Research landscape and selected projects

Wien, April 2018

Dr. Thomas Sobottka

Vienna University of Technology
Institute for Management Science
Department
Industrial and Systems Engineering

TU-Wien

Institute of Management Science

Department of Industrial and Systems Engineering

Who are we?

...and what is it we do every day?

Fraunhofer Austria Research GmbH

Connected with Science and Practice

TECHNISCHE UNIVERSITÄT WIEN Vienna University of Technology | TU Graz | Fraunhofer AUSTRIA | Wirtschaft und Industrie

Teaching → Research → Development → Realization → Application

Teaching

- 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

Applied Research

- Research for the benefit of businesses and as an advantage for society
- Development of innovative, industry oriented methods and technologies

Projects Financed by Industry

- Scientific findings translated in usable innovations
- Provider of Know-How for small and medium-sized enterprises without R&D departments on their own

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

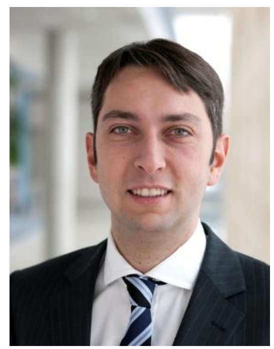
Labor Science and Organization

Univ.-Prof. Mag. Dr. Sabine T. Köszegi

Industrial and Systems Engineering

Univ.-Prof. Prof. eh. Dr.-Ing. Dr. h.c. Dipl. Wirtsch.-Ing. Wilfried Sihn

Human Centered Cyber Physical Production



Univ. Prof. Dr.-Ing. Sebastian Schlund

Financial Enterprise Management

Univ.-Prof. Mag. Dr. Walter Schwaiger

Facility Management

Ao. Univ.-Prof. Dipl.-Ing. Mag. Dr. Alexander Redlein

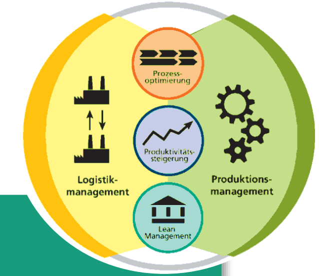
source: TU Wien, 2017

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

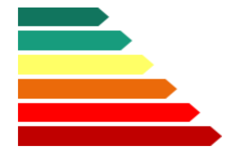
Range of Services – Current Main Topics

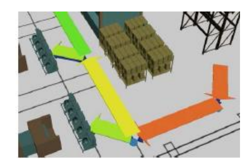
Initial Research, In-House-Development, Funded Research Projects



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





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TU Wien
Initiatives in Austria

Plattform Industrie 4.0 Austria

- Industrie 4.0 Austria – the platform for intelligent production

INDUSTRIE 4.0 ÖSTERREICH

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

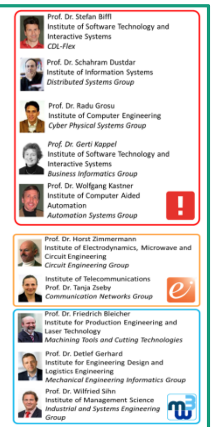
- Representation of a physical and virtual display of a best case factory
- Bundle of different competences of industry partners and research
- New prototypes, production technologies and systems as well as process technologies are tested together in a safe environment

Doctoral College

- **Initiative of TU Wien**

<u>Topics:</u>

- 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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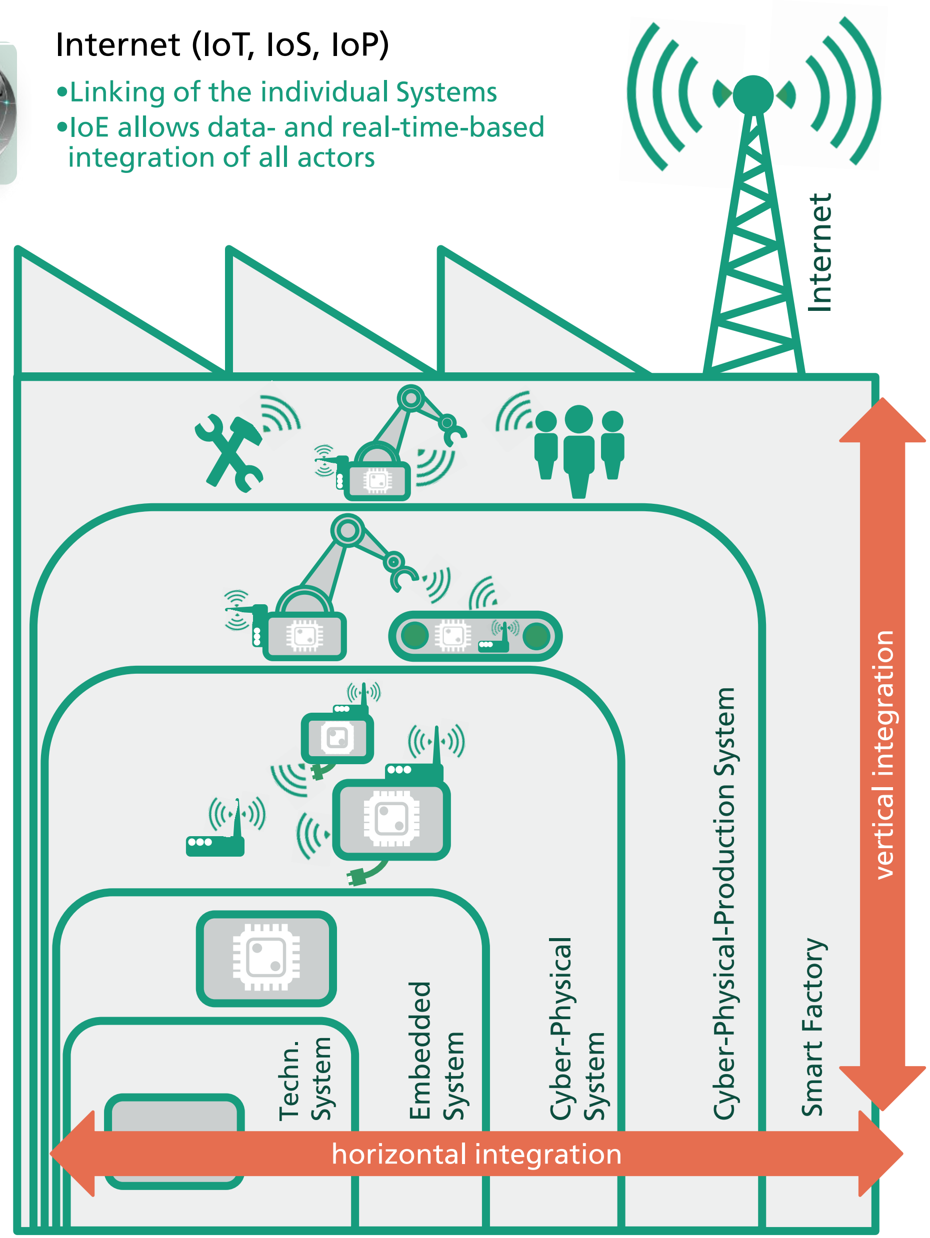
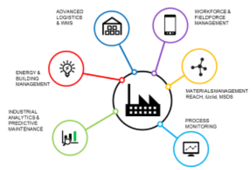
Industry 4.0

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;

