ATD Development – Status THOR-AV

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Some Facts on Automated Vehicles

- Basically, all OEMs and all Tier1 suppliers globally are working on automated vehicles
- They are competing with numberless high-tech companies for sector dominance

Google 阿里巴巴 Alibaba.com™ Baidu 百度

- Automated vehicles will be a step forward towards the Vision Zero
- However, many experts are sure that accidents will not disappear immediately – but may even increase in the beginning

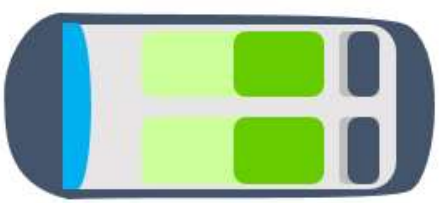
Logos above are property of the respective companies and only used to illustrate potential involvement in automated vehicles‘ development.

Occupant Safety vs. Seating Position

Manual driving
Standard positions and load-cases

Illustrations: ZF Occupant Safety Systems 2018
acc. to Jarouche 2018, IEDAS, Ingolstadt 2018

Working High levels of freedom to increase productivity



Relaxing Relaxed seating positions

Lounge Entirely new seating positions

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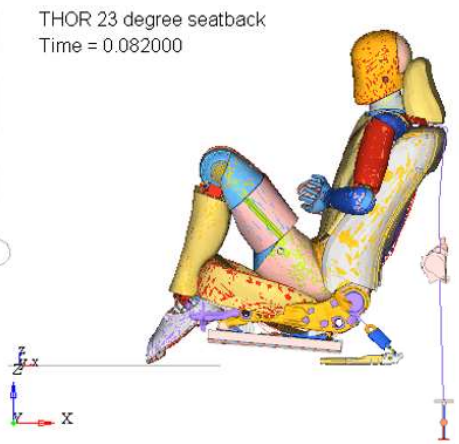
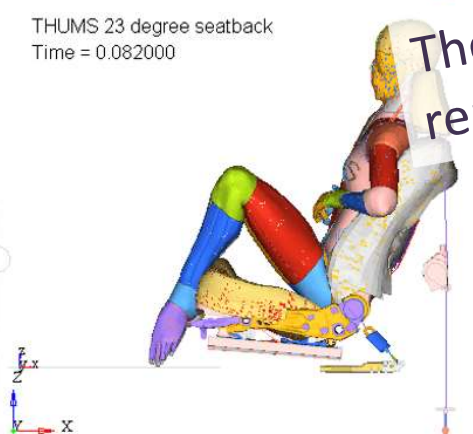
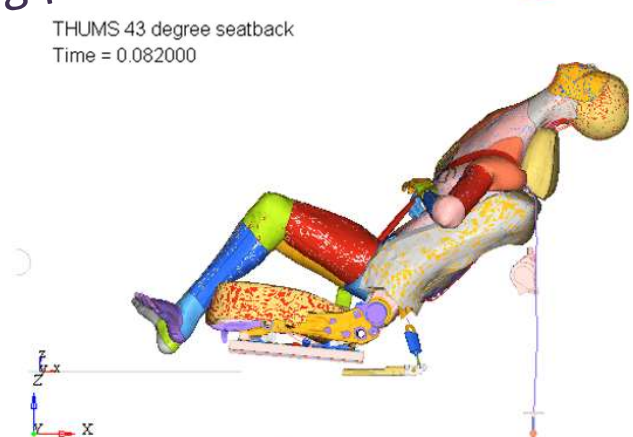
Rearward Seating Positions (Example)

	Standard	Relaxed	Lounging
THOR			
THUMS			

The THOR as the most advanced ATD cannot fully represent occupants in such seating positions

