EARPA Position Paper

Integrated and Connected Product Development and Production Process for a sustainable Mobility

Enabling Technologies for sustainable and affordable Road Transport

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ABOUT EARPA

Founded in 2002, EARPA is the association of automotive R&D organisations. It brings together the most prominent independent R&I providers in the automotive sector throughout Europe. At present its membership numbers 49, ranging from large and small enterprises to national institutes and universities.

INTRODUCTION

In all aspects of our daily life, we are going to be confronted with challenges related to the climate change requiring radical transformations by the whole society. The negative effects of the climate change have meanwhile been recognised by politic and industry resulting e.g. in the European Green Deal targeting for climate neutrality in Europe by 2050. Besides, Europe is facing demographic changes and socio-economic converting processes through relevant new technologies like digitisation. All these factors are affecting how we move people and goods resulting in a transformation of our transport system as a whole towards a climate-neutral but affordable and inclusive mobility for all. Such a transformation is only feasible on system level involving all stakeholders like industry, operators, cities and politics. Solutions must be found by integrating all different transport modes without predefining any technological approach. Besides technological solutions new business models like carpooling or carsharing needs to be considered. The required transformation of our transport system should be understood as a chance for economic growth and as one element to strengthen the competitiveness of Europe.

With respect to vehicle technologies, a defossilisation of the transport system, connected and automated driving (CAD), digitisation along the life cycle as well as a circular economy are becoming crucial elements in future product development having a direct impact on vehicle concepts, design and production. It is reasonable to assume that we will see in future a much higher diversity of drive trains. Besides battery-electric and fuel cell vehicles, advanced internal combustion engines will still play a role but on basis of alternative, climate-neutral fuels (e.g. synthetic, e-fuels, ...). Coming vehicle concepts must be tailored to this diversity and designed with a high modularity not only for drive train reason. The connected and integrated driving will pose new challenges particularly for the vehicle interior, which will be used differently in a transformed mobility. Functionality, comfort and aesthetics will gain importance requiring new design concepts for the interior as well. All the solutions for current and upcoming vehicle concepts have to be sought taking into account circular

economy principles, e.g. implementing secondary or bio-based materials, without penalties regarding weight, safety and costs. Furthermore, digitisation along the life cycle allows feeding back information into the product development resulting in more efficient and shorter processes including production. Finally, digitisation is an enabler to frontload the assessment of the ecological footprint of each technology. It should be common understanding that the right vehicle technology must be selected by its ecological footprint in the future, balanced with the life cycle costs (LCC) of the respective technology.

KEY RESEARCH NEEDS

The three pillars materials, design and production of the Foresight Group "Integrated and Connected Product Development and Production Processes" (FG ICPD) are considered as essential enabling technologies for a sustainable and affordable road transport. Overall, five focused research areas have been identified covering not only material, design and production but also vehicle concepts and life cycle. They represent cross-cutting research areas relevant for all types of vehicles or devises operated in current and future mobility scenarios. Besides, the identified research areas are not only addressing needs of road transport but of all transport modes and as such becoming pertinent for cross-modal issues and for exploiting synergies across transport modes. Following five research areas and topics are considered most important:

1) Advanced Materials

European R&I in products development transport area faces the unprecedented multiple-targets challenge of digitalisation, safety, automation, electrification by employing circular economy system. To address these, cutting-edge solutions based on advanced materials concepts must be developed. The demanding need to integrate multiple functionalities within life cycle sustainable material systems requires innovative design and development technologies, enabling advanced lightweight multi-materials and joining solutions and guaranteeing durability, comfort and crashworthiness by means of reliable, feasible and affordable solutions. The following research needs are identified:

- Implementation of materials based on a circular economy principles (use of secondary materials),
- Functional materials for exterior & interiors (increased performance for future mobility needs),
  - new functionalities like sensing, haptic, optic, self-cleaning, self-repair, …
  - high absorption for UV, IR, noise, pollutants, ….
  - novel electrical properties.
- Affordable bio-based materials meeting automotive requirements,
- Understanding and managing material and structural properties over life-time,
- Life cycle data base for materials and products,
- Predictive modelling and simulation methodologies for advanced materials,
- Repair concepts for multi-materials and composites.

2) Materials for Energy Storage and Conversion

The sustainable defossilisation of the automotive sector entails challenging development in battery-electric, fuel cell and advanced internal combustion engines with alternative, climate-neutral fuels

as well as their hybridization. Each technology and associated material present its own advantages to different vehicle purpose. However, essential key parameters of energy storage and conversation such as safety, costs, energy and power density as well as efficiency and durability have to be assessed against environmental improvements and availability of critical raw materials. The following research needs are identified:

- Materials for the electrified drive trains (battery, fuel cell, electronics, e-motor),
- Materials for advanced ICE using synthetic or e-fuels,
- Substitution of rare /scarce materials (magnets, alloys, energy storage, ….).

