New approach for a comprehensive method for urban vehicle concepts with electric powertrain and their necessary vehicle structures

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TRA TRANSPORT RESEARCH ARENA

DLR Next Generation Car (NGC)

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In the research project Next Generation Car (NGC) at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt, DLR), in the program topic of terrestrial vehicles, three different vehicle concepts are being developed according to the technical requirements and capabilities of 2030: Urban Modular Vehicle (UMV), Safe Light Regional Vehicle (SLRV) and Interurban Vehicle (IUV) (see Fig. 1). The aim of NGC is to consolidate the technologies, methods and tools for the various vehicle concepts researched at DLR in the field of transport, to generate synergies and to demonstrate research results. The NGC project is divided into the following areas: Vehicle Concepts, Vehicle Structure, Energy Management, Drive Train, Chassis and Vehicle Intelligence.

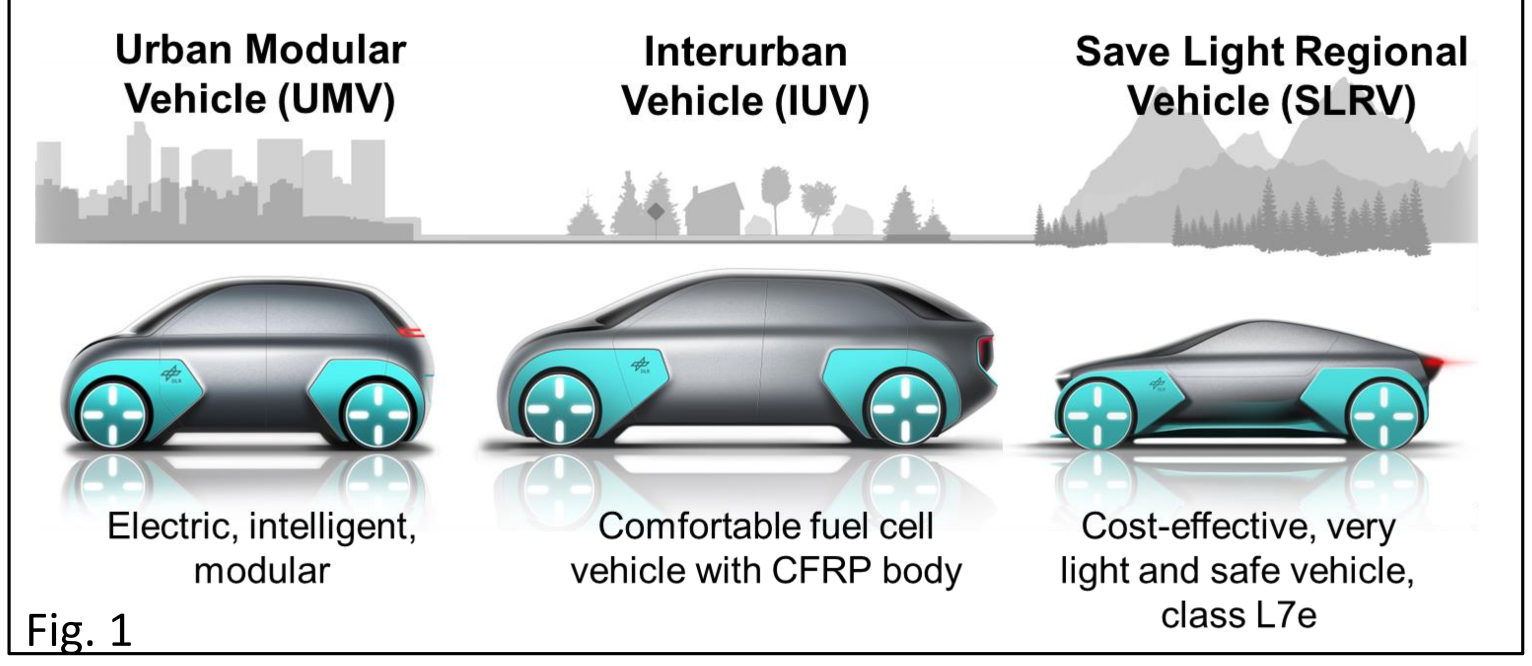

Fig. 1

Challenges and objectives

- Development of a vehicle concept and body structures with specific requirements.
- Representation of a modular body in white for electrified vehicles (form people to cargo vehicle, from assisted to fully automated vehicle).
- Electric, safe, lightweight, modular

Methodical approach

- Development of a new approach for a holistic method for urban vehicle concepts with electric powertrain and their necessary vehicle structures (Fig. 2).

