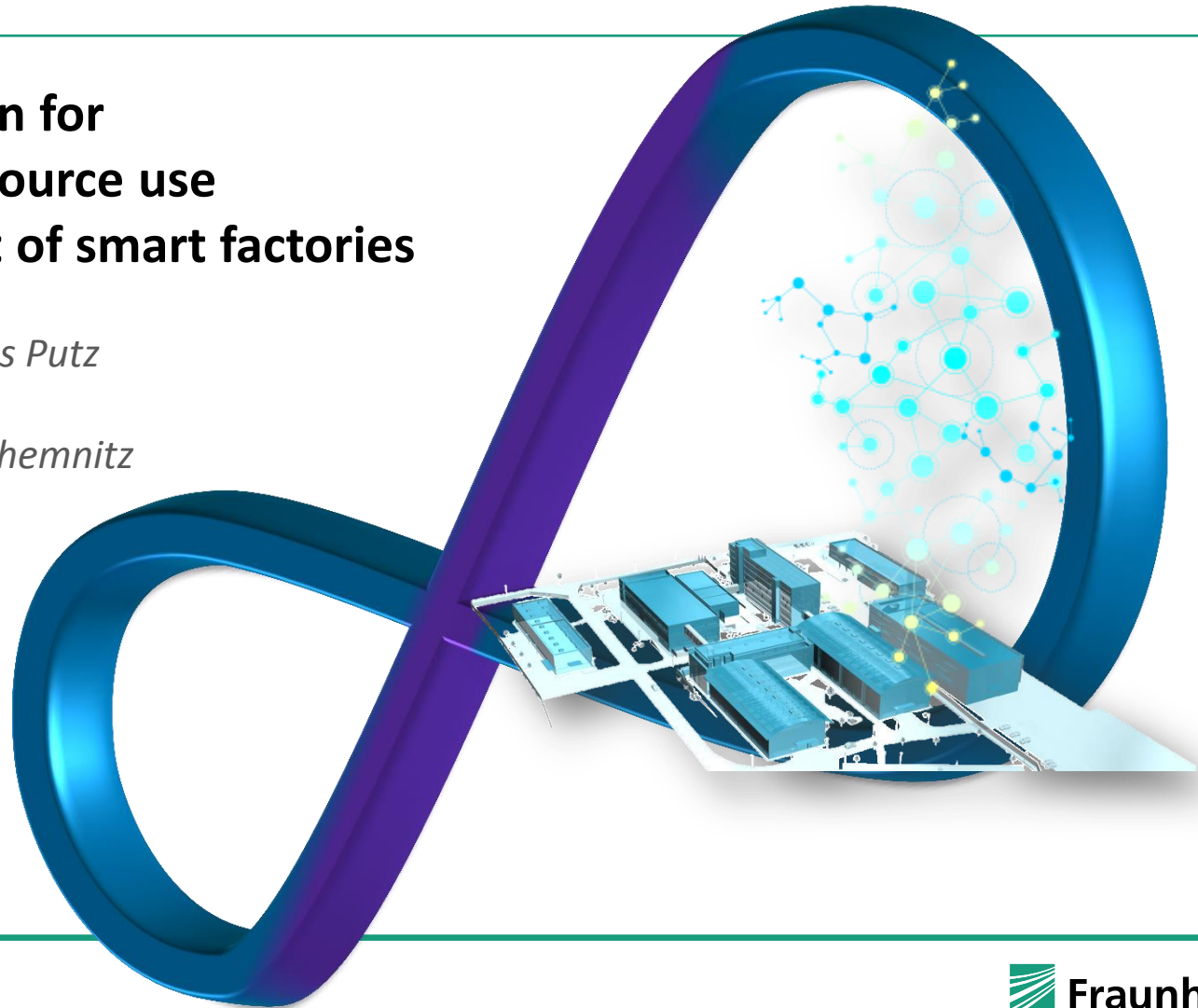
15th Global Conference on Sustainable Manufacturing 2017

RESILIENT PRODUCTION

**A precondition for
optimized resource use
in the context of smart factories**

*Professor Matthias Putz
Head of Institute
Fraunhofer IWU Chemnitz*

Haifa, 26.09.2017



Resilience

Originating

Ecology

Capacity of a system to tolerate disturbance while retaining its structure and function

Sociology

Ability to transform adversity into a growth experience



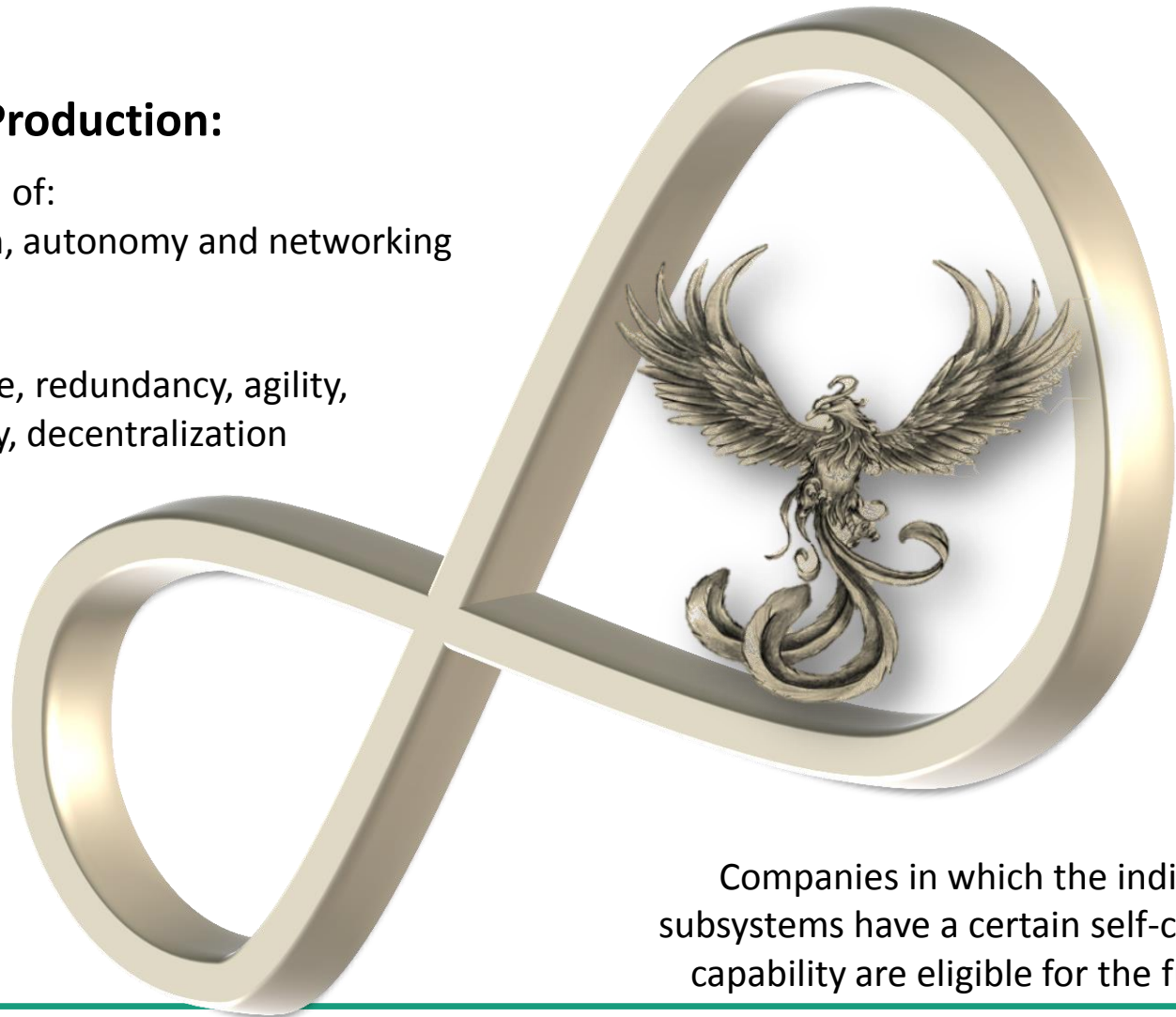
Resilience

... on complex, non-linear Systems

... such as Production:

a combination of:
differentiation, autonomy and networking

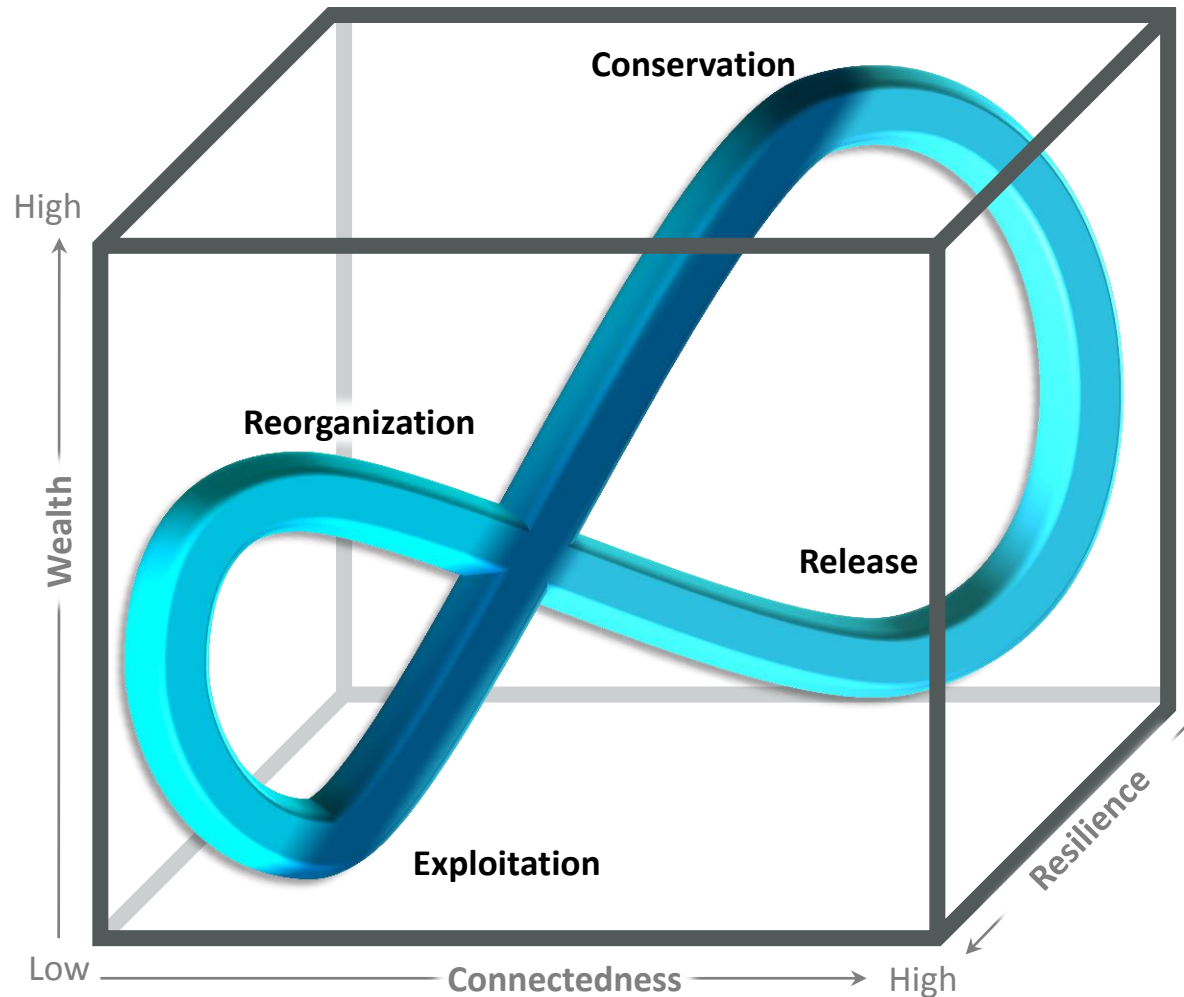
characteristic:
error tolerance, redundancy, agility,
learning ability, decentralization



Companies in which the individual
subsystems have a certain self-control
capability are eligible for the future!

