



Occupant Safety Prediction

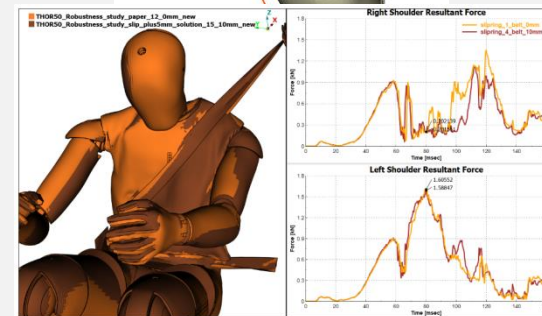
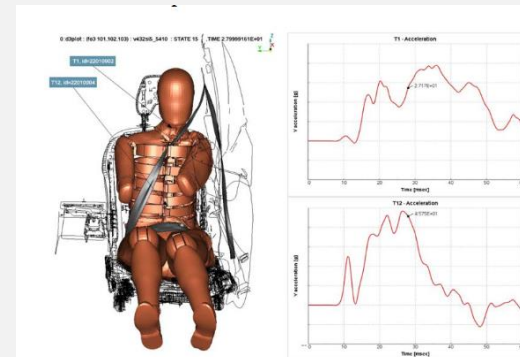
physics on screen

Occupant safety

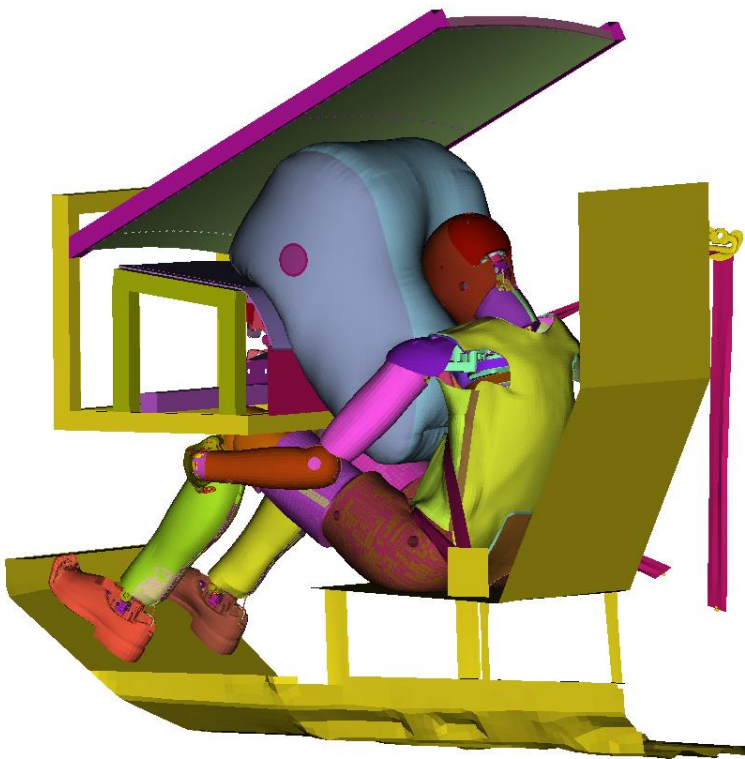
Occupant Injury Criteria, a Complete Solution for the Evaluation of Occupant and Structural, Simulation and Physical Test Results in META - 2018

