

# VIRTUAL REALITY AND VISUALIZATION FOR INDUSTRIE 4.0

Manfred Dangelmaier, Fraunhofer IAO



# Overview

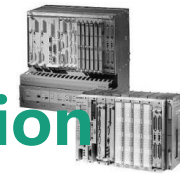
- Industrie 4.0 and Advanced Manufacturing
- VR and Visualization in Advanced Manufacturing
- Visualization on the Shop Floor
- Digital Experience and decisions in Planning and Engineering

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# Industrie 4.0

## Living in the 4th industrial revolution



»Smart Factory«



**Production line**  
Ford, 1914

First  
**Programmable  
Controller**

(SPS) »Modicon 084«  
1969

**4. Industrial Revolution**  
based on **Cyber-physical  
systems**

**3. Industrial Revolution - Automation**  
through the use of electronics and IT for further  
automation of manufacturing

**2. Industrial Revolution – Mass production**  
through implementation of mass production based on divided labour  
utilizing electricity

**1. Industrial Revolution - Mechanisation**  
through mechanical manufacturing facilities driven by hydro and steam power

Degree of complexity

End of 18. C	Beginning 20. C	Beginning 1970s	Today	Source: DFKI
<b>Employment</b>	Determination	Participation	Co-operation	
<b>Processes</b>	fixed	flexible	adaptive / in realtime	
<b>Resources</b>	to prediction	to consumption	to order	

# Industrie 4.0 and Advanced Manufacturing

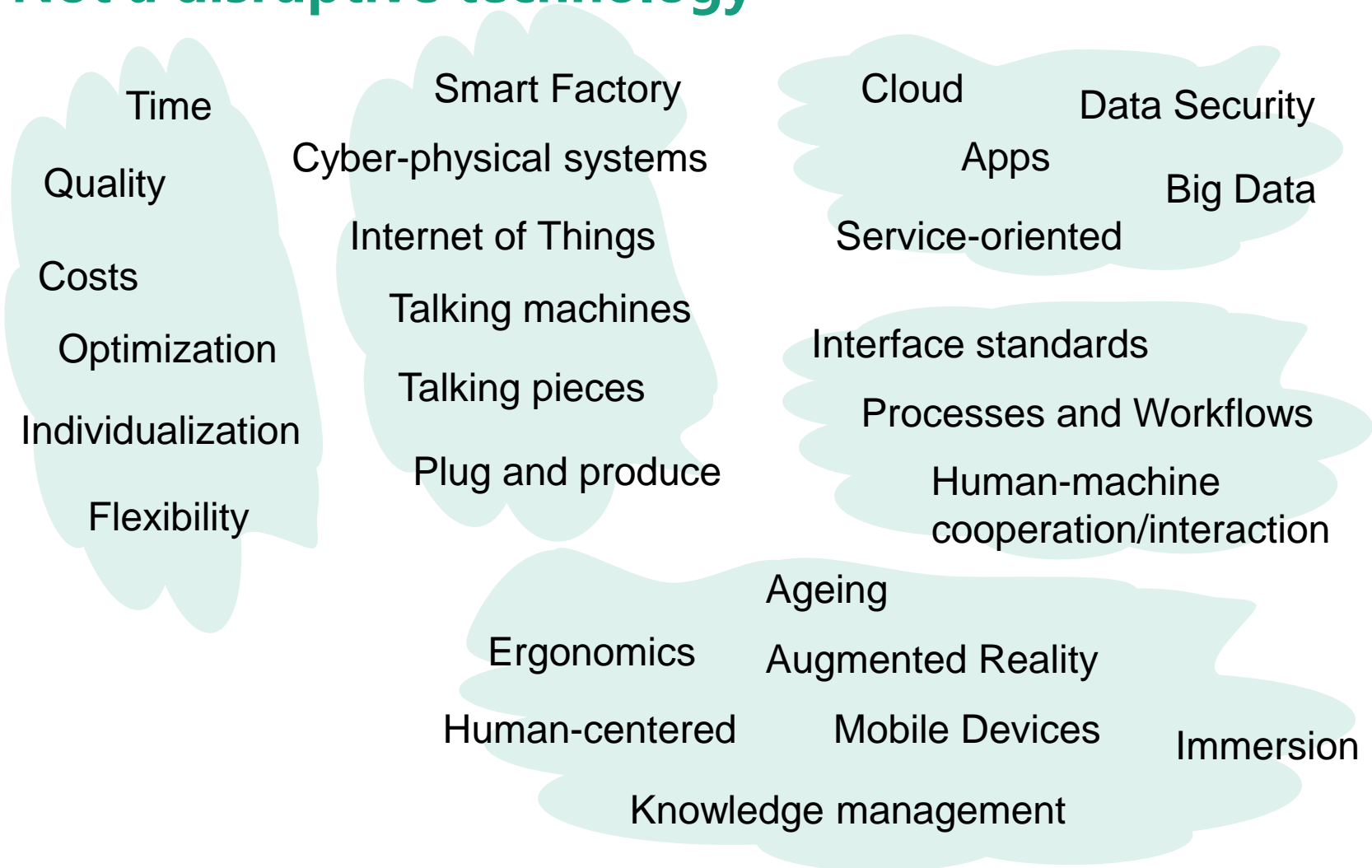
## More than just the internet of things

- The 4th Industrial (R)evolution
- Cyberphysical Systems and Internet of Things in Manufacturing
- Agenda setting for production research
- A project in the Hightech Strategy of the German government (and others)
- Label for funded research projects in Germany
  - 18 projects in »Autonomics for Industry 4.0«
  - 22 projects in the framework »Research for Tomorrow's Production«
  - ...



