Parametric study of FE seats in rear impact

Pablo Gracia Cemborain[1], Bronislaw Gepner[1], John Paul Donlon[1], Ayush Mehta[1], Reagan Hollar[1], Adrian Caudillo-Huerta[1], Daniel Perez-Rapela[2], Marcy Edwards[3], Jessica Jermakian[3], Jason Forman[1]

University of Virginia[1]

Human Injury Consulting and Research[2]

Insurance Institute for Highway Safety (IIHS)[3]

IWG EqOP
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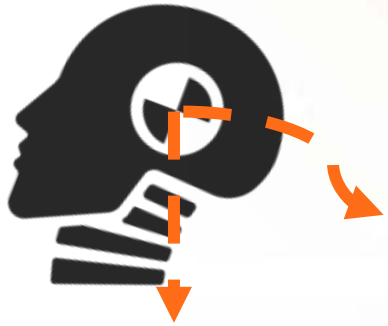
Project overview

Project goals

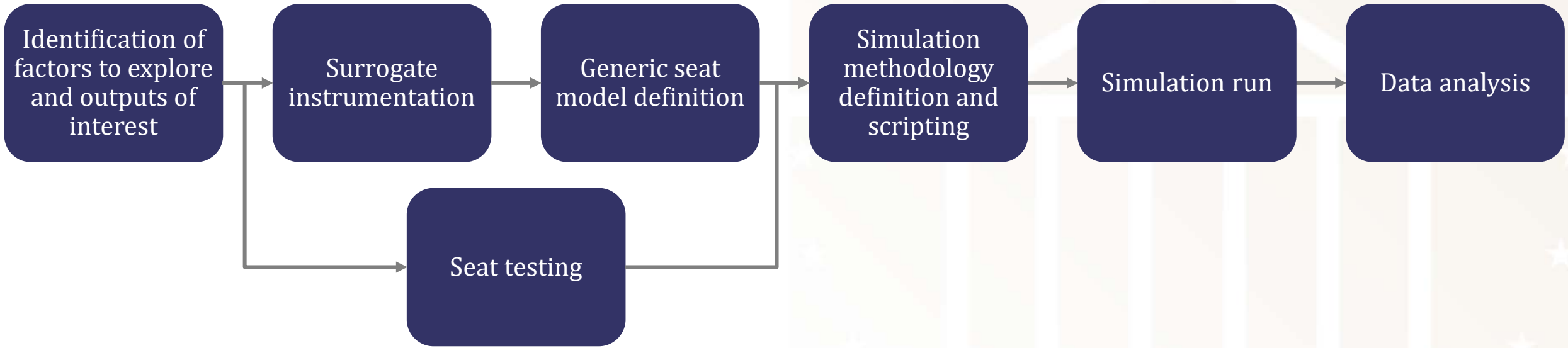
1. Identify which factors and injury metrics have the greatest influence on occupant response and robustness of the safety performance of the seat

2. Find correlations between the injury metrics and make recommendations for their use



General roadmap

Goal: Perform a sensitivity analysis to identify seat and intrinsic parameters that have the highest influence on rear impact scenarios



