

Automotive Simulation Credibility Experience

ANSYS CONFERENCE 2026

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**Add value.
Inspire trust.**

- Main topic (it's all about): **Using virtual simulations in Vehicle approval process**
- Presentation is about to share
 - Actual status of adoption of simulation in „EU“ approval regulatory act system
 - Current experience made on using augmented **simulation credibility** pilot project of frontal crash / FEM (LS Dyna OEM)
 - (similar experience made in active safety area with another OEM out of scope of presentation, but available)
 - Status of process how to adopt horizontal regulation enabling using simulations for approvals in general (likely with exemptions, e.g. emissions...)

Simulations in Regulatory acts or referred in WVTA



Regulatory act	No	Domain (typical, not limited to)	Subject
UN Regulation	58	FEM / Strength	Rear underrun protective devices (RUPDs) and their installation; rear underrun protection (RUP)
Regulation (EU)	130/2012	CAD / Geometry	Vehicle access and manoeuvrability (steps, running boards and handholds)
UN Regulation	11	FEM / Strength; Analytics / Kinematics	Door latches and door retention components
UN Regulation	46	CAD / Geometry	Devices for indirect vision and their installation
UN Regulation	21	CAD / Geometry	Interior fittings
UN Regulation	26	CAD / Geometry	External projections
UN Regulation	48	CAD / Geometry	Installation of lighting and light-signalling devices on vehicles
Regulation (EU)	1005/2010	Strength	Towing device
UN Regulation	125	CAD / Geometry	Forward field of vision
Regulation (EU)	1008/2012	CAD / Geometry	Windscreen wiper and washer systems
Regulation (EU)	1009/2010	CAD / Geometry	Wheel guards
UN Regulation	73	FEM / Strength	Lateral protection of goods vehicles
Regulation (EU)	1230/2012	CAD / Geometry	Masses and dimensions
UN Regulation	61	Fatigue	Commercial vehicles with regard to their external projections forward of the cab's rear panel
UN Regulation	55	Fatigue	Mechanical coupling components of combinations of vehicles
UN Regulation	102	Fatigue	Close-coupling device (CCD); fitting of an approved type of CCD
UN Regulation	107	CAD or MBS / Geometry	M ₂ and M ₃ vehicles
UN Regulation	66	FEM / Crash	Strength of the superstructure of large passenger vehicles
UN Regulation	93	FEM / Crash	Front underrun protective devices (FUPDs) and their installation; front underrun protection (FUP)
UN Regulation	66	FEM / Crash	Strength of the superstructure of large passenger vehicles
UN Regulation	29	FEM / Crash	Cab strength
UN Regulation	127	FEM / Crash	Pedestrian protection
Regulation (EU)	2022/1426	MBS / Active safety	Automated vehicles L4 in Small series
UN Regulation	157	Strength	RUP
UN Regulation	58	Strength	LPG
UN Regulation	67	Strength	CNG
UN Regulation	110	Strength	HYDROGEN
UN Regulation	134	Strength	ESC
UN Regulation	13H	MBS / Active safety	ESC
UN Regulation	140	MBS / Active safety	AEBS M1/N1
UN Regulation	152	MBS / Active safety	AEBS heavy duty
UN Regulation	131	MBS / Active safety	DCAS
UN Regulation	171	MBS / Active safety	ADS
Regulation (EU)	tbd	MBS / Active safety	ADS
UN Regulation	11	FEM / Strength; Analytics / Kinematics	Door latches and door retention components

How to get more?
Answer is ...?
Simulation Credibility Assessment

WVTA:
2018/858,
Annex VIII

Regulatory act
itself



Fresh wind for vehicle approvals @ Stakeholders



- Potential for utilization of virtual simulations for **homologation / certification** has never been higher
 - Supports **sustainability** via reduction of CO2 emissions of HW test samples
 - Reduces technical development **time** as well as Homologation lead-time
 - Brings the opportunity to **increase** the **effectivity** of safety measures addressing the physically invisible phenomena.
- **Approval authorities** are supporting and even pushing broader application
- **Technical services** are ready and actively contribute on process establishment. Competence needed: inhouse testing & simulations, homologation, auditing and more...
- Still there is **CoP**, **Market surveillance**, product safety and **liability** for defective product (state-of-the-art)

Different needs @ Manufacturers & Developers

Same approach: Keep quality, add efficiency

Message: Communication is a key, **Virtual Testing Management System** establishes the roles and processes, thus supports the communication intra/extra company

