Naturalistic Passenger Behavior: Non-Driving Postures and Activities in Front Seats

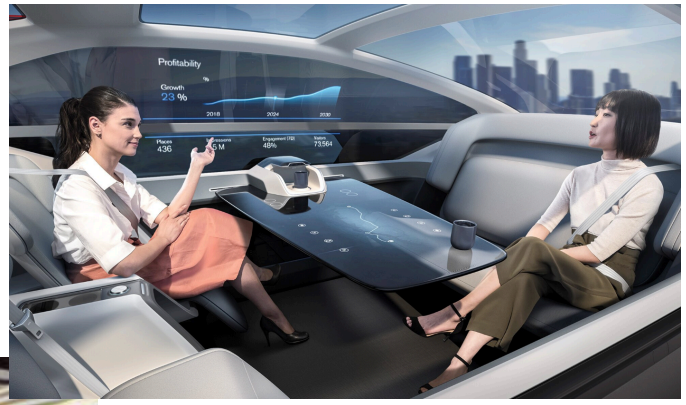
Updated 2020-02

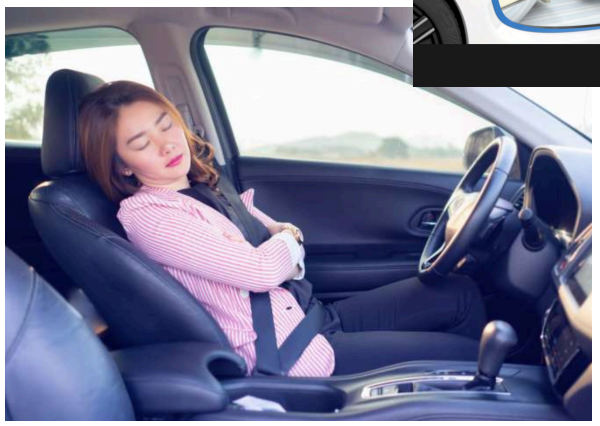
Matt Reed, Sheila Ebert, Monica Jones, Jason J. Hallman*

UMTRI TRANSPORTATION RESEARCH INSTITUTE UNIVERSITY OF MICHIGAN

* Toyota

What Will Passengers in Automated Vehicles Do?





Fun images from the web

What Will Passengers in Automated Vehicles Do?

Since general-purpose automated road vehicles do not yet exist, what's the best way to predict what future passengers will do?

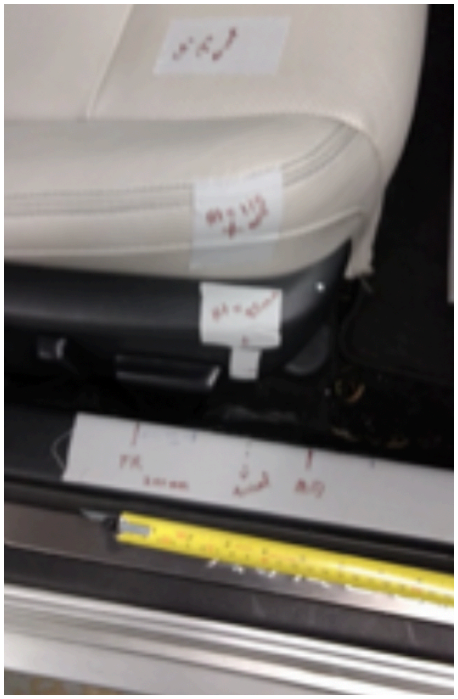
Study passenger behavior in current vehicles

Methods

- Instrument 75 privately owned vehicles with interior cameras
- Driven as usual for two weeks
- Manual coding of video to identify **front-seat passenger** behaviors
- Video-based method for estimating seat position and seat back angle

Grayscale camera with IR illuminators

Seat Position and Back Angle Calibration



Record seat position on arrival
(mm forward of full rear)

