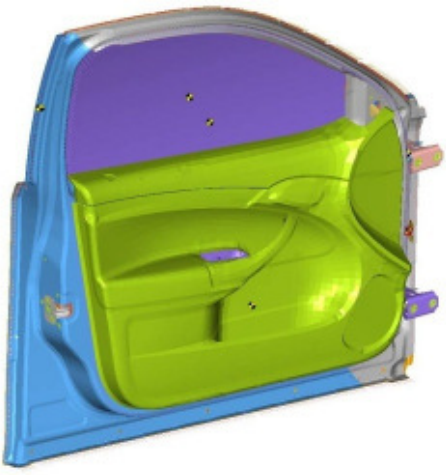


CAE Value AB

Simulate – Validate - Automate



Courtesy of Saab Automobile

Door Closing/Opening Efforts and Energies

Markus Kvist

www.caevalue.com

CAE Value AB

Virtual Prototypes – Real Results

CAE Value AB — *The Engineering Intelligence Company*

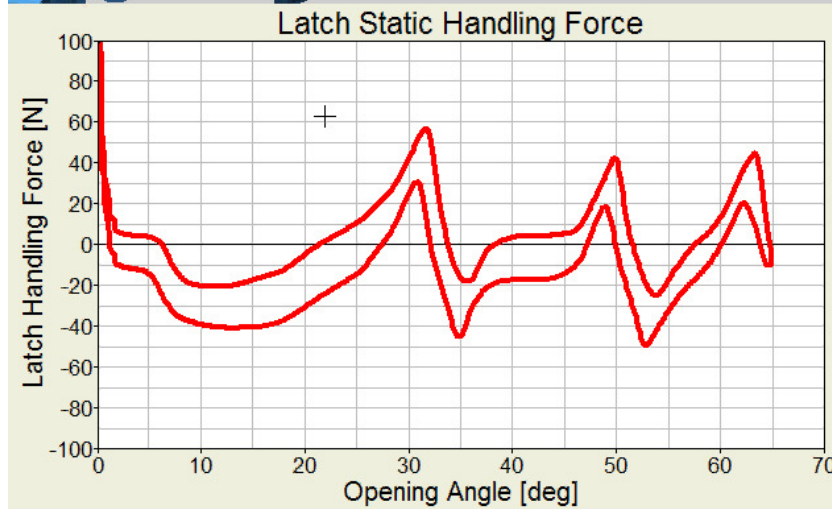
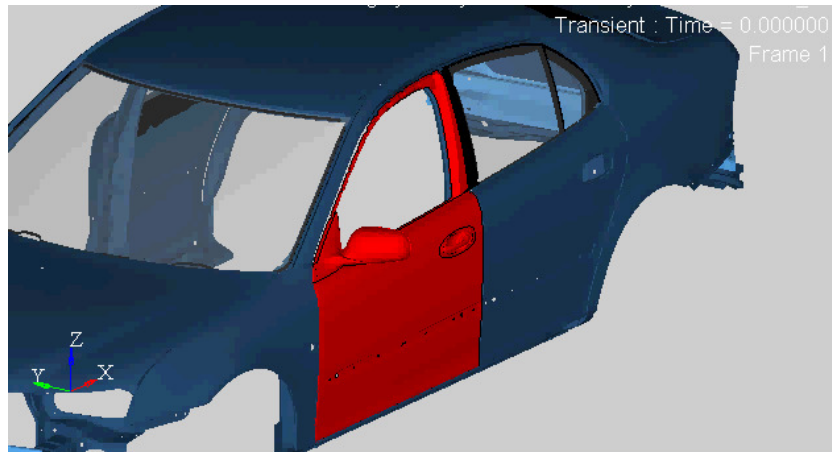
- Dedicated to improving value of simulation
 - Functional Virtual Prototypes
 - Process and data automation
 - Modeling techniques
- Combining industry experience with CAE
 - Vehicle Dynamics
 - General Machinery
 - Software Development
 - Process Focus
 - Validation



CAE Value AB

Virtual Prototypes – Real Results

Door Closing & Opening Analysis



Why

- Ensure that the door closes
- Meet design target for handling effort
- Tolerances and robustness