Post-processing of the 2020 Euro NCAP Frontal Impact test in META-2019

Performing DOE Studies in Occupant Protection using BETA CAE Tools - 2020



Occupant safety prediction

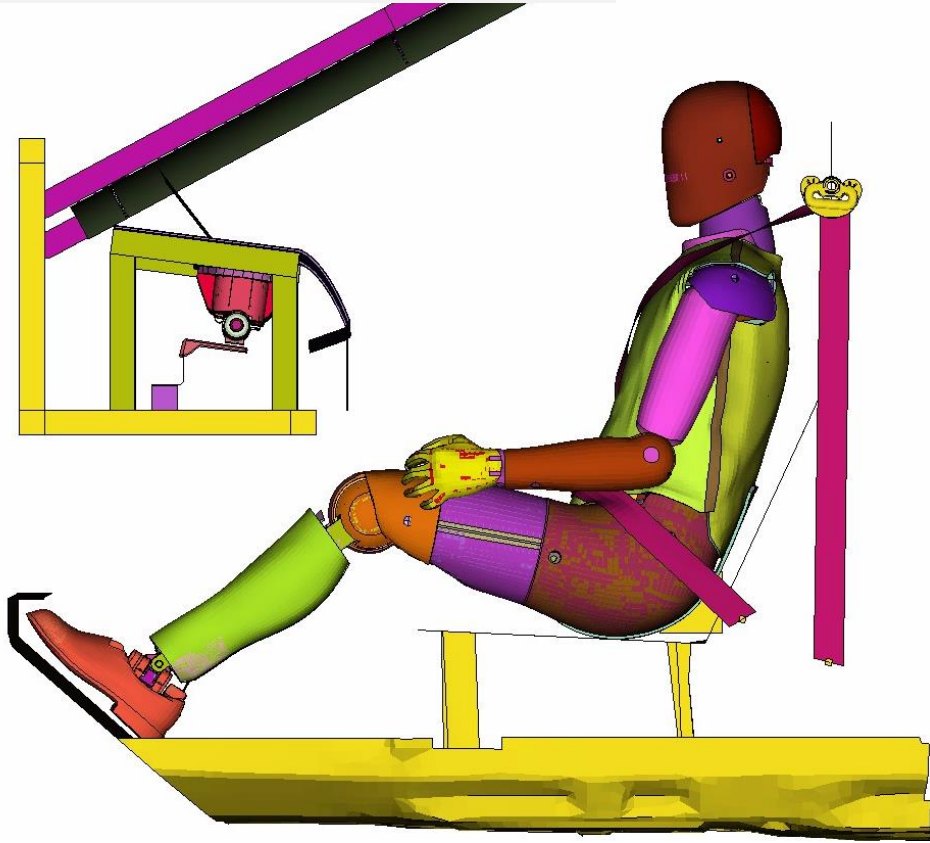


Simulation:
Sled test impact with
restraint and airbag

Steps:

- Parametric Modeling of sled test with ATD*
- Design Of Experiments
- ML Training and what if studies
- Optimization
- ML 3D/2D Results prediction of optimum design.

Occupant safety prediction



Load case

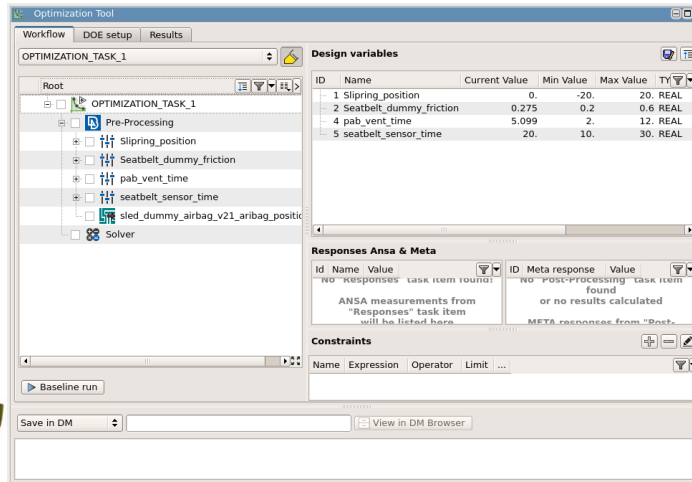
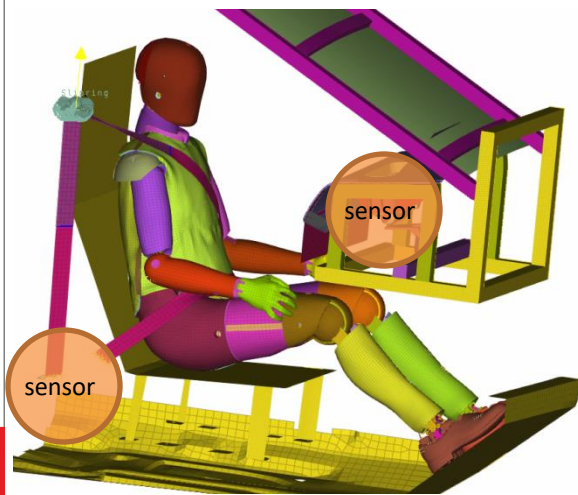
THOR 50 ATD

Sled test with airbag

Speed :32.7km/h

Occupant safety prediction

- Slip ring position (Z axis).
- Friction coefficient between seat belt and ATD
- Airbag venting trigger time
- Seatbelt sensor trigger time

