Research landscape and selected projects

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Who are we?
...and what is it we do every day?
Fraunhofer Austria Research GmbH
Connected with Science and Practice

- Research for the benefit of businesses and as an advantage for society
- Development of innovative, industry oriented methods and technologies
- Scientific findings translated in usable innovations
- Provider of Know-How for small and medium-sized enterprises without R&D departments on their own

- Cooperation between Fraunhofer, TU Wien and TU Graz
- Involvement of Fraunhofer in Teaching / Involvement of Students in R&D and consulting projects via master thesis and employment

Teaching
Applied Research
Projects Financed by Industry
Vienna University of Technology
Institute of Management Science IMW

Institute of Management Science
- Head of Institute: Univ.Prof. Dipl.WirtschIng. Dr.-Ing. Sihn Wilfried
- Staff: approx. 50 (not included: tutors and further staff)

- Research departments

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<tbody>
<tr>
<td>Univ.-Prof. Mag. Dr. Sabine T. Köszegi</td>
<td>Univ.-Prof. Prof. eh. Dr.-Ing. Dr. h.c. Dipl. Wirtsch.-Ing. Wilfried Sihn</td>
<td>Univ. Prof. Dr.-Ing. Sebastian Schlund</td>
<td>Univ.-Prof. Mag. Dr. Walter Schwaiger</td>
<td>Ao. Univ.-Prof. Dipl.-Ing. Mag. Dr. Alexander Redlein</td>
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Source: TU Wien, 2017
Fraunhofer Austria Research GmbH

- Full subsidiary of the **Fraunhofer-Gesellschaft**, founded in 2008
- Non-profit research organization

Division **Production and Logistics Management in Vienna:**
- Excellence in Operations Management: Optimization of industrial value adding processes and structures

Division **Visual Computing in Graz:**
- Digitalization, Virtualization, Visualization

**Fraunhofer Austria Innovation Center in Wattens (IZT):**
- Digitalization, Smart Data Analytics
Range of Services – Current Main Topics
Initial Research, In-House-Development, Funded Research Projects

Main Innovation Topics

- Industry 4.0 Road mapping
- Smart Maintenance
- Design of cyber-physical assembly systems
- Real-time logistics and production planning
- Value chain for generative production
- Resource efficient production design
- Integrated value stream management → FhA-Tool VASCO
- Factory and layout planning → FhA-Tool GrAPPA
Learning & Innovation Factory

- Display of a factory as a demonstration laboratory
- Learn environment for a hands on training of methods
- Industry-orientated and integrative education for industrial engineers

Pilot-Demonstration Plant

- Representation of a physical and virtual display of a best case factory
- Bundle of different competences of industry partners and research
- New prototypes, production technologies and systems as well as process technologies are tested together in a safe environment

Doctoral College

- Initiative of TU Wien

  Topics:
  - Productivity- and Employment-oriented Working System Design in CPPS
  - Virtual Engineering Design of CPPS
  - Cell Controller Design for Robotized Manufacturing Cells in the Smart Factory

Endowment Professorship

- Financed by:
  - Funding by BMVIT (Austrian Federal Ministry of Traffic, Innovation and Technology)
  - Equity capital of university
  - Cash payment of co-financing partners

- Includes the development and establishment of new research topics in Austria 
  such as Human Centered Cyber Physical Production and Assembly Systems by Sebastian Schlund

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Industry 4.0
Main-Modules of Industry 4.0

Internet (IoT, IoS, IoP)
• Linking of the individual Systems
• IoE allows data- and real-time-based integration of all actors

Smart Factory
• Linking people, machines and resources

Cyber-Physical-Production-Systems
• Specified application of CPS on the manufacturing industry

Cyber-Physical-Systems
• Merging physical objects with the virtual world on the IoE
• e.g.: Virtual Reality in Production

Embedded Systems
• Integration of hardware- and software-components in a comprehensive technical system

Source: http://www.alfred-kindl.de; IT INDORE; http://www.festo-didactic.com;

