10 YEARS OF SAFER

–TOWARDS EXCELLENCE IN RESEARCH AND COLLABORATION

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

"SAFER provides excellent multidisciplinary research and collaboration to eliminate fatalities and serious injuries, making Swedish society, industry and academia world leaders in vehicle and traffic safety."

THE PURPOSE OF this report is to present the effects and outcome of the 10 year investment in SAFER – vehicle and traffic safety centre at Chalmers. There is plenty written about SAFER and our results already – yearly reports, international evaluations and doctorial theses, all available through our website. These findings will not be repeated in detail in this report but sometimes referred to. We hope that this report will inspire you to read more and to share our belief that curiosity, diversity and openness drive competence and innovation!

SAFER research environment, Lindholmen Science Park
March 2016

The management group / Anna Nilsson-Ehle

Version 2: March 31, 2016

Table of Contents

1.

INTRODUCTION AND BACKGROUND

SAFER CONSISTS OF ITS PARTNERS. April 1st 2006, 20 partners from industry, academia and public organisations that shared a common view on the importance of traffic safety signed an agreement, which included a 10-year framework and a three-year Stage 1. Vinnova, the legal host Chalmers and all other partners together committed to fund 1/3 each. Vinnova's investment is MSEK 10/year. Additional partners have been attracted over time and currently SAFER consists of 34 partners.

SAFER has its roots in decades of cooperation between Chalmers and some of the industrial partners. The successful collaboration on neck injury research, with an economical benefit of more than 19 times the funding (evaluation 2005)[1], gave confidence in the potential of a joint research centre for vehicle and traffic safety. A pre-runner to SAFER, Gothenburg Vehicle Safety Centre at Chalmers (GVSCC), prepared the set-up, the agreement and the initial vision and goals.

The vision was rephrased in SAFER's second stage (2009) keeping the same essence "to eliminate fatal and severe injuries". In addition, the strategic document "Wanted position 2016" with its specific targets has been guiding the development since 2012 (Stage 3).

The approach to achieve outstanding results is based on the belief that competence and results develop in creative interactions pursuing a meaningful purpose. The purpose is expressed through SAFER Focus Topics – areas that together cover the current research priorities. Research on innovation shows that creativity is strong in "border-zones" where unexpected meetings (people, ideas, disciplines etc.) take place. These insights influenced Vinnova and the partners who designed SAFER to have its own work environment and an active openness to new partners and international collaborations. Today, over 300 people have access to SAFER.

Stage 1 was primarily concerned with the start-up. Promising results led to Stage 2 (2009) with a strategic plan focusing on: enhancing the identified strengths (competence present at SAFER, the meeting place and the dissemination of knowledge), improving project management, organisation and identity, and raising efforts regarding internationalisation, financing and cooperation with other centres and organisations. During Stage 2, the project portfolio had a strong growth and the leverage on SAFER's funding (of projects) became substantial – attracting externally funded projects with SAFER as leader or projects associated to SAFER led by a partner. A strategic cornerstone is to use SAFER funding for exploratory and high-risk projects decided by the Board in an agile process. These serve as pre-studies for larger, national or international projects. In this way, each Focus Topic, and SAFER as a whole, build a purposeful project cluster leading to the Wanted Position 2016.

The organisation shall encourage multidisciplinary collaboration. The management has a paradox to balance – 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 based on free will – the participation depends solely on the attractiveness of SAFER.

A target for SAFER is to establish a robust competence base. SAFER aims at being capable of taking on any project within the Focus Topics. In addition to foster creative networking and competence sharing on a daily basis, SAFER has established Competence Areas in fields that are key to traffic safety. The Competence Areas, led by respected scientists, gather SAFER partners' key persons to share and develop new knowledge within the respective field. This ensures contact with centres and organisations with similar, complementary or fundamental research, globally.

The partners govern SAFER via the shareholders meeting and via the Board, consisting of nine members. The Board meets 6-8 times a year including at least one dedicated strategy meeting. At Chalmers, SAFER is the core of the research profile Traffic Safety within the Transport Area of Advance. The daily operation is run by the director and the management groups. These teams consist of a few persons paid by SAFER and some partner employees' in-kind. Four Reference Groups are the formal arena for partners to meet and identify key issues and initiate needs-driven research. Each Reference Group is led by a member of the management group and is supervising a project portfolio. Focus Topic strategists are responsible to keep road maps, aligned with partner strategies, up to date.

2.

THE EVOLUTION OF SAFER IN A CHANGING WORLD

ROAD ACCIDENTS and their far-reaching consequences on humans and society are of great concern to all actors in the road transport system. Globally the number of fatalities/year grows and is in the order of 1.3 million. The concern has increased since 2006. United Nations (UN) has proclaimed the years 2011-2020 as the "Decade of Action for road safety".[2] Ambitious safety targets have been set in a number of countries and at European level there is a target of near zero accidents 2050 (EU White paper 2050). The need for an integrated and comprehensive approach in close cooperation with different stakeholders has become more evident which favours the holistic approach – a hallmark for SAFER.

During the past decade IT has had a significant influence on the safety development. The dominating concern 2006 was still crash safety with an emerging interest in driver support systems for crash avoidance. This caused SAFER to take some ground-breaking, strategic initiatives in driver behaviour studies and in control and communication technologies. During Stage 3, automated driving, a truly systemic issue, has emerged to become the dominating technology topic while the societal topic "liveable cities" has raised the concern of traffic safety for the increasing volume of vulnerable road users. Together these shifts raise the importance of research when safety becomes a boundary condition in the sustainable transport system. It is increasingly important for the international competiveness of the Swedish automotive industry that SAFER is at the forefront in this rapid development and acts as a catalyst and a driver as well as promoter for international collaboration and continued research funding at for instance European Union (EU) level.

The cluster in Sweden is stronger today than 10 years ago when SAFER started: more competence in academia and institutes, stronger product programmes in industry, high international respect for Vision Zero, several strong international collaborations between SAFER and well-respected research organisations, state-of-the art infrastructures like Active Safety Test Area (AstaZero), Research Vehicle Resource (ReVeRe) and driving simulator Sim IV. One financial sign is that the yearly value of the SAFER project portfolio 2006 was MSEK 60 whereas the corresponding figure for 2015 is some MSEK 180. The total value of ongoing projects 2015 is MSEK 440.

SAFER is well-known internationally in 2015, due to respected research results, good collaborative skills and its leading role in several well-organised conferences. In 2009 the first international conference on driver distraction and inattention was held in Lindholmen on SAFER initiative. SAFER was instrumental in awarding Gothenburg key conferences, such as the highly successful third international safe cycling conference (2014). In June 2015 the Enhanced Safety of Vehicles (ESV) conference was organised and well appreciated. SAFER has well-developed networks within EU, and has been a respected partner in the Seventh Framework Programme (FP7) projects as a Joint Research Unit (JRU) which is an asset for Horizon 2020 (H2020). Several collaborative initiatives with research organisations in the United States (US), China and Japan place high expectations on SAFER involvement and SAFER presence globally.

3.

EFFECTS AND RESULTS

PARTNER IMPACT, SOCIETAL OUTCOME AND INTERNATIONAL COLLABORATION

This chapter describes how SAFER has become a highly recognised player at the cutting edge of vehicle and traffic safety, through its distinctive methodology of multidisciplinarity, active partnerships and collaboration between researchers and partners in academia, industry and the public sector. Highlights, breakthroughs, results for Swedish growth, etc. will be presented, including success factors related to the performance and deliverables. Partner views on SAFER's contribution to the research area and society will be covered with an emphasis on how SAFER results, competence and knowledge have been utilised by partners to establish new products, processes and services. The added value of being a centre compared to other ways of research collaboration is discussed, as are the other types of collaboration and influential organisations to which SAFER is connected. An overview of how the international strategy has developed and the resulting activities, as well as the current state of collaboration is provided.

THE BASIC AIM OF SAFER is to enhance research and results as well as profound collaboration between the different stakeholders in traffic safety. The field of traffic safety is important for a sustainable transport system and also important for Sweden in the sense that safety is a core value for the Swedish automotive industry and several of its suppliers. They 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.

SAFER focuses primarily on pre-competitive research and projects including several partners. It is a multidisciplinary and diverse meeting place where the persons involved come from academia/institutes, industry and society. This means that those working at SAFER are employed by one of the partners. At the start of year 1, there were 90 "key persons" and at present there are some 300. "Key persons" refer to people who work at SAFER part or full-time and therefore need keys and access to the SAFER environment (both the office facilities as well as competence networks and common workspaces online). In addition, most partners have several employees engaged in traffic safety but not necessarily requiring own access to the SAFER office. In a creative and open innovation environment, diversity is an important aspect and a conscious concern. At present, about 36% of the key people are employed at Chalmers (SAFER's host) and the rest at other academic or institute partners, industry partners or public partners. Other diversity aspects at organisational level include partners of different sizes, maturity in subject, etc.

At individual level, diversity aspects of importance and present at SAFER include gender, multiculturalism, mixing senior/junior researchers, etc. SAFER consciously promotes a good gender balance and SAFER extended management group as well as SAFER Board now have close to 45% women. 20 adjunct professors from industry, institutes and governmental organisations are connected to SAFER. Through strategic funding from Chalmers, 30 post-docs have been part of the SAFER environment since 2010. Since the start of SAFER, 60 PhD students working in the SAFER environment have written their doctoral thesis, licentiate thesis, or both. 44 doctoral thesis defences (23 industrial and 21 academic PhD students) and 48 licentiate seminars (18 industrial and 30 academic PhD students) have been conducted.

It is a SAFER core value to promote and achieve interaction as well as strong links between the partners. This attitude influences all activities from weekly seminars to how the organisation is manned by all partners, to the set-up of projects and the design of the office space. One achievement, giving added value to the partners, has been to be accepted as a JRU in EU 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 is a need to limit the number of organisations per country in order to balance a consortium.

Most projects and applications that have been conducted during the years include several partners and these joint partner constellations have increasingly complex set-ups. It is evident that the pre-requisites and capability to organise strong consortia have grown and it has been possible to respond quickly to proposals from international research groups that look for Swedish partners. Competence at SAFER both needs and drives international collaboration.

Vehicle and traffic safety is a topic which encompasses a large number of research areas and disciplines. The competence profile at SAFER is thus multidisciplinary, spanning from mechanical engineering, computer engineering, and sensor technology to biomechanics, human factors, behavioural science, and statistics. This broad basis is possible through the contribution of SAFER's different partners. As part of the overall strategy, the competence is developed

and nourished in 12 partially overlapping Competence Areas which gather key persons from partners. It is the responsibility of each Competence Area to know state-of-the-art of global research and what is perceived as world-class research. Technology development, research and innovation has driven a widening of the scope since SAFER's start. Consequently, new competences and partners have been identified and added to SAFER's original 20 partners. Today there are 34 partners. The continued growth of the complexity and enlargement of the issues create need for even more partners. Additional information about all SAFER partners can be found on SAFER's website.[16]

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. This type of interaction is a catalyst to foster collaboration and fruitful, innovative ideas. The partners have access to several advanced testing and evaluation facilities, including driving simulators (at Chalmers, VTI, Volvo Car Corporation and Volvo Group), material and component testing (at Chalmers, Swerea IVF, KTH, Swerea SICOMP, SP, Volvo Car Corporation), crashworthiness testing (at Volvo Car Corporation, Autoliv, SP and VTI) and full-scale testing. The research infrastructures span from laboratory testing of sub-systems to field evaluations of complete human-technology systems. SAFER actively supports the AstaZero within which a full-scale physical test environment with different types of test tracks is available. In addition to contributions in the development phase of AstaZero, SAFER is leading the establishment of a full-scale vehicle laboratory at Chalmers (ReVeRe, see Chapter 4.1).

3.1
Impact on Partners and Society

SAFER IS ITS PARTNERS, and the Focus Topics (mentioned in Chapter 1) 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 results stemming from SAFER – some need input for strategic decisions, others need technical research to design new products, still others need to share resources or infrastructure to be able to afford research. The ongoing dialogues among partners on the future research needs and when breakthroughs can be expected are of great value, also when it comes to the interaction with societal actors outside SAFER.

A common theme among partners is competence creation and retention. Competence exists at individual as well as collective (organisational) level. Involvement of partner staff in SAFER activities, networks and projects creates competence in the partner organisations, thus enabling faster and more precise implementation and innovation.

The formation of SAFER has increased the dialogue and interaction between the partners. New types of collaborations have been established and new projects have been initiated. In particular interdisciplinary projects involving several disciplines can be regarded as a result. Examples of this are presented in Chapter 4.1. SAFER has also been a facilitator in bringing experts closer together and forming research teams, such as the behavioural expert team that was awarded a US governmentally funded research grant. Other examples of areas with successful collaboration within SAFER are child safety and human body modelling. Several SAFER partners have joined forces under the SAFER umbrella and this has very clearly boosted progress (see further the "SAFER Success Stories" in Appendix A). Thus, the formation of SAFER has brought experts from the partners closer together which has built a critical mass of researchers with SAFER as their common arena upon which further activities can be built. Yet another area of progress is driving simulator methodology and application. This topic has developed through fruitful collaboration between SAFER and the competence centre ViP (Driving Simulation Centre).

SAFER and its development has been the empirical setting for a 4-year qualitative case study by researchers in Open Innovation Management.[3] A general finding was that partners value the partnership and SAFER as such, but have not taken full advantage of SAFER's potential. SAFER is said to give an increased credibility to 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. At SAFER, collaborative multistakeholder research enhances the partner organisations' competitiveness and ability to contribute to a transport system with "near zero" fatalities and serious injuries. Furthermore, many partners appreciate the possibilities to influence the perspectives on future transport systems by belonging to SAFER and they also find it politically important to be able to influence and have insight into the safety agenda.

To further understand partner expectations a survey via a questionnaire to all large and normal-sized partners[4] was undertaken in December 2014. There were three groups of questions: the partners' perception of SAFER's added value, relationships and involvement with SAFER, use of SAFER competence and knowledge and a part focusing on the scope of traffic safety.

Partners are involved and engaged to different degrees and in different levels of SAFER's organisation. A general finding is that a higher degree of involvement means greater satisfaction. Based on the questionnaire it is clear that partners have a variety of reasons for being partners. For several partners safety is an important part of their business. They want to get benefit from competence, and see SAFER as a competence platform giving access to network and/or researchers. They expect to be able to gain and use generated knowledge by being involved. Other reasons are that they want to contribute research, knowledge, testing and support to SAFER. Some

partners see partnership as an opportunity to get research projects (and/or collaborations).

SAFER has several key strengths to build upon and nurture further. These include SAFER's strength as a network, the broad set of partners whose engagement enables a fruitful research network and broadened competence base. Partners furthermore appreciate that SAFER delivers research results for partner use, for example in their own knowledge building and projects.

Another survey was given to SAFER project managers in 2011 asking their view on expected effects of projects run in the SAFER environment. Regarding short-term project results, 60% state that within three years the project will have an impact on methods, 48% will have impacted decision-making, and 28% will have impacted new products. 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.

Besides the above mentioned surveys to partners and project managers SAFER has also, at the end of each operational stage, requested partners to comment on the value of SAFER in order to facilitate continuous and conscious development. These comments are included in respective evaluation report to Vinnova. Plenty has also been written about SAFER within the Open Innovation Management research area at Chalmers[5]. In 2009 a Master's thesis[6] on creative climate concluded that SAFER is characterised by many of the aspects often used when describing an innovative creative organisation. Both the social and physical creative environment perform well and one of SAFER's most valued characteristics is that of being a great meeting place where different people can interact and meet to share knowledge and experiences as well as network.

Mobility of employees between SAFER partners is a desired outcome of the collaboration and indicates a strong and robust competence network. 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 approximately 80 persons, senior researchers, young researchers and graduates, have moved between academic, industry and institute partners. Nearly half of them moved from academia to industry, many being master students and PhD students recruited by the industry after graduation. Since SAFER has not kept track as to where every master student has continued after leaving SAFER, most probably the mobility number is considerably higher.

3.2
Internationalisation

SAFER HAS A STRATEGY for internationalisation which was first set up in 2010 as a result of a project, Global Links (2008-2009). It was later revised using input from a subsequent benchmarking project, Global Links 2 (2011-2012). Both of these studies were funded by Vinnova. The basic idea of the strategy is that by creating strong connections to world class research environments and nurturing an international reputation for outstanding collaboration between industry and academia, it should be possible to strengthen Swedish safety research, innovation ability and global competitiveness, as well as influence the international research agenda.

One specific goal with Global Links 2 was to identify 2-5 international research and innovation environments that SAFER should develop collaboration with. Safety research organisations in Europe, the US and Asia were evaluated regarding their potential to enhance SAFER's competitiveness through collaboration, resulting in recommendations for concrete actions. A number of actual activities for selected cooperation candidates were suggested. In addition several general principles for research environment collaboration were derived.

As a result of both studies, collaboration has in fact been established with research environments in Europe, North America and Asia. This has also led to various collaborative projects with leading research organisations and within a broad range of research areas. In addition to these relations between different centres, there are, of course, numerous collaborations between individual researchers from different nations also outside these regions.

ACTIVITIES IN EUROPE

SAFER has consciously built up a high presence and become increasingly invited to different forums on the European scene. The aim is to engage in activities related to both influencing and participating in order to promote SAFER's research agenda and thereby its scientific level and partners' success. Worth mentioning regarding influencing is, for example, the membership in the European Automotive Research Partners Association (EARPA), both in the Safety Group and in the Board, and participation in the European Road Transport Research Advisory Council's (ERTRAC) scenario work on Road Safety Research beyond 2030. SAFER and its partners actively participate in the European Council for Automotive R&D (EUCAR), ERTRAC and ERTICO – ITS Europe. In addition, together with partners other task forces with relation to safety have been covered (e.g. electronics, materials, modelling, and urban mobility). Regarding participating SAFER has been involved in a number of FP7 projects as JRU and built a reputation of high competence, good teamwork and high-quality deliveries.

In 2013, H2020 succeeded the FP7 as the common European research programme. To influence the content, SAFER engaged in the FP7 EU project PROS[7] which was completed and reported in 2014 to the European Commission (EC). The foundation for SAFER's input was based on the partners' priorities. The aim of the project was to ensure that adequate amount of traffic safety content would be present in upcoming H2020 calls. SAFER was a work package leader and a vocal member of the steering committee of PROS, which resulted in concrete priorities and proposals for texts aimed for direct application in H2020 calls. In June 2014 SAFER responded to a Vinnova call and was awarded the coordination of a national influential platform *(Nationell påverkansplattform)* for traffic safety (TS-Europe). This has enabled an increased and dedicated involvement in different organisations that influence the European research agenda. TS-Europe utilises the outcome of earlier activities where SAFER has coordinated Swedish stakeholders, such as "Safe Future – a strategic research and innovation agenda" (SFIA), the PROS project, and consortia formed to apply for strategic innovation programmes.

TS-Europe has crafted messages and input provided to several channels involved in the shaping of the H2020 work programmes. An example; during its EU presidency in autumn 2014, Italy decided to focus on transportation safety and to hold a dedicated conference on the topic in December 2014. With the help of the Swedish Ministry of Enterprise and Innovation TS-Europe could ensure a central role in the conference's closing panel and leverage this occasion to promote traffic safety, communicate its messages and profile Swedish traffic safety and SAFER. The closing document was influenced and SAFER had the opportunity to directly shape parts of the upcoming H2020 call on Automated Road Transportation.

A number of SAFER partners have been engaged in project applications in the first round of calls of H2020, and two of the 2014-project proposals have been approved (2015 projects are under decision at the time of writing of this report). Several SAFER partners have well established European networks and have also historically been instrumental for SAFER's representation in EU's FP7 projects. An important

pre-requisite for these collaborations is that SAFER, in spite of its character as a competence centre with no legal status of its own, can be a partner in projects. This was solved already in 2007 so that SAFER in EU FP7 and also in H2020 is accepted as a JRU. In a given EU-project, partners that so wish can act together as SAFER with Chalmers as the legal host. In some EU projects, SAFER partners are independent partners and yet in other EU projects part of the JRU SAFER.

SAFER represented Chalmers 2011-2014 in the EU FP7 project SAGE[8] which consisted of a consortium of five regional clusters in Europe. Potential research themes and common projects in four thematic areas where defined (Safety, led by SAFER, and in addition Connectivity, Green, Mobility), which would leverage the collaboration of clusters and attract funding. Possibilities to develop an international collaboration strategy were evaluated following on-site discussions with different Asian regions where SAFER led the work for the Nagoya region.

The involvement in SAGE was due to SAFER's early involvement in discussions on cooperation between regional research clusters. In 2008 SAFER signed a Memorandum of Understanding (MoU) with the French automotive cluster Mov'eo and in 2011 with the French Transport Research Institute (INRETS, now IFSTTAR – French Institute of Science and Technology for Transport, Development and Networks) as well as with the Dutch automotive industry innovation programme HTAS.

ACTIVITIES IN NORTH AMERICA

Projects in the US with SAFER leadership or involvement are progressing well. As a token of its increasingly strong position, SAFER was awarded one out of the three highly prestigious NDS (Naturalistic Driving Studies) data analysis project grants from the US Strategic Highway Research Program 2 (SHRP2) in strong competition with 23 other highly knowledgeable research organisations, all from the US. The project was carried out as a collaboration between Sweden and the US, consisting of SAFER partners, and well-renowned US researchers. The results from this "SHRP2 S08 Safer Glances" project were presented in 2014 and have been highly appreciated. The success of the project is the result of a dedicated strategic effort at SAFER. The MoU in 2008 between US Transport Research Board (TRB), Vinnova and the Swedish Transport Administration regarding information exchange between SAFER and SHRP2 formed an important part of the strategy.

