



## HUMAN-CENTERED DIGITALIZATION

20-21 SEPTEMBER 2019 - GRAZ, AUSTRIA



# Citizen-Centered Design for Human-Technology Symbiosis

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## Selected Reference

A more detailed description of most ideas, analyses and proposals presented in this Keynote can be found in this journal paper:

Norbert Streitz (2019).

*Beyond 'Smart-Only' Cities:*

*Redefining the 'Smart-Everything' Paradigm.*

In:

Journal of Ambient Intelligence and Humanized Computing.

vol. 10, no. 2, pp. 791-812. Springer.

DOI: [10.1007/s12652-018-0824-1](https://doi.org/10.1007/s12652-018-0824-1)



*Note: This is a revised version of my presentation slides  
because selected images and pictures had to be left out.*

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## Outline

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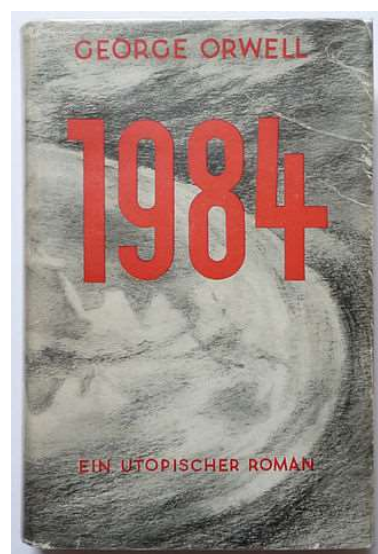
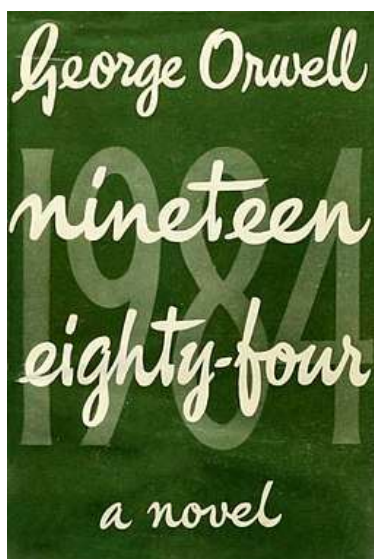
- Historical Context
- Domains of Issues and Research
- Hype about AI and Smartness
- Redefining the “Smart-Everything” Paradigm
- Human-Technology Symbiosis
- Design Trade-offs
  - Human Control vs. Automation
  - Privacy vs. Smartness
  - Examples in the Smart City and Industry 4.0 contexts
- Beyond “Smart-only” Cities
- Establishing a “Human ⇔ Cooperative System” Contract
- Seven Claims for Future Developments

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## George Orwell “1984”

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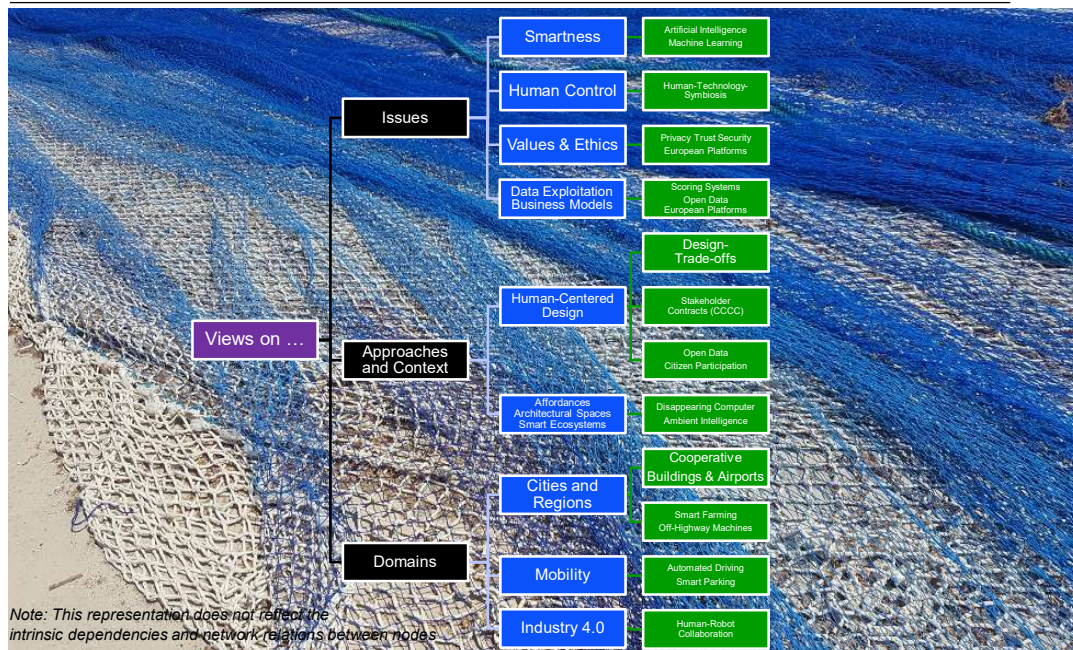
Dystopian novel published in 1949 (i.e. 70 years ago) about the future in 35 years!



