
WELCOME!
SAFER RESEARCH & PROJECT DAY
SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

SAFER RESEARCH & PROJECT DAY

Agenda March 9, 13:00-15:45

13:00-13:05 Welcome and introduction to SAFER´s Research & Project day – *Magnus Granström, SAFER's director*

13:05-13:20 MEDIATOR - MEdiating between Driver and Intelligent Automated Transport systems on Our Roads – *Christer Ahlström, VTI*

13:20-13:35 GLAD - Goods delivery under the Last-mile with Autonomous Driving vehicles – *Mikael Söderman, RISE*

13:35-13:50 Vulnerable Road Users - E-scooter ”target” – *Fredrik Åkeson, AstaZero*

13:50-14:05 FOT-E (Field Operational Test- Feature Extraction from Video) – *John-Fredrik Grönvall,* SAFER

14:05-14:20 Break

14:20-14:35 Autofreight – *Fredrik Von Corswant, Revere*

14:35-14:50 Safetynet for trucks – *Stefan Koychev, Volvo Group*

14:50-15:05 Human Body Model developments at SAFER – *Johan Iraeus, Chalmers*

15:05-15:20 Are Crash Test Dummies Representative of the Population? – *Anna Carlsson, CIT*

15:20-15:35 TEApan – *Bengt Arne Sjöqvist, Chalmers*

15:35-15:45 Summing up, *Magnus Granström*

Very welcome with questions/reflections and comments in the chat – we would like to interact with you during the presentation!

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Christer Ahlström, Raimondas Zemblys, Herman Jansson, Christian Forsberg, Johan Karlsson, Anna Anund

MEDIATOR

Effects of partially automated driving on the development of driver sleepiness

Event: SAFER Research & Project Day
Date: 2021-03-09

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 814735.

Mediator

About MEDIATOR

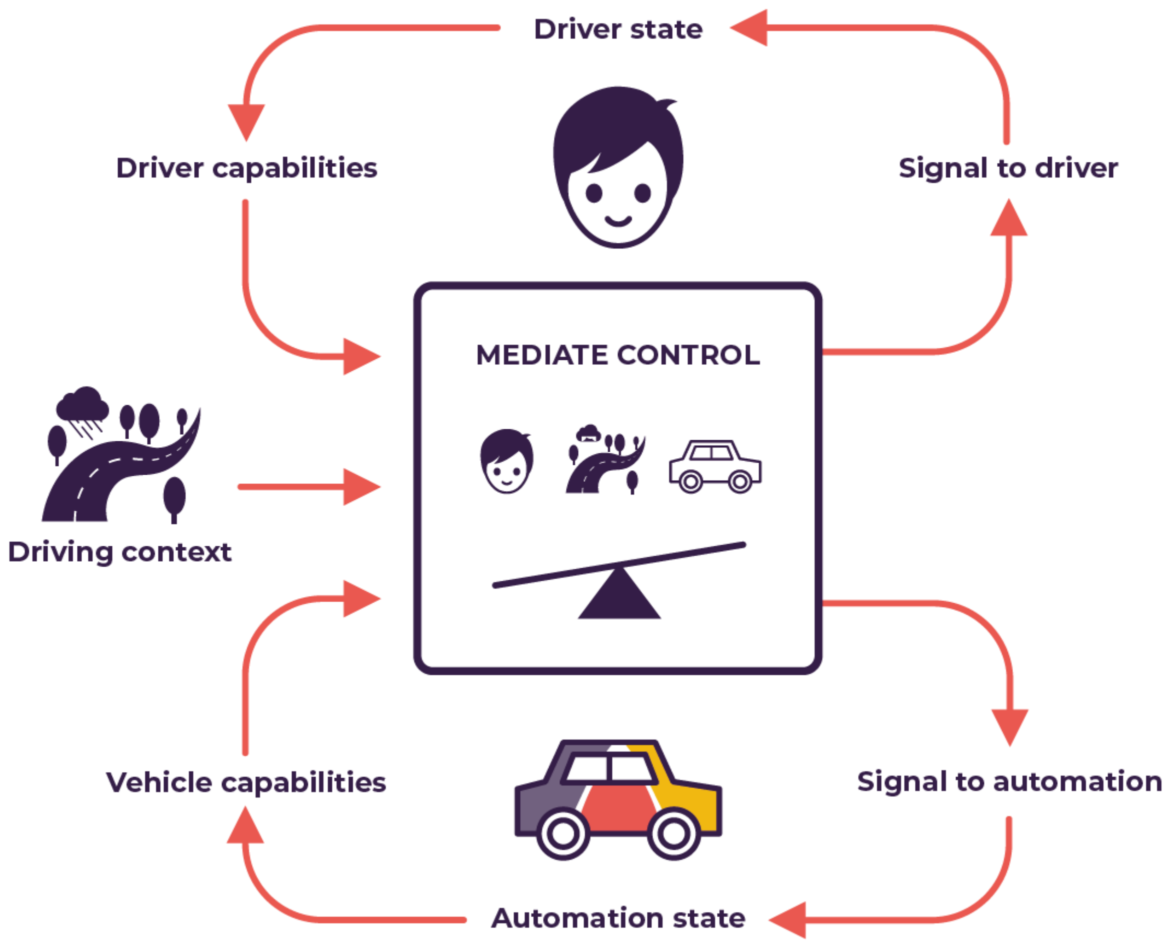
4-year project led by SWOV

Started on May 1, 2019

Funding from the EU Horizon 2020 research and innovation programme

About MEDIATOR

MEDIATOR will develop a mediating system for drivers in semi-automated and highly automated vehicles, resulting in safe, real-time switching between the human driver and automated system based on who is fittest to drive. MEDIATOR pursues a paradigm shift away from a view that prioritises either the driver or the automation, instead integrating the best of both.



https://mediatorproject.eu/

Mediator

Background

Knowledge about the prevalence and development of drive state as a function of automated driving functionality is needed.

Transition from alert to sleepy while driving on real roads in real traffic, during manual driving but especially during partially automated driving (level 2).

A secondary goal was to provide data for sleepiness detection algorithm development.

Collaboration between Smart Eye AB and the Mediator partners (VTI and Autoliv).

Design

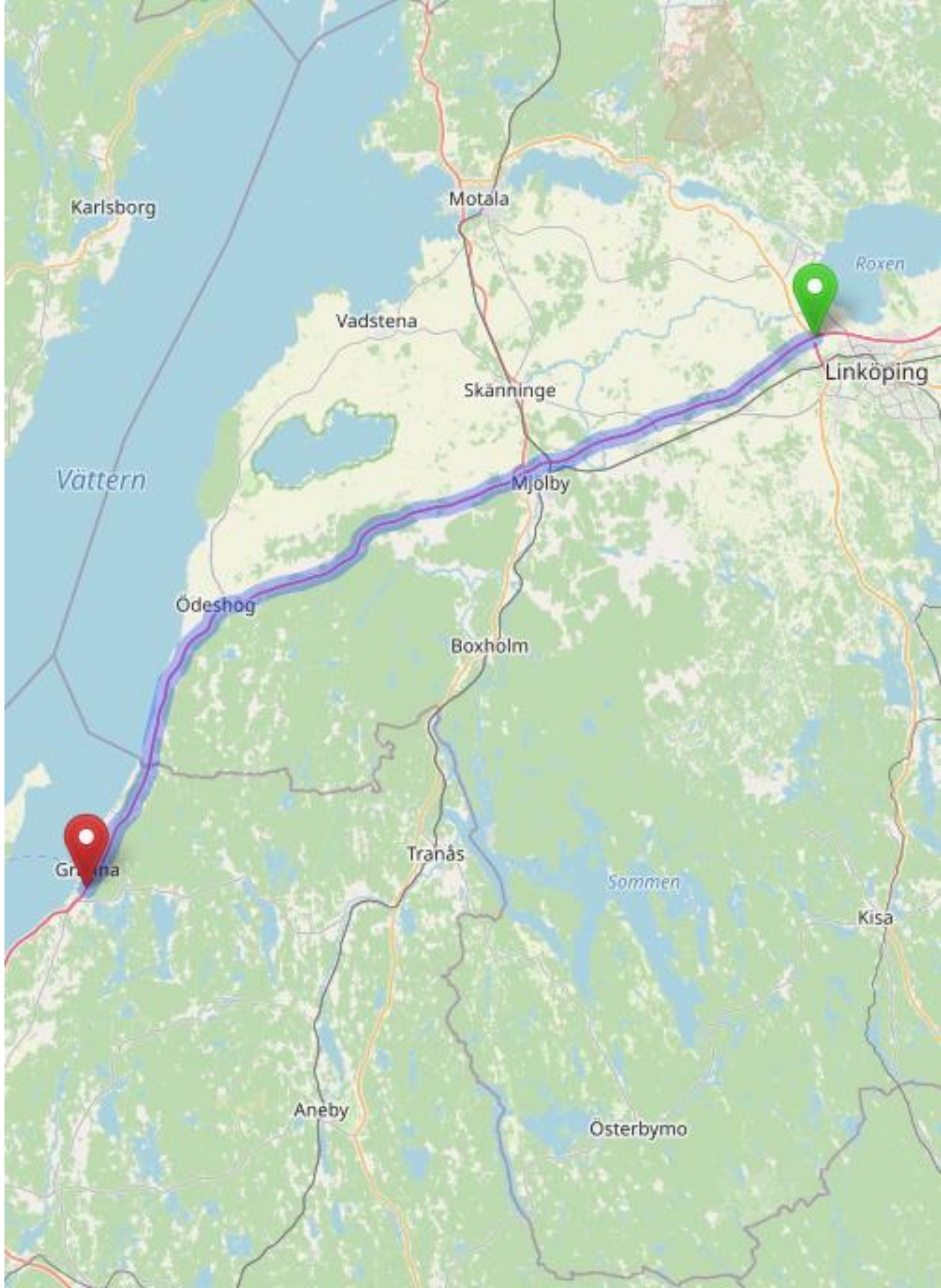
80 participants

2 visits (manual/automated)

2 drives back and forth to Gränna (~2h), day (alert) and night (sleep deprived)

2 instrumented vehicles

→ 80x2x2=320 driving sessions



Data

Kinematics: GPS, speed, ... (100GB)

Video: forward, interior, face, eye tracking (120 TB)

Physiology: heart (ECG), eyes (EOG), brain (EEG), respiration (500GB)

Subjective sleepiness rating (KSS)

Psychomotor Vigilance Task (reaction time)

Actigraphy (3 days prior to test)

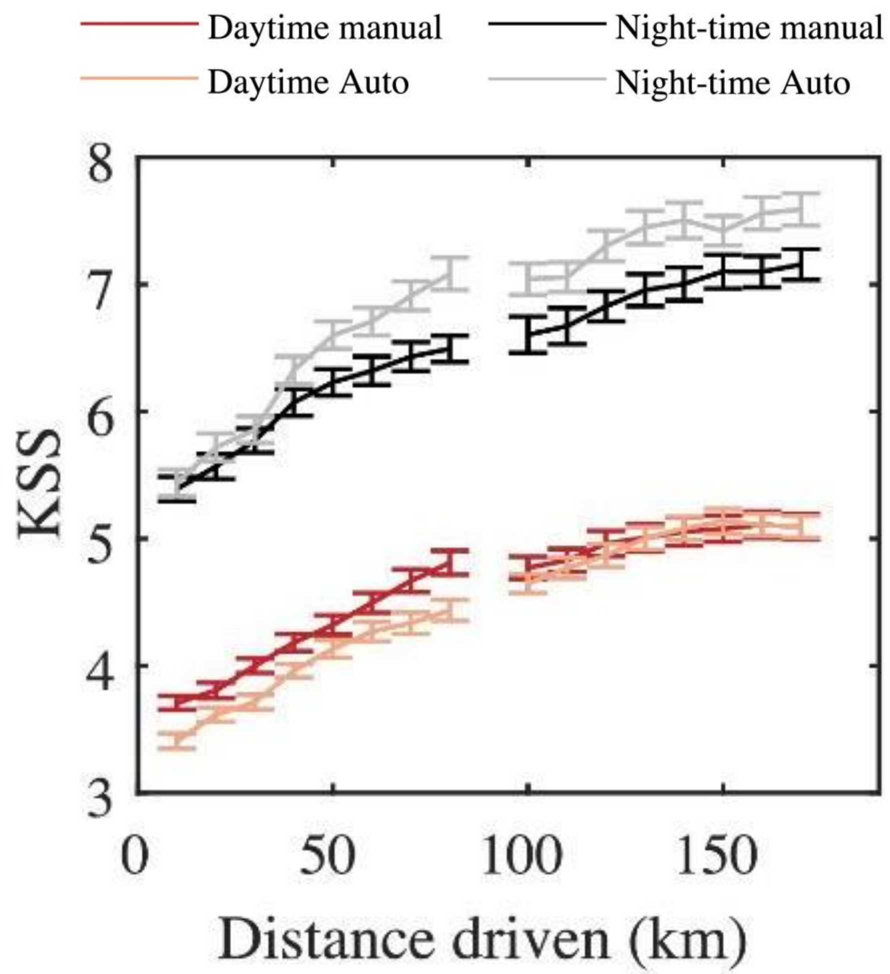
Subjective sleepiness

Manual vs L2 automated driving (**)

Daytime vs night-time (**)

Time on task (**)

Large increase in Karolinska Sleepiness Scale ratings after sleep deprivation and with time on task. Slight increase with L2 automation.



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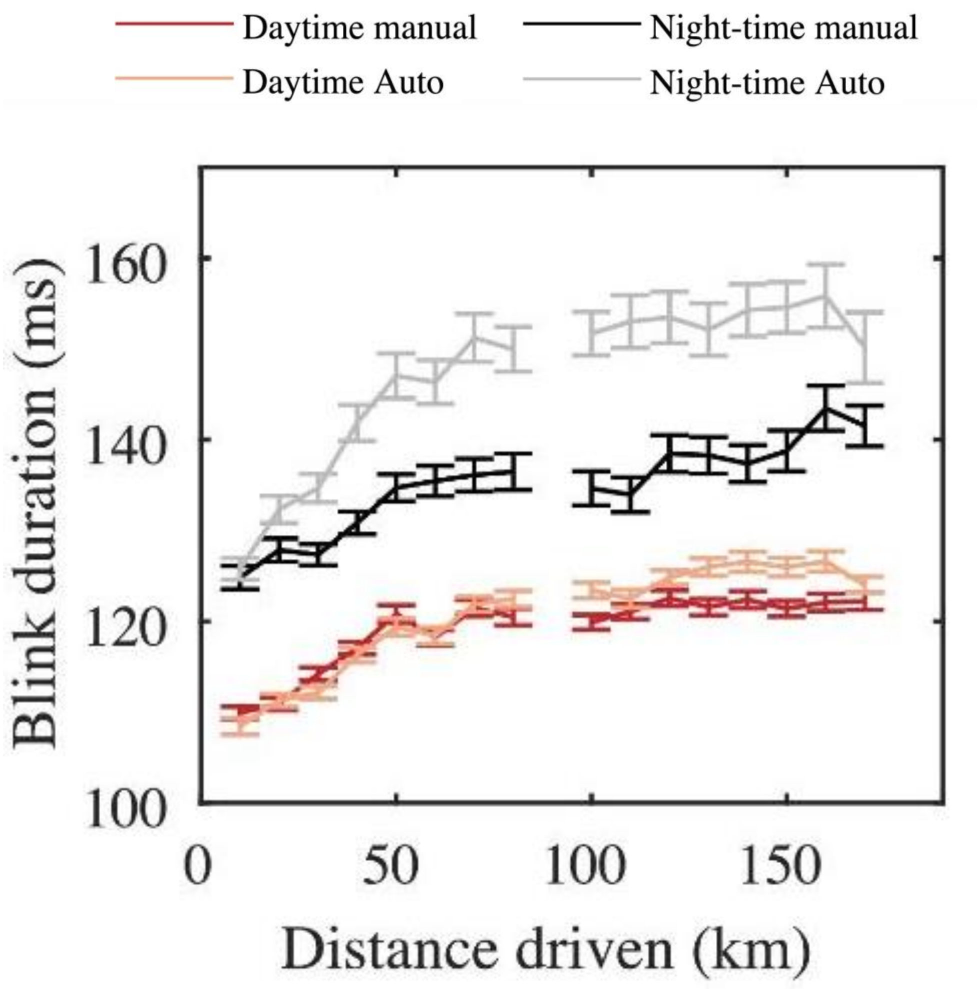
Blink duration

Manual vs L2 automated driving (**)

Daytime vs night-time (**)

Time on task ()

Large increase in blink duration after sleep deprivation. Large increase with time on task and L2 automation during night-time.



Mediator

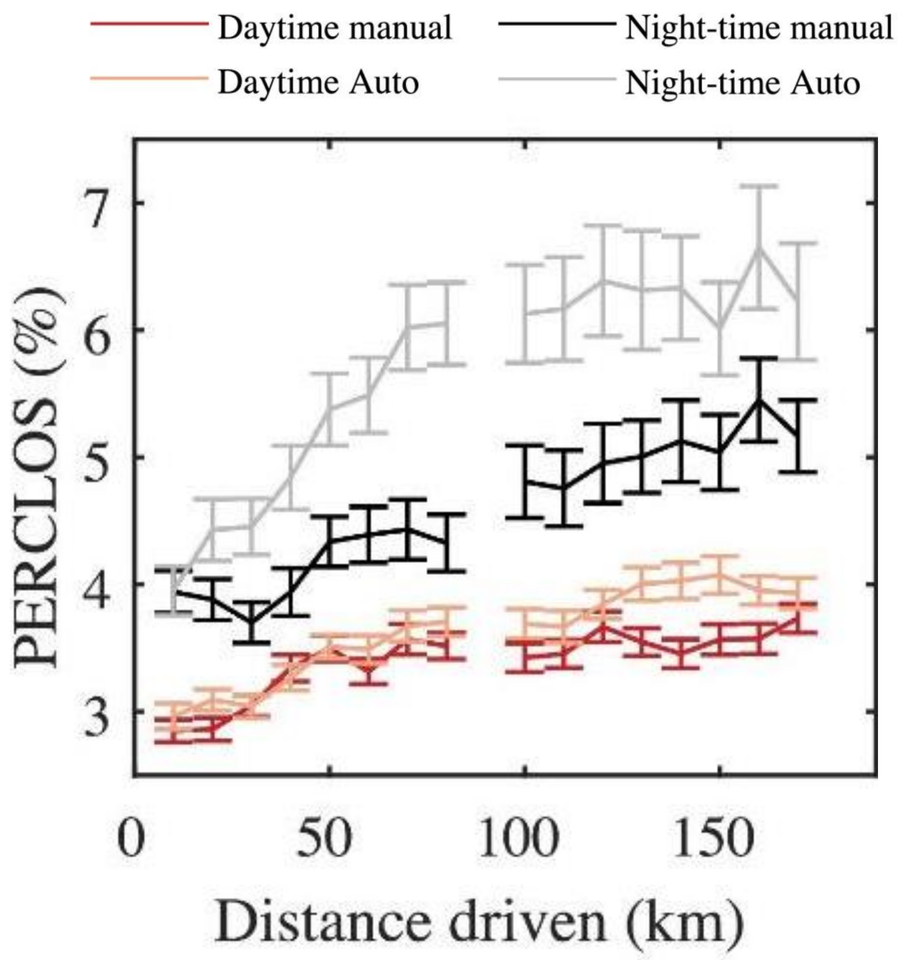
PERCLOS

Manual vs L2 automated driving (*)

Daytime vs night-time ()

Time on task ()

Increase in PERCLOS after sleep deprivation. Large increase with time on task and L2 automation during night-time.



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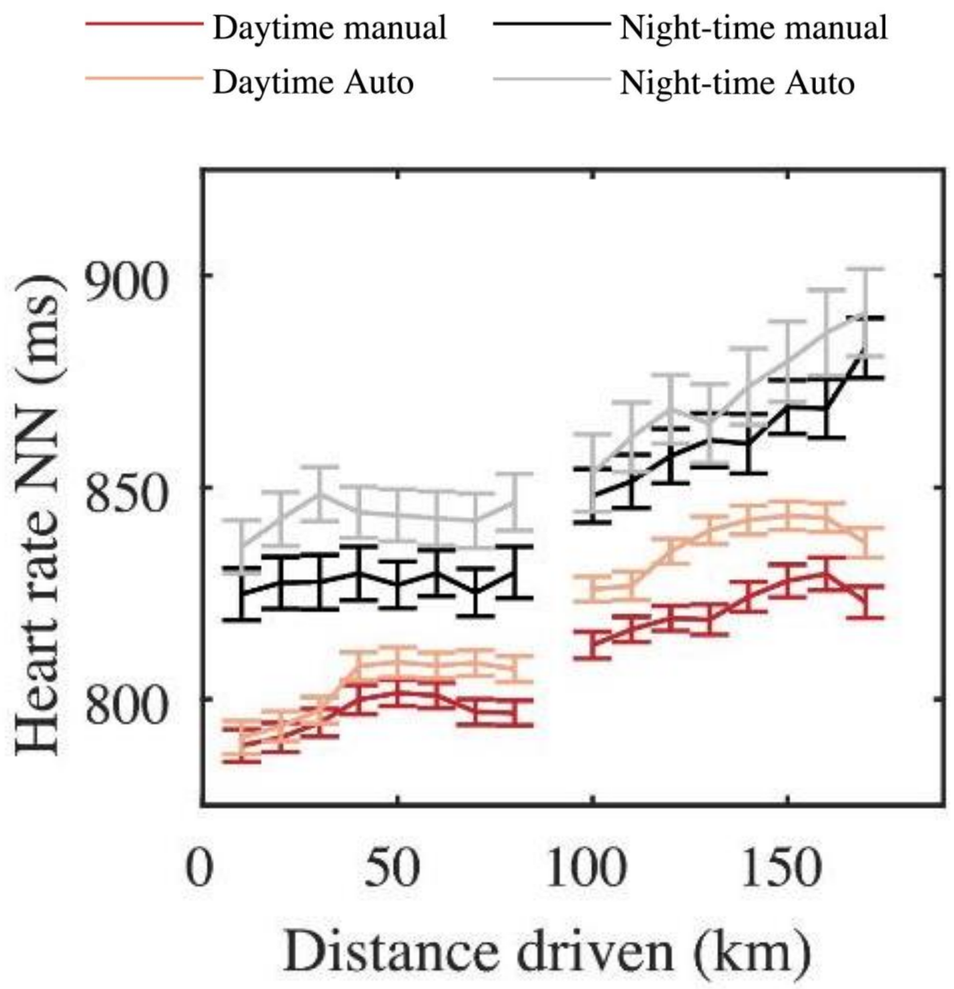
Heart rate

Manual vs L2 automated driving (**)

Daytime vs night-time (**)

Time on task (**)

Reduced heart rate after sleep deprivation, with time on task and with L2 automation.



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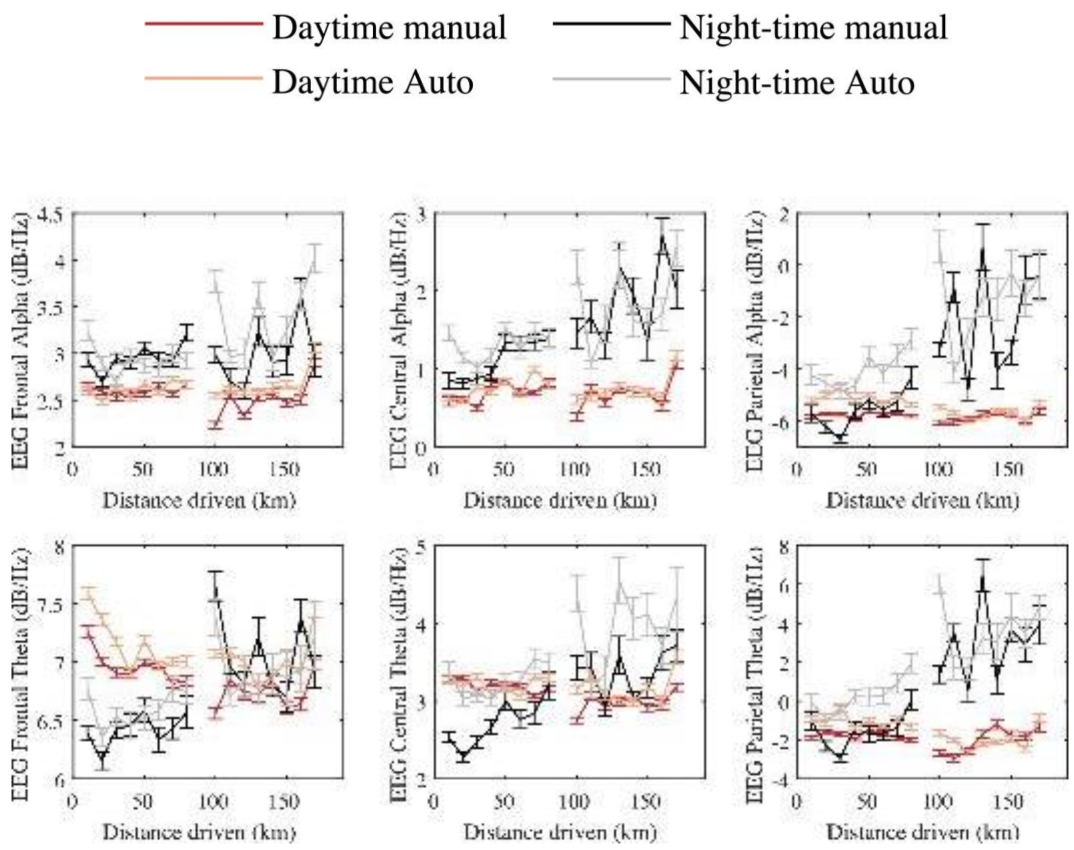
Brain activity

The results are less clear for EEG. The general picture is that alpha and theta content increase after sleep deprivation and to some extent with L2 automation, but mostly via interaction effects.



Mediator

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Effects of partially automated driving on the development of driver sleepiness

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ARTICLE INFO

Keywords:
Fatigue
Sleepiness
Partially automated driving
Level 2

ABSTRACT

The objective of this study was to compare the development of sleepiness during manual driving versus level 2 partially automated driving, when driving on a motorway in Sweden. The hypothesis was that partially automated driving will lead to higher levels of fatigue due to underload. Eighty-nine drivers were included in the study using a 2 × 2 design with the conditions manual versus partially automated driving and daytime (full sleep) versus night-time (sleep deprived). The results showed that night-time driving led to markedly increased levels of sleepiness in terms of subjective sleepiness ratings, blink durations, PERCLOS, pupil diameter and heart rate. Partially automated driving led to slightly higher subjective sleepiness ratings, longer blink durations, decreased pupil diameter, slower heart rate, and higher EEG alpha and theta activity. However, elevated levels of sleepiness mainly arose from the night-time drives when the sleep pressure was high. During daytime, when the drivers were alert, partially automated driving had little or no detrimental effects on driver fatigue. Whether the negative effects of increased sleepiness during partially automated driving can be compensated by the positive effects of lateral and longitudinal driving support needs to be investigated in further studies.