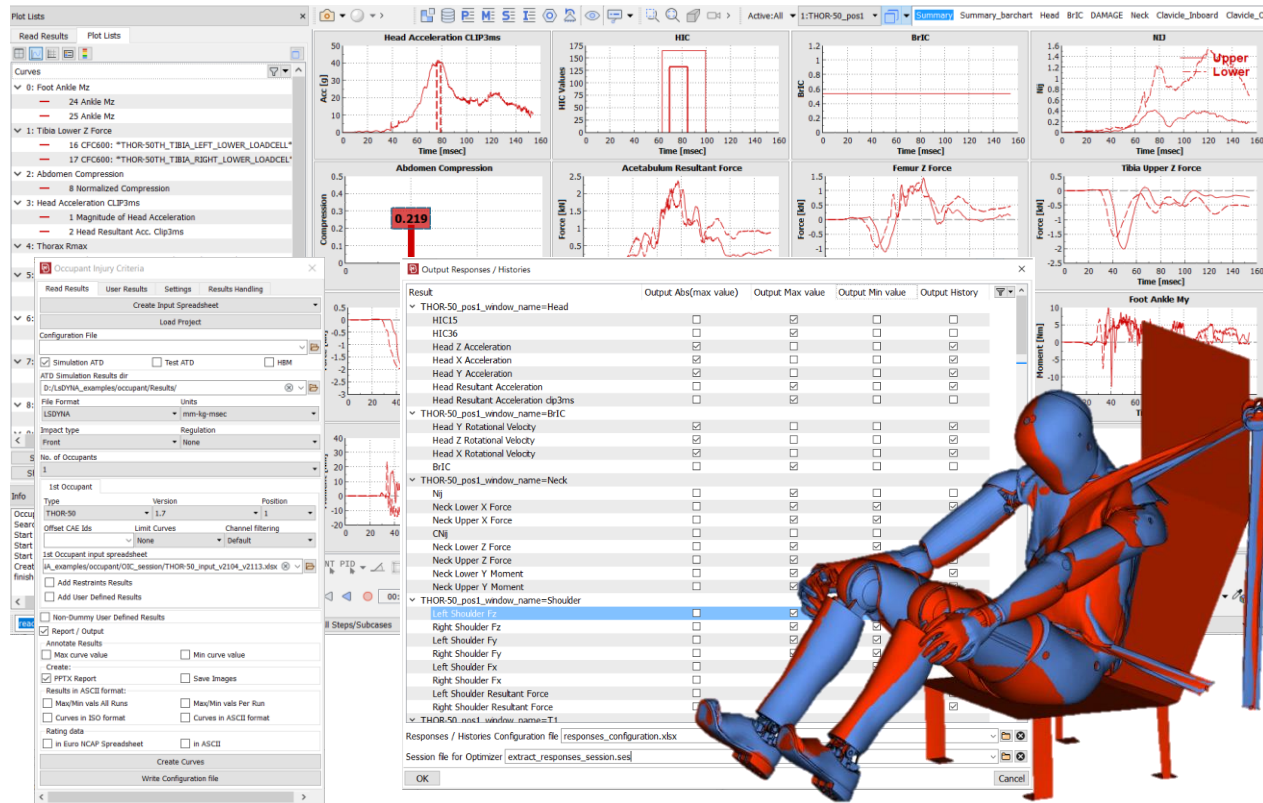


Parametrization

Design Variables

Optimization task

Occupant safety prediction

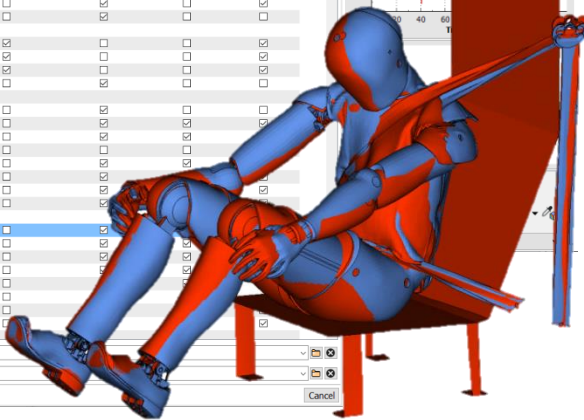


Post Processing

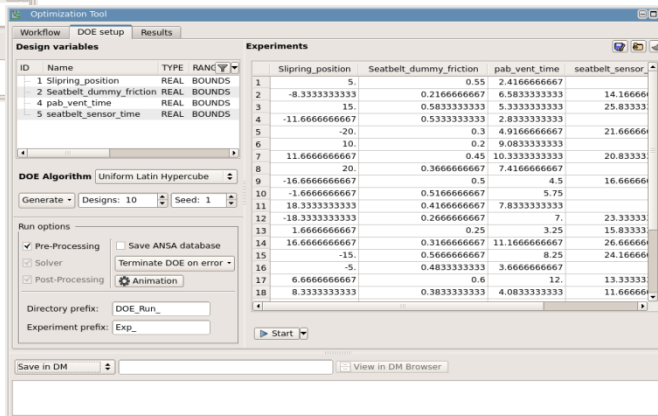
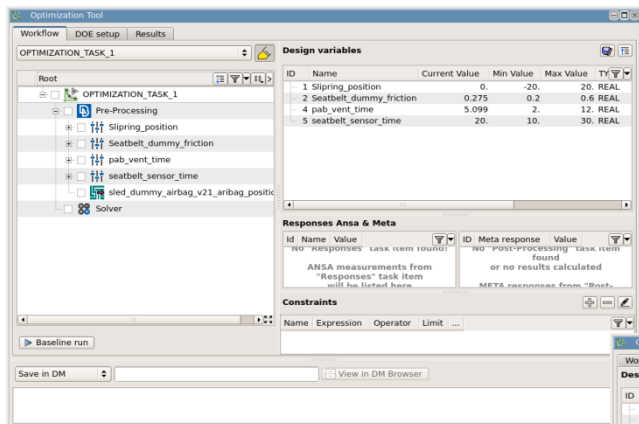
Occupant Injury Criteria

