

The Digitale Transformation of Human Machine Interaction

Human-Technology-Interaction 4.0 and the future of interaction between people and technology

3. Netzwerkforum Smart Production –
„Industrie 4.0 und Arbeit 4.0“

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I. The emerging world of interaction

- Breakthroughs
- ... and a networked world
- A short history...
- ... and the consequences

II. The intelligence of systems of systems

- Rediscover the Cybernetic approach
- The paradigm shift in artificial Intelligence: from Top-Down to Bottom-Up
- Approaches : multi agent systems in real-world applications

III. The new dimension of human machine interaction

- The role of the digital shadows
- It's all about cognitive computing ...
- ... Addressing problems of "human-like" complexity
- ... Copying human thought processes
- ... Intuitive intelligent interaction with humans...

IV. Ready to go to 4.0?

Just one line of development

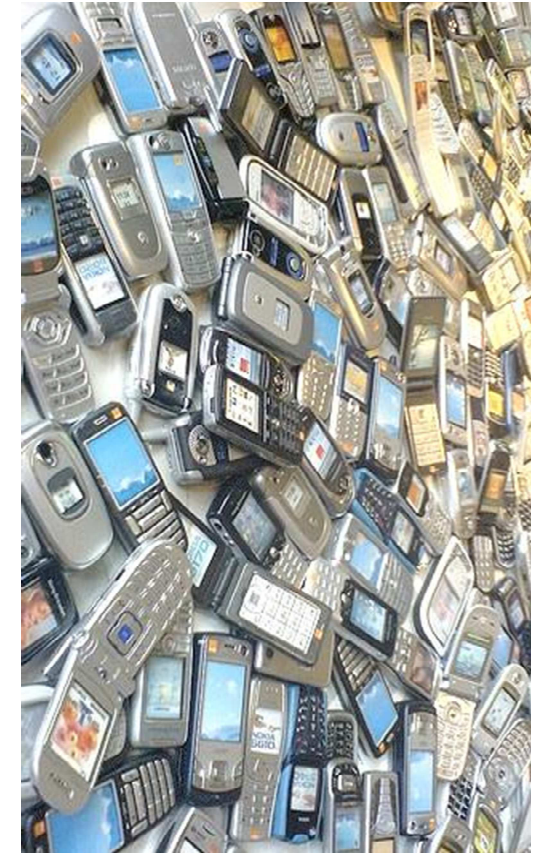
From the mobile to the car robot

3

- Almost **all people** of this world **have a mobile (7 Billions)**.
- **Smartphones** are already in charge of 30% of this world as the **first generation of „individual agents“**. In 10 year the figure of smart phones being in use will increase to the figure of people, living on this world.

From this viewpoint just think about:

- In 30 years about **1 Billion cars will drive fully automatic** – they will behave as intelligent robots.
- In 30 years all of us will have **„intelligent“ cloths**.
- In 30 years iron of buildings has to be intelligent by law.
-



4.0 will be everywhere

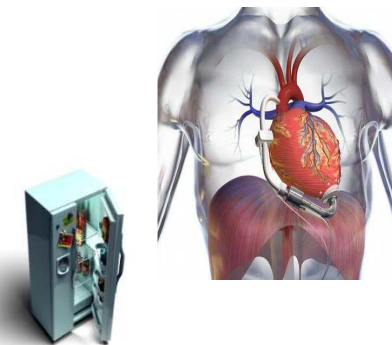
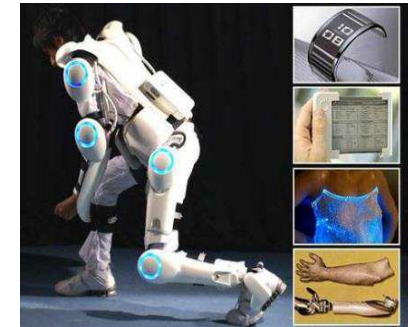
The digital transformation of all areas of live is just in the beginning

- The digital transformation is a global und local transformation of all areas of live. It is unavoidable. It is a huge chance to **recreate living, working and learning in a worldwide context.**
- These evolutions and revolutions are historically – if at all – **comparable with the introduction of mass printing facilities 500 years ago.**
- The Internet of Things will invade into **all devices of daily live.**
- In the long run most of **all reasonable devices technologies of this world will be intelligent** and perform a live long learning process by themselves and with humans.
- **4.0 – Cyberphysical Systems - is the roadmap:**
All areas will become „smart ...“ (data, factory, logistics, home, grid,.....)
- The new 4.0 products, services and process will be the **future strength of our economy**

