Delegation of Kyoto Association Corporate Executives, October 29, 2018

Future is our product
Sustainable. Personalized. Smart.
Participants

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Agenda

Delegation of Kyoto Association Corporate Executives, October 29, 2018:
Visit at Fraunhofer Institute for Manufacturing Engineering and Automation IPA

13:30 Welcome and Introduction (Institute Director Prof. Dr. Klocke)
13:35 Presentation Fraunhofer IPA (Mr. Schleef)
13:45 Industry 4.0 - trends & solutions offered by Fraunhofer IPA (Mr. Schleef)
14:00 Automation & Robotics at Fraunhofer IPA, tour (Mr. Fabritius)
14:20 Application Center Industry 4.0, tour (Mr. Trierweiler)
14:45 Q&A, potentials for collaboration
15:15 Farewell, transfer to Fraunhofer IAO
Outline

- Introduction Fraunhofer Gesellschaft & Fraunhofer IPA
- Industrie 4.0: Digitizing, value-adding
Fraunhofer is the largest organization for applied research in Europe

- More than 80 research institutions, including 72 Fraunhofer institutes
- More than 25,000 employees, the majority educated in natural sciences or engineering
- An annual research volume of €2.4 billion, of which €1.6 billion is generated through contract research.
  - More than 70% of this research revenue derives from contracts with industry and from public founded research projects.
- International collaboration through representative offices in Europe, America, Asia and the Middle East
Fraunhofer IPA as part of the Fraunhofer-Gesellschaft

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

- One of the largest institutes of the Fraunhofer-Gesellschaft
- IPA located in Stuttgart, the capital of federal state of Baden-Württemberg
- More than 50 years of experience implementing innovations for the industry
- Main customers are equipment/machinery and automotive industry

Fraunhofer institutes and facilities

Other sites
Namesake: Joseph von Fraunhofer (1787 – 1826)

- **Researcher**
  Discovered the “Fraunhofer Lines” in the solar spectrum

- **Inventor**
  Developed a new method for processing lenses

- **Entrepreneur**
  Director and partner of a glassworks
Who we are
Fraunhofer IPA
Researchers. Developers. Pioneers.
Fraunhofer IPA
Researchers. Developers. Pioneers.

Source: ARENA2036, Photo: Deniz Calagan
Fraunhofer IPA
Technology consultant and innovation driver since 1959

- Total operating budget: 63.0 million Euro
- Total investment budget: 4.0 million Euro
- Total industrial revenues: 24.1 million Euro
- More than 1,000 employees

New technical center “Gebäude D” in Stuttgart
Note: key figures for 2017, all locations

Fraunhofer Institute Center in Stuttgart
## Fraunhofer IPA
with an interdisciplinary organization

### Directors:
Prof. Dr.-Ing. Fritz Klocke and Prof. Dr.-Ing. Thomas Bauernhansl  
Deputy Director: Dr. rer. nat. Michael Hilt

### Location
Stuttgart

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<tr>
<th>Automotive</th>
<th>Machinery and Equipment Industry</th>
<th>Electronics and Microsystems</th>
<th>Energy</th>
<th>Medical Engineering and Biotechnology</th>
<th>Process Industry</th>
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<td>Resource-efficient Production</td>
<td>Networked Production</td>
<td>Intelligent Automation and Clean Manufacturing</td>
<td>Medical Engineering and Biotechnology</td>
<td>Surface Engineering and Materials Technology</td>
<td>Manufacturing and Process Engineering</td>
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<td>Sustainable Production and Quality Management</td>
<td>Factory Planning and Production Management</td>
<td>Robot and Assistive Systems</td>
<td>Biomechatronic Systems</td>
<td>Coating Systems and Painting Technology</td>
<td>Additive Manufacturing</td>
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<td>Efficiency Systems</td>
<td>digiTools for Manufacturing</td>
<td>Ultraclean Technology and Micromanufacturing</td>
<td>Laboratory Automation and Biomanufacturing Engineering</td>
<td>Electroplating</td>
<td>Lightweight Construction Technology</td>
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<td>Image and Signal Processing</td>
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<td>Functional Materials</td>
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### Additional Locations
- Fraunhofer Austria Research GmbH, Wien Production and Logistics Management
- Fraunhofer Project Group for Production Management and Informatics PMI, Budapest
- Fraunhofer Project Center for Electroactive Polymers at AIST Kansai
- Fraunhofer Project Group for Automation in Medicine and Biotechnology (PAMB), Mannheim
- Fraunhofer Project Group Sustainable Manufacturing, Bayreuth

### Administration and Business Development

Version as of: 06/2018

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Competences of Fraunhofer IPA
- key competences of our 14 departments -

