SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Stage 2 report

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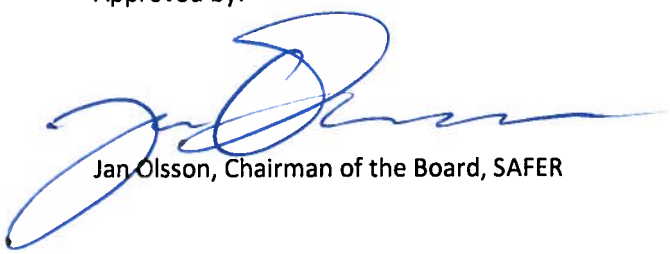

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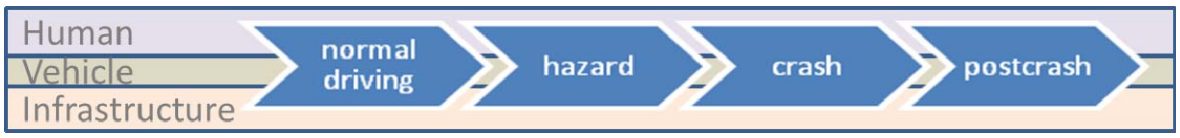
0. Summary - Popular version

SAFER is a vehicle and traffic safety centre, inaugurated in 2006. It is comprised of 24 partners from industry, academy and public authorities; Chalmers is the host and Vinnova the funding agency. The vision is to provide **excellent multi-disciplinary** research and **collaboration** to eliminate fatalities and serious injuries, making the partners from **society, academy and industry world leaders** in vehicle and traffic safety. The approach is to take a holistic, system approach to traffic safety This covers the influence of man, vehicle and infrastructure on safety during ordinary traffic, hazardous situations, incidents, accidents and post-crash rescue as schematically shown below. This approach guides the organisation of SAFER.



SAFER has managed to connect partners that individually are leaders in specific areas but together have a broader knowledge and resource base for addressing challenges in vehicle and traffic safety. Research at SAFER addresses topics encompassing a wide range of research areas and disciplines, spanning from deep technical issues to behavioural science on humans and from biomechanics of humans to organisation of infrastructure. To handle this SAFER has established twelve competence areas that gather researchers from all partners and from international networks. Researchers from different areas come together and do safety research projects. These research projects are grouped in four project portfolios, Pre-crash, Crash, Post-Crash and Traffic Safety Analysis. Presently 55 projects are ongoing and 217 persons are present at SAFER on a regular basis, whereof 97 are from Chalmers and 120 are from the other partners.

Some noteworthy results that exemplify SAFERs different activities are:

- The researchers at SAFER and its partners have established strong collaborations and exchanges with a number of national and international partners. For example, in the areas of Driver Behaviour and Traffic Safety Analysis, SAFER has, with the strategic use of the combined competences within Field Data (driving studies and accident investigations) and Behaviour in Accident Causation, managed to become one of the world leaders in the area of Naturalistic Driving Studies in just a few years. SAFER was newly awarded a prestigious analysis project from the Strategic Highway Research Program 2 (SHRP2) in the US.
- 110 publications produced (articles, conference papers, and reports) from projects at SAFER. In addition 9 dissertation thesis and 13 licentiate thesis have been completed by PhD students working in the SAFER environment. Pre-studies in Real-time wireless communications vehicle-vehicle and vehicle-infrastructure have resulted in multiple scientific publications and paved the way for Prof. Erik Ström to become the lead editor for the Proceedings of IEEE special issue on Vehicular Communications.
- Within the area of human modelling SAFER now provides a competence platform and a natural contact point for external cooperation for the SAFER partners. SAFER has a front position in whiplash injury biomechanics, child safety, and pedestrian safety.
- SAFER growth, in terms of annual project portfolio turnover, is on target with the goal to reach 200 MSEK by 2016. This is due to successful leverage of SAFER own resources, consisting of an annual budget of 11 MSEK cash and 19 MSEK partner in-kind.

SAFER has been a resource for all the partners by creating a focal point in Sweden for vehicle and traffic safety dialogue and collaboration. The ability for diverse SAFER organisations to quickly and effectively discuss strategic issues has lead to some notable support to regional cluster developments and research infrastructure and was an important contributor to the successful application by Chalmers for strategic research funding.

0.1 Summary

SAFER – Vehicle and Traffic safety Centre at Chalmers – started in 2006, finished Stage 1 in 2009 and will reach the end of Stage 2 on March 31st, 2012. Our vision is to provide **excellent multi-disciplinary** research and **collaboration** to eliminate fatalities and serious injuries, making the partners from **society, academy and industry world leaders** in vehicle and traffic safety. The SAFER strategy is to take a holistic, system approach to traffic safety. SAFER connects partners that individually are leaders in specific areas but together have a broader knowledge and resource base for addressing challenges in vehicle and traffic safety. By performing collaborative, multi-disciplinary research across organizational borders new expertise and research facilities will be developed. New findings will also be implemented faster when all the different stakeholders can meet in a common environment. SAFER acts as an open innovation platform with clear guiding values. Two new partners have joined during Stage 2, and SAFER now has twenty-four partners in total.

Research at SAFER addresses topics encompassing a wide range of research areas and disciplines. The competence profile at SAFER is multi-disciplinary, spanning across the technical research areas of mechanical engineering, computer engineering, and sensor technology. Human issues are also addressed and include biomechanics, human factors, and psychology. In all areas, supporting expertise in statistics, mathematics, and computational techniques are available. Twelve competence areas have been identified as essential in order to cover SAFER's scope of research and innovation: Field Data, Behaviour in Accident Causation, Human Factors Design, Driving Simulator Applications, Sensors and Communication, Functional Safety, Vehicle Dynamics, Infrastructure, Structures and Materials, Protective Systems, Biomechanics, and Traffic Systems. SAFER has developed a strong international reputation in the area of traffic and vehicle safety. As a research centre of excellence SAFER has produced notable results such as:

- SAFER has built a knowledge base that can address the chain from investigating the causes and impacts of incidents and accidents, developing preventive measures (technical as well as societal), and evaluating the effects. The overall purpose of the competence areas is to share and develop new knowledge through establishing networks incl. visiting researchers, arranging seminars and courses, identifying knowledge gaps, and initiating new R&D projects in order to close these gaps.
- Fundamental for research activities and development of competences are the facilities. Practical and easily accessible working spaces and meeting rooms within the centre have greatly increased the opportunities for frequent and engaged dialogues between experts with expertise in different areas. In addition, the partners have access to several advanced testing and evaluation facilities.
- The formation of SAFER has increased the dialogue and interaction between the partners. Since the establishment of SAFER, new types of collaborations have been established and new projects have been initiated within the centre. In particular inter-disciplinary projects, involving several disciplines, can be regarded as a result.
- The researchers at SAFER and its partners have established collaborations and exchanges with a number of national and international partners, both academic and non-academic. For example, in the area of driver behaviour, collaborations have been established with, e.g., the French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR), University of Wisconsin, *University of Michigan Transportation Research Institute (UMTRI)* and Chemnitz Technical University.

The research program at SAFER is distributed in the four project portfolios Pre-Crash, Crash, Post-Crash and Traffic Safety Analysis and currently comprises 55 projects. Some main results are:

- Successful growth of the research portfolios due to developments in partner expertise and reputation.
- 110 publications (articles, conference papers, and reports) from projects at SAFER. In addition 9 dissertation thesis and 13 licentiate thesis have been completed by PhD students working in the SAFER environment.
- The formation of SAFER has brought experts from the partner organizations closer and in particular allowed for an expansion of Chalmers safety research.

- SAFER has, with the strategic use of the combined competences within field tests and accidentology, managed to become one of the world leaders in the area of Naturalistic Driving Studies (NDS) in just a few years. As a confirmation of its new expertise, SAFER was newly awarded a prestigious analysis project of NDS Data from the Strategic Highway Research Program 2 (SHRP2) in the US.
- SAFER has, based on the experience from the project SeMiFOT, a major role in the performance of the European Commission 7th Framework Programme (7FP) supported project "EuroFOT".
- Begun to address needs for new physical test methods for evaluation of various types of active safety systems. The results from the first SAFER projects in this area are already being used by several partners in national and international projects.
- The SAFER research about elderly people in traffic has been expanded with a joint-research project together with MOVEO, France.
- Three SAFER student teams had high rankings (2nd, 3rd and 4th positions out of 9) in an international competition on cooperative driving in Holland in May 2011. The industrial partners together with researchers and teachers are forming a follow-up project due to the successful results in terms of establishment of a national competence platform, visibility and attention for products and research, and student engagement.
- The multi-stakeholder SEVS project, initiated by SAFER in collaboration with Swedish Hybrid vehicle Centre (SHC), delivered four scenarios with seven concept vehicles exploring the issues of future Safe, Efficient Vehicle Solutions. This has led to several new research projects (national and EU) and affected organisation and strategy for some partners.
- Within the area of human modelling SAFER now provides a competence platform and a natural contact point for external cooperation for the SAFER partners. Significant research steps have been taken.
- SAFER has a front position in whiplash injury biomechanics, child safety, and pedestrian safety. Other strong areas are brain injury and thorax-shoulder biomechanics. SAFER has a strong reputation in the development of crash dummies, and biomechanical assessment methods.

A common theme among partners, when describing the value and impact of SAFER, is competence creation and maintenance. Through the involvement of partner staff in SAFER activities, networks, and projects, expertise that is created and exploited in the partner organisations will eventually lead to faster and more precise implementation and innovation. The total amount of in-kind contributions is already well delivered and distributed within SAFER. Some partners are yet to fully consume their committed resources while others deliver far more than their original expectations. SAFER growth, in terms of annual project portfolio turnover, is on target with the goal to reach 200 MSEK by 2016. This is partly due to leverage of SAFER funding in own projects that has led to successful applications to national and international (mainly European) research programs.

ISAB (the SAFER International Scientific Advisory Board) has been established and had their first visit. Their findings and recommendations are valuable input to Stage 3 planning.

SAFER has been a resource for all the partners by creating a focal point in Sweden for vehicle and traffic safety dialogue and collaboration. The ability for diverse SAFER organisations to quickly and effectively discuss strategic issues has lead to some notable support to regional cluster developments and research infrastructure and was an important contributor to the successful application by Chalmers for strategic research funding. SAFER is located in Lindholmen Science park and has an office of 1500 m². 217 people have own access to the SAFER facilities.

1. Long-term Vision, Mission and Strategy

Vision - Borderless research to save lives

SAFER provides **excellent multi-disciplinary** research and **collaboration** to eliminate fatalities and serious injuries, making the partners from **society, academy and industry world leaders** in vehicle and traffic safety.

Mission - Enhance Traffic Safety

- Run collaborative research projects with excellent academic publications and high relevance to society and industry. Explore new research areas through pre-studies and participation in international networks.
- Combine the multi-disciplinary scientific competence available within SAFER to enhance scientific excellence as well as innovation capability.
- Serve as an open innovation centre for partners and international researchers and provide the prerequisites for creative and productive research collaboration
- Develop world-class competence, including research tools and methods
- Inspire students, researchers and product developers to be devoted to traffic safety.
- Disseminate results and knowledge to society.
- Be a well renowned international centre of excellence.

Strategy

SAFER strives to take a holistic systems approach to traffic safety. This covers the influence of man, vehicle and infrastructure on safety during ordinary traffic, hazardous situations, incidents, accidents and post-crash rescue as schematically shown in figure 1 below. This approach guides the organisation of SAFER.

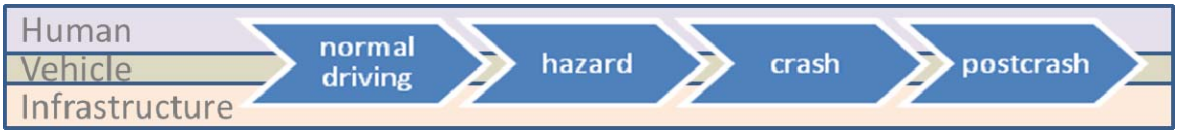


Figure 1. *Concept of holistic systemic approach to traffic safety.*

SAFER connects partners that together have a broad understanding and together can enhance traffic safety through different, complimentary contributions. By performing collaborative, multi-disciplinary research across organisational borders excellent competence and knowledge will be developed. New and sometimes ground-breaking findings will be implemented faster in all aspects of society, government policy, industrial applications and educational programmes.

SAFER develops a unique identity with clear **values** such as openness, respect for each other, curiosity, joy and **processes** for project initiation and execution, quality assurance, information sharing and **resources** such as a common workplace, data-bases, methods and tools and infrastructure for research. Creativity is a hallmark and thrives on diversity in all aspects and borderless networks seeking and attracting high competence where it is to be found.

SAFER grows by using its own resources as "seed funding" in chosen Focus Topics. This creates results that attract external research funding, new partners and excellent researchers.

2. Research Area, Competence Profile and Critical Size

The research at SAFER concerns vehicle and traffic safety, a topic which encompasses a large number of research areas and disciplines. The competence profile at SAFER is multi-disciplinary, spanning from mechanical engineering, computer engineering, and sensor technology to biomechanics, human factors, psychology, and statistics. This broad basis is possible through the contribution of the different partners. As part of the overall strategy, the competence is developed and nourished in Competence Areas. The core of a Competence Area is academia but all SAFER partner researchers are equally important. The competence supply at SAFER is based on the notion that the partners (institutes, industry, university) make resources available, recruit personnel when needed and develop the competences identified as crucial. Each group is led by a Competence Area Leader who also participates in the Extended Management Group as well as the Reference Group (see section 7). This allows for an influence on the research project portfolio at SAFER and ensures multi-disciplinary collaboration across research fields.

Twelve partially overlapping areas have been identified as essential in order to cover SAFERs scope of research and innovation (see table 1). They provide SAFER with an overall view of the process, from investigating the causes and impacts of incidents and accidents, to developing preventive measures (technical as well as others), and evaluating the effects.

