The Future Mobility Roadmap.

Trends, Technologies & Player

Whitepaper

Project A

Content

Preface

Germany’s favorite toy, the car, has finally arrived in the era of startups, with mobility being one of the huge issues of our time. But you hardly need this white paper to find that out, as the topic is ubiquitous: the Tesla craze, Uber’s IPO, scooters on roads and bike paths, the Berlkönig minibus cruising through Berlin controlled by an app, and we are all waiting with bated breath for fully autonomous vehicles. This fine new world of mobility shouldn’t just be more comfortable and modern than it used to be, but also contribute to saving the planet. What voters demand in the European elections must be delivered to the consumer. This creates an interplay that attracts entrepreneurs, founders, and investors alike. Here, social motives merge with technical innovations and, of course, startup opportunities. Investments into the mobility market are thus also exploding. But how do we now find our bearings?

We want to use this white paper to shed light on the topic of automotive mobility from our perspective: from that of a venture capital investor who supports startups and works closely with established companies on these topics. However, in doing so, we don't simply want to disseminate our own opinions and views, but rather give an overview, let experts have their say and thus make it easier for readers to dive into the topic. Our aspiration is initial segmentation, not absolute truth. Most recently, we used this approach in a whitepaper on digital health and we received highly positive feedback for it.

We believe that the challenges in the field of automotive mobility are particularly well-suited for established companies, startups, and legislators to find and offer exciting solutions together. However, up to this point in time the dynamics and interests are too varied. We also want to support the exchange between the different stakeholders with this whitepaper, so that we will hopefully see a new generation of startups in the near future and for automotive mobility to actually become what it could ideally be one day, modern and comfortable, but simultaneously also environmentally friendly, climate-neutral, and sustainable for coming generations.

Uwe Horstmann, General Partner at Project A, founded the investment fund Project A Ventures in 2012. Along with four partners, he invests in startups in Europe and around the world from a fund currently totaling nearly 250 million euros. He has built a team of 100 experts, who also support these startups operationally in addition to the financial assistance they receive. Together with private equity investors, he also participates in established companies in order to support them in their efforts towards digital transformation.

Connected Device on Wheels

The automotive industry is currently in the midst of the largest paradigm shift in its history – opening up the market for startups and newcomers for the first time.

When French inventor Gustave Trouvé rolled through the city center of Paris on his "Trouvé Tricycle", he did so soundly despite the cobblestones. Because Trouvé powered his vehicle with batteries – five years before Carl Benz made it possible for a car with an internal combustion engine to drive for the first time with his "Benz Patent Motor Car Number 1". However, the low charge capacity of the batteries and charging issues rapidly slowed down e-mobility. he robust petrol engines, on the other hand, allowed people to cruise around the area quickly for miles. In the following 130 years, automobile manufacturers focused predominantly on combustion engines, which they, together with clutches, gearboxes, motor shafts, and other components, developed into highly complex machines.

There are only a few companies today who have mastered this complexity – both technologically and economically. The production of automobiles with combustion engines is expensive, the fixed costs are considerable, and the margins are comparatively low; this makes the market entry barriers high. The automotive industry has thus, up to now, been virtually a private party. In Germany, there has been an oligopoly dominated by the major manufacturers VW, Mercedes, BMW, Audi, Opel, and Porsche for decades. And they have been successful at that. The German automotive industry achieved a turnover of around €423 billion in 2017 – a new record.[1]The industry is extremely important for the German economy, around 7.7 % of the country's total economic performance is directly or indirectly attributable to automobile production. To this day, every fifth car sold worldwide is from a German brand.

Still. But this could change now, as the old hubs of industry may be losing importance rapidly.

After the industry has existed for more than 100 years with virtually no change, it is now in the middle of the biggest paradigm shift in its history. The entire production chain – from research and development through to production including suppliers, dealers, and workshops – is being unsettled by changes worldwide. Cracks are increasingly developing in the formerly large rigid structures. For the very first time, newcomers such as multinational internet corporations, mobility service providers, startups, suppliers or even OEMs ("Original Equipment Manufacturers") have the chance to gain a significant share of a market that has been relatively closed off for a very long time.

The new players have already begun rewriting the rules. Companies like Uber or the Alphabet

1 VDA (2018): "Zahlen und Daten" – https://www.vda.de/de/services/zahlen-und-daten/zahlen-und-daten-uebersicht.html

subsidiary Waymo are competing with expertise in the fields of software, digital channels, and services. These fields are more important in the changing automotive markets than hardware, classic engineering know-how, and the aged brand values. The newly positioned tech startups and the new OEM Tesla are used to being close to their customers and collaborating with them – an invaluable asset in the new world of mobility. In comparison, the traditional car manufacturers haven't really known their clientele well up to now, because their vehicles have mainly been sold by dealers. That has to change now and they should get going as fast as possible, because the new competitors are generally very versatile. Tesla, for example, mainly sells its electric cars online, without the ballast of a dealership chain. Furthermore, newcomers - in contrast to the traditional automobile manufacturers - don't have to simultaneously wrap up discontinuing technologies such as the diesel engine, but they can concentrate on new and promising technologies. The legacy automotive industry is currently lagging to a large extent: 50 % of companies say they're a latecomer to digitization.[2]

There are four trends in particular that are responsible for the described disruptions of the old automotive world:

- → **Electrification of the powertrain**
- → **Autonomous driving**
- → **Connectivity between vehicles and between vehicles and the surrounding infrastructure**
- → **Shared mobility**

2 Bitkom (2017): "Intelligente Mobilität" – https://www.bitkom-research.de/WebRoot/Store19/Shops/63742557/59B8/ECB2/6F5E/2E01/BBD9/0A0C/6D04/210B/Bitkom-Charts_Intelligente_Mobilitaet_13_09_2017.pdf

→ Electrification

The switch to electric driving drastically lowers entry barriers for newcomers. A combustion engine with a gearbox is made up of around 1,200 to 1,400 individual parts – an electric motor, on the other hand, has about 200. This makes it much easier to manufacture battery-powered vehicles. New players can establish themselves in niches comparatively quickly if they have the batteries, control software, and engines sorted. Small startups like Sono Motors from Munich demonstrate this; so does the sports car manufacturer Rimac from Zagreb in Croatia or e.GO from Aachen, which collaborates with VW and uses the corporation's electric mobility platform. The large German manufacturers have only half-heartedly preoccupied themselves with electric cars thus far. They especially wanted to gather customer feedback and test the market.

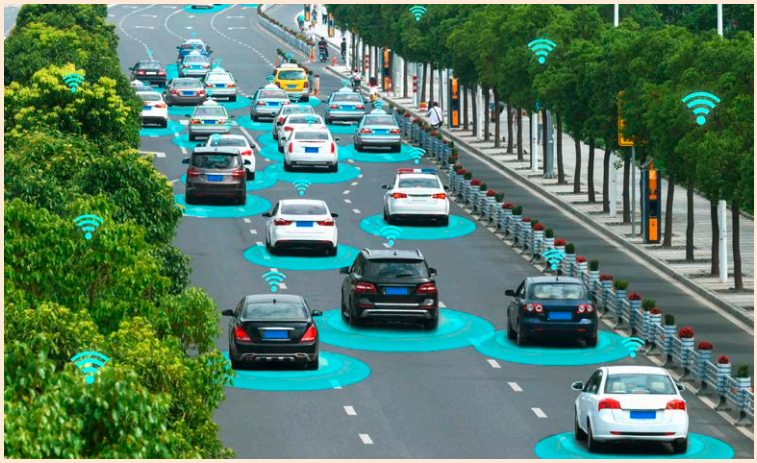
The key reasons for the reluctance: To date, the companies have continued to make a profit with combustion engines, so there was little incentive for them to change technology – and on the other hand, the customers were holding back with their demand as battery-operated vehicles are still more expensive and offer less range than petrol or diesel-powered cars. In addition, the infrastructure to charge the vehicles is only rudimentarily developed in most countries. Germany would probably need more than 40,000 charging stations in just three years. At present, only one quarter of that number exists.