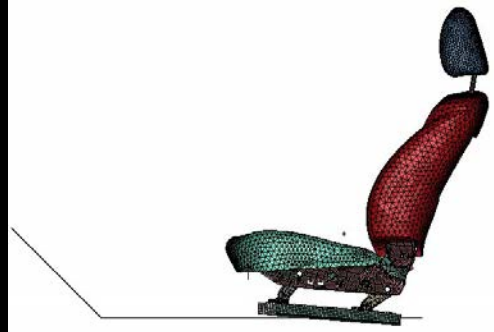
Identification of factors and outputs

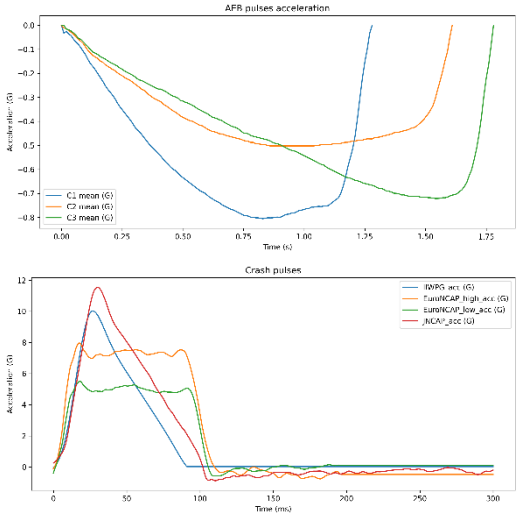
Factors

Geometry

Occupant

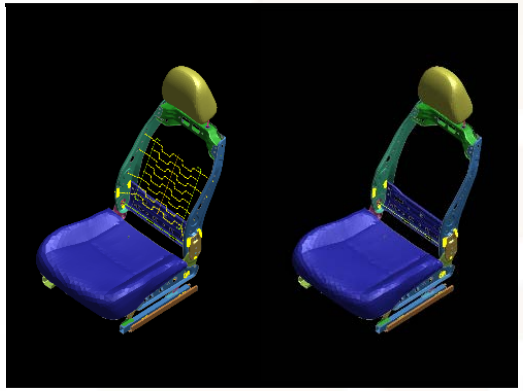
Stiffness

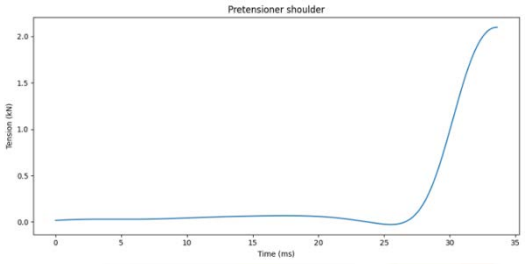




Braking and crash pulse

Components





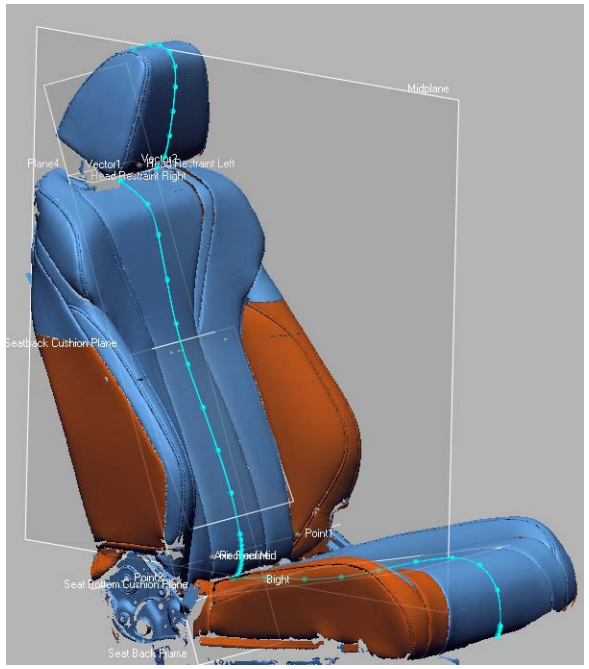
Pre/pretensioner performance

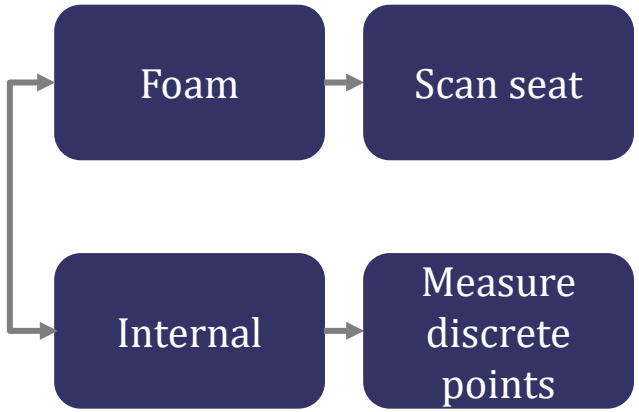
Outputs

Calculate injury metrics