OEM



- Modelling and Simulation toolchain integration (n' develop)
- Responsibility for the whole car as product as well as the processes
- Defines the M&S management system

Engineering Service Provider



- Work within M&S management
- Often integrated to OEM
- Toolchain user

SW Tool developer



- Tool(chain) development
- Responsibility for the toolchain itself

Passive Safety / Crash Experience of Simulation Credibility Assessment

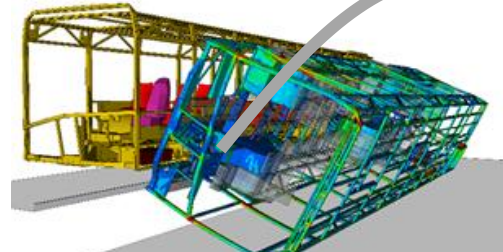
R137 – Full frontal crash focused to restraint systems

History of virtual testing (VT) in crash (Europe)

Horizontal regulation 



There's no way back...

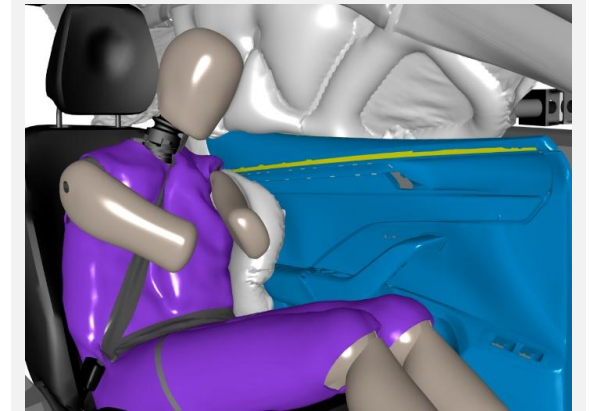


- Bus rollover
- Cab strength

- Annex XVI (8) to framework regulation e.g.:
 - Door latches & hinges
 - Head impact zone
 - Authority guidelines

- Individual approvals [ped. protect]
- (ALKS); ADS; DCAS >> **Simulation Credibility Assessment**
- EuroNCAP virtual far side
- WG EqOP Equity
- EuroNCAP crash protection
- **Frontal crash pilot: Simulations as crash ALTERNATIVE method proven by KBA (DE), LS-DYNA environment**

- WP.29 Proposal for R.E.3 Annex 8
- Wide consideration VT as an alternative to physical
- **Simulation Credibility as a must for virtual simulation acceptance in approval process**



1986 - 1999

2010 - 2018

2021 - 2025

2026 - ???

Rocket science?

- Simulation credibility assessment comes from NASA (**NASA – STD-7009A**) (originally assessment for fluid dynamic simulation)
- Good enough for crash & FEM?
 - **Yes >> It's universal**
- Anything missing for crash approvals?
 - **Yes**
 - **Processes**
 - **FEM/crash related topics**
 - **Defined KPI's**
 - Applicant & Assessor



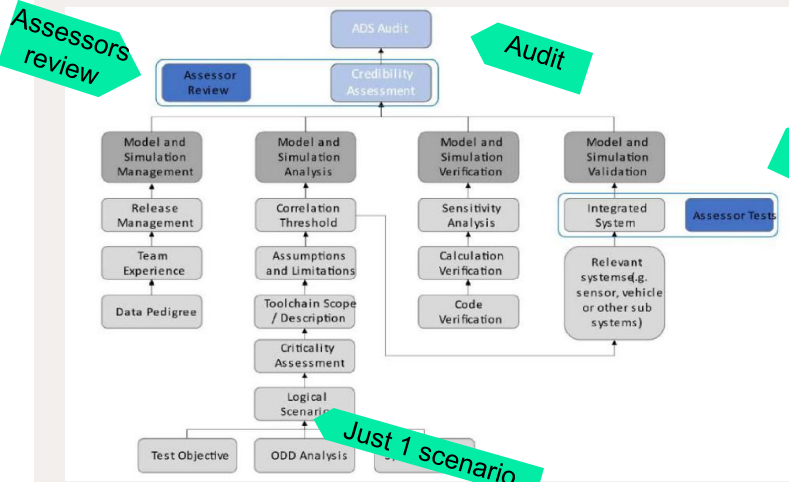
Example: Crash/FEM Processes (Activities)



