

>> The Short 4.0 Round Trip << :

From AI, Digital Natives and Innovation Cultures
towards to Future of Work, Life, and Society



HR 2025 – Personalarbeit der Zukunft
Stuttgart – Mercedes-Benz Museum
November 24th, 2016

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Cybernetics Lab IMA/ZLW & IfU
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RWTH Aachen University

I. Introduction

- Breakthroughs in Artificial Intelligence...
- ... and a networked world
- Back to the future: the rediscovery of cybernetics

II. Innovation in Times of Revolutions

- Who makes innovations? – The vendor change in 4.0
- What are innovations? – From the basics to innovation in 4.0
- How to innovate? – About innovation cultures in 4.0

III. Demographic Change and Digital Natives

- National and international population shifts
- Societal changes in the digitalization age - Trends in a „born digital“ world

IV. Work 4.0 – Blue-Collar, White-Collar and the Question of Creativity

- Pattern in the blue-collar/white-collar scheme
- Hi there, AI... 😊 - from GOFAI zu creative systems

V. Summary and Outlook

... leading to the 4th industrial (r)evolution...

Breakthroughs - A new era of artificial intelligence

Communication technology
bandwidth and computational power

Embedded systems
miniaturization

Watson
2011

Semantic technologies
information integration

Google Car
2012



→ Systems of “human-like” complexity

... leading to the 4th industrial (r)evolution...

Breakthroughs - Everybody and everything is networked

Communication technology

bandwidth and computational power

Embedded systems

miniaturization

Semantic technologies

information integration

Swarm
Robotics



Team
Robotics



Car2Infra-
structure



Smart
Grid

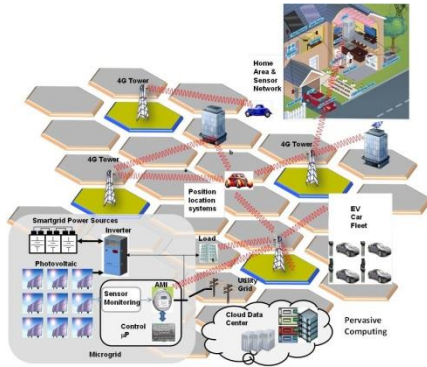
Smart
Factory



Everybody and everything is networked. - Big Data & Cyber-Physical Systems

“Internet of Things & Services, M2M or Cyber Physical Systems are much more than just buzzwords for the outlook of connecting 50 billions devices by 2015.”

Dr. Stefan Ferber, Bosch (2011)



Weidmüller, Vission 2020 - Industrial Revolution 4.0
(Intelligently networked, self-controlling manufacturing systems)

Vision of Wireless Next Generation System (WiNGS) Lab at the University of Texas at San Antonio, Dr. Kelley

„local“
to „global“

„local“
to „global“

around 1750

around 1900

around 1970

today

1st industrial revolution

Mechanical production systematically using the power of water and steam

Power revolution

Centralized electric power infrastructure; mass production by division of labor

Digital revolution

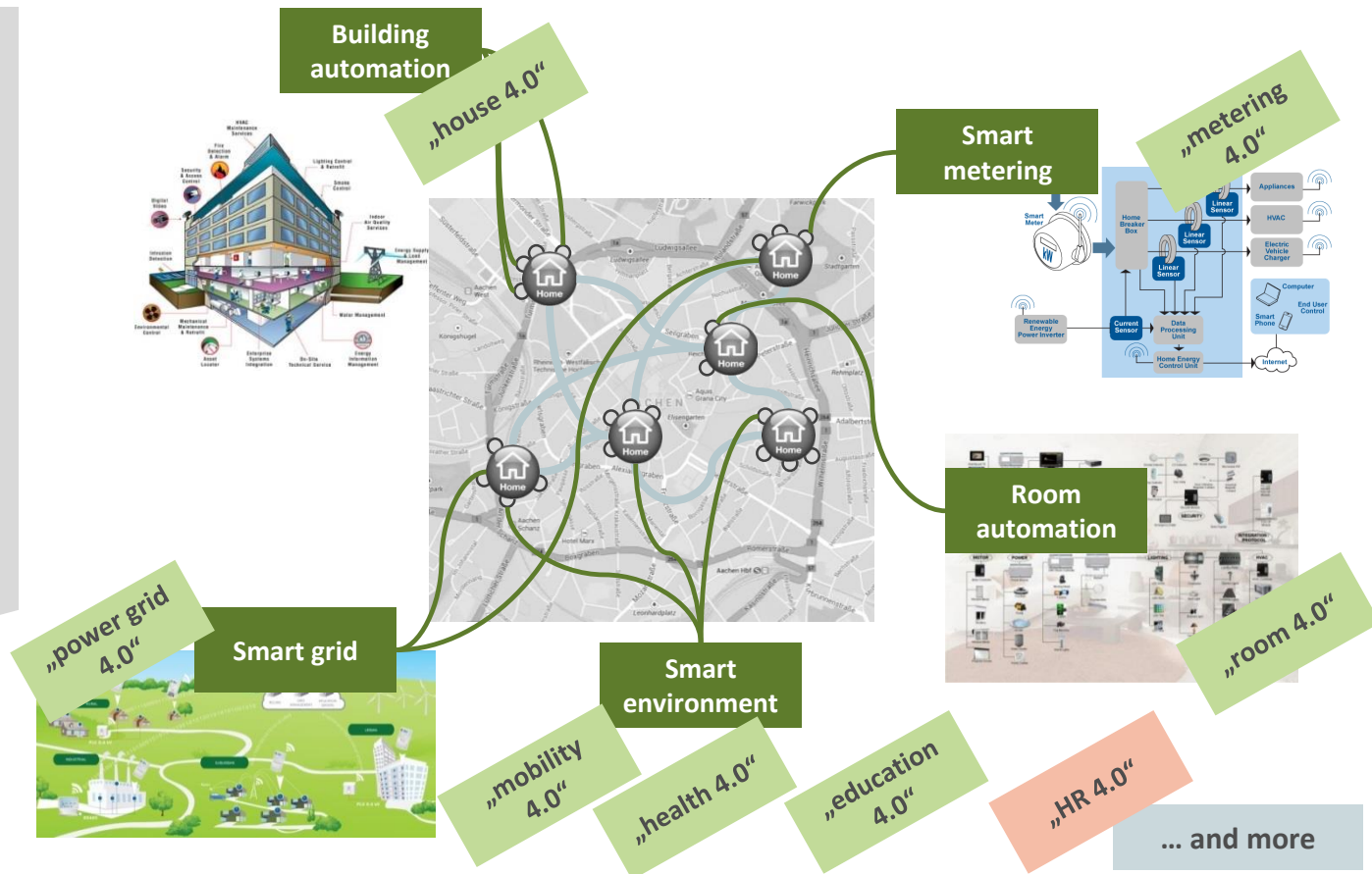
Digital computing and communication technology, enhancing systems' intelligence

Information revolution

Everybody and everything is networked – networked information as a “huge brain”

“Industry 4.0 will address and solve some of the challenges facing the world today such as resource and **energy efficiency, urban production and demographic change.**”

Henning Kagermann et.al.,
acatech, 2013



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... leading to the 4th industrial (r)evolution...
And how do these systems work?

