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OSCCAR (Future Occupant Safety for Crashes in Cars)

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Workshop on UN Regulation No. 14

25. April 2024

- Coordinator: Virtual Vehicle (VIF)

- 21 Partners from 8 countries (AT, BE, CN, DE, ES, FR, NL, SE)
    - 6 Tier suppliers
    - 4 OEMs
    - 4 Research organizations
    - 7 Universities

- Co-project "OSCCAR China" under H2020 Co-Funding Mechanism in initiation with Chinese MOST

- 9 associated research and stakeholder partners from Europe, Canada, Japan, South Korea, USA

- Resources
    - ~720 PM Effort
    - ~7.5M€ Budget

- Project run time: from 2018 to 2021

- Expected OSCCAR Impact time: 2020 to 2040?

The EU Horizon 2020 research project **"OSCCAR - Future <u>O</u>ccupant <u>S</u>afety for <u>C</u>rashes in <u>C</u>ars"** – aimed to develop 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 scenario 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

- Development of an **exploitation strategy** towards large scale **implementation of virtual testing methods** for advanced occupant safety solutions created during this project.

Highly automated vehicles and automated driving mode will enable new interior concepts


Conference type seating including seats rotated about
the vertical axis. Source: Daimler AG
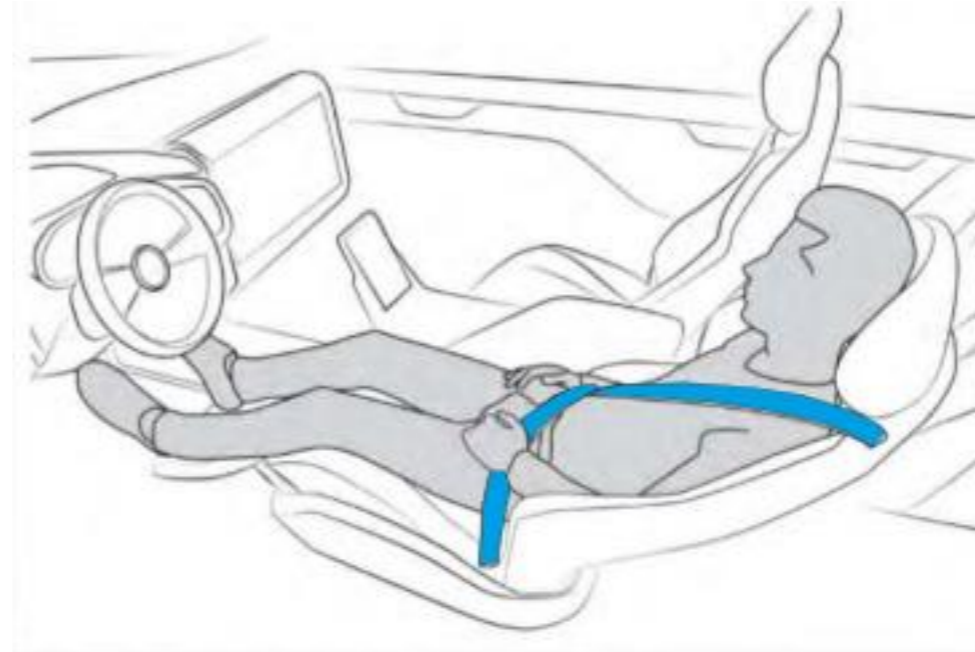
Relaxed position with highly reclined seat back.
Source: Östling et al. VDI Konferenz Fahrzeugsicherheit 2017

■ Currently, these kind of concepts are not possible (in driving mode)

→ no type approval procedures available

■ To increase / maintain level of passive vehicle safety new type approval procedures
needed including appropriate test tools → Crash test dummies?

Which test tool can be used to assess the passive vehicle safety of new seating concepts?