In Germany, the switch to electric mobility has been slow. In the first half of 2018, 17,234 new all-electric vehicles made it onto the German roads – in contrast to 1.8 million new diesel and gasoline vehicles. Electric cars make up a meagre 0.9 % of the total. If one also counts plugin hybrids, the numbers only increase a little. However, those numbers could soon rise steeply if politicians finally put their words into action. By 2021, around 40 % of all newly prefigured vehicle models should have battery or plug-in hybrid drives.[3] In China, now already, at least one-tenth of newly registered vehicles must be electrically powered. This represents 60 % of the global demand for electric cars and plug-in hybrids. In the largest car market in the world, the number of cars sold with alternative drive technologies equals the number of the total amount of cars sold in Germany.

While in China at least one tenth of the newly registered cars must already be electrically powered, the switch to electric mobility in this country is rather sluggish.

3 McKinsey (2019): "Race 2050 – A Vision for the European Automotive Industry" – https://www.mckinsey.de/publikationen/2019-01-08-race-2050-publikation

→ Autonomous driving



One of the great promises of car driving is the reduction of accidents.

While electrification has already begun to come into our reach, autonomous vehicles have been slow to become pertinent to consumers. In China and several US states, the first fully autonomous vehicles are already on the road. Providers such as Baidu, Waymo, and Uber are investing heavily in the development of robo-taxis to offer new modes of ride sharing. However, in Europe, the unclear legal situation on liability in the event of accidents or technical failure is slowing down development. Existing ADAS systems are already based on a variety of technologies, to which startups and companies from different industries, such as the graphics chip corporation Nvidia, are contributing. In Europe, these are primarily and increasingly sophisticated driver assistance systems that help users of mid to high priced vehicles.

With increasing prevalence and thus decreasing costs, these systems will also establish themselves for lower price categories – becoming as normal as anti-lock braking systems are today. Improvements in sensors, software, and computing performance are facilitating these developments.

Once the final technological and regulatory issues have been solved, up to 15 % of all newly sold vehicles could be completely autonomous by the year 2030.[4] And 40 % of the passenger kilometers traveled in Europe could be covered autonomously as early as 2039.[5] The result would be an increase in traffic safety with fewer accidents and fatalities due to the fact that human error is the cause of more than 90 % of all road accidents as drivers are distracted or careless. The increasingly automated driving functions could already reduce the number of fatalities on the roads in Germany by up to one fifth by 2020.[6] However, autonomous vehicles drive safest when no vehicles operated by humans are on the road at the same time.

4 McKinsey (2016): “Automotive Revolution – Perspective Towards 2030” – http://www.automotivelogistics.media/wp-content/uploads/2016/03/ALEurope16_MatthiasKaesser,McKinsey_Session1.pdf

5 PwC (2017): “Eascy – Die fünf Dimensionen der Transformation der Automobilindustrie” – https://www.pwc.de/de/automobilindustrie/pwc_automotive_eascy-studie.pdf

6 VDI (2018): “Automatisiertes Fahren – VDI-Statusreport Juli 2018” – https://www.vdi.de/vdi-statusreport-automatisiertes-fahren/publikationen/publikationen-details/pubid/vdi-statusreport-automatisiertes-fahren/

→ Connectivity

Cars that move through their environment autonomously must continuously obtain information. Ideally, this information is not exclusively collected by the vehicles via cameras, radars, or LIDARs, but they also receive data through communication with the transport infrastructure and other vehicles. These can be mobile roadworks that give notice of their position in advance, or intelligent traffic lights that broadcast ad-hoc traffic flow messages via 5G networks. Or the surrounding traffic, whereby the drivers warn each other directly about icy roads.

In addition, the vehicular infotainment systems plug into digital living environments via connectivity. This allows the passengers of autonomous vehicles, for example, to use various offers for communication, entertainment or shopping via interfaces for embedded software, for in-car payment, or for data-based services. One can do some work on the way to the office or configure one's smart home in the evenings.

Utilizing the data on consumer behavior or entertainment preferences, as well as vehicle and driver data, such as for insurance contracts or foresighted maintenance, will be part of the business model of the automotive industry in the future. Today already, a car that is integrated into state-of-the-art networks generates 25 gigabytes of data per hour.[7] In 2016, the industry only made 0.2 % of its total revenue from data-driven services. By 2030, the proportion could rise to 27 % of total revenue.[8] In any case, vehicles will then become part of complex networked mobility worlds – trundling communication centers that are permanently online.

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7 McKinsey (2018): "Ready for Inspection – The Automotive Aftermarket in 2030" – https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ready-for-inspection-the-automotive-aftermarket-in-2030

8 McKinsey (2019): "Race 2050 – A Vision for the European Automotive Industry" – https://www.mckinsey.de/publikationen/2019-01-08-race-2050-publikation

→ Shared mobility

By that time, new sharing offers with autonomous vehicles will be working smoothly; the market for it is huge. A privately-owned vehicle in Germany currently drives an average of 45 minutes per day.[9] Most of the time, the 47 million privately-owned vehicles stand around idle. Through sharing cars and autonomously operated vehicles, one third of all cars in cities could become obsolete. Nevertheless, the automotive industry would not experience any production slumps because the remaining vehicles would be used more intensively and thus have a shorter service life.

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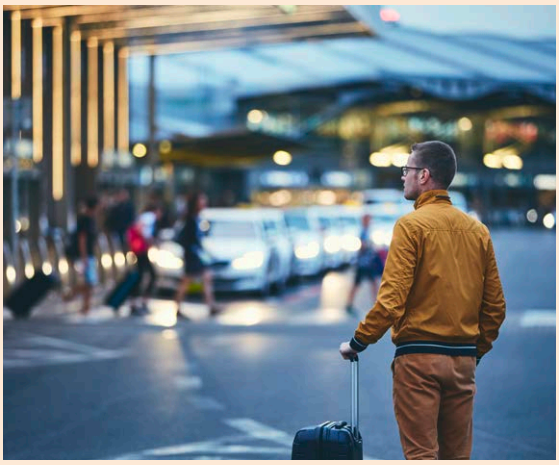
There are currently only around 18,000 car-sharing vehicles in Germany, with just over two million users.[10] These vehicles are primarily used in large cities, where one in seven people are registered with at least one provider.[11] Especially city dwellers between the ages of 20 and mid-30 spontaneously book mobility as a service if required, from private rental cars like Drivy, to car and ride sharing like Share Now (formerly DriveNow and Car2Go), to shared taxis like Moia and BerlKönig.

By 2030, every tenth car sold could be a sharing vehicle.[12] The manufacturer Smart is already selling its mini cars using the slogan "Ready to share". In the future, consumers will choose optimal mobility solutions, including sharing offers for specific use-cases, such as commuting to work or vacation. Passengers could then be on the move following the *packet switching* principle – similar to information on the Internet, where data packets spontaneously select the best possible variant from a variety of routes and connections.



Shared Mobility is already a reality in German cities and will continue increasing in popularity.

