Key Challenges for Future Mobility and Transport

EUCAR, June 2016

Introduction

EUCAR's members, the European automotive manufacturers, strive for a competitive industry whose products meet the needs of society. European collaborative Research & Innovation (R&I) supports this strategic objective by enabling cooperation among stakeholders and providing co-funding of precompetitive activities to mitigate part of the risk inherent in automotive research.

EUCAR is the European Council for Automotive R&D of the major European passenger car and commercial vehicle manufacturers. EUCAR facilitates and coordinates pre-competitive research and development projects and its members participate in a wide range of collaborative European R&D programmes. The European automobile manufacturers are the largest private investors in R&D in Europe with over €40 billion investment per annum, or 4% of turnover.

In 2015, EUCAR decided to launch a major strategic review process to better integrate societal expectations and potential disruptive trends. The main objective was to identify Key Challenges for the automotive industry until 2030. The Strategic Pillars and Commercial Vehicle Platform (see figure 1) of EUCAR provided the strategy framework for the key challenge identification process.

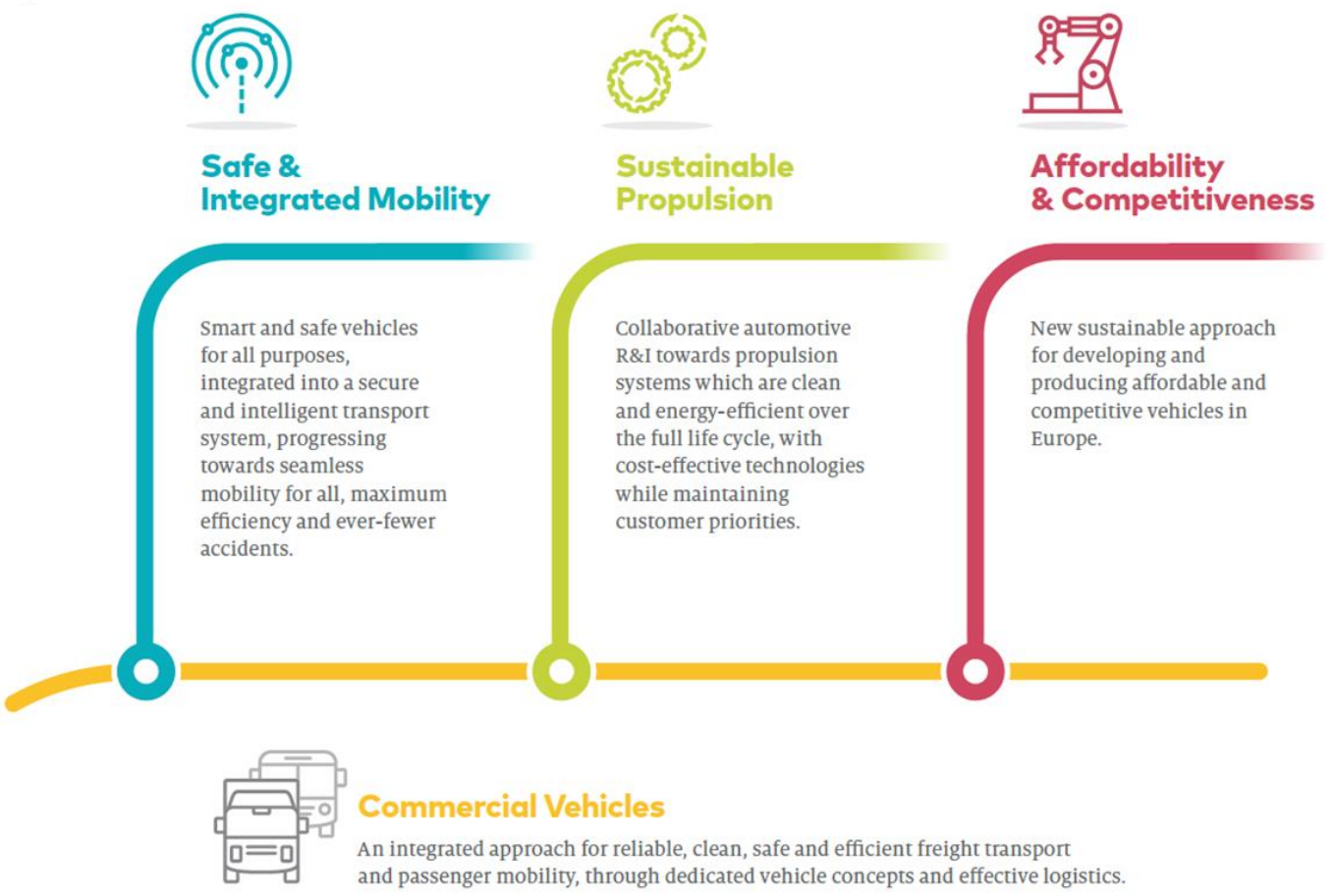

Figure 1: The three Strategic Pillars and the Strategic Commercial Vehicle Platform of EUCAR.