Human

Hybrid III

THOR

Initial test position

HBM

In-Crash Kinematics
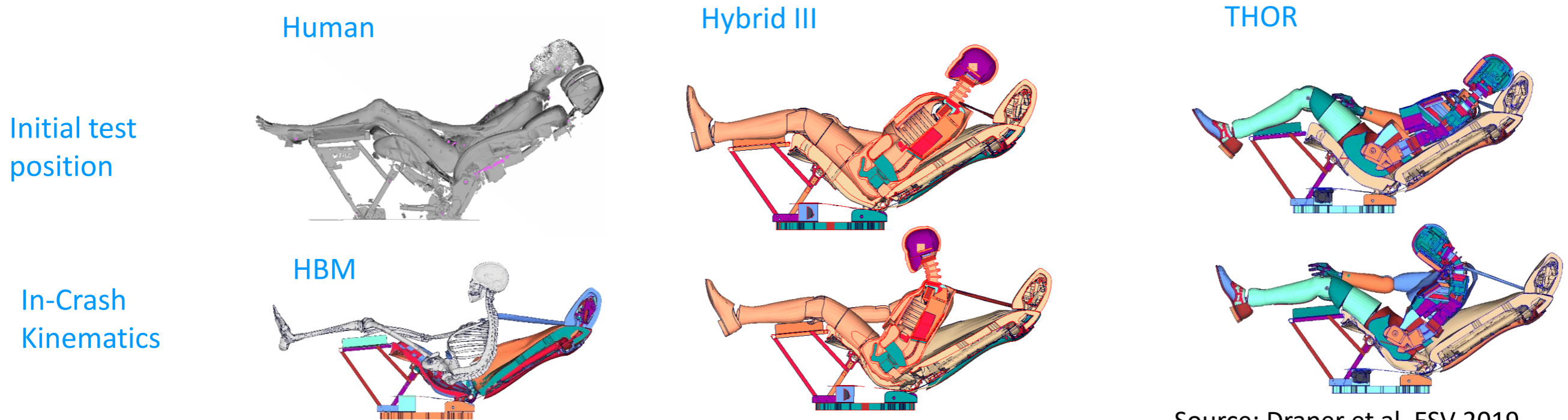
Source: Draper et al. ESV 2019

- Limitations of currently available test tools (ATDs/Dummies) in highly reclined seat:

  →Hybrid III: Unrealistic position (no contact with seatback)

  →THOR - More realistic position (contact with seatback and headrest), but still questionable biofidelity of kinematics and limitations to assess injury
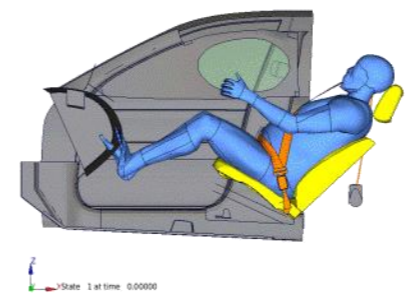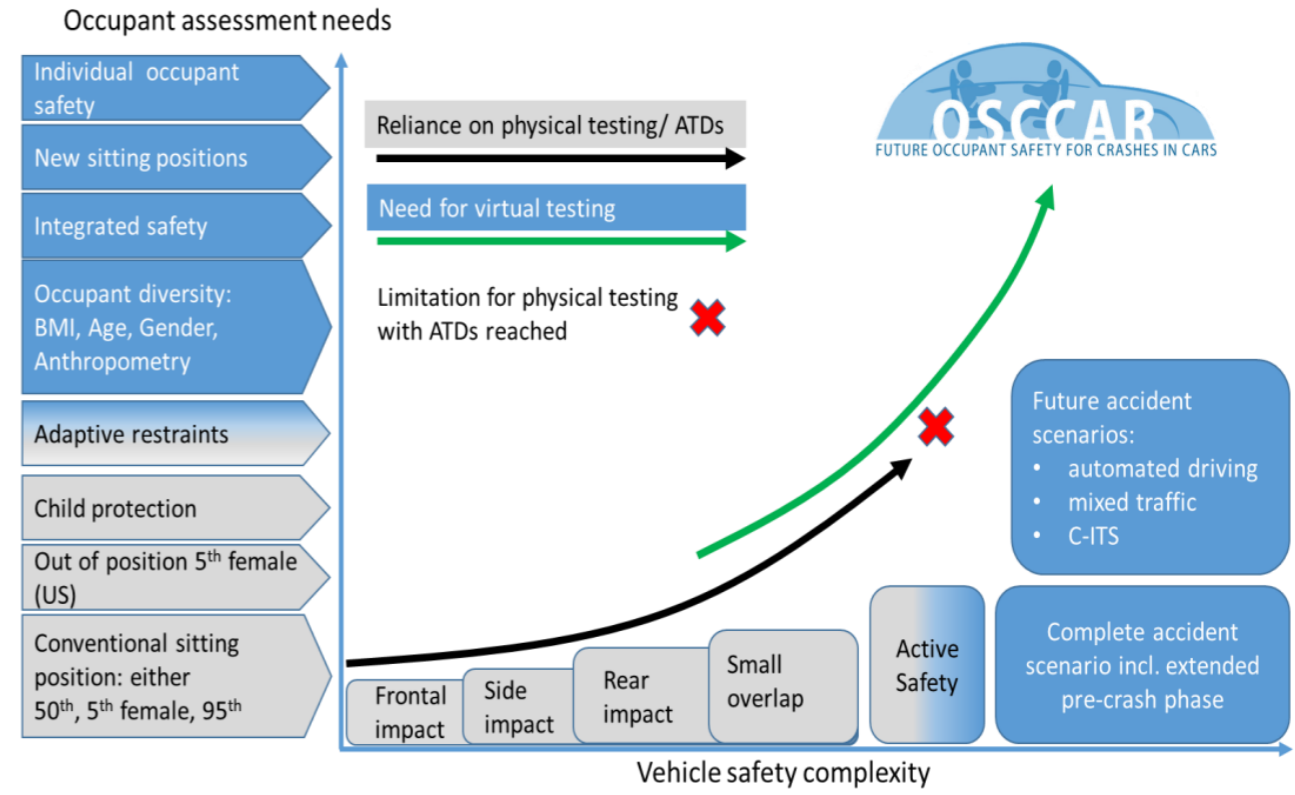
OSCCAR – Virtual Testing: Background & Motivation