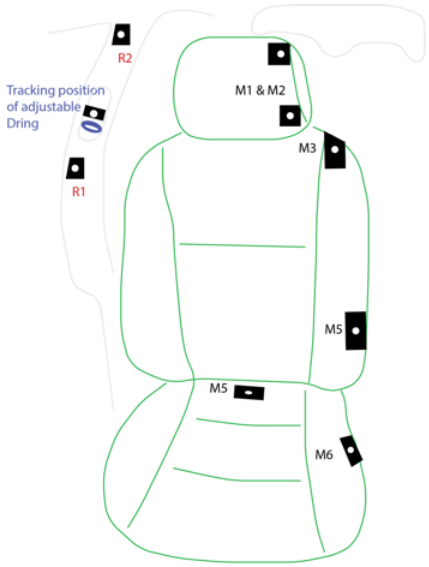
Record seat back and seat cushion angles

Tool developed in Huang and Reed (2006)
to estimate SAE J826 manikin measures

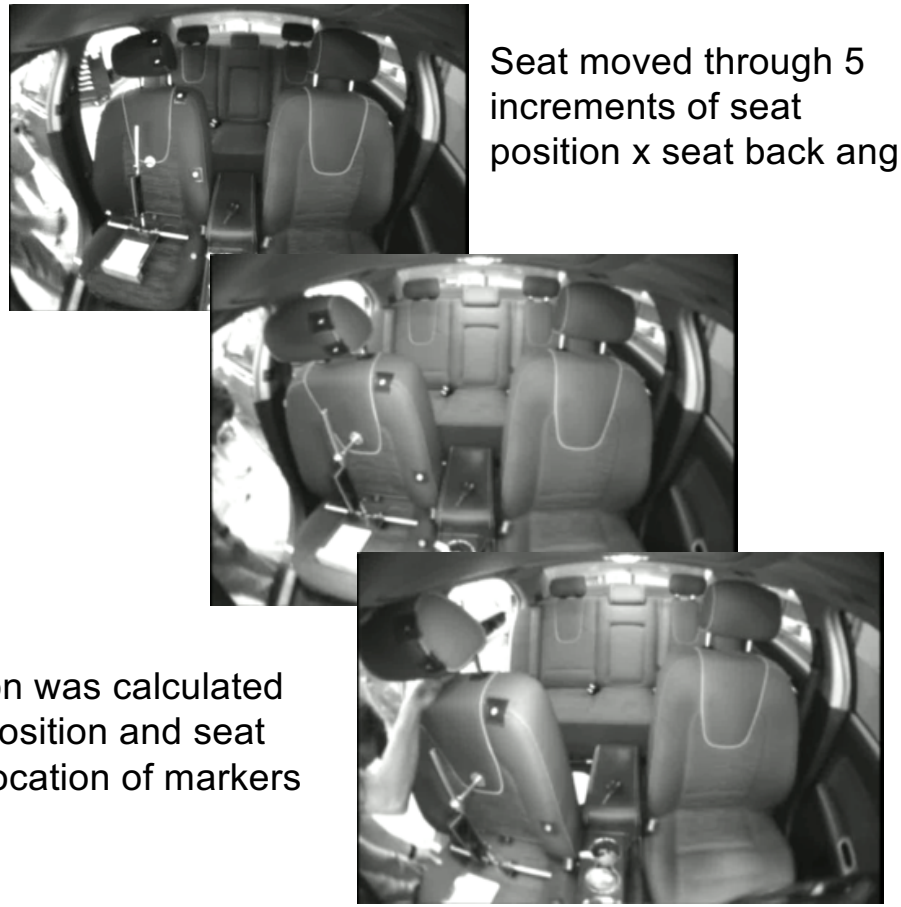
UMTRI

Seat Position and Back Angle Calibration

Reflective markers placed on seats



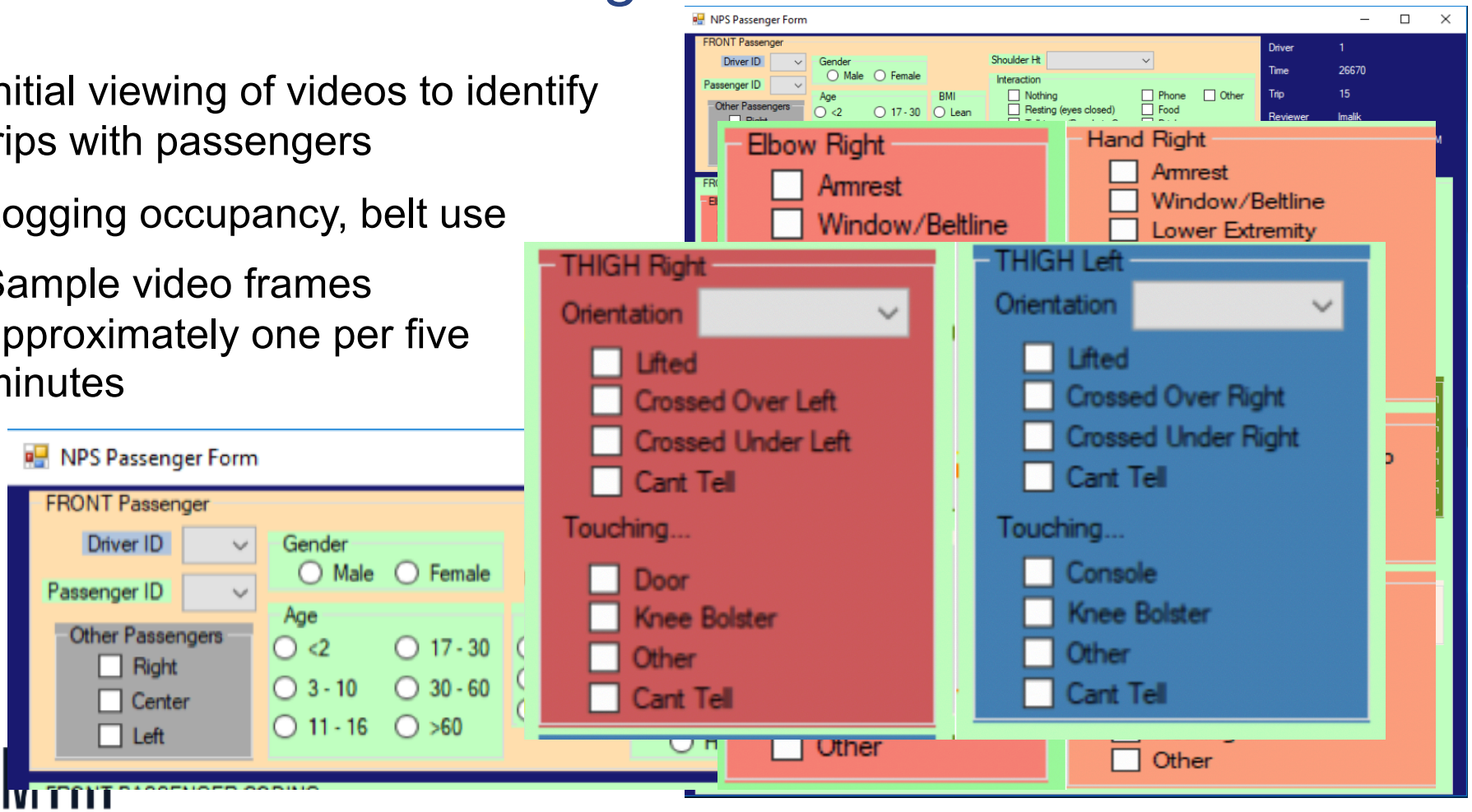
Calibration function was calculated to estimate seat position and seat back angle from location of markers in video frame



Seat moved through 5 increments of seat position x seat back angle

Coding Videos

- Initial viewing of videos to identify trips with passengers
- Logging occupancy, belt use
- Sample video frames approximately one per five minutes



High-Level Summary

In 75 vehicles:

Passenger is female in 72% of frames
(GES with induced exposure: 62%)