Pilot-Demonstration Plant by TU Wien

Overview and fields of application

Pilotfabrik Industrie 4.0

Overview

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

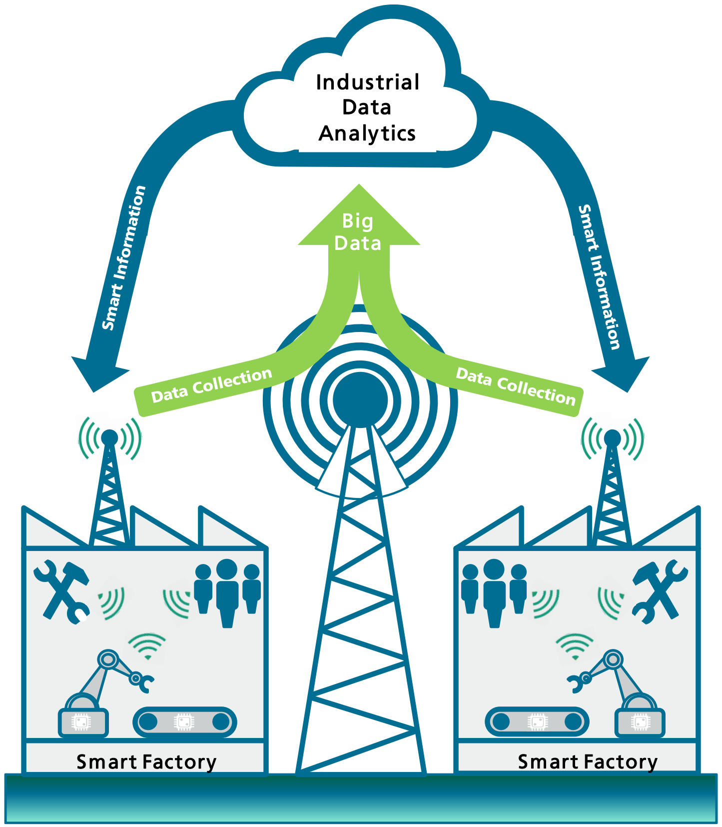
→ Realistic Model of a plant in a laboratory – Real industrial machines and logistic systems in a neutral test and research environment

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

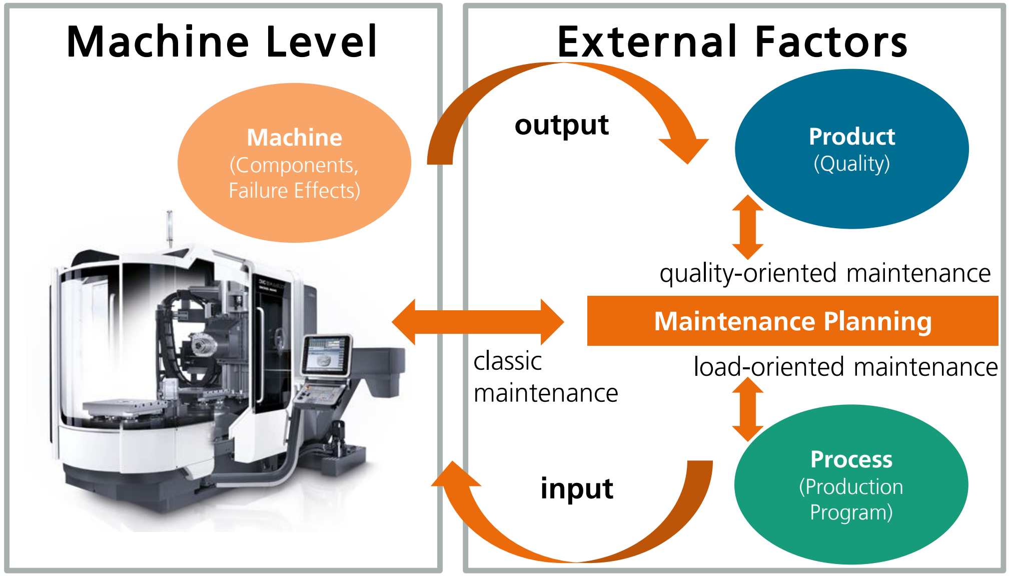
Maintenance 4.0

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

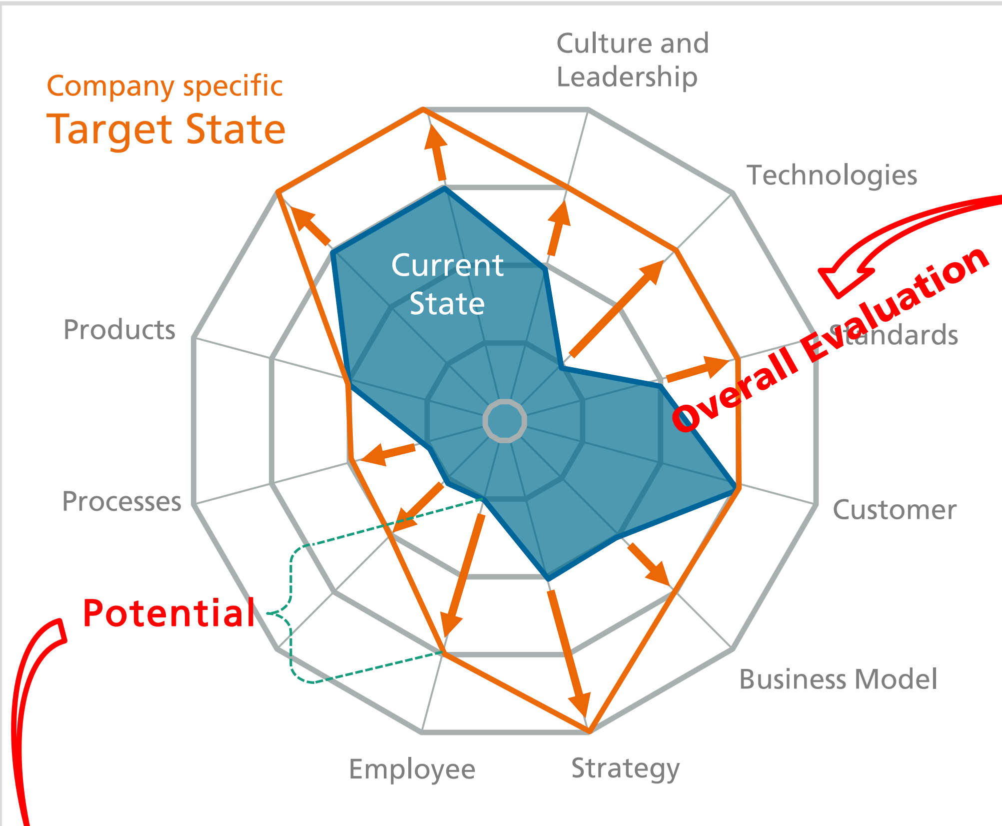
- **Maintenance control station and app** fro:
  - Forecasting failure time
  - Visualizing current machine data and KPIs
  - Display of deviations in quality data
- **Exploit:**
  - Reduction of **downtime** by **12-15%**
  - Reduction of **unpredicted downtime** by **10%**
  - **Saving** of **maintenance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

