VIP

Driving Simulation Centre

Virtual Road to the Future

Welcome to ViP

ViP Driving Simulation Centre is a joint initiative by VINNOVA and the ViP partners. From a VTI perspective, the thought of attracting and co-ordinating Sweden's competence and resources in the field of driving simulation was a challenge, but above all a Very Important, Inspiring and Innovative Proposal, Project, Platform – which became ViP.

Since the start in 2008, ViP has established an attractive environment for co-operation and competence development as well as for sharing and exchanging knowledge and experience in the field of real-time human-in-the-loop simulation. ViP builds and provides a unique platform of high quality tools, methods and open software for innovation and development of future vehicle functions, infrastructure, and transport system solutions by using advanced driving simulation. Thereby, the centre has been successful in introducing driving simulation in research and product development. Regarding product development, knowledge about the effects of alternative designs has been generated, which would have taken years to achieve in reality.

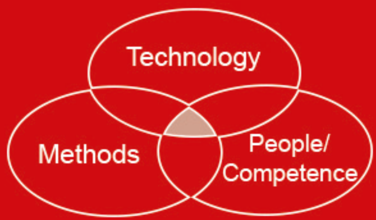
Scenario generation for different applications and methodology issues are essential topics in ViP. To this, the centre encompasses low, medium and high fidelity simulators, and an open, modular and compatible software architecture enabling efficient transfer of tools and models between sites.

A framework of common definitions, standards and models ensures that partners can work in a consistent way, easily move experiments between facilities, and easily compare results from different studies. Efficient re-use is facilitated and accelerates methodology development in the centre.

Within ViP, knowledge is transferred and experiences exchanged between partners via joint projects, workshops, demonstrations and a homepage including an intranet.

Networking at ViP workshops has been one cornerstone in the centre activities and the hub for exchanging and sharing results, information from the surrounding world, plans for the development and future of ViP as well as banding new project ideas.

The accomplished projects constitute another cornerstone. ViP has funded 45 projects, most of them deal with technical (software) and methodological development of the "ViP platform". The experience and knowledge gained from using the technical solutions and ways of working in applied projects are fed back and guide the next step of the technical and methodological development. ViP projects are initiated based on partner interests and needs. They contribute to the major partners' internal strategic projects and lead to new networks and markets for the smaller actors.



ViP platform

ViP welcomes new partners!

Editorial information

This booklet gives a background to and describes the first nine years of ViP Driving Simulation Centre, as well as gives a forecast of the future.

The text is produced by VTI in collaboration mainly with our partners at AB Volvo, Scania CV AB and Volvo Car Corporation.

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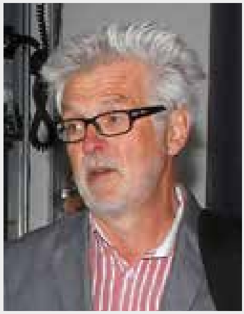
Editing, form, layout: Jonas Jansson, Lena Nilsson, Christina Karlsson, VTI

Contact the Research Director for the SIM unit at vip@vti.se

Content list

Preface

It all started some years after the turn of the millennium. VTI had just finished its third generation of driving simulators - the culmination of more than 25 years of simulator development - and the institute had a leading international position in the field of real-time simulation, reflected by established international researchers spending their sabbaticals at VTI. In parallel, VTI had established fruitful relations with the automotive industry in numerous joint projects.

For some years, the landscape of research funding had changed as “Centres of Excellence” - with substantial budgets for several years - had been established at different university departments. According to a joint call from three heavy-weight research councils, the same funding model should also be established at research institutes.

That seemed like a perfect chance to initiate a national centre - led by VTI - for the development of future vehicle functions, infrastructure, and transport system solutions using advanced driving simulation. We decided to go for it!

The call comprised several criteria for a “Centre of Excellence” and frankly we thought that we could tick almost every box from start, with the activities going on at that time. A working group was formed for involving the “right” partners, attracting their interest, obtaining their letters of intent, and jointly formulating the application.

In our opinion, we had a very strong proposal, with participation from the automotive industry as well as other end users and VR-companies. The ViP proposal was finally accepted by VINNOVA.

When launching the ViP centre, two key members were very important to find for the operational management, the Centre Director and the Chair of the Board. The first position was the easiest. Lena Nilsson had long experience as project manager, both nationally and internationally (EU-projects), and was recognized as a leading expert in using driving simulators for research purposes. Combined with her administrative skills honed at various positions at VTI, it went without saying that Lena Nilsson was our first proposal as ViP Director. The second position was solved through a lucky strike. We had meetings with representatives from AB Volvo. There we met Per-Olof Boström, who had retired from Volvo at that time. In our opinion he was an excellent choice as Chair of the ViP Board. Together, Per-Olof and Lena have managed, supported and supervised the work in ViP in a very commendable way.

Staffan Nordmark and Hans Erik Pettersson
Initiators/promotors of ViP

Would you be interested in becoming the Director of a competence centre for development and application of driving simulator methodology, with focus on human-machine interaction (HMI)? After twenty years of research in the fields of driver behaviour, design of driver support systems, human factors in transportation, and assessment methodology, and having been a very frequent user of driving simulators - that was an offer I could not refuse!

In my daily work, interaction with and support from many people – in the partner organisations, project and management teams - is necessary. All these people constitute ViP and they are what makes the "centre concept" work! Meetings and discussions with them in a creative and problem-solving atmosphere is something I very much appreciate and bring with me, as are the insights from following the projects where different ideas and competences are brought together to useful common results. Also, a supportive, close to the operative work, solution-oriented, and always available Chairman of the Board is invaluable – thank you P-O!

In my mind, it is a matter of course to routinely involving end-users in the system development, already from the conceptual phase – not only when physical prototypes are available. Human-in-the-loop simulation is an excellent possibility to do so, and gain their opinions and reactions for improved design solutions.

For the future, I foresee that the ViP community and platform will continue to be a resource in great demand when designing the connected and digitalised vehicles and transport systems of tomorrow. Will future vehicles be developed without any use of physical prototypes? If so, I hope virtual versions of vehicle functions and sub-systems as well as the complete vehicle will be tested in a "ViP environment". And I believe that humans, and thus human-in-the-loop simulation, will be as – or even more - important to involve in the design process of automated driving as they are today!

Lena Nilsson
Director of ViP

When the funding of ViP had been decided in 2007, I was contacted by Staffan Nordmark, who asked me if I would be interested to chair the board of the planned centre. I accepted the proposal with pleasure. To some extent I thought I understood the value of ViP. The use of simulation in the automotive industry was just starting to grow and my own view was quite narrow.

The work with the ViP board was very stimulating and I found myself surrounded by a group of talented people and I am impressed by the participating companies' ability to assign competent people. I have also felt that ViP has had good support from the top management at VTI and that has been very important. Also, the Director of the centre, Lena Nilsson, was like me assigned from the start of ViP and she turned out to be an excellent person in that position.

