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Auto 4.0

Digitale Transformation und die Zukunft des Autos

EDITORIAL

Liebe Leserinnen und Leser,

fliegende und selbstfahrende Autos begleiten uns seit Jahrzehnten in Science-Fiction-Filmen. Wird uns die anstehende digitale Transformation nun in die automobile Zukunft katapultieren? Werden Dank künstlicher Intelligenz alte Sicherheits- und Mobilitätsprobleme in der Smart City endlich gelöst werden? Die neuen Möglichkeiten des technischen Fortschritts eröffnen uns Dimensionen, die vor kurzem noch unvorstellbar waren.

Grundsätzliche Themen rund um Smart Mobility, Umwelt und Gesellschaft stehen am Anfang. Christian Egeler stellt die Frage nach der Raumplanung und welche Auswirkungen die Innovationen auf unsere Lebensweise haben. Daniel S. Martel sinniert grundsätzlich über die zukünftige Existenz des Autos und was anstehende soziale Umwälzungen und ökologische Erkenntnisse an neuen Chancen bieten, um mit den Herausforderungen von Klimawandel, Zersiedelung und Mobilität umzugehen. Und Klaus M. Hofmann erörtert, inwiefern Digitalisierung, Verkehrswende und Shareconomy die Mobilität der Zukunft prägen werden.

Oliver Kelkar konstatiert, dass das Auto der Zukunft primär ein Betriebssystem sein wird, das Daten sammeln und auswerten wird, und deshalb die Software wichtiger als die Hardware wird. Andrej Cacilo und Sebastian Stegmüller zeigen auf, welche Potentiale die Augmented-Reality-Technologie in Kombination mit der Vernetzung und Automatisierung der Fahrzeuge hat.

Haftung und Risiko beim Wechsel vom menschlichen Fahrer zum Roboterauto begleiten uns in den folgenden Artikeln. Erich Marte fragt, welche Herausforderungen auf Versicherungsgesellschaften zukommen, wenn ein Computer das Lenkrad übernimmt. Oliver Bendel schildert, was sein wird, wenn das vollautomatisierte Fahren den Durchbruch erlebt und das Roboterauto seinen Prototypstatus hinter sich gelassen hat. Nadine Zurkinden diskutiert, wer die strafrechtliche Verantwortung übernehmen soll, wenn der Autopilot versagt. Quentin Ladetto und Markus Hoepflinger analysieren Risiko-Auswirkungen einer integrierten Mobilität aus voll vernetzten und selbstfahrenden Fahrzeugen für Sicherheit und Verteidigung.

Zum Abschluss erläutert Marco Feser, welche Auswirkungen Industrie 4.0, veränderte Mobilitätsvorstellungen und Shareconomy auf den Vertrieb von Automobilen haben werden, und Detlef W. Schmidt macht Vorschläge, wie innovative Lösungen für das urbane Parken der Zukunft aussehen könnten.

Vergessen wir nicht: Vor rund 100 Jahren soll Kaiser Wilhelm II. gesagt haben: «Ich glaube an das Pferd. Das Automobil ist eine vorübergehende Erscheinung.» Und auch vom deutschen Konstrukteur Gottlieb Wilhelm Daimler wird aus dem Jahr 1901 überliefert: «Die weltweite Nachfrage nach Kraftfahrzeugen wird eine Million nicht überschreiten – allein schon aus Mangel an verfügbaren Chauffeuren.» Aussagen zur Zukunft bewegen sich im Spannungsfeld zwischen Machbarkeit und Vorstellbarkeit, oder wie Albert Einstein sagte: «Imagination is more important than knowledge. For knowledge is limited to all we now know and understand.»

Dr. Andreas M. Walker, Co-Präsident swissfuture

INHALT

ABSTRACTS

Christian Egeler

BACK TO THE FUTURE

From the point of view of the state the question regarding long-term planning of the traffic system is at what point should one actively intervene? From the point of view of spatial development the technological aspect of future cars is less of interest than the impacts the innovations have on the environment and our ways of life. Two scenarios for mobility in 2040.

