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# Computer Aided Ergonomics Case Study: Vehicle Brake System



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# Motivation

- Short development cycles require early ergonomic assessment.
- Better ergonomic performance without expensive features requires advanced ergonomic analysis tools.
- Many ergonomic issues are related to muscle activation.
- Customer clinics are not suitable for parameter screening and design optimisation.



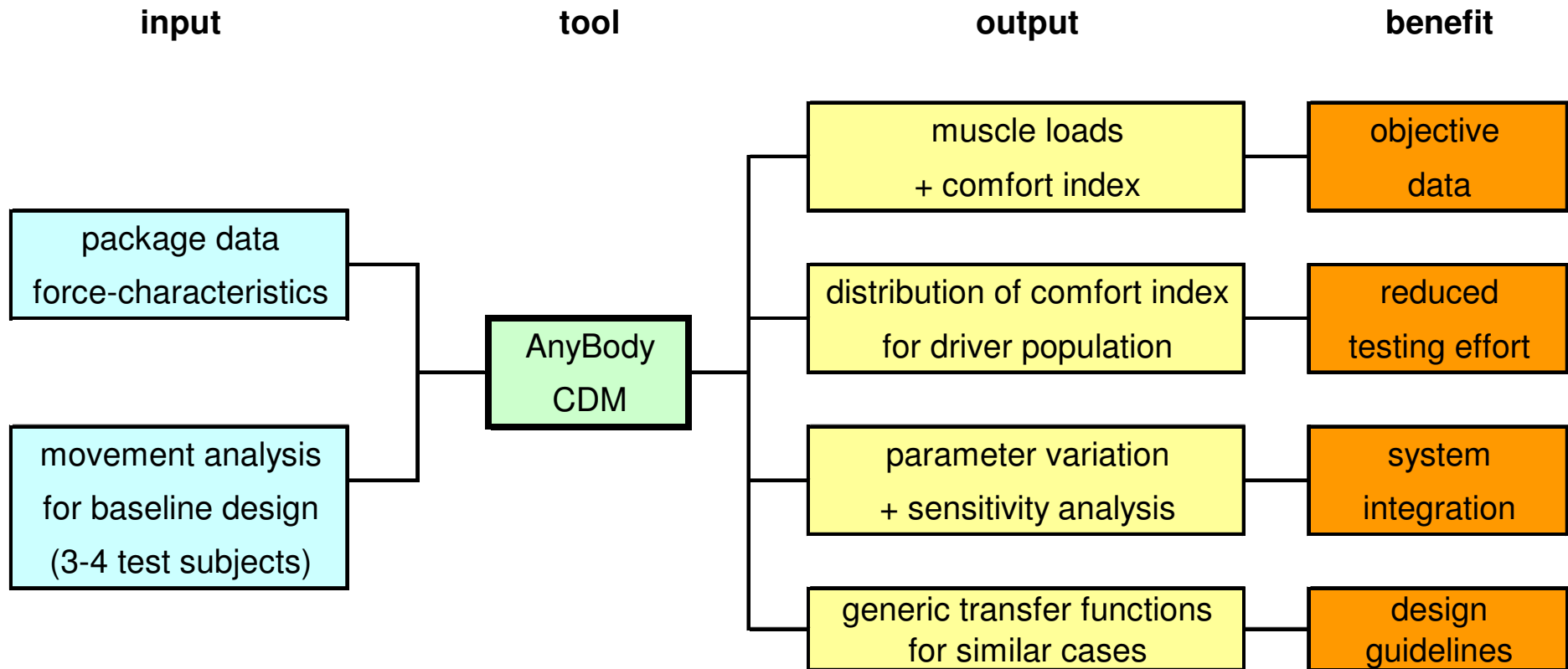
need for test methods and  
Computer Aided Ergonomics using  
a biomechanical model of the human body