SAFER has also specifically fostered links to University of Michigan Transportation Research Institute (UMTRI), based on a MoU between Sweden and Michigan's Ministry of Transportation. Through earlier experiences and results from two collaborative projects (SeMiFOT[9] and SeMiFOT 2), SAFER has further developed the methodology for Field Operational Tests (FOT) and NDS (see further in Chapter 4.1). The latest achievement in analysis infrastructure is the CAC[10] set-up between SAFER and UMTRI, where large data sets can be accessed and analysed remotely across the Atlantic (see further in Chapter 4.1). This infrastructure and the work on a global Data Sharing Framework (DSF), which SAFER is leading in the EU project FOT-Net Data[11], has raised interest and TRB has requested information from SAFER to help facilitate a more open access to the SHRP2 data. The recent SAFER and UMTRI collaboration project, MRMD[12] (see Chapter 4.1), on real world safety levels for cars in Europe and the US is an important input to the trade negotiations between the US and Europe. Another recent collaboration with University of Iowa has led to an MoU between the universities (Iowa and Chalmers) and the first activity, ACIENDA[13] project, resulted in an updated coding scheme for naturalistic driving data which is being fed into new ISO (International Standardisation Organisation) activities to standardise some areas of NDS analysis.

As proof of its international importance, SAFER became an affiliated organisation to Center for Child Injury Prevention Studies (CChiPS) in the US, including a joint research project on mild brain injuries in teenagers with US partners such as Children's Hospital of Philadelphia (CHOP) and the National Highway Traffic Safety Administration (NHTSA). The world-class level of research in collaboration with CHOP and its collaborative CChips centre was manifested when one of SAFER's visiting professors and associated researcher in SAFER's child safety research area, was appointed Honorary Doctor at Chalmers in May 2014.

SAFER is well-respected by NHTSA as a hub for Swedish traffic safety research. NHTSA trusted SAFER with the responsibility to be the local organiser of the bi-annual International Technical Conference ESV, held in Gothenburg June 2015 (see further in Chapter 4.3). The Swedish Minister for Infrastructure at the Ministry of Enterprise and Innovation gave an opening keynote speech at this high-level conference.

SAFER researchers have established contacts with Stanford and Berkeley which are in the forefront on issues of self-driving cars and a study visit to Stanford was conducted by four SAFER researchers. Many SAFER partners have long-standing relationships with influential actors in the US and in 2013 SAFER was asked to accompany Volvo Group and Chalmers in a discussion with Penn State University, to explore concrete possibilities for future collaborations. Projects and researcher based collaboration are also ongoing with SAFER partners and the University of Iowa.

ACTIVITIES IN ASIA

SAFER is continuing to develop its ongoing collaborations in Asia. The China-Sweden research centre for Traffic Safety (CTS), with Swedish partners Chalmers, Volvo Car Corporation and Volvo Group and Chinese partners Tongji University and the Research Institute for Highway safety (RIOH), was inaugurated in 2012 and is now in its second stage. The collaborative projects in the centre and the network provide opportunities for research and innovation activities in China. SAFER constitutes the Swedish research platform in this collaboration. There is also an articulated interest from other universities in developing further collaboration for instance with Tsinghua University and Wuhan University. The presence of SAFER in China resulted in SAFER co-hosting the second ADAS (Advanced Driver Assistance Systems) China Forum – "From ADAS to Driverless" – a conference held in Chengdu in June 2015.

The Japanese collaborations took off when SAFER participated in the Vinnova organised study trip in 2007 to various research organisations in exploring cooperation possibilities (mentioned earlier in this chapter). The findings resulted early on in joint research projects with the Japan Automotive Research institute (JARI) and Tokyo University of Agriculture and Technology (TUAT) within the field of accidentology and NDS. Within the area of impact biomechanics and in particular whiplash injury research, collaboration between SAFER partners and JARI started already in the mid-1990s. In the SAFER environment this collaboration has expanded into brain injury research and human body modelling. The most recent JARI collaboration concerns female whiplash injury research where different SAFER projects has made SAFER a very attractive research partner in this new emerging niche. Since 2012 there is an MoU with University of Nagoya Green Mobility Centre (GREMO). GREMO has research in several areas of interest to SAFER, for example driver modelling, signal processing but also autonomous small vehicles and sensors. The director of SAFER has been asked to play an active role in various GREMO conferences and symposia as well as participate as invited speaker in a TUAT symposium in 2012. The JARI connection and SAFER's role in the SAGE workshop in Nagoya 2013 (mentioned earlier in this chapter) also led to an increased exchange with Nagoya University where SAFER researchers have been invited to lecture. Collaborative projects with GREMO are in the planning stage. Exchange of research visits between Chalmers and Nagoya University, funded by STINT Initiation Grant, focusing on driver modelling and cross-cultural analysis of driving styles based on large-scale driving data are ongoing. Furthermore, based on these and earlier contacts with Japan, a collaboration related to a national Japanese FOT project, with JARI as coordinator and Nagoya University as data centre, is now being investigated and SAFER's long experience in FOTs is requested.

The international recognition of SAFER as a well-renowned player within vehicle and traffic safety has resulted in SAFER being approached to play an advisory role in a Malaysian project in 2013. The research project, which focused on motorcycle accidents with trucks, was funded by Agensi Inovasi Malaysia, and was conducted in Malaysia by partners from industry, academia and society. The SAFER engagement was funded by Vinnova.

SAFER signed an MoU with Transport Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology Delhi (IITD), in 2009. Apart from the collaborative project on post-crash rescue principles, student exchange programmes are on the agenda. For the yearly TRIPP international symposium and the international course on transport planning in traffic safety, in November 2015, the director of SAFER is on the scientific organising committee and a well-respected researcher at Chalmers has organised a PhD course ("Traffic Safety Global Perspective") through which nine master and PhD students from Chalmers will participate at TRIPP.

OTHER INTERNATIONAL ACTIVITIES

Collaboration in traffic safety between Australia and Sweden has a long tradition. SAFER has benefited from Swedish guest professors at Monash University Accident Research Centre (MUARC) and University of New South Wales (UNSW) as well as established new contacts which has led to researcher exchange at SAFER. Collaborative research on long-term health effects from road crashes is established with Neuroscience Research Australia (NeuRA) and the George Institute for Global Health. In June 2015 SAFER signed a letter of association to the Australian Driverless Vehicle Initiative managed by ARRB Group Ltd. Thanks to SAFER's unique research on behaviour and sitting postures of children in cars, researchers were invited to join a large research study at Monash University together with some additional Australian partners. Other international participants in that study is CHOP.

During 2014 SAFER was approached by the United Nations Centre for Regional Development (UNCRD), and asked to prepare a background paper on road safety for a well-established intergovernmental forum with high-level policy makers (ESTBAQ14). This conference addresses issues regarding environmentally sustainable transport. In 2014 the conference aimed at adding road safety to the sustainability scope, and SAFER prepared a well-received report with significant input from SAFER partner TØI. The paper's scope included societal and economic consequences of road crashes in a variety of countries, and potential solutions. Following the presentation at the conference, several other channels are used for further dissemination of the material. Examples include the publication in the journal Traffic Injury Prevention[14] and that SAFER was invited to be on a panel at a road safety seminar in Cape Town, South Africa, arranged by Volvo Group in September 2014.

During the years, SAFER has regularly had numerous well-established guest researchers and visitors in a variety of fields and from all over the world: Europe, North America, Asia and Australia. A few of these have/had long-term affiliations in projects or as adjunct professors and most of these researchers have given open SAFER seminars, which is an excellent way of knowledge sharing. The number of guest researchers has been increasing steadily during the years and this is a visible result of increasing international activity and collaboration as well as international visibility and recognition. Several SAFER researchers have also been present at conferences and delegation visits in various parts of the world. This international knowledge sharing and networking outside of SAFER's physical arena, as well as the cultural diversity existing also within SAFER (as mentioned in Chapter 3), are important for creative and open innovation environments.

EXTERNAL EVALUATIONS AND STRATEGIC CONSIDERATIONS

SAFER has an International Scientific Advisory Board (ISAB) which provides advice to the SAFER Board and management about the quality, scientific relevance as well as the organisation and production of the research at SAFER in an international context. The advice concerns both research carried out as well as future plans. A first scientific review meeting was held in February 2011 and a second in May 2014. The ISAB consists of leading independent scientists of high international reputation with complimentary expertise covering SAFER's field of research[15].

The first ISAB in 2011 provided valuable advice as how to further develop SAFER's international activities. The subsequent Stage 2 evaluation by Vinnova noted that recognition on the international arena has been reached but nevertheless some recommendations were given. Based to a large extent on this feedback, SAFER's management and Board made sure to take several actions. The Global Links 2 benchmarking study (mentioned earlier in this chapter) was one of these actions. Also, the international ambitions are given regular attention by being a standing point on every extended management meeting.

Different agencies, including Vinnova, have pointed out a desire for SAFER to address emerging markets and several SAFER's partners have in fact operations in these regions. A meaningful support should rest upon an emerging market strategy which in turn would require funds beyond SAFER's current scope.


TEST VEHICLE


nternational Conference on
ver Distraction and Inatt ntion
ber 4-6, 2013
SAFER

4.

EFFECTS AND RESULTS

RESEARCH AREA, COLLABORATIVE PROJECTS AND KNOWLEDGE PRODUCTION

This chapter describes SAFER's approach to the research challenges and what SAFER has achieved and led to, both on national and international level. Collaborative projects of importance (major achievements, findings and outputs, milestones, international relevance, etc.) will be presented and an assessment of the results (including measurable goals and indicators) will be given. Other important output (patents/licences, recognitions, demonstrators, etc. are mentioned). Progress and prospects of SAFER will be discussed as will project portfolio volumes and leverage. The dissemination of results and sharing of knowledge through conference/seminar activities are described and results from a bibliometric study on publications (volume, visibility, citation counts, co-production, etc.) are included.

SAFER HAS IDENTIFIED seven Focus Topics (see Chapter 4.1) for the most essential research questions and developed strategic plans (roadmaps) for each of them. This is a good example of SAFER's increasingly proactive approach and it goes well in hand with the mission of developing world-class competence, including research tools and methods in the main research areas. New research areas are also continuously being explored through pre-studies and participation in international networks. The Focus Topics constitute the framework for SAFER's research as well as for development of competences and collaborations, and they are a strategic tool in project selection. They provide guidance and direction for growth and focus, and it is therefore natural to describe results in relation to them.

The Competence Areas 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. Their influence on the research project portfolio at SAFER ensures multidisciplinary collaboration across research fields. SAFER provides pre-requisites for creative and productive research by combining these different competences and in addition serving as an open innovation centre for partners and international researchers. In this way scientific excellence and innovation capability are both promoted. The projects involve pre-competitive research activities and often exhibit a good mixture of industry and non-industry partners both nationally and internationally. When projects move into the competitive phases of system solutions and products, SAFER supplies researchers to industry.

The total project portfolio together with the activities in the Competence Areas as well as the planned and spontaneous interactions in the open innovation environment contribute to various results of SAFER and the competence growth of both individual researchers and partners. The open innovation aspect of SAFER is a strong asset. There has been a successful growth of the research portfolio due to high competence levels and good reputation.

SAFER is today well-known and since its start in 2006 SAFER has managed to build up a strong international reputation in the area of traffic and vehicle safety, in some key areas in particular (as will be presented in Chapter 4.1). SAFER partners and researchers continue to strengthen the international position and the role as spider in the global web for example in collection and analysis of driving data, child safety and human body models. Among rapidly growing areas are research related to automated driving and also vulnerable road users. SAFER is active through direct projects and by participating in different national and international groups. The international collaborations will be crucial for successful research and SAFER has consciously built collaborations with European consortia as well as US universities.

4.1
The seven Focus Topics – research projects and results

SAFER'S RESEARCH CAN be described through the Focus Topics mentioned previously. They can be seen as cross functional "umbrellas" for research projects, defined to ensure high relevance of the research and competence development. This also means that the Focus Topics have evolved over time. The aim is that SAFER in its 10th year (2016) should be at the cutting edge in specific research subjects within all Focus Topics – Appendix A shows that they all have "Success Stories".

All in all there are currently seven Focus Topics: Incidents and accidents, Methods for evaluation of vehicle and traffic safety, Driver state and behaviour, Design for accident prevention, Safety for novel vehicles and vehicle combinations, Human body protection, and Care and Rescue. The following sections describe each Focus Topic and the main results from projects, as well as important achievements and activities since the beginning of SAFER in 2006. Additional information about all SAFER projects and results can be found on SAFER's website[16]. The mentioned projects have been grouped under the current definition of Focus Topics. It should be noted that some projects are related to several Focus Topics and can thus be addressed multiple times in the aspect of the context.

INCIDENTS AND ACCIDENTS

This Focus Topic is a critical component of the research activities at SAFER and a backbone for future safety research. It encompasses projects addressing the collection, processing and analysis of traffic safety data, including priorities and effect analysis. Today the area has a strong focus on crash causation, crash avoidance and driving behaviour. This can be seen as a natural extension of this historically high priority activity in Sweden. Incidents and Accidents is the strongest collaborative topic at SAFER and is acknowledged by the partners as an asset for all. It also gives SAFER a strong identity and a position in the global research community. SAFER's world leading cluster of researchers connected to naturalistic data activities has an acknowledged international reputation to a large extent thanks to conscious strategic choices and activities throughout the years.

An in-depth accident database is considered to be of great long-term importance for maintaining competence in the area. Databases with field data have a long history at SAFER and are continuously evolving together with the kind of data collected and the analysis to be performed. The data collection which started early in SAFER's existence includes NDS/FOTs as well as crash investigations. At the national level SAFER has refined in-depth crash investigations in the projects INTACT[17] and INTACT II, the first one started already in 2007. These activities facilitated SAFER partners taking leading roles in international research projects on data activities and SAFER has become a data node for in-depth crash data. Examples of these projects have been at the EU level with DaCoTA[18] as well as at global level with "Initiative for the Global harmonisation of Accident Data" (IGLAD), where SAFER's strengths in this area allowed Chalmers to be appointed the central IGLAD coordinator. Another example of the recognition of SAFER's international status was the request to collaborate with UMTRI to investigate whether real world safety levels for cars in Europe and the US are equivalent although their legislated test standards are different. The MRMD[19] project, completed in early 2015, brought three SAFER partners together in initial project stages and then this SAFER group became the European focal point for data analyses from Sweden, Germany, Great Britain and France.

The increasing amount of advanced driver assistance and preventive safety functions has led to a need to understand several aspects of how these systems should be designed, how they are used and their performance in real world traffic. This, together with the need to understand the underlying causational factors behind crashes, has accelerated the interest in FOT and NDS – an area in which SAFER is deeply committed and continues to develop spearhead competence and leadership. With the strategic use of combined competences within field tests and accidentology, SAFER managed to, in just a few years, become one of the world leaders in the fairly new driving studies research area. One of the key factors in SAFER's success was a competence project (BASFOT) which SAFER started already in 2007 as a result of the need for strategic planning and investments and strong commitment from the SAFER partners. This project was used as a platform for performing a series of international collaborative projects giving access to more extensive data and possibilities to gain important insights in for example development of criteria and systems. Based on the initial experience from EU project FESTA[20] and results from one collaboration project with the US (SeMiFOT[21]), SAFER was well positioned to take on a major role in the EU supported

project EuroFOT[22] in 2008, as well as a central position in relations with the US and Japan. Within EuroFOT some 30 partners, including major European vehicle manufacturers, leading automotive technology suppliers and research institutes conducted Europe-wide vehicle field tests to assess the impact of advanced driver assistance and preventive safety functions in real traffic conditions. SAFER contributed with data successfully gathered in Sweden, the Netherlands and United Kingdom from 100 cars and 30 trucks.

Additional EU projects with significant SAFER involvement are a FOT on car-to-car and car-to-infrastructure communication (DRIVE C2X[23]), which was completed in 2014, and the first large scale European NDS on cars, trucks and powered-two wheelers (UDRIVE[24]), which is still ongoing. Throughout the projects, SAFER has continuously developed the FOT methodology consisting of data collection equipment, storage capabilities and analysis tools and facilities, thereby achieving a world leading complete platform for naturalistic driving data. In the case of UDRIVE, SAFER has been project manager for all analysis work and is also leading and hosting the central data centre with all project data, including remote access for all project analysis. The remote access technology has also been developed into the overseas CAC[25] in a collaboration project with UMTRI. SAFER is also pioneering naturalistic studies for bicycles, through re-using the tools and analysis methods at SAFER. The platform has been used for bicycles with and without electric assist, in projects like BikeSAFE and eBikeSAFE.

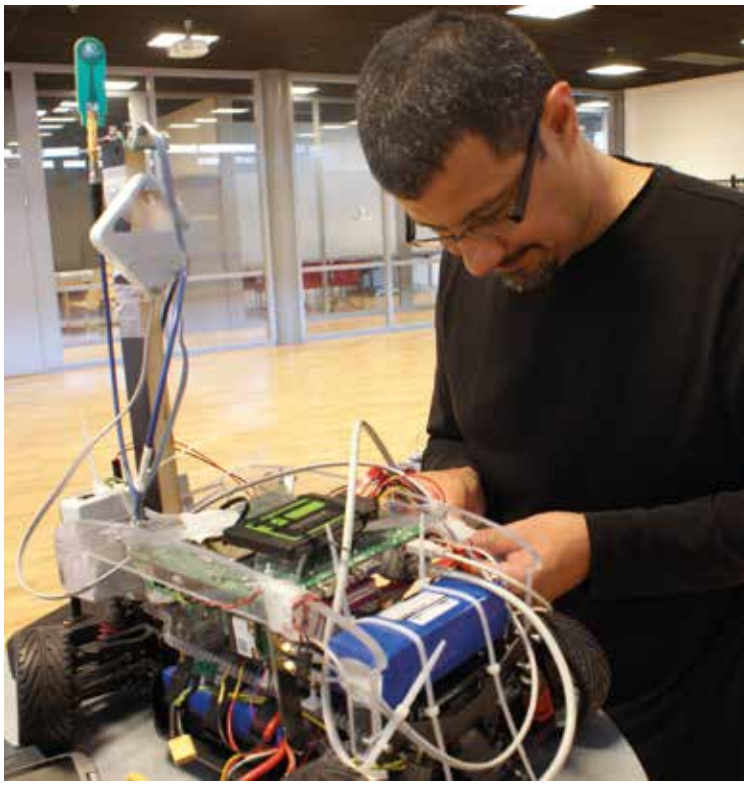
One very prestigious example of SAFER's increasingly strong position is the leadership of the NDS data analysis project ("SHRP2 S08 Safer Glances") awarded to SAFER by SHRP2 in the US. The results were published during 2014 and together with results from other accident causation projects, like DCBIN[26], ANNEXT[27], etc., it has put SAFER at the forefront of international research. In the recent (2014) H2020 EU call specifically addressing traffic safety analysis, SAFER partners have been part of no less than seven project proposals that contain elements in this Focus Topic, highlighting that SAFER is a sought after research platform for international researchers.

Outside the data collection projects, there are some examples of projects (e.g. DREAMi in collaboration with Japan and ANNEXT) where the data collected by a third party is analysed using new procedures developed by SAFER. As previously mentioned, this type of activity is important to initiate new research collaborations which in turn is an effective mechanism for SAFER to expand its access to larger amounts of data, giving opportunities for new research insights for the partners. Data collection is an expensive activity and is typically limited to specific regions and international collaboration facilitates research on socio-geographical differences. SAFER uses the Focus Topic to orient future research activities and data integration techniques have high priority to optimise national and international data sources.

SAFER has already had activities where different data types (e.g. NDS and crash data) are combined to produce more thorough evaluation of safety benefits. Projects like QUADRAE[28] and EFRAME[29] are exploring how different data sources complement each other and can be used to evaluate or even predict the performance on specific safety systems. These analyses are only possible if the organisations have mechanisms to access and query data from different sources and is currently facilitated by SAFER. This need is being addressed through different activities under the SAFER funded "Field Data Analysis Platform".

METHODS FOR EVALUATION OF VEHICLE AND TRAFFIC SAFETY

This Focus Topic identifies assessment procedures using data from both real and virtual environments and should also develop methods to process and analyse field data in new and innovative ways. It can thus be considered to be complementary to Incidents and Accidents and is often integrated in many projects developing new safety strategies. Priorities coming out of the assessments are critical for securing the utility of new safety systems and providing confidence in their market introduction. SAFER takes an active interest in the important development of research infrastructures and its world class environment include driving simulators, physical test facilities (material and crash testing), naturalistic driving data and an active safety test facility. SAFER is well positioned because of its experimental, field and simulation data sources that complement each other and can provide comprehensive system



evaluations. The escalating project activities indicate that there is world leading expertise and infrastructure available within the SAFER partners. The fact that SAFER partners have been approached to participate in at least three project proposals to the H2020 calls connected to this Focus Topic is a good sign of SAFER researchers having a network and research facilities of interest that extend beyond Sweden.

When looking at SAFER's project portfolio it is evident that SAFER has throughout the years taken some vital steps to proactively promote method development for infrastructure (Gulliver[30], "Scenario-Based Testing of Pre-Crash Systems", "Promoting Research at AstaZero", "Simulator Lab at SAFER" etc.). Similar to Gulliver, BAPS[31] is also an example of simulation models of traffic conditions to assess countermeasure

effectiveness and the introduction of these approaches is an important kernel for future activities, particularly for developing and evaluating active safety systems which avoid accidents. Physical tests of safety systems in real traffic require full scale vehicles. These have been used in various FOT studies (EuroFOT[32], UDRIVE[33], DRIVE C2X[34], etc.) and the expertise at SAFER will be further leveraged in further studies at the AstaZero test track.