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Pilot-Demonstration Plant by TU Wien
Overview and fields of application

Overview

- Research, development and demonstration of new technologies and systems
- Display of a plant as an experimental laboratory
- Realistic industrial education and research environment

Realistic Model of a plant in a laboratory – Real industrial machines and logistic systems in a neutral test and research environment

Fields of Application

Production Processes & Systems
Cyber-Physical Assembly Systems
Adaptive Logistics Systems
IT Integration & Digital Twin
Selected Research Topics
Data based maintenance using innovative forecasting algorithms

Initial Situation
- 15% - 60% of operating costs are used for maintenance
- ~ 30% of maintenance costs due to:
  - Premature part and tool change
  - Unplanned breakdown

Cause:
- Missing data material and insufficient data quality
- Missing connection of product-, process- and machine-data
- Missing knowledge about influencing factors
- Heterogenic system landscape

Objective and Use
Data based maintenance using forecasting algorithms to improve system availability and process stability.
- Development of data based decision making tool
- Application, testing and evaluation of sensor data
- Development of automated learning algorithms / dynamic set of rules
- Generation of recommendations for action
Selected Research Topics
Maintenance 4.0

Initial Situation
- A perfect component change in terms of time and wear, coordinated with production programs and quality, is not possible due to a lack of connection between machine, product and process data and information.
- Therefore maintenance is often performed at a wrong time, which leads to a wastage of resources. Equipment availability is purchased in exchange for high maintenance expenses.

Results & Exploit
- Maintenance control station and app fro:
  - Forecasting failure time
  - Visualizing current machine data and KPIs
  - Display of deviations in quality data
- Exploit:
  - Reduction of downtime by 12-15%
  - Reduction of unpredicted downtime by 10%
  - Saving of maintenance costs by 15%
  - Improvement of equipment availability
  - Reduction of expenses concerning preventive maintenance
  - Better decision-making & Planning capability

Machine Level

External Factors
output
- Product (Quality)
  - quality-oriented maintenance

Maintenance Planning
input
- Process (Production Program)
  - load-oriented maintenance

Partner & Founding Bodies

FFG
TU WAGEN
PIMPÁEL
GET THE WORK FLOW
MINTW
Fraunhofer Austria
Selected Research Topics
Industry 4.0 Maturity Model

Company specific Target State

Potential

Current State

Business Model

Employee

Strategy

Technologies

Processes

Customer

Standards

Products

Company specific

Culture and Leadership

Potential

Roadmap

Implementation Projects

Analysis Service Process & Requirements or assistance system

Technical Implementation of position control

Requirements specification and selection of system

Outlook: Automation of trimming process

Implementation of assistance system

Identification and Application of Sensor

Overall Evaluation

Detailed Evaluation

Evaluation Model
The research project BaMa has developed an energy-aware APS to optimize PPC according to ecological and economic goals simultaneously:

- Monitoring of energy consumption
- Prediction of energy consumption
- Optimizing the production planning to boost energy efficiency
Selected Research Topics
MMAssist – Assistance Systems in the Production for Human-Machine-Cooperation

- **Objectives & Tasks:** Research on assistance systems for trendsetting, human-focused work places involving human-machine-cooperation.

- **Our Contribution:** Development of adaptive assistance systems using human-machine cooperation in production
  - Modularization of cyber-physical assembly systems
  - Identification of assistance demand in context
  - Methods to evaluate work/assistance experience and production efficiency
  - Experimental implementation and evaluation
Generative production technologies will disrupt the industry. They can be used as supplements to conventional technologies, but to reach full potential, business models and value chains have to be rethought.