9 Federal Ministry of Transport (2018): "Mobilität in Deutschland 2017" – https://www.bmvi.de/SharedDocs/DE/Anlage/G/mid-ergebnisbericht.pdf?__blob=publicationFile

10 Federal Association CarSharing (2018): "Aktuelle Zahlen und Daten zum CarSharing in Deutschland" – https://carsharing.de/alles-ueber-carsharing/carsharing-zahlen/aktuelle-zahlen-daten-zum-carsharing-deutschland

11 Federal Ministry of Transport (2018): "Mobilität in Deutschland 2017" – https://www.bmvi.de/SharedDocs/DE/Anlage/G/mid-ergebnisbericht.pdf?__blob=publicationFile

12 McKinsey (2018): "Ready for Inspection – The Automotive Aftermarket in 2030" – https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ready-for-inspection-the-automotive-aftermarket-in-2030

From hardware to software

The four trends that were described above determine, influence, and accelerate each other. And they fundamentally change the automobile. In the future, it could evolve similarly to mobile phones, in which software and networking have become more important than the underlying hardware components. In addition, in-car software will grow more important than the engine, including horsepower. Accordingly, power in the industry is shifting away from hardware to software providers. The car is becoming a digital platform that combines mobility options and the corresponding demand. And from what used to be a manufacturing industry, a service industry emerges that is helping people get from A to B in different forms.

Focusing on software would also facilitate avoiding the industry's incredibly long development cycles. For classic vehicle model series, these cycles take six to seven years before a new product comes to the market. The industry reacts just as slowly to changing customer preferences and innovations. In the future, if cars primarily stand out through their underlying software components, they can be updated just as quickly as a smartphone or tablet.

However, unlike mobile devices, it's not just technological innovations that drive change in the automotive industry. The four trends are also triggered by politics and society; in an increasing number of countries around the world, politicians are ensuring that the automotive industry must rethink its processes due to legal guidelines for lower emission limits for CO2 which is harmful to the environment and climate. Manufacturers in Europe face penalties in the billions from 2020 onwards if they do not comply with the relevant CO2 limits. This is hardly possible without electric mobility. More and more countries, from Norway to China, plan to completely phase out combustion technology.

Another factor is the proliferating global urbanization, 55 % of the world's population currently live in cities.[13] The proportion is said to rise to 68 % by 2050. The car is still the primary means of individual mobility, with 57 % of all trips in Germany being undertaken by car.[14] But in cities, where distances are often short and there are other options to travel, such as public transport or shared mobility, it is only 40 % of the trips and this number is decreasing. In urban regions of industrialized countries at least, the motor vehicle could therefore lose significance for private transport. It will no longer be seen as a classic status symbol in the future and the automotive industry itself also believes this.[15] Fewer and fewer young adults are completing their driving licenses in Germany.[16]

The declining interest of Germans in their enjoyment of driving is also a reason for the shift in geographical priorities. Today, the majority of cars are sold and driven in other parts of the world. As the global center of the automotive industry, China must now be considered – and not just as a sales market, but also as a production location. While were a mere 87,000 cars being produced in China

13 UN (2018): "World Urbanization Prospects" – https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

14 Federal Ministry of Transport (2018): "Mobilität in Deutschland 2017" – https://www.bmvi.de/SharedDocs/DE/Anlage/G/mid-ergebnisbericht.pdf?__blob=publicationFile

15 Bitkom (2017): "Intelligente Mobilität" – https://www.bitkom-research.de/WebRoot/Store19/Shops/63742557/59B8/ECB2/6F5E/2E01/BBD9/0A0C/6D04/210B/Bitkom-Charts_Intelligente_Mobilitaet_13_09_2017.pdf

16 Federal Ministry of Transport (2018): "Mobilität in Deutschland 2017" – https://www.bmvi.de/SharedDocs/DE/Anlage/G/mid-ergebnisbericht.pdf?__blob=publicationFile

in 1970, that number jumped to 28 million in 2018.[17] Moreover, the four trends of electrification, autonomous driving, connectivity, and sharing are expected to grow faster in China than in the other major automotive markets, like Europe and North America, especially since the communist government has made this a priority on a political level. China could emerge as the leading market of the transformation.

Mobility and participation for all

In 2017, the automotive industry had a turnover of around €3 trillion worldwide shared between vehicle sales and aftermarket. The radical change taking place currently will not slow this down. On the contrary, it could almost double to €5.5 trillion by 2030. The automotive industry will likely generate around 80 % of this amount with the four major trends of electrification, autonomous driving, connectivity, and sharing, as well as the new business models emerging from there.

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The customers also benefit from this as alternative transport systems, such as electric mobility and optimized shared mobility services like autonomous driving, reduce costs for each kilometer driven. The part of the population that has a smaller budget will also be able to pay in small instalments rather than having to spend a lot of money on a car. Above all, autonomous sharing vehicles that are electrically powered benefit the society as a whole. They ensure the mobility and thus the social participation of older individuals, people with physical disabilities, and people without a driving license, including children and adolescents. And since every German driver is stuck in traffic on average for 30 hours a year[18] and Germans look for parking spaces in total for 560 million hours a year[19], they can now spend this time doing something more meaningful. The car takes care of itself.

17 McKinsey (2019): „Race 2050 – A Vision for the European Automotive Industry“ – https://www.mckinsey.de/publikationen/2019-01-08-race-2050-publikation

18 Inrix (2018): “Global Traffic Scorecard” – https://www.rbb24.de/panorama/beitrag/2018/02/berlin-verkehr-stau-traffic-scorecard-inrix-2017.file.html/180206%20Traffic%20Scorecard.pdf

19 VDI (2018): “Automatisiertes Fahren – VDI-Statusreport Juli 2018” – https://www.vdi.de/vdi-statusreport-automatisiertes-fahren/publikationen/publikationen-details/pubid/vdi-statusreport-automatisiertes-fahren/

10 Theses

from experts in the industry

01
Investments show the transformation

Andreas Cornet is a Senior Partner at McKinsey & Company, where he has spent more than 20 years working in the automotive industry.

Investments made in mobility startups reveal something about the future of the automotive industry. About €70 billion: According to our analysis, this is what it would cost every single car manufacturer to secure a top position in the technological spearhead in all four defining trends – autonomous driving, connectivity, electrification, and shared mobility ("ACES"). It's questionable whether individual manufacturers can handle this type of investment. Targeted acquisitions are a sensible strategy, among other things, as they result in lower costs. Since 2010, investors, including OEMs, have invested more than US$211 billion in more than 1,100 startups in the field of mobility.

Two developments are noticeable. First, automobile manufacturers and suppliers accounted for less than 10% of the investments in mobility startups. Although well-established companies develop many innovations in-house with great research and development expenditure – the number of their patents, especially in the areas of e-mobility and sensor technology, is increasing. However, the automotive industry must make sufficient use of the investment opportunities in startups. Second, nearly US$80 billion were invested in US startups since 2010, and US$50 billion in Chinese startups. Europe, not including the UK, comes to just under US$9 billion. So, the region is falling behind. It pays off to follow the trail of (investor) money: the data shows that the four ACES trends are gaining momentum – and the profound change that is taking place here.

02
Start with the cities

Karl-Thomas Neumann was the Chairman of the Board of Adam Opel AG and worked in Los Angeles today on the production of compact electric vehicles as an advisor to startup, Canoo.