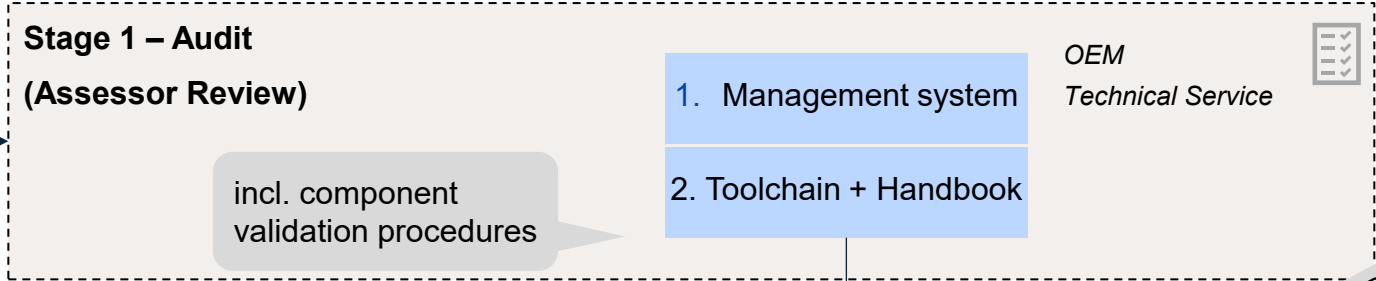
possible scheme

MAIN PILLARS:

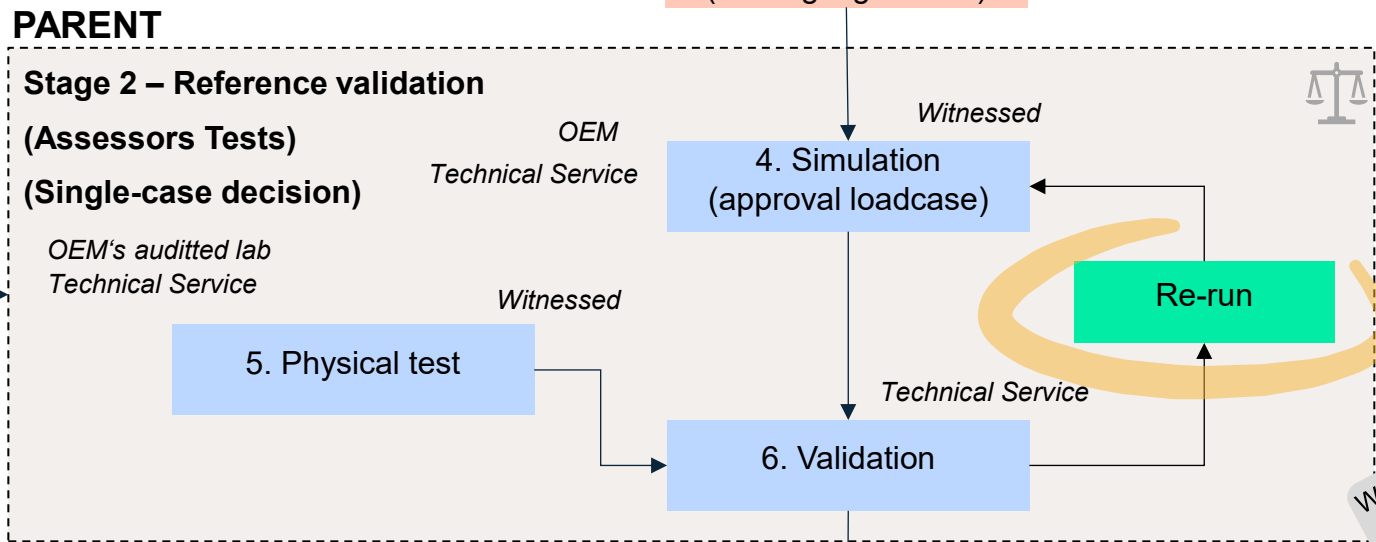
- R171 - Principles for credibility assessment for using virtual toolchain



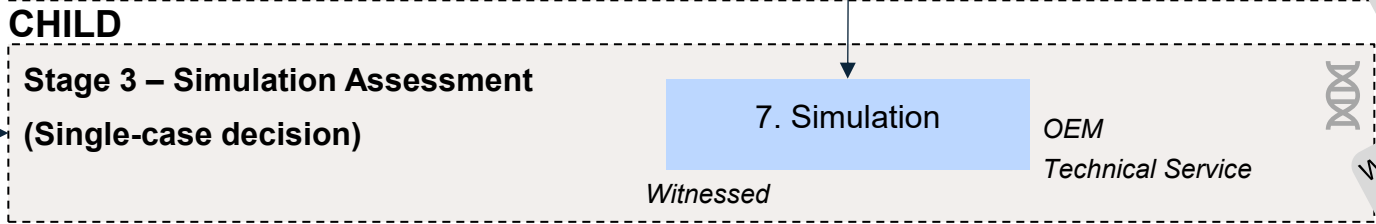
- + EuroNCAP state-of-the-art
- + Specific requirements