Several projects have had a common goal to develop procedures that can evaluate different types of safety systems, be they active safety (NGTEST[35]), passive safety (FIMCAR[36]) or integrated safety (ASSESS[37]). These test and evaluation methodologies are increasingly important as new safety functions are being developed and promoted. The EU project ASSESS, which was completed in 2012, provided the groundwork for European assessment procedures for vehicles combining active and passive safety systems. There are common SAFER partners between ASSESS and the previous "Scenario-Based Testing of Pre-Crash Systems" and this is an example of SAFER activities having been leveraged from national to international level. NGTEST is the type of project that is a benchmark for projects in the Focus Topic, combining data from test tracks, driving simulators and accident data. It was completed in 2015 and developed a process where the performance characteristics for a vehicle system were identified, assessment criteria established and then simulated, and physical test procedures developed.

Different infrastructure elements (simulation, FOTs, physical experiments, etc.) have unique benefits and limitations and no single approach gives a 100% representation of real performance. SAFER projects evaluating system performance must identify the statistical methods to translate their individual results to a real world performance and these techniques become more complex when different research modes are used. SAFER partners and projects are addressing this challenge and proposals for new evaluation techniques (BAPS, EFRAME[38], QUADRAE[39], NGTEST) are evidence that exploring this area is not only important but pursued at SAFER.

During the spring of 2014, a number of new projects were started at SAFER with the aim to develop infrastructure for novel vehicle dynamics and self-driving cars. The VICTIg[40] project is upgrading a driving simulator environment to assess the use of V2X communication with a driver in the loop. A central element for SAFER's future is ReVeRe[41] – a vehicle laboratory inaugurated in November 2015 and that will be open to academic researchers beyond existing industrial facilities and will support activities at AstaZero and educational programmes within SAFER. At least one passenger car and one truck will be research platforms for automated connected vehicles. Analytical assessment and prediction of safety benefits is also underway in projects like EFRAME and is a key requirement for the rapidly developing technologies and faster design cycles in industry. Retrospective evaluation techniques are not sufficient and the integration of real world and experimental techniques is crucial for future safety systems. Several of these efforts are expected to result in world leading capabilities for evaluation of safety systems.

DRIVER STATE AND BEHAVIOUR

This Focus Topic covers how drivers/riders of vehicles (ranging from bikes to trucks) and pedestrians in interactions with vehicles actually behave in traffic, not just how they are supposed to behave. It also covers permanent and temporary states of the driver, and driver state estimation and complete risk management for drivers are emerging areas as well. The topic grows in importance due to the more complex interaction with the increasing automation of vehicles. In national projects and large European projects unique knowledge, understanding and driver models of driver behaviour have been developed. This provides guidance to how to design new active safety and automated vehicle functions. The unique knowledge acquired has enabled explanations to driver behaviour issues that have since long been sought after. SAFER and its partner have a leading international position in driver modelling for ADAS systems and are also strong in understanding how drivers react to ADAS intervention. SAFER researchers participate in several H2020 proposals whereof two, in the 2015 call Mobility for Growth, has passed to the second stage.

Driver behaviour and quantification of its influence on safety are high priority areas in society. SAFER is moving forward in these important topics. In addition to projects focused on driver behaviour in cars there are also projects like BikeSAFE, BikeSAFER, e-BikeSAFE, NoRisk2Bike and DREAMi where other road riders and users (cyclists and pedestrians) have been the focus of behavioural studies. SAFER researchers have achieved good recognition with these projects for high quality and unique results in a relatively unexplored field. These projects address the traffic environment and can help design vehicle and bikes based safety solutions.

This Focus Topic has examples of projects where implementation of knowledge gained is transferred into the product development of new safety systems. The project FICA 2[42], developed a general framework for how to translate results from crash causation analysis into use cases and functional requirements for active safety systems. This framework was later used as the basis for the use case and requirement specification in the EU project interactIVe[43], completed in 2013. The project gained insights showing that the lateral intervention function, proposed as legal requirements for trucks, worsen the driver's situation compared to no intervention. The issues are currently further developed within EFRAME[44]. SHADES[45] I and II took a holistic and interdisciplinary approach on errors that can occur in different In-Vehicle Information Systems (IVIS) and ADAS. In the EU project AdaptIVe[46] the new concept of automating the driving, instead of intervening, is being studied with promising results. The effects on road safety were studied regardless of whether the errors arise from poor Human Machine Interface (HMI) or technical malfunctions. The SAFER funded SHADES projects are also good examples of results in terms of interdisciplinary projects involving several disciplines, such as behavioural science/human factors and engineering science, influencing the vehicle design. The research questions that remained after SHADES have been studied at Volvo Car Corporation within the SAFER and FFI *(Fordonsstrategisk Forskning och Innovation)* funded project "Verification of Active Safety Functions", completed in 2013. This project has produced novel methods which include relevant sensor limitations into virtual verification methods. One example, which resulted in a patent application[47], is a method for evaluating computer vision system performance by using augmented imagery. One of the recently started projects Trust-Me[48] is addressing these questions for automated vehicle functions.

Research results from SAFER partners and others have shown that distraction and/or drowsiness is a main contributing factor in a very large proportion of accidents. Based on this research, Volvo Trucks and Volvo Car Corporation have introduced Driver Alert System (DAS) to the market. The DAS is unique in its ability to be able to identify, with high precision, when a drowsy and/or intoxicated driver is not fit to drive. Research is progressing to address both driver distraction and fatigue risk management. Thus, complementary to focus on in-vehicle systems, preventive actions can also be taken before entering the vehicle and the driver can receive feedback after the trip.

As part of the FICA[49] 2 project, a conceptual model of driver attention was developed, based on a series of experimental studies. This model was subsequently used as the basis for a generic taxonomy of driver inattention developed by the Driver Distraction and HMI Working Group within the Bi-lateral US-EU Task Force on ITS (a collaborative effort between the US Department of Transportation and the EC). It has also been used as a theoretical basis for standardisation of the Detection Response Task (DRT) distraction assessment method within ISO TC22/SC39/WG8.

Research investigating "optimal" vehicle HMIs has also been done in a large national project including different research domains at Volvo Car Corporation, universities and institutes. The project EFESOS[50] was focused 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 ended in 2013 and has significantly improved and expanded the competence within this area.

The population of elderly people in many countries is increasing, and SAFER has taken on itself to gain 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 completed SAFER funded projects, "Safety for an Ageing Population 1 and 2", had the purpose of expanding research and establishing a prestigious knowledge base within SAFER. Using data retrieved from previous projects (FICA, EuroFOT[51], etc.), as well as from new experiments, it was possible to further capitalise and leverage partners' existing efforts. This SAFER research has been expanded with a joint-research project, "SAFE MOVE for older drivers", together with Mov'eo, France.

DESIGN FOR ACCIDENT PREVENTION

This Focus Topic covers how different functions can predict a potential crash, and give input to the control of the vehicle to avoid it. Automated functions can even be designed to avoid hazardous situations. There has been a fast evolution since this topic was established some nine years ago and it continues to grow and expand due to the fast development of active safety systems, semi-automatic, fully automatic vehicles and connected traffic system research. Applied research projects use knowledge about traffic accidents to develop new functions to avoid accidents. The outcome of projects is taking Swedish partners to the fore-front in several important areas, which has been confirmed by international experts. SAFER has three times been trusted with the FFI projects on "Boundary conditions for vehicle automation" with the aim to build a pre-competitive community and expand the understanding of safety as an essential pre-requisite for implementation.

It is essential for SAFER to engage in confined area automation since it is in this environment that research and technology development for automated vehicles will take place before it evolves into the public road domain. Several projects targeting automation in confined areas have been conducted and new ones have recently started (e.g. SARPA[52] and "Automated Safe and Efficient Transport System").

The autonomous systems will increase the need for efficient ways of verification and validation. The recently completed projects NGTEST[53] and QUADRA[54] focus on testing and evaluation. Both projects have generated deeper knowledge about the driver's behaviour and accident scenarios. NGTEST has evaluated scenarios in specific test environments and QUADRA is the first project ever that has developed driver behaviour models to be used in computer simulations and automated test track scenarios for evaluation of active safety systems. QUADRA insights have even resulted in a patent application[55] by SAFER partners on improved electronic stability control systems. These new types of new and virtual evaluation tools are essential to increase efficiency and effectiveness in verification and validation of active safety systems and semi-automation.

Three Swedish teams, consisting of SAFER partners, successfully participated with two cars (Volvo) and one heavy truck (Scania) and made 2nd, 3rd and 4th position in the 2011 finals of the international competition the "Grand Cooperative Driving Challenge" (GCDC). The vehicles were equipped with cooperative systems for platooning vehicles in car/vehicle trains in both city and highway driving. The work was performed within the SAFER and IVSS funded project CoAct[56], which was preceded by two pre-studies. These projects led to the Swedish truck manufactures renewed interest in platooning and consequently the still ongoing FFI project SERET[57]. Furthermore, the eight core partners from industry, institutes and academia decided to continue to develop the achieved national competence platform and give increased visibility and attention to related products and research. A new CoAct project was developed and these efforts have led to SAFER starting up the project "CoAct 2014-2015" to secure Swedish participation in the next version of the GCDC called "Interoperable GCDC AutoMation Experience" (i-Game). SAFER initiated this next competition at EU level together with the GCDC host TNO (Dutch Organisation for Applied Scientific Research) and succeeded in getting EU grants. As a result of SAFER's efforts, Viktoria-Swedish ICT is part of the core organisation of i-Game which will take place in 2016.

When FFI decided to launch a strategic program for automated vehicles in 2012, SAFER applied and was granted an open collaborative project "Boundary conditions for vehicle automation". This project explored the aspects of boundary conditions which led to a broad range of results including state-of-the-art overview, a white paper on Swedish opportunities, an innovative exploring of new research projects and issues, several inspirational out-of-the-box seminars and small pre-studies. One such project is AVIP, a master thesis, where the interaction between pedestrian and automated vehicles was studied and a HMI was developed with the intention to facilitate this interaction.

Vulnerable road users' safety can also be enhanced by cooperative technologies, one such project is the SAFER funded MASCOT[58] 2 which developed a safety application prototype warning the user (pedestrian) intending to cross a zebra crossing without having checked for oncoming traffic. The project VISAS[59] also demonstrated a cooperative safety application prototype that utilises information from both infrastructure- and vehicle-based sensors to warn vehicle drivers in critical situations (e.g. intersections where the drivers' view is obstructed by buildings).

There are several new projects that address the design of the more complex assistance functions and even fully automated functions aiming to prevent critical situations from occurring. Examples include AdaptIVe[60], SERET, "Automated Safe and Efficient Transport System" and SARPA. With these projects it is possible to see that the Focus Topic is evolving and addressing new challenges that are emerging, as active safety systems are starting to reach higher maturity and automated vehicles are about to enter the streets. Vehicle dynamics is also an important area. Enhancements are shown of electronic stability control in post-impact dynamics in multiple-impact accident events, utilising wheel-individual braking and steering. In the SAFER project "Active Dolly" the truck combination vehicle control can improve high speed stability significantly and also contribute to low speed maneuverability. This was demonstrated in full-scale on test track, using a converter dolly with steerable axles.

The project "Physical Layer Techniques for Vehicle-to-Vehicle Communications" is of basic research character in the area of vehicle-to-vehicle communication. It leverages results from two earlier pre-studies on "Real-Time Wireless Communications Vehicle-Vehicle and Vehicle-Infrastructure"

and “Wireless Communication V2V and V2I”, in which the important research problems were identified. The pre-studies have resulted in multiple scientific publications and paved the way for a SAFER Competence Area Leader and member of the SAFER extended management group to become the lead editor for the *Proceedings of the IEEE* (Institute of Electrical and Electronics Engineers) *special issue on Vehicular Communications*, which was published in 2011. The proceedings of the IEEE is a high-impact journal and the special issue has given SAFER valuable international visibility.

Projects at SAFER that have dealt with accident avoidance and future possibilities of autonomous driving include ASIS[61] and the EU project interactIVe[62]. The latter has taken steps towards the goal of crash-free traffic by developing ADAS for safer and more efficient driving, such as autonomous braking and steering systems based on a sensor platform that recognise the driving situation. The consortium that was active in interactIVe also started up the ongoing project AdaptIVe that targets several aspects of on-road automation. The “Non-Hit Car and Truck” project was completed during 2015 and brought together truck and car industrial partners as well as academia 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 were reached in sensor fusion techniques and collision avoidance algorithms (i.e. a shared sensor fusion platform among the partners and novel collision avoidance algorithms which include escape path planning in complex traffic situations).

A more recent initiative from SAFER is CarLive, a project with the target of setting up a self-driving vehicle platform for SAFER’s researchers. SAFER has also acknowledged the need for support to system approaches and taken an important initiative in the project ReVeRe[63] which is the build-up of a full-scale vehicle laboratory where researchers and industry can work on collaboration projects. Together CarLive and ReVeRe create a lab, platforms and infrastructures for intelligent vehicle research including cars, trucks, rapid prototyping environment and V2X infrastructure.

Several projects have run within the area of functional safety; for example BeSafe[64], EU project KARYON[65], Trust-Me[66], and Hazard Classification. The SAFER researchers are among the leading researchers in the area and have been part of development of the new functional safety standard ISO 26262. The KARYON project, completed in 2014, has successfully developed an architecture used in the development of cooperative scaled vehicles and quadcopters. The adaptive behaviour in reaction to failures interfering with the cooperation was lively demonstrated in an open event. As a consequence, future cooperative cars and airplanes can be built with less costly components and the overall design and development process can be simplified. Another recent project dedicated to functional safety is FUSE[67] addressing the problem of system safety in automated vehicles. Research by SAFER partners Volvo Car Corporation, City of Gothenburg, Swedish Transport Administration, Swedish Transport Agency, Autoliv, Chalmers and Lindholmen Science Park is used to address some of the safety issues of the DriveMe project where Volvo Car Corporation will have 100 vehicles driven by ordinary drivers that can drive in autonomous mode on some city roads in the Gothenburg area by 2017.

SAFETY FOR NOVEL VEHICLES AND VEHICLE COMBINATIONS

This Focus Topic covers the safety challenges and opportunities due to new vehicle designs and contains a variety of activities, which in several cases address the need to up-front integrate a safety perspective in new green and efficient mobility solutions. Within the emerging topic of electric vehicles, 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 and advanced vehicle dynamics. SAFER has the ambition to be a major actor identifying safety aspects of future vehicle strategies, mainly by understanding consequences of future transportation scenarios. This is an area of increasing interest and focus. At this stage, SAFER is the Swedish hub for the safety related issues in this area, as exemplified by the pioneering work in SEVS[68]. It is an ambition to position SAFER in a global research community as well.

A first and significant step towards the overall objective of creating strategies and developing cutting edge expertise regarding increased crashworthiness and safe vehicle dynamics, through advanced structures and novel propulsion and drivelines beyond 2030, was taken through the work of SEVS, during 2009-2010. This multistakeholder project, consisting of more than 10 SAFER partners, delivered four future scenarios with seven concept vehicles based on trends and tendencies in today’s world – creating a solid research strategy. The insight on how these vehicles must be valued in the context of the transport system and the different scenarios, has led to several new research projects (national and EU) and has affected the organisation and strategy of some partners. The main results were the scenario definitions and substantial reports on future high-priority research topics. The second phase 2012-2013 (SEVS2), resulted in a driving force model where four scenarios are described, including development of a unique methodology to handle and analyse complex systems.

SAFER was part of the EU project ELVA[69], completed in 2013, where six international partners worked towards the goal of developing dedicated architectures for electric vehicles. The ELVA project focused on electric cars for city passengers and urban delivery. Innovative design concepts were investigated, analysed and evaluated to not only meet all technical requirements, but especially take customer preferences directly into account while exploiting the new freedom in design offered by the electric drivetrain. ELVA was an important part of the

growth of competence within this area at SAFER. In addition, the ongoing EU project MATISSE[70] aims to make a significant step forward in the capability of the automotive industry to model, predict and optimise the crash behaviour of mass produced fibre reinforced polymer (FRP) composite structures, which will be extensively used in alternatively powered vehicles (APV). Within the project, a carbon fibre reinforced plastics (CFRP) beam, which can be pressurised to expand enabling modified crash characteristics, was developed and tested successfully as a door beam prototype. In a parallel EU project ENLIGHT[71], novel technologies are developed to reduce the weight of future electric vehicles by combining innovative materials and processes in a new design, while the EU project SafeEV[72] focuses on occupant protection in novel vehicle designs.

The development in the area of Computer Aided Engineering (CAE) tools for composite body concept assessment 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 this important field and the different needs of the partners. A pre-study ("CAE Tools for Composite Body Concept Assessment") in 2010, paved the way towards larger research projects with national funding: CompCrash[73] developing experimental characterisation methods of CFRP material properties in crash relevant load cases, and "Composite Crash Behaviour" developing CAE methods and tools for representative modelling of energy absorbing mechanisms in automotive structures made of advanced, in particular, carbon reinforced polymer composites. The ultimate goal in this area in a 10-year perspective is to establish confidence in crash predictions of composite vehicles to a level comparable with current state of the art for conventional metallic structures. In 2007-2008, a pre-study "Load Carrying Capacitors for Crash-Worthy Applications" was conducted exploring innovative structural design solutions in the area of novel electric vehicles. This pioneering work was important to the significant growth of safety related composite research, continuously expanding in network and activities, including contributing to the establishment of the Strategic Innovation Area on lightweight, LIGHTER.

The pre-study "Computational Methods for Crashworthiness Assessment of Windscreens" during 2012 focused on the development of CAE models of vehicle glass, a difficult task and very much needed by the industry. This pre-study has successfully resulted in a continuation project with German industry and a research institute (Fraunhofer EMI) to jointly address this task with five SAFER partners, starting the project CompMethGlass during 2014. This project not only provides realisation of optimal benefits for CAE full-scale vehicle testing, but also provides new strategic connections for SAFER.

"SAFER Electric Vehicles" focusing on the added flexibility that electric drive actuators can provide in terms of vehicle dynamics functionality identified spin-off applications for electric vehicles (autonomous functions, active safety testing infrastructure, etc.). SAFER participated in the project, IBS-Truck[74], finalising in 2011. The objective was to further improve active safety of heavy vehicle combinations with respect to yaw and roll stability. This project not only provided valuable knowledge to the industry, but it also contributed to competence development within SAFER as well as one patent application[75] regarding an arrangement for improving stability of a vehicle combination with actively steered axle and/or individual brake on at least one axle. More recently, a programme for the traffic safety implications of High Capacity Transport (HCT) was initiated. This collaboration between SAFER and CLOSER (a national collaboration platform for transport efficiency at Lindholmen Science Park) contains analysis of safety effects related to longer vehicles in traffic and encompasses accident statistics research, research on vehicle dynamics for long vehicle combinations, among other research areas.

HUMAN BODY PROTECTION

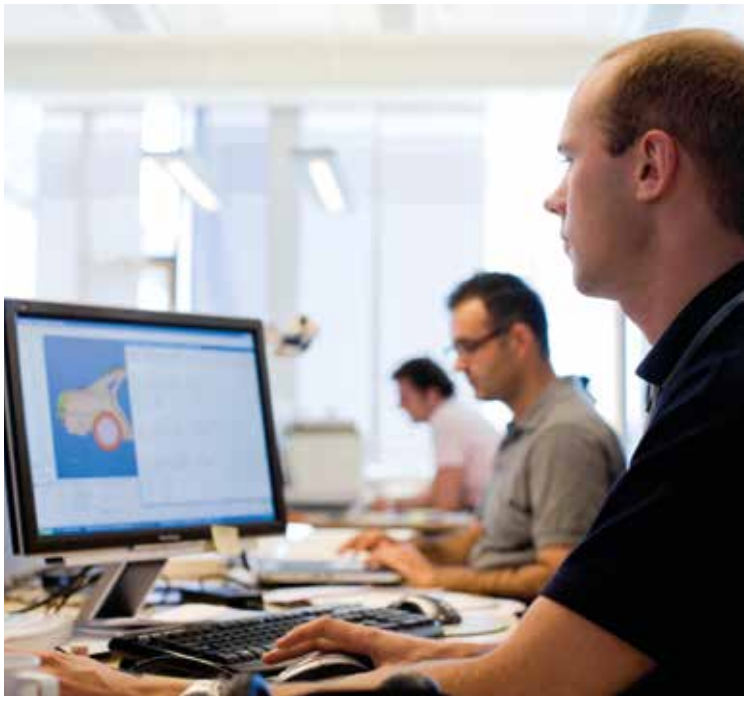
The Focus Topic covers biomechanical injury mechanisms, responses and consequences, the principles for protection including safety system usage and pre-sensing input as well as mechanical and mathematical occupant and unprotected road user models for complete crash sequences. This Focus Topic is a basis for all safety research dealing with crash outcome consequences and also includes the aspects of pre-crash situations, keeping SAFER's partners in the frontline of applied research in the area. Increased focus on pre-crash situations (including normal driving/riding) are motivated from a real world perspective, where also increased active safety systems emphasises the demands on understanding the impacts on outcome consequences. SAFER partners have a world leading position in the area of applied biomechanics research, exemplified by child safety, whiplash injury and pedestrian safety as well as a strong position in the development of crash test dummies and biomechanical assessment methods. SAFER enables the continuity of this position. Within human body modelling, SAFER provides a competence platform and a natural contact point for external cooperation. 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. The refined human body models, including the knowledge obtained in the pre-competitive joint research, are used by the industry in safety development such as autonomous braking systems and occupant restraint systems. The SAFER strategic investment has helped to significantly speed up the process of industrial implementation.

