OSCCAR

FUTURE OCCUPANT SAFETY FOR CRASHES IN CARS

OSCCAR-SAFE-UP workshop - Nov. 12th, 2020

OSCCAR project overview

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www.osccarproject.eu

OSCCAR has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768947.

Agenda

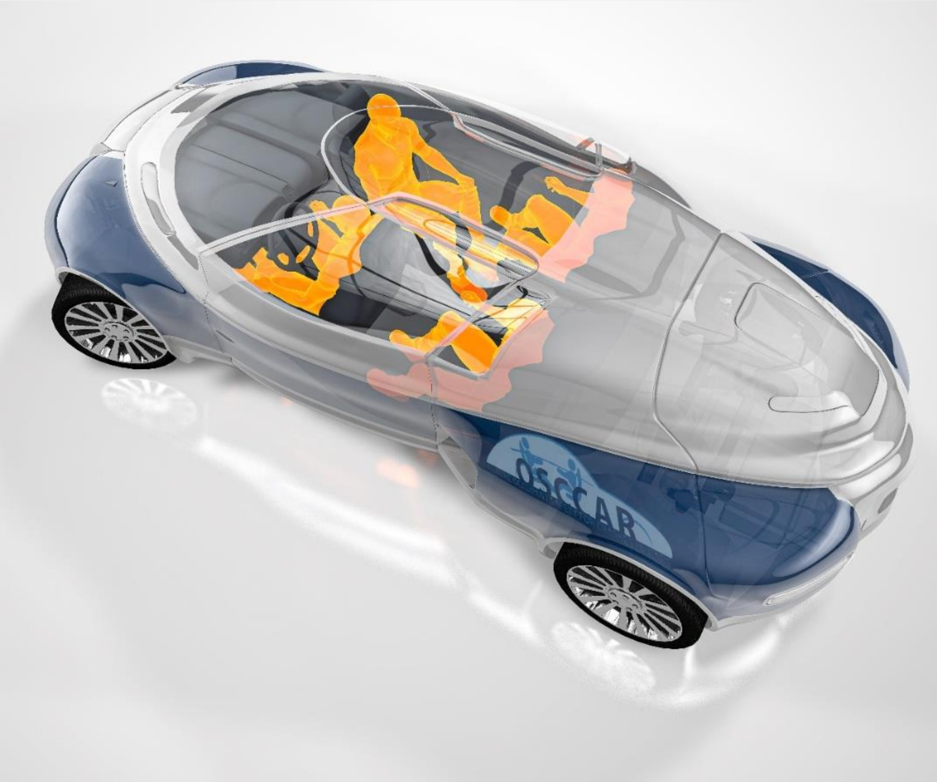
FUTURE OCCUPANT SAFETY FOR CRASHES IN CARS

- **OSCCAR overview** (Werner Leitgeb, Virtual Vehicle Research)

- Determination of future accident scenarios in SafeUP context (Daniel Schmidt, Robert Bosch GmbH) page 17ff

OSCCAR - Future Occupant Safety for Crashes in Cars

FUTURE OCCUPANT SAFETY FOR CRASHES IN CARS



Highly automated vehicles (HAVs) offer

- Better utilization of travel time; a place of relaxation, comfort and new communication opportunities
- new interior concepts with e.g. reclining seat functions and rotating seats
- overall safety benefits by taking human error out of the loop

To be successful HAVs need to:

- Act safety minded regarding “overall traffic”, “VRUs”
- Safeguard **all** types of occupants in **new sitting positions** in future **relevant** traffic accidents

Action points:

> Understand future mixed traffic accident scenarios
> Continuously address the whole accident phase
> Consider human heterogeneity requirements
> Derive suitable restraint principles
> Prepare for virtual testing & homologation in order to cope with the increased amount and variety of testing

OSCCAR Project

OSCCAR
FUTURE OCCUPANT SAFETY FOR CRASHES IN CARS

PROJECT PARTNERS

AUSTRIA

- TECHNISCHE UNIVERSITÄT GRAZ
- VIRTUAL VEHICLE RESEARCH GMBH

BELGIUM

- SIEMENS INDUSTRY SOFTWARE NV
- TOYOTA MOTOR EUROPE

CHINA

- TSINGHUA UNIVERSITY
- CHINA AUTOMOTIVE TECHNOLOGY AND RESEARCH CENTER

FRANCE

- ESI GROUP
- UNIVERSITE DE STRASBOURG

GERMANY

- BUNDESANSTALT FUER STRASSENWESEN
- ROBERT BOSCH GMBH
- LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN
- MERCEDES-BENZ AG
- RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN
- UNIVERSITAET STUTTGART
- VOLKSWAGEN AG
- ZF GROUP, PASSIVE SAFETY SYSTEMS, TRW AUTOMOTIVE GMBH