Communication technology
bandwidth and computational power

Embedded systems
miniaturization

Semantic technologies
information integration



**?? Steering -
Controlling ??**

Towards intelligent and (partly-) autonomous systems AND systems of systems

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Characteristics of Industrial Revolutions: The vendor change



Latest version of Google's self driving car (Huffington Post, 28.5.2014)



Sony announced autonomous car in 2015, based on their experience in visual sensors



Ford 021C concept car 2012, designed by Newson now at Apple (1999)



Apple Inc.



Tesla X 2015, other Teslas since 2006; Forbes: "most innovative enterprise"



Car specialists? – No.

- Connectivity & data specialists.
- Energy & sensor specialists.

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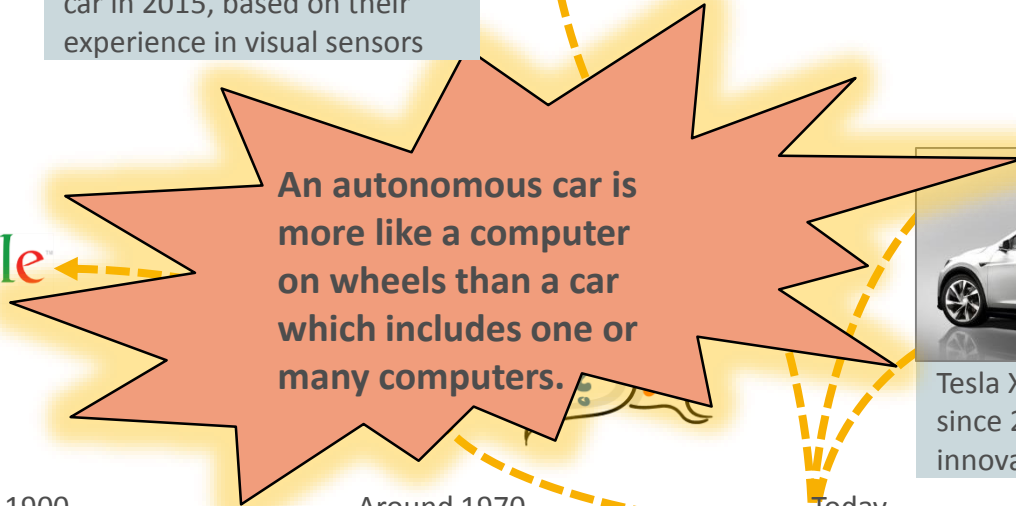
Ford 021C concept car 2012, designed by Newson now at Apple (1999)



Apple Inc.



Tesla X 2015, other Teslas since 2006; Forbes: "most innovative enterprise"



Google: First autonomic car with street license, 2012

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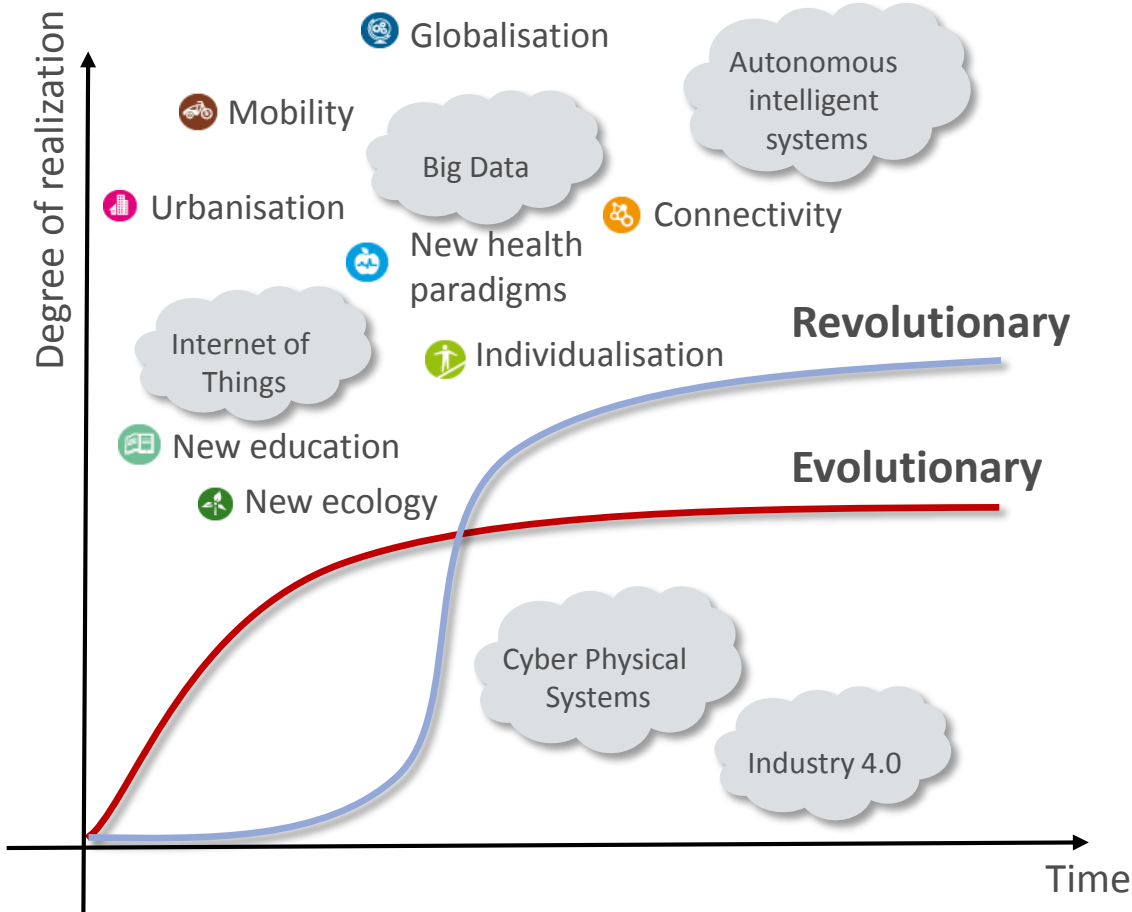
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Information Revolution

Everybody and everything is networked – networked information as a "huge brain"

The two ways of innovation



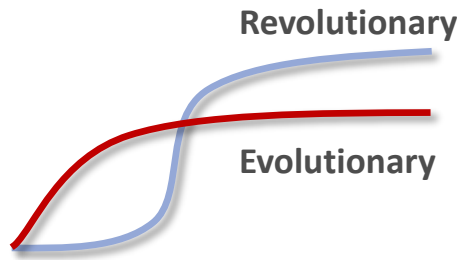
“Innovations are divided into **two categories**:

- **Evolutionary innovations** (continuous or dynamic evolutionary innovation) that are brought about by many incremental advances in technology or processes and
- **Revolutionary innovations** (also called discontinuous innovations) which are often disruptive and new.”