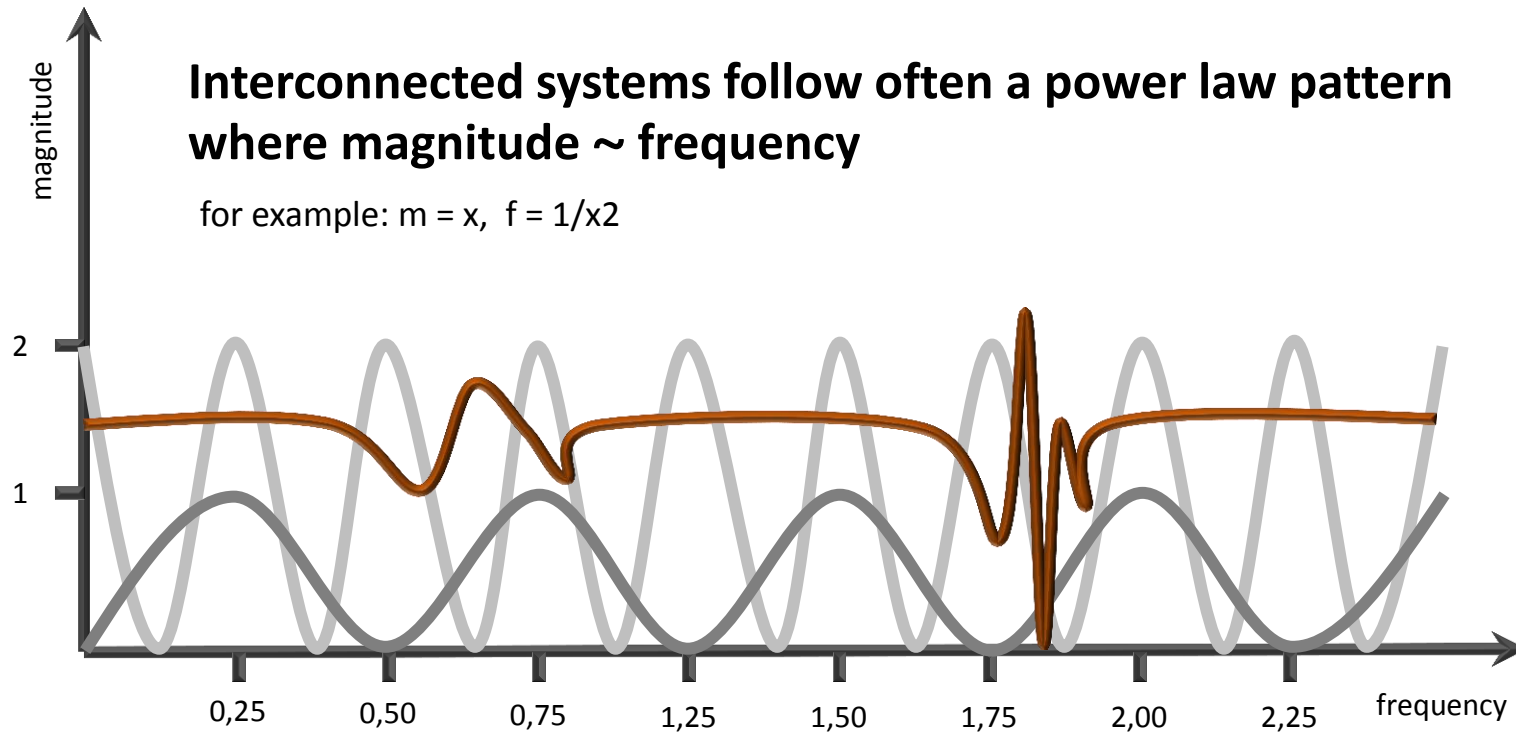
Need of Resilience on complex, non-linear Systems

Perpetually evolve through an “adaptive cycle” of growth, crisis, transformation and renewal



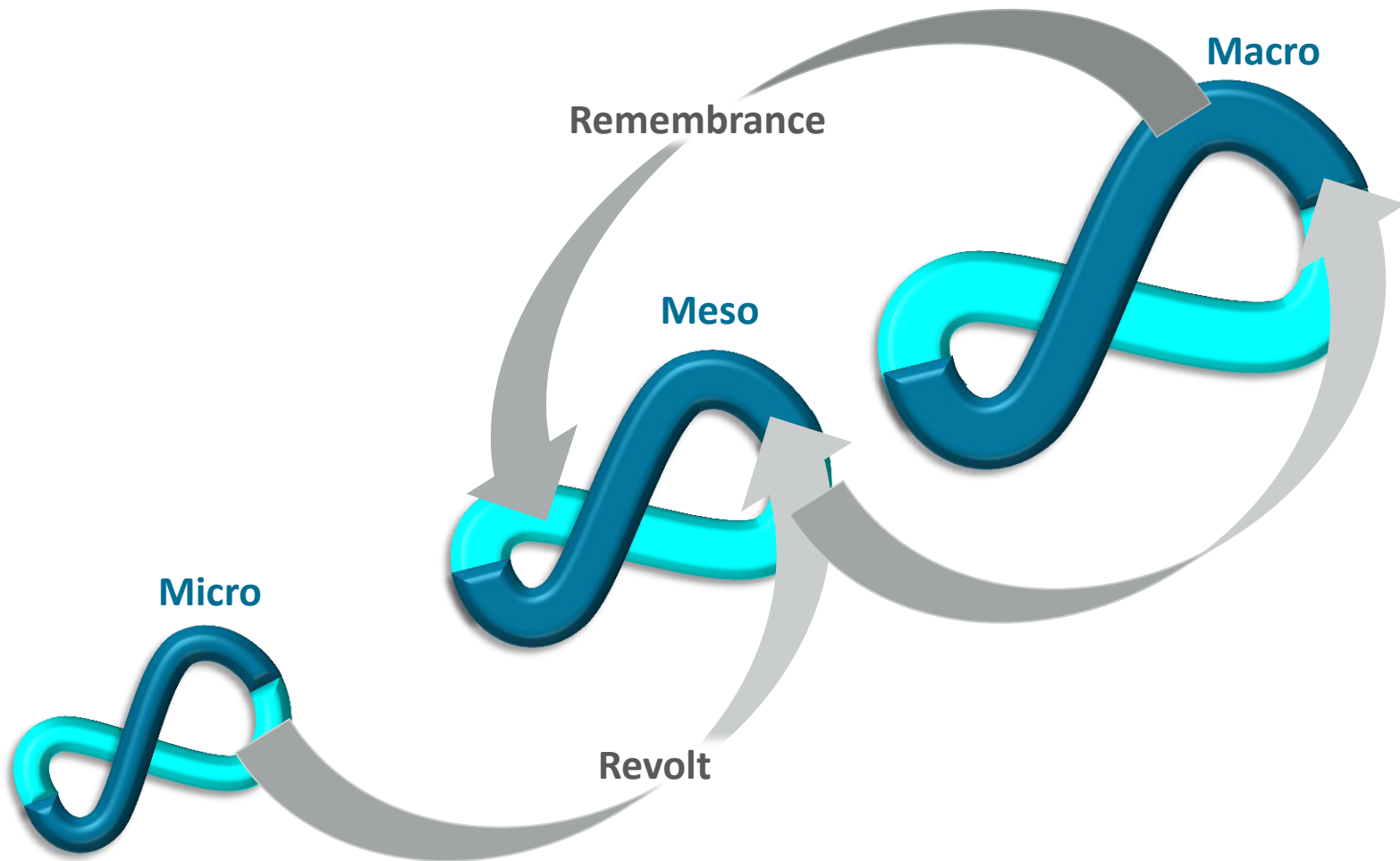
Need of Resilience on complex, non-linear Systems

Power law pattern of event-magnitude and -frequency



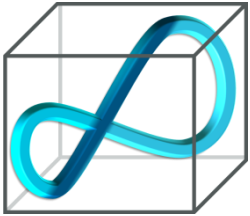
Need of Resilience on complex, non-linear Systems

Mutual dependency → cascading failures such as complex supply network



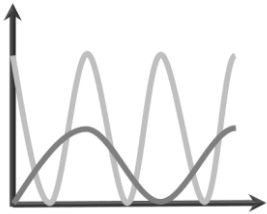
Need of Resilience on complex, non-linear Systems

Summary characteristic



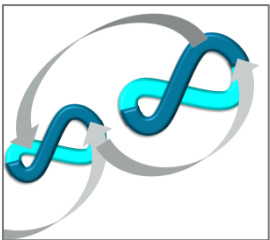
Adaptive cycle

“Creative destruction” provides opportunities for innovation – new scientific discoveries, new relationships and new business processes
→ Need: more resilient state for re-enters in the growth phase



Power law pattern

Prediction of occurrences are difficult → Need: improve enterprise resilience by anticipating change scenarios and finding creative ways to take advantages of system dynamic rather than merely reacting to disturbances

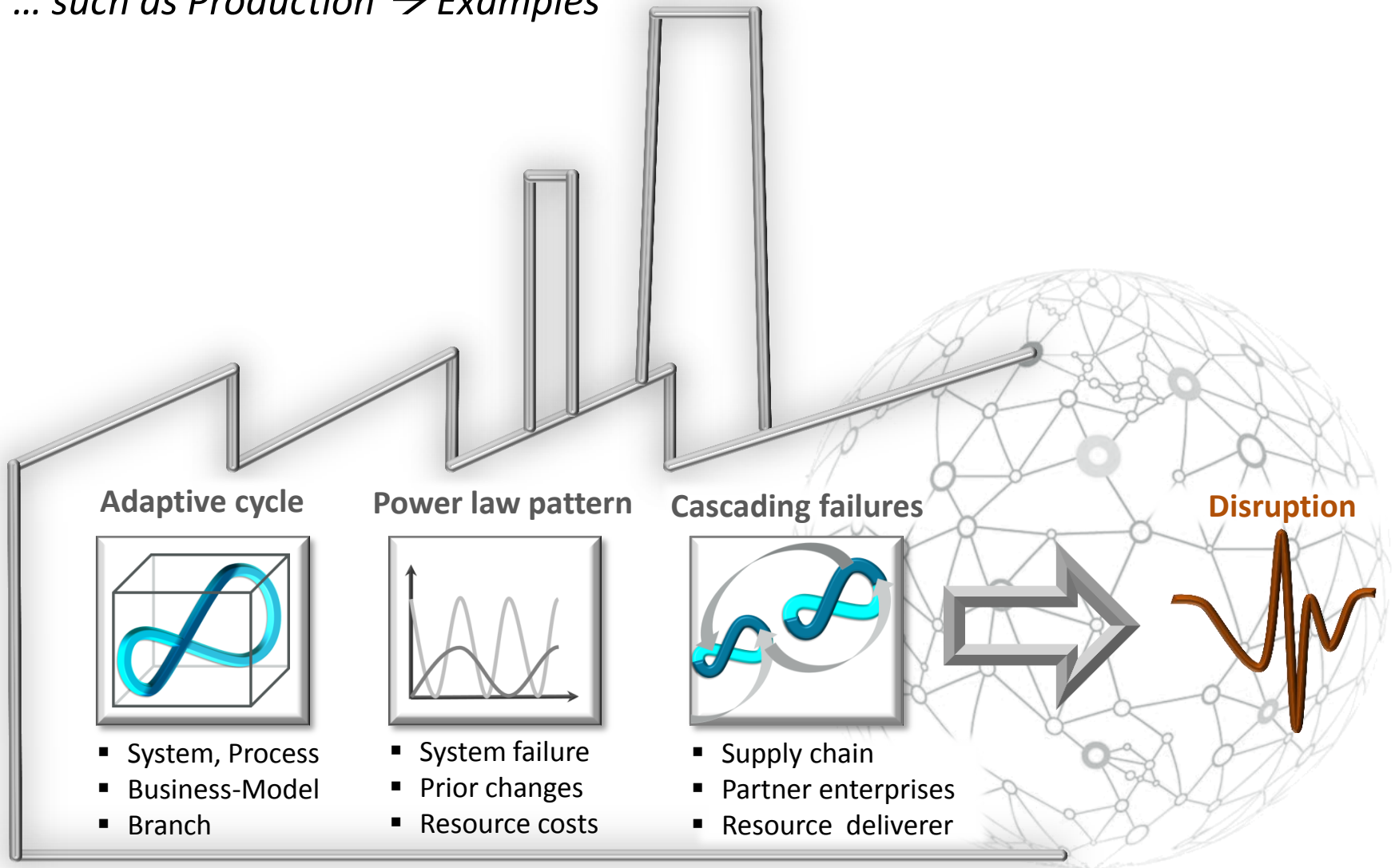


Cascading failures

Highly connected industrial systems such as a complex supply network, small disturbances can occasionally cascade into massive discontinuities that have lasting impacts on the business
→ networked systems are particularly unstable → Need of resilience ↑

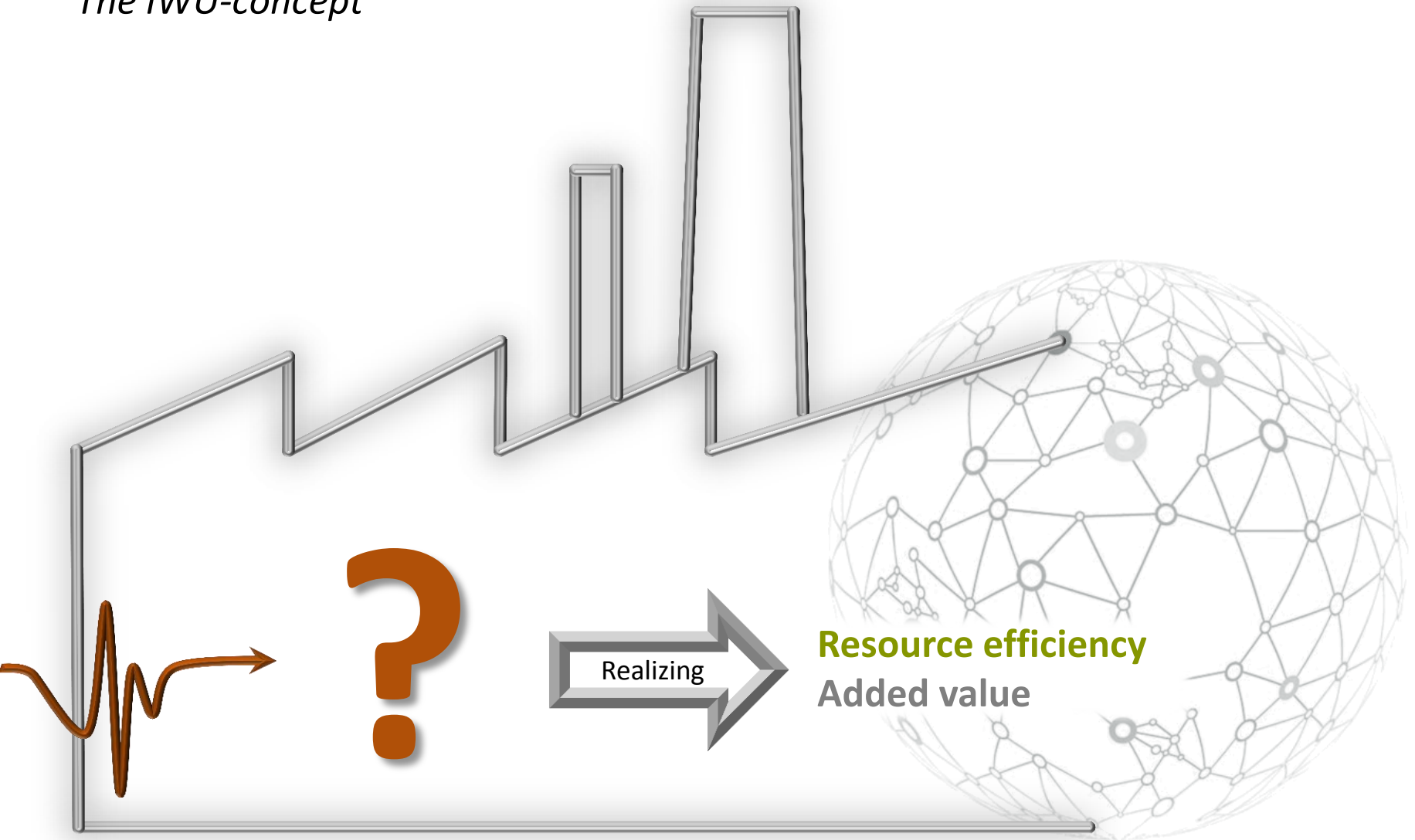
Need of Resilience on complex, non-linear Systems

