on-going projects
(orderd with rising start date)
Balancing Active and Passive Safety

Research Motivating Problem:
• New active safety measures will avoid many accidents, but they will not eliminate the risks.
• The need for passive safety may increase instead of decrease due to less energy consumptive, and therefore lighter and smaller vehicles

Research Question:
• What is the most effective and affordable combination of active and passive safety systems for specific vehicles in certain environments?

Deliverable:
• A methodology that describes a process to mathematically combine active and passive safety effectiveness models and their consolidation for optimization strategies
• 1 (VehDyn?) PhD graduated

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>Autoliv, Volvo Cars, SEMCON, Chalmers, VTI</td>
</tr>
<tr>
<td>Funder:</td>
<td>Vinnova, FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Claes Tingwall, Anders Kullgren, Bengt Jacobson, Ola Boström, Erik Rosén</td>
</tr>
</tbody>
</table>
High Speed Control of Long Combination Heavy Commercial Vehicles within Safe Corridors

Research Motivating Problem:
• Energy-efficient combination vehicles longer than 18m/25m are difficult to maneuver and not allowed today in EU/Sweden.

Envisioned product/solution, 2025:
• Autonomous driving function for Maintain lane and Change lane on multiple-lane roads and Maintain lane on single roads. (Incl. Abort, Emergency stop, Small obstacle avoidance, ...)
• Longitudinal and lateral vehicle motion control. 0 to 90 km/h.

Research question(s):
• How can “Traffic Prediction Simulations, with evolution of driver model parameters for varying severity in traffic situations” be used as concept for these functions?
• What phenomena is required to be modelled in driver, vehicle and surroundings (road&traffic) for these predictions?

Deliverables:
• Function, conceptual but executable, verified & demonstrated
• 1 VehDyn PhD graduated (“Automated long-haul of heavy long combination-vehicles”)

<table>
<thead>
<tr>
<th>Time</th>
<th>2012.04-2017.04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners</td>
<td>AB Volvo, Volvo Group Trucks Technology, Chalmers.Vehicle Dynamics</td>
</tr>
<tr>
<td>Funder:</td>
<td>FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Bengt Jacobson, Leo Laine, Mattias Wahde, Paolo Falcone</td>
</tr>
<tr>
<td>Links:</td>
<td><a href="https://research.chalmers.se/project/?id=464">Link 1</a> <a href="http://www.vinnova.se/sv/Resultat/Projekt/Effekta/Sakta-korridorer-hoghastighetsreglering-av-larga-fordonskombinationer/">Link 2</a></td>
</tr>
</tbody>
</table>
Improved Stability and Manoeuvrability using Electric Propulsion

Research Motivating Problem:
How can the advantages offered by electrified drivetrains over traditional engines in terms of control precision, accuracy, response time, etc., be exploited for improved (active) safety?

Envisioned product/solution:
• New and enhanced safety functions

Research question(s):
• Are there scenarios where an electrified drivetrain is beneficial for safety?
• How much is the benefit? Under what conditions?

Deliverable(s):
• Quantified safety benefit of electric propulsion in various accident scenarios.
• 1 VehDyn PhD graduated

<table>
<thead>
<tr>
<th>Time</th>
<th>2012-06 -- 2017-06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>e-AAM, Leannova, Chalmers, Autoliv</td>
</tr>
<tr>
<td>Funder:</td>
<td>FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Mathias Lidberg, Gunnar Olsson, Torbjörn Norlander, Ola Boström</td>
</tr>
</tbody>
</table>
Active Steering Force Feedback for Commercial Heavy Vehicles

Research Motivating Problem:
To meet the traffic safety goals for 2020 with safe commercial heavy vehicles, future active steering systems introduced in such vehicles must provide an intuitive and informative steering force feedback to the driver about the vehicle combination’s stability envelope, blended with safe driving in traffic by guidance in lane, obstacle avoidance, and during automated emergency braking.

Envisioned product/solution:
• Steering and braking coordination for avoidance of collision with oncoming traffic, by using common vehicle reference model

Research question(s):
Hypothesis: informative but not limiting constraints are preferred for steering force feedback for commercial heavy vehicles.