1. Introduction

Fatigued drivers show slower visual processing, loss of selective attention, poor distractor inhibition, reduced peripheral processing capacity as well as lapses and wake state instability (Chee, 2015; Krause et al., 2017; Van Dongen et al., 2011). This leads to worsened decision making, slower reaction times, reduced attention to the forward roadway and driving performance incapability (Anderson and Horne, 2013; MacLean, 2019). As such, sleepiness and fatigue are contributing factors in 5–50 % of all crashes (cf. Dawson et al., 2018), with median values usually falling between 15–25 % (Åkerstedt, 2000), and elevating the crash risk with 1.29–1.34 times compared to driving without fatigue (Moradi et al., 2019). These fatigue related crashes typically occur during night-time or in the early morning hours, after too many uninterrupted hours behind the wheel, or after extended periods of high or low workload (Williamson et al., 2011). In this paper, fatigue is defined as the biological drive for recuperative rest, with sleepiness as a special case referring to accumulated sleep debt, prolonged wakefulness, or troughs in the circadian rhythm.

A range of countermeasures can be implemented to address fatigue-related issues in transport, including public awareness campaigns, legal approaches, roadside initiatives, and in-vehicle technologies (Anund and Kecklund, 2011; Fletcher et al., 2005; Phillips et al., 2017). Some of these countermeasures aim to reduce the likelihood of fatigue-related driving whereas others aim to reduce the consequences of driving while fatigued. Driver support and intervention systems is a relatively new countermeasure that belongs to the latter category. These systems aim to prevent or reduce the impact of crashes in general, and as such they may also alleviate fatigue-related crashes. For example, lane departure warnings and lane keeping assistance reduce single-vehicle, sideswipe, and head-on injury crash rates (Cicchino, 2018; Sternlund et al., 2017; Wang et al., 2020). These crash types are often associated

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Conclusions

Partial automation led to increased sleepiness during night-time (after sleep deprivation), but had little effect on fatigue during daytime (after full sleep).

Difficult to say how this will affect crash risk. Lane keeping may prevent crashes and L2 disengagement may be used as a countermeasure.

Next steps in the project is to continue working on the mediation between the human and the automated system, and to design preventive and corrective countermeasures to keep the driver fit enough for the current automation level.

For more information:

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www.mediatorproject.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 814735.

GLAD

Goods delivery under the Last-mile with Autonomous Delivery Vehicles

Godsleverans under den sista milen med självkörande fordon

Mikael Söderman, RISE Research Institutes of Sweden
mikael.soderman@ri.se

General GLAD info

- **Type of project**: Research project with user testing and demonstration
- **Partners**: RISE (coordinator), Aptiv, Combitech, Clean Motion, Halmstad University
- **Length**: 2020-2022
- **Budget:** 11 690 000 SEK (6 903 000 SEK from Trafikverket, ca 60%)
- **Project team**: Multidisciplinary team with knowledge in perception and control systems, collaborative systems, vehicle design for new mobility solutions and human-machine interaction.
- **Reference group:** Chalmers, CLOSER, Foodora, HUGO/Berge, Johanneberg Scienece Park, Länsstyrelsen i Västmanland, MoveByBike, PostNord, SMOOTh, Trafikkontoret i Göteborg, Trafikverket, Unifaun

Overall Aim

To develop an **initial knowledge base** on **efficiency, safety and human experience** of small autonomous delivery vehicles (ADV) for the first and last mile delivery of goods in **Sweden**, and on how to create a balance between these three aspects from a socio-technical perspective.

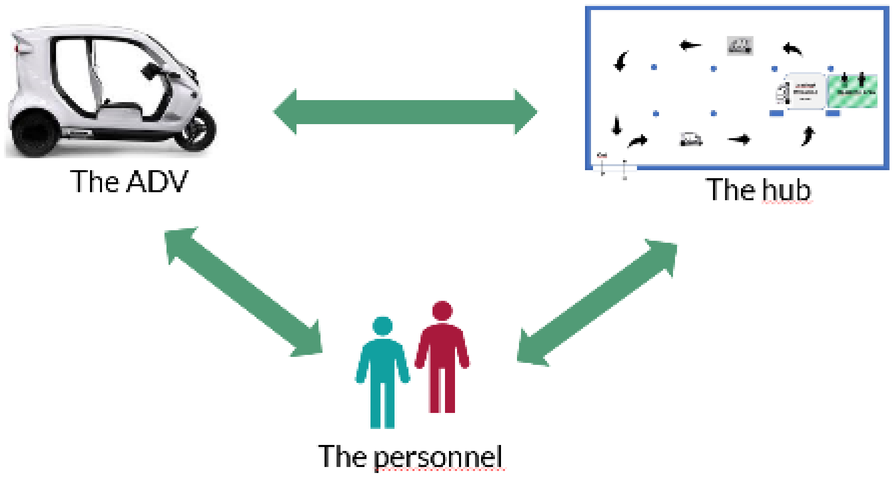
Autonomous Delivery Vehicles, ADV

Research areas

Business cases and policy constraints

Interactions and HMI

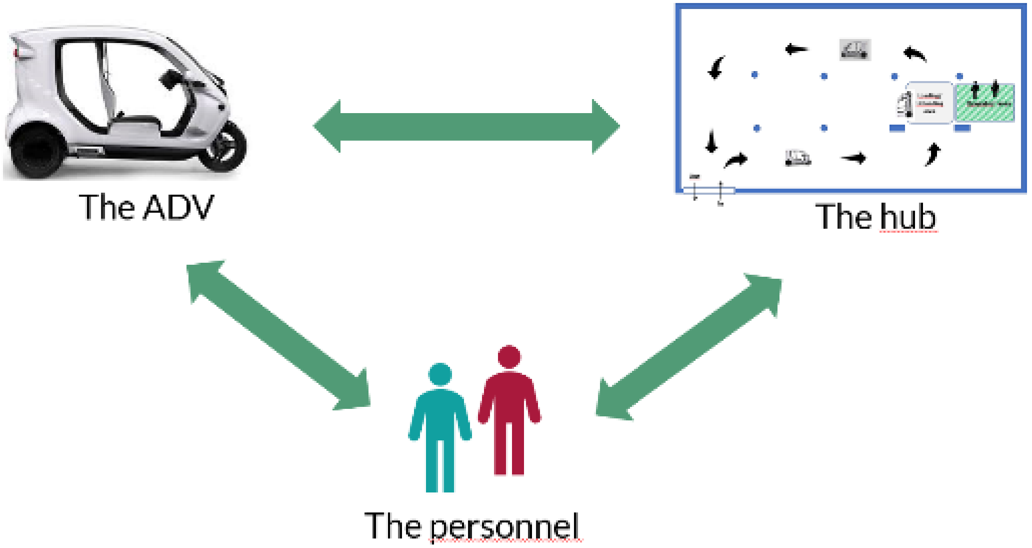
Evaluation methodologies



Study

ADVs operating in a hub/terminal for loading/unloading:

- Explore and identify problem areas, needs and requirements in different interactions points; *ADV – Personnel – Hub*
- Formulate preliminary functional requirements
- How to handle COVID19 restrictions

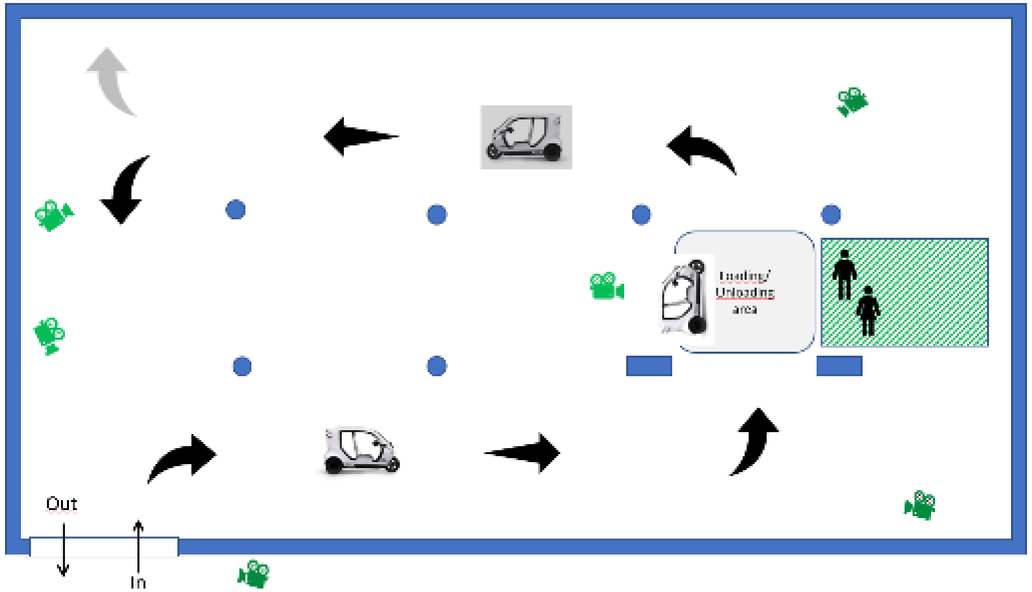


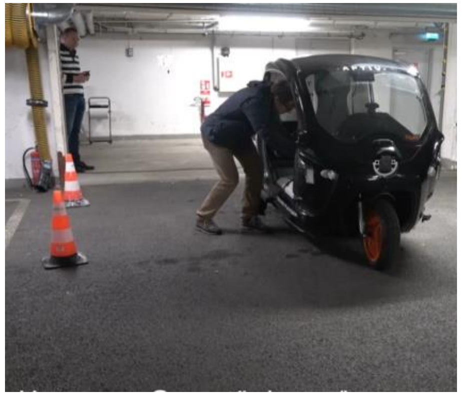
Study procedure

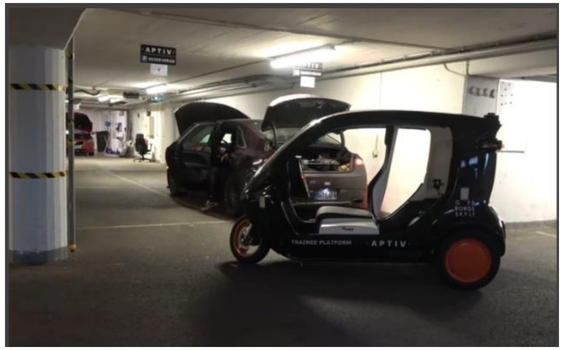
1. Visit and interviews at Postnord

Study procedure

2. Video illustrating an ADV operating in a ”hub”







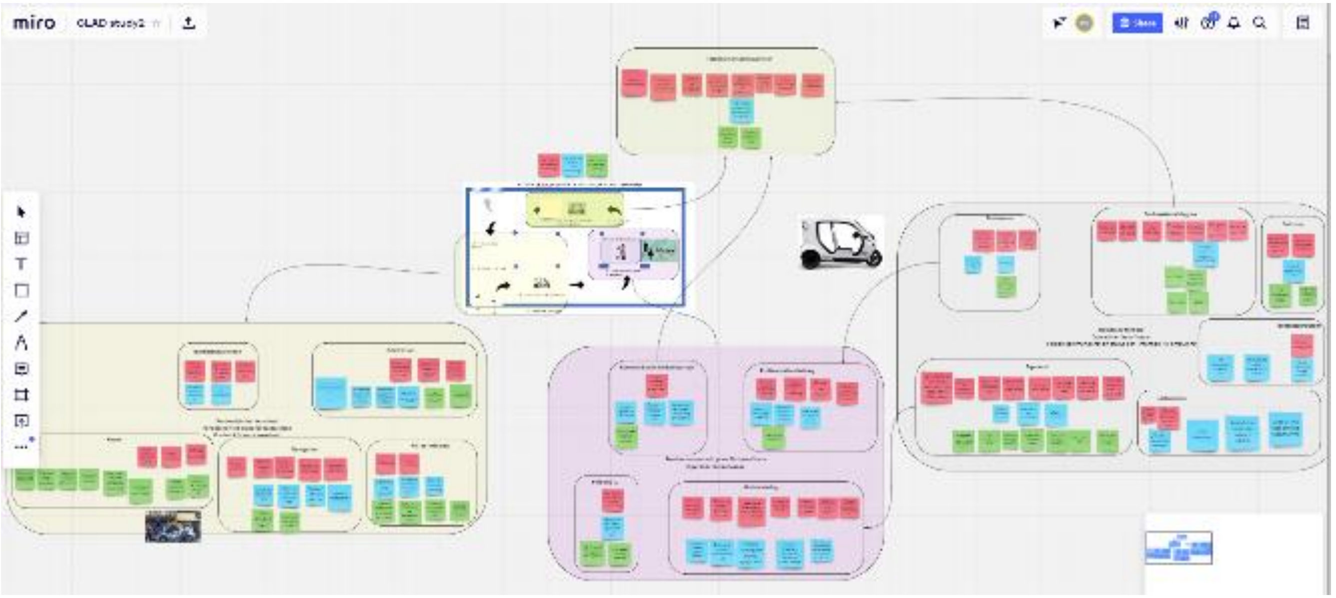
Study procedure

3. Workshop 1 with project partners

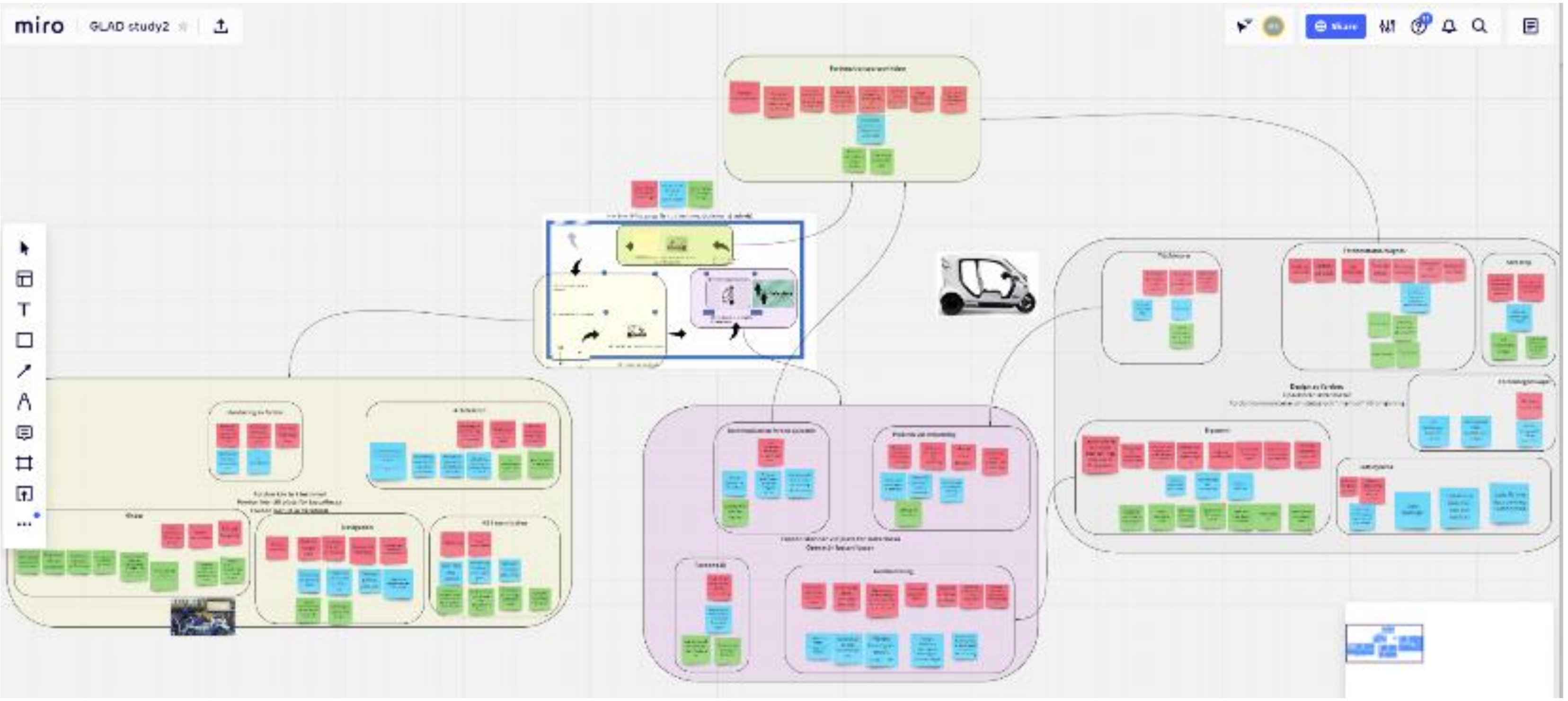
4. Workshop 2 with Postnord personnel

Video of the ADV in the hub

+ Online workshops with a digital whiteboard



Study procedure



Affinity diagram analysis

Identify problems, needs & requirement

↓

Prelimiary functional requirements

Functional requirements: The ADV

The opening to the box shall have the minimum dimensions x y z (TBD)

The ADV shall have a unique digital ID.

The ADV shall be able to navigate inside the terminal.

The ADV shall have a turning radius of maximum x meters.

The box shall be designed to prevent cargo to slide and overturn during transport.

The P-brake on the ADV shall be possible to activate manually.

The box shall have loading/unloading entries from the rear and from both sides.

The ADV shall be possible to be removed manually.

The box shall protect the goods from theft.

The ADV shall have a unique visible ID.

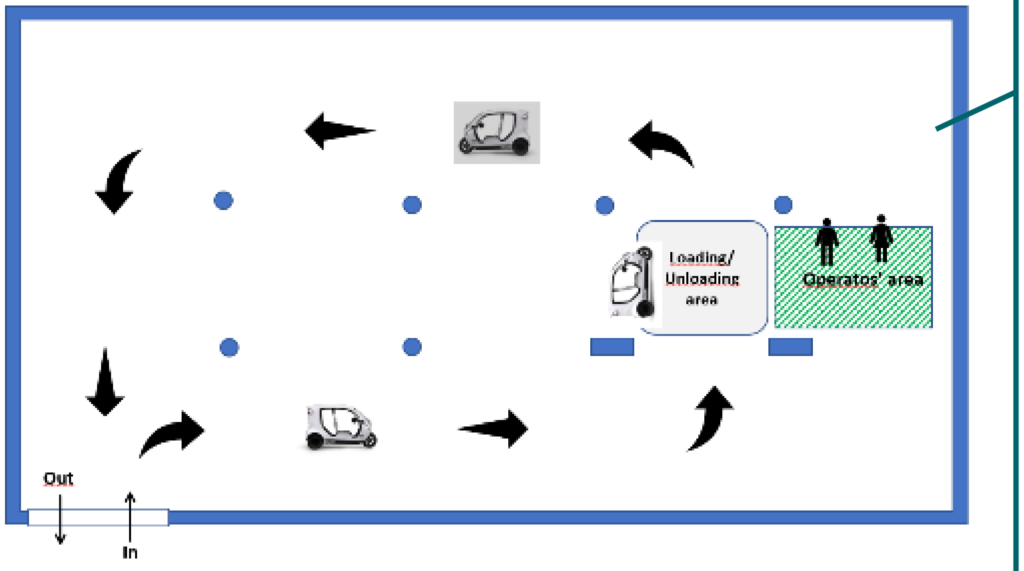
The height from the ground of the box floor shall be within in the range of x-y (TBD based on ergonomics)

The ADV shall indicate overload (of goods).

The ADV shall communicate its intentions (movements, missions etc.) to the surrounding.

The ADV shall communicate its status to the surrounding, e.g. Safe stop (safe to approach), Unsafe stop (not safe to approach).

Functional requirements: The Hub



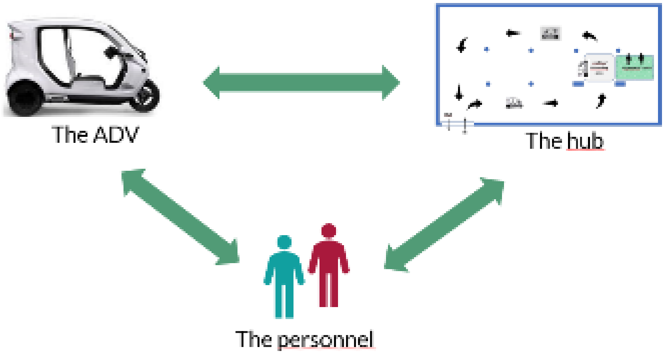
- The hub shall allow multiple ADVs to drive to and from their load/unloading area without interfering with each other.
- The hub shall be designed to handle queues to the loading area
- The hub shall allow a turning radius of the ADV of minimum x meters
- The hub should have dedicated lanes in for ADVs and for humans respectively.
- The hub shall be designed to handle failing ADVs
- The hub should have facilities for charging of the ADVs.
- The charging areas in the hub shall not interfere with the flow of goods and ADVs in operation.

Next steps

Needs & Requirements
Prelimiary functional requirements

Solution development

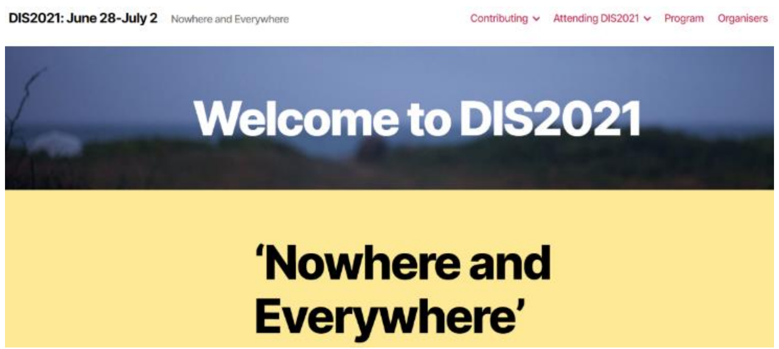
Test and re-design iterations



And in addition

- A number of the problems and challenges that were identified in the study will taken on by students at Chalmers (Mechanical engineering and Design and product development) in March-May as part of a course.

- A paper submitted to the DIS2021 conference



Thank you!

Mikael Söderman

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Vulnerable Road Users (VRU)

E-scooter target

Project leader Kasper Johansson

Presenter Fredrik Åkeson

fredrik.akeson@astazero.com

ASTAZERO

Project info

- FFI - Pre studie
- Project time
  - October 2020 - End of september 2021
- Budget
  - 500.000SEK

ASTAZERO

Background

- Initiative from Claes Tingvall ”Vision Zero”
- E-scooters has quickly become established in the "modern road infrastructure“
- Pedestrian and Bicyclist are common objects to which modern cars can prevent or mitigate a collision.
- E-scooters are today not classified objects to cars AD/ADAS systems
- **How does modern cars react to e-scooters?**

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Accidentology
light version

- **Most of the accidents with e-scooter are singel accident**
  - Balance problem (Friday an Saturday nights)
  - Pot-holes, slippery surfaces or edge of sidewalk

Folksam report: Kartläggning av olyckor med elsparkcyklar och hur olyckorna kan förhindras, Helena Stigson & Maria Klingegård

- **Serious accidents or fatal accidents with e-scooter**
  - Other vehicle, (car), involved in 80% of the cases
  - The accidents are very similar to accidents with bicycles

OECD/ITS 2020

ASTAZERO

Objective

- Develop a soft test target which can be used in development testing for cars AD and ADAS systems.

- Look into relevant scenarios for e-scooters
  - Existing Euro NCAP VRU Scenarios
  - Behaviours/scenarios that may be unique to the e-scooter?

Challenge!

No leg movement & high speed

Euro NCAP target for bicyclist and pedestrian

Car to Bicyclist Nearside

(CBNA & CBFA)

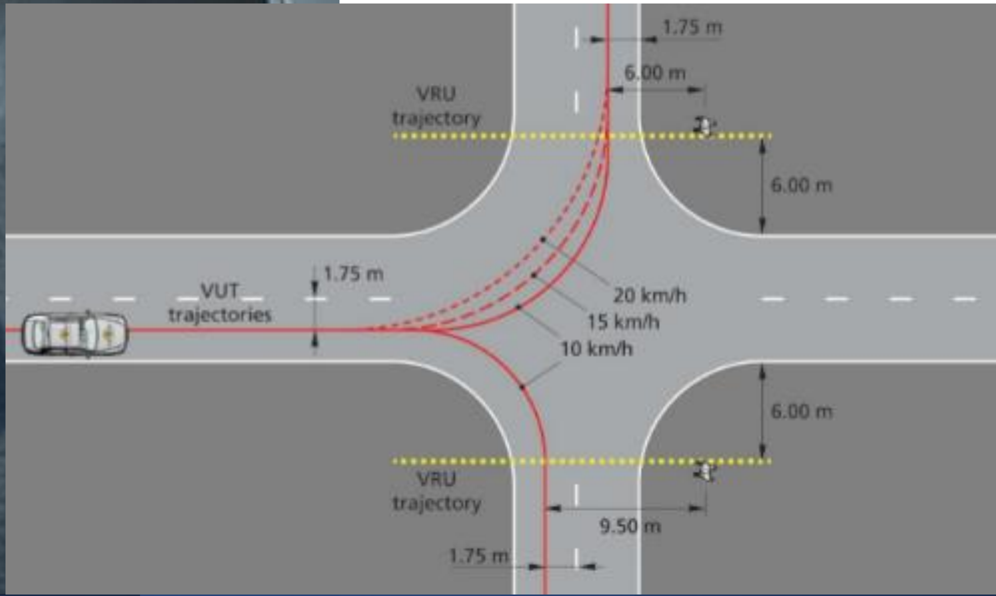
Car to Bicyclist Nearside Longitudinal

(CBLA)

FCW/AEB/AES

Car to Bicyclist Nearside Adult Obstructed

(CBNAO)



Car to Pedestrian Turning Adult (CPTA)

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Timing

Build up a soft prototype of an e-scooter

March

Radar measurements together with RISE

- Characteristics (Prototype / Real e-scooter)
  - Small and big scooters
  - Spinning / static wheels

Mar.–Apr.

Test to Euro NCAP Scenarios

- CBNA
- CBLA
- CBNAo
- CPTA
  - Other scenarios that need to be adressed

Apr.–July

Questions?