WP.29-197-14 Activity 1



WP.29-197-14 Activity 1



WP.29-197-14 Activity 2

Example: FEM Credibility levels



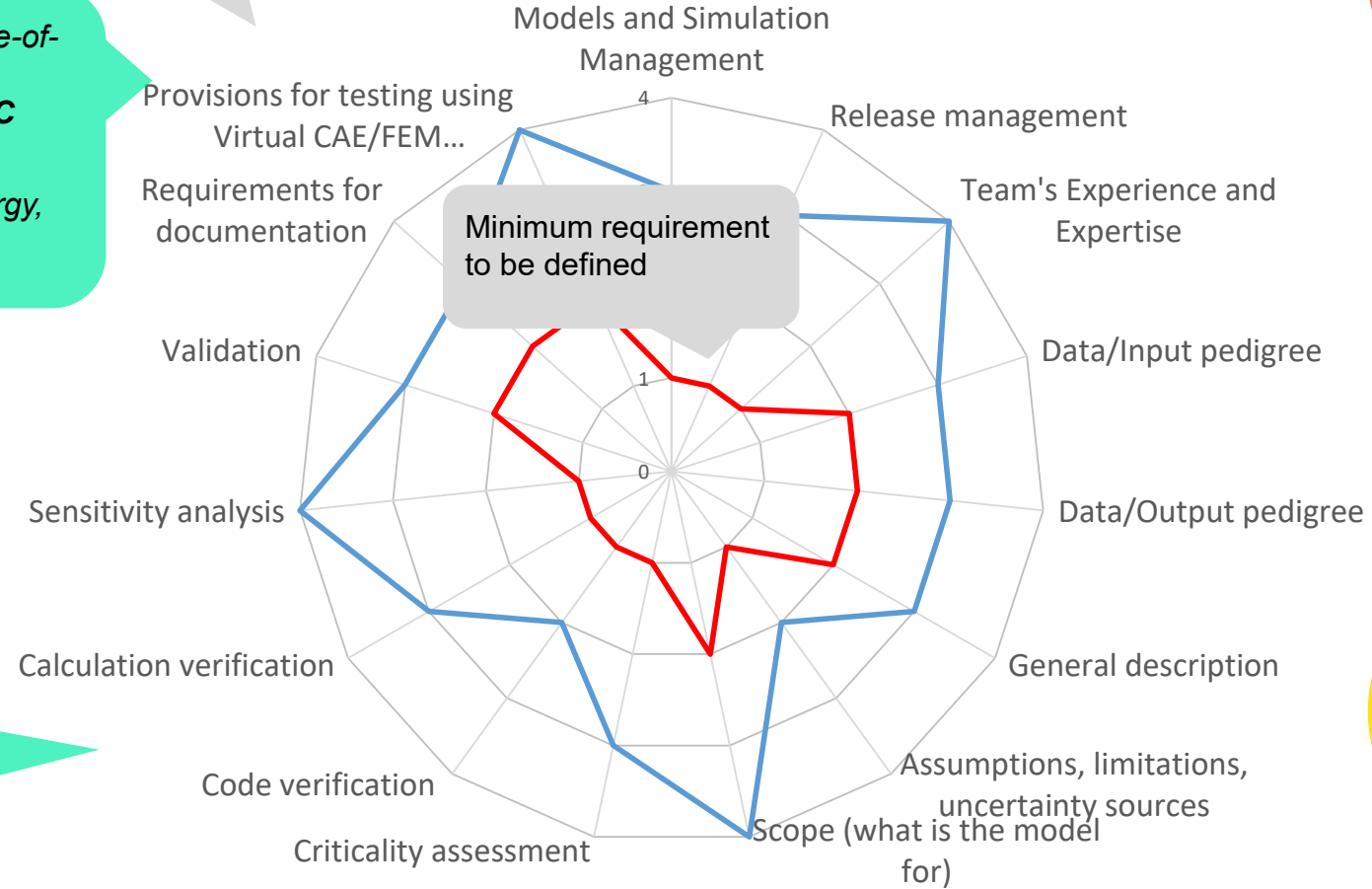
- M&S
- Management
- Analysis & Description
- Verification
- Validation

Addition of the state-of-the-art simulation **DOMAIN SPECIFIC requirements**
 e.g. hourglass-energy, massscaling etc, EuroNCAP like.