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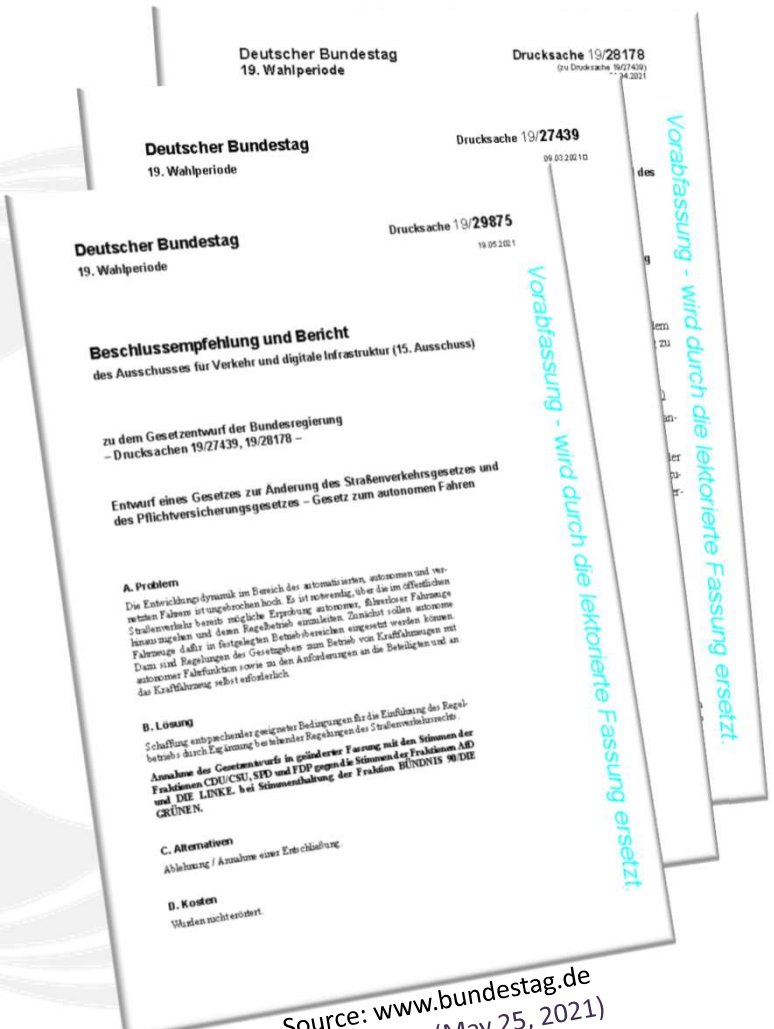
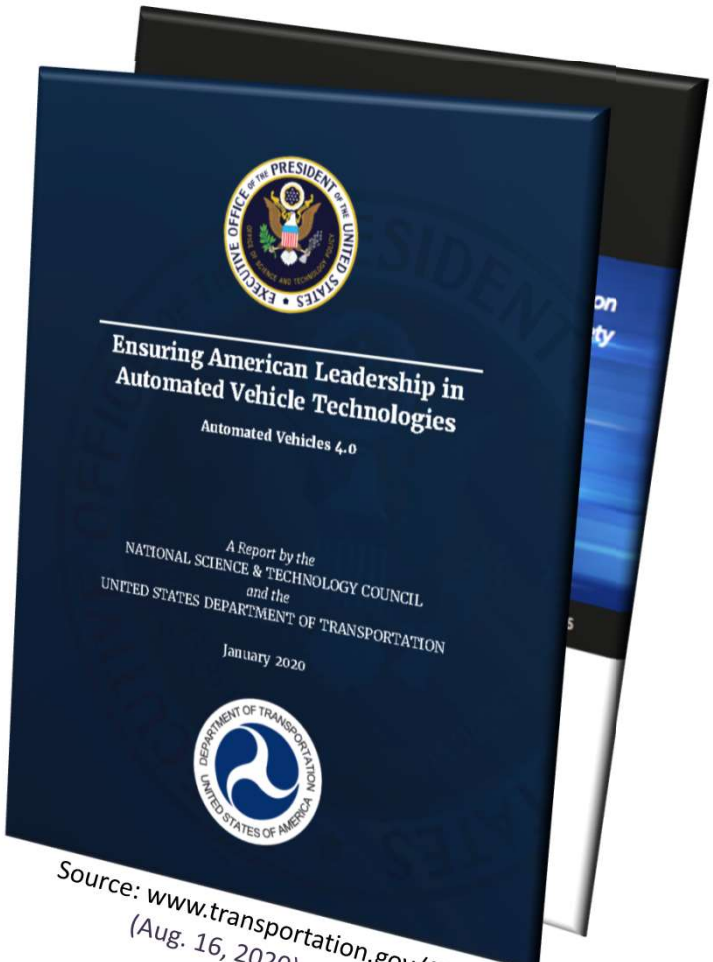
Legislators' Policies



Source: www.bundestag.de (May 25, 2021)

- Legislation processes seem to slow and to complicated for such a new and fast developing subject
- However, legislators do not wish to block progress but also are committed to safety of vehicle occupants
- Occupant safety is not specifically highlighted but certainly expected to just be considered
- Guidance is limited: Industry to assure that no unrealistic promises are made and available resources are considered appropriately

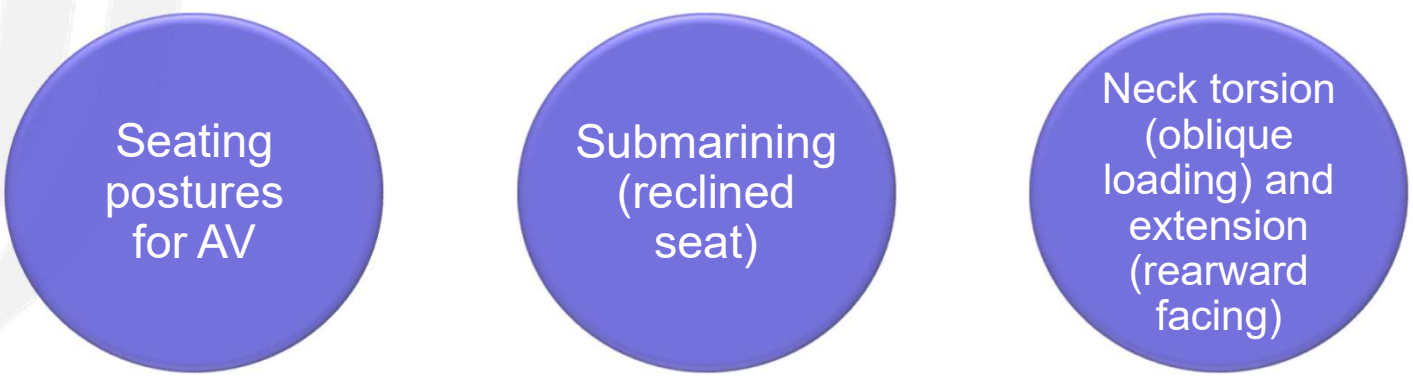


Source: www.transportation.gov/AV (Aug. 16, 2020)

