Challenges and Trends in the Automotive Industry 2019

Ehningen, Capital Market Day 2019
S&PwC supports the whole value chain transformation – Experts from Industry for Consulting

**Strategy**
- Portfolio Capability
- Operating Models

**Competitiveness**
- Product Cost
- CAPEX
- Productivity

**Organization**
- Benchmarking
- Best Practice
- Implementation

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**Introduction**

1. **Strategy**
   - Portfolio Capability
   - Operating Models

2. **Competitiveness**
   - Product Cost
   - CAPEX
   - Productivity

3. **Organization**
   - Benchmarking
   - Best Practice
   - Implementation

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**Products, Services**
- Globalization
- Industry 4.0
- New Mobility

**New Operating Models**
- Business digitization
- Connectivity

**References 2018**
- 50 Partners
- EMEA/China

**Partners**
- 14 OEM
- 8 Software CE
- 21 Supplier
- 3 Digital providers
- 4 Network providers
- 4 Raw Material
- 21 Supplier
- 14 OEM
- 8 Software CE
- 3 Digital providers
- 4 Network providers
- 4 Raw Material

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**Sales & service & network**
- Alphabet
- BNP
- PSA Groups
- MAHLE
- PSA Groups
- BNP
- PSA Groups
- MAHLE
- Alphabet
- BNP
New technologies and customer requirements lead to fundamental transformation of the automotive industry and its players

Introduction

Robust quality processes

1. Increasing complexity and number of variants
2. Validation of new technologies and shorter life cycles/market launches
3. Regulatory framework conditions
4. Increasing modularization
5. Increasing demand for tests and validations
6. High flexibility and responsiveness to changes
7. Knowledge about laws and regulatory framework
8. High level of responsibility through use of individual modules

Increasing and number of variants
Validation of new technologies and shorter life cycles/market launches
Regulatory framework conditions
Increasing modularization
Increasing demand for tests and validations
High flexibility and responsiveness to changes
Knowledge about laws and regulatory framework
High level of responsibility through use of individual modules

New Services

1) Vehicle-related services
- Safety
- Comfort

2) Digital ecosystem for the vehicle
- Entertainment
- Integration of Smart Home
- Mobility management

OEMs control vehicle-related services
Competitors in the digital ecosystem compete with OEMs for additional service offerings

Challenges for OEMs and suppliers

Fully autonomous driving – New operating models for OEM
- Usage-based payment
- "smart" vehicles
- Autonomous driving

Changed OEM operating model
Digital competitors control growing proportions of user experience

1. Safety
2. Vehicle management
3. Semi-autonomous driving
4. Comfort

Introduction

Short term

Medium term

2035+

Safety
Comfort
Vehicle management
Semi-autonomous driving
Entertainment
Integration of Smart Home
Mobility management

OEMs control vehicle-related services
Competitors in the digital ecosystem compete with OEMs for additional service offerings

Usage-based payment
"smart" vehicles
Autonomous driving

High level of responsibility through use of individual modules

Source: PwC Strategy& analysis
Introduction

Reality of E-Mobility in Germany Today – 2019

Goal of the Federal Government's Electromobility Initiative 2012 was 2.0 million e-mobiles by 2020.
Industry claims: E-Mobility mass production will start right now

Volkswagen MEB Platform is planned to be manufactured 1,0 m units p.a. as of 2022
Vision and Demand of Our Industry 2020

Demanding: Productivity wins by Robotic for Competitiveness throughout demographic change
Our digital dashboard helps to navigate the future as both carmaker and mobility service provider

Digital dashboard with key transformation areas

Chapter 1
Market radar

Chapter 2
Mobility & connected service heads-up

Chapter 3
Capabilities for the road ahead
01. Market radar
Consumers expect mobility services that are convenient, personalized, multi-modal and connected

**Multi-modal**

74% of consumers opt for the most convenient way to get from A to B – including the combination of multiple transport modes.

**Ubiquitously connected and integrated**

34% of European consumers expect to seamlessly receive connected car services\(^1\) – so does a 89% share of Chinese customers.

**On-demand**

47% of European consumers would consider giving up their own car in favor of widely available and adequately priced autonomous robotaxi services.

**Personalized**

70% of consumers expect mobility offers to be personalized – reflecting their personal needs and mobility patterns.