1 - Sustainable production and quality
- Resource-efficient material flows - Product development & lifecycle
- Management of hazardous substances - RoHS, REACh & measurements
- Quality management - optimized procedures and methods
- Maintenance and asset management – predictive maintenance

2 - Efficiency systems
- Energy management and optimization – implement efficiency projects
- Energy-efficient technologies and processes – efficiency by design
- Urban production – production plant environment
- Industrial smart grids - control energy efficiency and -flexibility
- Energy policies, strategies and financing


3 - Factory planning and production management

- Factory planning – from design to start of production
- Production management - value stream, process design & logistics
- Planning production strategies
- Planning assembly and manufacturing systems
- Supply Chain Management
- Lean (order) management

4 - DigiTools for manufacturing

- Cloud-Platforms - cut IT costs and optimize production processes. Virtual Fort Knox (VFK) – federative, safe cloud platform.
- Manufacturing systems – business processes linked through Industrie 4.0
- Software development process - high-quality, secure and cost-effective
- Production IT-solutions – providing the suitable tools

Competences of Fraunhofer IPA
- key competences of our 14 departments -

5 - Robot and assistive systems
- Intralogistics and material flow
- Welding and machining – robots for precision and high pay loads
- Assembly automation - fully- or partially-automated solutions
- Industrial and commercial service robots - autonomous assistants
- Household robotics: www.care-o-bot-4
- Software engineering and systems integration - Open-source software
- Planning and development of robot systems – IPA as your neutral partner

6 - Ultraclean technology and micromanufacturing
- Cleanliness technology - Cleanrooms and laboratories
- Cleaning technology – certification Fraunhofer TESTED DEVICE®
- Metrology
- Precision assembly and application technologies
- Clean Automation Technology - handling of fragile substrates

7 – Machine vision and signal processing
- 2D measurement and testing
- 3D measurement and testing including computer tomography
- 3D object recognition
- Scene analysis
- Process control and quality forecast
- Quality 4.0
- Machine learning
- Automation solutions
- Measurement services

8 – Biomechatronic systems
- Drive systems and exoskeletons - mechatronic assistance for humans
- Ergonomics - sustainable solutions for the worker
- Applied biomechanics – kinematics, design for prostheses and orthoses
- Biomimetics in Medical Engineering – transfer of natural principles
- Motion Control Systems – movements of humans while working
- Virtual Orthopedic Lab

Competences of Fraunhofer IPA
- key competences of our 14 departments -

9 – Laboratory automation and biomanufacturing engineering

- Automated laboratory devices, systems – from development to pilot production
- Automated cell and tissue culture – cell handling, controlled process sequences
- Liquid handling and related robotics - process automation, I-DOT nano dispensing technology
- Laboratory IT – development of control architectures, authorized SiLA Test Site

10 – Coating systems and painting technology

- Pigments and coatings – new formulas and processes
- Applied coating technology
- Analytics and material testing
- Wet application and simulation technology
- Powder application technology - TransApp® technique
- Paint process engineering – innovative plant design

https://www.ipa.fraunhofer.de/en/cooperation/industry-on-campus/niclas.html
Competences of Fraunhofer IPA
- key competences of our 14 departments -

11 – Electroplating
- Process development – new application techniques
- Plant design – tailored systems
- Consulting services – covering all aspects of electroplating
- Failure analysis - on-site analyses & corrective measures


12 – Functional Materials
- Energy storage – processes for batteries and supercapacitors
- Synthesis and functionalization of new materials
- Dispersion technology
- Application technology - printing and coating in production processes

13 – Additive Manufacturing
- Developing additive manufacturing processes
- Automating additive processes
- Hybrid process chains - complementary technologies for new applications
- Digital printing technologies - Inkjet printing and electrophotography

14 – Lightweight construction technologies
- Lightweight design – for energy and resource efficiency
- Machining and cutting technologies - development and implementation
- Sawing technologies - blades and machining processes
- Joining – huge improvement potential in current production processes
- Health protection and dust & chip extraction technologies
- Quality assessment - special measuring


Technical equipment and laboratories
In tune with the times

- Application Center Industrie 4.0
- Motion laboratory
- Biomanufacturing laboratory
- Factory planning cockpit
- Future Work Lab
- Electroplating laboratory
- Intervention room
- Labs for additive manufacturing
- Labs for cutting, joining and sawing
- Coating technology center
- nICLAS Laboratory automation
- Production laboratory
- Cleanrooms & cleanliness rooms
- Robotics experimentation area
- Model factory for functional coatings
- Virtual Orthopedic Lab