Automated Vehicles' Occupant Safety

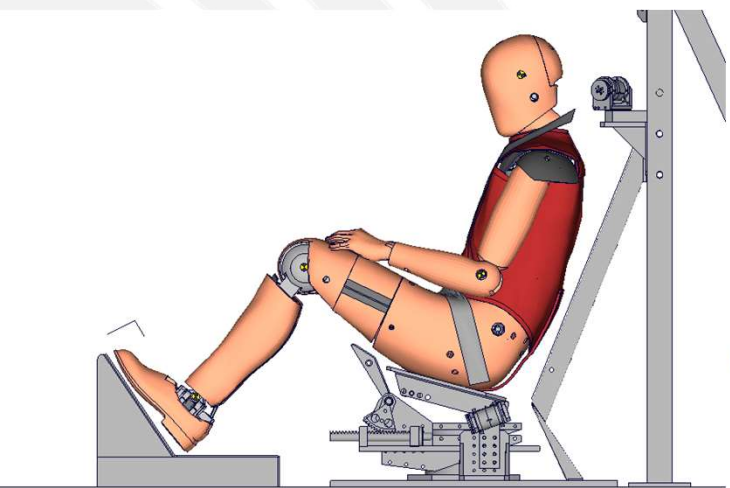
- Knowledge on AV occupant safety testing is limited
- Humanetics initiated the THOR-AV project in 2018
- First step is to make the minimum necessary changes to provide an immediate tool for testing, and then to improve the tool as we gain more knowledge into the process