Phase 1 - Development of the vehicle concept for an electric vehicles

- The initial definition of certain concept-determining parameters, based on research as well as on input from mobility studies and boundary conditions within the framework of the NGC project (Fig. 3).
- Consideration in a first rough specification sheet.
- Geometric and simulative overall vehicle investigation: In the simulative part the volume- and mass-intensive components are dimensioned with the aid of the driving resistance equation. In the geometric part, the dimensions of the passenger compartment and the front/rear of the vehicle are estimated (Fig. 4).
- Parametric CAD model: Geometric model constructed with which it is possible to control different areas of the construction space parametrically (Fig. 2).
- Detailed package study of various package configurations (Fig. 2).

Phase 2 - Development of the vehicle body structure for electric vehicles

- Selection of a basic shape variant and a drive package from phase 1 (Fig. 5).
- Investigation of vehicle space model using the topology optimization for global load pathfinding and the comparison with prior art body structures (Fig. 5).
- Load path interpretation to two different body structures (Fig. 5): The topology results are interpreted with load path derivation rules, for which the following rules are defined: unbranched structures to profiles; flat area with medium-sized element densities to shell/sandwich; branched structures to node elements.
- Detailing of body in white (Material selection, selection of the wall thicknesses, etc.): Example of design philosophy of BIW variant 2: Aluminum intensive frame structure with profiles and nodes with functionally integrated sandwich surfaces and flat components in FRP (Fig. 6).
- Virtual static and crash analyzes: With the calculation of the first eigenfrequency trimmed body of 45.6 Hz for the BIW variant 2 there is a first good value compared to the prior art of bodies in the A/B segment (average first eigenfrequency trimmed body 34,4 Hz) (Fig. 5/6).
- Prototypical validation of floor crash concept: The structure of the floor crash module of the UMV is shown in Fig. 7. Two sandwich crash elements are located in the crash area between the longitudinal beam and the sills. The crash elements are manufactured from an aluminium trapezoidal sheet and two aluminium covering layers, attached with structural adhesive and screws. The crash concept provides for a buckling in the door sill profile and then buckling of the two trapezoidal sandwich absorbers. The deformation zone ends just before the zero intrusion zone on the longitudinal beam before the battery box. The comparison between simulation and experiment of the crash module shows good correspondence with a intrusion of approximately 166 mm and energy absorption of 26 kJ (Fig. 7).
- Overall assessment of the vehicle concept and body development.