What do I have to offer so that everyone can drive an electric car? In other words, not just the wealthy who can afford a Tesla or one of those big electric SUVs that you see on the market now. Everyone. It shouldn't just be a normal car that is only equipped with a different drive, because electric drives can then only compete with combustion engines at a high

price due to the large battery that is required. Instead, this car must be completely rethought and redesigned. The result looks completely different to any cars that have been produced up to now.

Cities are the best place to put this new car on the road. Here, people are increasingly using different means of multimodal transport, the trips are rather short, space is limited. A suitable car should be as small as possible in its external dimensions so that it can easily be maneuvered in urban areas, but at the same time be as spacious as possible in the interior so that it can be used multifariously. A few examples for required space would be for multiple seats when hailing rides, for storage space to transport bicycles, or for delivery services, which already cause a lot of traffic in cities. The result is not a golf cart, but a real car. But it must be a car for inner cities, the perfect starting environment for electric mobility. And since urbanization is advancing at an increasing rate globally, urban applications are not just a good starting point. They are also the future.

03
Set up a library of standards

Prof. Lutz Eckstein heads the Institut für Kraftfahrzeuge (ika) at the RWTH Aachen and is, among other things, the Chairman of the VDI company for vehicle and traffic engineering.

Automated driving offers many opportunities – but also goes hand-in-hand with some challenges. The first thing is to establish a social consensus on how safe this form of movement has to be. Is it enough for the systems to drive more safely than an average driver, or do they have to be better than, for example, 85% of a representative group of drivers? And how can we prove this level of safety in the course of approval? Automated vehicles would have to drive billions of kilometers if one wanted to provide such evidence with the driving tests common today. This is not only impossible due to the time and costs required, but it is also ethically questionable.

One solution would be to do the majority of the driving tests on computers. This requires powerful simulation tools that operate based on a comprehensive data collection. However, we are only at the foot of the mountain with this data collection. For this purpose, relevant traffic situations must be continuously collected and processed. These should then be used in scenarios for the development, safeguarding, and authorization of automated driving functions. They make up a kind of library of standards for the development of systems for automated driving. In addition, the intelligent linking of rule-based approaches and artificial neural networks, with which the cognitive and in particular the anticipatory abilities of a human driver can be modeled, also requires extensive amounts of data. There are thus numerous promising approaches for research and development in this field.

04
Develop intermodal mobility

Prof. Stefan Bratzel is the founder and Director of the independent research institute "Center of Automotive Management" at the University of Applied Sciences in Bergisch Gladbach.

Intermodality, in other words linking different modes of transport to a polynomial transport chain, is one of the most important trends in the mobility of the future. For decades, mobility was primarily monomodal: anyone who had a car planned their trips with it. However, because different modes of transport are now being offered, with networked and connected data, and end customers being able to use this network via their smartphone, a system revolution is taking place: Users can, depending on the desired profile – speed, comfort, costs, environmental friendliness – change between intermodal transport carriers.

However, no app yet exists that links all mobility options, from the bicycle to the airplane. This is not surprising because a task of this caliber is hugely demanding. Just as an example, you would need regional offers of all traffic data of a specific region, including cycle times and utilization of the public transport system, as well as availability of ride, car, and bike sharing options in real time. Moreover, not only the planning has to be simple and reliable, but also the booking. The complexity increases exponentially when it comes to international offers. There is currently no provider that can manage this alone, even if protagonists like Moovel or Google are trying. But promising business models will open up for those who successfully master even only a part of these requirements. Especially because they can then partner up with other parties to come to more comprehensive solutions.

05
Specialize on AI

Prof. Daniel Cremers is the Chief Scientific Officer at Artisense, a startup headquartered in Palo Alto, Munich, and Tokyo, which works to improve the 3D vision acuity of vehicles by using simple cameras and complex algorithms.

As we know, many providers are currently working on getting autonomous vehicles on the road and to test them there – from popular protagonists like Tesla and Waymo to incumbent OEMs. However, the classic OEMs are at a disadvantage because their expertise mainly lies in hardware, i.e. in mechatronics, sensors, and cameras. But autonomous vehicles must be able to plan routes, avoid hindrances, and react to confusing situations. And the hard-

ware is just the foundation here. What is decisive is having the correct software, the right algorithm. Is the person planning on going over the pedestrian crossing, or is he / she just standing there reading a newspaper? These are complex questions that only artificial intelligence can answer as quickly and reliably as a human driver would.

The hardware expertise of the automotive companies is not yet sufficient to solve these problems. They have mainly been focused on machines for years – and now they almost have to start from scratch in some areas. This is where a gap opens, which startups that specialize in AI and data analysis could fill and as the OEMs barely have the time to build up this know-how themselves, they will need to purchase it from external sources. However, the question remains whether they are willing and able to keep up with the remuneration of the US software companies, who they compete with on the global market for specialists and know-how.

06
Think of politics as a point of contact

Nicole Hoffmeister-Kraut (CDU) is the State Minister for Economic Affairs, Labor, and Housing in Baden-Württemberg, the most important German automotive industry hub.

In the State of Mobility, Baden-Württemberg, the entire value chain of vehicles is concentrated in a very small space. Therefore, it is obvious that the state government, economy, and society are working closely together in the context of the "Strategy Dialog of the Automotive Industry" in order to shape the transformation of mobility; there are numerous measures at work here. The point of contact for all issues relating to new mobility is the state agency e-mobil BW. As an innovation agency based in Baden-Württemberg, it manages the clusters for electromobility and the hydrogen economy. Startups, investors, and also established companies can use the "VentureZphere at Boerse Stuttgart" platform to find suitable strategic partners and financial backers, exchange ideas, and form co-operations.

In addition to this, there is the industry-specific promotion of startups through eight start-up BW accelerators at locations in Karlsruhe, Mannheim, Heidelberg, Walldorf, Tübingen, Freiburg, Breisach, and Stuttgart. The focal points of the M.Tech accelerator in Wizemann Areal Stuttgart are topics such as mobility, engineering, and manufacturing. All things considered, we have suitable offers at our disposal for startups, small and medium-sized enterprises, as well as investors, so that the automobile location of Baden-Württemberg can master the largest transformation in its history. We believe that politics must play an active role here and cooperate with the protagonists. Because the change can only be a success if everyone is moving in the same direction.

07
Use the cooperation platform

As the Managing Director of the Verband der Automobilindustrie (VDA), Martin Koers is responsible, among other things, for suppliers, development service providers, and startups, as well as of digitisation.

To master the profound technological challenges that the automotive industry is currently facing, it also incorporates external expertise. Especially Startups have become increasingly important in recent years. Often, they can – apart from the complex business processes and rigid structures of the automotive value chain – quickly come up with new ideas, transform them into products, and subsequently test them. To ensure that this innovation potential is not restricted to car manufacturers and larger suppliers, it is important to promote networking and exchange between, on the one hand, small and medium-sized companies in the automotive industry and, on the other hand, startups from the entire ecosystem of mobility.

VDA has made the cooperation platform automotive-collab.com available since the end of 2016, free of charge. New startups and up and coming companies can present their activities here in just a few clicks, integrate the company's own Twitter account, and publish news or event dates. This allows startups to get in touch with potential partners to collaborate with. Thus, VDA operates in two directions: small and medium-sized companies connect with startups and benefit from their ideas, products, and solutions. In turn, startups receive support via VDA regarding questions on technical standardization, regulation, and market development, and can find cooperation partners and customers in the automotive industry.

08
Focus

Mamatha Chamarthi has worked in the automotive industry for more than 20 years and as the Chief Digital Officer (CDO) he has been responsible for the digitization of ZF Friedrichshafen AG since 2016.