A new kind of technological intelligence

Some Examples

- The smart home will be a interactive multimedia platform – **the fridge will speak**, all energy consumptions will be centrally controlled.
- The **heating equipment** will be intelligent (i.e. System GeniAx from WILO).
- **Medical online control** will be possible in the private home.
- **Intelligent window glasses** will absorb energy and distribute it in a controlled way.
- **The auto bumper** will be intelligent and adapt it`s stiffness to the environment.
- There will be an body **embedded back up cardiovascular pump** in case of an cardiac arrest.
- The embedded computer system in my jacket will become one of **my personal agent**, giving me advice and warnings.



... 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



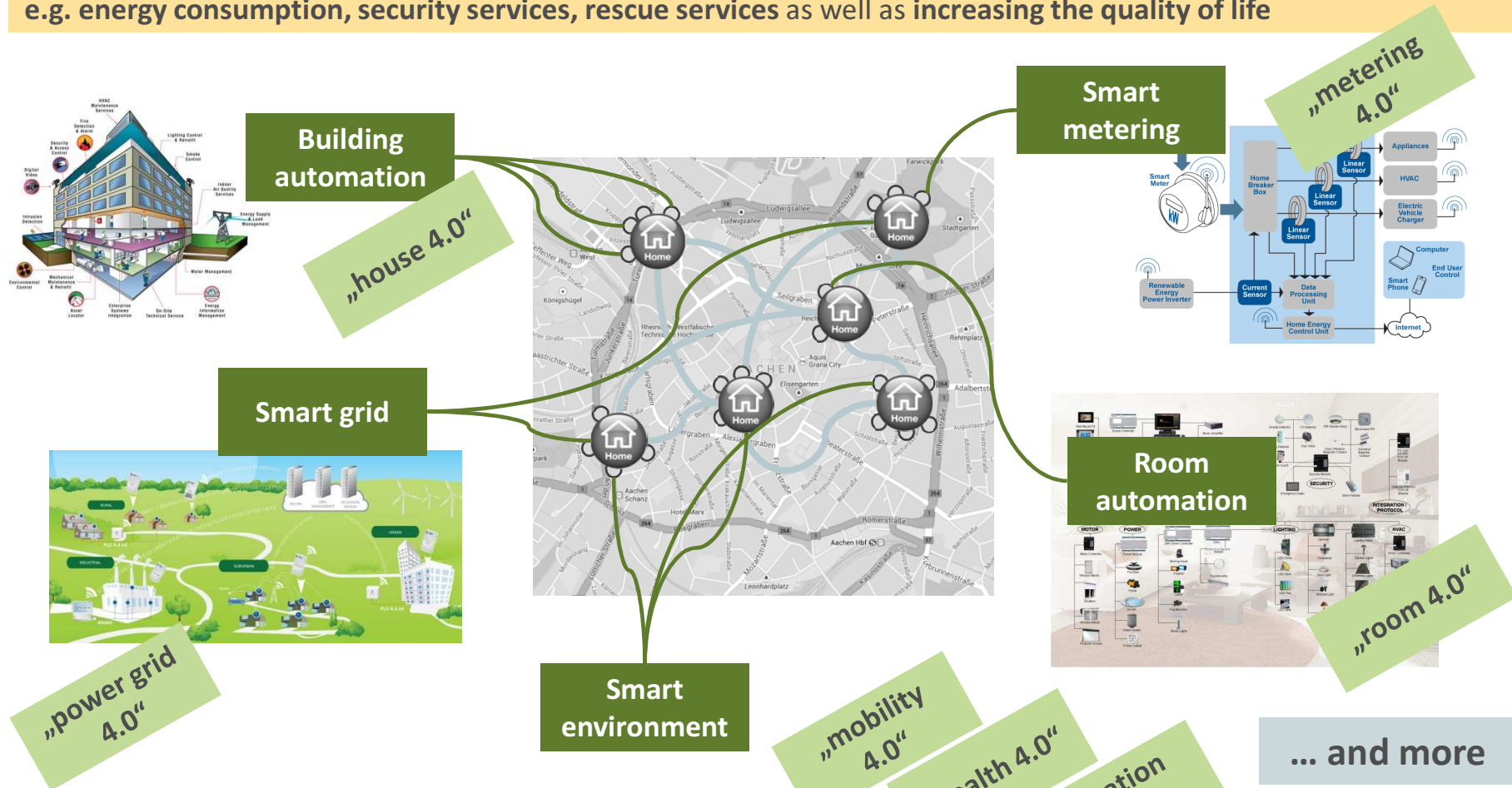
→ Systems of "human-like" complexity

... towards a networked world

Not restricted to industry: cyber physical systems in all areas

Back to: The earth converted into a huge “brain”... (Tesla 1926)

Integrating complex information from multiple heterogeneous sources opens multiple possibilities of optimization: e.g. energy consumption, security services, rescue services as well as increasing the quality of life



... towards a world of systems of systems

And how do these systems work and learn together?