The field of driving simulation has changed radically since ViP started. One important difference between the first two phases of ViP, is that the use of human-in-the-loop simulation has grown so much that the results needed, to develop the simulation tools, have to come from several sources. The ViP partners, representing different views and interests, can form successful project teams leading to results and increased knowledge that take all participants to a higher level. The vehicle manufacturers wish to use as much of their data and models as possible in the whole development chain, from early desktop simulation to driving in proving ground. It is obvious that tools like hardware-in-the-loop, driving simulators and track testing developed by partners in VICTA, ViP and AstaZero can work together to make this possible.

ViP's accomplishments so far include a network of organisations and individuals, representing users and best competence in human-in-the-loop simulation. ViP represents an on-going development and maintenance of common sources for methods, scenarios, models of vehicles and environment. The centre enables joint planning of common development and research needs. One future challenge is the re-use of methods, scenarios and models. There have to be well developed and agreed interfaces between different kinds of data in order to avoid unnecessary re-work when data is used at a new location or in a simulation of higher or lower sophistication. There is a need for continued methods development, like the ones carried out in ViP.

Per-Olof Boström
Chairman of ViP

“For the future, I foresee that the ViP community and platform will continue to be a resource in great demand”

Lena Nilsson
Director of ViP

"The development in the fields of computer and display technology makes driving simulators more and more affordable"

Driving Simulation and Virtual Prototyping

Driving simulation allows a driver to experience the sensation of driving a vehicle in a virtual environment.

Driving is a multisensory task where visual, audible, tactile and vestibular stimuli are used. Advanced driving simulators aim at simulating and presenting all these impressions to the driver in an immersive way. This is often called high fidelity simulation and requires a realistic driver environment, an immersive visual system, a high performance audio system and a moving base.

The development in the fields of computer and display technology makes driving simulators more and more affordable. For many purposes, a desktop computer connected to a steering wheel and pedals may be sufficient. Driving simulation is an area under rapid expansion because of its great potential in cutting cost and time, whilst providing better products and drivers.

There are several areas of application where each area puts different requirements on the simulator. Driving in a virtual reality offers several advantages to real driving and it is important to realise that the goal of a simulated drive may not always be to be as realistic as possible. On a very general level some of the most important tasks are:

- Product development – to give designers as good an understanding of the product as possible, thus, reducing development cost and time and raising product quality.
- Research – to provide a valid behaviour response from test participants, that can be used to draw conclusions on behaviour when driving on a real road.
- Education and training – to provide understanding to the driver, thus, improving quality of the education leading to better driving behaviour in real traffic. It should also make training less expensive and more efficient.
- Medical testing – to provide accurate indicators to judge a person's driving capability.
- Demonstration – to give insight into new designs and concepts and visualise new ideas as well as contribute to decision processes.
- Racing – to optimise a real vehicle to a particular track and minimise the driver's lap time with a particular chassi setting.
- Entertainment – to provide an enjoyable driving sensation.

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Regardless of which application a simulator is used for, it provides large benefits compared to testing in the real world, for example:

- **Full control of the experiment.** A simulated scenario can be repeated exactly for each test participant. This gives a high validity when comparing behaviour between drivers, which is crucial for research, training, medical testing and product development.

- **Dangerous situations and scenarios can be tested.** In many cases, the most important situations to study are dangerous events. In a simulation, behaviour can be studied, up until the moment a collision occurs, without risking any injuries.

- **Accelerated testing.** Driving simulation enables test drives of a vehicle in an early concept phase. Simulation also makes rapid parameter changes possible. For example, tyre characteristics, suspension geometry, suspension characteristics can be changed from one second to the next. This cannot be achieved when in a real vehicle on the test track, and gives chassis engineers a new tool for both more extensive and accurate testing.

- **Enabling a drive of future infrastructure.** In a simulated environment, testing of infrastructure designs is easily accomplished, for example driving in non-existing infrastructures that are still in the design phase; displaying effects that cannot be seen or sensed in real life, such as braking distance, making solid objects transparent; full control of the weather and visibility conditions.

- **Real feedback.** Getting real drivers’ experiences and opinions on conceptual or not yet existing solutions.

A Competence Centre for Driving Simulation - A Short History

Back at the beginning of the 21st century, the industry need for efficient and more cost-effective product development was driving the area of virtual and model-based development.

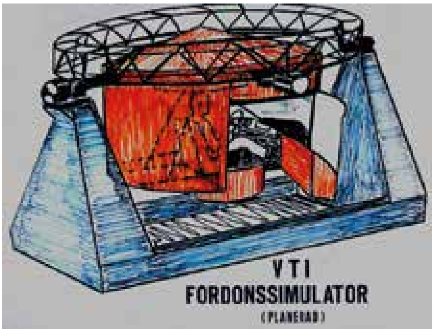
Several of the industry partners were using driving simulation in their product development.

VTI was a pioneer in advanced driving simulation, for research purposes, since the 1970s.

The focus on human-centred design was increasing. Especially human-machine interaction in relation to new driver support and active safety systems and connected vehicles had gained interest.

Because of all these activities, Sweden has become a prominent actor, especially in the field of advanced driving simulation.

So, the idea to create a driving simulation competence center, to bring actors within Sweden together and to promote simulator-based development, was a logical step.



The Evolution of Driving Simulation

The field of virtual reality, digitalisation in general, and driving simulation in particular, is still under rapid development.

Since the start of ViP, several driving simulator facilities have been established at the ViP partners. ViP has played a significant role in the realisation of those simulators and several

SIM IV moving base simulator, VTI

S2 simulator, Chalmers

2008

2011

SimulaTor, Scania

HMI Usability Lab simulator, Volvo Cars

of the facilities use software and technical components developed in the centre. Even more important, methods, scenarios and virtual environments are continuously developed for different applications. Methodology - how to use simulators in the best way - is still a very open area for research.

Custom made simulator, VTI

2014

2017

Chassis simulator, Volvo Cars

Cruden simulator, Chalmers

Scania - a Success Story

Creative and Iterative HMI Design

In 2012, Scania invested significantly in driving simulator capability; an investment afforded by, and supported via, collaboration in the ViP consortium. The 2012 upgrade included the implementation of VTI's core simulator platform at Scania, integrated with a full truck instrument panel, 180 degrees projection, and a 7.1 surround sound system.

Immediately following the integration at Scania, the simulator became operational and remains a highly used and much demanded resource. The SimulaTor has secured multiple successes for the design teams, and for the organisation as a whole.

For example, for much of 2012 and 2013, the SimulaTor was used to support product development within the FFI funded project 'Methods for Designing Future Autonomous Systems' (MODAS).

The question addressed in the MODAS project was, "If a highly autonomous truck were technically possible, what would be the best possible driver environment from a driver's perspective?". To answer that question, multiple rounds of user testing were conducted in the SimulaTor. Indeed, five separate studies were conducted to support three iterations of design, including separate studies to investigate information distribution and interaction preferences.

The results of the MODAS project were so successful that the project secured over 20 conference and journal publications, appeared on Swedish national television, and maintained a project blog that was accessed over 1700 times from 61 countries. The SimulaTor was a key facilitator of the project successes.