NETHERLANDS

- SIEMENS DIGITAL INDUSTRIES SOFTWARE

SPAIN

- IDIADA AUTOMOTIVE TECHNOLOGY SA

SWEDEN

- AUTOLIV DEVELOPMENT AB
- CHALMERS TEKNISKA HOEGSKOLA AB
- VOLVO PERSONVAGNAR AB

PROJECT COORDINATOR: virtual vehicle

PROJECT FACTS

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START: JUNE 2018 **DURATION:** 36 months

PARTICIPATING ORGANISATIONS: 21

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WWW.OSCCARPROJECT.EU

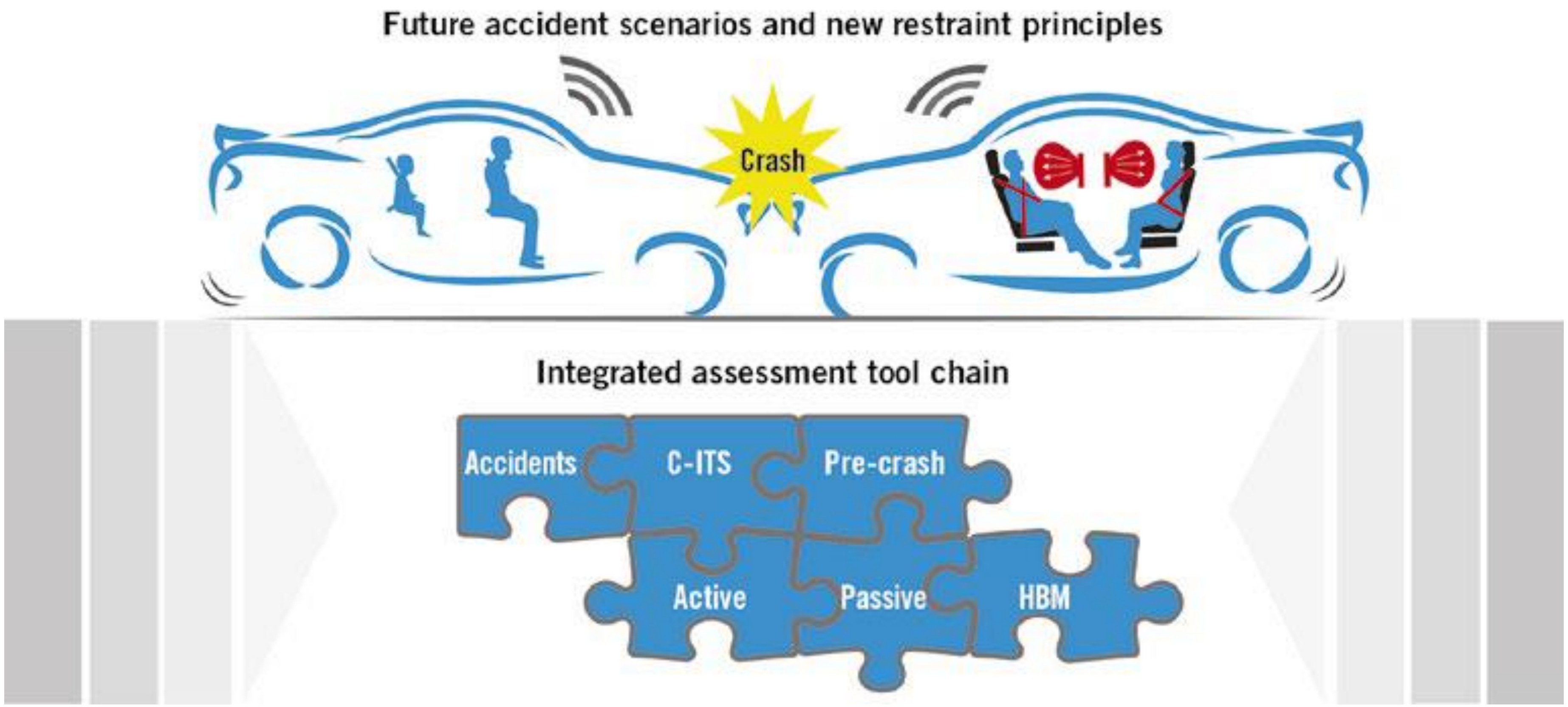
OSCCAR – Main Objectives

The EU Horizon 2020 research project **"OSCCAR - Future Occupant Safety for Crashes in Cars"** - develops a novel, simulation-based approach to safeguard occupants involved in future vehicle accidents

- Understanding future accident scenarios involving passenger cars
- Demonstration of **new advanced occupant protection** principles and concepts addressing future desired sitting positions made possible by HAVs
- Contribution to the development of **diverse**, **omnidirectional**, **biofidelic** and **robust HBMs**
- Establishment of an integrated, virtual assessment framework for complex scenarios as needed for the development of advanced protection systems for all occupants
- Contribution to the **standardization of virtual testing procedures** and promotion of HBMs acceptance in order to pave the way for virtual testing-based homologation