Table 1. *Overview of Competence Areas.*

Competence Area *Keywords*	**Area Leader**	**Partners**
Field Data *Methodology, accident monitoring, investigation, and analysis*	Dr Hans Norin, Chalmers	Chalmers, Sahlgrenska University Hospital, Volvo Cars, AB Volvo, Saab Automobile, Scania, Autoliv, Swedish Transport Administration, TØI Norway, Folksam, VTI
Behaviour in Accident Causation *Analysis of human behaviour, deriving safety priorities*	Dr Trent Victor, AB Volvo	AB Volvo, Chalmers, Volvo Cars, Saab Automobile, Autoliv, Swedish Transport Administration, TØI Norway, VTI
Human Factors Design *Human-centred development, design principles, HMI*	Prof MariAnne Karlsson, Chalmers	Chalmers, Gothenburg University, Autoliv, AB Volvo, Saab, VTI
Driving Simulator Applications *Methodology*	Dr Lena Nilsson, VTI	Chalmers, VTI, Volvo Cars, Viktoria Institute, AB Volvo, Saab Automobile, SP, Swedish Transport Administration, Autoliv
Sensors and Communication *Sensor technology, signal processing, wireless communications*	Prof Erik Ström, Chalmers	Chalmers, Imego, SP, Viktoria Institute, VTI, Epsilon, Volvo Cars, AB Volvo, Saab Automobile, Autoliv, TØI, Swedish Transport Adm.
Functional Safety *Overall safety life cycle, fault detection, ASIL*	Jan Jacobsson, SP	Chalmers, SP, Volvo Cars, AB Volvo, Autoliv, Saab Automobile, Scania
Vehicle Dynamics *Vehicle motion; sensing/estimation and optimisation/control*	Prof Bengt Jacobson, Chalmers	AB Volvo, Scania, Volvo Cars, Saab, VTI, KTH, Chalmers
Structures and Materials *Modelling and characterisation of advanced materials, crashworthiness assessment*	Dr Martin Fagerström, Chalmers	AB Volvo, Autoliv, Chalmers, Epsilon, Saab Automobile, SP, Volvo Cars, VTI, Swerea SICOMP
Protective Systems	Prof Mats Svensson,	Autoliv, Sahlgrenska Academy, Chalmers, IMEGO,

Biomechanics *Biomechanics, human body modelling*	Chalmers	AB Volvo, Volvo Cars, Saab Automobile, Folksam, SP, the Swedish Transport Administration, VTI
Traffic Systems *Analysis of accident avoidance on the system level*	Dr Cristofer Englund, Viktoria Institute	KTH, Chalmers, Halmstad University
Infrastructure *Design of roads and road way structures incl. communication*	Vacant	

The overall purpose of the Competence Areas are to share and develop new knowledge through e.g. establishing networks incl. visiting researchers, arranging seminars and courses, identifying knowledge gaps and initiating new R&D projects in order to close these gaps. It is the responsibility of each Competence Area to know state-of-the art of global research and what's perceived as world-class research. Each should also have a short and long-term plan for competence development. To make this work, a close dialogue between the partners is a necessity. Academia has a special responsibility to ensure the scientific quality. In brief, the Competence Areas can be described as follows:

- **Field Data** includes competences involved in the whole chain from collection of data, analyses (case data and aggregated data), data storage and management, to effect analyses. The individuals involved have world-leading, long-term experience within accident monitoring, investigation and analysis.
- **Behaviour in Accident Causation** aims at understanding and quantifying the role that human behaviour plays in causing accidents, and at deriving safety priorities from this knowledge. Typical research activities include the design of experiments and epidemiological studies, quantitative analysis of driver performance and state, behaviour modelling, analysis of questionnaires and interviews, and development of driving behaviour theories. Close interaction with the Human Factors Design, Field Data Management, and Driving Simulator Applications Competence Areas is important.
- **Human Factors Design** is concerned with the interplay between human beings (users) and technical systems, how technical systems should be designed in order to achieve efficient, safe and satisfying interaction. In the SAFER context, this means sharing and developing further knowledge on, e.g. the behaviour of the driver in interacting with and using different in-vehicle safety systems or the pedestrian at road/street crossings given different design solutions. Interaction with other Competence Areas at SAFER is essential, in particular with Behaviour in Accident Causation and Field Data Management and Driving Simulator Applications.
- **Driving Simulator Applications** has the aim to build competence regarding simulator methodology and use in traffic and vehicle safety research, as an important complement to field studies and FOT/naturalistic studies. The area will be a forum for presenting and discussing methodological matters in relation to simulator studies carried out at SAFER. The Competence Area also has an important role in supporting other areas regarding methodological issues and experimental work.
- **Sensors and communication** are enabling technologies for active safety systems. Sensors, such as radars, cameras, pressure sensors, etc., are used to collect information. Signal processing is used to fuse, refine, and extract information from the sensor output and communications, wired as well as wireless, are used to transfer information. The aim is to develop competence by sharing know-how and identifying issues for future research and joint projects.
- **Functional Safety** is a key property as incorrect functionality may cause risks for the road users. All safety-related systems (e.g. active safety systems, brake control, engine control, steering and airbag control) have to provide the expected level of functional safety. The increasing number of programmable electronic systems in the automotive industry has stressed the need to ensure functional safety at the proper integrity level. The objective of the Competence Area Functional Safety is to build competence within the area, and to create a forum for exchanging experiences between experts.
- The Competence Area **Vehicle Dynamics** is concerned with vehicle motion, including sensing/estimation and optimisation/control. Of specific interest for safety is vehicle motion in ground plane and how vehicles are actually driven in real-life, safety-critical, traffic situations. The

ambition is to build further competence by forming a national and global network, coordinate research to close identified competence gaps, and secure competence through coordinated education (MSc, PhD, courses for engineers in industry).

- **Structures and Materials** has the aim of meeting the sharpened societal and environmental requirements on future vehicles without compromising with the high level of safety in vehicles of today. This is to be tackled by developing and implementing lighter materials and more advanced (adaptive) structures. Hence, the Competence Area incorporates internationally competitive competences and extensive experience in several essential areas: vehicle concept development, modelling and characterisation of advanced lightweight materials (e.g. composites, high strength steel, aluminium), component testing, joining technology and methods for crashworthiness and vehicle-to-vehicle compatibility assessment.
- The two areas **Protective Systems** and **Biomechanics** engage the same researchers. Competences include e.g. fundamental biomechanics of the brain, neck and thorax, human body modelling, child safety, and pedestrian kinematics. The overall aim of this area is to form a strong network in the field of biomechanics and protective systems that will assist in forming ad hoc task forces to address upcoming questions concerning impact biomechanics and protective systems. One vision is to create scalable and tuneable human body models that can represent a variety of different road user categories (size, age and gender) and that are able to respond with active muscles both pre-crash and in-crash. The ambition is to create and provide open access models that can be used and further developed by other researchers worldwide.
- **Traffic Systems** includes competences needed to perform research on accident avoidance by acting on the system level above the individual vehicles. This includes most ITS approaches and the area of cooperative systems design. When wirelessly connecting vehicles and letting them share information in a cooperative system, the overall performance in the traffic system regarding throughput, energy efficiency and safety will increase. The goal is to build competence around cooperative systems, functions and services, remote sensing and situation awareness that are enabled by communication between vehicles. The research activities will typically include: wireless communication, control theory, intelligent agents, data mining, HMI and system architecture.

Fundamental to research activities and the development of competences are the facilities. Practical and easily accessible working spaces and meeting rooms have greatly increased the opportunities for frequent and deep dialogue between experts with know-how in different areas. The partners have access to several advanced testing and evaluation facilities, including material characterisation and component testing (at Chalmers, Saab, SICOMP, SP, VCC), crashworthiness testing (at VCC, Autoliv, SP and VTI), and simulator studies (at Chalmers, VTI, VCC and Volvo). One result of the collaboration between the partners is that the S2 simulator at Chalmers has been improved by implementing VTI's graphics and sound software (increasing the compatibility between the Chalmers and VTI simulators) and fine tuning of the new hardware and software. SAFER has initiated and completed a driving simulator in order to have a simple HMI-simulator in direct connection to the SAFER environment, to be primarily used by master students connected to SAFER projects. SAFER is also actively involved in the plans for ASTA (Active Safety Test Area) within which a physical test environment with different types of test tracks will be created. The testing and evaluation facilities offered to the partners allow for a complete evaluation circle, from laboratory testing of sub-systems to field evaluations of complete human-technology systems.

SAFER is well-known and has a strong international reputation in the area of traffic and vehicle safety, in some key areas in particular. SAFER has e.g. a leading position in the area of biomechanics. SAFER also has a strong position in the development of crash dummies and biomechanical assessment methods. The growing activity in human body modelling has already placed SAFER among the more well-known organisations within Europe. Furthermore, SAFER has well-known expertise in experimental biomechanics. An area in which SAFER is developing spearhead competence and leadership is Field Operational Tests (FOTs) and Naturalistic Driving Studies, a relatively new research field with many actors from among the partners. SAFER is deeply committed to this field, within and beyond Europe. Developments are rapid, however, and a great deal of effort will be needed to stay at the forefront. An example of an area in which SAFER is moving forward is distraction and (in)attention. The development of a bi-annual international conference Driver Distraction and Inattention is one activity that has put

SAFER on the map. Another emerging topic is electric vehicles where SAFER has taken the initiative to understand how safety research issues are to be integrated in the basic aspects of new efficient vehicle concepts. This is of particular interest for lightweight design for crashworthiness, new protection systems for occupants and vulnerable road users and advanced vehicle and aero dynamics.

The formation of SAFER has increased the dialogue and interaction between the partners. Since the establishment of SAFER, new types of collaborations have been established and new projects have been initiated within the centre. In particular inter-disciplinary projects, involving several disciplines, can be regarded as a result. One example is the SHADES project (System Safety through the Combination of HMI and Dependable Systems) which combines behavioural science/human factors and engineering science (see section 11f, table 5.2). Another example is a recently granted project," Driver response to transient disturbances", dealing with drivers' response to external transients on the vehicle involving researchers from the areas of human factors, vehicle dynamics, and driving simulator studies (see section 11f, table 5.2). SAFER has also been a facilitator in bringing experts closer together and forming research teams, such as the behavioural expert team assembled for the SHRP2 project proposal (see section 11f, table 5.2). Two areas that have gained particularly by the collaboration within SAFER are child safety and human body modelling. Several SAFER partner organisations have joined forces under the SAFER umbrella and this has very clearly boosted the progress. Thus, the formation of SAFER has brought experts from the partner organisations closer and in particular allowed for an expansion of Chalmers activities that now are fully integrated in the SAFER office. This has helped to build a critical mass of researchers that have the SAFER office as their common arena. Another area where progress has been made is the methodology concerned with driving simulator studies. This topic has developed through fruitful collaboration between SAFER partners but importance must also be acknowledged the contact with ViP competence centre.

The researchers at SAFER and its partners have established collaborations and exchanges with a number of national and international partners, both academic and non-academic. For example, in the area of driver behaviour, collaborations have been established with, e.g., the French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR), University of Wisconsin, University of Michigan Transportation Research Institute (UMTRI) and Chemnitz Technical University. A network on human neuro-cognitive functions monitoring is under development. In the area of sensors and communication, cooperation has been ongoing for some years with, e.g., Lund University, Karlsruhe Institute of Technology and Vienna University of Technology. Regarding structures and materials collaboration is established within Europe through participation in the EU projects FIMCAR and ELVA but also outside Europe (primarily through VTI and Volvo Cars) with e.g. Japan Automotive Research institute (JARI), Japan Automobile Manufacturers Association (JAMA), European Enhanced Vehicle-safety Committee (EEVC), and the (US) National Highway Traffic Safety Administration. In the area of biomechanics and protective systems, collaboration involves e.g. Karolinska Institutet, the Royal Institute of Technology, Graz Technical University, Hannover Medical University, Japan Automobile Research Institute, and the Children's Hospital of Philadelphia. Collaboration and exchange is also under development with Delft Technical University and Toyota.

The different areas and groups have evidently reached different levels of maturity, i.e. some are well established (e.g. biomechanics), other areas are developing (e.g. driving simulator applications), and some are under establishment (e.g. traffic systems). In some cases, the number of senior researchers has reached a satisfactory level, in other areas further growth is essential in order to secure a positive development. However, at Chalmers the Area of Advance in Transportation has enabled senior researchers to increase their research activities on traffic safety. Significant funding has been devoted by Chalmers to also employ postdoctoral researchers as a means to increase the critical mass and complement existing competence.

3. Centre Partners – Companies and public service partners

The basic aim of SAFER is to enhance profound collaboration between the different stakeholders in Traffic Safety. The subject of Traffic Safety is important for a sustainable transport system but also important for Sweden in the sense that the Swedish automotive industry and its suppliers have safety as a core value and need to be among the world leaders to stay competitive. Swedish society and the national and regional traffic authorities also hold high aspirations in traffic safety and have successfully adopted measures in infrastructure design and legislation to enhance safety.

The driving forces behind SAFER's partner structure are both the evolution of good experiences and the foresight that accident avoidance means that new stakeholders need to be involved. Historically, successful collaborations between Chalmers and the vehicle industry in e.g. child safety and occupant protection has led to more complex collaborations such as the innovative research collaboration on whiplash injury protection. The evaluation of this in 2005 showed that some 100 MSEK in research funding gave more than 1900 MSEK in return to society. In addition, it increased competitiveness in the Swedish industry.

IT and new technologies associated with this open up the possibility for totally new solutions to accident avoidance. To grasp that opportunity, new competences and new partners have to become associated with traffic safety research and innovation. An important task for SAFER is to incorporate new partners and facilitate their integration and devotion to traffic safety. It is stated in the partner agreement that SAFER shall be active and open to new partners.

The organisation of SAFER, with four Reference Groups as the core operative structure, is designed to ensure that project initiation and set-up are based on a lively dialogue among the partners on future needs. The four Reference Groups (Pre-Crash, Crash, Post-Crash and Traffic Safety Analysis) are the formal arena for partners to meet and identify key issues and initiate needs-driven research. SAFER focuses on pre-competitive research such as understanding injury and accident/incident mechanisms, designing models, principles and concepts for developing counter-measures. When projects move into the competitive phases of system solutions and products, SAFER supplies researchers to industry.

When a project is started, it is important to agree on results and deliverables. Before a project is approved, it has to be described how it supports SAFER long term strategies and the expected outcome in terms of research as well as innovations, networks and competence. SAFER puts emphasis on long-term achievements, beyond the stage of advanced product development. Thus, SAFER gives priority to pre-competitive projects including many partners where the results may be taken further in the industrial PD-processes or initiate new research projects.

It is a core SAFER value to promote and achieve integration and strong links between the partners. This attitude influences all activities from weekly lunch seminars, to how the organisation is manned by all partners, to the set up of projects and the design of the office. One achievement has been to be accepted as a joint research unit (JRU) in European projects. SAFER can act as a partner consisting of several SAFER partners. This is valuable when a SAFER partner lacks the competence or resources to be on its own, or when there are too many Swedish partners and there needs to be only one or two for the balance in the consortium.

The original 20 founding partners were sprung from successful collaborations and complemented with safety-related institutes, industries and organisations. All of them have continued through Stage 2. Four new partners have joined; Viktoria Institute and TÖI (the Norwegian Institute of Transport Economics) during Stage 1, and Swerea IVF and City of Gothenburg, the Traffic and Public Transport Authority, during Stage 2. All partners (except for Vinnova) are presented in this section including Chalmers, the host of SAFER. The alignment of interest with SAFERs efforts and interaction with SAFER is further commented by the partners in section 5.

Autoliv, the worldwide leader in automotive safety, develops, manufactures and sells state-of-the-art automotive safety systems like air bags, seat belts, and safety electronics with sensors, with the aim to substantially reduce traffic accidents, fatalities and serious injuries. Autoliv has more than 43 000 associates, and facilities in all major vehicle producing countries. Autoliv's traffic safety research, Autoliv Research, is concentrated to Vårgårda in Sweden, where approximately 25 scientists and researchers work on accident analysis, bio-mechanics, human factors, safety restraints and sensing technologies for future safety systems.