**Shared**

70% of Chinese vehicle owners could imagine earning money from sharing their car via a peer-to-peer platforms, while only 28% would do so in Europe.

**Experience-driven**

When traveling fully autonomous, music streaming with 46% and video streaming with 42% are considered most relevant by consumers to enhance their experience.

**Subscription-based**

The majority of consumers would be willing to pay up to $250 for a monthly subscription of unlimited rides within town.

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\(^{1}\) Real-time traffic information, communication and advertising, news stream, music stream

Source: PwC Strategy\& consumer research, 2018, n=3000 (EU, USA, CHN)
Electric and autonomous vehicles are subject to volatile regulatory frameworks across the E.U., China and the U.S.

**Regulatory trends**

### USA

**Electric**
- Target controversy between “CARB” states and EPA
- Gap between CARB’s ZEV sales targets and EPA’s emission standards freeze
- OEMs anxious about disparate US regulations

**Autonomous**
- Individual legislation in each state → fast ratification
- AVs on public highways permitted in selected states (Florida, Nevada, Virginia,...)
- Michigan and California allow driverless vehicle tests

### China

**Electric**
- Licensing privileges for BEVs and PHEVs in many cities
- Mandatory EV quota planned for 2019
- Stepwise reduction of vehicle subsidies until 2022

**Autonomous**
- AVs receive only test vehicle status, driver mandatory for testing on public roads
- L3 mode allowed in Germany, yet unclarity about certification
- Legal initiatives for AVs on the political agenda, no nationwide regulations issued yet
- Test vehicle registrations for public highways in 7 cities (incl. Beijing and Shanghai)
- Many players already testing with local regulations of certain cities

### EU

**Electric**
- Local focus on NOX & particles
- Credits for EVs to avoid CO2 non-compliance penalties
- Inner-city bans of ICE planned

**Autonomous**
- AVs receive only test vehicle status, driver mandatory for testing on public roads
- L3 mode allowed in Germany, yet unclarity about certification

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Regulator as (1) accelerator, (2) inhibitor, (3) or neutral

Abbreviations: CARB – states that have adopted the California Emission Standards; EPA – US Environmental Protection Agency; ZEV – zero emission vehicle; EV – electric vehicle; AV – autonomous vehicle
Electric vehicle sales will be boosted by legislation especially in China and E.U. after 2020

Electric vehicles (in total new vehicle sales) (E.U., U.S., China; in millions)

- 44% share of electric in 2030
- Strong legislative push from 2020 on
- Sufficient public charging infrastructure ~2025
- Cost of operations tipping point differs by segment and use pattern

- 20% share of electric in 2030
- As mobility patterns are not expected to change notably until 2030, EV technologies follow conventional S-curve adoption paths based on relative cost advantages

- ~50% share of electric in 2030
- Strong legislative push from June 2018 on
- Integrated charging infrastructure ~2025
- Cost-of-operations advantages by segment and use pattern already evident

Strategy&

Source: PwC AutoFacts
Commercial applications will be first; China is far ahead

Robo Intralogistic
Robotaxis
Robo-Last Mile
Autonomous vehicles could be used in significant numbers after 2025

Autonomous vehicles (in total new vehicle sales) (E.U., U.S., China; in millions)

- ~25% of new cars with level 4/5 in 2030
- Assuming tech will allow level 4/5 adoption from 2028 onwards & regulation in place
- Robotaxis driving on specific routes / defined areas from 2025 onwards

- Share of level 4/5 up to ~10% in 2030 – point of inflection expected after 2030
- Assuming a slower transformation in the US, as mobility behavior is driven by lower TCO of traditional cars than elsewhere
- ~35% share of level 4/5 in 2030
- Assuming tech will allow level 4/5 adoption from 2028 onwards & regulation in place
- Growing middle class open for new mobility modes and pushing demand for autonomous

Abbreviations: TCO – Total Cost of Ownership
Source: PwC AutoFacts
Shared-autonomous mobility will have strongest growth in China

Distribution of mobility types in road-bound personal mobility

Source: PwC AutoFacts, Strategy& analysis

1. in % of total person km "road" driven
Vehicle parc expected to decline in Europe, followed by the U.S. — yet, still growing in China