"If a highly autonomous truck were technically possible, what would be the best possible driver environment from a driver's perspective?"

AB Volvo - a Success Story

Highly Automated Freight Transports

Driving the future today! - High fidelity Long Combination Vehicles in realistic environments for evaluating different levels of future automation.

After a 10+ years rewarding journey we can now actually drive our trucks into the future. Not only by ourselves but also together with our customers, partners, academia and authorities, all needed to co-develop a sustainable transportation system. For us, a driving simulator environment acts as a time machine where we can explore, evaluate, optimise and verify future transport solutions long before any physical concepts exist.

To reach this capability, a number of studies have been conducted. With a vision to study various levels of automation of Long Combination Vehicles in highway scenarios, a first step was to secure that critical events can be triggered in a realistic way. This was done by implementing software-in-the-loop code of an existing Electronic Stability Control (ESC) system to validate driver behaviour in critical situations such as a moose suddenly crossing on an icy road or being surprised by a sharp curve with decreasing radius.

A continuation of this work led to the Ph.D. thesis “Driver behaviour models for evaluating automotive active safety” presenting a method to quantify the safety benefits of existing and future safety systems by a combination of simulator studies, naturalistic driving studies and mathematical driver models. Part of the findings have been patented and will be implemented in future vehicles.

Another task has been to secure a high fidelity experience of the vehicle and its road and traffic environment. Off-line simulation models of Long Combination Vehicles have been implemented together with representations of real known roads and challenging traffic scenarios. Validations by

experienced drivers and specialists indicate a level of realism that also allows vehicle dynamics testing and evaluation of design changes at a sub-system level.

To prepare the simulator environment for future studies of automated driving functionalities, a real-time optimisation-based trajectory planning algorithm has been implemented as a result of two extensive thesis projects.

Our on-going research is now focusing on different levels of automation ranging from active steering force feedback to fully automated driving. In these studies the driving simulator environment has proven to be a necessity for developing advanced safety and productivity systems. Furthermore, it has allowed professional drivers to have first-hand experience of the future and provide valuable feedback.

"For us, a driving simulator environment acts as a time machine where we can explore, evaluate, optimise and verify future transport solutions long before any physical concepts exist"

Volvo Cars - a Success Story

Drivers' Interaction with Next Generation ADAS

The first generations of Advanced Driver Assistance Systems (ADAS) that apply automatic braking of the vehicle have been available for some years now. These systems are expected to be effective countermeasures, and drivers generally accept brake interventions. Safety systems that assist the driver by lateral interventions or lateral support in critical situations such as road departure and rear-end accident scenarios, will be introduced in next generation ADAS. Those systems would theoretically be efficient, but it is important to build knowledge about driver-system interaction to verify and tune the performance of the systems.

To learn more about the interaction between drivers and lateral assistance systems, several studies have been conducted in different test environments; Field Operational Tests (FOT), test track and advanced full-motion driving simulators.

FOT studies are limited in the number of critical scenarios and test track tests have limitations to include the driver-in-the-loop in complete critical scenarios. Advanced full-motion driving simulator studies make it possible to test complete critical scenarios with the driver-in-the-loop. Two ViP projects have focused on method development in this area.

The projects have included development of methodology and methods for comparative testing of lateral interventions or lateral support in run-off-road events and evasive manoeuvre scenarios in a simulator, validated by tests on a test track. This methodological development has aimed to validate the driver's reactions in the simulator, based on the driver's reactions in a car on a test track in the same scenarios, secondary tasks and test procedures. The results from validation tests have shown the importance of such tests.

The results from a first round of simulator experiments have shown that a successful road departure scenario requires a well-tuned sequence of a secondary task, a deviation from road, and the integration of a lateral support function. The results also show that further tuning is needed in the simulator related to the scenario design, steering sensation and motion cueing. Results from simulator experiments in road-departure and rear-end accident scenarios will be used to develop the first generation of driver models for the driver interaction in those scenarios.

"These systems are expected to be effective countermeasures, and drivers generally accept brake interventions"

Trafikverket - a Success Story

The Stockholm Bypass Tunnel

The design of new infrastructure puts high demands on safety. At the same time the infrastructure should also promote high efficiency, through-put and give an enjoyable experience to the road user. Even when following guidelines for road construction, the behaviour and experience of a road user is not easy to predict before the infrastructure is built. Driving simulators offer a possibility to test drive a design before it is implemented.

The Stockholm Bypass is the largest infrastructure project in Sweden to date. The entire project includes motorways, bridges and two tunnels; one of which, the Stockholm Bypass Tunnel, will be 16.5 km long.

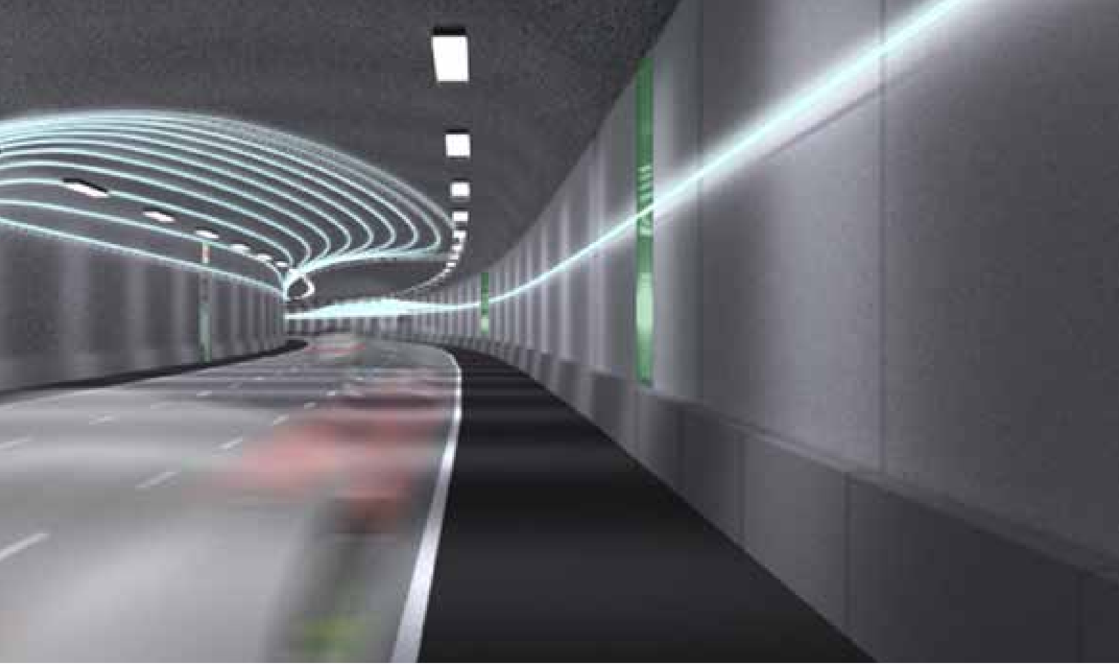
A high level of road traffic safety is always important and when the road is in a tunnel, and especially in a long tunnel, maintaining the highest possible level of safety is paramount.