Main areas of necessary improvements identified

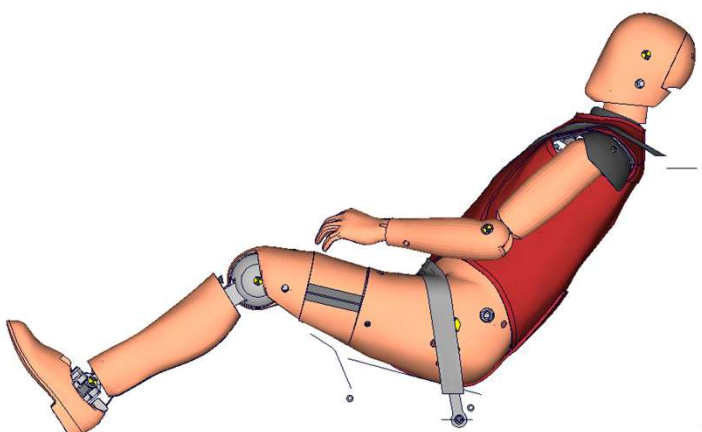


Seating Postures at Different Seatback Angles

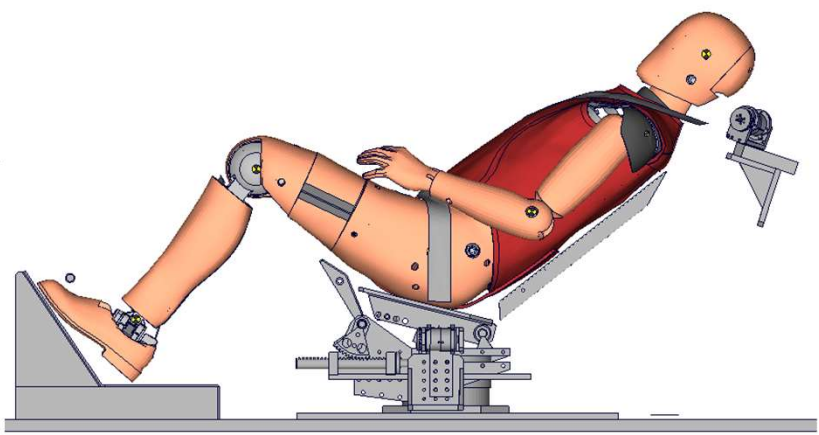
25°



45°

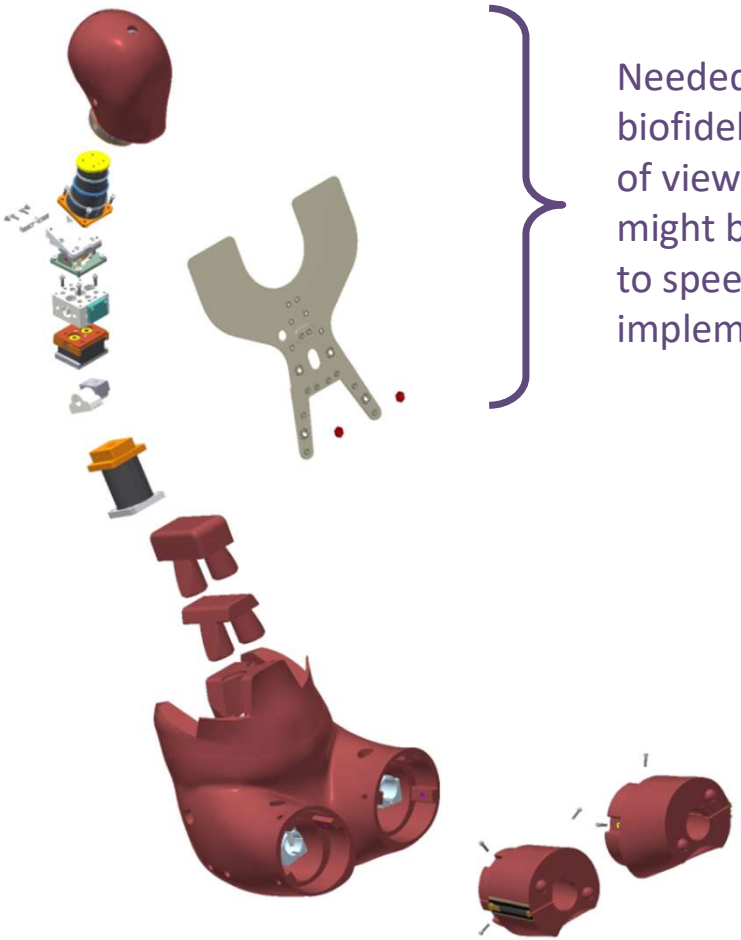


60°



Based on Reed, Ebert 2018

THOR-AV-50M

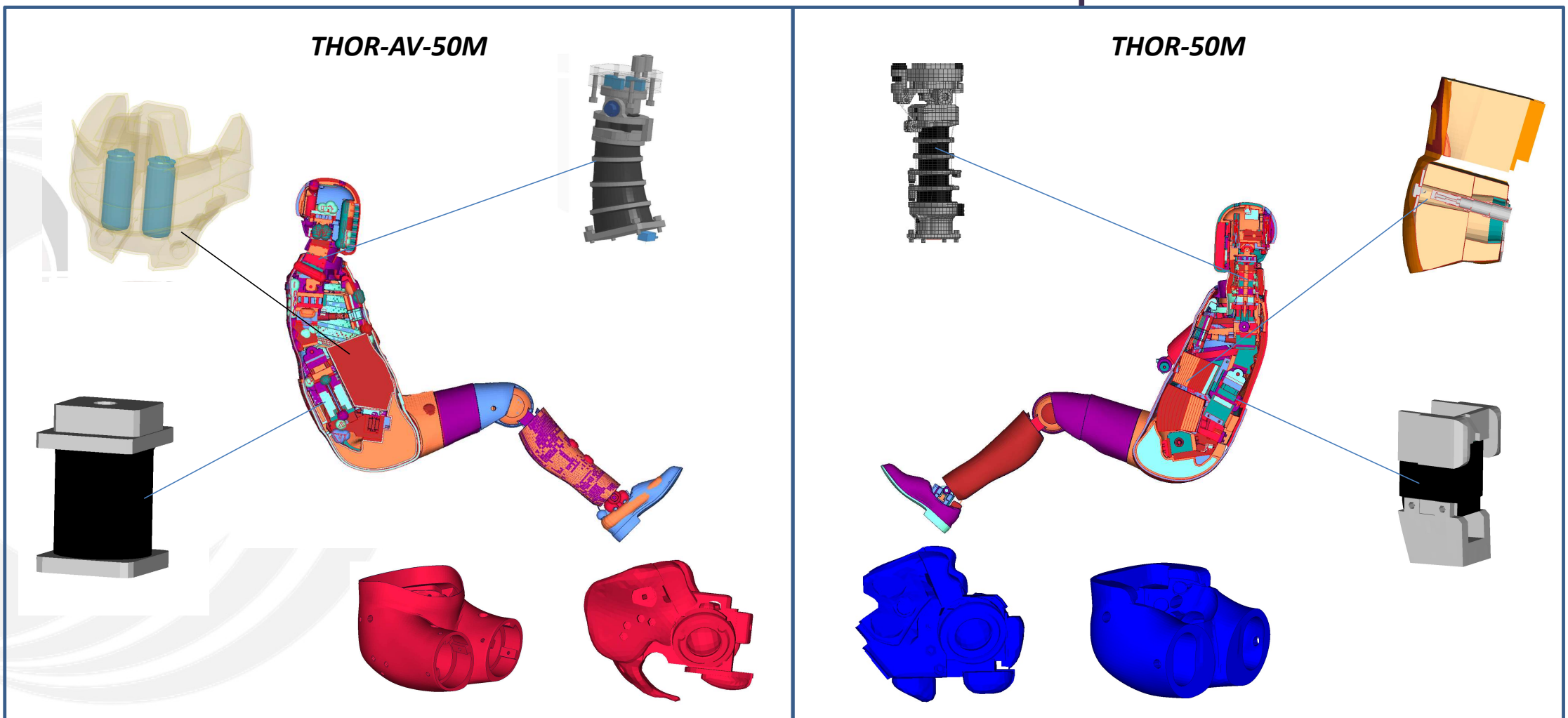


Needed from a biofidelity point of view – but might be skipped to speed-up implementation