Communication technology
bandwidth and computational power

Embedded systems
miniaturization

Semantic technologies
information integration



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

around 1750

1st industrial revolution

Mechanical production systematically using the power of water and steam

around 1900

Power revolution

Centralized electric power infrastructure; mass production by division of labor

around 1970

Digital revolution

Digital computing and communication technology, enhancing systems' intelligence

today

Information revolution

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

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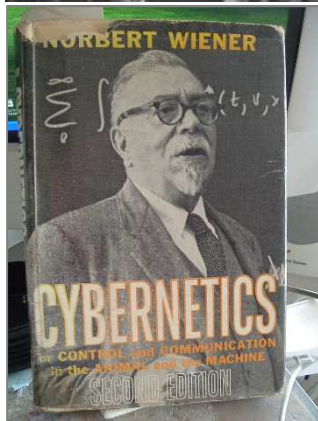
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The Basis of thinking in system with high complexity und dynamics (Dynaxity)

The central elements of Cybernetics

- - **Term:** „governance“, to navigate
 - **Born around 1940**
 - **1948:** “Cybernetics or control and communication in the Animal and in the machine” (Norbert Wiener)
 - **until 1953:** Macy-Conferences



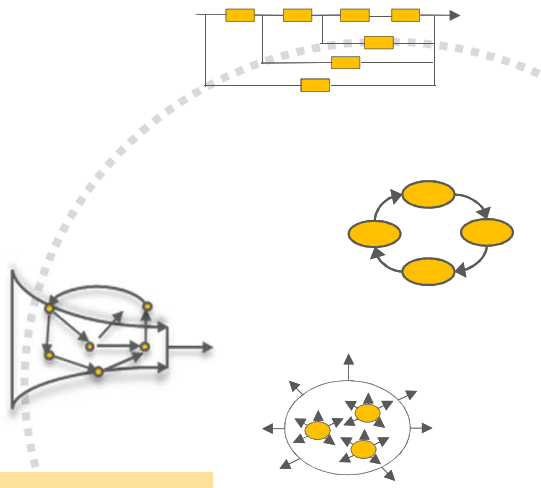
Feedbackloop
Circular explanations for systems behavior, self-regulation (Forrester, Ashby)

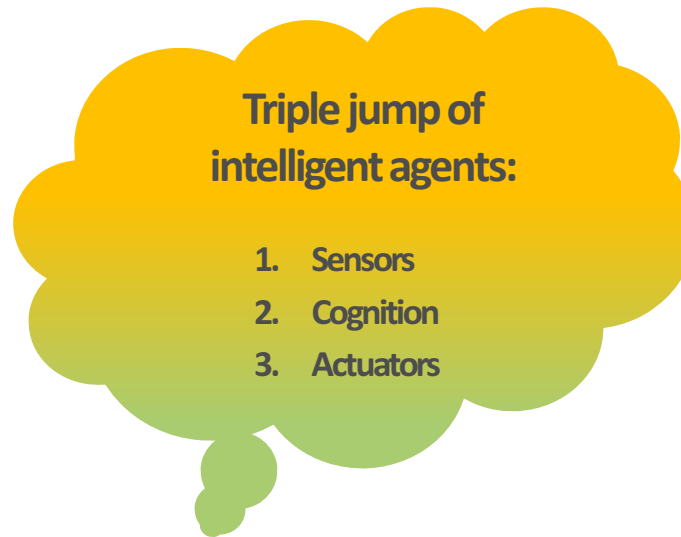
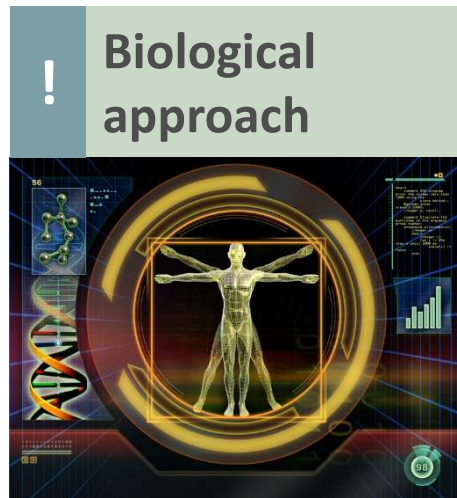
Autopoiesis
System capacity to maintain and stabilize itself (Maturana, Varela)