Review of VT in past project:
→ Motivation for Virtual Testing for passive vehicle safety assessment

1.) **Replace existing RT** (real testing) based procedures/ regulations by VT (virtual testing) → with focus on **saving costs and test effort** (no new tests/ requirements)

2.) **Extent the scope of protection** by adding test conditions using existing test tools (ATDs) and procedures by combined real and virtual testing (hybrid approach/grid approach)
→ First Euro NCAP Far-Side Pilot

3.) **HBMs in a VT process** to address the limitation of ATDs → EU-Project OSCCAR: HBMs for new seating postures, user diversity (small vs. tall, male vs. female, Western vs. Asian), obesity,...

Occupant assessment needs

- Individual occupant safety
- New sitting positions
- Integrated safety
- Occupant diversity: BMI, Age, Gender, Anthropometry
- Adaptive restraints
- Child protection
- Out of position 5th female (US)
- Conventional sitting position: either 50th, 5th female, 95th

Reliance on physical testing/ ATDs

Need for virtual testing

Limitation for physical testing with ATDs reached

Future accident scenarios:
- automated driving
- mixed traffic
- C-ITS

Complete accident scenario incl. extended pre-crash phase

Frontal impact | Side impact | Rear impact | Small overlap | Active Safety

Vehicle safety complexity

Solutions to address limitation of current test tools (dummies/ATDs) ?

Modification /Improvement of existing dummies
　　to enable new positions or address user diversity
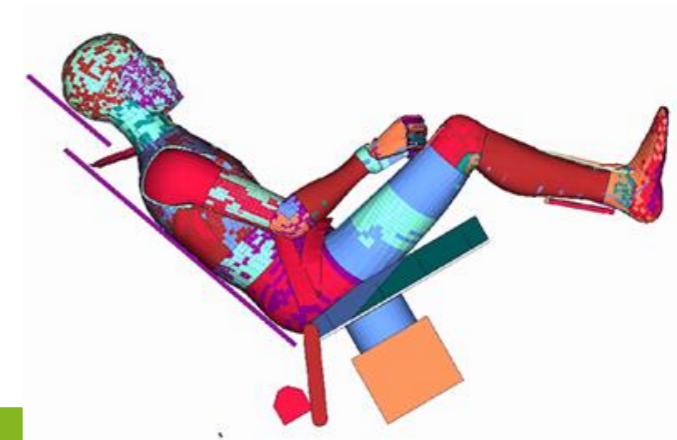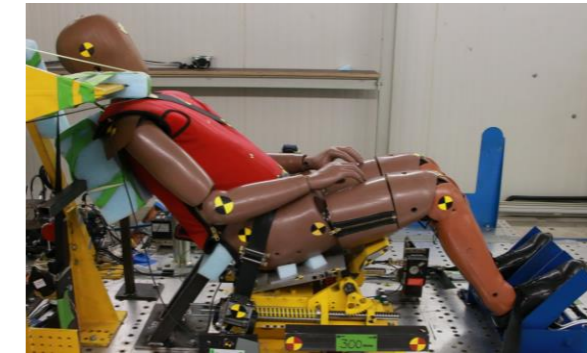
Disadvantages:

- Time consuming process to agree on new dummy design

- Increased complexity leads to lower robustness and repeatability

Alternative approach:

Improved Human Body Models
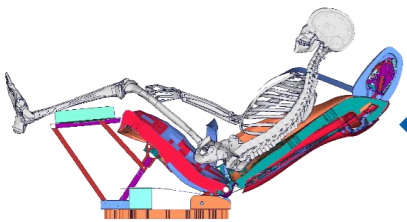　　in a virtual testing and assessment procedure
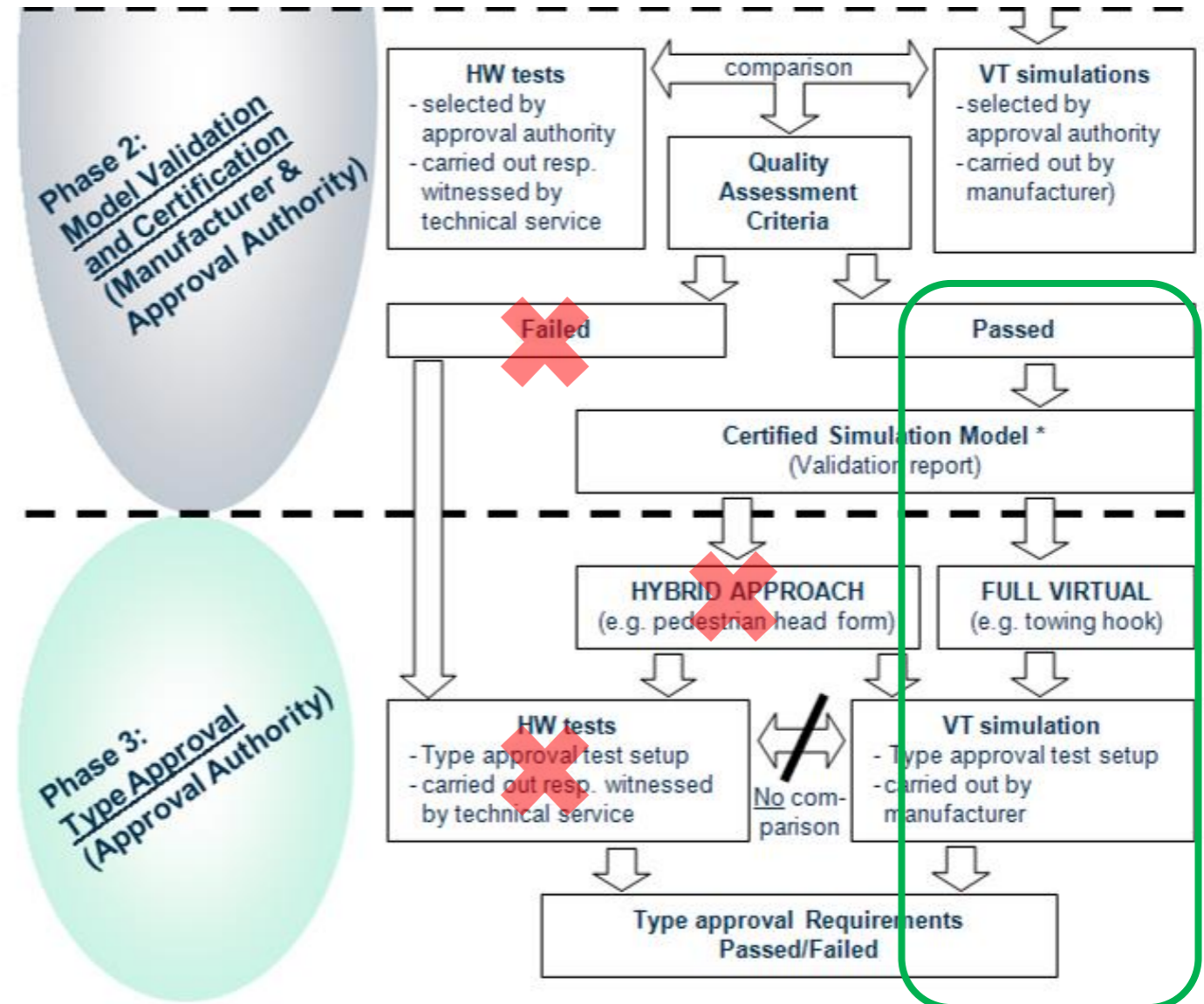
→ OSCCAR follows this approach