IMPORTANT:

- In times of Industrial Revolutions, the revolutionary innovations dominate.
- In the times between, the evolutionary innovations dominate.

The innovators' dilemma



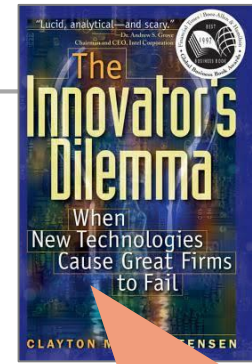
Evolutionary innovations:

- Improvement and optimization of an already existing product or process
- Changes ,locally‘
- **Mainly carried out by established players**



Revolutionary innovations:

- Something „really new“
- Characterized by categorial changes and with strong consequences for the society, ,globally‘
- **Mainly carried out by market newcomers**



By C. M. Christensen, 1997
new edition 2015

- The more professional organization are, the stronger they tend to remain in their traditions since...
 - ... management structure is organized in such a way that it „reproduces“ itself
 - ... clients‘ sugestions always address traditional ways
 - ... self-affirmation feedback...
- Standard management methods as TQM, CIP(KVP), Kaizen, standards, lean management, etc. address evolutionary processes
- ... hampering categorial changes, system changes and disruptive changes

Since the 1960s:



- research on organizational cultures in respect to innovation, “innovation culture”

Breakthrough of the “culture concept” in the 1980s

Hofstede’s “cultural dimensions theory” (1980)

- 5 cultural dimensions
- Still most cited European social scientist
- Critics addresses mainly the particular dimensions and the measurement process, but not the general approach.



Hofstede (1991):

Culture is the collective programming of the mind which distinguishes the members of one group from another.

Organizational culture...

- ... transfers the concept of culture from cultural anthropology (national cultures) to organisations.
- ... represents the collective values, beliefs and principles of organizational members.
- ... is a product of such factors as history, product, market, technology, and strategy, type of employees, management style, and national culture.

[Wikipedia, 2015]

Innovation culture:

Innovation culture describes a specific type of organisational culture addressing the generation of innovation in the organisation.

[Wikipedia, 2015]

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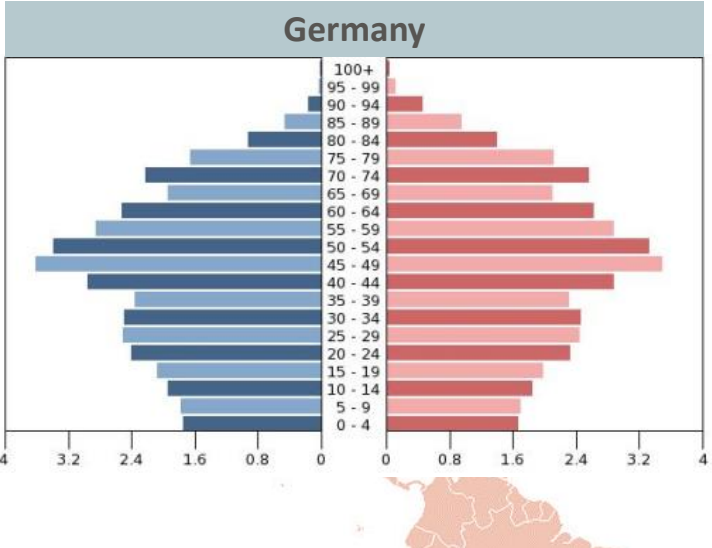
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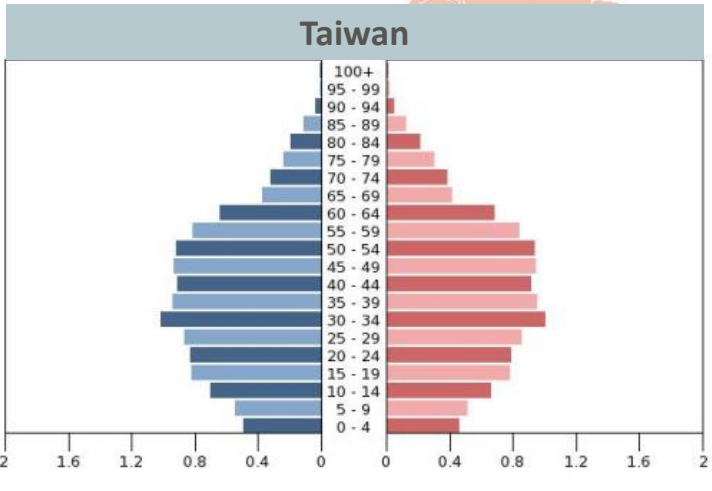
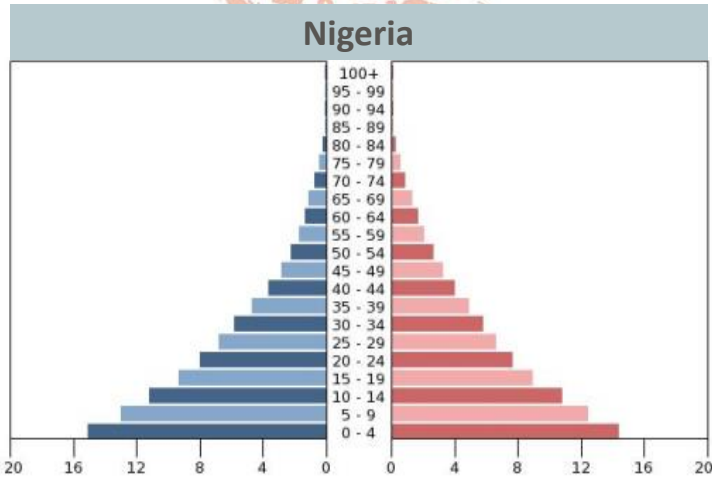
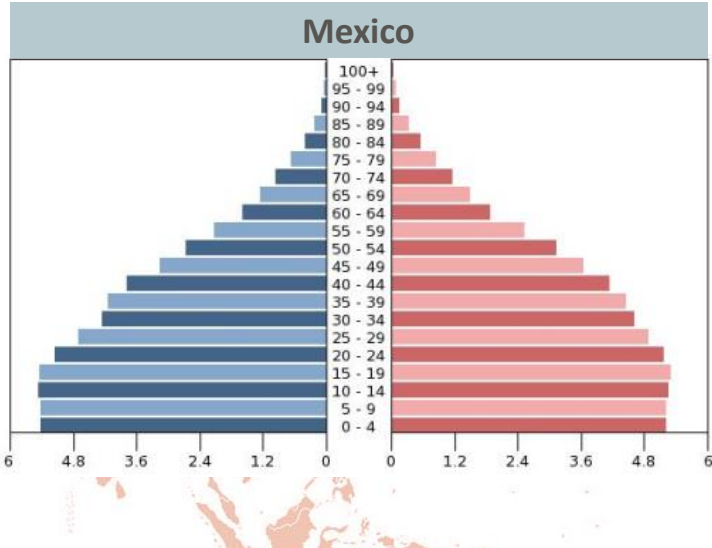
V. Summary and Outlook