Following the long heritage of child safety, involved SAFER partners joined efforts in SAFER's cluster of "child safety and protection of rear seat occupants" and together driven international activities having impact on the global agenda. Several joint projects have been conducted over 10 years. In addition, between 2009 and 2015, the SAFER child safety cluster has

invited international researchers to four SAFER workshops resulting in joint publications, initiation of new research projects, as well as the first international Child Safety Conference in China in 2014. SAFER's child safety research and researchers are internationally renowned, which has resulted in SAFER becoming a part of a US-based head injury research project as well as an international study with a base at Monash University, Australia. This study looks at children's behaviour in cars during normal driving. SAFER partners have influence on international and national child safety work, exemplified by EuroNCAP consumer testing, the regulatory work within UN ECE, as well as serving as the chairman of the International Standardisation Organisation (ISO) working group, including the Swedish national mirror group. This together with our four international SAFER workshops enable a large and efficient network for competence gathering and influences on rule making, development of standards and efficient dissemination of project results and directions of future developments.

Thanks to strategic investments with significant SAFER resources in start-up projects, SAFER has a strong core group of activities in the area of human body modelling, which involves several major projects in two main areas: injury prediction and "low-g" capability, such as braking and steering. In addition, a project was run providing insights into scalability of the human body model. Regarding the capability of human body model to predict injury, the first steps were taken in a side impact project initiated by GVSCC, followed by the EU project THORAX[76] and the SAFER start-up project "Improved Injury Prediction using HBM" during 2009-2012 focusing on chest and shoulder injuries in frontal impacts. These activities have continued and expanded into further projects including more injury types ("Improved Injury Prediction using HBM, part 2", "FFI-Lateral THUMS", "Oblique loadings THORAX[77], "Injury Prediction using HBM" and "Pedestrian - Head and Neck, part 2"). Enhancement of injury prediction capabilities together with important biomechanical research are generated. Becoming more important with increased penetration of active safety systems, for instance pre-crash braking systems, SAFER has contributed with ground-breaking research and model development. Initiated by the SAFER start-up project A-HBM and followed by the FFI project A-HBM[78] step 2 a unique working human body model capable of pre-braking with following crash event was developed. Besides a compilation of unique human response data in braking, the A-HBM step 2 project provided active muscles implemented on an adult size human body model to be used in safety technology developments. SAFER's leading position in the area has attained international recognition and the progress continues on in A-HBM step 3 which will further refine the model to also include lateral "low-g" movement capability. Additionally, developments in child human body model implementation of active muscles were also successful, resulting in a working rigid body human model.

During the first years of SAFER, a modified shoulder for the physical THOR crash test dummy was developed to enable enhanced bio fidelity in crash situations with oblique kinematics ("Crash test dummy for oblique kinematics"). This shoulder



is now evaluated by test institutes, including NHTSA, and is considered for future regulatory or consumer information tests. More recently, additional projects ("Oblique loadings THORAX", FFI THOR[79]) were started, including refinement of the FE THOR model incorporating the modified shoulder, as well as performing physical crash testing for dummy evaluation and refinement. These projects are run in close interaction with vehicle developments.

Steps have been taken to gain real world pedestrian safety knowledge by combining knowledge of human body modelling, biomechanics and field data analysis. The steps include research projects, but also pedestrian protection innovations introduced by the industry partners. Multiple projects combine research at Chalmers and KTH together with industrial partners, refine the models and develop injury criteria for protection system development.

SAFER activities within the area of soft-tissue neck injury (also called whiplash injury) protection in rear-end impacts are in world-class. Within the EU project ADSEAT[80], a FE model of a scaled down crash test dummy BioRID model, that is a virtual female sized version of the BioRID (EvaRID), was developed. In addition, a physical crash test dummy prototype (BioRID 50F) was developed within ADSEAT and further developed in a national project. Steps are continuously taken in whiplash injury mechanism research and to further understand the gender differences in rear end impact situations. The success of the ADSEAT project, completed in 2013, together with the human body modelling capabilities and strong history of neck injury research and world first innovations by SAFER partners, enabled national funding for the ongoing project ViVA[81] targeting development of an open source 50% female human body model as well as next generation whiplash protection

assessment procedure. SAFER has devoted attention to the under-researched aspects of female whiplash injury occurrence and also taken a first step in understanding general gender differences in a wider context.

CARE AND RESCUE

According to World Health Organisation (WHO), EU and others, post-crash actions play a significant role in order to reduce overall mortality and injury severity in all road traffic accidents and road users. Improvements in this area will therefore significantly reduce human suffering and society costs related to traffic accidents. The Focus Topic Care and Rescue focuses on the post-crash phase and started as a consequence of a revitalisation of SAFER's post-crash activities during 2012. In 2014 it was recognised as a new SAFER Focus Topic and today several projects are running under this umbrella. The stakeholders include SAFER's existing partners but also additional actors representing areas like rescue services, healthcare, Information and Communication Technology (ICT) and MedTech industry.

Since the Focus Topic is fairly young in comparison to the other SAFER Focus Topics, the short-term focus is to continue to establish a relevant project portfolio and to involve further SAFER partners and other stakeholders in the activities. In the long-term the objective is to become a significant international player at the forefront within research and development of methods and solutions aiming at traffic accident related care and rescue. Specific assets supporting this ambition is a close relation and established networks with healthcare and actors in the rescue chain, as well as research within ICT, bio-medical engineering, medicine and pre-hospital care. The open arena Pre-hospital ICT Arena established at Lindholmen Science Park in 2015 is a unique asset with respect to this. This arena is a true triple-helix collaboration platform with more than 30 national partners participating. It addresses the complete pre-hospital process from incident detection through transport to delivery at the correct hospital and ward. Pre-hospital ICT Arena is the result of the project Metis, which ran between 2012 and 2014. Another asset, also located within Lindholmen Science Park is TUCAP – an arena with focus on rescue call-taking and dispatch.

As part of the introduction of the Focus Topic a pre-study looking at its short- and mid-term international strategy was initiated. The final report from early 2015 strongly supports the chosen strategy and topics identified by the Focus Topic. It also supports the fact that the SAFER and Pre-hospital ICT Arena environment is a unique asset, and that the selected research and development areas are internationally relevant and considered important by the international traffic safety community. The Focus Topic addresses challenges within two defined areas: incident detection, prioritising and dispatch, and on-scene support.

Incident detection, prioritising and dispatch deals with activities and actions to support quicker notification, dispatch, resource optimisation and prioritising as soon as an incident is a fact. It involves areas like eCall and "on-call" applications, automatic crash notification (ACN), smartphone algorithms for crash-detection, and Injury Severity Prediction (ISP). Examples of projects and project outcomes (including products) are: JALP (crash notification for bicyclists utilising smartphones), 4-JALP (crash notification for all-terrain vehicles utilising smartphone), D-ISP (Dispatch Injury Severity Prediction) and Via Appia. The latter is a project, completed in 2015, and also a concept aiming at efficient handling of road user incident alarms, using smartphones and ICT to improve traffic safety on a broader scale and facilitating the packaging of new ICT offerings containing alert notifications of various types (eCall, JALP etc.). Apart from cars, road users using bicycles, motorbikes, all-terrain vehicles (ATV) and horses are also included. Via Appia has a wide partner group. An important feature within the Via Appia concept is ISP. The incident detection, prioritising and dispatch area also studies how healthcare and rescue personnel, by utilising ICT, can be better informed and prepared for handling of a road traffic accident already "on-route", that is before arriving on scene.

On-scene support focuses on the activities at the accident scene, and involves topics like care and prioritising of victims on scene and in transport (pre-hospital care), operations on-scene and secondary effects of a traffic accident. Projects address detection of occult injuries, triage and prioritising, extrication and post-crash fires. Occult injuries like traumatic brain injury (TBI), pneumo-thorax and haemo-thorax are significant challenges to post-crash trauma care. These conditions are fairly frequent and if not detected early and correctly handled in the care process they result in severe injury or even death. In SAFER projects occult injuries are addressed utilising two different techniques, microwaves and electric bio-impedance, which may be used independently or in combination. Both methods are in a first exploratory clinical phase, and the research on pneumothorax (in collaboration with trauma experts in Stavanger, Norway) was selected as best poster at the London Trauma Conference 2014. For triage and prioritising the aim is to introduce new and improved algorithms included in computerised clinical decision support systems.

During 2015 the pre-study ExtricAction has been launched. It addresses extrication (e.g. how to take people out of a crashed car), a process for which scientific evidence and understanding is lacking. This project aims at exploring how the already existing excellent knowledge among SAFER partners in areas like human body modelling can be applied to this important area.

Statistics show that post-crash fires in different vehicles account for several deaths and severe injuries. Therefore it is important to understand and find ways to reduce these as well as to learn how to cope with challenges in future design, constructions and rescue processes. In order to gain a better understanding of the subject the pre-study "Post-Crash Fires in Road Vehicles" was initiated during 2015.

4.2
Project portfolio(s)

A RESEARCH PROJECT at SAFER relates to one or several of the seven Focus Topics, each of the Focus Topics is linked to one or more of the four Reference Groups and they are: Pre-Crash which handles projects on accident prevention (accident avoidance and crash mitigation), Crash covers projects concerning injury prevention, Post-Crash handles projects on mitigating consequences of accidents and Traffic Safety Analysis concerns projects aiming at understanding traffic conditions and the causation and dynamics of accidents and injury occurrence (see Figure 1). For practical reasons a specific project belongs to, and is managed via, a Reference Group, even if it can relate also to others.

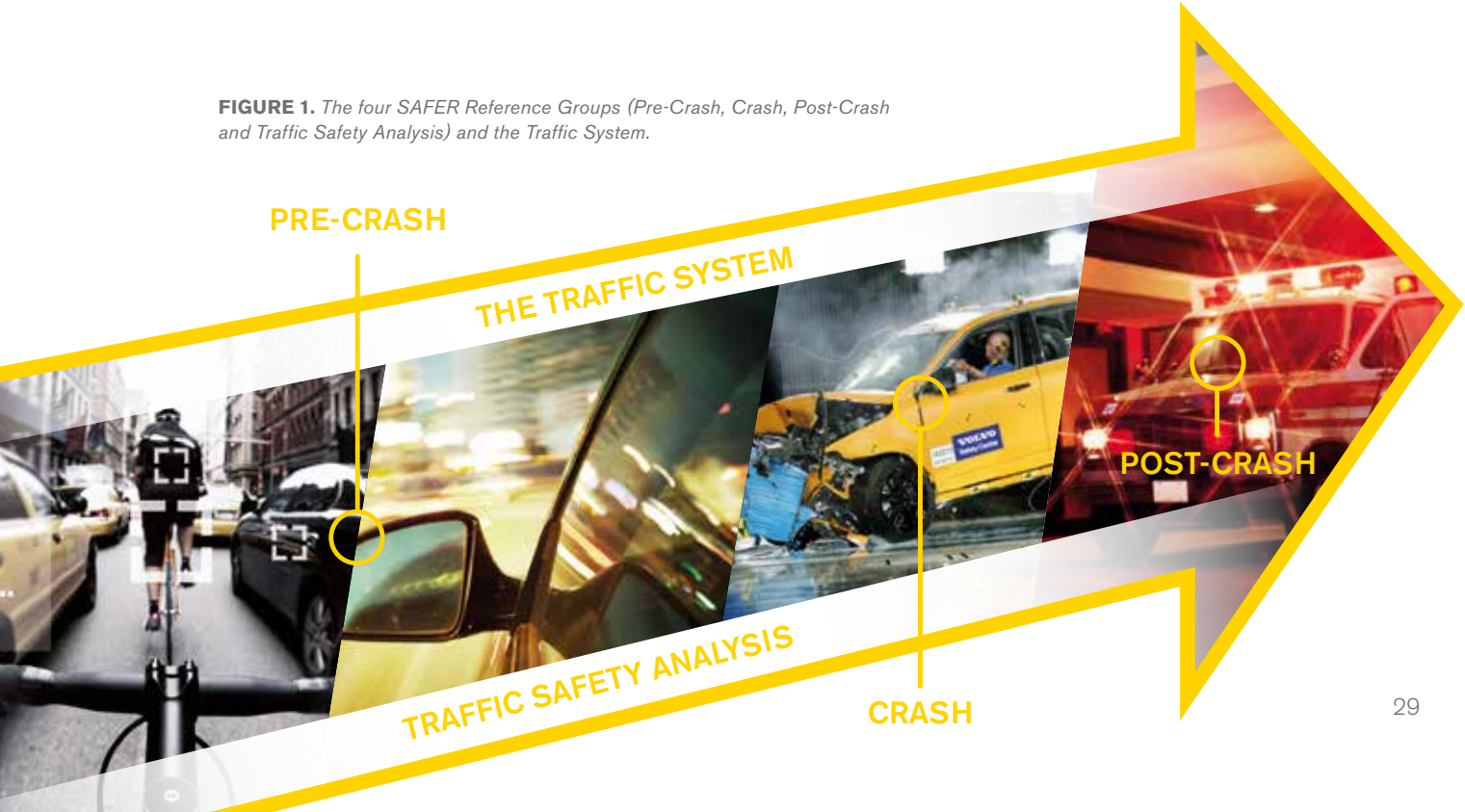
The organisation of SAFER, with the Reference Groups as the core operative structure, is designed to ensure that project initiation and set-up are based on a lively dialogue among the partners on future needs. The Reference Groups recommend project proposals to the management group and Board (for decision). 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. The Reference Groups include representatives from all level 1 and 2 SAFER partners and the Competence Area leaders and are the base for establishing world class competitive project portfolios.

Each Reference Group hosts a mix of projects: pre-studies for future projects, and small and large national and international projects. Based on these factors, and others, projects are either "own" or "associated". A project present at SAFER can be initiated at SAFER and/or funded by SAFER ("own") or started by SAFER partners in another context and brought in to the SAFER environment ("associated") where it can thrive and benefit from the presence of other projects and researchers.

Since interdisciplinary collaborative research is a key approach to excellence and innovation, guidelines from the SAFER Board state that projects should involve at least two partners preferably from different stakeholders. The majority of the projects involve 2-4 SAFER partners and some 22% involve 5 or more. Before a project is approved it has to be described how it supports SAFER long-term strategies (e.g. contribution to real world traffic safety), how the results may be taken further in industrial product development, and the expected outcome in terms of research, publications and PhDs as well as innovations, networks and competence.

For each individual project there is a project structure and an agreement on deliverables, time, costs and intellectual property rights (IPR). To support the project activities and follow-up (on both the SAFER side and project side), considering the many different partners involved, a web-based tool for project management and documentation is used (Webforum). Results are regularly discussed in the Reference Groups, documented in reports and other publications; presentations at conferences and knowledge sharing through

FIGURE 1. *The four SAFER Reference Groups (Pre-Crash, Crash, Post-Crash and Traffic Safety Analysis) and the Traffic System.*



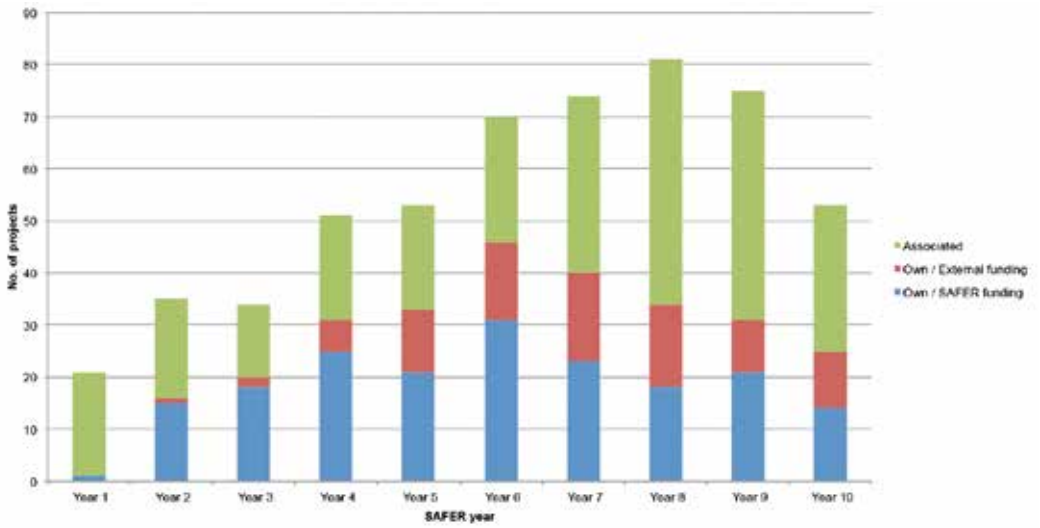


FIGURE 2. *Number of Reference Group projects per SAFER year and divided by funding type. (Note: Many own projects have both SAFER and external funding. This figure only considers the main funding. Data for ongoing year 10 are incomplete.)*

seminars at SAFER are encouraged. SAFER keeps track of all projects by monitoring 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 towards an external funder (own projects). This is the case for instance when SAFER acts as JRU in EU programmes but also in several national projects. Project status is regularly discussed at the SAFER management group meetings.

The understanding of SAFER's added value and assets have become more profound as the 240 some research projects (own and associated), since SAFER's start in 2006, have shown and continue to show successful results and international visibility. The biggest Reference Group is Pre-Crash (97 projects out of the 240 total), followed by Traffic Safety Analysis (64 projects), Crash (61 projects) and Post-Crash (19 projects). In addition to these Reference Group projects, there is a total of about 60 Competence projects which are characterised by strategic initiatives. Currently there are some 60 Reference Group projects and pre-studies ongoing.

Regarding the number of projects there has overall been an increase throughout the years (as can be seen in Figure 2). During SAFER's year 10, fewer own projects have been initiated due to lack of "free" cash. In addition, many projects were completed right before the start of year 10. There was a particularly large increase in number of projects in the beginning of year 9 due to a dedicated "SAFER call". As year 10 is still ongoing additional projects might be added. Some differences in trends can be seen depending on type of project funding.

PROJECT FINANCES[82]

The total value of the projects since 2006 is MSEK 1,400. Figure 3 presents the distribution of projects between the four project portfolios (Reference Groups) including Competence projects as well as their funding sources: SAFER, external and funding in associated projects. The total value of the current project portfolio is about MSEK 440 (own and associated projects). An original goal for SAFER was to reach an annual project portfolio turnover of MSEK 200 by year 2016. Considering that the estimation for the annual project portfolio turnover year 9 was MSEK 180, SAFER is on target. When SAFER started in 2006 the existing annual project portfolio, consisting of associated projects, was estimated to MSEK 60.

During Stage 1 (April 1st 2006-March 31st 2009), decisions were taken on projects and activities up to budget, but the actual consumption of resources lagged behind. This was well compensated during Stage 2 when SAFER grew and picked up momentum. Bold proactive decisions were taken and some projects where decided that continued into Stage 3. Projects are planned and run according to their specific total lifetime, independent of SAFER's stages.

The project portfolio is built on mixed financing. A typical (and encouraged) project evolution starts with SAFER financing a pre-study which evolves into a partly SAFER funded pre-project, and eventually a full project with external financing. SAFER has consciously funded research areas and projects that are not yet mature enough to apply for funding through other national or international funders, although they still represent important research areas.

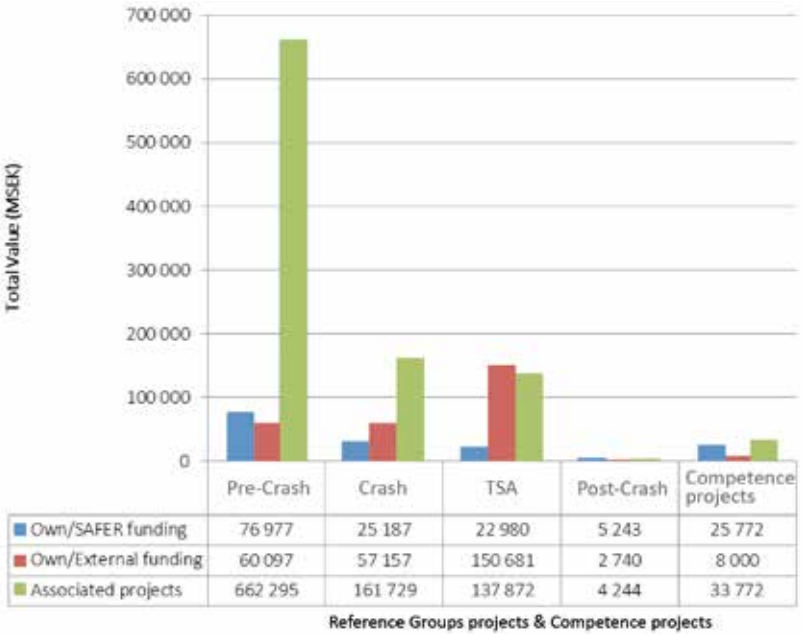


FIGURE 3. *Project portfolios' total value per Reference Group and Competence projects and by different funding types. (Note: The "associated bar" in Pre-Crash is actually higher, as represented by the number below the bar. The original height could not be illustrated in the same graph as the much lower Post-Crash bars.)*

The main sources of external project funding have been FFI and EU Framework Programmes. They usually require 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.