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## Selected Views on the Future

### Issues, Challenges, Questions, and some Answers



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## The Perception of the World is Changing



Foto: Luca Bruno / AP

**Election of the Pope 2005**  
*„experience by being there.“*

**Election of the Pope 2013**  
*„experience via recording“*



Foto: Michael Sohn / AP

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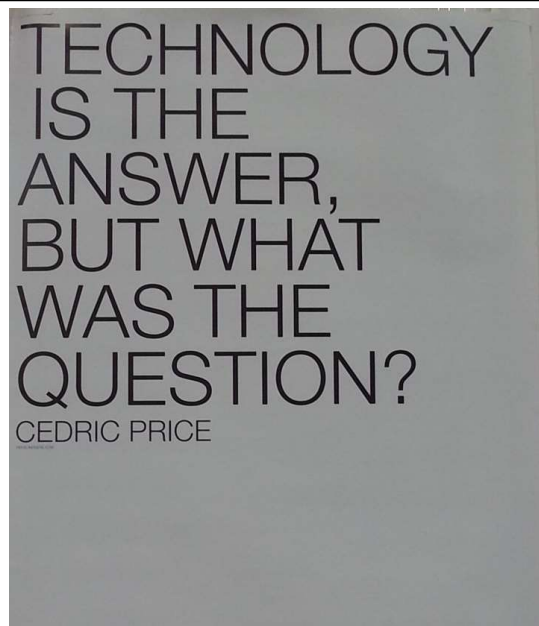
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## Cedric Price – British Architect (1934 – 2003)



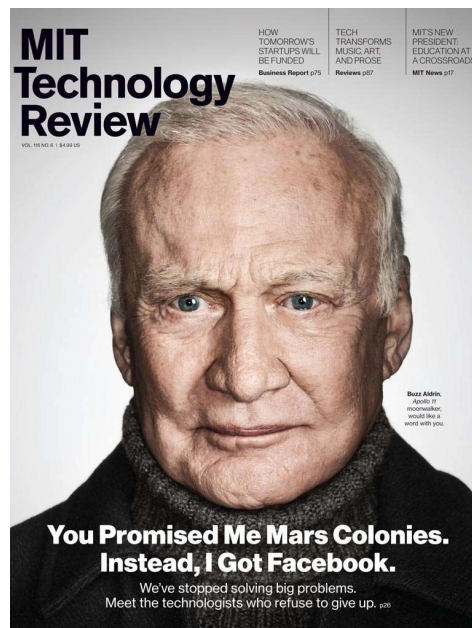
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## Buzz Aldrin - Apollo 11 Moonwalker



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## The next big thing: Smartness and Artificial Intelligence



Hokusai: *The Great Wave off Kanagawa* (1830 - 1832)

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## The 'Smart Everything' Paradigm\*

- Combination of Internet of Things (IoT/ IoE) with automated and autonomous 'smart' technologies.
- IoT provides ubiquitous infrastructure instrumenting environments (smart buildings, smart city, ...) with sensors and actuators and soon with smart materials.
- Artificial Intelligence (AI) provides the software level acting on the IoT infrastructure at a ubiquitous scale.
- As a result: Smart Devices and their algorithms control processes, services, devices, and thus our environments.
- Humans are increasingly removed from being the 'operator' (thus losing control), because they are – at an ostensible level of the discussion - considered to be the cause of errors ...



\* Streitz (2017) Reconciling Humans and Technology: The Role of Ambient Intelligence. Keynote Paper. Proceedings of the 2017 European Conference on Ambient Intelligence. Springer, LNCS 10217.

\* Streitz (2019). Beyond 'Smart-Only' Cities: Redefining the 'Smart Everything' Paradigm. Journal of Ambient Intelligence and Humanized Computing. vol. 10, no. 2, pp. 791-812. Springer.

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## Why redefine ?