... such as Production → Examples



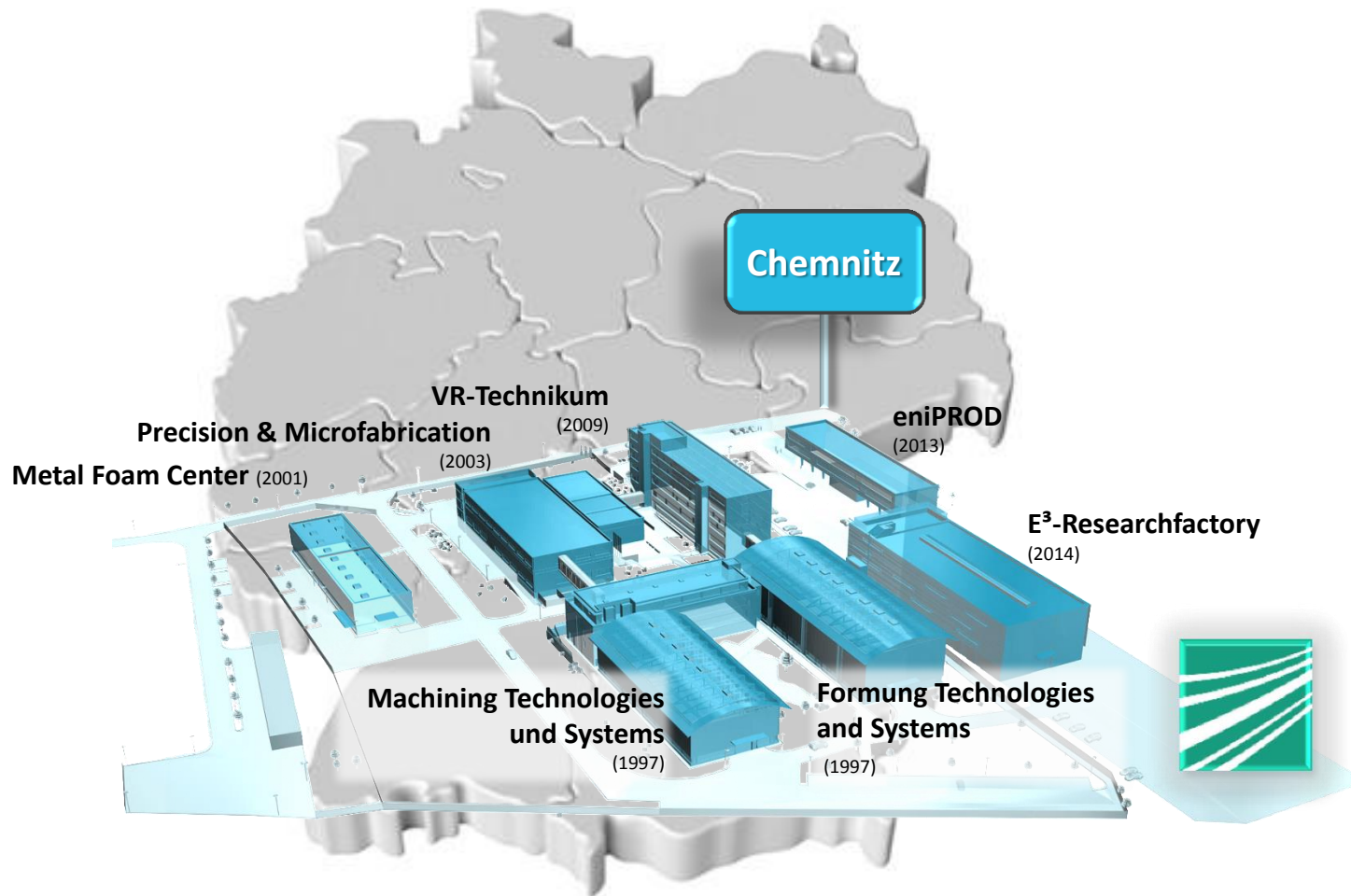
Resilient Production

The IWU-concept



Resiliente Production

Made@FraunhoferIWU → Overview infrastructure



Resiliente Production

Made@FraunhoferIWU → Overview research areas



Prof. Dr.-Ing. Welf-Guntram Drossel Mechatronics and Lightweight Structures

Mechatronics

- Adaptronik
- Medical Engineering
- Project House smart³
- Technical Acoustic

Functional Integration /Lightweight

- Functionally Integrated Lightweight Construction
- Additive Processes

Textile Lightweight Design

- Systems and Technologies for Textile Structures
- Applied Plastics Technologies

Cyber-Physical Production Systems



Prof. Dr.-Ing. Dirk Landgrebe Forming Technology and Joining

Sheet Metal Forming

- Sheet Metal Processing and Basics
- Active Media Forming and Die Concepts

Bulk Metal Forming

- Hot Bulk Metal Forming
- Cold and Precision Forming

Joining

- Thermal Joining
- Mechanical Joining



Prof. Dr.-Ing. Matthias Putz Machine Tools, Production Systems and Machining

Production Systems and Machines

- Machine Tools
- Car Body Construction and Assembly
- Robotics

Smart Factory Digitization & Automation

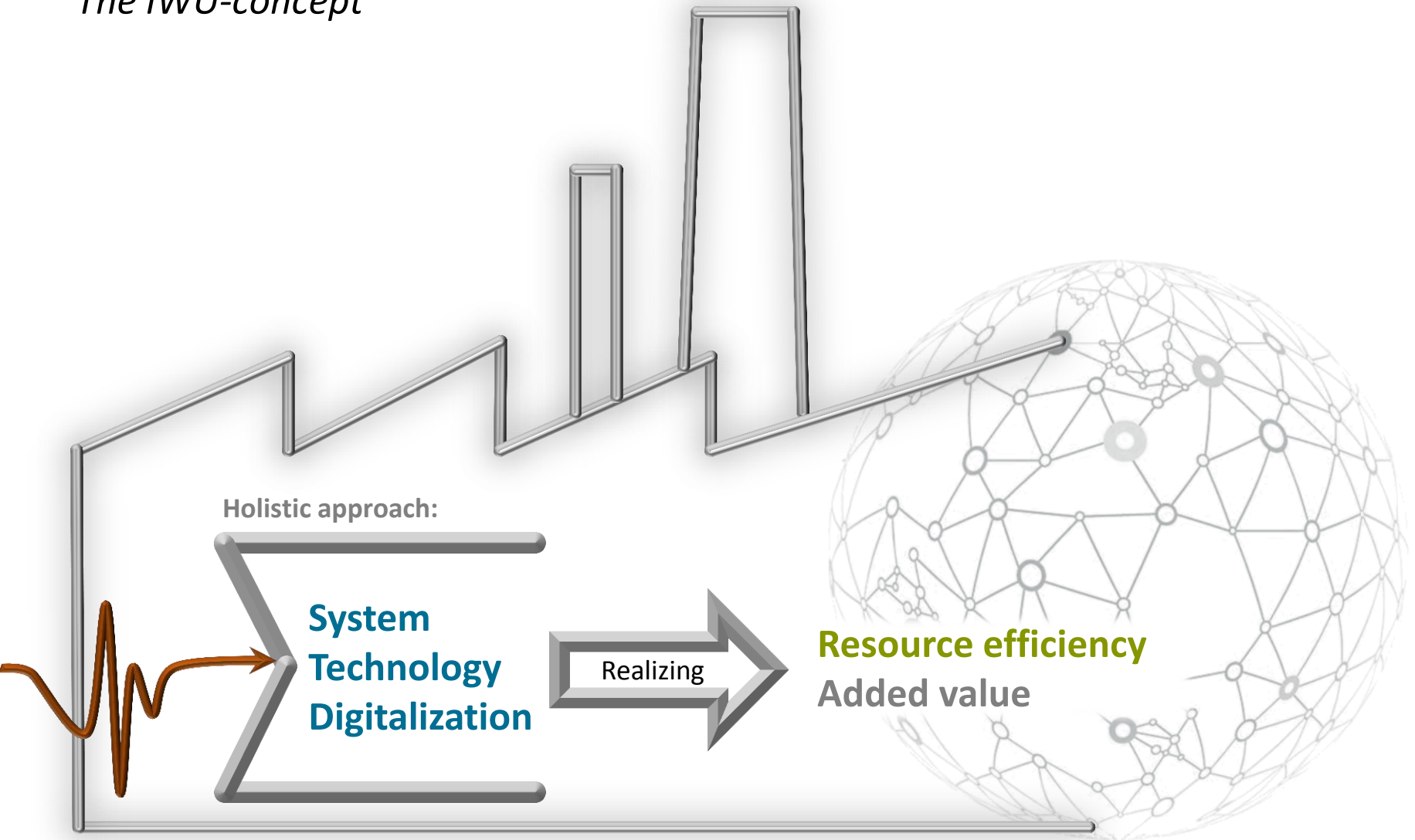
- Resource Efficient Factory
- Digitization in Production
- Automation and Monitoring

Machining and Removal

- Chipping Technology
- Functional Surfaces / Microsystems Manufacturing
- Special Machines

