Technische Hochschule Wildau
Technical University of Applied Sciences
WILDAU

Gijón, 03/22/2023

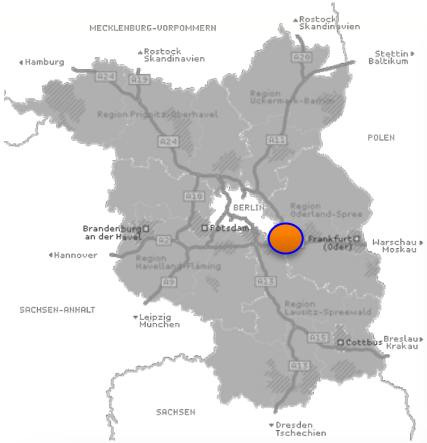
WS3: German Experience on Education for Industry 4.0

Jörg Reiff-Stephan
Edunet World Association

Agenda

- **Technical University of Wildau**
- **Motivation for Industry4.0**
- **Project „Edu4Ind4.0“**
  - Scope
  - Method
  - Results
- **Interdisciplinary studies**
- **Summary & Outlook**

TH Wildau – Place to be



…70 years of experience in teaching engineering

…31 years since its founding in 1991

…2 Faculties:
Engineering and Natural Sciences (INW)
and Business, Computing and Law (WIR)

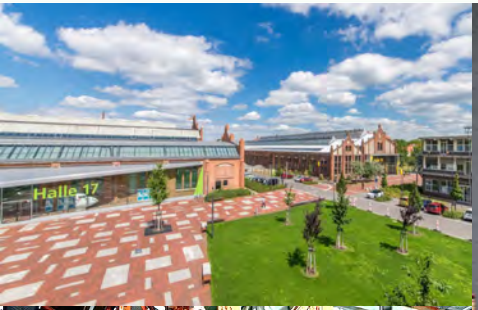
… The largest University of Applied Sciences in Brandenburg

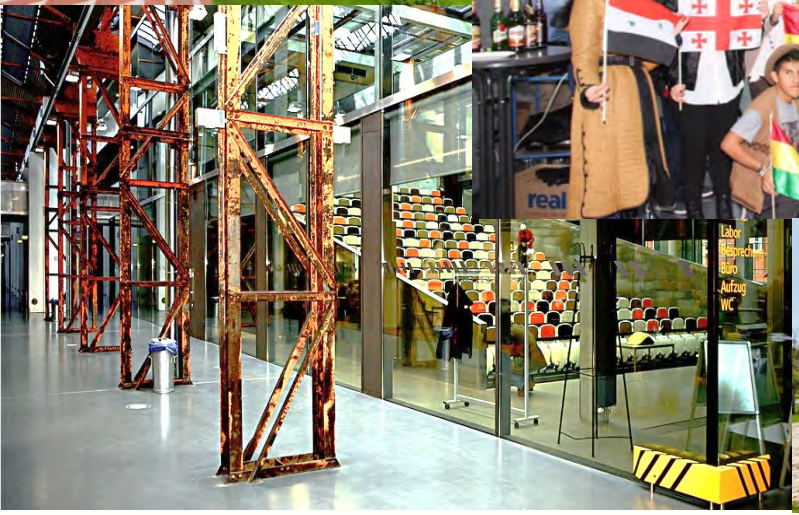
TH Wildau – Profile

Green Campus

Close to Berlin & surrounded by lakes, water and forests…

Characteristics





Philosophy of studies

descriptive approach - - -> diagnostic approach - - -> predictive approach - - -> prescriptive approach

degree of participation

descriptive-explanativ research

... prescriptive-technologicale science

theoretical work
- Frontalunterricht -

...

laboratory work
- praktische Laborarbeiten -

project based learning
- projektbasiertes Lernen -

prescriptive education
- präskriptive Bildung -

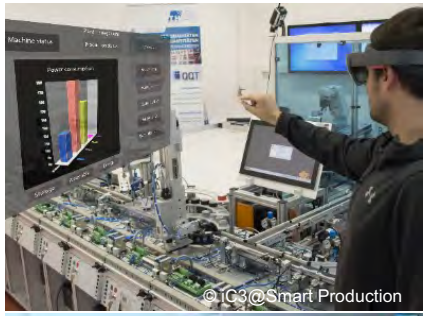
cognitive education
- Kognitive Bildung -

1980 2000 2020

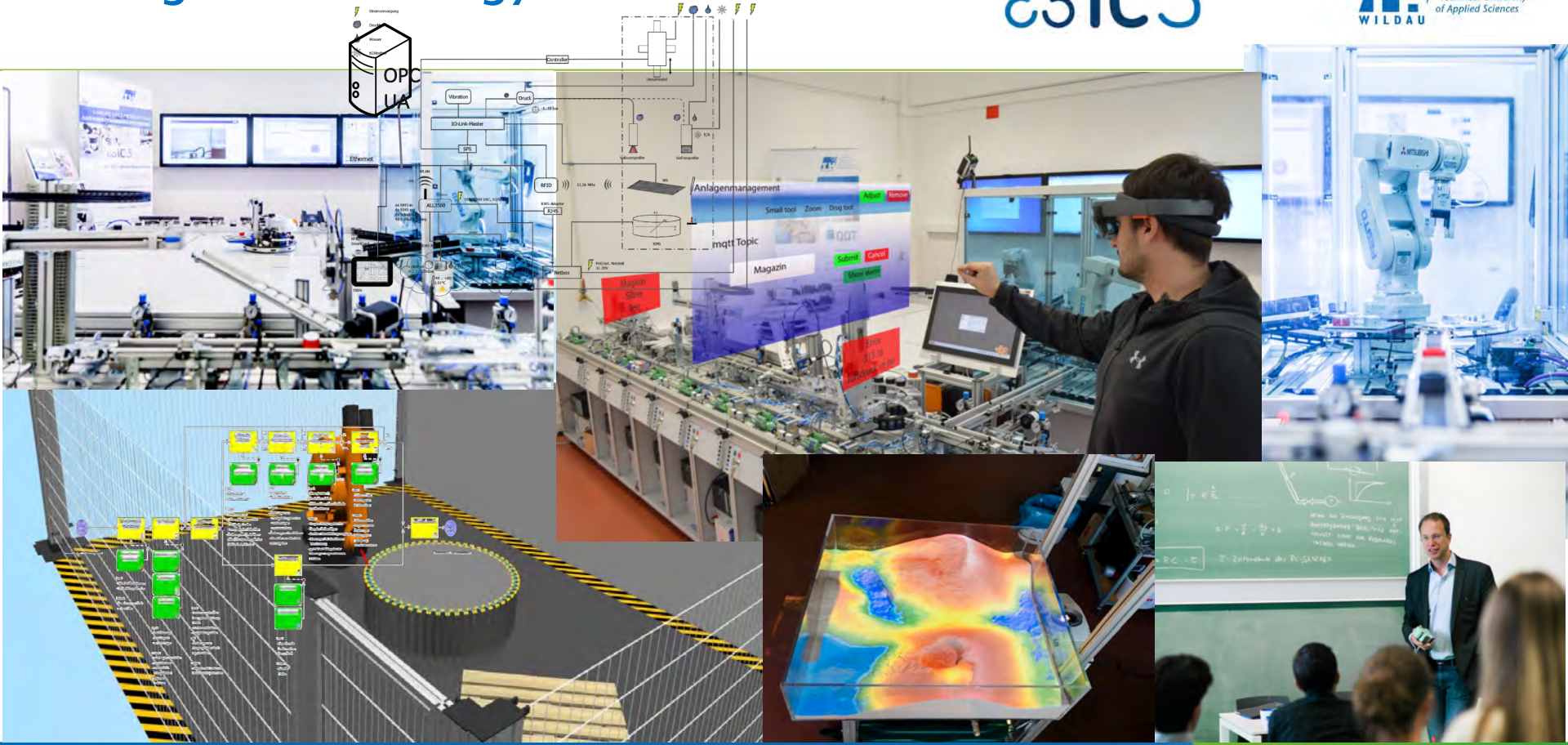
Demonstrators and Model Factory (2011 -)

Technische Hochschule Wildau
Technical University of Applied Sciences

Worker Assistance & Learning-on-the-Job	Test Bed – iC3@SmartProduction	Assembly Systems & Dev. Environment	Laboratory for Intralogistics