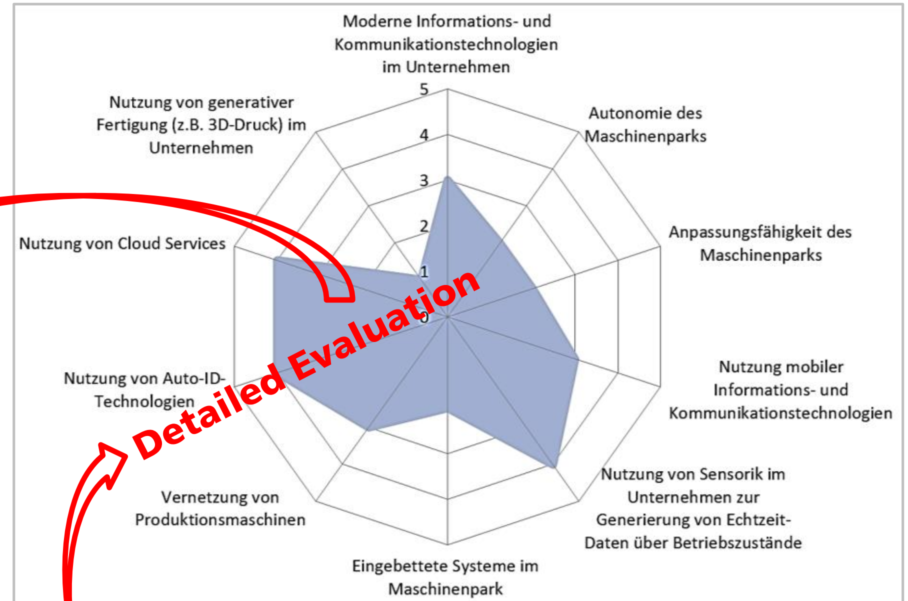


Partner & Founding Bodies

Selected Research Topics

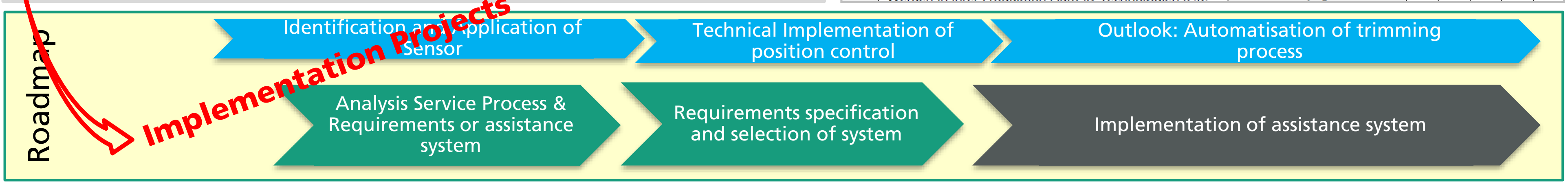
Industry 4.0 Maturity Model





9.5	Sind in Ihrer Produktion Sensorik-Systeme zur Generierung und Nutzung von Echtzeit-Daten im Einsatz?	1 – 5 (Nicht im Einsatz – Sehr umfassend eingesetzt)	☐	☐	☐	☐	☐
9.6	Sind elektronische Rechner und Computer (Embedded Systems) in Ihre Produktionsmaschinen integriert? (Mit dem Ziel der Digitalisierung und Vernetzung der Maschinen)	1 – 5 (Nicht vorhanden – Sehr umfassend vorhanden)	☐	☐	☐	☐	☐
9.7	Sind die Produktionsmaschinen Ihres Unternehmens in der Lage selbstständig miteinander zu kommunizieren bzw. Informationen auszutauschen? (M2M-Kommunikation)	1 – 5 (Nicht in der Lage – Sehr gut in der Lage)	☐	☐	☐	☐	☐
	Werden in Ihrer Produktion Auto-ID-Technologien (z.B.						

Evaluation Model



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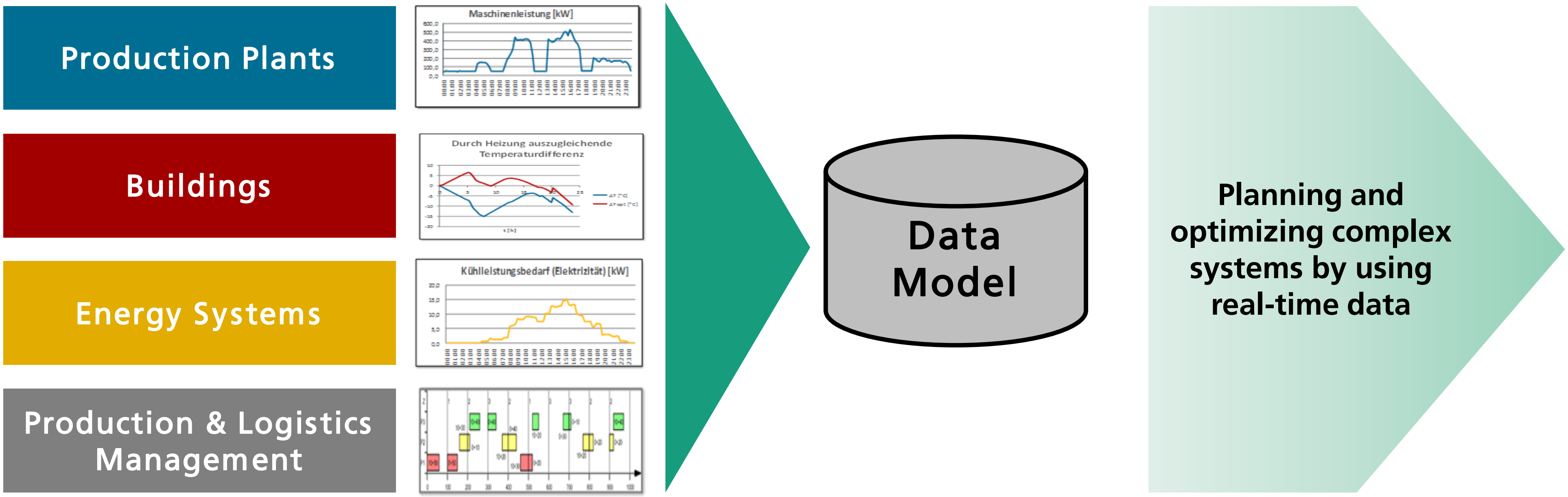
Selected Research Topics
Balanced Manufacturing



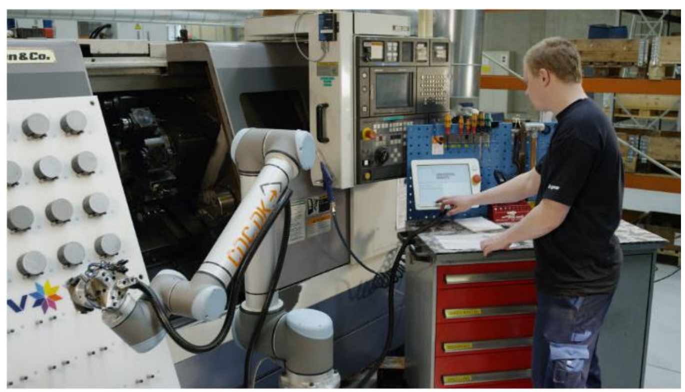
The research project BaMa has developed an energy-aware APS to optimize PPC according to ecological and economic goals simultanously:

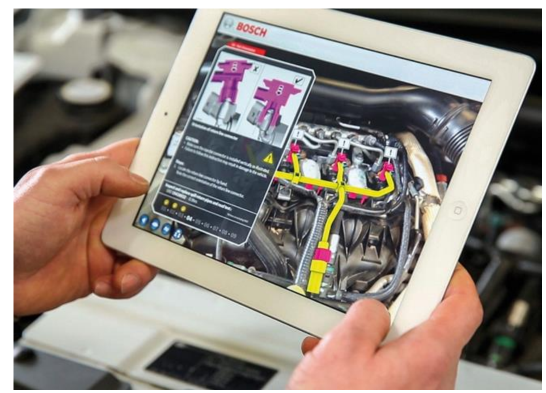
- Monitoring of energy consumption
- Prediction of energy consumption
- Optimizing the production planning to boost energy efficiency

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





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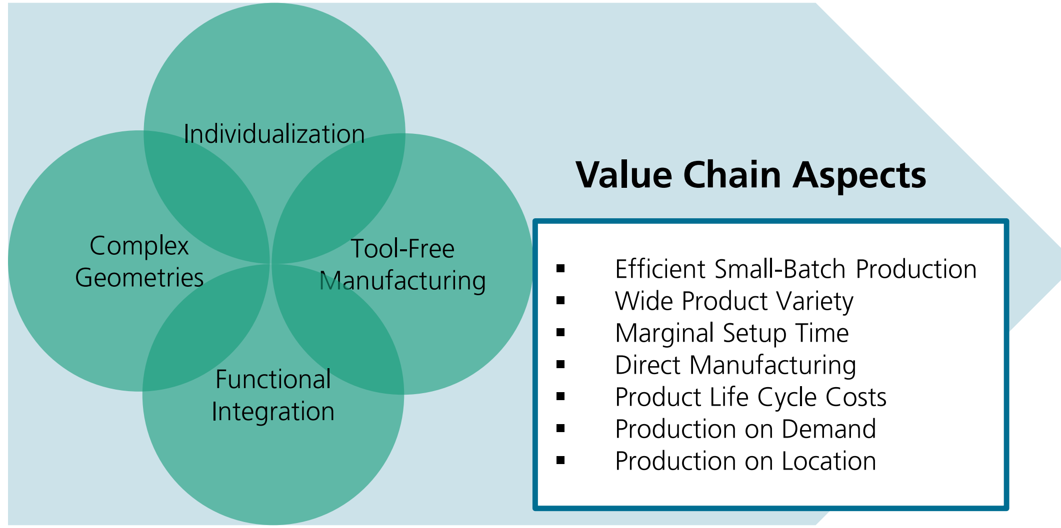
Selected Research Topics

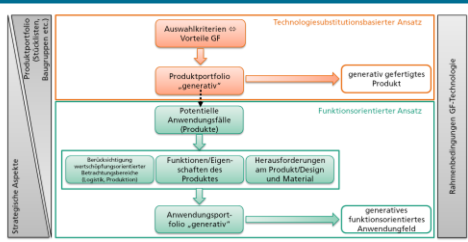
Value Creation Systems and Business Model Development in Additive Manufacturing

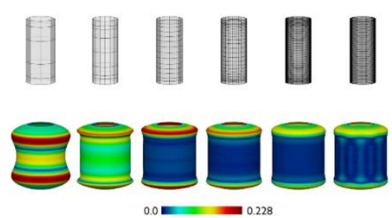
Generative production technologies will **disrupt** the industry. They can be used as supplements to conventional technologies, but to reach full potential, **business models** and **value chains** have to be **rethought**.