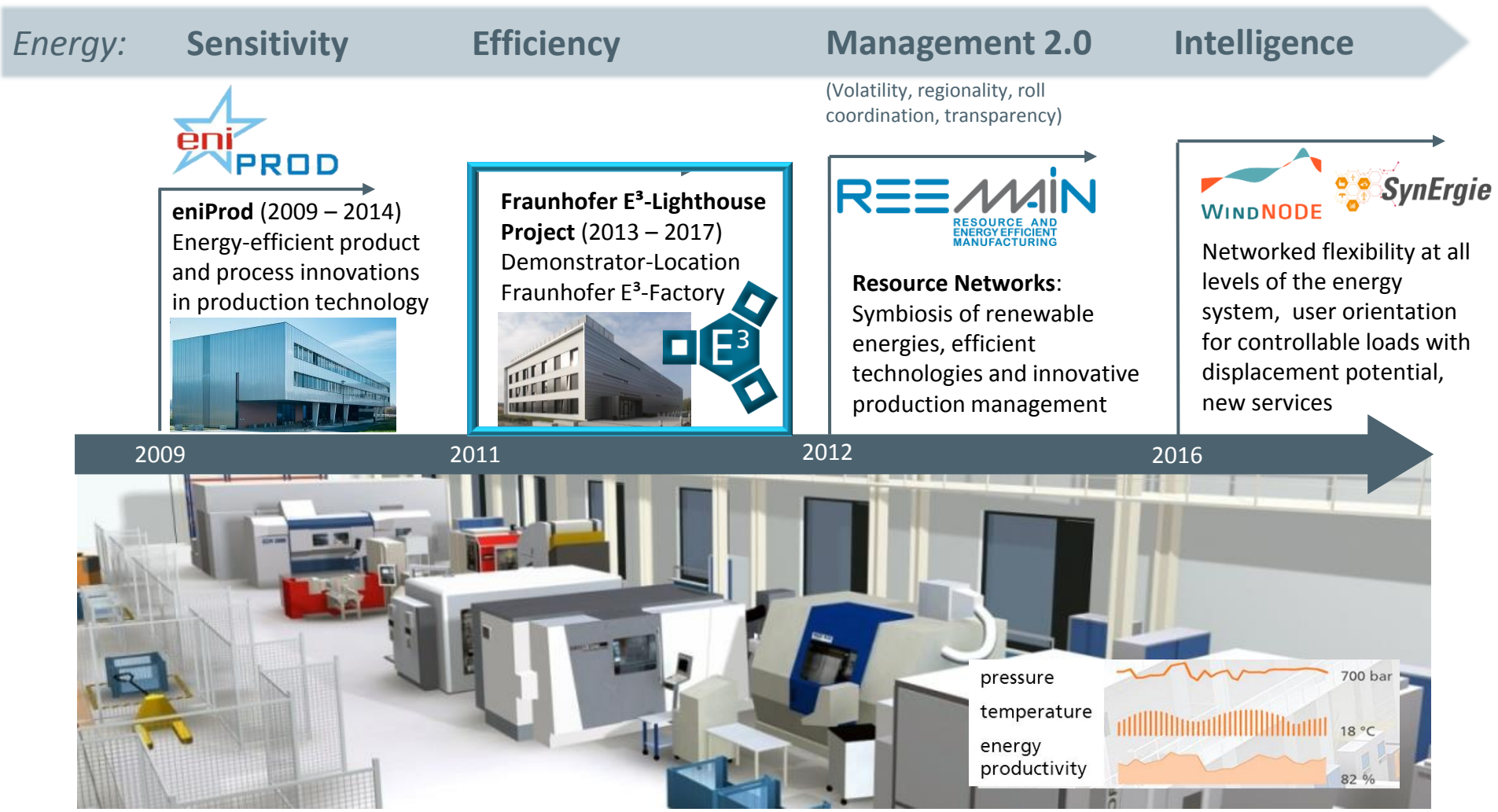
Resilient Production

The IWU-concept



Resource efficiency

The IWU core competence → Technology + System



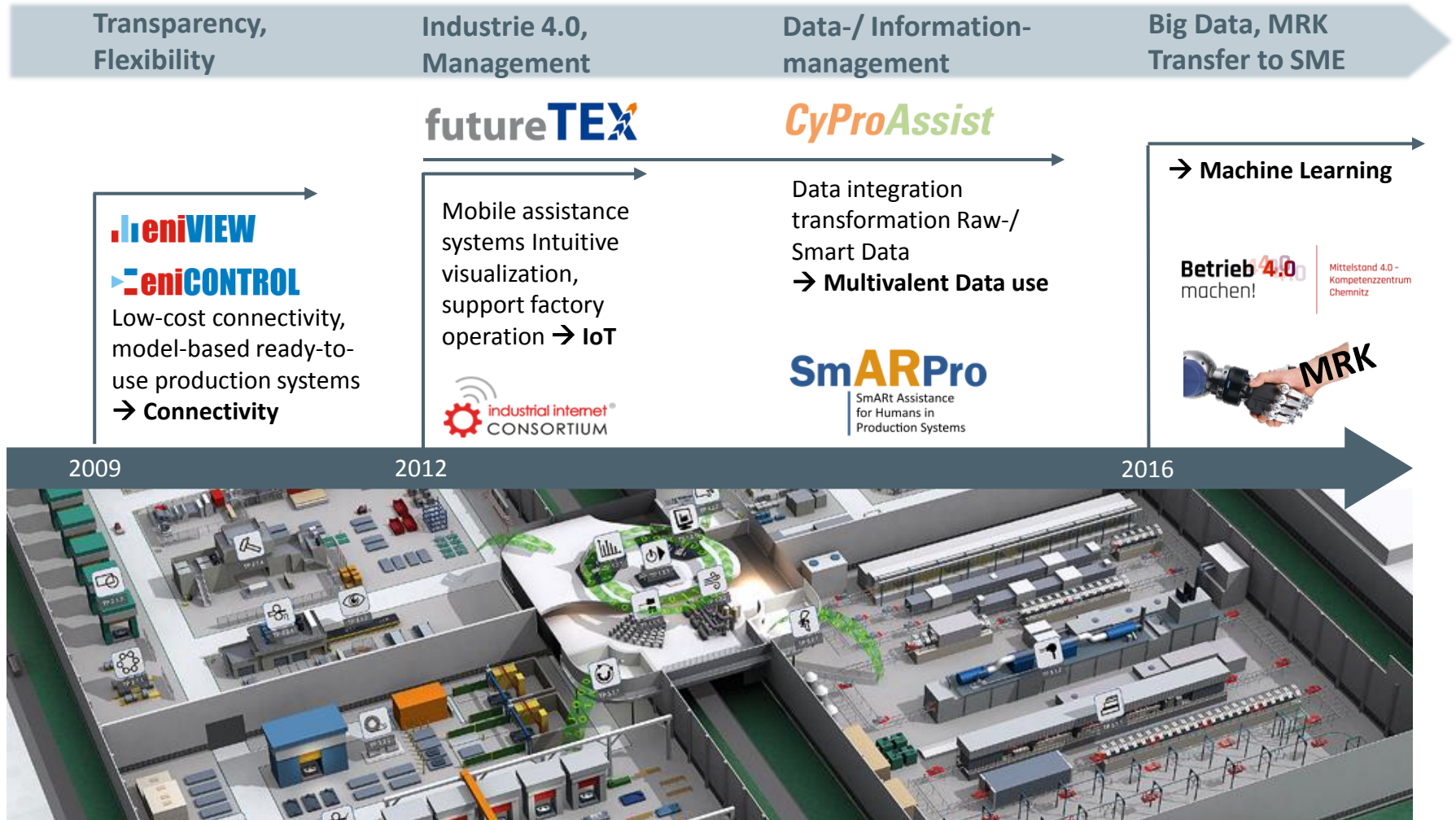
Resource efficiency

The IWU core competence → Technology + System + Digitalization



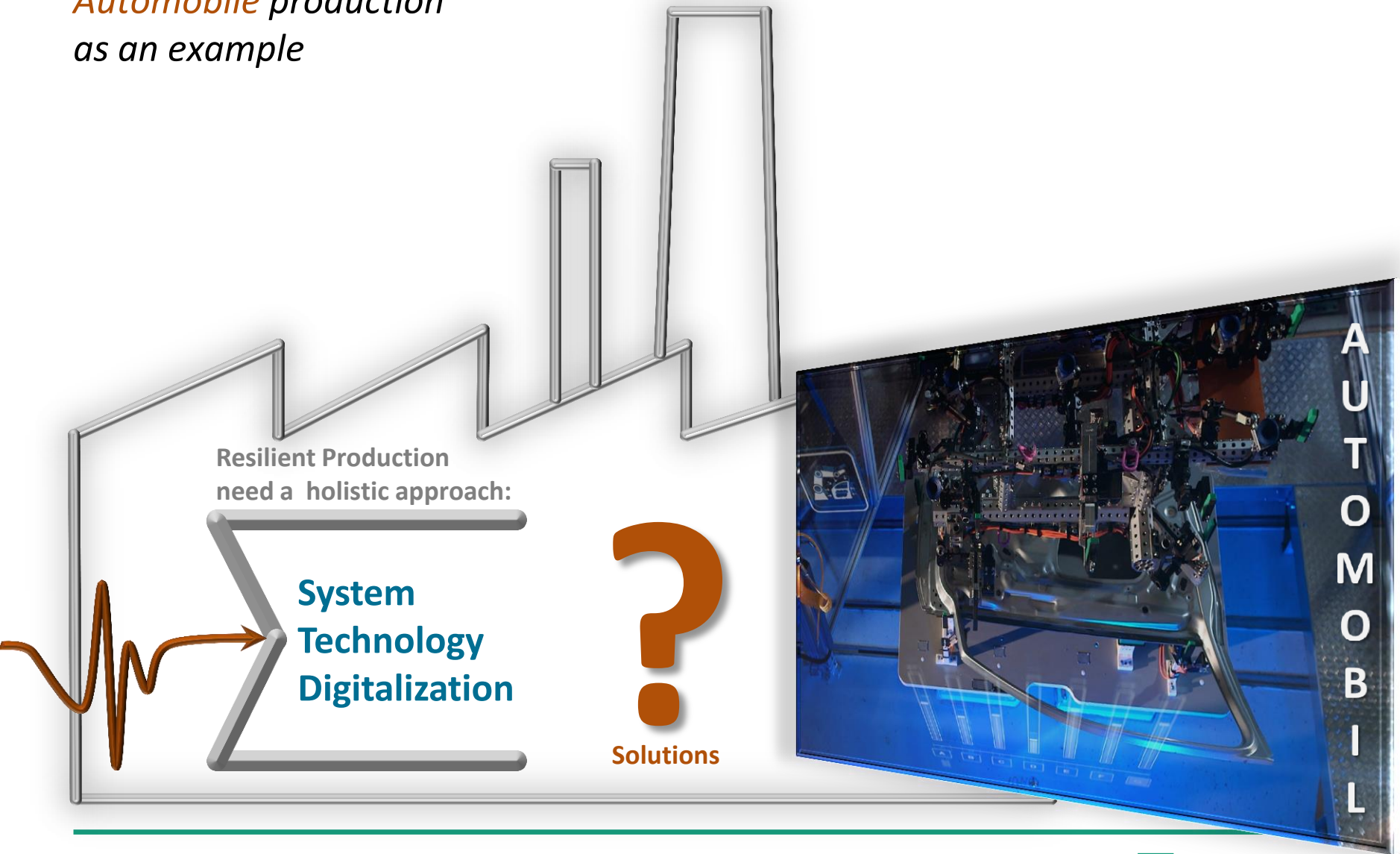
Resilient Production

Sphere of IWU research activity → Digitalization



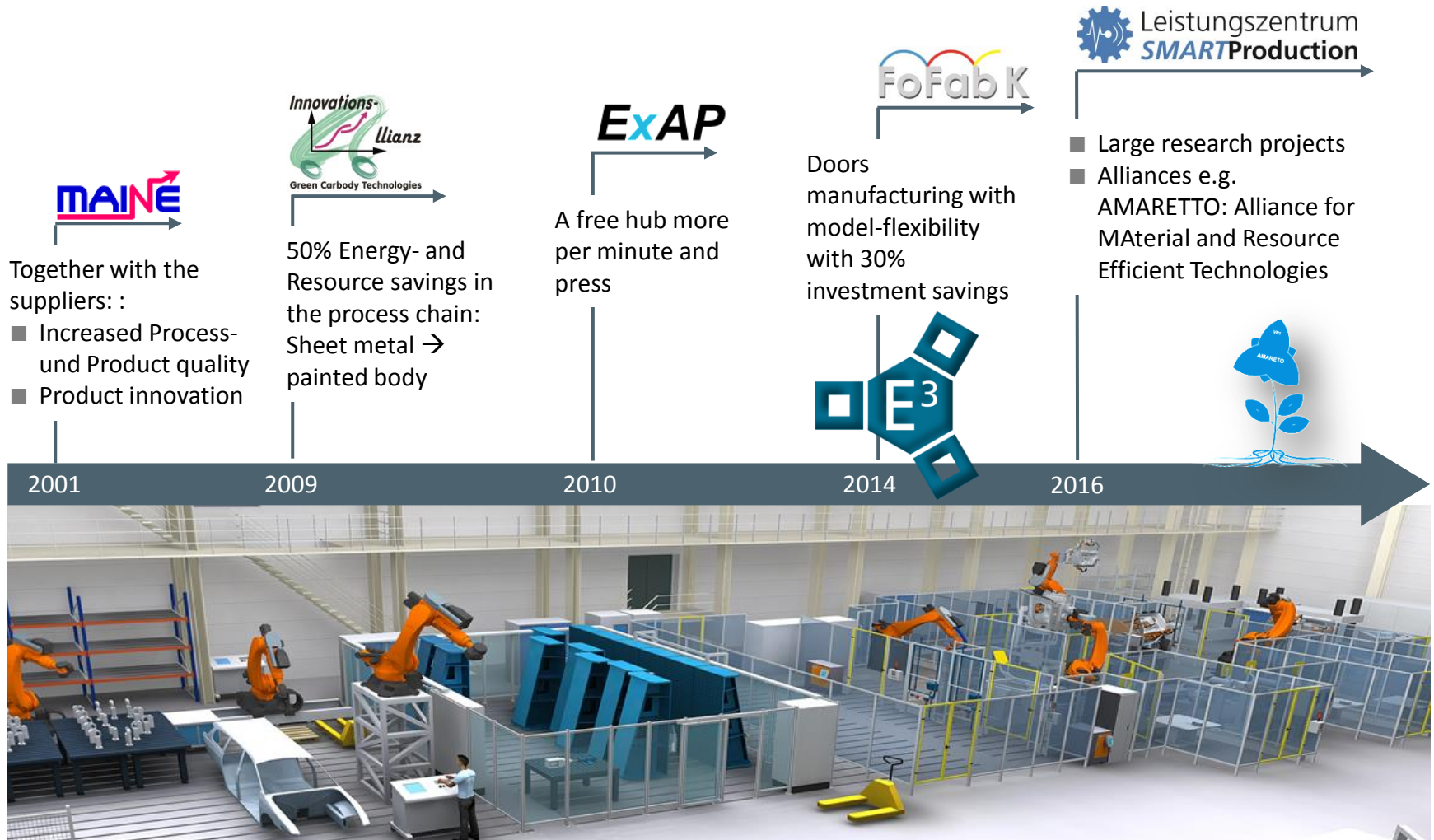
Resilient Production

Automobile production
as an example



Resilient **Automobile** Production

Sphere of IWU research activity → Technology + System



Resilient **Automobile** Production

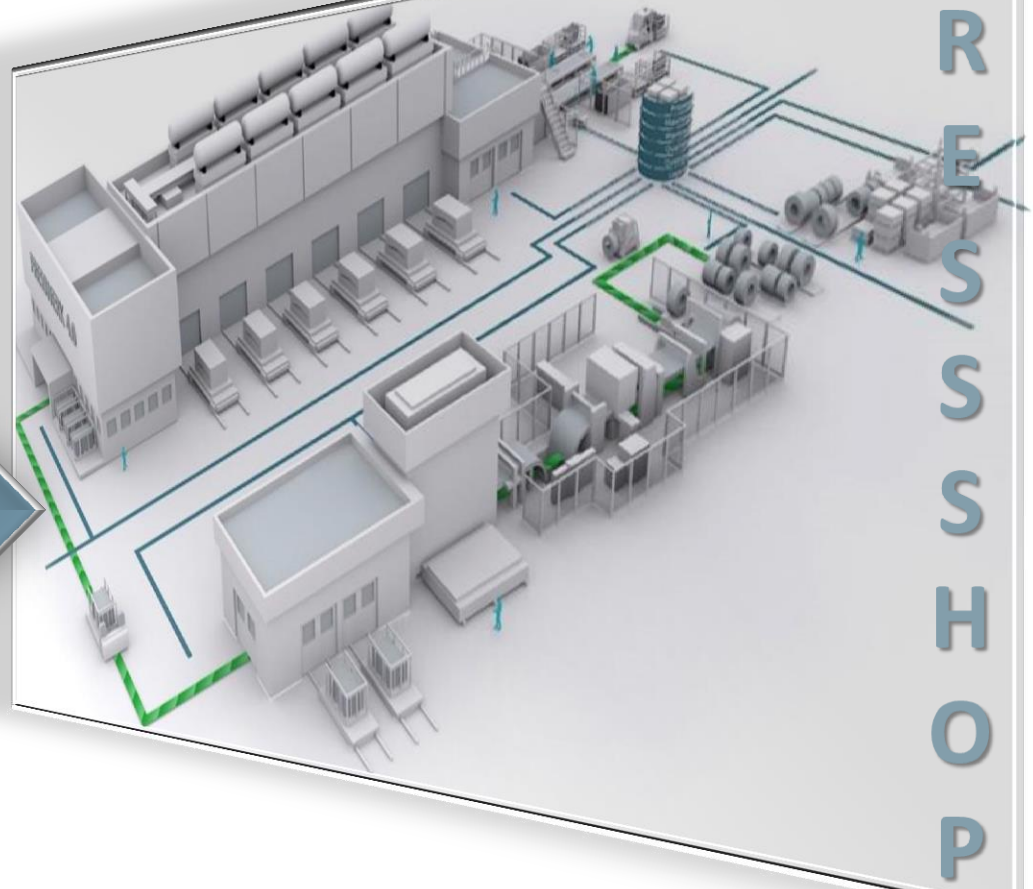
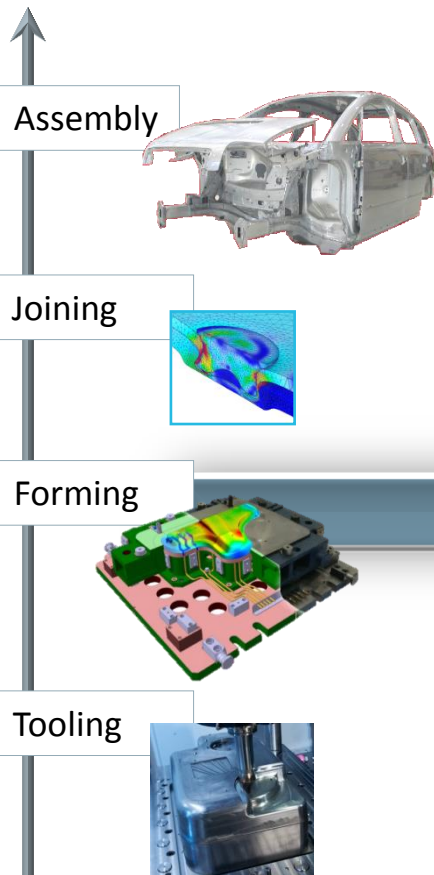
Subjects of IWU research



Resilient **Automobile** Production

Solutions for industrial use in smart factories

Process chain *Auto body*



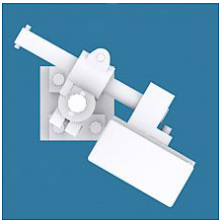
Resilient **Automobile** Production

Press shop 4.0 → overview modules



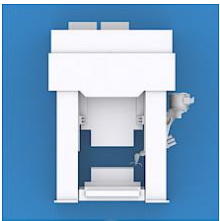
Linked Factory

Data platform
for enterprises



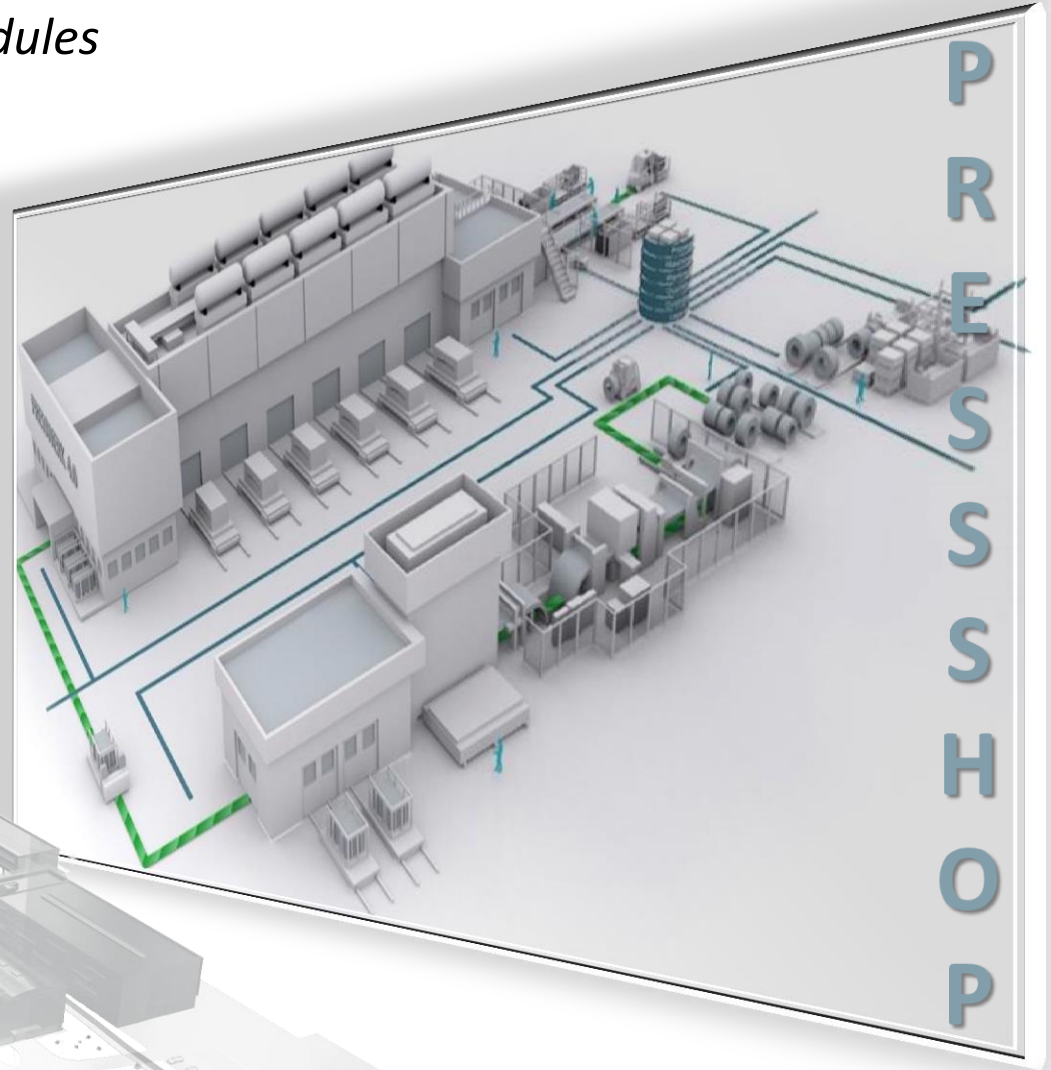
XEIDANA®

Inline quality control



Machine 4.0

Adaptronik components,
Condition monitoring





Prozessdaten
Maschinendaten
Werkstoffdaten
Werkzeugdaten
Qualitätsdaten
Lagerdaten

Linked Factory