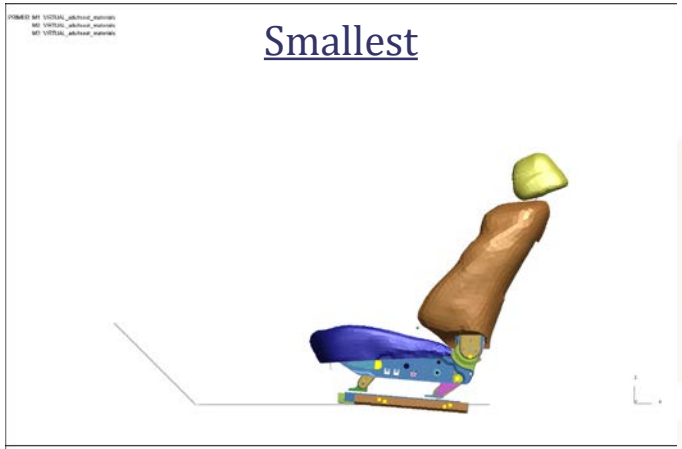
Methods and Tools

Seat morphing

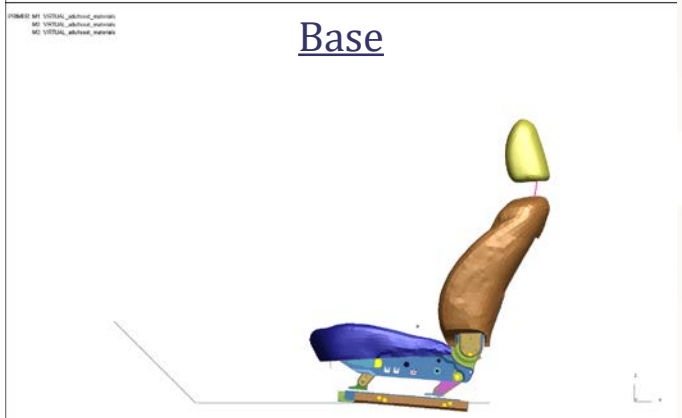




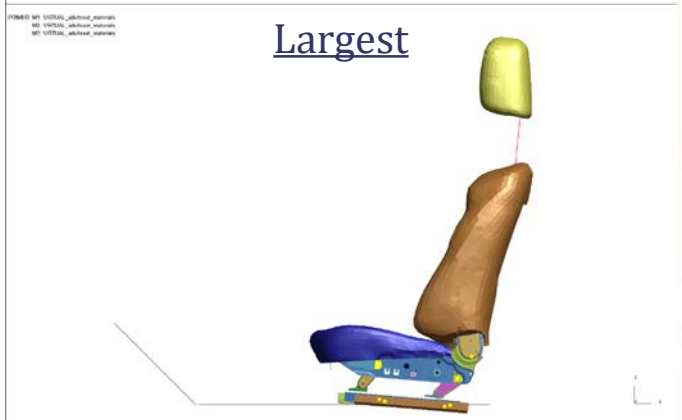
Smallest

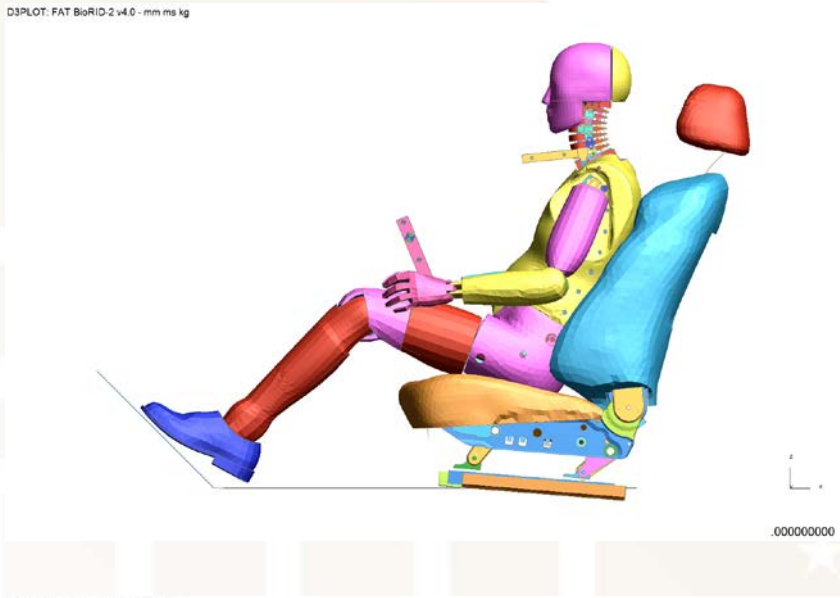


Base



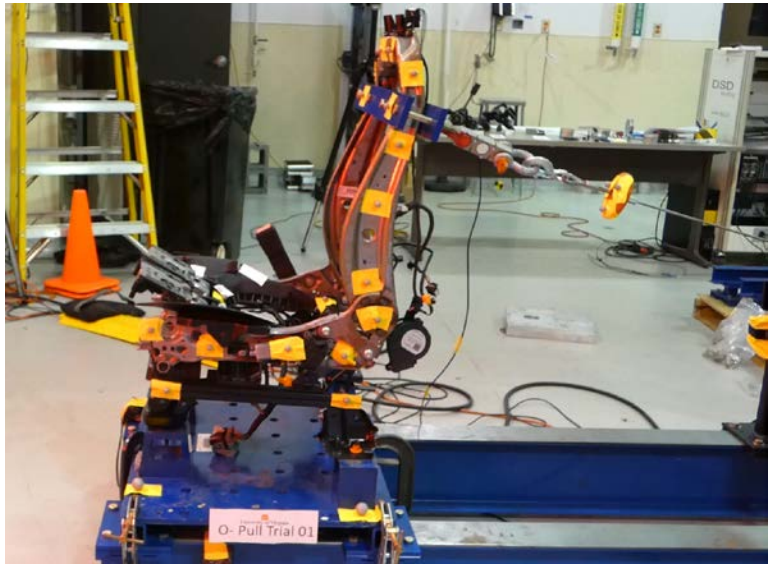
Largest

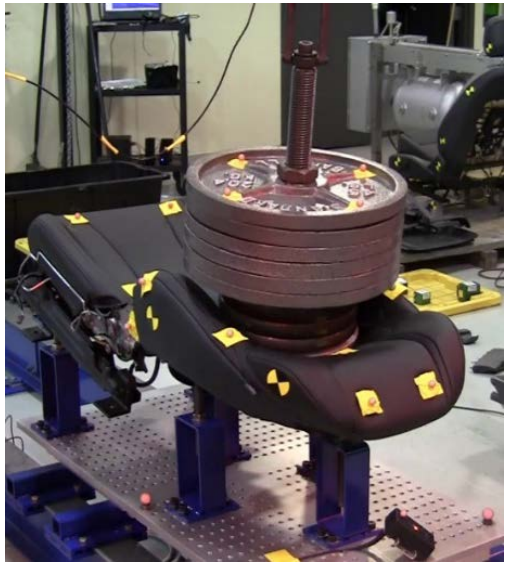


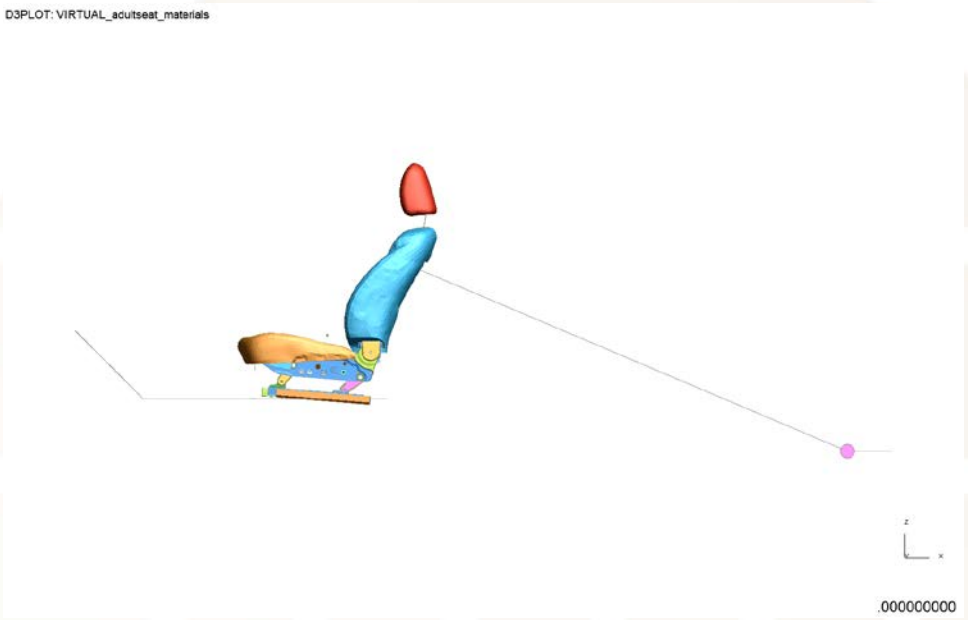


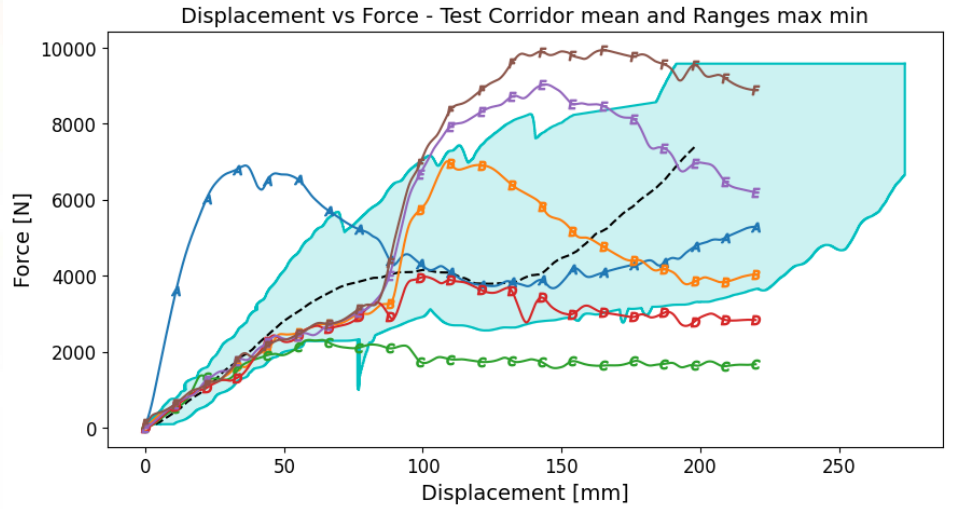
Seat: Open VT – Open Access Front Seat Model