A realistic and accurate model of the tunnel was implemented in close co-operation with the designers and architects of the Swedish Transport Administration. Two studies were carried out to study the conceptual design.

The first study focused on the novel light design and drivers' in-lane driving patterns. The participants were also asked about the design, which gave a good rating of approval for the tunnel design concept.

The second study evaluated the underground on-ramp design and drivers' performance in merging into the main tunnel. The study resulted in recommendations on traffic densities where merging may be difficult and design suggestions to make it safer.

Furthermore, the tunnel model was used in a pilot study to export road environments. The study was conducted together with Monash University Accident Research Centre in Melbourne, Australia. The model



could successfully be ported to the Monash simulator environment and a third study was conducted on the effect of texting and reading text messages while driving in a tunnel was studied.

"Driving simulators offer a possibility to test-drive a design before it is implemented"

VTI - a Success Story

Electrified Roads

Charging as you drive is one promising way to provide energy to electric vehicles.

The Swedish goal of a fossil free transport sector year 2030 means a fundamental change in the transport sector. One way to reach this target is by electrification. To successfully implement such systems, more effort on increasing knowledge and innovations is needed. Driving simulation has been used to develop, evaluate and demonstrate different concepts of electrification of roads and vehicles.

Electric Road Systems (ERS), where vehicles receive electricity continuously while driving, could be one way to reach the target of a fossil free transport sector. A test and demonstration environment in a driving simulator was developed to test and evaluate ERS concepts and electric vehicles driving on ERS.

A user study was conducted, where 25 drivers drove a 40 kilometre long route, both in a hybrid truck on ERS and in a conventional truck. The study was carried out in the VTI driving simulator Sim II, which is an advanced driving simulator with a large moving base system and a Scania truck cabin. The comparison between driving the hybrid truck on ERS and the conventional truck, showed no remarkable differences, neither on drivers' experience of safety and aesthetics nor on driving behaviour. However, the average speed was 2 km/h higher and the energy consumption 35 % lower when driving on ERS.

For the dissemination of project results to actors and potential users of ERS, a large number of simulator demonstrations have been conducted. A press release and a number of magazine articles have also been published and a film has been displayed on YouTube. In addition, a portable ERS driving simulator was constructed and used to reach a broader audience.

The development of the ERS simulation was

based on the ViP platform. Both the basic simulation software and the implemented road (Riksväg 40 between Göteborg and Jönköping) was developed in ViP projects.

> "It is clear that the driving simulator environment is a useful tool in optimising how the road should be electrified"

The project developed a comprehensive simulation demonstrator of the ERS concept and provided results on energy savings. The simulation environment also proved to be a valuable planning tool where one could visualise different electrification concepts like overhead powerlines, conductive and inductive charging from the ground. The electrification layout of the road was also an output of the project. The electrification is dependent on both the vehicle (battery capacity, capability to charge and recharge from kinetic energy), the physical design of the road (for example intersections) and the drivers' behaviour.

It is clear that the driving simulator environment is a useful tool in optimising how the road should be electrified.

“There is a strong trend in automotive development towards connected, automated and electrified vehicles. What role do driving simulators play in this development?“

The Future of Driving Simulation

Driving simulators are believed by many to be a key enabler for the development of tomorrow's transport system. Some of the main areas where driving simulation is expected to grow in importance are:

Development of automated driving systems – Driving support on all levels of automation puts emphasis on the interaction between driver and vehicle. To maximise the safety and effectiveness of automated systems, clear interfaces and interaction designs are required. Driving future vehicles under high automation conditions may be quite different from the driving we are used to, for example, the driver may only want or be required to give strategical or tactical inputs by voice commands, touch screen interfaces or other novel driving interfaces. Driving simulators are well suited tools for designing these types of systems, with a human-centred focus. Issues of importance are the handover of control between the driver and the vehicle as well as to avoid mode confusion.

The ability to present vestibular stimuli in a driving simulator will have an increasing importance in some cases, for example, when driving under full automation. If the driver does not have the eyes on the road, hands on the wheel or is occupied with a different task than driving, the only notion of what the vehicle is doing may be through its motion.

Development of complex connected vehicle systems – As vehicles are becoming connected, they will be able to offer new types of services and functions. Vehicles will be, to a much larger extent, sub-systems of the whole transport system. The complexity of new vehicle system designs will be a challenge, not only from a human factors perspective but also from system testing and safety perspectives. The ability to virtually test drive with new connected functions and cloud services offers great advantages. From a service provider's point of view, there should not be any difference between a driving simulator and a real vehicle. Therefore, one important feature of future driving simulators is to host real vehicle electrical systems and to run instances of the real vehicle software. Co-simulation, in general, between driving simulators and other simulators, such as hardware-in-the-loop (HiL) as well as traffic simulators, will be important for testing future systems.

**Decreased use of physical prototypes - **The automotive industry is constantly striving for a more efficient product development and shorter lead times.

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One of the main methods to achieve this is model-based development. As Computer Aided Engineering (CAE) tools and models reach higher fidelity, physical testing can be replaced by simulations. However, assessment by human test drivers is still crucial. Here, driving simulators play an important role.

Driving simulation also enables a great number of tests that are hard to accomplish on a test track, such as changing tyres (model) instantaneously. The final verification and validation of simulation results is always done in a real vehicle, but planning of test activities can be greatly improved using simulation.

Important topics for future testing are the establishing of standards for data formats, evaluation protocols and test methods that can be interchanged between simulation and physical testing. That will facilitate the creation of tool-chains ranging from CAE to driving simulation to track testing.

Driver training - While other disciplines frequently use simulator training, driver training in simulators is in its early phases. Using simulators in training offers several obvious advantages such as the environmental impact, repeatability and controllability of scenarios. Research indicates, that to improve safety performance, it is most important to work with higher levels of cognition in the training, such as impulse control, self-assessment, risk awareness. As driving simulators offer the possibility to experience dangerous situations and making errors without any risk of being injured, they offer a potential for better driver training.

What kind of driver license should be required for driving autonomously driven cars? As the driving task changes with highly automated driving and becomes more procedural, other types of driver training may be required. This is another area where driving simulators could be very useful.

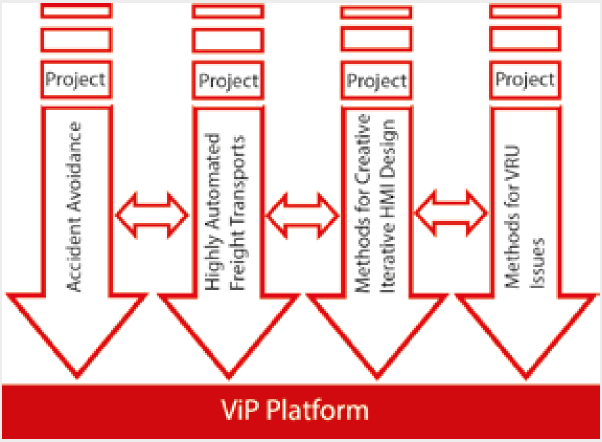
"What kind of driver license should be required for driving autonomously driven cars?"

