Effects of electrified powertrains and driver assistance on body design

AMAP
Advanced Metals and Processes

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AMAP
Advanced Metals and Processes

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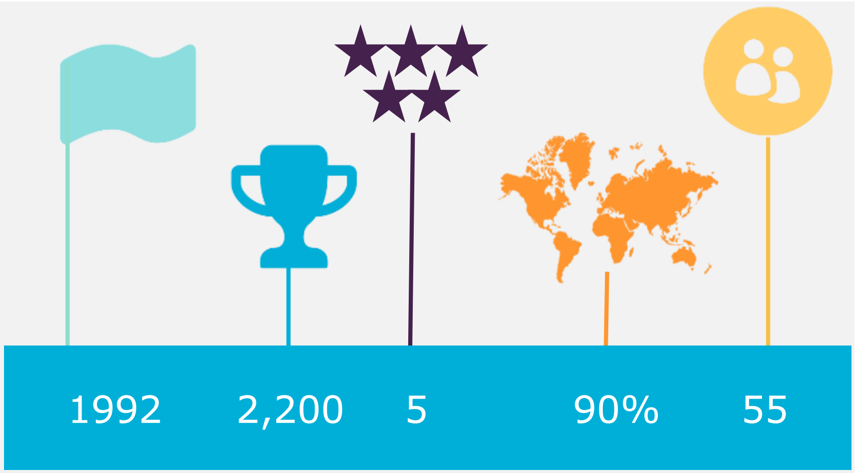
Data collection,
Analysis,
Evaluation

Consulting:
Goal Setting,
Strategy,
Concept Development

Implementation:
Monitoring,
Reviewing,
Performance measurement

Our spotlight industries – the primary focus is on technology



- Which trends for battery pack casing will emerge?
- Which factors drive electric propulsion?
- How will turbo chargers penetrate hybrid powertrain design and why?
- What is real demand for fast chargers?

Project examples: chassis, body

SuP has carried out different projects recently regarding body, lightweight and joining technologies.

Die casted components in body chassis and interior

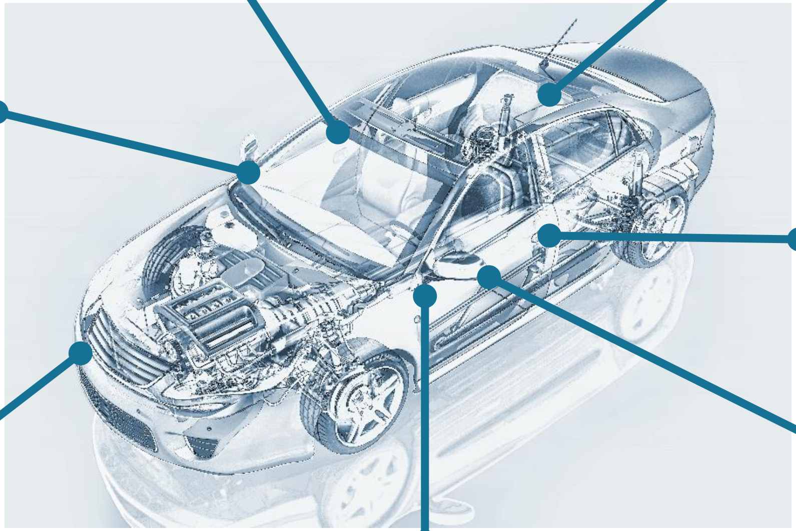
Use of die casted components in light vehicles

Global market for adhesives in interior

Trends, strengths and weaknesses of different kinds of adhesives and technologies

Global market for adhesives in exterior

Trends as well as strengths and weaknesses of different kinds of adhesives and process technologies



Battery technology

Market development of batteries for automotive and stationary applications

Use of aluminum sheet metal in light vehicles

Calculation of market size for Europe and North America

Trends in joining technology

- Strength and weaknesses of different joining technologies
- Estimation of market size