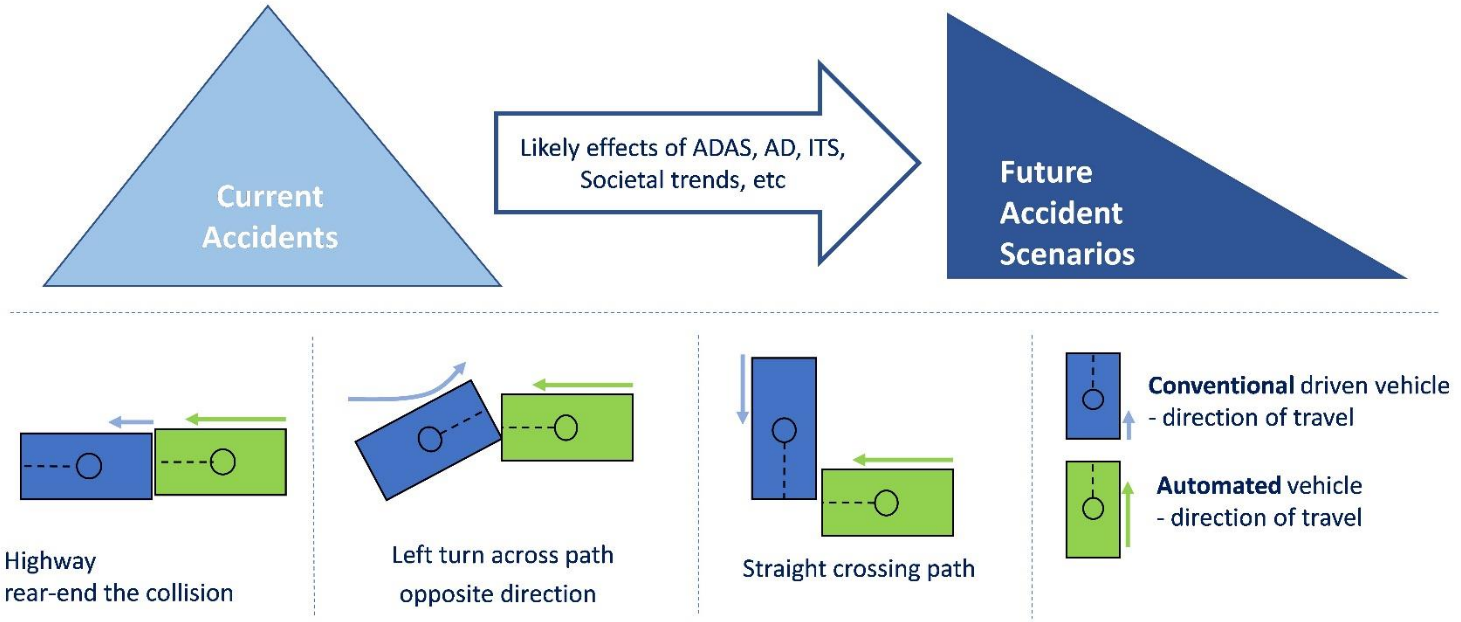
OSCCAR Motivation

Car crashes and occupant injuries will happen in the future …



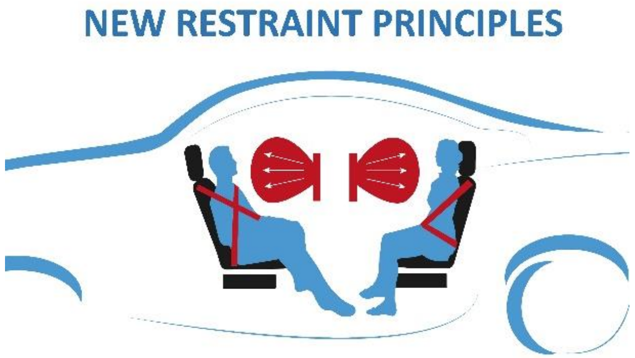
OSCCAR – Future Accident Scenarios

- Methodology to predict future crash configurations based on accident data and pre-crash simulation.
- Description of the persisting accidents that are expected to remain with the onset and market penetration of automated driving.
- Methodology to estimate generic crash pulses for novel crash configurations, based on state-of-the-art FE vehicle crash models



OSCCAR – Occupant protection principles

- Test case matrix for motivating Test Cases to be used within OSCCAR for investigating protection principles, and for demonstrating the whole tool chain evaluation.
  - Three dimensions of test cases
    - **Crash configuration** including pre-crash kinematics and crash pulse
    - **Occupant Use Case** (Vehicle interior, seat configuration and position, sitting posture of the occupant, and interior specific features)
    - **Individual human variations** (gender, size, age, anthropometry)
- User studies on future sitting position preferences
- Six passenger protection principles working groups established
  - Partner workshops on protection principle ideation and selection
  - build up of respective generic interior models
  - physical test series performed for interior/ restraint model validation and general occupant behavior