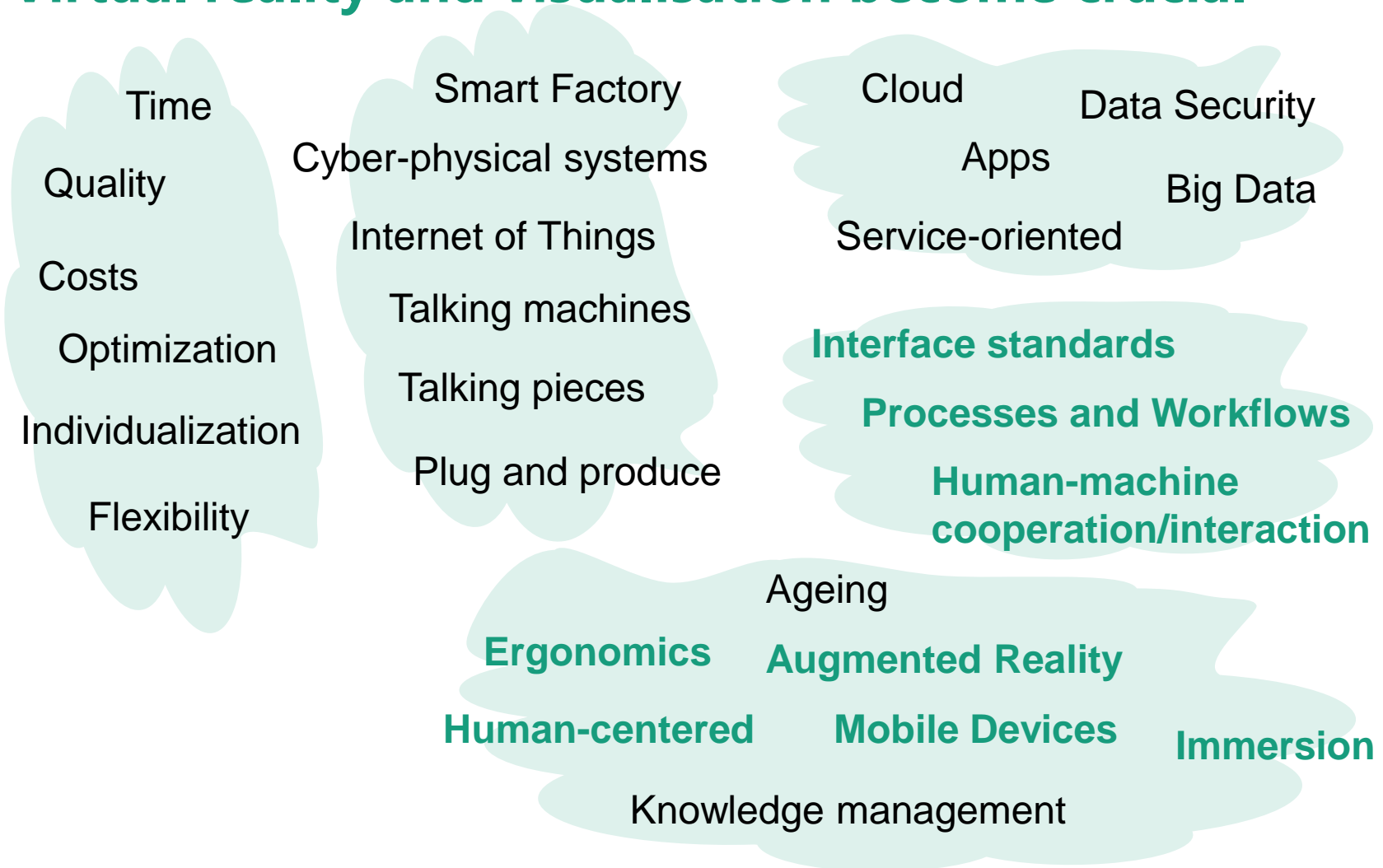
# Industrie 4.0 and Advanced Manufacturing

## Not a disruptive technology



# Industrie 4.0 and Advanced Manufacturing

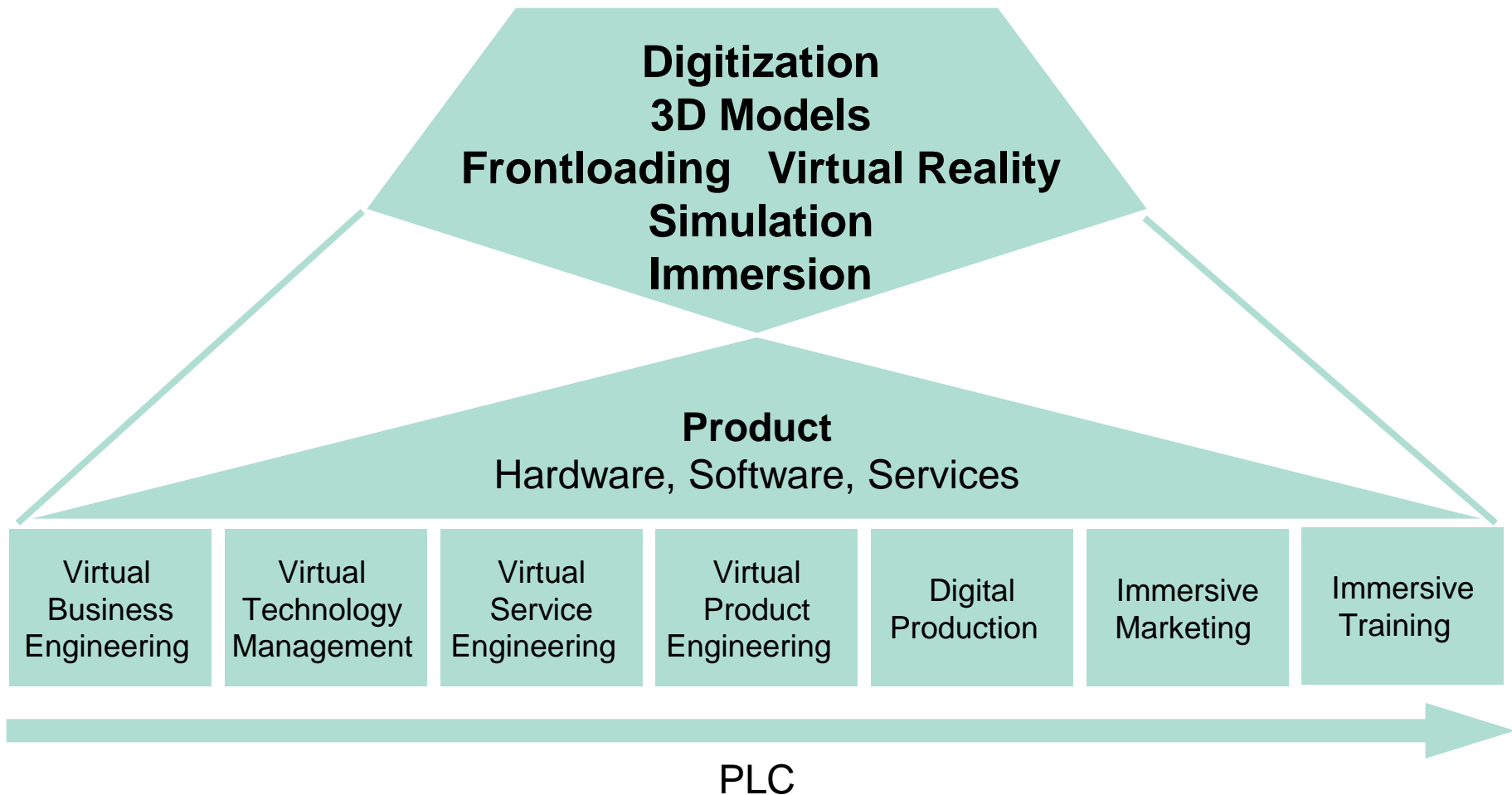
## Virtual reality and visualisation become crucial