Deliverable(s):
• Verification and demonstration of the Novel functionality
• Competence captured in publications, inventions/patents and theses and in one person
• 1 VehDyn PhD graduated

<table>
<thead>
<tr>
<th>Time</th>
<th>2012.09 – 2017.12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>Volvo Group Trucks Technology, Sentient Sweden, Chalmers</td>
</tr>
<tr>
<td>Funder:</td>
<td>FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Bengt Jacobson, Jochen Pohl, Leo Laine</td>
</tr>
</tbody>
</table>

Trajectory for automated emergency braking from 90km/h to standstill
Execute automated emergency independent of disturbance e.g. split mu
TyreOpt

Research Motivating Problem:
There is no organized method to select (design?) tyres for truck combinations. The problem requires multi-objective-optimization.

Research question(s):
• How does cost function and constraints look?
• How can this be optimized?

Deliverable(s):
• Expert knowledge based inter- and extrapolation of tyre measurements
• Optimization method/results
• 1 Mathematics PhD graduated with VehDyn knowledge

Time: 2012.08 - <year.month>


Funder: FFI.Energi&Miljö

Advisor: Ann-Brith Strömberg, Michael Patriksson, Bengt Jacobson
Integrated Propulsion, Braking and Steering

Research Motivating Problem:
Long truck combinations are good for transport efficiency, but lead to problems in manoeuvrability, braking and traction.

Envisioned product/solution, 2025:
- Actuator configurations and functions which improves performance of long truck combinations through co-ordinated control of Propulsion, Braking and Steering.

Research question(s):
- How is the cost function look for transport economy?
- What are the limiting driving situations?
- Which actuator configurations are optimal?
- How should these actuators be controlled?

Deliverable(s):
- Topologies [so far: A-double, 2 axle/1 channel steering on dolly, Sensing TBD]
- Controls [FF+StateFeedback $H_\infty$ Ctrl of Dolly Ste, HiSpd]
- 1 Mechatronic PhD graduated with VehDyn knowledge

<table>
<thead>
<tr>
<th>Time</th>
<th>2012.08 - &lt;year.month&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funder:</td>
<td>FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Jonas Fredriksson, Bengt Jacobson</td>
</tr>
</tbody>
</table>
Torque Sensing for Vehicle State Estimation - TorqSens

Research Motivating Problem:
Today’s functions are limited by quality of estimates of vehicle states. The scope of this project is to improve vehicle dynamics by utilizing electric propulsion actuators as sensing elements for estimating vital vehicle states. The project aims at investigating the new sensor possibilities for estimates of vehicle states (e.g. tire properties, tire to road friction, vehicle speed etc.). Feasibility of estimator induced excitation will also be studied.

Envisioned product/solution:
• Novel estimator algorithms

Research questions:
• How should the vehicle state estimator be designed?
• How can the quality of the estimated variables be formulated?
• What vehicle functionality can be achieved and/or improved by improved vehicle states?
• How to excite without disturbing driver (safety, drivability etc.) to achieve best conditions for the estimator

Deliverables to which results will contribute:
• The overall deliverable from the project will be a proposal for how to improve functionalities through improved vehicle state estimation in vehicles which are fully or partly propelled with electrical motors.
• 1 VehDyn PhD graduated

<table>
<thead>
<tr>
<th>Time</th>
<th>2013.01 – 2015.12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partners:</td>
<td>VCC, Borg Warner, Chalmers (VEAS &amp; Mechatronics)</td>
</tr>
<tr>
<td>Funder:</td>
<td>FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Bengt Jacobson, Fredrik Bruzelius, Jonas Fredriksson (s2), Mats Jonasson (VCC)</td>
</tr>
</tbody>
</table>
Research Motivating Problem:
Vehicle winter testing is needed for various purposes (OEM development tests, driver behavior studies, etc.) but associated with difficulties like low repeatability and reproducibility, danger and high cost. Driving simulators are great tools and can potentially be used as a substitute for real life testing if the virtual environment fidelity is high.