OSCCAR HBM VT approach:

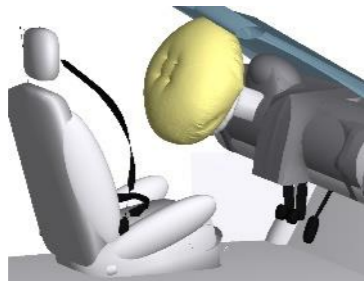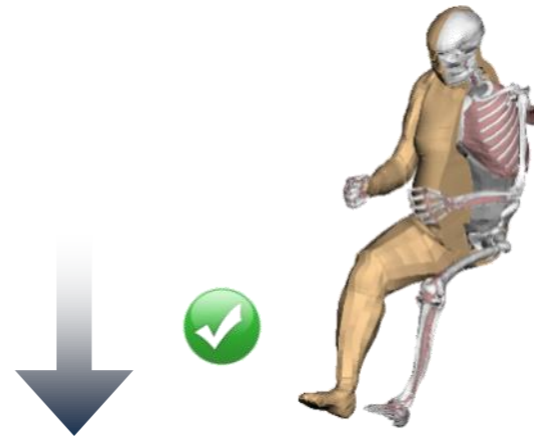- No real tests possible in Type approval test setup (No real test tool existing)

HW (Real) tests

- Failure of validation tests no option
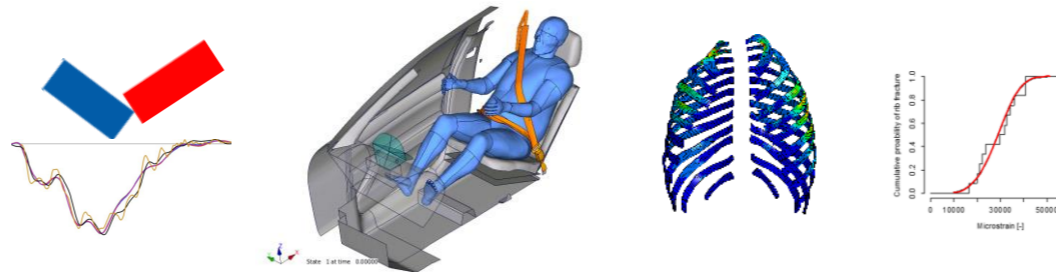- Fully VT based type approval is the only option to pass regulation (No hybrid (grid) approach

Phase 2: Model Validation and Certification (Manufacturer & Approval Authority)

HW tests	comparison	VT simulations
- selected by approval authority - carried out resp. witnessed by technical service		- selected by approval authority - carried out by manufacturer)

Quality Assessment Criteria

Failed — Passed

Certified Simulation Model * (Validation report)

Phase 3: Type Approval (Approval Authority)

HYBRID APPROACH (e.g. pedestrian head form) — FULL VIRTUAL (e.g. towing hook)

HW tests	No comparison	VT simulation
- Type approval test setup - carried out resp. witnessed by technical service		- Type approval test setup - carried out by manufacturer

Type approval Requirements Passed/Failed

What is needed for an HBM based VT procedure

HBM based Safety Assessment Simulation Procedure

Full Virtual Testing with HBM in new load case

- Standardised virtual test procedure (Occupant positioning, belt installation,...)
- HBM based assessment criteria (kinematics/injury)

Vehicle Environment Model certified/approved for VT

OSCCAR HBM based Full Virtual Testing procedure

Phase 1: Vehicle Model Development

Vehicle Environment Simulation Model develoment by OEM)
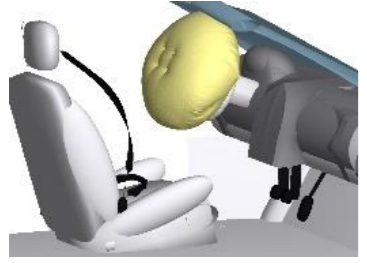
Code-specific **quality requirements** (numerical correctness, discretization, convergence, element quality, control settings etc.)