Traditional automotive companies, whether they are OEMs or Tier-1 suppliers, can be risk-averse. They primarily engage in the secure environment of established markets for the pending transformation. However, real innovations usually take place where different industries intersect. Particularly successful entrepreneurs in flexible, technology-oriented startups know this. Big companies like ZF do have expertise that startups may be lacking. But to survive and thrive, the giants must regularly top up on entrepreneurial mobility and

creativity. That is why startups are a very valuable asset to the ecosystem.

Every partnership between ZF and a startup is initiated with the process of brainstorming. During this phase, the startup modifies its existing ideas to our product and corporate strategy. Mutual respect is vital, together with open collaboration and a free exchange of ideas. When we invite a startup to our table, it must prove its confidence in its product concept; it must also limit the scope of its product and not start working on ten or twenty features simultaneously. After all, it was the original approach that led the established company to address the startup as a potential partner. By the way, this step and the following incubation are the easiest phases for startups. The subsequent phases of scaling and commercialization then become more difficult.

09
Be bold and convincing

As the Director of Partnering & Venturing at Porsche Digital GmbH, Oliver Frenz is responsible for cooperation with startups and other external partner companies as well as venture capital investments.

As the digital competence center of Porsche AG, Porsche Digital GmbH develops new business models as well as digital products and services. The responsible teams map the entire development cycle, from the initial idea, to prototypes and the verification of concepts with customers, to the continuous improvement of on-going real products and services. An example is the digital model Porsche Impact, with which customers can calculate their CO2 emissions based on their annual mileage and donate to support climate projects to neutralize these CO2 emissions.

Partners are extremely important to Porsche Digital in the course of developing new business models. These partners particularly include startups with innovative business models and technologies that have been integrated into co-creation as equal development partners right from the start. startups should know what they are capable of – and keep their promises. Because in the end, the customer's digital experience is the most important thing. To do this, business models and technologies must work flawlessly. At the same time, partners must be bold and convincing to question existing issues in order to develop the best solution in the end. For Porsche Digital, it's all about offering its customers a digital experience far beyond a simple sports car and tapping into new customer groups. That's why our potential partners should also be able to think far beyond the topic of mobility.

10
Precisely laying down partnerships in contracts

After more than 20 years of experience in the automotive industry, Andreas von Lochow is now the CEO of scheibenwischer.com and a council member of AZOWO, which offers cloud-based software for B2B fleet management and mobility sharing.

The urban mobility market in Germany is essentially saturated. From classic car rentals to car-sharing and e-scooters in metropolises – it's no problem at all to get from A to B in this country. That is why customers are not looking for new concepts themselves. Why would they? They assume that they already have everything they need. Accordingly, there is little to no digital demand for it. New providers thus have to think very carefully about what they have to offer. In any case, they should first focus on a very particular target group so as not to spend too much money on brand building and testing their concepts.

Those who have resolved these fundamental questions for themselves, should not enter this difficult market alone. Instead, they should look for a strong partner to expand their reach as quickly as possible. Because the potential customers don't know anything about the new offer yet. However, startups should be careful when dealing with strong strategic partners; they could make it difficult for a young company for two reasons: either it starves from too little attention – or it is crushed by a grip that is too tight. Therefore, startups shouldn't just consider their target groups, but also specify the type and form of strategic collaboration from the very beginning and then establish it contractually. startups can only succeed in the difficult mobility market if they have thought about both aspects in detail.

“How do we want to get from A to B?”

Interview

The transport researcher, Prof. Dr. Andreas Knie, who heads the Research Group of Economic Policy at the Wissenschaftszentrum Berlin für Sozialforschung (WZB), about the approval of consumers and the lack of political willingness in the transformation of the automotive industry.

Professor Knie, vehicle mobility is facing the biggest transformation since its invention. What are the factors in the coming years that will influence the transformation in society?

The underlying question is how we want to travel in the future, especially in the cities. In Germany, in particular, the status quo is very firmly fixed, with privately owned petrol and diesel motor vehicles that drive on public roads and park in public spaces. All this is protected by law in Germany, among others by road traffic regulations or the Public Transport Act. Now, with the new platforms for car-sharing, ride-hailing, and the like, and with the increasing level of automation, networked vehicles, and electromobility, something completely new is ablaze. But this is not yet on the map in Germany, the German Transportation Minister first has to consider it. If we want to develop cities to be sustainable, cars that are almost exclusively private property spending 95 % of their time occupying public space are no longer part of a viable future perspective. We need a combination, we must predominantly use transportation instead of owning it, and as clever as possible, so that people get from A to B seamlessly. If that works, consumers won't hesitate to accept the new automobility.

In this country, there seems to be a certain hesitation about autonomous vehicles. Will people get into these cars without thinking twice when they become available?

The culture of trial-and-error is lacking in Germany, but is especially prevalent in the USA. We are very conservative and don't allow anything that is not 100 % safe. And that's why only very small steps are taking place in regard to autonomous driving in this country. People would be happy to use this means of transport. We spent a year investigating semi-autonomous vehicles in a practice pilot project on an enclosed campus, and the approval values were significant: 80 % of users get in without thinking twice. The dramatic questions that are asked, where one hears about the machine running over either an old man or a child in an emergency, have almost no relevance in practice. The larger the number of machines on the road, the safer the roads are overall.

According to users, how secure does their data related to sharing and connectivity have to be?

Data protection will not play a role beyond the statutory standards. With smartphone usage over the past decade, we have noticed that consumers are willing to fully disclose their data if they expect it to be of high utility value to them. There is currently a different problem in Germany regarding data: There is no func-

tioning “roaming” in transport offers because every provider just keeps their data to themselves. It is common practice in telecommunications for devices to be able to register in any available network and, at the end, have the provider issue a central invoice. But this does not work in public transport yet. Anyone traveling by public transport needs their ticket, and for car-sharing, he/she pays other providers; anyone who rents an e-bike does so from a different company. Customers need eight, ten, twelve different apps. This hinders development.

> If politicians should eventually decide that only electric cars should drive in the inner cities, then this could be the incentive that is lacking.

Shared mobility will primarily be based on electric drive-trains. What is currently inhibiting their prevalence the most? The lack of infrastructure to charge vehicles, the skepticism of consumers, the unwillingness of manufacturers?

Beyond pure rhetoric, above all, there is a lack of political willingness. Electric cars are more expensive to procure, with unclear performance. Moreover, the offer is currently limited. Conversely, electromobility does not yet offer clear advantages; up to now, you can neither park freely nor drive with fewer restrictions. If politicians should eventually decide that only electric cars should drive in the inner cities, then this could be the incentive that is lacking. However, I haven’t really seen much movement in this regard in politics thus far.

If the change in thinking does occur at some point: Where will the required electricity for e-mobility on a broad scale come from?

The one million electric vehicles that were envisioned by politics at one point, would result in a consumption increase of one percent of the entire electricity market. That’s not even worth mentioning. If electrification establishes itself, we don’t assume that there will be almost 47 million cars on the road, as is currently the case with combustion vehicles in Germany. The entire fleet will be halved through more intensive use and a shift to public transport, railway transport, and other means of transport. And we can supply 20 to 25 million cars with power by expanding renewable energy sources. Similar developments

apply to truck fleets. The pending changes in mobility thus also have an ecological impact.

Which social value will the car still hold then?