Keywords: regional development, whole transport system, mobility services, mobility-as-a-service, location attractiveness, whole mobility look

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Daniel Stanislaus Martel

NOT «MORE EFFICIENT» CARS – BUT MORE THOUGHT ABOUT THEIR USE IS NEEDED

The car is a part of all our lives, at least in the first world. Early memories of excursions, traffic jams and breakdowns have given way to informed future speculation during the lunchbreak. As adults we value them because they give us independence. However when we pay the first monthly instalment, the ownership becomes annoying. The sustainability discussion has led to innumerable initiatives for the improvement of the car. Rarely, however, are there fundamental thoughts about their actual existence. Social revolutions and ecological realisations present the opportunity to question the necessity of those four wheels.

Keywords: environment, climate change, urban sprawl, mobility, waste of resources

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Klaus Markus Hofmann

MOBILITY 4.0 – EVOLUTION OF A DIGITAL MOBILITY STRUCTURE

Digitalisation, transport change and share economy will shape mobility of the future.

Keywords: digitalisation, share economy, digital markets, energy, climate protection, internet of things, Digital infrastructure, data sovereignty

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Oliver Kelkar

SOFTWARE BEATS HARDWARE

The car of the future is not a car – but an operation system: smart software gathers data, evaluates it and provides custom-made offers for the user. The increasing relevance of software has not only resulted in a convergence of the sectors but has created new value chains: fast, globally networked and multifunctional.

Keywords: software, digitalisation, industry 4.0, networking, new business models, sustainability, Second machine age, digital disruption

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Andrej Cacilo, Sebastian Stegmüller

THE CAR OF THE FUTURE AS AN INTERFACE BETWEEN HUMAN AND URBAN LIFE AND ECONOMIC SPACES

Even though augmented reality technology has not been able to fulfil its great expectations, marked by the failure of Google Glass, for instance, signs point to an imminent breakthrough on the market. In the automobile industry especially, augmented reality combined with extended networking and car automation makes for a noticeable «boost in attractiveness» which both authors clarify in their contribution.

Keywords: augmented reality, data collection, data sources, connected services, locations based services, communications platform

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Erich Marte

THE COMPUTER AT MY STEERING WHEEL

Digitalisation is forging irresistibly ahead – and does not stop at the car. The self-driving car is one of the most prescient future themes. This also presents a great change in challenges facing the insurance industry.

Keywords: digitalisation, self-driving cars, insurance, accident probability, risk minimisation

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Oliver Bendel

THE ROBOT IN THE ROBOT

The automatic or autonomous car, lovingly dubbed by some as the auto-automobile, is discussed the world over. They run around in the form of prototypes, but also in the guise of quite normal off-the-peg cars. When a Tesla Model S and a Mercedes E-Class, mastered or not mastered by its autopilot it is at least to a degree automated or even highly automated driving. But how are we going to cope with accidents? How can the car then become part of our everyday life? What will happen if fully automated driving makes a significant breakthrough and the robot car is suddenly beyond its prototype status? The author poses questions and forwards assumptions which at first glance appear audacious but upon further consideration acquire a certain plausibility or even correspond to reality.

Keywords: robot, robot car, artificial intelligence, machine ethics, innovation, platform, digital markets

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Nadine Zurkinden

WHO IS TO BE PUNISHED, WHEN THE AUTOPILOT FAILS?

Even today traffic poses a general risk to one's life. Automated driving will, in all probability increase traffic security – but will naturally never completely prevent accidents. If we leave the driving to technology, who takes on the responsibility under penal law for failure and malfunctioning?

Keywords: self-driving cars, robot cars, auto pilot, permitted risk, penal law, traffic law, technological risks, test drives, exemption permits

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Quentin Ladetto, Markus Hoepflinger

TOWARDS INTEGRATED MOBILITY: SECURITY AND DEFENCE PERSPECTIVES OF A POSSIBLE FUTURE ECOSYSTEM

From a technological point of view, future cars can be considered as mobile, interconnected subsystems with various sensors, powerful hardware and optimized software for computation, communication devices and energy supplies. Taking advantage of driverless capabilities and the possibility to gain and maintain 'full' access, cars could be used for active sensing as well as for almost any kind of applications in security and defence operations.

Keywords: technology, big data, artificial intelligence, energy, nanotechnology, human enhancement, robotics, sensor data, security, defence, armed forces

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Marco Feser

INDUSTRIAL REVOLUTION 4.0 AND THE INFLUENCE OF CHANGED CONSUMER BEHAVIOUR IN THE OPERATION OF AUTOMOBILES

In the years to come the automobile industry will be changed profoundly, contributing, above all, to different concepts of mobility and the increasing significance of the sharing economy – an overview of the trends.