Data platform for enterprises

BENEFIT

Smart connections
Transparency
Fast reaction times
Productivity increase



Linked Factory

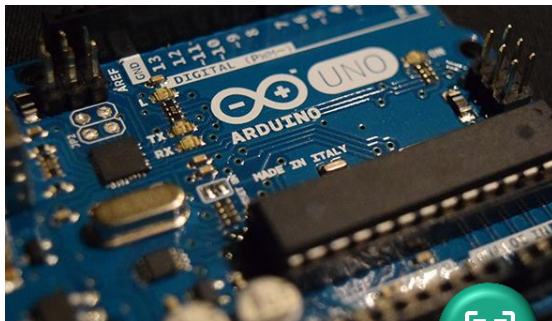
Data platform for enterprises



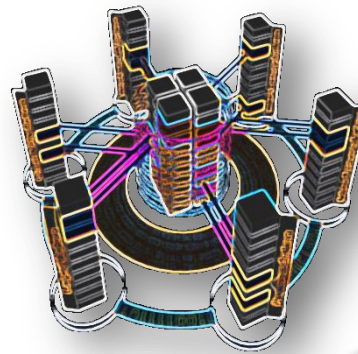
... as a component of the Modular kit I4.0



Smart systems



Smart objects



Linked Factory



Interaction



Data science





XEIDANA®

*Inline quality control
for Zero-mistake-production*

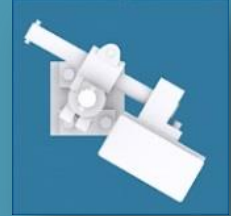
BENEFIT

100% detection of cracks
and deviations
Fast parallel data
processing



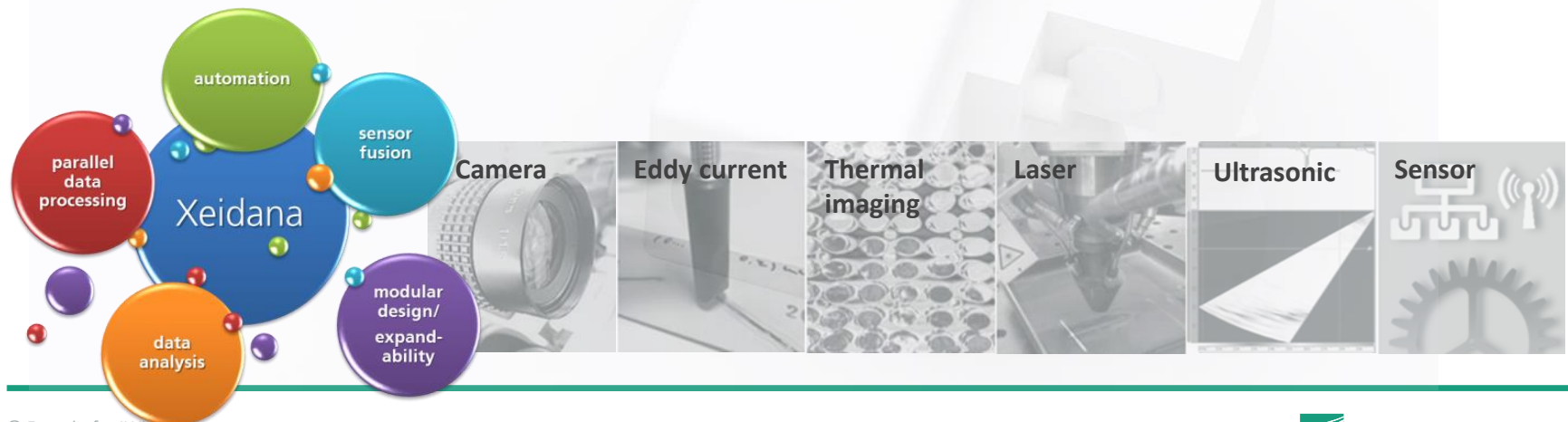
XEIDANA®

Inline quality control for Zero-mistake-production



With a single software, all tasks from data acquisition to automated quality control are covered

- Integration into existing production plants
- Optical inline inspection of components by using multiple camera systems and image processing algorithms
- Multitude of inspection and measurement tasks combined in one system
- Linking to data hubs such as “Linked Factory”
- Supply of measured results to various terminal devices in real time





Machine 4.0

*Flexible Condition Monitoring
Databased lifetime prediction*

BENEFIT

Equipment availability ↑ (50%)

Energy efficiency ↑ (20%)

Equipment life time ↑ (30%)