Tool

Session file



Occupant safety prediction



Dataset Creation

DOE In DM

KOMVOS

- Key Values
- Curves
- Videos
- Images, etc..

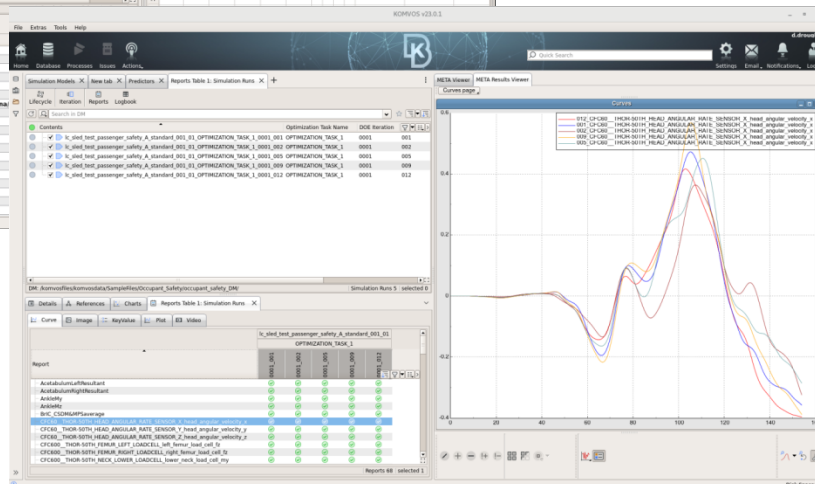
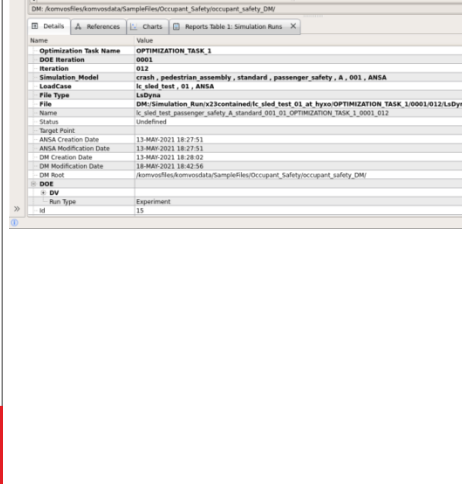
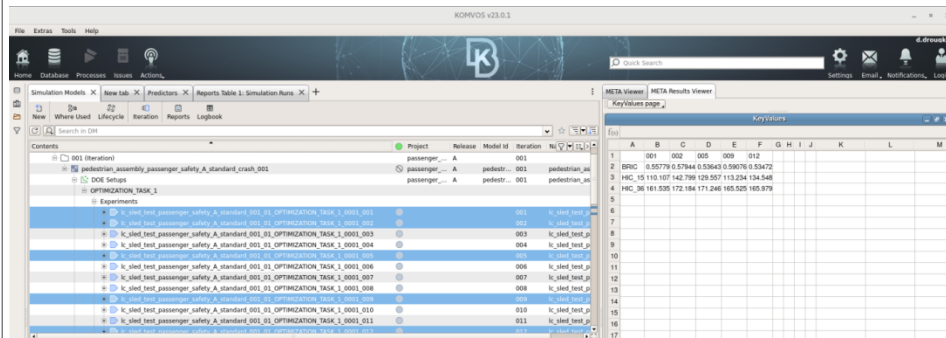
Occupant safety prediction

