Effects of Driver Attributes on Lower Abdomen Contour

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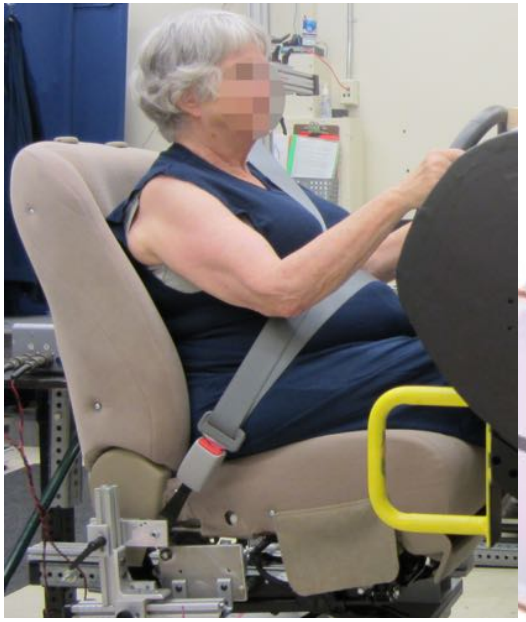
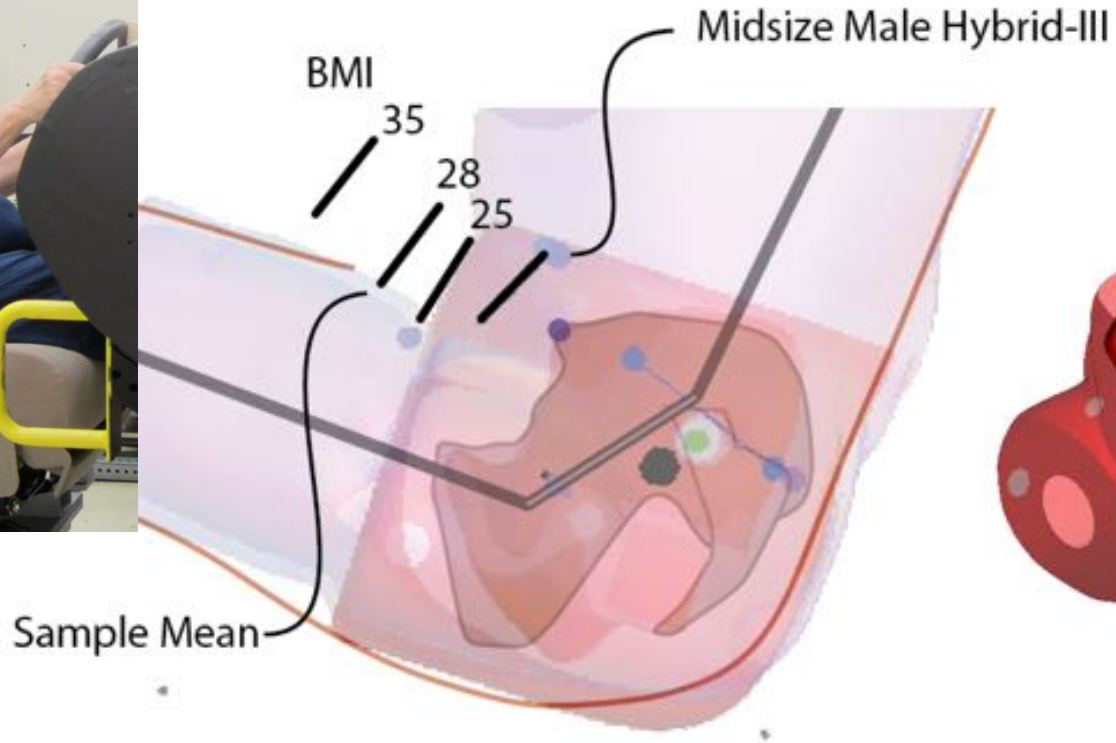
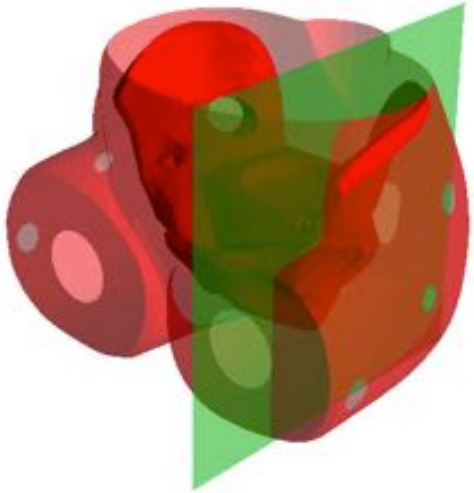
Previous Results: Lap Belt Fit

Mean belt locations with respect to ASIS for 97 drivers at lateral location of anterior-superior iliac spine (ASIS)



T070
70 years
31 BMI
1630 mm





Midsize male pelvis in mean posture
Mean belt locations at lateral position of ASIS (not occupant centerline)