Envisioned product/solution:
• Motion feedback strategies for winter driving,
• Enhanced vehicle and tire-to-winter road surface interaction models

Research questions and output
• How should the surface/tire be modelled w.r.t local properties like roughness, grip vibrations to reproduce real life phenomena
• How should the motion platform of the driving simulator be tuned to reproduce a motion sensation that is perceived with high realism
• 1 VehDyn Licentiate of Engineering graduated

<table>
<thead>
<tr>
<th>Time</th>
<th>2014.01 -- 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partners:</td>
<td>VTI, Volvo Cars, Volvo GTT, Chalmers</td>
</tr>
<tr>
<td>Funder:</td>
<td>ViP, VTI, TSS</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Fredrik Bruzelius, Bengt Jacobson</td>
</tr>
</tbody>
</table>
OCEAN, Operating Cycle Energy mANagement

Research Motivating Problem:
Real vehicle usage rarely corresponds to what was anticipated in development and sales stages. Hence, vehicles are not optimal for their actual use.

Envisioned product/solution:
Improved design of longitudinal actuation subsystems (e.g. propulsion and brake) and corresponding vehicle level functionality.

Research question:
• How to describe real vehicle usage, suitable for Design and Sales-to-order processes?
• How to collect and process logged data to such format?

Deliverables:
• Novel mathematical format for operating cycles
• Above exemplified for at least one heavy hybrid vehicle
• 1 VehDyn PhD graduated

<table>
<thead>
<tr>
<th>Time</th>
<th>2014-01.. 2017-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers</td>
<td>Volvo GTT, Volvo Cars, SP, Chalmers</td>
</tr>
<tr>
<td>Funder:</td>
<td>FFI</td>
</tr>
<tr>
<td>Advisors:</td>
<td>Bengt Jacobson, Sixten Berglund, Björn Lindenberg / Jan Andersson</td>
</tr>
</tbody>
</table>

Current vehicles on road

Operating cycle components

data logging

data processing

Use-case compositor

Generally available infrastructure and environmental data

Customer

development

sales-to-order

Transport Mission / Use-case

Operating cycle
Performance Based Standards for High Capacity Transport in Sweden -- PBS

Research Motivating Problem:
- There is no legislation allowing long vehicle combinations, EMS+

Envisioned product/solution:
- New vehicle combinations allowed

Research question(s):
- What performance based requirements should apply?
- Which combinations fulfill these?
- (Vehicle Motion Control/Arb&Coord)

Deliverable(s):
- Proposal of PBS for Sweden
- Proposal of some transport efficient
- 1 VehDyn PostDoc done

<table>
<thead>
<tr>
<th>Type</th>
<th>Assigned name</th>
<th>Combination Scheme</th>
<th>Length/GCM [meters] [ton]</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Vehicle Combination</td>
<td>VCMC2</td>
<td><img src="#" alt="VCMC2" /></td>
<td>16.5/40</td>
</tr>
<tr>
<td></td>
<td>VCMC3</td>
<td><img src="#" alt="VCMC3" /></td>
<td>18.75/40</td>
</tr>
<tr>
<td></td>
<td>VCMC4</td>
<td><img src="#" alt="VCMC4" /></td>
<td>18.75/40</td>
</tr>
<tr>
<td>Modular vehicle combinations</td>
<td>VCMC5</td>
<td><img src="#" alt="VCMC5" /></td>
<td>25.25/60</td>
</tr>
<tr>
<td></td>
<td>VCMC7</td>
<td><img src="#" alt="VCMC7" /></td>
<td>25.25/60</td>
</tr>
<tr>
<td></td>
<td>VCMC9</td>
<td><img src="#" alt="VCMC9" /></td>
<td>25.25/60</td>
</tr>
<tr>
<td>Prospective Modular Vehicle Combinations</td>
<td>VCMC10</td>
<td><img src="#" alt="VCMC10" /></td>
<td>31.5/80</td>
</tr>
<tr>
<td></td>
<td>VCMC11</td>
<td><img src="#" alt="VCMC11" /></td>
<td>27.3/66</td>
</tr>
<tr>
<td></td>
<td>VCMC13</td>
<td><img src="#" alt="VCMC13" /></td>
<td>30.9/80</td>
</tr>
<tr>
<td></td>
<td>VCMC15</td>
<td><img src="#" alt="VCMC15" /></td>
<td>33.8/90</td>
</tr>
</tbody>
</table>