Demographic change... Population shift (international)

→ Aging/shrinking societies

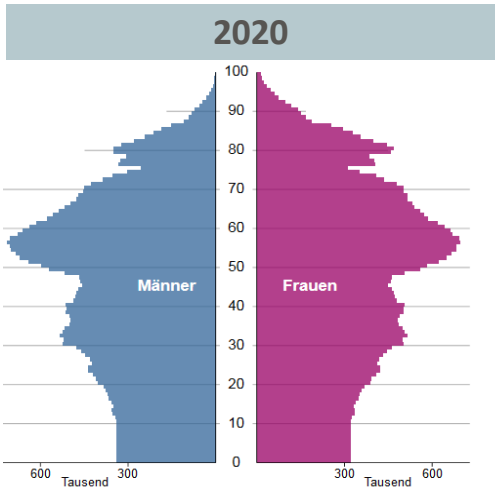
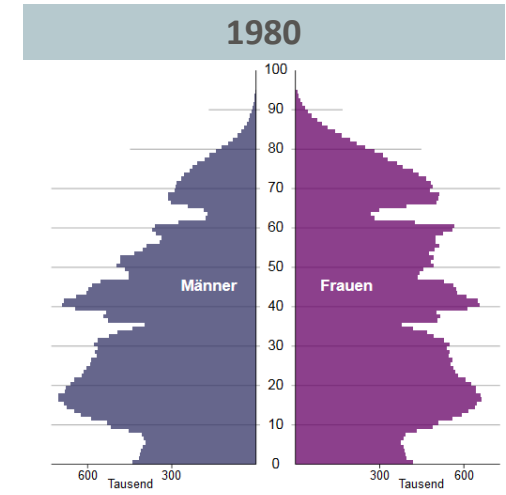
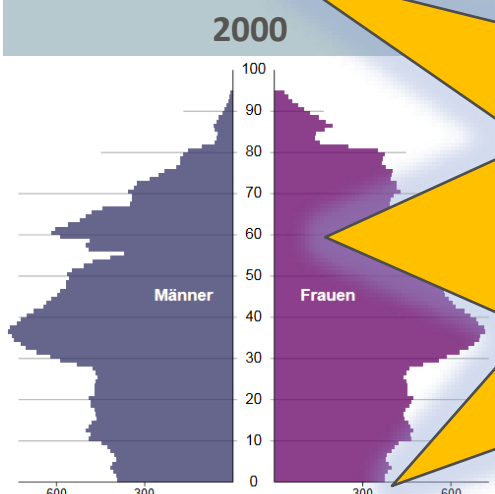
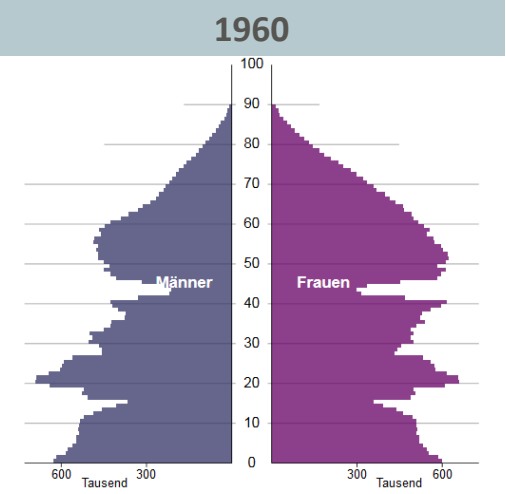


→ Growing societies

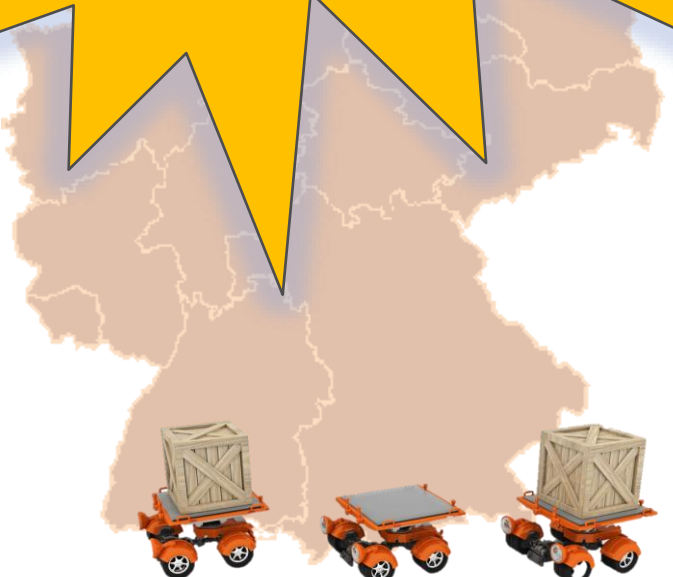


Demographic change... Population shift (national)

→ Aging/shrinking Germany



With this shrinking population,
the current productivity of
Germany cannot be sustained
without the broad use of
„robots“ in all areas!!



© Statistisches Bundesamt 2015

The customer gets powerful.

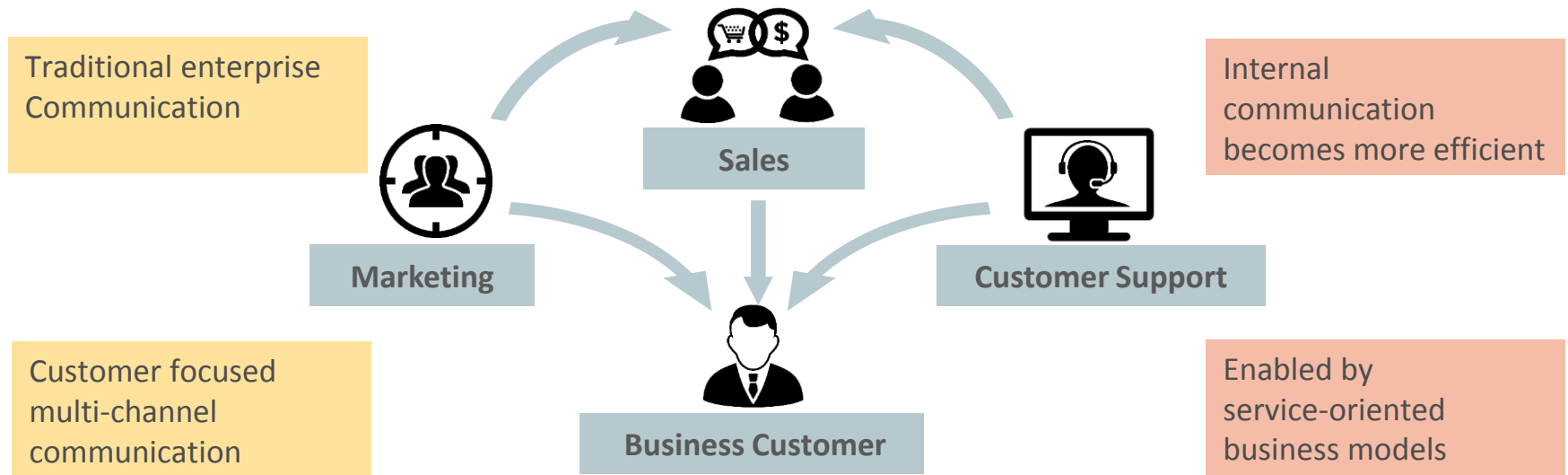


And: he/she expects services in business (B2B) to work in the same comfortable way as at home (B2C).