Fredrik.akeson@astazero.com

FOT-e

Field Operational Test- Feature Extraction form Video

John-Fredrik Grönvall, SAFER
Torsten Wilhelm, Smarteye

Henrik Lind, Smarteye

Partners

CHALMERS
UNIVERSITY OF TECHNOLOGY

Autoliv

SMART EYE®

• FOT data

- The SAFER ND platform datasets include 7 500 000 km of driving data
- FOT dataset is 10 years old and contains of:
  - Camera view pointing on the driver upper body but no automatic annotation
  - Low resolution driver monitoring camera (DMS) . The DMS technology at the time provided very noisy output

	Driver Monitoring	Cabin Monitoring
Videos	160x160, 10Hz, H264	352x288, 12.5Hz, H264
Software	Implemented AI based algorithms with higher availability on low resolution images	new Smart Eye CMS (Object detection, Person detection, Body pose, Activities (phone, hands-on-wheel, …)
Analysis	No ground truth available Use gaze direction for EOR analysis Use head position for head OOP analysis	Compare SE results with GT annotations

Objectives

- **Data enrichment**
  - Seat belt detection
  - Extract eye, head and body posture from existing video data, both for active and passive purposes
  - Seat position measurement
  - Extract action data (eating, texting etc..) from recorded data
  - Driver identification
- **Anomynization**

- Cabin Monitoring System

Hands On Wheel	Phone usage	Out-Of-Position
1: no hands	0: unknown	0: unknown
2: left hand on/right hand off	1: no phone usage	1: central position
3: left hand off/right hand on	2: talking left hand	2: out-of-position
4: both hands on	3: talking right hand	**Seat-belt**
5: unknown	4: texting left hand	Belted/Non belted
	5: texting right hand	

Driver monitoring system

Head pose	Eye	Functions (annotated in dataset)
Head position X,Y.Z	Gaze ray	Eyes on road/other gaze zones tbd
Head angle X,Y.Z	Eye lid closure	Talking
		Long eye closure (tbd)
		Distraction (tbd)

smart eye

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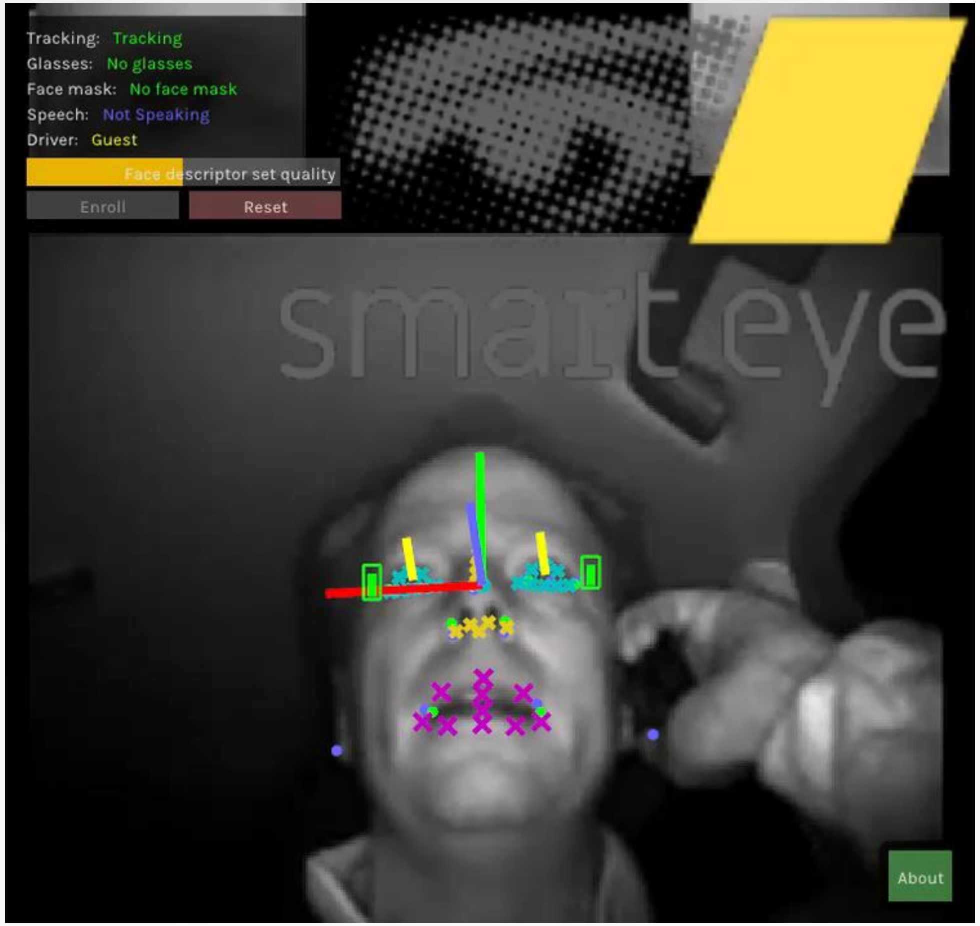
- CMS/DMS example 1



Videos are agreed to be showed in public by Henrik Lind (driver)

smart eye

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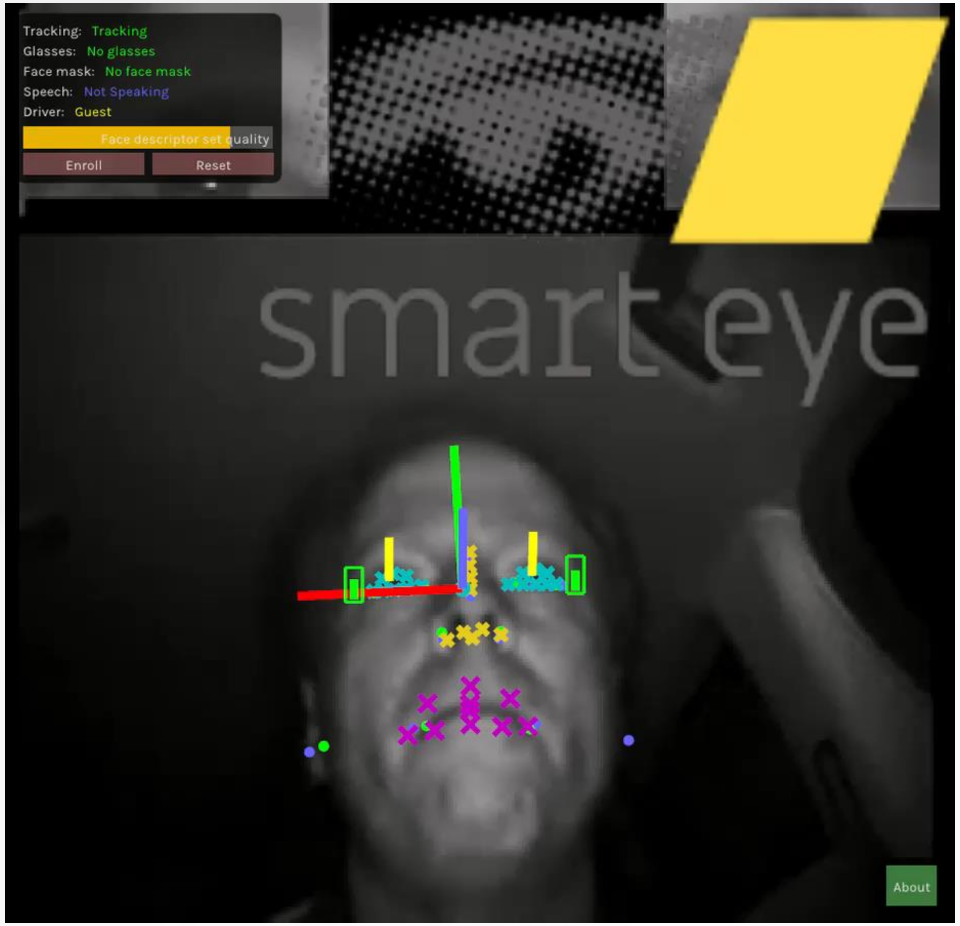
• CMS/DMS example 2



Videos are agreed to be showed in public by Henrik Lind (driver)

smart eye

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• DMS analysis

smart eye

• Problems and Future Work

- Smart Eye DMS trained on higher resolution eye images- now very low resolution
- Smart Eye CMS was trained on IR images / FOT data very low resolution greyscale images
  - Object detection produces false positives and false negatives
  - Unstable Body pose

→ Retrain CMS on subset of annotated FOT data and RGB/Grey images of SE data

→ Automated gaze zone adjustment since camera mounting position is different in individual FOT cars

→ Run and verify automated annotation on larger data set

→ Extract functional details (WP5) like distance from head rest for passive safety use.

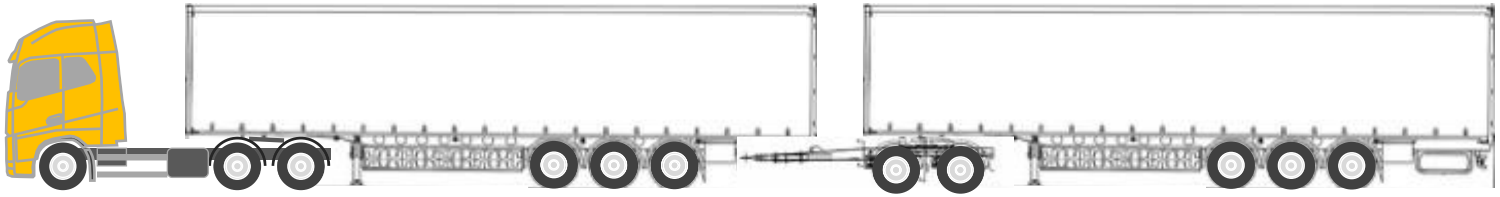
→ Run on all EuroFOT data

Auto Freight

Highly Automated Freight Transports

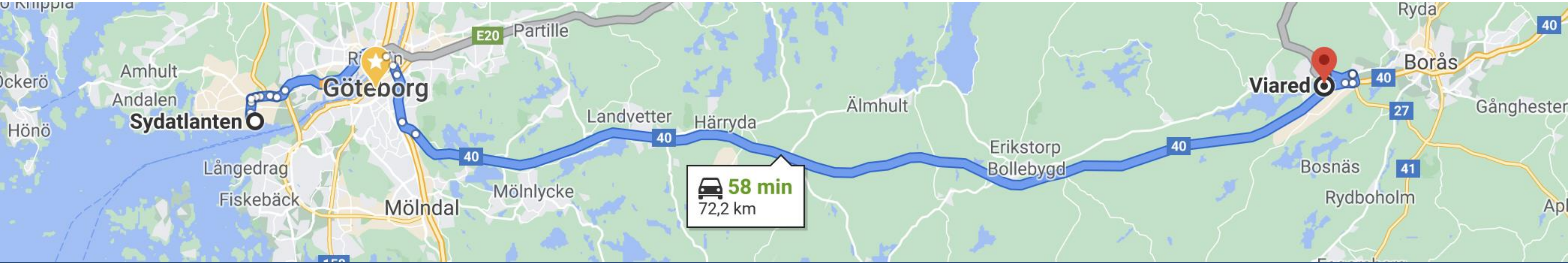
Fredrik von Corswant
2021-03-09

Project scope



A-double vehicle

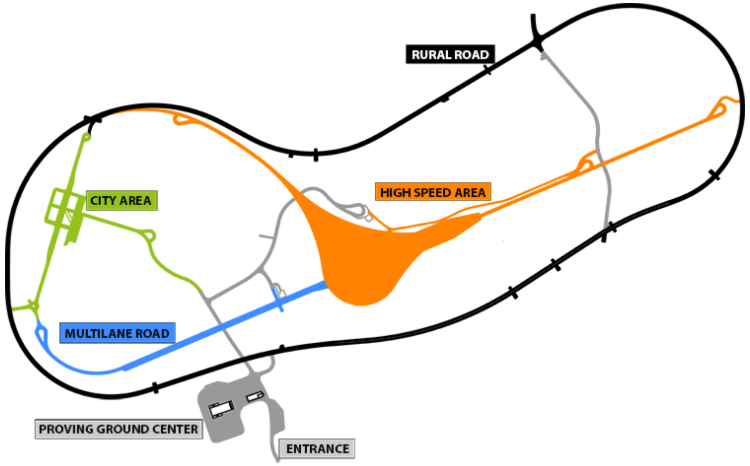
- Efficient container transports Gothenburg Harbor – Viared Borås
- A-double – Two container trailers instead of one
- Multi-client logistics system for import and export flows
- Vehicle automation and driver support systems



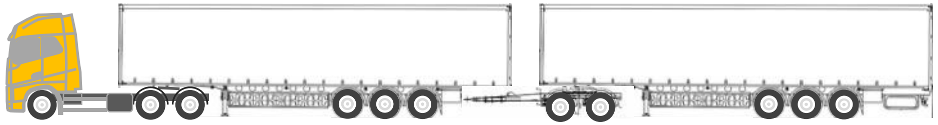
REVERE
RESOURCE FOR VEHICLE RESEARCH AT CHALMERS

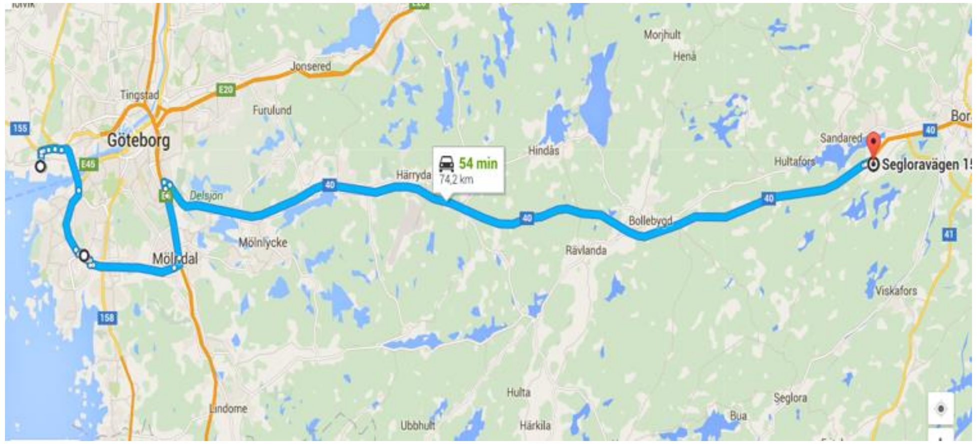
Test vehicles

Research vehicle
Research platform
Test track
Fully equipped with sensors
Full actuation

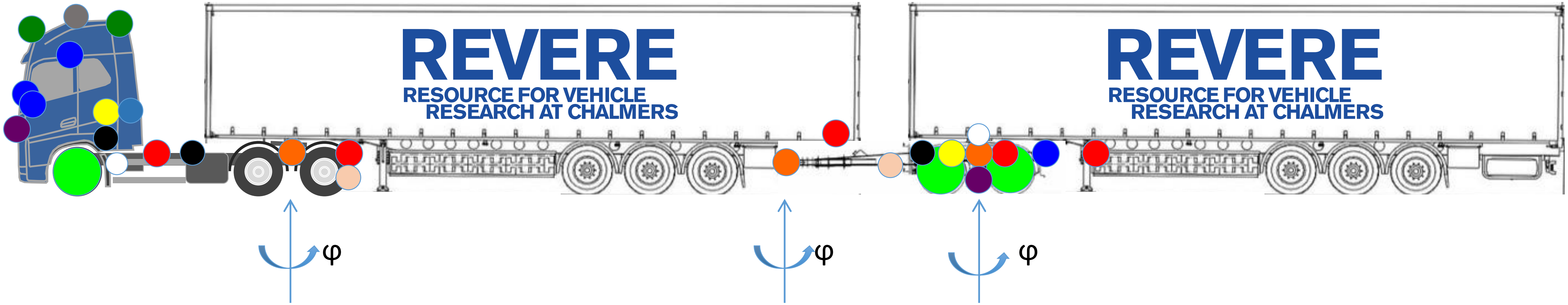


Logistics vehicle
Daily operation
Public roads
Subset of sensors
Data collection





Autofreight research vehicle



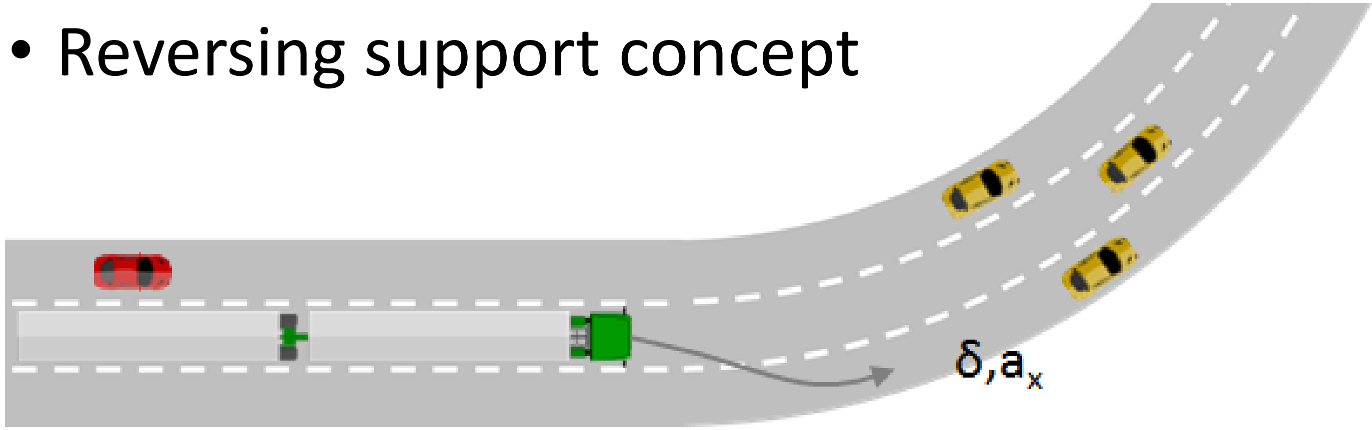
- Angle sensor
- Inertial Measurement Unit (IMU)
- Computer for perception etc
- GPS Antenna
- Camera
- Laser scanner (LIDAR)
- Steered axle
- WiFi between vehicles in combination
- Time sync for all data (PTP)
- Computer for data logging
- V2V and V2I communication
- Auxiliary power supply
- Radar

Efficient logistics

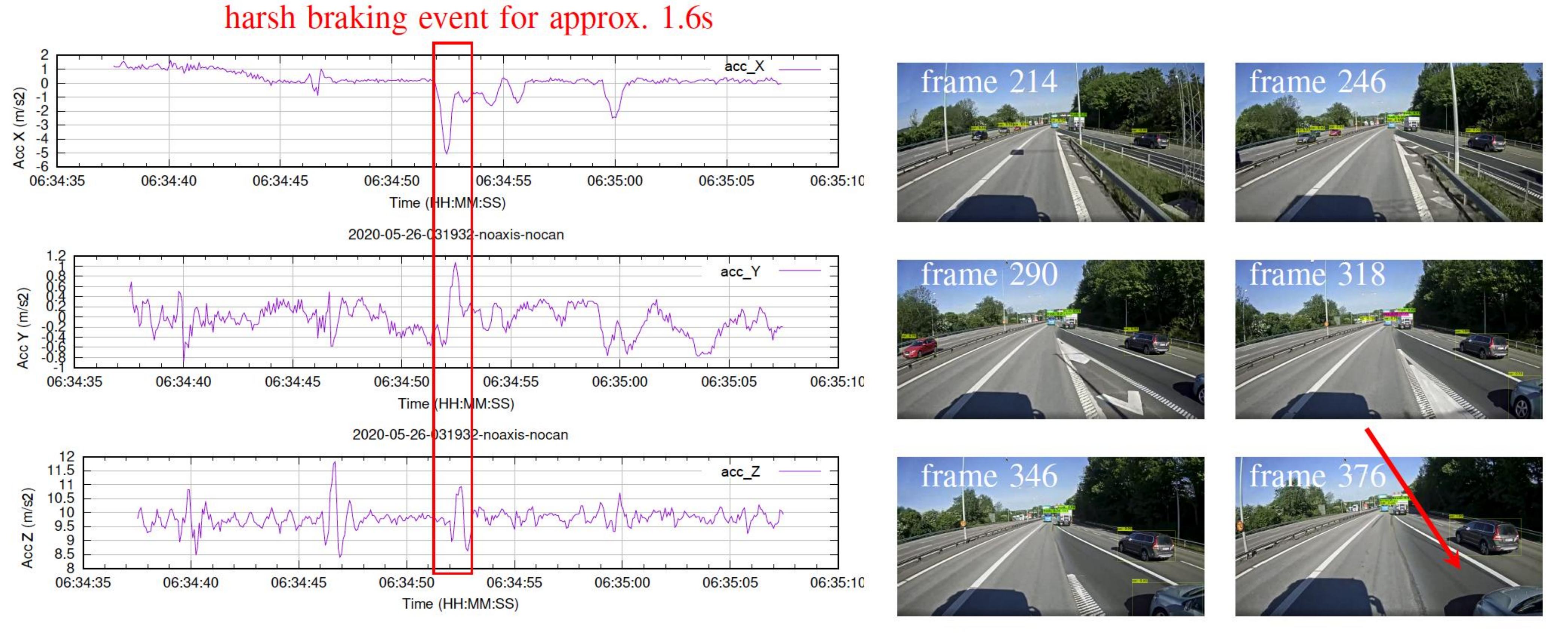
- Optimization of transport capacity
- Two round trips per day
- Multi-client system
- Transparent booking portal
- Balanced import and matching export
- Further improvements with increasing volumes and more export goods

Vehicle Automation & driver support

- Driving scenarios and vehicle dynamics
- Vehicle Motion Management
- Semantic segmentation
- Data sets
- Reversing support concept



Real traffic data logging



(a) Event in the acceleration data.

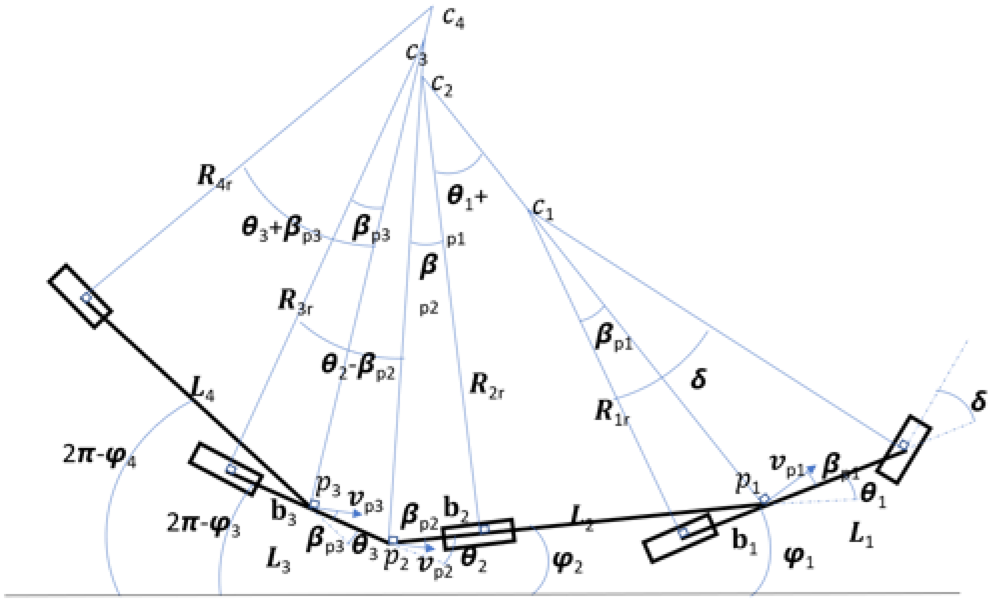
(b) Traffic situation of the event with object detection.

Fig. 2. Event where the truck was forced to conduct an unintended deceleration maneuver; no collision happened.

REVERE
RESOURCE FOR VEHICLE RESEARCH AT CHALMERS

The need for a reversing support system

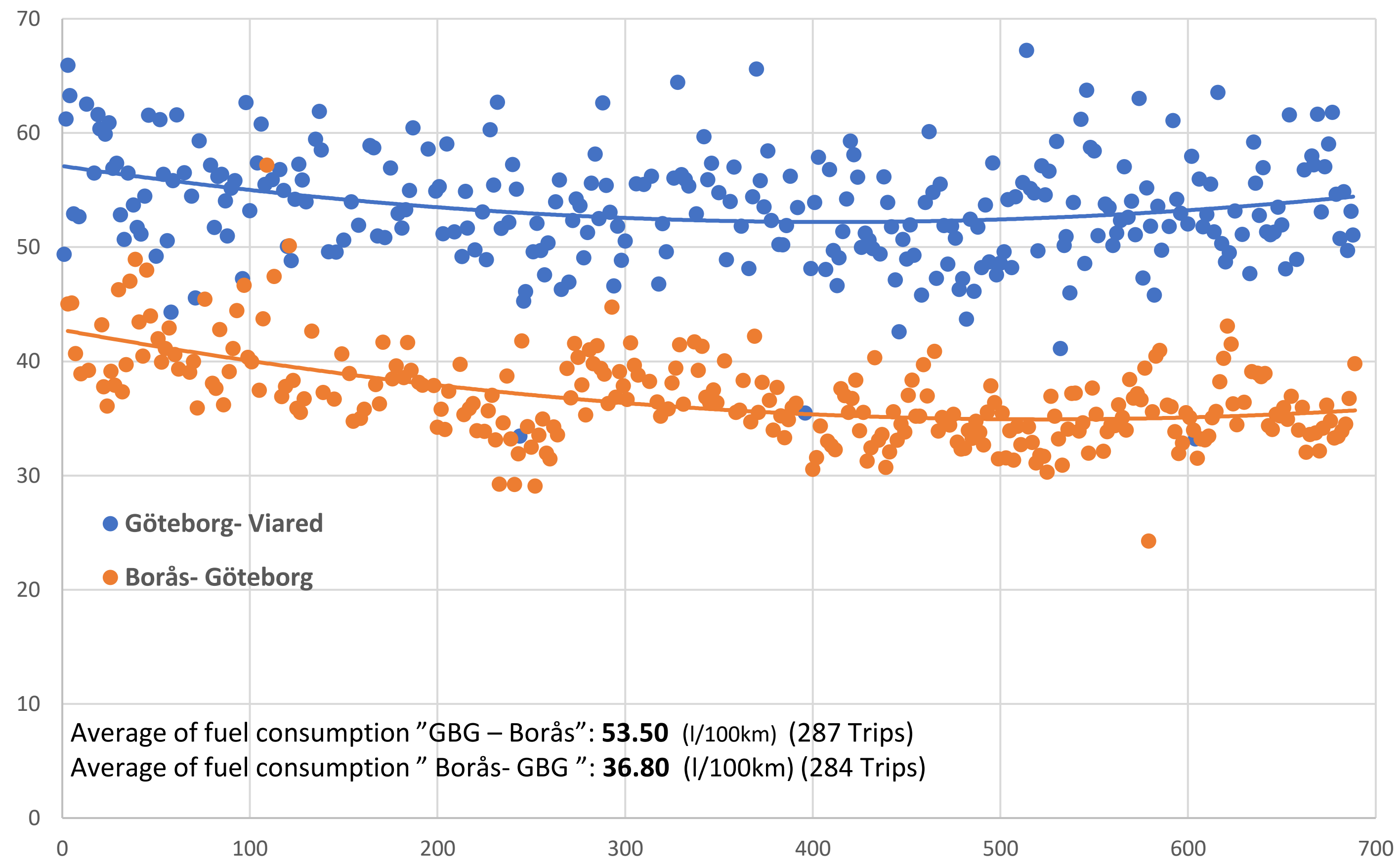
- Difficult task, requires very skilled drivers
- Vehicle has three articulation points
- Knob for setting reversing radius
- Driver in charge of reversing
- System takes over steering wheel



REVERE
RESOURCE FOR VEHICLE RESEARCH AT CHALMERS

Fuel economy - results

- >50 000km during 2020
- 715 trips
- A-double vs single trailer
  - On road: -30%
  - At hub: +25%
  - Total reduction: 21%
- Improve first and last mile operations



Next steps

- Open multi-client system
- Engage more companies in the Viared area
- A-double with (hybrid) electrical propulsion
- Traffic safety research, e.g. VRU's
- Driver support systems for reversing long vehicles
- Improve hub operation and first/last mile efficiency

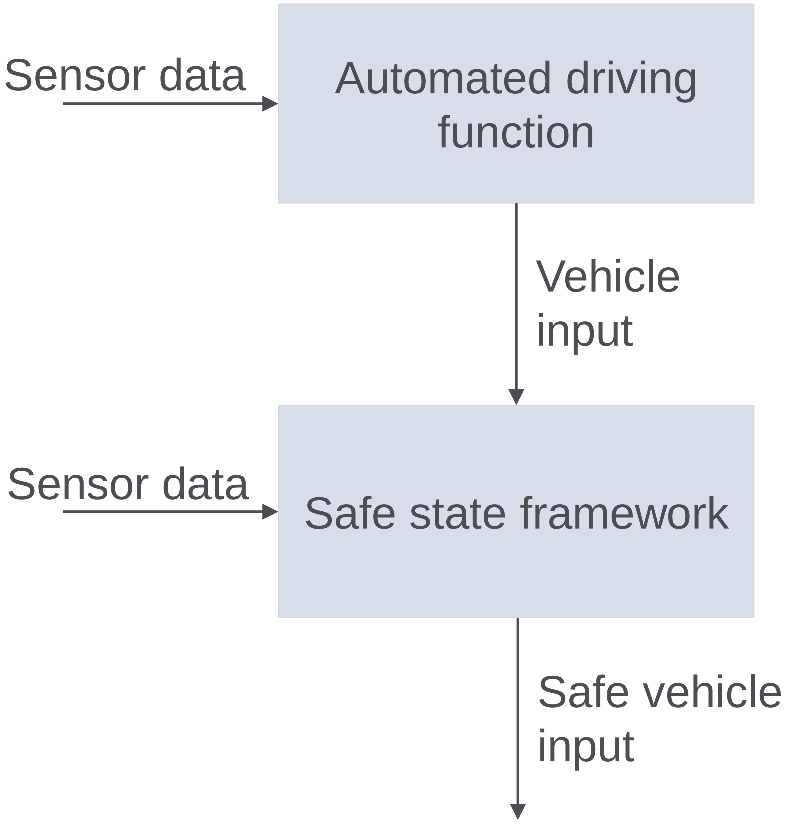
Thank you!