How

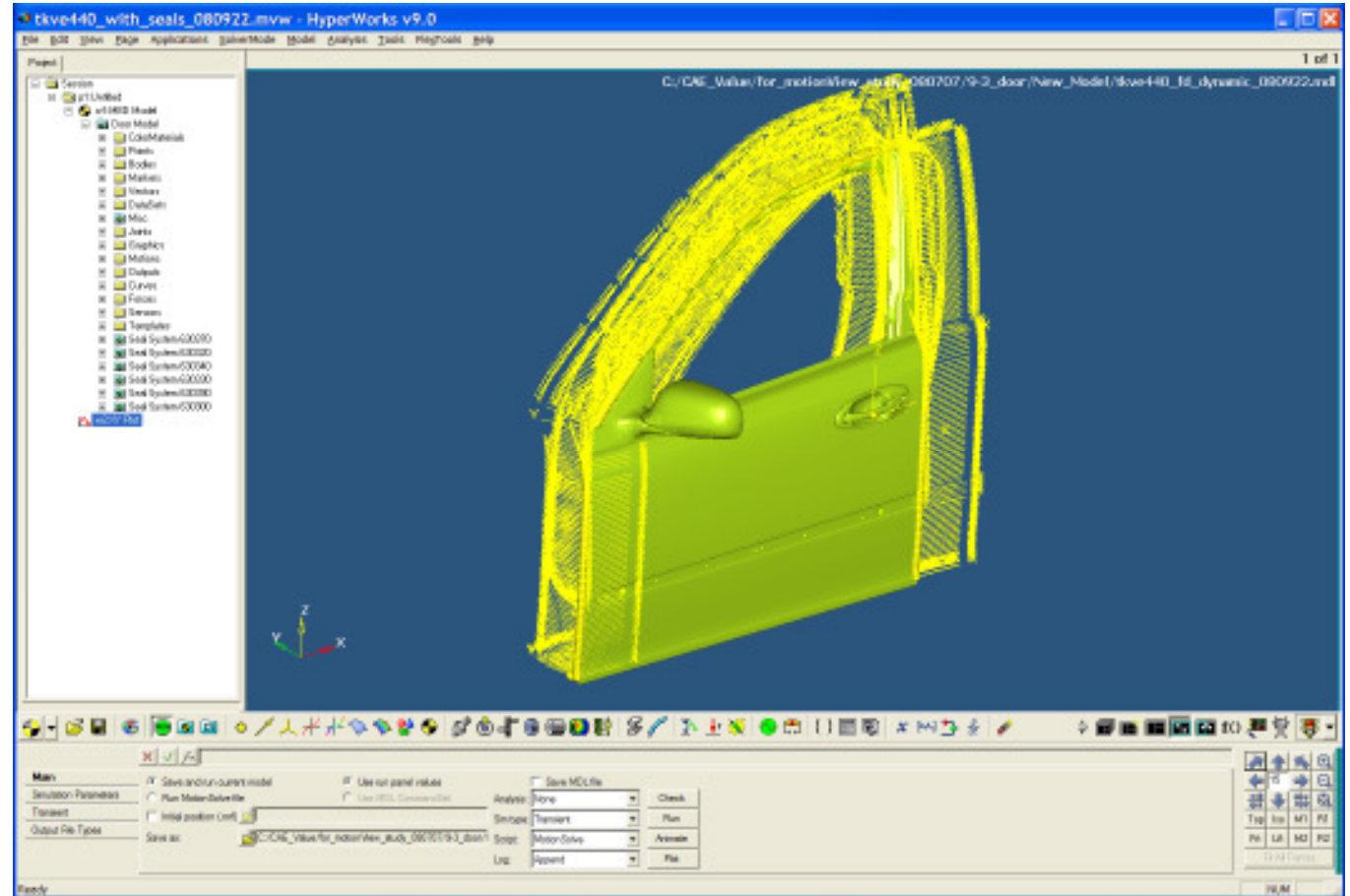
- Automated process for efficient study of closing/opening dynamics