Chalmers University of Technology is located in Gothenburg and focuses on research and education in technology, natural science and architecture. The University was founded in 1829 and was run as a private institution until 1937, when the institute became a state-owned university. In 1994, the school once again became a private institution, owned by a foundation. Chalmers has 11000 students and employs 2300 people of which 1600 belong to the faculty. Chalmers has 17 departments and mobilises its efforts around 8 areas of advance: Transport, Energy, Materials, Nano Technology, Production, ICT, Built Environment and Life Sciences. In 2010 Chalmers, received strategic research funding from the government to develop the Transport Area of Advance which is focusing on the development of three research profiles: *Traffic Safety*, *Transport Efficiency and Customer Adapted Logistics* and *Sustainable Vehicle Technologies*. The research is closely linked to education, innovation and implementation.

The Traffic and Public Transport Authority of the **City of Gothenburg** is working toward efficient, safe and sustainable mobility in the city. Apart from the major international and regional roads, the Traffic and Public Transport Authority is responsible for planning, constructing and maintaining the roads and tramlines in Gothenburg. The Authority is also responsible for improving the cycling infrastructure, and is a key actor in working for a modal shift towards extended use of public transport and cycling. With the overall responsibility for urban transport in Gothenburg, and with a long term commitment to improve road safety, the Authority has achieved considerable improvement, and the city can today be regarded as a forerunner in implementing and mainstreaming road safety into all aspects of planning, construction and maintenance.

Epsilon is a Swedish consultancy in technology and systems development. With around 1300 employees and 8000 independent partners and specialists in different networks, we operate in a broad market area. Two of our focus service areas are simulation-based development of passive safety systems and development of active safety systems. In order to be prepared for future technology challenges, it is our ambition to improve our skills and increase our experience in the area of vehicle and traffic safety.

Folksam, one of the largest insurance companies in Sweden, has a vision of contributing to the sustainable development of society, where road traffic safety is an important area. Folksam is one of the leading research organisations regarding analyses of real-world car crashes, including data from crash recorders installed in cars. Sweden is a leading country regarding safety in the road and transport system. One important factor for this success is probably that we have a tradition of cooperation between the different stakeholders in a multidisciplinary way.

Imego is a modern, business-oriented research institute that develops micro- and nanotechnology-based sensors and systems using the latest research results. Imego's business philosophy is to produce demonstrators, prototypes and products together with, and on behalf of, companies and researchers. Imego participates actively in SAFER to help tackle the sensor challenges of tomorrow's transport systems.

Lindholmen Science Park has brought together key players within intelligent vehicles and transport systems, mobile internet and modern media and design. All have overlapping interests regarding the advanced use of information and communication technology. One of the principal tasks of the company is to stimulate and create effective forms of cooperation between companies, universities and society.

Region Västra Götaland (VGR) is the public body responsible for healthcare and regional development in the region of Västra Götaland. VGR has a unique position by combining its two responsibilities, particularly supporting innovation and R&D industry collaborations within internationally competitive

focus areas such as safety, automotive and ICT, which are all represented in SAFER and Lindholmen Open Arena. VGR interacts with SAFER first and foremost through its clinical researchers and clinicians at Sahlgrenska University Hospital, who participate in research projects.

Saab Automobile AB is a premium car manufacturer with operations worldwide. Saab is marketing and selling cars in more than 50 countries worldwide. Saab is delivering world class safety performance and considers the research scope of SAFER to be an area of high priority for our future competitiveness, as well as for the Swedish vehicle industry as a whole.

Saab Electronic Defence Systems operations are based on our close interaction with customers requiring efficient solutions for surveillance and for threat detection, location and protection. This has created a unique competence in the area of radar and electronic warfare, and a product portfolio covering airborne, land-based and naval radar, electronic support measures and self-protection systems as well as sensors for civil security applications. For increased flight mission efficiency and flight safety we supply mission avionics and safety critical avionics computers for both civil and military customers.

Scandinavian Automotive Suppliers (FKG) is the association of automotive suppliers in Sweden, Norway and Finland and a member of Clepa. One of the cornerstones in the mission is to support skills development. Safety has long been an important part of the competitiveness of Swedish automotive brands. Therefore, it is imperative that Sweden stays on the cutting edge in terms of safety, and SAFER is an important research centre in the safety cluster.

Scania is one of the world´s leading manufacturers of trucks and buses for heavy transport applications, and of industrial and marine engines. The ambition is to supply the world's most demanding customers with the most competitive and optimal transportation solutions for their needs. Scania's research and development activities are concentrated in Sweden and about four percent of Scania's sales are invested in R&D. In order to guarantee a sustainable and efficient transport system, road safety is naturally one of Scania's main priorities and the cooperation with SAFER will continue to enhance on the topic of road safety. We find it of great importance to participate in world-class research. There is a need for a stimulating national research environment with multidisciplinary cooperation in order to provide leading edge competence for the future.

Swerea IVF offers advanced R&D and consulting services to the manufacturing and engineering industry. Our goal is the rapid introduction of new technologies and methods to practical use in our customers' operations. Our customers include industrial companies as well as public institutions. Swerea IVF is part of the Swerea Group, a Swedish industrial research group that encompasses Sweden's industrial research institutes within the fields of materials, process, product and production technology.

Swerea SICOMP AB is a Swedish non-profit research institute focusing on composites. SICOMP is involved in several international, European and national research programmes and has a history of close collaboration with the Swedish automotive industries, which has resulted in a number of test methods, simulation programs, patents, prototypes and commercial applications.

SP Technical Research Institute of Sweden is Sweden's largest, single-source resource for vehicle manufacturers and their suppliers. In addition to technical evaluation and research services, we offer certification of quality management systems and calibration of measuring equipment. With a turnover of more than SEK 1000 million, and a staff of 1030, SP is one of Sweden's largest research institutes. SP aims to establish strong clusters of research and innovation by cooperation with industry, universities and research institutes. SAFER forms just such a cluster.

The **Swedish Transport Administration** is assigned with the overall functionality for the road transport system. Our task is to co-operate with others to develop an efficient system in the direction stipulated by the Swedish Government and Parliament. We have been commissioned to contribute to a safe, environmentally sound and gender-equal road transport system that offers individuals and the business community easy accessibility and high transport quality. The work on traffic safety is based on "Vision Zero", meaning that no one should be killed or injured for life in traffic. So far, SAFER has given STA

access to a close and fruitful dialogue with stakeholders in the road transport system. The understanding of the future demands of the infrastructure has grown rapidly and STA consider itself to be in the forefront of modifying the infrastructure to the future vehicles.

TeliaSonera provides network access and telecommunication services that help people and companies communicate in an easy, efficient and environmentally friendly way. TeliaSonera is a partner in SAFER with the aim to learn more about how telecommunication can be used for road traffic safety.

TØI (Institute of Transport Economics) is a Norwegian national institution for transport research and development. The Institute was set up in 1958, and in 1986 the Institute became a private, independent research foundation. The Institute receives its annual base funding from the Research Council of Norway. An objective of the Institute is to carry out applied research on issues connected with transport and society. Its sphere of activity includes most of the current major issues in road, rail, sea and air transport. TØI has a long tradition in road safety research, especially the social, economic, and psychological perspectives. SAFER adds a valuable network, an inspiring research environment and opens up for collaboration.

With its eight faculties, the **University of Gothenburg** is the most wide-ranging and versatile university in Sweden, offering unique opportunities for cooperation and development. The university has extensive research in many areas of importance for SAFER. At the IT-faculty there are a number of research groups with connection to safety, e.g. Security, Interaction design and Software Engineering. The Sahlgrenska Academy has research in a number of areas highly relevant for vehicle safety.

The **Viktoria Institute** was founded in 1997 at the initiative of the local industry in West Sweden. Today, Viktoria Institute is a part of Swedish ICT. Their task is to do research and development in applied information technology in collaboration with the industry, the public sector and universities. The research focuses on vehicle and transportation, with ICT as the enabler towards sustainable mobility. Application areas are: Open Vehicle, Cooperative Systems, Electromobility, Vehicle Diagnostics and Sustainable Transports.

Volvo Car Corporation (VCC) designs, develops, manufactures and markets Volvo Cars in over 100 countries in 2010, sales amounted to 373,525 units. The company was founded in Sweden 1927 and currently employs about 19,500 people. The headquarter is situated in Gothenburg where you also find the main units within product development and design. During 2010, Zhejiang Geely Holding Group completed the acquisition of Volvo Car Corporation from Ford Motor Company. In order to strengthen the commitment to safety and the environment, a collaboration with the best researchers is needed. SAFER has proven to be such a centre of excellence.

The **Volvo Group** provides transportation-related products and services with a focus on quality, safety and environmental care. Our customers are active in more than 180 countries, and Volvo has a workforce of about 100,000 employees. Safety is a core value since many years. Volvo's goal is to reduce the risk of accidents as well as mitigate the consequences. Our long-term vision is zero accidents.

VTI, Swedish National Road and Transport Research Institute, is an independent and internationally prominent transport research institute. With about 190 employees, VTI is the largest transport research environment in Sweden. The institute has a broad competence profile, with key capabilities in the areas of safety, economy, environment, traffic- and transport analysis, behaviour and man-machine-transport system interaction. Besides the head office in Linköping, VTI is located in Borlänge, Stockholm, and in Göteborg where research focuses on vehicle technology and traffic safety.

4. Research Programme and results

SAFER's research programme comprises a large number of projects, as listed in appendix F, table 5.1. The total project portfolio together with the work/discussions in the Competence Areas as well as the planned and spontaneous interactions in the open innovation environment contribute to the results of SAFER and the competence growth of the individual researchers and partners.

A few noteworthy highlights are:

- Successful growth of research portfolio due to strong competence and reputation
- There are about 110 publications (articles, conference papers and reports) from both own and associated SAFER projects. In addition, 9 dissertation thesis and 13 licentiate thesis have been completed by PhD students working in the SAFER environment. All publications, also per Reference Group, can be seen in appendix G, table 6.1.
- A majority of the projects have three or more partners involved (see appendix F, table 5.1).
- The formation of SAFER has brought experts from the partner organisations closer and in particular allowed for an expansion of Chalmers activities that now are fully integrated in the SAFER office. This has helped building a critical mass of researchers that have the SAFER office as their common arena. It has become the natural and neutral meeting place for its partners.
- SAFER has, with the strategic use of the combined competences within field tests and accidentology, managed in just a few years to become one of the world leaders in the area of Driving studies. As a token of this position, SAFER was newly awarded a prestigious analysis project of NDS Data from Strategic Highway Research Program 2 (SHRP2) in the US, in strong competition with other highly knowledgeable research organisations.
- SAFER has, based on the experience from SeMiFOT, a major role in the performance of the European Commission 7th Framework Programme (7FP) supported project "EuroFOT"
- There is a need for new physical test methods for evaluation of various types of active safety systems. Several projects within SAFER address this need. The results of the first of these projects are already being used by several SAFER partners.
- The population of elderly people in many countries is increasing, and SAFER has taken on the task of gaining knowledge regarding their needs and the change in driving behaviour needed to sustain their transport mobility by using their cars as long as possible. The SAFER research has been expanded with a joint-research project together with MOVEO, France.
- Three SAFER student teams (Chalmers University of Technology, the Royal Institute of Technology and Halmstad University) with two cars (Volvo) and one heavy truck (Scania) made 2, 3 and 4 position in an international competition, the Grand Cooperative Driving Challenge, in Holland in May 2011. The vehicles were equipped with cooperative systems for platooning vehicles in car/vehicle trains in both city and highway driving. The industrial partners, together with researchers and teachers, are forming a follow-up project due to the successful results in terms of establishing a national competence platform, visibility and attention for products and research, and student engagement.
- The multi-stakeholder SEVS project, initiated by SAFER in collaboration with Swedish hybrid vehicle centre, delivered four scenarios with seven concept vehicles exploring the issue of future Safe, Efficient Vehicle Solutions. The insight how these vehicles must be valued in the context of the transport system (different in different scenarios) has led to several new research projects (national and EU) and effected organisation and strategy for some partners.
- The FIMCAR and THORAX projects have had extensive dialogues with the international research community and keep SAFER organisations connected to influential individuals and organisations in the area of crashworthiness.
- Within the area of human modelling, SAFER has been the driving force and facilitator for joining efforts and significantly increased the total number of researchers involved in the area. Today SAFER provides a competence platform and a natural contact point for external cooperation between SAFER partners. Significant research steps have been taken.

- SAFER has a leading position in whiplash injury biomechanics, child safety, and pedestrian safety. Other strong areas are brain injury and thorax-shoulder biomechanics. SAFER has a strong reputation in the development of crash dummies, and biomechanical assessment methods.

The Focus Topics constitute the framework for SAFER's research programme. The Focus Topics as a strategic tool in project selection were identified at the end of phase 1, and the contents have been refined during phase 2. The Focus Topics provide guidance and direction for growth and focus, and it is therefore natural to describe the results in relation to them. Each Focus Topic also includes a "living" road map outlining the desired long-term achievements and projects forming a discussion platform for the partners. Based on the discussion within the Focus Topics, synergy effects can be achieved by parallel projects and a critical mass of researchers can be obtained within the strategically chosen areas. At the moment there are six Focus Topics, guiding the priorities for SAFER, namely:

- Incidents and accidents – priorities and effect analysis
- Driver state/action/reaction
- Prediction for accident prevention
- Methods for evaluation of vehicle and traffic safety
- Safety for novel electric vehicles and vehicle combinations
- Human models and biomechanics

The content and achievements will be described in more detail for each Focus Topic below as well as more detailed results from the projects. Some projects are related to several Focus Topics and will thus be addressed multiple times in the aspect of the context. A short description of each project, except the competence projects, is found in appendix F, table 5.2. Since SAFER is an organisation involving volunteer cooperation between partners, the project ideas are mainly reactions to partner strategies and more seldom SAFER's own proactive projects. Efforts are however made to be more proactive through strategic discussions in the management teams and Reference Groups. The Focus Topics is an important tool for this.

Incidents and Accidents – Priorities and Effect Analysis

The Focus Topic of "Incidents and accidents – priorities and effect analysis" covers development of methods for collection, storage and analysis of field data together with the actual analysis of the data, to provide a holistic understanding of the causations and the effects of road incidents and accidents. The main research areas in this Focus Topic are Driving Studies, Accident Investigations, and parts of Post-Crash.

The area of *Driving Studies* covers activities within Naturalistic Driving Studies (NDS) and Field Operational Tests (FOT). Data from normal driving in real traffic with vehicles equipped with different types of sensors, i. e. cameras, GPS and eye tracking etc., will help the understanding of the causes of incidents and accidents. The area Driving Studies is an excellent example of how SAFER, with the strategic use of the combined competences within field tests and accidentology, have managed in just a few years to become one of the world leaders in this new area of research. As an expression of this position, SAFER was newly awarded a prestigious analysis project of NDS Data from Strategic Highway Research Program 2 (SHRP2) in the US, in strong competition with other highly knowledgeable research organisations.

The need for strategic planning and investments and strong commitment from the SAFER partners resulted in the competence project BASFOT(K1, table 11), starting in 2007. The project has been the platform for FOT/NDS activities such as project proposals, competence identification, networking including MOUs, visiting guest researchers and investments in NDS equipment. The "BASFOT" project was one of the key factors in SAFER's success within this area, as it facilitated regular strategic discussions and guided all activities. The "BASFOT" project ended in December 2009. The need to continue with the

project was identified and approved by the SAFER board. Project "BasFOT2" (K1, table 11) started in the beginning of 2010 and will continue until the end of SAFER Phase 2, in March 2012.