And – more again: the **digital native** is entering the scene. This guy does not even know what a fax machine is used for. Everything outside the internet does not exist!

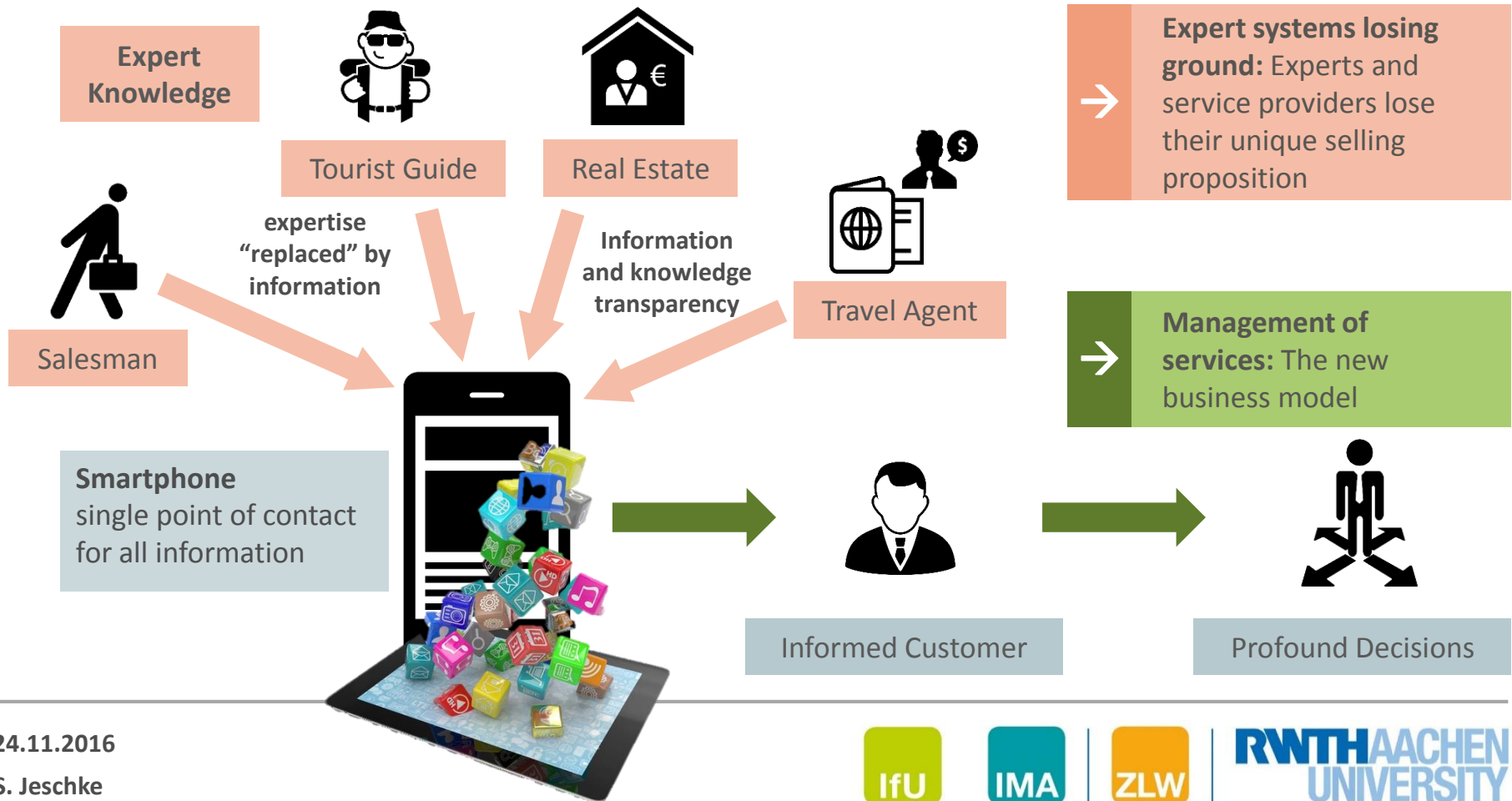


Business units – such as marketing, sales, customer support – communicate with each other, but also directly and autonomously with the customer.



Services become available and experts become obsolete!

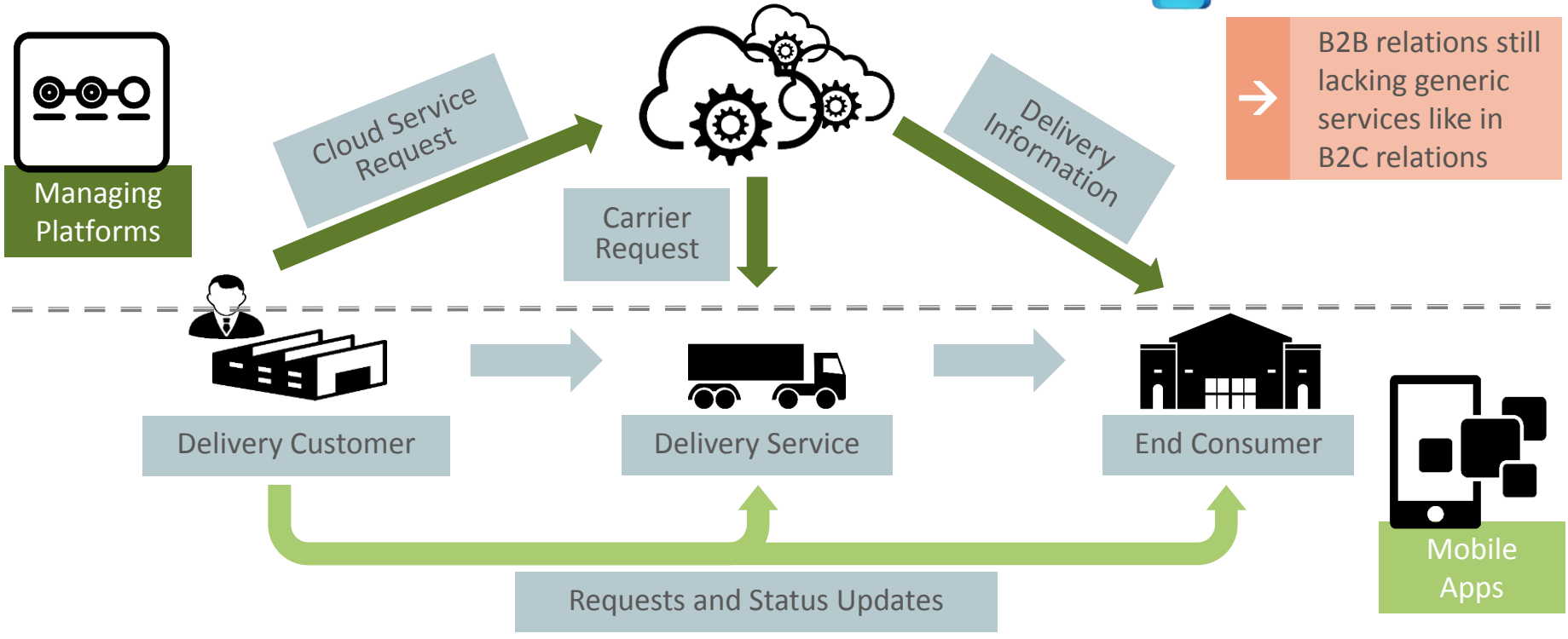
As information becomes more and accessible, experts lose information power. This observation is inline with all earlier changes along the information chain, starting with the book printing ...