HIGH INTEGRITY SYSTEM FOR ENSURING SAFETY OF AUTOMATED DRIVING FEATURES

Stefan Kojchev
Volvo Autonomous Solutions
stefan.koychev@volvo.com

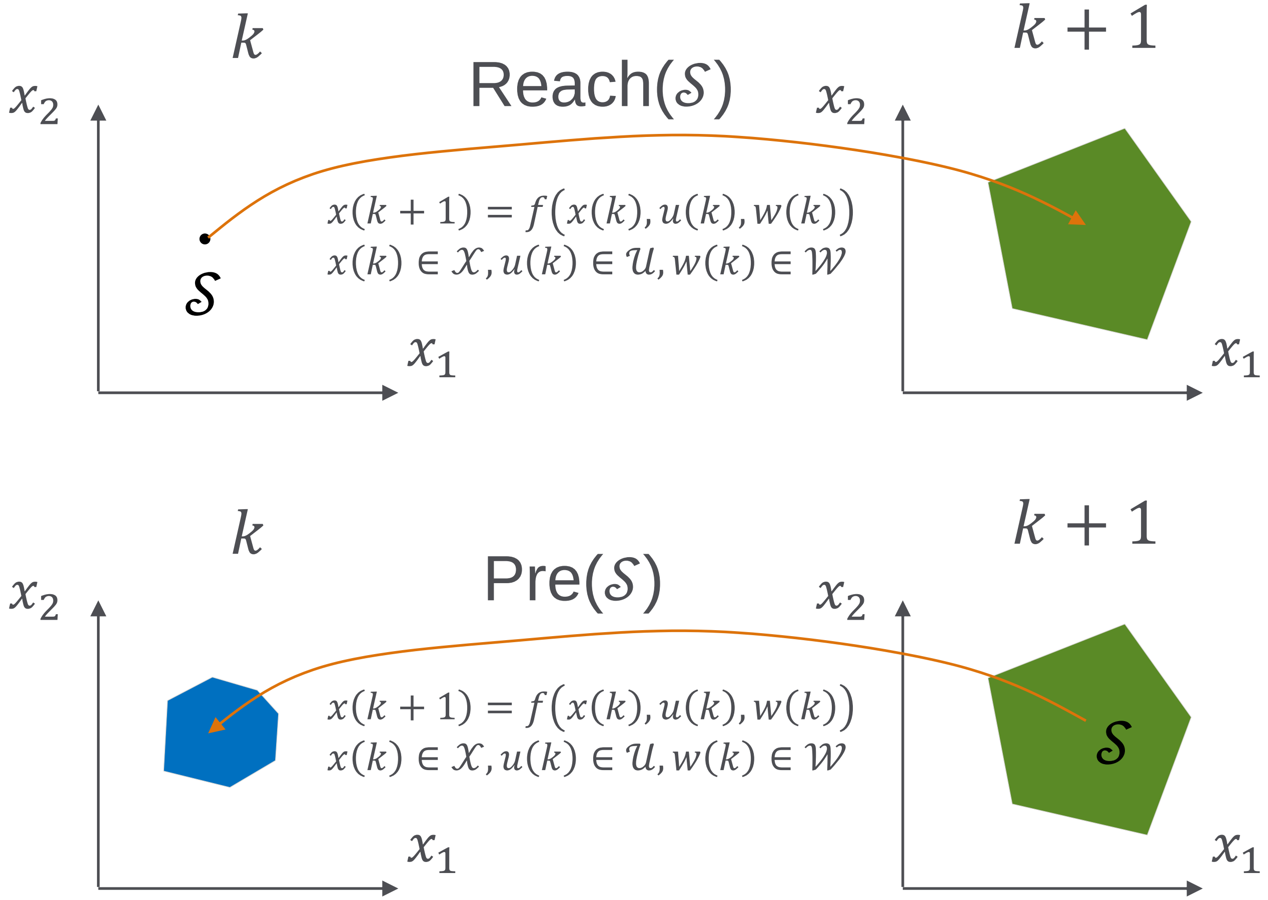
Introduction

- Why?
  - High functional safety rating
  - Automated driving functions are difficult to be verified
  - Susceptible to change
- Concept
  - Monitor and evaluate if the vehicle input from the AD function leads the vehicle to a safe state
  - Intervene by initiating a safety procedure



The safety monitoring concept*

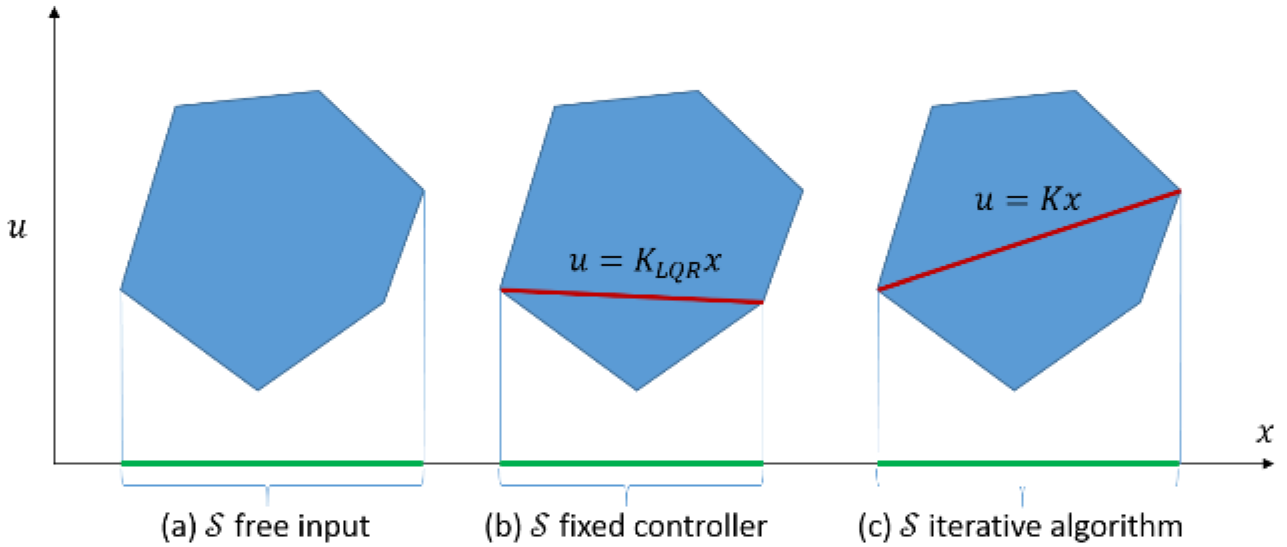
- Reachability
- Offline:
  - Permissible set based on backward reachability
- Online:
  - Adaptation of the permissible set
  - Safety check by set membership



* Kojchev, Stefan, Emil Klintberg, and Jonas Fredriksson. "A safety monitoring concept for fully automated driving." In *2020 IEEE 23rd International Conference on Intelligent Transportation Systems (ITSC)*, pp. 1-7. IEEE, 2020.

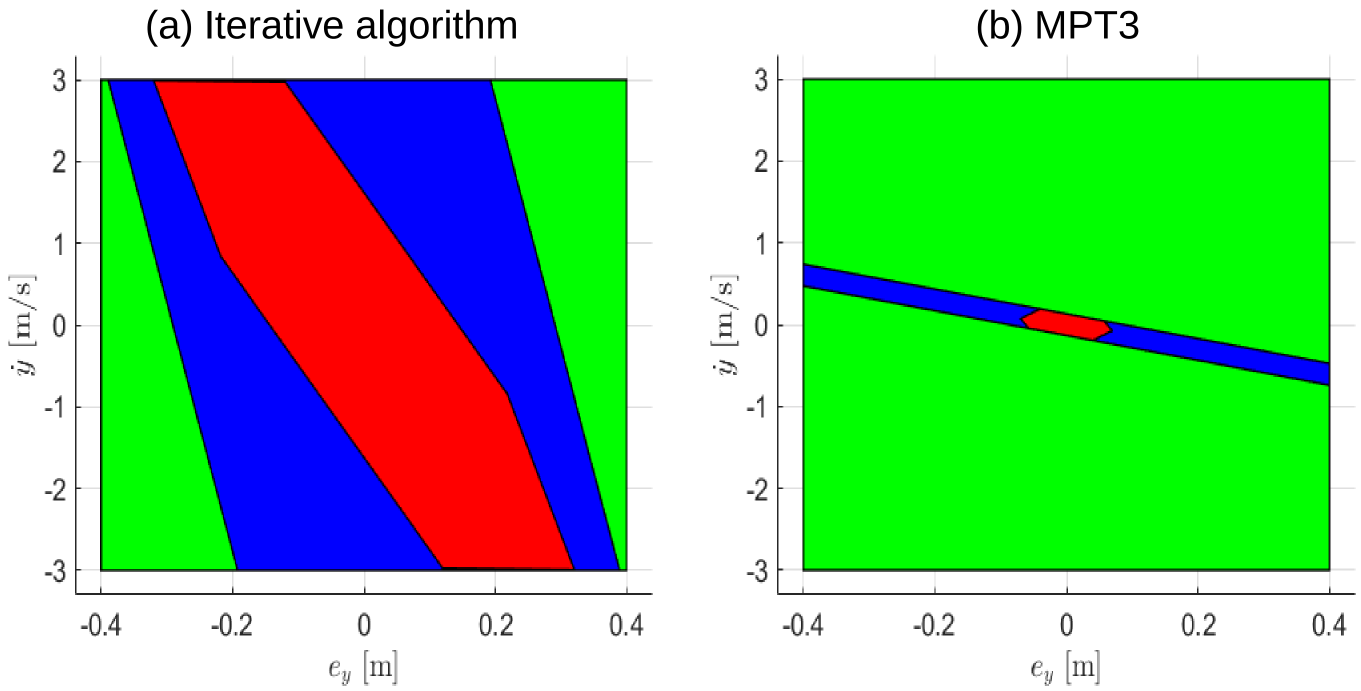
Current focus

- For an LTV system what is the maximum backward reachable set ($\mathcal{S}$)?
  - Free input (a)
  - Fixed controller (b)- approach in previous paper
  - Iterative algorithm (c)
- Main contributions:
  - Derived LMI conditions
  - Iterative algorithm for volume increase
- Numerical example:
  - Bicycle model
  - Compared with “naively” designed controller



Current focus

- Results:
  - Backward reachable sets with increased volume
  - Time-varying control-law
  - More computationally demanding
- Extensions:
  - Non zero symmetric sets
  - More complex control-law
  - Uncertain parameter varying systems



Thank you
Tack!

Human Body Model Development at SAFER

2021-03-09

Johan Iraeus, johan.iraeus@chalmers.se

FFI Strategic Vehicle Research and Innovation

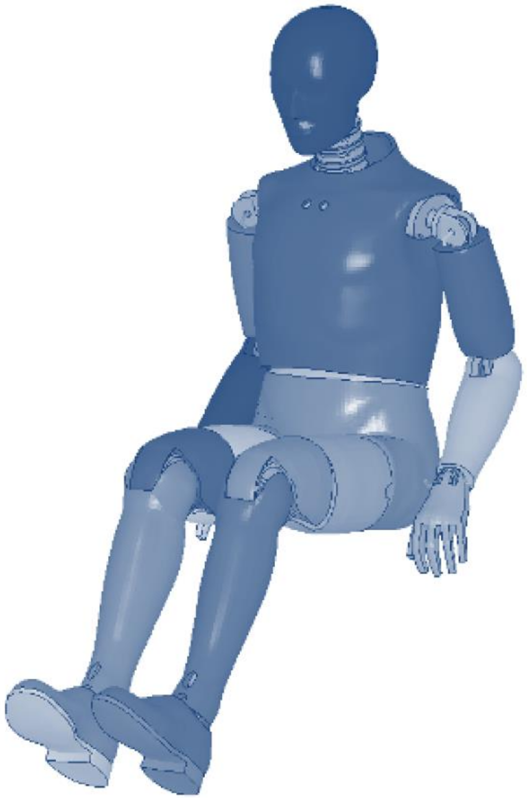
OSCCAR FUTURE OCCUPANT SAFETY FOR CRASHES IN CARS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768960.

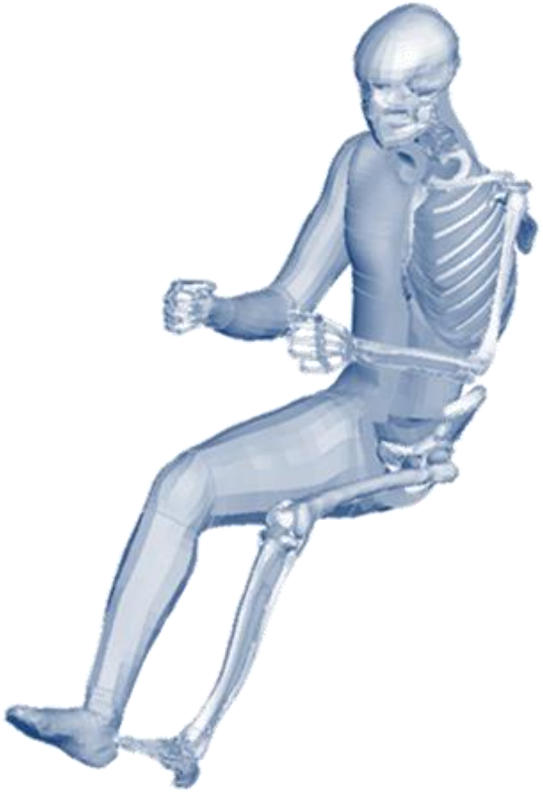
What is a Human Body Model (HBM)?

Physical
Crash test dummy

Virtual
Crash test dummy

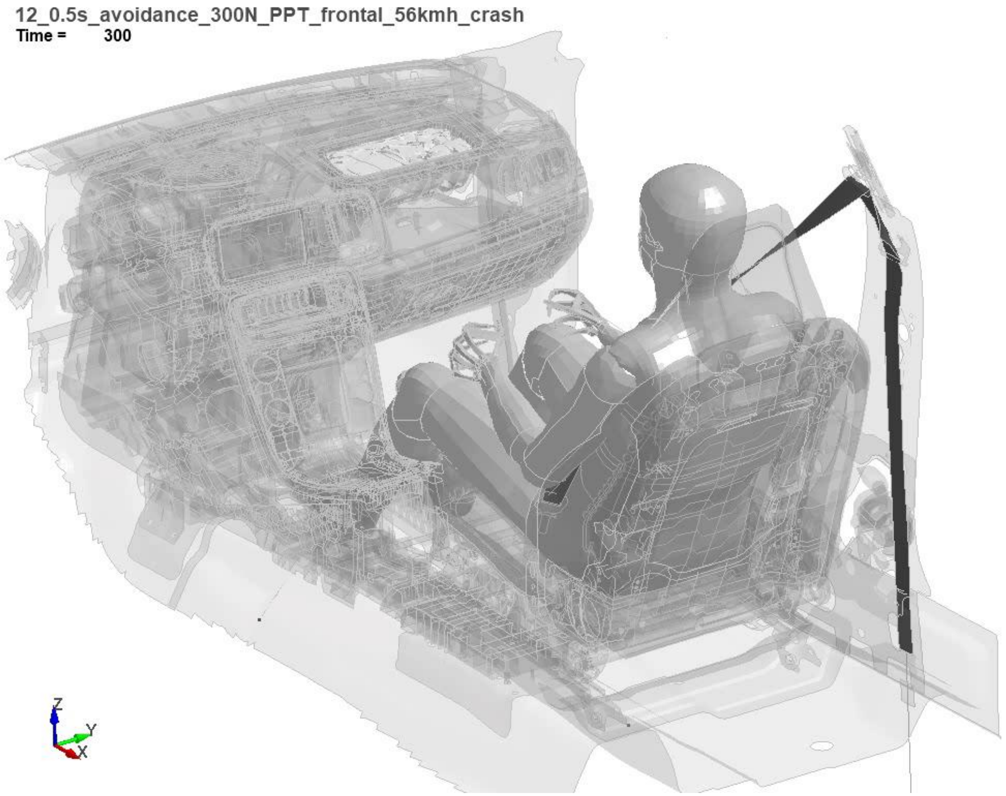


Virtual
Human Body Model



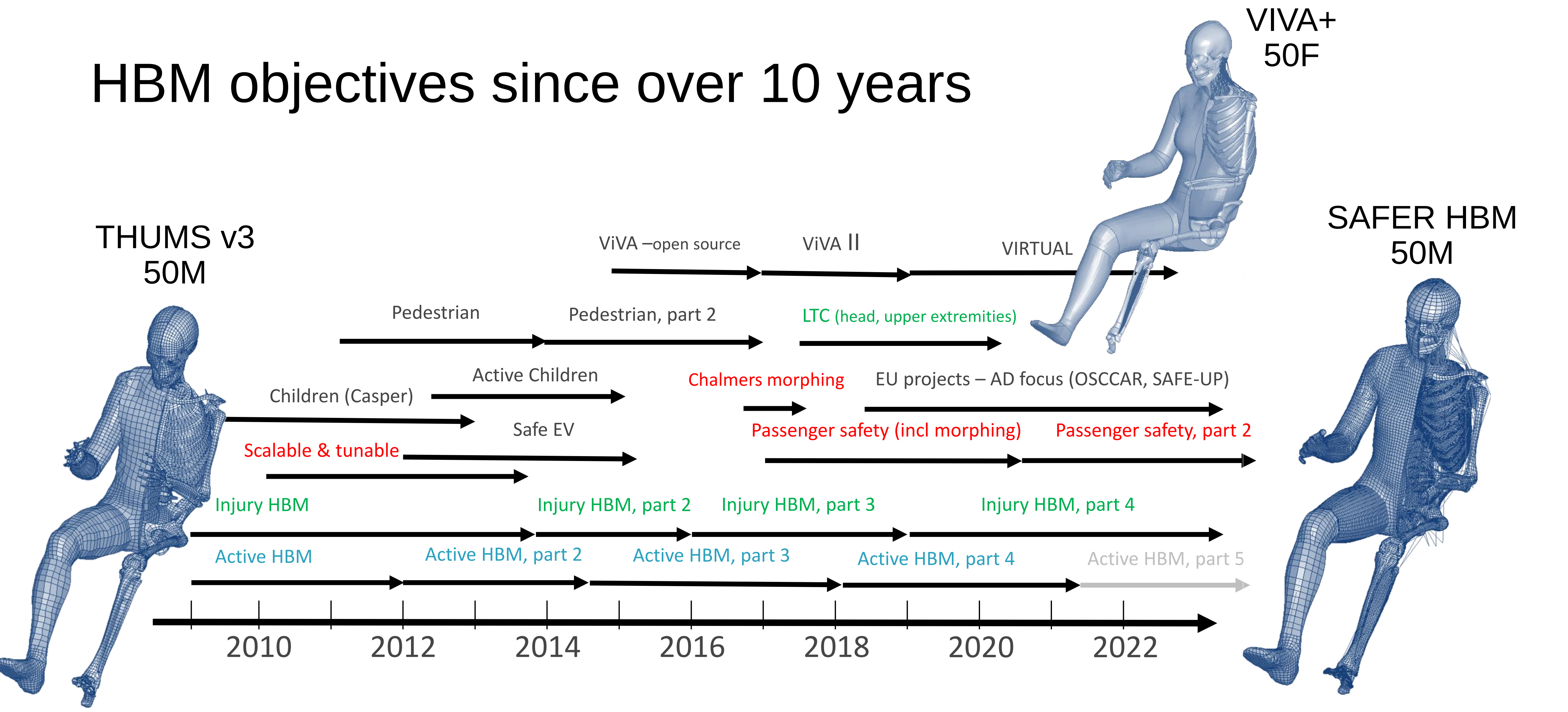
HBM objectives since over 10 years

"A robust, scalable, tunable HBM with injury prediction capabilities, that can simulate the whole pre-crash to in-crash sequence"



Unpublish results from the Active Human Body model project)

HBM objectives since over 10 years



HBM objective: Scaling and tuning

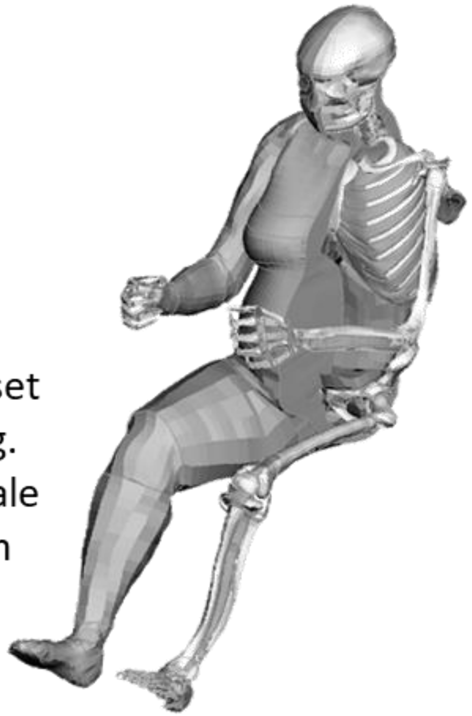
SAFER HBM v9.0

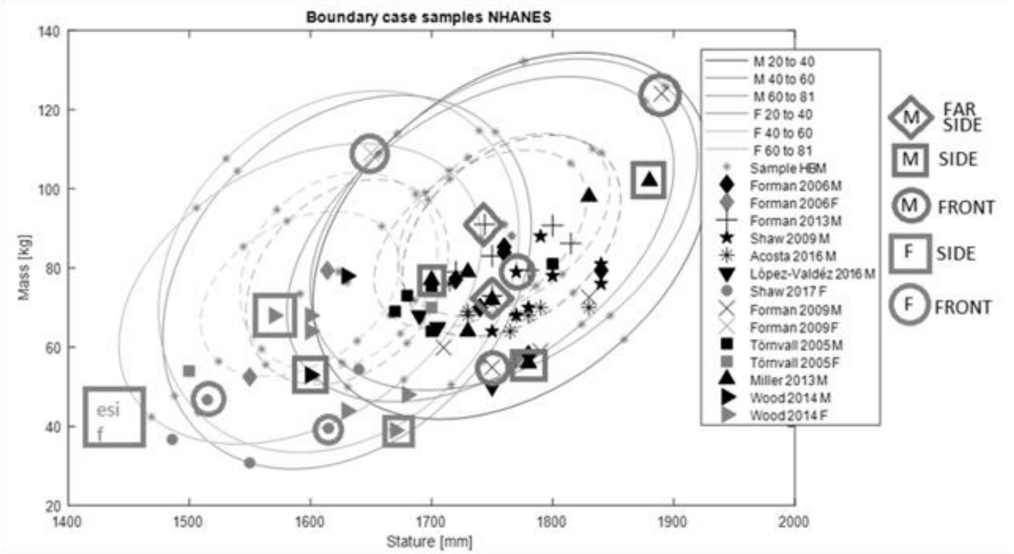
Morphing

Using predifined set of parameters, e.g.