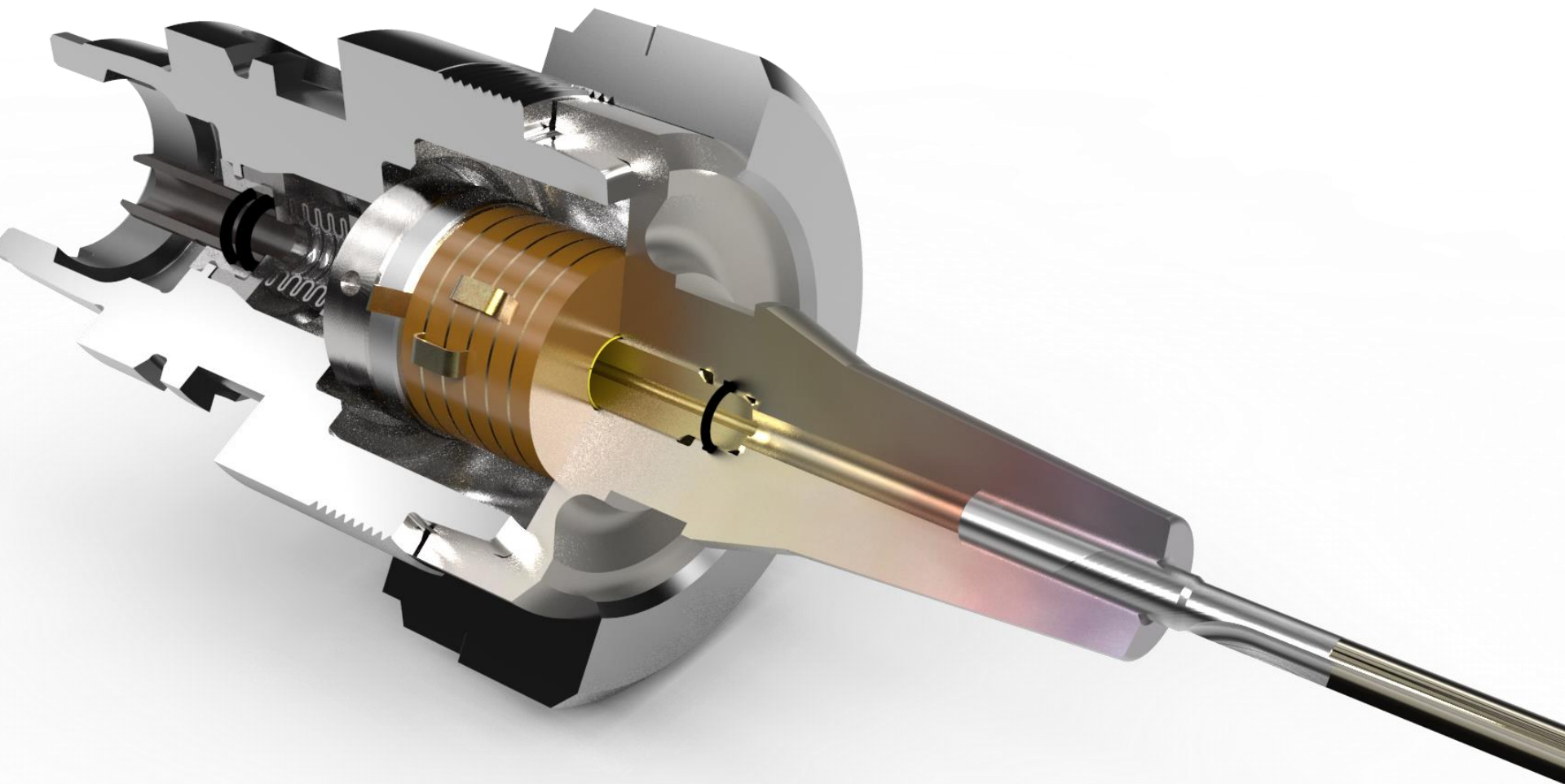
Maintenance costs ↓



Flexible Condition Monitoring Databased lifetime prediction

- Integration of data from control, drives and additional sensors
- Monitoring of important machine assemblies by calculating characteristic values relevant for specific conditions
 - Level 1: alerting when limit values are exceeded
 - Level 2: lifetime predictions by using intelligent algorithms





Machine 4.0 –

Application of adaptronik components

BENEFIT

Component quality ↑

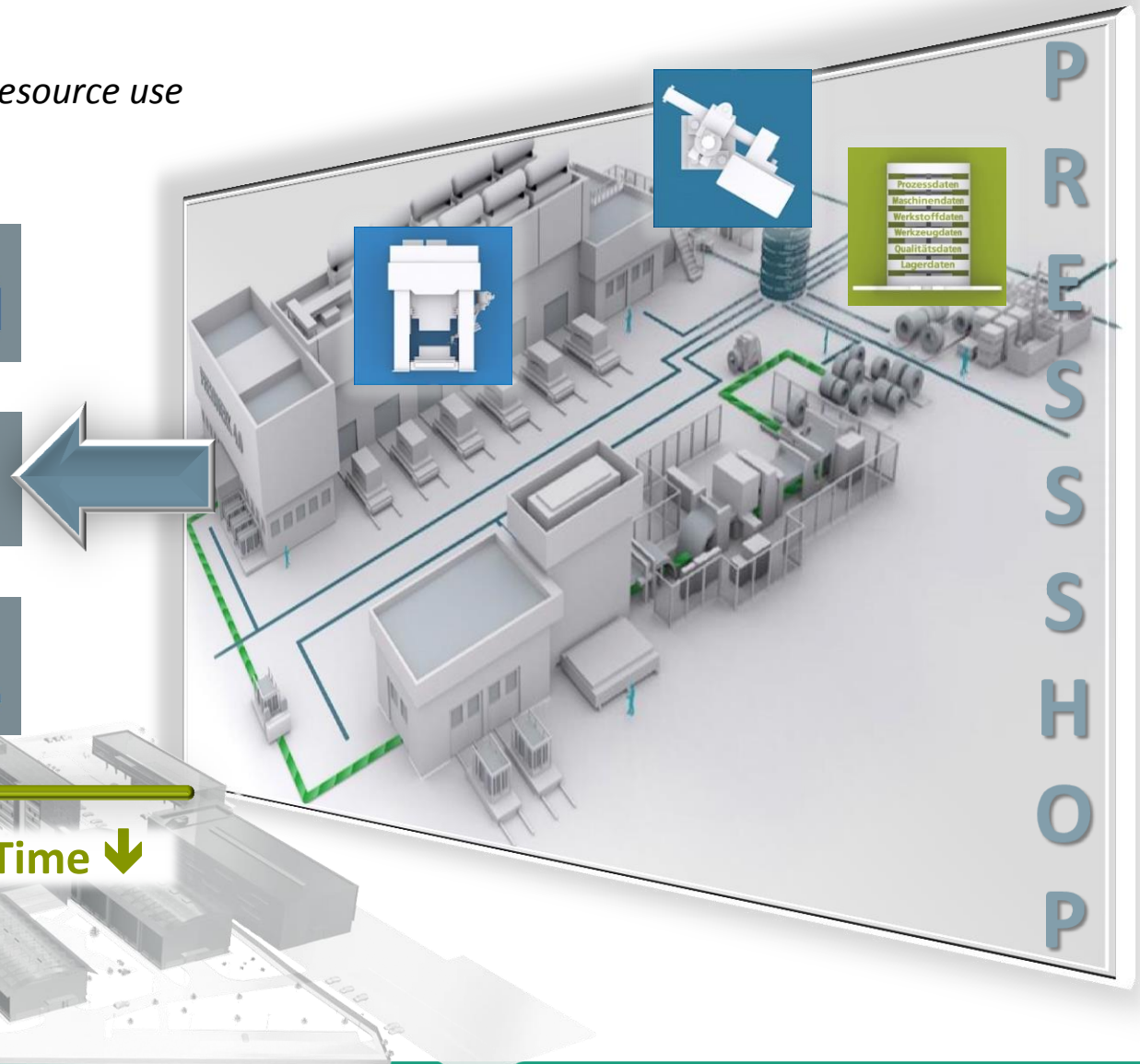
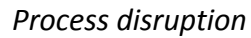
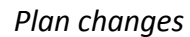
Processing time ↓ (50%)

Tolling life time ↑ (50%)

Post processing ↓

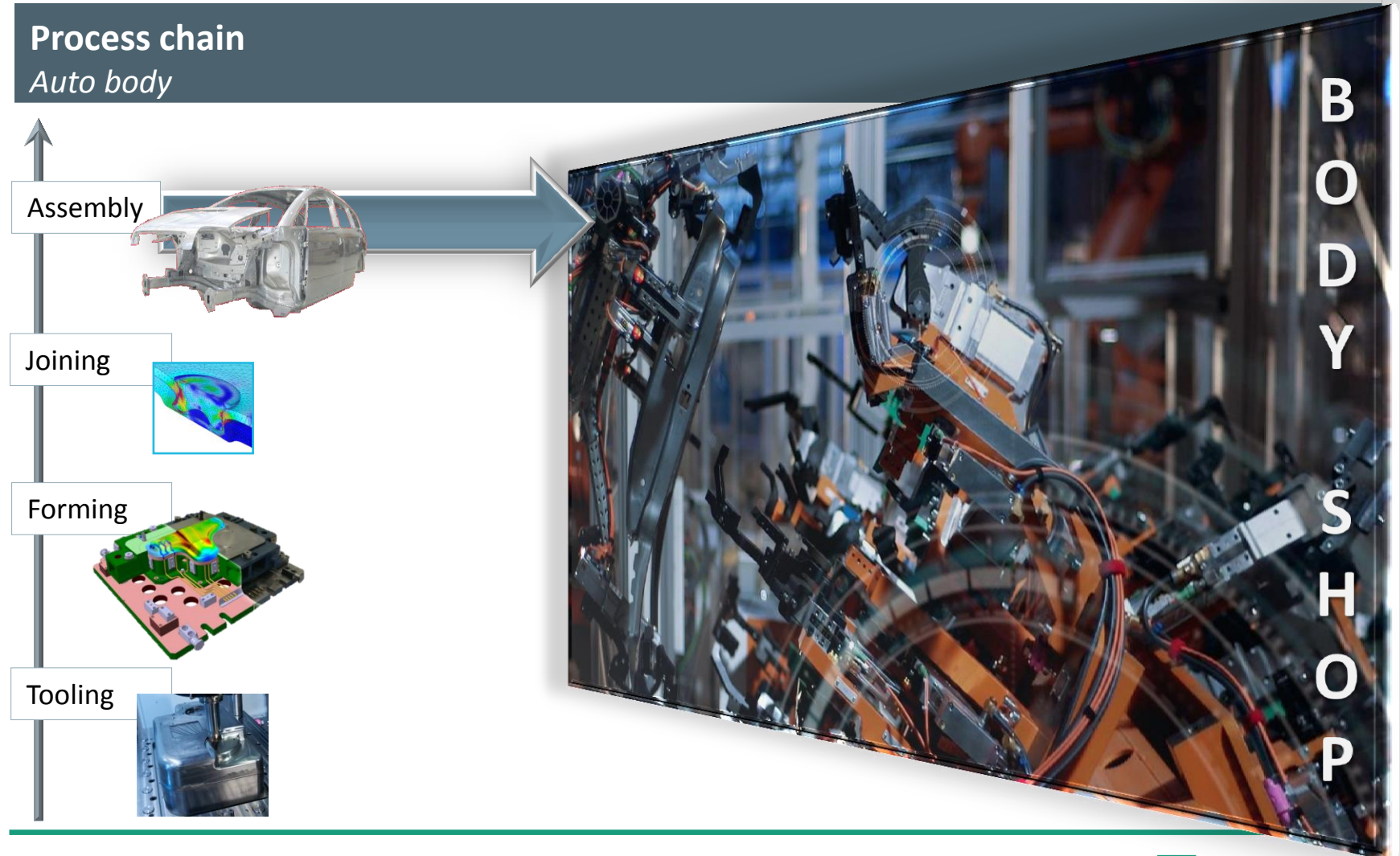
Total benefit for optimized resource use