Digital Technology at iC3:Labs



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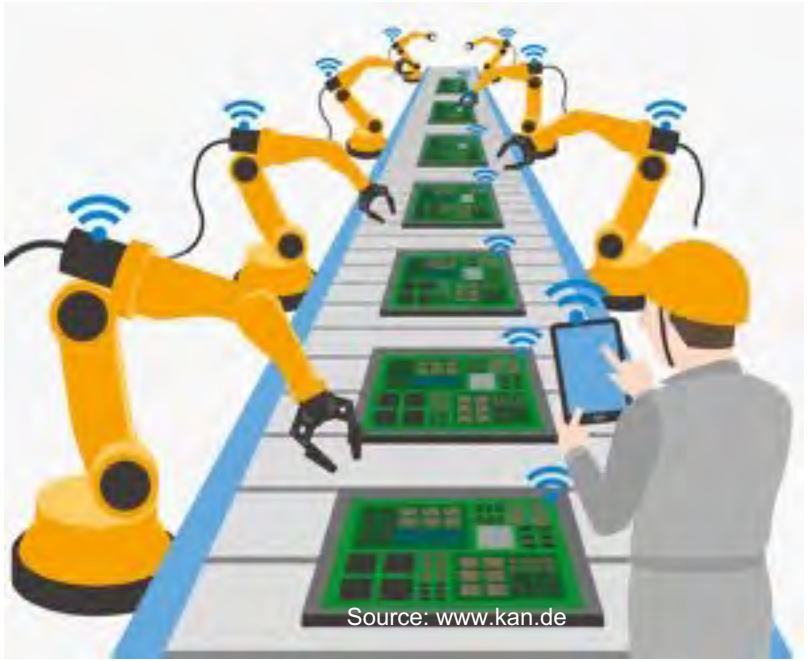
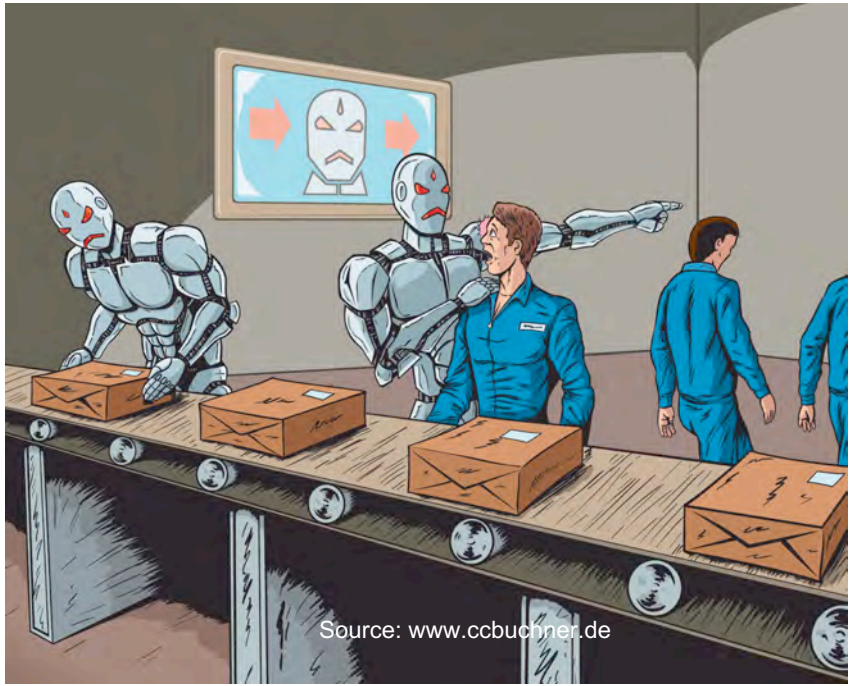
What is Industry4.0?