2733 trips with front-seat passengers

51128 total front-seat passenger minutes

306 unique front-seat passengers

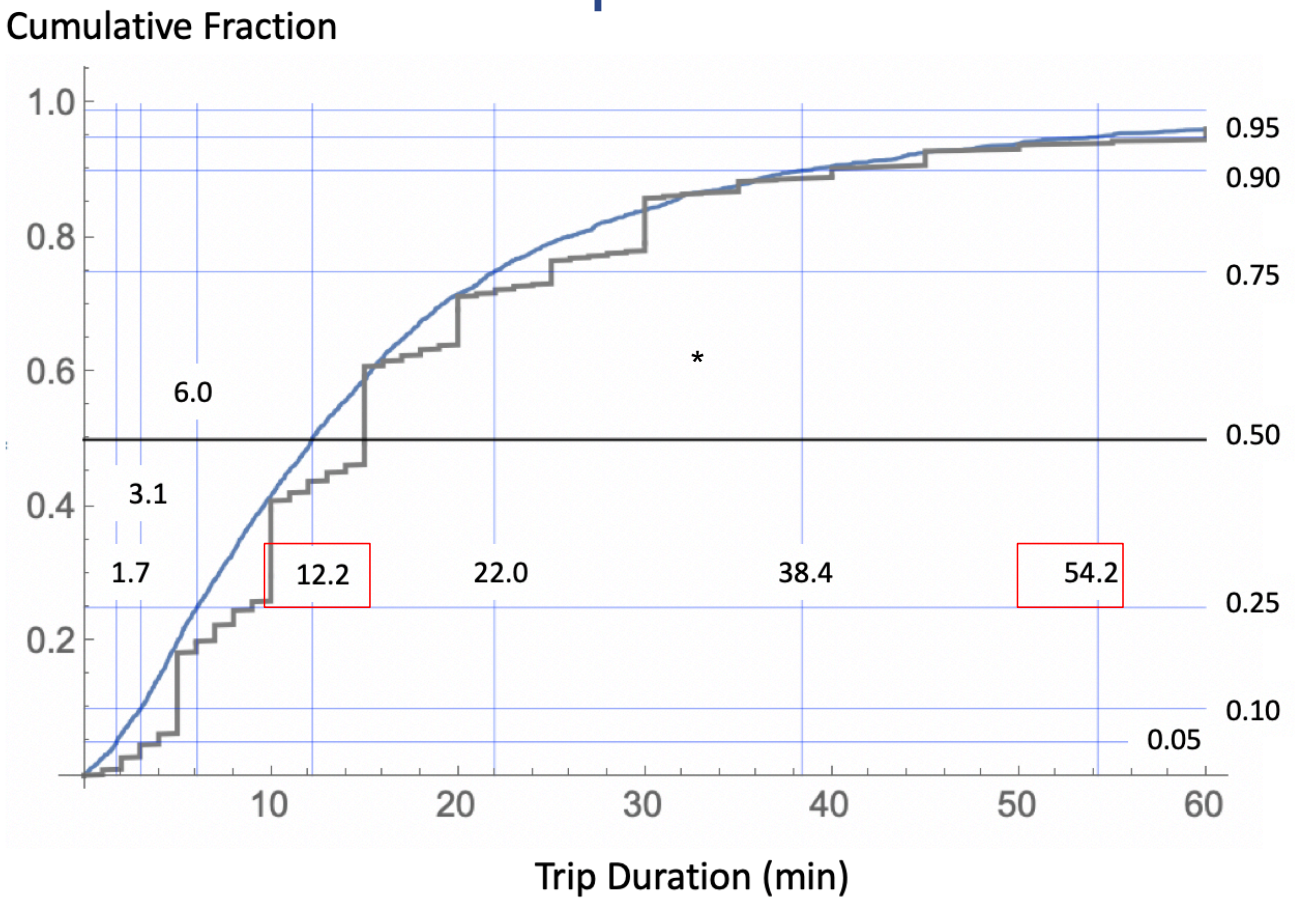
13638 video frames coded

5 frames per trip on average

3.7 minutes of travel time represented by each frame

UMTRI

Trip Duration



*2017 National Household Travel Survey (self-report)

Seat Belt

Overall 97% belt use

Shoulder Belt

71.5%	MidClavicle
21.5%	LatClavicle
2.7%	None
2.7%	OnNeck
0.8%	ForwardofBody
0.7%	UnderArm