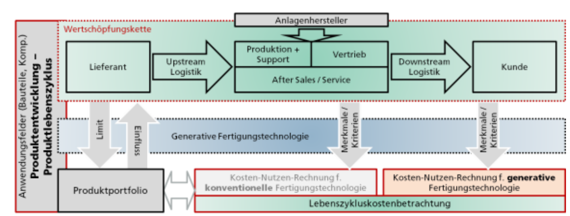


The research objectives of TU Wien and Fraunhofer in this project are investigations from a product and value creation process perspective as well as business model development in additive manufacturing

Identification of fields of application	Digital model creation and optimization	Implementation of generative value chain







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

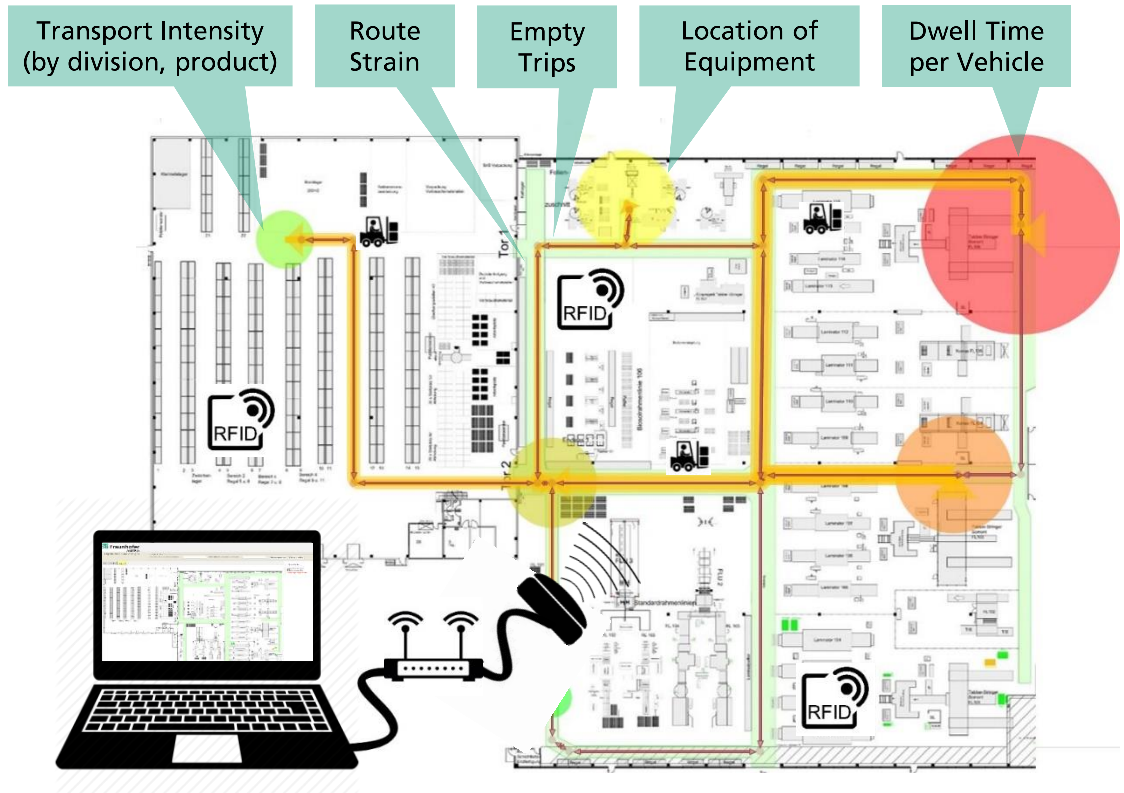
The **research content of TU Wien** contains:

- 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



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Selected Research Topics

Digital Twin

Initial Situation

Precise planning and controlling not possible due to:

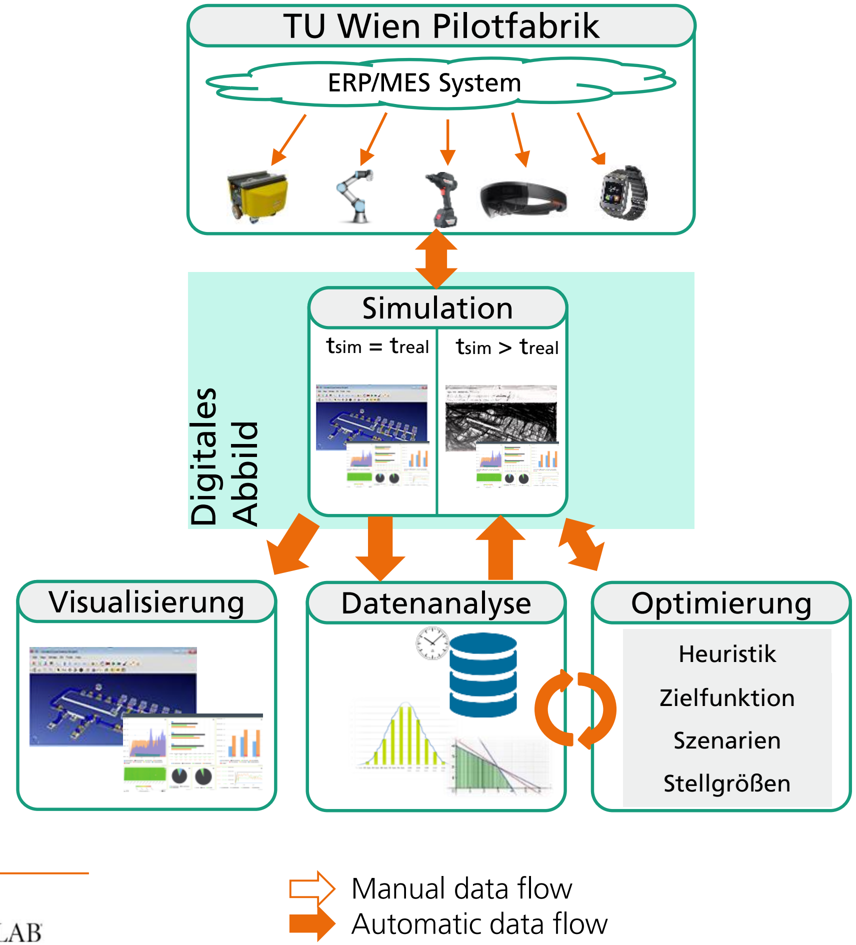
- Insufficient data basis
- Discontinuous IT-system
- Interface losses between disparate planning level

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



Tools

Tecnomatix, OPC UA, Apache Kafka, tableau, TCP/IP, SAP, MATLAB

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TU-Wien

Institute of Management Science

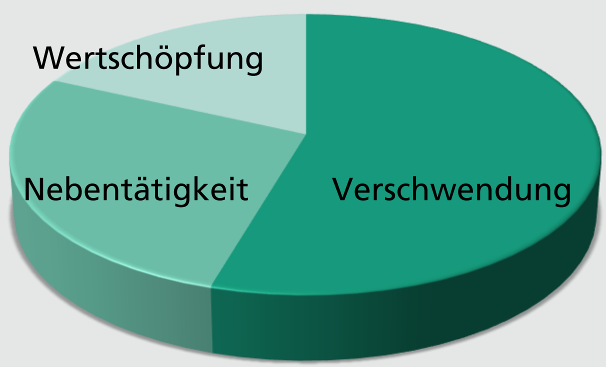
Department of Industrial and Systems Engineering

Could this be relevant?

…which elements of our industry related work might fit this project?