The Future of ViP

ViP will continue to promote best practice for the use of driving simulation in product development. This includes joint work on methods and technology, simulator fidelity and validation, as well as standardisation of methods and data formats.

ViP has developed a complete driving simulation software, which is published on the common repository ViPForge as an open asset, for any partner to use in their own research or development. This Open Source software gives researchers and developers full access to the source code and software documentation as well as published validation studies. ViPForge also holds open assets such as validated models of vehicles, driving environments and scenarios.

In the continuation of ViP, methods and technology development will be driven by the need of scenarios and use cases for collaborative studies of important and prioritised issues in certain focus areas. Current focus areas identified by the partners are Accident Avoidance, Highly Automated Freight Transports, Methods for Vulnerable Road User (VRU) Issues, and Methods for Creative Iterative HMI Design.



Results from applied projects in the focus areas will be used to further develop the ViP platform, in other words, implementations and models will augment the assets on ViPForge. Knowledge generated will be introduced in university courses and scientifically published to promote and strengthen driving simulation methodology and utilisation. Other issues of high priority are re-use of developed scenarios, models and development tools in experiments, at simulator facilities of varying fidelities, as well as standardisation and adaptation of developed methods to industrial development processes.

Next phase of ViP strives to integrate driving simulation in a tool chain where tests and experiments can be seamlessly moved between desktop, driving simulator and test track.

Equally important for the development of the ViP platform is the scalability and modularity of driving simulators. The same software and scenarios should be possible and easy to use in simple and advanced driving simulators. What simulator (level of fidelity) to use in an experiment is an important issue for making simulation more cost efficient and applicable for model-based development.

Being a partner in ViP involves access to:

- ViPForge, the complete ViP driving simulation software well suited for research and development, including the source code and support about assets available on ViPForge.
- Models of roads, vehicles, graphical driving environments and scenarios for different applications.
- Workshops and demonstrations.
- A large network of specialists in driving simulation.

Facts and Figures

Two phases of ViP have been completed; phase 1 ranging from January 2008 to September 2011 and phase 2 from October 2011 to December 2016. A positive evaluation of ViP at the end of phase 1, initiated by VINNOVA and carried out by Faugert, resulted in a clear "go on" decision.

Workshops

Together with the projects, the ViP workshops - held about twice a year – have been attractive key centre activities. At the workshops, status and achievements in ongoing projects have been presented and discussed. Developments in models and tools have also been demonstrated.

Presentations by invited guest speakers from other, national and international, simulation-related environments have now and then been included in the workshop programs. Networking at the workshops has been the hub for exchanging and sharing results, information from the surrounding world, plans for the development and the future of ViP as well as banding new project ideas.

Numerous workshops have also been arranged during ViP projects addressing more exclusive topics and attracting more immediate participant groups.

Associated projects

Software and tools developed in the centre have, in co-operations with actors outside ViP, been used in projects associated to ViP. Project examples are: development of a virtual platform for test and demonstration of models for electrified roads and vehicles, simulation-based verification of systems and functions, and implementation of a virtual version of AstaZero test track.

Several internal projects at the ViP partners have also been performed in association with the work in ViP.

Custom simulators

An important spin-off activity has been the development of small stationary simulators based on the ViP software. These simulators have been delivered to different customers for very specific applications, such as medical assessment of drivers, driver and engine driver training, and demonstration of collisions and critical situations involving wildlife.

ViPForge Database

A repository, the common software platform, ViPForge, has been created where developed software, scenarios, documentation of algorithms and models are available for ViP partners.

Funding

The work and activities within ViP have been financed by VINNOVA and the ViP partners. The total budget has been slightly more than 93 million SEK, see below for details.

	Phase 1	Phase 2	Total
VINNOVA cash	15 000 kSEK	20 000 kSEK	35 000 kSEK
Partner cash	5 940 kSEK	5 920 kSEK	11 860 kSEK
Partner inkind	18 900 kSEK	27 500 kSEK	46 400 kSEK
Total	**39 840 kSEK**	**53 420 kSEK**	**93 260 kSEK**

Networking and Benchmarking

Several Swedish initiatives of high relevance to ViP exist for which collaborative relations already are in place or have been discussed. Examples are SAFER/Chalmers, VICTA Lab, AstaZero and LiU to whom ViP connects by, for example, joint projects, software sharing and common PhD students. ViP offers tools and methods as well as the competence to apply them, while the needs and experiences of these other initiatives are of the greatest importance in guiding the technical and methodological development in ViP towards a re-usable and compatible test environment.

Benchmarking of and visits to the most prominent international driving simulation environments have been undertaken. Contacts and co-operation have been established with among others Monash University Australia, Leeds University England, DLR Germany, NADS US, Tongji University China and Toyota Japan.

ViP funded projects

Focus area: Technical platform

Technical Platform for support of ViP activities (Tools)
Project manager: VTI

Head and Eye Behaviour Measurement and Visualisation in Simulators (VisualEyes)
Project manager: Saab Automobile

Real Life Scenarios for Simulations Methods and Environment (Industrial needs)
Project manager: VTI

Sound generator for a driving simulator
Project manager: VTI

Simulator-Based Design, re-use (SBD)
Project manager: HiQ

Methods to improve and evaluate the Motion Sensation in driving simulators (MeMoS)
Project manager: VTI

Simulator harmonisation and enhancement VTI-Saab/Pixcode (SimHarm)
Project manager: Saab Automobile

Common software platform
Project manager: VTI

Driving Environment Design Tool (DeDT)
Project manager: HiQ

Real roads in simulated environments for the virtual testing of new vehicle systems (Known Roads)
Project manager: VTI

High Speed Control of Long Combination Heavy Commercial Vehicles within Safe Corridors
Project manager: AB Volvo

ViP Graphics engine interface (Greit)
Project manager: Dynagraph

Fully linked visual behaviour measurements in a simulated world (VIMSI)
Project manager: VTI

Driving environment design Tool 2 (DeDT2)
Project manager: HiQ

Implement and demonstrate the SimArch architecture (SimArch2)
Project manager: VTI

Towards general usability and drivability for ViP platform resources (Raisins)
Project manager: HiQ

Winter testing in driving simulator (WinterSim)
Project manager: VTI

ViPCity
Project manager: Dynagraph

Night time scenarios in simulators – a pre-study of the needs, knowledge and possible solutions
Project manager: VTI

Lesson learned from the development of Scania simulator (LL SimulaTor)
Project manager: Scania

Communication and Code Modularity of ViP's simulator software (CoCoMo)
Project manager: VTI

Focus area: Methodology Framework

Methodologies for Assessment by Simulation: A state-of-the-art study (Methods)
Project manager: VTI

Validation of Method - FICA 2 Study 3
Project manager: Saab Automobile

Secondary Task Workload Test Bench (2TB)
Project manager: VTI

Autonomous driving evaluation methodology and scenarios (ADEMAS)
Project manager: VTI

Methodology development, method development and application: Driver's reactions during 2nd task to autonomous steering interventions in run-off-road scenarios in simulator and on test track (eLKA)
Project manager: Volvo Cars