# Virtual Engineering in the Product Lifecycle

## Advanced Manufacturing needs Virtual Engineering





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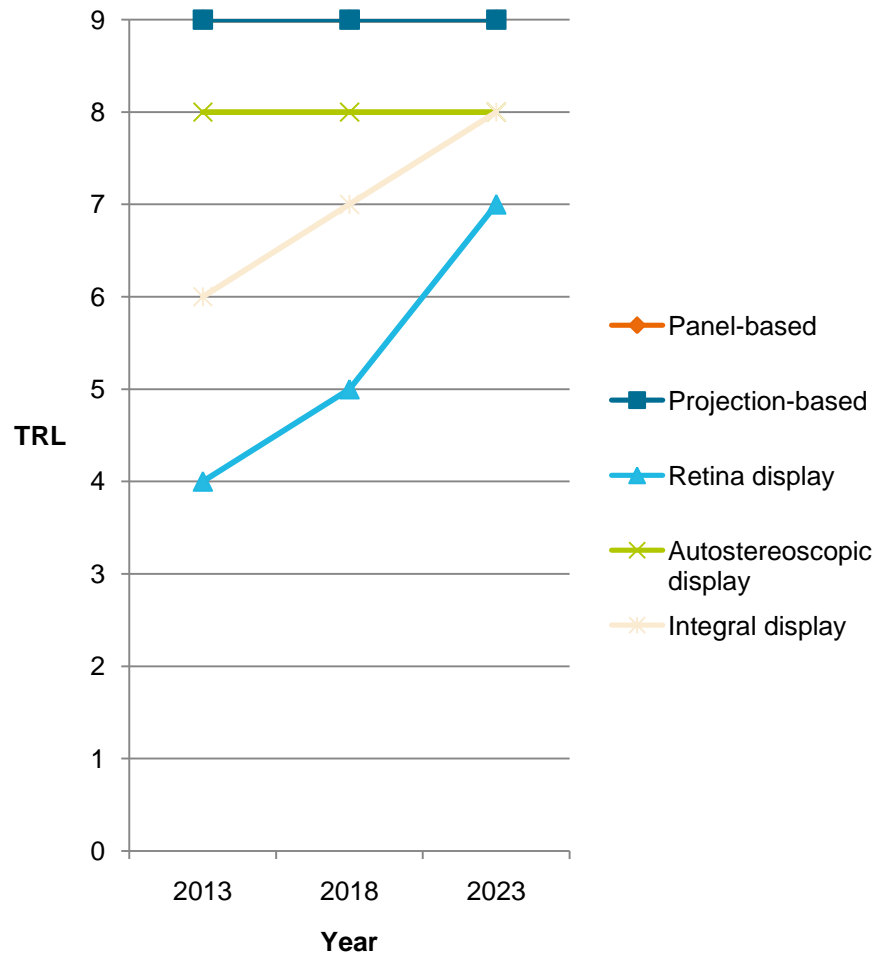
# AR/VR Key technologies for Advanced Manufacturing

## Roadmaps from a Fraunhofer study

- Display technology (n=5)
- Tracking (n=5)
- Interaction devices (n=8)
- Haptic devices (n=9)
- Integration technology (n=5)