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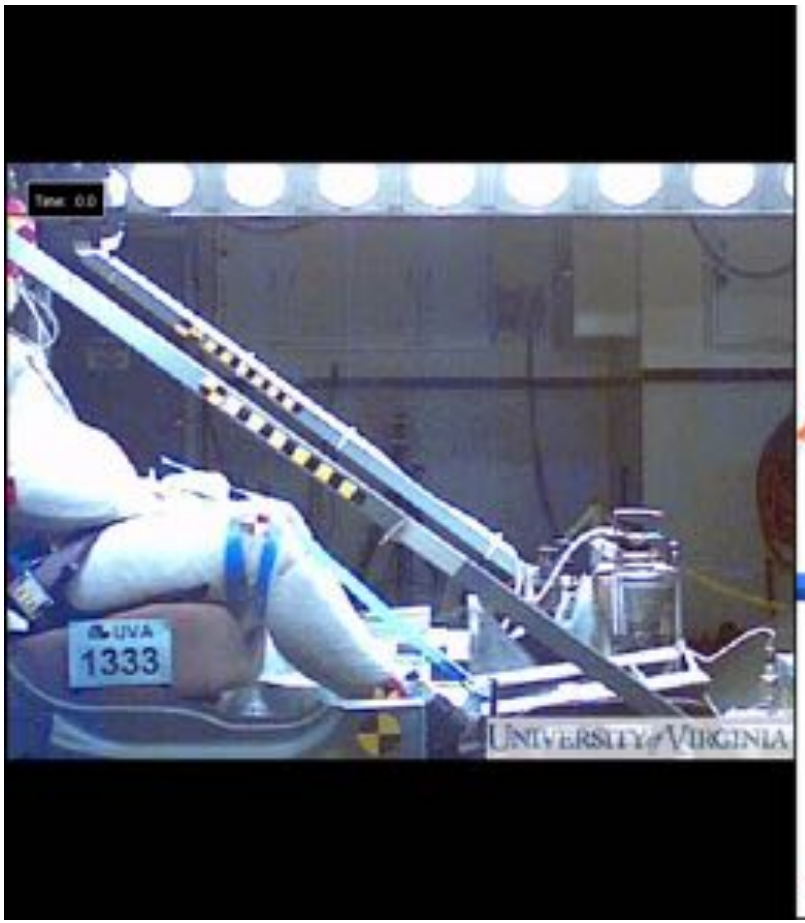
Reed et al. (2013) Stapp.

Adverse Kinematics

Forman et al.



Wang et al.

Comparison between test and simulation for a obese occupant

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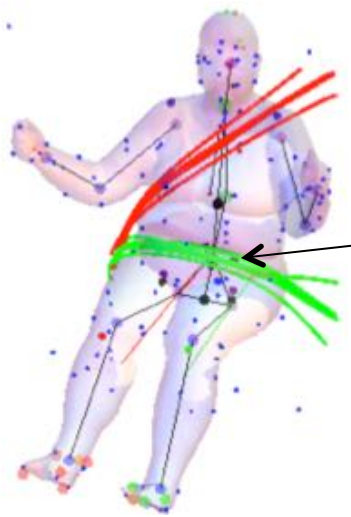
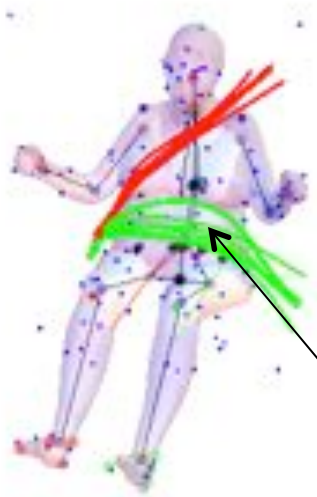
Belt Routing and Abdomen Contour

Belt position and webbing length are affected by both abdomen contour and driver behavior (belt donning).

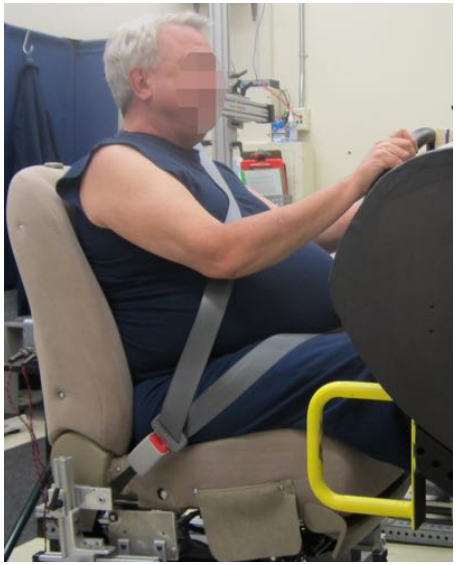
What is the range of abdomen contour?