Driving Studies is a relatively new research area and therefore the focus has been knowledge development, methodology development and networking. To enable this, a number of extensive projects have been active during 2009-2011.

As a basic methodology project, the collaborative project between Sweden and the U.S., "SeMiFOT– Sweden Michigan Naturalistic Field Operational Test (C3)" was active 2008 through 2009, and was reported during 2010. This project gathered 13 organisations from the automotive industry, Swedish road authority and academia involved in the topic to further develop the Naturalistic FOT method. The results from SeMiFOT consist of tools and knowledge of how to perform a FOT/NDS through the entire chain of data collection, data storage and the analysis phase. The experience from "SeMiFOT" has given Sweden and SAFER's partners a central position in EU projects (e.g. "EuroFOT", "FOT-NET", "TeleFOT") and in international relations (e.g. "SHRP2", Sweden-Michigan Partnership and in Japanese collaboration). A new project "SeMiFOT2" (C12) started in January 2010 and will continue until October 2012. The main objectives were to further develop promising methods from "SeMiFOT" and thereby prepare SAFER for analysis projects such as "SHRP2". SAFER has, based on the experience from "SeMiFOT", a major role in the performance of the European Commission 7th Framework Programme (7FP)-supported project "EuroFOT (C2)". The project has 28 partners, including major European vehicle manufacturers, leading automotive technology suppliers and research institutes. The partners have conducted Europe-wide vehicle field tests to assess the impact of advanced driver assistance and preventive safety functions in real traffic conditions. The SAFER partners have been responsible for the subprojects Research and Hypothesis and Data Management Tools and have led the Task Force Data Sharing. As identified earlier, SAFER has successfully gathered data in Sweden, Holland and England from 100 cars and 30 trucks. The project is now in the analysis phase and will end in February 2012.

The 7FP project "FOT - Net (C6)", which was essentially a project for networking and information sharing, continued until the end of 2010. The project formed a strategic networking platform to facilitate for European and international stakeholders to present the results of FOTs/NDS, identify and discuss common working items and promote a common approach for FOTs. A continuation of this project "FOT - Net2 (C15)" was started in January 2011, where SAFER has taken the leading role in NDS and the Definition of Events and Incidents. A SAFER joint project with researchers from Japan was initiated and completed during 2009 (C4), where future collaboration areas were identified. This project resulted in several joint activities, such as seminars, visits by Japanese researcher to Sweden and visits from Swedish researchers to Japan. The project "DREAMi (C13)" is a result from this collaboration, where a promising method of applying the accidentology method DREAM to incidents shown on video is explored. Recently a SAFER project proposal for the SHARP2 S08 Analysis of the SHRP2 Naturalistic Driving Study Data has been approved. In competition with 23 applicant research teams from the US, SAFER was one of the four proposals selected with the review: "The review committee is pleased to receive a proposal from a highly qualified team with extensive experience and a wide range of subject matter expertise. Overall, the committee´s evaluation concluded that the proposal was responsive to the RFP and demonstrated understanding of the critical demands of this central project in the SHRP2 Safety Program." This is a very prestigious award and has undoubtedly strengthened SAFER's position in the area. The award and successful completion of the project may provide many additional opportunities for SAFER in the future. The project will start in the fall 2011.

The project "Comparative Analysis of Driver Behaviour between US and EU, based on Naturalistic Field Operational Test data (C17)" will transfer knowledge of FOT/NDS data between analysis experts while comparing datasets and data analysis procedures from European and American FOT studies. Another FOT area that is in an early phase of development is "Cooperative systems". The project "Drive C2X (C16)", dealing with FOT cooperative systems, will perform a comprehensive assessment of cooperative systems through extensive European Field Operational Tests. The project started in 2011 and will continue through 2013. SAFER together with Test Site Sweden is responsible for the Gothenburg Test Site. A newly started project, "Global Inattention Taxonomy Definition", will define a common taxonomy of attention failures to be used in accident databases and NDS. SAFER has developed a data management platform for FOTs and NDS in the SeMiFOT and euroFOT projects. To operate and further develop this

platform for future projects, a request for funding support has been submitted to the Research Council (Vetenskapsrådet), who will make a decision in November 2011.

The area of *Accident Investigation* has been a high priority for many years, and several of the SAFER partners have a long tradition and deep knowledge in the field. The goal is to maintain a leading position in the area and continue to be an internationally attractive partner. During the past year, some extensive projects have been ongoing. INTACT is a project with Swedish partners from the industry, Chalmers, and the Swedish Transport Administration. The project that started in 2007 and finished in 2010 has focused on developing methods to collect, store and analyze in-depth data from accidents. There has been an extensive and successful cooperation between the partners. A database platform for in-depth accident data has also been developed. An underlying purpose of the project was to prepare for the continuous collection of accident data at an in-depth level. At the end of 2009, a screening of the project was carried out (C10) to clarify whether a continuation of the project was desirable and possible for the SAFER partners involved. The result from this screening was very positive and preparations to continue the project were started. Creating an in-depth accident database was considered to be of great long-term importance for maintaining competence in the area, but also to ensure a better position in terms of applications for future International projects. Closely connected with the Swedish in-depth database plans is the project "DaCoTA (C5, C9)", which started in 2009 and will finish in 2011. This is an EU-project, which is a pilot project for a possible future data collection for the whole of Europe. The associated project "FICA2" focuses on developing methods for evaluating and verifying principles/systems within active safety. Knowledge from this and earlier FICA-projects was disseminated to other researchers via the project "Analysis of accidents and dangerous incidents in transport: Method development and opportunities for learning (C7)", where Transportøkonomisk Institutt, in Norway, and Chalmers have been the main active partners. This project finished in April 2010.

The Focus Topic is relevant to *Post-Crash* area because it deals with understanding real traffic situations and how to get correct information to the relevant response (rescue) actors and to communicate with them in real-time. In 2008 SAFER, Security Arena and the Viktoria Institute started a pre-study on sensor-assisted situational awareness (E1). This was successful and has led to two consecutive projects, "LiveResponse 2 (E3)" and "LiveResponse 3 (E4)". LiveResponse is about live video opportunities for emergency response work. The different response actors, like ambulance and rescue staff, share the same information that is broadcasted via mobile phone by the team "first-on-scene". Thus the understanding of the actual situation and the organisation of rescue work is significantly improved. These projects have been highly appreciated and the solutions are being implemented. It has created international interest. In November 2009, SAFER formulated a project (E5) together with TRIPP (The Transportation Research and Injury Prevention Programme at the Indian Institute of Technology) in New Delhi. In 2010, a MoU between SAFER and TRIPP was signed covering this project which compares long-term outcome for people injured by accidents in two different cases: "high-tech ambulance service" and "brought to hospital by any transport means".

Driver State/Action/Reaction

"Driver state/action/reaction" covers how we actually behave in traffic, not just how we are supposed to behave. It covers, for instance, permanent and temporary states of the driver, such as fitness for driving (impaired drivers), why and how we take risks and what we do to compensate for risks. It also covers the driver´s interaction with in-vehicle information systems (including nomadic devices) and interaction with advanced driver assistance systems, how the driver reacts to and accepts warnings as well as automatic interventions of active safety systems such as emergency braking.

The "Workshop on Cognitive Neuroscience and Driver Attention (A20)", which will take place in conjunction with the SAFER-organised conference on Driver Distraction and Inattention" in September 2011, will bring together leading scientists with an interest in cognitive neuroscience and visual attention with leading automotive industry researchers. The central topic of the workshop is how modern research in cognitive neuroscience regarding visual attention can be applied to the problem of driver distraction and inattention. The workshop as well as the conference are examples of how SAFER provides a platform for not only dialogue and research among partners but also for an international research community.

The project “Safety Assessment QUADRA – Quantitative Driver Behaviour Modelling for Active Safety Assessment (A15)” is the first project ever that aims at developing driver behaviour models to be used in computer simulations to evaluate active safety systems. This new type of evaluation tool for active safety systems can be compared with crash test dummies that have been used for a long time to evaluate passive safety systems. Within QUADRA, one industrial and one academic PhD student are working together to develop and verify quantitative models of driver behaviour, which can be applied in computer simulations with the purpose of evaluating, verifying and/or fine-tuning active safety systems.

The population of elderly people in many countries is increasing. To maintain their transport mobility by using their cars as long as possible, it is important to understand the needs of elderly drivers and their changing driving behaviour. A pre-study (A4) was performed in 2007 to investigate the safety needs within the growing field of senior drivers. A ongoing PhD project, “Safety for an Ageing Population 2 (A14)”,with the purpose of expanding research and establishing a well-reputed knowledge base within SAFER whilst further capitalising and expanding on the resources already allocated within the partners and forming a SAFER platform including using data retrieved from FICA, EuroFOT and more. This national project is complemented by a joint research project with France “SAFE MOVE (A27)”, that is derived from discussions with MOVEO and French researchers. "SAFE MOVE" has three complementing approaches. Factors leading to under- and overestimation of cognitive performances and driving ability will be studied. Possibilities for using a driving simulator for training and learning will be investigated. Developing assistance systems in the car itself will help keep older people driving longer.

When designing car HMIs, one of the challenges is how to inform the driver about the traffic situation and potential danger, to help the driver to drive in an environmental friendly way and to avoid accidents. Research investigating 'optimal' car HMIs is being done in a large project including four PhD students and different research domains at Volvo Cars, universities and institutes. The project is called "EFESOS - Environmental Friendly Efficient Enjoyable and Safety Optimized Systems" and focuses on visual and auditory displays with the aim of presenting information in a natural and intuitive way to avoid an extra workload and causing distraction. The project is halfway through and expands competence and promotes effective knowledge transfer between partners as the main result. It has a strong presence in the SAFER environment, with a majority of industrial researchers present, highlighting the innovations in this research field.

Vehicle Information Systems (IVIS) and Advanced Driver Assistance Systems (ADAS) are designed for the primary function without faults being present. However, errors do occur, and it will be very important to handle these errors, which can be driver errors or technical errors. The projects "SHADES I and II - System Safety through combination of HMI and DEpendable Systems” (A10, A28) take a holistic view, where the effects on road safety are studied regardless of whether the errors arise from poor HMI or technical malfunctions. PhD students employed at VTI and SP, respectively, work together in an interdisciplinary approach to handle errors in driver-safety systems. Also, similar research questions are studied by an Industrial PhD student at Volvo Cars within the project “Verification of Active Safety Functions”. This project has been ongoing since 2007 and implementation of the knowledge gained is transferred into the product development of new safety systems. A third project within the area is an EU project "ADAPTATION – Driver's Adaptation Processes in Response to ADAS use" where Volvo Technology is an active part. This project comprises nine other European academic and industrial partners and aims at studying the whole range of adaptation processes.

Prediction for Accident Prevention

The Focus Topic "Prediction for Accident Prevention" covers how different systems can predict a potential crash, and gives input to the control of the vehicle to avoid it. Technologies concerned are, for instance, real-time wireless communication (V2V and V2I), sensing of own vehicle's motion and behaviour and sensing of the surrounding traffic, signal/image processing and algorithms, functional safety, vehicle dynamics control systems, and the vehicle dynamics during automatic intervention of a crash avoidance system.

The project “Physical Layer Techniques for Vehicle-to-Vehicle Communications (A19)” is of basic research character in the area of vehicle-to-vehicle communication. It leverages results from two earlier pre-study projects in "Real-time wireless communications vehicle-vehicle and vehicle-infrastructure (AD2)" and "Wireless communication V2V and V2I (AD4)", in which the important research problems were identified. The pre-studies have resulted in multiple scientific publications and paved the way for Prof. Erik Ström (Competence Area Leader and member of the SAFER Extended Management Group) to become the lead editor for the Proceedings of IEEE special issue on Vehicular Communications, which was published in July 2011. The Proceedings of the IEEE is a very high-impact journal and the special issue has given SAFER valuable international visibility.

Another project within the area of V2V communication is the project "Principle Other Vehicle Warning (A23)". This is a joint project between SAFER and VIP (a “sister” centre on simulator methodology) aiming at evaluating the effectiveness of a warning given by one actor in a pending collision to the other actor for he/she to take an evasive action. With the area of V2I, a pre-study was run 2010 to investigate which traffic applications are suitable to develop based upon intelligent road marks. The Project "VISAS – Volvo Infotainment Support for Automotive Safety" study and develop infotainment and safety functions based on communication between car and infrastructure. One work package of the project deals with the active safety of pedestrians and bicyclists in urban intersections. Also, a pre-study "MASCOT – Personal Monitoring and Assisting System for Cooperative Applications Outdoors and in Traffic" has been recently started to evaluate the possible potential of a wearable system for detecting vulnerable road users.

Several studies have shown the high effectiveness of ESC (Electronic Stability Control) systems. These systems are standard equipment in new cars sold in many countries today. However, current ESC systems are not designed for sudden disturbances that can arise from curb contact, impacts with guard rails, lane edge drop offs, or minor vehicle impacts. The project “Enhanced/Robust Stability Control (AD3)” studies how these disturbances can be detected, analyzed and handled, for example by other vehicle control inputs such as steering, to work in conjunction with brake-based ESC systems. This work can form the basis for the next generation of ESC systems.

Two projects are run within the area of functional safety; "Functional Safety for Systems of Road Vehicles (A18)" and "BeSafe-Benchmarking of Functional Safety". The SAFER researchers are among the leading Swedish researchers in the area.

Three Swedish teams from Chalmers University of Technology, the Royal Institute of Technology and Halmstad University participated with two cars (Volvo) and one heavy truck (Scania) very successfully in an international competition, the Grand Cooperative Driving Challenge, in Holland in May 2011. The vehicles were equipped with cooperative systems facilitating platooning of vehicles in car/vehicle trains in both city and highway driving. The work was performed within the project “CoACT Cooperative Autonomous Car Train (A25)” at SAFER. The CoACT project was preceded by two pre-studies "Grand Cooperation Driving Challenge pre-study (A16)" and "PreACT (A24)" in order to prepare for the competition. The projects has led to new educational activities, two films showing the project process and competition, media coverage, interview in MIT Technical Review. The eight core partners from industry, institutes and academia have decided to develop the achieved national competence platform and to start a new project “CoAct 2”.

Several other projects within SAFER deal with accident avoidance and future possibilities of autonomous driving. "ASIS – Algorithms and Software for Improved Safety" combines research by four PhD students (both industrial and academic) in several departments at Chalmers. Based on the vehicle and its environment, crash avoidance scenarios are studied while focusing on crash avoidance, but also including how to utilise passive safety systems more efficiently. The results from the project feed into vehicle system development as well as increase knowledge in the academic world about vehicle electronics and safety. The project "Systems for Roadway Departure Avoidance" focuses on lane and roadway departure warning and control systems for developing new active safety functions based on real world needs. The European research project "InteractIVe" takes a step towards the goal of crash-free traffic, by developing advanced driver assistance systems for safer and more efficient driving, such as autonomous braking and steering

systems based on a sensor platform that recognises the driving situation. Recently, a national project named "Non-Hit Car and Truck", was started which joins both truck and car industrial partners as well as academics with the focus on developing technologies to reduce crashes and particularly address the situations for which today's active safety systems are not yet sufficient. Results will be reached in sensor capability and sensor fusion techniques.