Time: 2013-12 – 2016.12

Customers / partners: Trafikverket, Transportstyrelsen, Volvo GTT, Scania, Parator, VTI, Chalmers

Funder: FFI & (Transport Area of Advance @ Chalmers)

Advisor: Bengt Jacobson, Leo Laine

CHALMERS
Vehicle Dynamics group
Active Dolly Build-Up

Research Motivating Problem:
• Chalmers have no full-scale experiment platform for long truck combinations with distributed actuation

Envisioned product/solution:
• Actuated dolly as an enabler for long HTCs

Research question(s):
• How should actuator integration look for such experiment platform?
• Sizing, packaging, signal interface, etc

Deliverable(s):
• One active dolly experiment platform & Demonstration
• 1 VehDyn PostDoc
• (Synergies with build-up of Chalmers’ Research Vehicle Resource)

<table>
<thead>
<tr>
<th>Time</th>
<th>2013-12 – 2016.12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>Volvo GTT, Parator, Chalmers.VehDyn</td>
</tr>
<tr>
<td>Funder:</td>
<td>Volvo GTT, Parator, SAFER &amp; Chalmers</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Bengt Jacobson, Leo Laine</td>
</tr>
</tbody>
</table>
**EVE - INNOVATIVE ENGINEERING OF GROUND VEHICLES WITH INTEGRATED ACTIVE CHASSIS SYSTEMS**

**Research Motivating Problem:**
- #Exchange?

**Envisioned product/solution, year:**
- <1-2 novel products/solutions to which the research contributes to>

**Research question(s):**
- #the 3 WPs?

**Deliverable(s):**
- #Exchange?

<table>
<thead>
<tr>
<th>Time</th>
<th>&lt;year-month&gt; .. &lt;year-month&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>TU Delft, Virginia Tech, UP, dSpace, ...</td>
</tr>
<tr>
<td>Funder:</td>
<td>EU (Marie Curie)</td>
</tr>
<tr>
<td>Advisor:</td>
<td>&lt;main advisor first&gt;</td>
</tr>
</tbody>
</table>
Optimal Distributed Propulsion

Research Motivating Problem:
• Long Combination Vehicle (LCV) are transport and energy efficient. But, if not cleverly designed, they can have limited motion performance, e.g. grade-ability, off-tracking, rear-ward amplification.

Envisioned product/solution:
• Optimal Distribution (over axles) of propulsion for LCVs

Research question(s):
• Which axle/axles is/are best to propel with respect to productivity (incl. energy and other performance and economy)?
• How should such propulsion be designed, including conceptual control.

Deliverable(s):
• Proposal of distributed propulsion, generally and for some specific LCVs.
• One VehDyn PhD

<table>
<thead>
<tr>
<th>Type</th>
<th>Assigned name</th>
<th>Combination Scheme</th>
<th>Length/GCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yorktown Vehicle Combination</td>
<td>VCMC2</td>
<td></td>
<td>16.5/40</td>
</tr>
<tr>
<td></td>
<td>VCMC3</td>
<td></td>
<td>18.75/40</td>
</tr>
<tr>
<td></td>
<td>VCMC4</td>
<td></td>
<td>18.75/40</td>
</tr>
<tr>
<td>Medlow vehicle combinations</td>
<td>VCMC5</td>
<td></td>
<td>25.25/60</td>
</tr>
<tr>
<td></td>
<td>VCMC7</td>
<td></td>
<td>25.25/60</td>
</tr>
<tr>
<td></td>
<td>VCMC9</td>
<td></td>
<td>25.25/60</td>
</tr>
<tr>
<td>Perspective Motion vehicle Combinations</td>
<td>VCMC10</td>
<td></td>
<td>31.5/80</td>
</tr>
<tr>
<td></td>
<td>VCMC11</td>
<td></td>
<td>27.3/66</td>
</tr>
<tr>
<td></td>
<td>VCMC13</td>
<td></td>
<td>30.9/80</td>
</tr>
<tr>
<td></td>
<td>VCMC15</td>
<td></td>
<td>33.8/90</td>
</tr>
</tbody>
</table>