Narrow range of belt locations



Wide range of belt locations



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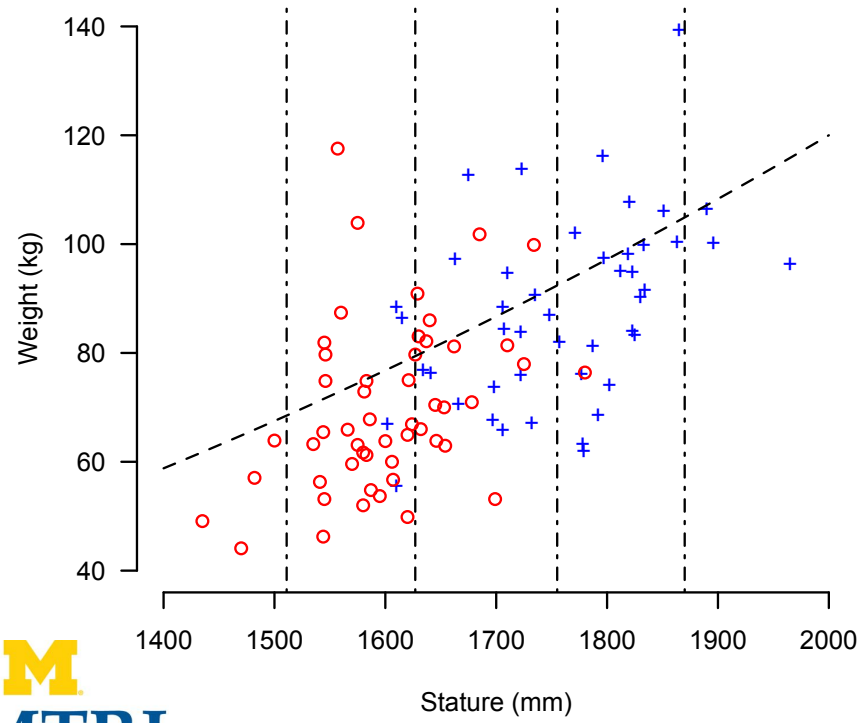
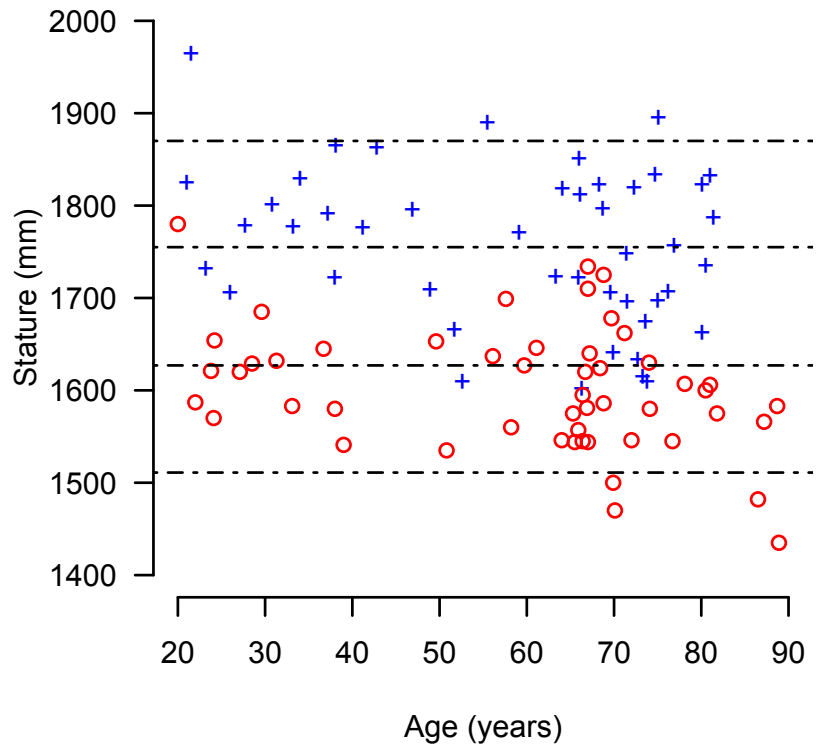
Methods

Men and women with a wide range of age and body size

Measure	Men (N=46)	Women (N=51)
Stature (mm)	1759 (85)	1601 (67)
Body Weight (kg)	87.9 (17)	69.9 (16)
Body Mass Index (kg/m^2)	28.4 (4.9)	27.3 (5.7)
Erect Sitting Height (mm)	913 (40)	845 (42)
Age (years)	58 (19)	59 (20)