Key Challenges for Safe and Integrated Mobility

In the area of Safe & Integrated Mobility, co-funded research supports the development of technologies and services that meet customer and societal demands whilst fulfilling more and more challenging regulatory standards. The identified key challenges are:

Digitalisation – the next generation of safe, smart and connected vehicles

Digitalization and connectivity are certainly one of the dominating trends in the first quarter of the 21st century. It modifies the way we think about our future mobility and future mobility needs. Digitalization has altered various societal expectations on business and services. In the connected world customers are used to extensive customisation without accepting long manufacturing and delivery times. The young generation Y (i.e. born between 1980 and1999) and the millennials (i.e. born after 2000) highly value their connectivity and ability to be always connected.

Future mobility solutions and vehicles will not only provide the connectivity for their users but embrace the opportunity of ever growing computing power, high speed connectivity, deep learning algorithms for artificial intelligence, fast processing and decentralised data handling. Through the fast technological evolvement in IT and semiconductor industries a complete new range of applications for smart and safe mobility will be possible. Further, new market entrants, used to the short innovation cycles start evaluating the business opportunities and mobility use cases. This will go hand in hand with the need for new skills (e.g. IT/ICT and artificial intelligence/deep learning). The key-challenge is:

> How to maximise the impact of smart and safe mobility solutions, and stay ahead in the race for global competitiveness for digitalisation and connectivity of vehicles?

Safe and secure connected vehicles (including privacy protection)

Connected vehicles are progressively entering the market and the outlook for the next 10-20 years foresee a huge increase of market share. The technological advantage and the customer expectations for connectivity provide a growing key challenge to secure the connection and the internal vehicle communication against outside intrusion (i.e. hacking). The challenge is growing as time is on the hackers' side through the increasing computing power. Any solution should therefore consider the whole vehicle lifecycle. Further, the residual risk (remaining risk after consideration of all security measures) need to be properly addressed to guarantee safe operation.

> How to secure connected vehicles from manipulation and threats to guarantee safe operation and protection of goods?

Enabling SAE level 4 automated vehicles

In the second and third decade of the 21st century, one of the most exciting and inspiring trends for the automotive industry is the evolution towards highly automated driving. Recent research show promising results for further development. However, there are still many questions to be answered in the interplay between human perception and driving tasks and the automated vehicle functions. Specifically, between Level 3 and Level 4 automation some technical and operational challenges remain. The central question is:

> How to enable safe SAE level 4 automated driving at mass-production costs?

Certification and validation for automated driving (including the functions' testing)

Automated driving and automated vehicle functions pose a great challenge for future certification and validation. Many different driving situations and scenarios need to be tested and validated, and current available procedures do not provide an efficient and cost-effective solution. Virtual testing and certification with the ever-increasing calculation power might provide a suitable solution. However, the base data as well as the common understanding and procedures are lacking and therefore need to be addressed within this key challenge:

How to test, certificate and validate automated driving functions?

Future integrated mobility: vehicles, business models and solutions

New emerging business models for shared vehicles (e.g. car or ride sharing and car pooling) and new mobility concepts for future urban and interurban mobility will change the way we see future integrated mobility. *Mobility as a Service* (MaaS) is seen as a logical step towards closing the gap between public and private transportation. This new situation/trend might change the requirements and user expectations for future vehicles entirely. The personalisation and customisation for the subscribed mobility service however still pose a challenge. Future integrated mobility and it's societal impact strongly depends on the customer acceptance of provided services and the vehicle provision (e.g. data for efficient traffic management). The key challenge is:

How to meet customer expectations for personalisation and customisation of shared mobility services and vehicles?

Key Challenges for Sustainable Propulsion

In the area of Sustainable Propulsion, co-funded research supports the development of technologies and services that meet customer and societal demands whilst fulfilling more and more challenging regulatory standards. The identified EUCAR key challenges are:

Optimised powertrain technologies for future hybrid vehicles

Mobility of people and transportation of goods are fundamental needs of our modern society and the evolution of the road transport system will improve through advances in vehicle and powertrain technologies in accordance with the future fuels & energy scenario. The Internal Combustion Engine (ICE) has played a fundamental role over the last century and most likely will continue to do so even over the medium- to long-term (until 2030 and beyond).