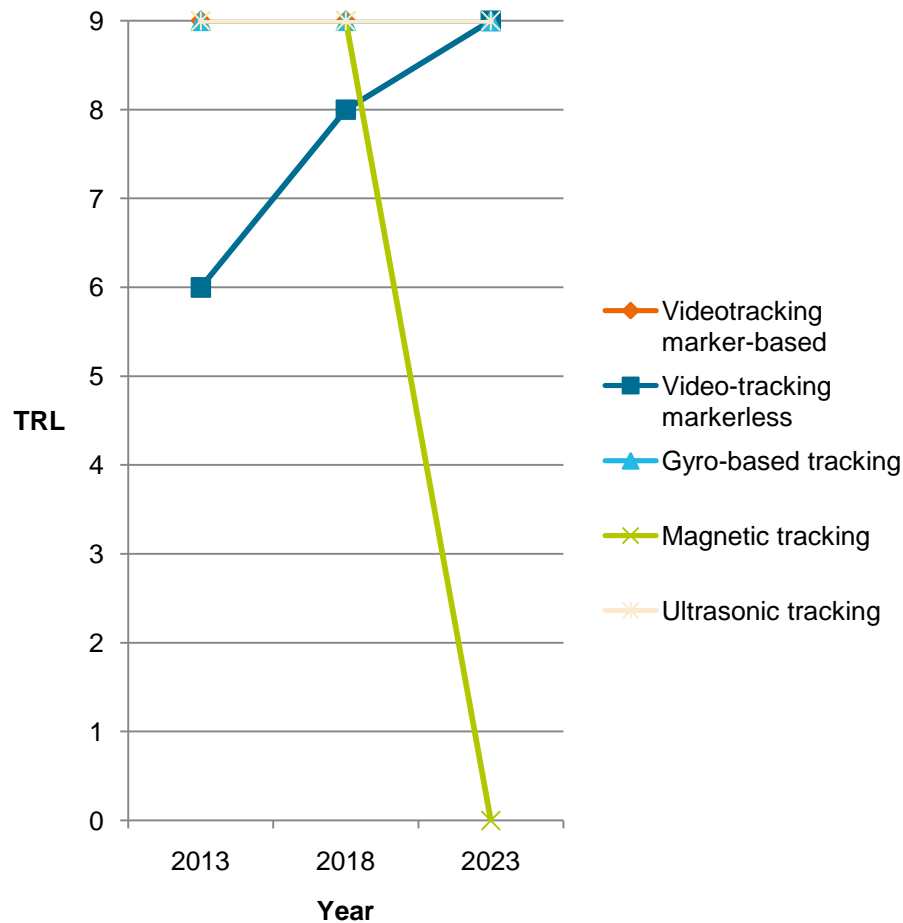


# Technology Roadmap - Display Technology (for VR)



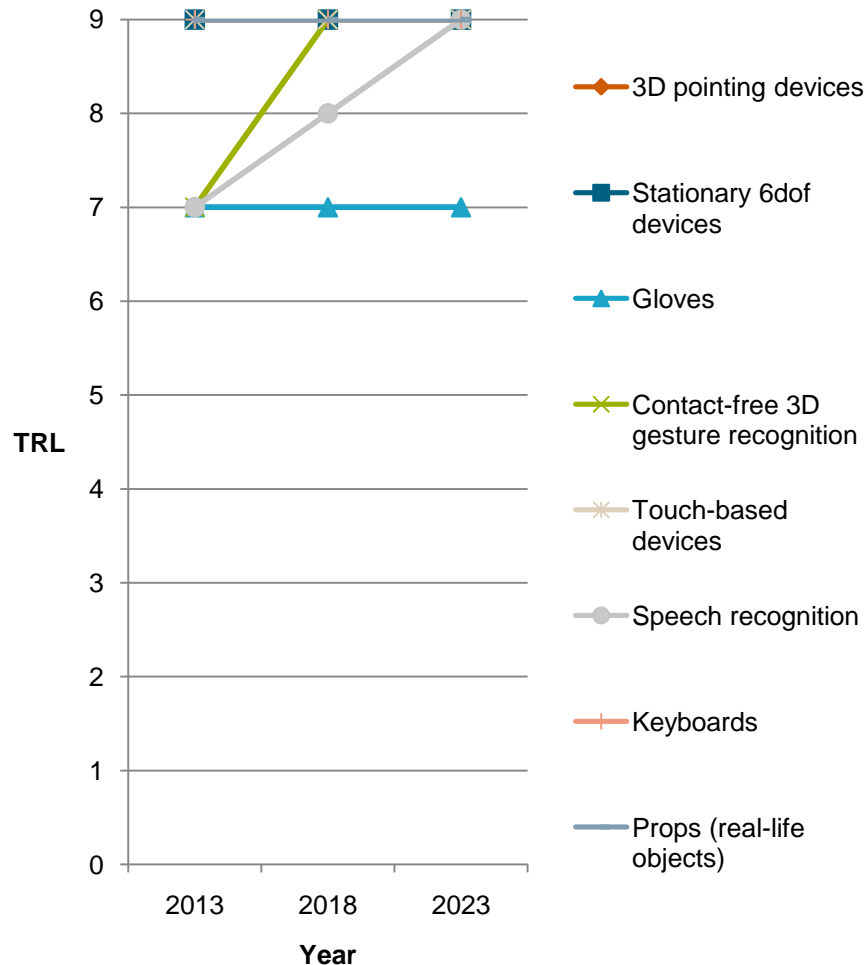
- **High TRL for projectors and panels – they remain the standard**
- Autostereoscopic displays seem to stagnate
- Integral displays are an existing niche but will not reach high TRL
- **Retina displays are the universal head-mounted candidate for the future**

# Technology Roadmap - Tracking



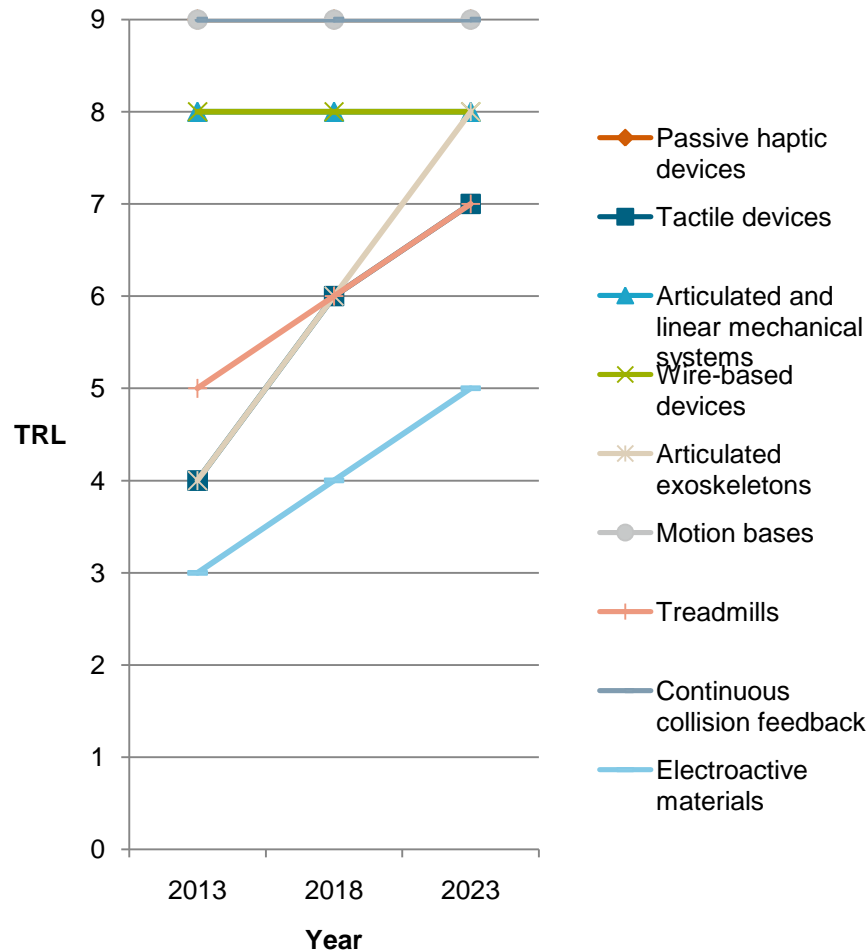
- **High TRL for established tracking technologies**
- Marker-based video tracking is the benchmark
- **Markerless video tracking is the evolving technology**
- Magnetic tracking becomes obsolete