Seat testing





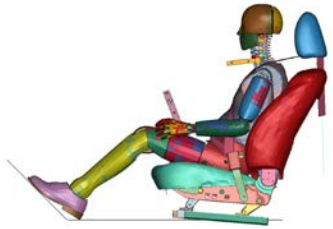




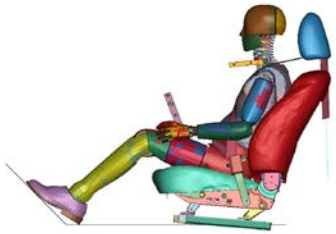
Pre-crash

Pre-Crash
AEB Graci C3

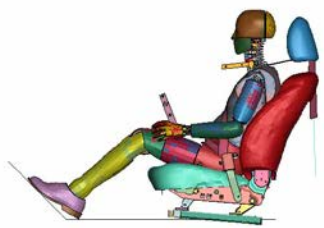
Crash
AEB Graci C3 (0.5s)
+
ENCAP High

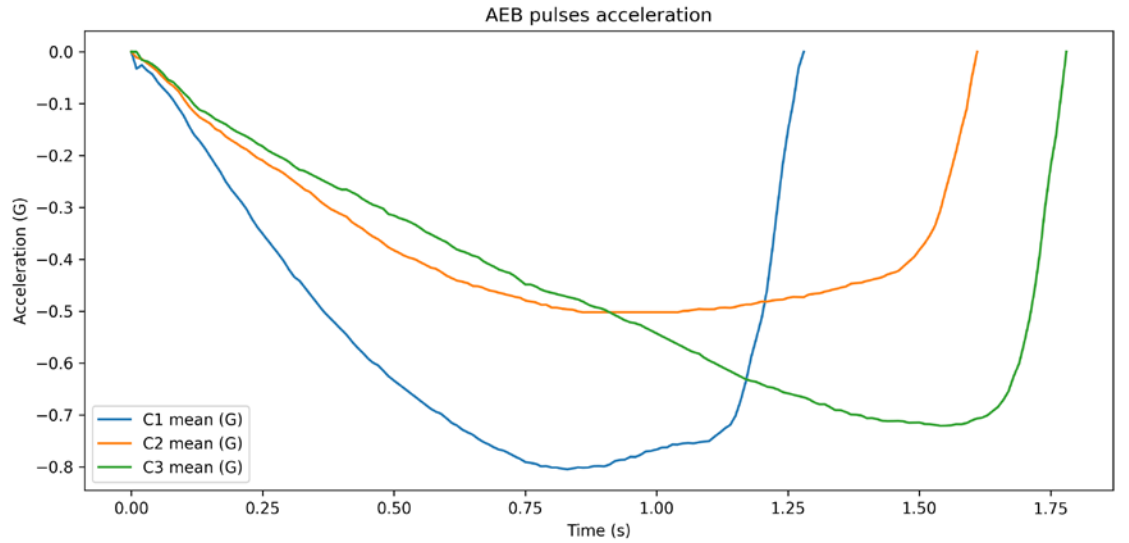


Crash
AEB Graci C3 (1s)
+
ENCAP High



Crash
AEB Graci C3 (1.5s)
+
ENCAP High

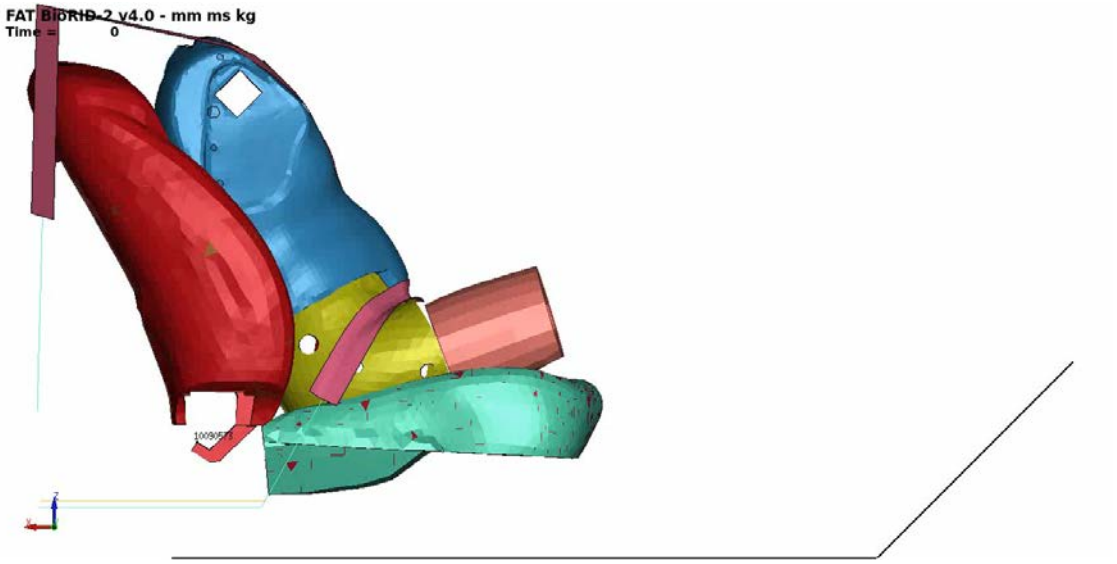




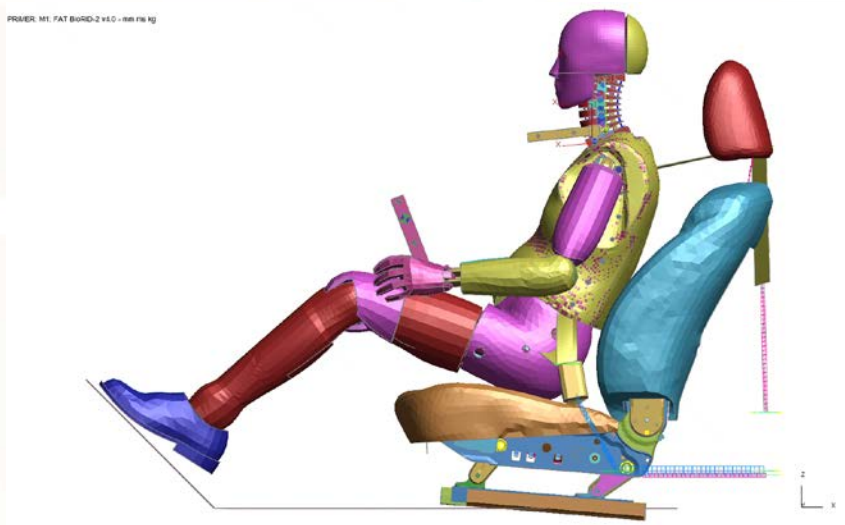
Sources: Graci 2021 - Quantitative characterization of AEB pulses across the modern fleet