Occupant protection principles – HBM application

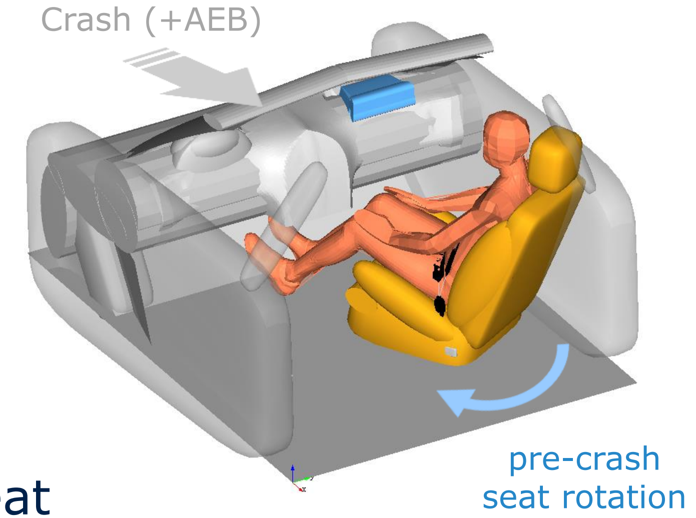
- Occupant protection principles:
  - Conception and investigation of advanced occupant protection principles for sitting positions and postures related to automated driving:
    - Restraints to be adapted towards new boundary conditions
    - Repositioning of the occupant into a conventional seating configuration prior to a crash
  - Considering aspects like occupant variety and omnidirectional occupant loading by use of HBMs
  - Virtual investigation of protection principles and hardware demonstration of selected cases

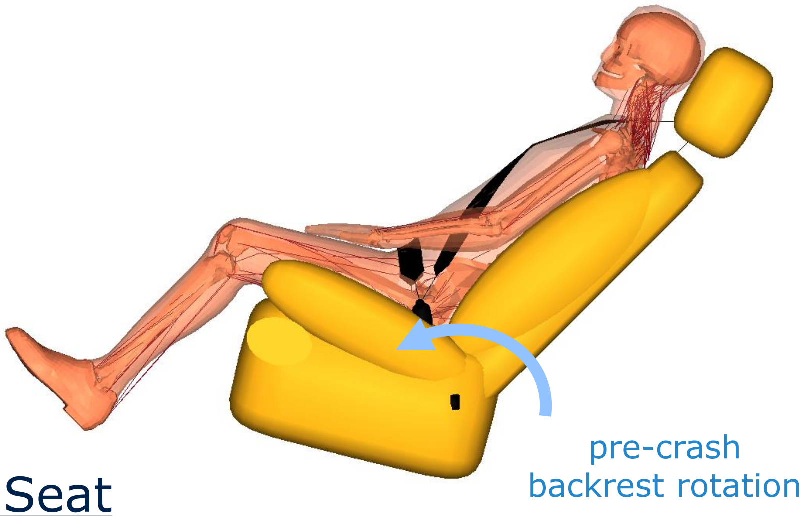
Protection Principles

#1	#2	#3	#4	#5	#6
Swivel Seat	Inertia Seat	Anti Submarining	Mushroom Airbag	Reclined Seat	Far Side

Occupant protection principles – HBM application

- Occupant protection principles - Repositioning of the occupant:





- <u>Swivel Seat</u>
  - Use Cases & Principle:
    - Occupant sitting slightly rotated, pointing away from the driving direction
    - The seat will be rotated around z-axis towards direction of crash during pre-crash phase
    - Active (defined rotation-time curve) and passive (inertia driven) rotations are considered

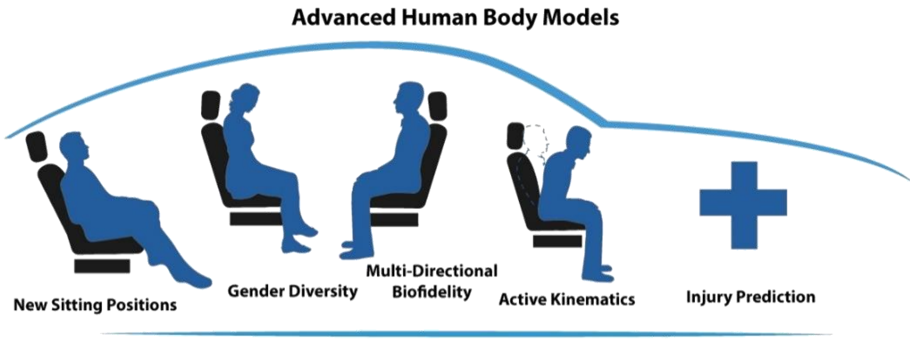
  Related publication: [Becker et al. IRCOBI 2020]

- <u>Reclined Seat</u>
  - Use Cases & Principle:
    - Occupant sitting in a relaxed seating position with a reclined backrest angle
    - Prior to the crash the backrest rotates to an upright angle to raise the occupant into a “normal” sitting posture

  Related publication: [Östh et al. IRCOBI 2020]

OSCCAR – HBM updates

HBMs



- Enhancement of HBMs
  - Material models have been developed and implemented
  - Organ dimensions have been provided
  - HBMs have been further refined and morphing activity started