# Technology Roadmap - Interaction Devices



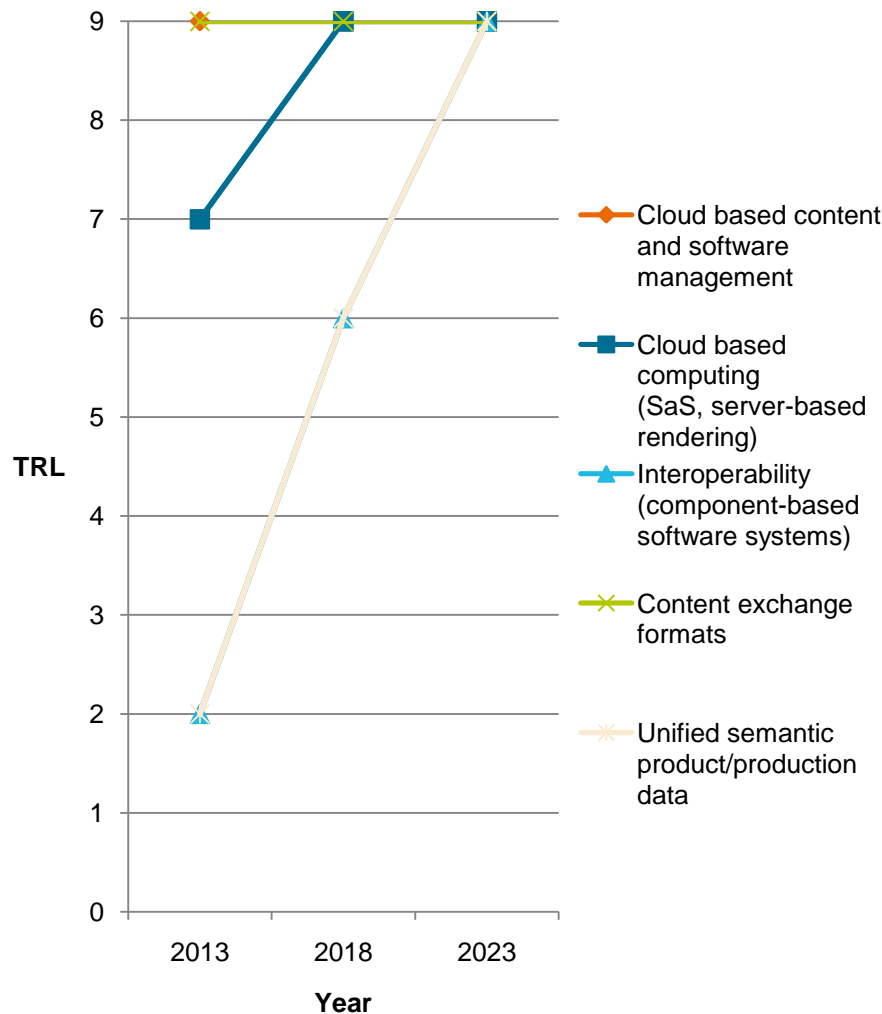
- Established interaction devices remain in use
- **Contact-free gesture recognitions develops rapidly**
- Speech recognition evolves further and remains a bearer of hope
- Gloves stagnate

# Technology Roadmap - Haptic Devices



- Haptic technologies are immature and have limited development potential
- **Current research activities encourage expectations in development of exoskeletons**

# Technology Roadmap - Integration Technologies



- System integration technologies will further improve driven by developments in internet technologies
- **»Cloud« solutions for AR/VR will mature quickly**
- Interoperability technologies will reach TRL 9
- Considerable improvement in applicable product/ production semantic data



# VR and Visualization in Advanced Manufacturing

## Focus on application not on technology readiness

Scale	Value	Definition	ARL
WRL	3	Highly standardised and automated workflows	12
WRL	2	Automated workflow	11
WRL	1	Established repeated processes	10
WRL	0	Workflows not defined	9
TRL	9	Actual technology proven through successful deployment in an operational setting	9
TRL	8	Actual technology completed and qualified through tests and demonstrations	8
TRL	7	Prototype ready for demonstration in an appropriate operational environment	7
TRL	6	System/subsystem model or prototype demonstration in a simulated environment	6
TRL	5	Component and/or validation in a simulated environment	5
TRL	4	Component and/or validation in a laboratory environment	4
TRL	3	Analytical and experimental critical function and/or proof of concept	3
TRL	2	Technology concept and/or application formulated	2
TRL	1	Basic principles of concept observed and reported	1
ARL= Application readiness level			
WRL=Workflow readiness level			
TRL=Technology readiness level			

# Top 50% Applications in Advanced Manufacturing

## Application readiness levels partly insufficient

Rank	Lifecycle Stage	Application	ARL
1	Product Development	CAD review	12
2	Product Development	Ergonomic evaluation	12
3	Product Development	Interactive functional validation (DMU)	12
4	Production planning	Tool development / making	12
5	Sales	Product presentation	12
6	Product Development	Styling review	11
7	Production planning	Factory/facility planning	11
8	Production planning	Manufacturability	11
9	Sales	Product configuration/customization	11
10	Marketing	Tradefair product demonstration	10
11	Product Development	User Experience Validation	10
12	Sales	Requirement acquisition	10
13	Product Development	Simulation visualisation in CFD	9
14	Product Development	Validate virtual against physical prototype	9
15	Production planning	Assembly planning	9
16	Production planning	Ergonomic evaluation	9
17	Research	Early prototyping	8
18	Product Development	Requirement acquisition	8
19	Production planning	Stakeholder communication in facility planning	8
20	Maintenance	Maintenance planning	8
21	Maintenance	Maintenance instructions AR	8
22	Marketing	Showroom	7,5
23	Product Development	Simulation visualisation in functional validation	7,5

### Life Cycle Stages



■ N=46

■ ARL scale 0 - 12

# Applications in Advanced Manufacturing

## Many with higher ARL and potential benefits

	ARL	Potential Benefit
<b>Marketing</b>		
Tradefair product demonstration	10	5,8
<b>Research</b>		
Virtual manufacturing development	7	9,7
<b>Product Development</b>		
Simulation visualisation in functional validation	7,5	8,5
Styling review	11	7,9
CAD review	12	7,4
Ergonomic evaluation	12	8,5
Interactive functional validation (DMU)	12	8,5
Validate virtual against physical prototype	9	7,9
<b>Production planning</b>		
Tool development / making	12	7,0
Factory/facility planning	11	8,1
Spatial documentation	5	7,9
Manufacturability	11	7,9
Assembly planning	9	7,9
Ergonomic evaluation	9	8,9
<b>Sales</b>		
Product presentation	12	8,3
Requirement acquisition	10	8,1
Product configuration/customization	11	8,3
<b>Phase-out</b>		
Dismantling planning of machinery	1	8,3
Decommissioning of plants	1	7,9

### Life Cycle Stages



- N=46
- ARL scale 0 – 12
- Potential Benefit 0 – 12

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# The APP<sup>SIST</sup> Project

## A German Industrie 4.0 project

**CPS-integrated** systems and services for mobile and context aware **knowledge** and **activity support** in smart production environments

### Objectives

- Development of holistic service-oriented architecture and system
- Use-case oriented implementation and validation
  1. Start up operation of new production component/line
  2. Root cause analysis and correction
  3. Maintenance, service and fault correction
- Integration of organizational and competence management issues



### Technology

- Context-sensitive and adaptive systems
- Service-oriented cloud enabled knowledge and learning management
- Mobile and augmented reality interface technology