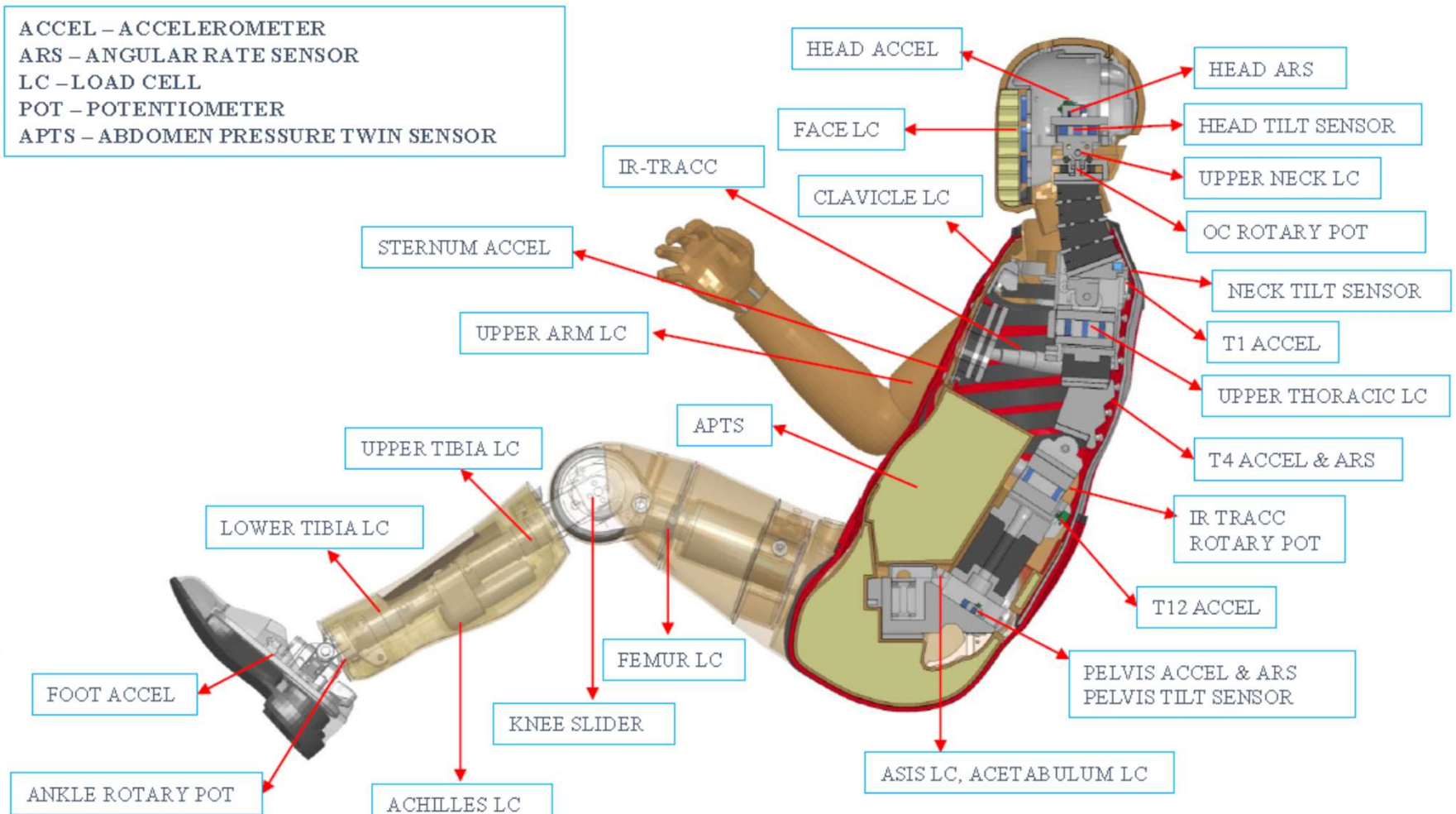
Figure does not show the final version!

- Numerous modifications to achieve reclined seating positions as in automated vehicles
- Complemented by further improvements to the existing THOR-50M ATD
- Aiming for high biofidelity ranking in forward, rearward and lateral seating positions
- Based on latest biomechanical research
- Users to decide for a new dummy, a full AV kit or a simplified kit for reclined seating only