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Methods

Body measurements in hardseat and laser scanner

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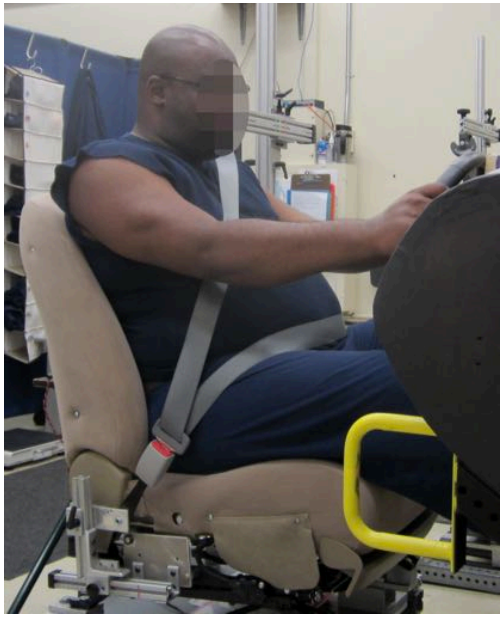
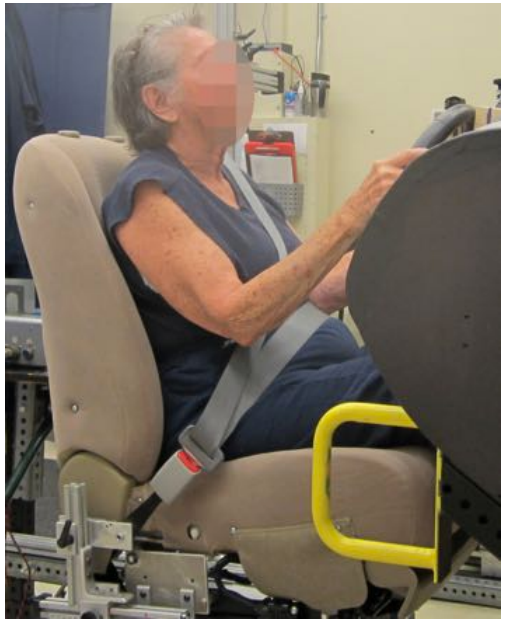
Body Scan Data



Approximate driving posture

Estimated pelvis size and location



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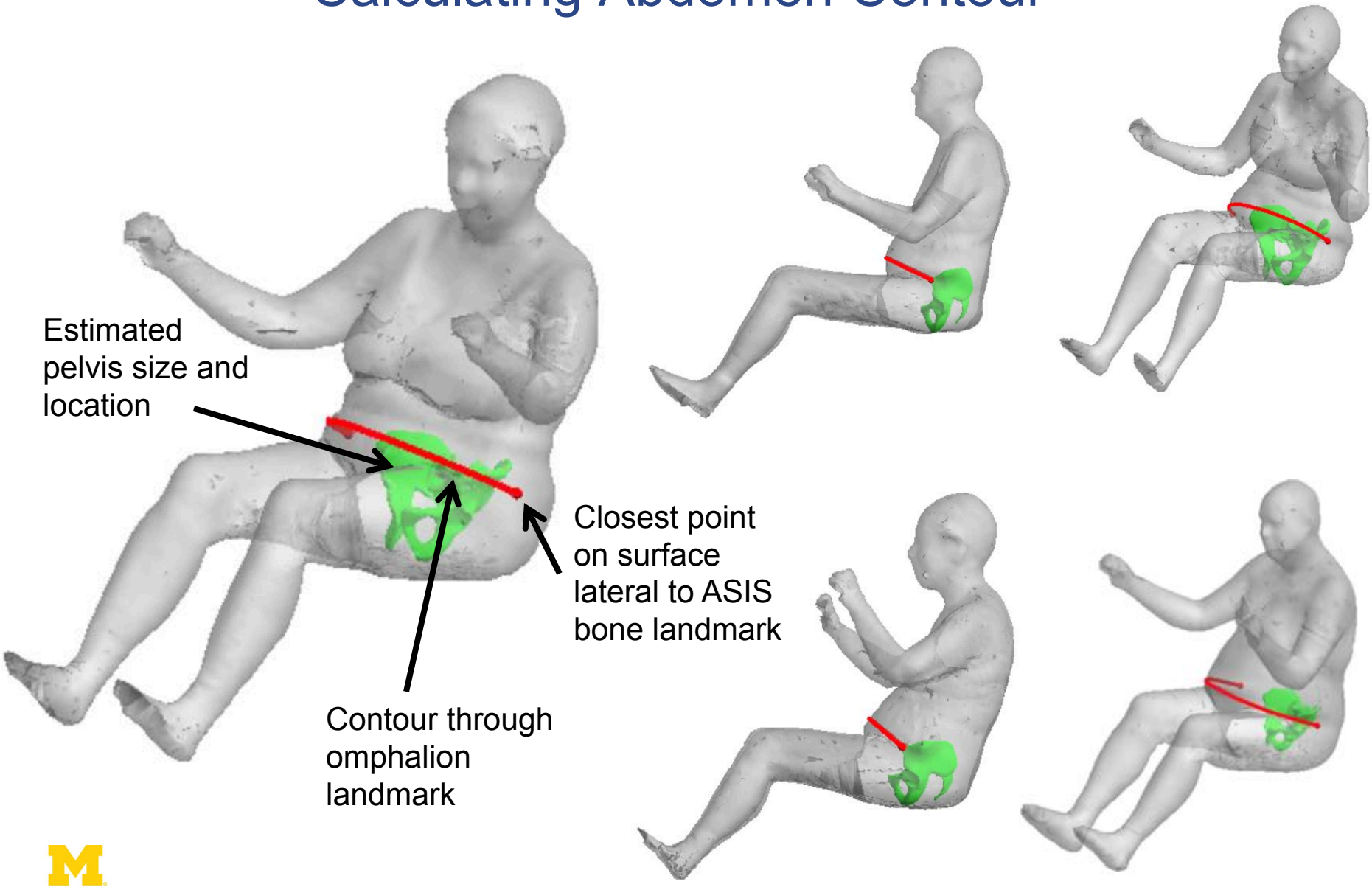
Calculating Abdomen Contour