The research objectives of TU Wien and Fraunhofer in this project are investigations from a product and value creation process perspective as well as business model development in additive manufacturing.
Selected Research Topics
Power Semiconductor and Electronics Manufacturing

This international research project drives the development of **self-controlled factories** forward. Its main topics are:

- Smart Production
- Cyber-Physical Production Systems
- Social impact of Industry 4.0 on future workplaces

The **research content of TU Wien** contains:

- Industry 4.0 Compatible MES Systems
- Smart Process Control Systems
- Automated Decision Making Support
- Technology Assessment
**Selected Research Topics**

Position finding based material flow in Real-Time

- **Automated** data generation, acquisition and analysis in **Real-Time**
  - Transportation
  - Material
  - (Empty) truss
  - Equipment (e.g. devices)

- Addition of historic, manual booking details to increase data quality and consistency
Selected Research Topics
Digital Twin

Initial Situation
Precise planning and controlling not possible due to:
- Insufficient data basis
- Discontinuous IT-system
- Interface losses between disparate planning level

Simulation based planning and controlling tool rooted in a Real-Time, holistic and digital image of the production system.

Objective and Use
Tool using a Digital Twin for:
- Flexible production planning
- Dynamic and autonomous production controlling
- Multi-criteria production optimization
- Visualizing of Live-Dashboards
Could this be relevant?

...which elements of our industry related work might fit this project?
Einführung ins Lean Management

Die 7 (9) Verschwendungsarten aus dem Toyota-Produktionssystem

Überproduktion: Produzieren, was nicht benötigt wird
Bestände: Hohe Umlaufbestände sowie aufgeblähte Material- und Fertigteilelager
Wartezeiten: Liegezeiten von Material zwischen Prozessschritten; Mitarbeiter warten auf Maschinen oder Material
Ausschuss: Unterbrechung des Flusses durch Fehler; benötigt Zeit, Aufwand und Fläche für Analyse und Beseitigung
Bewegung: Unnötige Wege zur Beschaffung bzw. Suche von Material, Werkzeugen oder Informationen
Transport: Bewegung von Material zwischen Prozessschritten oder zu und von Lagerflächen, lange Transportwege, provisorisches Abstellen und unnötig häufiges Ein- und Auslagern
Bearbeitung: Überdimensionierte Maschinen, falsche oder fehlende technische Ausstattung, Rüstzeiten, Zwischenreinigung, ungünstiger Produktionsablauf an der Maschine oder in der Montage, Nacharbeit
Kommunikation: Unzureichende Kommunikation führt zu mehrmaligen Nachfragen oder aber auch zu Missverständnissen
Unnötige Prozesse: Prozesse, welche keinen Mehrwert besitzen
Einführung ins Lean Management
Lean Production | Auswahl Ansätze/Methoden/Werkzeuge

Lean-Production Methods (Elements of Production Systems)
Wertstromdesign
Gesamtprozesse effizienter gestalten

Ist-Zustand

Soll-Zustand
Wertstromdesign | Merkmale eines effizienten Wertstroms
10 Leitlinien für die Konzeption von Soll-Wertströmen

1. Orientierung am Kundentakt
2. Kontinuierlicher Fluss
3. FIFO Bahnen
4. Pull-System (Supermarkt)
5. Schrittmacherprozess (Ein-Punkt-Steuerung)
6. Flexibilität durch Ausgleich des Produktionsmix
7. Freigabe von kleinen, gleichmäßigen Arbeitsportionen
8. Verbesserung von Engpässen
10. Wertstromorientiertes Layout

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Arbeitsplatzorganisation mittels „5S“
„5S“ - Der Weg zur verschwendungsfreien Produktion
Analysemethoden | Kurzübersicht
Strukturiertes Vorgehen und sichere Ergebnisse durch Methodeneinsatz