Lap Belt

85.0%	OnLap
12.4%	OnBelly
2.1%	None
0.3%	Can't Tell
0.3%	Missing

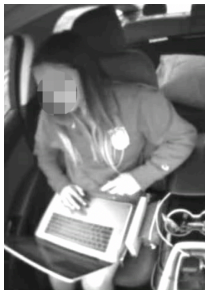
Activities

Behavior	Percent
Talking	46.0%
Phone	26.4%
Nothing	25.9%
Other	5.7%
Food	3.2%
Resting	2.2%
Drink	1.6%

(More than one behavior could be tabulated per frame)

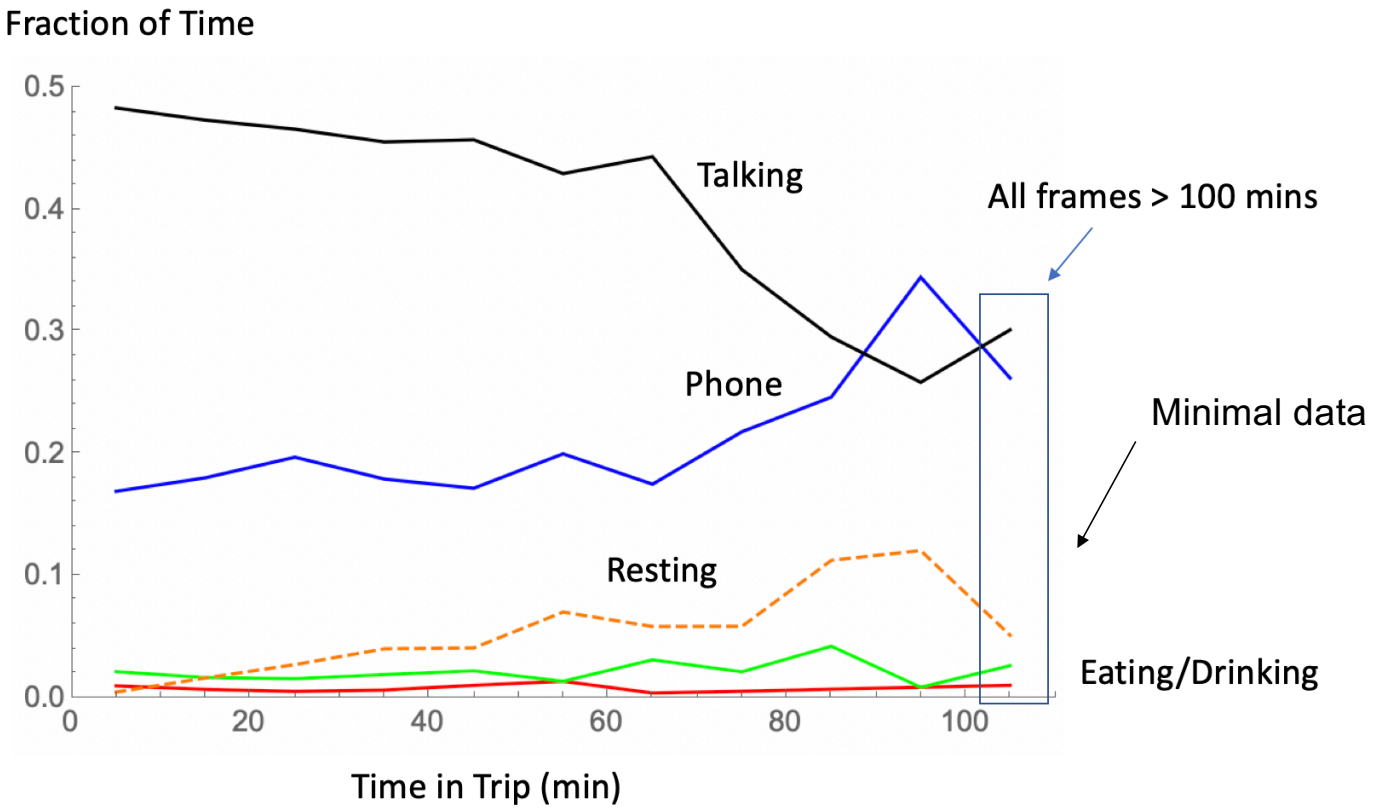
	F	M
Talking	45.9%	45.6%
Nothing	24.7%	29.4%
Phone	19.4%	16.0%
Other	3.6%	3.1%
Resting	2.2%	2.4%
Food	2.0%	2.0%
Missing	1.4%	0.7%
Drink	0.9%	0.7%
	100.0%	100.0%