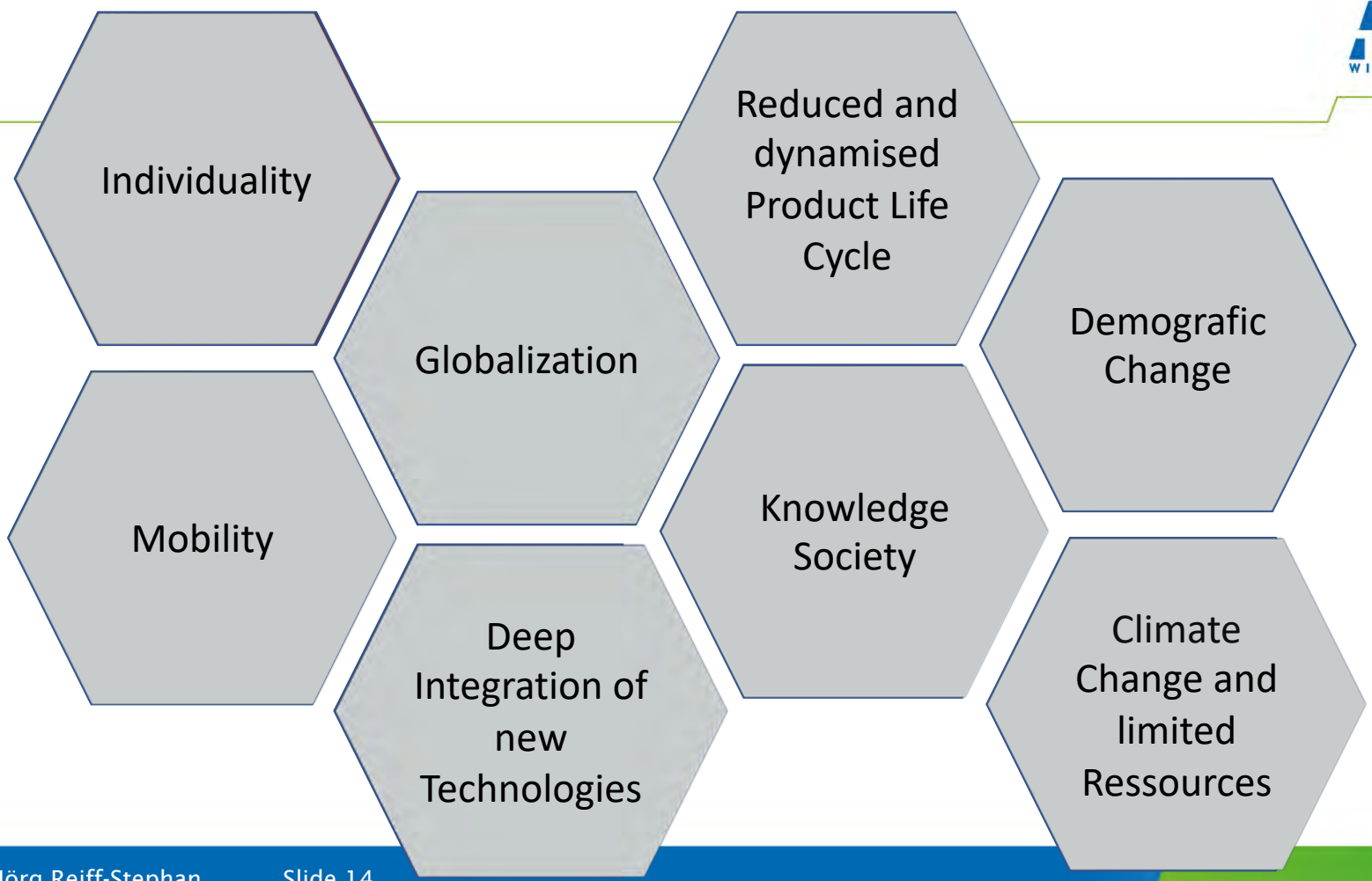
Industry4.0

How I see it

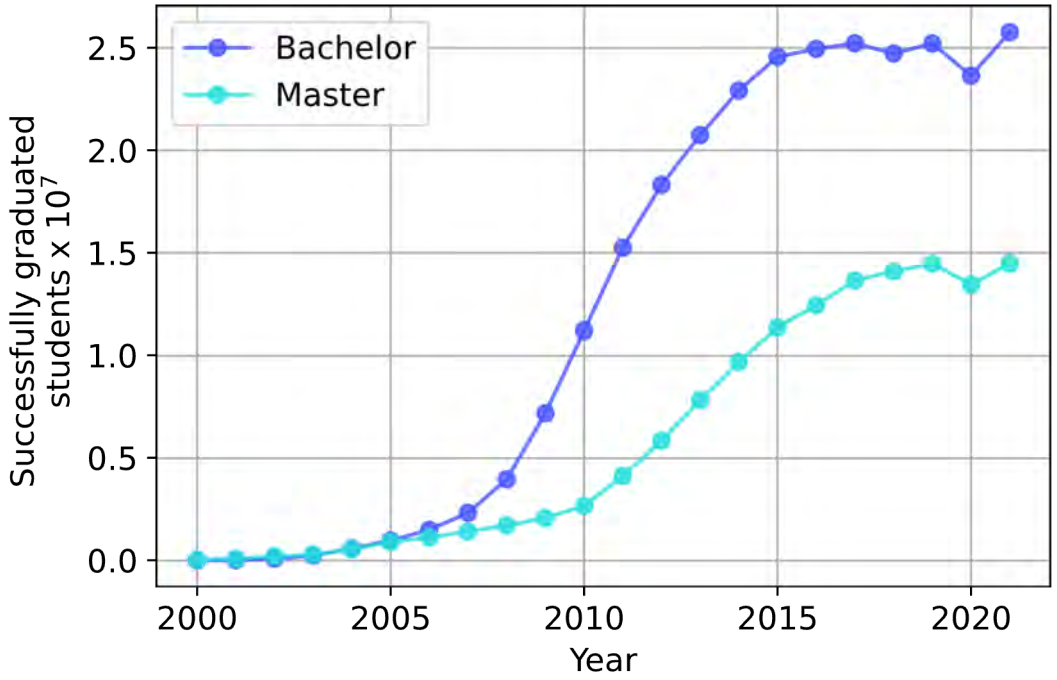


How my parents see it

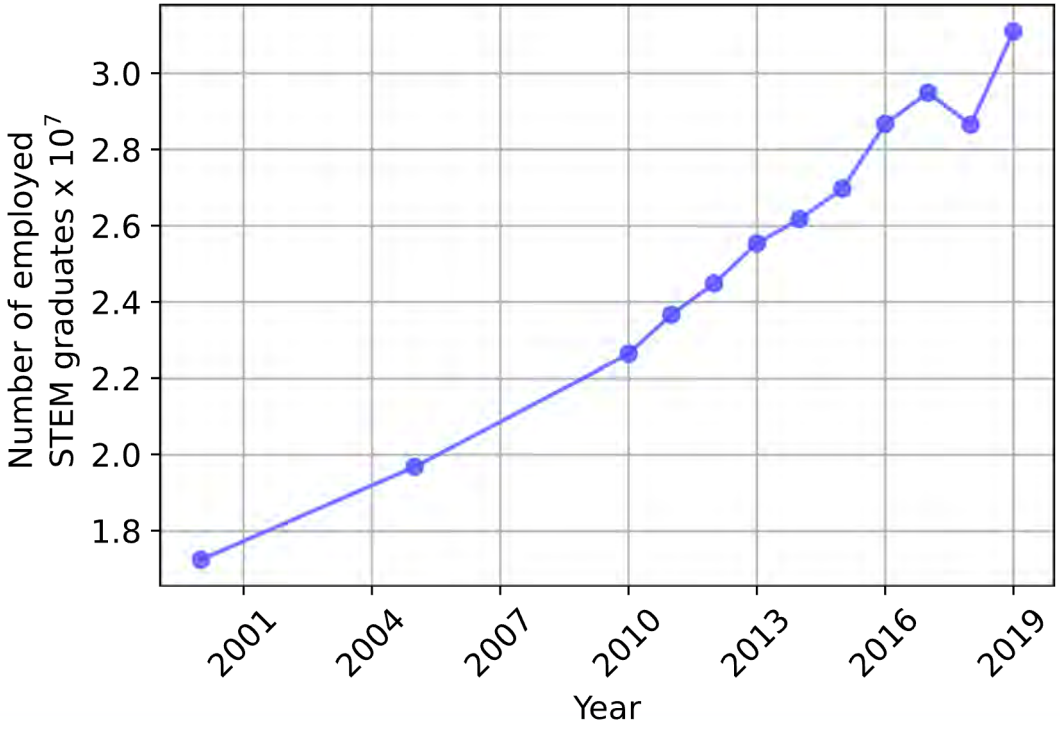



Individuality
Reduced and dynamised Product Life Cycle
Globalization
Demografic Change
Mobility
Knowledge Society
Deep Integration of new Technologies
Climate Change and limited Ressources

Graduated Students in Germany per Year

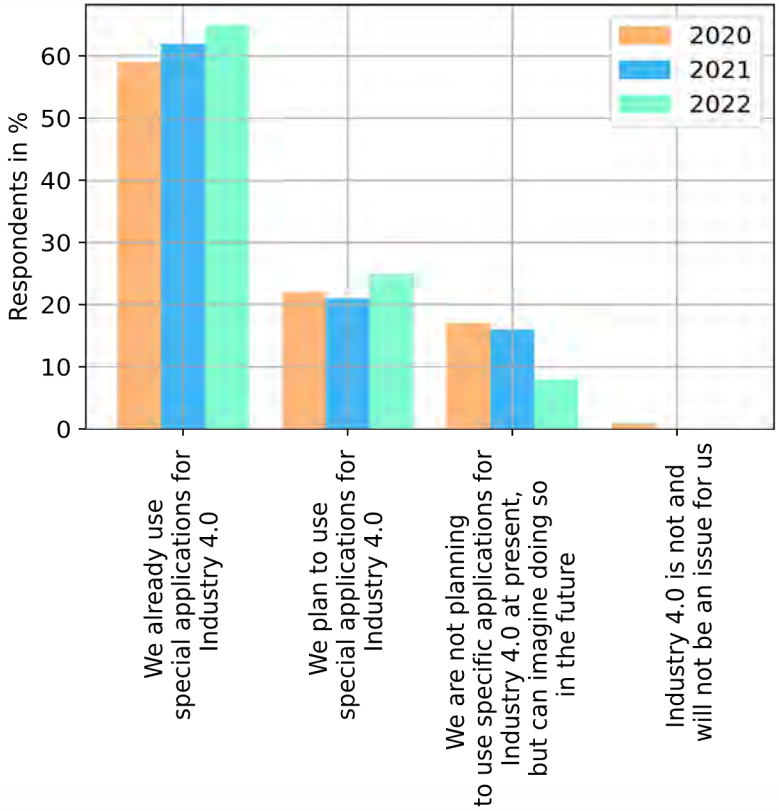


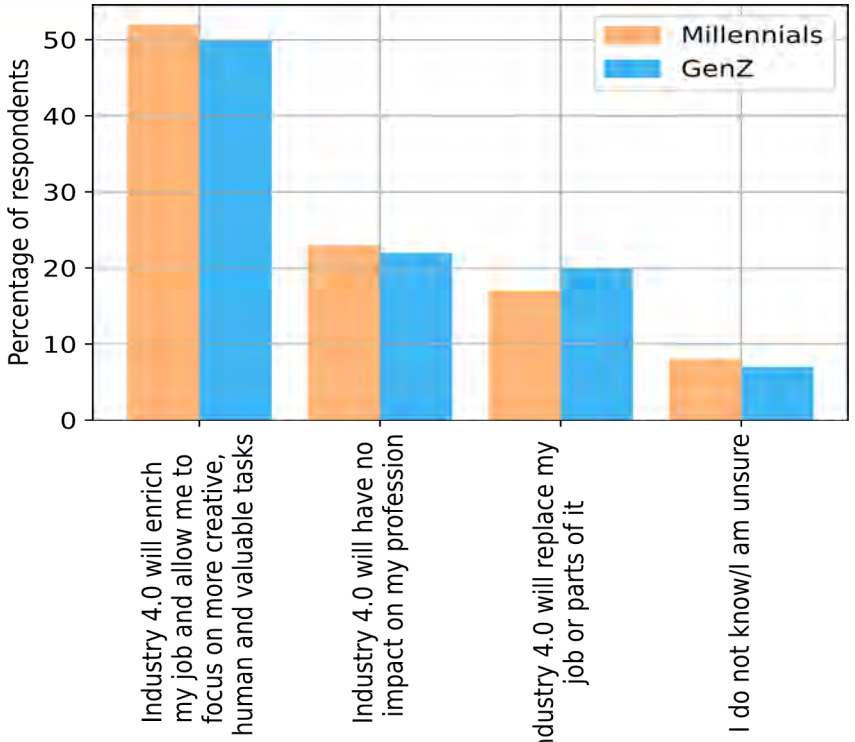
Number of Employed STEM graduates



Number of employed STEM (science, technology, engineering, and mathematics) graduates has almost doubled within 20 years in Germany!

View on Industry 4.0 – Companies & Students





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Project Objectives

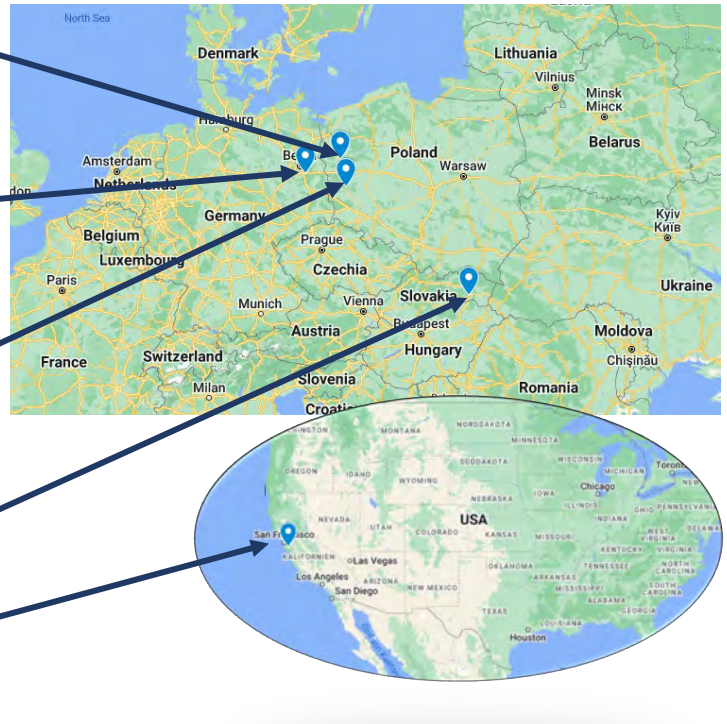
Erasmus+ „Edu4Ind4.0“

- Higher education learning framework:
  - Competences regarding Industry 4.0
  - Experience/ Practice based
  - International cooperation /validation
  - Current status assessment and strategy building
- Networking:
  - Industry 4.0 experts
  - Industry 4.0 teachers from Slovakia, Poland & Germany
  - Governmental organizations & entrepreneurs