There will still be people in the future who need to have a car as a status symbol. But these will then be older individuals, and this could possibly be mitigated by the demographic development. For the vast majority, mobility will be a commodity like gas, water, or electricity. The times of vehicles being scarce, and thus a luxury item, are over.

The symbolic power of the car as a status symbol will also change in the future.

Case Studies

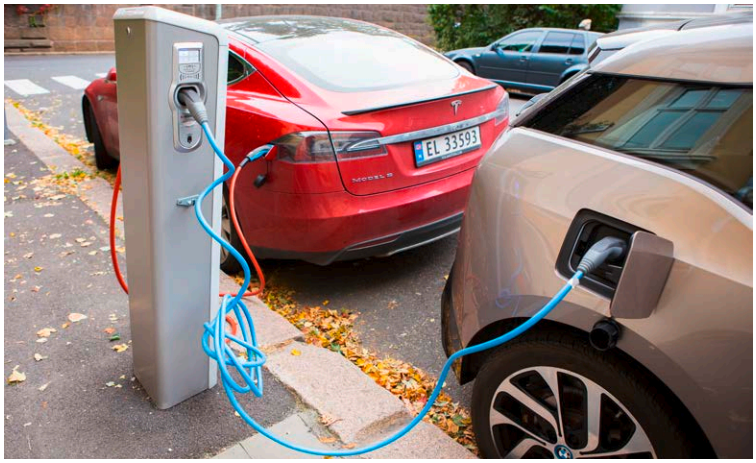
Startups become „software suppliers“ for automobile manufacturers

The new suppliers: Swiftly into the front row

There is probably no better place to see who will dominate the automotive industry in the future than at the two major trade fairs held in the USA at the beginning of the year: While the automotive industry is still trying to attract audiences with heavy, oversized combustion engines at the Detroit Motor Show, i.e. cars of yesterday, trends for the mobility of tomorrow can now be found at the CES electronics fair in Las Vegas. There, in addition to manufacturers of on-board infotainment systems such as Samsung and new players like Nvidia, creative startups are presenting solutions for the future of automotive mobility. These often end up as production models.

The new suppliers predominantly specialize in digital applications and data processing. This includes sensors for driver assistance systems, as well as software for e-mobility, technology for connecting the car to the Internet and smartphones, and security engineering. In these areas, OEMs and Tier-1 suppliers have only gotten involved relatively late in the game – they are lagging accordingly. Based on research by Simon-Kucher, global expenses of OEMs and Tier-1 suppliers for software and development in the field of software is increasing by 16.1 % annually, from €37.9 billion in 2015 to €168.8 billion in 2025. But the limited pool of experts alone indicates that the industry will remain dependent on external assistance for the foreseeable future.

The result: Many startups are moving up swiftly into the front row of suppliers and are directly being involved in production. In the end, there are strategic partnerships between the large players and the highly specialized startups. The companies subsequently use the startups as outsourced research departments. And, for their part, the startups gain access to material and financial resources.



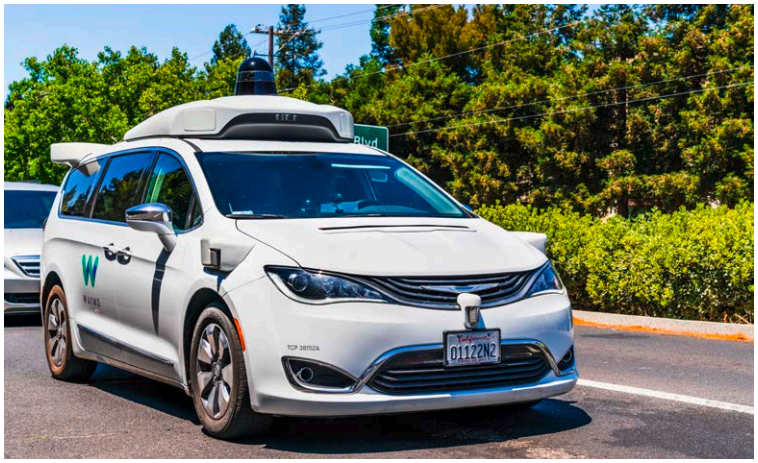
Norway is the absolute pioneer for electric cars and plug-in hybrids.

Norway: World champion in e-mobility

The Norwegians have probably become used to the low humming sound made by cars with electric drives, as nowhere else in the world are proportionally more electric cars and plug-in hybrids than on the streets of the Scandinavian country. And the proportion of electro cars continues to increase: According to a study conducted by the CAM Institute in Bergisch Gladbach, the population of 5.3 million Norwegians purchased around 73,000 electric cars and plug-in hybrids in 2018. This means that one in two newly registered cars in Norway is electrically powered. To compare: The population of 83 million Germans purchased 68,000 electric vehicles in the same year – which equates to a mere two percent of the market share for new registrations.

The reason that e-mobility is so successful in Norway is not a consistent ecological focus of its inhabitants. Rather, the government relies on a combination of high costs for the users of combustion engines and purchasing incentives for electric cars. This means that drivers of diesel and gasoline vehicles have to pay relatively high parking and toll fees and taxes for their vehicles and fuel. Conversally, the government finances its generous support for electric cars and plug-in hybrids; drivers can save on tolls of many roads, use ferries without tickets, use the fast lane in urban areas, and park their vehicles on specially allocated spaces to park and charge their vehicles for free. The Norwegian state abolished VAT on emission-free vehicles in 1990 already. The goal is to completely cease the sale of combustion engines from 2025.

Experts criticize that the national market still has to prove that it will continue to grow even if the state cuts its generous support. This is expected to start gradually from 2020. Oslo is already now considered to be one of the quietest and cleanest metropolises in the world – the capital of a country that has ironically become relatively wealthy as Western Europe's largest oil and gas producer.



The visions of the tech giants were great, but the reality was partly different.

Apple and Google: Tech giants with progress and problems

In the beginning there was the Firefly. In 2014, Google unveiled the prototype of a driverless car without a steering wheel, gas pedal, or brake pedal. The cute, rounded vehicle served as a test and learning platform. Google had begun its first experiments on autonomous driving in its mysterious X Lab as early as 2009. This has now grown into a company called Waymo, a subsidiary of the Google parent company Alphabet. Among other things, the company produces hardware systems for autonomous driving, tests self-driving cars with its simulation software Carcraft, operates a logistics division and autonomous vehicles drive on the road in several US cities, for example in Phoenix and Chandler in the state of Arizona.

In California, the home of Waymo, just over 60 companies currently have a license to test autonomous vehicles. In addition to Waymo and other established manufacturers and suppliers, this includes Apple – the tech giant is also pushing its way into the mobility market. But the example shows that the high-tech companies from California, who are otherwise used to rapid successes, also have to fight in this market.

The CEO of Apple, Steve Jobs, was already interested in an “iCar” in 2008 when Tesla presented its first model. He originally wanted to bring his first autonomous car onto the market by 2020 under the project name Titan. Since then, there have been repeated rumors about prototypes, reports on project progress and announcements of collaborations, among others, with BMW and Mercedes-Benz. However, the latter seem to have failed because Apple wanted to keep the software and the design under its control, as usual – hard to imagine for German premium manufacturers. Apple did collaborate with VW in 2018, converting a T6 transporter into an autonomous vehicle. But a private car, which is supposed to be “the ultimate mobile device” according to investor Carl Icahn, has not yet been presented by Apple. Instead, up to 5,000 Apple employees are said to be producing software for autonomous vehicles of project Titan. Small steps – which might eventually be followed by a larger one.

Formula E is an environmentally friendly and forward-looking technology for Grand Prix events in major cities.