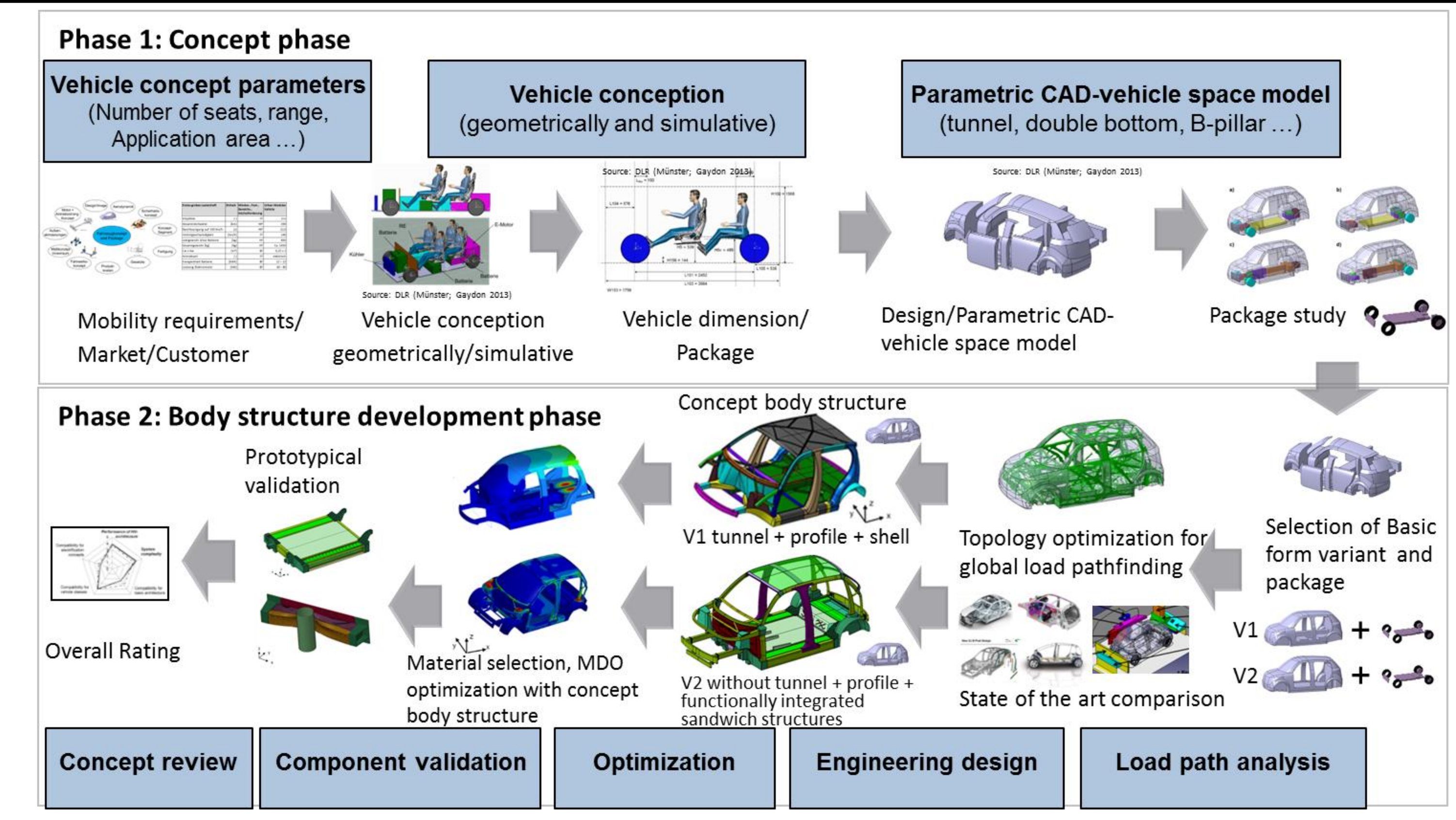

Fig. 2

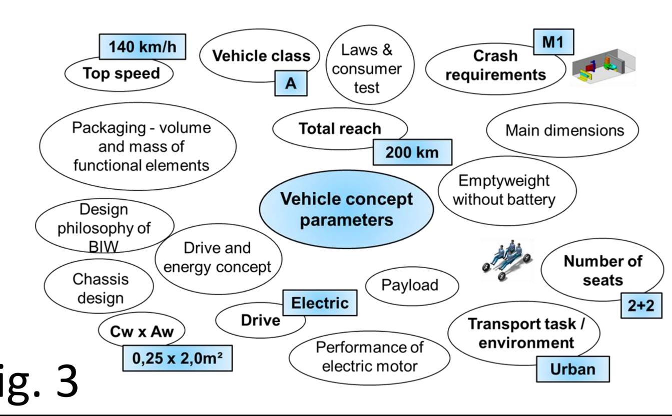

Fig. 3

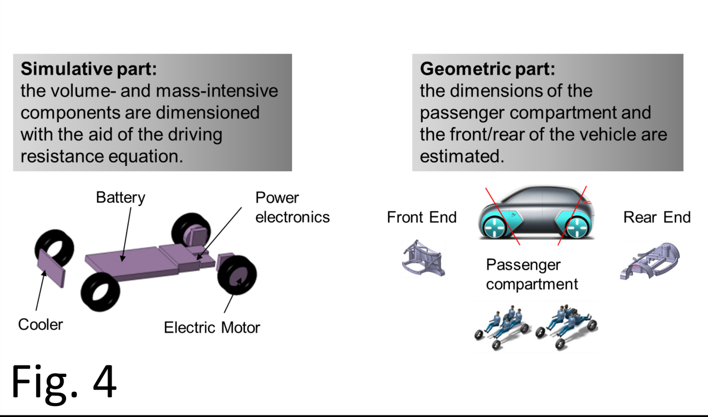

Fig. 4

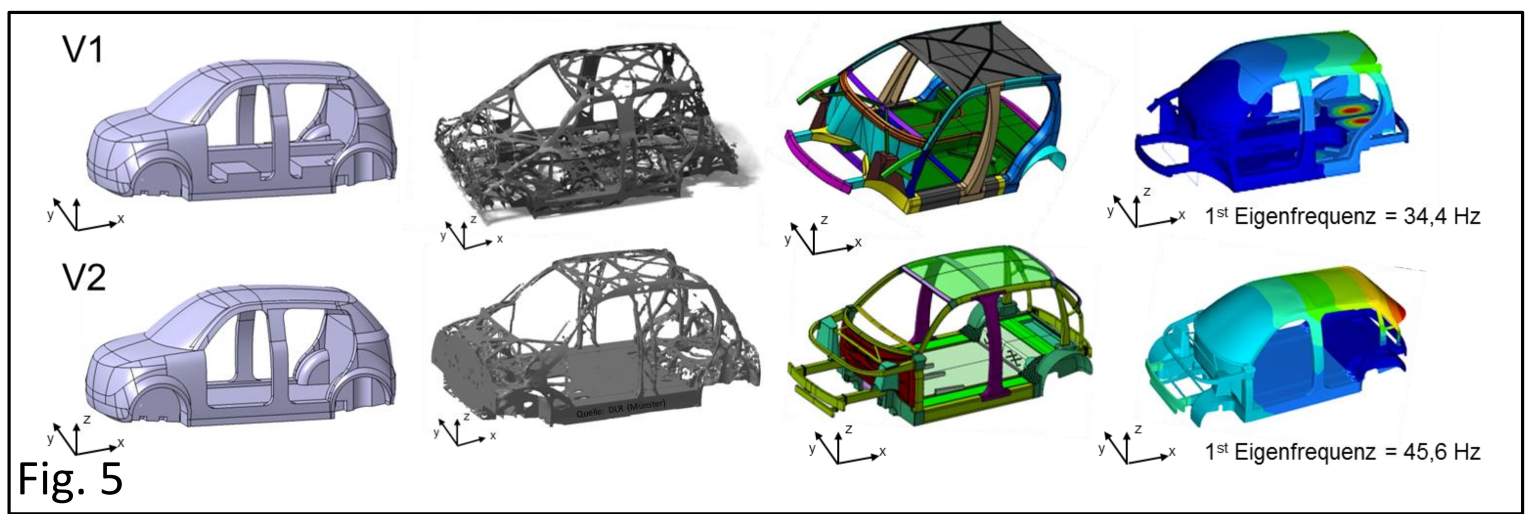

Fig. 5

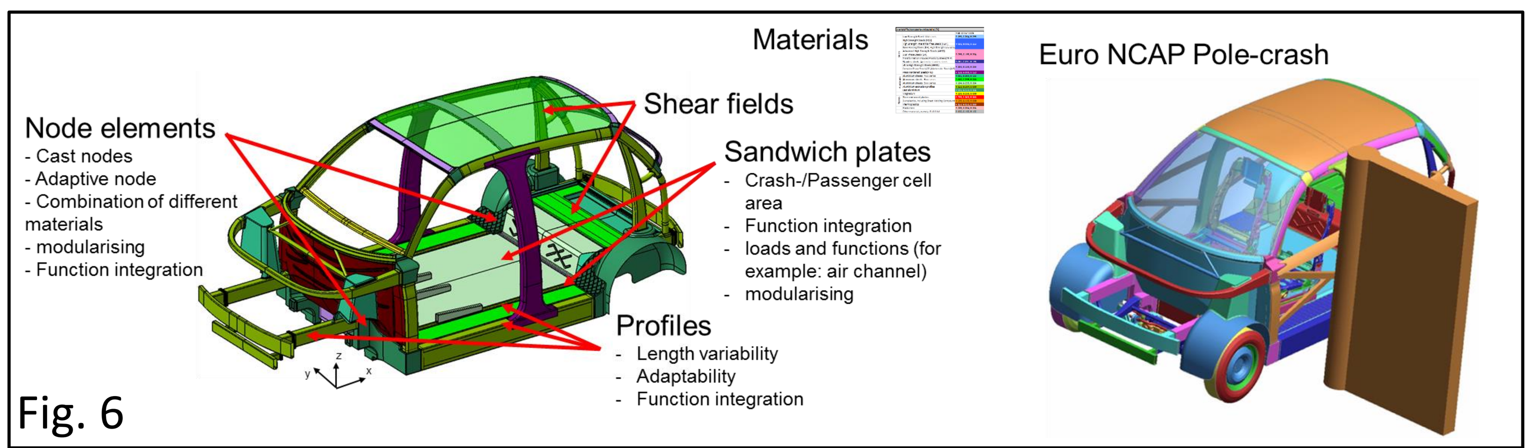