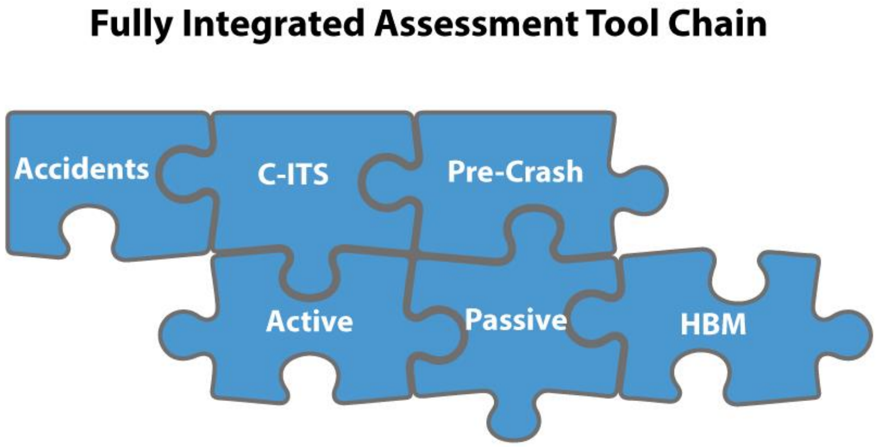
- Volunteer data for pre-crash kinematics
  - Models of the important validation data environment build and available
  - Pre-selection for validation catalogue
  - Further development of active HBMs concepts

- Joint work on harmonized injury criteria started

OSCCAR – Integrated and comparable assessment

Integrated, continuous and comparable assessment

- Common simulation “input” criteria that allow for comparing results
- Software tool for reproducible HBM seating procedure in development
- Comparable and common assessment using the OSCCAR enhanced open source software tool “Dynasaur”
- Enabling standardized solver output processing for different solvers used within OSCCAR



https://gitlab.com/VSI-TUGraz/Dynasaur

Virtual Testing requirements

- Development of virtual testing and assessment procedures
- First proposal of a procedure for virtual environment validation published

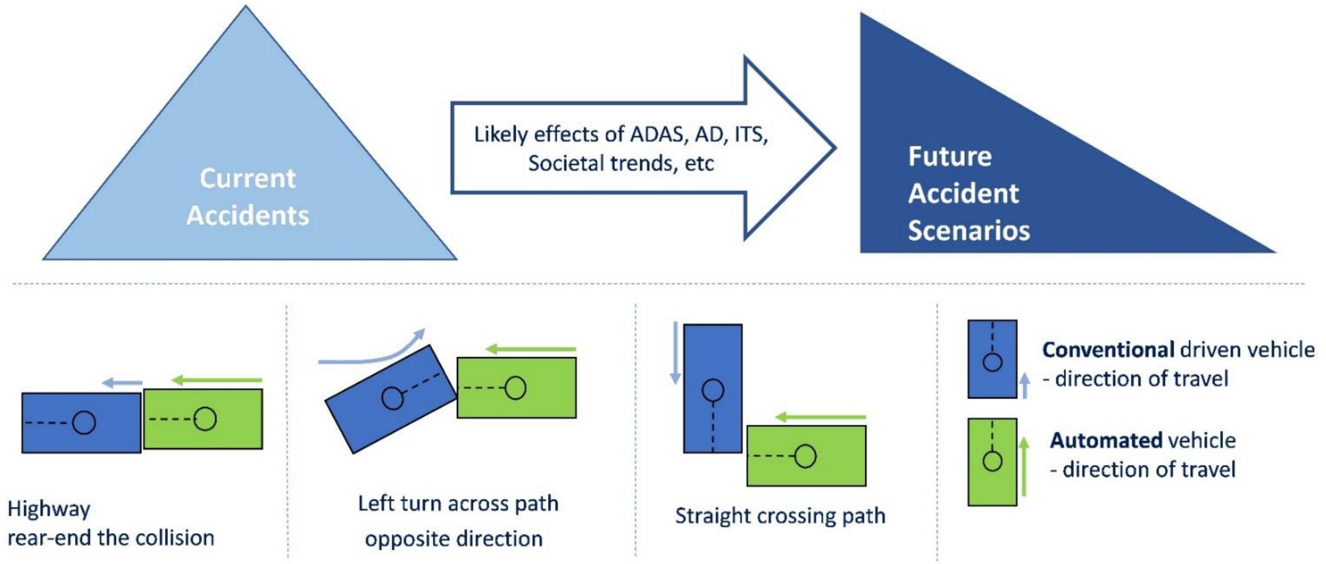
  Eggers et al., Validation procedure for simulation models in a virtual testing and evaluation process of highly automated vehicles, VDI-Tagung Fahrzeugsicherheit 2019