Use of different body materials

- OEMs' lightweight approach
- Driver for a paradigm change

Source: SuP

Megatrends

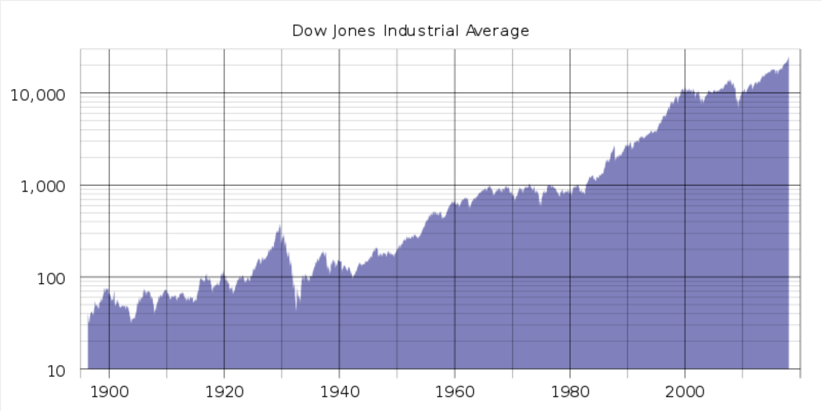
Electrification

ADAS

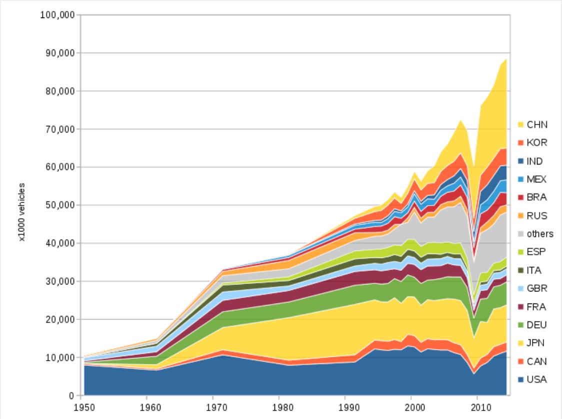
Summary and outlook

The automotive industry currently faces an extremely volatile situation.

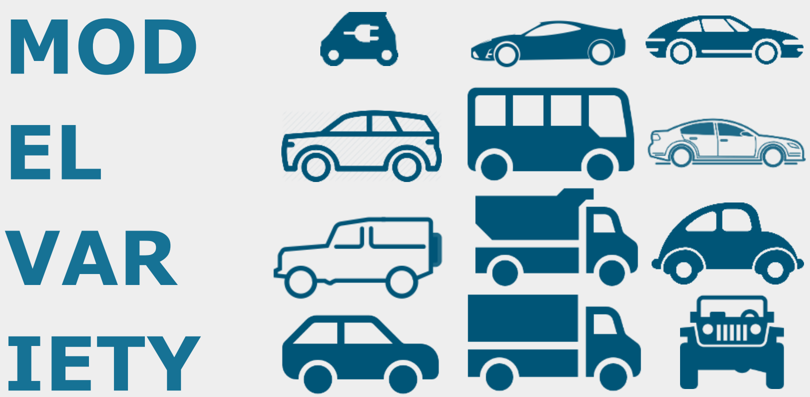
Industry stock values are on all-time high.



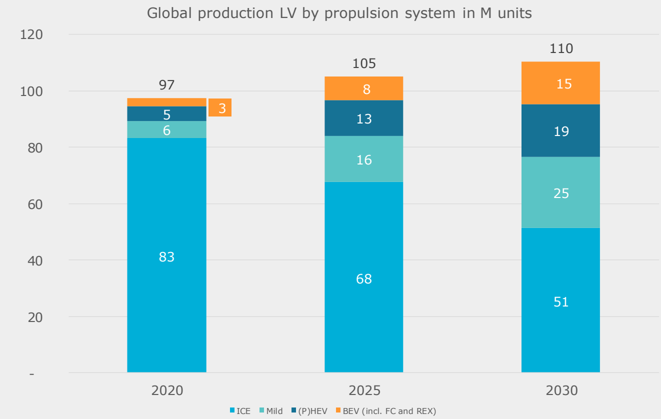
Global LV production has risen to 100 M units.



Variations emerged from 0 to 10^{32} variations.