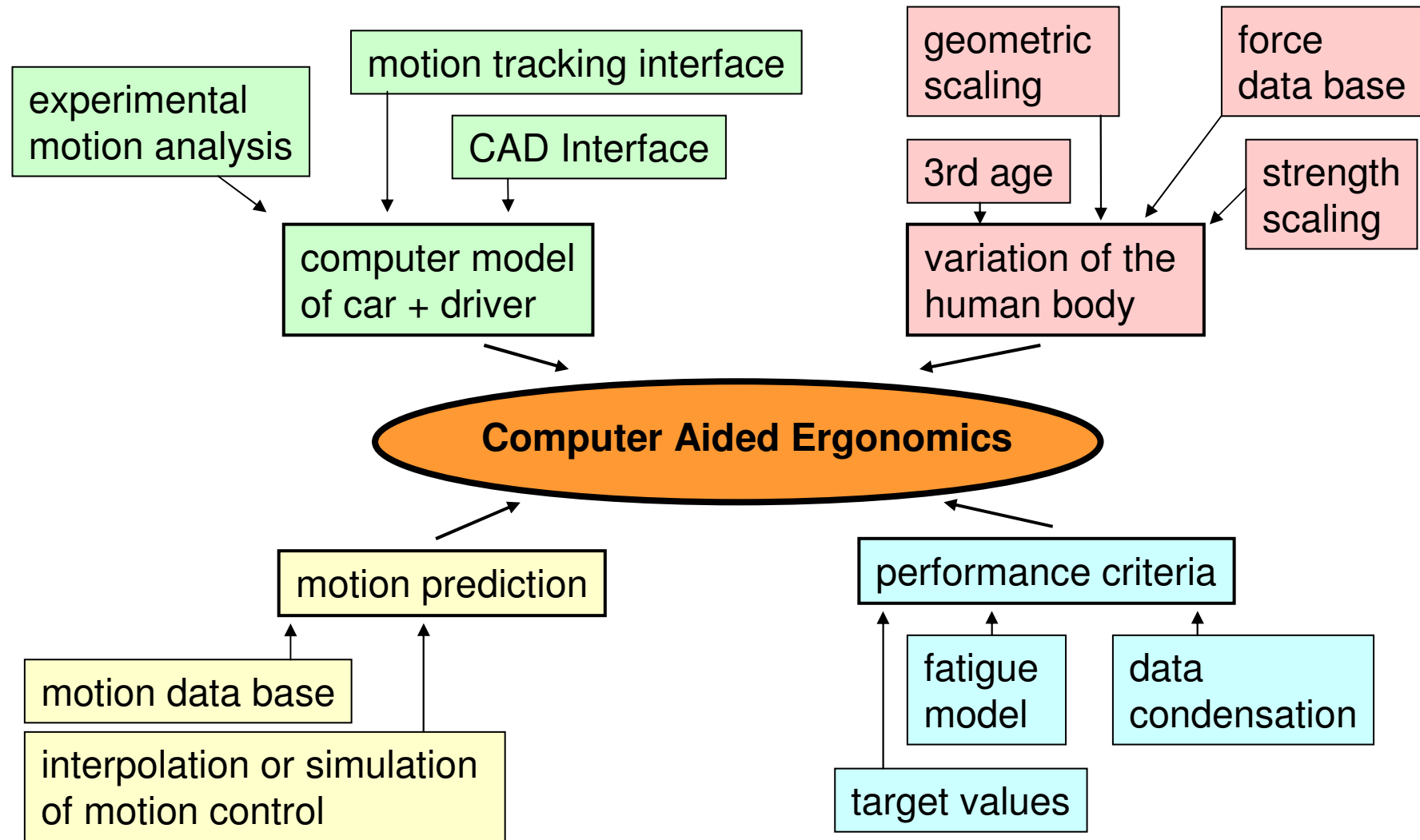
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# Role of the AnyBody Car Driver Model