- The planned abundance of automating everything and seeking solutions in AI environments only operated by algorithms should be warning signs, due to a wide range of problems:
- **Inappropriate, insufficient, error-prone behavior**
- **Rigidity**
- **Missing transparency, traceability, and accountability**
- **Ethical issues**
- These are new more crucial dependency implications beyond the already existing current dependencies in terms of electricity ('black-outs') and "standard" software/hardware combinations with their failures and volatility in terms of attacks.  
=> we are loosing control

## Problems of the 'Smart Everything' Paradigm - 1

### Problem Set A: *Inappropriate, Insufficient, Error-prone Behavior*

- Progress / capabilities of "AI" are overstated  
due to venture capital interests (history of AI not very promising)  
Even researchers in the industry (Mobileye) are warning of a hype.
- Machine Learning is very dependent on the quality of training data and system parameters, small variations cause dramatic differences in the results (AAAI conference, 2018)
- Everyday Autonomous (?) Driving is far away
  - This application is sold as a show case of AI, despite deadly accidents (Uber, Tesla "Autopilot")
- Artificial **U**nintelligence: How Computers **Mis**understand the World. Meredith Broussard (MIT Press, 2018)



## Problems of the 'Smart Everything' Paradigm - 2

### Problem Set B: *Rigidity*

- while there is incomprehensible flexibility (see Problem Set C), there is also the opposite:
- *Rigidity* – which is a great problem.
- Examples can be found with numerous AI-based call centers:  
Customers lose control and are deprived of getting appropriate/ individual services, because there interventions are not attended to and not accepted.  
Speech-based interfaces are rigid, don't accept non-standard input and often have no context awareness.

Example: I call DHL on Saturday checking if a registered mail was delivered.  
I am asked to provide various information, in several steps.  
Only at the end of a number of questions and answers, I am informed:  
“*You are calling outside our business hours, which are Monday – Friday ....*”  
HOW STUPID IS THIS SYSTEM not to inform me right away in the beginning ?

## Problems of the 'Smart Everything' Paradigm - 3

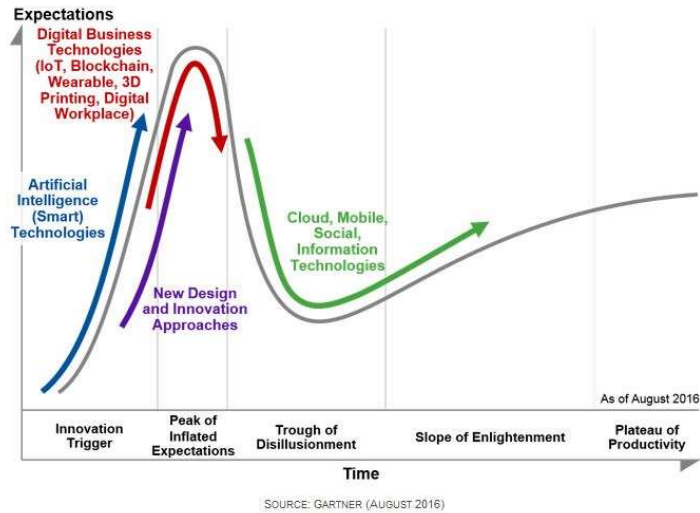
### Problem Set C: *Missing Transparency / Traceability*

- Assuming AI provides working solutions, there are other problems:
  - AI behavior shows incomprehensible flexibility and is not transparent
  - untraceable AI behavior implies there is no reproducible/replicable outcome  
Example: high-frequency trading can not be retraced and re-enacted
  - AI can evade, is potentially not accountable, results in a lack of liability
- The White House Report (2016) on  
“Preparing for the Future of Artificial Intelligence”  
asks for Algorithmic Responsibility, establishing reliable practices to build trust and understanding in the construction and mechanisms of fundamental algorithms used in software code.

*When nobody can trace the underlying argumentation/rationale of decisions/actions, we have a serious problem, an issue the people pushing the hype don't talk about, but we should be scared about it !*