Development of a lane-change scenario for safety assessment of Long Combination Vehicles (LCV)
Project manager: VTI

Driver's reactions to lateral autonomous support and interventions by braking and steering in simulator and on test track (eLKA2)
Project manager: Volvo Cars

Collaboration strategy related to a common technical platform for Simulator-Based Design activities (CoolLab)
Project manager: HiQ

Vehicle Dynamics Testing in Simulators (VDTestS)
Project manager: VTI

Simulator Course for Students
Project manager: VTI

Focus area: Applications

Accelerated testing of FCW for trucks
Project manager: Scania

Sleep detection eyetracker (SleepEYE)
Project manager: Volvo Cars

Methods for design and evaluation of heavy vehicle stability systems (ESP)
Project manager: AB Volvo

Efficiency and acceptance assessment of two different HMI solutions for drowsiness detection system
Project manager: Scania

Advanced driving simulator to evaluate sound design strategies for Intelligent Transport Systems
Project manager: Scania

Driving in tunnels – impact from design and driving environment factors on driver performance
Project manager: Swedish Transport Administration

Active and passive Lane Departure Warning Systems (LDW)
Project manager: Swedish Road Marking Association

Strengthen Performance Active Safety Simulator (SPASS)
Project manager: VTI

Driver and system controlled heavy vehicle steering driver behaviour in normal and critical traffic situations and evaluation of active steering driving support (DB2)
Project manager: AB Volvo

Principal Other Vehicle Warning (POVW)
Project manager: VTI

Sleep detection eyetracker validation part II (SleepEYE II)
Project manager: Volvo Cars

The effect of noise on driving performance and driver sleepiness (SleepNoise)
Project manager: Volvo Cars

Development of the Stockholm bypass Tunnel Model – extension of surface road network and tunnel ramps for tests of safety features and future traffic scenarios (Tunnel 2)
Project manager: Swedish Transport Administration

Design and use of road marking symbols in the roadway (Symbols)
Project manager: Swedish Road Marking Association

ViP publications and PMs

(Published in ViP's own series at www.vipsimulation.se)

ViP publication 2010-1: Performance of a one-camera system and a three-camera system. Christer Ahlström et al. (public).

ViP publication 2010-2: Detecting sleepiness by Optalert. Christer Ahlström et al. (public).

ViP publication 2010-3: Real life scenarios for simulations, methods and environment - Industrial needs. Martin Fischer et al. (ViP internal).

ViP publication 2010-4: Technical platform for support of ViP activities – Tools. Martin Fischer et al. (ViP internal).

ViP publication 2010-5: Accelerated testing of FCW for trucks - Driving behaviour after exposure to repeated critical events. Carina Fors et al. (public).

ViP publication 2011-1: Pilot evaluation of using large movement driving simulator experiments to study driver behaviour influence on active safety systems for commercial heavy vehicles. Gustav Markkula et al. (ViP internal).

ViP publication 2011-2: Simulator-based design re-use. Tobias Östlund et al. (ViP internal).

ViP publication 2011-3: Advanced driving simulator to evaluate sound design strategies for intelligent transport systems. Johan Fagerlönn et al. (public).

ViP publication 2011-4: Methodologies for assessment by simulation - A ViP inventory. Magnus Hjälmdahl et al. (ViP internal).

ViP publication 2011-5: Effects of forward collision warning, initial time headway and repeated scenario exposure on driver response in emergency lead vehicle braking scenarios. Mikael Ljung Aust et al. (public).

ViP publication 2011-6: Camera-based sleepiness detection. Carina Fors et al. (public).

ViP publication 2012-1: ViP SimHarm "White book" - Simulatorharmonisering och förbättringar. Henrik Bergström et al. (ViP internal).

ViP publication 2012-3: Driving Environment Design Tool – DeDT: Enhanced Capacity to Produce Complex and Dynamic Traffic Environments. Torbjörn Alm et al. (ViP internal).

ViP publication 2013-1: Simulator validation with respect to driver sleepiness and subjective experiences. Carina Fors et al. (public).

ViP publication 2013-2: Investigation of driver sleepiness in FOT data. Carina Fors et al. (public).

ViP publication 2013-3: SIREN - Sound Generator for Vehicle Simulation. Anders Andersson et al. (public).

ViP publication 2013-4: Driver acceptance and performance with LDW and rumble strips assistance in unintentional lane departures. Lars Eriksson et al. (public).

ViP publication 2014-1: Secondary Task Workload Test Bench - 2TB. Katja Kircher et al. (public).

ViP publication 2014-2: Principle Other Vehicle Warning. Birgitta Thorslund et al. (public).

ViP publication 2014-3: Stockholm Bypass Tunnel: Merging Traffic Study - Technical report. Christopher Patten et al. (public).

ViP publication 2014-5: Raisins – towards general usability and drivability for ViP platform resources. Torbjörn Alm et al. (public).

ViP PM 2014: ViP Common Software Platform. Björn Blissing (ViP internal).

ViP PM 2014: Greit - Graphics engine interface. Carl Johan Andhill et al. (ViP internal).

ViP publication 2015-1: Legibility of road marking symbols in the roadway. Sara Nygårdhs et al. (public).

ViP publication 2015-2: Known Roads - Real roads in simulated environments for the virtual testing of new vehicle systems. Arne Nåbo et al. (public).

ViP publication 2015-3: Night-time scenarios in simulators - A prestudy of needs, knowledge and possible solutions. Anna Anund et al. (public).

ViP PM 2015-1: CoolLab - Collaboration strategy related to common technical platform for Simulator Based Design activities. Calle Isakson et al. (ViP internal).

ViP PM 2015-2: A method for road description based on map data and road measurements - White Paper. Mattias Hjort et al. (public).

ViP publication 2016-1: High speed control of long combination heavy commercial vehicles within safe corridors. Peter Nilsson et al. (public).

ViP publication 2016-2: SimArch 2 – Implementation and demonstration of the SimArch architecture. Anders Andersson et al. (public).

ViP publication 2016-3: SleepNoise. Eva Lahti et al. (public).

ViP PM 2016-1: Körsimulering och visualisering i framtidsforskningens tjänst. Arne Nåbo et al. (public).

ViP PM 2016-2: ViPCity. Carl Johan Andhill et al. (public).

ViP PM 2016-3: Driving environment Design Tool 2 - DeDT2: Enhanced capacity to produce complex and dynamic traffic environments. Martin Stenmarck et al. (public).

ViP PM 2016-4: Communication and Code Modularity of ViP's simulator software – CoCoMo. Jonas Andersson Hultgren et al. (ViP internal).

ViP PM 2016-5: ViP Lesson Learned – Implementing and Using the ViP Simulator Platform at Scania. Matteo Manelli et al. (public).

ViP PM 2016-6: SPASS – Strengthen Performance Active Safety Simulator. Martin Fischer et al. (public).