Credibility levels for each factor

Credibility Assessment Scale FEM

— Threshold — Achieved



Uncertainties >> Safety margin (@parameters)

Add 3rd party **software evaluation** of critical tools to keep the „ILAC“ quality established e.g. for physical calibrations

Risk based (@Tools & Models)

Audit incl. Simulation Handbook

like ISO 17025 for simulations

Model and Simulation Management

- **General management**

- Simulation and test management e.g. ISO 9001... (or lab evaluated); ISO 17025
 - Periodical exchange & re-audits
- Input/Output data pedigree: Tracking, e.g. automated procedures for prevention of human errors, documentation
 - Saving the entire simulation not feasible
- Release management: e.g. unique ID of the setup of the toolchain and simulation task

- **Experience & Expertise**

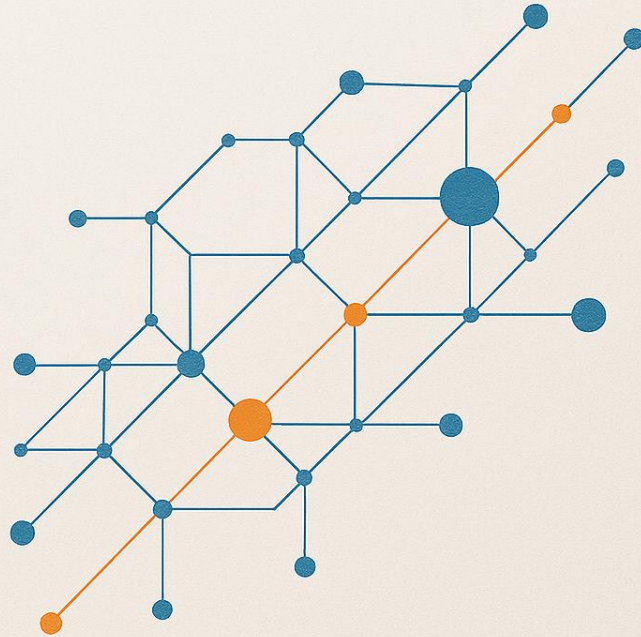
- **Independency** of tool developers/assessors and users is achieved
- Training **evidence** is really important



Analysis & Description



SIMULATION HANDBOOK



March 12, 2026

Jan Hnilica, dpt XYZ

- Scenario definition
 - Full-scale (crash) is given
 - Describe those for **validation** of sub-models, components, materials...
- Description of assumptions, limitations, uncertainties; scope
- **Criticality** assessment @ Tools and models
 - Risk approach (aka ISO 26262), e.g. modelling maturity vs. safety risk
 - Shows the **tools & models** with the most detailed analyses and attention
- **Simulation handbook** split acc. to IP protection:
 - Hand over of general part
 - Rest is made available

Verification of M&S: Correct methods

- **Code** (logical flaws)
 - Own scripts and SW tools incl. excel formulas
 - e.g. Solver > ask timely the supplier (e.g. verification manual, ideally assessed by **3rd party**)
- **Calculation** (numerical errors)
 - Rounding errors etc., typically small compared to physical / concept errors
- **Parameter sensitivity analysis** (input-output function known, sufficient scope)
 - „Fundamental role“ > definition of critical parameters > **for uncertainty evaluation**
 - **Safety margin** dependency on **physical test quality** and known uncertainties

$$u_c(y) = \sqrt{u_1^2 + u_2^2 + \dots + u_n^2}$$

Vocabulary

#Error
#Accuracy
#Precision
#Scatter
#Variance
#Uncertainty
#Safety margin
....