Keywords: industrial revolution, connected services, sharing economy, self-driving car

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Detlef W. Schmidt

CONNECTED PARKING – INNOVATIVE SOLUTIONS FOR FUTURE URBAN PARKING

The multifunctional mobility world of the future – wishing to carry the cost of the strived-for goals of CO_2 emissions – includes not only the most varied kinds of automobile but also new infrastructures and digital services. Efficient space and traffic planning is essential for this diversity of mobility: parking of the future must be fast, comfortable and plannable.

Keywords: sustainability, CO_2 goals, mobility diversity, traffic burden, parking space use, innovation, digitalisation, efficiency

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Keywords: Technology, Big Data, Artificial Intelligence, energy, nanotechnology, Human Enhancement, robotics, sensor data, security, defence, armed forces

Quentin Ladetto, Markus Hoepflinger

In order to anticipate the future of the armed forces and their operational capabilities, it is paramount to follow the advances in the numerous civilian and military technological fields. Such necessity is becoming even more important from a defence point of view as civilian investments and developments in technologies have overcome military resources in many research fields.

Additionally, there is a reciprocal relationship between doctrine and technology. While the doctrine shows how military forces are deployed, technologies enable these possible actions, which, in their turn influence their deployments. Technological superiority does not necessarily lead to success. However successful doctrine often exploits the full technological potential available. At the same time it is important to ensure that a doctrine, through technological innovations and other developments, remains competitive against any opponent as well as any form of opposition. Unfamiliarity cannot be confused with improbability, thus there is a requirement to maintain a deeper awareness of the direction of technological advances and how they could converge to provide advantage to possible adversaries.

Technology foresight is therefore an instrument for long term anticipation that aims at supporting strategic decisions. Challenged by exponential advances in technology in combination with the changes in the nature of conflicts and warfare, any fixed predictions would be illusory given the evolutionary nature the environment. For this reason, rather than trying to bet on a winner, we are more focusing on identifying the potentially disruptive technology races which will impact our future.

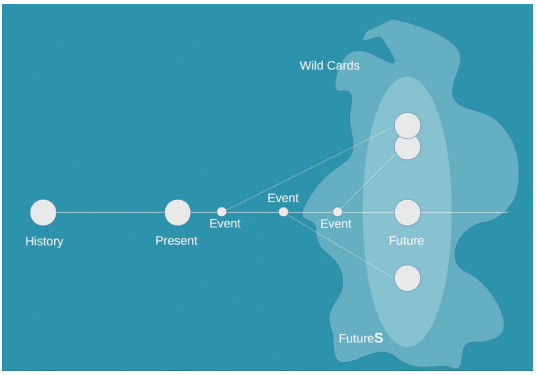

Figure1: Preparing for the future is done not by predicting one future only, but by taking into account different events which will help shaping possible landscapes or futures

To structure the approach, an innovative and collaborative platform has been developed together with the company Envisioning Ltd with the mission of *creating a collaborative, decentralized visualization platform to collect intelligence about technologies, understand their readiness level and provide the best links towards publications and actors in the field.*

In such a normally "sensitive" environment, the collaborative approach is based on the belief that technologies and their readiness level are of interest to a lot of heterogeneous actors from different industries. This level of information can be shared and only *how* a technology is used in applications and products rises the level of confidentiality and sensitivity of the information.