Doctoral and Licentiate Theses with ViP Contributions

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Benderius, Ola (2012). Driver Modeling: Data collection, model analysis, and optimization. Licentiate Thesis, Chalmers University of Technology, Department of Applied Mechanics, Gothenburg, Sweden.

Fagerlönn, Johan (2011). Designing Auditory Warning Signals to Improve the Safety of Commercial Vehicles. Doctoral Thesis, Luleå University of Technology, Department of Business Administration Technology and Social Sciences, Luleå, Sweden.

Kusachov, Artem (2016). Motion Perception and Tire Models for Winter Conditions in Driving Simulators. Licentiate Thesis, Chalmers University of Technology, Department of Applied Mechanics, Gothenburg, Sweden.

Ljung Aust, Mikael (2012). Improving the Evaluation Process for Active Safety Functions. Addressing Key Challenges in Functional Formative Evaluation of Advanced Driver Assistance Systems. Doctoral Thesis, Chalmers University of Technology, Department of Applied Mechanics, Gothenburg, Sweden.

Markkula, Gustav (2013). Evaluating vehicle stability support systems by measuring, analyzing, and modeling driver behavior. Licentiate Thesis, Chalmers University of Technology, Department of Applied Mechanics, Gothenburg, Sweden.

Markkula, Gustav (2015). Driver behavior models for evaluating automotive active safety. Doctoral Thesis, Chalmers University of Technology, Department of Applied Mechanics, Gothenburg, Sweden.

Nilsson, Peter (2015). On Traffic Situation Predictions for Automated Driving of Long Vehicle Combinations. Licentiate Thesis, Chalmers University of Technology, Department of Applied Mechanics, Gothenburg, Sweden.

Tagesson, Kristoffer (2015). Truck Steering System and Driver Interaction. Licentiate Thesis, Chalmers University of Technology, Department of Applied Mechanics, Gothenburg, Sweden.

Thorslund, Birgitta (2014). Effects of hearing loss on traffic safety and mobility. Doctoral Thesis, Swedish Institute for Disability Research and Linköping University, Department of Behavioural Sciences and Learning, Linköping, Sweden.

Journal Papers and Book Chapters

2016

Fors, C., Ahlström, C., & Anund, A. (2016). A comparison of driver sleepiness in the simulator and on the real road. Journal of Transportation Safety & Security. Online publication, 2016-08-31.

Hjälmdahl, M., Krupenia, S., & Thorslund, B. Driver behaviour and driver experience of partially and fully automated truck platooning: a simulator study. Submitted to ETRR European Transport Research Review.

2015

Anund, A., Lahti, E., Fors, C., & Genell, A. (2015). The effect of low-frequency road noise on driver sleepiness and performance. PloS ONE, 10(4): e0123835. doi:10.1371/journal.pone.0123835.

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Benderius, O., Markkula, G., Wolff, K., & Wahde, M. (2014). Driver behaviour in unexpected critical events and in repeated exposures – a comparison. European Transport Research Review, 6, pp. 51-60.

Markkula, G., Benderius, O., & Wahde, M. (2014). Comparing and validating models of driver steering behaviour in collision avoidance and vehicle stabilization. Vehicle System Dynamics, 52 (12), pp.1658-1680.

Thorslund, B., Ahlström, C., Peters, B., Eriksson, O., Lyxell, B., & Lidestam, B. (2014). Cognitive workload and visual behavior in elderly persons with hearing loss. European Transport Research Review. Online publication, 2014-05-29, pp. 1-9. doi:10:1007/s12544-014-0139-z.

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Markkula, G., Benderius, O., Wolff, K., & Wahde, M. (2013). Effects of experience and electronic stability control on low friction collision avoidance in a truck driving simulator. Accident Analysis & Prevention, 50, pp. 1266-1277.

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Ahlström, C., Kircher, K., Rydström, A., Nåbo, A., Almgren, S., & Ricknäs, D. (2012). Effects of visual, cognitive and haptic, tasks on driving performance indicators. In N.A. Stanton (Ed.), Advances in Human Aspects of Road and Rail Transportation. Special Issue from the 4th International Conference on Applied Human Factors and Ergonomics, and 1st International Conference on Human Factors in Transportation, pp. 673-682. CRC Press

Eriksson, L., Bolling, A., Alm, T., Andersson, A., Ahlström, C., Blissing, B., & Nilsson, G. (2012). LDW or rumble strips in unintentional lane departures: Driver acceptance and performance. In N.A. Stanton (Ed.), Advances in Human Aspects of Road and Rail Transportation. Special Issue from the 4th International Conference on Applied Human Factors and Ergonomics, and 1st International Conference on Human Factors in Transportation, pp. 77-86. CRC Press.

Ljung Aust, M., Engström, J., & Viström, M. (2013). Effects of forward collision warning and repeated event exposure on emergency braking. Transportation Research Part F: Traffic Psychology and Behaviour, 18, pp. 34-46.

Johansson, E., Karlsson, E., Larsson, E., & Eriksson, L. (2012). Implementation and evaluation of lane departure warning and assistance systems. In N.A. Stanton (Ed.), Advances in Human Aspects of Road and Rail Transportation. Special Issue from the 4th International Conference on Applied Human Factors and Ergonomics, and 1st International Conference on Human Factors in Transportation, pp. 37-46. CRC Press.

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Fagerlönn, J. (2011). Urgent alarms in trucks: effects on annoyance and subsequent driving performance. IET Intell. Transp. Syst., Vol. 5, Iss. 4, pp. 252-258.

Fischer, M., Sehammar, H., Ljung Aust, M., Nilsson, M., & Weiefors, H. (2011). Advanced driving simulators as a tool in early development phases of new active safety functions. Journal of Advances in Transportation Studies (RSS2011 Special Issue), December 2011, pp. 171-182.

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Sandin, J., Fischer, M., Eriksson, L., Augusto, B., & Nocentini, A. (2016). Effects of Sensory Cues on Perceived Simulated Speed. Proceedings of the Driving Simulation Conference & Exhibition (DSC 2016 Europe VR), 7-9 September 2016, Paris, France, pp. 171-178.

2015

Andersson, A., Andersson Hultgren, J., Leandertz, R., Johansson, M., Eriksson, S., & Jakobson, O. (2015). A Driving Simulation Platform using Distributed Vehicle Simulators and HLA. Proceedings of the Driving Simulation Conference & Exhibition Europe (DSC 2015 Europe), 16-18 September 2015, Tübingen, Germany, pp. 123-130.

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Sandin, J., Augusto, B., Nilsson, P., & Laine, L. (2015). A Lane-Change Gap Acceptance Scenario Developed for Heavy Vehicle Active Safety Assessment: A Driving Simulator Study. Proceedings of the 3rd International Symposium on Future Active Safety Technology Towards zero traffic accidents (FAST-zero’15), 9-11 September 2015, Gothenburg, Sweden, pp. 537-543.

Sandin, J., Augusto, B., Johansson, R., Svanberg. B., & Petersson, M. (2015). Evaluation of a Run-off-Road Scenario for Driving Simulators used for the Assessment of Automatic Steering-Wheel Interventions. Proceedings of the 3rd International Symposium on Future Active Safety Technology Towards zero traffic accidents (FAST-zero’15), 9-11 September 2015, Gothenburg, Sweden, pp. 545-550.