Fig. 6

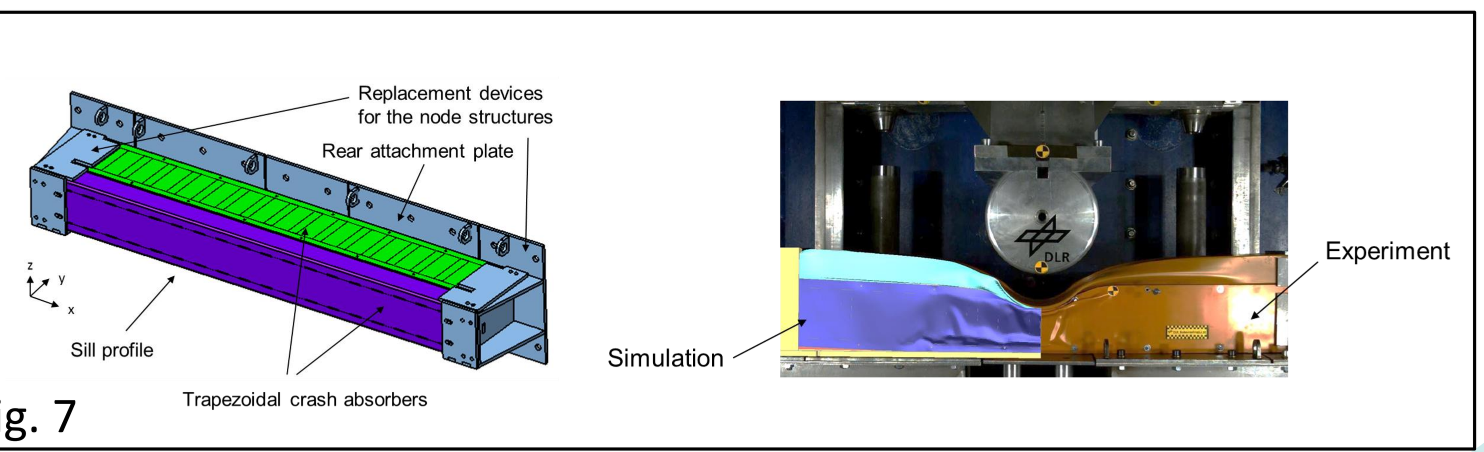

Fig. 7

Outlook and summary

- Detailing the entire body structure and virtual simulation/optimization.
- Prototypical validation other body in white components.
