WELCOME TO OSCCAR NEWSLETTER!

The Horizon 2020 EU funded project "OSCCAR – Future Occupant Safety for Crashes in Cars" focuses on future occupant protection where highly automated vehicles will be equipped with new and more comfortable sitting positions. These novel seat positions and sitting postures implicate new challenges while driving automatically especially for the safety of the occupants. OSCCAR aims at developing a novel simulation-based approach to safeguard occupants in traffic accidents under project coordination of Virtual Vehicle Research GmbH. It unites 21 international partners from industry and research working together to provide the necessary virtual simulation tools for the development and assessment of advanced automated vehicle systems.

Currently, nearly 2 years of OSCCAR have passed, the first official EU review was successfully completed and OSCCAR is well on track to reach its original research and innovation goals.

In addition to several finalized deliverables and publications, comprehensively documenting the work done in OSCCAR so far, this newsletter presents selected highlights and achievements from the five technical work packages from OSCCAR project.

NEWSLETTER CONTENT

HIGHLIGHTS AND ACHIEVEMENTS FROM THE FIRST 18 MONTHS OF OSCCAR PROJECT

DETERMINATION OF FUTURE ACCIDENT SCENARIOS

lead by MERCEDES-BENZ AG

The entire project OSCCAR will deliver an integrated approach to enhance the personal safety for all occupants in automated vehicles. OSCCAR-WP1 addresses the key question: **What will be the impact of automated vehicles onto road safety and, in particular, which future accident scenarios has an automated vehicle to face?**

In order to estimate future relevant accidents at the time when automated vehicles are introduced in Europe, it is important to predict the impact of current and future trends in automotive technologies. Accident characteristics may change due to effects of Advance Driver Assistance System (ADAS), Car-to-X (C2X) communication and social trends. In WP1, we conducted an extensive study combining a simulation-based analysis with accident statistics in order to extract and extrapolate future remaining and relevant accident scenarios. For this study, WP1 focused on self-driving vehicles in highway situations and urban self-driving vehicles in crossing scenarios.

The challenges of WP1 span a wide range from, e.g., market estimations (How fast will automated vehicles be introduced in Europe?) over accident statistics (Will an accident of kind xy be avoided by an automated vehicle in the year 2030?) to traffic simulations (By how much will the traffic increase in the next decades?).

HIGHLIGHTS & ACHIEVEMENTS FROM THE FIRST PROJECT PERIOD

In the first project period, WP1 has contributed to OSCCAR with an extensive report on future accident scenarios (**Deliverable D1.1)**, publicly available on OSCCAR Website). To provide a fast and solid foundation for OSCCAR, the focus was set on a brief analysis of the general (or inherent) avoidance potential of automated vehicles in combination with re-simulations of current accidents where one vehicle was virtually enhanced with automated driving functions. As a first result, about 290 000 accidents with casualties could be avoided assuming full penetration of automated vehicles in the EU vehicle fleet by simply “obeying traffic rules”.

In addition, WP1 provided future crash configurations, especially for urban intersections. After a reduction of the various crash configurations by clustering, WP1 calculated crash pulses of the most important crash configurations using not only the academic but also the combined knowledge of leading car companies within OSCCAR.

Altogether, WP1 results of the first project period set a strong foundation and will further contribute to the overall OSCCAR success