**Total vehicle parc** (in millions, auton./electr./connected, in % of total vehicle parc)

- Uptake of connected, electric and autonomous after policy and technology breakthroughs
- Overall increase of distance driven and strong growth in relative share of vehicle-based mobility (China in particular)
- Increased vehicle utilization and turnover due to sharing/pooling resulting in declining vehicle base
- China: increase of new vehicle sales as new mobility modes become more affordable (larger customer base)
Industry profit share of traditional suppliers, OEM vehicle sales and aftermarket could almost halve to 41% by 2030

Global automotive value pool shifts

**Revenue distribution**\(^1\) (in $bn)

<table>
<thead>
<tr>
<th>Year</th>
<th>MaaS(^2)</th>
<th>Connected Services</th>
<th>Suppliers - Tech</th>
<th>Financing</th>
<th>Aftermarket</th>
<th>Insurace</th>
<th>New Vehicle Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>5,315</td>
<td>2%</td>
<td>12%</td>
<td>8%</td>
<td>14%</td>
<td>48%</td>
<td>13%</td>
</tr>
<tr>
<td>2030</td>
<td>8,931</td>
<td>2%</td>
<td>22%</td>
<td>9%</td>
<td>5%</td>
<td>38%</td>
<td>7%</td>
</tr>
</tbody>
</table>

**Profit distribution**\(^1\) (in $bn)

<table>
<thead>
<tr>
<th>Year</th>
<th>MaaS(^2)</th>
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<th>Suppliers - Tech</th>
<th>Financing</th>
<th>Aftermarket</th>
<th>Insurace</th>
<th>New Vehicle Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>377</td>
<td>41%</td>
<td>13%</td>
<td>11%</td>
<td>16%</td>
<td>41%</td>
<td>71%</td>
</tr>
<tr>
<td>2030</td>
<td>637</td>
<td>41%</td>
<td>30%</td>
<td>9%</td>
<td>10%</td>
<td>26%</td>
<td>41%</td>
</tr>
</tbody>
</table>

**Key levers**

- **MaaS** increases *vehicle utilization* and respective vehicle wear/tear → higher vehicle related sales, but declining vehicle base
- **MaaS fleet owners** emerge as growing buyer segment with higher bargaining power → lower margins in aftermarket, financing, and insurance
- **Autonomous** increases technical vehicle complexity/value provided by new tech suppliers, but reduces collisions → shift in insurance business and aftersales
- **Vehicle electrification** reduces power train complexity, vehicle maintenance need, and traditional supplier contribution → reduced traditional supplier revenues

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1) based on Strategy\& 2030 Scenario. Totals may not equal sums shown due to rounding; 2) Vehicle-based mobility as a service, incl. “shared autonomous” & “shared driver-driven”

Note: consolidated view; supplier value pools not eliminated from vehicle/aftermarket/MaaS revenues to show full industry value pools; Source: PwC Autofacts, IHS, HBR, Technavio, Thomson Reuters, Oxford Economics, OEM Reports, Strategy\& Analysis
The engineering supplier market is expected to grow with a CAGR of approx. >6%

**ESO market per region (EUR Mio.)**

ESO market development per region

<table>
<thead>
<tr>
<th>Year</th>
<th>DE</th>
<th>US</th>
<th>CN</th>
<th>IN</th>
<th>MX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>7,387</td>
<td>2,426</td>
<td>3,977</td>
<td>5,034</td>
<td>9,175</td>
</tr>
<tr>
<td>2011</td>
<td>9,175</td>
<td>5,034</td>
<td>5,557</td>
<td>5,214</td>
<td>9,666</td>
</tr>
<tr>
<td>2012</td>
<td>10,229</td>
<td>5,522</td>
<td>5,522</td>
<td>5,522</td>
<td>11,453</td>
</tr>
<tr>
<td>2013</td>
<td>11,453</td>
<td>6,215</td>
<td>6,215</td>
<td>6,215</td>
<td>12,346</td>
</tr>
<tr>
<td>2014</td>
<td>12,346</td>
<td>6,667</td>
<td>6,667</td>
<td>6,667</td>
<td>13,235</td>
</tr>
<tr>
<td>2015</td>
<td>13,235</td>
<td>7,152</td>
<td>7,152</td>
<td>7,152</td>
<td>14,138</td>
</tr>
<tr>
<td>2016</td>
<td>14,138</td>
<td>7,673</td>
<td>7,673</td>
<td>7,673</td>
<td>15,033</td>
</tr>
<tr>
<td>2017</td>
<td>15,033</td>
<td>8,231</td>
<td>8,231</td>
<td>8,231</td>
<td>16,058</td>
</tr>
<tr>
<td>2018e</td>
<td>16,058</td>
<td>8,830</td>
<td>8,830</td>
<td>8,830</td>
<td>17,128</td>
</tr>
</tbody>
</table>