(Only one behavior per frame)




UMTRI

Activities



Activities in 10-minute bins

Postures – Deviations from Nominal

Head Roll

%	Value
84.9%	Neutral
10.1%	Tilt Right
3.7%	Tilt Left
1.1%	Missing
0.3%	Can't Tell

Head Yaw

%	Value
65.4%	Neutral
19.1%	Rotated Right
14.1%	Rotated Left
1.1%	Missing
0.3%	Can't Tell

Head Pitch

%	Value
67.1%	Neutral
28.6%	Down
3.0%	Back
1.1%	Missing
0.2%	Can't Tell

Face Direction

%	Value
55.0%	Windshield
22.5%	Lap
13.2%	Pas Window
7.5%	Driver
1.2%	Missing
0.5%	Can't Tell
0.2%	Behind

UMTRI

Postures – Deviations from Nominal

Torso Roll

84.6%	Neutral
7.5%	Tilt Left
6.7%	Tilt Right
1.1%	Missing
0.1%	Can't Tell

Torso Pitch

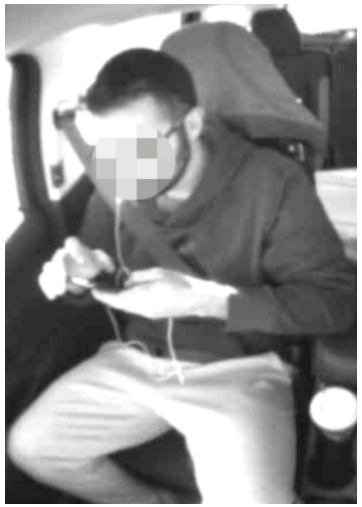
85.6%	Neutral
9.6%	Forward
3.6%	Backward
1.1%	Missing