Increasingly the optimisation of the powertrain goes hand-in-hand with all types of hybridisation applications as well as dedicated alternative-fuel engines. In particular, the ongoing electrification of the powertrain will continue to progress according to the different vehicle mission profiles, while the need to increase energy security and reduce the dependency on fossil- and oil-based fuels will promote wider exploitation of renewable energy sources.

As concerns the Commercial Vehicles market, it is expected that ICEs will remain predominant for years to come given the need for high energy density for the propulsion of larger vehicles.

How to optimise combustion processes and architectures to make ICEs even cleaner, more efficient and cost competitive?

Affordable Zero Emission Vehicles (BEVs/FCEVs)

Moving towards the widespread market penetration of zero emission vehicles is an ambitious societal challenge that could become a reality in the next decades. In the longer term perspective, the development stage of a European electricity and hydrogen infrastructures is seen as a key enabler for Battery Electric Vehicles and Fuel Cell Electric Vehicles to become more popular and appealing to customers.

Further steps have to be made to adapt the range of these vehicles to the customers' expectation and identify cost-effective solutions for the systems and components (e.g. the battery and its management system) in order make these vehicles affordable. New vehicle concepts better suited for future integrated mobility systems and urban-mobility needs, both for people and for goods transportation, must also be developed.

How to develop Zero Emission Vehicles that are affordable and are supported by an appropriate energy infrastructure?

Sustainable Fuels & Energy Provision

Energy is essential for transport: today, fossil fuels (oil and natural gas) still provide the major source. While global transport fuel demand is growing rapidly, the reduction of energy-related CO2 emissions is paramount in order to mitigate climate change effects and environmental impact.

Biofuels (liquid and gaseous fuels produced from biomass) as well as new pathways to produce synthetic fuels based on renewable energy sources will prove to be an essential element for the future energy needs of the transport sector. Technical impact assessments comparing all of the different feasible pathways are essential to evaluate all the stages of the life of products from cradle to grave (i.e. from raw material extraction through materials processing, manufacture, distribution, use, repair, maintenance, and disposal or recycling).

How to optimise road transport with sustainable fuels and energy, reducing GHG emissions from well-to-wheel and noxious emissions from tank-to-wheel?

Key Challenges for Affordability & Competitiveness

In the area of Affordability & Competitiveness, co-funded research supports the development of technologies which support a competitive automotive industry, producing affordable passenger and commercial vehicles meeting customer and societal demands, whilst fulfilling more and more challenging regulatory standards. In this Strategic Pillar EUCAR recognises three key challenges:

Digital breakthrough of automotive development and manufacturing

In the second and third decade of the 21st century, the automotive industry is expecting more challenges and changes to meet than in the past century. A wide range of differing requirements starting with societal goals for safe, clean and efficient mobility; user customisation and personalisation; increasing number of differing vehicle types for different mobility solutions and concepts; circular economy; technical regulation; etc. call for more adaptability in the manufacturing processes. Recent technological developments in production such as additive manufacturing (3D printing) or smart industries may provide the solutions to address this key challenge. However, affordability and the benefits of mass-production regarding cost-effectiveness as well as the roles in human-machine collaboration have to be considered. A digital breakthrough of the complete manufacturing processes itself is needed. The central question remains:

How to transform manufacturing processes to fulfil customisation needs, deliver customer experience, vehicle variety and consider future requirements at industrialized mass-production costs?

Affordable lightweight and efficient vehicles

Lightweight design and lightweight materials have been an important research topic across various sectors (e.g. aviation, automotive, shipping industries). Future mobility and vehicle concepts rely heavily on the technological advancements in lightweight construction. The main challenge for automotive applications seems to be cost-effectiveness. All lightweight materials (e.g. composites, aluminium, magnesium and high-strength steel) offer weight reduction but come at higher costs.

In particular, carbon fibres composites have higher potential in terms of weight reduction. However, the successful introduction in mass production vehicles rely on breakthrough technologies for production of raw materials and processing. The expectation for the medium term is that lightweight and weight reduction will become even more important for automotive manufacturers with stricter CO2 regulations. In addition, battery electric vehicles will benefit from weight reduction with increased range. However, considering current customer expectations and willingness-to-pay will pose a certain challenge for the wide-scale implementation of lightweight in automotive applications. An integrated approach combining materials, design, joining processes, product and manufacturing engineering and manufacturing as well as end-of-life strategies are needed to address this key challenge:

How to reduce the average total vehicle weight by ~25%
without conceding safety or customer expectations at affordable costs?