Decentralization
Decentralized navigation, bottom up processes (Stafford Beer)

Emergence
Spontaneous new properties, swarm behavior (Wolfram, Gell-Mann)

Complex Systems
Multi-component systems in complex interactions (Stafford Beer)





'only biological brains are intelligent'

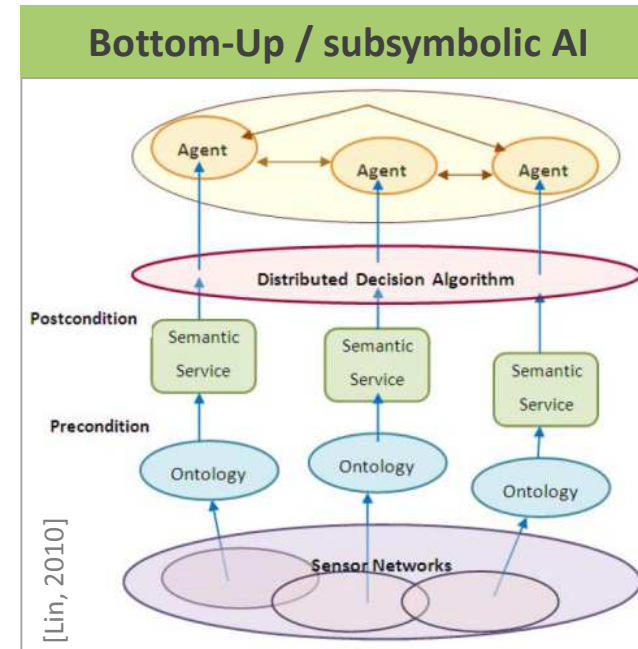
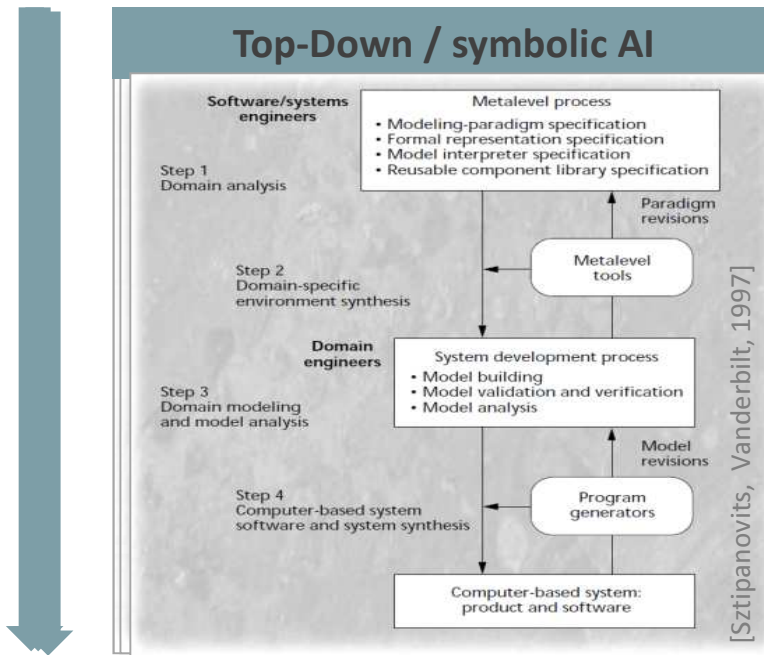
'any behaviorally equivalent functional system is intelligent'

biological-centered

„symmetric“

The paradigm shift in artificial Intelligence From Top-Down to Bottom-Up

→ Two competing movements?