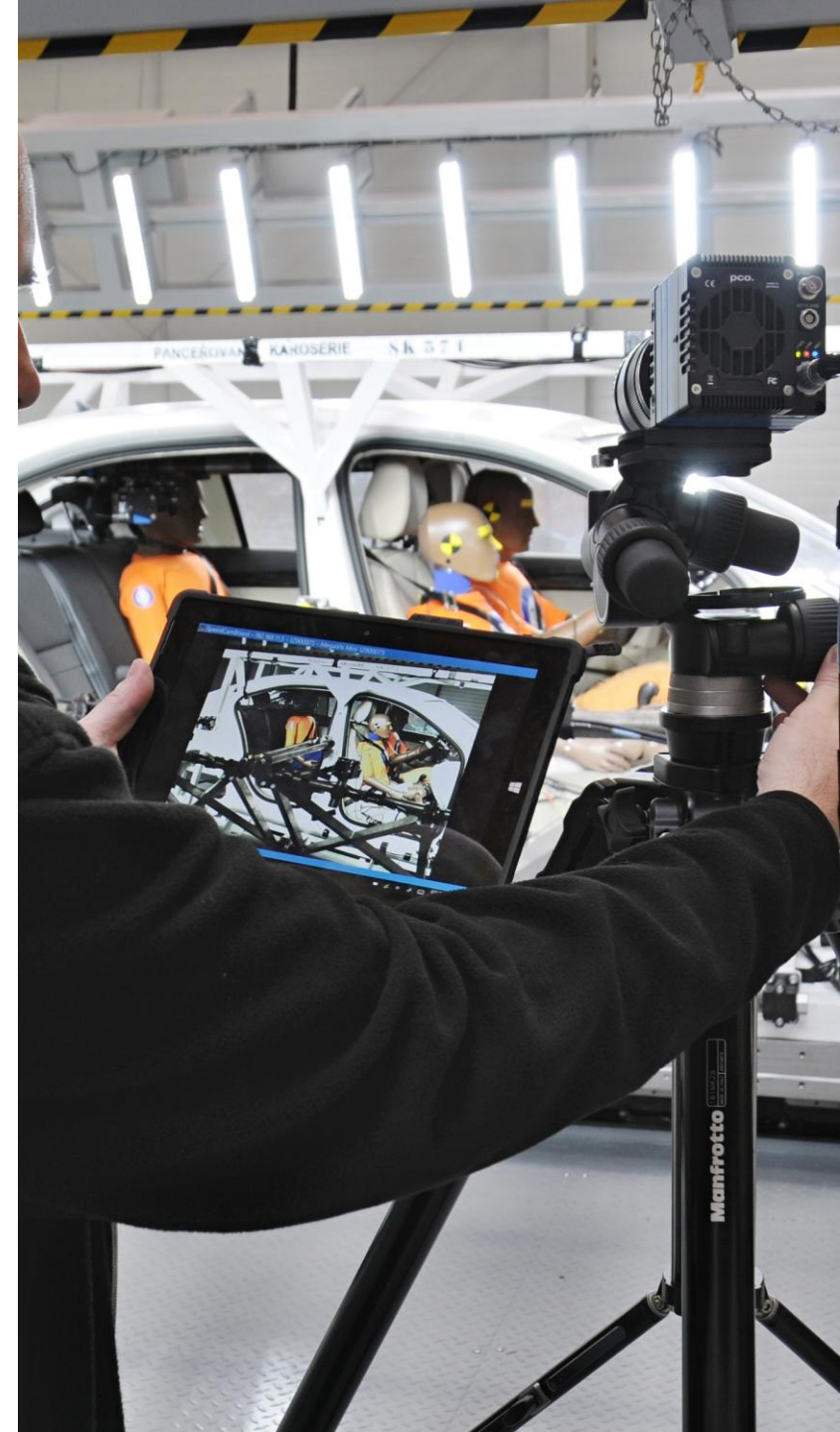


Validation: Quantitative determination

- **Approach**

- Measures of performance (e.g. dummy head acc, B-pillar acc)
 - Goodness of fit (metrics e.g. S_{sensor} acc. to ISO 18571:[2024]; d_{AC})
 - Accuracy requirement (limit value e.g. $S_{\text{sensor}} < [0,5]$)
-
- Full scale comparison is the culmination of validation activities done before
 - Plenty of tools and models to be validated, focus on restraint systems
 - Validation tests more **instrumented** (development like) in contrast to pure homologation tests
 - e.g. **Crash dummy models** > validation including verification, code etc., ILAC standard? If not present, then at least OEM's quality checks instead

$$d_{AC} = \left| \frac{AC_{test}}{AC_{limit}} - \frac{AC_{sim}}{AC_{limit}} \right|$$