© Fraunhofer IPA
Typical Forms of Cooperation with Fraunhofer IPA

**Bidirectional R&D Projects**
- Specific R&D task, study, test, prototype
- Objective → offer → result/tech transfer
- Standard form of collaboration (>50%)

**Strategic co-operations**
- Longer term framework agreement
- Strategic R&D (roadmap), tech transfer → Your R&D, pre-development resource

**Why Fraunhofer?**
- Neutrality, non-profit
- Experience, competence, infrastructure
- Industrial mind-set, processes, quality
Strategic Cooperations @Fraunhofer IPA: Examples

- **Trumpf**
  - Automation and IT in sheet metal manufacturing,
  - Control technology/Industrial IT of the future
  - Big Data

- **Denso (Japan)**
  - Automated agile production lines (assembly)
  - Human-robot-collaboration, IT architecture
  - Intuitive configuration, use, servicing, agile lines

- **Schunk**
  - Gripping technology of the future
  - MRK/I4.0-gripper, Machine Learning

- **DESMA**
  - Injection molding machines – predictive maintenance
Fraunhofer IPA
working hand-in-hand with German industry

- Over 1,000 projects with industrial customers each year
- Goal: to improve the competitiveness of manufacturing companies with a focus on the strategic cornerstones of mass sustainability and mass personalization
Fraunhofer IPA
with an international network

- Field offices and project centers in Germany, Austria, Hungary and Japan
- Further partnerships under development in the USA and China
- A fifth of all projects are outside Germany

Source, left-hand photo: School of Mechanical Engineering, Shanghai JiaoTong University
Fraunhofer IPA with a scientific reputation

- 32 in-house inventions
- Over 50 newly-published patent specifications
- More than 700 publications
What we offer
Manufacturing topics of today and tomorrow
Trends influencing our work

Manufacturing organization
- Service engineering and hybrid business models for decentralized production and complex value systems
- Adaptable manufacturing systems
- Highly-efficient energy usage and energy management
- Resource and quality management

Production processes
- Generative processes
- Machining fiber and composite materials
- Processing functional and nano materials
- Coating technologies and materials
- Flexible machines and handling systems

Information and communication technology, automation
- Data-based and knowledge-based systems and processes
- Cyber-physical manufacturing systems, decentralized automation solutions

Robotics and assistive systems
- Human-factory interaction
- Laboratory automation
- Production of / with biological systems

Source: BMBF-Foresight-Zyklus II, search phase 2012-2014, 3rd interim result; selected research and technology perspectives 2030
Networking science and practice
Fraunhofer IPA as a center for knowledge transfer
Cooperating at the highest level
What we do

- Product development and optimization
- Process development and optimization
- Technology development and optimization
- Assessments, tests and certifications
- Organization and procedure optimization
- Market analyses and innovation consulting
Cooperating at the highest level
What we offer

- Single orders
- Large-scale projects with numerous partners
- International collaborations
- Strategic partnerships
- Innovation clusters
- Spin-off companies
- Licenses
- Further training
Cooperating at the highest level
What sets us apart

- Innovation transfer to applications
- Objective consulting services as an independent contact partner
- Project teams tailored to specific requirements
- Excellent research and industrial network
- Topic-related seminars, events and study programs
Cooperating at the highest level
“Industry on Campus” with centers and labs

Automotive: “ARENA2036”
Ergonomics: “Future Work Lab”
Machines: “Metal processing of the future”
Laboratory: “nICLAS”

Note: selected current lighthouse projects
Cooperating at the highest level
"Industry on Campus“ with centers and labs

"Mass Personalization" performance center in Stuttgart

Development of cross-industry technologies, processes, manufacturing systems and new business models for manufacturing personalized products cost-efficiently in collaboration with industry

- for personalized assistive systems, medical and sports products
- In the field of modularized construction, transformable vehicle concepts, as well as consumer products and services
- in quality assurance, logistics and the manufacture of personalized therapeutic products
Digitizing value-adding
Development Stages of the Digital Transformation
From the digital image to the autonomous system

1. Digitization
   Creating digital images of analog processes (e.g. NC technology, 2-D CAD, MRP/ERP)

2. Virtualization
   Digitally modeling processes (e.g. CAD/CAM, FEM, digital factory)

3. Networking
   Connecting all value adding processes via broadband telecommunication (e.g. industrial IoT, cloud computing, CPS, 5G)

4. Autonomization
   Combining classic technologies and artificial intelligence to create autonomous, self-organizing systems (e.g. autonomous transport systems, autonomous robots)

Source: Fraunhofer IPA
Horizontal and lateral Integration
From B2B and B2C to Business to User (B2U)