**Partners:** DFKI, Fraunhofer IAO, RUB, IMC, MBB, Brabant& Lehnert, **Festo**

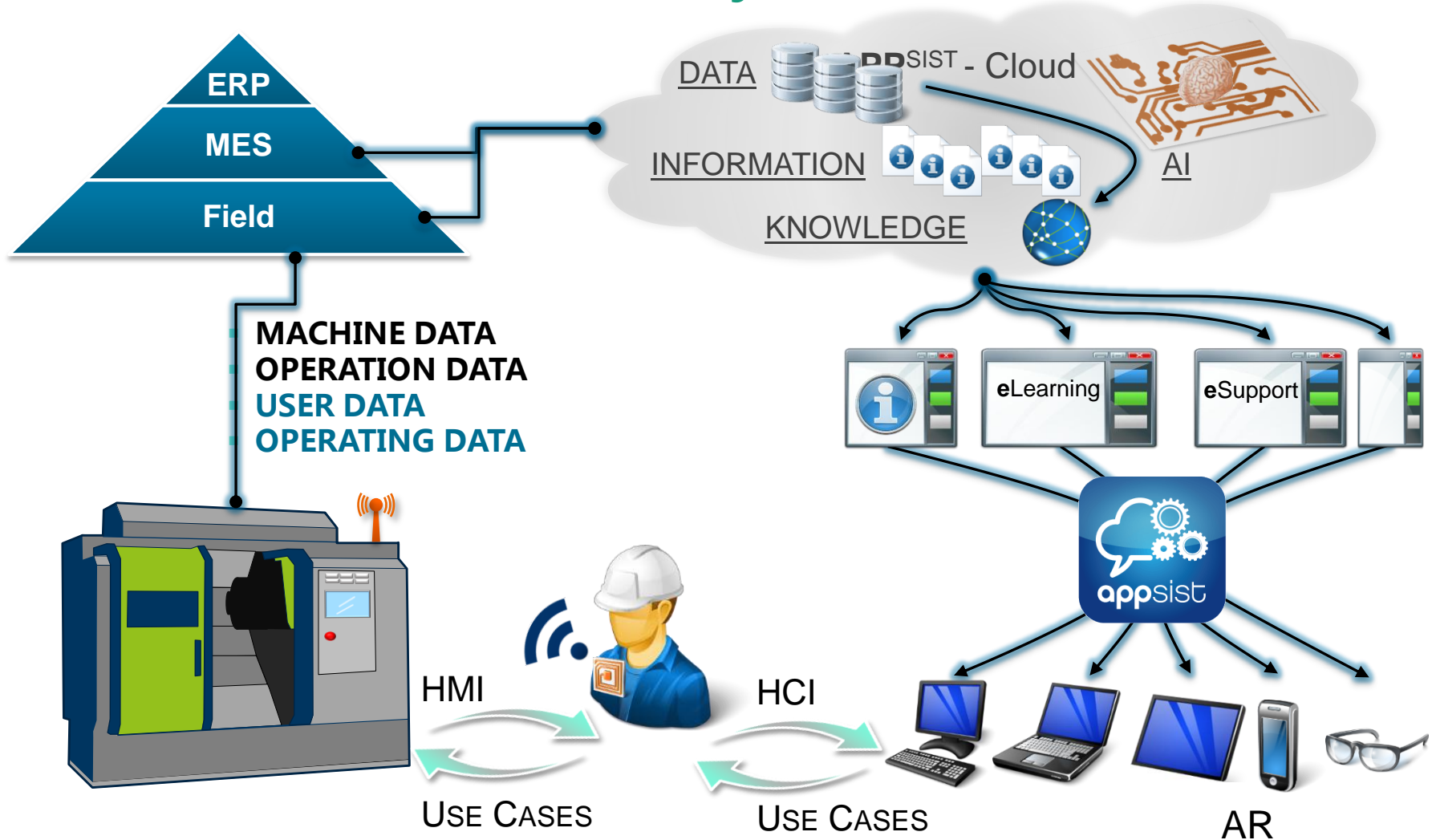
**Programme:**



**Budget:** ~5.7 Mio €

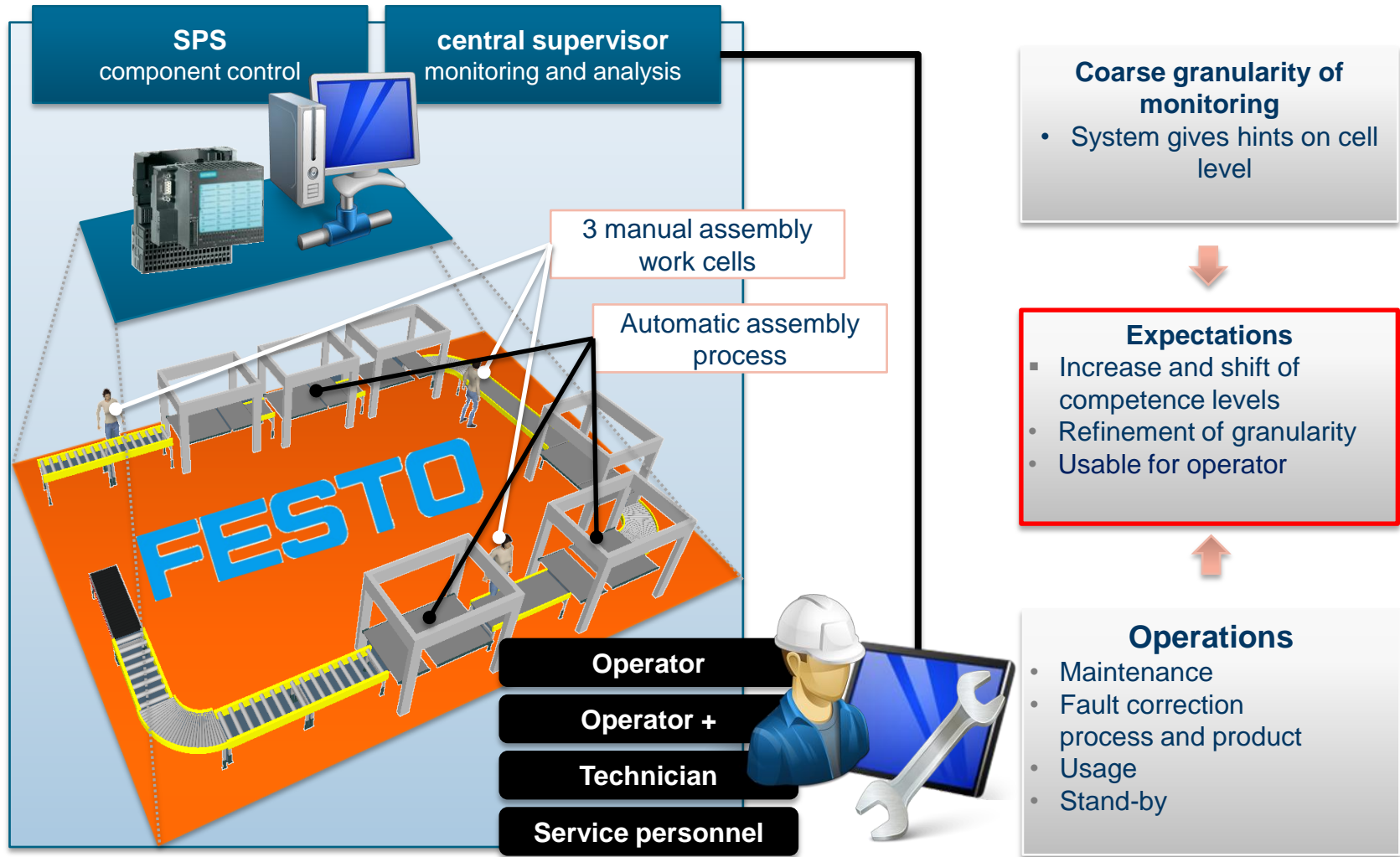
# Overview APP<sup>SIST</sup> – System Solution