- Gender=Female
- Height=175cm
- BMI=40
- Age=25yr

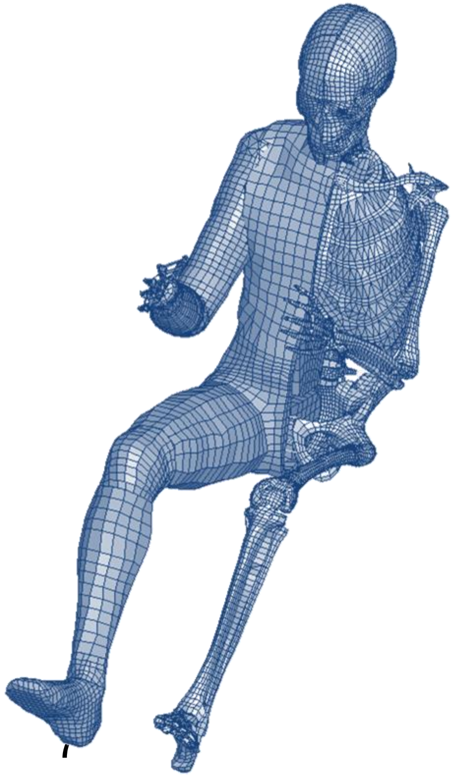
Morphed SAFER HBM v9.0





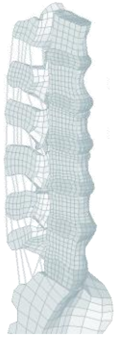
HBM objective: Injury Prediction

THUMS v3
50M



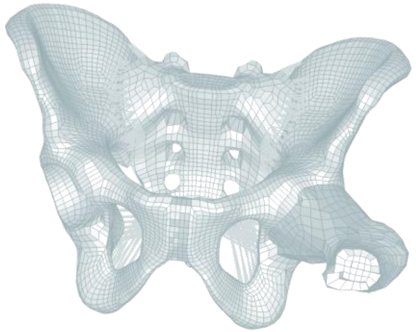
KTH Head and Brain
(Kleiven)

Lumbar Spine

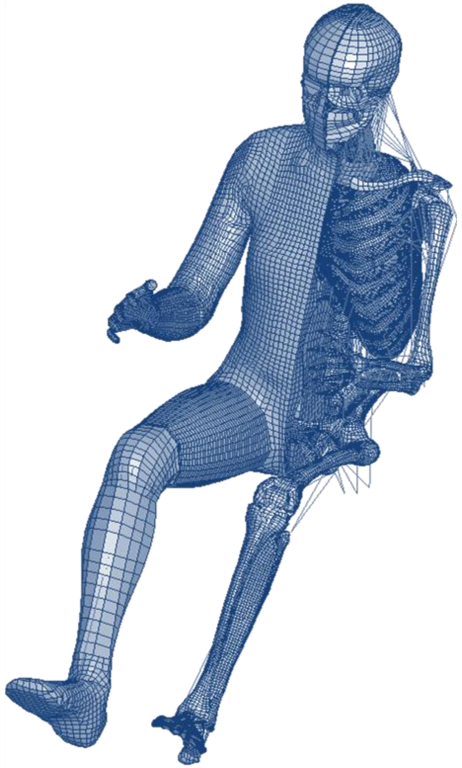


Chalmers ribcage (Iraeus)

Chalmers pelvis (Brynskog)

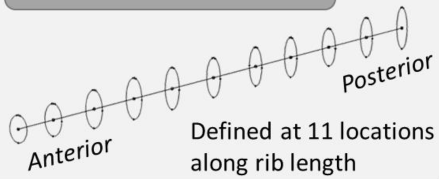


SAFER HBM
50M



HBM objective: Injury Prediction

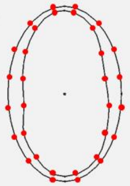
1. Elliptic cross sections



Defined at 11 locations along rib length

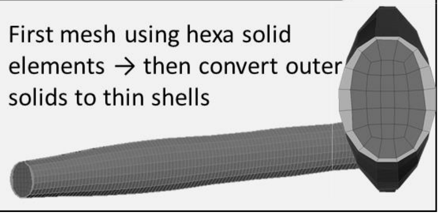
2. Cortical thickness

Defined at 16 locations around the perimeter



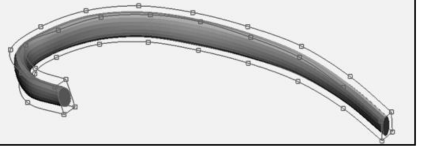
3. Create surface and mesh

First mesh using hexa solid elements → then convert outer solids to thin shells



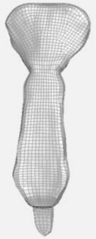
4. Morph to fit 3-D shape

Morph rib to fit curvature and twist to statistical rib model



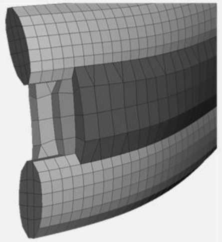
5. Create averaged sternum

Create sternum based on statistical model



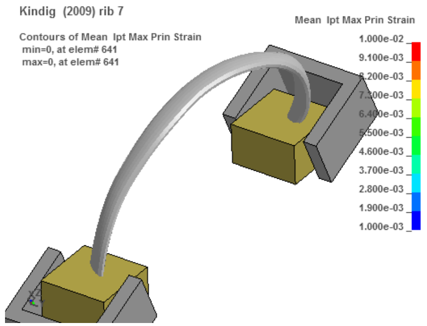
6. Add intercostal muscles

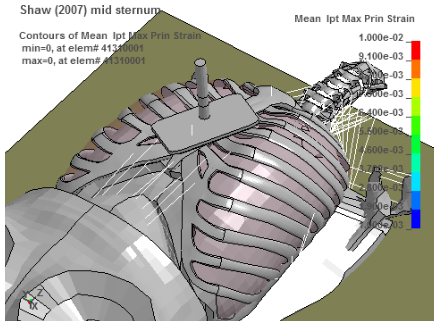
Create solid element based intercostal muscles based on averaged data

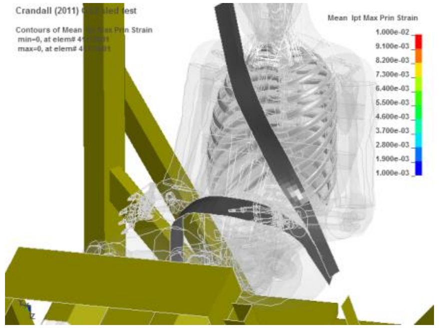


7. Assemble ribcage

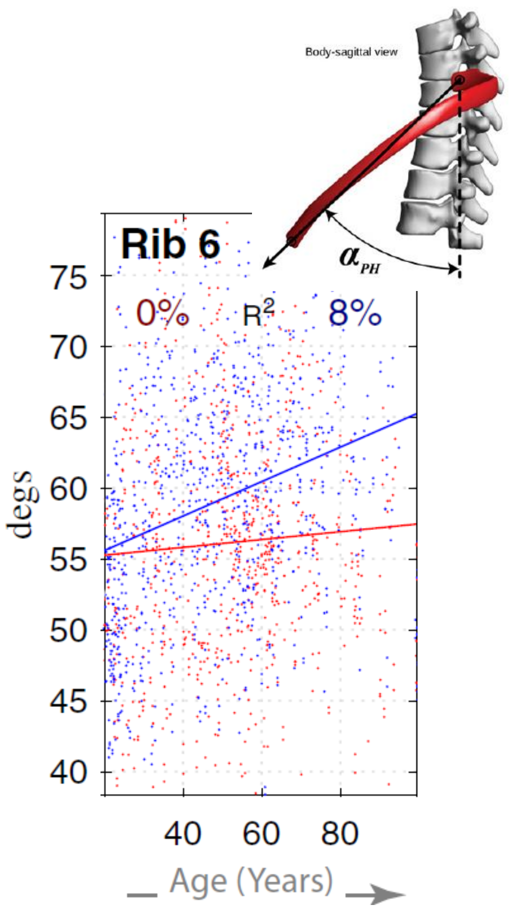
Adapt costa cartilage to ribs and sternum using morphing. Adapt posterior rib ends to spine.







HBM objective: Injury Prediction + Scaling and tuning

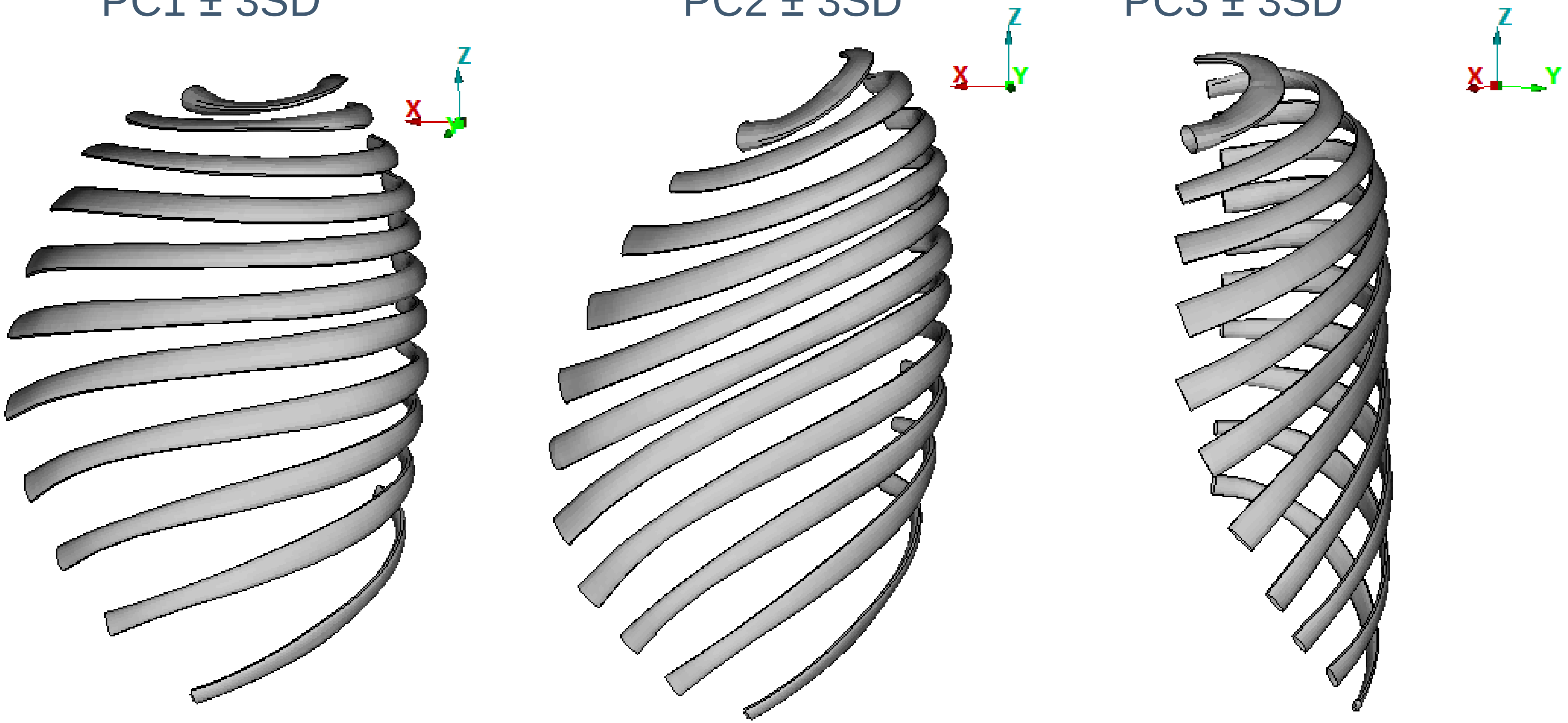


males females

PC1 ± 3SD

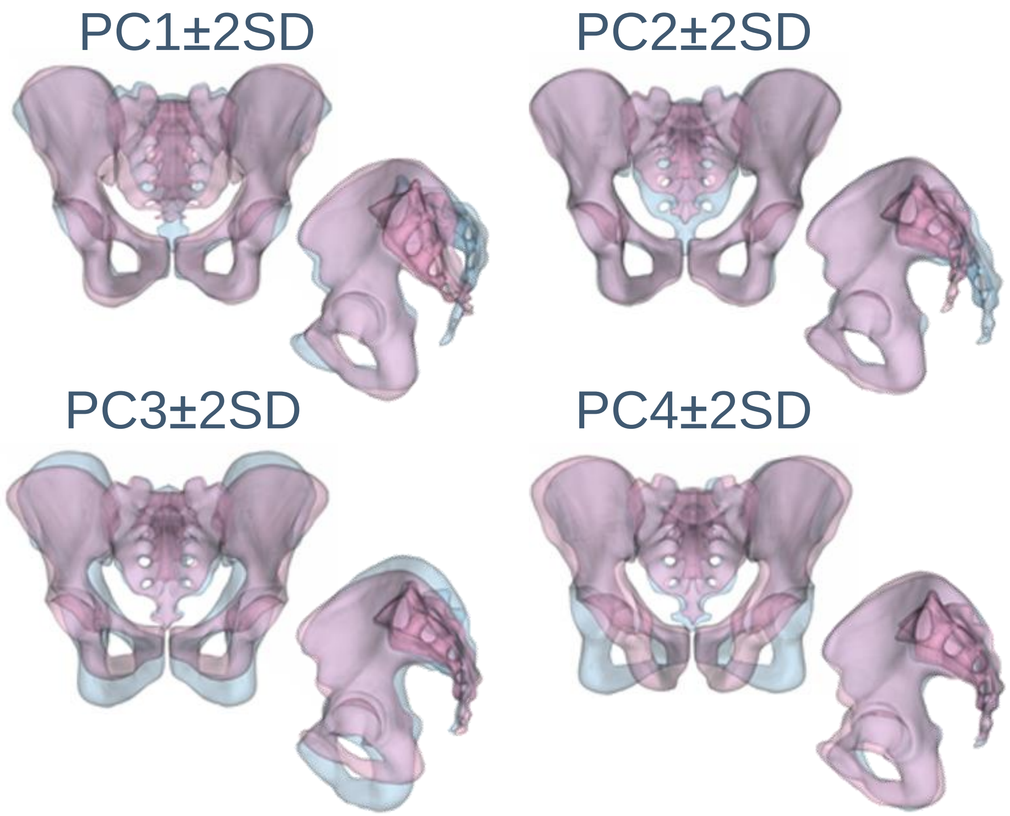
PC2 ± 3SD

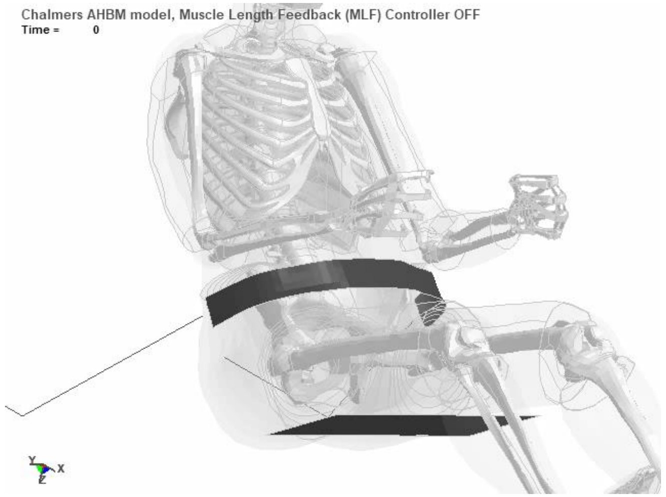
PC3 ± 3SD

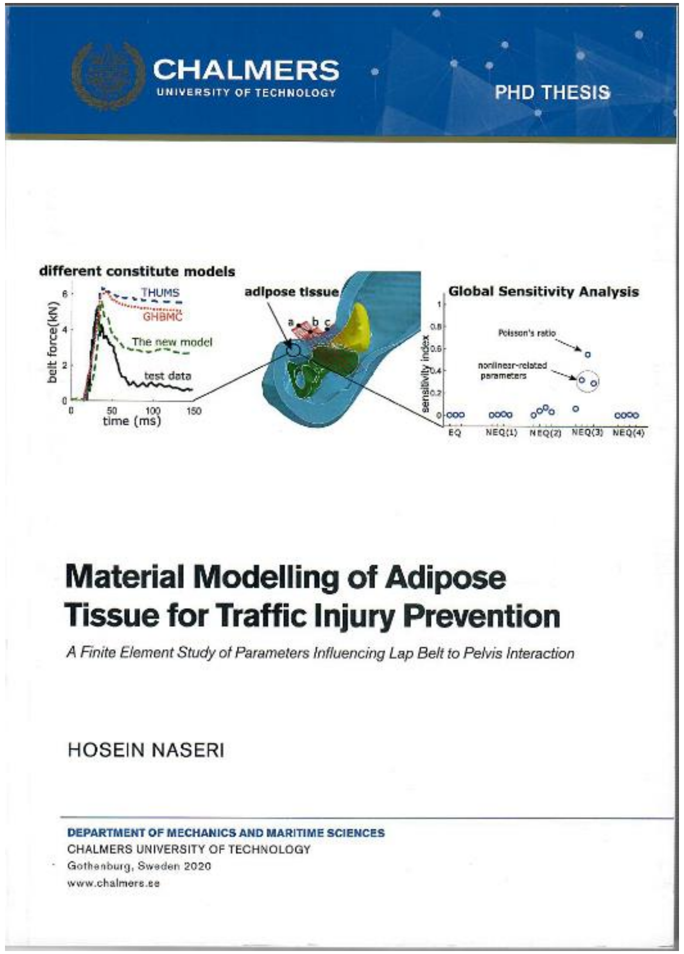


SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

HBM objective: Injury Prediction + Scaling and tuning

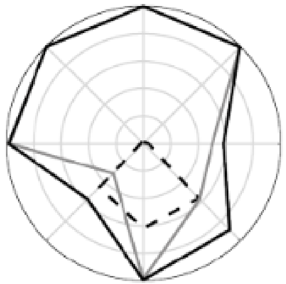




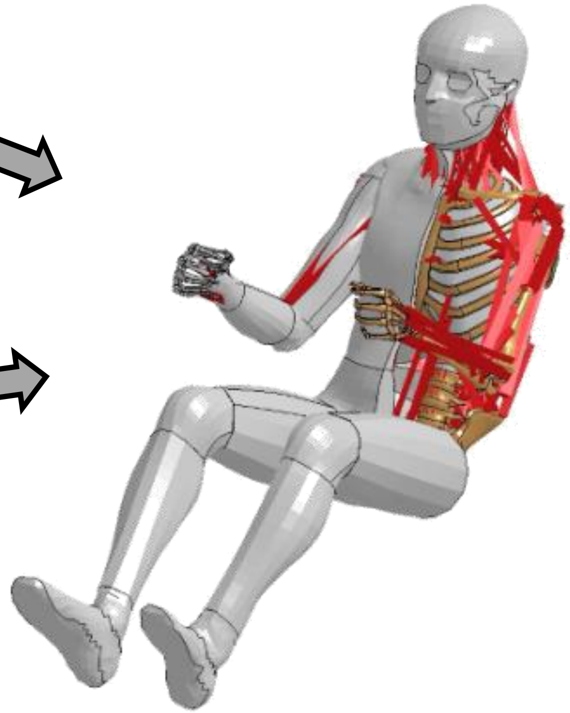


Unpublish results from the Injury Human Body model project)

HBM objective: Pre-crash to in-crash



SAFER HBM v9



SAFER HBM v10 beta

Passive model

Active model

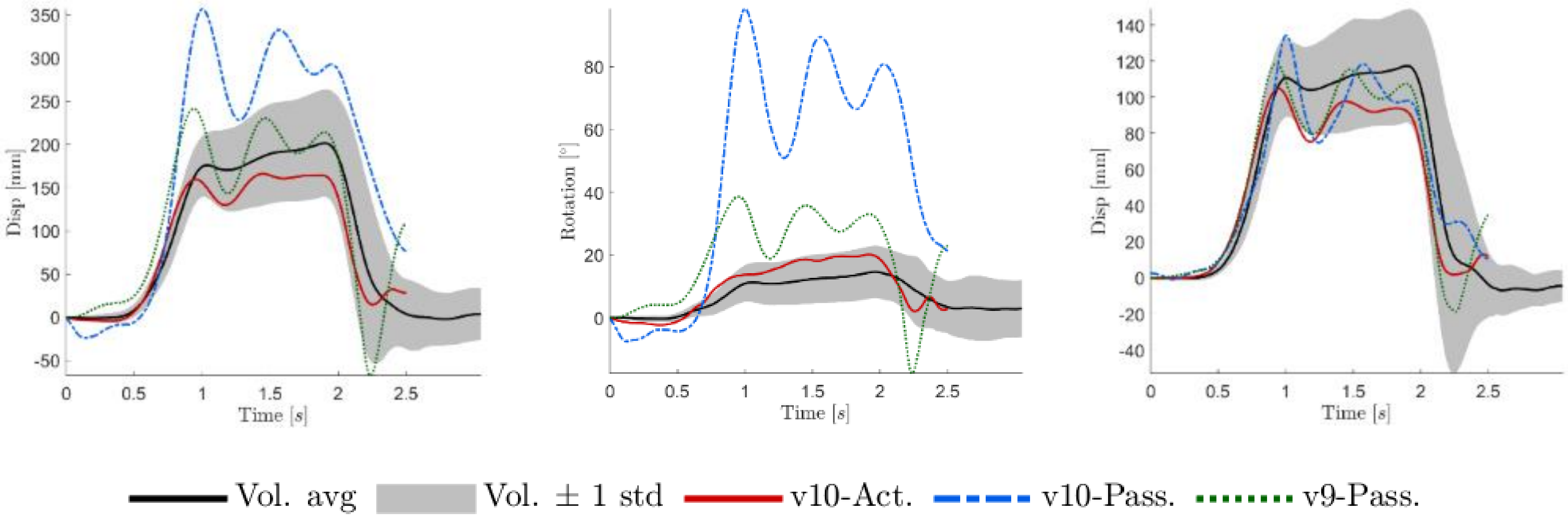
(Combination of östh et al. 2014, Ólafsdottir et al. 2017, Larsson et al. 2019)

(Unpublish results from the Active Human Body model project)

HBM objective: Pre-crash to in-crash

- Passengers in 1 g braking

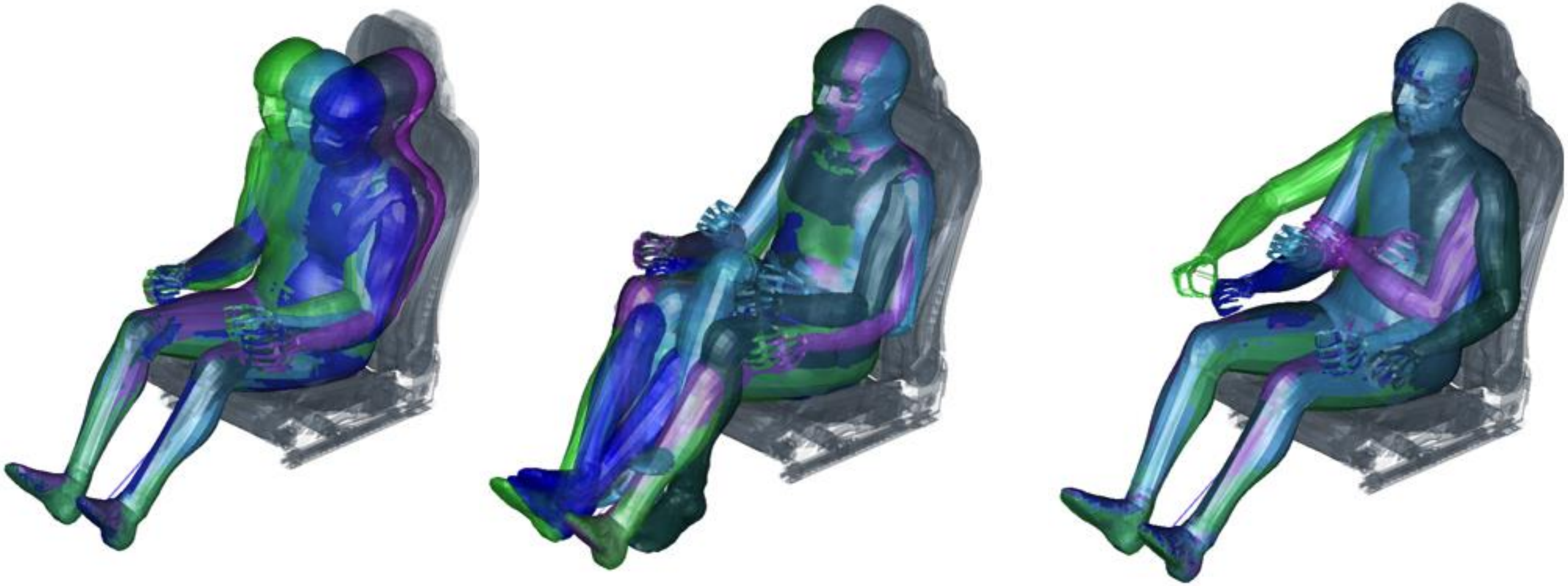
Head forward translation | Head pitch (flexion) | T1 forward translation



Unpublish results from the Active Human Body model project)

HBM objective: Pre-crash to in-crash

- Initial position and posture



Leledakis (2020) unpublished

HBM development at SAFER

- We[1] have a scalable and tunable human body model, SAFER HBM, capable of detailed injury prediction of some important body parts
- The model has been developed in a multitude of projects, and belongs to the project partners
- The model can simulate the whole pre-crash to in-crash phase
- Current works involves ensuring its biofidelity in AD environments

- We[1] are working on making the model available to all SAFER partners, and the rest of the world
- For that we need to secure a long-term support function, that requires some funding.

[1] The SAFER HBM partners' strategy group (Autoliv, VCC and Chalmers)

Does female occupants have the same protection level as male occupants?

Are Crash test Dummies Representative of the Population?

A pre-study

Anna Carlsson, Stiftelsen Chalmers Industriteknik

Pernilla Bremer, Sweden

SWEDISH TRANSPORT AGENCY

AIM

Purpose of this study?

- Have female occupants the same protection level as male occupants?
- How representative are crash test dummies of the female population?

2

General statistics

- Injury risks are higher for females than males*)

*) *when controlling for factors such as crash severity, restraint usage, blood alcohol content*

General statistics

Females in comparison to males:

- Narragon et al. (1965): **11%** higher injury risk
- Evans (2000): **35%** higher fatal injury risk (25 yo)
- Bedard et al. (2002): **54%** higher fatal injury risk
- Bose et al. (2011): **47%** higher MAIS 3+ injury risk
  71% higher MAIS 2+ injury risk
- Forman et al. (2019) **73%** higher MAIS 3+ injury risk
  142% higher MAIS 2+ injury risk

General statistics

Females greater risk of:

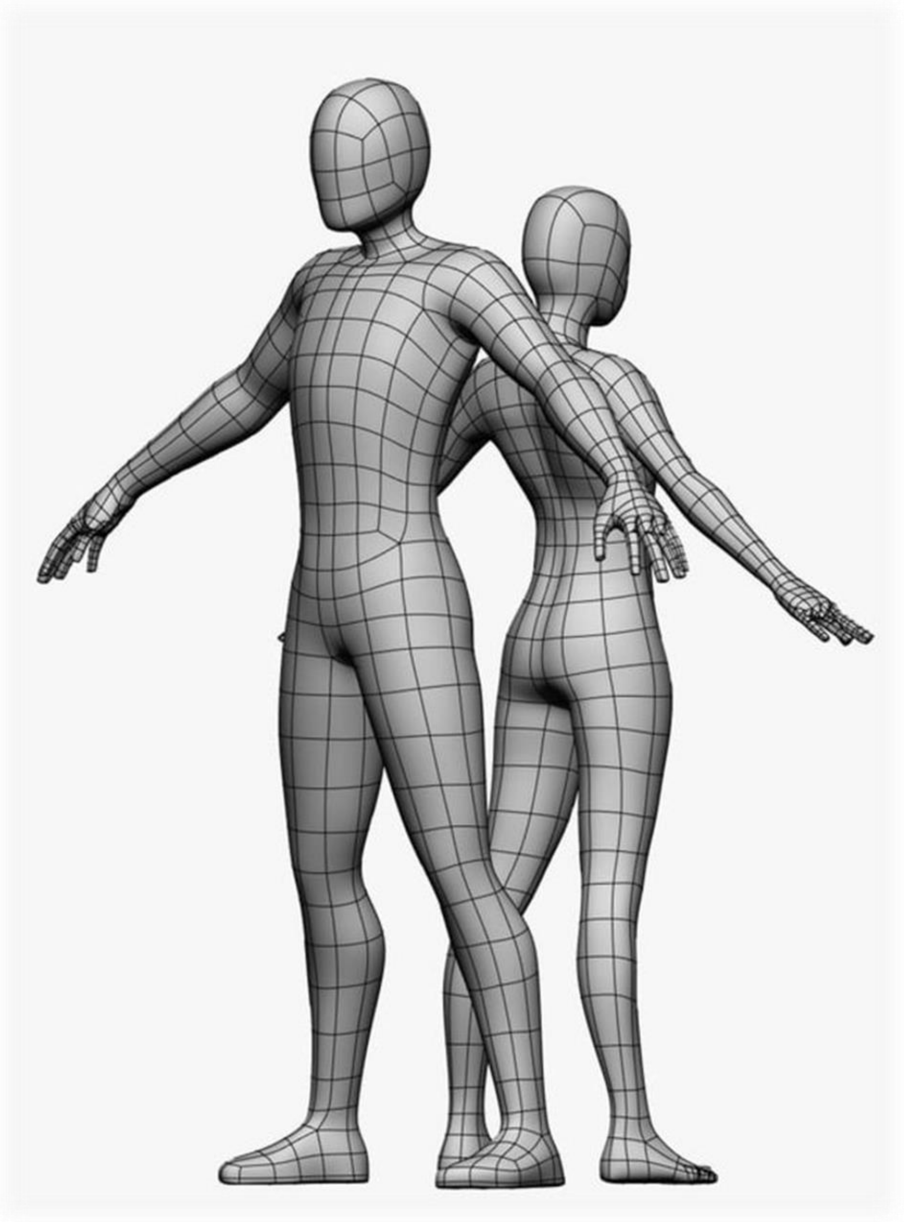
- Spine, thorax, extremity injuries

  (Welsh & Lenard 2001; Bose et al. 2011; Parenteau et al. 2013; Kahane 2013)

Males greater risk of:

- Head injuries

  (Parenteau et al. 2013; Welsh & Lenard 2001)