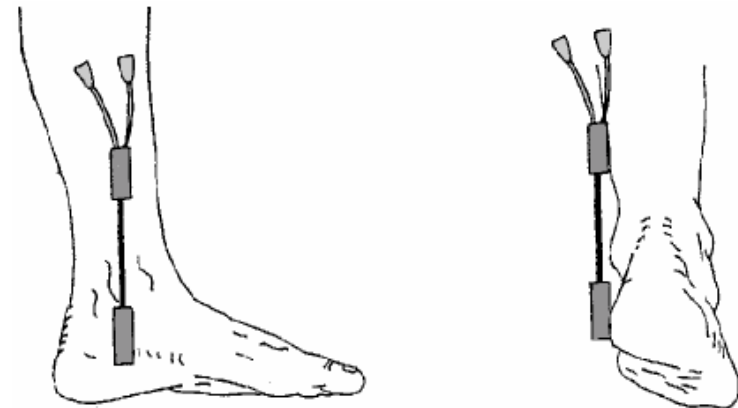


# Working Areas: Computer Aided Ergonomics

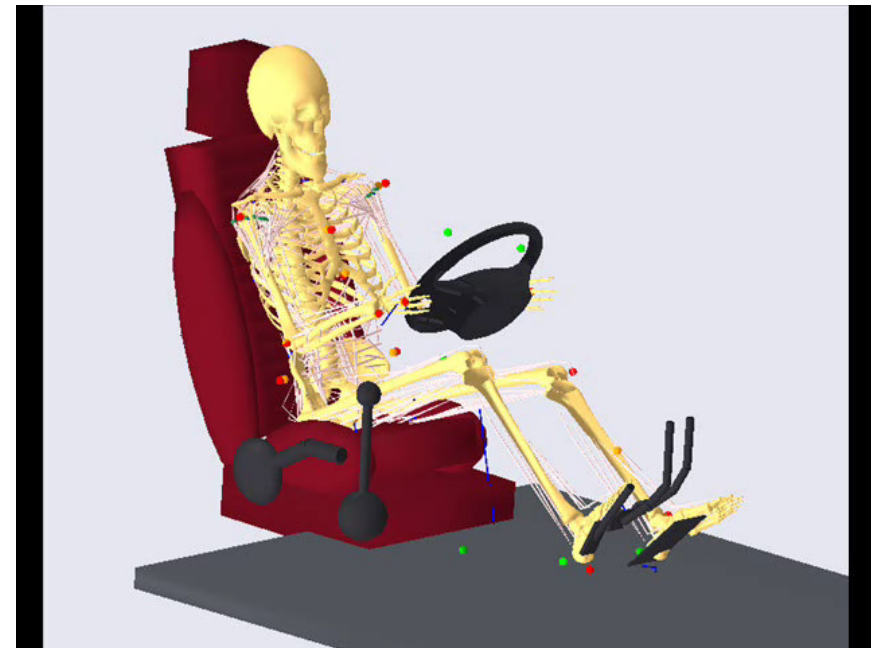
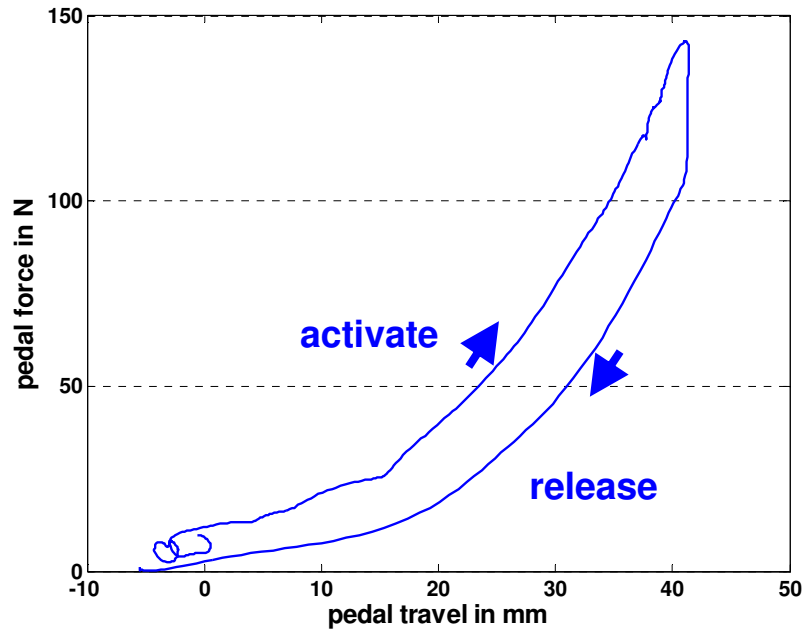