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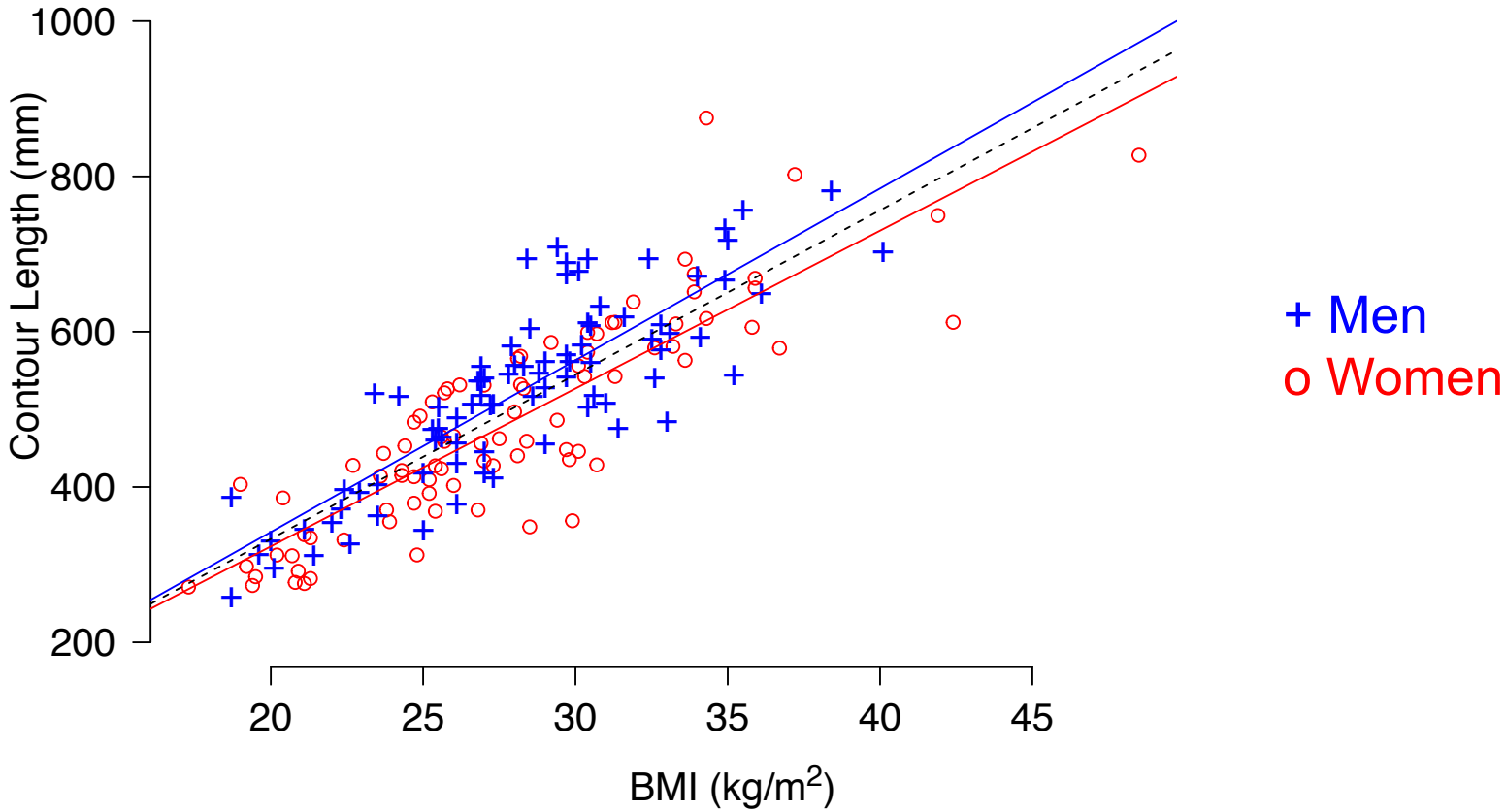
Results – BMI Effects



Contour Length (mm) = -149 + 1.27*Age + 20.5 BMI, R^2_{adj} = 0.75, RMSE = 65.2 mm