Time: 2016-01-01 .. 2019-12-31

Partners: Volvo GTT, Chalmers (vehDyn & Logistics?)

Funder: FFI.EnergiOchMiljö

Advisor: Bengt Jacobson, Manjurul Islam, Leo Laine
Max Road Grip or The influence of Non-Steady-State Tire Characteristics on Road Vehicle Handling and Stability

Research Motivating Problem:
Body, suspension, wheel torque, tyre and road cooperate differently in different vehicles and manoeuvres. Existing design rules for traditional designs are not (proven) to give near optimal designs for novel design concepts and new vehicle usage/manoeuvres. Examples of problem areas are typically transient manoeuvres for: High speed stability, Rear axle kinematics, Varying Tyres.

Envisioned product, year:
• Chassis/Suspension/WheelTorque/Tyre optimized to each other, ≥2025

Research question(s):
• How does body, suspension, wheel torque, tyre and road interact, especially in transient manoeuvres?

Deliverable(s):
• 1 PhD graduated in Vehicle Dynamics
• Mathematical models
• Design rules/methods

<table>
<thead>
<tr>
<th>Time</th>
<th>&lt;year-month&gt; .. &lt;year-month&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>Leannova, Chalmers.VehDyn, Chalmers.Dynamics</td>
</tr>
<tr>
<td>Funder:</td>
<td>Chalmers, Leannova</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Mathias Lidberg, Peter Fokow</td>
</tr>
</tbody>
</table>
“Sub-subject” roles,
e.g. Adjunct Professorships in certain specialization within Vehicle Dynamics
Vehicle Dynamics - Modelling and Control

Research area:
Mathematical modelling is the fundamental tool in understanding vehicles behaviour. A major challenge is to find the balance between complexity and completeness in application such as control, estimation and simulation.

Vision:
By better use of better models improve estimation, control and simulation to understand and control the motion of ground vehicles.

Examples of research questions:
• What is important to model in winter driving conditions?
• How can control of electrical drives be used to estimate tire to road friction?
• How can aerodynamic effects in an overtake be incorporated in real time application of vehicle dynamics?

Areas of activity:
• Researcher at the The Swedish National Road and Transport Research Institute (VTI) in vehicle dynamics, tire dynamics and control.
• Friction estimation in electric drives – FFI project TorqSens
• Simulation of winter conditions in driving simulators – ViP project WinterSim
• Vehicle testing using augmented reality – FFI project NG-Test Methods

<table>
<thead>
<tr>
<th>Time</th>
<th>2014 – 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funder:</td>
<td>The Swedish National Road and Transport Research Institute</td>
</tr>
</tbody>
</table>
Truck Longitudinal Dynamics

Research Motivating Problem:
Commercial vehicles are of vital importance for public transportation and transportation of goods. For sustainability of society and competitiveness of Swedish vehicle industry, advancements must be made in the areas of energy efficiency and driving performance.

Envisioned product/solution:
Improved design of vehicular powertrains and adaption to real use.

Research question:
• How to improve longitudinal actuation (primarily powertrain) design?
• How to improve the fit between corresponding attributes and customer needs (energy consumption, safety, driveability)?