Back End

Focus on value-adding

Focus on positioning

Front End

Ecosystem

Value-adding system

Production network

Factory

Service supplier

Prosumer

Horizontal integration

Lateral integration
Example for Business Ecosystems
»Farmnet 365« – an agricultural machinery initiative

- **Online Tracking**
  Real time access to farm information any time from anywhere

- **Traceability**
  Digital, automated and complete documentation

- **Transparency**
  Integration of all farm processes

- **Efficiency**
  Decision support and knowledge transfer

- **Quality**
  Tracking, documentation and early warnings

- **Analytics**
  Prediction, Big Data processing

source: farmnet
Example Trumpf: Customer becomes Prosumer in the Manufacturing of Stamping Tools

Mass Personalization through radical rationalization of inefficiencies within the complete value system

- Customer configures and plans individual stamping tool on a platform and dispatches the order autonomously (prosumer).
- Order information (incl. NC-programs) is generated automatically and transferred to shop floor (CAD/CAM/digital twin).
- Work piece controls manufacturing (autonomous production/ digital shadow).
- Workers cooperate with robots and machines (human as conductor of value creation).

- productivity: +120 %
- space requirement: -35 %
- delivery reliability: +140 %
- delivery time: 4h instead of 4 days
- customer complaint rate: -80 %
Robots are getting mobile, flexible and safe

Example:
SEW Eurodrive – free navigating AGV carries robot for „bin picking“
## Industrie 4.0 @ Fraunhofer IPA
### Our Service Portfolio

<table>
<thead>
<tr>
<th>Industrie 4.0 Services</th>
<th>Content</th>
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<td>Industrie 4.0 Readiness Check</td>
<td>7-step-model for introducing Industrie 4.0 production</td>
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<tr>
<td>Industrie 4.0 Business Models</td>
<td>Enterprise-specific adaption and orientation of strategic position towards digitization and networking</td>
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<td>Industrie 4.0 Studies</td>
<td>Design and realization of significant and valid studies in the field of Industrie 4.0</td>
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<td>Industrie 4.0 Maintenance</td>
<td>Smart and predictive maintenance</td>
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<td>Industrie 4.0 Solutions</td>
<td>Production-IT-architectures, cyber-physical production systems, IT-services, Quality 4.0, Internet of things and big data</td>
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<td>Application Center Industrie 4.0</td>
<td>Cooperative development and research platform</td>
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<td>Education and Training Program I4.0</td>
<td>Seminars and workshops in the area of Industrie 4.0 coordinated by the Stuttgart Production Academy</td>
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**Industrie 4.0 Roll-out**

7-step model for introducing Industrie 4.0 production

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<td>expert</td>
<td>decentralized design of use cases in the</td>
<td>decentralized design of use cases with</td>
<td>communication and involvement of staff, shop</td>
<td>implementation of use cases (80-20 rule)</td>
<td>definition of roadmap for roll-out of successful</td>
<td>roll-out over the whole enterprise with continuous</td>
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<td>information</td>
<td>company focus on real-time decentralization,</td>
<td>executive management goal: selection of</td>
<td>committee customers, suppliers, lead customers,</td>
<td>cost and benefit of cases over the whole</td>
<td>Industrie 4.0 use cases over the whole</td>
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**Contact:** Andreas Bildstein, Competence Center Digital Tools for Production
Andreas.Bildstein@ipa.fraunhofer.de, +49 711 970-1255
Cooperating at the highest level
What could be the first steps

- Production-Quickcheck - Company faces a challenge, IPA brings technical expertise
- Orientation Workshop - IPA advises on innovation and production structure
- Feasibility Study - IPA determines potential of e.g. innovative process
- Technology-Scouting - IPA helps to find technological options for e.g. a process
- Potential analysis - IPA supports through workshop and implementation phase
- Cooperation long-term - Innovation framework set-up for several years
- I4.0-Readiness Checks - see slides above
- Ultra-F-Check - Efficiency check regarding resources and energy
- Project Collaboration - Support needed for Project Work related to Innovation
  - IPA helps with expertise

- Refer to website
Application Center Industrie 4.0
Our showcases

Showcase: Autonomous Production
Self-controlled operation and autonomous optimization

Showcase: Digitizing Value-Adding
Rule-based production through data connectivity

Showcase: The Personalized Product
Additive manufacturing technologies and data analytics

Showcase: Humans as Conductors
Cyber-physical systems for personalized assistance
Fraunhofer IPA
Your contact partner

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Future is our product
Sustainable. Personalized. Smart.

Giving you a competitive edge

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www.wir-produzieren-zukunft.de