Seatbelt

3 pretensioner seatbelt: Shoulder, buckle and anchor

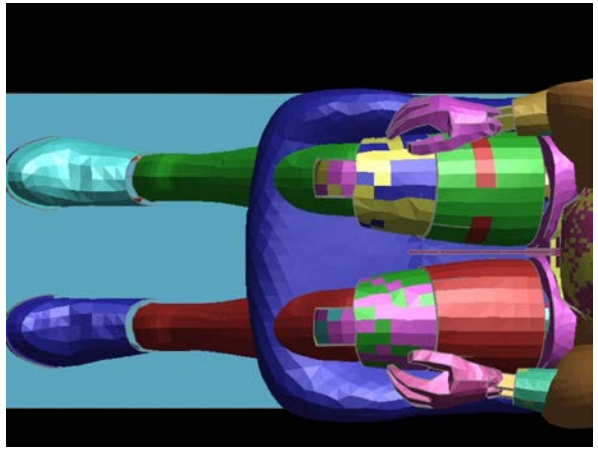


Seatbelt refit

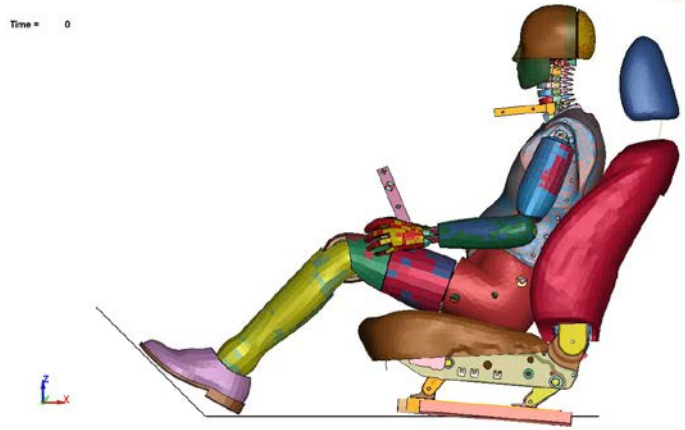


IIHS tests simulation

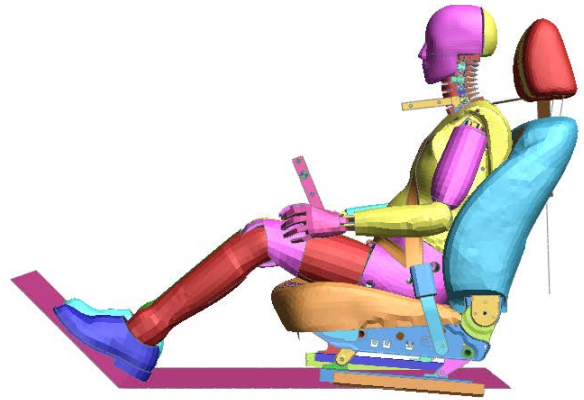
Pre-position → **Position** → **Crash**

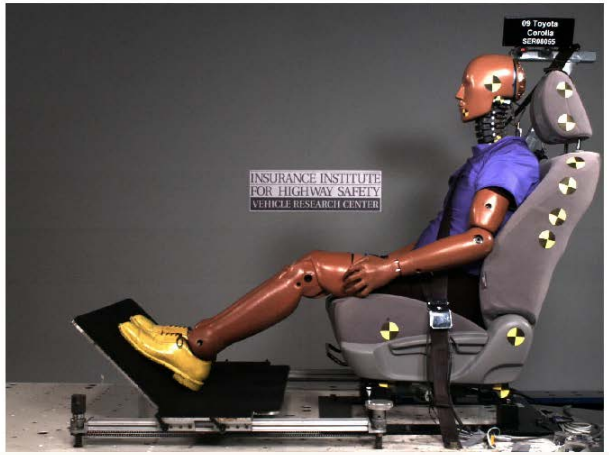


- Adapt to every occupant and seat shape
- Minimize simulation time (High computational cost)