Areas of activity:
• Powertrain engineering at Volvo GTT, CO2 legislation – VECTO, VehProp
• SHC – Svenskt Hybrid Centrum, CVEC – Complete Vehicle Energy Control, SAE, SVEA
• Operating Cycle Descriptions – FFI project OCEAN

<table>
<thead>
<tr>
<th>Time</th>
<th>2015 - 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funder</td>
<td>Volvo GTT, Powertrain Engineering</td>
</tr>
</tbody>
</table>
concluded projects
(ordered with falling end date)
Urban Personal Vehicles, 2-track

Research Motivating Problem:
Unnecessary energy and space consuming with traditional passenger cars for urban personal transport.

Envisioned product/solution, 2023:
Novel downscaled passenger vehicles (UPVs)
Novel legislation

Research question(s):
• How should a UPV platform be designed, to enable desirable vehicles for customers and society, and have a business case for OEMs?

Deliverable(s):
• Concept selection and initial requirement set
• 1 application for a platform research project including demo building

<table>
<thead>
<tr>
<th>Time</th>
<th>2014.05 – 2015.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>VCC, VTI, Chalmers</td>
</tr>
<tr>
<td>Funder:</td>
<td>SAFER, Trafikverket</td>
</tr>
<tr>
<td>Participating persons:</td>
<td>Karin André, Lars Stenvall, Chris Patten, Bengt Jacobson, et al</td>
</tr>
</tbody>
</table>

“Car-replacers” (2-track)

“Bike-replacer” (1-track)

Transport cost

Accident risk
AstaZeroSim

Research Motivating Problem: New verification environments (simulators and test track) emerge; but they need tool & method development to enable efficient driver training, concept evaluation and test planning.

Envisioned product/solution:
- Efficient & safe ambulance transports (thanks to better trained drivers)
- Generally better vehicles (thanks to increased availability of simulator and track-testing in automotive industry & at universities)

Research Question:
- Scaling: What parameters can be evaluated by training in DesktopSim and Sim4, respectively? (Evaluated by means of real driving at AstaZero.)
- Training: Is risk awareness training for ambulance drivers possible using a Desk Top Simulator? (To some extent a subset of the first question.)

Deliverable:
- Desktop simulator design, such that it becomes tool for driver training, concept evaluation (modular Vehicle Model,) and test planning (manipulate-able scenarios).
- Several (∼7) DeskTop Simulators
- Virtual model of AstaZero

<table>
<thead>
<tr>
<th>Time</th>
<th>2014.01 – 2015.06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>AstaZero, Autoliv, Chalmers, KTH, Skaraborgs Sjukhus, SP, VTI</td>
</tr>
<tr>
<td>Funder:</td>
<td>Vinnova, FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Bengt Jacobson, Jonas Sjöberg</td>
</tr>
</tbody>
</table>
Urban Personal Vehicles, 1-track

Research Motivating Problem:
Unnecessary energy and space consuming with traditional passenger cars for urban personal transport.

Envisioned product/solution:
Novel vehicles, novel legislation

Research question(s):
• Technology forecast
• Forecast of critical situations

Deliverable(s):
• 1 report

<table>
<thead>
<tr>
<th>Time</th>
<th>2013.09 – 2014.08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>Trafikverket, Chalmers</td>
</tr>
<tr>
<td>Funder:</td>
<td>Trafikverket, ...</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Bengt Jacobson</td>
</tr>
</tbody>
</table>
Driver response to transient disturbances on vehicles in safety critical situations, DRONT

Research Motivating Problem:
Transient disturbance may cause safety critical situations. Two problems for passenger vehicles are studied:

- Aerodynamic disturbance while overtaking a large vehicle.
- Disturbances from a 1st impact, affecting the post impact motion and the risk for secondary events.

Driving simulator is used as the primary tool in this project.

Research questions

- How does the driver react to, and how safety critical is, the aerodynamic disturbance while overtaking a large vehicle cause safety?
- How does the driver react to a 1st impact, and how much does an automatic motion control reduce the risk for secondary events?
- 1 VehDyn PostDoc (+2 PostDocs, at Fluid Dynamics and Human Factors)

Deliverables:

- Vehicle models for aerodynamic disturbances and violent post-impact motion
- ...
Post Impact Stability Control

Research Motivating Problem:
Vehicle and human beings are subjected to more than one hazardous event in the traffic accidents.