Torso Yaw

88.5%	Neutral
5.5%	Rotated Right
4.8%	Rotated Left
1.2%	Missing
0.1%	Can't Tell

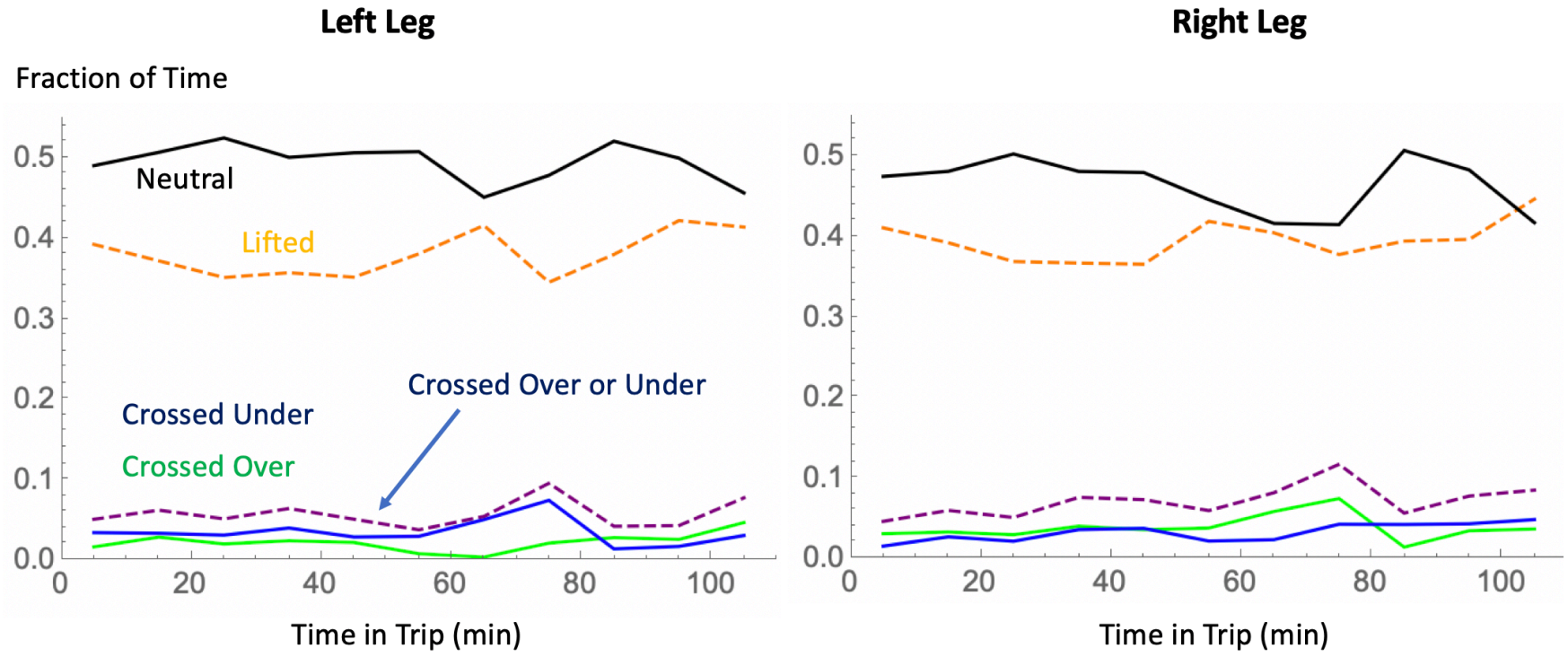
Non-Neutral Lower Extremity Postures

Left		Right	
48.5%	None	46.2%	None
37.9%	Lifted	39.7%	Lifted
6.6%	Can't Tell	7.0%	Can't Tell
3.4%	CrossedUnder	3.8%	CrossedOver
2.3%	CrossedOver	2.4%	CrossedUnder