**ESO market growth per region**

<table>
<thead>
<tr>
<th>Year</th>
<th>DE</th>
<th>US</th>
<th>CN</th>
<th>IN</th>
<th>MX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>3,498</td>
<td>62</td>
<td>11,453</td>
<td>1,417</td>
<td>175</td>
</tr>
<tr>
<td>2015</td>
<td>6,215</td>
<td>356</td>
<td>17,128</td>
<td>366</td>
<td>420</td>
</tr>
</tbody>
</table>
| 2016 | 9,473 | 1,029 | 14,138 | 39 | 2012-2020 absolute and relative growth per region

**Market radar**

Geographical attribution based on where operations are located not contracted.

Strategy&

ESO: Engineering service Offering. RoE = Rest of Europe (excluding Germany)

Sources: Strategy& analysis, Market Model
Forward-looking concepts with a completely new structure and new functions are already in place

**Example – Iconiq**

**Styling Trends**

- Big screens, bigger,.....
- Under Body LED
- Exterior Lighting (in blue)
- Night View Sealing
- Useability in new dimensions
Natural Interaction will be a real challenge for OEM, suppliers and customers

Many technical solutions upcoming
Gaining for customer acceptance
New interior solutions will differentiate the new mobility

Clean, Robust, Unlimited Functionality For Shared Mobility
New Technologies have to be rolled out with a strong strategic orientation to visibility and functional impact.

Feasibility of metallic effects, tailgates and structured surfaces can be classified as short-term implementation. Future topics can be implemented with a longer time horizon.

**Need for action**

- **High feasibility**
  - Technical solution / material available in the market
  - Suppliers established
  - Process blueprint available

  - Painted metallic effects
  - Plastic tailgate
  - Structured surfaces
  - MuCell

- **Medium-term feasibility**
  - Basic solutions available
  - Concrete strategy
  - VE projects / supplier exploration

  - Component integration
  - Stable surfaces
  - Stiffeners
  - Foiled bumpers

- **Long-term horizon**
  - Development of concepts and fields of application

  - Environment interaction
  - Morphing
02. Mobility and connected service heads-up
Mobility platforms beat traditional transportation offerings in choice, convenience, and price

Mobility service platforms

- Aim at providing passenger transportation that is more convenient and at a better price than traditional offers through more efficient asset use and/or better orchestration of ecosystem partners.
We see four Ways-to-play in the mobility market with different scope

<table>
<thead>
<tr>
<th>Target audience</th>
<th>Offering scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2C</td>
<td>narrow</td>
</tr>
<tr>
<td>B2B</td>
<td>broad</td>
</tr>
</tbody>
</table>

- **Mobility Advisor**
  - Navigation Apps
  - B2C
  - Narrow

- **Specialized Mobility Enabler**
  - B2B
  - Narrow

- **Mobility-as-a-Service Provider**
  - B2C
  - Broad

- **Operating System Provider**
  - B2B
  - Broad
The value of MaaS is expected to grow at a combined 25% p.a. from 2017 to 2030 to reach ~USD 1,400 billion in the US/EU/China.

**Estimated MaaS market size development, U.S.** (in USD billions)

- 2017: 47
- 2025: 170
- 2030: 250

**Estimated MaaS market size development, E.U.** (in USD billions)

- 2017: 25
- 2025: 198
- 2030: 451

**Estimated MaaS market size development, China** (in USD billions)

- 2017: 15
- 2025: 201
- 2030: 656

Note: vehicle-based mobility as a service, incl. "shared autonomous" and "shared driver-driven". based on Strategy& 2030 scenario.