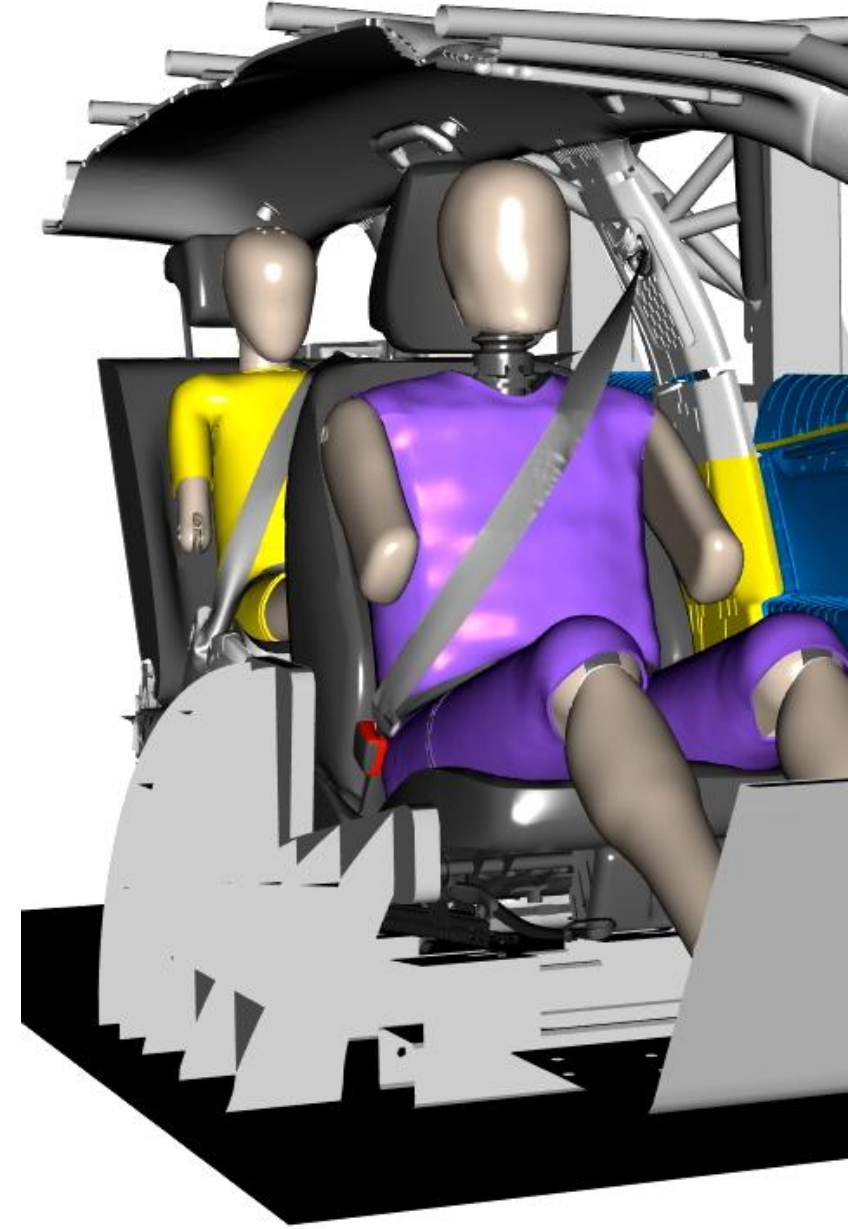
Family building. Scope.