State of the Art in Higher Education: Courses directly referring to Industry 4.0 in Germany

Partner

- Akademia im. Jakuba z Paradyża – organizacja wiodąca
- University of Applied Sciences Wildau
- Polskie Towarzystwo Ekonomiczne w Zielonej Górze
- Uniwersytet Techniczny w Koszycach
- US-Polish Trade Council



Method

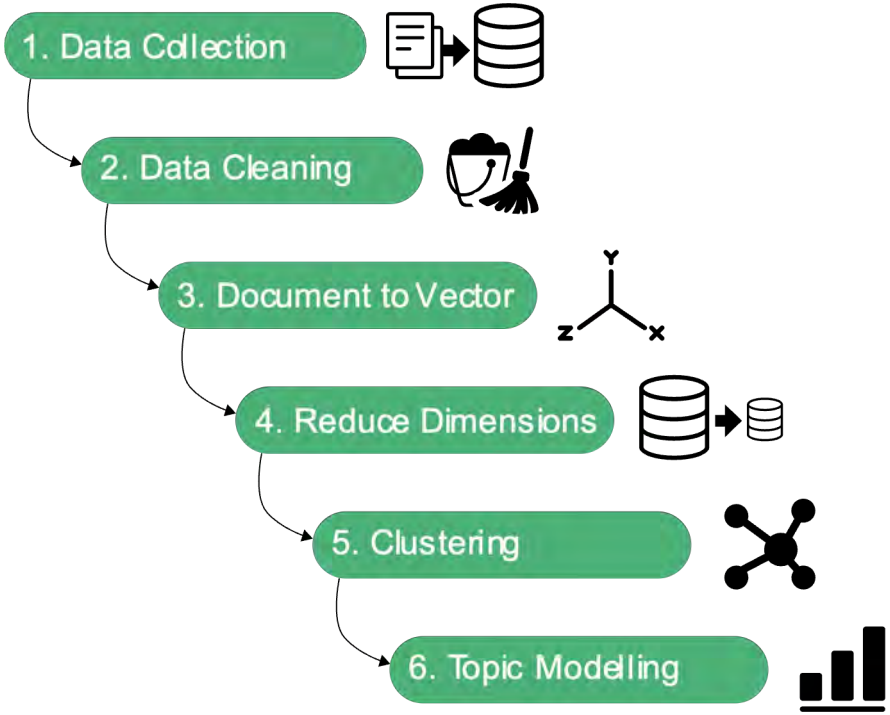
Questions

Are there study programs with an explicit focus on Industry 4.0?

What are the core topics of these courses and can they be classified according to these topics?

How is the distribution of core topics related to either technical and economical courses?

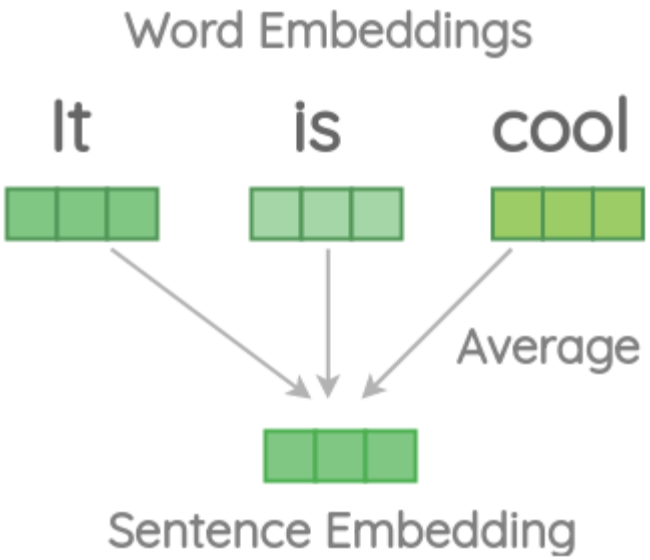
Approach



	A	B	C	D	E	F	G
1	Hochschule/Uni	staatlich/ privat	Studiengang	Ba./Ma./Dr.	Anzahl Semester	Kurzbeschreibgung Studiengang	Ort / Campu
2	DHBW - Duale Hochsch	staatlich	Betriebswirtschaftsle	B.A.	6	Moderne Industrieunternehmen	70174 Stutt
3	AKAD University	privat	Maschinenbau - Indi	B.Eng.	7	Maschinen und Anlagen „made i	70174 Stutt
4	AKAD University	privat	Wirtschaftsingenieu	B.Eng.	9	Viele alte Geschäftsmodelle falle	-
5	CBS International Busir	privat	BWL Industriemanag	B.A.	6	Studiere Industriemanagement:	52062 Aach
6	Duale Hochschule Gera	staatlich	Wirtschaftsingenieu	B.Eng.	6	Die digitale Transformation der I	07546 Gera
7	Fachhochschule Südwe	staatlich	Data Science	B.Sc.	6	Big Data, Data Engineering – gro	59872 Mesc
8	Fachhochschule Wedel	privat	Data Science & Artifi	B.Sc.	7	In der Spezialisierung als Data Sc	22880 Wed
9	Hochschule Aalen - Tec	staatlich	Digital Product Desig	B.Eng.	7	Gegenstände vernetzen und zu e	73430 Aale
10	Hochschule Aalen - Tec	staatlich	Maschinenbau / Dig	B.Eng.	7	Unser Studiengang richtet sich a	73430 Aale
11	Hochschule der Bayeris	privat	Smarte Produktion u	B.Eng.	7/9	Smarte Produktion steht für die	80797 Mün
12	Hochschule Fresenius H	privat	Digital Business Mar	B.Sc.	6	Ob selbstfahrende Autos, intelli	69126 Heid
13	Hochschule Hannover	staatlich	Ingenieurinformatik	B.Eng.	7	Digital Natives für die Zukunftsb	30539 Hanr
14	Hochschule Harz	staatlich	Smart Automation /	B.Eng.	7	Im Studiengang Smart Automati	38855 Wer
15	Hochschule Kaiserslaut	staatlich	Digital Engineering	B.Eng.	7	Digital Engineering ist ein anwer	76726 Germ
16	Hochschule Landshut -	staatlich	Intelligente Systeme	B.Eng.	7	Alle sprechen über Digitalisierun	84036 Land
17	Hochschule Mannheim	staatlich	Automatisierungstec	B.Sc.	7	Industrie 4.0 und Internet of Thi	68163 Man
18	Hochschule Mannheim	staatlich	Technische Informat	B.Sc.	7	Informationstechnik steckt prakt	68163 Man
19	Hochschule Mittweida	staatlich	Automation Industri	B.Eng.	6	Mit dem Schwerpunkt Automati	09648 Mitt
20	Hochschule München	staatlich	Digital Engineering	B.Sc.	7	Im Bachelorstudiengang Digital I	80335 Mün
21	Hochschule Trier	staatlich	Internet of Things - I	B.Eng.	7	Dinge, die über das Internet eige	54293 Trier