Dataset Creation

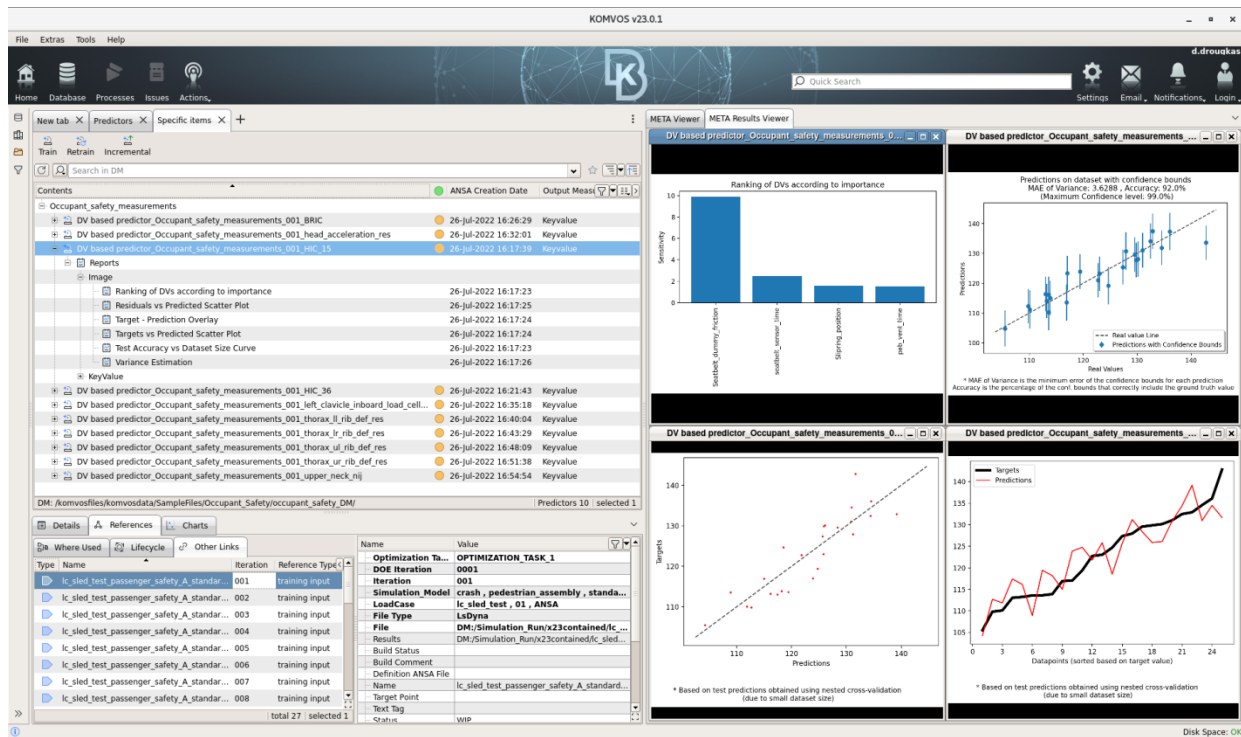
DOE In DM

KOMVOS

- Key Values
- Curves
- Videos
- Images, etc..