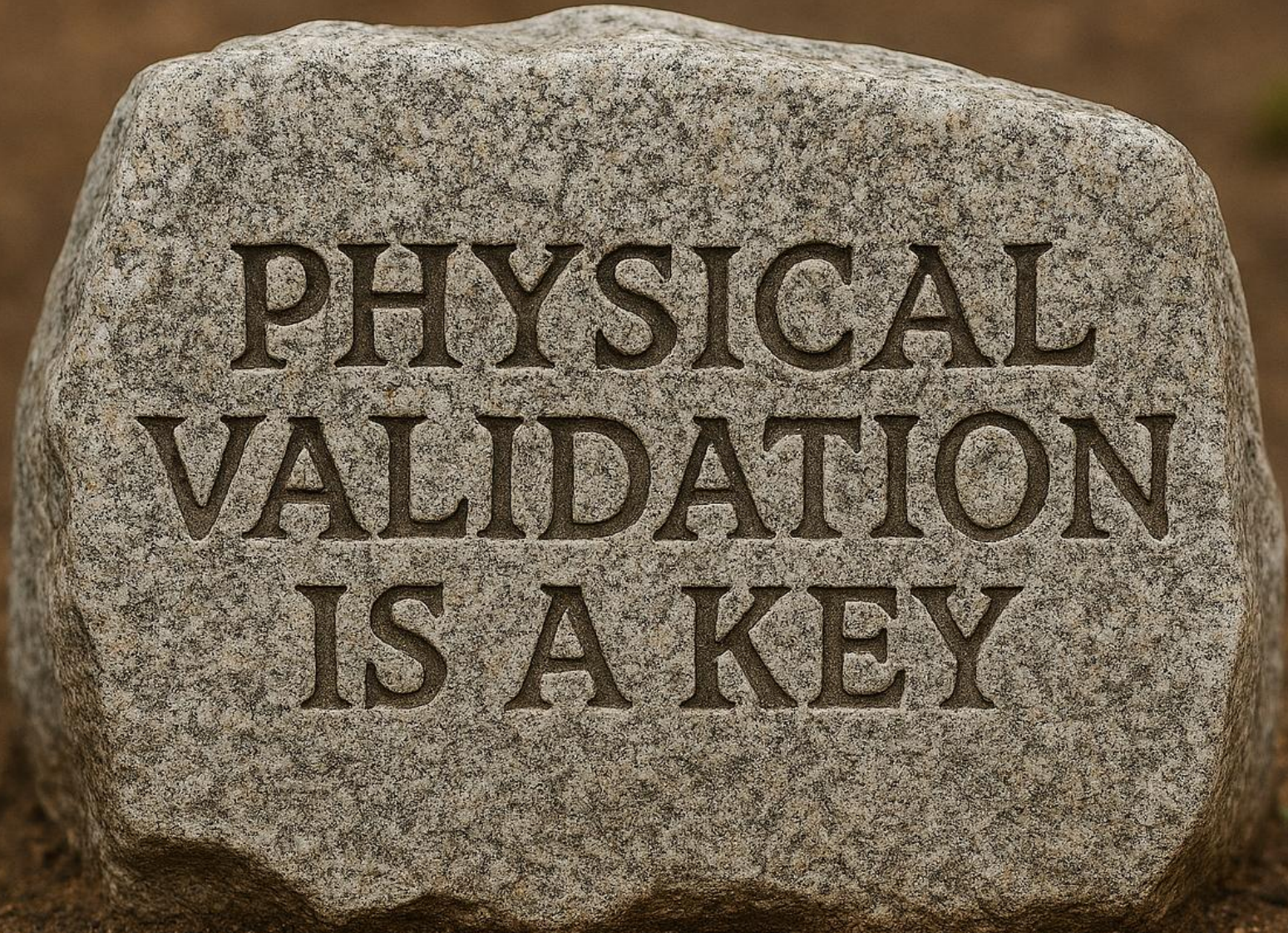


- **Family**
 - Range of parameters of the vehicle to be covered by full-scope validation crash
 - e.g. derived bodywork styles; different seating positions (future), ...
- **Parent**
 - Representative of vehicle family both in the physical world as well as simulation model during the full-scale **validation** (crash)
- **Child(ren)**
 - Same physical as well as simulation **DNA**
 - Done in the already **audited** environment verified and **validated** toolchain
 - **Safety margin** resulting from uncertainties applied to the results
 - e.g. bio-criteria

Other comments

- Documentation
 - Simulation **handbook**
 - Reports: Audit **report**, test & comparison **reports**, validation **report**, technical (homologation) **report**
- SW In-the-loop: SW evaluation needed e.g. **sensoric SW** performance (> **Functional Safety**)
- **Indirect evidence** of electric safety or fuel drip, buckle opening force, door opening > analysis & reference to physical (parent) test
- **Single case decision** (based on analysis, evidence and discussion)
 - e.g. Possibility for expert to say no/better or justification of higher efficiency: e.g. case of Safety margin breach





Take it or leave it



- In testing there is always something to go wrong
- Prevention: ISO 17025 and like = Simulation credibility assessment
 - KPI's to be harmonized
- No (credible) simulations without physical (or other relevant) M&S validation

Next (Automotive) steps



- Formally
 - Intention to move on with latest existing document, means **ADS** GTR draft regulation made **universal enough**
- Technically to solve missing or unclear points, e.g.:
 - Definitions, terminology,
 - STU/component coverage,
 - Criticality analysis harmonization
 - Audit skills,
 - **Credibility level definition**
- Next discussion after summer break in September

Active Safety / ISA Experience upon request....

Thank you!



INTERESTED IN:

- Simulations & it's Credibility
- Functional safety & SOTIF
- Cybersecurity
- AI

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DOPRAVA 2030 contribution?

- Automared driving [flying?]

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