Failure analysis



Resilient **Automobile** Production

Solutions for industrial use in smart factories



Resilient **Automobile** Production

Body shop → overview modules



Linked Factory

Data platform
for enterprises



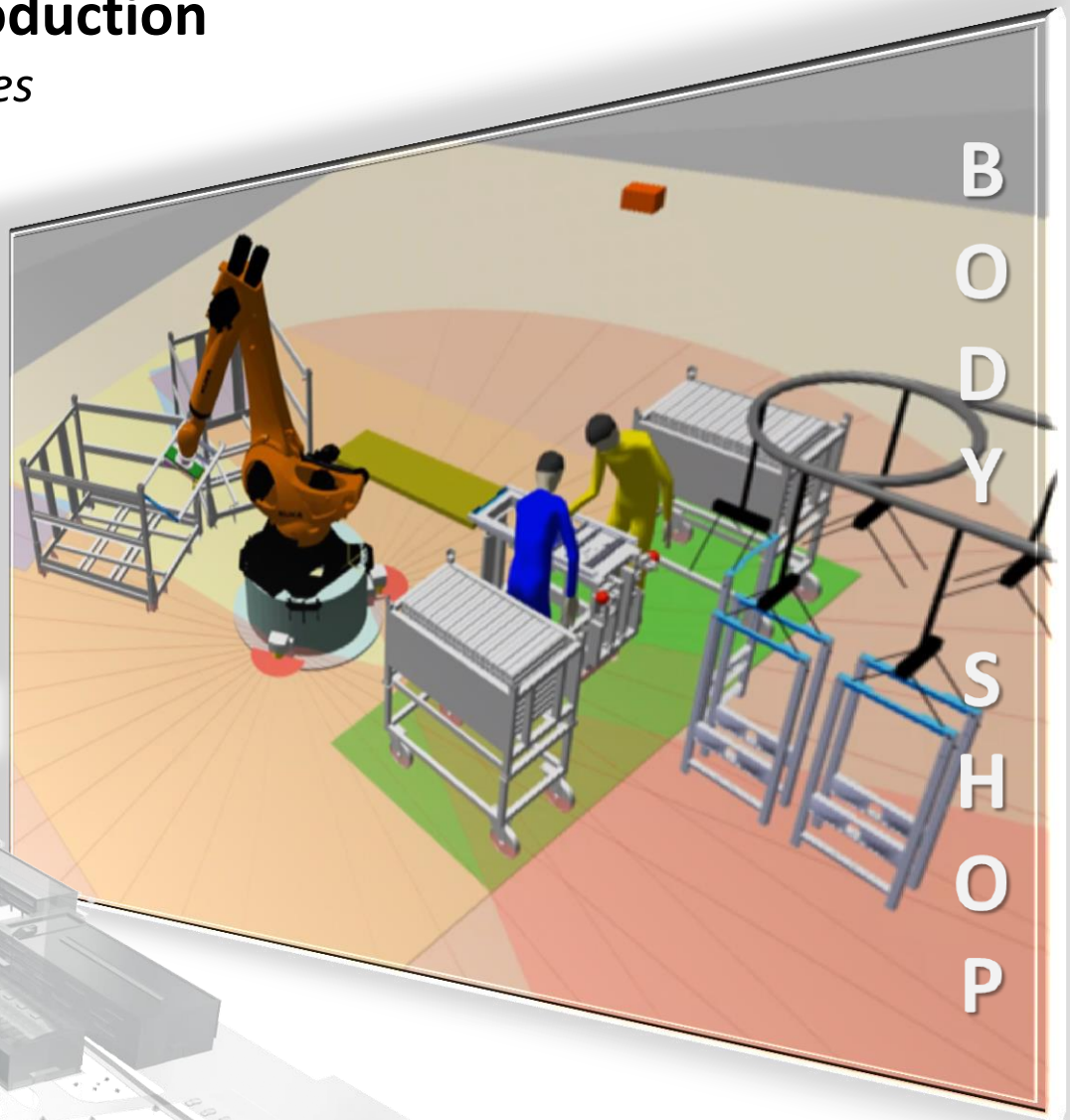
HRI

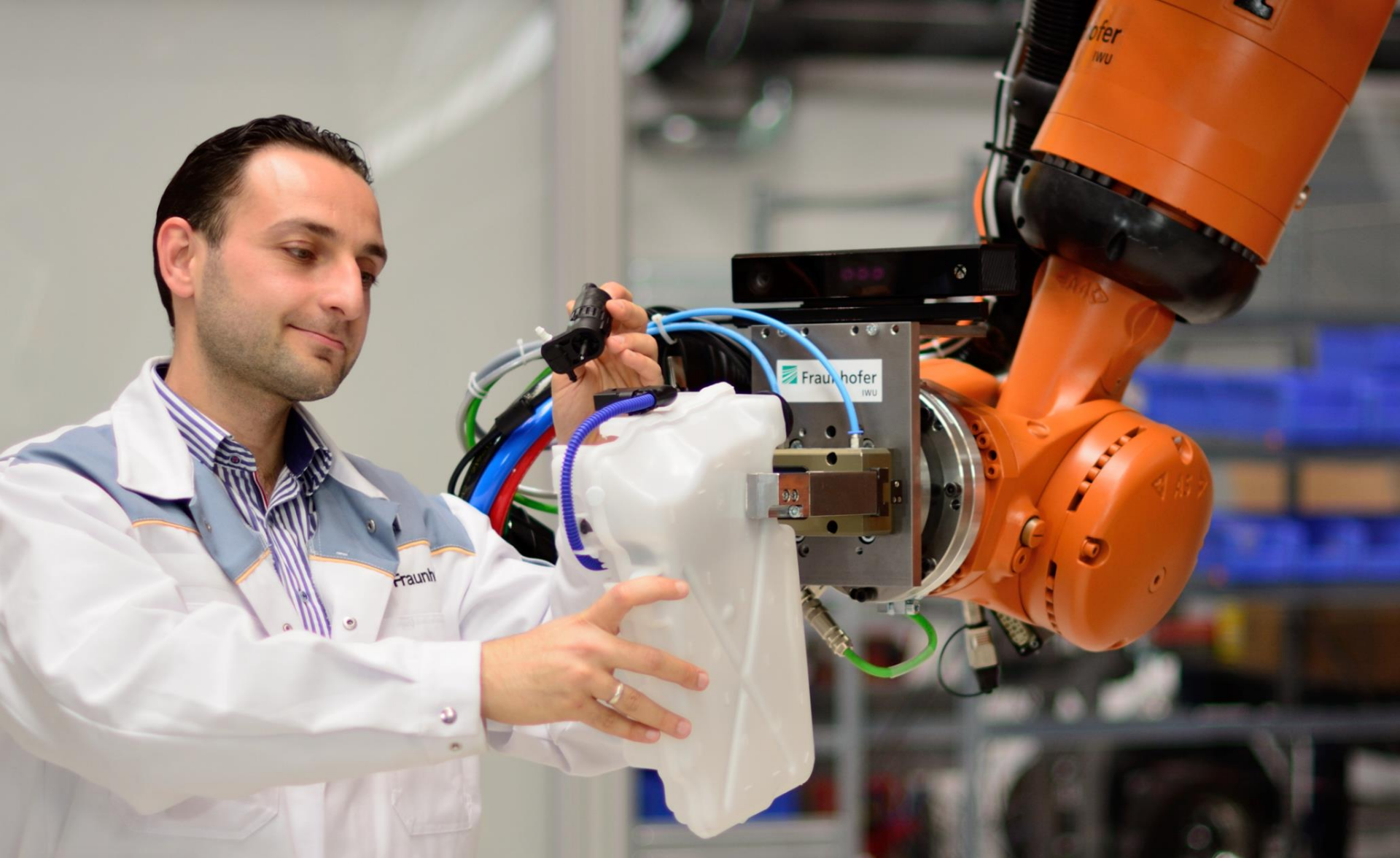
Human-Robot-Interaction
e.g. Safe human-robot
collaboration at heavy load



Shimming

Automated device adjustment





Human-Robot-Interaction

Collaboration with heavy-duty robots - safe and efficient!



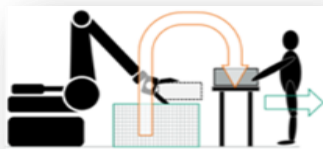
Human-Robot-Interaction

Collaboration with heavy-duty robots - safe and efficient!

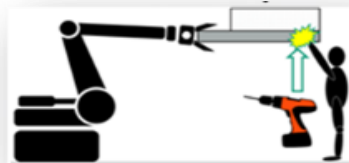


Flexible, multiple redundant security system

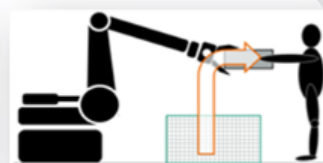
- Intelligent image processing algorithms with plausibility check
- New classification methodology with 4 co-operation level
- Concepts for security, danger and cooperation zones
 - Multidimensional modeling
 - Flexible and dynamic response
 - Customized robot control



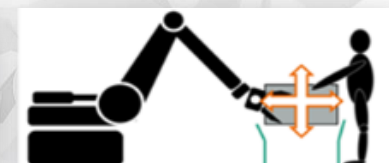
Production without
safety fence loose



Robot works as
third hand



Robot grasp/deliver
objects to human hand

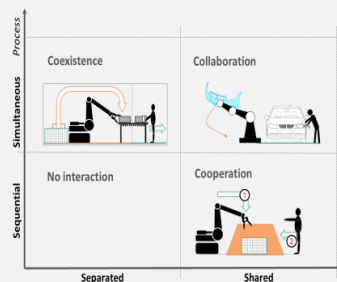
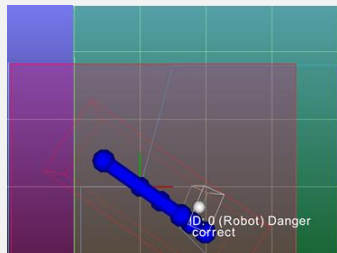
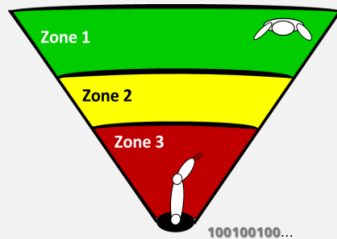


Human guide robot in
his forces/moments

The IWU-Solution

Concept of safe + flexible Human-Robot-Interaction

State of knowledge



New Approach

System

- Superordinate safety system
- New intelligent algorithms

Zones

- Zone modeling
- Dynamic zones
- Flexible Configuration

Levels

- New cooperation levels
- Definition of the requirements
 - Human features
 - Robot parameters
- Derivation of the safety functions

SAFE + FLEXIBLE HRI LEVELS

Towards most effective distances + movements





Human-machine-communication

Collaboration with heavy-duty robots - safe and efficient!



Benefit



Higher degrees of freedom in the assembly process



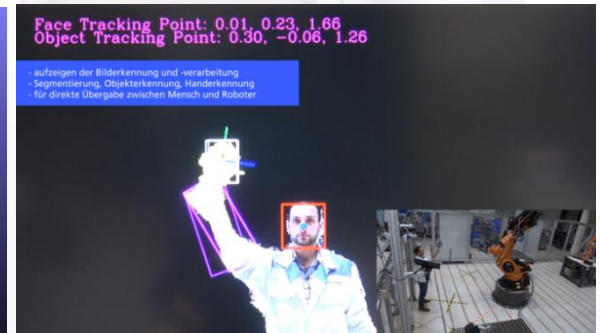
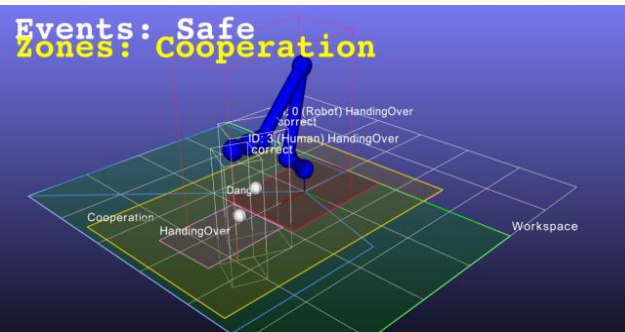
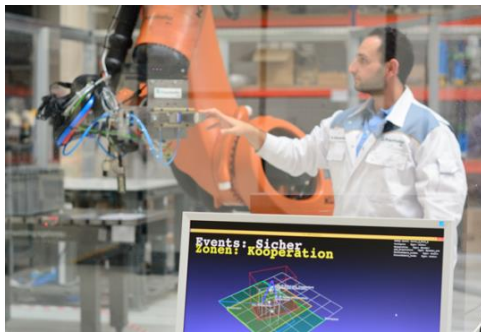
Avoiding physically demanding work, e.g. About overhead work

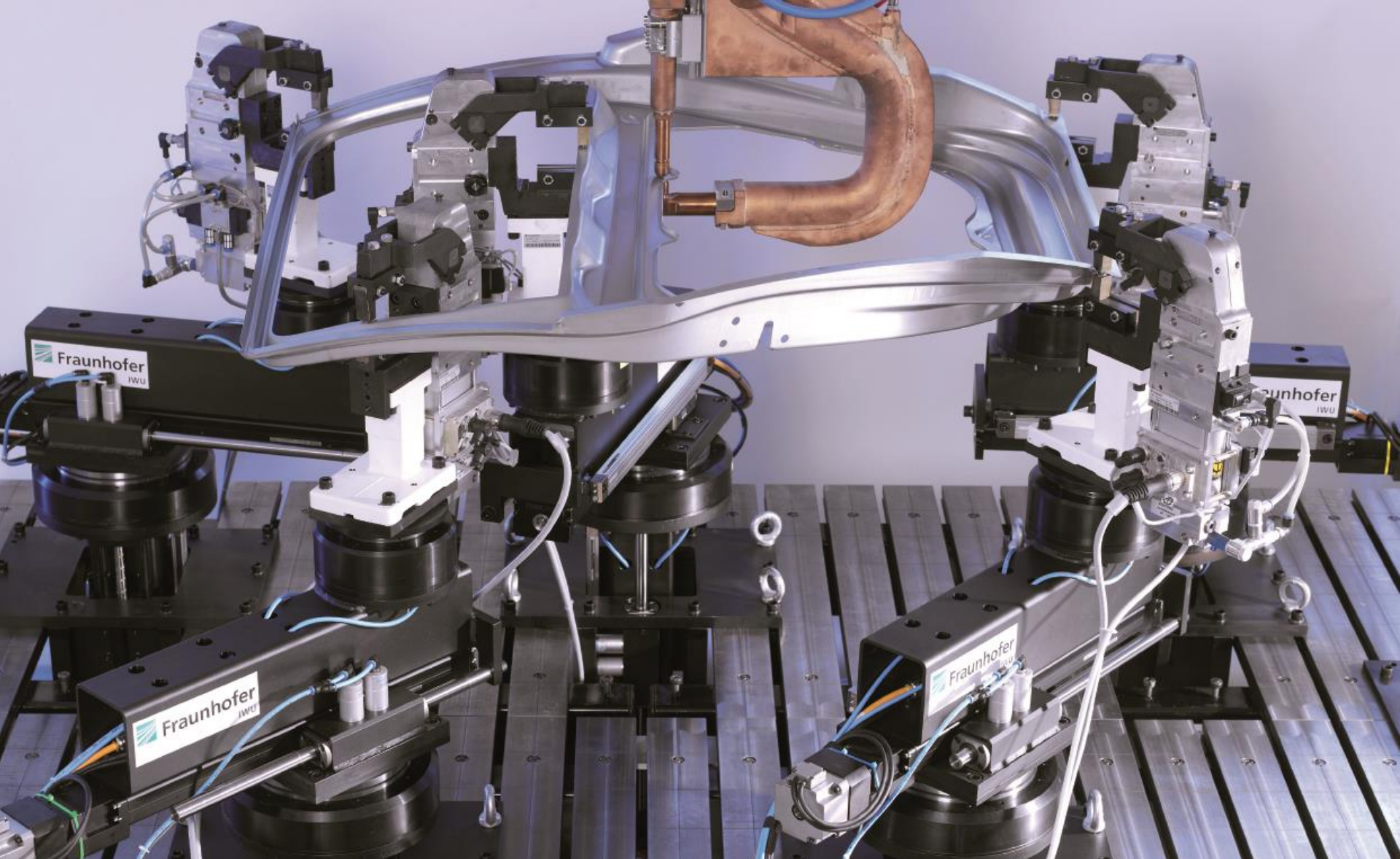


Avoiding time losses through manual intervention Faster and more flexible process sequences



Man and heavy load robot in the same work area ? Improvement of the area utilization rate





Automatically Shimming

Device adjustment - efficient and reproducible!