Einführung ins Lean Management

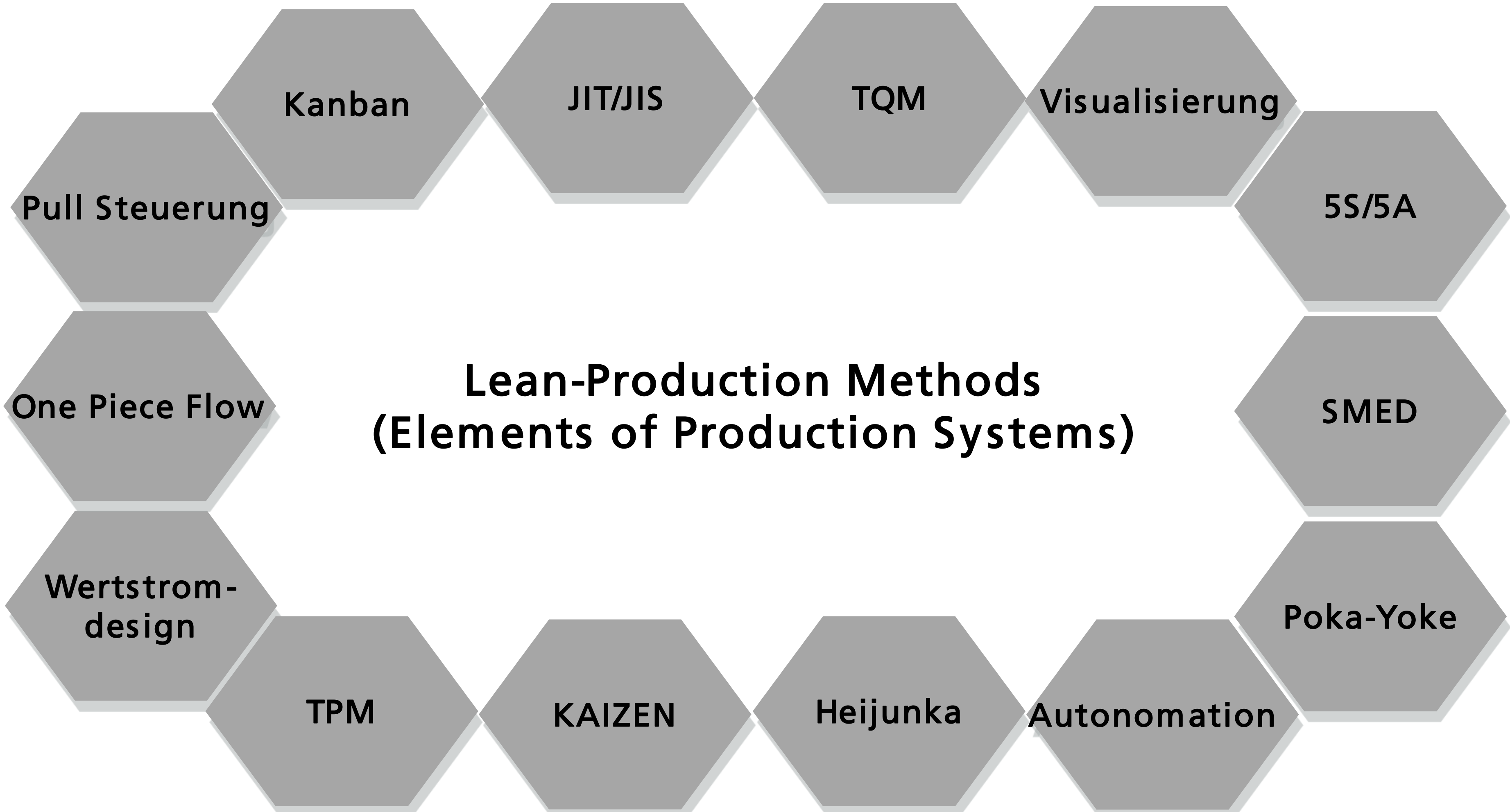
Die 7 (9) Verschwendungsarten aus dem Toyota-Produktionssystem



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



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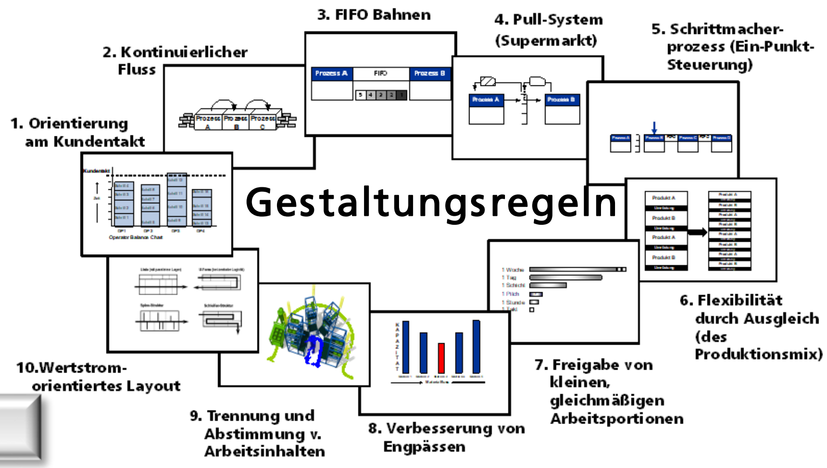
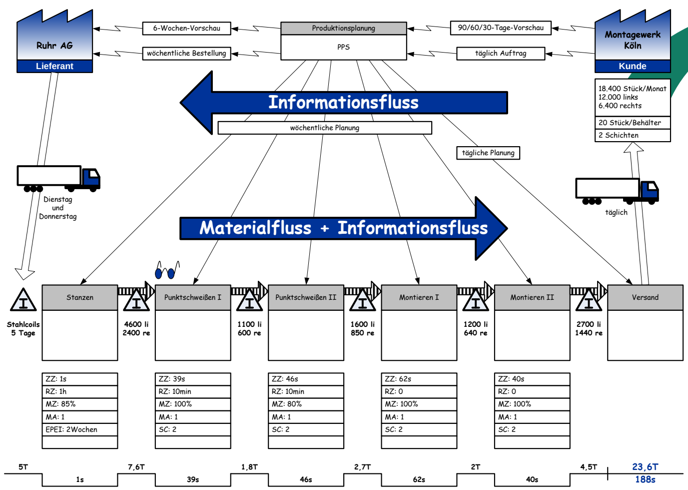
Wertstromdesign