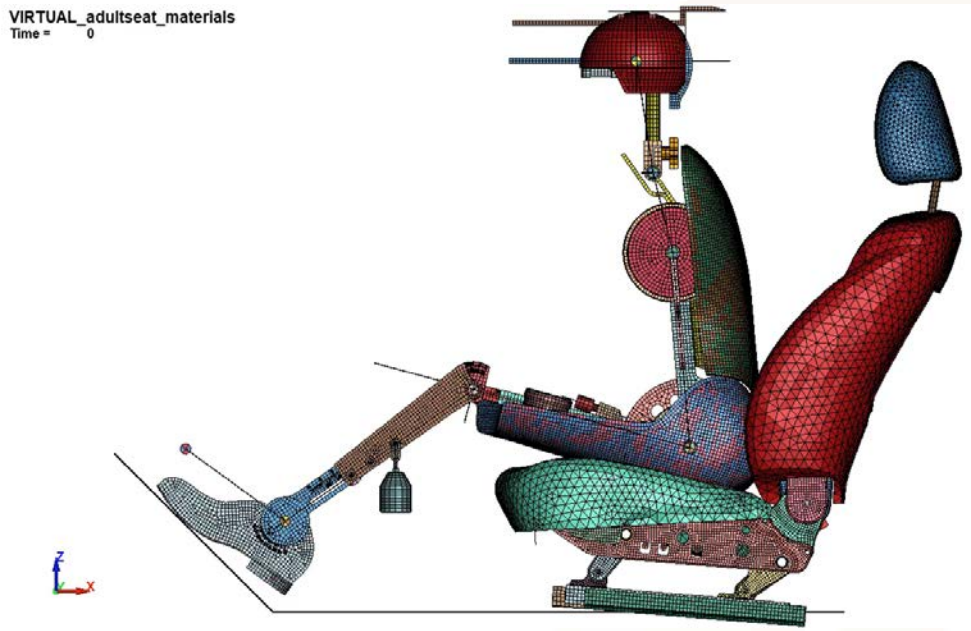


- Possibility to position the dummy without a known H-Point location

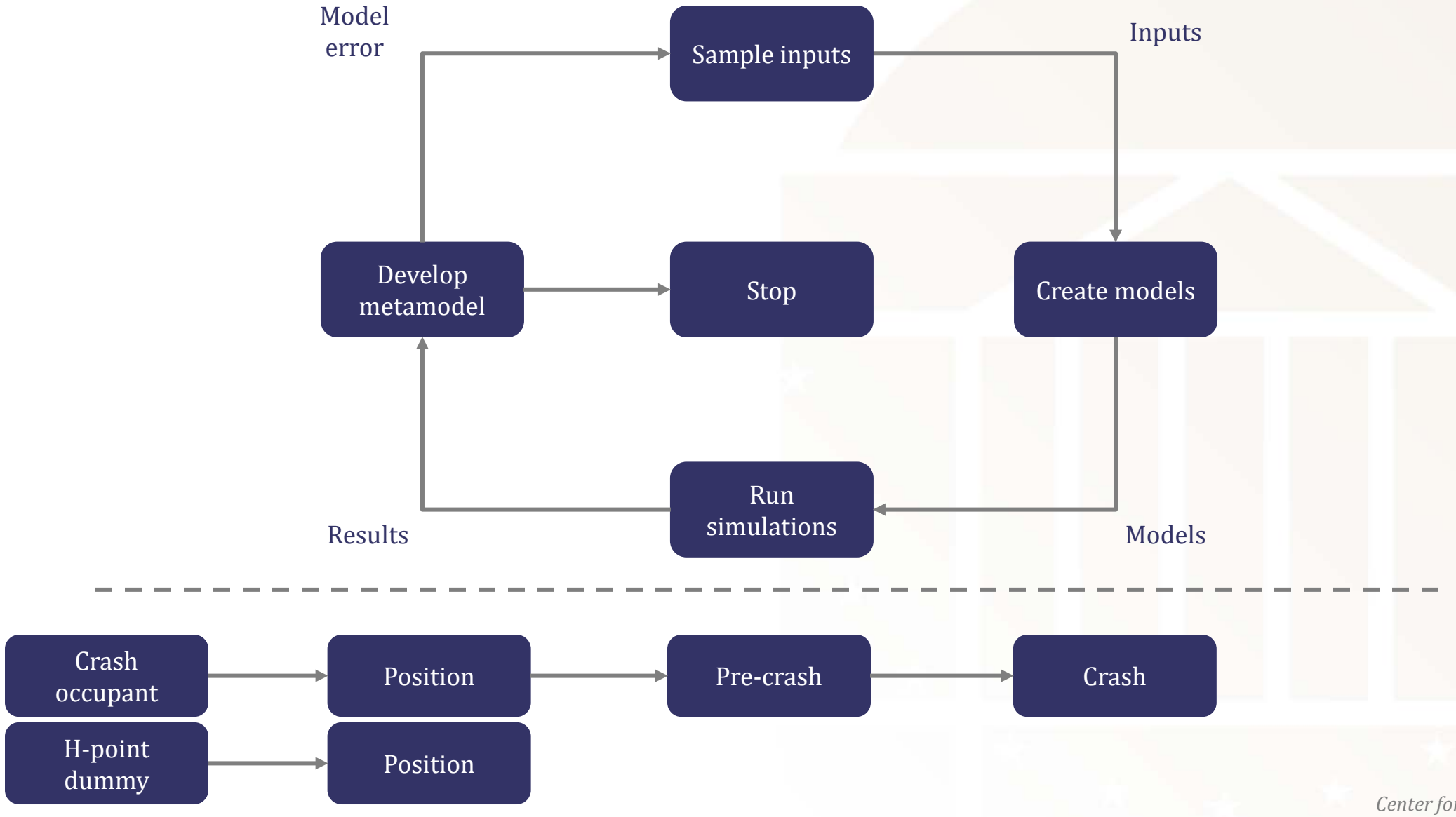




H-point machine positioning



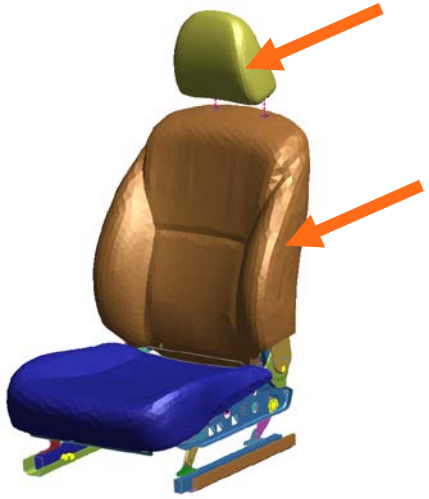
Overview

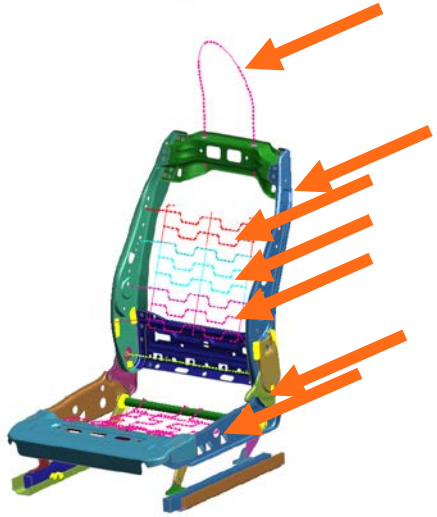

Model error
Sample inputs
Inputs
Develop metamodel
Stop
Create models
Run simulations
Results
Models
Crash occupant
Position
Pre-crash
Crash
H-point dummy
Position

Parametric study

Variables

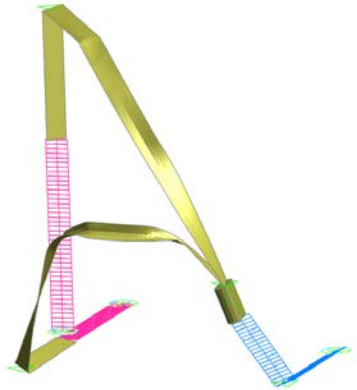
Variable election by stage – Position





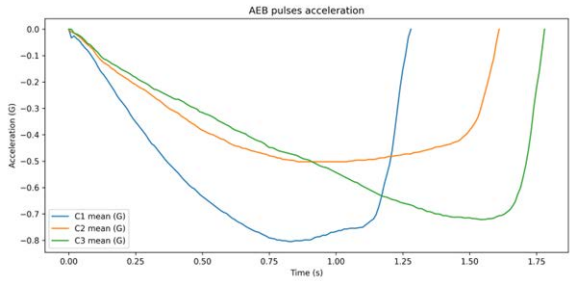
Variable election by stage – Pre-crash

Position → Pre-crash → Crash



Pre-pretens.

- Presence x1
- Curve x1
- Location x1
- Time to fire x1



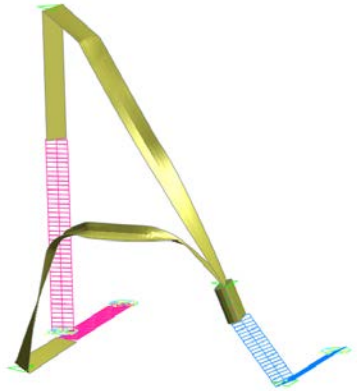
Precrash

- Curve x1

x5

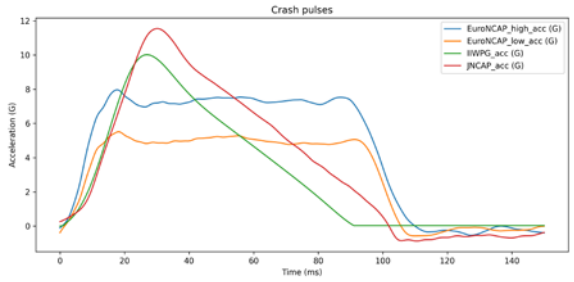
Variable election by stage – Crash

Position → Pre-crash → Crash



Pretens.