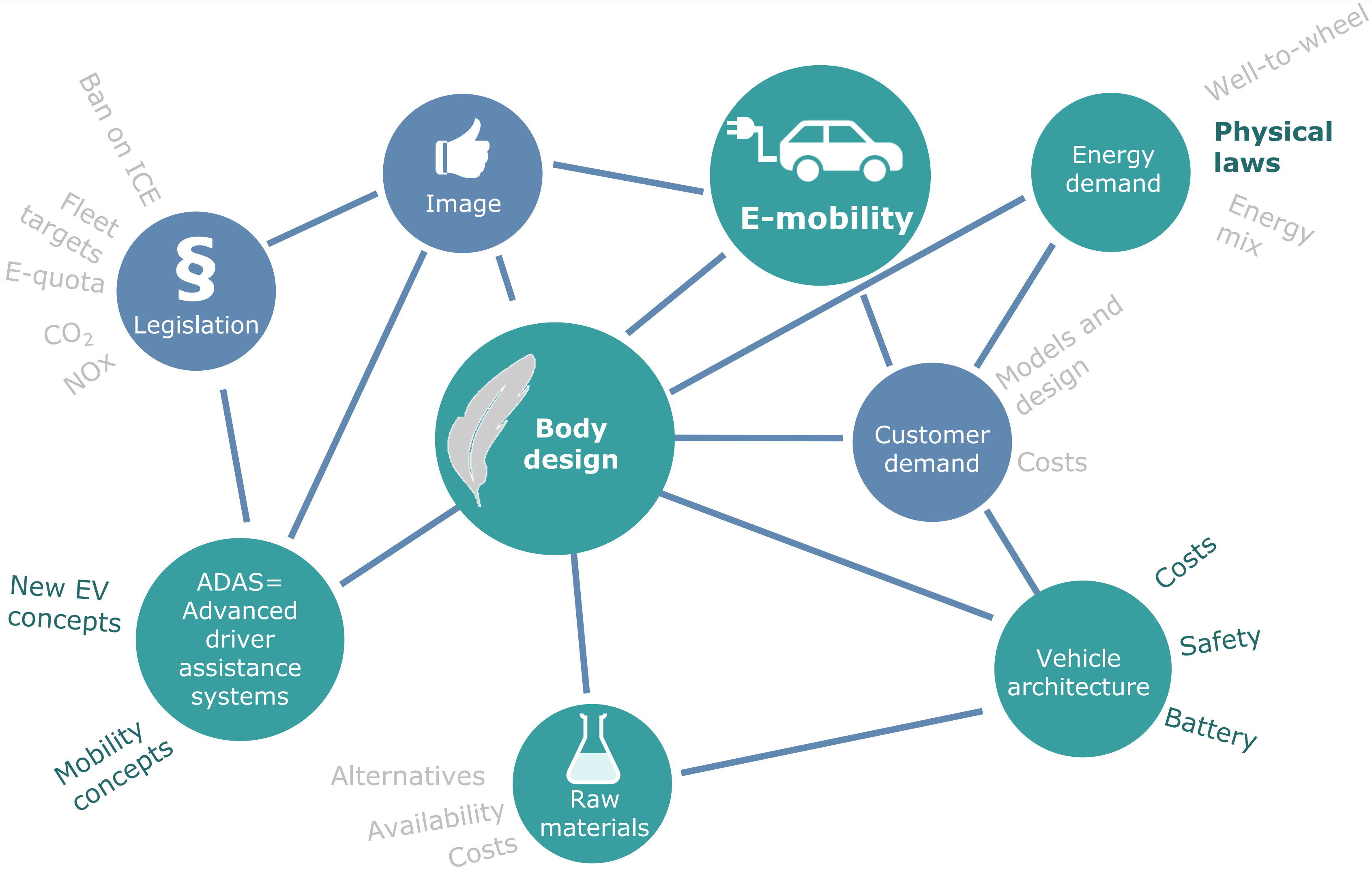


Global LV production is likely to grow until 2030.



Sources: DowJones Industrial Average, Wikipedia, IHS, SuP

Body design is driven by a multitude of factors in different ways.



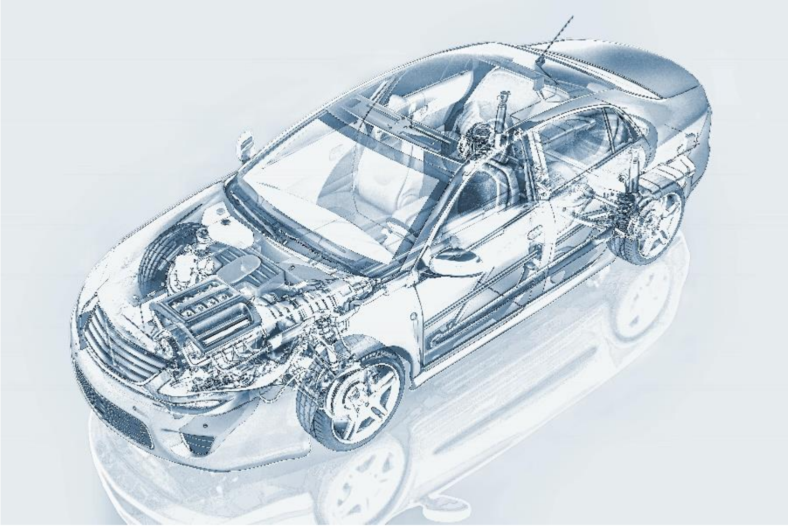
Source: SuP

Reduction of accidents and fatalities, of emissions and natural resources drive us as well as individualization.