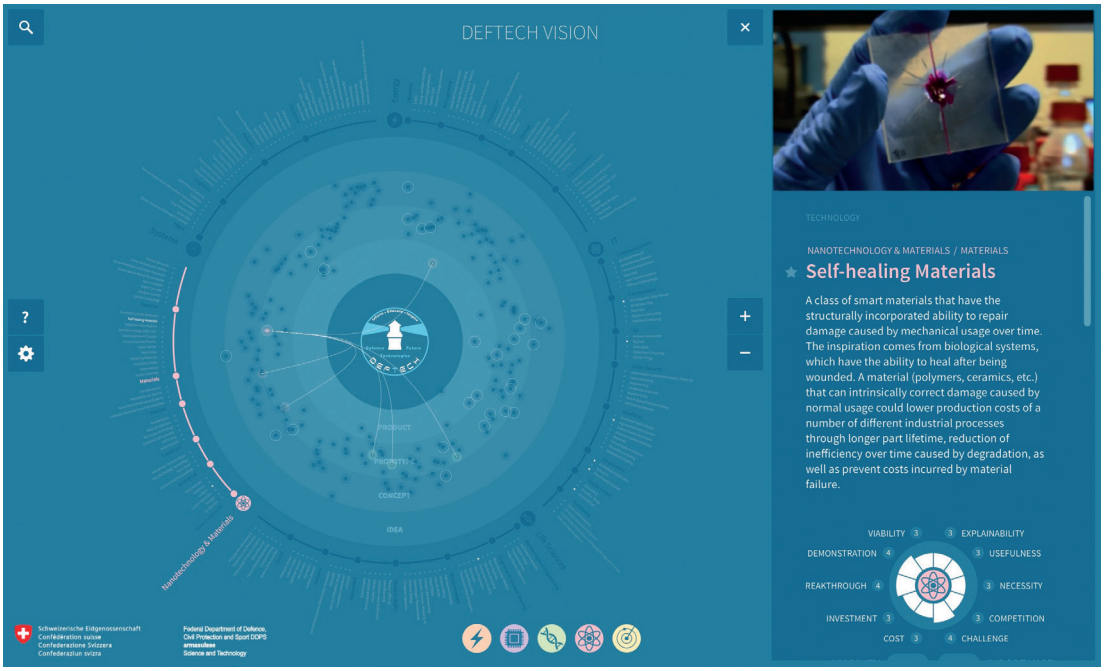

Figure2: The collaborative technology platform regrouping all technologies and accessible under https://technologyhorizon.org

Technology trends

The challenge being the coverage of the 360° horizon of the technologies, a first attempt has been made is dividing them into 5 main, debatable, categories. Each category is organized in clusters, composed by the single technologies.

Information & Communication – The Big Data and artificial intelligence challenge

With increasing computing power, the variety of sources of data from sensors to social networks, the amount of information available about anything grows exponentially over time. As communications media develops in parallel, any information will be available anyplace and anytime. Network-centric warfare grows, and so does the cyber security threat. With increased computational abilities, artificial intelligence and machine learning will help make sense out of this Big Data challenge and are enabling the prediction of future behaviors as well as the real-time presentation of scenarios that could favor a better situational awareness and better decision processes.

Energy – The efficiency and diversification focus

The ability to acquire energy is becoming more and more compact as alternative methods in the energy fields open the way to to renewable sources such as sun, the wind, biofuels. Progress in storage, charging/generation, and weight are some of the key enablers for autonomous and remote pilot systems.

Besides renewable energies, compact nuclear fusion and micro nuclear reactor could reduce the necessity of operational logistic energy lines.

Nanotechnology & Materials – The high performance and adaptability enablers

Nanotechnologies are enabling the manufacture of lighter, stronger, more reliable, lower cost, higher performance and more flexible electronic, magnetic, optical and mechanical devices. Materials with new, different properties will appear such as self-adaptive materials responding to the environment, this includes self-healing materials.

Different type of manufacturing such as Atomically Precise Manufacturing (APM) and Additive Manufacturing (3D Printing) offers new opportunities for logistics and allow the creation and production of new forms and shapes.

Life Science – The genetic, synthetic revolution and the augmented-self

With quickly increasing capacity for the manipulation of DNA and creation of synthetic organisms, it is now possible to better understand human genetic defects or vulnerabilities and target individuals or groups specifically. Recruitment of soldiers could start before birth.

Human enhancements span from external systems such as exoskeletons to internal solutions increasing the performance of the human brain. These aim to produce more robust and enduring people where health will be permanently monitored and their capabilities improved.

Systems – The robotics, autonomous systems and space endeavors

The number of unmanned systems is increasing. Starting with a man IN the loop, ON the loop (like a person still behind the steering wheel in case

of emergency), the trend is to have systems, and swarms of systems, able to perform without a human operator and manage extensive tasks in complicated environments for extended periods of time (man OUT of the loop). Unmanned systems will have a major impact on logistics and on how humans and machine will interact together.

These 5 categories are not evolving independently one of the other, but in harmony, one benefiting of the progresses of the other. The speed of development is also accelerating at a pace some don't hesitate to consider as exponential.

Additionally, if for most of these technologies the main research and development takes place today in the civilian & commercial world, the dual-use in a military environment seems almost obvious.

Is superiority in information, rapidity, agility, mobility (and lethality) not the ultimate dream of any armed forces?