Thorslund, B., & Jansson, J. (2015). Effects of hearing loss shown in both driving simulator and real traffic. Proceedings of the 3rd International Symposium on Future Active Safety Technology Towards zero traffic accidents (FAST-zero’15), 9-11 September 2015, Gothenburg, Sweden, pp. 637-641.

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Hjort, M., Källgren, L., Augusto, B., & Fröjd, N. (2014). Evaluation of truck cabin vibration by the use of a driving simulator. Proceedings of the 13th International Symposium on Heavy Vehicle Transport Technology (HVTT13), 27-30 October 2014, San Luis, Argentina.

Jansson, J., Sandin, J., Augusto, B., Fischer, M., Blissing, B., & Källgren, L. (2014). Design and Performance of the VTI Sim IV. Proceedings of the Driving Simulation Conference Europe (DSC 2014), 4-5 September 2014, Paris, France, pp. 4.1-4.7.

Lahti, E., Genell, A., & Anund, A. (2014). SleepNoise. A simulator based study of the effects of noise on driver drowsiness. Proceedings of the Driving Simulation Conference Europe (DSC 2014), 4-5 September 2014, Paris, France, pp. 21.1-21.4.

Nilsson, P., Laine, L., & Jacobson, B. (2014). Performance characteristics for automated driving of long heavy vehicle combinations evaluated in motion simulator. Proceedings of the IEEE Intelligent Vehicles Symposium, 8-11 June 2014, Dearborn, Michigan, USA. pp. 362-369.

Sandin, J., & Nilsson, P. Drivers' Assessment of Driving a 32 Meter A-double with and without full automation in a moving base simulator. Proceedings of the 13th International Symposium on Heavy Vehicle Transport Technology (HVTT13), 27-30 October 2014, San Luis, Argentina.

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Jansson, J. (2013). Driver Reactions to Horn and Headlight Warnings in Critical Situations – A Simulator Study. 16th International Conference Road Safety on Four Continents (RS4C), 15-17 May, 2013, Beijing China.

Nilsson, L. (2013). Evaluation of Human-Machine-Interaction in relation to Driver Assistance Systems and presentation of the competence centre ViP. 2nd International Symposium on Traffic Safety, Tongji University, 19 May 2013, Shanghai, China.

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Anund, A., & Fors, C. (2012). Driving in tunnel and the effect on sleepiness. Poster at the 4th International Conference on Applied Human Factors and Ergonomics and 1st International Conference on Human Factors in Transportation, 21-25 July 2012, San Francisco, US.

Fischer, M., Eriksson, L., & Oeltze, K. (2012). Evaluation of methods for measuring speed perception in a driving simulator. Proceedings of the Driving Simulation Conference Europe (DSC 2012), 6-7 September 2012, Paris, France, pp. 71-93.

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Ahlström, C., Kircher, K., & Sörner, P. (2011). A field test of eye tracking systems with one and three cameras. 2nd International Conference on Driver Distraction and Inattention, 5-7 September 2011, Gothenburg, Sweden.

Fischer, M., Sehammar, H., Jansson, J., Nilsson, M., Normén, A., Ekström, J., Kristiansson, U., Pettersson, S., & Weiefors, H. (2011). Integration of vehicle electrical system components and production code active safety functions into a driving simulator. International Symposium on Dynamics of Vehicles on Roads and Tracks (IAVSD'11), 14-19 September 2011, Manchester, England.

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Ceci, R. (2010). Driver workload in simulated road tunnels - Possible implications for ITS applications. 17th ITS World Congress "Ubiquitous ITS", 25-29 October, 2010, Busan, Korea.

Fagerlönn, J. (2010). Distracting effects of auditory warnings on experienced drivers. 16th International Conference on Auditory Display (ICAD-2010), 9-15 June, 2010, Washington, D.C, USA.

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Nilsson, L. (2009). ViP Development and application of driving simulator methodology. Human Factors and Ergonomic Society Europe Chapter (HFES-EC), Annual Meeting, 14-16 October 2009, Linköping, Sweden (Poster presentation).

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Photo gallery



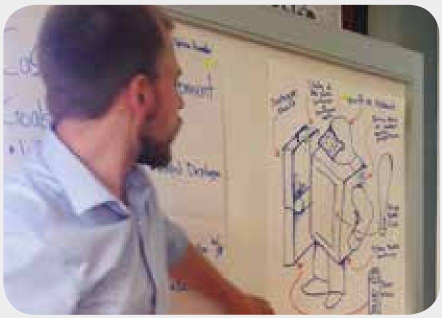








“The most important resource in ViP is the people involved and their competence”



ViP is the People Involved

Members of the ViP Board, per 2016

Per-Olof Boström (chairman) Martin Nilsson Volvo Car Corporation Stefan Edlund AB Volvo Torkel Varg Scania CV AB Ulrika Landelius Swedish Transport Administration Jonas Jansson VTI Patrik Holm HiQ (representing the other parties) Claes de Serves VINNOVA (co-opted member)

Previous Board members

Arne Nåbo Saab Automobile Hans Fils Scania CV AB Kristoffer Johansson HiQ (representing the other parties) Pontus Matstoms VTI Stein Knibestöl Dynagraph (representing the other parties) Torbjörn Alm HiQ (representing the other parties) Ulf Eriksson Swedish Transport Administration Urban Christiansson Volvo Car Corporation

Members of ViP Operational Team at VTI, per 2016

Lena Nilsson Centre director Annika Norberg Finances and project administration Christina Karlsson Information and communication Jonas Andersson Hultgren Technical support Pia Lindström Project generation

Previous ViP Team members

Erik Rothzén, Margareta Klang, Finances and project administration

Members of ViP Evaluation Committee (EC)

Anna Selmarker and Martin Dillman Scania CV AB Dennis Saluäär and Kristoffer Tagesson AB Volvo Robert Broström and Staffan Davidsson Volvo Car Corporation Ruggero Ceci Swedish Transport Administration Arne Nåbo and Anna Anund VTI Carl Johan Andhill and David Orebäck Dynagraph Jonas Larsson and Henrik Stenström Empir Calle Isakson and Torbjörn Alm HiQ Ingemar Söderlund and Martin Krantz Smart Eye Göran Nilsson and Björn Johansson Swedish Road Marking Association

Previous EC members

Annie Rydström Volvo Car Corporation Erik Wikenhed AB Volvo Helene Karlsson Dynagraph Henrik Bergström Empir Ingrid Pettersson Volvo Car Corporation Jonas Jansson VTI Leif Johansson Dynagraph Rolf Hultman Bombardier Per Strömgren Swedish Road Administration Alexandra Semitcheva Swedish Road Administration Sven-Olof Lundkvist VTI

Partners

SCANIA

vti

VOLVO

empir
IT knowledge by experience

smarteye

HiQ

TRAFIKVERKET

SVMF

DYNAGRAPH

VINNOVA

ViP
Driving Simulation Centre