Methods for Evaluation of Vehicle and Traffic Safety

Advancements of vehicle and traffic safety must be demonstrated through evaluation procedures. The Focus Topic "Methods for Evaluation of Vehicle and Traffic Safety" covers methods to explore, validate and evaluate safety systems. This Focus Topic encompasses all three phases of the crash event (Pre-crash, Crash, and Post-Crash) as well as all traffic elements (human, vehicle, and driver). The Focus Topics is a basic foundation for all SAFER research activities to ensure that on-going research activities have access to state-of-the-art evaluation methods.

Evaluation procedures vary dramatically in their technical background and maturity for application. Passive safety has benefited from statistical analysis of accident data as well as crash test evaluation tools conducted in Sweden. SAFER has projects that advance these areas of existing competence but they are also exploring newer evaluation procedures in the field of accident prevention. These newer activities include applying driving simulators, human behaviour modelling, monitoring of various accident avoidance systems (vehicle as well as infrastructure based) in real traffic environments, and full scale dynamic testing. Examples of the current activities in this high-priority Focus Topic are presented to highlight how the SAFER environment is succeeding.

Most OEMs and system suppliers are developing pre-crash detection systems. However, there are limited standardised test methods, test devices, and evaluation procedures available. The project "Scenario-Based testing of Pre-Crash Systems (A13)" had the objective of developing ways to verify and test performance of detection systems independent of the technology implemented. This national project involves three SAFER members and focused on test scenario development for intersection crashes involving passenger cars.

While project A13 had crash scenarios as the primary focus, the project "Developing Targets for Testing of Rear-End Collisions (A17)" had a more concrete goal. This national project addresses the technical issues related to the testing hardware needed for evaluating pre-crash systems. Specifications for test devices must be identified and solutions for safe, repeatable, and representative test devices must be available. Human drivers cannot be exposed to high risks, and there is a need for different targets and dummies that resemble real vehicles. The project focuses on rear–end collisions while the project "Smart Automotive Sensing (A26)" focuses on pedestrian dummies that can be used for evaluating pre-crash sensing systems. The project is a bilateral French-Swedish research initiative (presently pending due to problems with the financing in France). The objective of the project is to develop pedestrian dummies for possible use in laboratory tests of sensor systems, in crash test track tests, and in the virtual world.

A larger project, "ASSESS – Assessment of Integrated Vehicle Safety Systems for Improved Vehicle Safety (A11)", is an EU project with a larger partner base and research scope. ASSESS includes the scenario identification, test device development, and evaluation procedures for front-to-rear impacts. The project focuses on the use of autonomous braking systems and will provide the groundwork for European assessment procedures for vehicles combining active and passive safety systems. ASSESS is an important project that encompasses and incorporates research topics in Projects A13, A17, and A26. There are common SAFER partners between the three projects and is an example how the SAFER activities can be leveraged from national to international level.

Another example of SAFER projects spanning the national and international arenas are two projects addressing the crash component of an accident. A SAFER-associated project included five OEMS, one supplier, and university/institute researchers for identifying evaluation methods for frontal crash compatibility. Three of the SAFER partners are now involved in the SAFER project "FIMCAR - Frontal Impact and Compatibility Assessment Research (B10)". This EU involves all major European research

and industry stakeholders and has had a close dialogue with the UNECE regulatory members. FIMCAR is producing assessment criteria for frontal crash evaluation with the help of a completed, associated project at SAFER, "Compatibility between vehicles" (2006-2010).

Recently, a project "Balancing Active and Passive Safety" was started, focusing the balance between active and passive safety measures for the most common accidents or traffic situations in the scenarios for year 2030+ as identified in SEVS (B12, further described below). The project will cover the development of the methodology to evaluate the balance of active and passive safety.

While the previous discussion has discussed accident scenarios and physical testing approaches, SAFER is also active in the development of evaluation methods for human behaviour and responses in traffic. There are two main methodologies that are employed by the various SAFER partners. One involves driving simulators, where driver response to different conditions can be studied in controlled conditions. The other approach is the use of real traffic conditions in the FOT/NDS studies completed or in progress in the SAFER environment.

There are many different driving simulators available to the SAFER partners. The initiative of the pre-study "Simulator Lab at SAFER (A22)" was to study the issues that might arise from moving and merging equipment and methods from different SAFER partners into a joint simulator lab, identifying the needs, identifying problems, and proposing solutions to solve these issues.

The last examples of projects in the Focus Topic "Methods for Evaluation of Vehicle and Traffic Safety" are related to the analysis of FOT/NDS data. SAFER has successfully developed expertise and resources for collecting and analysing naturalistic driving data. Using some of the guidelines developed in the EU-project "FESTA Field operational test support action (C1)", newer projects like "Dreami (C13)" and "Comparative Analysis of Driver Behaviour between US and EU based on Naturalistic Field Operational Test Data (C17)" are now underway at SAFER. In particular, project C13 is an opportunity to combine data from different sampling areas (crash investigations and FOT/NDS) and also to develop new evaluation methodologies for studying the factors causing accidents and incidents.

Safety for Novel Electric Vehicles and Vehicle Combinations

Electric vehicles and vehicle combinations cover the safety of such vehicles, including the pre-crash, crash and post-crash aspects. It also includes a strategic dimension as these vehicles are closely connected to the future transport system design and to research on future energy-supplies, communication infrastructure, etc. Within pre-crash, the focus is on vehicle dynamics including assessment tools (mathematical models and virtual testing). The crash and post-crash aspects include structural crashworthiness design guidelines for self and opponent protection (including rescue aspects) for new safety-driven lightweight designs, including protection of batteries/capacitors, development of design and assessment tools and system design optimisation for novel vehicles.

A first and significant step towards the overall objective of creating strategies and developing cutting edge competence regarding increased crashworthiness and safe vehicle dynamics through advanced structures and novel propulsion and drivelines beyond 2030 was taken through the work of SEVS - Safe, Efficient Vehicle Solutions (B12). A pre-study "Load carrying capacitors for crash-worthy applications (B4)" was conducted prior to SEVS exploring innovative solutions in the area of novel electric vehicles. Also, a pre-study "SAFER Electric Vehicles (A12)" focusing on the added flexibility that electric drive actuators can provide in terms of vehicle dynamics functionality was completed and identified spin-off applications for electric vehicles (autonomous functions, active safety testing infrastructure, etc.), and what research materials needed to propel SAFER to a world leading position in this research area.

Within "SEVS", scenarios, strategies and research topics were identified as well as steps taken in creating a multi-disciplinary collaborative research with Swedish Hybrid Centre (SHC) and future European partners. SEVS presented the results of Phase 1 in June 2010. The purpose of SEVS was to explore how safe, efficient and affordable future vehicles should be designed and to explore future transport scenarios

beyond 2030 and to ascertain what research needs to be performed, with a special focus on safety and energy consumption. The project team consisted of members with different areas of expertise in order to explore important synergistic effects and possible conflicts between new technologies. The project was initiated by SAFER and Swedish Hybrid Vehicle Centre (SHC). The project adopted a holistic approach in which the vehicle was regarded as a part of the solution in a traffic system with social factors as an important aspect as well. Four different future scenarios based on trends and tendencies in today's world were created to address uncertainties and to create a solid research strategy. The main results were the scenario definitions and substantial reports on future high-priority research topics. The results were presented to a wide audience, including a mobile poster exhibition, with the focus on obtaining a broad level of involvement by both researchers, public and governmental bodies. It has led to several new research projects and proposals (national and EU) and has affected the organisation and strategy of some partners.

SAFER is a part of the EU project "ELVA (B14)", where six international partners combine their efforts within the area of advanced electric vehicle architecture and adds to the area of safety for future light-weight vehicles. The ELVA project focuses on electric cars for city passengers and urban delivery, where traffic volume is high and the impact on the local environment is most significant. Knowledge transfer to other vehicle types will be facilitated by a novel design approach. The ELVA project will generate, investigate and analyze innovative design concepts and is an important part of the growth of competence within this area at SAFER. One of the new Post Doc positions being recruited is to be a valuable contribution for this.

SAFER is also a part of the project, "IBS- Truck Integrated Braking and Steering for Active Safety of Heavy Vehicle combinations" with the objective of further improving active safety of heavy vehicle combinations with respect to yaw and roll stability. This project not only provides valuable knowledge to the industry, but it also contributes to competence development within SAFER.

Project applications for further projects are waiting for approval with the overall goal of creating a critical mass of researchers and PhD students in the area of safe, novel electric vehicles. While waiting for the large applications to be approved, a smaller SAFER project (B15) was established during in 2010 to explore the CAE tools for composite body concept assessment. This area is of high importance for effective composite development in vehicle design and also exemplifies SAFER's strength at combining large and small projects to address the different needs of the partners. Project applications have been made to continue this strategically important material research.

Human Models and Biomechanics

The Focus Topic "Human Models and Biomechanics" covers biomechanical injury mechanisms, responses and consequences, the principles for protection including safety system usage as well as mechanical and mathematical occupant and vulnerable road user models.

Within the area of human modelling, the main objective of building cutting-edge competence that is valuable for SAFER's partners through the creation of a strong network and a critical mass of researchers and PhD students working together, has been successfully met. Thanks to strategic investments with SAFER resources, SAFER now has a strong core group of activities in the area of human modelling, involving researchers in more than eight projects. The ongoing activities are a combination of projects funded by EU ("THORAX", "CASPER"), FFI ("Biomechanics heavy vehicles", "Active human body models for virtual occupant response"), SAFER (B7, B9) and a combination (B5, B13) involving both academic and industrial PhD students. During 2011, a pure SAFER project (B8) produced a Lic. Eng. and was continued in a second phase (as well as expanded to include 2 PhD students) as a pure FFI sponsored project. Over the years, a total of more than five PhD students and nine senior researchers from Chalmers, Saab Automobile, Autoliv, Volvo Technology and Volvo Cars have been working in this area, together with several master thesis projects. Beside the international cooperation within the EU projects "THORAX" and "CASPER", international cooperation in this area also includes a joint study at TU-Delft by one of the PhD students (project B8), regular contacts including meetings/workshops with the researchers at TU-Graz and regular contacts with researchers at University of Virginia. For the industrial

partners, the SAFER competence platform of human model development and the pre-competitive research is especially valuable for providing close access to people with core competence in the area. The refined human models, including the knowledge obtained in the joint projects, are regularly used by the industry in safety development, such an autonomous braking systems and occupant restraint systems. The SAFER strategic work has helped to significantly speed up this process of industrial implementation. Also, the growing activity in human body modelling has already placed SAFER among the more well-known organisations within Europe, and the interest shown by other universities proves its high academic relevance. In 2010, a pedestrian safety project (B13) was granted FFI funding, whereby one PhD student at Chalmers and one PhD student at KTH were hired to work on the project together with four industrial partners. This project will further strengthen SAFER's research within pedestrian safety and also tighten the collaboration with the researchers at KTH.

Most of the work has been applied to a common research tool; the adult THUMS human body model, that investigates both the human properties in low-g (such as pre-crash braking) and high-g situations for occupants in passenger cars as well as heavy trucks. The vision is to create scalable and tuneable human body models that can represent a variety of different road user categories in terms of size, age and gender, and that are able to respond with active muscles both pre-crash and in-crash. The ambition is to create and provide open access models that can be used and further developed by other researchers worldwide. Collaboration and exchange is under development with a number of international partners such as the Royal Institute of Technology, TU-Delft, TU-Graz, UMTRI, and Toyota.

Although the focus during the last years has been on mathematical modelling, further development of the mechanical models (crash test dummies) is on the agenda for needed improvements. An example of such project was the finalised project "Dummies for oblique collisions", where SAFER partners developed a modified shoulder to the THOR dummy which is now being evaluated by NHTSA, IIHS and other.

Within the area of Biomechanics, success has been in line with the overall aim of maintaining and developing the world class reputation of SAFER researchers in the area of applied biomechanics and injury prevention. SAFER has a leading position in whiplash injury biomechanics, child safety, and pedestrian safety. Other strong areas are brain injury and thorax-shoulder biomechanics. SAFER has a strong reputation in the development of crash dummies, and biomechanical assessment methods. Child Safety and Human Body Modelling are two areas that have benefited particularly from the collaboration within SAFER. Several SAFER partner organisations have joined forces under the SAFER umbrella and this has very clearly boosted progress. In general, the formation of SAFER has increased the dialogue and interaction between the partners that previously worked and collaborated in the fields of biomechanics and protective systems, as well as added new researchers and contacts. The formation of SAFER has also brought experts from the partner organisations closer and in particular allowed for an expansion of Chalmers activities that now are fully integrated in the SAFER office. This has helped to build a critical mass of researchers that have the SAFER office as their common arena.

The stated ambitions are extra high within the areas of whiplash research and child safety. Also, within thorax, shoulder and brain biomechanics the objective is to play an active part within a wider research community, developing a niche of fundamental research. The involvement in the EU projects "THORAX", "ADSEAT" and "CASPER", the Human body modelling projects and the national brain project (B11) are examples of this, with the ambition of further strengthening these areas. Within the area of whiplash, VTI is the leader of the EU project "ADSEAT - Adaptive Seat to Reduce Neck Injuries for Female and Male Occupants" including one SAFER PhD student and several SAFER senior researchers. One of the main results of the project is a FE model of a scaled down BioRID model. SAFER partners, being the creator of the BioRID dummy during the 1990s, are a clear example of the continued leadership in the area. Based on a SAFER pre-study in 2008 (B6), preparation of a project on rear end impact test methodology is discussed in order to further strengthen the industrial partners' leadership in whiplash protection system development. Within the area of thorax and shoulder, the EU project THORAX and project B7, form the platform for this research and international cooperation. Within the area of pedestrian safety, significant steps have been taken towards the objective of combining knowledge of human modelling, biomechanics, field data analysis, with the aim of increasing knowledge of real world

pedestrian safety. The recent pedestrian project (B13) forms the platform for this research and cooperation. In terms of the project examining rear seat safety for small occupants (B5), additional funding from FFI enabled the project to be expanded by one additional PhD student as a complement to the two industrial PhD students halfway through the project. This project is a brilliant example of how combined efforts by four partners will help maintain Sweden and SAFER as an important centre of excellence, contributing to external activities and setting the agenda in child safety and rear seat safety research. SAFER hosted the spring meeting in 2009 of the ISO working group of Child Restraints and the project has direct connections to ISO activities as well as the ECE R44 update. The researchers in the project have produced several publications in the area over the years. The project hosted a visiting professor, Kristy Arbogast from Children's Hospital of Philadelphia (CHOP), for a month during June 2009. This was followed by a one-day national seminar on Child Safety and a two-day project workshop in September together with six invited senior researchers from USA. The ground braking studies of children in cars during driving were acknowledged by international researchers and SAFER researchers are now part of an Australia-based project involving also US researchers. In September 2011 SAFER will host a follow-up workshop in Prato, Italy, inviting a group of researchers from USA, Australia and Europe. The joint SAFER activities within child safety have also resulted in that SAFER will become an affiliated organisation to Center for Child Injury Prevention Science (C-ChIPS) in USA and a joint research project regarding brain injury has been set up in collaboration with CHOP and NHTSA, US.