Formula E: Well-functioning switch to series production

At first glance, everything seems to be normal at the Formula E car races: flat sports cars racing through hairpin bends, battles and daredevil overtaking maneuvers abound. But there's a significant difference to conventional car racing: The roaring sound of combustion engines is missing; instead, not much more than the humming of the electric motors and the squealing of the tires on the asphalt can be heard. Since it began in 2014, Formula E has not only become a popular racing spectacle, but has also established itself as the leading technology laboratory for electric mobility. It has thus become a driving force in the development of electric mobility. No wonder that numerous major manufacturers such as Mercedes, BMW, Audi, Porsche, DS, Nissan and Jaguar are represented by their own racing teams by no later than December 2019. Compared to Formula 1, which is not really significant for the mass market due to its highly complex drive and chassis technology, a successful transfer from the racetrack into series production takes place at the Formula E.

To name an example, software solutions from Audi racing cars have already been used in E-tron models, where they regulate the battery temperature or supply the engine with electricity as needed. The supplier Schaeffler pre-tested engines in the Formula E season for its electric sports car Schaeffler4ePerformance in order to "gain the maximum amount of knowledge from Formula E for the production works", as the company announced. And BMW engineers even speak of a "cycle" of technology transfer. Because sharing insights flows in both ways: The same engineers who worked on the i3 and i8 have developed an e-racing car for BMW, which uses the same powertrain as the pioneer electric cars in an improved form. In addition to technology transfers of this kind, OEMs operating a Formula E team benefit from a boost to their image. After all, the E-Series is environmentally friendly with future technology – and not on remote racetracks, but on courses in the middle of metropolises such as Paris or Hong Kong.

The trends in personal mobility do not necessarily also apply to the transportation of goods.

Freight vehicles: Significant differences compared to passenger cars

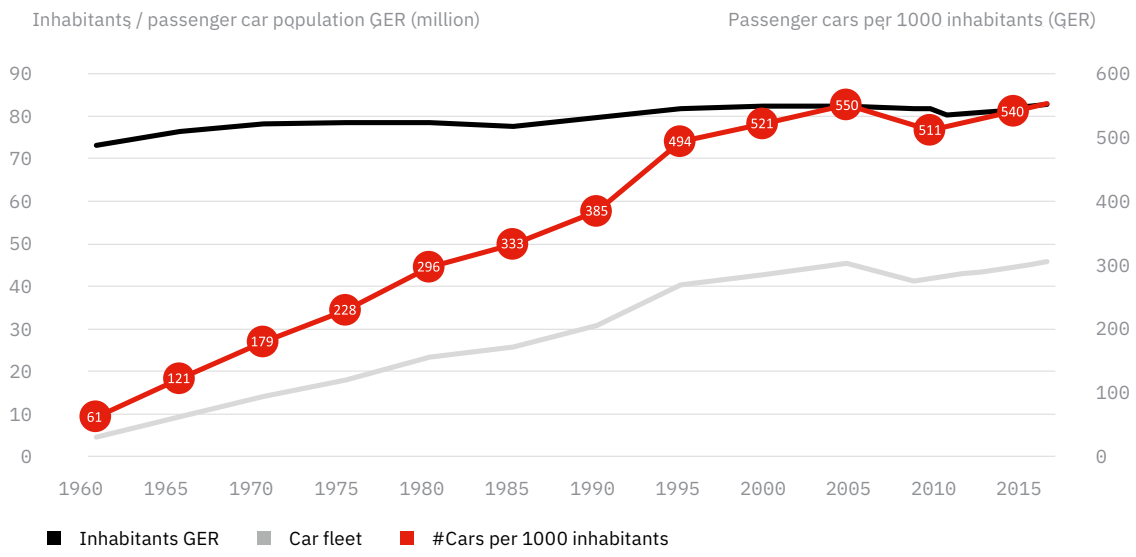
The major trends that are currently radically changing passenger cars can also be found in freight vehicles – however, in some cases with significant differences. Sharing is not yet of relevance with freight vehicles. However, numerous manufacturers are trying to produce autonomous or semi-autonomous trucks, such as the US startup companies Starsky Robotics, Ike, and TuSimple, which are joined by Einride from Sweden, Volvo and MAN, as well as Torc Robotics, recently acquired by Daimler. The German corporation focuses on this field after halting a major research project on platooning in early 2019. With this technology, several trucks connect by radio signals to form convoys, and then drive behind each other in very close distances. The objective of this "electronic tow bar", besides having lower personnel costs and using less space on highways, is lower fuel consumption. However, according to Daimler, savings were not as high as hoped, even under optimal conditions. Instead, Daimler is now focusing on automation and is investing around €500 million in the coming years. This could pay off because freight vehicles, especially on highways – where there are no cyclists or pedestrians – can be automated comparatively easily.

The situation also differs from that of passenger cars in terms of electrification. Tesla intends to enter production with their semi-trailer truck "Semi" by 2020. However, experts currently rate e-trucks as only being useful for short or medium haul routes, like distribution rounds or garbage collection. For example, Deutsche Post is having a subsidiary that builds the Streetscooter, an electrically powered pickup truck, which can also be used by builders, municipalities, and delivery services. For longer distances, however, the weight of the batteries in the e-truck could restrict the possible cargo load so much that the entire operation becomes unviable. For long-haul routes, trucks with fuel cells would work well, once they are ready for series production. The US startup Nikola is currently working on this. Their trucks have a range of up to 1,900 kilometers. To compare: Tesla's Semi only manages around 800 kilometers.