Benefit

Upfront prediction of opening/closing efforts

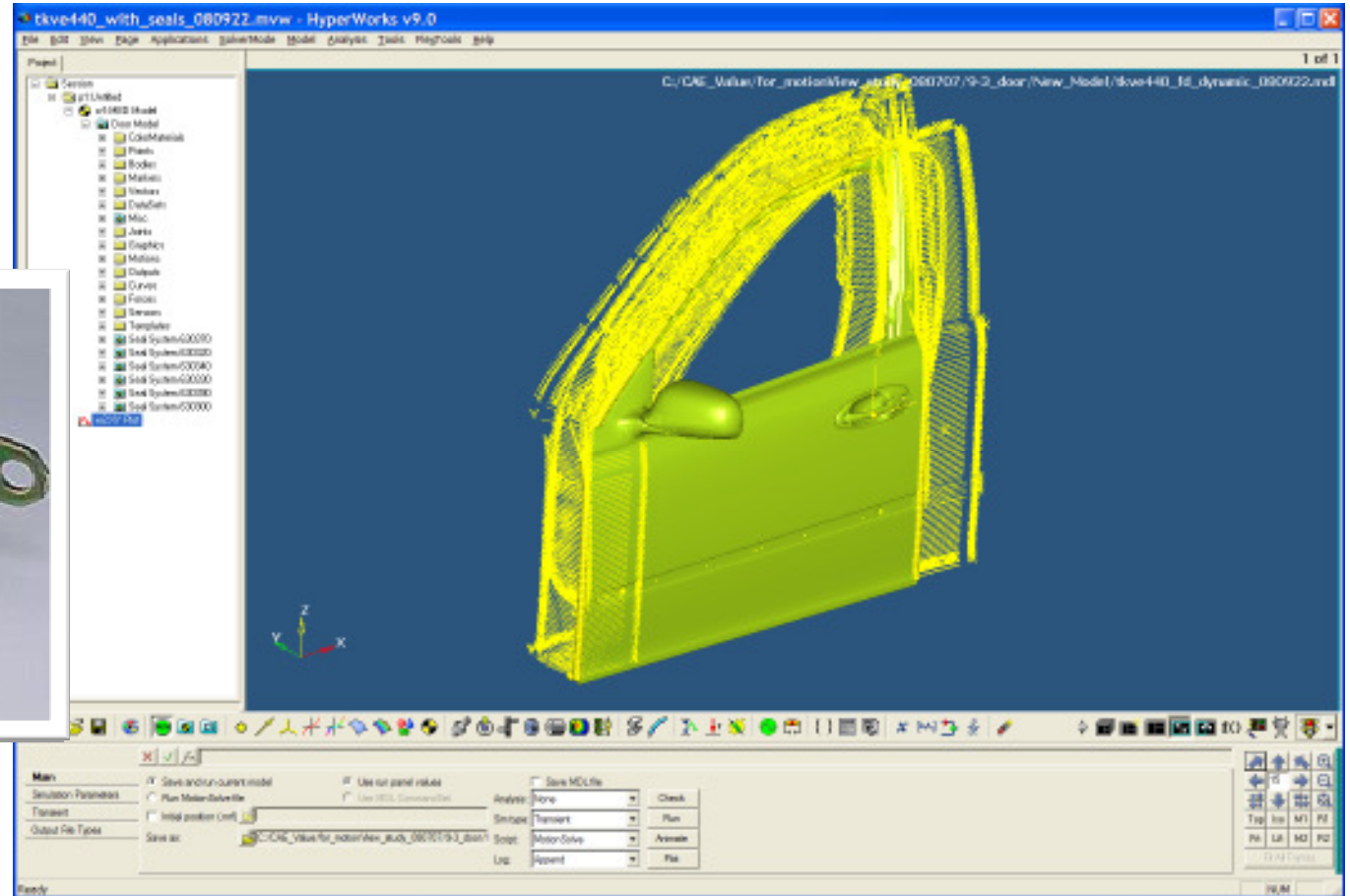
Which are the important components?

■ Seals



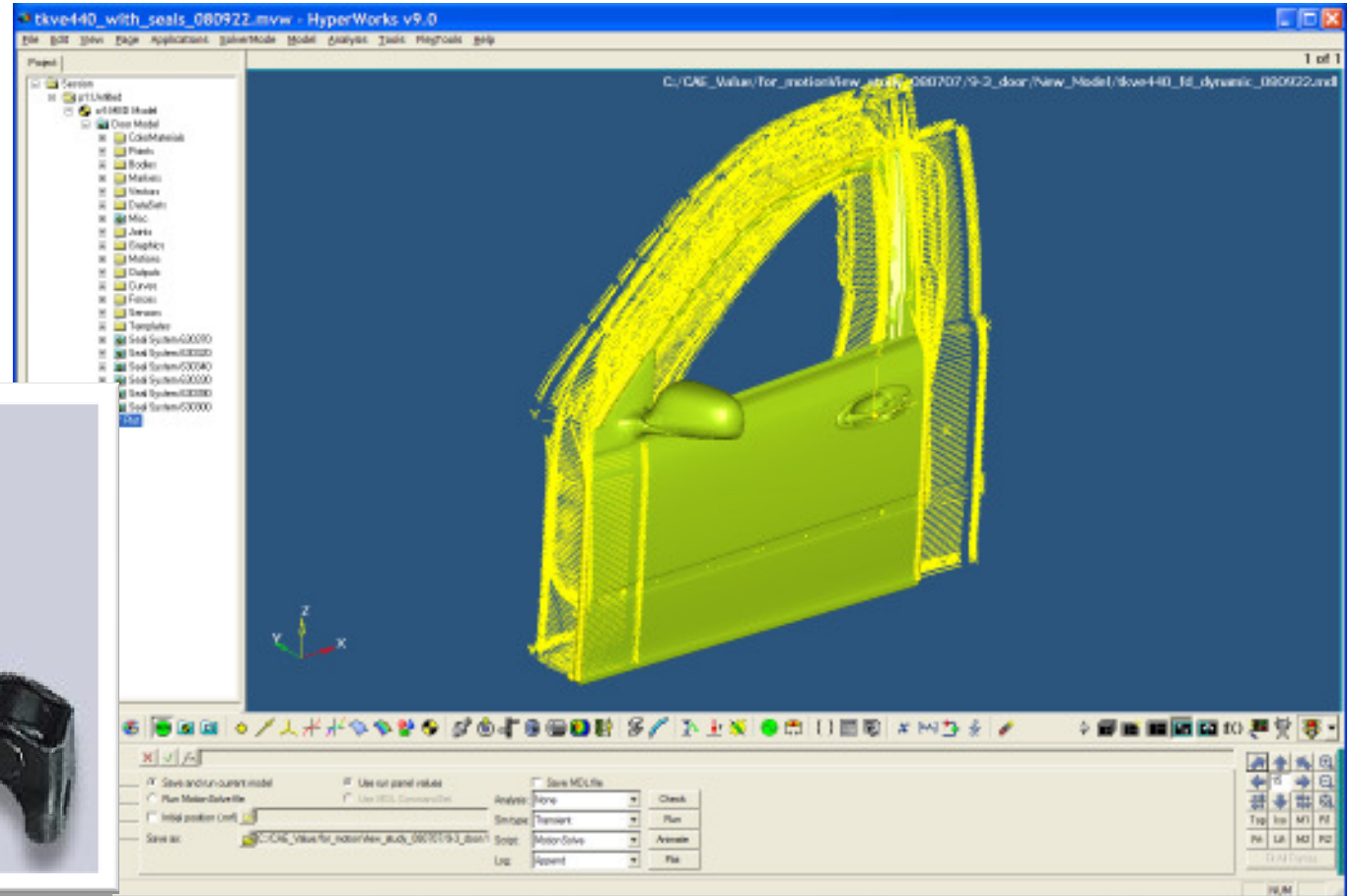
Which are the important components?