- Harmonization efforts
- Homologation Test Case Demonstration

Harmonization of Virtual Testing

OSCCAR – Virtual Testing II

- Providing the bigger picture on complete story for virtual testing needs
  - Generic load-cases of future relevant accident scenarios
  - Methodology to estimate generic crash pulses for novel crash configurations, based on state-of-the-art FE vehicle crash models



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Harmonization of Virtual Testing

Harmonization of virtual testing
Virtual testing basic needs

Glossary and definition of relevant terms: “What is and what is needed for a valid model”

Verification:	Assessment of accuracy of computational model solving the mathematical problem.
Validation:	Assessment of the degree to which a computational model is an accurate representation of physics being modelled.
Calibration:	The process of modifying (parameters of) a model or tool to reach a performance target defined beforehand.
Certification:	The process of official approval that a model and its associated data are acceptable for a specific purpose. Purpose describes the use in an existing procedure, e.g. consumer rating or legislation with Virtual Testing.

developed in cooperation with Thumbs User Community TUC

OSCCAR – Virtual Testing IV

Homologation Test Case Demonstration

- OSCCAR demo case for an exemplary procedure for future virtual approval using HBMs
  - Extrapolation of hardware test based validity to new, "virtual only" Test Case
  - Focus on reclined, forward facing occupant position
- Demonstration of a method that delivers comparable results, the basis for credibility and acceptability
- Continuous virtual assessment of the pre- and in-crash phase

O_1 E_1

WP1 Determination of future accident scenarios

12 November 2020

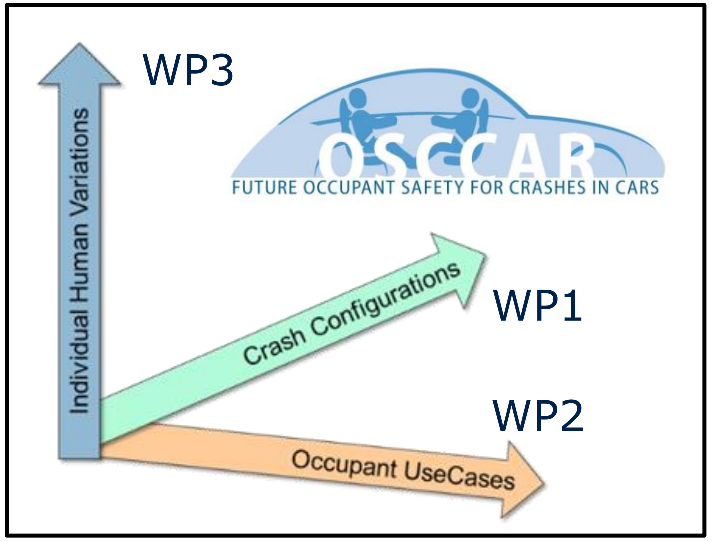
Daniel Schmidt (Robert Bosch GmbH)

OSCCAR has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768947.

Tasks & Deliverables of WP1

Objective: To apply **accident research** and to combine it with **future trend analysis** and insights from other real world data in order **to derive an outlook to future remaining** accident scenarios

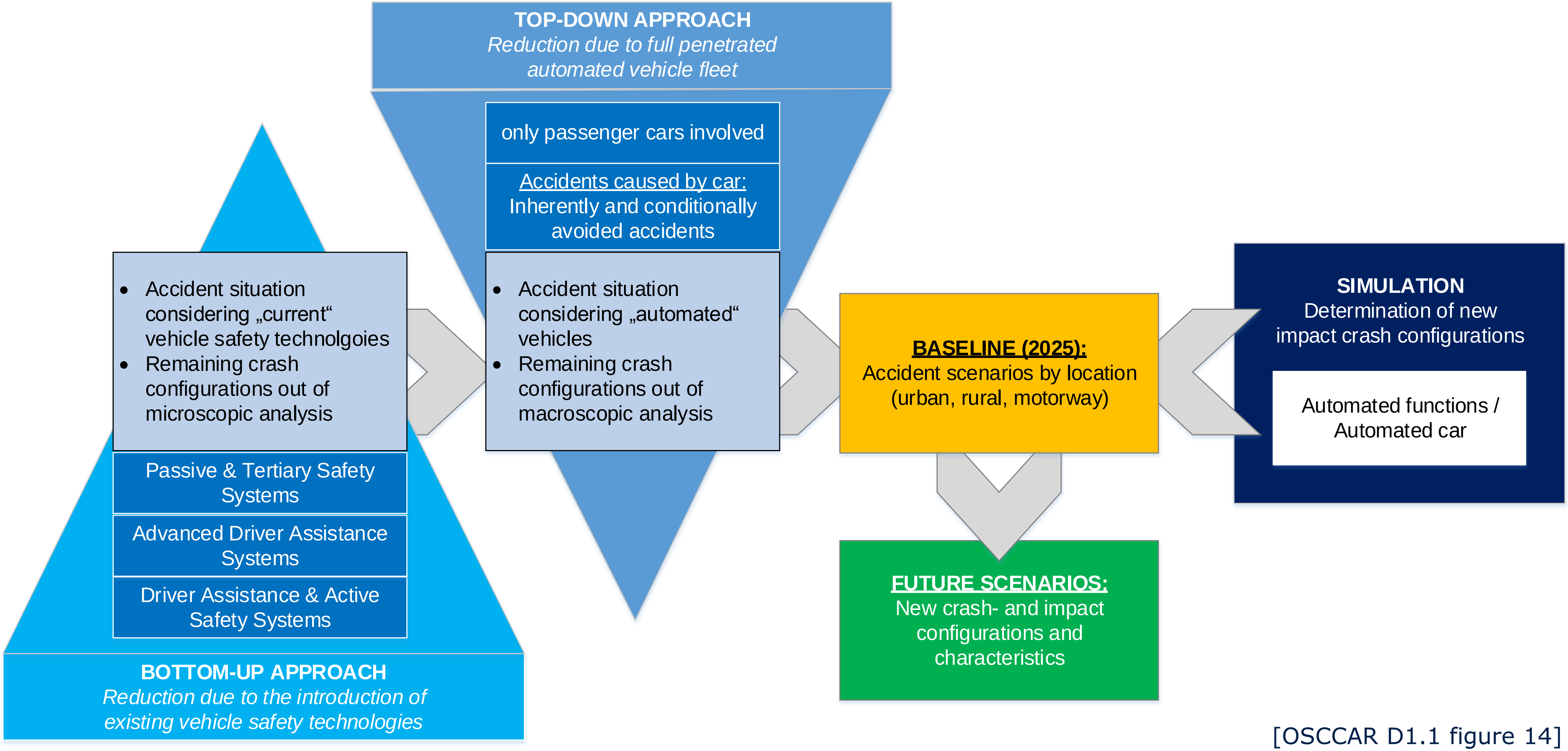
- **T1.1 Methodology framework for integrated assessment**
- **T1.2 Traffic simulation / accident scenarios along with use cases for AD**
- **T1.3 Parameter for EU & China traffic model based on real world data analysis**