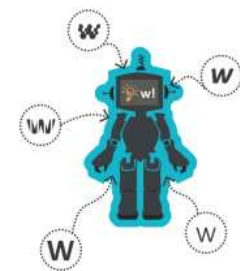
GOFAI

Good old fashioned Artificial Intelligence; based on high-level "symbolic" knowledge representations

Knowledge storage / knowledge retrieval

Knowledge on demand / knowledge acquisition

Connectivism
interaction as basis of intelligence



Horizontal coupling (manufacturing/logistics) – to lot size 1

→ Organization forms on demand – individualized by client - initialized by product

- ↗
- Heterogenous player modeled as multi agent concept
- Models from biology and social sciences
- Basis on Autopoiesis & embodiment theory

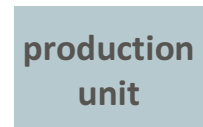
- !
- Product agitates as “super-agent”:
- Plans production and transportation steps
- Requests service from agents
- Negotiates with other products for agent-resources

-
- Konvoi 2005-2009, RWTH with partners
- (partly) autonomous driving via convoys



outside world

fabrication



virtual service provider

© Daniel Ewert 2013

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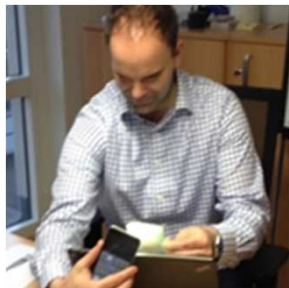
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Mensch-Technologie-Interaktion 4.0: Eine neue Art der Technologie-Intelligenz

Der digitale Schatten (oder die digitale Haut) wird zu einem dominierenden Teil der menschlichen und technischen Identität. Die Interaktionsdimensionen werden vielschichtiger werden:

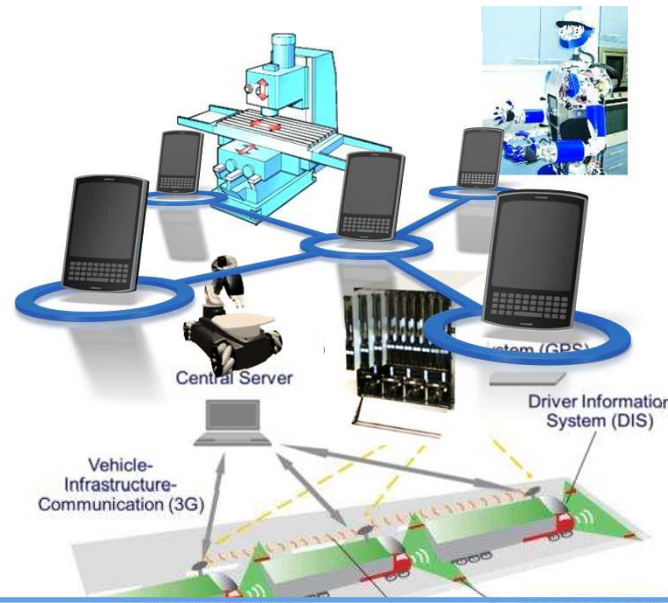
Kommunikation zwischen digitalen Schatten von Menschen und/oder technischen Geräten



Mensch-zu-Maschine-Kommunikation



Maschine-zu-Maschine-Kommunikation



Mensch-zu-Mensch-Kommunikation



menschliche/technische Kommunikation mit deren digitalen Schatten (Haut)

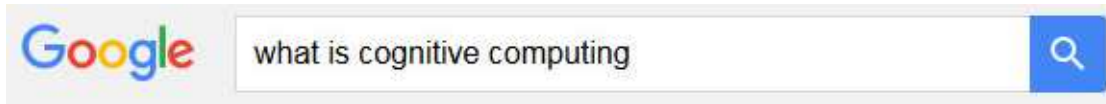


Die allgegenwärtige und **unauffällige** Interaktion zwischen den digitalen Schatten von Technologie und Menschen wird alle Aspekte von Kommunikation dominieren.

Three steps

It's all about "Cognitive Computing"

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Addressing problems
of "human-like"
complexity

Copying human
thought processes

Intuitive intelligent
interaction with
humans...

Let's ask Google

Definitions around "Cognitive Computing" (I)

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"Cognitive computing (CC) makes a **new class of problems computable**. It addresses complex situations that are **characterized by ambiguity and uncertainty**; in other words it handles human kinds of problems. ...To do this, systems often need to weigh conflicting evidence and suggest **an answer that is "best" rather than "right"**. Cognitive computing systems **make context computable**."