Electrification
- Function/ components
- Design

V2X communication
- Legislation
- Components (sensors, camera, displays)

Crash protection
- Legislation
- Material
- Design



Lightweight
- Material
- Construction design components
- Joining technology

ADAS
- Legislation
- Components (sensors, camera)

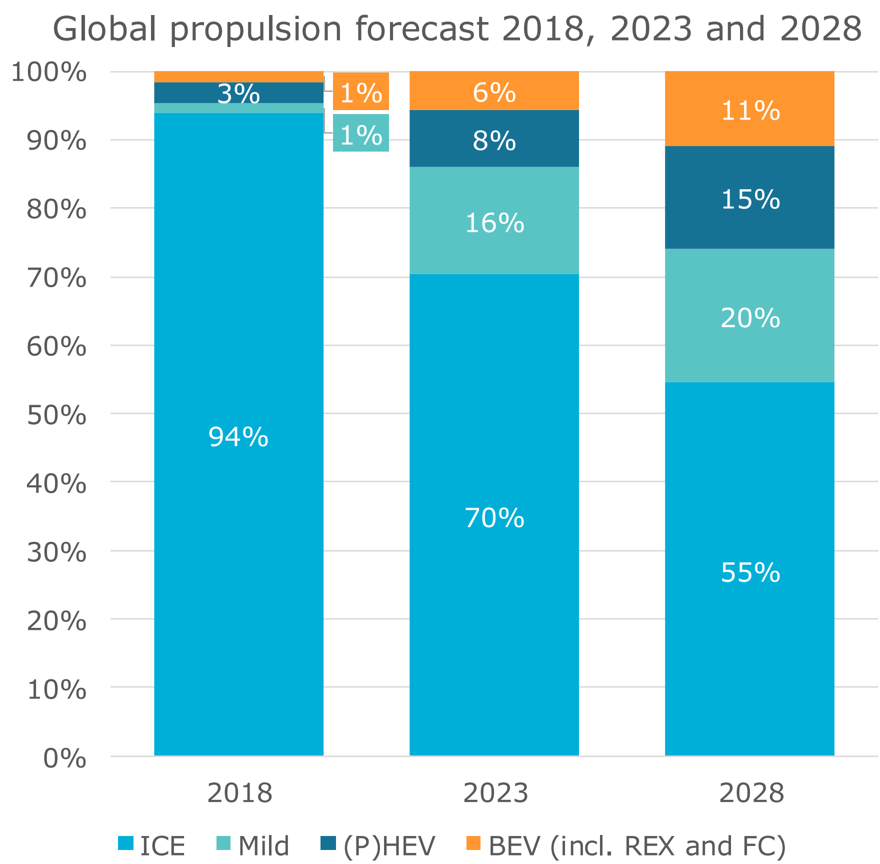
Lighting & communication
- Legislation
- Components, signaling, displays

Source: SuP

- Megatrends
- **Electrification**
  - Definition
  - Direct requirements
  - Indirect requirements
  - Consequences for body design
- ADAS
- Summary and outlook

Electrification – Propulsion concepts

The share of BEVs will gradually increase.
In 2028, BEVs will account for 11% of global automotive LV production.



Source: SuP based on IHS Database

Internal combustion engine – ICE

Propulsion only by combustion engine.

Mild Hybrid Electric Vehicle – 48V

Propulsion mainly by combustion engine with a 48V starter generator that supports the engine.

(Plug-in) Hybrid Electric Vehicle – (P)HEV

Propulsion either by combustion engine, electric motor or combined.

Battery Electric Vehicle - BEV

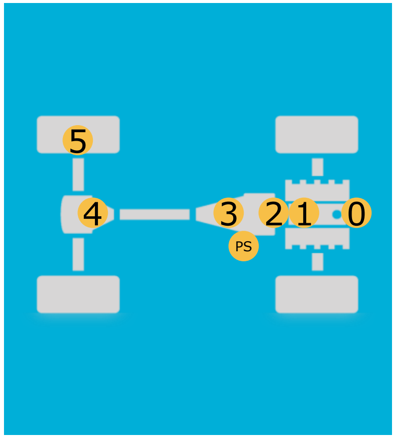
Propulsion only by electric motor. For range extended vehicles (REX), a small ICE supports the engine for some operation modes.