Logistics 4.0 or „Logistics as a Service“ (LaaS)

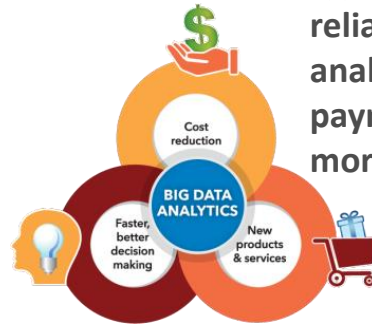
The terminology is based on concepts as Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) up to Anything-as-a-Service (XaaS). It is sometimes referred to as "on-demand XY", without hosting or owning the necessary infrastructures and tools.

The philosophy behind it is: "Just do it – I don't care how!"



Service Innovations

Lateral thinking - what's next?



SAS: all types of reliability analysis, e.g. payment moral etc.

Which new business models are about to break through?

- Will the product be delivered to customer before it has been ordered, „Anticipatory Shipping“?
- Send medicine before a disease spreads...
- Who is ordering?
- Which kind of foresight do Big Data Technology will come up with in the future?

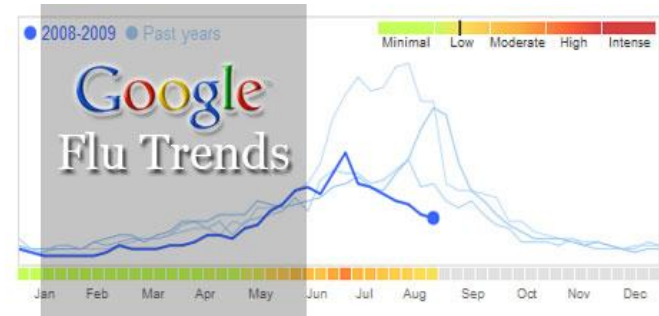


?



gild

GILD: “Roboter Recruiting”; selecting employees on a purely algorithmic basis



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The typical assumption...

→ ... that job changes in 4.0 are mainly addressing blue collar jobs and/or routine jobs does not hold true.

→ From „blue collar – low qualified“ to „white collar – middle class“...

but probably, this is just a transition phenomenon



White collar jobs

... are under massive change due to the enhancement in AI, here the impact often hits “middle class jobs”

Decentralized platforms

... with automated consensus models (e.g. blockchain) take over complex administrative tasks e.g. in **judiciaries**



High qualified jobs

... as e.g. health professionals face already the taking over through AI in certain fields by Watson, Google Flu, etc.



IBM Watson

Social robots

... will become capable of taking over even complex tasks with personal presence as in **health or home care**



Virtual and augmented environments

... allowing for new **international players**, even in tasks requiring humans and presence



Autonomous systems

... as autonomous cars and more advanced production technology will **change the blue collar** – low qualified as well





Remember Mario: What if the machine could learn, how to solve a level?
Why not use some kind of intelligent trial-and-error?



[SethBling, 2015]

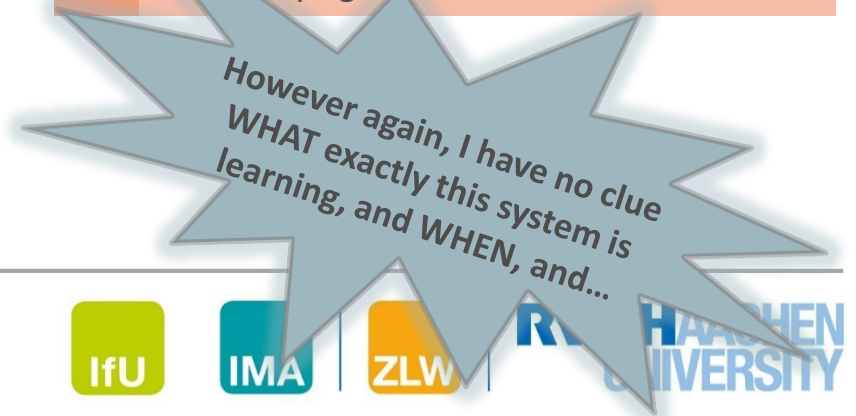
Neuroevolution of augmenting topologies (NEAT) [Stanley, 2002]

- **Genetic algorithms on top of neural networks**
- At each **state** the system decides what **action** to perform
- Actions are **rewarded** if Mario does not die in return
- Level progress by **evolving** neural networks



Human factor is "very small"

- reduced to very general, mainly formal specifications of the neural network...
However, humans still influences the underlying representation model



Reinforcement learning (R-learning)

is inspired by behaviorist psychology – maximizing the expected return by applying a sequence of actions at a current state.

→ can be applied to broad variety of problems

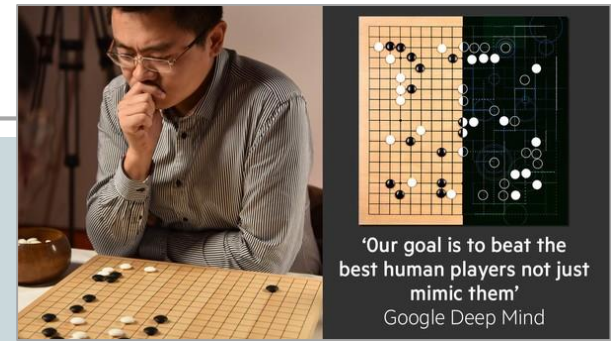


Deep learning

Where the Story Goes: AlphaGo



Go originated in China more than 2,500 years ago. Confucius wrote about it. As simple as the rules are, Go is a game of profound complexity. This complexity is what makes Go hard for computers to play, and an irresistible challenge to artificial intelligence (AI) researchers. [adapted from Hassabis, 2016]



The problem: 2.57×10^{210} possible positions - that is more than the number of atoms in the universe, and more than a googol times (10^{100}) larger than chess.