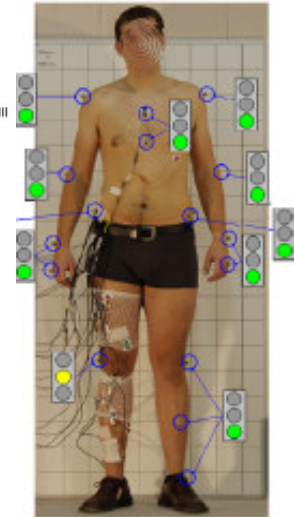
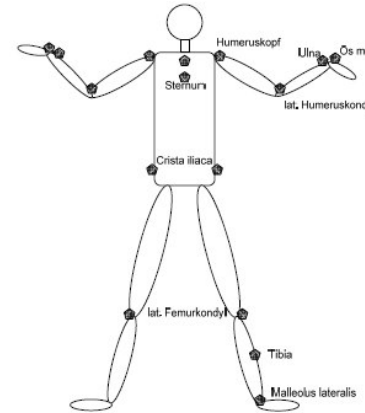
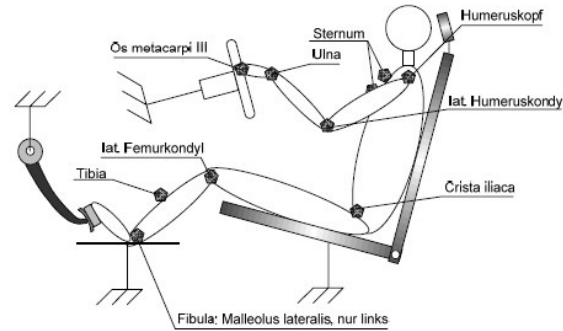
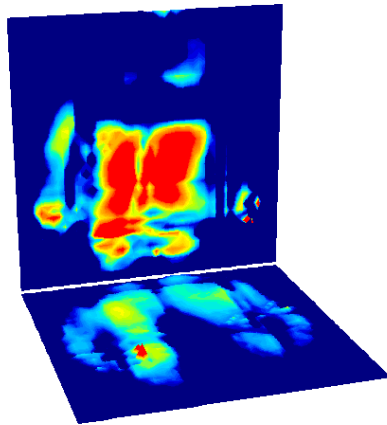