Model calibration based on previous models, test data (e.g. material data base) and validation tests

Calibrated Vehicle Environment Model – status frozen (ready for VT)

Phase 2: Vehicle Model Certification (Validation check)
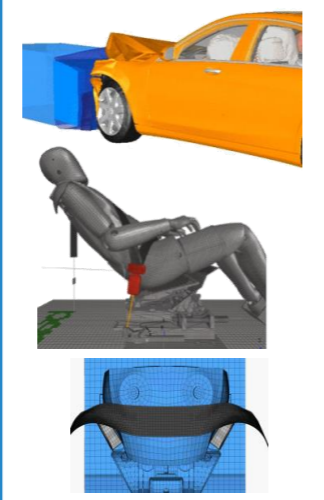
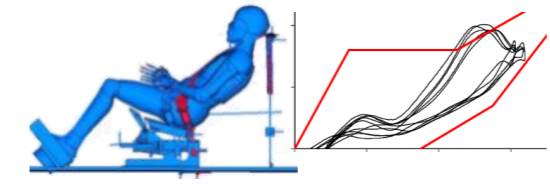**Validation Simulations performed by (OEM)**

Simulation data
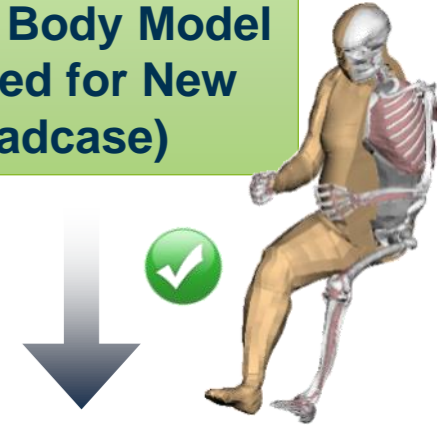
Objective Acceptance Criteria

Test data

Hardware Validation Tests (performed or wittnessed by NCAP/Technical Service)

Vehicle Enviroment Model certified /admitted for VT

HBM Certification / Validation Requirements for New Load Case

Human Body Model (certifed for New Loadcase)

Phase 3: Safety Assessment Simulation

Full Virtual Testing with HBM in new load case:
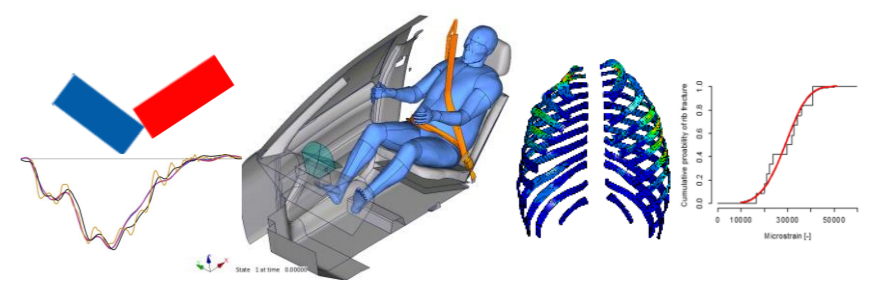
- Test and assessment tool: HBM certified for new load case
- Vehicle/sled simulation model approved for VT
- Standardised virtual test procedure (Occupant positioning, belt installation,...)
- HBM based assessment criteria (kinematics/ injury)

OSCCAR Virtual testing procedure

Objective of OSCCAR: Definition of **Validation tests**

Requirements for validation tests:

- Tests to confirm the validation of vehicle /restraint model in a new assessment load case

- Validation tests should be representative of the test tool (HBM) loads to vehicle /restraints in the new loading condition

Different options:

- Full scale crash in standard configuration (NCAP, homologation)

- Sled tests in standard configuration

- Sled tests representing loading in new test configuration (new loading direction, seat rotated/reclined) with

- Subsystem/component tests (airbag, seat,…)

- Which validation test tool? standard ATD, simplified validation ATD

OSCCAR Virtual testing procedure

OSCCAR pilot case → Possible options for validation tests

OSCCAR pilot case New HAV accident scenario (impact angle velocity from accident analysis)

- New seating posture

  → Highly reclined seat (seat back angle 60°)