- Seals
- Hinge



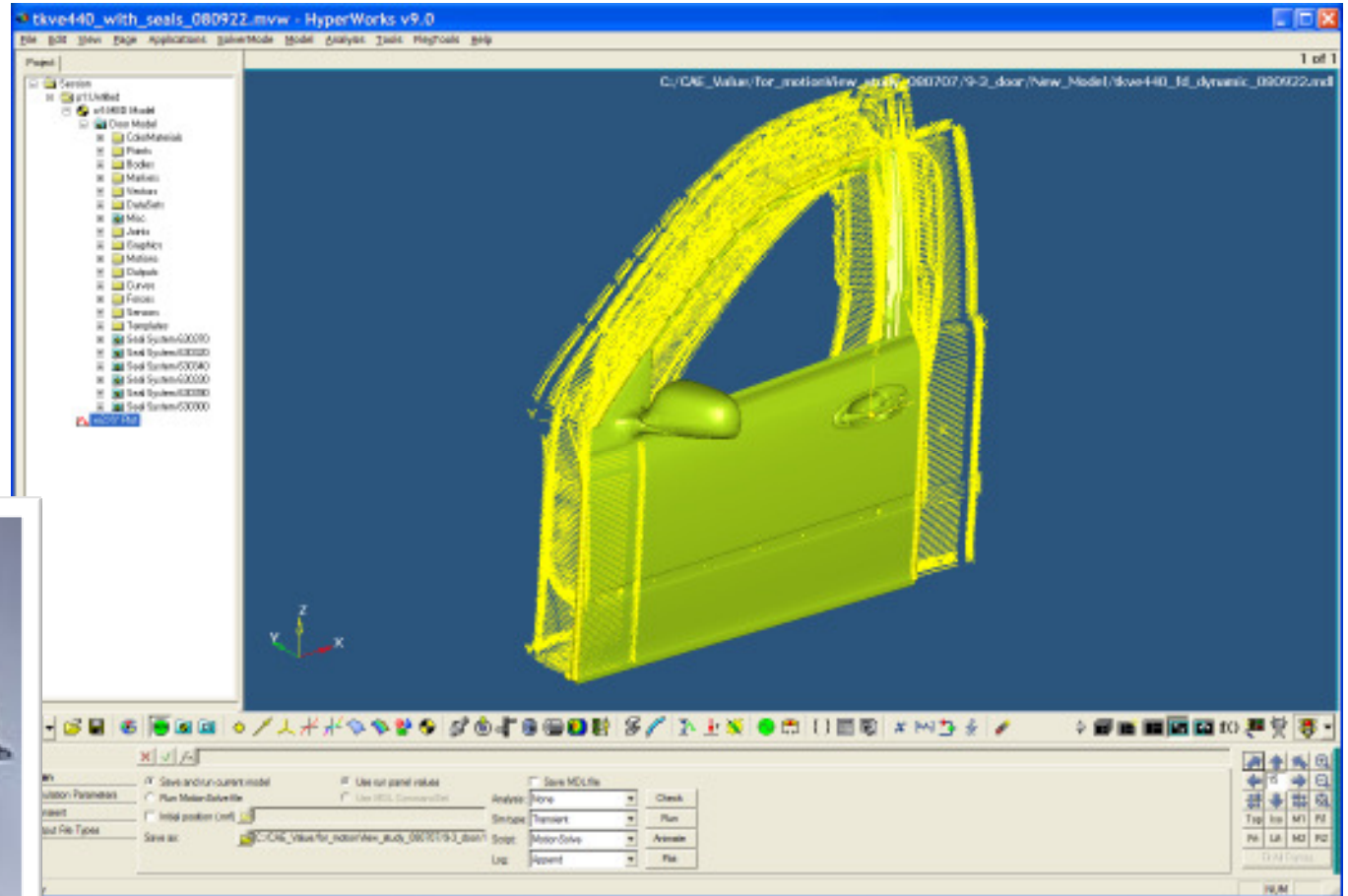
Which are the important components?