## Interaction follows mobility and hands-free needs



# An APP<sup>SIST</sup> Industrial Use Case

## Increase and shift competence levels





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# VR Technology in Planning and Engineering

## Colocated team work with 3D models in VR





# VR Technology in Management

## Experience based decisions in groups



# Mondo Non Suffit – The World is not Enough

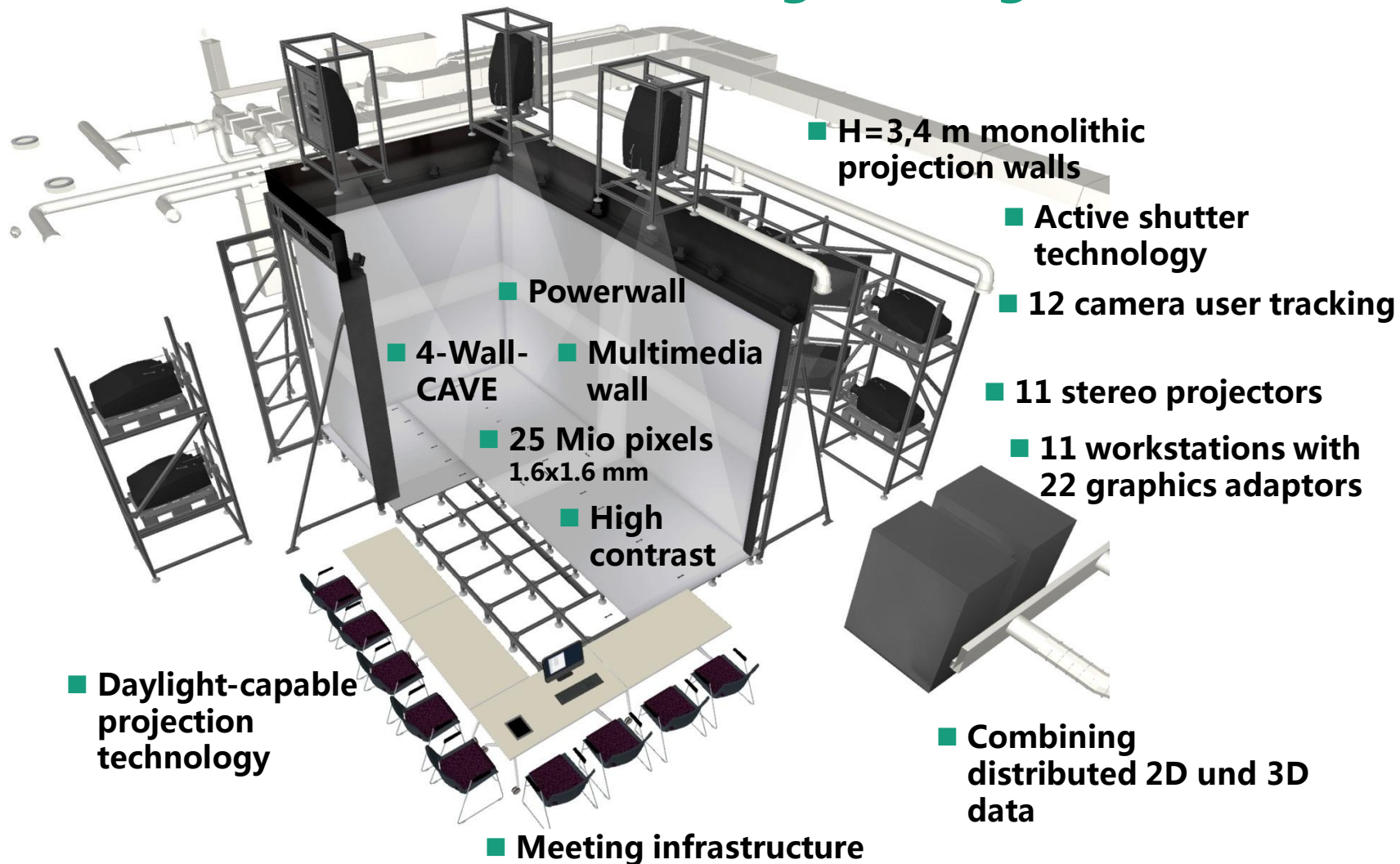
## Bring 3D world and background data together





# Immersive Engineering Lab

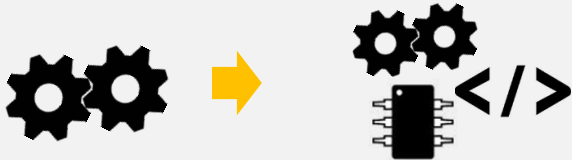
## SoA infrastructure for Virtual Engineering



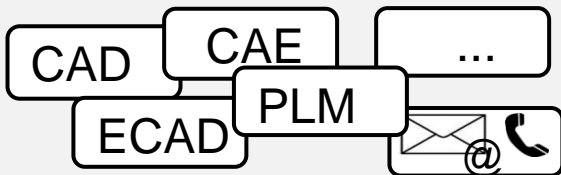
# IntelliDesk – The Engineering Workplace of the Future

## Surround yourself with your data

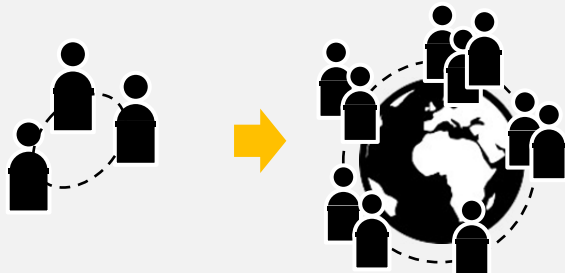
Products become more complex  
Mechanics      Mechatronics, CPS