Fuel Cell Electric Vehicle - FC

Propulsion only by electric motor.

Electrification

Direct effects of electrified powertrains are obvious.



Powertrain designs

motor allocation

PX

Chemistry list

of different batteries

- NCA
- NMC
- LTO
- LFP

Cooling

of electrified vehicles

- Air
- Coolant
- Refrigerant
- Oil

Battery

design and allocation

- L-shape
- Distributed
- Skateboard

Source: SuP

Direct effects from electrification

Demand and properties of components drive significant changes of body design.

Powertrain space	Motor and controller are smaller than engine and transmission	More space in vehicle front
All-wheel-drive	Two motors (or more) in case of AWD	No cardan shaft, no cardan tunnel
Vehicle assembly	No need for classic marriage	No open front needed
Battery	Battery compartment needed	Low floor skateboard design
Chassis layout	Wheels can be allocated closer to the corner	Longer wheelbase, comfort
Thermal management	Less cooling demand for engine	less space needed for different heat exchangers (engine, EGR, CAC, AC, motor, battery PE)

Source: SuP

Indirect effects from electrification

Use and application of electrified powertrains cause a multitude of effects.

Area	Effects	Consequences
Speed	Top speed goes down Less transient operation (range)	Drag effect possibly less relevant Weight becomes more relevant
Weight	Weight increase from battery Lightweight benefits? Range, battery cost	Lightweight design: material, processes, joining technologies
Battery case	Battery contribution to vehicle stiffness Battery contribution to crash protection Battery swap design/replacements	Open body floor design Sturdy carrier/flanges required Releasable joints required
Noise	Sound level goes down Noise reduction gets essential	Insulation required Silent structural design
Safety	Passive safety Battery protection, HV systems Active safety	Crash protection Venting if thermal runaway Protected allocation
Charging demand	Allocation of HV components Thermal management	Short HV wiring demanded New thermal infrastructure

Source: SuP

Battery case design – Trends

A flat skateboard-shaped battery pack located in the underfloor is the future trend for purpose designed electric vehicles.

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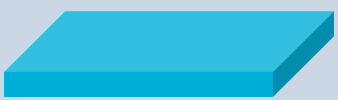
Shape

T-shape

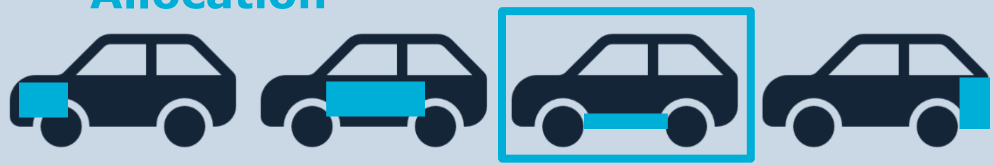
- Fits to conventional vehicle designs
- Geometry derived from existing body
- Low-volume efficiency
- Expensive housing
- E.g. Volkswagen e-Golf, GM Volt

Skateboard design



- Fits to EV purpose
- Height dependent on cell size
- High-volume efficiency
- Simple housing
- E.g. BMW i3, Volkswagen I.D. family

Allocation

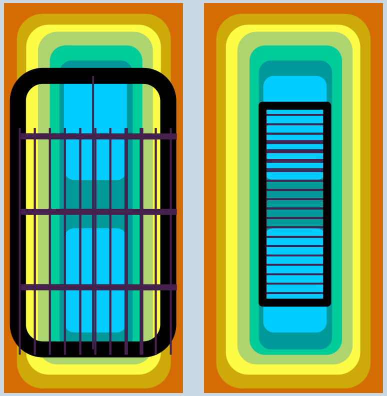


Underfloor battery pack

- Integration of battery into vehicle structure and vehicle crash concept in order to optimize stability and balance
- Increased space inside the vehicle cabin and more freedom regarding vehicle design
- Low center of gravity and optimal weight distribution improves vehicle performance
- Battery pack design is limited in height and requires customization option regarding width and length

Safety

- Battery case design increasingly incorporates crash safety functionality
- Allocation of battery is either in areas with low crash probability or design is rigid enough to provide protection in possible crash



Colors represent risk of deformation according to Daimler Proceedings Soczka-Guth AABC 2018

Source: SuP research

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Advanced driver assistance

Vehicle assistance and vehicle control have a strong impact on future vehicle design and value chain.