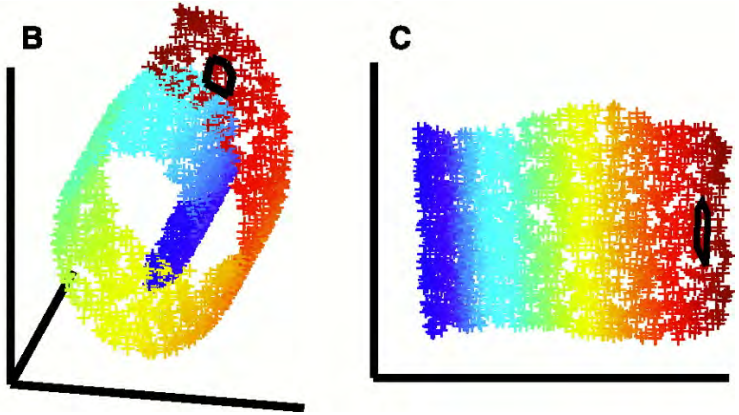
Tabelle1

Language Encoder & Dim. Reduction

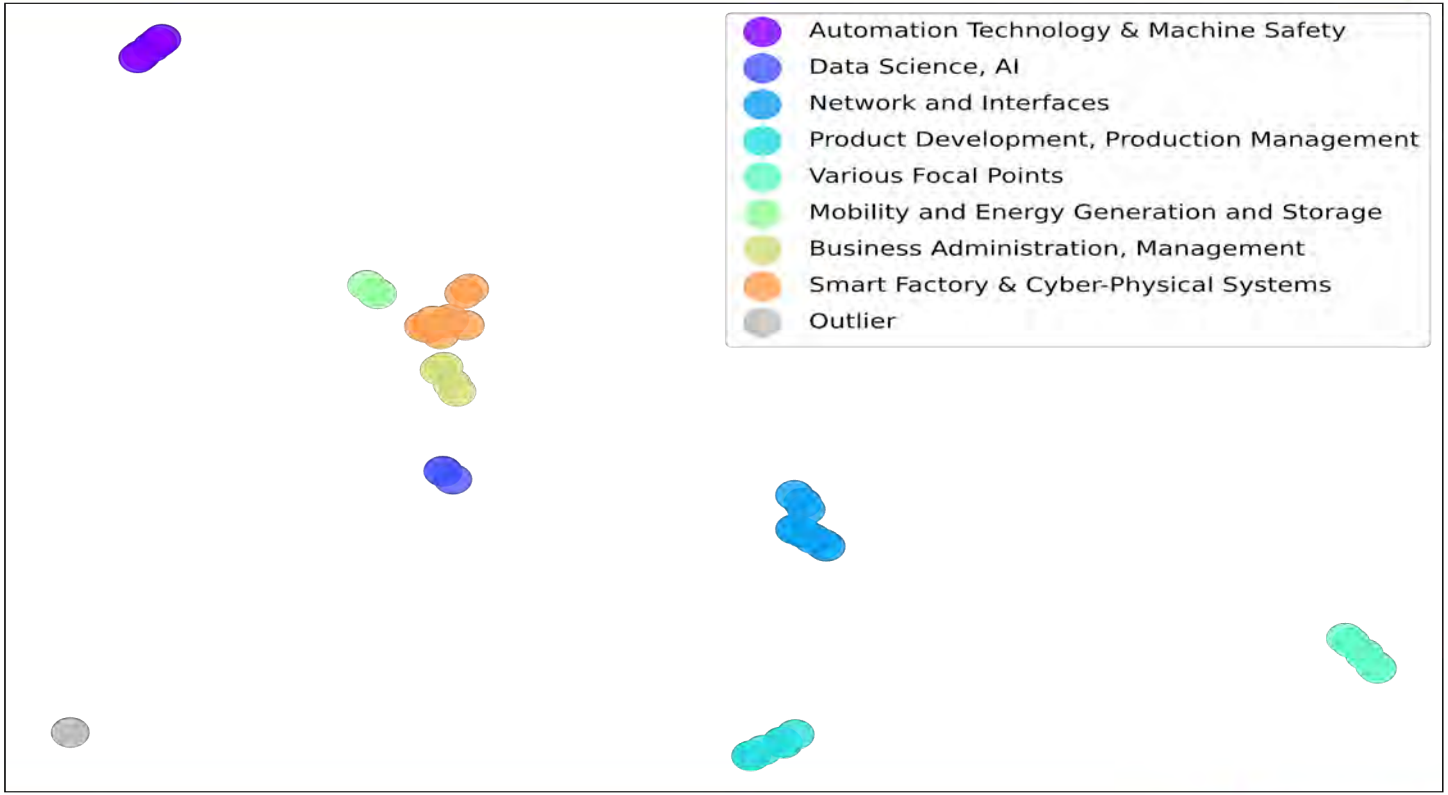


512

Dimensions



Clustering & Topic Modelling



Topic Modelling

Automation Technology & Machine Safety	Data Science	Production Development, Production Management	Networking and Interfaces	Various Focal Points	Business Administration, Management	Smart Factory & Cyber-Physical Systems	Mobility, Energy Generation and Storage	Outlier
5	3	6	9	6	4	9	3	2
			Total:			47		

- 8 Clusters (Similar study courses) and 2 outlier
- Biggest Clusters “Networking & Interfaces” and “Smart Factory & Cyber-physical Systems”
- Most courses focus on Production

Map of faculties offering educational courses on industry 4.0

47 study courses
across Germany

Comparison of GDP in € with Industry4.0 courses considered in this research per federal state

Federal State	Portion of GDP	GDP in millions €	Industry 4.0 courses	
Nordrhein-Westfalen	20,50%	733.257	6	12,77%
Bayern	18,50%	661.541	9	19,15%
Baden-Württemberg	15,00%	536.041	12	25,53%
Niedersachsen	8,80%	315.808	3	6,38%
Hessen	8,50%	302.532	1	2,13%
Berlin	4,60%	162.950	1	2,13%
Rheinland-Pfalz	4,50%	162.220	3	6,38%
Sachsen	3,80%	134.511	2	4,26%
Hamburg	3,50%	126.710	1	2,13%
Schleswig-Holstein	2,90%	104.506	1	2,13%
Brandenburg	2,20%	78.656	-	
Sachsen-Anhalt	1,90%	67.111	3	6,38%
Thüringen	1,80%	65.466	3	6,38%
Mecklenburg-Vorpommern	1,40%	49.461	-	
Saarland	1,00%	35.638	-	
Bremen	0,90%	34.213	-	
online			2	
Germany	**100%**	**3.570.620**		

Number of employees in mechanical engineering in Germany by federal state in 2020 and 2021

Number of employees in mechanical engineering in Germany by federal state in 2020 and 2021	2020	2021		Industry 4.0 courses	
Baden-Württemberg	321.999	311.353	30,5%	12	25,5%
Bayern	227.814	223.677	21,9%	9	19,1%
Nordrhein-Westfalen	198.550	195.138	19,1%	6	12,8%
Niedersachsen	63.261	63.389	6,2%	3	6,4%
Hessen	45.951	45.357	4,4%	1	2,1%
Rheinland-Pfalz	39.369	40.871	4,0%	2	4,3%
Sachsen	39.696	37.762	3,7%	3	6,4%
Schleswig-Holstein	20.110	20.192	2,0%	1	2,1%
Thüringen	17.607	17.271	1,7%	3	6,4%
Saarland	15.353	15.520	1,5%		0,0%
Sachsen-Anhalt	14.084	13.737	1,3%	3	6,4%
Hamburg	12.114	12.413	1,2%	1	2,1%
Berlin	8.255	8.346	0,8%	1	2,1%
Mecklenburg-Vorpommern	7.351	7.238	0,7%		
Brandenburg	5.400	5.251	0,5%		
Bremen	4.417	4.268	0,4%		
Online				2	4,3%
	1.041.331	1.021.783	1	47	1

Bachelor's Degrees

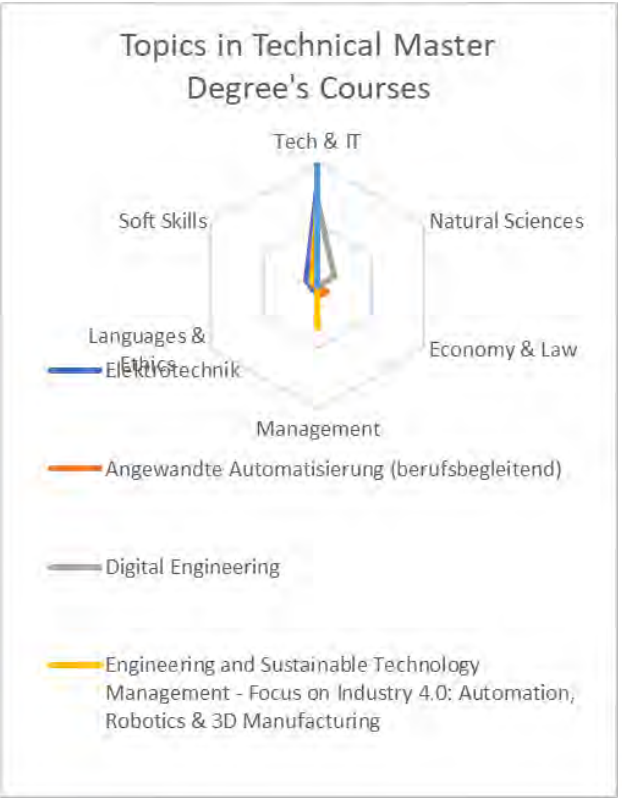
Technical Bachelor Degree's Courses

	course	university	capabilities	competences	entry requirements
	Smart Automation / Elektrotechnik, B.Eng.	Hochschule Harz	- analytical thinking - development of software	- ability to work in a team	- general University Entrance Qualification
	Data Science, B.Sc.	Fachhochschule Südwestfalen	- analytical thinking	- acting responsibly	- general University Entrance Qualification
	Industrie-4.0-Informatik, B.Eng.	Ostbayerische Technische Hochschule Amberg-Weiden	- analytical thinking	- ability to work in a team - acting responsibly - communication skills	- general University Entrance Qualification
	Automatisierungstechnik und Industrie 4.0, B.Sc.	Hochschule Mannheim	- independent way of working	-flexibility - communication skills	- general University Entrance Qualification
	Digital Engineering, B.Eng.	Staatliche Studienakademie Glauchau - Berufsakademie	- analytical thinking	- communication skills - ability to work in a team	- general University Entrance Qualification - practice partner or company required

Bachelor's Degrees economical Focus

course	university	capabilities	competences	entry requirements
Data Science & Artificial Intelligence, B.Sc.	Fachhochschule Wedel	- analytical thinking	- ability to work in a team	- general higher education entrance qualification - recruitment test
Betriebswirtschafts-lehre – Industrie, B.A.	DHBW - Duale Hochschule Baden-Württemberg	- independent way of working	- understanding of innovation - flexibility	- general higher education entrance qualification - recruitment test - English B2
Digital Business Management, B.Sc.	Hochschule Fresenius Heidelberg	*	-flexibility - communication skills	- general higher education entrance qualification
BWL Industriemanagement - Industrie 4.0, B.A.	CBS International Business School	- analytical thinking	*	- general higher education entrance qualification - practice partner or company required
Wirtschaftsingenieur wesen Industrie 4.0, B.Eng.	IU Internationale Hochschule	- analytical thinking	- leadership skills - flexibility	- general higher education entrance qualification