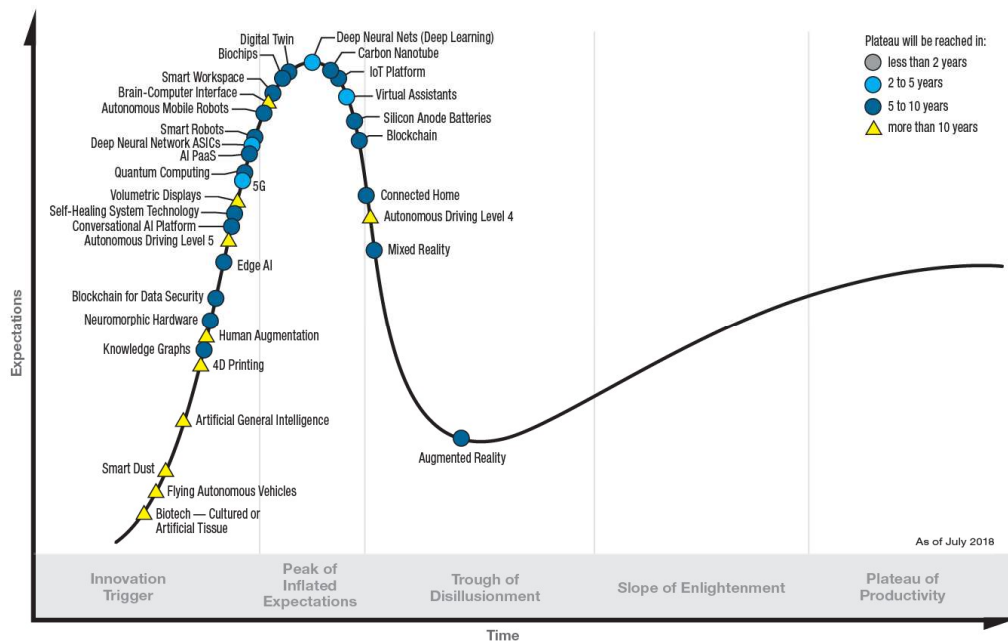
## Megatrends and Hype Cycles

Figure 1. Megatrends Across Gartner 2016 Hype Cycles



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## Hype Cycle for Emerging Technologies (2018)



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## Warnings against Artificial Intelligence

### Elon Musk (2017):

*„The competition for supremacy in AI at the national level will be the most likely trigger of the Third World War“.*



*“ ... there is a need for proactive regulation of AI.”*

### Open Letter to the United Nations (signed by Elon Musk, Steven Hawking, ...)

*As companies building the technologies in Artificial Intelligence and Robotics that may be repurposed to develop autonomous weapons, we feel especially responsible in raising this alarm.*

....

*Lethal autonomous weapons threaten to become the third revolution in warfare. Once developed, they will permit armed conflict to be fought at a scale greater than ever, and at timescales faster than humans can comprehend. These can be weapons of terror, weapons that despots and terrorists use against innocent populations, and weapons hacked to behave in undesirable ways. We do not have long to act. Once this Pandora's box is opened, it will be hard to close.*

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## Disturbing News ...

- Recently China announced that some of the smartest students in the country have been recruited from high school to begin training as the world's youngest **AI weapons scientists**.
- The 27 boys and 4 girls, all aged 18 and under, were selected for the four-year experimental programme for intelligent weapons systems at the Beijing Institute of Technology (BIT) from more than 5000 candidates.
- The US Army Contracting Command has called on potential vendors in industry and academia to submit ideas to help build its **Advanced Targeting and Lethality Automated System (ATLAS)**, which will use AI and machine learning to give ground-combat vehicles autonomous targeting capabilities.

Source: <https://blog.webit.org/2019/05/01/artificial-intelligence-threat-opportunity/> (1. May 2019)

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## How bad is the situation?

- It seems that we have a situation as it was described in the poem by Goethe: Der Zauberlehrling – The Sorcerer's Apprentice
- *“Die ich rief, die Geister werd ich nun nicht los.”*
- *“The spirits that I’ve summoned ignore my commands.”*



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## Goal: Human-Technology Symbiosis

- **Symbiosis:** Greek “συμβίωσις” for “state of living together”
  - mutually beneficial relationship between two parties
  - allows each to profit in tandem with the other.
  - typically used to describe natural phenomena, e.g., the relationship between bees and plant pollen (=> “mutualism”) (and there is also “commensalism” and “parasitism”).
- **Human-Technology Symbiosis** refers to defining how humans will live and work harmoniously, cooperatively, and respectfully together with technology.

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## Human-Centered Design and Design Trade-offs

### Interdisciplinary Approach & Teams

- Computer Science
- Engineering
- Design
- Psychology
- Architecture
- Sociology
- Economy



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## Redefining the 'Smart Everything' Paradigm

### Approach

- What kind of "*smart world*" do we want to live in?
- What are the problems preventing a "*smart-only*" world?
- How can we *redefine the "smart everything, everywhere, every time" paradigm* in order to reconcile the situation?