The growth of the project portfolio and its changes year by year reflects the outcome of SAFER efforts. The number of projects have grown in line with the strategy of using SAFER funding to build competence and attract national and international funding. The precise volume of the project portfolio is mirroring effects of changes in national and international research programmes for automotive and transport research. The EU research programmes (FP7 and the current H2020) are important to SAFER and the outcome of different grants has been quite successful throughout the years. For the coming H2020 calls SAFER is active in several ways to promote traffic safety as an important research topic. This has been possible due to a Vinnova grant for a national influential platform with the purpose to enhance presence in Europe. International funding requires excellent researchers but also research project managers and coordinators, which SAFER can facilitate.

CENTRE FINANCES

The framework agreement stipulates an annual contribution of MSEK 10 from Vinnova, MSEK 10 from Chalmers and MSEK 10 from all other partners together. The first year had reduced funding. Cash funding apart from Vinnova is MSEK 1/year from Chalmers and since 2011 a membership fee. This sums up to MSEK 116 cash and about MSEK 250 in-kind for the entire period.

As SAFER's project portfolio and numbers of researchers grow so does the cost to run the platform. In average, over the 10-year period, 49% of SAFER cash resources have been invested in research projects and pre-studies and 51% invested in the platform. This is labelled "common costs" and include SAFER management and administration, office rent, seminars and conferences, communication and other common activities and expenditures. This represents 12% of the total "own" research activities or 4% of the total project portfolio.

Given the size of the project portfolio, the proactive ambitions, the number of partners and external collaborations the size of the core team, which is perceived as "SAFER dedicated staff", is competitively lean.

The cash resources for SAFER are governed by the Board. The in-kind is regarded as cash controlled by the specific partner. The Board qualifies the contribution's value to SAFER and whether it can be accepted as in-kind. The follow-up of partner contributions is done through a so called "sign-off" procedure. The total amount of in-kind contributions has been well delivered and distributed within SAFER. Since projects run over several years and through many stages, 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 proactive and challenging.

4.3
Knowledge Production, Visibility and Bibliometric Study

NEXT TO THE KNOWLEDGE produced through the research, projects and collaborations (mentioned in previous chapters), for the purpose of cross-fertilisation and exchange of knowledge and ideas, competence development of staff and students, and stimulation of national and international cooperation, SAFER has throughout the years been organising a vast number of internal and external seminars, project days and conferences. The annual SAFER Project Day, focusing on results from ongoing projects, is open to researchers and the public alike. There are weekly internal Thursday seminars led by a Competence Area or Reference Group and in approaching the end of year 10 about 250 had been conducted involving some 440 speakers from both SAFER partners as well as other national/international researchers. The external SAFER seminars are open to anyone who is interested and in average 11 have been held per year, with an increase during the last years. Guest researchers and visitors have often been presenters at these seminars which is a perfect way to gain knowledge of the status of traffic safety research around the globe. SAFER is acknowledged as a meeting place and the various seminars are appreciated by the partners as efficient means to share knowledge, create visibility and dialogue among SAFER researchers on current topics, as well as offer great opportunities for networking.

SAFER has built its strong brand through visibility and through actively participating in debates, panels and seminars at various events. Within many traffic safety areas, SAFER is now renowned to the extent that organisations frequently approach SAFER for collaboration, expert opinions, or giving talks at conferences and seminars. Research results are being disseminated through the website[83] as well as through press releases and news articles, with good media coverage. For instance, within the area driver distraction and mobile phone usage in cars, SAFER has represented new research methods (NDS) and remarkable and ground-breaking results world-wide, which have been covered in national and international media. Another example is the pioneering analysis methodology of crash data designed and implemented in the MRMD[84] project resulting in the first side-by-side comparison of predicted risk for EU-regulated and US-regulated vehicles, where the results have raised media interest world-wide. Results from a naturalistic cycling study performed at SAFER, regarding incident risks in the interaction between pedestrians, bicyclists and cars, led to considerable public interest in Sweden as well as coverage by the media. Furthermore, the "Grand Cooperative Driving Challenge" received a lot of media coverage including an interview in *MIT Technology Review*. The brand is also built through organising and hosting conferences and SAFER is famous for providing a friendly, open and professional atmosphere for these. Since 2009, eight conferences whereof four during 2015, have been hosted and organised by SAFER.

The bi-annual International Conference on Driver Distraction and Inattention (DDI) was founded in 2009 by SAFER and IFSTTAR (former INRETS). It has gathered a dedicated community of behavioural researchers, engineers and governmental representatives three times at SAFER in Gothenburg. Each conference gathered approximately 150 delegates from more than 20 countries. A selection of the peer reviewed papers have been published in a book compilation by Ashgate Publishing. The fourth DDI conference was held in Australia in November 2015 together with ARRB Group Ltd. DDI has put SAFER on the map and is an example of how SAFER provides a platform for not only dialogue and research among its partners but also for an international research community. The SAFER partners have thus been able to utilise the network created by SAFER and bring international knowledge to Sweden, knowledge that has been materialised into the partners' commercial products.

The 24th International Technical Conference ESV, held in June 2015 (mentioned in Chapter 3.2), was indeed a challenge for SAFER due to its size, fame and high expectations, which SAFER handled exemplary. According to the evaluation it was a true success with its 856 delegates from 26 countries. More than 170 paper presentations were given and eight student teams participated in a student competition.

The International Cycling Safety Conference in November 2014 was also a great success. Held for the first time outside the Netherlands, it was attended by a record-high audience of 160 participants from 23 countries. This was somewhat of a break-through for the conference and it gave SAFER researchers an opportunity to show their broad competence and to build new international networks. A high level cycling expert meeting was held in conjunction with the conference in order to broaden the views on cycling safety research needs in an international perspective.

SAFER's well-known reputation, and the continuous collaborations with Japan, led to that the Japanese International Symposium on Future Active Safety Technology Towards zero traffic accidents (FAST-zero) was hosted by SAFER and

Chalmers in September 2015. The conference was successfully conducted with 191 delegates from 15 countries. SAFER was approached already in 2012 regarding this third symposia which for the first time was held outside of Japan. This is yet another token of SAFER's professionalism and credibility.

In May 2013, SAFER was asked by the Ministry of Enterprise and Innovation to represent Swedish traffic safety, together with VTI and the Swedish Transport Administration, at the annual International Transport Forum. At ITS World Congress 2009 in Stockholm, as well as the high-level EU meeting in Gothenburg the same year, SAFER was one of the organisations representing Swedish traffic safety and demonstrating active safety systems live at the events. SAFER also encouraged Chalmers to host the International Research Council on Biomechanics of Injury (IRCOBI) conference, which took place in Gothenburg in September 2013. In June 2016, SAFER will host the prestigious IEEE Intelligent Vehicles Symposium with an expected 400-500 delegates.

On the national arena, SAFER has organised sessions yearly at Transportforum in Linköping, and presented at Tylösand conference several times. In addition to disseminating research results to partners and the researcher community, SAFER has done so also to the public. For example, SAFER has taken an active role in organising seminars at the yearly Gothenburg Science Festival and several times per year together with the National Society for Road Safety (NTF Väst), which is the non-profit Swedish organisation for enhancement of traffic safety. Activities like these are appreciated both by the public and by the researchers who reach other target groups with their research.

Within the education area, thanks to SAFER's expertise and network of people and organisations, it was possible to incorporate a comprehensive Automotive Safety specialisation track in the new master's programme Automotive Engineering at Chalmers in September 2007. The courses involve experts from many SAFER partners and evaluations show that the students appreciate the high industry involvement. SAFER facilities are used both by bachelor and master thesis students and there are always between 10-30 students working at SAFER. Many master thesis projects are also carried out at the industry partners' facilities.

SAFER Insight[85] is the first comprehensive web-based portal for advanced traffic safety education on an international level. It was launched in November 2012 and the purpose is to provide students and professionals with courses and seminars in vehicle and traffic safety. Currently, the portal encompasses 10 training providers and the number of courses varies between 15 and 45 depending on time of year. The training providers are the SAFER partners, or MOU partners of SAFER. The extended management group at SAFER functions as a guarantee for quality of the courses.

The dissemination of research results and knowledge to society (besides impact on and utilisation by partners) can also be seen in the impressive number of project publications produced by SAFER.

BIBLIOMETRIC STUDY

A bibliometric study was recently conducted[86] in order to give a picture of the research performance of SAFER and its project results including different types of published material, with a specific focus on peer reviewed journal articles and conference papers for citation impact and collaboration analyses. The focus on conference papers is justified by them being a substantial portion of published cutting edge research in areas where scientific breakthroughs occur at a high rate, such as engineering and computer science (i.e. SAFER publications' most covered areas). Moreover, they represent a remarkable share of SAFER publications. For both journal articles and conference papers, the citation impact and collaboration analyses are based on data from the international scientific database Scopus (Elsevier), which has a better coverage of SAFER publications than Web of Science (Thomson Reuters) because of the general better coverage of for instance conference papers.

PUBLICATION VOLUME

SAFER's research projects (own and associated) have produced more than 600 publications since the start in 2006, including peer reviewed journal articles (20%), conference papers (49% – some 80% of which have been published as proceedings or special issues of regular journals), books and book chapters (1%), reports (18%) and theses (12%). Publications which are still listed as "in preparation/in press" or will be made available in the near future (e.g. accepted papers of conferences that have not yet been held) are not included. In addition, these numbers also exclude publications from research conducted within SAFER but not belonging to a specific project (e.g. some PhD and post-doc research). A certain degree of underreporting should also be considered, especially during the most recent years. The publication volume during the years is shown in Figure 4, where 2013 represents the highest peak especially regarding the number of conference papers produced. It can be interpreted that there was an increased activity and participation by SAFER researchers in various conferences in 2013 when many of the bi-annual conferences (e.g. ESV, IRCOBI, FAST-zero and DDI) took place. The increase can also, at least partially, be explained by the higher number of ongoing projects during that year (see also Figure 2).

It is important to highlight that the sum of journal articles and conference papers is 69%, which is definitely a really good level if one considers that these are the more visible and therefore widely spread publication types.

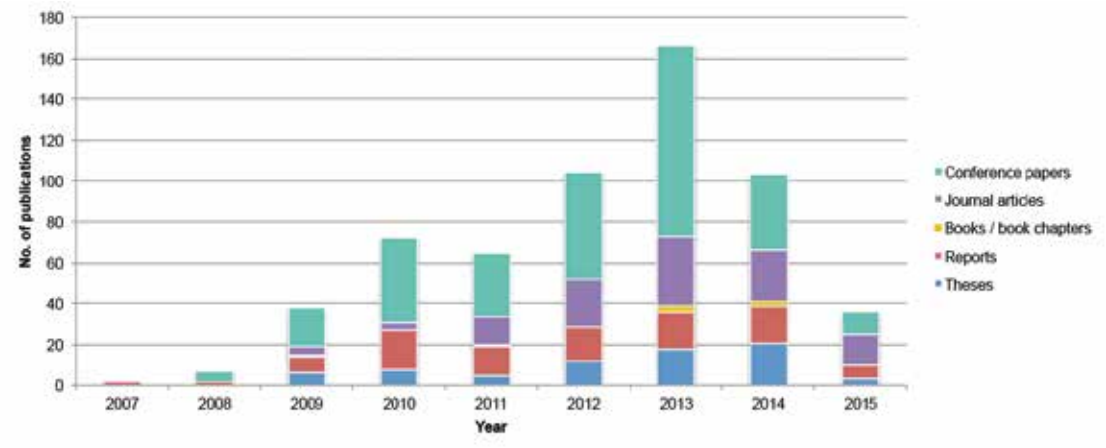


FIGURE 4. *SAFER publication volume over time, grouped by publication type. (Note: Data for ongoing publishing year 2015 are incomplete.)*

VISIBILITY IN MAJOR INTERNATIONAL DATABASES AND JOURNALS

The share of SAFER publications found in the Scopus database is 36% (corresponding to 213 publications), which is a high figure compared to Chalmers Transport Area of Advance's (29%). One should keep in mind that the coverage of non-peer reviewed material (such as the many SAFER reports and theses which can be seen in Figure 4) is very low in major databases, including in Scopus.

To give an idea of the visibility in an academic context, 98 journal articles (82% of the total) are published in international scientific journals covered by Scopus and 14% of them appear in journals ranked as highly prestigious publication channels (level 2) in the Norwegian Scientific Index[87]. The Norwegian Index classifies journals and publishers into "level 1" and "level 2", where "level 2" is reserved for the internationally most prestigious journals and publishers within a certain discipline.

As per the conference papers, 114 (48.5% of the peer reviewed ones) are covered by Scopus, which only includes those published as full-text papers. Considering this, and the fact that conference papers do not have, in general, as much coverage as journal articles this is certainly a positive result.

CITATIONS ACCORDING TO SCOPUS

Citation counts is a recognised method for measuring scientific impact and visibility of publications. Only raw citation counts are presented[88] since a rigorous citation analysis, which is only possible when publications have at least one full year to gather citations, would thereby have excluded a lot of SAFER's more recent publications.

The analysis in the Scopus database gives a total of 345 citations of the 98 SAFER journal articles, with a collective Hirsch index of 9, meaning that 9 of the articles have at least 9 citations. The most cited journal article has 26 citations and is published in the prestigious (i.e. Norwegian level 2) *Composites Science and Technology.* Other frequently cited articles are published in the also prestigious journals *Safety Science and Transportation Research Part F: Traffic Psychology and Behaviour.* Moreover, SAFER articles have been cited by 276 papers with affiliations from 32 different countries. For the 114 SAFER conference papers, the analysis results in 116 citations, with a collective Hirsch index of 5. The most cited conference paper has 9 citations and is published in the *proceedings of the Annual Scientific Conference of the Association for the Advancement of Automotive Medicine* (AAAM). More cited papers have been published in the globally well-known *IEEE conference proceedings.* SAFER conference papers have been cited by 106 papers from 23 different countries.

In total, SAFER journal articles and conference papers have been cited by 382 papers from 37 different countries (Figure 5), which is more than double the number of countries which have co-produced publications with SAFER (see Figure 6). Also, it is clear that a number of countries are included which SAFER does not have collaboration with but have still discovered SAFER's research.

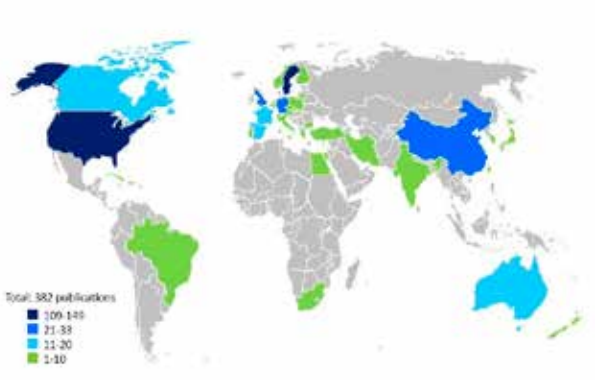


FIGURE 5. *Geographic spread of SAFER impact, based on authors' addresses stated in papers citing SAFER publications in the Scopus database 2008-2014. The colour code gives an idea of the number of papers per country.*

FIGURE 6. *Geographic distribution of SAFER internationally co-authored publications. The colour code gives an idea of the number of publications per country.*

PARTNER AND INTERNATIONAL COLLABORATION

As a measure of the fruitful collaboration between the SAFER partners, 99 of SAFER's project publications (corresponding to 46.5% of the total) are co-authored by at least 2 of the 34 SAFER partners (according to Scopus).

The number of internationally co-authored publications (i.e. included authors with affiliations from at least two different countries) is 62 (corresponding to 29% of the total), with 18 countries represented. The most common affiliations, excluding Sweden, are USA and various European countries, but even countries in Asia and South America are represented (see Figure 6).

In summary, the results of this bibliometric study indicate visibility and recognition of SAFER's knowledge production. It is clear that SAFER's collaborative research has resulted in many academic publications covered by Scopus, and with high relevance to society and industry, and the fact that SAFER publications do get cited is indeed positive although it is more difficult to conclude about the quality of the publications[89] since they for instance have not been compared to publications by other national or international research centres in the same field[90]. Another positive aspect is the fact that knowledge has been produced through close collaboration between SAFER partners and in a way that has led to a broad spread of SAFER's impact on global research.

In a further bibliometric study, development over time for SAFER would be interesting to include as would comparisons with other centres. Type of funding and changes in funding often have an effect on publication volumes and number of citations, even if there are no clear connections of how quickly and to which extent this happens. Share of publications published through Open Access model and impact on policy documents, government agency reports and newspapers as well as social media would also be interesting.

Throughout SAFER's existence, the need for tools to guide advancement towards the vision has been recognised and explored. The challenge is to find objectives, indicators and follow-up processes suitable for an open innovation research environment based on common values and trust. SAFER has been true to the overall vision and over-arching goals. The increasing trust between the partners over time has made it possible to move towards setting common priorities and measurable targets. A "Wanted Position" for SAFER's 10th year, 2016, was established 2012 as the target for Stage 3. It consists of five parts and has become respected as the guiding document. A key consequence is the establishment of research road maps for all Focus Topics to support the fulfilment. This shows that SAFER today has a strong strategic tool-kit for creating even more results and added value.

5.

WANTED POSITION 2016 – CURRENT STATUS AND CONCLUSIONS

VISIBLE AND MEASURABLE RESULTS IN PRACTICE (1)

Results from SAFER projects have received high public as well as scientific attention. During Stage 3 good examples are the SAFER-led US project "SHRP2 S08 Safer Glances" with ground-breaking research results regarding driver behaviour in accident causation, the SAFER funded QUADRA[91] with new approaches to driver modelling and the comparative study MRMD[91] of US and EU vehicles' performance in real traffic. The latter has been an important ingredient in the transatlantic trade discussions.

Results generated in SAFER projects have been applied by partners and this has evidently contributed to increased safety on the roads. Volvo Car Corporation acknowledges the collaborative research within SAFER as one important contributor to the recent recognition of their newest car model Volvo XC90 which was awarded five stars and achieved top ratings in its 2015 Euro NCAP tests. The XC90 with standard City Safety technology stood out as the first car from any manufacturer to score full points in Euro NCAP Autonomous Emergency Braking Car to Car rear-end tests.

Over the years SAFER continuously and consciously has built competence in all relevant research areas, which have been enhanced to address also bicycling safety and automated and connected traffic. The development of the bike safety application JALP! is one example of an idea transferred into a publicly available product. Chalmers' vehicle lab ReVeRe[92] is a direct offspring of a SAFER funded pre-study. SAFER has had an active role in the establishment of the Strategic Innovation Programme Drive Sweden, partly thanks to results from the project "Boundary conditions for vehicle automation".

In Appendix A, SAFER Success Stories give these and more examples of visible impact from all SAFER research areas.

The capability to host high quality, well-attended scientific conferences is yet another sign of a well-respected community with high impact in its field. This is one of the directly measurable deliverables set up in 2006. As a token of credibility, SAFER has been trusted with hosting several respected international conferences. This gives researchers and partners in SAFER an opportunity to show their broad competence, to build new international networks and to influence research agendas and policies. The value of being the focal point and setting the agenda instead of researchers and partners having to travel the world and search for attention cannot be overstated.

HUB FOR SWEDISH TRAFFIC SAFETY RESEARCH (2)

In 2013, SAFER coordinated the establishment of a national strategic research and innovation agenda – "Safe Future" – outlining 18 ambitions for accident free traffic. The effort engaged over 45 organisations and addressed traffic safety as well as business opportunities and innovation. The agenda and SAFER's involvement in international key priority setting projects are a basis for driving the Swedish research in the field. SAFER has established and leads TS-Europe, the national platform for traffic safety aimed at influencing Europe's research programmes and agendas, which in turn should enhance the opportunities for Swedish actors' successful application to EU research funding. To this point, numerous SAFER partners are active in national and international H2020 related activities and proposals. SAFER, which can act and is appreciated as a JRU, has also been directly contacted by several consortia who have asked for SAFER's specific competences.

Under SAFER's leadership, relevant Swedish stakeholders in the comparatively low-maturity area of cycling safety managed to develop a winning proposal for an FFI strategic area in 2015. Other examples of identifying and engaging stakeholders for future traffic research include initiatives on boundary conditions for automated driving and on methods for human monitoring, where SAFER in both cases acts as a node and catalyst for several research collaborations.

The evolution of traffic safety over SAFER's 10 years has encouraged connections and involvement with relevant stakeholders in a wider community. Through this, complementary competences are being built while at the same time SAFER's expert knowledge are being translated into benefits for society and industry. On both the Swedish and international arena, SAFER has initiated and coordinated seminars and workshops that have attracted a committed and renowned audience. Connection to stakeholders is done within SAFER's core areas and competences for which SAFER is renowned. This enhances the capacity to stay world-leading. SAFER has also been instrumental in the development of important research infrastructures, such as AstaZero, Sim IV and ReVeRe. SAFER's ecosystem in mid-2015 is shown in Figure 7.

ACKNOWLEDGED AS A WORLD LEADER IN TRAFFIC SAFETY RESEARCH (3)

An extensive report about research at SAFER was prepared for the second ISAB review in May 15-16, 2014. The purpose of the ISAB was to assess SAFER research achievements and give recommendations for future development. The ISAB stated in their evaluation report that; *"The expertise that is available among the partners is unique and it is poised to make great strides in research in safety and other related areas with relatively less investment than other such institutions… SAFER is definitely on track towards achieving its Mission. The SAFER concept is sound, it has an impressive industrial network, as well as impressive academic production in many areas and SAFER researchers constitute a well-connected research community."*

In 2016, SAFER should be at the cutting edge in specific research subjects within all Focus Topics. This has already been achieved and the present status for each Focus Topic has been presented in Chapter 4.1. The Competence Areas play an important role in ensuring a critical mass of excellence. They constitute communities of seniors and experts from SAFER partners but do also attract international researchers to seminars, activities and projects. SAFER's research projects (own and associated) have produced more than 600 publications since the start in 2006. 98 journal articles (82% of the total) are published in international scientific journals covered by Scopus and 14% of them appear in journals ranked as highly prestigious publication channels (level 2) in the Norwegian Scientific Index. SAFER journal articles and conference papers have been cited by 382 papers from 37 different countries.