Masters's Degree



Technical Master's Degree Courses

course	university	capabilities	competences	entry requirements
Elektrotechnik, M.Sc.	Hochschule Trier	- in-depth knowledge - ability to work scientifically	- leadership and management skills - ability to work in a team	- Bachelor's degree in electrical engineering min. average of 2.5 and 210CP -German language skills
Angewandte Automatisierung (berufsbegleitend), M.Eng.	Fachhochschule Bielefeld	- analytical thinking -in-depth understanding of the technologies created by Industry 4.0 at the production level - understanding of	- acting responsibly - ability to work in a team	-Bachelor's degree in engineering or natural sciences min. average 3.0 + 12 months of work and 210 CP - letter of motivation - tabular CV
Digital Engineering, M.Sc.	Bauhaus-Universität Weimar	- understanding of engineering problems - data analysis - interpretation of complex results for different stakeholders	- scientific work skills - flexibility - in-depth knowledge of various model	- Bachelor's degree in engineering min. average 2.3 - English B2 - English-language letter of motivation - possibly job interview
Engineering and Sustainable Technology Management - Focus on Industry 4.0: Automation, Robotics & 3D Manufacturing, M.Eng.	SRH Berlin University of Applied Sciences	- design, implement and market innovative systems and technologies - introduce, promote and optimize digital twins	- expertise in technology management and Industry 4.0 - suitability for expert and	- Bachelor's degree in engineering or natural sciences - letter of motivation - English language certificate - CV - job interview
Automatisierung, M.Sc.	Hochschule für Angewandte Wissenschaften Hamburg	- knowledge of the design and implementation of real-time algorithms - knowledge of applications for decentralized and regenerative energy supply	- leadership and management skills	-Bachelor's degree in engineering or natural sciences with min. 210 CP and grade "good" -Diploma Supplement - Letter of motivation

Economical Master's Degree Courses

	course	university	capabilities	competences	entry requirements
	Smart Factory - Industrie 4.0, M.Eng.	Hochschule Esslingen	- digitize business processes - develop solution concepts appropriate to the situation and change management processes	- recognizing digitization potential - aptitude for leadership - ability to assess the limits of meaningful digitization	- Bachelor's degree in engineering - student must be among the best 35% of the cohort
	Wirtschaftsingenieurwesen – Product Innovation, M.Sc.	Hochschule Furtwangen - Informatik, Technik, Wirtschaft,	-experts for goal-oriented product innovation - goal-oriented planning, design and realization of innovations	- leadership and management skills, - ability to work in a team	- Bachelor's degree - CV - letter of motivation - proof of German and English language skills
	Digital Production Management, MBA	Leuphana Universität Lüneburg	-strategically align and digitize production systems; - Understand your company's processes and strategies	-leadership and management skills - flexibility -application of methods for solving problems	- Bachelor's degree in engineering - 12 months of relevant work experience - good command of English
	Technologie & Management, M.Sc.	Provadis School of International Management and Technology	-Change Management - Project and Process Management, Innovation Management, Quality Management, Service Development	- Technology Management, Project and Risk Management, Intercultural Communication and Heterogeneous Teamwork, Digital Transformation	- Bachelor's degree min. average 2.5 - good knowledge of English
	Digitalization and Innovation, MBA	Hochschule für Angewandte Wissenschaften Hof	- the know-how to initiate practical innovations in a company or your own start-up	- development of intercultural competence - valuable professional experience	-Bachelor's degree; -at least 180 CP - German, at least level A1 - 12 months work experience - letter of motivation

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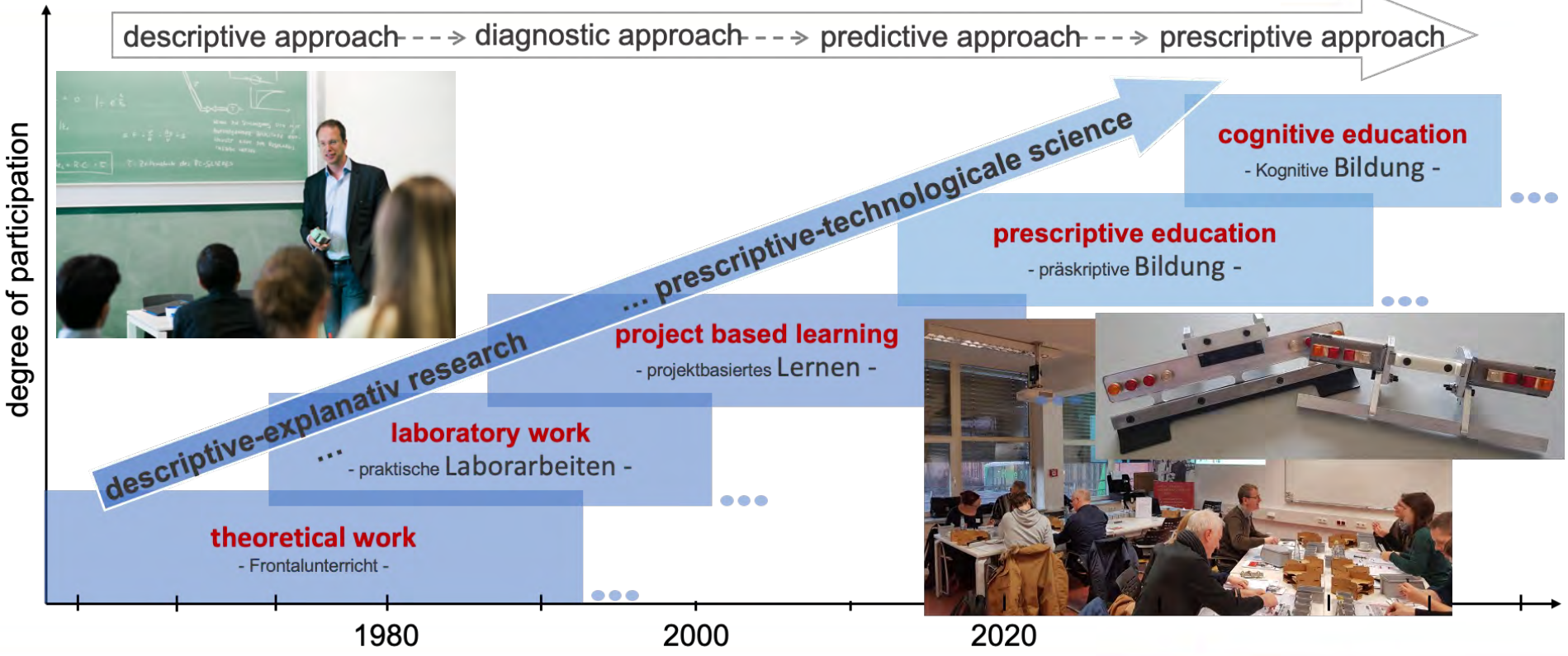
Philosophy of studies



Interdisciplinarity

R se ch
Ob e

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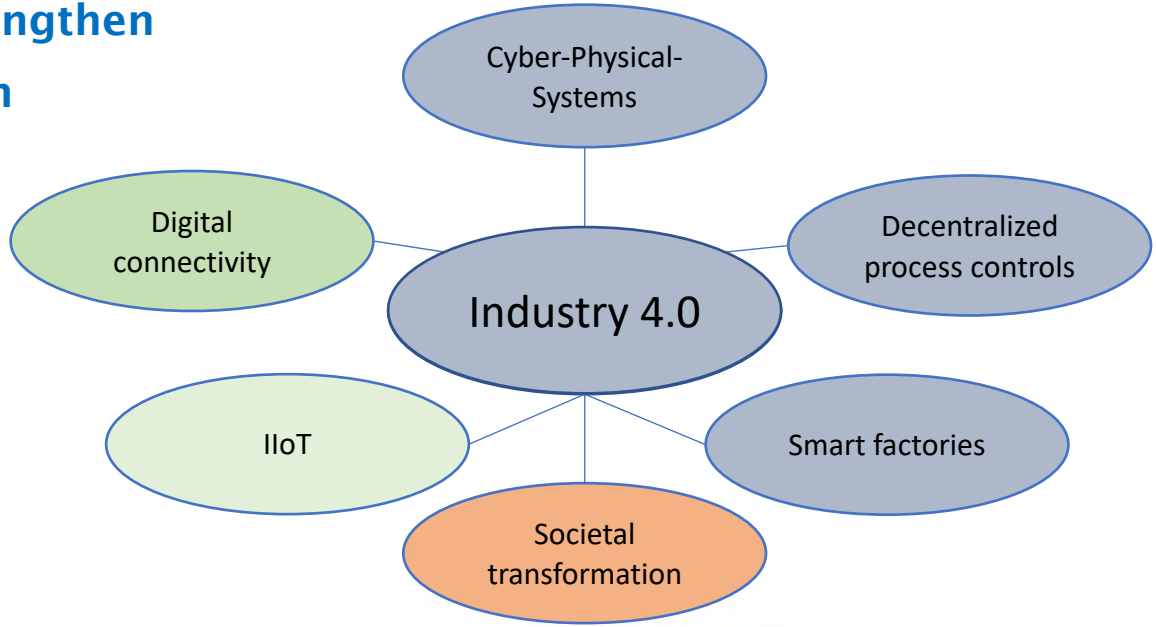
Interdisciplinarity and Industry4.0