5. Impact on partners

As described in Section 3 and 4 *SAFER is its partners*, and the Focus Topics are the outcome of the needs and interests of the whole partner group. Different partners have different agendas and will chose to use different aspects of SAFER results – some need input for strategic decisions, others need technical research for to design new products, still others need to share resources or infrastructure to be able to afford to stay competitive. The ongoing dialogues among partners on the future research needs and the realistic assumption on when breakthroughs can be expected are of great value, also when it comes to the interaction with other such discussions in society, outside SAFER.

A common theme among partners is competence creation and retention. Competence exists on individual as well as organisation level. Through the involvement of partner staff in SAFER activities, networks and projects, competence is created in the partner organisation and this will eventually lead to faster and more precise implementation and innovation.

SAFER is studied by a research project "Management of Open Innovation". This project is running from 2008 – 2012 and is conducted by three senior researchers at Chalmers and one full time PhD student. The project presently consists of the following elements:

- "Managing open innovation" Longitudinal interview study (13) of Director at SAFER
- "Open innovation in practice" project observation" (covering a part of the SEVS project B12)
- "Initiating open innovation" interviews with board and management team at SAFER
- "Leveraging on open innovation" Five interviews with specific partner organisations
- "Participation in an open innovation arena" 27 interviews with all partner organisations (except 2)
- "Managing and organising distributed creativity" PhD project (2007-2012)
- Master thesis literature review on Open innovation part 2 (2010)
- Master thesis on creative climate at SAFER (2009)
- Master thesis literature review on Open innovation (2009)

The interview sections of this research project will be presented and discussed with the partners in a workshop on October 27th, 2011. The conclusions will be part of the Stage 2 results for SAFER. Presently, we have as a general finding that all interviewed partners value the partnership and SAFER as such, but want to more actively utilise SAFER's full potential. SAFER is said to give an increased credibility for the partner through its affiliation. Although several of the partners meet in other constellations, they find that SAFER has a unique value and an important role to play as an open innovation centre where collaborative multi-stakeholder research enhances the partner organisation´s competitiveness and ability to contribute to a transport system with "near zero" fatalities and serious injuries. Furthermore, many partners appreciate the possibility to influence the perspectives on future transport systems and also find it politically important to be able to influence and have insight into the "safety agenda". In some cases, it has meant that a partner has become part of the discussions that precede decisions that can influence the partners business or organisation.

Another partner benefit is a better and broader understanding of how a partner's own transport solutions work in the bigger context, thus influencing the partner's product planning and business agenda.

Actually, one partner has developed a new business area in the company due to the collaborations created in SAFER. However, we have not, so far, information on any actual products that have come out of SAFER yet. This is hardly surprising given the short period of 5 years existence.

Specifically for this report, all partners have a couple of lines as feedback on the perceived value of SAFER and the comments below are grouped according to type of impact. The actual comments are written in italics.

A meeting place that creates important networks and strong project portfolios

The main achievement is the creation of a meeting place for multi-disciplinary research(ers) in the area of road safety. This has enabled successful implementation of national and international research projects.

SAFER have created an environment for meetings with key traffic safety experts that have strengthened Autoliv's network both in Sweden and globally. Several projects have been started which have the potential to generate know-how in important areas for improved safety.

SAFER has been an important arena to further enlarge such cooperations.

SAFER is an important partner to identify interdisciplinary research projects on which academia, industry, institutes and public authorities work together.

SAFER offers a unique platform for open innovation, where opportunities are created for projects in which academia can work together with several vehicle companies.

SAFER is an important centre for collaboration and day-to-day interaction.

Being a partner of SAFER gives us a fruitful and close link to important researchers and stake holders in the traffic safety field.

Impact via project importance and results

Research areas like naturalistic driving/field operational tests and distracted driving have been greatly developed through partner cooperation in SAFER which has contributed to a forefront position for Sweden in these areas.

As a direct result of the research in SAFER projects i.e within naturalistic field operational test, the knowledge within the Volvo team has increased regarding driver behaviour, methods & equipment. This knowledge is key to be able to develop future active safety systems & functions in our vehicles.

Impact through gained competence

Examples in the passive safety area are rear seat safety, child safety and human body modelling which all are areas where the latest know-how is important for a company like Autoliv. SAFER have also managed to establish an expertise in active safety with the strong focus on FOT and the conferences on Drowsiness and Distraction. Especially the latter is very important for us.

Our partnership in SAFER have resulted in participation in several research project and seminars which have given our consultants, not only more knowledge, but also the access to a valuable contact network.

For TØI, being a SAFER partner has resulted in useful research cooperation with other SAFER partners, supplementing our behavioural and social science competence in traffic safety with other competence, particularly related to vehicle technology. In addition, it has resulted in fruitful exchange of knowledge through participation in Reference Groups, Competence Areas, and various seminars and conferences initiated by SAFER

We need to collaborate with the best researchers. SAFER has proven to provide such a centre of excellence.

As a direct result of the research in SAFER projects i.e within naturalistic field operational test, the knowledge within the Volvo team has increased regarding driver behaviour, methods & equipment. This knowledge is key to be able to develop future active safety systems & functions in our vehicles. Furthermore, SAFER provides a foundation for our industrial PhD programme and it is also an important base for future recruitments.

Understanding traffic safety future trends

Several partners comment on gaining knowledge on how the automotive industry thinks concerning future products, thus making it possible to innovate services and products that are of interest to other SAFER partners. They see an increased knowledge and understanding of the automotive industry. Some comments on this:

We believe that the solution to complex road safety problems must involve all major stakeholders and that world-class multi-disciplinary research is a key for success. This is why we are a part of SAFER.

Autoliv's research group is a partner in SAFER with the aim to learn more about the latest technologies and network with other companies, universities, and organisations active in the area of traffic safety.

SAFER enable us (Epsilon) to an easy access of this(xx) research area and to be a part of its progress.

Combining vehicle safety issues in a multi-disciplinary, systems oriented, research programme with involvement from industry and academia, gives a strategically project scope that has the potential of changing the way vehicles are built in the future.

For Saab Electronic Defence Systems it is important to follow the technology trends and developments in the civil security sensors area, and to share knowledge and insights with other industry-, university- and organisational partners.

Through SAFER we get an excellent platform to keep track of automotive sensor requirements.

The FKG mission in SAFER is to inform our members of on-going and coming activities at the centre that supports our member companies. This could lead to that companies will participate in projects or propose new projects.

The SAFER membership enables Swerea IVF to work closely together with both academic and industrial partners regarding further development of safe vehicles.

Telia is partner in SAFER with the aim of learning more about how telecommunication can be used for road traffic safety.

Impact on Partners innovation capability

One important factor for this success is probably that we have a tradition of cooperation among the different stakeholders in a multidisciplinary way For Folksam it is important to take part in SAFER, for two main reasons, to contribute to keeping Sweden's leading position in road traffic safety, and to contribute to reducing road traffic injuries and their consequences.

It also speeds up the company's work to develop new products based on safety issues within the automotive sector.

SICOMPs involvement in SAFER is to promote and support development of crashworthy composites for vehicle structures. In particular, SICOMP is involved in developing multifunctional structural composites aimed for electric storage in future vehicles.

The objective of SP is to strengthen its research through cooperation in SAFER.

Collaboration within SAFER supports Viktoria's goal of contributing to sustainable development and growth of Swedish automotive and transport industry.

Impact from SAFER as a part of the bigger cluster

SAFER is also part of a bigger cluster and wants to contribute in that. Lindholmen Science Park gave this feedback

- *Greatly contributed to make Lindholmen an international environment for vehicle and traffic safety.*
- *Actively participated in multi-disciplinary collaboration projects, showing a great will to cooperate.*
- *Developed a solid project portfolio, with a large number of international projects and partners.*
- *Actively contributed to create an exciting content at Lindholmen. SAFER is a very important resource and raises lots of attraction at international visitors.*

Project leader views on impact

A survey was given to SAFER project leaders in August 2011 asking their view on impact connected to their projects. The questions addressed a short-term (<3 years) and a long-term impact, how many partners that would benefit from the result and in which dimension (method, process, product, service, decision support and other impacts). This is a first attempt to find tools for evaluation of the benefit of project results to the SAFER partner. The survey was sent to all project leaders for finished and ongoing projects since the start in 2006, including SAFER associated projects, totaling 109 projects and pre-studies. To date 24 project leaders have answered the survey, but we expect full response to the workshop in late October. The low response rate does not allow for a reliable analysis, so far, but an analysis of the 24 responses received, can give a flavor of the type of answers we can get.

Regarding short term project results, 60 percent state that within three years the project will have an impact on methods, 48 percent will have impacted decision-making, and 28 percent will have given impact in new products.

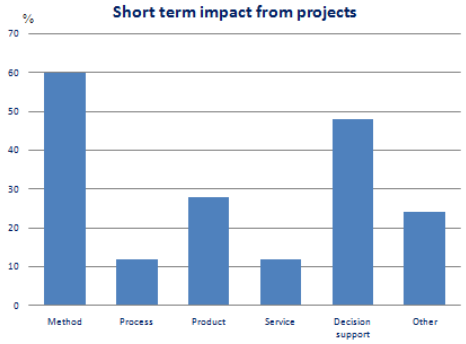


Figure 2. *Short-term impact from projects, percent of all answers (n=24).*

Long-term the impact is high and encompasses multiple dimensions. The majority of results appear in the 4–6 year span, but a few projects will have their initial impact after 10 years or more.

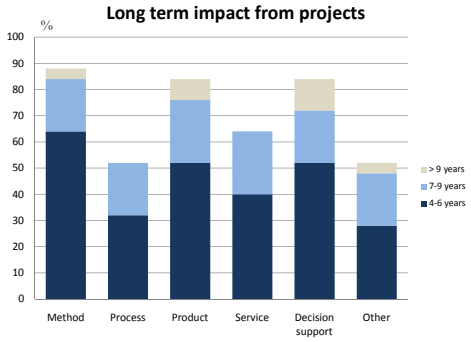


Figure 3. *Long-term impact from projects, percent of all answers (n=24).*

6. Financial Report for stage 2

Financing

According to the partner agreement for Stage 2, running from April 1st 2009 to March 31st 2012, SAFER has a total funding of at least 92,255 MSEK. Vinnova is providing cash 30 MSEK, Chalmers together with Gothenburg University is responsible for 3 MSEK in cash and the rest is in-kind. All other partners' undertakings have mainly been in-kind, although the agreement is prepared for annual cash fees. These will be introduced as of Year 6. Two new partners have joined adding 0.33 MSEK.

Table 2. *SAFER resources Stage 2, Budget (agreement) and forecast. Expanded version see appendix I, table 8.*

Partners	Budget		Forecast	
	Cash	In-Kind	Cash	In-Kind
Vinnova	30 000	-	30 000	-
Chalmers, GU	3 000	27 000	3 069	28 663
All other partners *	-	32 255	1 450	48 472
Total	33 000	59 255	34 519	77 135

* in Stage 2 main agreement

The cash to SAFER is solely governed by the Board. The in-kind is to be regarded as cash controlled by a specific partner. Thus, the partner decides if the contribution should be made and the Board decides if the contribution is valuable to SAFER and can be accepted as in-kind. The follow-up of partner contributions is done through a so called "sign-off" procedure. SAFER forecasts the total finances for Stage 1 and Stage 2 at each board meeting. It is important to track the finances from the start of SAFER as projects run over several years and through many stages, and the resources are booked as soon as a decision is taken. The in-kind is an important tool to ensure competence and infrastructure contributions from all partners. At the same time, a sufficient cash level is necessary to be able to create a proactive centre.

During Stage 1, decisions were taken on projects and activities up to budget, but the actual consumption of resources lagged behind. 14 MSEK in cash was thus transferred to Stage 2 (see appendix X, table T8, unspent Stage 1). This was well compensated during Stage 2 when SAFER grew and picked up momentum. The forecast of known projects and common expenditures leaves a surplus of 5.7 MSEK of which 0.7 MSEK is reserved for new projects, pre-studies and other activities during Stage 2. The remaining 5 MSEK is reserved for Stage 3 (see appendix X, table T11). The total agreed in-kind is already in good supply, although some partners are lagging behind while others deliver far beyond expectations. The forecast in table 2 above, is high compared to budget due to that partners now deliver both Stage 2 budget and remaining in-kind from Stage 1.

Chalmers Transport Area of Advance, since 2010, has been granted Swedish national strategic research funding for Traffic Safety. The amount of this grant is well in the order of Chalmers in-kind undertaking in SAFER. These research grants play an important role in engaging Chalmers researchers in Traffic Safety and thus support the development of SAFER towards a world class research centre.

The Chalmers in-kind is also used for recruiting postdocs, guest researchers and other temporary personnel of high competence, as well as for temporary assignments such as writing of applications.

As SAFER grows the common costs are also growing and are now just over 50 percent of the cash funding. Common costs include SAFER management and administration, office rent, seminars and conferences, communication and other common expenditures**.** The size of SAFER 2016, according to the strategy, will be such that SAFERs own funding at the time will be sufficient only for common centre costs and strategic activities. This fact also stresses aspects of in-kind contribution as this is more suitable

for project work than for tasks like management and communication. The ability to attract external funding for projects is increasingly important.

External project funding usually requires in-kind contributions of the partners. When SAFER applies for projects where several SAFER partners are engaged, the partners are expected by the funder to support the external projects with in-kind contributions. This can in some cases be considered as in-kind to SAFER, but in the case where Vinnova is the funding agency (like in FFI) this is not permitted.

Project finances

Since the start of SAFER in 2006, 86.5 MSEK of the resources have been allocated to projects, whereof 81 MSEK will be spent by the end of stage 2. Projects are planned and run according to their specific total lifetime, independent of SAFER's stages. Due to this, SAFER keeps track of decisions regarding all completed and ongoing projects from the start of the centre (see appendix I, "project portfolio budget, own projects"). Factual project cost is followed up on a regular basis. In this report (appendix I, table 8), shows the factual outcome for year 4 and 5. Year 6 is forecasted.

Projects in the SAFER environment are split in two categories," own projects" governed according to SAFER financial rules and project procedures and "associated projects" with external grants and governance (see appendix Table 12) but part of the total project portfolio and follow-up. The total project turnover, including all projects, own and associated, in the SAFER environment is monitored regularly. The goal for SAFER is to reach an annual project portfolio turnover of 200 MSEK by year 2016.When SAFER started in 2006 the existing annual project portfolio was estimated to 60 MSEK. At this point we have more than doubled the total yearly turnover.

The growth of the project portfolio and its changes year by year reflects the outcome of SAFER efforts, but also the effect of changes in national research programmes for automotive research creating a gap in funding for the years 2008 and 2009. The new national programme (FFI) setup was also influenced by the ongoing recession, shifting focus towards more short-term applied research. SAFER chose to start some PhD projects with own funding to remedy this situation and proactively prepare for the coming research needs and funding programmes. However, SAFER's own cash is far too limited to carry the cost for continuous PhD programmes and a central concern is the funding of PhD students. Presently, some industrial in-kind is used for financing of PhD students, employed in the industry, but for PhD students employed by universities financing is difficult.