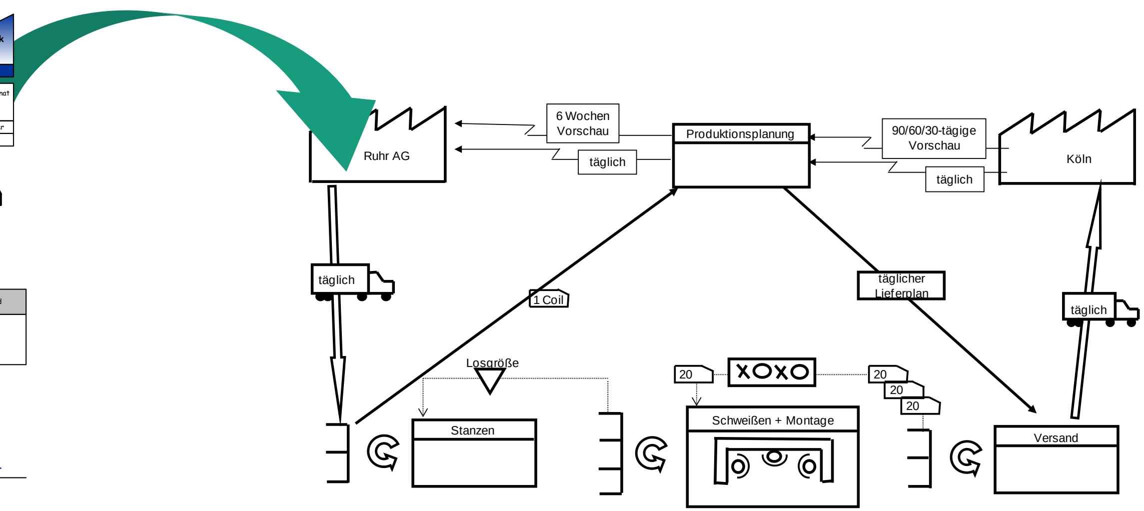
Gesamtprozesse effizienter gestalten



Ist-Zustand



Soll-Zustand



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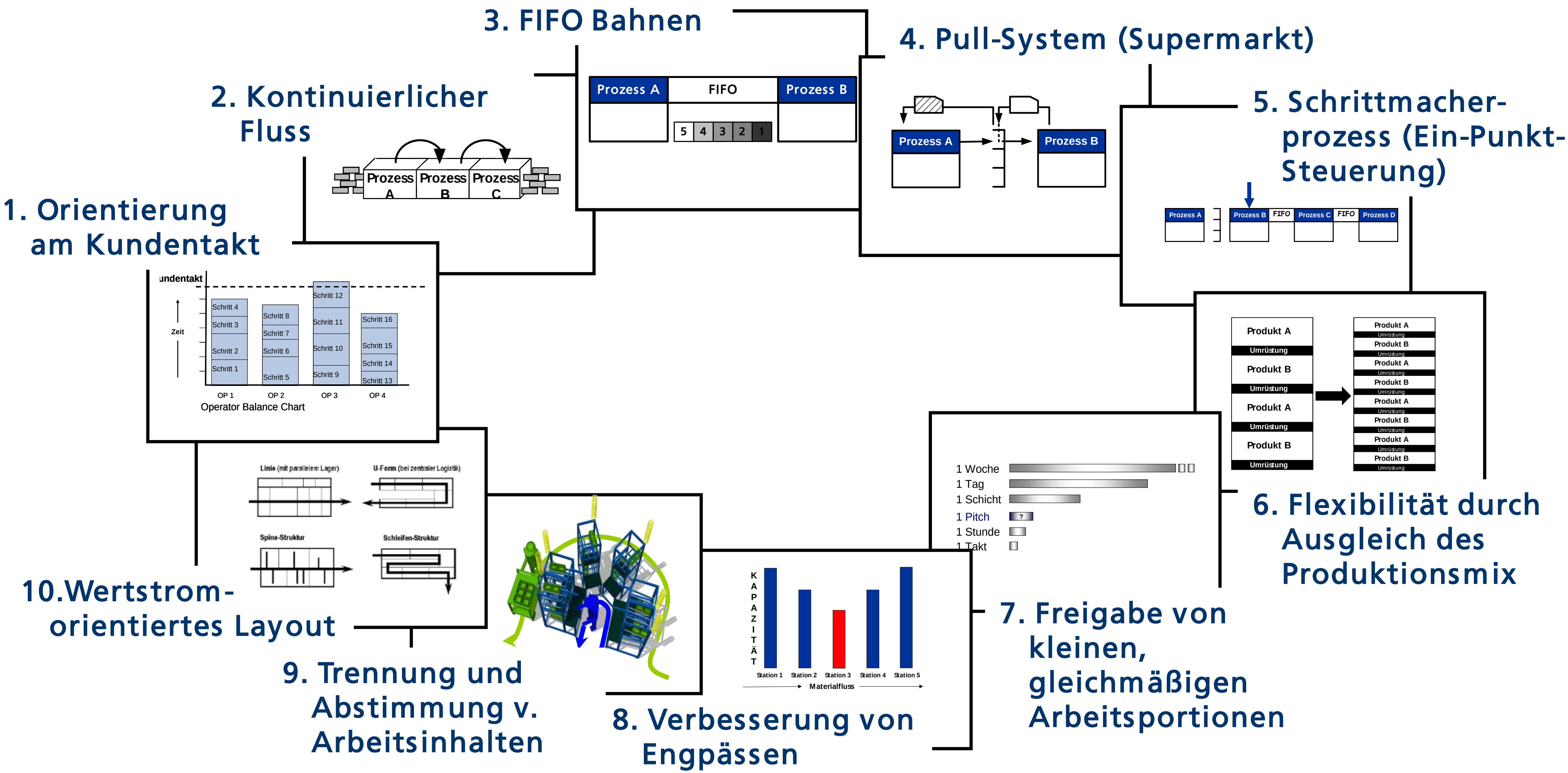
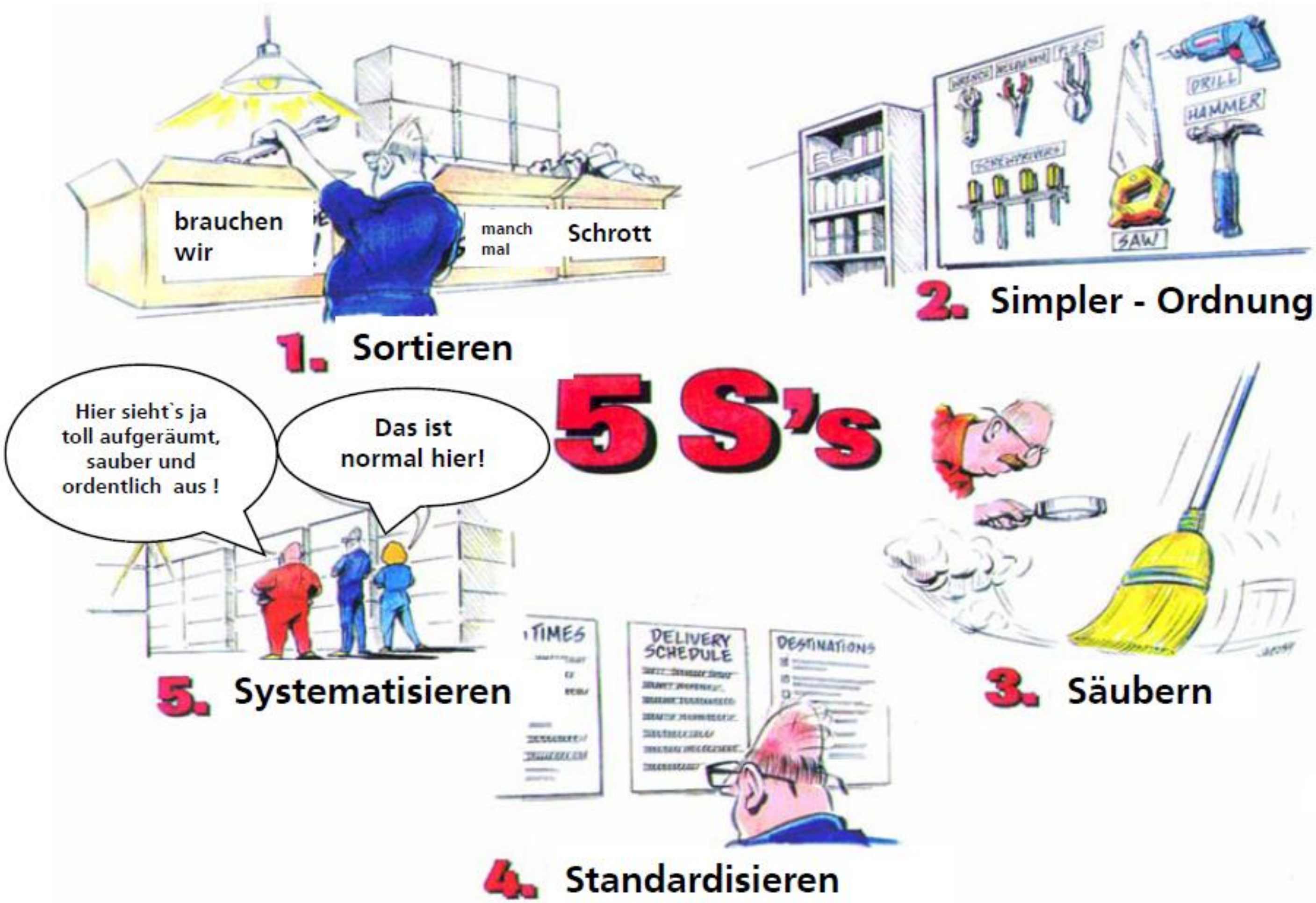
Wertstromdesign | Merkmale eines effizienten Wertstroms

10 Leitlinien für die Konzeption von Soll-Wertströmen



Arbeitsplatzorganisation mittels „5S“

„5S“ - Der Weg zur verschwendungsfreien Produktion

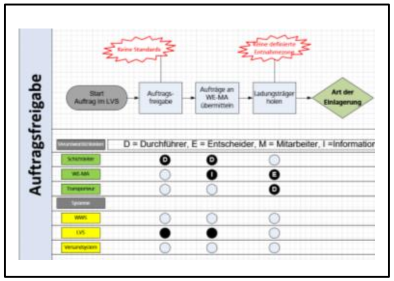


Analysemethoden | Kurzübersicht

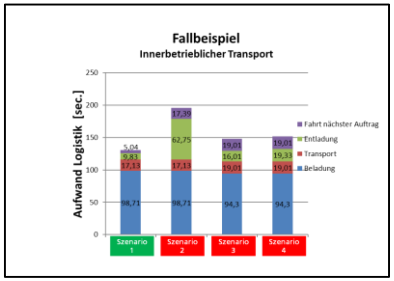
Strukturiertes Vorgehen und sichere Ergebnisse durch Methodeneinsatz