# Validation Study: Braking

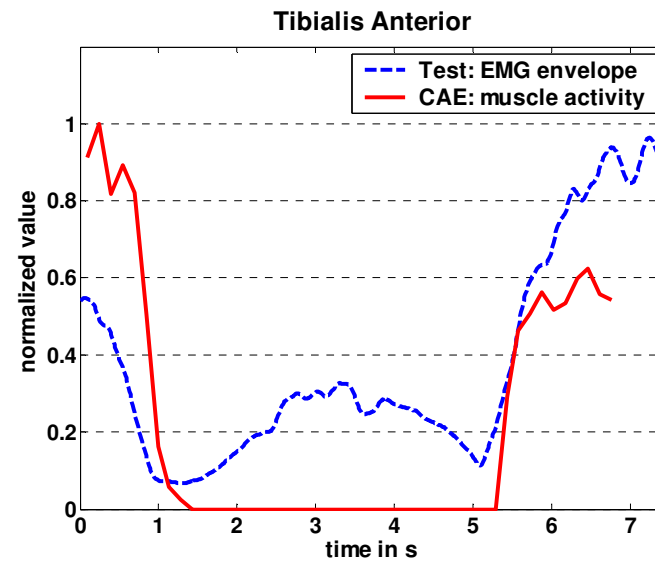
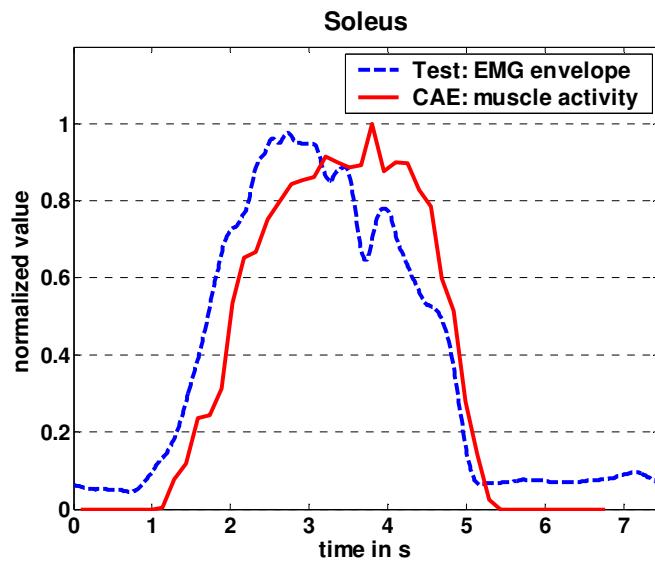
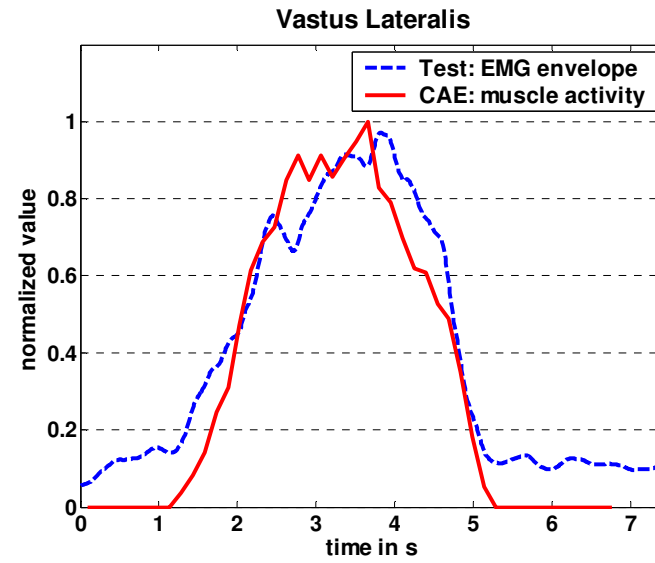
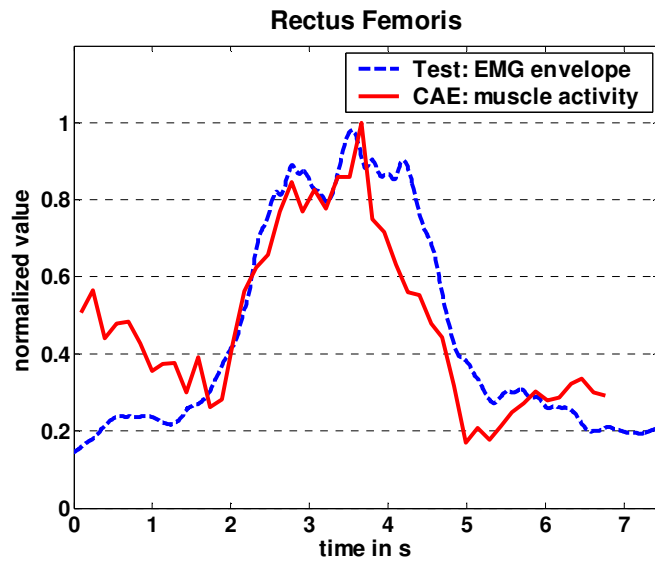
- Ford test vehicle, tunable force characteristic for brake pedal. Partially obstructed view.
- Motion analysis:
  - Qualisys for the upper body and the left leg;
  - Goniometers at the right leg;
  - Potentiometer for right heel
- External Loads:
  - contact switch to identify heel position;
  - pressure mapping to estimate seat support;
  - force transducer at the brake pedal
- EMG measurements of right leg muscles