Occupant safety prediction



Predictors

HIC_15

HIC_36

BRIC

Head acceleration

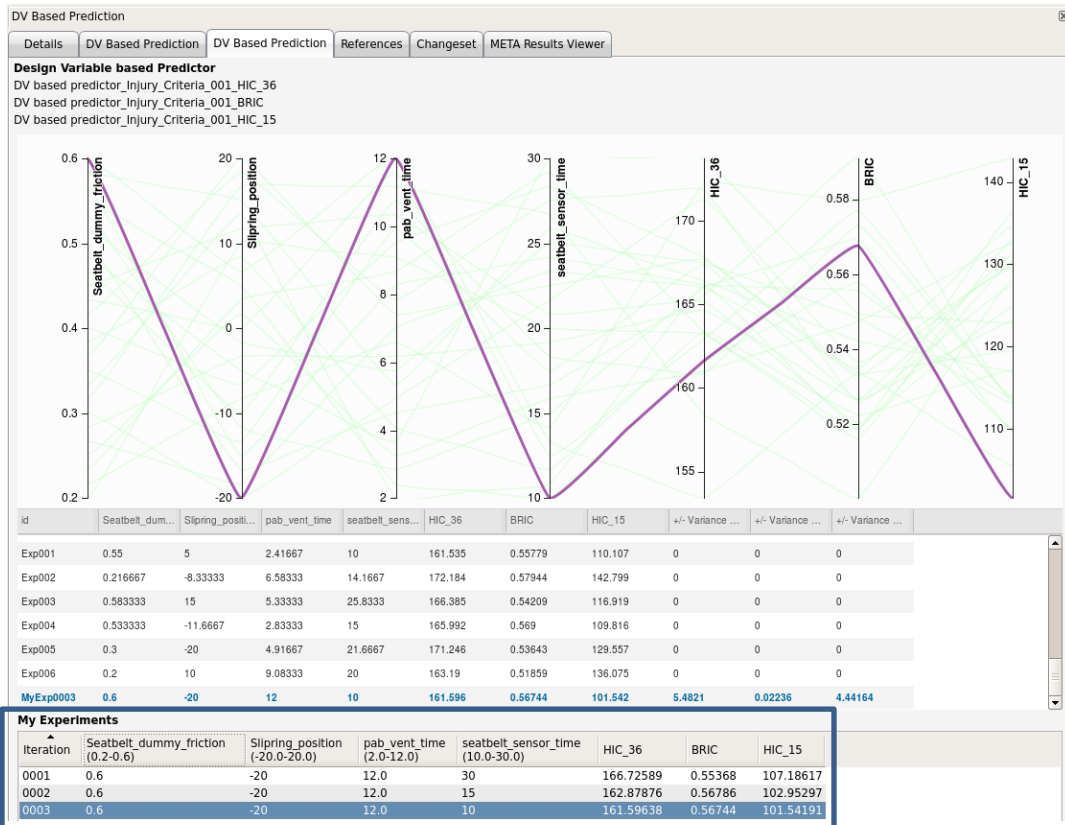
Left clavicle inboard load

Thorax rib (upper/lower)

results

Upper neck

Occupant safety prediction



Prediction

Design Exploration

Occupant safety prediction

Results	
Name	Value
Name	Minimize_HIC15
Iteration	001
Algorithm	Simulated Annealing
Method	RSM
DOE	
DV	
Seatbelt_dummy_friction	
Initial Value	0.6
Max Value	0.6
Min Value	0.2
Slipping_position	
Initial Value	6.6666666667
Max Value	20
Min Value	-20
pab_vent_time	
Initial Value	12.
Max Value	12
Min Value	2
seatbelt_sensor_time	
Initial Value	13.3333333333
Max Value	30
Min Value	10
Optimization	
Constraints	
Constraint_1	HIC_36 < 170
Constraint_2	BRIC < 0.58
Objectives	
Objective_1	HIC_15 Minimize