Examples of cutting edge results from each of the seven Focus Topics selected from a plethora of projects include: the analysis methodology of driver behaviour through NDS, the understanding of driver distraction, the unique modelling of driver behaviour, sensor fusion techniques and collision avoidance algorithms applied in vehicle demonstrators, CAE methods and tools for modelling of energy absorbing mechanisms, the active human-body modelling of drivers in pre-crash situations, the detection of occult brain haemorrhage.

FIGURE 7. *SAFER's ecosystem, mid-2015.*

A BROAD SET OF PARTNERS AND COLLABORATIONS IN ORDER TO ENSURE THE STRATEGY AND EXPLORE NEW NEEDS AND COUNTERMEASURES (4)

The group of partners has grown from the original 20 to 34 in October 2015. The most recent additions were welcomed at the shareholders meeting in May 2015: Cycleurope (SAFER partner), and Trivector and Umeå University (associated partners). During the year, University West and Mälardalen University were also accepted as associated partners.

The intensified focus on automated driving has resulted in a number of activities driven by SAFER partners but also involving several other actors. SAFER takes on a role in the programme office of Drive Sweden – the strategic innovation programme on automated transportation. This national programme, which was granted in May 2015 is led by Lindholmen Science Park. It spans beyond road transport and gives access to new contacts and insights into a wider field of research needs.

Continued efforts have been made during the year to support the China-Sweden research centre for Traffic Safety (CTS) inaugurated in 2012. Collaboration partners are Volvo Group, Volvo Car Corporation, RIOH and Tongji University, with SAFER as the Swedish platform. National and regional efforts for developing test beds have progressed. The research infrastructures mentioned in Wanted Position 3, and also partners' demonstrators and test beds, are all arenas providing additional opportunities for collaboration.

Additional international partners and collaborations are detailed in Chapter 3.2. SAFER has increased visibility on the international arena in particular in Europe but also in the US, Australia and Asia.

A BALANCED PROJECT PORTFOLIO AND A LONG-TERM FINANCING OF THE CORE OPERATIONS (5)

The balanced project portfolio has been regularly discussed at Board meetings and in the management group. The total project portfolio has reached the size that was the original target and the distribution across Reference Groups and Focus Topics has developed in symbioses with the traffic safety area and the dynamics of projects and available funding.

The demand for research on automated vehicles, driver behaviour and vulnerable road users is growing which explains a rapid growth of Pre-Crash projects. In March 2015, the ongoing Pre-Crash portfolio corresponds to 70% of the total which is an increase of 12% since last year.

SAFER has been successful in attracting external funds. Actually, SAFER own funding (cash + in-kind) is less than 5% of the total project portfolio. The distribution of own and external funding varies between the different portfolios due to the availability of research grants for different topics. The internal "SAFER call" launched late 2013 resulted in 10 projects during 2014 ensuring good use of all SAFER funding for Stage 3.

FINAL WORDS

Long-term financing options for SAFER beyond Stage 3 have occupied the Board and the management group in a more intense way since 2013. This work has resulted in a scope and content description for Next SAFER which is used for applications and discussion with old and new partners. It is as true now as when we decided on Wanted Position 2016 – SAFER needs a core funding for its operations AND a sufficient level of resources to support exploratory risk projects and be proactive on new research issues.

It is our hope that this report has given a fair picture of what SAFER is, its accomplishments and value to partners, hereby laying a platform for Next SAFER which should further exploit our strengths in collaboration, resulting in excellence and innovation. The capability exists to deliver excellent research and innovation driven by partners' needs and interest to shape future traffic safety.


5
FUTURUM
TNO
TNO 1

APPENDIX A:

SAFER SUCCESS STORIES

SAFER SUCCESS STORY: Boundary Conditions for Automation (ARV)

"The ARV project has provided a creative arena for cross-brand collaboration around vehicle automation."

Christian Grante
Volvo Group Technical Specialist Preventive Safety and Automation
Volvo Group Trucks Technology (GTT)

- **Collaboration arena for Swedish industry and academia giving a context to on-going and new projects**
- **Inspiring SAFER partners to "think outside the box" through seminars and workshops**
- **White paper on Swedish areas of strength concerning automated driving**
- **Gained and disseminated knowledge on state-of-the-art**
- **Introduced the notion of "boundary conditions for automation," particularly regarding traffic safety**

In 2012 FFI had identified a need for a collaborative platform regarding the quickly emerging issue automated driving. SAFER offered to use the existing SAFER structure and was granted a project in 2013 named Boundary conditions for Automation (ARV). ARV support the target that Sweden should be in a lead position in the area of vehicle automation. Focus is to identify and explore the non-competitive prerequisites for the introduction of Automated Vehicles (AVs) in regular traffic.

Benefit to the project partners and impact on society:

- An arena for creative collaboration in non-competitive areas in automated driving
- A cross-brand dialogue to find major implementation obstacles - beyond technology
- Shared competence in the most critical areas in cooperation with institutes and academia
- A common understanding of key areas where Sweden can take a lead position
- Found and analysed experiences gained in non-automotive areas- where automation is more established
- Keep SAFER partners informed on state-of-the-art and current focus areas for research
- Find ways of promoting AVs for increased safety and reduced carbon footprint

Think outside the box:

The approach from start, trying to identify the true challenges in the introduction of AVs, has been to "think outside the box". Initially the project worked with Mines ParisTech using a 3-step method (KCP) for idea generation. Building on the results from this Chalmers (MORE) was involved to refine four ideas generated at the workshops. The project core team developed a comprehensive mind-map covering all areas of interest and this is used continuously to find new areas to explore in workshops and pre-studies. Another approach has been to look at potential opportunities and benefits of AVs from other angles – e.g. the assumption is that we can read or work while "driving" – but what about motion sickness?

Measurable results:

- Numerous pre-studies, workshops and inspiration days for SAFER partners
- Numerous presentations to FFI and SAFER
- Scientific paper accepted and presented at FISITA 2014 World Automotive Congress
- State-of-the-art report on global activities within the area of vehicle automation
- White paper on the grounds and purposes for the ARV collaboration platform
- On-going pre-study with Luftfartsverket (LFV) for increased safety on airports

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 3,5 MSEK external (cash and inkind)

Partners: SAFER (the partners that are not FFI partners), AB Volvo, Autoliv, Scania, Swedish Transport Administration, Volvo Cars (CPAC Systems (Volvo), LFV, Saab AB - non SAFER partners)

Funders: FFI

Period: 2013 – ongoing

Oct 2015

SAFER SUCCESS STORY: Care and Rescue

"The multi-disciplinary approach and the deep and broad competence, which are found in the SAFER focus topic Care & Rescue, have paved way for new and important research, development and innovation within the traffic injury area."

Per Örtenwall
Associate Professor in surgery
Chief Physician

- **Quickly established new Focus Topic**
- **Addressing significant society challenges**
- **Unique multi-disciplinary approach**
- **Close relation to Prehospital ICT Arena and TUCAP at Lindholmen Science Park**

According to WHO, EU and others postcrash actions play a significant role in order to reduce overall mortality and injury severity for road traffic accidents. Improvements in this area will significantly reduce society costs and human suffering.
The focus topic Care & Rescue started as a consequence of a revitalization of the postcrash reference group activities during 2012. In 2014 it was recognized as a new SAFER Focus Topic and today several projects are running under this umbrella.

Benefit to the project partners and impact on society:

- New products and solutions for industry, and new and improved care processes and methods
- Societal cost savings and less human suffering
- New national and international networks and co-operations
- Potential to have impact on future regulations and policies
- New research infrastructures and research fields
- Invitations to seminars/project collaborations

Approach:

Care & Rescue address post-crash challenges for all road-users through research and development within two defined domains: 1) Incident Detection, Prioritizing & Dispatch, 2) On-scene support.
Within *Incident Detection, Prioritizing & Dispatch,* the objectives are quicker and more accurate detection and notification of incidents (e.g. improved eCall functionality), and improved incident assessment and prioritization including injury severity prediction.
Within *On-scene support,* the objectives are to improve care and prioritization of causalities on-scene and in transport. This includes detection of occult traumatic injuries like TBI (Traumatic Brain Injury), improved triage and clinical decision support, and improved extrication methods. *Care & Rescue* covers cross-disciplinary research and development involving a broad spectrum of stakeholders and disciplines within academy, industry and society. These include SAFER partners as well as new actors representing areas like emergency rescue services, healthcare, ICT and MedTech industry.

Measurable results:

- 2 post-docs
- Masters theses
- Publications
- Conference presentations and abstracts
- Initiation of Competence area Human Monitoring

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 5,4 MSEK SAFER internal (cash and inkind), and 5,4 MSEK external

Partners: AB Volvo/WirelessCar, Autoliv, Chalmers, Cycleurope, Folksam, If, irezQ, Landräddningen, Lindholmen Science Park (TUCAP and Prehospital ICT Arena), Region of VästraGötaland, Sahlgrenska Academy, SOS Alarm AB, SOS International, University of Borås, University of Gothenburg, Volvo Cars

Funding: FFI, Folksam, Länsförsäkringar, Chalmers, University of Borås, Vinnova

Period: 2012– ongoing

Oct 2015

SAFER SUCCESS STORY: Child safety research

"Our SAFER front-line research and global reputation helps us act with a stronger voice internationally, protecting children in cars around the whole world."

Lotta Jakobsson, Senior Technical Leader, Injury Prevention, Volvo Cars
Adjunct Professor, Vehicle Safety, Chalmers

- **Product on market: Input to comfort support cover for integrated booster cushion**
- **Project results have contributed to EuroNCAP introducing rating of the rear seat**
- **Autoliv experiences a great demand from almost all customers who want products which decrease the injury risk for rear seat passengers**
- **Influence on global child safety agenda, incl. ISO, UN ECE update**

The aim is to reduce child car passenger injuries and fatalities by research and knowledge sharing that focus real world safety needs. Sweden has a long history in child safety and this program has, and shall continue to, ensure that Sweden remains a hub for child safety research, contributing to setting the global agenda of child safety.

Benefit to the project partners and impact on society:

- Perceived as world leading in the field, frequently requested as lecturers
- Significant contribution to national child safety guidelines (eg. NTF, Trygg Trafikk)
- Child restraint developments for increased usage and safety; including significant influence on ECE regulation
- Creation of new product ideas which Autoliv are working on internally and also together with Volvo Cars
- Initiated and co-organized first international child safety conference in China
- An extensive global network with eminent child safety researchers
- New products will be implemented in cars on the market within a few years and the effect from these will then be visible in statistics on the number of children injured in traffic

The approach is based on five pillars:

Perform research based on real world needs, eg. research on pre-crash child behaviour relevant for protection; Continuously scan and contribute to the global dialogue, including standards, regulation, rating and consumer information; Gather skilled SAFER partners, invite the best child safety researchers in the world and on a win-win basis share experiences and identify future focus areas and actions; Funding principles: SAFER money used for pre-study, international workshops and national child safety seminars; Flexible time plan and content, to adapt to needs in the national/international current topics, eg. timely presentation at the GRSP significantly influencing the upcoming regulation on boosters (UN ECER129 phase 2).

Measurable results:

- Two Ph.D., one Lic.Eng.
- Numerous publications and presentations
- Kristy Arbogast - Chalmers Honorary Doctor 2014
- Four international workshops (2009, 2011, 2013, 2015)
- Three open seminars (2009, 2013, 2015)

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 4,8 MSEK SAFER internal (cash and inkind) and 27 MSEK external

Partners: Autoliv, Chalmers, Saab Automoblie, Volvo Cars

Funders: FFI

Period: 2006-ongoing

Oct 2015

SAFER SUCCESS STORY: CoAct – building competence in active safety and connected vehicles, preparing for automated driving

"The CoAct project has led to an increased interest from the universities for the Automotive Sector in general and vehicle automation in particular. VCC has employed several former CoAct participants."

Henrik Lind
Technical Expert
Volvo Car Corporation

- **Competent students attractive to industry**
- **Collaboration opportunity for Swedish industry and academia around Automated Vehicles**
- **Vehicle automation moving from single-vendor to a more realistic multi-vendor approach**
- **Cost-effective and challenge driven innovation**

In 2010 SAFER entered the GCDC student competition with the aim to form a strong coordinated initiative for competence building. The ambition was to make Sweden a center for active systems research, development and testing. This initiative is named CoAct (Cooperative Active Safety). It is a part of the vision to globally rollout automated and cooperative vehicles for increased safety and reduced carbon footprints. Challenge driven innovation is used as an engine to create cost-effective and innovative solutions in collaboration between industry, institutes and academia.

Benefit to the project partners and impact on society:

- Attracting and educating students and researchers in cooperative driving
- Contribution to and validation of existing ETSI and CEN communication standards for advanced automated vehicle maneuvers
- Increased collaboration between universities (course planning and content) and industry (requirements on technical skills)
- Building valuable international networks in relevant areas of business and technology
- Facilitating roll-out of automated vehicles on an international level

Step-by-step to lead position:

Industrial partners in SAFER identified a competence gap in active safety and cooperative driving. Decision was taken to enter an international student competition, the first Grand Cooperative Driving Challenge (GCDC) taking place in Helmond (NL) in May of 2011. Three Swedish student teams, supervised by senior researchers and industry experts, participated successfully. SAFER with partner Viktoria Swedish ICT as project lead, fostered the acquired knowledge and in 2013 were awarded an FP7-project together with TNO, IDIADA and TU/e to organize the challenge in 2016. SAFER decided to sponsor the participation of the Swedish teams under the CoAct name. Swedish OEMs are contributing with vehicles and expertise. Universities supervise student teams.

Measurable results:

- Successful participation by three Swedish teams in the Grand Cooperative Driving Challenge (GCDC) 2011 with places 2, 3 and 4 out of 9 participating teams
- Currently four Swedish universities (five teams) have signed up for GCDC 2016
- 90% of the individual participants in CoAct 2011 where absorbed by the automotive industry within 3 months after the competition
- Numerous technical papers and positive and visible media attention
- Testing of systems at AstaZero
- CoAct teams collaborating with in-house development projects at OEMs
- Viktoria Swedish ICT is a core team partner of EU-project iGames organizing GCDC 2016

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

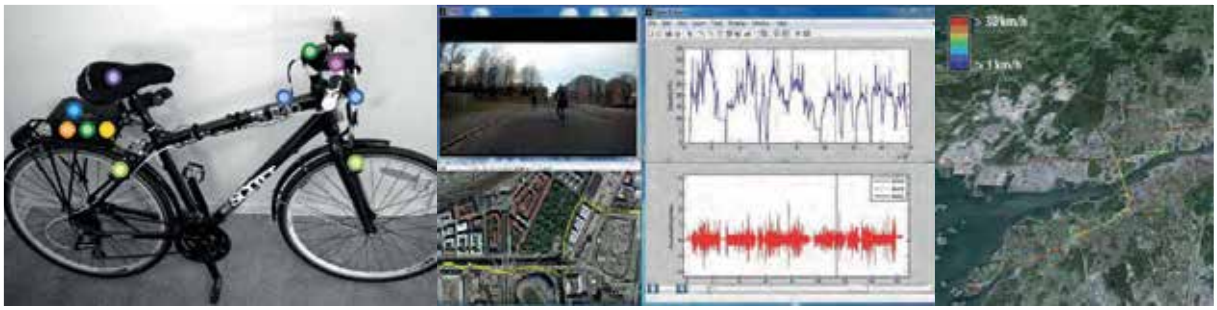
Funding: 3 MSEK SAFER internal (cash and inkind) and 14,2 MSEK external

Partners: AB Volvo, AstaZero, Chalmers, Halmstad University, KTH, Linköping University, Scania, Swedish Transport Administration, Viktoria Swedish ICT, Volvo Cars, and a number of 2:nd tier suppliers for the OEM industry.

Funders: IVSS, FFI

Period: 2013 - 2016

Oct 2015



SAFER SUCCESS STORY: Cycling safety

"The unique collaboration between SAFER's partners has focused on cycling safety research, a very important area for the holistic view of traffic safety and the possibility to reach zero accidents."

Irene Isaksson-Hellman, If P&C Insurance

SAFER and Chalmers are today a world leader in cycling safety research, having

- **o pioneered collection and analysis of naturalistic cycling data**
- **o published several scientific papers on the topic**
- **o organized the 3rd International Cycling Safety Conference**
- **o led several projects on cycling safety**
- **o actively participated to different networks on cycling safety**
- **o attracted the interest of the national and international press and media**

To understand cyclist behavior and how cyclists interact with other road user, in order to guide the development and evaluations of countermeasures to bicycle accidents.

Benefit to the project partners and impact on society:

- In 2012, Chalmers pioneered collection and analysis of naturalistic data from instrumented bicycles at SAFER. These data provided novel insights into accident causation, infrastructure design, and road user behaviour and supported the development of a cooperative application to assist cyclists and drivers at intersections.
- Starting 2013, data was also collected from instrumented electrical bicycles. Interaction between cyclists and other road users was found to be the pivot point for cycling safety analysis and one of the major challenges, together with visibility, for new e-bikes.
- The 3rd International Cycling Safety Conference was organized in Gothenburg, November 18-19 2014,
  - Over 160 delegates participated. 65% of them came from 22 dierent countries outside Sweden.
  - Over 50 oral presentations and papers were presented.
  - Several stakeholders including the city authority, the cycling manufacturers, and the vehicle manufacturers actively participated to the conference success.
- Insurance and exposure data on bicycles from SAFER partnerts was combined to naturalistic data in 2015. Novel data analysis tools and methodologies were developed to combine these data as pieces of the same puzzle. The results gave new insight about rider behaviour and intoxication in particular.

Step-by-step to lead position:

Cycling is increasingly popular in Europe raising new safety concerns. SAFER responded to these safety concerns by porting established methodologies from vehicle and traffic safety research to cycling safety to support and promote this healthy and environmental friendly activity by making it safer. As cycling data is limited, novel analyses methodologies combining dierent data types from dierent institutions were employed to partly overcome this limitation leveraging on the SAFER network.

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

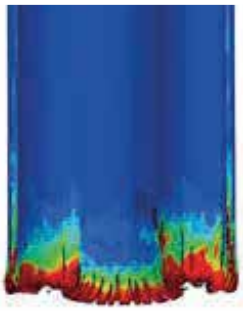
Funding: 2 MSEK SAFER internal (cash and inkind), and more than 2 MSEK external

Partners: Chalmers, City of Gothenburg, If

Funders: VINNOVA, Swedish Transport Administration

Period: 2012-2015

Oct 2015



SAFER SUCCESS STORY: Fibre reinforced polymer composites in automotive applications

"We need to develop accurate and efficient CAE tools for structural polymer composites, to help meet future emission requirements by reducing weight."

Kaj Fredin, Manager Strategy, Concepts and Advanced Engineering, Volvo Car Corporation

- **SAFER initiated significant progress within the area, exemplified by formation of Chalmers Composite Cluster and growth of PhD students**
- **Important role in current European projects on crashworthiness of composite structures**
- **Contributed to establishment of LIGHTer**

Transportation road vehicles need to significantly reduce emissions of greenhouse gases, whereby weight reduction is a key. As a consequence, increased usage of fibre reinforced polymer composites, which have high stiffness, strength and energy absorption capabilities per kilogram material, is of highest priority. A crucial enabler for the introduction of these materials is however an increased capability to, by numerical simulation, predict the material response in a crash.

Benefit to the project partners and impact on society:

- A strong national consortium with 10 partners from industry, institutes and academia (out of which 7 are SAFER partners) collaborating on crash modelling of composites.
- Partner involvement in all five European SEAM cluster projects related to vehicle safety, lightweighting and composite materials.
- Formation of Chalmers Composite Cluster, a joint initiative between Chalmers and Swerea SICOMP involving industry partners such as Volvo Car Corporation and GKN Aerospace.
- Strong link between SAFER and LIGHTer (the national Strategic Innovation Area on lightweight).
- An increase from zero to seven PhD student projects in the period 2009-2015. Resulting in Europe's largest training effort of doctoral students for the modelling of energy absorption in composite crash structures.
- New materials for increased safety, e.g. a composite that can reduce its stiffness by 90% in a few microseconds and thereby provide increased pedestrian protection.

The approach:

A significant journey starting with the SAFER pre-study "CAE Tools for composite body concept assessment" conducted in 2010 has been achieved. A direct outcome of the focused work on developing the area is the Chalmers Composite Cluster, a strong formation jointly driven by Chalmers and Swerea SICOMP with active contribution from industry. The current research portfolio comprises five national PhD projects on modelling and characterization of composite materials for automotive applications, the majority focusing crashworthiness. On top of this, SAFER researchers are active in four European Projects related to vehicle safety and composite materials. The ultimate goal of these efforts in a ten years perspective is to establish confidence in crash predictions of composite vehicles to a level comparable with current state of the art for conventional metallic structures.