Automatically Shimming

Device adjustment - efficient and reproducible!

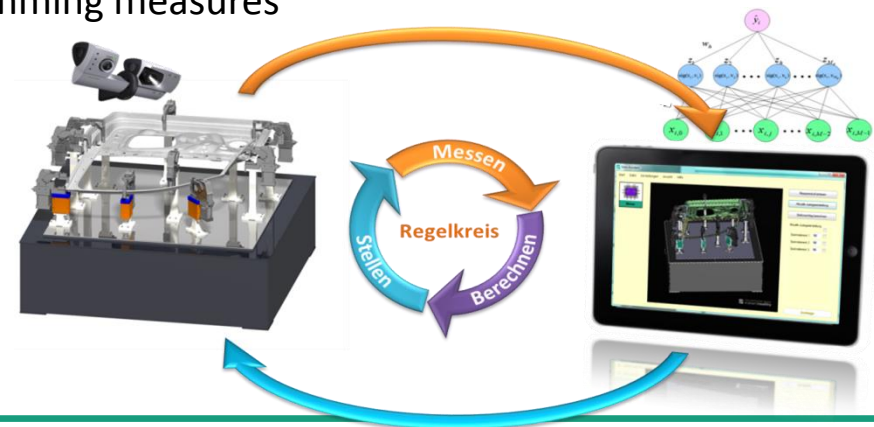


Automatically adjustment with closed loop control

- Revolutionary system for automated adjustment
- Device (s) with shimming modules
- Recording of the measuring dimensions from the shim modules
- Intelligent control software for calculation of the position measurement with KI (neural network)
 - Automatic control circuit
 - Storage and documentation of current shim values
 - Testing and reproducibility of shimming measures

Your Benefit

- Reduction of commissioning
- Increase availability
- Reduction rework
- Reduction committee



Resilient **Automobile** Production

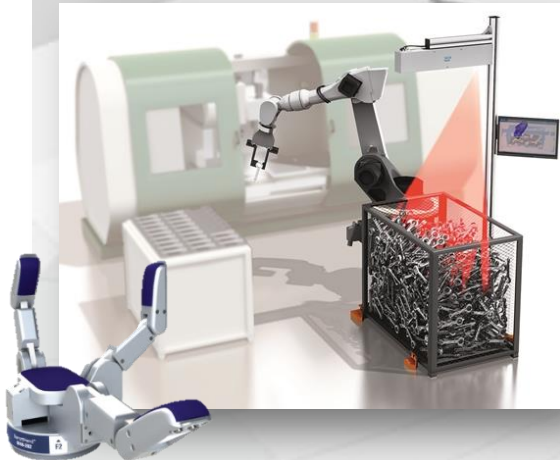
Body shop → other applications



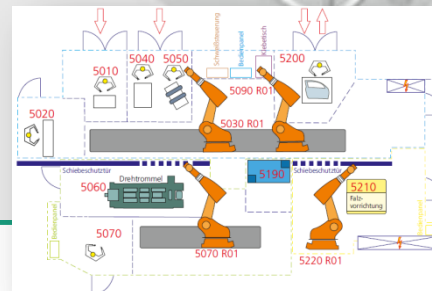
Energy certificate

- close to production
- Freely available procedure (www.aida-zertifikat.de)

Grasping as a human model



- Body shop 4.0
- Handle in the Box 4.0
- Automation of complex, now manual and time-consuming work



Robot automatization

Resilient **Automobile** Production

Body shop 4.0

Total benefit for optimized resource use

FoFab K



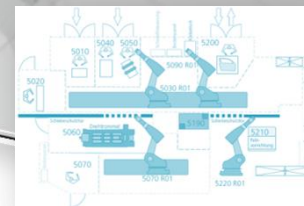
Fully flexible
body construction

Flexibility \uparrow , Energy \downarrow ,
Time \downarrow , Transparency \uparrow



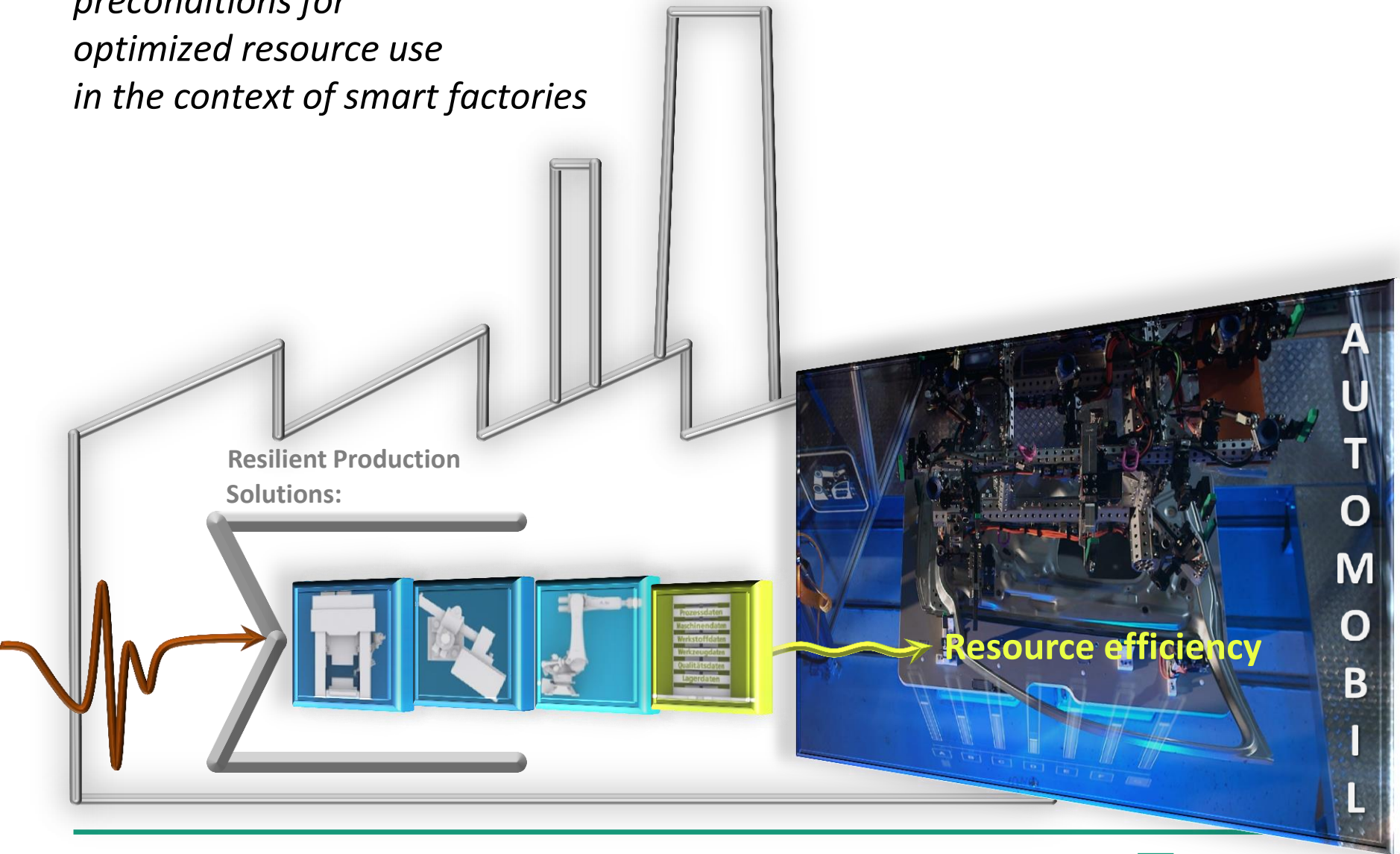
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Resilient **Automobile** Production

*preconditions for
optimized resource use
in the context of smart factories*



Resilience

Example for illustration from everyday life ...

Meeting with friends at the lake ...

... without resilience ...

*In the preliminary clarification
of open questions!*

- *Who has when time?*
- *Where do we meet?*
- *Who brings what?*

*On end of this process is a plan,
where deviations are difficult to
implement.*

... with resilience ...

*Only a messenger group is created in
advance!*

A: Weather is good, I go!

B: Do we have drinks?

C: I'll bring some!

D: ... me too

A: I'm there! Regular place is unfortunately occupied!

A: Other side of the lake is free.

B: We also have shadows there?

A: No!

B: Okay I'll pack a sunshade.

...

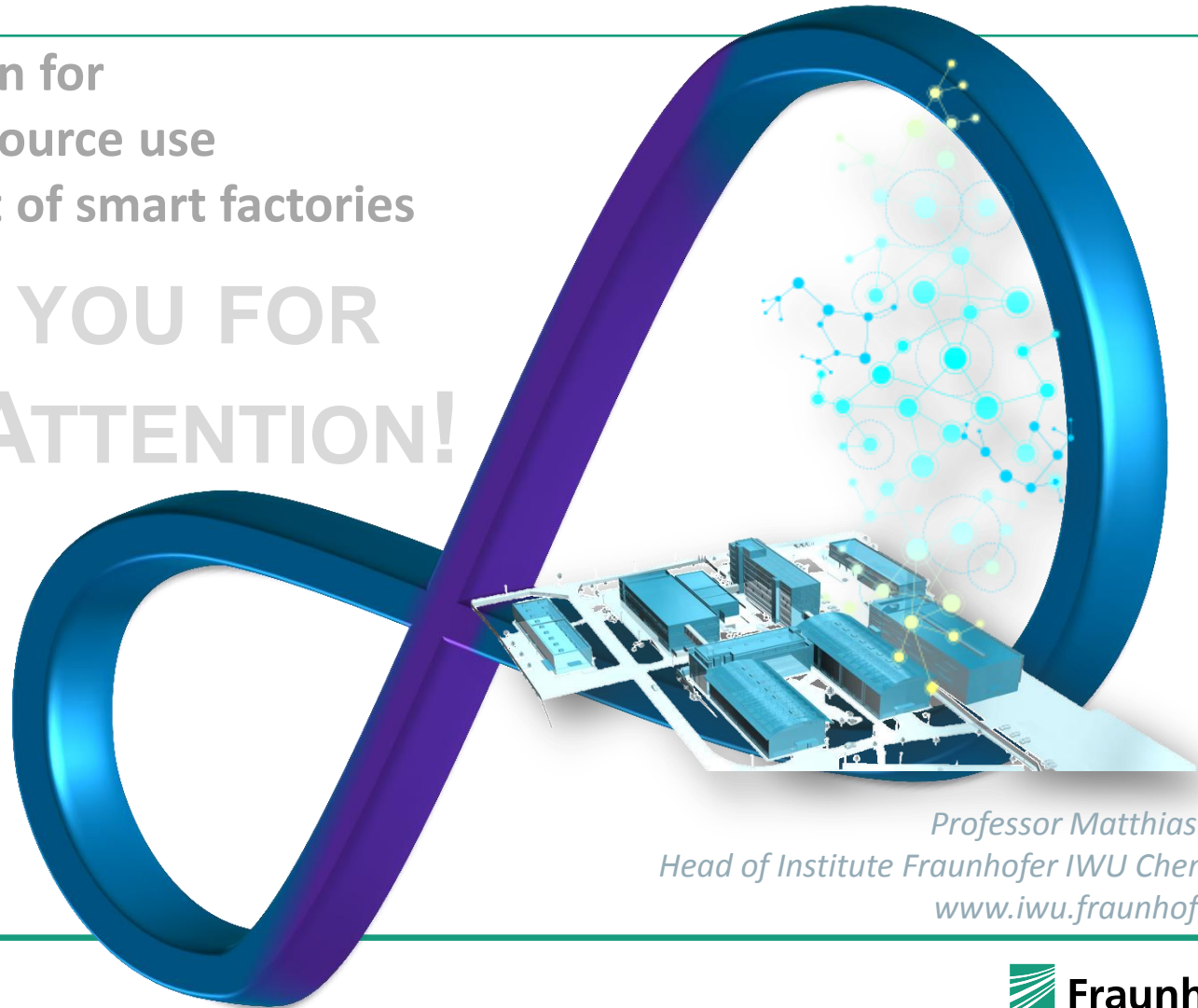
Agile Organization!

15th Global Conference on Sustainable Manufacturing 2017

RESILIENT PRODUCTION

A precondition for
optimized resource use
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THANK YOU FOR
YOUR ATTENTION!



*Professor Matthias Putz
Head of Institute Fraunhofer IWU Chemnitz
www.iwu.fraunhofer.de*