THOR-AV-50M in Comparison to THOR-50M



THOR-AV-50M Instrumentation



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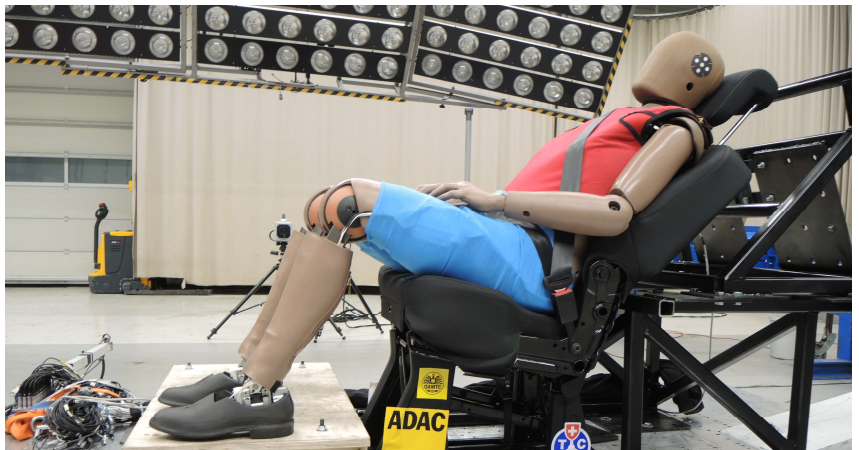
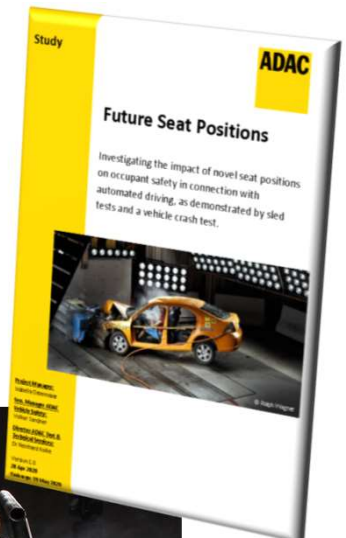
Testing with THOR-AV-50M

- THOR-AV-50M is a tool to meet immediate needs for the fast growing AV restraint system development
- THOR-AV-50M goals
  - Test alternative seating postures
  - Further improve biofidelity
  - Starting forward and rearward
  - Provide hardware and FE model
- NHTSA's PMHS test program is expected to provide further know-how

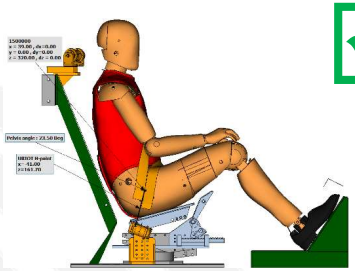
PMHS = Post-Mortem Human Subjects





Sources: ADAC

Biofidelity Evaluation of the THOR-AV-50M (not yet finalized)



Uriot et al. 2015 Stapp
setup with LAB seat (25deg)

Richardsen et al. 2020 IRCOBI
setup with LAB seat (50deg)

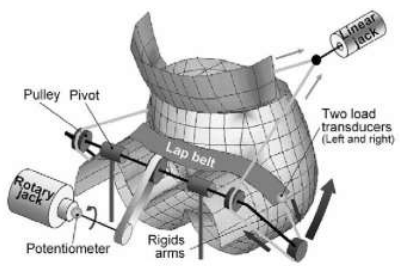
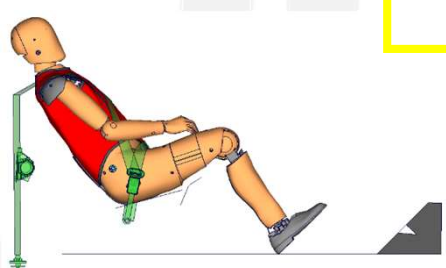


FIGURE 2: Test set-up.

Uriot et al. 2006 Stapp
setup of CEESAR for belt pulling test



UMTRI setup with LAB seat (45deg)

Faurecia with LAB seat (60deg)

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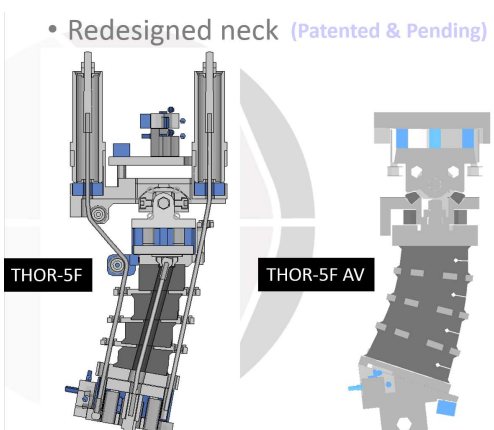
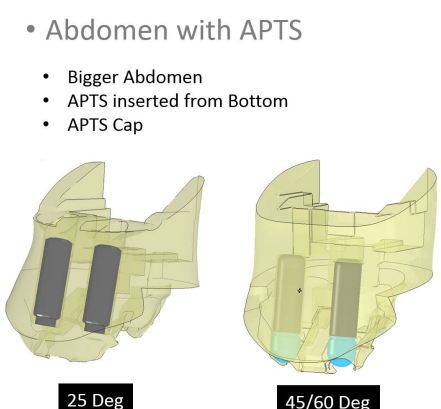
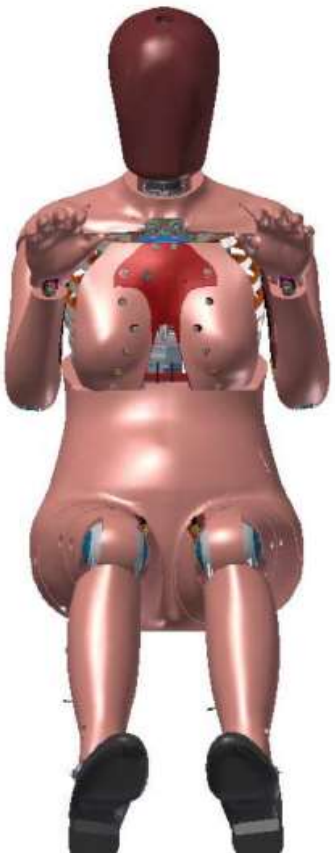
Introduction THOR-AV-5F