- Presence x1
- Curve x1
- Location x1
- Time to fire x1



Crash

- Time to crash x1
- Curve x1

x6

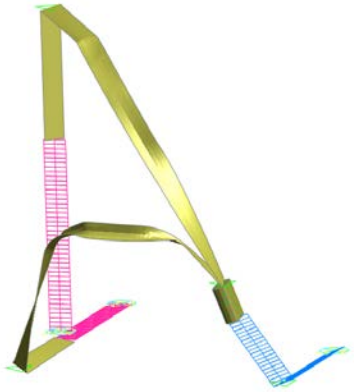
Phases

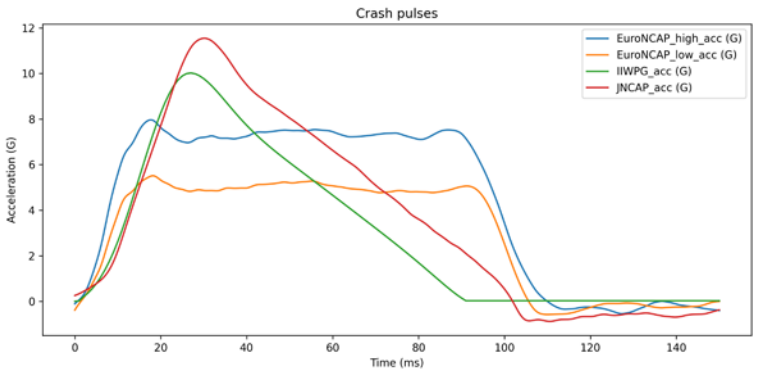
Phase 1

- Explore seat and occupant factors
- HPM positioning, occupant positioning and crash

Phase 2

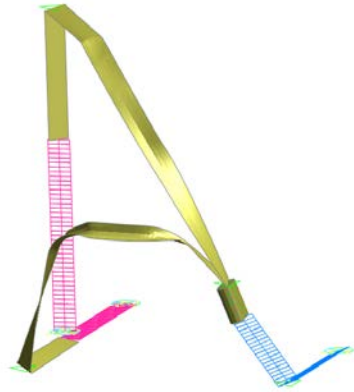
- Explore pretensioner and crash factors