→ Bringing it all together!

Data-driven learning

Training set

30 million moves recorded from games played by humans experts



Creating deep neural networks

12 network layers with millions of neuron-like connections



Predicting the human move
(57% of time)



Reinforcement learning

Learning non-human strategies

AlphaGo designed by **Google DeepMind**, played against itself in thousands of games and evolved its neural networks; Monte Carlo tree search



March 2016:

Beating Lee Se-dol (World Champion)

AlphaGo won 4 games to 1.
(5 years before time)



Achieving one of the grand challenges of AI

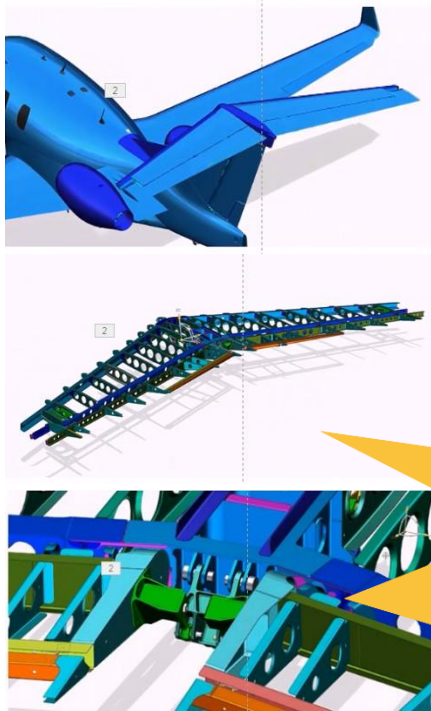
[Hassabis, 2016]

! What if ... we would use AI not only for “boring and lengthy routing work” – but as an entity to inspire us, come up with its own ideas ...

- Enriching our perspectives through foreign intelligence types, in line with the diversity philosophy, but in its original intention, namely in terms of “variety of mental models” ?

! Siemens “Product Design and Manufacture” -

<https://www.youtube.com/watch?v=IDtmy6YorG4> (10/2016)

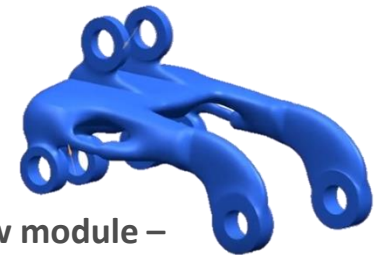
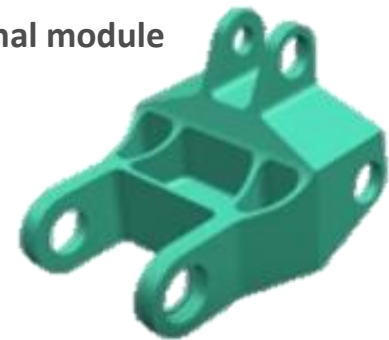


Setting:

the elevator bell crank is to be new-designed. Relevant parameters are weight (!), strength, stress path, energy efficiency...

Hidden agenda:
Innovation. Overcoming
the “human bias” and
“NIH” syndrome

The original module



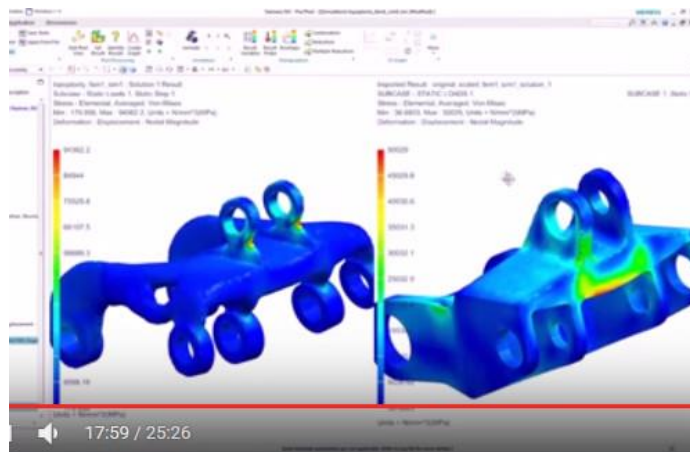
The new module –
design-process supported by AI

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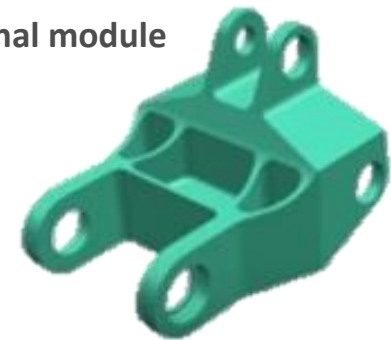
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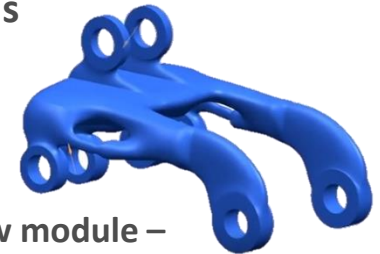
<https://www.youtube.com/watch?v=IDtmy6YorG4> (10/2016)



The original module



Cognitive Computing:
using biological models



The new module –
design-process supported by AI

Result (selective...):

- Much less residual stress
- 20% lighter
- Much more organic design



“**Creativity** is a phenomenon whereby **something new** ... is formed. The created item may be intangible (such as an idea, a scientific theory, a musical composition or a joke) or a physical object (such as an invention, a literary work or a painting).”

[adapted from Wikipedia, last visited 5/3/2016]

- **DII (descriptions for images in isolation):** Traditional storytelling software
- **SIS (stories for images in sequence):** new approach towards storytelling, including
 - Based on SIND - Sequential Image Narrative Dataset: 81,743 unique photos in 20,211 sequences, aligned to both descriptive (caption) and story language.
 - [Margaret Mitchell / Microsoft, 04/2016, together with colleagues from Facebook]

			
DII	A group of people that are sitting next to each other.	Adult male wearing sunglasses lying down on black pavement.	The sun is setting over the ocean and mountains.
SIS	Having a good time bonding and talking.	[M] got exhausted by the heat.	Sky illuminated with a brilliance of gold and orange hues.