- „Industr[y/ie] 4.0“ dating back to 2011
- A German initiative to strengthen Germany-based production
- Viewed from different perspectives
- Usual combination: traditional Production Science and ICT



Interdisciplinarity and Industry4.0

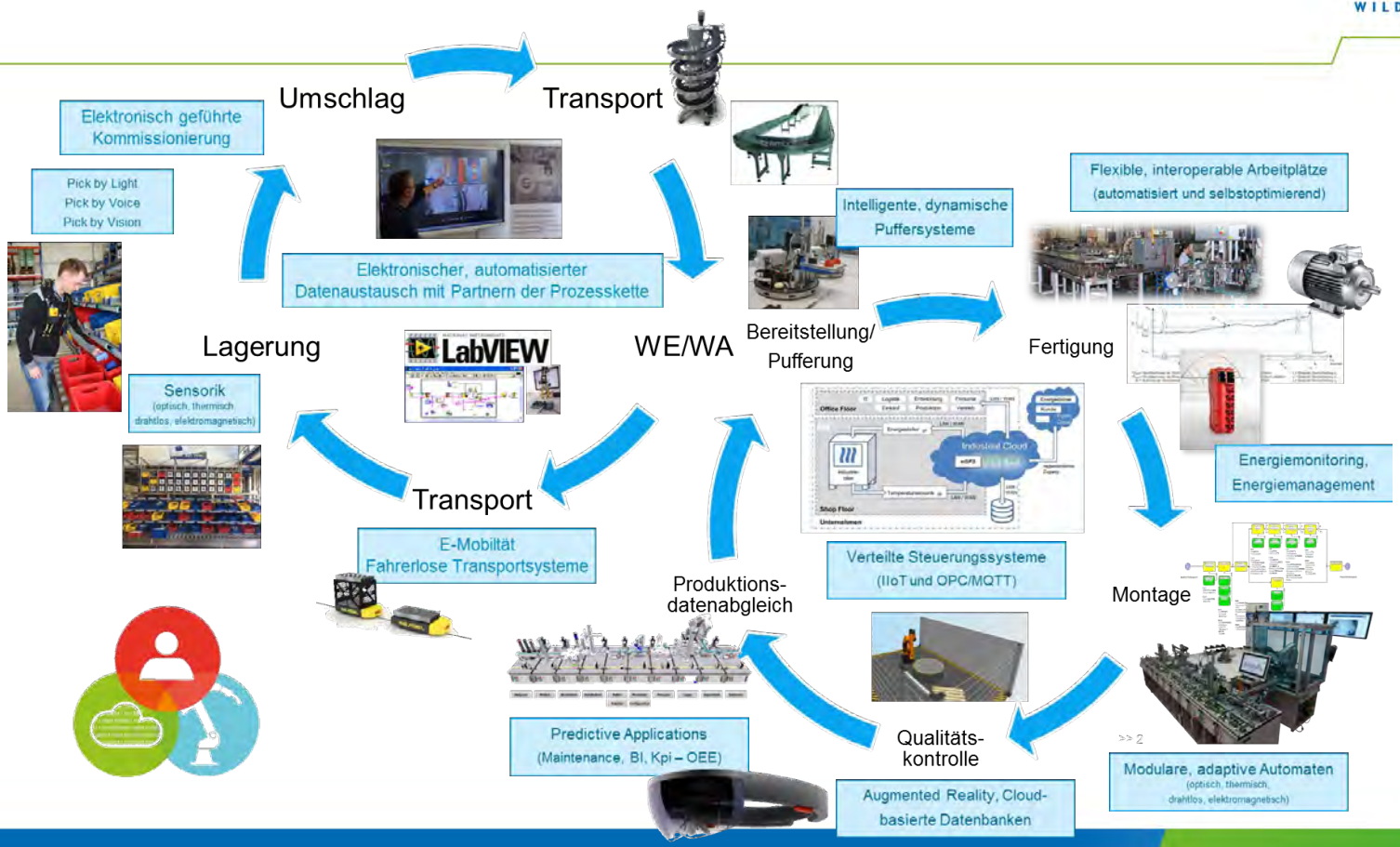
Rigid Disciplines — Adopting Skills

- **ICT-share of staff**
- **Chair calls from outside the field**
- **Application driven**

Chairs of Production Science

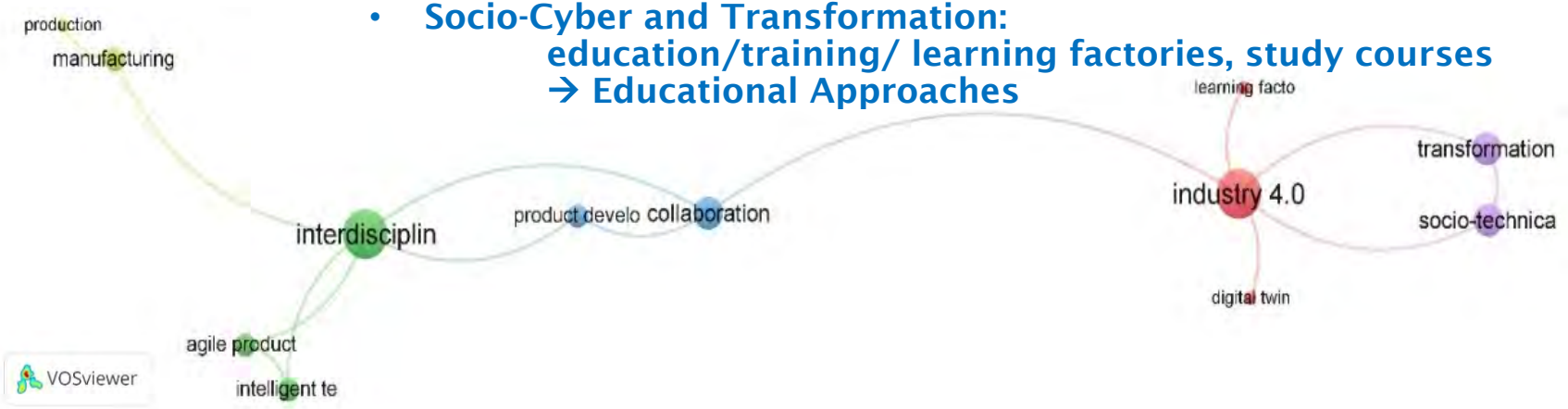
- ***Industry 4.0 by itself is interdisciplinary***
- **Trend indicator**
- **Lagging by bureaucracy**

Automation & Intralogistics



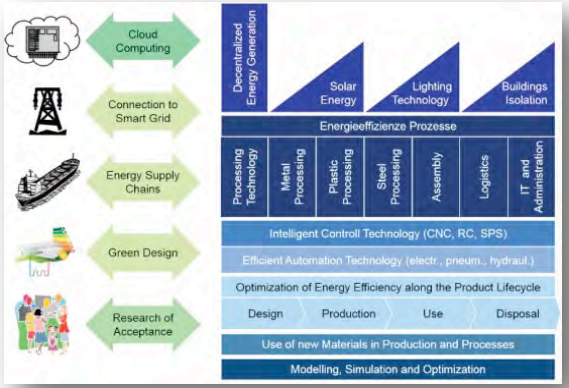
Methodology – A Structured Literature Review

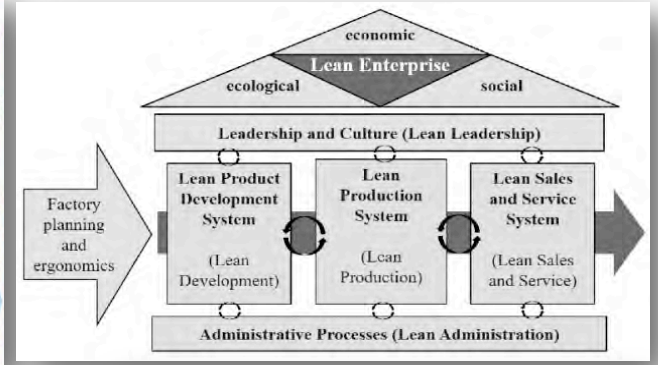
- Validation of Search Strategy
- No signs for overwhelming trend
- Collaboration:
  Product - Design & Manufacturing
  H-H, H-M, M-M
- Socio-Cyber and Transformation:
  education/training/ learning factories, study courses
  → Educational Approaches