Research question(s):
How to control the post impact vehicle motion in order to mitigate or avoid the secondary events in multiple-event accidents?

Envisioned product/solution, 2020:
A new active safety function that controls the vehicle post impact dynamics.

Deliverable(s):
• Developed function
• 1 VehDyn PhD graduated

<table>
<thead>
<tr>
<th>Time</th>
<th>2009-01 .. 2014-06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>VCC, SAFER</td>
</tr>
<tr>
<td>Funder:</td>
<td>SAFER, FFI</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Bengt Jacobson, Mats Jonasson</td>
</tr>
</tbody>
</table>
interactIVe

Research Motivating Problem:

interactIVe addresses the development and evaluation of next-generation safety systems for Intelligent Vehicles, based on active intervention. Currently available systems are mostly independent functions. Chalmers is involved in SP5 INCA, that focuses on INtegrated Collision Avoidance systems.

Envisioned product/solution:

- Integrated collision avoidance system that actively controls the longitudinal and lateral motion of a heavy vehicle.

Research question(s):

- What is the best way to employ steering and/or braking to avoid an accident in an emergency situation?

Deliverable(s):

- Heavy vehicle dynamics model & path stability control algorithms.

<table>
<thead>
<tr>
<th>Time</th>
<th>2010.01 – 2013.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers / partners:</td>
<td>Volvo, Ford, VCC, Delphi, Chalmers, ICCS, and 23 other partners.</td>
</tr>
<tr>
<td>Funder:</td>
<td>EC; 7th Framework</td>
</tr>
<tr>
<td>Advisor:</td>
<td>Mathias Lidberg</td>
</tr>
</tbody>
</table>
Lateral Stability of Heavy Vehicle Combinations (HVCs)

Research Motivating Problem:
Poor lateral performance of HVCs

Research question(s):
• What are lateral performance issues of HVCs at high speeds?
• How can lateral performance of HVCs be improved?

Deliverable(s):
• Steering-based controller for lateral performance improvement of HVCs

Time: June 2006 – Aug 2012

Customers/partners: Volvo Truck
Funder: IVSS
Advisor: Mathias Lidberg
Direction Sensitive Locking Differential (DSLD)

- The DSLD can distribute the engine torque to the drive wheels efficiently by allowing each drive wheel to contribute in accordance with its capability.
- The DSLD can also significantly increase the stability of the vehicle and together with ESC give an overall improvement in stability as well as fuel efficiency.

Researcher: Mathias Lidberg
Partner: Teknometall AB
Safety Margins and Feedback Strategies for All Wheel Drive Vehicles (AWD)

- Advances in individual drive of AWD vehicles provides means to enhance not only performance but also the maneuverability of passenger vehicles.
- By developing control strategies for AWD vehicles we can warn and support the driver at limit handling conditions.

Industry PhD student: Matthijs Klomp
Partner: Saab Automobile
Advisers: A. Boström, M. Lidberg, B. Egardt, G. Olsson
Electric vehicle blended braking (EVBB)

**Problem:** How to recover brake energy with maintained or enhanced driver controllability, vehicle performance and stability.

**Research questions:**
- How much electric power can be re-couperated with simple brake hardware and brake blending systems, respectively, with maintained driver controllability
- How to control the regen braking power from the e-motor to maintain vehicle stability for different e-motor configurations.
- Functional safety for brake blended systems

- **Time:** 2 years, remaining 2011 and 2012
- **Technology:** xxxx
- **Cost:** ≈ 4,18 MSEK, funded as:
  - ≈ 1,67 MSEK from FFI,
  - ≈ 2,51 MSEK in-kind from Saab (and eAAM 2012)
The objective of the ID4EV project is to develop energy efficient and safe brake and chassis systems for the needs of fully electric vehicles and the improvement of active safety and comfort for a faster introduction of fully electric vehicles.

Researchers: Mathias Lidberg and Paolo Falcone
Partner: Renault, Continental, ZF, TNO
IDIADA, ICOOR, FKA
Sponsor: EU