3) Production and End-of-Life Processes

The increasing importance of demand-driven (e.g. digitalization of the mobility, customisation) manufacturing capabilities implies the development of facilities able to produce in a robust and agile way. Challenges are, among others, to enable "first time right manufacturing" when producing customised or highly modular products or when introducing improvements to current products while ensuring zero defect and scalability as much as possible and the seamless integration of smart systems and collaborative robots in the production processes. Besides, sustainability as required to preserve our ecosystem has become a critical issue for the automotive industry demanding for minimization, replacement, recovery and reuse of materials. Following research needs are identified:

- Advanced manufacturing technologies for multi-material parts and smart materials,
- New recycling strategies and processes incl. re-manufacturing and disassembly concepts
- Qualifying additive manufacturing for safety-critical automotive parts,
- Inline control concepts improving quality parts (zero deficient parts),
- Flexible manufacturing and assembly lines by utilizing advanced human-machine interactions (robot assisted manufacturing, integration of mobile robots in assembly).

4) Tools for Accelerated Product Development and Design

The design and manufacturing processes as well as business models in the automotive sector are currently facing significant changes triggered by the required transformation of the transport sector. In order to stay competitive and to implement climate-neutral technologies, the automotive industry product development cycles have to be shortened significantly. Furthermore, needs to meet consumer demands and to deal with new supply chains demand for shorter go-to-market timelines. Therefore, advanced tools and methodologies allowing for multi-scale and multi-domain simulations and enabling fastest design, testing and flexible production of vehicles are needed. The following research needs are identified:

- Digitisation as enabler of CO_2-neutral and sustainable lightweight solutions,
  - Feeding back information of the use phase into the product development,
  - Front loading of impact assessment incl. LCA/LCC.
- Digital twin enabled product development,
- Virtual validation, verification and homologation,
- Seamless product life cycle and supply chain management,
- Big Data and Machine Learning for material & product development and impact assessment.

5) Advanced Vehicle Concepts

The need for advanced vehicle concepts is mainly driven by economic, environmental and societal challenges. A major development target will be to establish a fit for purpose design in future vehicle concepts while taking into account modularity and scalability with a common part strategy to reduce costs. Typical representatives of a fit for purpose design can be urban light vehicles or commercial vehicles for the last mile delivery. Furthermore, legal requirements to reduce emissions significantly will foster the implementation of new drive train technologies. Especially in the near future, fuel cell and battery electric vehicles will take up a decisive role. The package design of these vehicles allow rethinking the structural concept. In addition, future trends like autonomous driving and connectivity influence the design of interior concepts, which have to ensure a well-being atmosphere for occupants on the one hand and meet safety standards on the other. More than ever, advanced vehicle concepts need to be safe and sustainable while creating a high level of driving pleasure. Applying new design tools and integrating new high performance material and process technologies into sustainable vehicle concepts will be a key challenge. In this regard, sustainability must be evaluated over the entire value chain and life cycle of the vehicle as part of the complete mobility and social system. The following research needs are identified:

- Fit-to-purpose and diverse markets,
- Integration into the mobility system,
- Life cycle viable vehicle concepts,
- Adapted to new business models,
- Adapted to CAD,
- Design to X (emission-free, circular economy, recyclability, re-use, comfort, …),
- Advanced interior concepts.

EXPECTED IMPACT

It is expected that the defined research areas and topics will make an impact towards a carbon-neutral road transports and mobility in general by 2030. Although a significant positive impact will be made along the full life cycle, the FG ICPD is focusing on the product development along the full value chain and on the vehicle's End-of-Life. Most significant will be the provision of tools and methods enabling a technology selection based on the best compromise between ecological footprint and life cycle costs. With this context, the following impacts are targeted for by 2030:

- Reducing lead-time to market of vehicles by 25% as compared to 2020,
- Reduction of development costs by 20% as compared to 2020,
- Reducing Greenhouse Warming Potential (GWP) in the production phase by 50% (incl. impact of raw materials) as compared to 2020,
- 50% of materials used are secondary or bio-based,
- The use of critical materials (e.g. rare earths) is reduced by 30% through substitution and/or recycling.

CONCLUSION

Increasing the efficiency and minimising the ecological footprint in product development through advancements in material and production technologies as well as in design methods and tools are important measures towards a carbon-neutral road transport and for its implementation. EARPA members provide highly recognised expertise in above research areas to all stakeholders, thus jointly addressing the societal challenges of this time. These EARPA research areas are aligned with the European Union priorities, and their consistent integration in the Horizon Europe programme across all pillars, societal clusters and partnerships would be highly appreciated. To this end, EARPA members are happy to interact with other stakeholders to develop these topics further.

For further information, please contact our contact persons of the Foresight Group "Integrated and Connected Product Development and Production Processes"

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