- Average occupant (50%ile)

- OSCCAR approach for sled model validation

  - Validation sled tests and simulations with **THOR-50**M and **Hybrid-III-50M** in reclined position
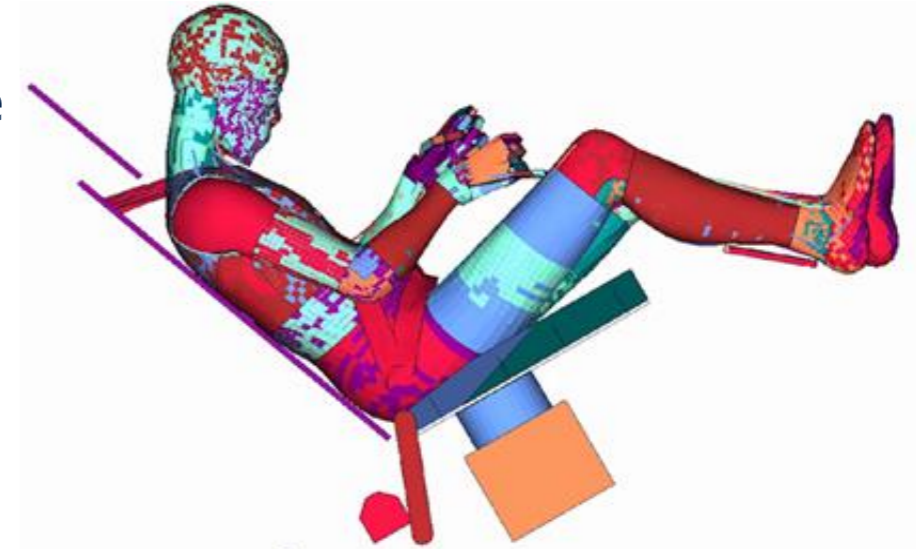
Objective procedure needed to assess correlation of simulation and test data

- How to achieve trust in simulation model and VT based assessment

→ Pass/Fail criteria to distinguish valid and non-valid model response

→ Reliable validation acceptance criteria are needed **considering test scatter in real test!**

- **Demanding** enough to assure the trustworthy and reliable validation of vehicle environment

- **Achievable** thresholds to make sure validation can be fulfilled, if no RT based alternative is available

Acceptance criteria (Pass / Fail threshold) needed
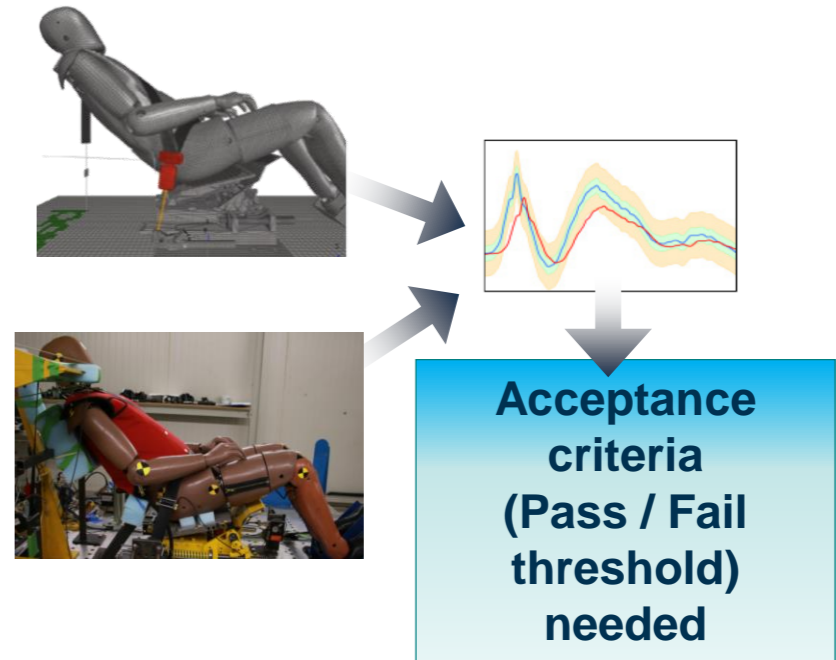
- **CORA or ISO rating?**