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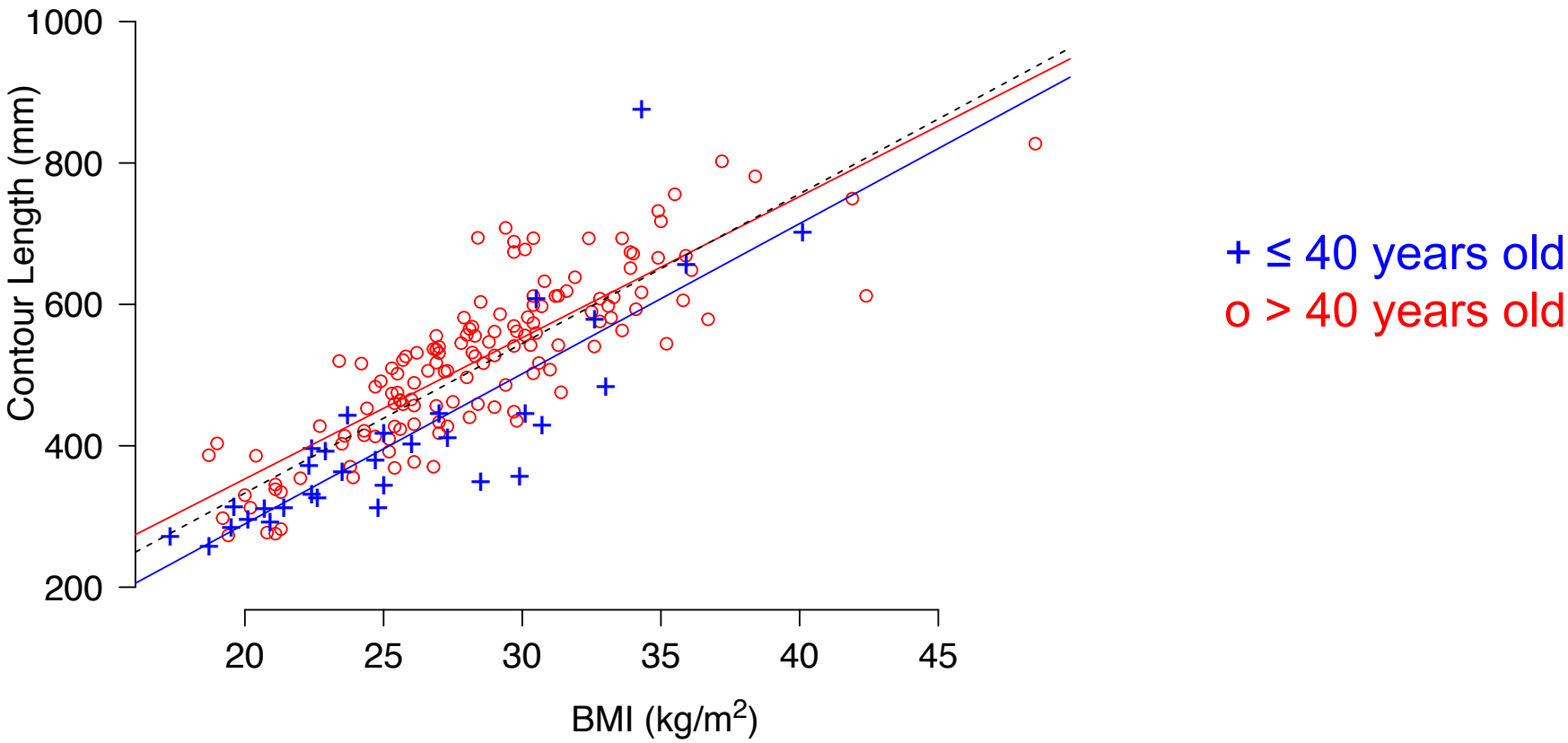
Results – Age Effects



Contour Length (mm) = -149 + 1.27*Age + 20.5 BMI, R^2adj = 0.75, RMSE = 65.2 mm

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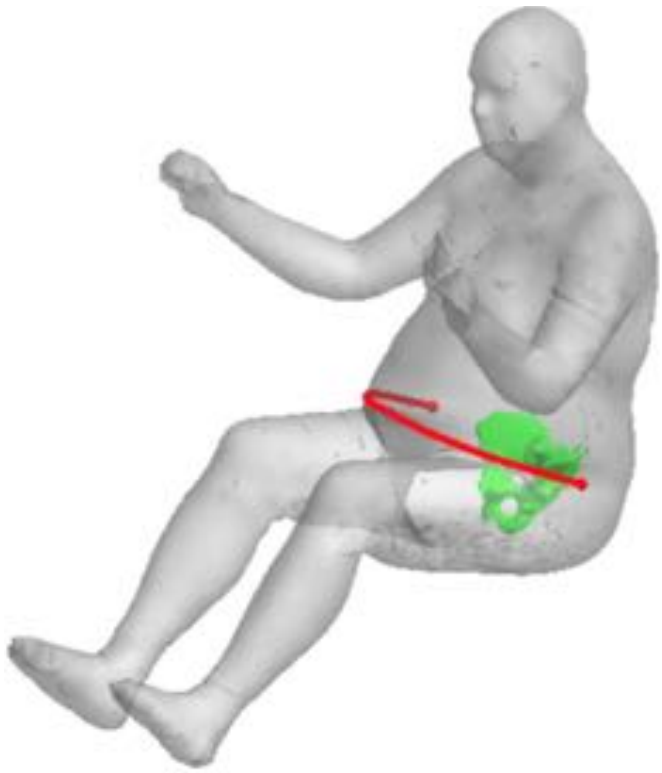
Discussion