Source: expert interviews, PwC Autofacts, Strategy& analysis.
The domain ADAS /AD is subject to most significant and most complex technological change and a good example for distributed safety

**High-level view on domain ADAS / AD – Distributed safety**

**Expected Impact**

- New concepts for safety- and fallback paths are required
- **In-vehicle approach** for autonomous driving is **highly integrated**
- Multiclouds enable bringing adjacent safety
- Level 5 autonomous driving will most likely be enabled by a cloud backend with AI
- Various designs and architectures will emerge
- **Safety transforms** from individual ECU to all functions and layers and must be reflected in organization
There are so many uncertain drive situations

… trap for autonomous cars ;)
The value of connected services will grow at a combined 28% p.a. from 2017-2030 to reach USD76 billion in the US/EU/China

Vehicle-centric connected services – Market potential

**Estimated connected services market size development, U.S. (in USD billions)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>1.3</td>
<td>10.3</td>
<td>19.6</td>
</tr>
</tbody>
</table>

**CAGR 2017-30** +23%

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**Estimated connected services market size development, E.U. (in USD billions)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.8</td>
<td>8.6</td>
<td>16.7</td>
</tr>
</tbody>
</table>

**CAGR 2017-30** +26%

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**Estimated connected services market size development, China (in USD billions)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.6</td>
<td>16.8</td>
<td>39.5</td>
</tr>
</tbody>
</table>

**CAGR 2017-30** +38%

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Note: based on Strategy& 2030 scenario  
Source: expert interviews, PwC Autofacts, Strategy& analysis
Fifth screen will be the new point of sales

New technologies enable usability and driver focus for connected services.
03. Capabilities for the road ahead
Winners will shift gears in 5 areas to meet future of mobility demands

New paradigms in automotive …

... ask for gears to be shifted
Operating models and workshare is shifting

New paradigms in automotive …

… ask for gears to be shifted

Take away No. 1: The customer group is growing for ESO
New working environment will lead to new organizations

New paradigms in automotive …

Take away No. 2: Organizations will change, buying center of clients is transforming
Engineering service providers have made high investments in electronic capability development; competition is intensifying as a result.

**Investments in "competence" development**

**Current investment focus for the development of competencies in the area of E/E...**

Engineering service provider investments

**... will significantly intensify future competition in E/E**

**Detailed product portfolio**

**Take away No. 3: The ESO market is already moving to advanced capabilities**
Testing and validation is an essential part of software development and is often ~ 50% of the workload

**Example: Autonomous/assisted drive test environment**

- **Database**
  - Storage of video data (>1 million km, 15 PetaByte)

- **HIL Farm**
  - >60 reinjection units

- **KPI Calculation**
  - Calculation of >200 key performance indicators

- **Basic data**
  - Selection and marking of relevant scenes and assessment of quality

- **MMS**
  - Management system for performing automated tests

- **KPI Report**
  - Automatic generation of test reports for each software version

Subproject for the planning and execution of software tests and the verification of compliance requirements parallel to the software development

Establishment of complex databases and controls for automatic testing of HiL, SiL and MiL systems parallel to the software development process

**Test environment**

- Setup of a test environment for the **automatic validation** of camera functions and performance tests by Tier-1 Supplier
- Approximately **50% of the development** costs were needed to set up and run the test environment
- Strong **underestimation of the complexity** of the required IT infrastructure and special test software
- Autonomous Drive requires one of the **most complex test infrastructures**

**Take away No. 4:** Testing is the key issue for sustainable products

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Source: Strategy& analysis, Tier-1 Supplier; KPI=Key Performance Indicator; HiL=Hardware in the Loop; SiL=Software in the Loop
ESO will prepare for a holistic transformation to build the necessary competencies and skills

**Necessary skills**

- Organizations foster **innovation**, **recognize customer needs**, and **enable** continuous after-sales improvement (on-air updates)
- Ensure best-in-class **technology/differentiating skills** (e.g. architecture design, agile software development, testing, artificial intelligence)
- Organizations work **decentralized with central know-how in modern, function-related areas**
- Development organizations with **strong profiles** and **conscious location** decisions (Best Cost Country vs. Best Capability Country) are necessary
- Organizations plan to have sufficient **for protection**
- Cross-functional **competency building** and **scalable project setups** (e.g., campus concept)
- Organizations promote **"Digital Change Culture"** within the company

Realignment & Balancing Organization

**Take away No. 5:** Next level ESO transformation starts right now

*Image of a globe with various elements like processes, customer, product, and more.*