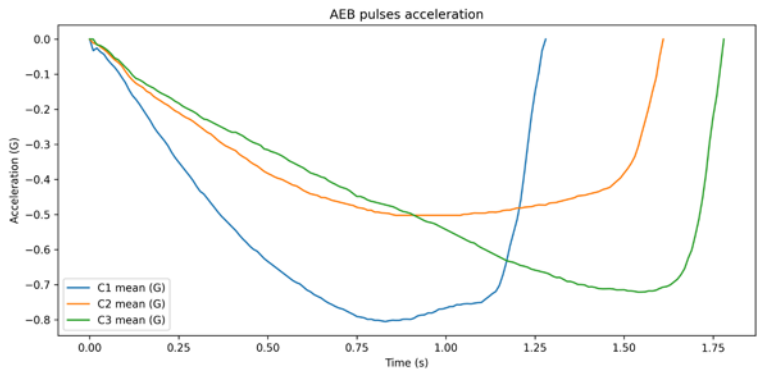




Phase 3

- Explore pre-pretensioner and precrash factors

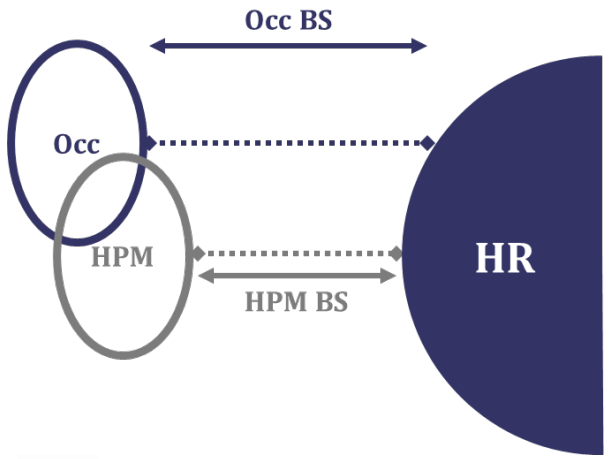


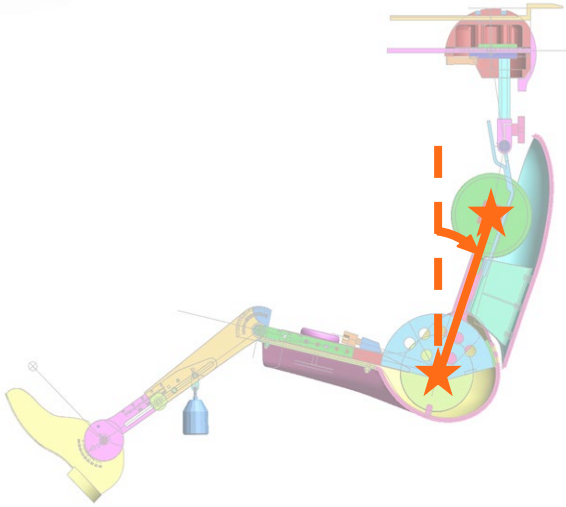


Analysis & Metamodel

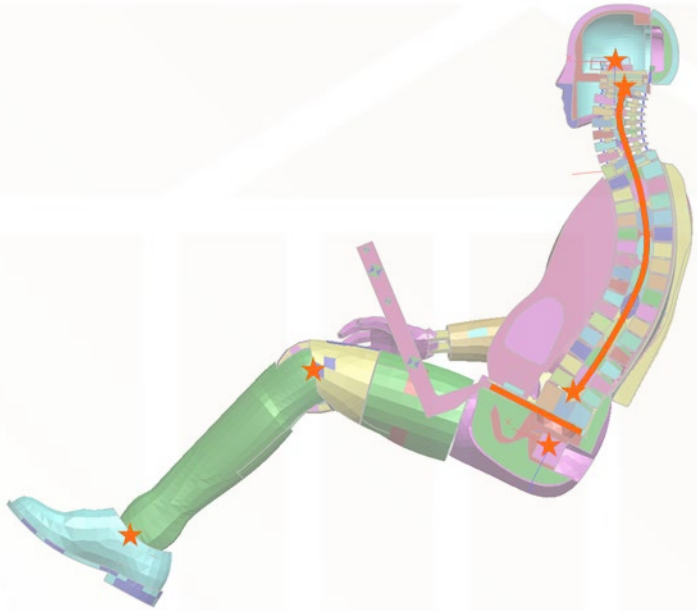
Analysis

Position / Precrash

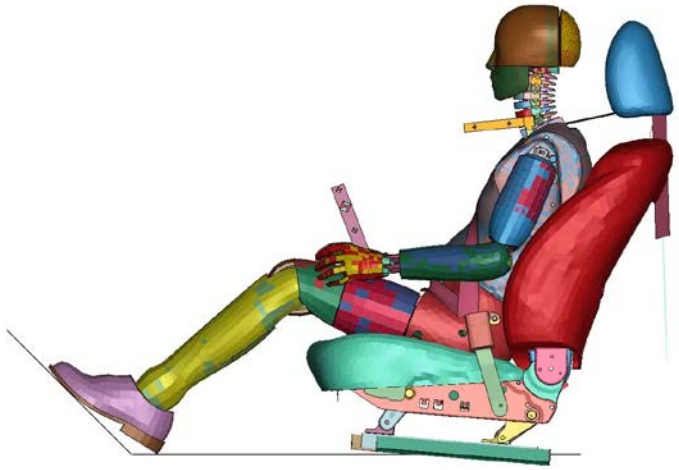




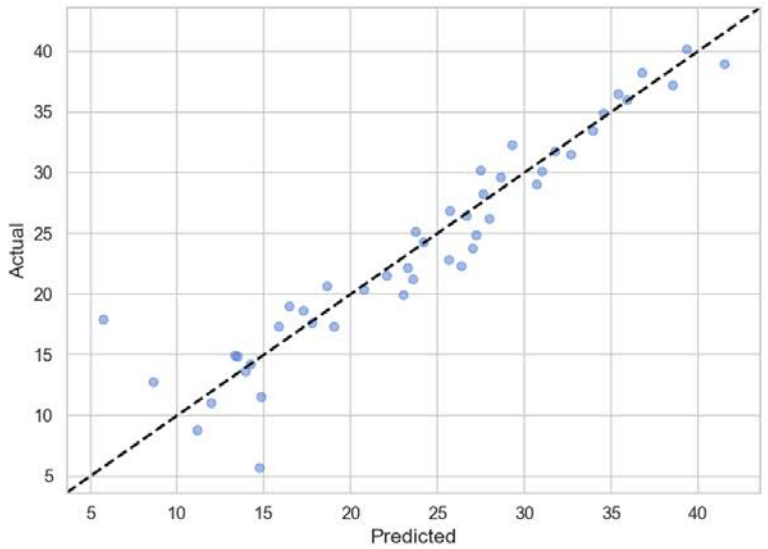
Crash

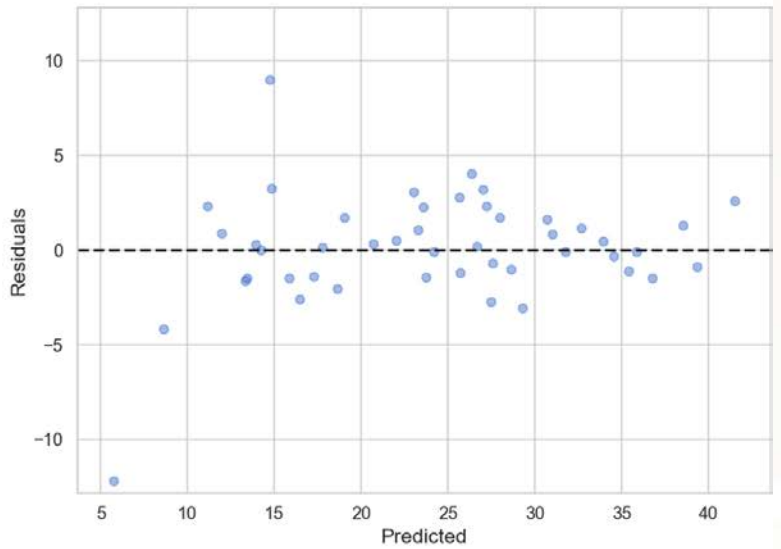


Metamodel



Machine Learning Algorithm





Algorithm
Linear Regression
Ridge Regression
Lasso Regression
Random Forest
XGBoost
Neural Network

Preliminary conclusions

All parameters

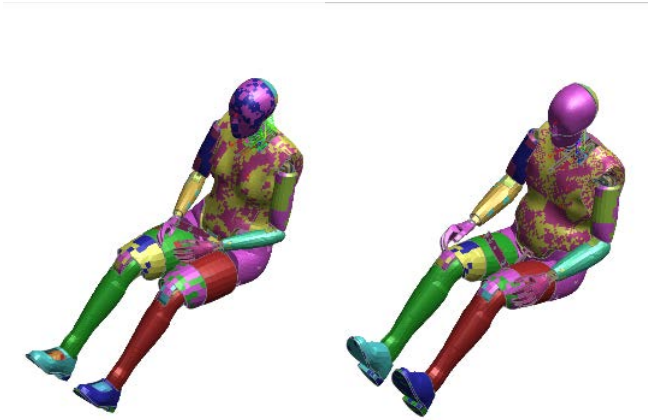
- No single model parameter improves or worsens all dummy output metrics at the same time

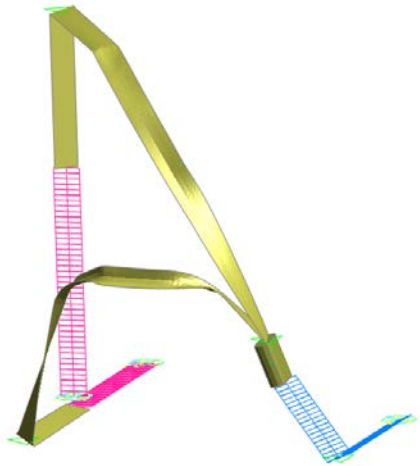
Occupant parameters

- Occupant variation shows important differences in certain dummy output metrics, but not all of them

Seat /Restraint design parameters

- Seat stiffness (Both foam and frame) seems to play an important role in multiple dummy output metrics
- The seat design parameters that are important for dummy output metrics differ by occupant type (BioRID vs EvaRID)





Parametric study of FE seats in rear impact

Thank you!

Pablo Gracia Cemborain: fmx7jf@virginia.edu

Jason Forman: jlf3m@virginia.edu

LinkedIn
Pablo Gracia Cemborain