- Lower abdomen contour relative to the pelvis is much longer for individuals with high BMI
  - → greater belt webbing length
  - → greater flesh deformation before substantial pelvis force in frontal impacts
- BMI has a much larger effect than age, across the population, and gender is unimportant for this variable
- Countermeasures to improve belt fit for higher-BMI individuals might reduce the increased risk in frontal impact



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Morphed GHBMC Models

	Stature 1.75m, BMI 25	Stature 1.75m, BMI 30	Stature 1.75m, BMI 35
Age 30			
Age 70			

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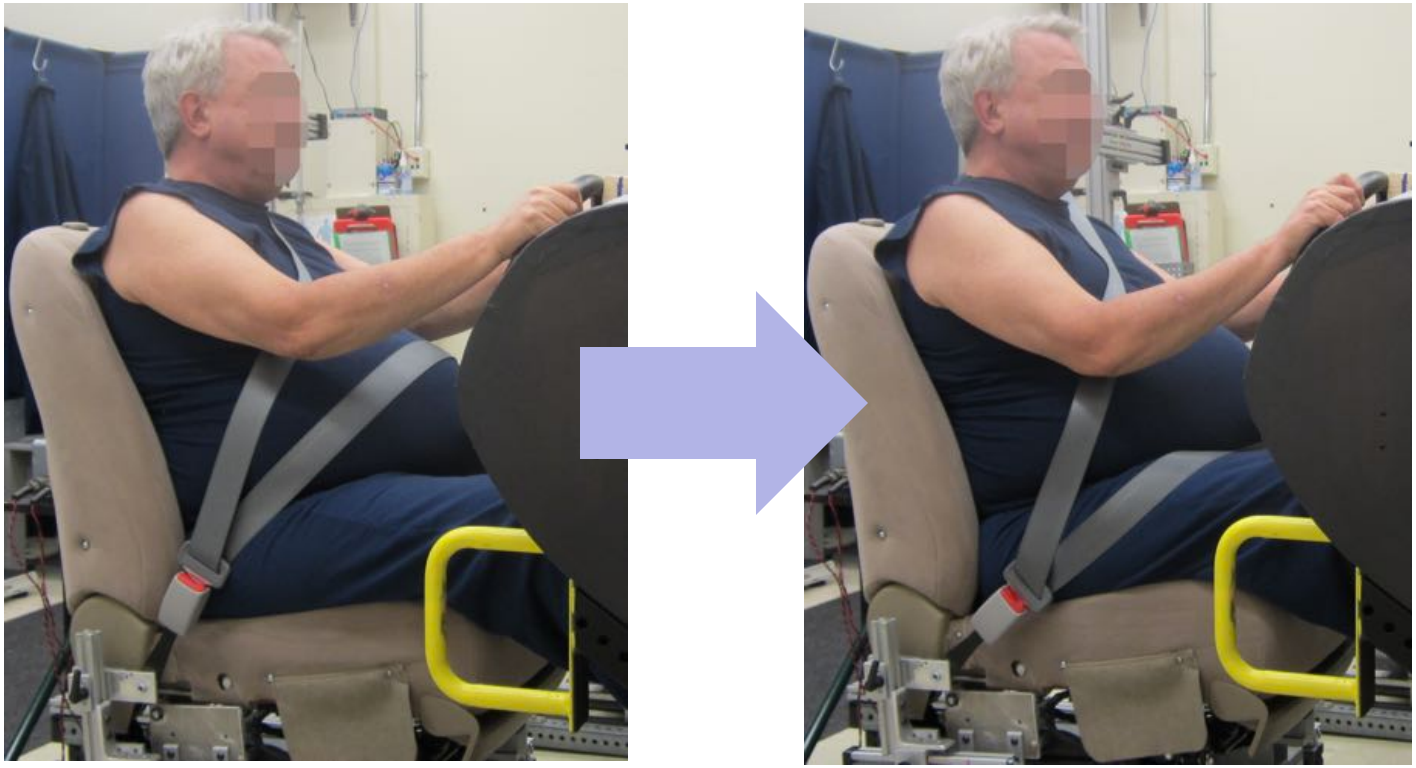
Whole-body morphing by controlling 160k landmarks on the ribcage, pelvis, femur, tibia, and external body shape

Future Work

Can drivers be educated to place their belts more effectively regardless of BMI?

Can belt system design counter these effects?