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## Redefining the 'Smart Everything' Paradigm: Smart Spaces Make People Smarter

- Humans exploit the data (and their partial aggregation) to take more mature, i.e. informed decisions and actions based on suggestions and recommendations.
- Thus, people have more information when (urban) spaces are "self-aware smart", i.e. instrumented, providing a first analysis.
- In the new paradigm, the "smart (urban) spaces" do not act autonomously, but function like companions, supporting people in a cooperative fashion.

=> ***the smart space is a cooperative space and makes people smarter !***

- This paradigm shift requires that  
***humans are in the loop and in control***  
***humans should own the loop***



Streitz (2019). Beyond 'Smart-Only' Cities: Redefining the 'Smart Everything' Paradigm. Journal of Ambient Intelligence and Humanized Computing. vol. 10, no. 2, pp. 791-812. Springer.

(Streitz et al, IEEE Computer, March 2005)

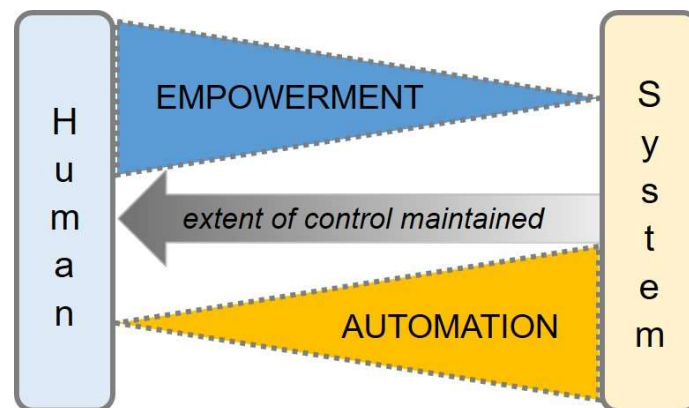
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## Trade-Off between Automation and Control



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Design trade-off between human empowerment and system automation depending on the extent of human control maintained

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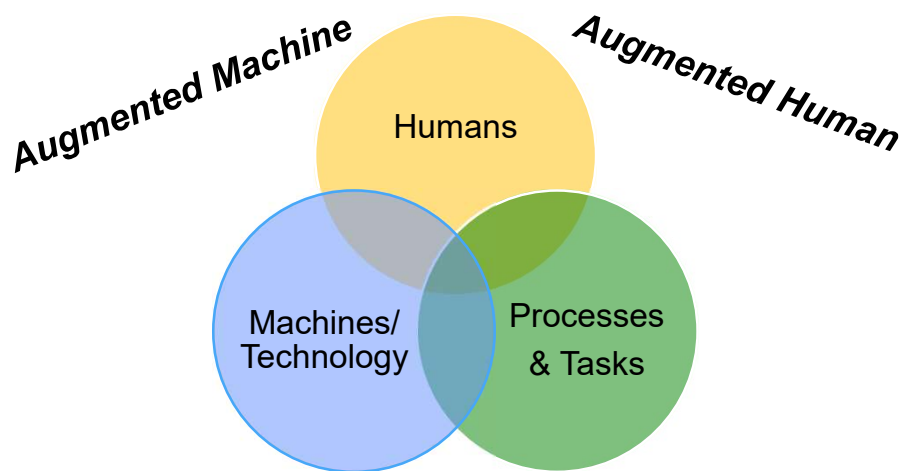
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## Towards Mixed Intelligence and Balanced Automation



We should take the best of both worlds (capabilities) and combine them in an integrated fashion for mutual augmentation. Robots are a complement to, not a replacement for, human workers.

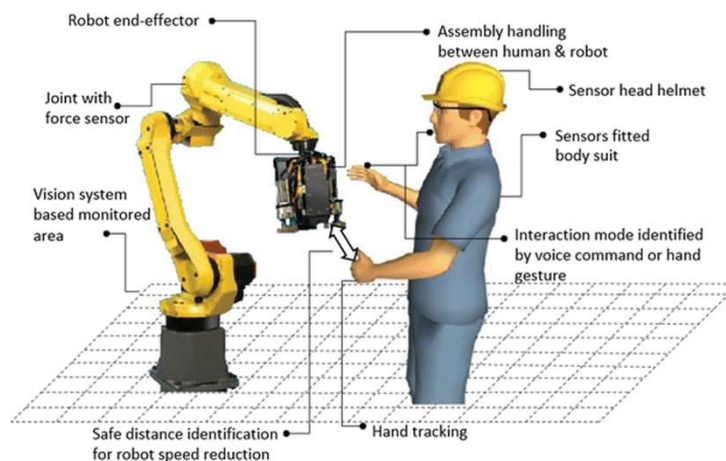
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## Human-Centered Automation and Collaborative Robots



Collaborative Robots will grow in popularity, because they will work safely alongside humans and are often far cheaper compared with their industrial counterparts. As collaborative robots become more capable in industrial settings, they will see greater adoption by manufacturers.