Optimization

Simulated Annealing

Machine Learning -

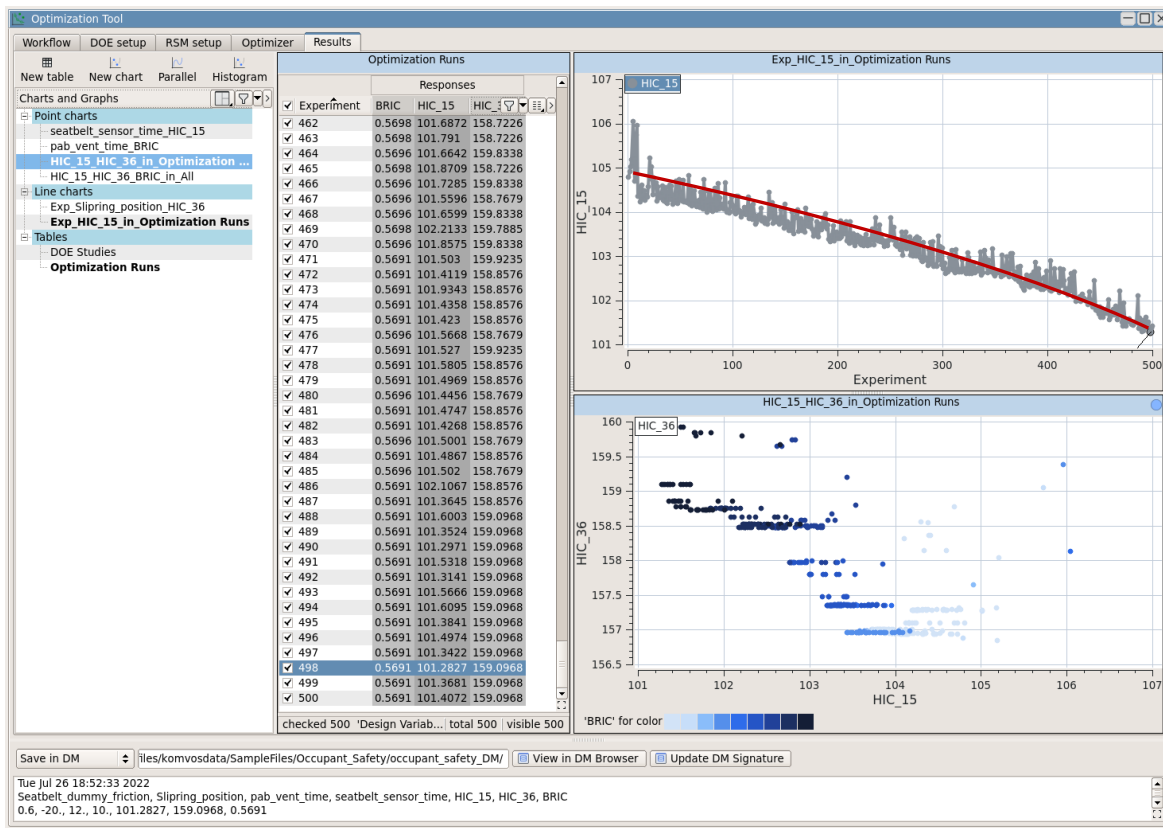
predictor as RSM

Minimize HIC15

Constrain HIC36 at 170

Constrain BRIC at 0.58

Occupant safety prediction



Optimization results

Objective
Constraints
Correlation

Occupant safety prediction

Optimization results

Response	FE Analysis result	Prediction	Error (%)
HIC_15	102.026	101.541	0.47%
HIC_36	158.489	159.096	0.38%
BRIC	0.5297	0.5674	6.87%
<u>ATD measurements</u>			
Head acceleration (<i>mm</i>)	38.905	38.5627	0.88%
Left clavicle inboard load cell(kN)	1.3762	1.3916	1.11%
Right clavicle inboard cell(kN)	1.204	1.260	4.54%
Upper neck nij	0.3988	0.4022	0.84%
Thorax rib LL (<i>mm</i>)	59.148	58.401	1.27%
Thorax rib LR (<i>mm</i>)	17.603	17.126	2.74%
Thorax rib UL(<i>mm</i>)	65.597	66.321	1.09%
Thorax rib UR(<i>mm</i>)	43.722	43.421	0.69%

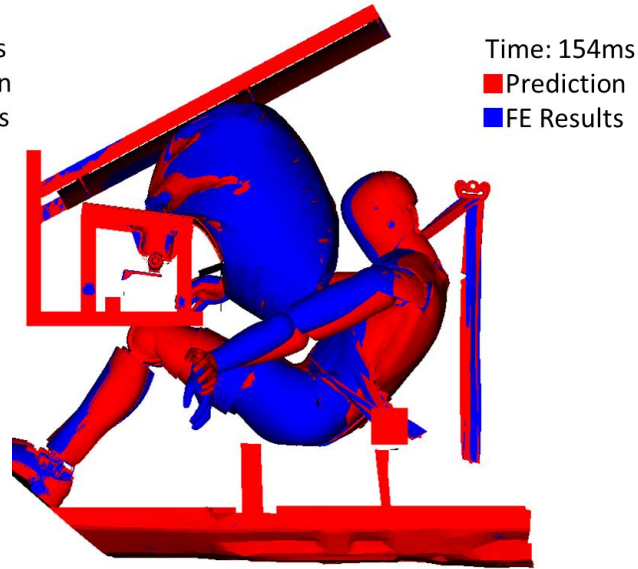
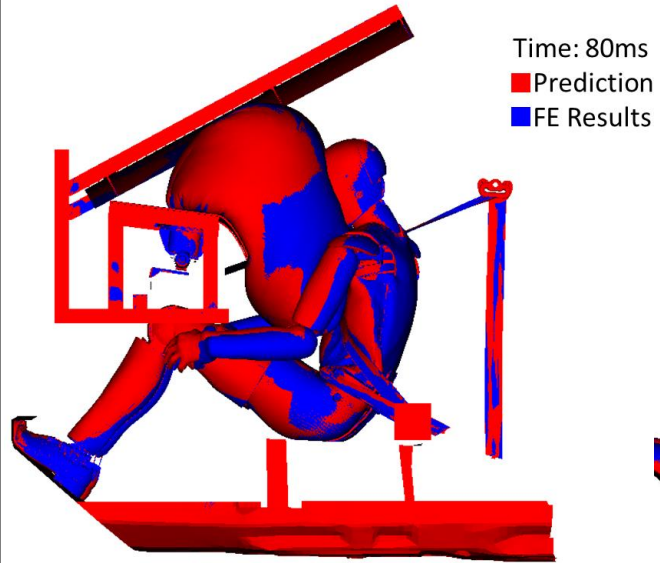
Occupant safety prediction

		Initial	Optimum	Reduction
Obj.	HIC 15	132.365	102.026	22.92%
Const.	HIC 36	165.047	158.489	3.97%
Const.	BRIC	0.534	0.5297	0.8%