- Detailing of vehicle concept and vehicle body structure further derivatives (Fig. 8).
- Prototypical construction of complete vehicle structure.

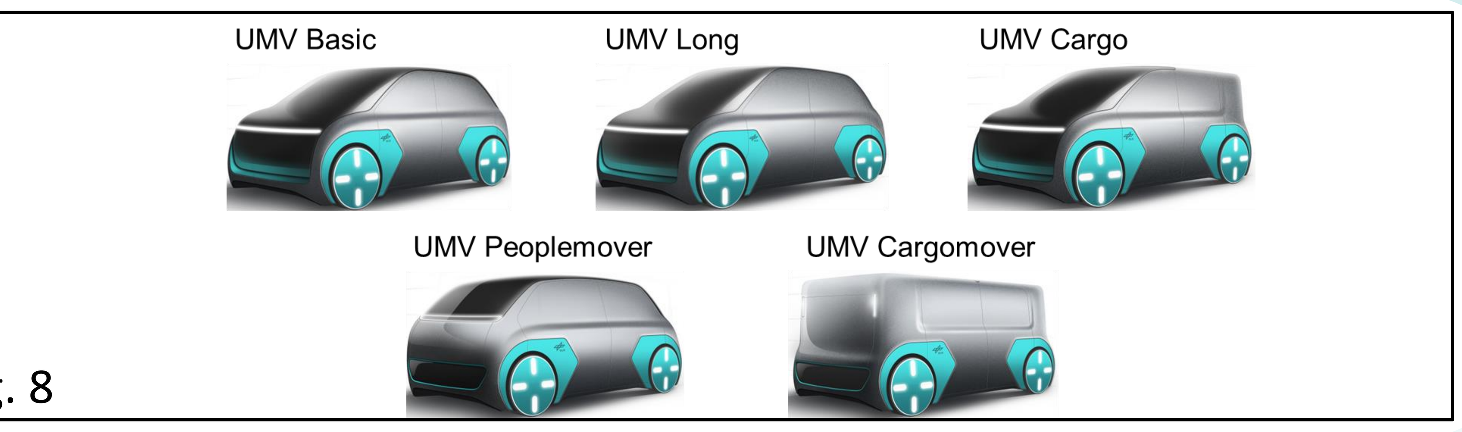

Fig. 8

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