Measurable results:

- 1 Ph.D., 1 post-doc
- 1 new full Professor in Lightweight Materials and Structures
- 1 open seminar series on composites in the automotive industry (3 seminars during 2010)
- Numerous publications and presentations

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

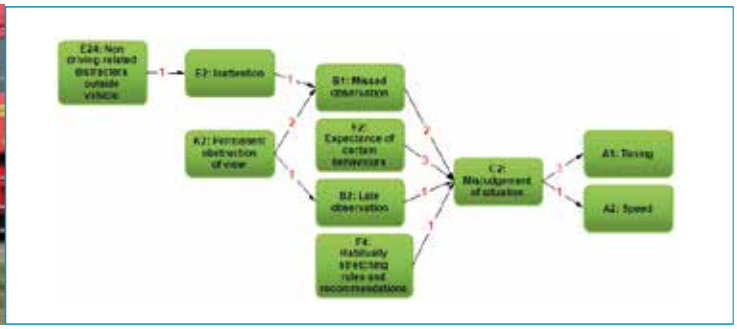
Funding: 4,3 MSEK SAFER internal (cash and inkind), and more than 33 MSEK external

Partners: AB Volvo, Autoliv, Chalmers, Swerea SICOMP, Volvo Cars, ÅF. (Semcon, DYNAMore Nordic, Escenda, Altair Engineering – non SAFER partners)

Funders: FFI, EU, Energimyndigheten, Chalmers (SOT)

Period: 2009-2016

Oct 2015



SAFER SUCCESS STORY: Field data analysis platform

"The analytical work at SAFER has provided Volvo Cars with useful tools to accurately evaluate the effectiveness of rear-end crash avoidance systems and also for comparing the crashworthiness of European and US car fleets."

Anders Eugensson
Director, Government Affairs
Volvo Car Corporation

- **Newly developed assessment method for active safety system testing**
- **Built world-class infrastructure for accident data collection**
- **Provided input for policy decisions, e.g. negotiations concerning the Transatlantic Trade and Investment Partnership (TTIP)**
- **Hub for the Initiative for the Global Harmonisation of Accident Data (IGLAD).**
- **Among world leaders in accident analysis**

Develop a platform for field data collection and analysis to further improve the understanding of real-world accident problems.

Benefit to the project partners and impact on society:

- The national infrastructure for accident data collection (INTACT) was developed by SAFER partners and was later adopted by the EU to be used for in-depth accident investigations on European level.
- INTACT contributed to Sweden becoming the hub for the Initiative for the Global Harmonisation of Accident Data (IGLAD).
- A new test-based assessment method for crash avoidance systems effectiveness measured by its ability to reduce the number of injuries in rear-end collisions.
- Provided input on motor-vehicle crash risk of EU and US vehicles to the negotiations concerning the Transatlantic Trade and Investment Partnership (TTIP).
- Analysis concerning High Capacity Transports used in negotiations for longer truck combinations in the EU.

Approach:

The field data platform was initiated by the collaboration in INTACT and was extended to include advanced analyses. SAFER's commitment widely contributed to this success by supporting the development of a field data analysis platform to recruit a senior research analyst. This led to deeper collaboration in field data analyses among the SAFER partners as well as other organisations world-wide.

Measurable results:

- Up-to-date accident data.
- Hub for the IGLAD consortium.
- Several peer-reviewed papers.
- Research driven policy making.
- European acknowledged methods.
- Collaborative research with University of Michigan Transportation Research Institute (UMTRI)

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 5 MSEK SAFER internal (cash and inkind) and 53,6 MSEK external

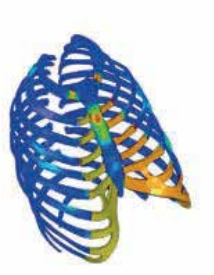
Partners: AB Volvo, Autoliv, Chalmers, City Of Gothenburg, Folksam, If, Saab Automobile, Scania, Swedish Transport Administration, TØI, University of Gothenburg, Volvo Cars, VTI

Funders: VINNOVA, VR, EU, and others.

Period: 2007– ongoing

Oct 2015






SAFER SUCCESS STORY: Human body modelling cluster

"Working together in the SAFER HBM cluster has significantly sped up and increased the quality of real world safety occupant protection research and system development."

Lotta Jakobsson, Senior Technical Leader, Injury Prevention, Volvo Cars
Adjunct Professor, Vehicle Safety, Chalmers

- **Development and validation/evaluation of state-of-the-art human substitute tools for crash analyses.**
- **Acknowledged as a major international player in HBM research.**
- **Enhancement of HBM injury prediction capabilities and important biomechanical research in collaboration with international partners.**
- **Influence on the global arena to promote open-source and sharing of HBMs.**

The aim is to build competence on human body models (HBMs) among the SAFER partners. HBMs are important tools for advanced safety system developments. The challenge is to provide omnidirectional HBMs that can predict injury and have a biofidelic response in scenarios ranging from emergency events to crashes in all different impact directions, representing a broad range of the human population.

Benefit to the project partners and impact on society:

- Enhanced tools for development and assessment of safety systems; the SAFER A-HBM (active adult occupant), an active child occupant model and a pedestrian HBM with detailed head and neck involving muscle activation possibility.
- Enhanced tools for development and assessment of safety systems; i.e. the SAFER A-HBM and an active child model.
- New insights to injury mechanisms and protective principles by combining fundamental biomechanical research and applied research, such as reconstructions of real world crashes with omnidirectional loading.
- Harmonized HBMs and shared model improvements.Several SAFER workshops to identify needs and prioritize future research actions.
- A strong international network that contribute to research.
- Yearly invitations to international human body modelling conferences and workshops.

Communication is the core strategy:

Following some initial projects on HBM evaluations, SAFER project funding was used to recruit one senior researcher and two doctoral students at Chalmers in 2009. The strategy is to have close communication between the key people at all SAFER partners actively working with HBMs and jointly connect to international research groups. Research questions are defined based on needs of all partners and focus strategic areas that complement other international efforts, such as modelling of muscle activity for pre-crash and applied injury prediction capabilities. Close international collaborations ensure access to validation data to assess HBM biofidelity and updated knowledge transfer to the SAFER partners.

Measurable results:

- One Docent, three Ph.D., more than five Lic.Eng.
- Numerous publications and presentations.
- 1st price in the recognized international STAPP car crash conference student paper award.
- HBM enhancements for adult pedestrian and occupant, as well as child occupant.
- A world-first open-source female HBM is being developed.

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

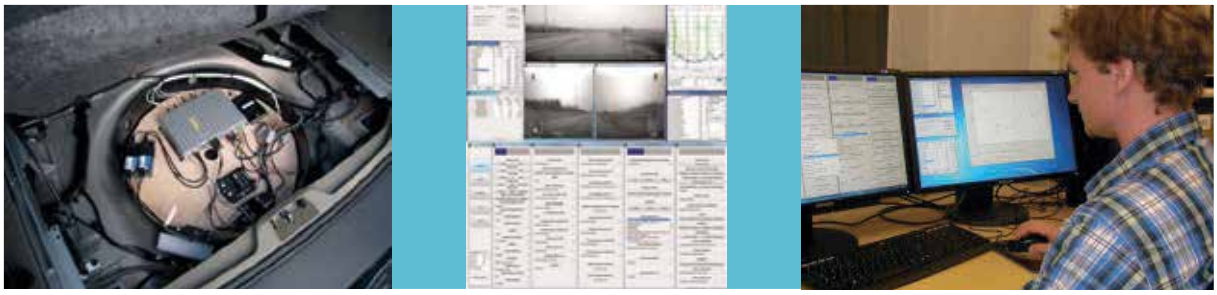
Funding: 11 MSEK SAFER internal (cash and inkind) and almost 60 MSEK external

Partners: AB Volvo, Autoliv, Chalmers, Royal Institute of Technology (KTH), Sahlgrenska University Hospital (VGR), Umeå University, Volvo Cars, VTI, ÅF

Funders: FFI, VR, EU, Folksams forskningsfond

Period: 2006 - ongoing

Oct 2015



SAFER SUCCESS STORY: Naturalistic data platform

"SAFERs platform for naturalistic driving data is used in our global projects in Sweden, US and China. The platform plays an important role when analysing and understanding driver behaviour, and is used in the development of our active safety systems."

John-Fredrik Grönvall, Senior Research Manager, Field data
Volvo Car Corporation

- **Common world class infrastructure for naturalistic data (ND) collection, secure data storage and analysis**
- **SAFER chosen as Central Data Centre in the largest ND study in Europe**
- **Cross-Atlantic Connected Analysis Centres with remote access developed and tested at SAFER and UMTRI**
- **The platform almost self-financed through projects since the start**
- **Data Protection Concept developed for all stages in data handling**
- **Tools for collection of naturalistic data from vulnerable road users (pedestrians and bicyclists)**

The objective was to develop a secure, world-class, platform for handling naturalistic data from data collection over data storage and processing to analysis to gain control of the quality of data and results, and to maintain the world-class level over the years. SAFER was technically challenged by being the first in Europe to develop such a platform, and administratively challenged on how to finance the platform over the years.

Benefit to the project partners and impact on society:

- Common robust data collection system, vehicle adaptation, and vehicle monitoring services, used in numerous projects
- Common data processing principles, using High Performance Computing
- Common data storage structures and data processes facilitating data sharing and re-use
- Common analysis tool, FOTWare and NatWare
- Platform includes communication capabilities for cooperative applications
- Infrastructure developed together, reducing the cost for partners
- Remote access facilities
- The ND platform and its data as a facilitator for project consortium invitations

The challenge was approached using eight key strategies:

Develop our own infrastructure from data collection over data storage to data analysis to learn the process, gain control of the quality and understand the challenges; Collaborate with UMTRI, to learn from their expertise in naturalistic data handling; Develop a strategy for the financing of the platform over time; Investigate data protection issues due to personal privacy and Immaterial Property Rights together with the four Swedish OEMs; Capitalise on the knowledge among the SAFER partners for the development of the ND platform; Implement support for a variety of ND data types (continuous and event based, and cooperative systems data); Develop a remote access method, where researchers can access data globally, using remote desktop.

Measurable results:

- SAFER has developed a set of common data management principles, hardware and tools, supporting the complete chain from collecting data in vehicles, to analysis of data.
- SAFER has established good relations with many data providers, and access to several important ND databases globally.

(See also SAFER Success Story Naturalistic Driving Data)

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 11 MSEK SAFER internal (cash and inkind) and over 113 MSEK external

Partners: AB Volvo, Autoliv, Chalmers, City of Gothenburg, If, Lindholmen Science Park, Saab Automobile, Scania, SP, Swedish Transport Administration, TÖI, University of Gothenburg, Viktoria Swedish ICT, Volvo Cars, VTI, ÅF

Funders: Chalmers (SOT), EU, National Academy of Sciences, Swedish Transport Administration, VINNOVA, VR

Period: 2007 - ongoing

Oct 2015

SAFER SUCCESS STORY: Naturalistic driving data

"SAFER brings together a unique combination of collaborators that are increasingly essential for addressing complex driving safety opportunities, such as naturalistic data analysis. SAFER is leading the world in its analysis of naturalistic data, helping to understand driver distraction and to model driver behaviour."

John D. Lee
Emerson Professor
University of
Wisconsin-Madison

- **Common world-class infrastructure for naturalistic data (ND) collection, storage and analysis**
- **One of the world leaders in naturalistic data handling and analysis**
- **One of three consortiums awarded US analysis projects on the world´s largest ND dataset SHRP2**
- **World leader in collection and analysis of naturalistic data from bikes and e-bikes**
- **Leader in the development of the FOT/NDS Data Sharing Platform for Europe**

The challenge is to better understand the interaction between the driver/rider, the vehicle and the environment including other road users and thereby understand incidents and accidents causation as well as how different vehicle systems enhance safety. The objective is to reduce the number of fatalities and seriously injured in road traffic.

Benefit to the project partners and impact on society:

- Network including the most prominent researchers in the area from the US, Europe, Australia, Japan and China
- Mobile phone use policy in Sweden influenced through SAFER researchers
- Naturalistic driving data integrated and used in the courses at Chalmers
- Data processing and analysis methods developed for naturalistic data, resulting in scientific papers and reports
- Data Protection Concept developed, ranging from data collection, storage, analysis and re-use of data
- Founder of the Driver Distraction and Inattention conference, held three times at SAFER attracting the best researchers
- 3rd International Cycling Safety Conference (ICSC 2014) held at SAFER (record high attendance)
- Information exchange on naturalistic data topics with SHRP2 based on an agreement (MoU) between TRB, VINNOVA and Swedish Transport Administration

The challenge was approached using seven key strategies:

Provide initial SAFER funding for early start-up: networking, travel, lead in proposal writing; Learn from the best, starting with UMTRI and continuing with expertise in key areas such as statistics and human behaviour; Build a complete data handling infrastructure consisting of data collection equipment, database structures and analysis tools, to gain control of the quality and understand the challenges; Use all competences within SAFER and be open-minded as the area is new, complex, and a large variety of competences are needed; Develop a world class worldwide network to get access to vital competences and form strong consortiums; Form a vision of the area in 2016 to create energy to achieve world class; Produce quality results to attract renewed funding.

Measurable results:

- One of three consortiums awarded US analysis projects on the world´s largest ND dataset SHRP2
- Numerous scientific papers and reports based on methods for and results from analysis using naturalistic data
- Founder of the Driver Distraction and Inattention conference, held three times at SAFER attracting the best researchers

(See also SAFER Success Story Naturalistic Data Platform)

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

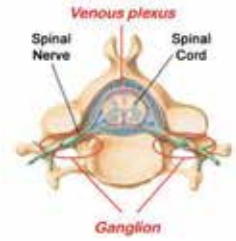
Funding: 11 MSEK SAFER internal (cash and inkind), and more than 113 MSEK external

Partners: AB Volvo, Autoliv, Chalmers, City of Gothenburg, If, Lindholmen Science Park, Saab Automobile, Scania, SP, Swedish Transport Administration, TÖI, University of Gothenburg, Victoria Swedish ICT, Volvo Cars, VTI, ÅF

Funders: VINNOVA, EU, National Academy of Sciences, Swedish Transport Administration, VR, Chalmers (SOT)

Period: 2007 - ongoing

Oct 2015



SAFER SUCCESS STORY: Neck injury prevention

"The BioRID dummy with its human-like response to low speed rear collisions has been key to our safety ratings and has promoted vehicle seats with demonstrably fewer real world injuries."

Adrian K. Lund, President, Insurance Institute for Highway Safety

- **As the BioRID II dummy creators, taking the lead in setting the future directions in the area, exemplified by the development of the world-first mid-size female dummy model**
- **State-of–the-art real world data analyses providing important input to regulation, standard development and car design**
- **Research results confirm the in house developed neck injury criterion NIC providing best correlation to neck injury risk**
- **Ongoing work on a new female human body model for neck injury assessment in rear impact to be delivered open source**

Neck injuries (often called whiplash injuries) can occur in all collision types, and is one of the most challenging injury types in safety research and developments, mainly due to difficulties to diagnose. They account for 64% of all disabling car occupant injuries in Swedish. The aim is to identify injury mechanisms and develop assessment methods and guidelines that allow industry to develop effective protection.

Benefit to the project partners and impact on society:

- SAFER research has significantly contributed to occupant dummies and models, starting with the mid-size male dummy, BioRID, in 1998 followed by mathematical models of BioRID and a mid-size female counterpart, EvaRID, in 2011.
- Development and validation of the most recognized neck injury criterion for rear-end impacts, the NIC.
- Key contributor in the development of international rear-end impact assessment methods, exemplified by EuroNCAP.
- Joint research activities resulted in world-first protection systems by Volvo and Saab in 1997, SAFER research has shown these systems to be state-of-the art still.
- Hypothesized and partly corroborated a completely new injury mechanism and injury site (pressure induced cervical dorsal root ganglion injuries), providing important input both to the engineering and medical society .
- Currently developing a new average female size Human Body Model (HBM) with a detailed neck. First focus being neck injury assessment in rear impacts.

Approach:

This effort involved several SAFER partners, starting in the 1980ies, and is still ongoing. During the SAFER period in total eight projects are performed involving varying partner constellations. The projects include accident data analyses, accident reconstructions, experimental biomechanics, dummy development, seat testing and computer modeling. Results are shared internationally, enabling independent evaluations and wide implementation tools and criteria. This approach was proven successful making the BioRID and NIC world standard and used globally for car developments. The same approach is used for the continued work, mainly focusing protection for females and development of human body models, as well as the experimental work on injury mechanisms.

Measurable results:

- In total about 10 PhD examinations, whereof two during 2006-2015
- One Post-Doc period
- Numerous journal and conference papers

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

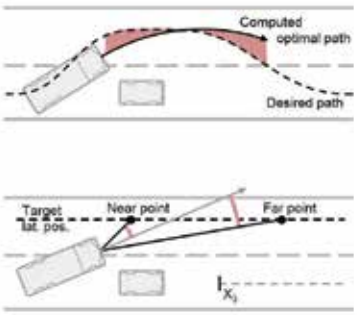
Funding: Approx. 2,5 MSEK SAFER internal (cash and inkind), and 18 MSEK external

Partners: Autoliv, Chalmers, University of Gothenburg, Epsilon (ÅF), Folksam, Saab Automobile, Swedish Transport Administration, Volvo Cars, VTI

Funders: VINNOVA, FFI, EU

Period: 2006-ongoing, joint research history back to 1985

Oct 2015



SAFER SUCCESS STORY: Quantitative Driver Behaviour Modelling for Active Safety Assessment (QUADRA)

"Knowledge and competences gained in QUADRA give us now an opportunity to quantify safety benefits of future safety systems in early development stages. Newly identified driver behaviours are now considered in the development of our future generations of vehicle stability control systems."

Stefan Edlund, Chief Engineer
Chassis Strategies & Vehicle Analysis
Volvo Global Trucks Technology

- **Computer simulations allowing system evaluation at an unprecedented level of detail (e.g. effects for individual drivers, or on specific real-world crashes)**
- **Models and evaluation methodology are influencing product development processes and tool chains at both Volvo Cars and AB Volvo**
- **Several novel ideas and findings that connect driver modelling with state of the art neuroscience, potentially game changing for future driver modelling research**

Virtual testing methods are increasingly important for automotive product development. The QUADRA project developed mathematical models of drivers' behaviour in critical traffic situations, to allow computer simulation of driver interaction with active safety systems in the final seconds leading up to a crash (or its avoidance). The challenge, at the time when the project was decided, was that driver behaviour modelling was a new and highly unproven topic. SAFER decided to push this emerging area by supporting an academic PhD student in collaboration with an industrial PhD student funded by FFI.

Benefit to the project partners and impact on society:

- Mathematical models of driver behaviour in selected crash scenarios – "virtual crash test dummies with a brain"
- Computer simulations allowing system evaluation at an unprecedented level of detail (e.g. effects for individual drivers, or for specific real-world crashes)
- Several concrete ideas for system improvements, including one patent application
- Models and evaluation methodology are influencing product development processes and tool chains at both Volvo Cars and AB Volvo
- Strengthened international collaboration through a Scientific Advisory Board with leading researchers from Europe and the US
- Several novel ideas and findings that connect driver modelling with state of the art neuroscience, potentially game changing for future driver modelling research
- Extensive media coverage for one of the findings (taken up by more than 100 news outlets worldwide)

Approach:

One key decision, agreed upon in a pre-study for the project, was to constrain the driver modelling very tightly to a few well-defined applied scenarios. In this way, it was possible to look very deeply into each separate scenario, and reach across the full cross-disciplinary chasm from vehicle dynamics and safety systems, via psychology all the way to neuroscience. Thus, the modelling could keep a high scientific level, while at the same time remaining in touch with the intended application. Furthermore, since driver modelling was a relatively new area for all of the project partners, interactions with leading international experts were established in the form of a Scientific Advisory Board.

Measurable results:

- Two PhDs graduated
- Numerous publications and presentations
- One patent application

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 2,3 MSEK SAFER internal (cash and inkind), more than 21 MSEK external

Partners: AB Volvo, Chalmers, Volvo Cars, VTI

Funding: FFI

Period: 2010-2014

Oct 2015

SAFER SUCCESS STORY: SAFER A-HBM (Active - Human Body Model)

"With this unique SAFER-developed tool, advanced integrated (passive and active) safety systems for occupant protection are developed to save even more lives and reduce even more injuries."

Bengt Pipkorn
Director, Simulation and Active Structures, Autoliv

- **Development of world first tool, "SAFER A-HBM" simulating occupant in braking with a following crash event enabling industrial application for development of active safety systems and advanced protection systems.**
- **State-of-the-art research on car occupant muscle-responses, attracting international research collaboration.**
- **Unique set of volunteer data on occupant kinematics in potential pre-crash events.**

Human Body Models (HBMs) are state-of-the art tools for injury biomechanics research and occupant protection system development. HBMs are mathematical models of human bodies. Developments of active safety technologies (eg. braking, steering) call for human models functioning both in a pre-crash and the crash phase, why the effect of occupant postural and reflexive responses must be accounted for in HBMs by the addition of neuromuscular control schemes.

Benefit to the project partners and impact on society:

- A unique FE-HBM with active muscle control has been developed and validated by SAFER partners, called the SAFER A-HBM.
- Up to date, the SAFER A-HBM has been used to study the effect of reversible seat belt pre-tension on occupant pre-crash posture during braking events.
- Recently, the pre-crash functionality of the SAFER A-HBM has been connected to the crash functionality of the model, enabling study of a whole sequence of pre-crash braking with a following frontal crash. This is a first of its kind FE-model.
- Industrial implementations in product development processes are ongoing.
- Through a number of research projects, collaborations with internationally renowned researchers within the field of neuromuscular control have been established.
- Long term research project plan established (for a total period of over 10 years), aiming at advances addressing complex events in multiple directions involving control of muscle activation.