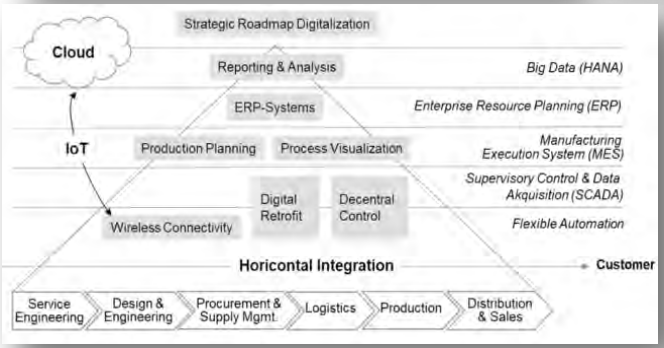


Methodology – A Structured Literature Review

- „Learning Factories“







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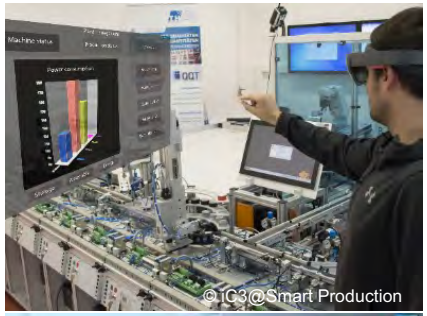
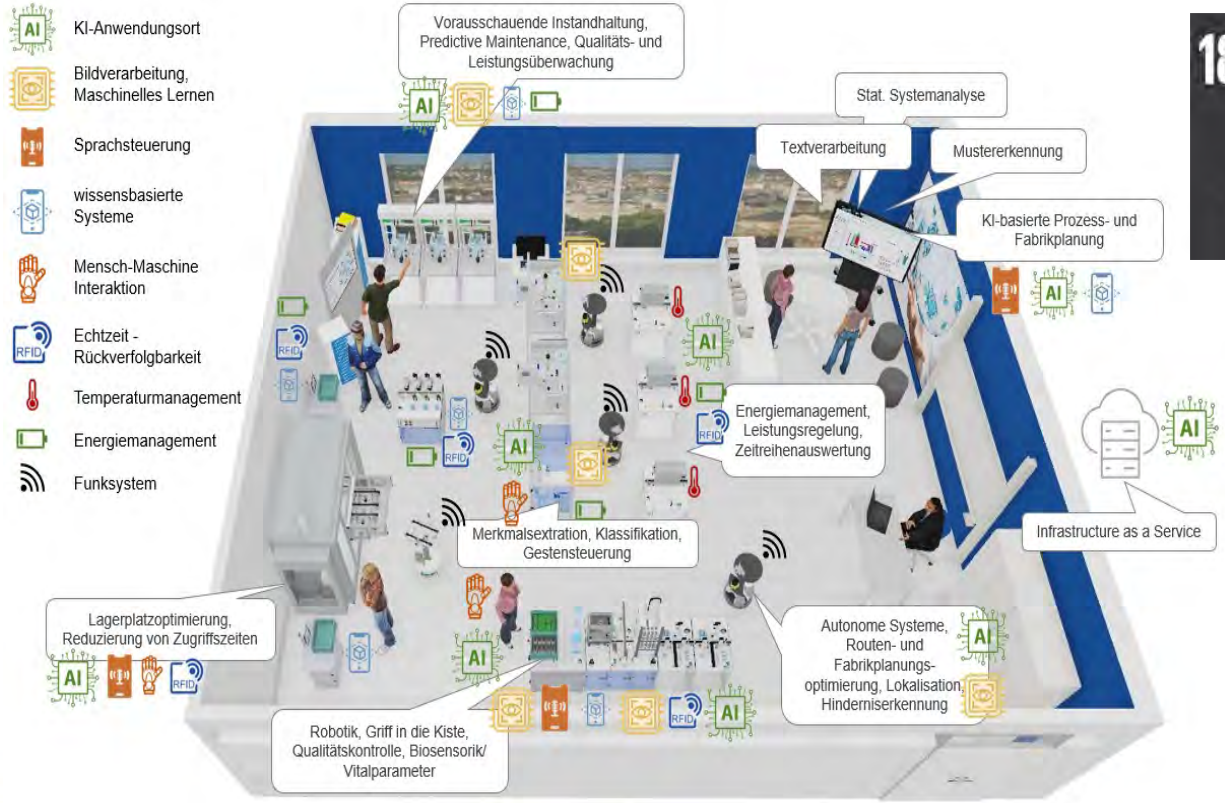
Technical University of Applied Sciences

Worker Assistance & Learning-on-the-Job	Test Bed – iC3@SmartProduction	Assembly Systems & Dev. Environment	Laboratory for Intralogistics

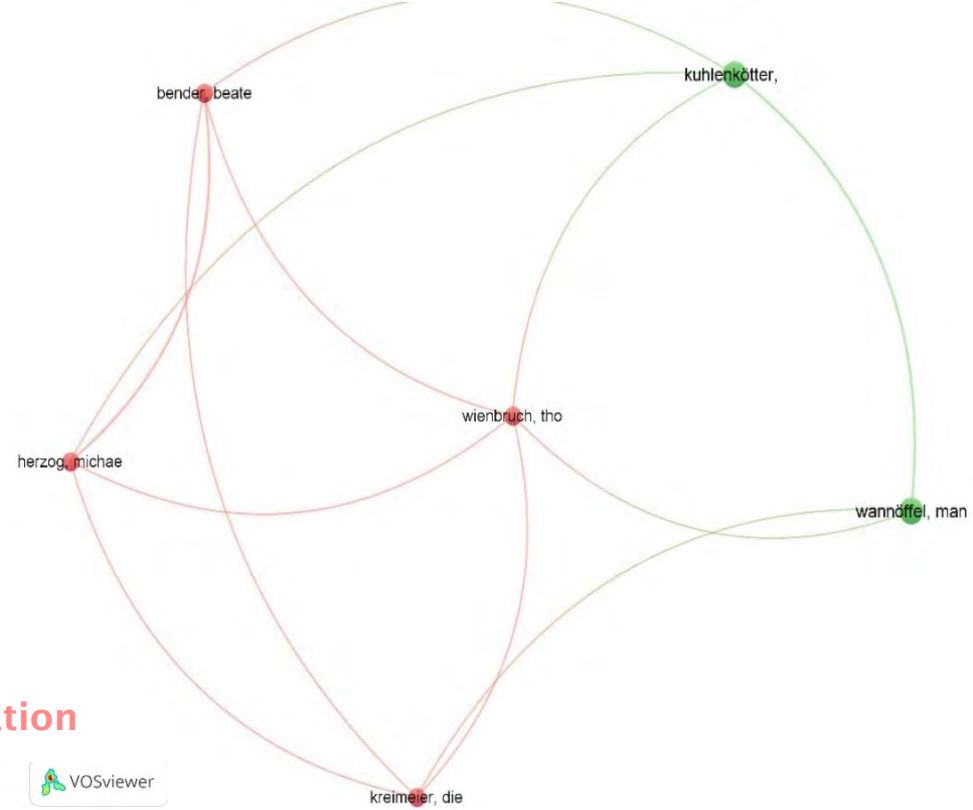


„Thinking outside the box“

KILEAN



Methodology – A Structured Literature Review



- **Author analysis:**

  Learning Factory

  +

  PLC, MES, Digital Twin, Participation

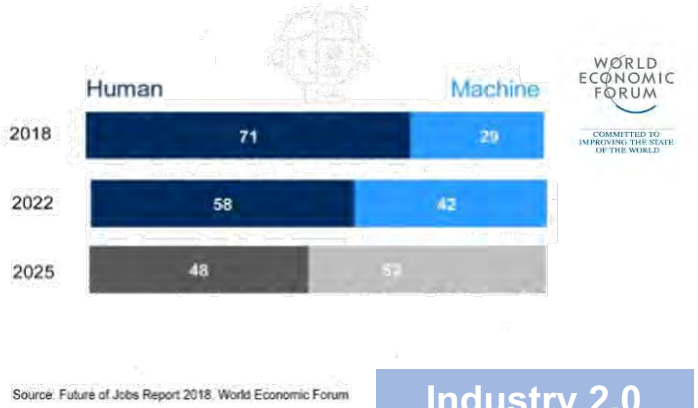
Agenda

- **Technical University of Wildau**
- **Motivation for Industry4.0**
- **Project „Edu4Ind4.0“**
  - Scope
  - Method
  - Results
- **Interdisciplinary studies**
- **Summary & Outlook**

Summary

- **Interdisciplinary by Definition**
- **Trends:**
  - Collaboration:
    Product - Design & Manufacturing
    H-H, H-M, M-M
  - Socio-Cyber and Transformation:
    → Educational Approaches / (Re-/)Training
- **Author Expertise:**
  Learning Factory
  +
  PLC, MES, Digital Twin, Participation

Change through human centering



Digital Transformation

Industry 1.0
mechanisation

1784: mechanical loom

Industry 2.0
electrification

mass production

1870: assembly line

Industry 3.0
automation

1969: programmable logic controller / SPS

Industry 4.0
smart connectivity

mass customization

Today: digitalization, IoT, Big Data, CPS, Cloud Computing …

Industry 5.0
Industry 4.x
unification

mass personalization
-
Human-robot-co-working, bio-economy

AI, digital twin, quantum computers, …

Tomorrow: socio-cyberphysical system, robotics and AI, bionics, economy, sustainability, Society 5.0, ….

complexity

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„The acquisition and computation of informations describe the most valuable enabler of innovations in the near future of global production.“