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## Automation ≠ Autonomy / Human-Vehicle Cooperation

- *Humans are the most autonomous objects today!*
- Automation is a tool, resource, system, method enabling humans to accomplish tasks that are otherwise difficult or impossible.
- SAE levels of Driving Automation ( ... *not autonomous* driving)

Level	Name	Narrative definition	Execution of steering and acceleration/deceleration	Monitoring of driving environment	Fallback performance of dynamic driving task	System capability (driving modes)	ISO 26262 ASIL	SAE level
<b>Human driver monitors the driving environment</b>								
0	No Automation	the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task	System	Human driver	Human driver	Some driving modes	Partially automated	2
<b>Automated driving system ("system") monitors the driving environment</b>								
3	Conditional Automation	the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene	System	System	Human driver	Some driving modes	Highly automated	3
4	High Automation	the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene	System	System	System	Some driving modes	Fully automated	4
5	Full Automation	the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver	System	System	System	All driving modes	Fully automated	5

(Comment: Automobile = Greek: *αὐτός* *autós*, ('self') and Latin: *mobilis* (,mobile')

=> autonomous automobile is a tautology)

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## Issues and Problems of Automated Driving - 1

- False recognition and its legal implications
  - Example: Speed Limit Info system in current cars does not reliably recognize time restrictions and provides the driver with wrong information (although this is very simple pattern recognition)
  - Human drivers can mentally correct wrong information, but how about sending the wrong info ("*driver drives too fast*") to car insurance and/or police ? => legal implications !
- Physical Hacking: Tiny changes can cause ML to fail
  - Minimal modifications on signs or objects (no problem for human recognition) disturb 'deep learning' so much, that they produce completely wrong results
  - There is no difference for the users/customers between whether ML/AI malfunctions or is hacked by "scam stickers"
  - Expert quote: *The best way to trick autonomous cars is to have a picture of a child in the rear window ...*



Univ. of Washington and UC Berkeley

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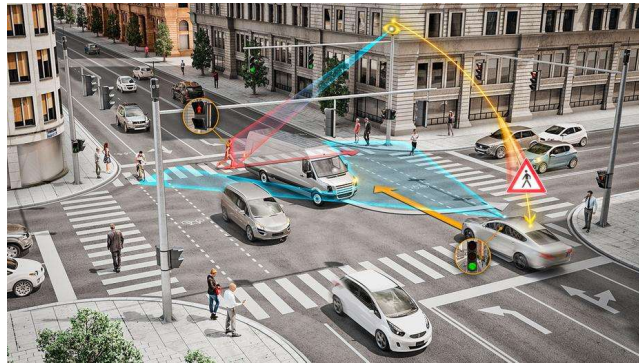
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## Issues and Problems of Automated Driving - 2

- Current approaches focus on instrumenting individual vehicles
- Insufficient city instrumentation: obstruction not really accounted for
- Lack of taking the urban environment (streets, crossings, traffic lights, parking slots, etc.) into consideration => *Self-Aware City*
- Complimentary instrumentation: “smart crossing” proposal by Continental at the CES 2019 in Las Vegas (but => “urban spies”)



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## Issues and Problems of Automated Driving - 3

- Predictions about when Automated Driving “*will be there*” are not precisely formulated: where (special lanes, freeway, city, ...), at which SAE level, under which weather conditions, etc.
- Level 3 and 4 (in some areas) in 2030 (2018 Workshop of Hyundai Motor Group)
- Deadly accidents with Uber and Tesla cars (“Autopilot” marketing problem)
- Department of Motor Vehicles California reports for 9 registered car firms: self-driving cars failed roughly every 3 hours in 2016.
- Mixed traffic challenge: automated car & non-automated cars
- Ethical / moral (decision) issues (<http://moralmachine.mit.edu>)
- How about a “driver license test” for driverless cars?
- Truck “platooning” is a realistic model in the medium future
- Cooperative automated driving optimizing collective behavior

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## Redefining the „Smart-Everything“ Paradigm

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### Two major Issues

- Design trade-off „*Automated / Autonomous Systems vs. Humans in the Loop and in Control*“
- Design trade-off „*Smartness vs. Privacy*“

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## Perspectives on Privacy => it's deteriorating

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- Privacy as a legal and moral right
- Privacy as a socially negotiated feature
- Privacy as a commodity you pay for and trade
- Privacy as a privilege (implication of above)
- No privacy due to suppressive governments (“1984”)
- Social Credit System (black lists, sanctions, ...), in China planned for 2020 and now in test phase.
- ▶ Two aspects:
  - Outgoing data (logging, tracking, surveillance, ...)
  - Incoming data (intrusion, unsolicited communication, ...)