- THOR-AV-5F is based on THOR-5F dummy
- Less design changes required due to better recent THOR-5F design
- Updates from THOR-5F to THOR-AV-5F are mainly abdomen and neck



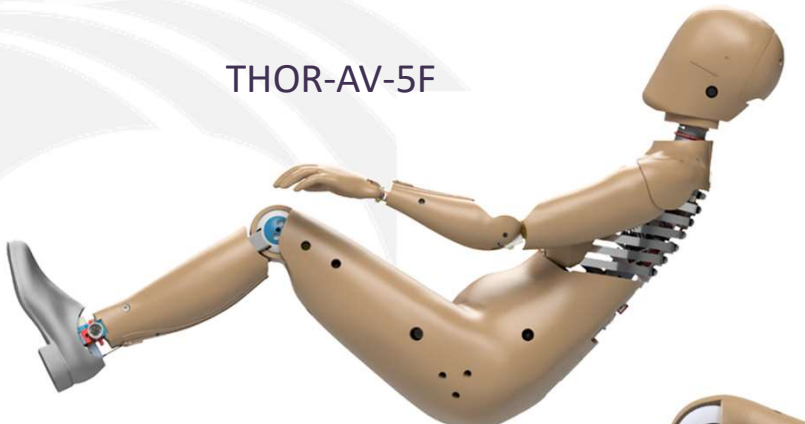




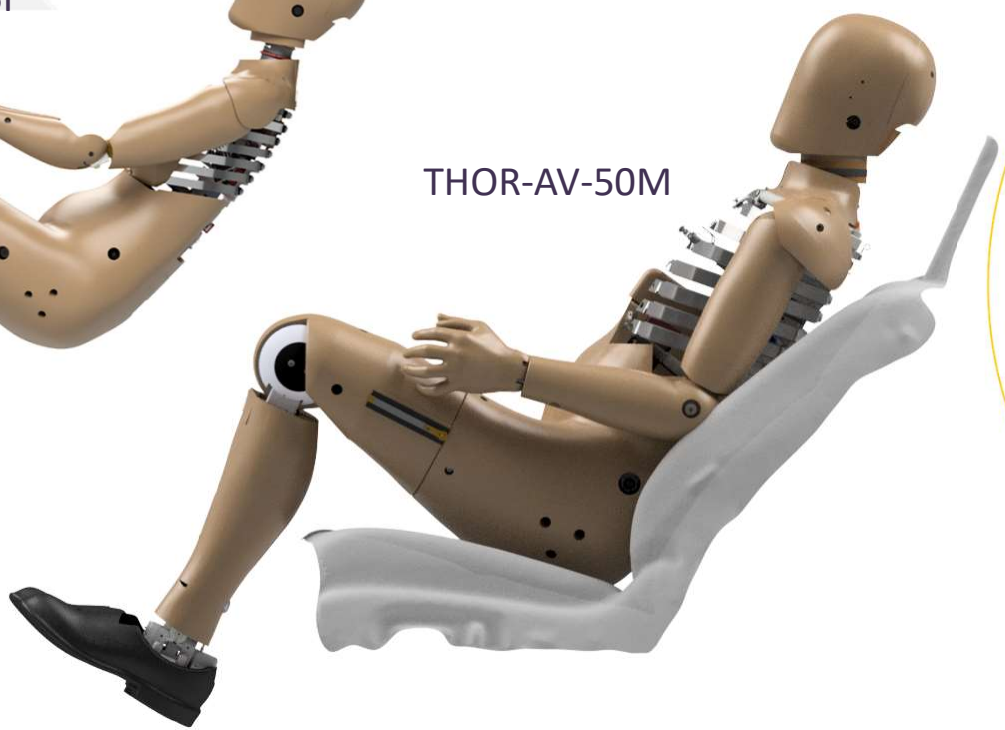
ATD Solutions for AV