Addressing problems of "human-like" complexity



what is cognitive computing



→ Mobile transportation robots from flexible routing

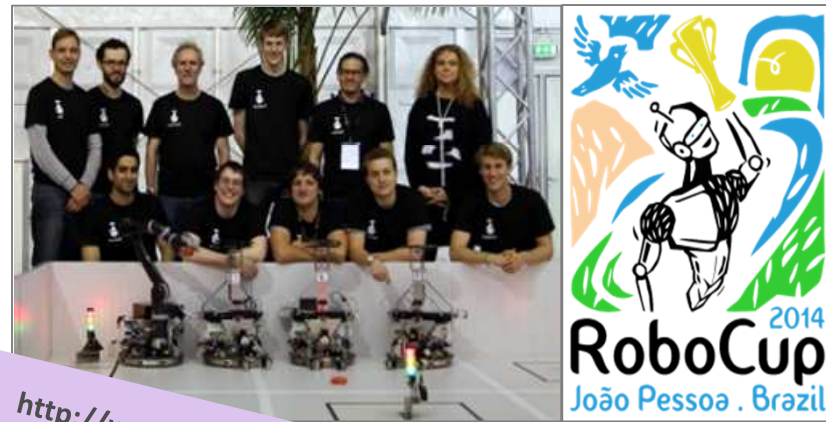


- ! Competencies:
- localization & navigation
 - computer vision
 - adaptive planning
 - multi agent strategies
 - sensory & hardware

- Competitions robocup:
- 2012: 0 points in World Cup 😞
 - 2013: 4th in World Cup 😐
 - 2014: Winner of the GermanOpen 😊
 - 2014: Winner of the World Cup** 😄
 - 2015: Winner of the World Cup** 😄



- ↗ Critical factors for success:
- Totally decentralized
 - No "hard coded components"
 - Strong cooperation
 - Re-planning during tasks



<http://www.carologistics.org/>

Let's ask Google

Definitions around "Cognitive Computing" (II)

19



"Cognitive computing (CC) makes a **new class of problems computable**. It addresses complex situations that are **characterized by ambiguity and uncertainty**; in other words it handles human kinds of problems. ...To do this, systems often need to weigh conflicting evidence and suggest **an answer that is "best" rather than "right"**. Cognitive computing systems **make context computable**."

Addressing problems of "human-like" complexity



what is cognitive computing



> WhatIs.com

"Cognitive computing is the **simulation of human thought processes** in a computerized model... involves **self-learning systems** that use **data mining, pattern recognition** and **natural language processing** to mimic the way the human brain works."

Copying human thought processes

Lend the robots a face

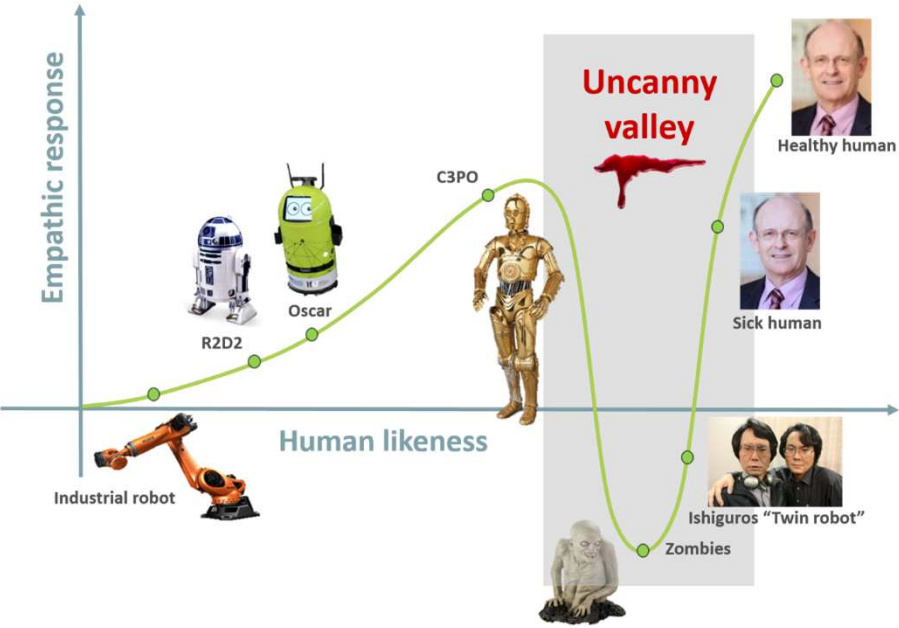
Into Service Robotics: The next step – the “Oscars”

Projects at IMA/ZLW & IfU 2016

→ Transform mobile robotic experiences into the field of service robotics



- ! Performing service robot tasks
 - Distribute brochures and serving drinks
 - Path planning, room exploration, ...