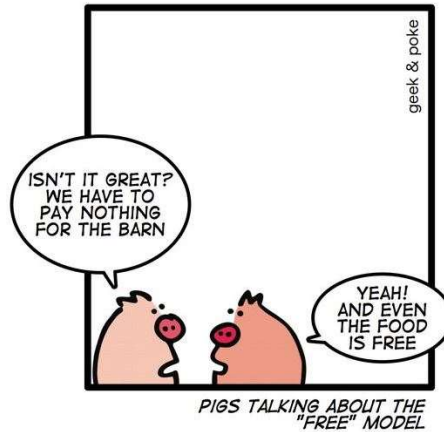


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## Privacy is Turning into a Privilege

- seemingly free services and products are not free ...



Facebook (or you name it) and You:  
*If you're not paying for it, you're not the customer.  
You're the product being sold.*

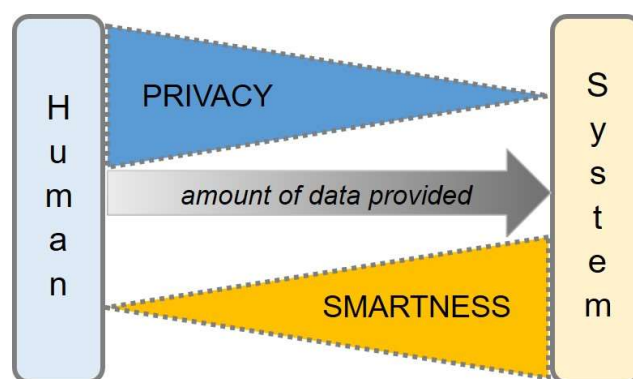
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## Trade-Off “Smartness vs. Privacy”



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Design trade-off between privacy by control over personal data  
vs. degree of smartness provided by a smart system or service

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## Privacy Issues in Hybrid, Smart Cities

- Privacy discussion mainly focused on social media (Facebook, ..)  
(please check your favorite website at <https://cookiepedia.co.uk/> )
- Privacy infringements become more important in smart urban environments.
- In the virtual world, you can have “fake identities”
- In the real world, this is difficult to achieve, because the “virtual” data are complemented/ augmented by “real” data of you:
  - pictures showing you
  - walking and driving trajectories
  - recognition of real objects you are wearing, carrying or using, ...
  - Example: touching/opening a door: real world with known location
  - your bicycle/ car/ ... is a tagged object broadcasting its location and properties
- You can't avoid it. All objects and their parts will be tagged, resp. have integrated IDs (=> Digital/ Semantic Product Memory). Invisible size and no chance to remove.

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## Smart Cars and Street Lights as Urban Spies

- We get new issues beyond the ubiquitous, but usually visible/announced CCTV surveillance cameras
- Smart cars enhanced with multiple sensors for autonomous driving (cameras, ultrasonic sensors, radar, LIDAR, GPS, ...), but soon you will not see them (=> disappearing computer)
- Will these sensors go asleep when the car parks at the curb and the engine is turned off? Nobody knows! They might monitor pedestrians, peek into houses, ...
- Smart street lights are also equipped with sensors (e.g., for smart parking, monitoring traffic), alert functions
- Digital out of Home (DooH) and in-door advertising displays (real, Deutsche Post) recognize properties (gender, age, and soon identities ...) of people walking by or standing in line
- Who owns, is in control has access to all these data?
- Principal Problem: how do people know what is going on? (an implication of the ‘disappearing computer’ approach ...)



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## Privacy by Design combined with Regulations

- Privacy by Design / Privacy by Default:  
making it a first-order design objective (not a subsequent add-on)
  - Privacy Enhancing Technology (PET)
- Privacy by Design as competitive advantage (USP) for EU / Japan
  - Example of Iceland (physical safety + legislation + own underwater cable)
- Regulations to prevent Privacy Infringements
  - Germany (since 1983)  
Personal data belong to the citizens and cannot be collected without consent  
("Recht auf informationelle Selbstbestimmung")
  - European Union
    - Data Protection Directive (since 1995/1996)
    - General Data Protection Regulation (GDPR [www.eugdpr.org](http://www.eugdpr.org))  
(adopted in 2016, enforced since 25. May 2018)
    - everybody who wants to do business in Europe has to obey these rules !
    - e-Privacy Regulation (still to be approved by the EU Parliament)

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## Privacy and Security as a USP

- Moving everything to the "Cloud"  
causes big security and privacy problems ...
- **Example of Iceland:**  
new business model by providing
  - 1) safe and secure physical facilities for servers
  - 2) cheap and clean energy (geothermal)
  - 3) separate sea link cable between  
Iceland and Denmark
  - 4) introduction of privacy-conform legislation  
(Examples of clients: BMW i3, DeepL, ...)