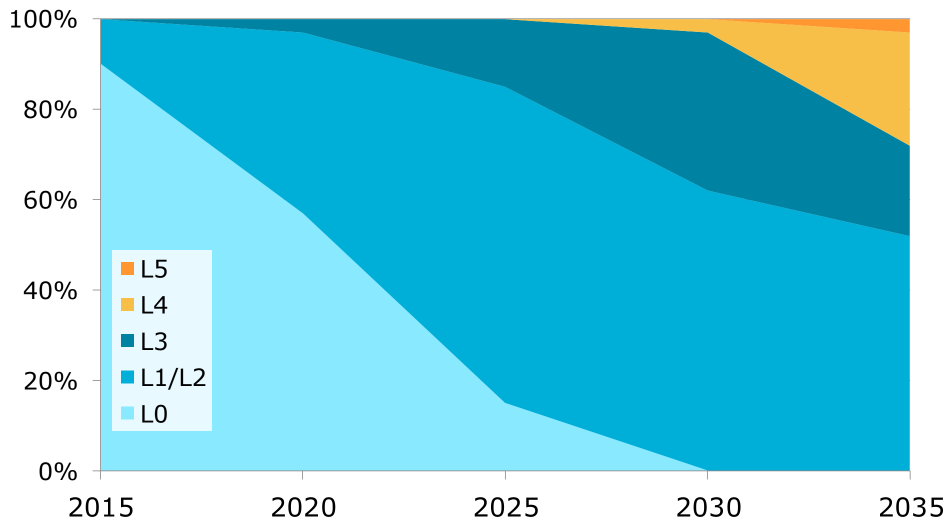
Technology

Which technology is required or most appropriate for sensors?
Camera, laser, lidar, ultrasonic, infrared,…

Location of system components

Where will ADAS sensors, actuators, ECU and interfaces be allocated?

European market penetration of levels of automated driving



Interfaces

What will human-machine-interfaces (HMI) look like?

Use patterns

How will autonomously operated vehicles be used?

Source: SuP

Demand and properties of components drive significant changes of body design.

New components	Sensors (Radar, Lidar, camera, US) Antennae for communication	Front, A-pillar and roof space Fin antennae as known
Change in HMI	Controls become optional Information level changes	Degradation of controls probable Signaling only if demanded Status information needed Communication devices rise
Components vanish	No exterior mirrors	Cameras and displays instead
Multi purpose interior	More flexible interior	Moveable and rotating seats Controls retractable Multi-functional surfaces
Body style follows changing functions	Better utilization of road surface Modular approach chassis/container Outer shape and inner design changes	Bubble body design Dashboard cross bar may vanish B-pillar may vanish
C2X communication	Body surface needed for communication	Body surface becomes exterior display

Source: SuP

Indirect effects from ADAS

Utilizing driver assistance enables and drives changing use patterns.

Speed	• Top speed goes down • Less transient operation (long range)	• Seats more comfort oriented
Noise	• Noise becomes significantly disturbing if passengers are used not to drive	• Demand for any active and passive noise reduction from body and component design, insulation, materials processes
Comfort	• Chassis comfort will be regarded completely different. Body stiffness and smooth suspension become mandatory	• Active dampers/jaw stabilization • Rear wheel steering • Active cornering
Passive safety	• New ORS concepts suitable for multitude of passenger positions, airbags or protective net designs	• Different strategy for ORS fixing points possible
Active Safety	• Active chassis lift or lower in pre-crash-situations	• Ability to distort actively?

Megatrends

Electrification

ADAS

Summary and outlook

Summary

Although many factors influence the body design, not all of them are clear yet.

Electrification

- Change of powertrain design and weight increase due to battery pack require adaptations
- Assembly processes will change accordingly
- Use patterns adapt to changing conditions
- Consequently an EV will be a different vehicle with different properties.

ADAS

- ADAS effect on vehicle design comes in a more continuous way compared to electrification.
- Sensors enter vehicles in a slow optimization process.
- Use of highly assisted vehicles are learning patterns even for passengers.
- Consequently our picture of mobility will change significantly.

Body challenges

- Weight reduction becomes more significant.
- Body will change entirely – at first fast but adaptive through electrification, later substantially through breakthrough of autonomous driving.
- Solutions have to be either adaptive in functionality or adaptable through interchangeable components.

Thank You!

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