Methoden

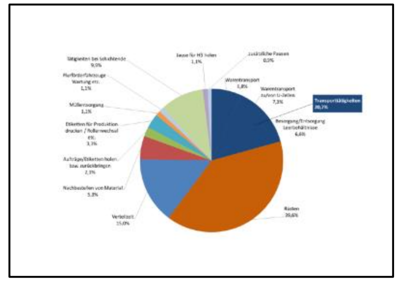
Prozessanalyse



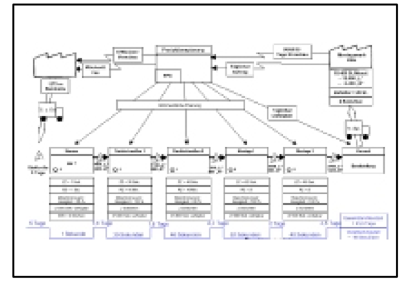
Zeitanalyse mittels MTM



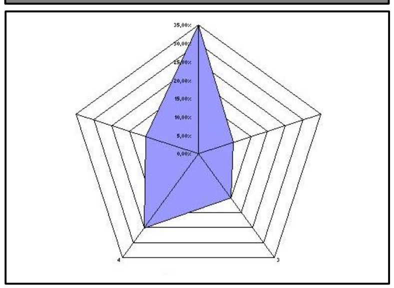
Tätigkeits-strukturanalyse



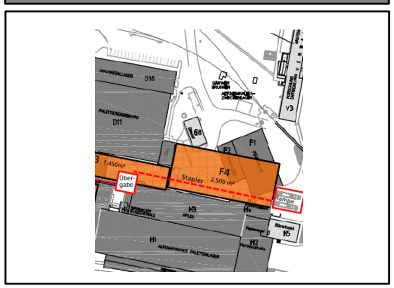
Wertstrom-Design



Technologie-bewertung

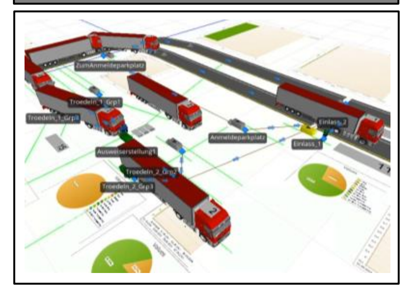


Layout-analyse



Materialfluss-Optimierung

Optimierung/ Simulation



Wertstrommanagement-Tool VASCO

Effizienteres Wertstromdesign durch Tool-Unterstützung

„Exploring your value streams“

VASCO

USABILITY – intuitive grafische Bedienung

E=mc² – standardisierte Berechnung von KPIs & Datenlinien

Verschwendungen identifizieren & Energiepotentiale aufdecken

€ – Kostenreduktion sofort bewerten

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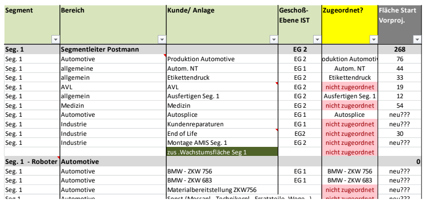
Materialflussoptimierung & Layoutplanung

Materialflussanalyse-Modell: Aufbau und Ablauf

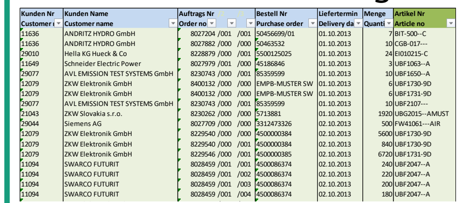
▶ Flächen-Bilanz & Transportwege



▶ Stücklisten & Materialeigenschaften

SLARTG	SLARTK	Einsatzmeng
BA0-826---	BA0-826-2-	1
BA1-100--E	BA1-100-2E	1
BA1-100--E	EG070889-D	1
BA1-100--E	EG070890-A	1
BA1-101--E	BA1-101-2E	1
BA1-101--E	EG070889-D	1
BA1-101--E	EG070890-A	1

▶ Stückzahlen & Stückzahlentwicklung

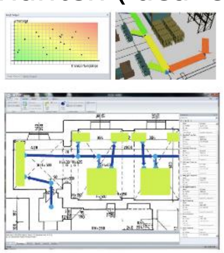


▶ Arbeitspläne → Prozessabfolge

Artikelnummer	Änderungsart Artikel	Betrieb Artikel	Betrieb Artikel	Arbeitsplatz	Betrieb Arbeitsplatz	Arbeitsfolge
ARARTN	ARAEAA	ARBTRA	APBTRA	APAPZN	APBT	APARF
EG0707371A	0	1	1	00110	391	20
EG0707371A	0	1	1	60015	331	70
EG0707371A	0	1	1	60020	331	80
EG0707371A	0	1	1	60045	331	100
EG0707372A	0	1	1	00110	391	20
EG0707372A	0	1	1	60045	331	90
EG070890-A	0	1	1	00100	391	10
EG070890-A	0	1	1	10016	361	30

Materialflussmodell

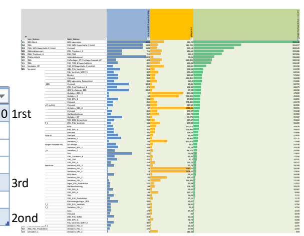
▶ Layoutvarianten (Ideal & Real) erstellen



▶ Transportaufwand-Bewertung

Reallayout - Direkttransporte

Varianten	Aufwand [m/a]	Schichten-Differenz/a	
Var_01	1.662.181	0	1rst
Var_02_a	1.840.784	11,91	
Var_02_b	1.725.615	4,23	
Var_03_a	1.707.137	3,00	
Var_03_b	1.686.440	1,62	3rd
Var_03_c	1.720.822	3,91	
Var_03_d	1.662.640	0,03	2ond



▶ Nutzwertanalyse mit weiteren Bewertungskriterien

Nutzwertanalyse		Gewichtung	Priorität	Gewichtung [%]	Var. 1		Var. 2_a		Var.3_d	
					Bewertung	relative Bewertung	Bewertung	relative Bewertung	Bewertung	relative Bewertung
1.1	Materialfluss	6	1.	25,00%	6	1,50	4	1,00	6	1,50
1.2	Kundeneindruck	6	1.	25,00%	0	0,00	3	0,75	4	1,00
1.3	Bereichstrennung (Schutz)	5	3.	20,83%	1	0,21	5	1,04	5	1,04
1.4	Wachstumspotential für Automotive	4	4.	16,67%	4	0,67	6	1,00	6	1,00
1.5	Freifläche von 200 m²	2	5.	8,33%	6	0,50	6	0,50	6	0,50
1.6	Aufwand (für Umstellung)	1	6.	4,17%	0	0,00	5	0,21	2	0,08
		24		100,00%						
		Punkte			2,88		4,50		5,13	
		Ranking			3.		2.		1.	