- *Privacy and Security will turn into a USP, providing added value.  
This focus provides opportunities for EU-/Japan-based companies.*

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## Values and Ethics

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- The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems (AIS)



- <https://ethicsinaction.ieee.org/>
- EAD First Edition is available since April 2019 (collective public editing & commenting process since 2016)
- Example: ethical / moral issues in automated driving  
=> <http://moralmachine.mit.edu>

N. Streitz, D. Charitos, M. Kaptein, M. Böhlen (2019). Grand Challenges for Ambient Intelligence and Implications for Design Contexts and Smart Societies. Tenth Anniversary Issue, *Journal of Ambient Intelligence and Smart Environments*. 11 (1). IOS Press (pp. 87 - 107)

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## Beyond 'Smart-Only' Cities towards Humane, Sociable and 'Cooperative' Cities

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- Enabling citizens to exploit their individual, creative, social and economic potential and to live a self- determined life.

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## Goal: Reconciling People and Technology => Human-Technology Symbiosis



- *Human-Technology Symbiosis in the context of cities:*
- Establishing calm technology and ambient intelligence for smart services.
- “Keeping the human in the loop and control” to respect individual & social life.
- Respecting the rights of citizens, especially in terms of privacy.
- Viewing the city and its citizens as mutual cooperation partners, where the city is smart in the sense of being self-aware and cooperative towards its citizens (e.g., collection/ sharing of data for mutual benefits, Open Data, inter-operability)
- Acknowledging capabilities of citizens to participate (=> participatory design).
- Motivating citizens to get involved and being part of the urban community.
- Establishing mutual trust & respect for motives and vested interests of all parties.
- Establishing a common purpose of citizens and other relevant stakeholders.
- Establishing a “human ⇔ cooperative system” contract

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## Establishing a “Human ⇔ Cooperative System” Contract

- Need for **counter proposal** to automated, AI-controlled environment
- **Keeping the Human in the Loop and in Control**
  - Re functionality: division of labor & responsibilities between systems and humans
  - Re data: self-determination of which data are provided for which added value (see also the discussion on privacy)
- **Common Purpose of citizens, city authorities, stakeholders, ... is the basis for**
- **Establishing a dynamic “Citizen ⇔ Cooperative City Contract” (CCCC or C<sup>4</sup>) for negotiating the trade-off between automation & control, smartness & privacy as the basis for data exploitation**
  - It will be based on rules and regulations that organize the relationships between the different stakeholders in a city: citizens, city administration, service providers and other city-related companies
  - Some of the regulations can be based on the General Data Protection Regulations (GDPR) of European Commission (effective since May 2018 !)
  - Implementation idea: ‘smart contracts’ using a block chain approach

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## Future Cities are to be Designed for Humans as *Humane, Sociable and Cooperative Cities*

We can achieve the goal of moving beyond “smart-only” cities by

### **Reconciling People and Technology**

which implies

### **Citizen-Centered Design Approach**

### **Rethinking the “Smart Everything” Paradigm**



### **Establishing a “Citizen ⇌ Cooperative City Contract” (CCCC / 4C)**



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## Seven Claims for Future Developments

- 1) *The more the computer disappears and becomes invisible, the more it determines our lives.*
- 2) *It's all there in the environment => The world around us, the city is the ambient “interface”, requiring new affordances.*
- 3) *Need to redefine the “Smart Everything” Paradigm.*
- 4) *People-oriented design, people-empowering smartness: “Keeping the human in the loop and in control”.*
- 5) *Smart spaces are designed as “Human-Technology Cooperation Spaces” making people smarter.*
- 6) *Privacy will become a commodity and is endangered, unless we do something against this development. (assuring it, could be a USP for European / Japanese industry)*
- 7) *Establishing a “Citizen ⇌ Cooperative City Contract” (C<sup>4</sup>): trade-offs on automation & control, smartness & privacy.*



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## Citizen-Centered Design for Human-Technology Symbiosis



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