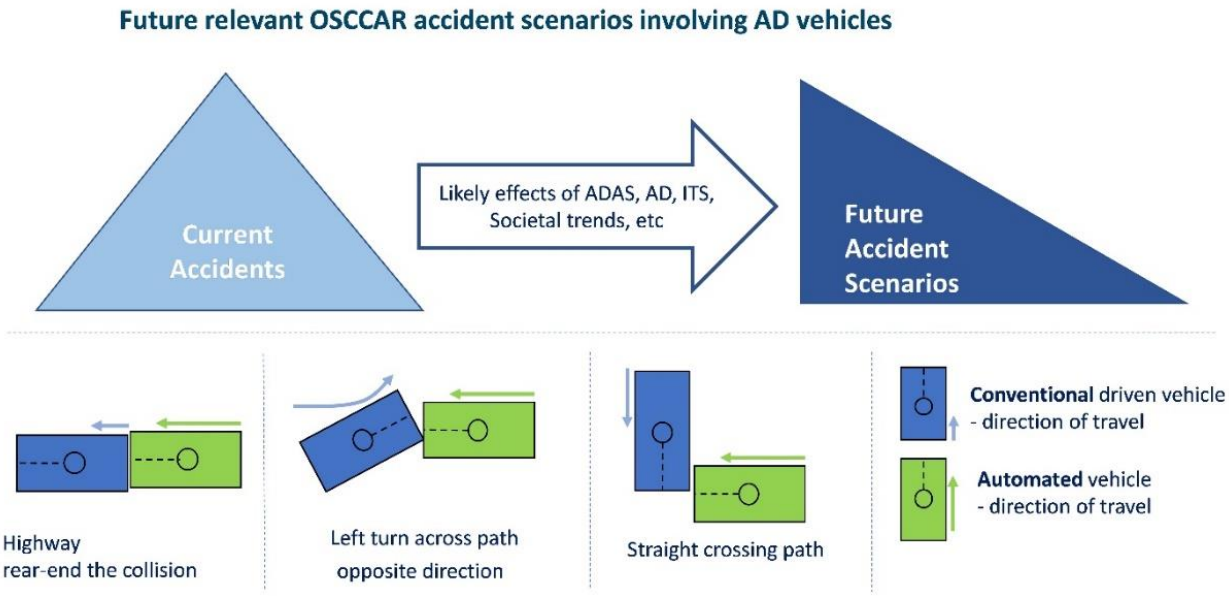


Figure 1 *Future relevant OSCCAR accident scenarios involving AD vehicles*

BRIEF OUTLOOK INTO THE NEXT PROJECT PERIOD

In the next project period, WP1 will focus on a demonstrator, i.e., a traffic simulation including automated vehicles based on the open-source framework openPASS and estimate the development of future accident statistics on the European level for the next decades.

DEVELOPMENT OF ADVANCED OCCUPANT PROTECTION PRINCIPLES

lead by ika/ RWTH & fka GmbH

WP2 deals with the conception and investigation of advanced occupant protection principles for high and fully automated vehicles. Since future interiors will offer more degrees of freedom for passengers, e.g. rotated or reclined seating positions, the restraint systems like belts or airbags must be adapted towards these new boundary conditions. Furthermore, a repositioning of the occupant into a safe seating configuration prior to a crash forms an integral part of a corresponding holistic safety concept.

Therefore, the main objective of WP2 is to **define and further elaborate several advanced occupant protection principles addressing different future seating configurations and vehicle automation levels** respectively. Different hardware test series are performed in order to gain data for the validation of the respective simulation models and to demonstrate the functionality of selected protection principles.

HIGHLIGHTS AND ACHIEVEMENTS FROM THE FIRST PROJECT PERIOD

In a first step a methodology has been developed in order to structure and define combinations of aspects relevant for occupant protection evaluation in future passenger cars. A so-called Test Case thereby contains specifications regarding seating configurations, sitting postures, individual human variations (for

example age and size) as well as future crash configurations (WP1). Two user studies have been performed on preferred seat rotation and sitting postures in future cars in order to provide input with regard to the developed methodology.

For the virtual investigation of advanced passenger protection principles respective simulation models have been generated. These generic models represent possible future interior concepts. The main step for identifying and selecting the advanced passenger protection principles (PP) took place in an ideation workshop with involvement of almost all OSCCAR partners. Finally, five advanced protection principles have been selected for further investigation.