- **Overall model rating or individual thresholds per channel?**

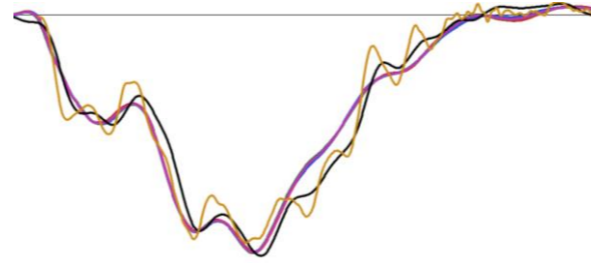- **Weighting factors based on test scatter?**
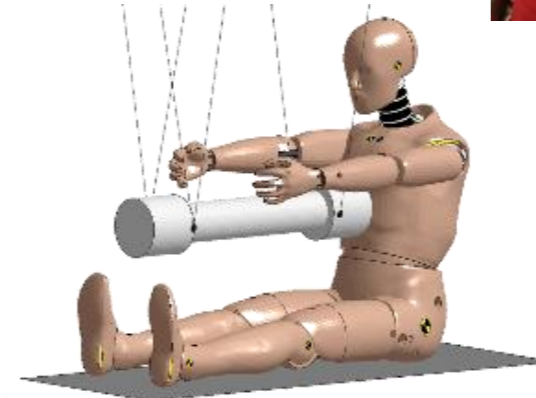
OSCCAR Virtual testing procedure

How to consider real test scatter in a validation procedure?
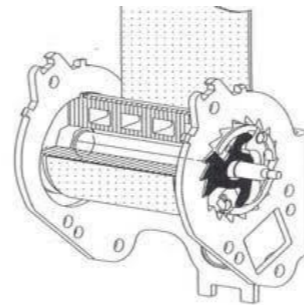
Three main sources of test scatter:

(1) Scatter in real test procedure
(pulse, dummy positioning, belt routing,…)

(2) Variation in validation device
(hardware dummy/tool variation)

(3) Variation in vehicle components

→ Ideas and concepts to address the different sources of scatter in a VT process were developed within OSCCAR → OSCCAR_D5.1_Standardised procedure for validating a vehicle environment for VT (https://www.osccarproject.eu)

Validation device for vehicle environment validation

Motivation for a validation device (VD) in a VT process

- Real testing device (VD) representing the occupant is needed for vehicle environment validation

- VD only to be used for validation not for (injury) assessment!

Requirements for a VD:

- VD as a test device should represent the interaction between HBM and restraint systems in validation load case as similar as possible compared to the assessment simulation (including possible new restraint concepts)

- Realistic human-like (HBM-like) occupant kinematics in the new load case

- Robust, repeatable, reproducible in real testing

- No (advanced) internal instrumentation needed (no injury assessment)

- Corresponding CAE model needed? Or HBM as direct reference?
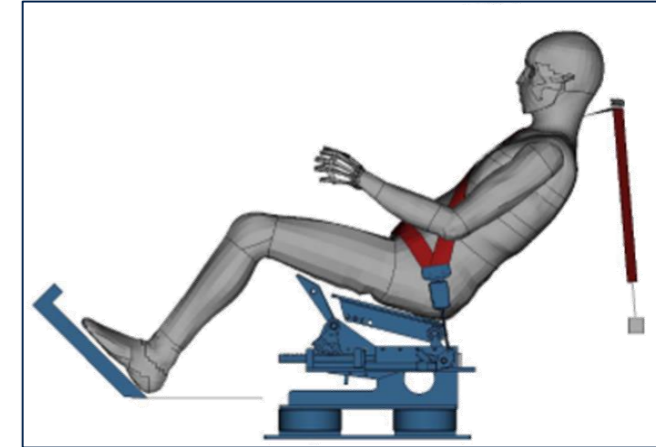
Summary of OSCCAR Results related to VT

- A general process for an HBM-based VT procedure was developed applicable to reclined seating with main focus on a validation-based certification of the sled simulation model

→ The process was applied to a reclined seating demonstration case using sled tests with THOR-50M and Hybrid-III-50M for validation

- Further ideas and concepts how to consider RT scatter in the validation procedure were discussed

- Requirements for an appropriate validation device to be used for validation of the vehicle environment model within this process were discussed

- HBM updates were developed within OSCCAR. Needs for further research to improve HBMs reading biofidelity and injury prediction for reclined seating were identified

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Thank you!

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