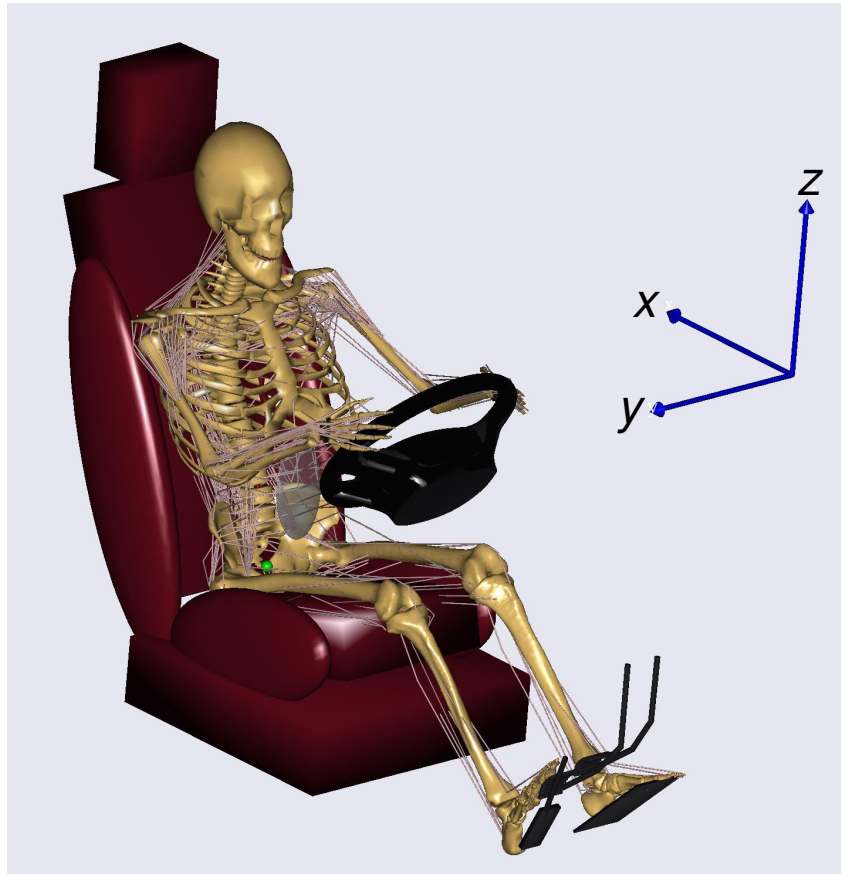
# Validation Study: Braking



# Validation Study: Braking



# CAE Parameter Variation: Seating Position



AnyBody Car Driver Model,  
Ford Mondeo package,  
artificial brake characteristic,

variation of the H-point,  
50% female human model,

Factor	min	max	levels
x-pos	-0,16	-0,08	5
y-pos	-0,01	0,01	3
z-pos	-0,025	0,05	4

[m], 50% female pos. , compared to 95% male H-point

DoE with full factorial design,  
3rd order polynomial model  
(without cubic effect of y-pos,  
due to array construction)