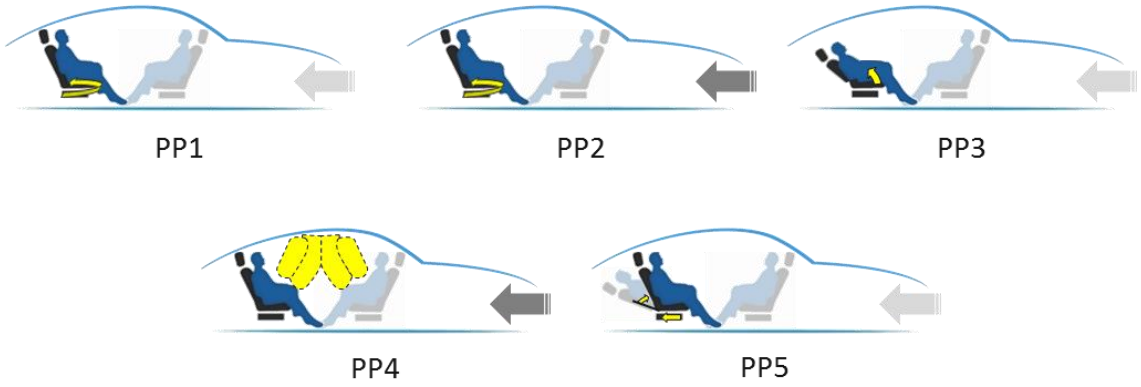


Figure 2 *Selected advanced passenger protection principles (PP)*

PP1 addresses an occupant who is sitting in a slightly rotated position (pointing away from the driving direction). If a crash is unavoidable, the seat will be actively rotated in crash direction. PP2 is similar but here the seat rotation is caused due to the inertia of seat and occupant by an active release of the seat, i.e. no actuator is needed. This is achieved by the removal of special bolts in the seat structure. The focus of PP3 is on a reclined seating position and the challenges for the restraint system and the testing devices associated with such a configuration. PP4 is based on a living room interior configuration with upright seating positions, i.e. the occupants are sitting forward and rearward, facing each other. In case of a crash a so-called mushroom airbag is inflated from the vehicle roof, filling up the space between the occupants. PP5 comprises an active seat for different reclined seating configurations. Prior to the crash the backrest is actively uprised to bring the occupant from a reclined into a “normal” upright sitting posture. At the same time, the seat base allows a longitudinal displacement which offers additional space for deceleration and energy absorption.

BRIEF OUTLOOK INTO THE NEXT PROJECT PERIOD

- Conduct of main studies for the different protection principles
- Further test series for demonstration of selected protection principles and validation of simulation models

HUMAN BODY MODELS FOR ASSESSMENT OF NEW SAFETY SYSTEMS IN FUTURE VEHICLES

lead by CHALMERS TEKNISKA HOEGSKOLA AB

State-of-art mathematical models of the human, here referred to as Human Body Models (HBMs), predicts fairly well humanlike kinematics but to a lesser extent tissue strains in typical crashes and for typical occupant positions. Some of the models have the capacity to predict humanlike response in pre-crash braking events. These HBMs are typically representative of an average male.

Future vehicles are likely to be highly automated and as such enabling other driver positions than in traditional vehicles. One example of such a position is a driver being more reclined. While this allows for superior comfort, this position calls for more advanced restraints which then require more advanced HBMs for the assessment and development of these restraints.

The overall aim with Work package 3 is to provide updated and validated HBMs, representative of the entire population at risk, that can be used in the assessment and development of advanced restraints for future autonomous vehicles.

WP 3 provides improved material models for HBMs, knowledge about the human shape in seated positions, methodologies for scaling HBMs, and data and models that enable superior and standardized validation of the updated HBMs. A special task is devoted to the enhancement of models of the human muscle control system. The new knowledge will be used to improve existing HBMs with the target to predict humanlike pre-crash and in-crash events for occupants in novel seating positions. Finally, new and standardized injury criteria for these HBMs will be made available.

One of the main challenges is to source biomechanical data that allow the development of advanced HBMs.