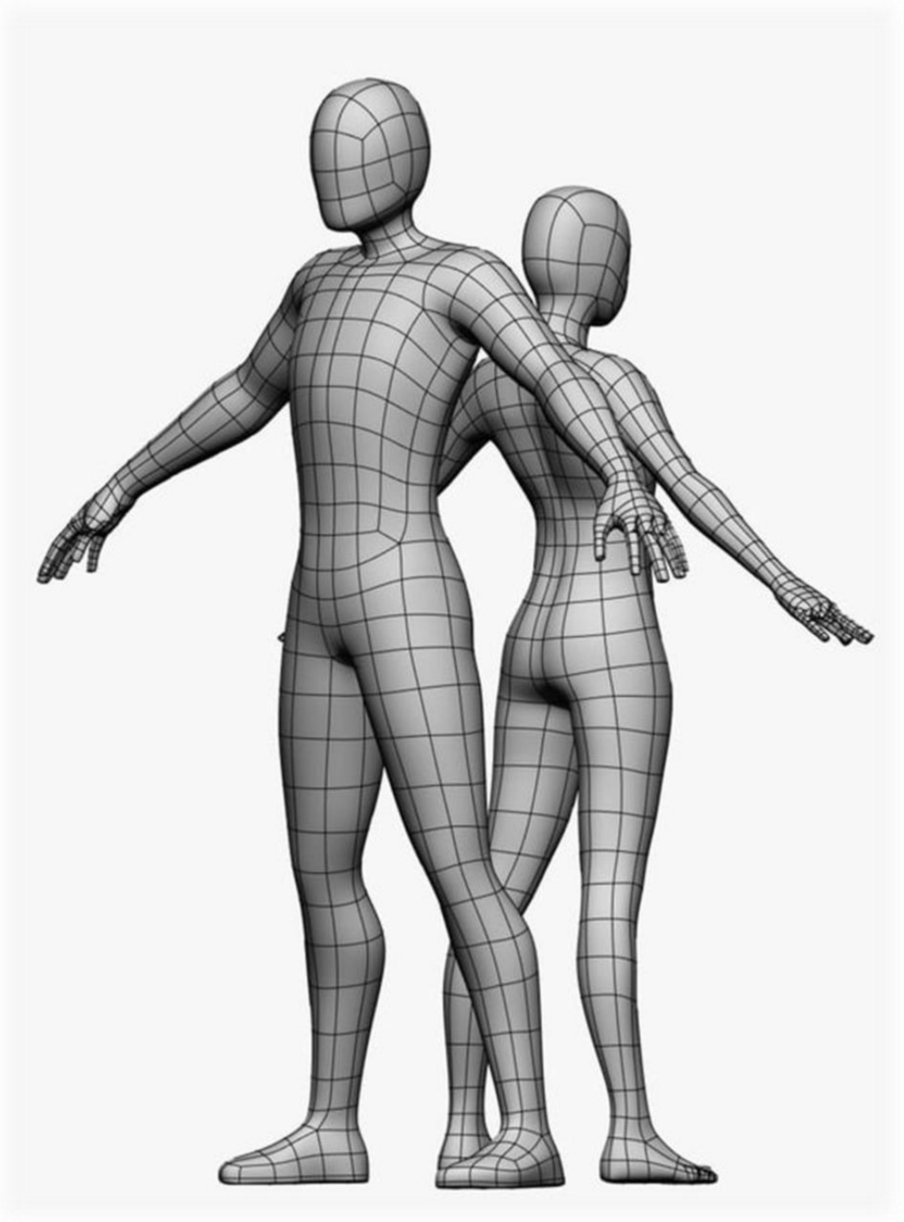


3 RESULTS

General statistics

Females:

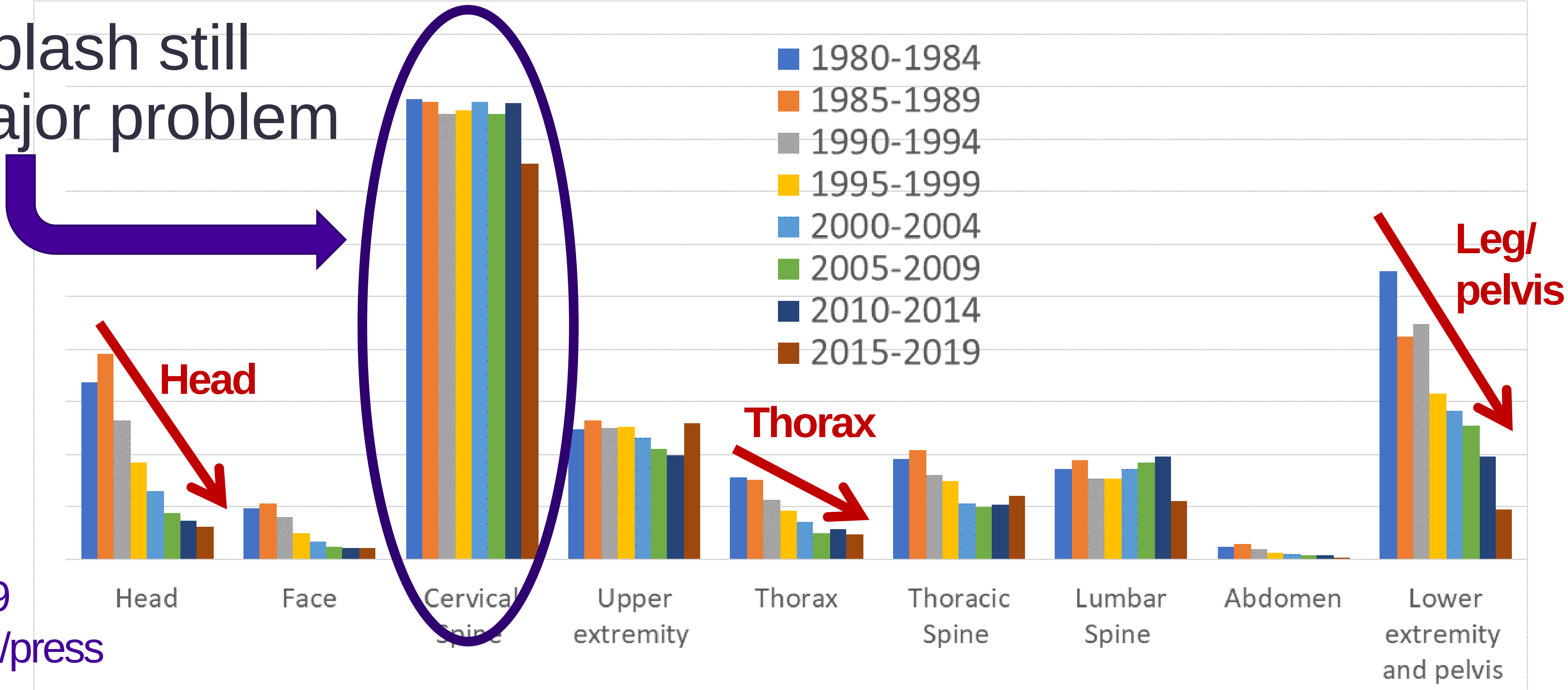
- Sustain injuries at lower velocity changes (Δv)
  (Mackay & Hassan 2000; Welsh & Lenard 2001s)
- Show greater increase in thoracic injuries with increasing age
  (Ridella et al. 2012; Forman et al. 2019)



RESULTS

Permanent medical impairment

- Whiplash still a major problem

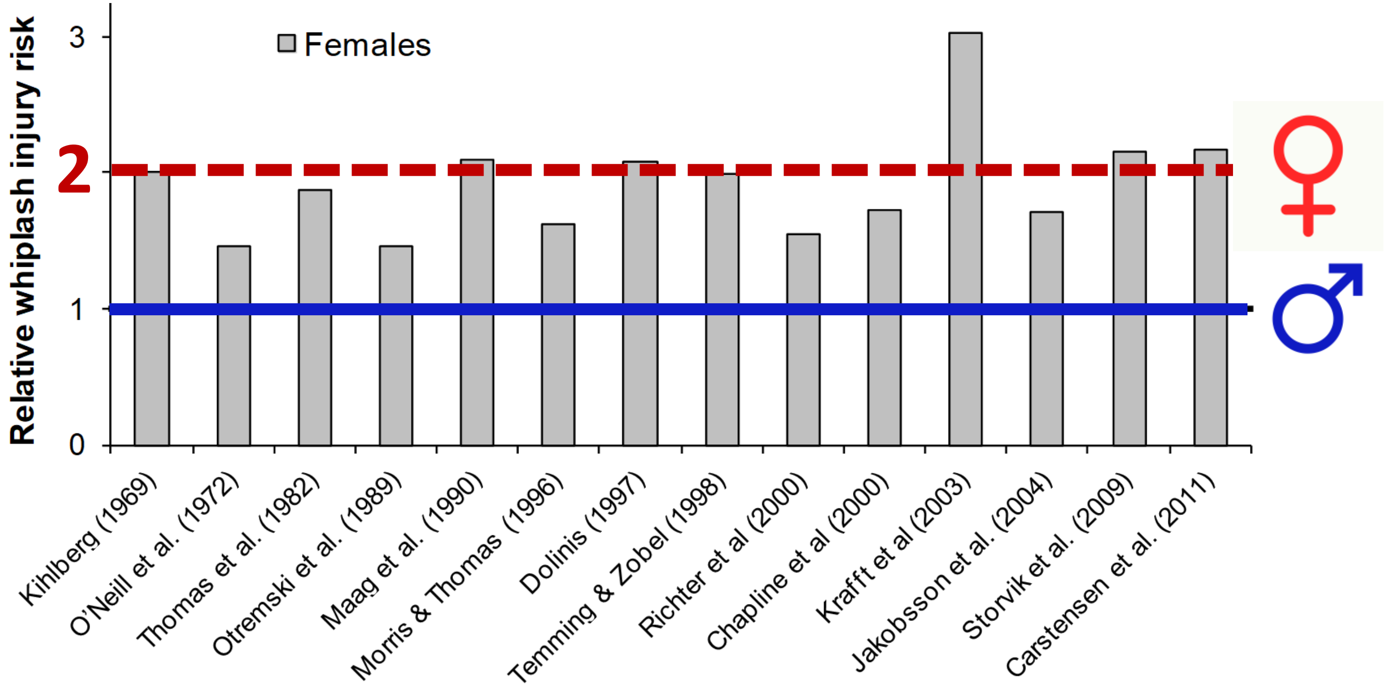


Hur säker är bilen 2019
Accessed: Folksam.se/press

RESULTS

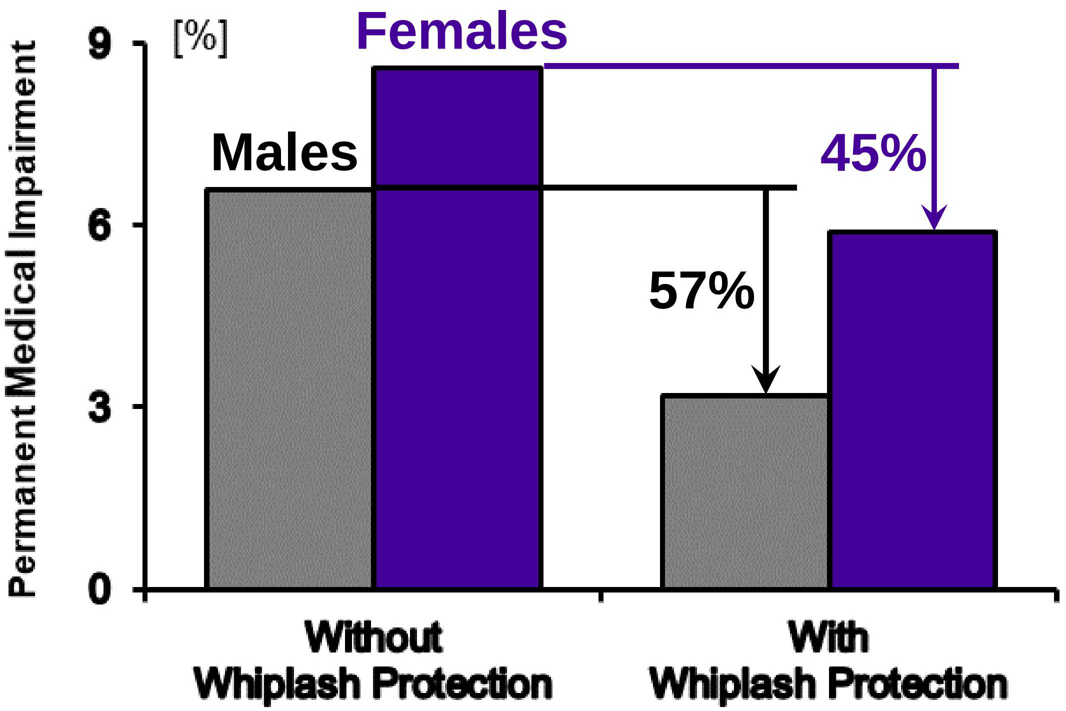
Whiplash

- Females have a higher risk of whiplash injury



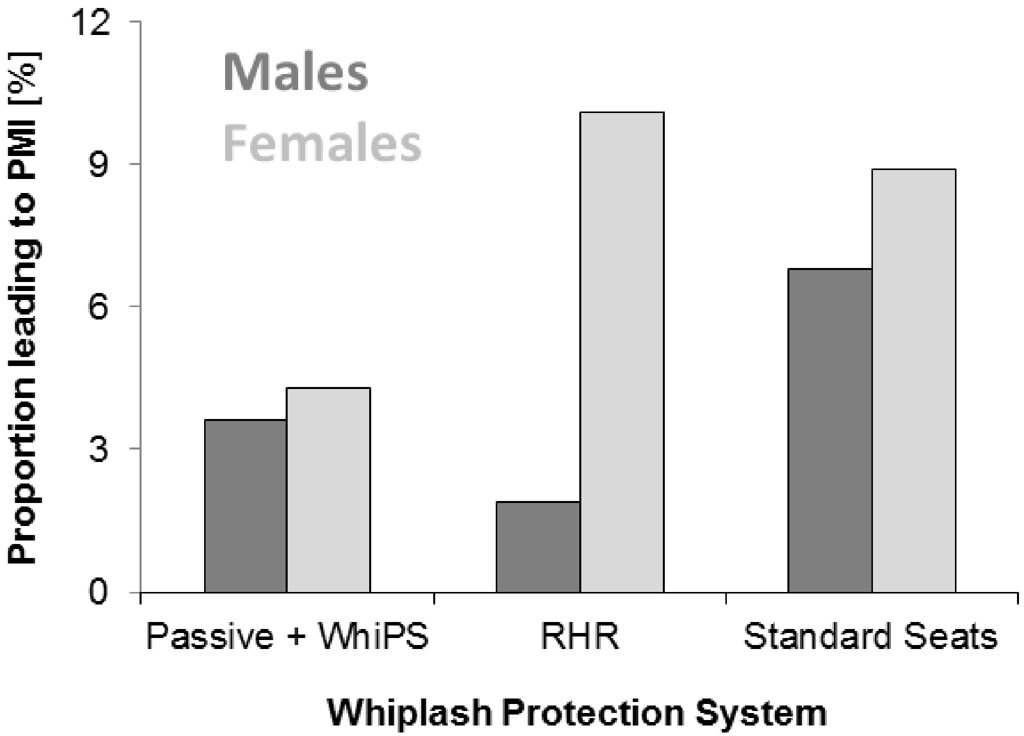
Whiplash

- Whiplash protection systems are (in general) less effective tor females compared to males (Kullgren & Krafft 2010)



Whiplash

- Different effectiveness in protecting females with different types of whiplash protection systems
  (Kullgren et al. 2013)



Are we different?

- Size:

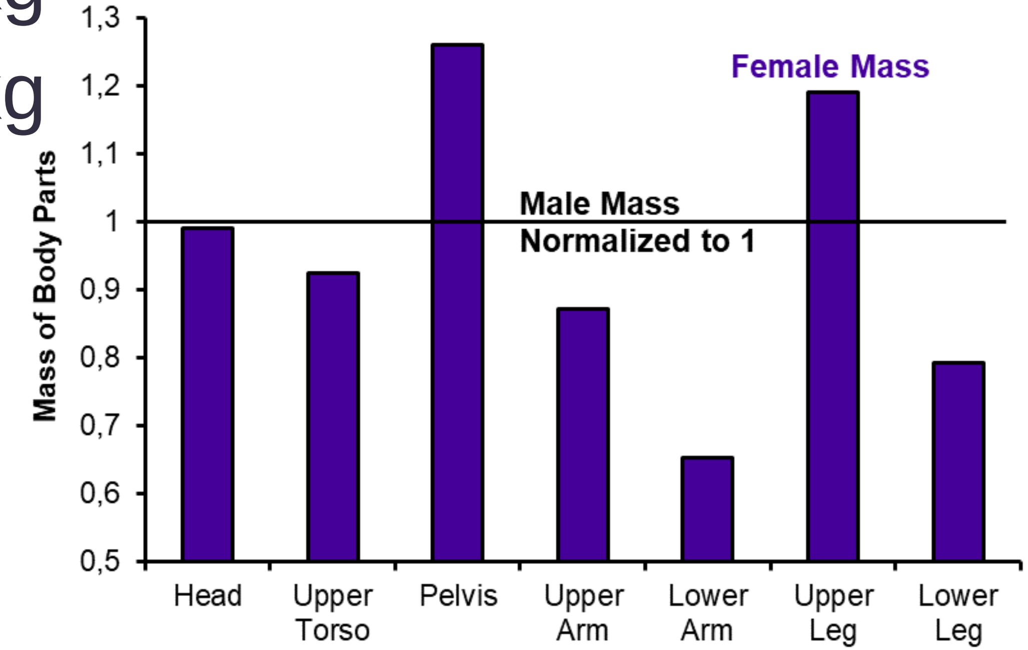
  Average female: 162 cm / 62 kg

  Average male: 175 cm / 77 kg

  (Schneider et al. 1983)

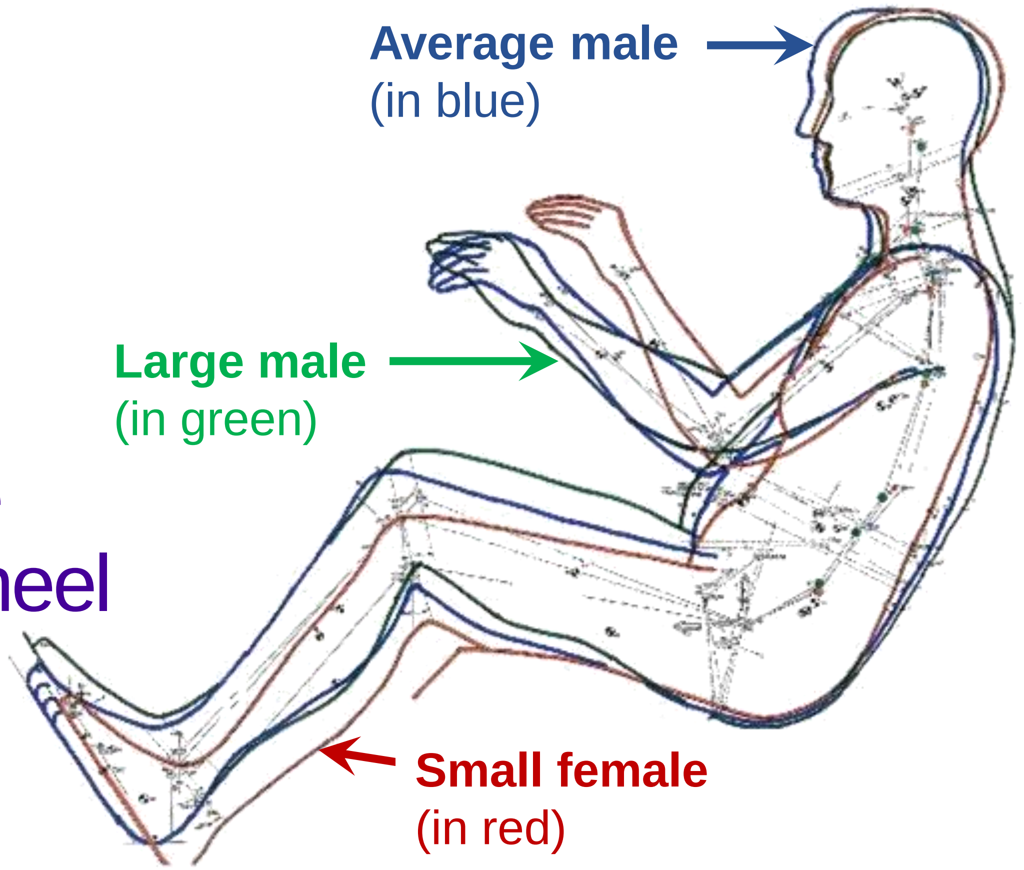
- Mass distribution

  (Young et al. 1983; McConville et al. 1980)



Different size

- Different seated posture
- Females tend to have:
  - Different arm position
  - Shorter head restraint distance
  - Shorter distance to steering wheel
  - Different leg position
  - More upright seated posture
  - Shorter distance to floor pan



Picture based on UMTRI data

3 RESULTS

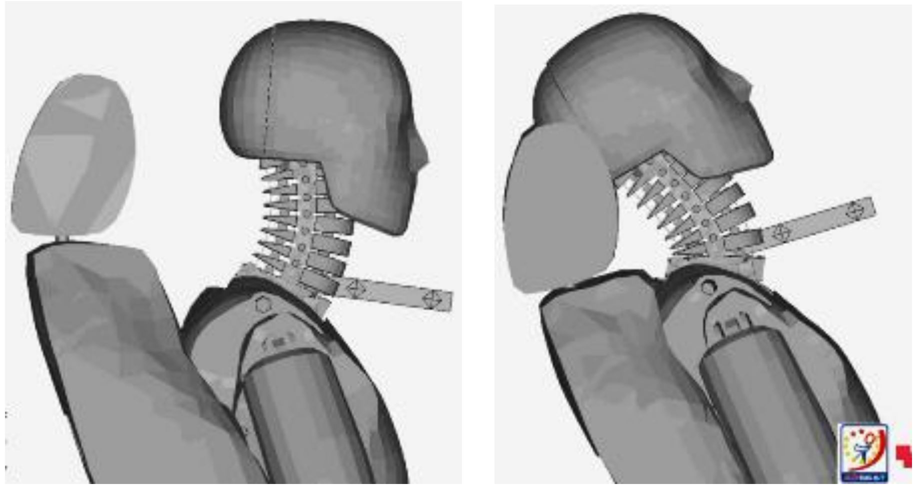
Different geometry

Example:

- Focus on the HR being positioned too low (“males”),
- No focus on the HR being positioned too high (“females”)

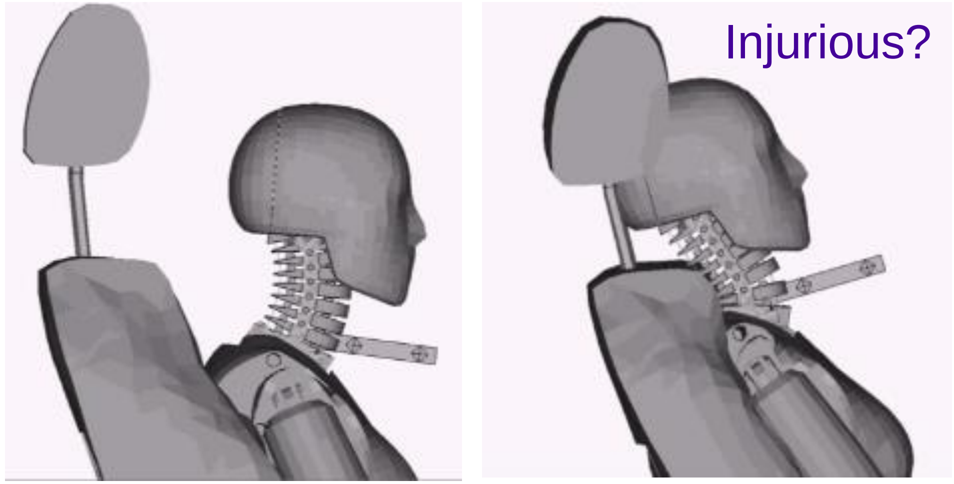
Head restraint in low position

Average male



Head restraint in high position

Average female



Pictures from www.adseat.eu

2 RESULTS

Are we different?