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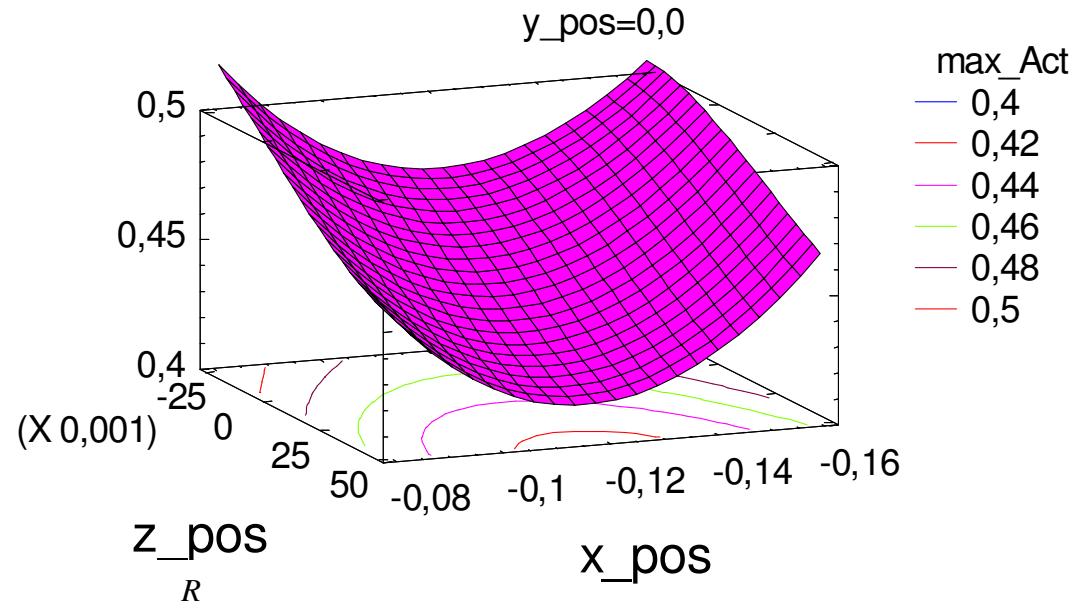


# CAE Parameter Variation: Seating Position

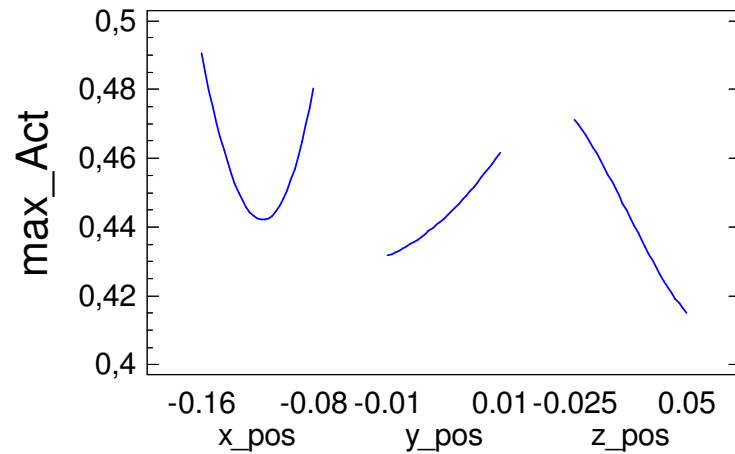
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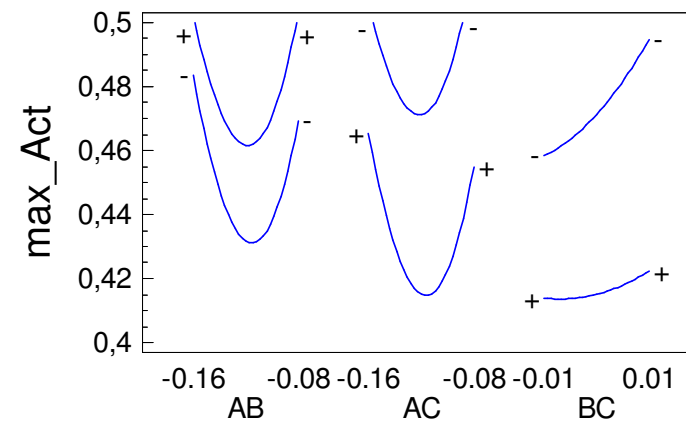
3rd order polynomial model  $R^2_{adj} = 96\%$