Optimization results

FE Results comparison

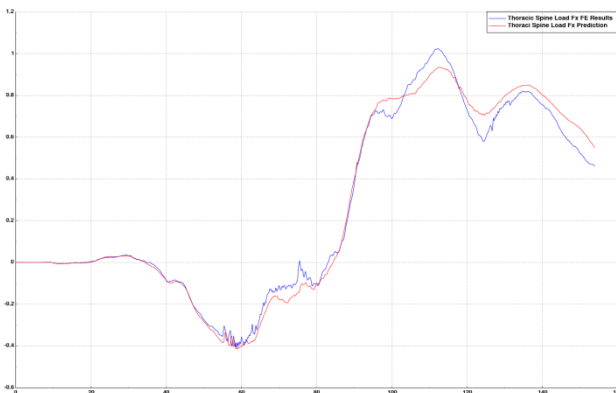
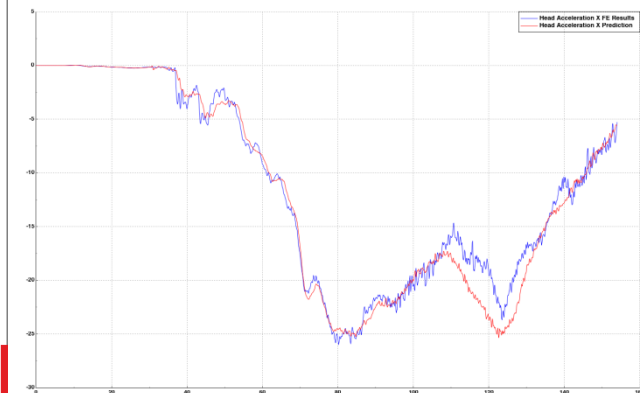
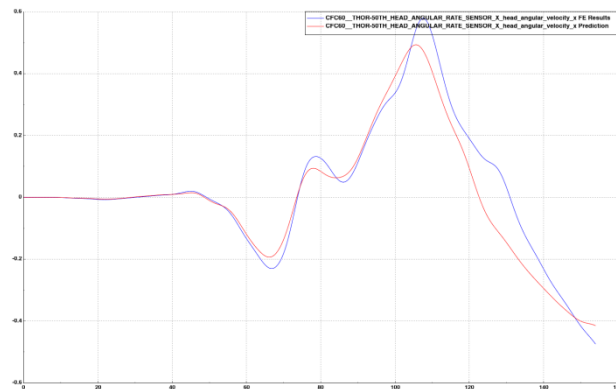
Occupant safety prediction



3D Results Prediction

ML Prediction vs FE Results

Occupant safety prediction



2D Results Prediction

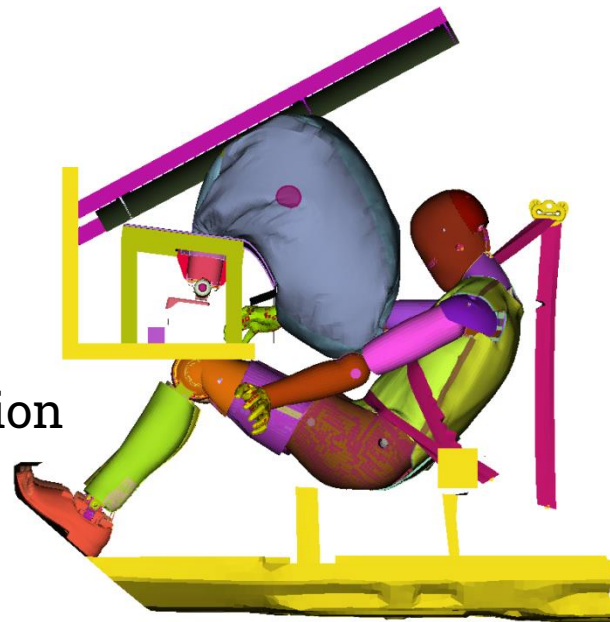
ML Prediction vs FE Results

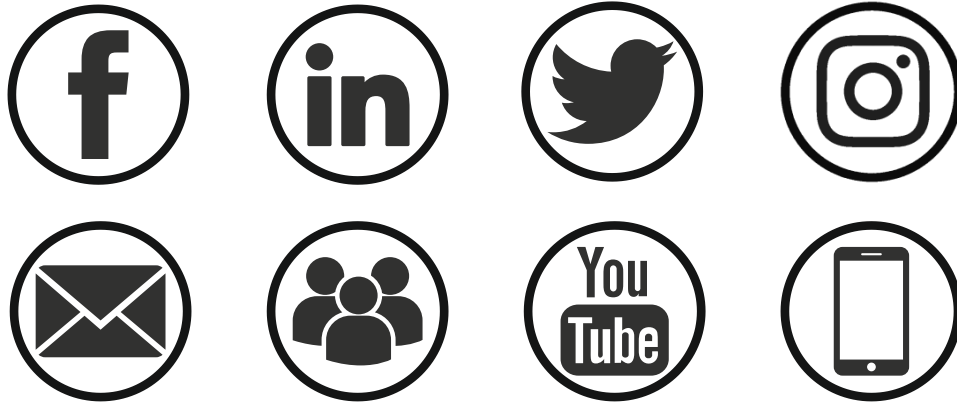
ML Training from:

- Analysis result files
- Post processing reports

Occupant safety prediction

- Machine Learning
- Optimum design
- What if studies substituting repetitive CAE
- Speed up product development with faster and accurate RSM Optimization
- ML 3D/2D Results prediction of optimum at fraction of time





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