Defence and Security perspective of cars 4.0

Having access to the sensor data of civil cars can obviously be interesting for public security sector as well as for civil protection and for defence. This will of course raise many questions related to international law, ethics, arms control, which will not be covered in this article. However, from a technological point of view, future cars can be considered as mobile, interconnected subsystems with various sensors, powerful hardware and optimized software for computation, communication devices and energy supplies and a locomotion subsystem.

If today the use is more of collecting and processing data onboard to assist a human driver, sensor data can be used on a larger timescale and also in a wider context to plan, improve, analyze and optimized functionalities as well as infrastructures.

Using civil cars as pure sensor sources for military purposes would allow gathering data from regions of high interest, such as densely populated areas or regions with destroyed or degraded transportation infrastructure. However, certain spaces that are relevant for armed forces might not be 'naturally' covered. Taking advantage of the driverless capabilities, cars could be used for active sensing. Thus, a region of interest could be automatically and in some way optimally covered for surveillance or reconnaissance and they could potentially also be employed, additionally to pure sensing, as effectors. If armed forces are able to gain and maintain 'full' access to future cars, they could be used for almost any kind of applications, besides the typical ISR (Intelligence, Surveillance, and Reconnaissance) tasks also for electronic warfare, cyber warfare, for EOD/IED Defeat (Explosive Ordnance Devices / Improvised Explosive Devices), as navigation support or for communication, to identify and defeat CBRN (Chemical, biological, radiological and nuclear) threads, for obstacle placement, for supply, evacuation operations, as decoy, for target inspection or designation, and even for conventional warfare on the ground.

Car4.0 as sensor for defence operations

Knowing the positions of the cars allows increasing the situational awareness about the distribution of cars and thus an estimation of the people density on the roads. Such a 'real-time' estimation, today largely inexistent, might be important to assess the risk of damage of enemy attacks and own counter measures and might thus support the identification of optimal counter strikes or actions. Further, having access to common onboard sensors, such as cameras, could help to gather additional information about the state of the important infrastructure, such as streets, bridges or buildings and therefore to identify bottlenecks in logistics and to better plan the course of actions.

Car4.0 as electronic and cyber warfare tool

Having cars equipped with flexible communication subsystems (e.g. software defined radios) with the ability to receive and emit electromagnetic signals enables them not only to detect, identify and localize enemy sources, but also to degrade their communications e.g. by jamming or spoofing the signals or by enabling cyber attacks from multiple sources. Compared to conventional EW tools of armed forces, the larger amount of sender/emitter and their spatial distribution could render counter-measures more difficult and less efficient.

Car4.0 as navigation support

Today, many military systems relies on satellite based navigation support (GPS/GLONASS etc.) that can technically be jammed or spoofed. Future cars could be used to increase the robustness of actual approaches or to even replace them: Sensing & localizing the electromagnetic emission of multiple cars at once could help to detect and correct drift or jumps in existing positioning systems signals or potentially even replace them.

Car4.0 as communication relays

The communication subsystems of cars could be used to extend the military communication infrastructure. Having the possibility to build up a dynamic mesh network with spatially dense nodes could allow transmitting data with lower signal strength, a less predictable message path and high redundancy. Thus reducing the enemies possibilities to degrade the communication and increasing the security.

Car4.0 as mobile data center

Similar to actual smartphones, future cars will most probably incorporate powerful hardware to process and store data. Idling processors could be used to execute computationally expensive algorithms, such as to encrypt the enemies communication and data could be stored at non-static locations. Extending 'the cloud' by a significant amount of mobile computers would allow increasing the robustness, safety and security.

Car 4.0 as tool for civil protection to optimize evacuation operations

To reduce chaotic situations in evacuation operations, civil cars could be employed to move civil persons out of the evacuation zone in a synchronized manner. Together with other sensor sources, the car's sensor could be used to improve the situational awareness about enemy threats. By accessing the car's autopilot, the evacuation plan could be dynamically adapted to the threat, and cars could be automatically rerouted around damaged infrastructure, dangerous areas or traffic bottlenecks. Thus, traffic jams and the danger to civil persons could be reduced and evacuation operations could be performed more efficiently.

Even while mostly not suited for off-road navigation and not equipped with specific military payloads, its large number, its availability and its relatively low costs, its high velocity and agility, its embedded sensors,computers and communication equipment might make of future cars a very useful platform for numerous applications in the security and defence domain.

To which extent civilian cars will be suitable and used for such tasks: this will be subject to the future!

Quentin Ladetto

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Markus Hoepflinger

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