Main Effects Plot for max\_Act



Interaction Plot for max\_Act



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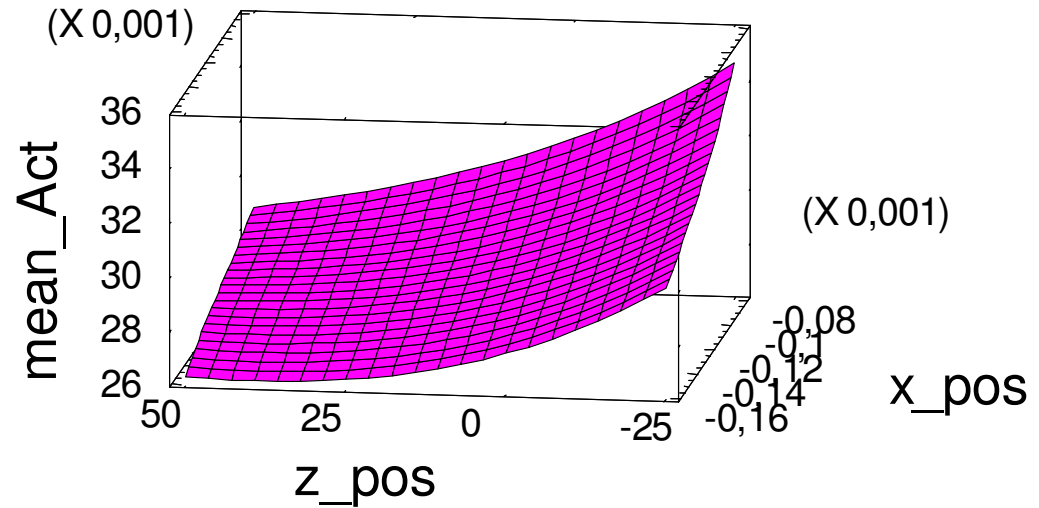
# CAE Parameter Variation: Seating Position

y\_pos=0,0

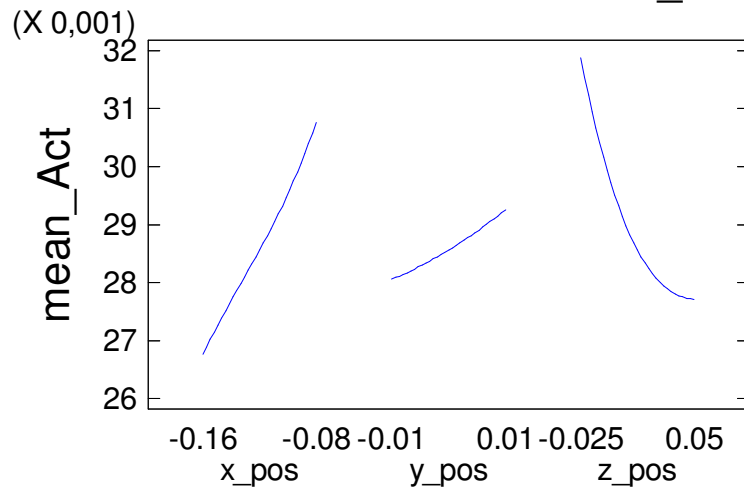
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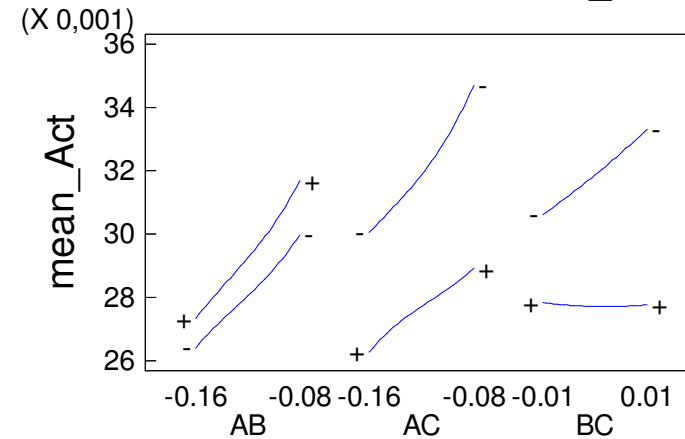
3rd order polynomial model  $R_{adj}^2 = 98,6\%$



Main Effects Plot for mean\_Act



Interaction Plot for mean\_Act



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# Conclusions

Computer Aided Ergonomics is a valuable tool to improve the vehicle design.

Many working areas need to be addressed simultaneously.  
Several of them are related to the human body as such,  
others will streamline the workflow and speed up the turn around time.

The validation results of the AnyBody Car Driver Model are promising.

Meta-modelling helps to communicate results to the product development.  
DoE seems to work well in this context.



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