- Size
- Mass distributions
- Age dependence
- Hormones
- Pregnancy
- Anatomy
- Osteoporosis

Existing Crash Test Dummy Sizes

Small female
(5th percentile)

Stature: 1.51 m
Mass: 47 kg

Average female
(50th percentile)

Stature: 1.62 m
Mass: 62 kg

Average male
(50th percentil

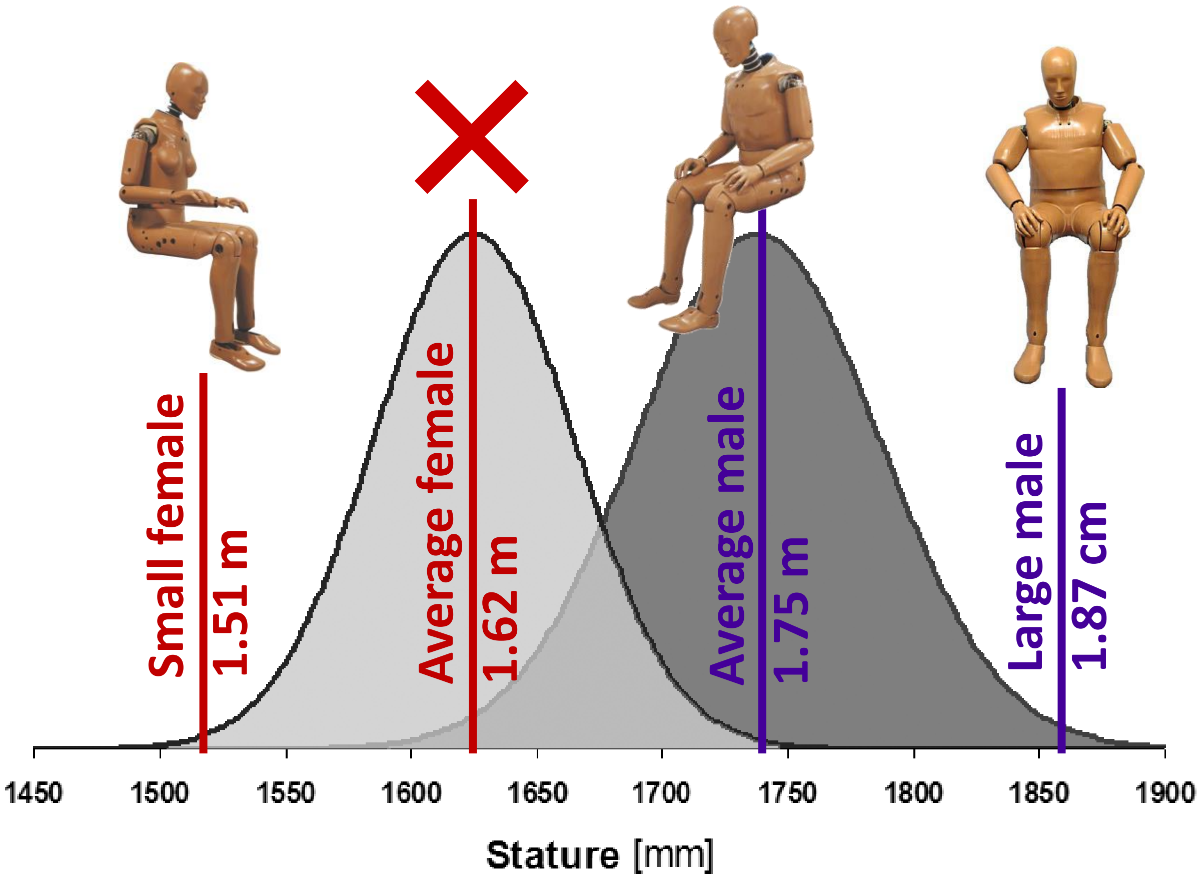
Stature: 1.75 m
Mass: 77 kg

Large male
(95th percentile)

Stature: 1.87 m
Mass: 102 kg

www.humaneticsatd.com/crash-test-dummies

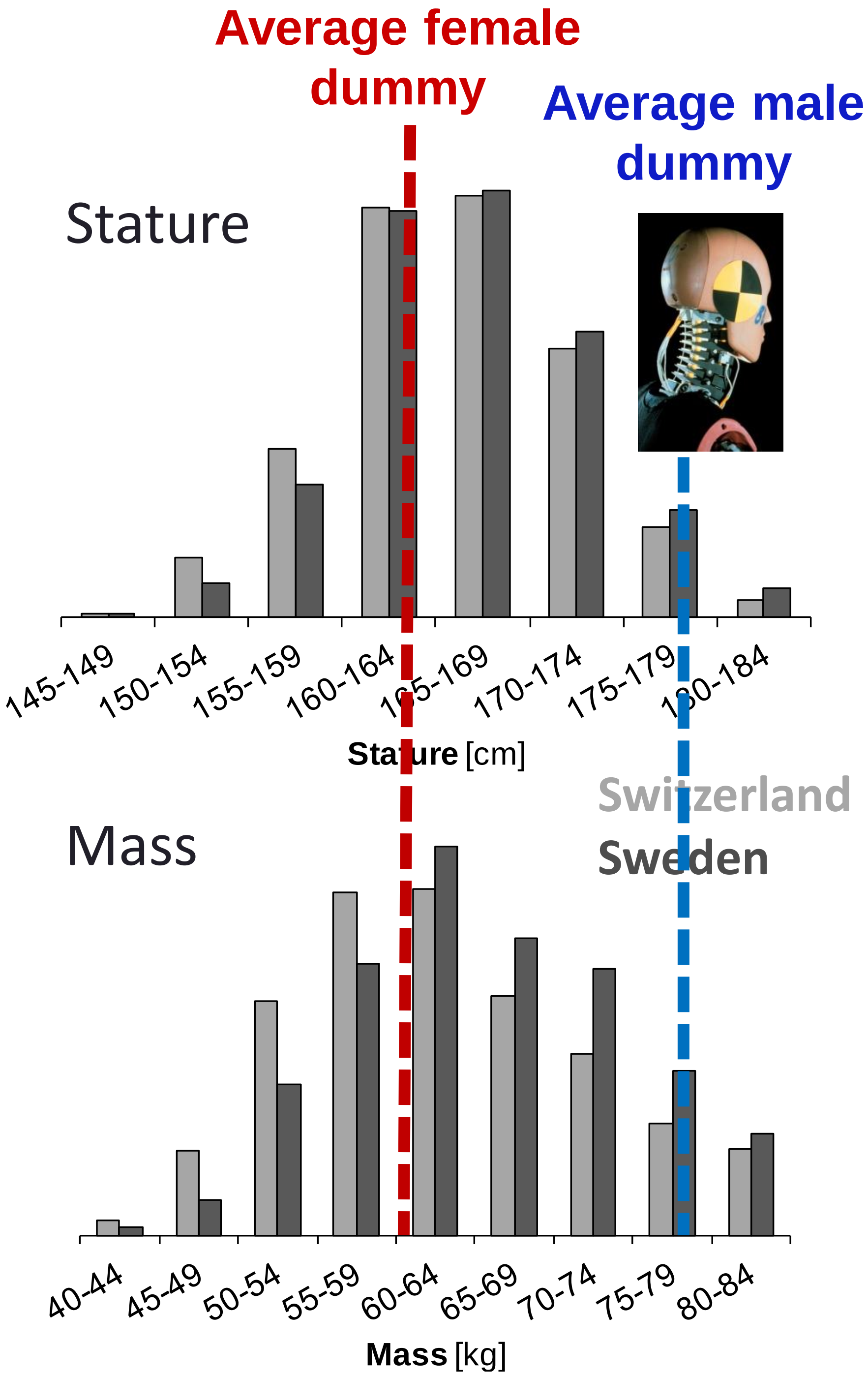
Distribution of statures



Based on
Pheasant & Haslegrave (2006)

Rear impacts

- Statures & masses
  of females with whiplash injuries
  in Switzerland & Sweden
- An average female dummy
  would correlate in size
  to the females most
  frequently injured



Available Crash Test Dummies

Impact Direction	Dummy Type	Dummy Size			
		Female		Male	
		Small	Average	Average	Large
Frontal	THOR	×		×	
	HIII	×		×	×
	HII			×	
Side	SID-IIs	×			
	ES-2			×	
	ES-2re			×	
	WorldSID	×		×	
Rear	BioRID-II			×	

www.humaneticsatd.com/crash-test-dummies

To conclude

- Crash related injury risks are higher in females
- Females poorly represented by existing dummies

Future needs

- Dummies of both men and women, of different sizes and ages, for robust vehicle safety assessment
- Information about body size (stature and mass) in traffic injury databases
- Injury data reported for females and males separately

Future possibilities

- Human body models of females and males may provide a powerful extension to the crash test dummies in future virtual test procedures

Thank you for your attention!

TEAPaN – Traffic Event Assessment, Prioritizing and Notification

Connects smart accident detection with optimal use of society's blue light resources

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Alternative title:

”From Via Appia pre-study 2014 to TEAPaN-1 2019”

or

”Rome wasn´t built on one day”

or

“Long Day's Journey into Night”

2014

Many deaths from motor vehicle accidents can potentially be prevented if the 'right' actions are taken early in the care chain

Traffic Inj Prev. 2016 Oct 2;17(7):676-80. doi: 10.1080/15389588.2016.1149580. Epub 2016 Feb 18.

Potentially preventable prehospital deaths from motor vehicle collisions.

Ray JJ[1], Meizoso JP[1], Satahoo SS[1], Davis JS[1], Van Haren RM[1], Dermer H[1], Jill G[2], Bahouth GT[2], Blackbourne LH[3], Schulman CI[1].

Author information

Abstract

BACKGROUND: In 2011, about 30,000 people died in motor vehicle collisions (MVCs) in the United States. We sought to evaluate the causes of prehospital deaths related to MVCs and to assess whether these deaths were potentially preventable.

METHODS: Miami-Dade Medical Examiner records for 2011 were reviewed for all prehospital deaths of occupants of 4-wheeled motor vehicle collisions. Injuries were categorized by affected organ and anatomic location of the body. Cases were reviewed by a panel of 2 trauma surgeons to determine cause of death and whether the death was potentially preventable. Time to death and hospital arrival times were determined using the Fatality Analysis Reporting System (FARS) data from 2002 to 2012, which allowed comparison of our local data to national prevalence estimates.

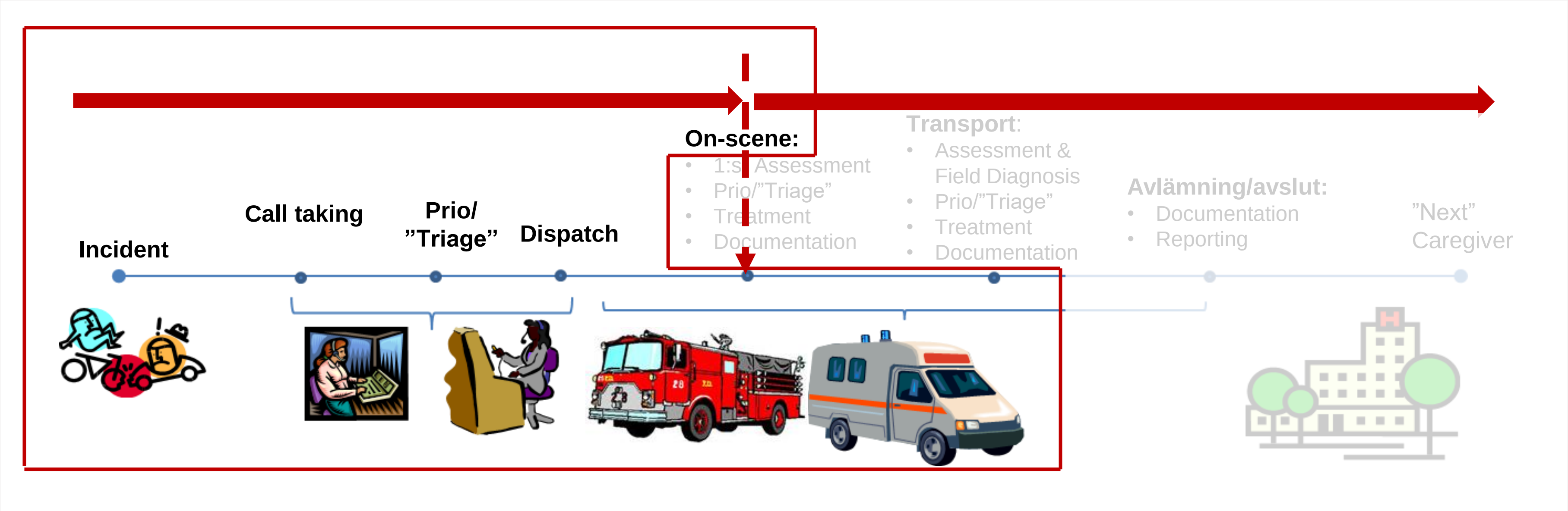
RESULTS: Local data revealed that 39% of the 98 deaths reviewed were potentially preventable (PPD). Significantly more patients with PPD had neurotrauma as a cause of death compared to those with a nonpreventable death (NPD) (44.7% vs. 25.0%, P =.049). NPDs were significantly more likely to have combined neurotrauma and hemorrhage as cause of death compared to PPDs (45.0% vs. 10.5%, P <.001). NPDs were significantly more likely to have injuries to the chest, pelvis, or spine. NPDs also had significantly more injuries to the following organ systems: lung, cardiac, and vascular chest (all P < .05). In the nationally representative FARS data from 2002 to 2012, 30% of deaths occurred on scene and another 32% occurred within 1 h of injury. When comparing the 2011 FARS data for Miami-Dade to the remainder of the United States in that year, percentage of deaths when reported on scene (25 vs. 23%, respectively) and within 1 h of injury (35 vs. 32%, respectively) were similar.

CONCLUSIONS: Nationally, FARS data demonstrated that two thirds of all MVC deaths occurred within 1 h of injury. Over a third of prehospital MVC deaths were potentially preventable in our local sample. By examining injury patterns in PPDs, targeted intervention may be initiated.

2/3 dies within 1h and 1/3 Preventable

=> Reduce delays and improve diagnosis accuracy

The prehospital care chain at a traffic accident
(and in many other situations)



What can we do to improve this phase?

2014
Bengt Arne Sjöqvist
&
Stefan Candefjord
gets an idea!

"eCall – that sounds good,
but no one has asked us if we want or can send an ambulance"
(leading ambulance representative)

EU eCall

Is it going to work like this?

Maybe?

Tranarpsbron 2013

Could this have been avoided?

Maybe?

Our concept addresses these questions!

What does this mean?

Completely new opportunities to improve road safety
and reduce death rates and injuries

Via Appia is a societal system/process innovation (. . . among other things!)

SAFER Post-crash/Crash & Rescue

Targeted Areas and project examples

Post-crash

1. *Identify incident*
2. *”Triage” & prioritize*
3. *Decide on rescue process*
4. *Notify others*

Incident detection and actions

Dispatching & Triage

eCalls for all Road Users


DISP/Triage


COPE


“Smarter” eCalls

Via Appia/TEAPaN

1. *Diagnosis & observations*
2. *Triage & prioritize*
3. *Decide on care process*

On-Scene

Clinical Decision Support & Triage

Detect Occult Injuries

Patient Extrication


OSISP, Triage & CDSS

Intracranial Bleedings

Thorax Injuries

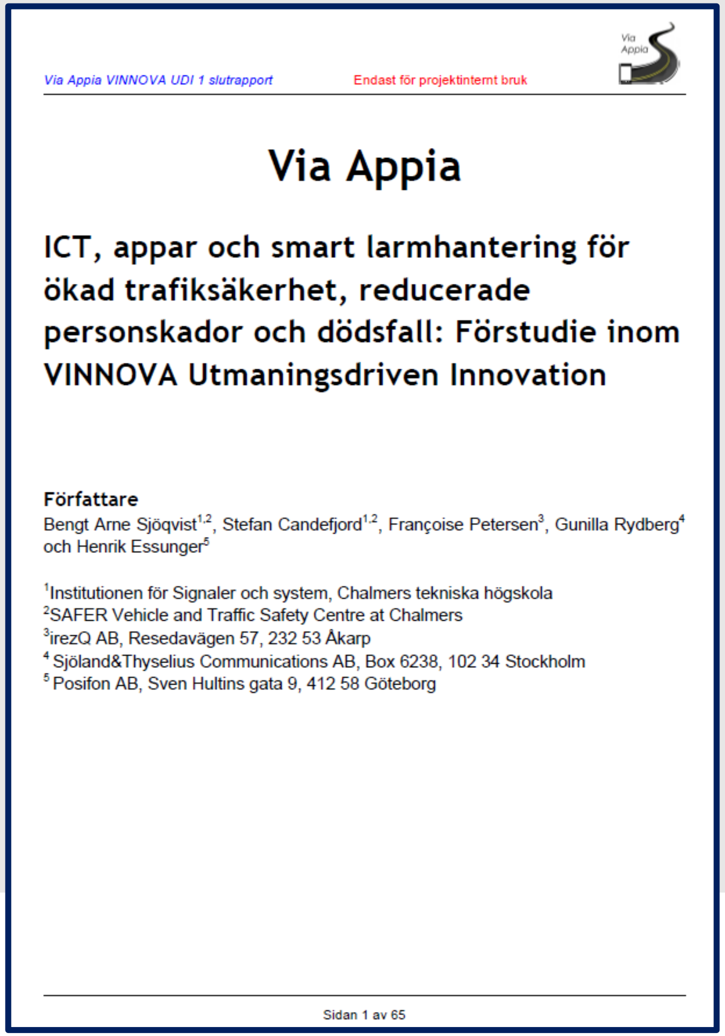

Micro-waves

2014 – 2015

Prestudy

Financing: Vinnova & partners

Result 1: Comprehensive Report



Via Appia VINNOVA UDI 1 slutrapport   Endast för projektinternt bruk

Via Appia

ICT, appar och smart larmhantering för ökad trafiksäkerhet, reducerade personskador och dödsfall: Förstudie inom VINNOVA Utmaningsdriven Innovation

Författare

Bengt Arne Sjöqvist[1,2], Stefan Candefjord[1,2], Françoise Petersen[3], Gunilla Rydberg[4] och Henrik Essunger[5]

[1]Institutionen för Signaler och system, Chalmers tekniska högskola
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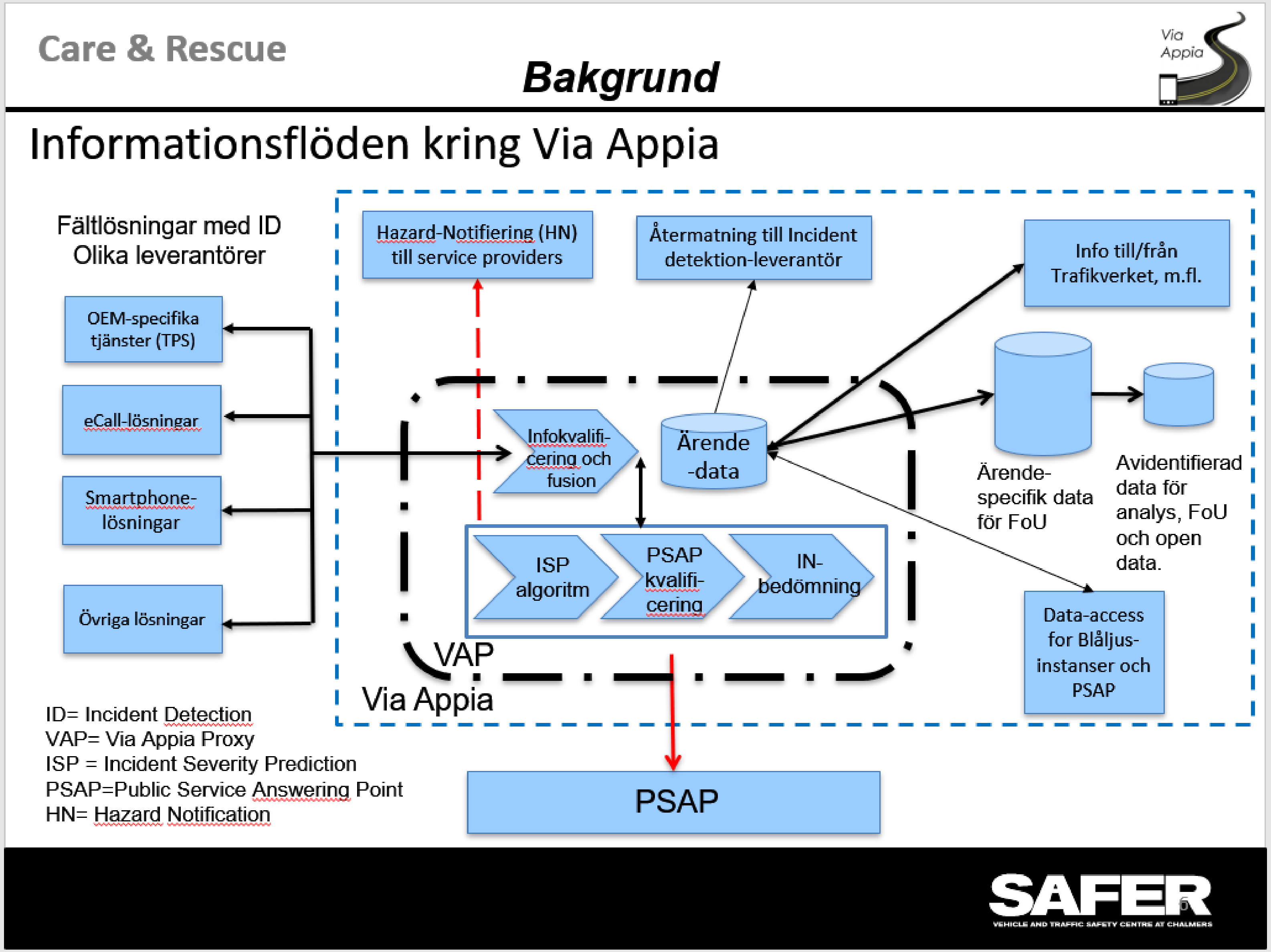
Sidan 1 av 65

2014 – 2015

Prestudy

Financing: Vinnova & partners

Result 2: Proposed system design



2015 – 2016

- 2 attempts to get financing
- 20/18 parties signed up
- No success - rejected!

Project budget:
Approx. 20MSEK
Vinnova:
10MSEK

Care & Rescue

Via Appia

VINNOVA Stärker Sveriges innovationskraft för hållbar tillväxt och samhällsnytta

Utmaningsdriven innovation - finansiering

Steg 2: Samverkansprojekt

Verksamhetssida Uppdaterad: 28 april 2015

Utveckling och integration

Detta steg är öppet endast för de som fått finansiering i det Steg 1: Initiering. Därför finns inte utlysningarna inom det andra steget med bland våra öppna utlysningar. De som kan söka får istället information direkt från oss.

I det andra steget är huvudfokus på utveckling och integration, det vill säga utveckling av de lösningar som identifierats som saknade eller inte tillräckligt välutvecklade under initieringsprojektet. Detta innefattar även att integrera lösningarna till en helhetslösning som bidrar till att möta samhällsutmaningar.

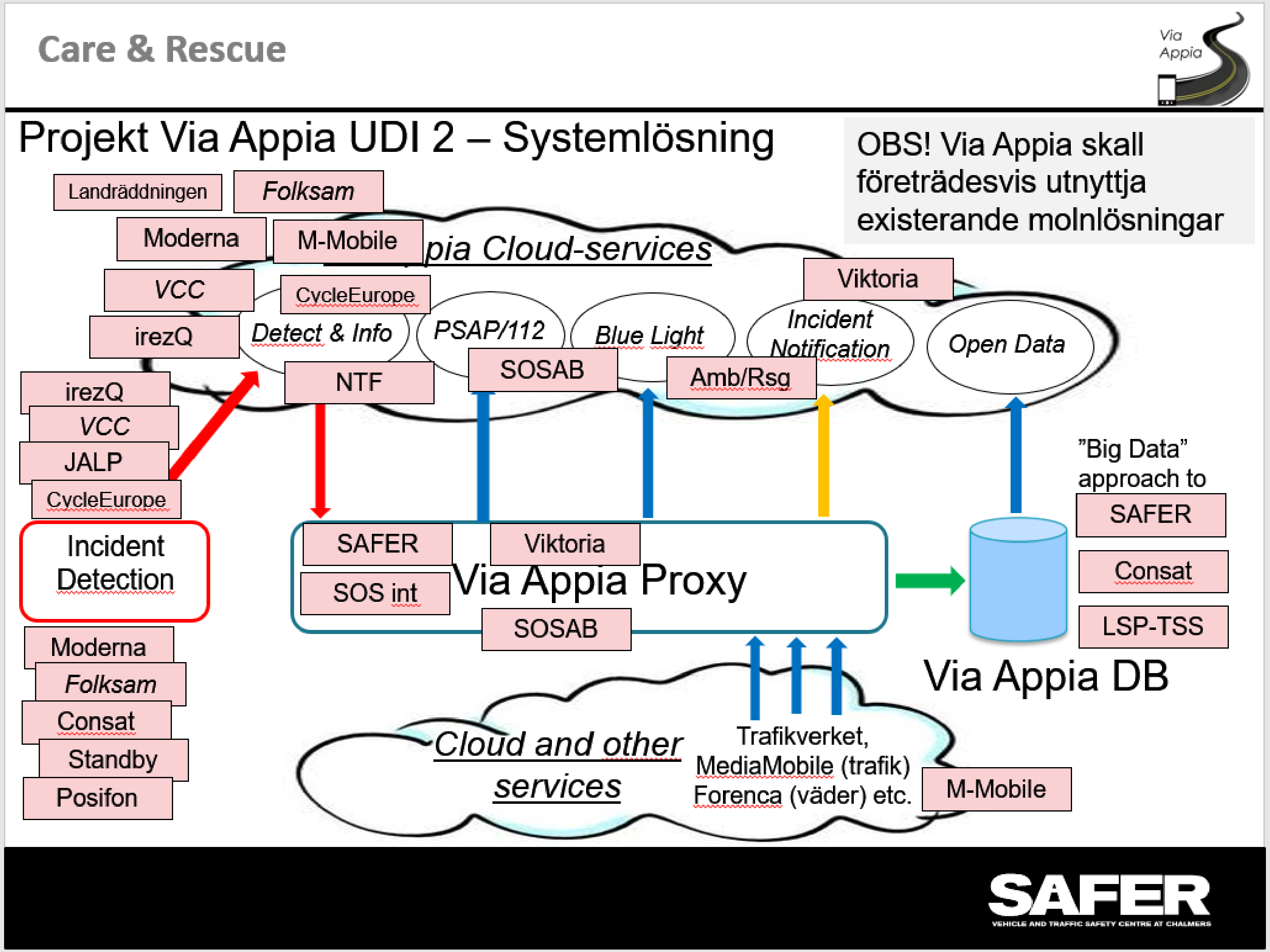
Det är kritiskt att relevanta aktörer involverats i arbetet, inklusive slutanvändare och kravställare. Projektet behöver även arbeta med kommunikationsplaner i syfte att förbereda lösningens tillämpning och nyttiggörande, och säkerställa att resultaten kan spridas inom såväl som utanför konstellationen.

SAFER VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

2015 – 2016

- 2 attempts to get financing
- 18/20 parties signed up
- No success!

Project budget:
Approx. 20MSEK
Vinnova:
10MSEK

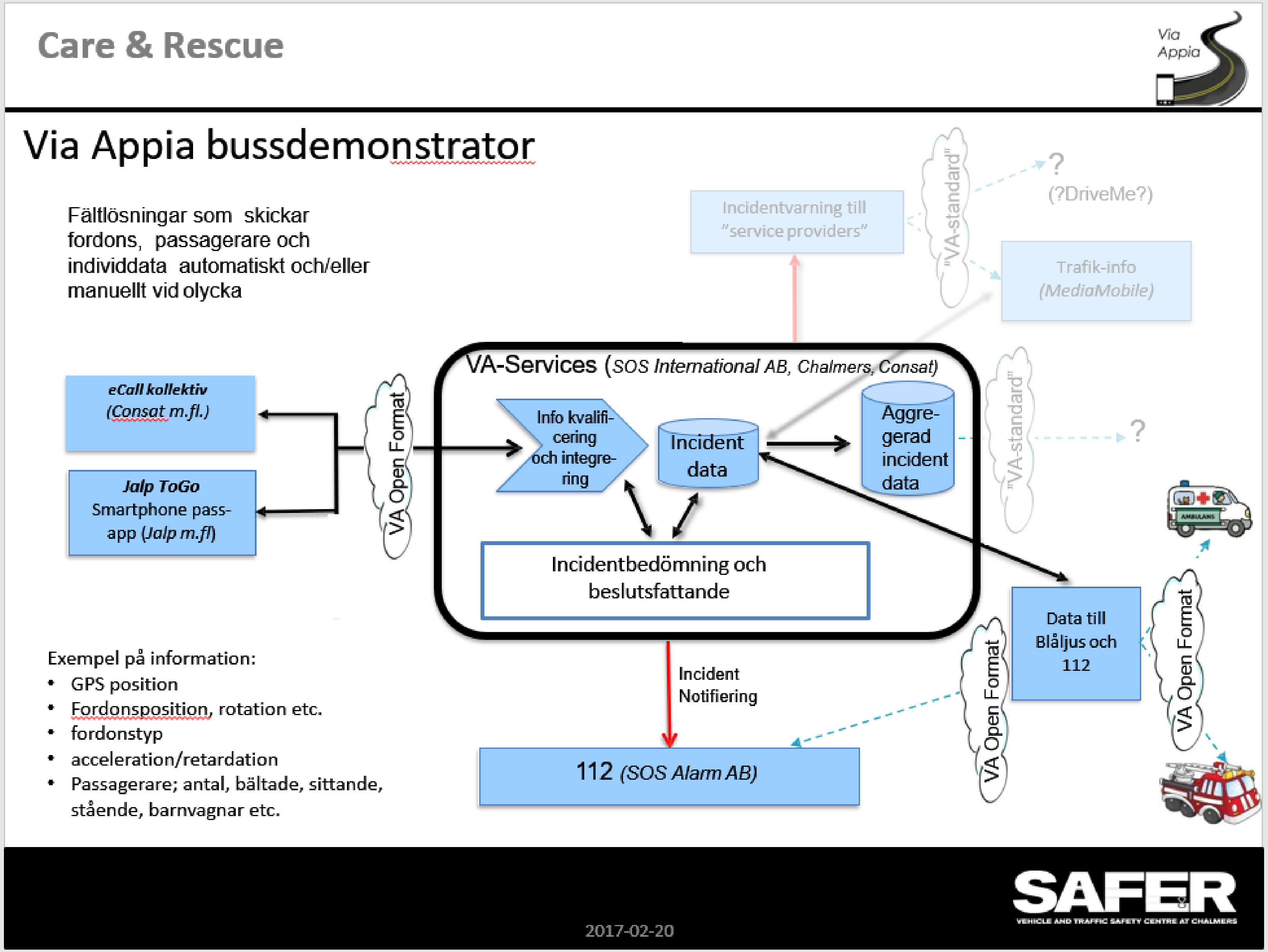


2017

A scaled down project

Focus:

Busses and coaches



2017

A scaled down project

Focus:

Busses and coaches

… and Lindholmen centered!