Big software variety



More complex collaboration



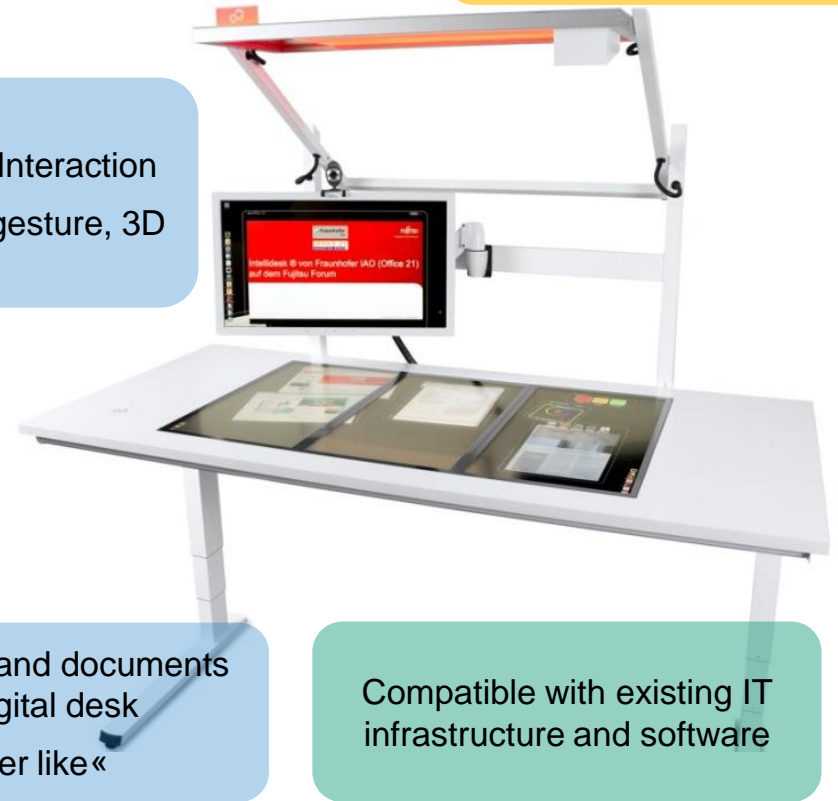
Unified communication  
integrated

Personalization: lighting  
and ergonomics

Multimodal Interaction  
multitouch, gesture, 3D

Applications and documents  
on a digital desk  
»paper like«


Compatible with existing IT  
infrastructure and software

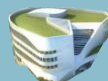


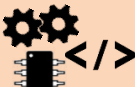
# Projection Table – The Meeting Room of the Future

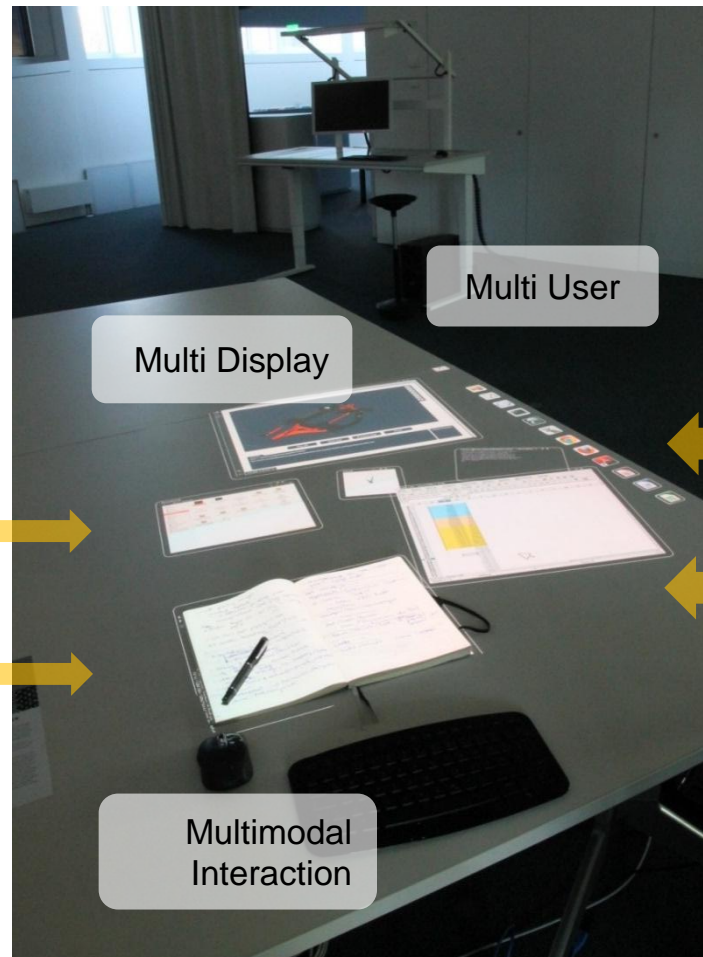
## Share your data with others

### Use Cases


 Quality and production planning


 Architecture and construction

 Product Engineering



### Integration

 Data / IT infrastructure

 Application software



# Carry Home Messages

- Industrie 4.0 and Advanced Manufacturing
  - We are living in the 4th Industrial (R)evolution
  - It is more than the Internet of Things – The Human Interaction aspect is crucial
- VR and Visualization in Advanced Manufacturing
  - Focus on application readiness - not on technology readiness
  - Application readiness level often insufficient
  - But there are applications with higher application readiness levels and potential benefits
- Visualization on the Shop Floor
  - Interaction devices will be selected according to mobility and hands-free needs
  - Immersion will be achieved by Augmented Reality
- Digital Experience and decisions in Planning and Engineering
  - Perfect VR worlds are not enough – we need background data to understand and decide
  - Instead of CAVES we need mixed media / mixed reality interaction environments
  - The workplace for Advanced Manufacturing will allow us to arrange all data around us and support 2D and 3D direct interaction
  - The display/projection environments in non-immersive meeting rooms have to change accordingly

# Contact

**Dr. Manfred Dangelmaier**

Director

Head of Business Unit Engineering Systems

Fraunhofer IAO  
and IAT University of Stuttgart

[www.iao.fraunhofer.de](http://www.iao.fraunhofer.de)

Phone +49 711 970-2107

[manfred.dangelmaier@iao.fraunhofer.de](mailto:manfred.dangelmaier@iao.fraunhofer.de)

Fraunhofer IAO  
Nobelstrasse 12 | 70569 Stuttgart | Germany