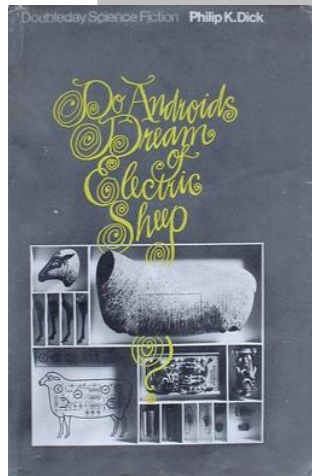
Visual-Storytelling by **Microsoft**
based on deep neural networks (convolutional neural networks)



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“Do Androids Dream of Electric Sheep?”

(science fiction novel by American writer Philip K. Dick, published in 1968)



Computational creativity (artificial creativity) ... is a multidisciplinary endeavour that is located at the intersection of the fields of artificial intelligence, cognitive psychology, philosophy, and the arts. [adapted from Wikipedia, last visited 5/3/2016]

Live from **Universidad de Málaga**
 Monday, **July 2nd 2012**
 London 19:30
 Madrid 20:30

Concert: **CAN MACHINES BE CREATIVE ?**

Colossus	piano:	Gustavo Díaz-Jerez
Ugadi	violin:	Cecilia Bercovich
Alphard	clarinet:	Cristo Barrios
Kinoth	violin:	Cecilia Bercovich
	piano:	Gustavo Díaz-Jerez

UMA5

„Can machines be creative?“ by **lamus**, a computer cluster composing classical music by genetic algorithms, concert for Turing's 100th birthday [youtube]



Van Gogh's *Starry Night* interpreted by **Google DeepDream** based on deep neural networks

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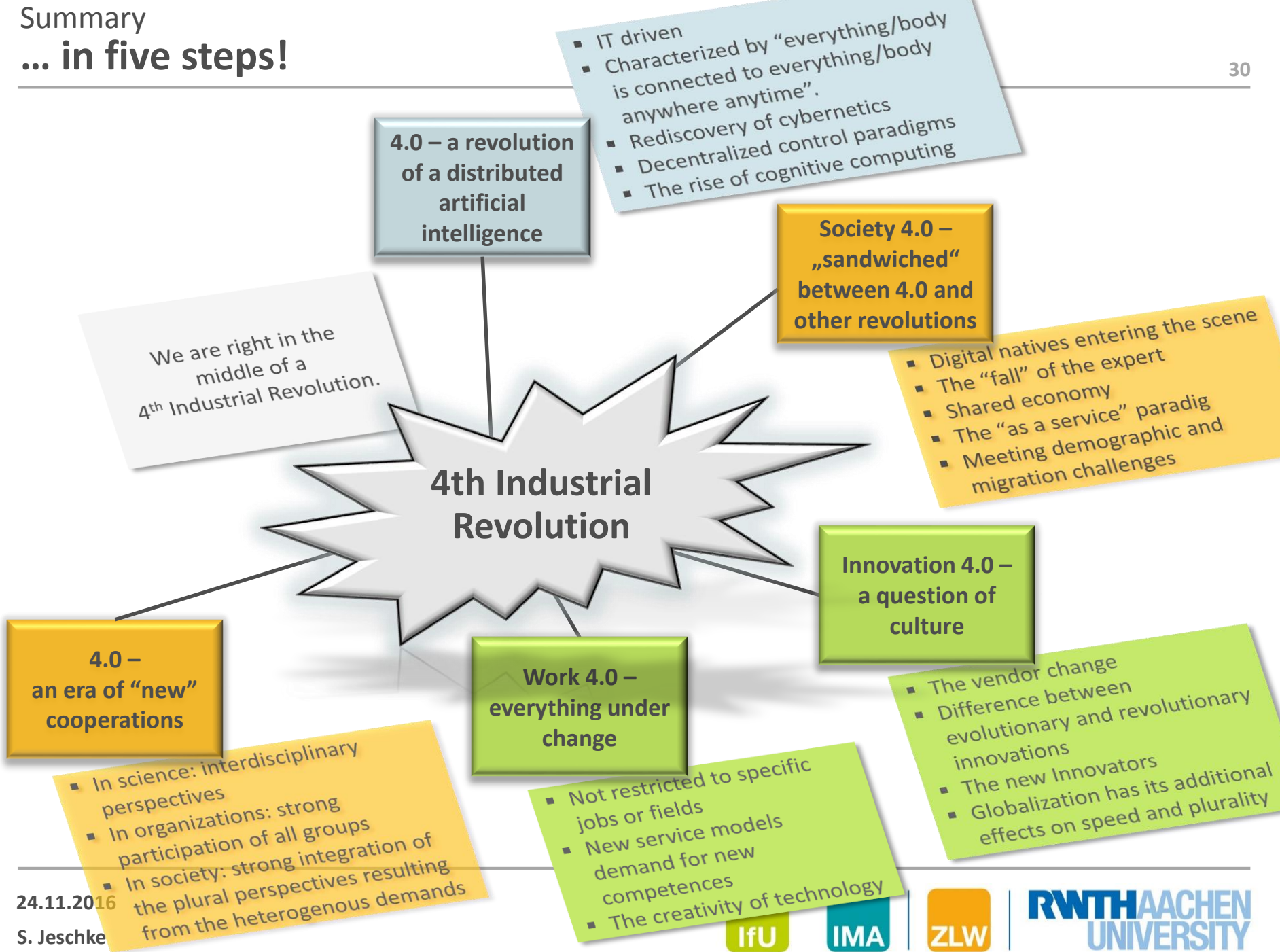
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- 1968 Born in **Kungälv/Sweden**
- 1991 – 1997 Studies of **Physics, Mathematics, Computer Sciences**, TU **Berlin**
- 1994 **NASA** Ames Research Center, Moffett Field, **CA/USA**
- 10/1994 Fellowship „Studienstiftung des Deutschen Volkes“
- 1997 Diploma Physics
- 1997 – 2000 **Research Fellow** , TU Berlin, Institute for **Mathematics**
- 2000 – 2001 **Lecturer**, Georgia Institute of Technology, **GA/USA**
- 2001 – 2004 **Project leadership**, TU Berlin, Institute for Mathematics
- 04/2004 **Ph.D.** (Dr. rer. nat.), TU Berlin, in the field of **Computer Sciences**
- 2004 Set-up and leadership of the Multimedia-Center at the TU Berlin
- 2005 – 2007 **Juniorprofessor** „New Media in Mathematics & Sciences“ & Director of the **Multimedia**-center MuLF, TU Berlin
- 2007 – 2009 **Univ.-Professor**, Institute for IT Service Technologies (IITS) & Director of the Computer Center (RUS), Department of **Electrical Engineering**, University of **Stuttgart**
- since 06/2009 **Univ.-Professor**, Head of the Cybernetics Lab IMA/ZLW & IfU, Department of **Mechanical Engineering**, RWTH **Aachen** University
- 2011 – 2016 **Vice Dean** of the Department of **Mechanical Engineering**, RWTH **Aachen** University
- since 03/2012 **Chairwoman VDI Aachen**
- since 05/2015 **Supervisory Board of Körber AG**, Hamburg