No success!!!

Care & Rescue

Via Appia

En tänkbar konstellation

Grunden är intressenter runt Lindholmen Science Park:

- SAFER/Chalmers
- LSPAB; (PICTA ,TUCAP, Drive Sweden, VICTA, TSS)
- RISE/Victoria
- Consat

Kompletterat med några andra ”gamla” Via Appia intressenter som signalerat ”positivism”:

- SOS International
- SOS AlarmAB
- Mediamobile
- Jalp Systems
- Ambulans
- Räddningstjänst

Tänkbara andra intressenter:

- Keolis
- Västtrafik
- Bergkvarabuss
- Viscando
- ?

Tekniken finns men skall anpassas, knytas ihop och sättas i sitt totala sammanhang!

SAFER VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

2017-02-20

2018/2019

A new initiative together with Volvo Cars

Via Appia

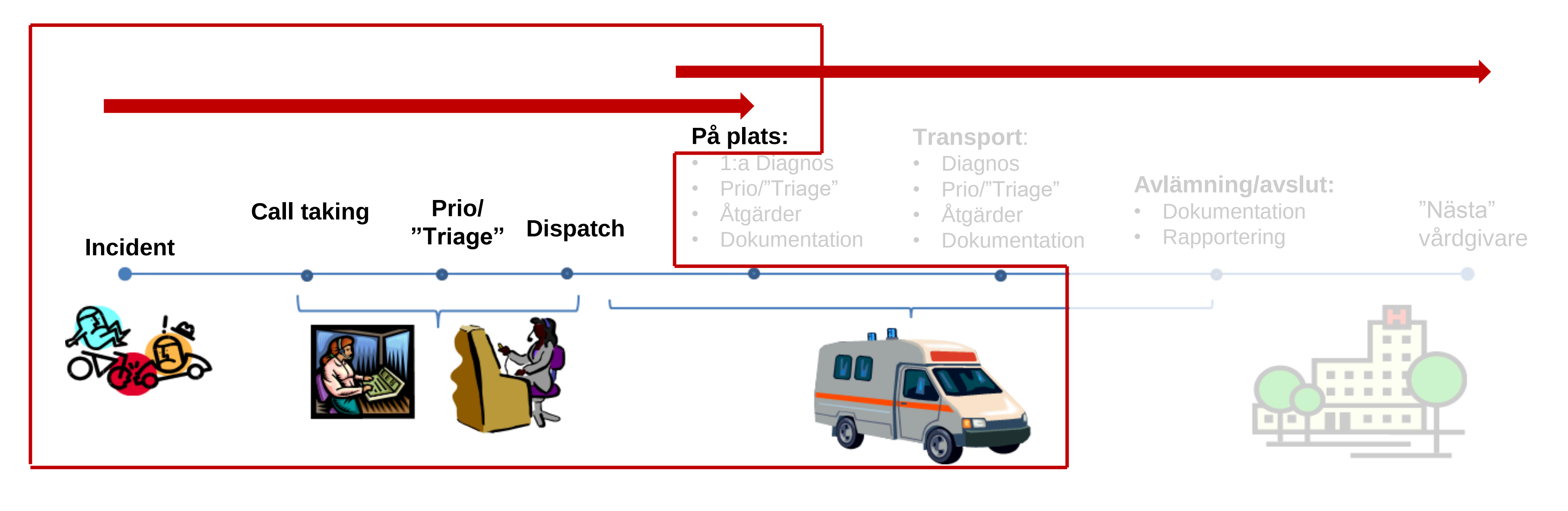
=>

TEAPaN

– Traffic Event Assessment, Prioritizing and Notification

TEAPaN – **T**raffic **E**vent **A**ssessment, **P**rioritizing **a**nd **N**otification

Rescue operation and the prehospital care chain



TEAPaN Focus!

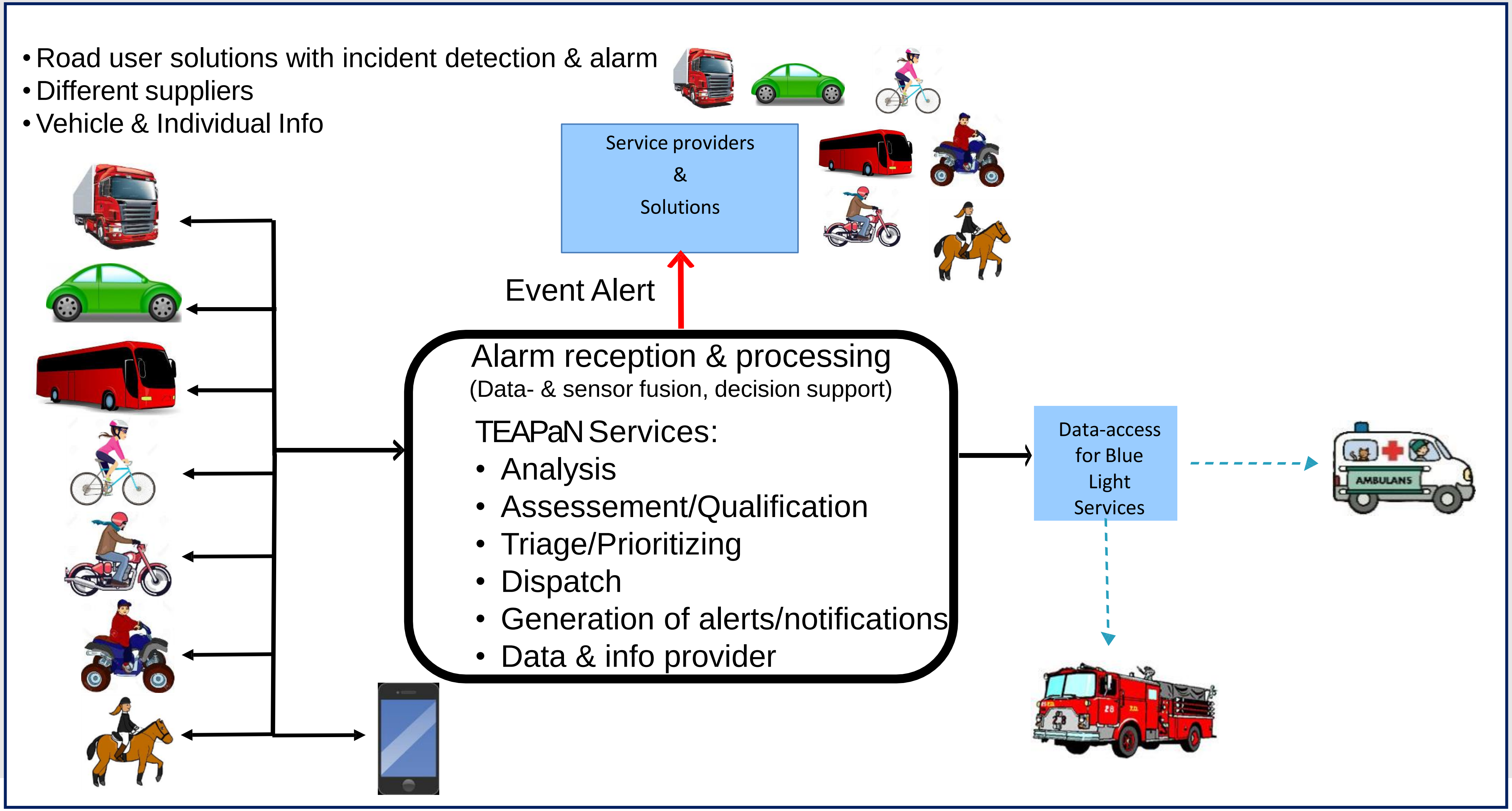
How can we improve the situation of those 'affected' in a road accident already at this stage?

Our goal: An optimized rescue operation with correct priorities and recources!

We can't send "what is available" at every incident immediately – other things may have a higher priority

TEAPaN – **T**raffic **E**vent **A**ssessment, **P**rioritizing **a**nd **N**otification

Information flow and services in TEAPaN



TEAPaN – **T**raffic **E**vent **A**ssessment, **P**rioritizing **a**nd **N**otification

2019 - Application to Vinnova/FFI for the project TEAPaN – 1

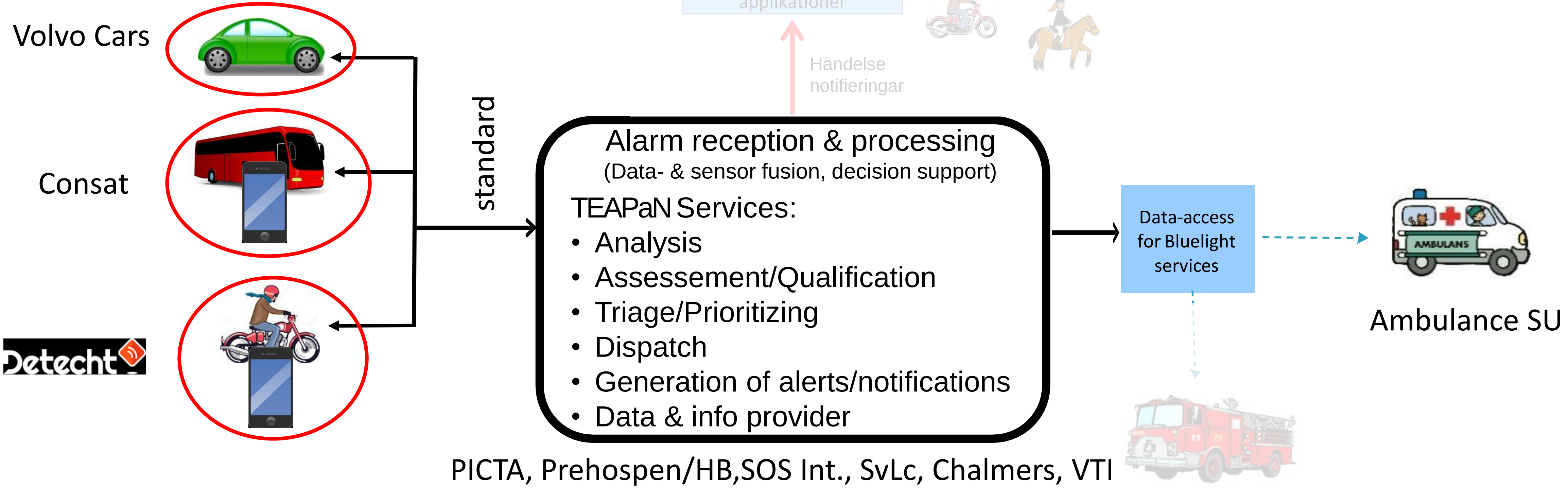
1. *TEAPaN-1* focuses on the healthcare chain and how it can be improved in terms of e.g. response times, choice of resources and precision in crucial decisions.
2. Vehicle solutions, services, incident assessment of alarm handlers, and interaction with ambulance are designed and demonstrated in simulated and practical applications.
3. Furthermore, proposals are made for business arrangements and routes to broad use.

Application approved!
Project time: 2019-12-01 to 2021-12-31
Budget: ≈ 10.7 MSEK
Vinnova/FFI: ≈ 5.3 MSEK

TEAPaN – Traffic Event Assessment, Prioritizing and Notification

TEAPaN – 1

- Road user solutions with incident detection & alarm
- Different suppliers
- Vehicle & individual info combined
- Standardized and open interfaces



TEAPaN – **T**raffic **E**vent **A**ssessment, **P**rioritizing **and** **N**otification

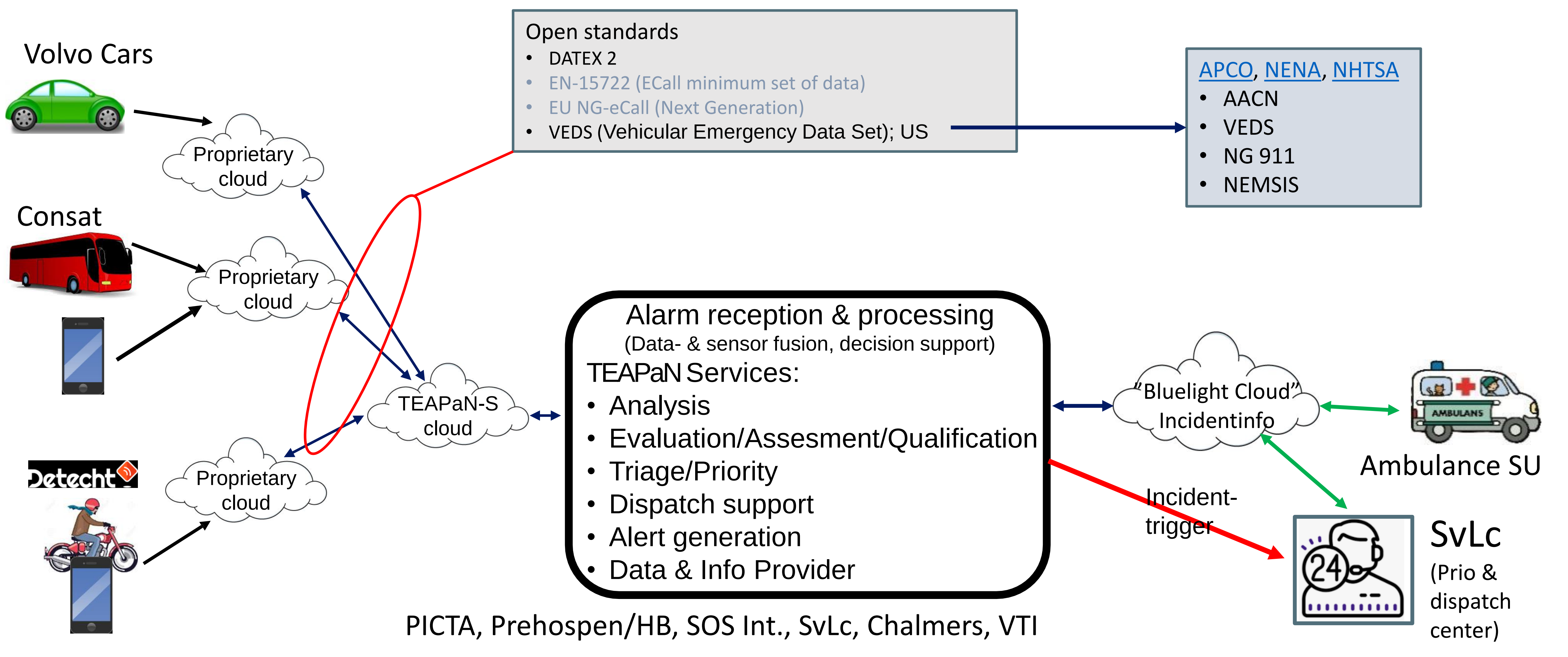
TEAPaN – 1; Project design and status today

TEAPaN-1 2019

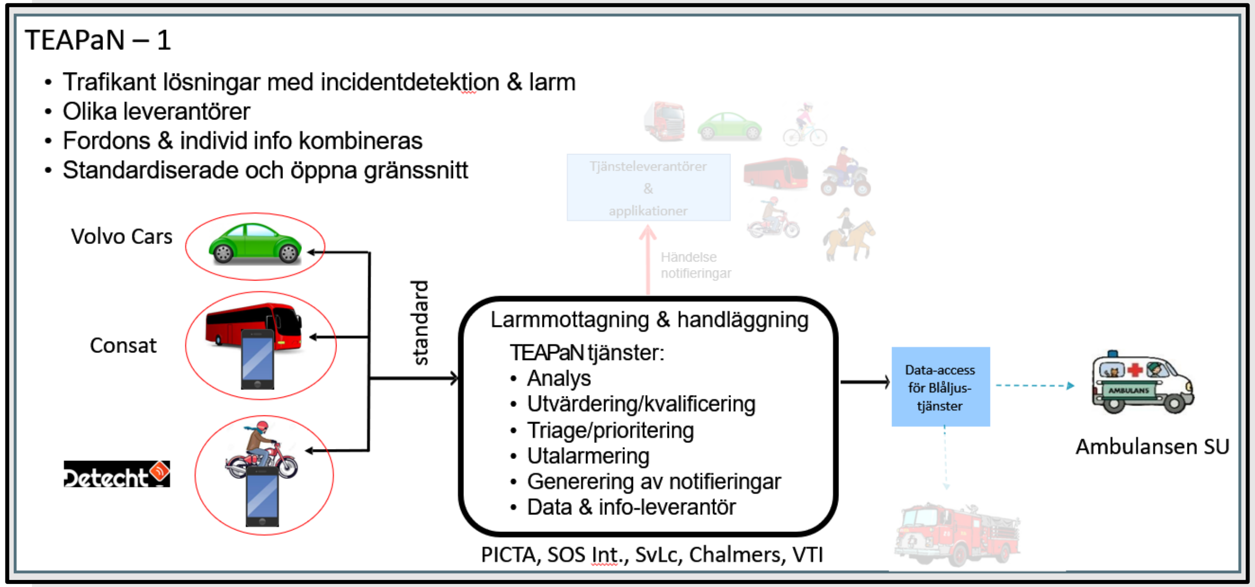
	2019				2020				2021				2022			
Aktivitetet	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
AP1 Orkestrering				2019-12-01												
AP2 Design Fordon																
AP3 Design TEAPaN-S																
AP4 System & Demo teknikutv																
AP5 Simuleringar & Demonstrator																
AP6 Affärsmodell & Samverkan																
AP7 Legalt & integritet																
AP8 Dissemination																

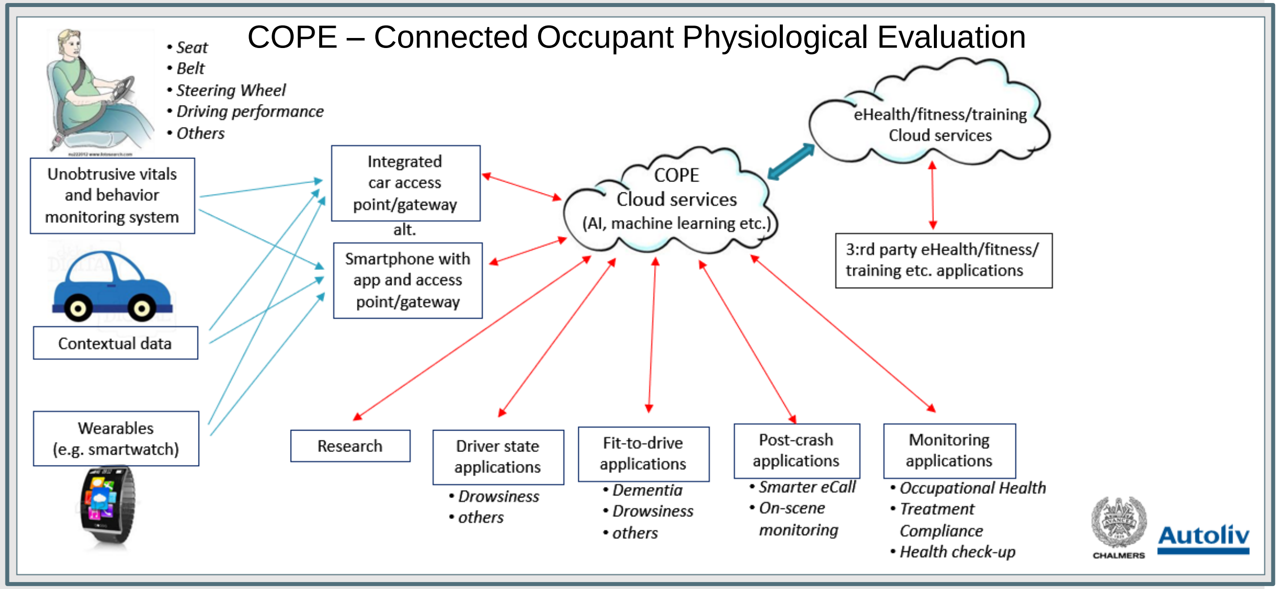
TEAPaN – **T**raffic **E**vent **A**ssessment, **P**rioritizing **a**nd **N**otification

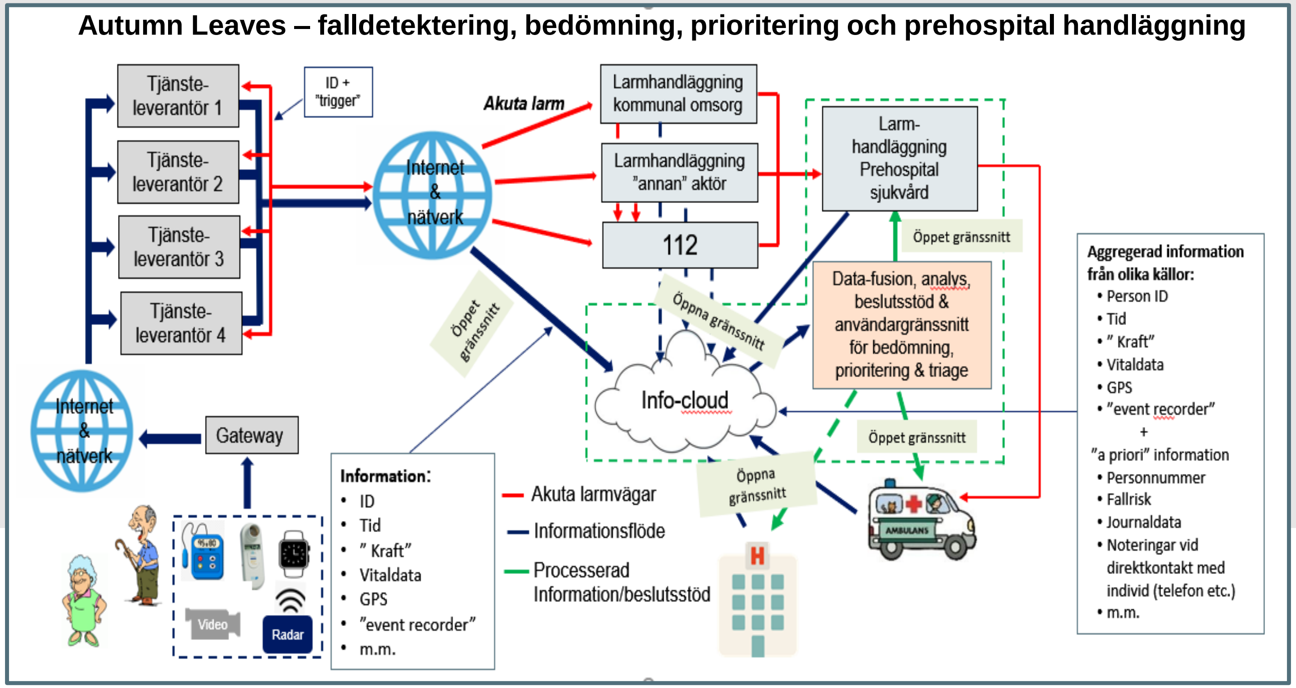
TEAPaN – 1; System overview

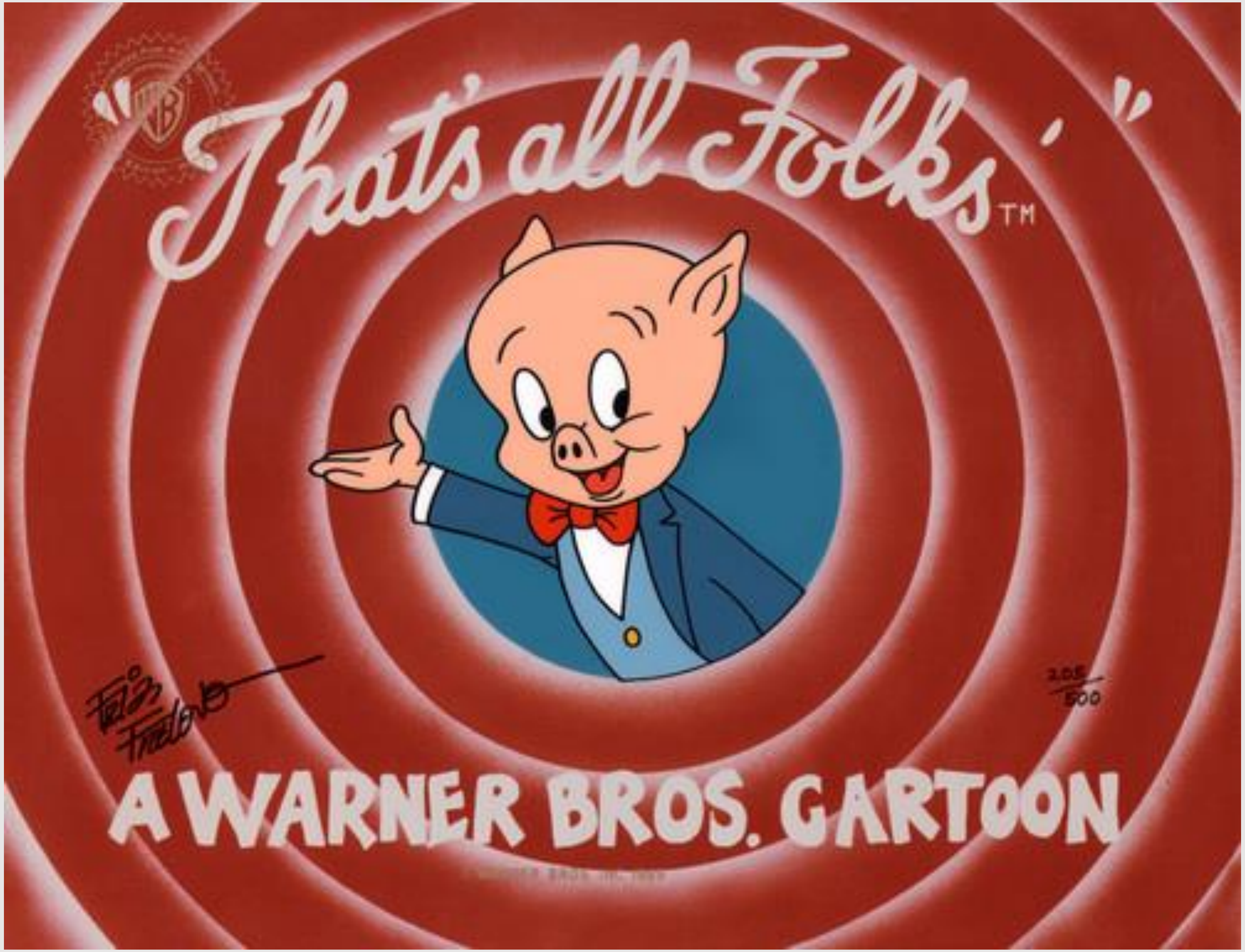


In our cluster - Prehospital R&D in a wider perspecive









"That's all Folks!"
TM
A WARNER BROS. CARTOON
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