International funding

The EU research programmes such as the 7th FP are increasingly important to SAFER. Management and researchers are engaged in organisations (EARPA, ERTRAC) and networks to promote the traffic safety issues, influence the research agenda and the set up of strong consortia. The outcome regarding grants from 7 FP has been quite successful. SAFER researchers are also active in the US and have recently been granted funding for an analysis project within the federal program SHRP2.

International funding requires excellent researchers but also research project leaders and coordinators. This category of staff is an important expertise of its own which needs to be part of common resources.

7. Organisation and Management of the Centre

Organisational philosophy at SAFER

The organisation of SAFER is set up to facilitate multi-disciplinary collaboration and excellence, not only within SAFER, but also in interaction with associated centres and organisations. It shall encourage and foster the values of an open and dynamic centre – trust, curiosity, open-mindedness, respect for each other, risk-taking. Thus, the organisation and management have to live with a paradox – 1) structure and transparency for many different partners, with different cultures, so they interact and trust that "things are done right and fair" and 2) flexibility and few restrictions to allow for curiosity and initiatives. SAFER is a volunteer organisation, the participation, both from individuals and organisations, is based on free will and the attractivity of SAFER.

The organisational base for sharing ideas, initiating projects and developing SAFER, consists of the four Reference Groups and the twelve Competence Areas. A Competence Area gathers researchers from all partners. A Reference Group consists of partners and Competence Area Leaders.

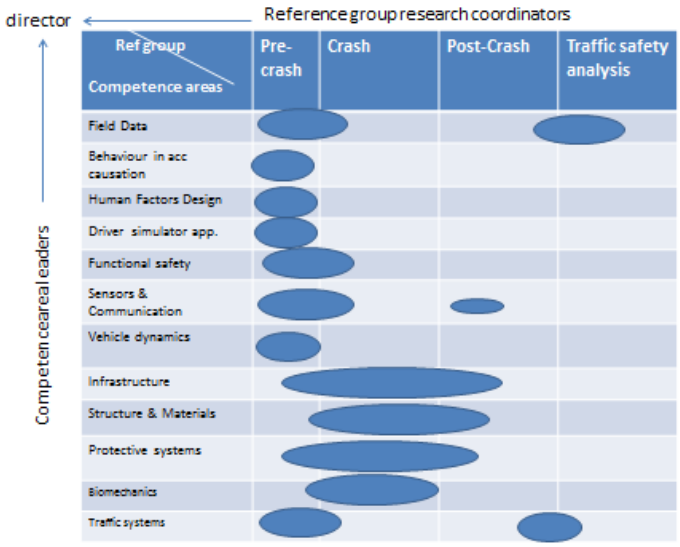


Figure 4. *Competence Areas and Reference Groups. Circles show main couplings.*

Project portfolios provide all information on projects and are supervised by the Reference Groups which meet about 6 times a year. Competence Areas meet on a regular basis, driven by the specific prerequisites for that area. To get a strong commitment from all partners and to facilitate the understanding and communication it is vital that partners meet on all organisational levels. It is desirable that people engaged in SAFER also meet and discuss in their own organisations, ensuring that things happening at SAFER also are understood and supported by the partner.

Parallel to the structured ways of working, SAFER is organised to foster creative networking and competence sharing on a daily basis. The environment as such and the organisation of work places is an important tool. The notion of key-people (people with own access) and the activities to create a community at SAFER is based on weekly lunch-seminars, SAFER-days and common activities of ad-hoc character. Individual researchers and projects are encouraged to be present in the environment.

Individuals carry competence and values. Thus the manning of groups, projects and teams is crucial to achieving the long-term vision. Diversity concerning gender, culture, partner organisation etc., is always a conscious concern. The learning and networking aspect is also considered, mixing senior and junior, and

creating a certain redundancy to facilitate mobility. Pairs of students from different disciplines are also encouraged.

Organisation description and evolution

The organisation of SAFER and the terms of reference for different units are described in the General Agreement of SAFER. The descriptions are detailed and a result of thorough discussions based on the experience from Stage 1 and the foreseen needs for Stage 2. The organisation is executed according to this but is also evolving due to changes in the environment that require new or adapted structures. An example of this is the operational development at Chalmers, where eight Areas of Advance were introduced in 2010. SAFER has since then been the core centre for Traffic Safety within Area of Advance Transport, which leads to new tasks for the Director of SAFER, improved communication with connected transportation research issues and centres, improved visibility towards Chalmers researchers, and long-term funding of critical competences. Another example is the effect of successful collaborative projects that require strengthening of Competence Areas and project clusters.

Partners, Shareholders Meeting and Board

The partners govern SAFER via the Shareholders Meeting, where all partners hold a place, and via the Board consisting of nine members approved by the Shareholders Meeting. All partners meet once a year and in conjunction with the formal meeting a half day presentation of SAFER projects is given.

The Board is to be chaired by industry and three positions are reserved for Chalmers. The Board meets 7-8 times a year including a longer strategy meeting in August. Members are presented in appendix C, table 2.

At the Shareholders meeting in May 2011 a new "classification" of partners was decided on. Three partner categories were introduced based on the size of contribution to SAFER. Level 1, large partners, hold a place in the Board and in the Reference Groups, Level 2, normal partners, hold a place in the Reference Groups and finally Level 3, small partners, is a new category that opens up SAFER for SMEs that want to be part of SAFER environment and activities but don't have sufficient research activity for normal partnership.

Reference Groups

The research at SAFER is conducted in four research programmes (Pre-Crash, Crash, Post-Crash and Traffic Safety Analysis), each led by a Research Coordinator (see section 4 and appendix D, table 3). The Research Coordinators are members of the SAFER Operative Management Team (LG). Projects are initiated, discussed in the respective Reference Group and recommended to the Management Team and the Board. The Reference Groups include representatives from all SAFER partners (Level 1 & 2) and the Competence Area Leaders and are the base for establishing world class competitive project portfolios. The agenda covers new project ideas, project reports and final results as well as strategic issues like input from all partners on the Focus Topics and on conferences, seminars and international collaborations and calls.

Competence Areas

The Competence Areas have evolved since the start of SAFER and been further developed during Stage 2. The Competence Areas are broader than academic research groups and gathers key persons from all SAFER partners that have a research interest in the Competence Area (see section 2 and appendix D, table 3). Each area is led by a Competence Area Leader (CAL) who is a member of SAFER Extended Management Team (SLG). It is the responsibility of each Competence Area to monitor state-of-the art of global research and what's perceived as world-class research. Each should have a short and a long-term plan for competence development.

Centre Director and the Management Groups

The Director heads the management groups of SAFER. The Operative Management Group (LG) consists of the Director and the research coordinators. The Director is responsible to the Board for management group decisions After Stage 1 it was decided to recruit a scientific leader, but this position is still vacant. The specific tasks have been executed by other management team members. The Extended Management Group (SLG), also includes the Competence Area Leaders, an international coordinator, the communication officer and the financial officer. "Large project" leaders are also invited. To be successful, the manning of projects and the development of competence must be managed in a dialogue between coordinators and research leaders from academia, institutes and industry.

The management groups are important for the interaction between SAFER partners. It is desirable that the members can represent different partners and in that way ensure a true collaborative approach on all SAFER issues. This enables a consistent partnership on all organisational levels and a consistent leadership for SAFER regarding methods and values, including diversity (nationality, gender, age etc) in manning of projects or participation in dissemination activities. The Research Coordinators as well as the Competence Area Leaders should preferably be in-kind contributions.

Legal structure

Chalmers is the legal host for SAFER and SAFER is the core of the research profile Traffic Safety within the Transport Area of Advance at Chalmers (Styrkeområde Transport). The Director has the financial responsibility and signing authority for SAFER and reports to the Board. The SAFER board in turn reports to the Shareholders Meeting as well as to the president of Chalmers.

SAFER is a Joint Research Unit as defined in the EU 7 FP and can participate as a partner in EU projects. Chalmers is the beneficiary and other partners in SAFER can join as Third Parties (according to defined procedure). SAFER partners can also (and mostly do) join as independent project partners.

Project work process

SAFER's project work process covers project management and procedures, which apply for SAFER projects. This is described in the document "Projektarbetssättet". The core forum for initiating and monitoring projects is the Reference Groups. For each individual project there is a project structure and an agreement on deliverables, time, costs and IPR. A web-based SAFER project management tool is used. SAFER keeps track of all projects and their progress and turn-over but takes the full project management responsibility solely for projects with SAFER financing and for projects where SAFER is project manager on behalf of an external funder ("own projects"). This is the case, for instance, when SAFER acts as Joint Research Unit (JRU). A list of all projects, own and associated, are continuously updated and presented to the SAFER board at each meeting. SAFER projects are presented on SAFER website (see also table 5).

International Scientific Advisory Board (ISAB)

The International Scientific Advisory Board (ISAB) of SAFER is an advisory body to the SAFER management and board. The ISAB provides advice about the quality, scientific relevance and organisation of the research at SAFER in an international context. The advice concerns both the research carried out as well as future plans. The ISAB consists of three leading independent scientists of high international reputation with complimentary expertise covering the SAFER research field. They are elected for three years and they may be re-elected once (maximum term is six years). They will visit SAFER once a year in spring during 3 days. Members are presented in appendix E, table 4. A first meeting was held in February 2011. Based on written material, presentations and interviews the ISAB presented a report with findings and recommendations. Actions based on this report have been initiated.

8. Personnel of High Competence

Personnel at SAFER

SAFER is a meeting place with a physical work area of 1500 m² in the main building in Lindholmen Science Park. SAFER moved here in August 2010, to get a bigger and more functional office connected to other open innovation activities such as Security Arena, Open Arena Lindholmen and Test Site Sweden (TSS). Each person belonging to SAFER is employed by a partner. People who need access to the SAFER environment on a more regular basis may get a key to the facilities. Presently, there are 217 people who have a key to the SAFER office and thus are called "key-people" (see appendix I, table 10). Of these key-people 97 are employed by Chalmers (or students at Chalmers) and 120 are from other partners. Furthermore, 19 are academic PhD students and 19 are industrial PhD students, thus making the PhD students 18 percent of the total staff. 24 percent of the PhD students come from outside of Sweden. In total, 28 percent of the key-people at SAFER has moved to Sweden from another country.

One third of the key-people at SAFER is women. Traditionally the field of traffic safety attracts both men and women and SAFER consciously promotes a good gender balance. SAFER has successfully recruited females on management positions. Equal opportunities also encompass other diversity aspects such as nationality, age and on an organisational level partners with different size, maturity in subject etc.

In addition to the key-people, most partners have more employees engaged in traffic safety but not in need of their own access to the SAFER office. Many of these are to be considered as SAFER associates. Concerning Chalmers some 130 researchers, including PhD students, at eight departments or more engage in traffic safety related research. 40 of these researchers are entitled to strategic research funding through the Chalmers' Area of Advance in Transport.

The mobility between SAFER partners is a key indicator for SAFER's added value. The mobility can be of different types: Employees moving from one partner to another, employees with several affiliations and employees temporarily (often connected to specific projects) employed with another partner. Since the start of SAFER a number of employees that have been active within SAFER have moved from one partner to another, including senior researchers, and including movements between industry and academia. Many of the Chalmers employed PhD students spend part of their working time at one of the industry partners, mostly in conjunction with using the facilities at the industry partner. Industry employed PhD students regularly spend time in the SAFER office in order to improve their communication with supervisors and to make better use of the academic environment including various forms of exchange with other PhD students and researchers. SAFER and its partners have chosen to regard these staff movements with a positive and encouraging attitude but not yet initiated any separate activities to actively foster this mobility.

Education and teaching at Chalmers

SAFER researchers, from all types of partner organisations, are involved in teaching at all levels within Chalmers. However, to strengthen the education in the area of safety, Chalmers Foundation granted SAFER resources to develop a more complete programme, named SAFER Insight. The idea is to start from the existing courses and develop a complementary programme so that all SAFER Focus Topics are supported by education. The courses shall be available for both students and practitioners and support the needs of the industry, society and academy. It will be connected to the Chalmers Automotive and Transport Academy. During 2010/11 this funding was used for course development and for master students supervision and participation in two international student competitions: Grand Driving Cooperative Challenge in May 2011 and Formula Student in June 2011. The SAFER facilities are used by both bachelor's thesis and master's thesis students, and during spring 2011 there were 27 students working at SAFER. Many master thesis projects are also carried out at the industry partners' facilities. Out of these 27 master students, 81 percent have a first degree from outside of Sweden. SAFER coordinates a PhD student network within the research area driver behaviour. It gathers students not only from Chalmers but from all universities with PhD students within the field.

The master's programme Automotive Engineering at Chalmers was introduced with support of SAFER in September 2006. The safety track includes three courses: Vehicle and Traffic Safety; Advanced Active Safety and Impact Biomechanics, and the Vehicle Dynamics track includes three courses, Vehicle Dynamics, Advanced Vehicle Dynamics and Hybrid Vehicles and Control. A significant part of the lectures are given by staff from SAFER's industrial partners. In addition to lecturers, the course participants also get access to experimental equipment of SAFER partners such as several driving simulators, test vehicles and crash laboratories.

The Swedish Transport Administration, Chalmers and VINNOVA have agreed to set up a **Vision Zero Academy** at Lindholmen. This will be a valuable collaboration partner to SAFER and enhance SAFERs ability to achieve their vision. The aim for Vision Zero Academy is to provide key global players with knowledge- and research-based advice and recommendations on how a fast and effective innovation and implementation process for safety-systems-oriented measures can be created.

Finally, it can be mentioned that SAFER/Chalmers are intensively involved in discussions on international cooperation in the field of education in automotive engineering and cooperation between regional research clusters, in particular in the field of sustainability (greening), mobility and vehicle safety. Various initiatives have been taken that may lead to a so-called Knowledge Innovation Community (KIC) on *mobility and automotive* within the so-called European Institute of Technology (EIT). Projects in which Chalmers/SAFER were involved in included the GAST project (completed in 2009), the new project SAGE (starting in Nov. 2011) and the proposal development for a KIC called Zero CO2 (2009).

Recruitment of strategic competence and competence development of students and staff

A part of Chalmers strategic research funding for Traffic Safety is earmarked for postdocs and guest researchers. One intention is to fund 15 postdocs yearly, dedicated to traffic safety on top of Chalmers department's regular recruitment. All Competence Areas, except Functional Safety, have recruited postdocs funded this way. Special focus is given to these recruitments from an international and gender perspective.

SAFER has regularly had several guest researchers and visitors from all over the world; USA, Asia and Europe. A few of these have/had long-term affiliations in projects or as adjunct professors, for example Jac Wismans, TNO/Safetec, Michael Regan, IFSTTAR, Kristy Arbogast, Children's Hospital of Philadelphia (CHOP), and Tim Gordon, UMTRI. An overview is given in appendix H, table 7. All of these researches have given open SAFER seminars (listed in appendix G, table 6.2), which is an excellent way of knowledge sharing.