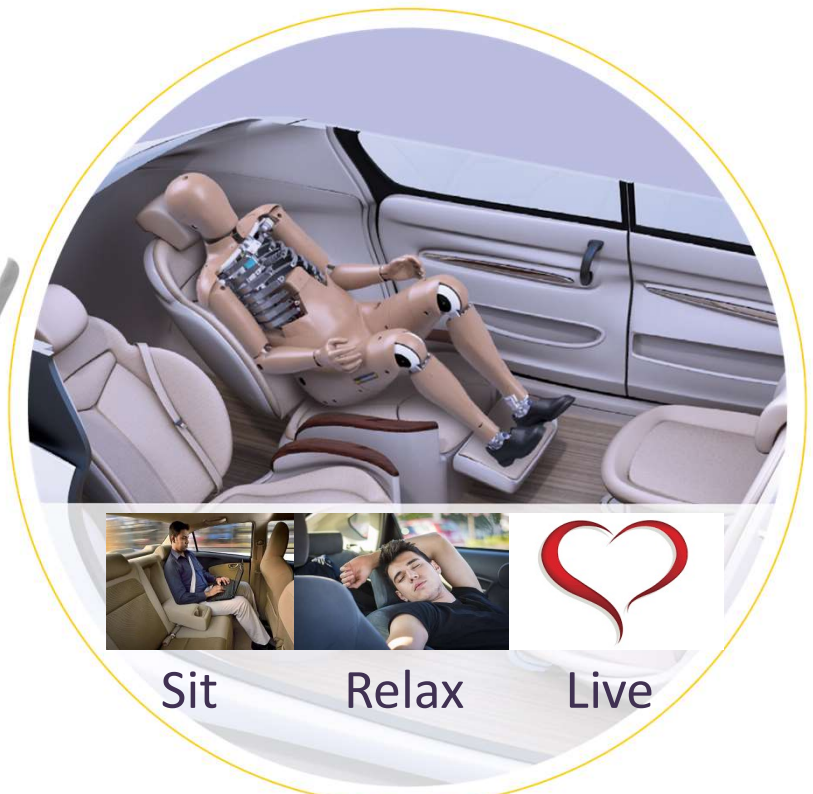
For both hardware available, CAE model available, feel free to contact us for a budgetary quote!

THOR-AV-5F



THOR-AV-50M





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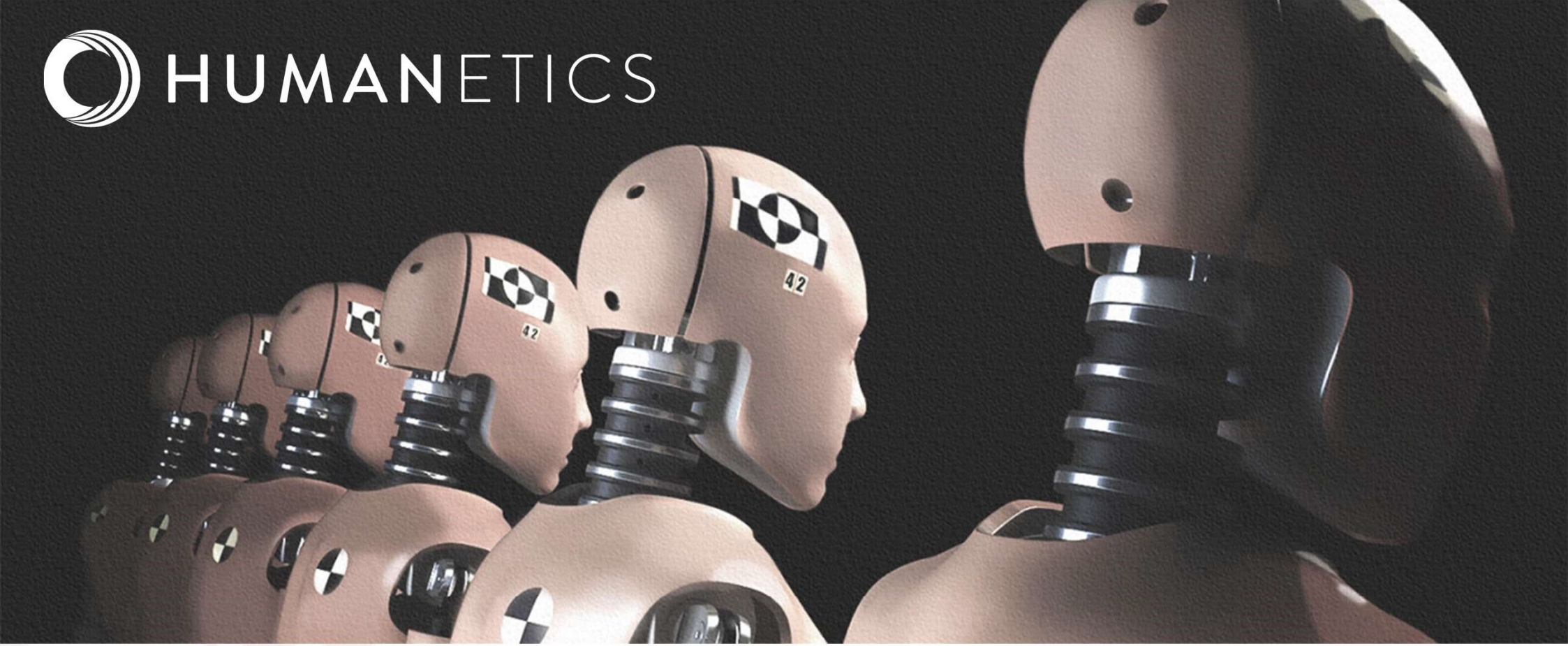

Thank you!