- ! 1. Investigating “new” human machine Interfaces and interaction schemes
 - Simple, intuitive
 - Schematic eyes following you
 - “natural eyes behavior”: randomly looking around, showing interest by blinking, looking bored, ...

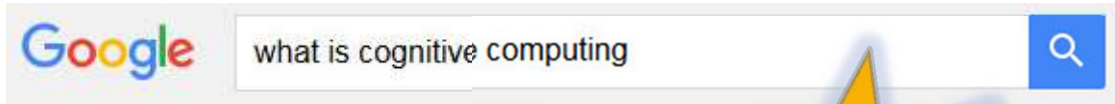
- ! 2. Investigating the “Uncanny Valley”: when features look almost, but not exactly, like natural beings, it causes a response of revulsion among the observers (Mori 1970)
- 3. Investigating diversity specific reactions (gender, age, culture) to artificial systems and in particular robots

Let's ask Google

Definitions around "Cognitive Computing" (III)



"Cognitive computing (CC) makes a **new class of problems computable**. It addresses complex situations that are **characterized by ambiguity and uncertainty**; in other words it handles human kinds of problems. ...To do this, systems often need to weigh conflicting evidence and suggest **an answer that is "best" rather than "right"**. Cognitive computing systems **make context computable**."



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IBM
"Cognitive computing systems [are] a category of technologies that uses natural language processing and machine learning to **enable people and machines to interact more naturally** [...]. These systems will learn and interact to **provide expert assistance** to scientists, engineers, lawyers, and other professionals **in a fraction of the time it now takes**."



New forms of human machine interaction

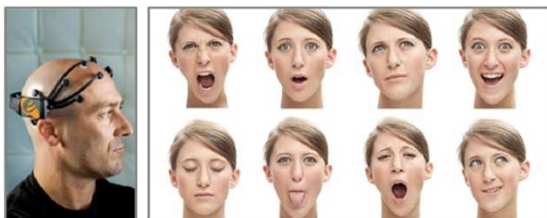
Automatic Emotion Recognition

- 1. Emotion form an important part of communication –
 - not an „add-on“ on audio, ...
- 2. Emotions are an intrinsic part of intelligence -
 - not an „add-on“ on ratio, ...

• Emotions are expressed in very different ways (via voice or vital data as heart beat, EEG etc.).

• Through equally different sensoric (microphone, EEG machine, camera etc.), these data can be recorded and interpreted.

• Emotions can be detected uni- or multimodal.



Project IMOTION at IMA/ZLW & IfU: the emotional navigation system



- Using emotions as basis for **behavior adaption**:
- Shouting at it will make it change its behavior
 - Praising stabilizes behavior
 - Randoms enable global instead of local optima