HIGHLIGHTS AND ACHIEVEMENTS FROM THE FIRST PROJECT PERIOD

- Skin, muscle and fat tissue models have been developed and are being included and evaluated in several different HBMs.
- Abdomen adipose tissue geometries have been characterized for a number of individuals.
- Morphing and scaling tools have been adopted and HBMs representative of different occupant characteristics have been generated.
- A new advanced neck FE-model for HBMs have been developed and validated.
- A HBMs representing small Asian females have been developed.
- A muscle model with active muscle force controlled from the internal dimensions of the muscle element has been developed and evaluated.
- Various muscle control systems have been explored and implemented in HBMs. Evaluation is ongoing.
- Injury criteria and risk functions for use with advanced HBMs have been reviewed. For some of these criteria, e.g. rib fracture based on strain in the ribs, special subtasks have been started with the target to develop harmonized criteria.

BRIEF OUTLOOK INTO THE NEXT PROJECT PERIOD

Next period will mainly focus on finalizing ongoing work and reporting. Activities in WP 2 identified a need for an improved model of the pelvis and lumbar spine. The latter will be developed in the next period. Enhanced pelvis models are being developed within the VIRTUAL project; however improved modelling of the muscles of the gluteal region will be part of the OSCCAR project.

Active HBMs will be evaluated. Passive response of morphed models will be compared to an average male model to determine a representative family of models required to evaluate in-crash response for the population at risk.

DEVELOPMENT OF ROBUST AND EFFICIENT CRASH SIMULATION TOOLS FOR INTEGRATED ASSESSMENT & OVERALL IMPACT DEMONSTRATION

lead by VIRTUAL VEHICLE RESEARCH GMBH

Workpackage 4 develops the tools and methods to ensure a standardized, comparable virtual assessment including the use of human body models.

In order, to guarantee comparable simulation results a workflow was defined. Figure 3 shows the workflow and additionally the OSCCAR activity for the certain steps. Following this workflow, a check is executed prior to the simulation run which verifies the simulation output settings. The next step to obtain comparable HBM simulations is to start them from the same initial position. Therefore, a positioning tool is developed, which moves the HBM from its delivery position to the initial simulation position. After simulating the pre-crash phase, the kinematic information is transferred from the pre-crash HBM to the in-crash HBM with a tool developed in OSCCAR. Finally, after executing the in-crash simulation, a standardized assessment is done by using the open source tool DynaSaur, which was further enhanced in this workpackage.

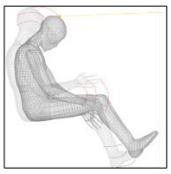
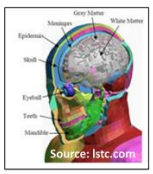
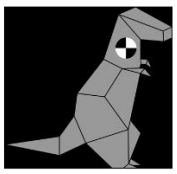
Quality check	Positioning	Pre-Crash Phase	Transition	In-Crash Phase	Assessment
					
Check list / tool	Positioning tool & method	Active models	Transition tool	Enhanced HBMs	Harmonized assessment

Figure 3 *Transition of kinematics from pre- to incrash models and finally the assessment of the simulation*

HIGHLIGHTS AND ACHIEVEMENTS FROM THE FIRST PROJECT PERIOD

For comparing simulation results the definition of a standardized output is mandatory. To compare the simulation results which are generated from different project partners within the OSCCAR project, a pre-simulation tool and check list is developed to monitor simulation boundaries. Values like output content (node set information, energies,…) and output frequency are tracked and summarized in a simple protocol.

Further, a standardized sitting procedure and a solver independent tool for HBM positioning in a deformable seat model was developed. The tool is executable in the software Piper. Landmark coordinates from sources like volunteer studies or PMHS tests can be taken to define the position to which an HBM should be seated. The tool then automatically produces FE solver input files which transfer the HBM from its delivery position to the sitting position (Figure 4).