<table>
<thead>
<tr>
<th>Methoden</th>
<th>Prozessanalyse</th>
<th>Zeitanalyse mittels MTM</th>
<th>Tätigkeitsstrukturanalyse</th>
<th>Wertstrom-Design</th>
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<tbody>
<tr>
<td>Technologiebewertung</td>
<td><img src="image1" alt="Diagramm für Prozessanalyse" /></td>
<td><img src="image2" alt="Diagramm für Zeitanalyse mittels MTM" /></td>
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<td>Layoutanalyse</td>
<td><img src="image5" alt="Diagramm für Technologiebewertung" /></td>
<td><img src="image6" alt="Diagramm für Layoutanalyse" /></td>
<td><img src="image7" alt="Diagramm für Materialfluss-Optimierung" /></td>
<td><img src="image8" alt="Diagramm für Optimierung/Simulation" /></td>
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Wertstrommanagement-Tool VASCO
Effizienteres Wertstromdesign durch Tool-Unterstützung

Intuitive grafische Bedienung

standardisierte Berechnung von KPIs & Datenlinien

Verschwendungen identifizieren & Energiepotentiale aufdecken

Kostenreduktion sofort bewerten

„Exploring your value streams“
Materialflussoptimierung & Layoutplanung

Materialflussanalyse-Modell: Aufbau und Ablauf

- Flächen-Bilanz & Transportwege
- Stücklisten & Materialeigenschaften
- Stückzahlen & Stückzahlentwicklung
- Arbeitspläne → Prozessabfolge
- Layoutvarianten (Ideal & Real) erstellen
- Transportaufwand-Bewertung
- Nutzwertanalyse mit weiteren Bewertungskriterien

Layoutkonzept
Materialflussgünstige Werks-Struktur
Wachstumsflächen und günstige Flächennutzung
Nahtlose Vorbereitung der Detailplanung (durch durchgängiges Materialflussmodell)
Materialflussoptimierung durch Layout-Maßnahmen

► Neuanordnung von Bereichen und Anlagen

**Wirkungspotential Layout-Maßnahmen**

<table>
<thead>
<tr>
<th>Szenario</th>
<th>Transportaufwand [m]</th>
<th>Reduktion um</th>
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<tbody>
<tr>
<td>IST</td>
<td>2 482 839</td>
<td>0%</td>
</tr>
<tr>
<td>fixe Stationen</td>
<td>1 703 639</td>
<td>31%</td>
</tr>
<tr>
<td>alles neu - Version 1</td>
<td>1 328 619</td>
<td>46%</td>
</tr>
<tr>
<td>alles neu - Version 2</td>
<td>1 113 222</td>
<td>55%</td>
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</table>

Produktgruppe xy
Jahresstückzahl: 1.899
Das kann nur Simulation leisten
Typische Anwendungsfälle für den Simulationseinsatz in der Produktion

Komplexe Systeme → analytische Lösung nicht möglich
- viele Elemente (Kapazitäten), Wirkzusammenhänge & komplexe Materialflüsse
- Statisch-analytisch höchstens stark vereinfacht zu berechnen
- Sim. kann Komplexes detailliert & realitätsnah planen

Systeme abhängiger Kapazitäten planen
- Vorgangszeiten sind real immer stochastisch fluktuierend (Abweichungen vor allem bei manuellen Vorgängen)
- in Vorgangskette akkumulieren sich die Verzögerungen!
- Sim. kann stochastische Fluktuation vollständig erfassen

Vorgänge im Zeitverlauf planen
- exakte Auftragsreihenfolgen, veränderliche Kapazitäten → statische Rechnung nicht aussagekräftig!
- exakte Bewegungsfolgen als Planungsgegenstand
- nur Simulation bildet den Zeitverlauf ab

Auslastung

zwei identische Aufträge: trotz $\sum_{Vorzug} = \sum_{schneller}$ ist Gesamtverzug $t_{G-Verzug}$
Produktion im Takt
Effizienzsteigerung und Planbarkeit der Produktion

Produktionsplanungskonzept

- Takt setzt einen Standard, der langfristig über KVP verbessert werden kann
- Nebenzeiten der MitarbeiterInnen werden reduziert
- über einfache Produktionsplanungsregeln kann eine harmonische Produktion erreicht werden
- nicht nur „strenger Produktionstakt“, auch taktorientierte Fertigung ist möglich
We are looking forward to accompanying you in innovative projects...

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