- Seals
- Hinge
- Check link



Which are the important components?

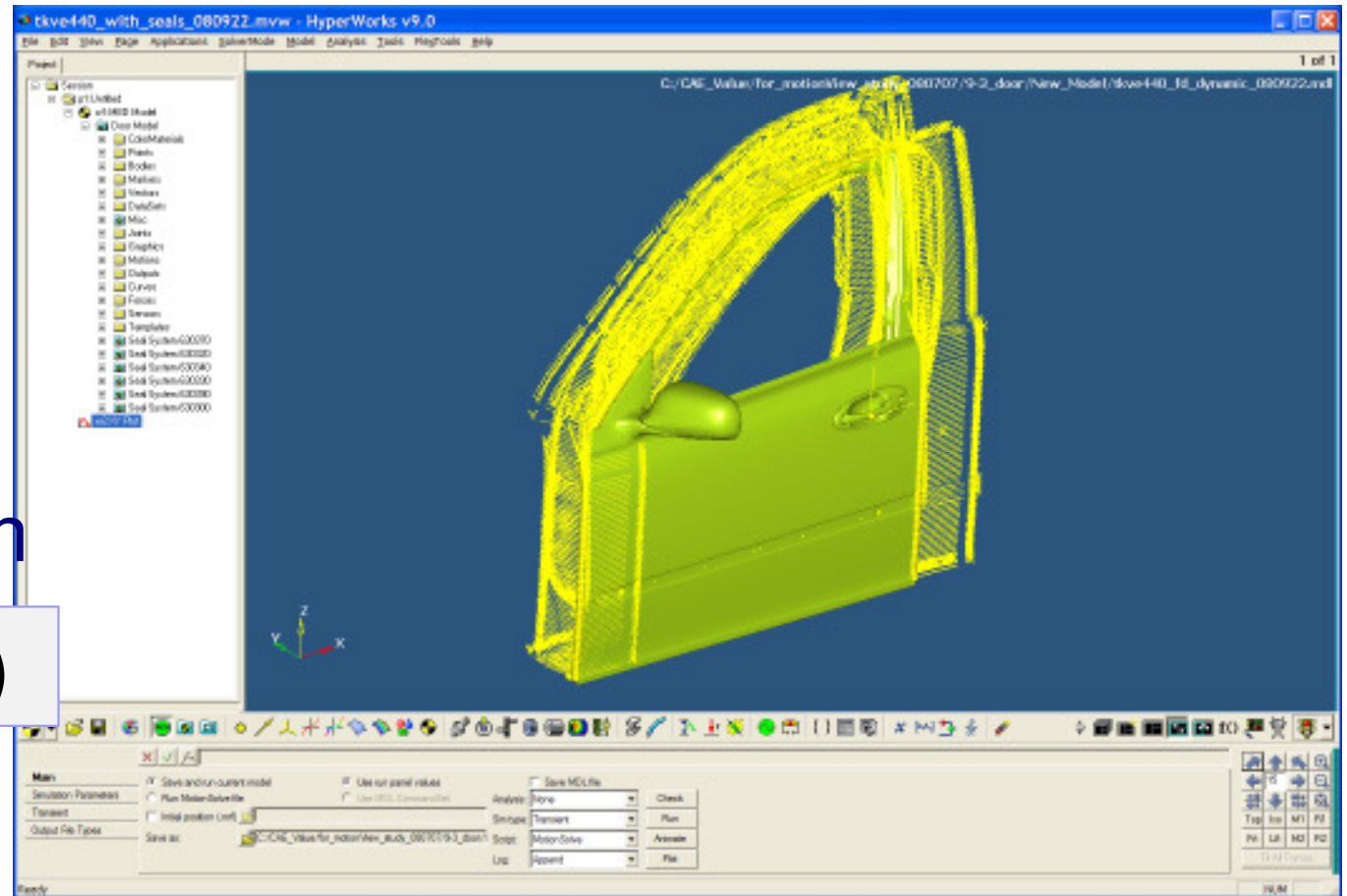
- Seals
- Hinge
- Check link
- Latch



Which are the important components?