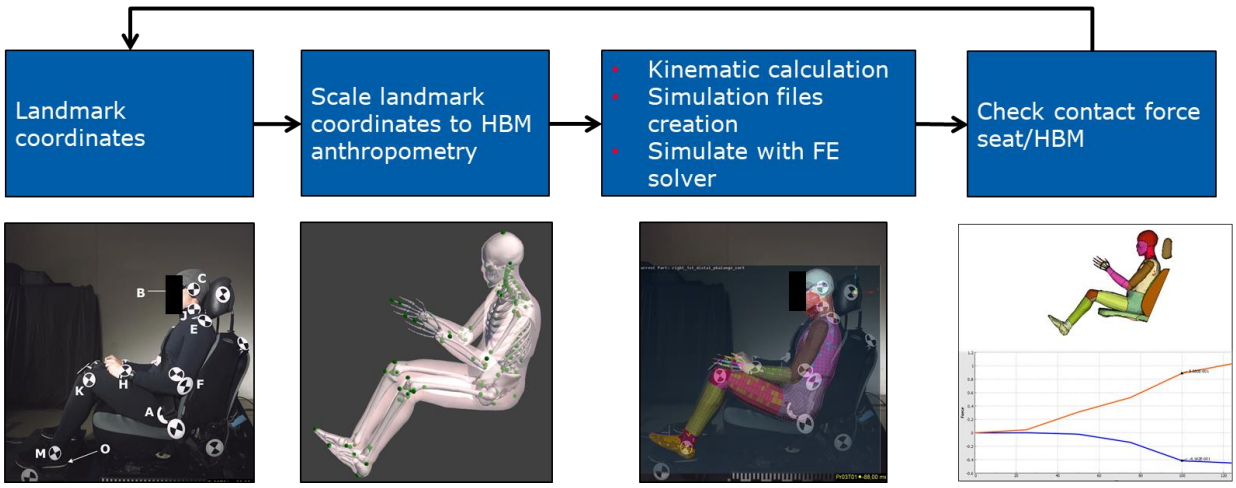


Figure 4 *Positioning workflow*

BRIEF OUTLOOK INTO THE NEXT PROJECT PERIOD

- Apply the positioning tool for the OSCCAR homologation test case
- Develop the method for kinematic transition between pre- and incrash models
- Finalize the enhancements for the post-processing tool DynaSaur

STANDARDIZATION OF VIRTUAL TESTING

lead by LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN

As some questions related to occupant safety in automated vehicles seem to be difficult to be answered using physical crash tests and anthropomorphic test devices (dummies), new approaches in simulation are used in OSCCAR to address those questions. Such approaches can be seen as first steps towards Virtual Testing complementing, and more importantly, replacing physical tests in the future. Work Package 5 shall **create a foundation for rules and definition of procedures to allow credible virtual testing in the future.**

HIGHLIGHTS AND ACHIEVEMENTS FROM THE FIRST PROJECT PERIOD

The procedures of the EU project IMVITER have been specifically reviewed in the future context of virtual testing with human body models and adopted accordingly.

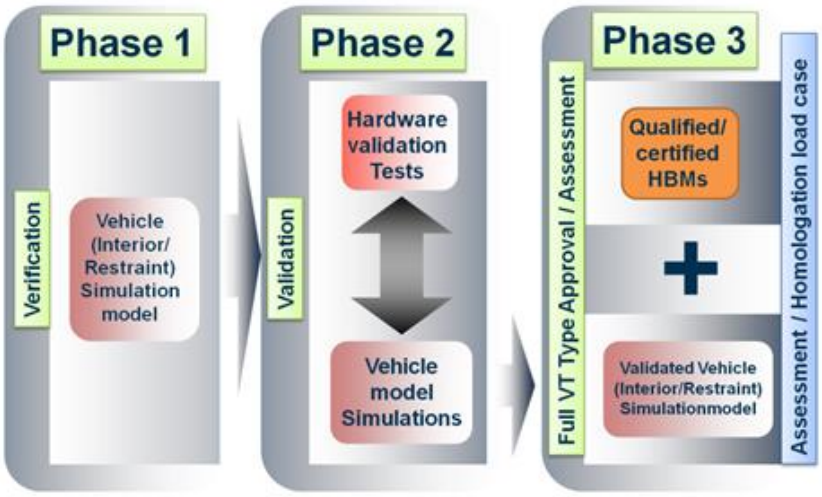


Figure 5 *Adopted human body models in the future context of virtual testing*

BRIEF OUTLOOK INTO THE NEXT PROJECT PERIOD

Work Package will develop and publish reports on recommendations for standardised approaches in the fields of