Competitive automotive innovation cycles

Digitalisation and connectivity are certainly one of the dominating trends in the first quarter of the 21st century. It modifies the way we think about our future mobility and future mobility needs. However, with this trend comes a major challenge for the automotive industry. The technology cycles of information technology and semiconductor industries becomes more and more relevant for the automotive business. Moore's law (i.e. an observation that chip performance will double every 18 month at half the cost) leads to very short life-cycles in the telecom and computer business (<1 year) which do not match the innovation cycles in the automotive industries (>5 years). Therefore, we have to accelerate our innovation cycles to be able to implement state-of-the-art technologies in future vehicles and meet required time to market from a consumer perspective. Technological advancement in virtual engineering will certainly enable us to go a step further, bringing design, engineering and manufacturing closer together. Virtual certification if implemented will aid in reducing costs and development lead-time. Fast processing and decentralised data handling and management will increase the innovation capability of the industry. Big data and deep learning algorithms will improve the development and engineering processes. However, the central question remains:

How to substantially reduce the vehicle development lead-time and meet required time to market with consistent or improved quality and similar or reduced investments?

Key Challenges for Commercial Vehicles

In the Strategic Platform Commercial Vehicles, co-funded research supports the development of truck and bus specific technologies, which are not covered in the three main EUCAR Strategic Pillars: Sustainable

Propulsion, Safe & Integrated Mobility and Affordability & Competitiveness. The Strategic Platform Commercial Vehicles EUCAR recognises the following key challenges:

Urban commercial vehicle 2030

It is expected that more and more people are living in urban agglomaration in the future. This has a major effect on future transport needs, especially in urban environments. To maintain a good air quality in cities where more and more transport movements are required, an increase of energy efficieny and reduction of emissions is necessary and needs further support and research efforts. These efforts will pave the way towards competitive zero-emission urban commercial vehicles.

Despite the fact that urban areas are more densely populated, road-safety shall not be compromised and even increase further. In urban areas, commercial vehicle drivers benefit from a good knowledge and oversight of their surrounding environment. Therefore, additional measures and sensors need to be found to increase safety. In addition, increasing levels of automation will contribute to having less accidents in cities on the longer term.

Higher levels of automation will support decongestion and increase availability of roads. To increase the optimization potential the differentiation between urban commercial vehicles and long-distance transport is neccesary. A connected and integrated European logistic network can provide a framework for optimal urban commercial vehicle operation. It will optimise the whole logistics network.

How to fulfil the requirements of the future urban environment on emissions, energy consumption, road-safety and traffic flow while increasing the amount of required transport movements?

Long-haul commercial vehicle 2030

The growing economy is closely linked with increasing need for transportation. It is clear that road transport is vital to satisfy this demand and provide means for transportation specifically where other modes cannot grow so fast. Despite this increasing demand, emissions and energy use from transportation shall decrease significantly. Therefore, further research for more sustainable long distance propulsion is needed, as well as vehicles with more flexibility with respect to weight, dimensions and shape to increase the efficiency of a long-haul commercial vehicles.

Higher levels of automation in long-haul transport will support the driver to fulfil the tasks with higher efficiency and improved safety. Fully autonomous or even driver-less long-haul commercial vehicles could provide solutions for future long distance transport, driving time regulation and safety. Still, societal aspects need to be considered. Higher levels of automation also contributes to optimize road use and decrease congestion.

Connected long-haul commercial vehicles are better integrated in the European logistic networks, leading to higher utilization ratios. Because of the long distances and the high amount of cargo moved this will have a significant impact on emissions, energy consumption and road use for the entire European commercial vehicle fleet.

How to fulfil the requirements on emissions, energy, road-safety and traffic flow while increasing the amount of required long-haul transport movements?

Integrated logistic system

The integrated European logistic system, connecting future urban and long-haul commercial vehicles with each other and other data sources, is key for the optimized transport of people and goods. Connected to this logistic system, the vehicles are operated in a more effective way. The utilization rate of commercial

vehicles can be increased by having more people or goods moved per vehicle and also by reducing the amount of empty kilometres driven. Such, a largely integrated approach requires the possibility to physically share and distribute cargo among vehicle platforms and therefore unified loading units are essential. Further, efficient processes to improve handling of goods between modes and within one mode at the right location is key for the successful integrated logistic system.

How to provide commercial vehicles fulfilling the needs from an integrated logistic system and benefit from the optimisation potential?