Major milestones for WP1**:**

- **D1.1 [report] Accident data analysis - remaining accidents and crash configurations of automated vehicles in mixed traffic**
- **D1.2 [software demonstrator] openPASS framework for integrated safety assessment**
- **D1.3 [report] Future collision type matrix**

OSCCAR approach:
Estimating Europes future accident situation



[OSCCAR D1.1 figure 14]

OSCCAR approach:
How to determine remaining accidents in mixed traffic?

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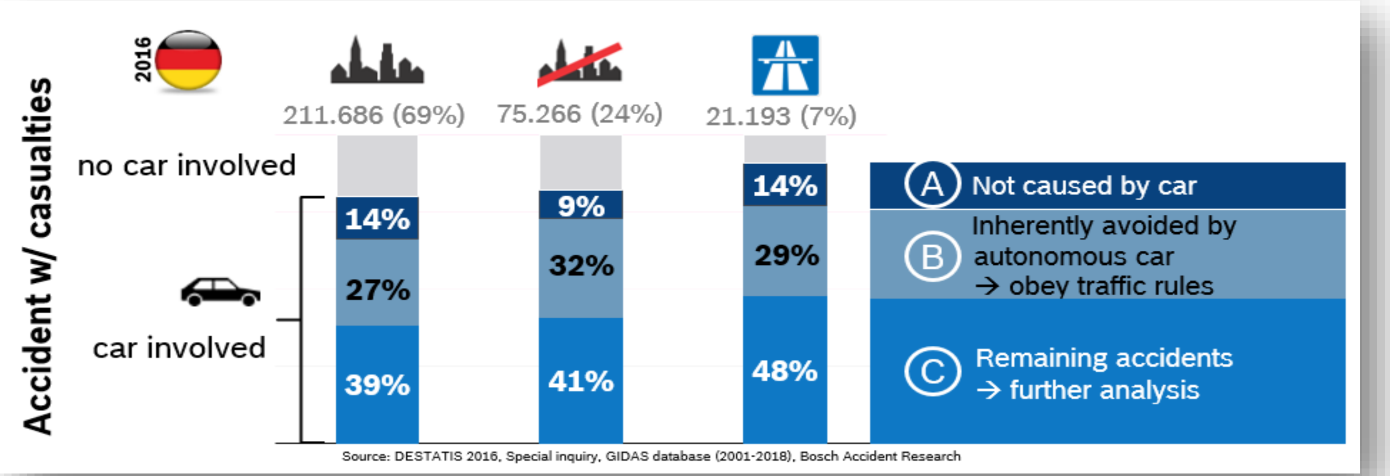
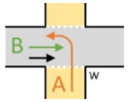
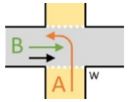
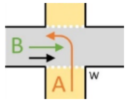
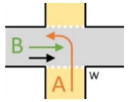
Assumption: AD model = „safety minded driver"; no violation of traffic rules & behaviour adaptation