- Validation of the occupant environment (seat, restraint system)
- Requirements for human body models and their handling to be used
- Assessment of results derived from human body models

OSCCAR OUTLOOK

The OSCCAR project is set to run for nearly another year and a half. During this time, it is wanted to demonstrate amongst others the feasibility of virtual assessment methods for future vehicle occupant safety needs and provide relevant research for improved future occupant safety. Detailed information on published OSCCAR Deliverables “Accident data analysis and its limitations, the remaining accidents and crash configurations of automated vehicles in mixed traffic”, and “Test case matrix and selecting demonstrator test cases” can be found below.

OSCCAR is already internationally recognized and known for relevant research on highly relevant future vehicle occupant safety topics through the high-level joint research by 21 international partners. Also in the next project period OSCCAR project will clearly focus on raising awareness of future vehicle safety in close collaboration with North American and Asian partners as well as EU projects projects like **VIRTUAL** . The efforts from all OSCCAR partners in intensive joint work will lay the foundation for future harmonized virtual testing of advanced vehicle protection systems and the homologation of future sitting positions.

Selected results and articles/publications from OSCCAR project with the according links can be found below.

OSCCAR RESULTS AVAILABLE ON THE OSCCAR WEBSITE

Results from Workshop on Virtual Testing and Open Source Human Body Modelling together with VIRTUAL project

ATZ article " Future occupant safety in accidents with passengers"

OSCCAR deliverables

- **D1.1 Accident data analysis -remaining accidents and crash configurations of automated vehicles in mixed traffic**
- **D2.1 Test Case Matrix and selecting Demonstrator Test Cases**

Selected publications out of OSCCAR

- **Passenger Muscle Responses in Lane Change and Lane Change with Braking Manoeuvres using two Belt Configurations: Standard and Reversible Pre-pretensioner,** Ghazaleh Ghaffari, Karin Brolin, Bengt Pipkorn, Lotta Jakobsson, Johan Davidsson, Journal Traffic Inury Prevention, Volume 20, 2019
- **Modelling and Validation of the 3D Muscle-Tendon Unit with solid Finite Elements in LS-DYNA for Active Human Body Model applications,** Nuno A. T. C. Fernandes, Syn Schmitt, Oleksandr V. Martynenko, IRCOBI – International Research Council on the Biomechanics of Injury Europe Conference, Florence, Italy
- **Sitting Postures and Activities in Autonomous Vehicles – New Requirements towards Occupant Safety,** Anna-Lena Köhler, Julia Pelzer, Kristian Seidel, Stefan Ladwig, HFES 63rd Annual Meeting, Seattle USA
- **How Will We Travel Autonomously? User Needs for Interior Concepts and Requirements Towards Occupant Safety,** Anna-Lena Köhler, Fabian Prinz, Lining Wang, Julian Becker, 28th Aachen Colloquium Automobile and Engine Technology, Aachen, German
- **Development and Validation of a Generic Finite Element Ribcage to be used for Strain-based Fracture Prediction,** Johan Iraeus, Bengt Pipkorn, IRCOBI – International Research Council on the Biomechanics of Injury Europe Conference, Florence, Italy
- **Predicted crash configurations for Autonomous Driving vehicles in mixed German traffic for the evaluation of occupant restraint system,** Martin Östling, Hanna Jeppsson, Nils Lubbe, IRCOBI – International Research Council on the Biomechanics of Injury Europe Conference, Florence, Italy

GENERAL PROJECT INFORMATION

More information on OSCCAR is available on our website: **www.osccarproject.eu**.

Our latest news are also available on Twitter and Linkedin:

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Follow us on LinkedIn: **https://www.linkedIn.com/groups/13655575**

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