- Seals
- Hinge
- Check link
- Latch
- Air Evacuation

$F(\omega, a, c_d, p, \dots)$

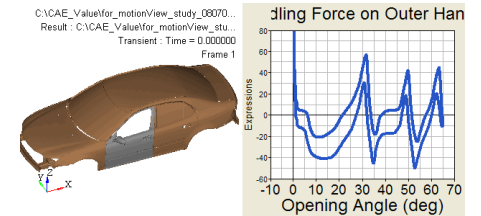


Which analysis events do we need?

1. Opening
 - Quasi-static
2. Closing
 - Quasi-static



Balance hinge line and check link to achieve ergonomic targets



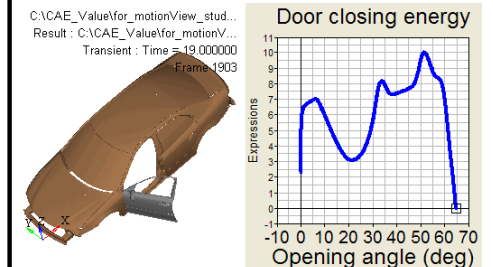
3. Closing
 - Dynamic



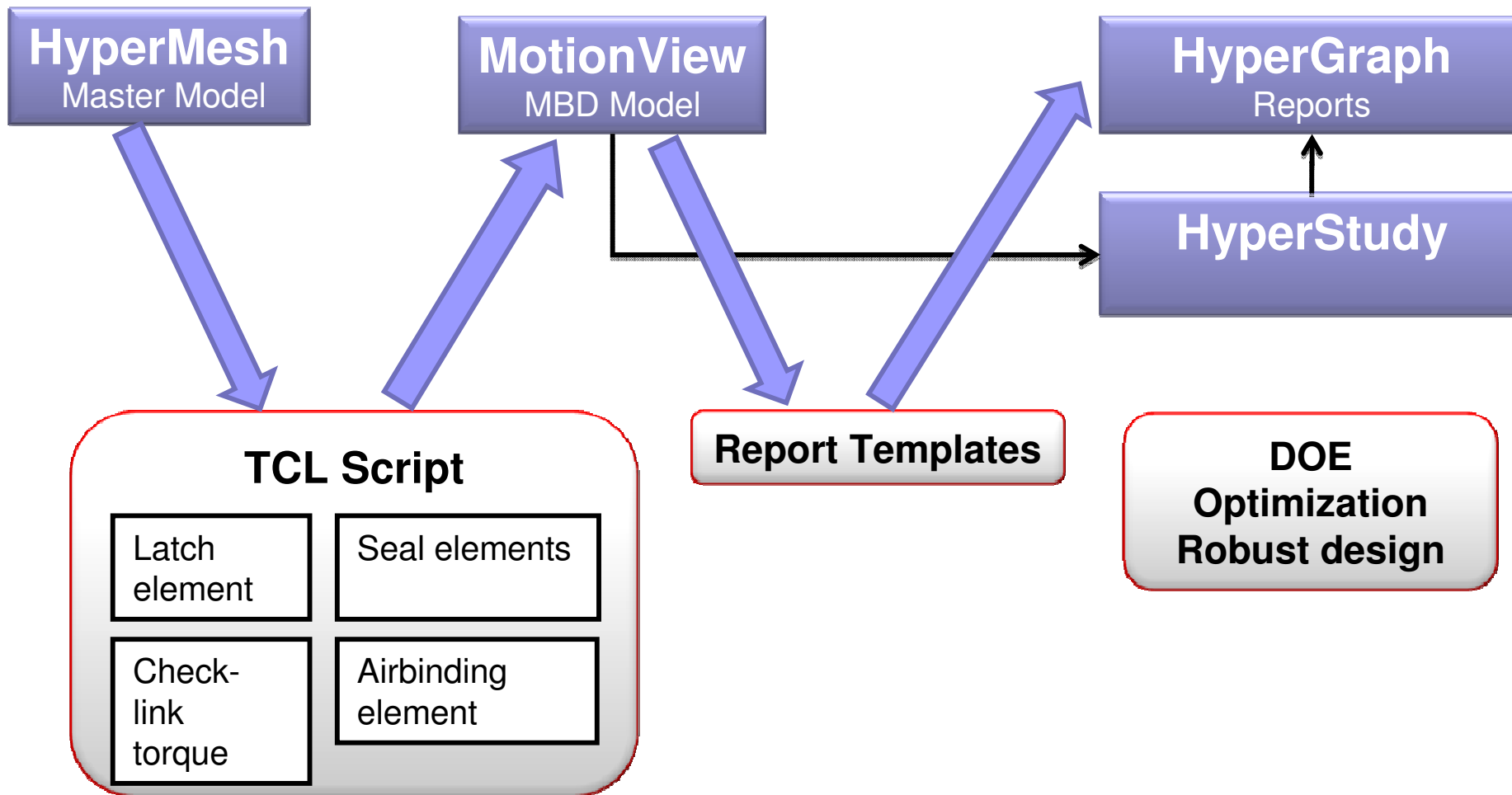
Balance

- Hinge line
- Check link
- Seals

To ensure door latch



Process Architecture



Example of a DOE

Problem description:

Balance hinge line and check link to achieve ergonomic targets and at the same time ensure full latching

Design Parameters

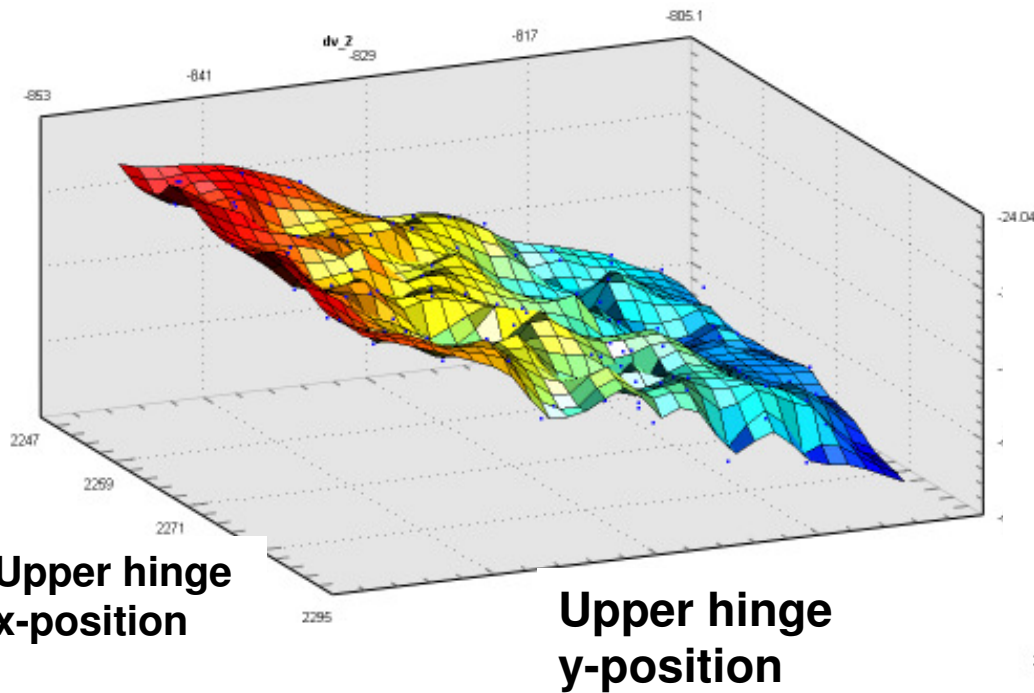
- Upper hinge x- and y-position
- COG position
- Mass

Responses

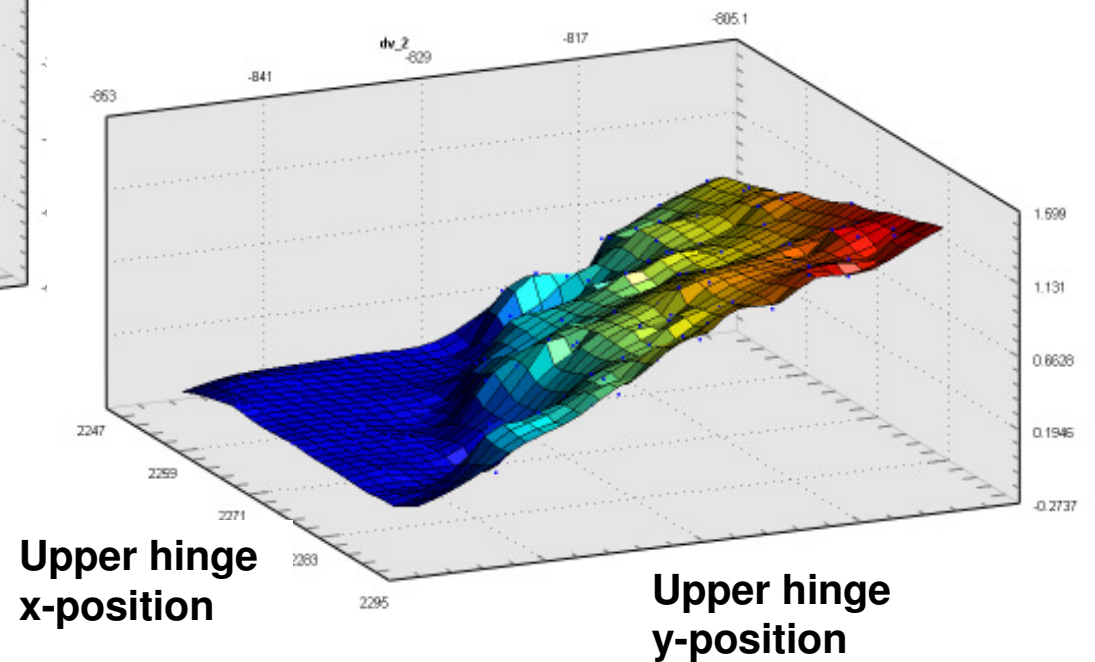
- Detent forces (at 6 different positions)
- Latch velocity at closing