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Acknowledgements

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http://www.toyota.com/csrc/

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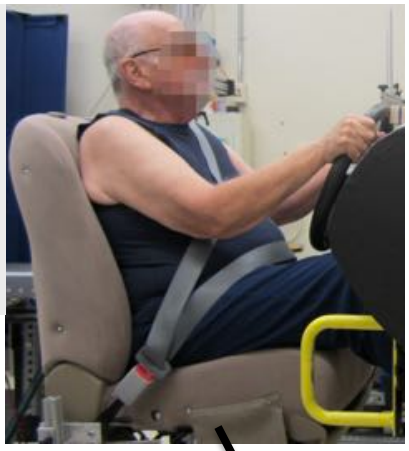
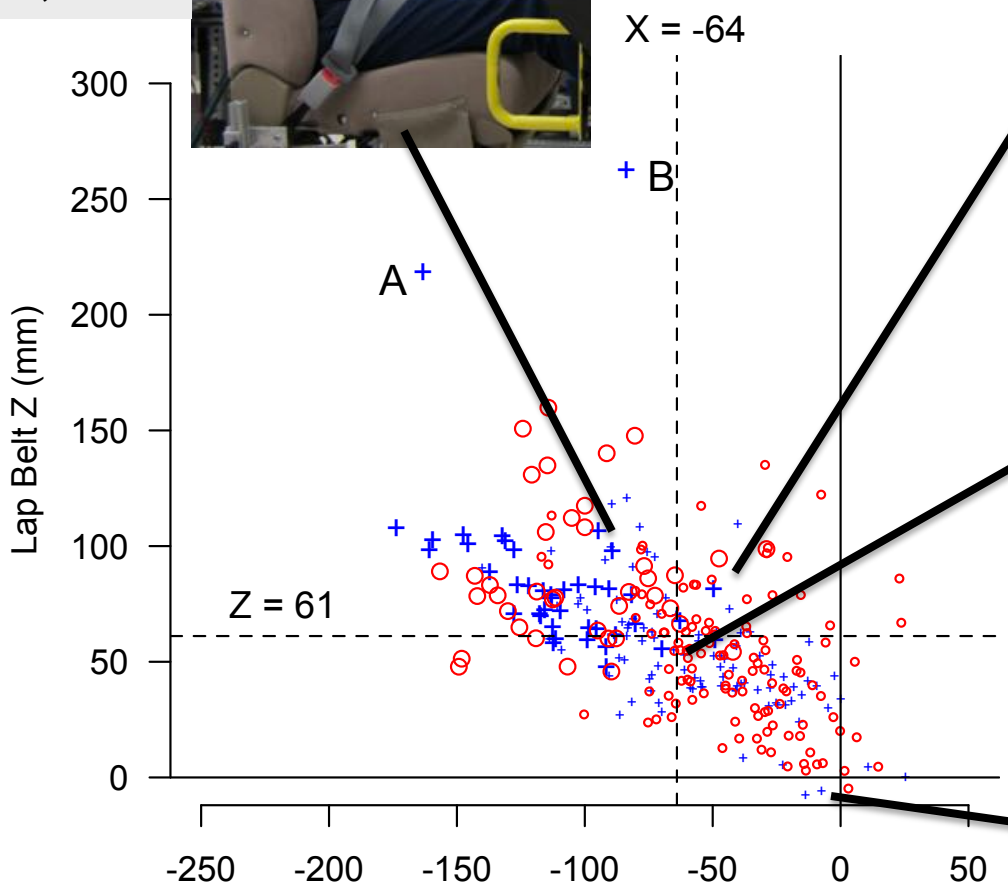
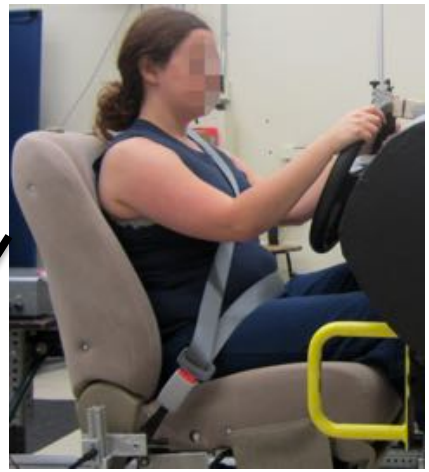
Results

Lap Belt Fit

T060
80 years
35 BMI
1663 mm
-99, 117

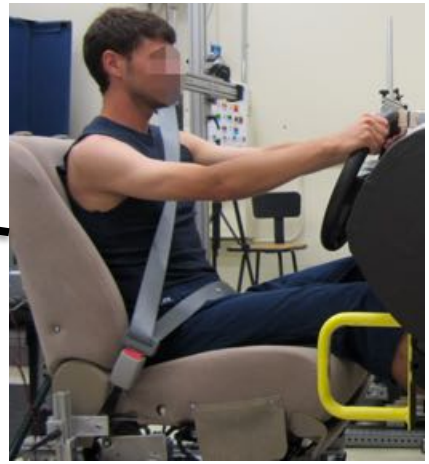






T044
24 years
29 BMI
1621 mm
-53, 83

T053
72 years
24 BMI
1697 mm
-64, 51



T029
28 years
20 BMI
1779 mm
-5, -1

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