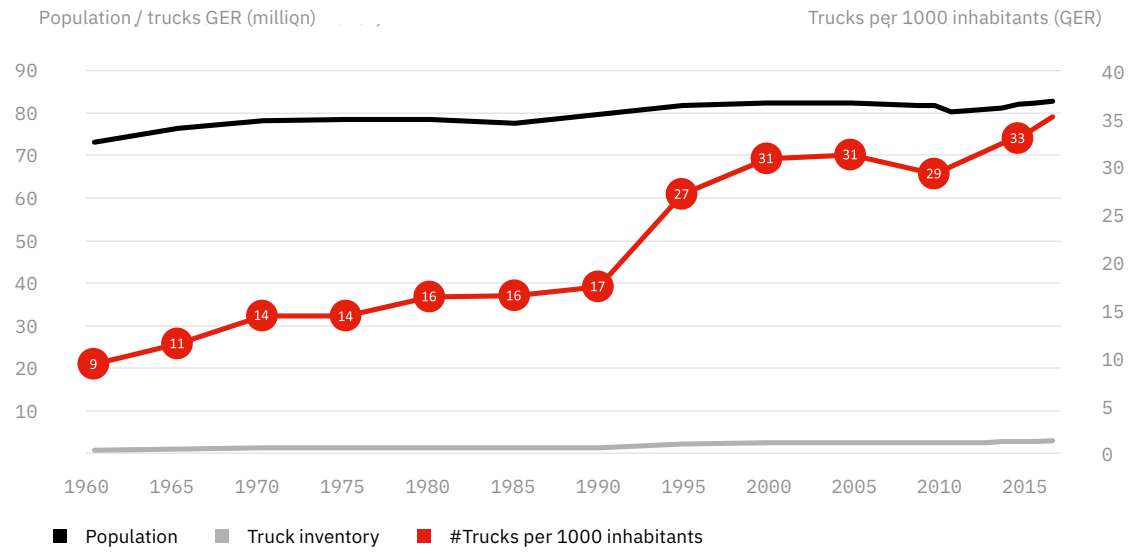
Graphs

The classic automotive industry is booming – for now

Inhabitants / Car Fleet GER



Inhabitants / Truck Fleet GER

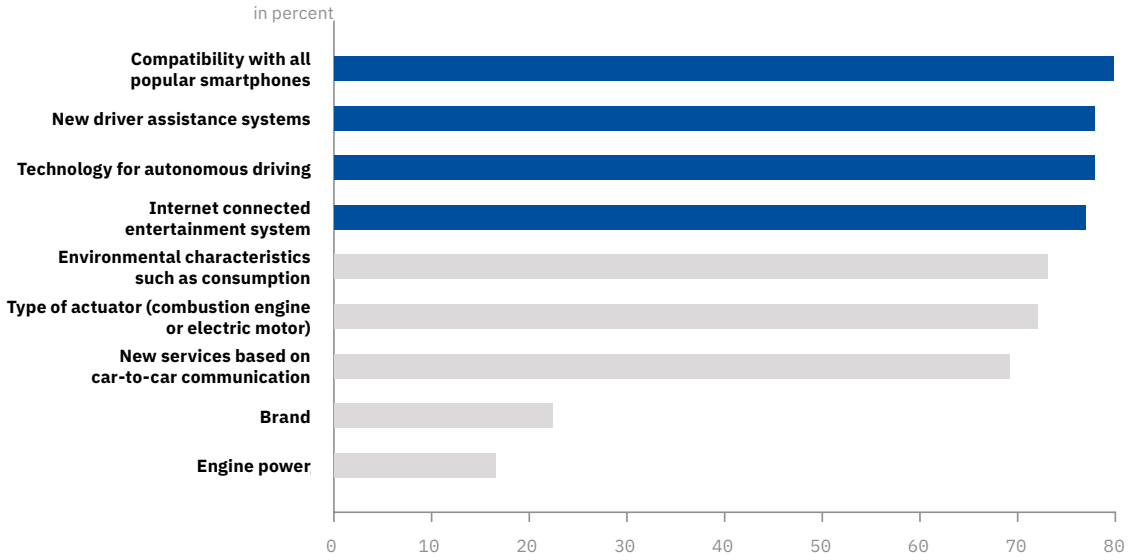


Source: Project A

The automotive industry is in the midst of the biggest transformation in its history. Nevertheless, their classic business – namely the sale of vehicles that are still for the most part driven by combustion engines – continues to run well. This is reflected, for example, by the steady increase of cars per 1,000 inhabitants in Germany, which is heading for a new all-time high, after a slight decline in 2010. According to the Federal Motor Transport Authority, more than 47 million cars drive in Germany today. That is more than one car per household. The number of trucks also continues to rise, partly due to the increasing mail order business. The automotive industry is booming – for now.

Digital technologies determine market success

Which purchase criteria will play a more important role in the car market in 2030 than they do today?

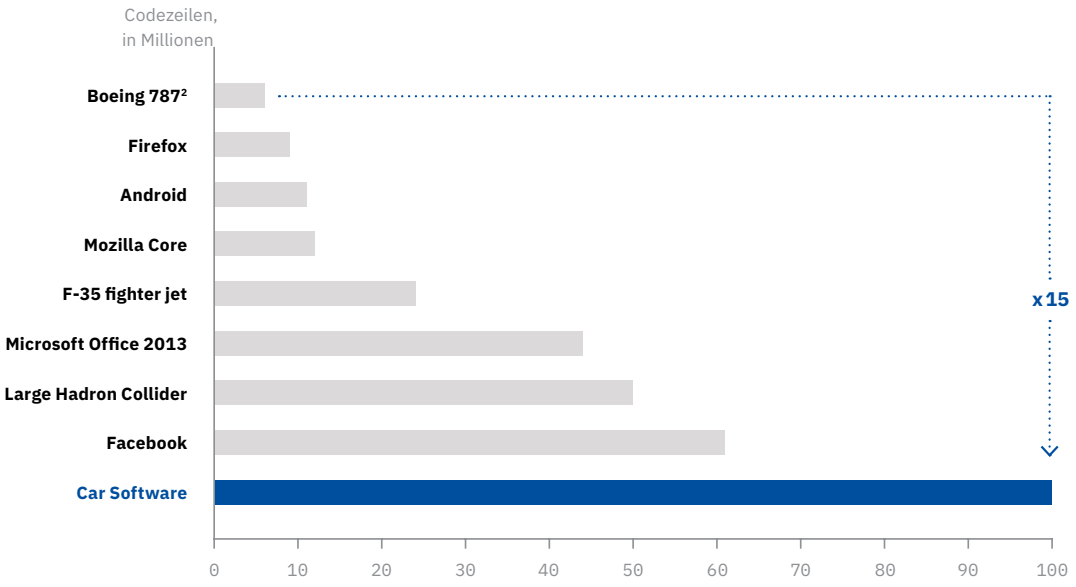


Basis: All companies surveyed (n=177), multiple answers possible, source: bitkom

Project A

The automotive industry is adapting to the coming transformation: In a survey conducted of 177 companies in the automotive industry by the digital association Bitkom, the vast majority were convinced that digital technologies will be decisive for the success of their own new models in 2030. At the top of the list are technologies for connectivity and for autonomous or semi-autonomous driving. The type of drive as a purchasing criterion, i.e. combustion or electric motor, is a few places behind, but still ranks among the leaders. The industry itself only places comparatively small importance on the two factors that today are still the most important criteria for purchasing: the brand of the car and engine performance.

Outstanding complexity: Software in cars



[2] Nur Avionik- und Online-Support-Tools. Die gesamte Flugsoftware verfügt über 14 Millionen Codezeilen.
Quelle: IHS; www.visualcapitalist.com/millions-lines-of-code; McKinsey Center for Future Mobility (McKinsey Center für zukünftige Mobilität)

Cars seem to be turning into rolling connected devices more and more. This is reflected in the complexity of the software that controls a car with all its functions: it contains 15 times more lines of code than the software that a Boeing 787 “Dreamliner” uses for flying and online support tools – and twice as much as the control system of the particle accelerator “Large Hadron Collider” at the European Nuclear Research Center CERN near Geneva. The only software that comes close to the complexity of an average car software is Facebook.

Executive Summary

The automotive industry is in the midst of the largest paradigm shift in its history. Worldwide, the entire production chain – from research and development through to production including suppliers, dealers, and workshops – is being unsettled by disruptions. For the first time in the industry, which was previously almost a closed market due to high entry hurdles, newcomers also have a chance on a large scale. This includes digital corporations and mobility service providers as well as startups, suppliers and even OEMs (Original Equipment Manufacturers).

The new players will be competing on expertise in the fields of software, digital ecosystems, and services. These areas are more important in the changing automotive markets than hardware, classic engineering know-how, and old brand values. The newcomers are flexible, they no longer do everything – from development and production to sales and service – themselves. And they don't have to simultaneously wrap up discontinuing technologies such as the diesel engine, like the old automobile manufacturers, but they can focus all their efforts on new technologies.

In particular, four trends are responsible for the disruptions of the automotive industry:

- **Electrification of the powertrain**
- **Autonomous driving**
- **Connectivity between vehicles and between vehicles and the surrounding infrastructure**
- **Sharing, i.e. shared mobility**

These four trends fundamentally change the car. However, the current transformation will not slow down business. On the contrary, it could almost double by 2030. The automotive industry will then generate around 80 % of its turnover with the four major trends and the resulting new business models.

Imprint

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