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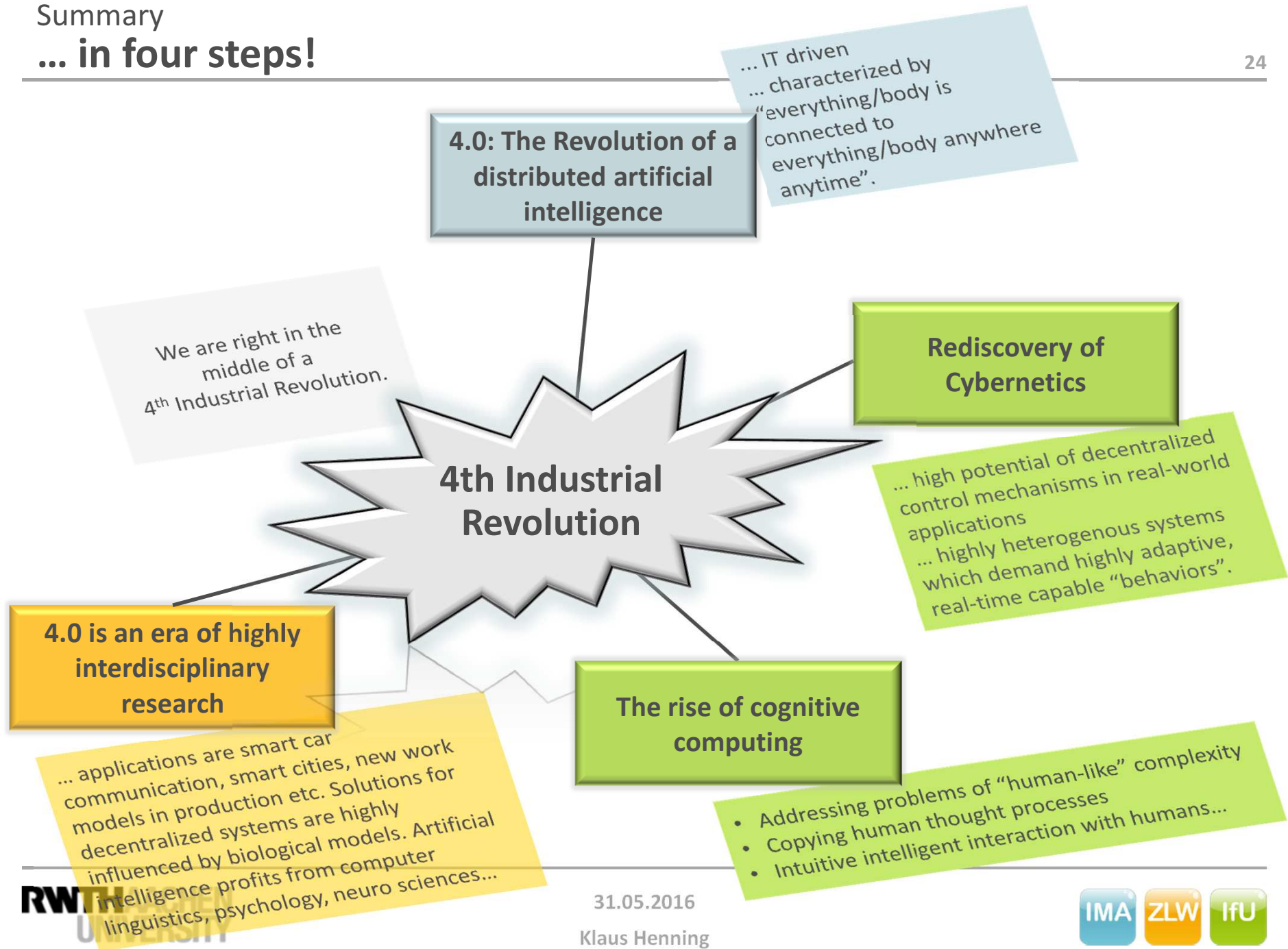
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Summary ... in four steps!



Nowadays, technology is often passive. Future HTI will see a much more active role of everyday technology: i.e. in administration, medicine or mobility.

Is it comfortable, ...



Necessary, ...



The average person is likely to generate more than one million gigabytes of health-related data in their lifetime. Equivalent to 300 million books.

IBM Watson Health

Or even scary?



Thank you!

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... studierte Elektrotechnik und Politische Wissenschaften, promovierte über Mensch-Maschine-Systeme und habilitierte über Entropie in der Systemtheorie. Er war 25 Jahre lang Leiter des größten Institutsclusters für Kybernetik (IMA/ZLW & IfU der RWTH Aachen University). Jeweils einige Jahre war er Mitglied im Präsidium des VDI, Prorektor für Finanzen der RWTH und Dekan der Fakultät für Maschinenwesen der RWTH.

Heute ist er Senior-Berater und Mitgesellschafter der P3 OSTO GmbH, ein Unternehmen der P3 group - www.osto.de.



Er ist Mitglied des Vorstands des Instituts für Unternehmenskybernetik (IfU e.V) an der RWTH Aachen und als Senior Advisor Mitglied des Board of Management des Cybernetic Clusters IMA/ZLW & IfU an der RWTH Aachen.

Er ist Vorsitzender des Aufsichtsrats der Xenium A.G., München, Mitglied des Universitätsrats der Universität des Saarlands und Mitglied des Zukunftskommission des Wirtschaftsrats der CDU.

Derzeit kommen die meisten von ihm betreuten Kunden – meist auf Vorstands- und Abteilungsleiterebene aus der IT-Branche, universitären Krankenhäusern und der Zulieferindustrie des Maschinen- und Anlagenbau, der Automotive Branche, der Luft- und Raumfahrtindustrie sowie der Logistik.

Er hat – zusammen mit zwei Kollegen – 2011 bis 2012 den Zukunftsdialog der Bundeskanzlerin „Wie wollen wir leben?“ wissenschaftlich koordiniert.

Seine Erfahrungen hat er in einem Buch „Die Kunst der kleinen Lösung – wie Menschen und Unternehmen die Komplexität meistern“ zusammengefasst, das 2014 im Murrmann- Verlag erschienen ist.