Ergebnis

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

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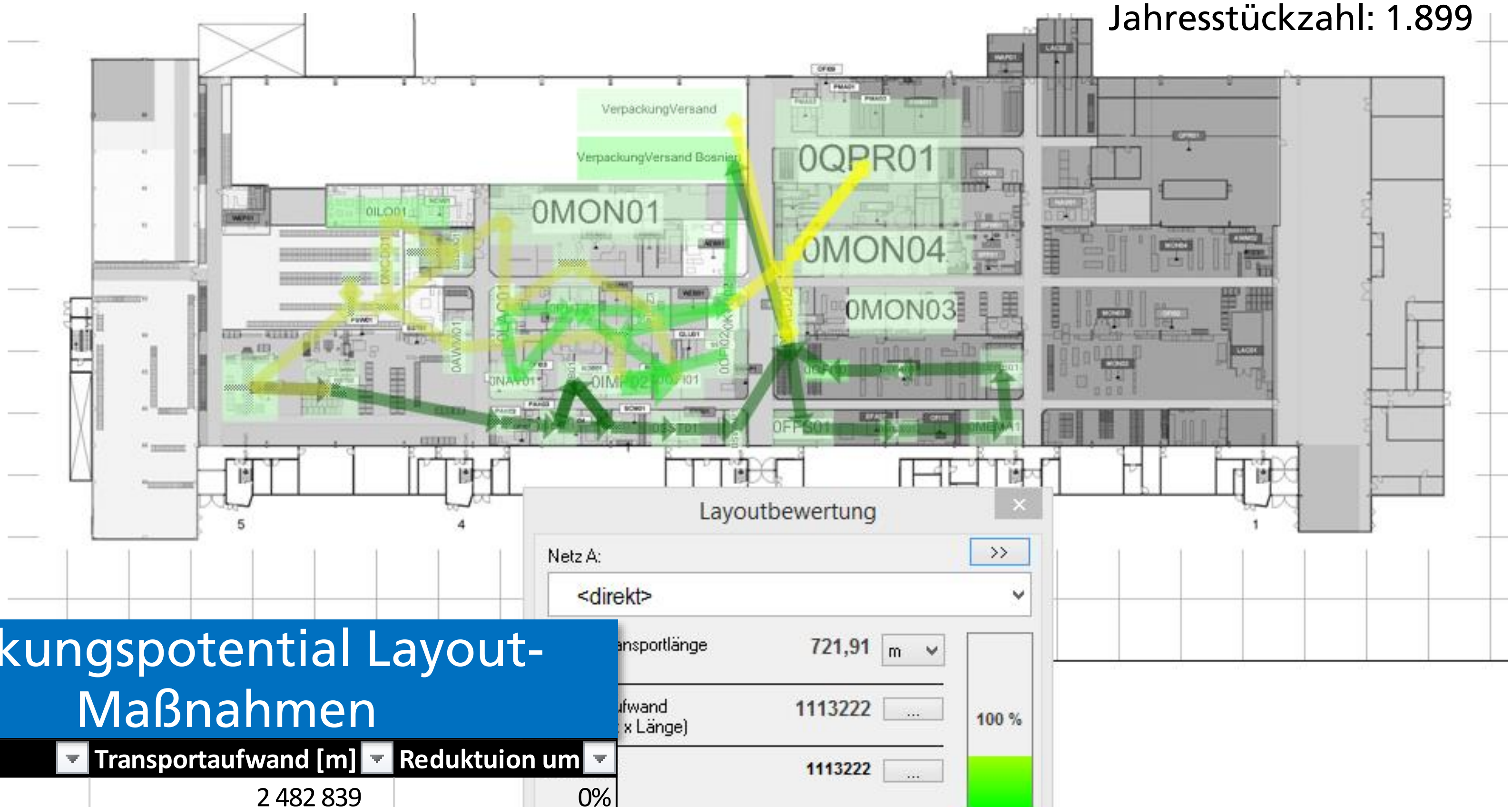
Materialflussoptimierung durch Layout-Maßnahmen

► Neuanordnung von Bereichen und Anlagen

Produktgruppe xy
Jahresstückzahl: 1.899



Wirkungspotential Layout-Maßnahmen

Szenario	Transportaufwand [m]	Reduktuion um
IST	2 482 839	0%
fixe Stationen	1 703 639	31%
alles neu - Version 1	1 328 619	46%
alles neu - Version 2	1 113 222	55%

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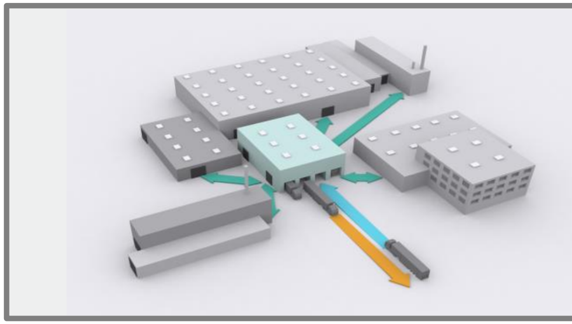
Das kann nur Simulation leisten

Typische Anwendungsfälle für den Simulationseinsatz in der Produktion



Komplexe Systeme → analytische Lösung nicht möglich

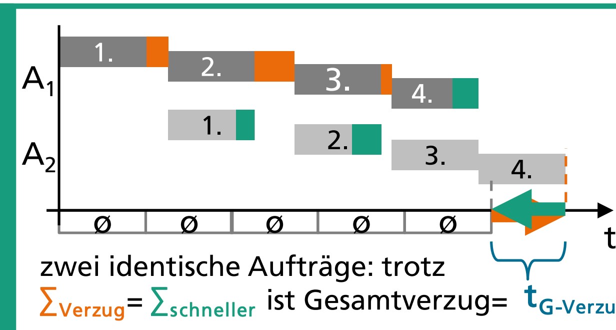
- viele Elemente (Kapazitäten), Wirkzusammenhänge & komplexe Materialflüsse
- Statisch-analytisch höchstens stark vereinfacht zu berechnen

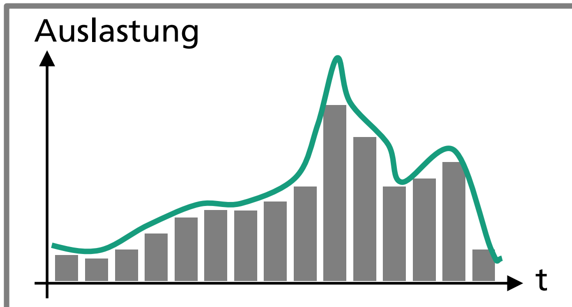
▶ Sim. kann Komplexes detailliert & realitätsnah planen

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

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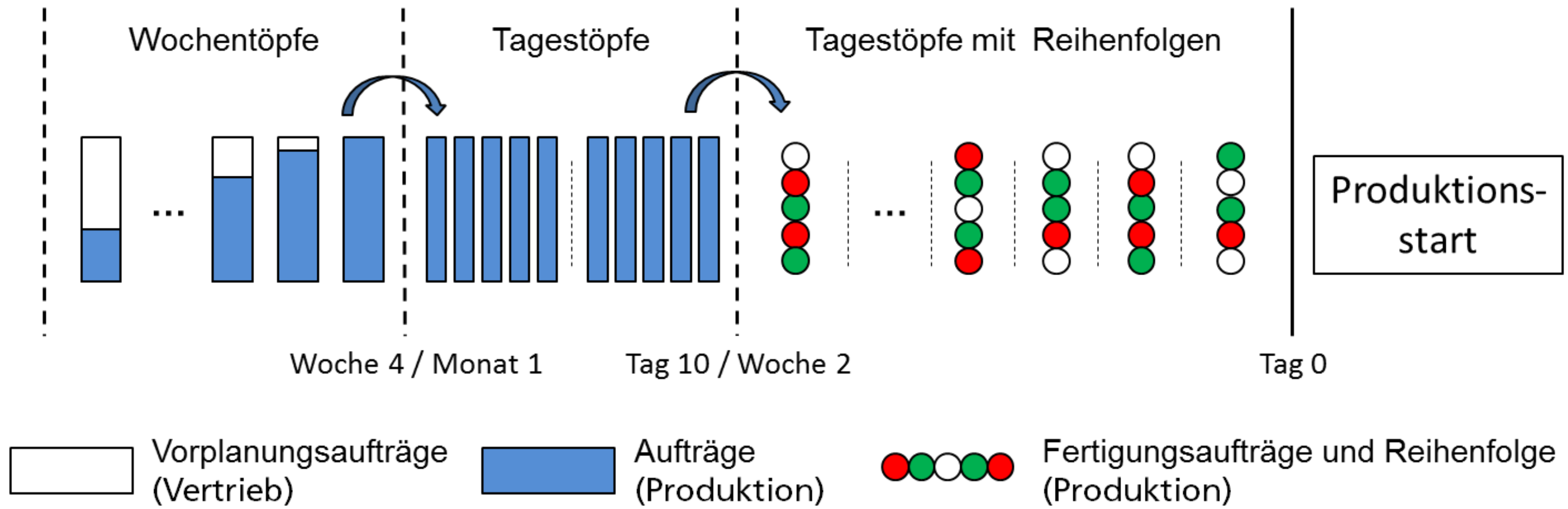
Produktion im Takt

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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