DOE Results

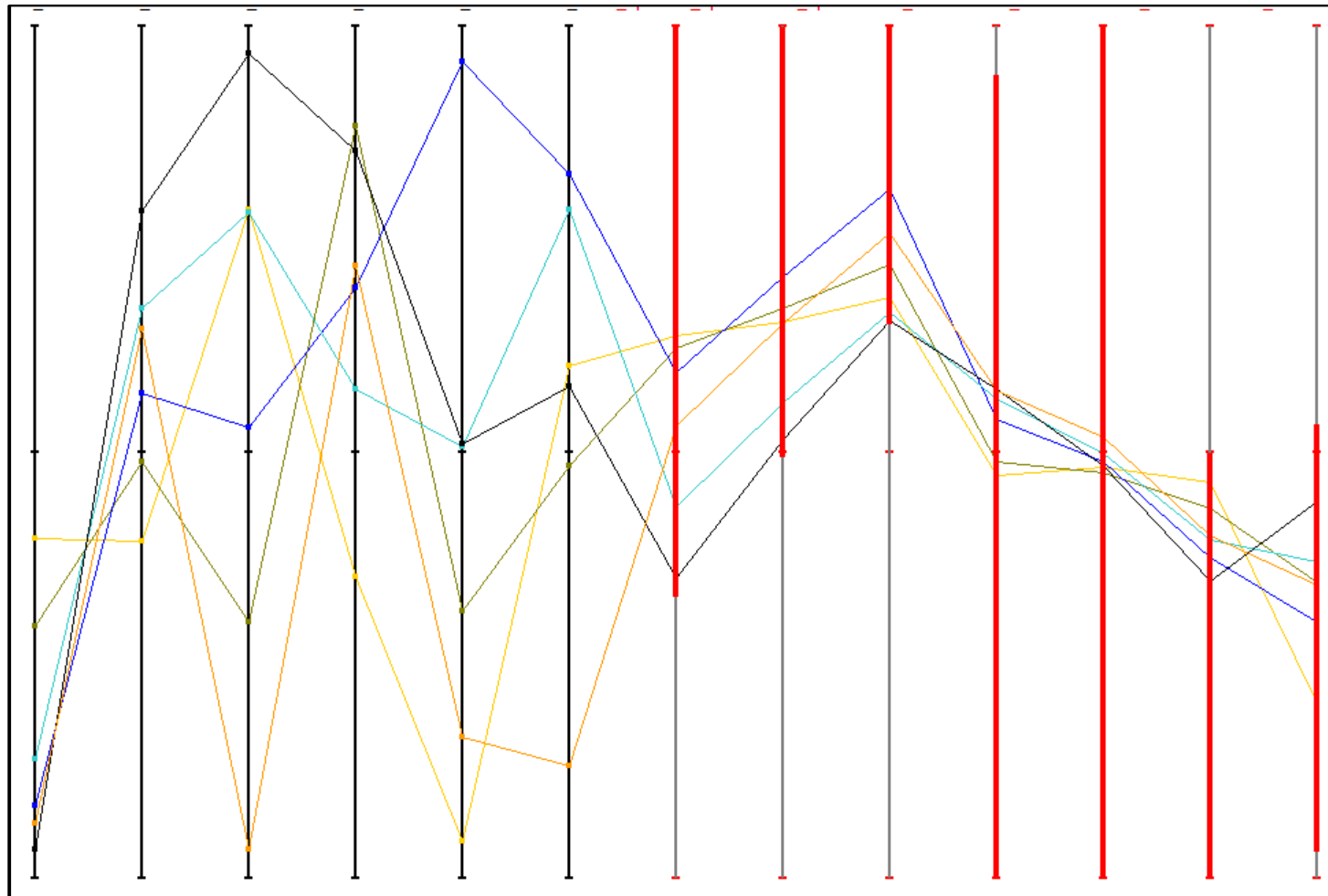
Max opening force at
1st check link crest



Latch velocity



DOE Results



Conclusions

- Door opening/closing simulation can be carried out with good predictive capability
- Hyperworks was used to create efficient framework for this type of simulations
 - Data extraction from FEA HyperMesh
 - MBD Modeling in MotionView
 - Analysis in MotionSolve, Hyperstudy
 - Reporting in HyperGraph

Conclusion