For the purpose of cross-fertilisation of knowledge and ideas, competence development of staff and students and stimulation of national and international cooperation, SAFER, among others, organises internal and external seminars, project days and conferences. An overview is given in Appendix G, table 6.2. The internal seminars, which during Stage 2 amounted to 60 seminars, gather around 35 participants on average each time. It serves as a means to create visibility and dialogue among SAFER staff on current topics.

Part of the research work carried out at SAFER is within international cooperation projects. For PhD-students involved in such projects this offers the opportunity for travelling abroad and sometimes also working abroad. This also brings in international students working at SAFER (see examples in appendix F, table 5.3). Travel to international conferences is common practice for SAFERs PhD students and researchers alike.

9. Plans for Development

The vision of SAFER can be seen as a linkage of one external and one internal long-term objective – the contribution to a sustainable society through the elimination of fatalities and severe injuries and the success of the partners in their respective assignments. The plan leading up to these objectives is based on the idea that competence and results develop simultaneously in interactions, and the starting point must be to organise to allow this to happen. Schematically this can be described in the figure below:

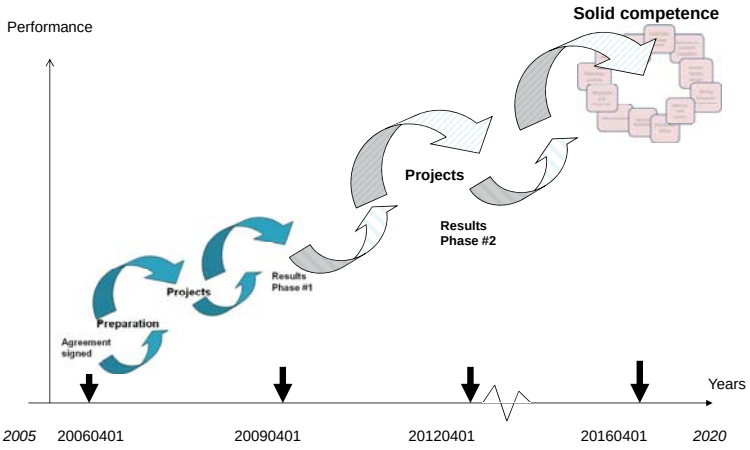


Figure 5. *Competence building through project collaboration.*

Stage 1 was primarily concerned with the start-up of the centre, and the evaluation of that stage resulted in a strategic plan which has been the guide for Stage 2. In short, it was decided to enhance the identified strengths - Competence present at SAFER, the meeting place and dissemination of knowledge - and to make improvements regarding Project management, Identity and Organization. It was further decided to put efforts into internationalisation, financing, and cooperation with other centres and to connect and create synergies with other areas sharing the same technologies and objectives for achieving a sustainable transport system. All in all, this provided SAFER 10 challenges for the centre to develop during Stage 2. These challenges will be met by the end of year six and next stage will focus on "Adding Value", enhancing the specific qualities that we now associate with SAFER.

Added value of SAFER

The added value of SAFER is tentatively called Open Innovation Capabilities and encompasses values, processes and resources that together will enhance our ability to reach our two high-level long-term objectives. The Board and management of SAFER have identified five main areas, equally important, to measure and track - Competence, Collaboration, Attractivity, Mobility and Project impact. Indicators within each of the areas will be developed and used as challenges for Stage 3.

Table 3. *Example of indicator for SAFER performance during Stage 3.*

Perspective	Indicator, examples
Competence	no of researchers, professionals, students ; publications; examinations
Attractivity	resources, funding; mentioning, web visits, media; international contacts, MoU
Collaboration	no of partners, SAFER level, project level; no of projects, activities at SAFER
Mobility	no of persons with multi-affiliation; no of people changing employer
Project impact	no of projects with impact on: Decision-making, methods, advanced engineering, new products or services ; no of ground-breaking results

Results and the implementation

Expected results from stage 3 are a project portfolio close to a yearly turnover of 200 MSEK a year. The projects are still to a major extent within our present Focus Topics (although some new topics can be expected to emerge), and the results are finally starting to produce visible improvement in real traffic. The aim of each Focus Topic for Stage 3 and beyond is described below and some specific examples are given

- **Incidents and Accidents** – effects and priorities aims to be at the forefront of the holistic understanding of the occurrence and effects of incidents and accidents. Further foster and develop the established core competence in accidentology. Enhance and establish performance within driving studies regarding both collection and analysis methodology.

  Example: The analysis project award for the US project SHARP2 is expected to be an important step towards more comprehensive analysis collaboration with researchers in the US on driver behaviour. In Europe, the area of Naturalistic Driving Studies (NDS) has begun to develop and SAFER aims to maintain a leading role. Right now, an FP7 call on NDS is an important base to further develop the knowledge on crash causation. In order to effectively manage future projects, the research infrastructure for collecting, hosting and analysing Naturalistic Driving Data, which today has been built up within SAFER, will be consolidated and further developed. At the end of Stage 3, a long-term building of a database for in-depth studies of accidents has been established and researchers with high skills in accident data analysis are participating in the continuous project activities.

- **Driver State/Action/Reaction** - Establish a multi-disciplinary human factor research platform. Build the foundation for strong collaboration between partners in SAFER and international researchers to perform groundbreaking behavioural research.

  Example: By analyzing NDS-data, driving simulator studies (e.g.in SIM 4), and testing with cars in active safety test areas (like ASTA) having built up a knowledge about the consequences of the driver not having their "*eyes on the road*" during various long-term intervals (from a few seconds to several seconds) in different traffic environments and for various reasons (communication, manual interaction with in-car information systems, use of nomadic devices etc.). Another research achievement by the end of Stage 3 should be an understanding of good principles for the driver-to-vehicle HMI for various information and communication functions to keep the "*eyes off the road*" within acceptable short times (not more than one or a few seconds each time depending on the traffic situation).

- **Prediction for accident prevention** - Support cutting-edge fundamental research on enabling technologies within sensor, computers and communications engineering. Create a research platform combining multi-disciplinary expertise from fundamental and applied areas. Build strong research in robust vehicle dynamics including (semi) automatic accident avoidance and aerodynamic effects. Develop leading edge competence in sensor fusion and vehicle communication for accident avoidance technologies

  Example: At the end of Stage 3 there are a number of research vehicles equipped with low latency (in real time) V2V communication systems that are being used for evaluation in active safety test areas (such as ASTA) as well as in real traffic. Each vehicle broadcasts continuously to other vehicles its own position (GPS based) and speed, information each other vehicle can continuously use for estimation of risk of collision. The research vehicles are used for the development of reliable V2V communication principles in different traffic environments.

- **Methods for evaluation of safety systems** - Actively contribute to the development of new test areas meeting the evaluation needs of future safety systems. Develop evaluation methodologies for drivers, vehicles, nomadic devices and safety systems (incl. sensing and communication systems) in simulators, test areas, and in real traffic environments that reflect various relevant traffic scenarios.

Example: By the end of Stage 3, it has been demonstrated that a number of (dangerous) driving behaviours that have been found in NDSs can also be seen (repeated) in driving simulators (as SIM4), as well as in driving experiments in active safety test areas (as ASTA). Research has then found what the prerequisites for this repeatability of driving behaviours are. These findings will increase the value of future use of simulators and active safety test areas in the study of driving behaviours and the development and evaluation of countermeasures.

- **Safety for Novel Electric Vehicles and Vehicle Combinations** - Create strategies and develop edge-competence for increased crashworthiness and safe vehicle dynamics by advanced structures and novel propulsion and drivelines beyond 2030. Participate in strong multi-disciplinary collaborative research projects with national and European partners. Create a critical mass of researchers and PhD students in the competence areas crucial for safe novel electric vehicles in order to establish a leading research hub.

  Example: SEVS2 project to be finalised, making the findings from SEVS more defined and identifying key competence areas. A number of core projects in fundamental research to be performed, starting to build the critical mass of researchers.

- **Human Models and Biomechanics** - With human modelling we will build leading edge competence and tools valuable to SAFER's partners, focusing on fundamental research and applied aspects with complex kinematics and various human properties. Guard and develop the world-class reputation of SAFER researchers in the area of applied biomechanics and injury prevention. Focusing on selected topics and basing the research on real world safety needs.

  Example: We expect a human model to work in low-g and high-g situations, helping to predict injury in complex situations, also including translational and rotational pre-crash kinematics. Increased international network in model development and strengthened acknowledgement within identified SAFER core biomechanics competence areas.

International collaboration

SAFER has a strategy concerning internationalisation which was set up in 2010, a result of a one-year project, called global links, funded by Vinnova. The long-term objectives decided on are:

- Have MoU agreement with eight well renowned organisations in 2016
- Be represented at Brussels at least 10 times a year *e.g.* in EARPA meetings.
- Organise at least 1 international conference each year
- Have at least 10 guest researchers visiting SAFER for at least a week each year
- Have at least five researchers from SAFER visiting an organisation abroad for at least a week.
- Organise 1-2 international delegation trips each year.

Visible results on societal level

A result of SAFER beyond Stage 3 is that there will still be a strong Swedish industry with its R&D in vehicle- and traffic safety based in Sweden. New companies concerned with accident avoidance technologies and safety assessment methodology will be established and have high reputation and international visibility.

There will be demonstrators in Gothenburg city and in other parts of Sweden based on SAFER research results. Specifically ASTA, the active safety test area, will be profitable and on the forefront of testing and analyzing. The test scenarios will be an integrated part of an advanced testing- and modelling complex, where integrated traffic safety analysis, driving simulators, system models (physical and mathematical) support the full scale testing at ASTA proving ground.

In 2015 SAFER is prepared to host the ESV conference and has applied for this via the Swedish contact point.

Activities to reach the targets for Stage 3

The ongoing plans at SAFER continues. Advices from the International Advisory Board have been incorporated in the strategy. ISAB recommended improvement regarding internationalisation, volume of scientific output, organisational clarity and efficiency, structure and availability of material and presentations and proactivity. Furthermore SAFER was encouraged to continue with the in-depth investigations and enhance field data analysis work. This together with the conclusions from the Board and the feedback from all partners results in even more emphasis on building competence and establishing common resources such as project management capacity, a supportive meeting place and infrastructures for real data collection and analysis as well as test beds and simulators.

Benchmarking with some international research environment will be carried out together with Chalmers. This will enhance our understanding of success factors and will, in combination with our own research and dialogue on management of open innovation, give valuable input for the target setting.

The acknowledgement of the complexity of the traffic system, driven by both the technological advancement in IT, electronics, new findings in human behaviour research and the system approaches to our grand societal challenges creates breakthroughs in accident avoidance systems, but at the same time poses new threats to traffic safety. Therefore, SAFER needs to initiate and enhance activities concerning the system competence and the new research areas associated with safety.

Efforts will be made to attract new partners that can complement those already present. Examples of such partners could be the telecom operators, technical consultants, social media, and energy suppliers. The partners should be selected based on SAFERs strategic needs.

The less mature Competence Areas of SAFER will be strengthened to reach a critical size, in terms of both range and depth. Particularly, the infrastructure Competence Area will be addressed. A Competence Area Leader will be appointed and supported to initiate the necessary first steps. More senior researchers need to be involved and the Chalmers Transport area of advance will play an important role.

SAFER must foster more collaboration with other Swedish academies. Collaborations exist on a project level and in some of the Competence Areas, but during Stage 3 this must result in strong links on the centre level. Collaboration with other "platforms" must also be enhanced to deal with the transport system level. Lindholmen Science Park hosts several important collaborative partners such as Security Arena, Test Site Sweden, visualisation Centre to mention a few. Integration with other research and innovation bodies which are relevant for SAFER's interest should also be pursued. This includes connecting to the Chalmers Areas of Advance for Energy and Built Environments.

SAFER will continue to be one of the drivers for SEVS – Safe, Efficient Vehicle Solutions - and stimulate the scenario methodology for dialogue and identification of future research needs beyond 2030.

An emerging important field will be to engage in standards and policy issues. SAFER research will increasingly be used to support decision-making in society. SAFER will be a platform for communication of research results, more proactive and visible during Stage 3. The connection to Vision Zero academy will be essential.

Efforts will be made to significantly raise cash contributions from large industrial partners in order to secure necessary resources for SAFER to further develop.

10. Further information

Outreach activities

International visibility is important, and SAFER strives to be present at essential events. An overview of international outreaching activities is given in appendix G, table 6.2. One example of this kind of activity is when SAFER participated in a Western Sweden exhibition booth at the very large "ITS 2009 Conference" in Stockholm in September 2009. The same exhibition was then again used at a high level EU meeting about "Future Road Transport" in the end of October 2009 in Gothenburg. At this event, SAFER (Autoliv and VTI) demonstrated for the participants a typical road crossing accident scenario.

In September 2009, SAFER arranged a Sweden -North American seminar on Child Safety: "Child Occupant Protection: Current knowledge and future opportunities". Together with six invited senior researchers from USA, Swedish researchers gave presentations about the broad competence SAFER has within the area. The seminar was highly appreciated and gathered 80 participants. In September 28-29th, 2009 SAFER in collaboration with IFSTTAR (previously INRETS), arranged the conference The 1st International Conference on Driver Distraction and Inattention at Lindholmen Science Park, Gothenburg. The event gathered during the two days over 150 participants in total, with 45% of the visitors coming from outside of Sweden. A second, follow-up conference is planned to take place September 5-7th, 2011. SAFER has also had an exhibitor booth at the ESV conference in both 2009 and 2011.

As an effort to disseminate research results to the public (and not specifically a research audience), SAFER together with the City of Gothenburg, organised a seminar about inattention and accidents in May 2011. This was an attempt to reach an audience which usually is not the main target audience for SAFER.

SAFER management team members have had several invitations to be keynote speakers at seminars and conferences. For instance, Director Anna Nilsson-Ehle participated as speaker at the inauguration of the VTI simulator SIM4 in 2011.

SAFER in the media

SAFER has during Stage 2 been written about in several partner magazines such as VINNOVA Nytt, Vägverkstidningen, Chalmers magasin, Lindholmen Science Parks newsletter, VTI Aktuellt. Other papers in which SAFER has been mentioned include Göteborgs-Posten (several times), Dagens Nyheter, Automotive Sweden, Aftonbladet, Promotive. SAFER researchers have also been interviewed in Swedish radio, for example in conjunction with the Driver Distraction Conference in September 2009. The Driver Distraction Conference also resulted in broadcast in Swedish TV news.

The SAFER web site is on the Chalmers portal. The website includes calendar, news & events related to vehicle and traffic safety, vacancies, research reports, press releases etc. During autumn 2009, a film about SAFER was produced. The film is now published on YouTube and printed on DVDs for distribution to guests, partners, exhibitions and external activities. A new brochure about the centre was produced in June 2011.

11. Facts about the Centre

Appendix A: CV of Centre Director

Appendix B: Centre Partners - table 1

Appendix C: Board of Directors – table 2

Appendix D: Management Team – table 3

Appendix E: International Scientific Advisory Board – table 4

Appendix F: Research Programme – table 5.1, table 5.2, table 5.3

Appendix G: Publication and Presentation Activity – table 6.1, 6.2

Appendix H: International Activity – table 7

Appendix I: Financial Reports – table 8, table 9, table 10, table 11, table 12

Appendix I, extra: Project portfolio budget, own projects

Appendix J: Websites