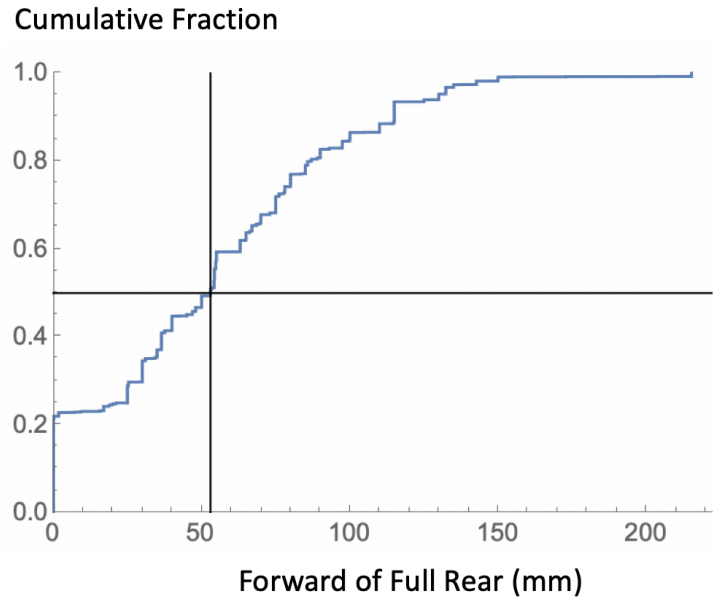


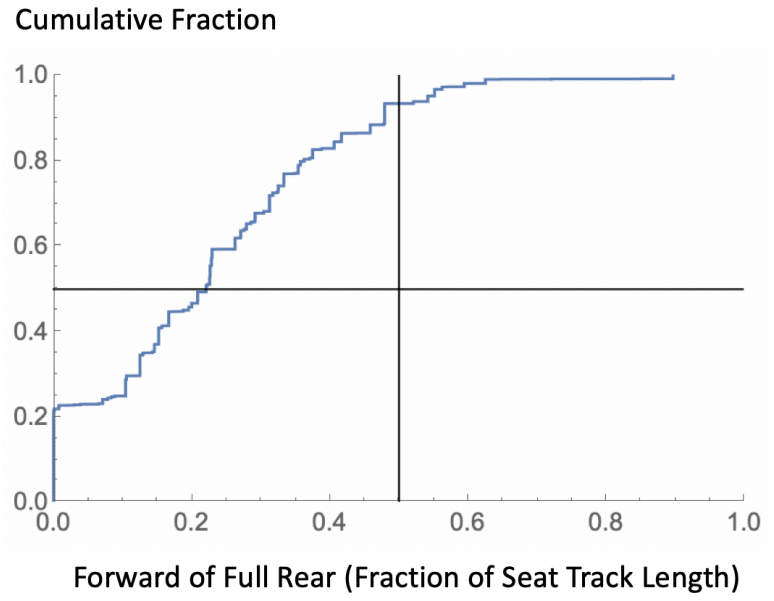
UMTRI

Non-Neutral Lower Extremity Postures



Seat Position





No seat position or seat-back-angle change in 40 of 75 (53%) vehicles
16 cases of seat position change

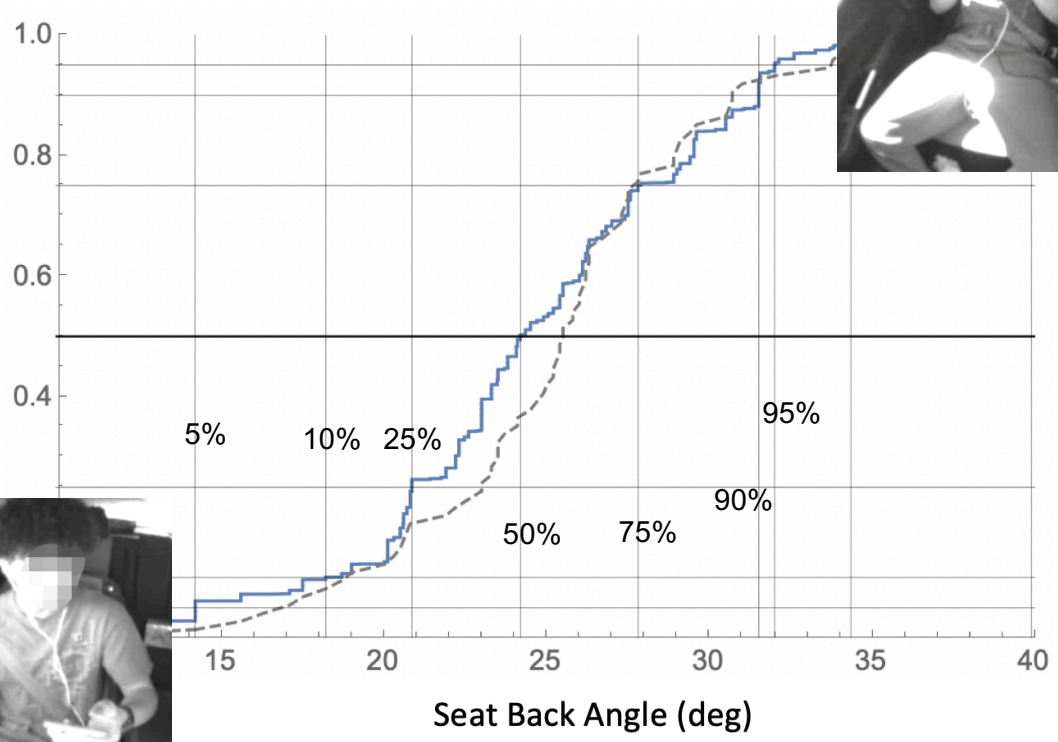
Seat was ~full rear 23% of time
Seat was rearward of mid track 81% of time

UMTRI

Seat Back Angle

Mean seat back angle was 25.4 (6.4) deg

The seat back angle was greater than 30 degrees in approximately 15% of frames and greater than 35 deg in only 84 frames (0.7%).



Arrival distribution is dashed line

Summary and Implications

- Visibly poor belt fit is common (>10%)
- Non-nominal passenger postures are common, particularly head rotated or tilted downward (10-50%)
- Passengers sit rearward: 23% full rear, 81% aft of mid track
- Highly reclined postures (>35 deg) are rare

Are restraint systems sufficiently robust to deviations from nominal test postures and belt fit?

Work to improve protection for current passengers will benefit future automated vehicle passengers

Acknowledgement

UMTRI

Contacts

Matt Reed
mreed@umich.edu

UMTRI