- **Human vs. human** = original accident data



- **Mixed traffic: AD vs. human / Human vs. AD**
  a. AD is „main causer" of collision
     - Inherent avoidance ➔ case is filtered out („HURSU")
  b. AD is only involved in collision
     - Human driver still causes accident
       ➔ re-simulation of reconstructed collision with AD reaction

	Situation by initiator	Filter criteria
#1	Accident initiator („A") 	**Human driver vs. human driver** • Participant „A" is causing the accident and has a **human driver** • Participant „B" has a **human driver**
#2	Non-Accident initiator („B") 	**Human driver vs. automated car** • Participant „A" is causing the accident and is **human driven** • Participant „B" is referred to a passenger car and is **automated**
#3	Accident initiator („A") 	**Automated car vs. human driver** • Participant „A" is causing the accident and is **automated** • Participant „B" is **human driven** ➔ "*Inherently avoided*" because automated cars obey way of right
#4	Accident initiator („A") 	**Automated car vs. automated car** • Participant „A" is causing the accident and is **automated** • Participant „B" is **automated** ➔ "*Inherently avoided*" because automated cars obey way of right

OSCCAR approach:
Example: GIDAS urban intersections

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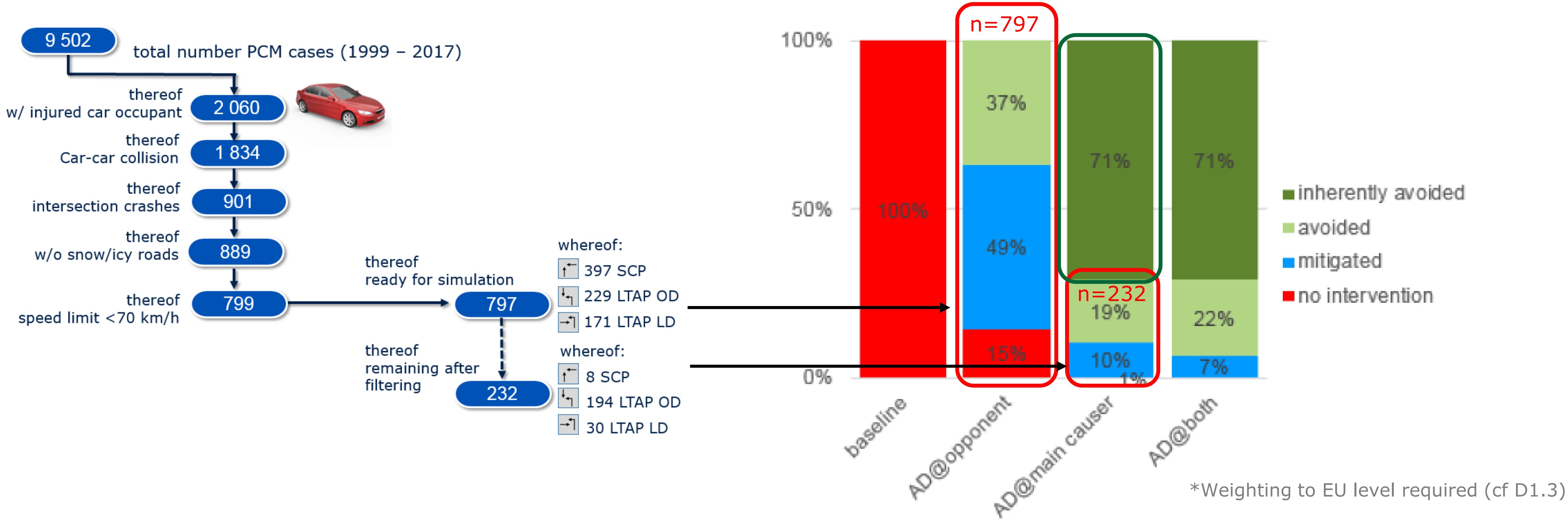

1. Determine if accident would be inherently avoided by AD vehicle [assuming obeying traffic rules, etc]
2. Simulation 1 (n = 797): AD is opponent and tries to avoid collision caused by human driver
3. Simulation 2 (n =232): AD is replacing original main causer
4. Remaining cases = mitigated/no intervention cases from simulation results

OSCCAR – downloads, results

OSCCAR public deliverables and downloads:

http://osccarproject.eu/media/

OSCCAR @ Ircobi 2020:

Östh et al.: Evaluation of Kinematics and Restraint Interaction when Repositioning a Driver from a Reclined to an Upright Position Prior to Frontal Impact using Active Human Body Model Simulations

Becker et al.: Occupant Safety in Highly Automated Vehicles Challenges of Rotating Seats in Future Crash Scenarios

Mroz et al.: Effect of Seat and Seat Belt characteristics on the Lumbar Spine and Pelvis Loading of the SAFER Human Body Model in reclined Postures

Nölle et al.: Defining Injury Criteria for the Muscle-Tendon-Unit

OSCCAR @ Human Modelling Symposium 2020

https://www.carhs.de/en/human-modeling-program.html

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