Approach:

Based on SAFER partner needs, an existing HBM was further enhanced by the addition of a model package containing muscles and a neuromuscular control scheme. The model is validated using data derived from large volunteer studies performed to study car occupant muscle responses to autonomous and driver braking interventions. In close collaboration with the industry partners, academic research staff carried out complex volunteer tests with state-of-the-art measurement methods in real vehicles driving in almost naturalistic conditions.

Measurable results:

- 1 Ph.D., 2 Lic. Eng.
- 6 journal articles in high level journals
- Several conference presentations
- 1st price in the recognized international STAPP car crash conference student paper award

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 3,6 MSEK SAFER internal (cash and inkind), approx. 22,6 MSEK external

Partners: AB Volvo, Autoliv, Chalmers, Saab Automobile, Umeå University, Volvo Cars

Funders: FFI

Period: 2009 – ongoing

Oct 2015

SAFER SUCCESS STORY: SEVS, Safe Efficient Vehicle Solutions

"In Volvo Cars' R&D plan for strategic areas in need for competence, manning and specific studies, the SEVS "drivkraft model" was used."

Lars Greger, Manager Technology Strategy & Planning, Volvo Car Corporation

- **A generic, strategic and tactical methodology ("The SEVS Way") to handle complexity and uncertainty by involving relevant stakeholder experts in a participatory and exploratory analysis**
- **A driving force model and metrics for simultaneous evaluation of the properties safe, green and affordable for a given use case**
- **Influenced the product strategy decision for one of the partners who used the SEVS methodology in-house**
- **Influenced innovative ideas for new urban vehicles**

The aim is to enhance both safety and energy efficiency in the transport system through a holistic approach. New, energy-efficient vehicles can be made safe and affordable if all desired properties are considered from the very beginning and the context in which they exist is integrated in the analysis. SEVS, Safe Efficient Vehicle Solutions, is an explorative project addressing complex societal and technological challenges related to the future transport of people and goods **and at the same time** shaping efficient tools and methods for dealing with such complexity and uncertainty involving experts from many different organizations.

Benefit to the project partners and impact on society:

- SEVS has developed a generic method for how to work efficiently in cross-disciplinary explorative projects and perform analysis of complex societal development.
- The project provides a "smorgasbord" of results and insights of possible future societies and the different driving forces that influence the shaping of the future transport system. These methods and insights prevent errors commonly made when analyzing the future.
- SEVS has built a community of researchers, vehicle engineers, planning experts in society and industry and others that now share a common understanding of a scenario-based approach.

Approach:

The approach is to organize stakeholders in a workshop based process. Between workshops in-depth studies are conducted. One core activity is to agree on the most uncertain influencing factors and define scenarios based on this. The consequences for different use cases in the transport system are then explored. Since complexity by definition cannot be divided into smaller separate pieces, SEVS developed methods and tools enabling a holistic analysis. The participating experts should have a high degree of diversity and span over fields like social sciences, vehicle technologies, city traffic administration, and resource analysis. SAFER as an Open Innovation Platform facilitated and strengthened the trust among people.

Measurable results:

- Four complementary scenarios of the future society has been developed
- Seven vehicle concepts (desktop studies) to illustrate effects on vehicles based on scenario
- Creation of a driving force model which describes driving forces, their relations and how they shape the future transport system
- A generic method to analyze which transport solution the user will select, based on the scenarios and selected use cases
- About 100 seminars and workshops with multi-disciplinary teams and about ten dissemination seminars
- Deeper understanding of mega cities challenges, using Shanghai as the study case
- Several reports e.g. "Electro Mobility in Norway - Experiences and Opportunities with electric vehicles", The SEVS Way and about 20 sub-reports (not public), the SEVS Brochure and the Exhibition
- Input to more than six new projects; e.g., Balancing active and passive safety, Urban Personal Vehicle, and applications e.g. Multi-purpose Urban Mobility Solution (UDI)

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 1,6 MSEK SAFER internal (cash and inkind), and 20,5 MSEK external

Partners: AB Volvo, Autoliv, Bisek, Chalmers, Göteborgs stad, Göteborgs Universitet, IBM, Innovationskontor Väst, Innovatum, Johanneberg Science Park, KTH, Malmeken, Mistra Urban Futures, Scania, SP, Swedish Hybrid Vehicle Centre, Volvo Cars, VTI

Funders: FFI

Period: 2009-2014 (phase 1 and phase 2)

Oct 2015

SAFER SUCCESS STORY: System Safety through the Combination of HMI and Dependable Systems I and II

"The opportunity to recruit a PhD with unique knowledge in automated driving is a result of the SHADES project that provides Volvo Cars with key competence for the development of self-driving cars."

Mikael Kjellgren, Manager,
Active Safety Sensor & Systems A&V
Volvo Car Corporation

- **Unique knowledge on drivers' ability to handle technical system failures**

The aim was to benefit from SAFERs multi-disciplinary scope and combine research in HMI with research in dependable systems to increase system safety in vehicles and define the connections between behavioural science and dependable systems. The scope was later enlarged to encompass knowledge of the relation between drivers and vehicle automation.

Benefit to the project partners and impact on society:

- A novel method to assess the safety of transitions from automated to manual driving when vehicle automation fail
- Development of driving simulator methodology (design of experiment and measures such as 'point-of-no-return')
- Strategies to improve driver controllability in situations where technical failures occur
- Implications for design of driver HMI
- Further knowledge on the consequences of introducing driver assistance systems and automation in cars
- Enhanced knowledge of drivers' experiences of using assistance systems in everyday life
- Successful multi-disciplinary collaboration
- Strengthening of national competitiveness through collaboration; (industry/academia/institutes) and coordination of driving simulator equipment and methodology

Approach:

Recruit Ph.D. students with a human factors and an engineering background respectively; Make use of the broad competence base in institutes and academy; Carry out the project with a co-research approach (simultaneous and integrated rather than parallel activities); Apply a mixed methods approach to research activities; Secure involvement and input from industrial partners.

Measurable results:

- Two Ph.D.;
- Two master theses;
- A number of journal and conference papers;
- One invited book chapter;
- Several prominent presentations for national and international audiences, including academia as well as OEMs;
- VTI simulator software implemented in Chalmers' simulator.

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 13,2 MSEK SAFER internal (cash and inkind)

Partners: AB Volvo, Chalmers, Saab Automobile, SP, Volvo Cars, VTI

Funders: SAFER

Period: 2008-2011; 2011-2014

Oct 2015



SAFER SUCCESS STORY: Vehicle Dynamics Competence Area and cooperation around test vehicles

"A close collaboration between academia and the industry is, of course, of great importance to our region. When we see a possibility to strengthen the bond between these two, we try to take that opportunity, as with the ReVeRe lab."

Johnny Magnusson, President
Regional Executive Board
Region Västra Götaland

- **A complete research infrastructure – spanning from computer simulations, driving simulators, full scale vehicles, to the AstaZero proving ground**
- **A well-functioning research community – the Vehicle Dynamics Competence Area**

SAFER started to form Competence Areas as a way to create communities gathering experts within the partner organizations. Vehicle Dynamics started in 2008 with core partners from Chalmers, KTH, Scania, Volvo, Volvo Cars and Saab Automobile. In 2009, Saab Automobile contributed a first test vehicle (as inkind to SAFER) to Vehicle Dynamics Competence Area. That vehicle has been used in many research project and many courses. It has been the embryo for fostering a flourishing experimental vehicle research. The build-up of workshop facilities enabled to expand with a Volvo S60 and, through another SAFER project, a truck converter dolly. This encouraged SAFER to spend resources on a pre-study for a full-scale vehicle laboratory that should enable independent research and education experimentation for active safety systems and automated driving. In November 2015 the result is a laboratory at Lindholmen, ReVeRe, with two new test vehicles - a Volvo XC90 and a Volvo FH tractor 6x2. In the overall context with the unique test track AstaZero close to SAFER, this lifts the automotive research significantly.

Benefit to the project partners and impact on society:

- SAFER's researchers have the capacity to perform experimental complete vehicle tests, primarily on AstaZero test track but also in real traffic. This leads to innovative cutting edge research.
- Complete vehicle experiments
  - help to find the right problems, bringing in real life aspects of imperfect tyre/road, sensors/actuators, traffic, driver, weather and other road users, and bringing in integration aspects in a vehicle.
  - are valuable for development and validation of computer simulations and results from driving simulators.
  - bring researchers together to cooperate with a common test object.
  - enhance the learning experience for students.

Approach:

The strategy for vehicle and laboratory expansion has been to be responsive to the needs in projects and education. The Competence Area strategy is to be as collaborative as possible and to create a welcoming community. The regular meetings are thus moved between the partners' different geographical sites. A common road map for competence development is openly shared. Open seminars in collaboration with other stakeholders have been held on a yearly basis.

Measurable results:

- The first Saab 93 is still alive and used in research and education.
- The ReVeRe full-scale vehicle laboratory is inaugurated.
- The infrastructure contains Volvo S60, Volvo, XC90, a converter dolly for semi-trailers, a Volvo FH tractor and a driving simulator.

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

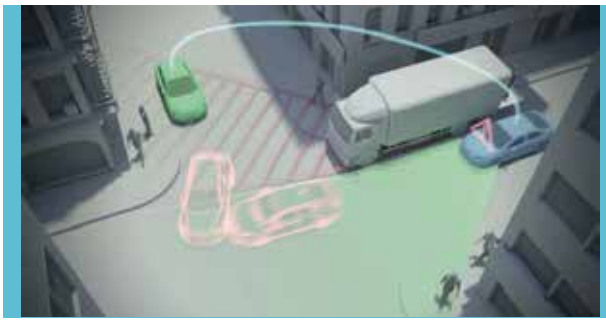
Funding: 14,5 MSEK SAFER internal (cash and inkind) and 64,6 MSEK external

Partners: AB Volvo, Autoliv, Chalmers, CPAC Systems, Kapsch TrafficCom, KTH, Mälardalen University, NEVS, Parator, Region Västra Götaland, Parator, Saab Automobile, SP, Swedish Hybrid Center, Swedish ICT, Swedish Transport Administration, Volvo Cars, VTI, ÅF

Funders: SAFER, VGR, FFI, VINNOVA

Period: 2008-ongoing

Oct 2015



SAFER SUCCESS STORY: Vehicular communication research

"Chalmers, with their deep knowledge of communication technologies and worldwide research network, contributes with excellence towards Volvo Cars' research and development of connected safety systems."

Mikael Nilsson, Technical Expert
Volvo Car Corporation

- **Visibility and impact on the international academic community**
- **Academic excellence through publications and invited talks**
- **Establishing critical mass of researchers in vehicular communication**

The aim is to build world-class academic competence in key areas of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. The SAFER project Physical Layer Techniques for Vehicle-to-Vehicle Communications served as a critical springboard in this, and has allowed prof. Erik Ström and his co-workers to establish Chalmers as a leader in vehicular communication research. The purpose is to gain fundamental knowledge of vehicular radio channels and to devise novel design and analysis methods for the physical layer of a V2V communication system. This knowledge is vital for enabling real-time, reliable, scalable, low-delay V2V communications, which needed for challenging traffic safety applications. The knowledge is used to increase the competitiveness of the SAFER partners and the academic status of Chalmers.

Benefit to the project partners and impact on society:

- Established Chalmers as an internationally attractive partner for research on vehicular communications as evidenced by, e.g., invitations to join EU projects such as METIS (FP7) and HIGHTS (H2020) and prof. Erik Ström's appointment as Co-Chair of the Topical Working Group on Vehicular Environment in the EU COST action IC1004 Cooperative Radio Communications for Green Smart Environments.
- Established Chalmers as an academic leader in the field of vehicular communications, indicated by, e.g., prof. Erik Ström's appointment as guest editor for the prestigious journal Proceedings of the IEEE special issue on Vehicular Communication, external examiner of Ph.D. theses in Germany, Austria, France, and South Africa, and invited speaker at national and international scientific conferences

The approach:

Generic research problems were identified through interaction with the SAFER partners and the international academic community. Problems suitable for a PhD student were defined and Wanlu Sun was recruited after a very competitive selection process. Her work has proven to be of excellent quality and has led to many highly regarded publications. International recognition of Chalmers as a leader in vehicular communication was established by engaging in the academic community by, e.g., co-chairing a COST Action (European Cooperation in Science and Technology) working group and taking initiatives for special sessions at conferences and special journal issues. Industrial relevance was ensured by interaction with SAFER partners. More funding was acquired and the number of Ph.D. students and senior researchers engaged in vehicular communications has increased. This positive spiral was kick-started by the SAFER project Physical Layer Techniques for Vehicle-to-Vehicle Communications.

Results as a direct consequence of the SAFER project:

- 1 Lic. Eng.
- 5 conference and 1 journal papers in prestigious journals
- Service to academic community
- Numerous invited talks at national and international events

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Funding: 1,9 MSEK SAFER internal (cash and inkind)
Partners: AB Volvo, Chalmers, SP
Funder: SAFER
Period: 2007-2013

Oct 2015

Notes and References

1. Sandberg Eriksen, Knut; Steen, Arild; Elvik, Rune; Hagman, Rolf; Hervik, Arild (2004): Effektanalys av nackskadeforskningen vid Chalmers, Vinnova Analys, VA 2004:07.
2. http://www.un.org/en/roadsafety/
3. Yström, Anna (2013): Managerial Practices for Open Innovation Collaboration: Authoring the spaces "in-between", Dissertation thesis, Chalmers University of Technology, 9789173858762
4. Since 2012 there are three levels of partnership: large, normal and associated.
5. Over 20 conference articles as well as book chapters and journal articles.
6. Balta, Kayahan; Zwick, Matthias (2009): Creative Climate within an Open Innovation Arena – A Case Study, Chalmers University of Technology, E 2009:030.
7. Priorities for Road Safety Research in Europe
8. Safe and Green Road Vehicles
9. Sweden Michigan Naturalistic Field Operational Test
10. Connected Analysis Centres
11. Field Operational Test Networking and Data Sharing Support
12. Mutual Recognition Methodology Development
13. Analysis of Crash- and Injury Contributing Factors Based on Event Triggered Naturalistic Driving Data
14. Wismans, Jac; Skogsmo, Ingrid; Nilsson-Ehle, Anna; Lie, Anders; Thynell, Marie & Lindberg, Gunnar (2015): Commentary: Status of Road Safety in Asia, Traffic Injury Prevention, DOI: 10.1080/15389588.2015.1066498.
15. The ISAB (2014) consists of five members: Dr Joseph Kanianthra, USA; Dr Kazuya Takeda, Japan; Dr Anne Guillaume, France; Dr Martin Baumann, Germany; and Dr Marika Kolbenstvedt, Norway.
16. www.chalmers.se/safer
17. Investigation Network and Traffic Accident Collection Techniques
18. Road Safety Data Collection, Transfer and Analysis
19. Mutual Recognition Methodology Development
20. Field Operational Test Support Action
21. Sweden Michigan Naturalistic Field Operational Test
22. European Field Operational Test on Active Safety Systems
23. Driving Implementation and Evaluation of C2X Communication Technology in Europe
24. European Naturalistic Driving and Riding for Infrastructure & Vehicle Safety and Environment
25. Connected Analysis Centres
26. Driver Comfort Boundaries in Intersection Negotiation
27. Analysis of Naturalistic External Datasets
28. Quantitative Driver Behaviour Modelling for Active Safety Assessment - Expansion
29. Evaluation Framework for Commercial Vehicle Safety Systems and Services
30. Large-Scale Vehicular Prototyping using Open Source Testbeds of Miniature Vehicles
31. Balancing Active and Passive Safety
32. European Field Operational Test on Active Safety Systems
33. European Naturalistic Driving and Riding for Infrastructure & Vehicle Safety and Environment
34. Driving Implementation and Evaluation of C2X Communication Technology in Europe
35. Next Generation Test Methods for Active Safety Functions
36. Frontal Impact and Compatibility Assessment Research
37. Assessment of Integrated Vehicle Safety Systems for Improved Vehicle Safety
38. Evaluation Framework for Commercial Vehicle Safety Systems and Services
39. Quantitative Driver Behaviour Modelling for Active Safety Assessment – Expansion
40. Vehicle ICT Innovation Methodology
41. Research Vehicle Resource Lab Build-Up
42. Factors Influencing the Causation of Accidents and Incidents
43. Accident Avoidance by Active Intervention for Intelligent Vehicles
44. Evaluation Framework for Commercial Vehicle Safety Systems and Services
45. System Safety Through Combination of HMI and Dependable Systems
46. Automated Driving Applications and Technologies for Intelligent Vehicles
47. Ödblom, Anders; Nilsson, Jonas. 2012. Augmented Vision in Image Sequence Generated from a Moving Vehicle. Patent application EP2639771, filed March 16, 2012, European Patent Office.
48. Time-Efficient Robust Verification of Autonomuous Vehicles - Theory and Methods
49. Factors Influencing the Causation of Accidents and Incidents
50. Environmental Friendly Efficient Enjoyable and Safety Optimised Systems
51. European Field Operational Test on Active Safety Systems
52. Safe and Robust Platform for Automated Vehicles and Machines
53. Next Generation Test Methods for Active Safety Functions
54. Quantitative Driver Behaviour Modelling for Active Safety Assessment
55. Markkula, Gustav. 2013. Vehicle control system and method for determining a desired yaw rate of a vehicle. Patent application PCT/SE2013/000034, filed March 6, 2013, European Patent Office.
56. Cooperative Autonomous Car Train

57. Safe Road Train for Efficient Transports
58. Development of a Scientific and Technological Platform for Vulnerable Road Users' Active Safety
59. Volvo Infotainment Support for Automotive Safety
60. Automated Driving Applications and Technologies for Intelligent Vehicles
61. Algorithms and Software for Improved Safety
62. Accident Avoidance by Active Intervention for Intelligent Vehicles
63. Research Vehicle Resource Lab Build-Up
64. Benchmarking of Functional Safety
65. Kernel-Based Architecture for Safety-Critical Control
66. Time-Efficient Robust Verification of Autonomous Vehicles - Theory and Methods
67. Functional Safety and Evolvable Architectures for Autonomy
68. Safe, Efficient Vehicle Solutions
69. Advanced Electric Vehicle Architectures
70. Modelling and Testing for Improved Safety of Key Composite Structures in Alternatively Powered Vehicles
71. Enhanced Lightweight Design
72. Safe Small Electric Vehicles through Advanced Simulation Methodologies
73. Characterisation of Crash Behaviour of Composites towards Future Lightweight Road Vehicles
74. Integrated Braking & Steering for Active Safety of Heavy Vehicle Combinations
75. Tagesson, Kristoffer; Laine, Leo; Kharrazi, Sogol. 2011. Method and arrangement for vehicle stabilization. U.S. Patent application 14/354,570 - PCT/SE2011/000194, filed October 31, 2011, European Patent Office.
76. Thoracic Injury Assessment for Improved Vehicle Safety
77. Thorax and Head Response to Oblique Loading in Different Severities using Different Restraint Systems - PMHS Responses Compared to those of THOR and THUMS
78. Active Human Body Models for Virtual Occupant Response
79. Frontal and Oblique Impact - Injury Risk and Counter Measure Evaluation using the upgraded THOR Dummy
80. Adaptive Seat to Reduce Neck Injuries for Female and Male Occupants
81. Virtual Vehicle-Safety Assessment: Open source HBM addressing gender diversity
82. All financial numbers in this section are in accordance with calculations made per 30 June 2015
83. www.chalmers.se/safer
84. Mutual Recognition Methodology Development
85. www.saferinsight.se
86. The bibliometric study was conducted for all project publications 2007-2015 and information about these has been collected from the project managers (e.g. through project follow-up reports provided every 3-6 months) and from Chalmers Publication Library. The last complete collection from project managers covers publications reported up until 31 March 2015, although some additional publications reported up until 30 June 2015 (when the study/analysis was done) have been included in this study. The methods (regarding using Scopus, the Norwegian index etc.) were chosen upon recommendation by Chalmers Library.
87. More information about the Norwegian Index: https://dbh.nsd.uib.no/publiseringskanaler/Forside
88. Not normalised in terms of research sub-fields, publication types, or years or fractionalised in terms of number of authors. Self-citations are included.
89. Citations may be an indication of quality but does not have to be.
90. Evaluation of research groups are often not public or it can be difficult to find relevant comparison objects (research focus, staff, funding and number of research hours etc. influence the outcome).
91. Quantitative Driver Behaviour Modelling for Active Safety Assessment
92. Research Vehicle Resource Lab Build-Up

List of Abbreviations

ADAS	Advanced Driver Assistance Systems
AstaZero	Active Safety Test Area
CAE	Computer Aided Engineering
CFRP	Carbon Fibre Reinforced Plastics
CHOP	Children's Hospital of Philadelphia
CTS	China Sweden Research Centre for Traffic Safety
ESV	Enhanced Safety of Vehicles
Euro NCAP	European New Car Assessment Programme
FFI	Fordonsstrategisk Forskning och Innovation
FOT	Field Operational Tests
FP7	Seventh Framework Programme
GVSCC	Gothenburg Vehicle Safety Centre at Chalmers
H2020	Horizon 2020
HMI	Human Machine Interface
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IFSTTAR	French Institute of Science and Technology for Transport, Development and Networks
INRETS	French Transport Research Institute
ISAB	International Scientific Advisory Board
ISO	International Standardisation Organisation
ITS	Intelligent Transport Systems
JARI	Japan Automotive Research Institute
JRU	Joint Research Unit
MoU	Memorandum of Understanding
Mov'eo	French automotive cluster
NDS	Naturalistic Driving Studies
NHTSA	National Highway Traffic Safety Administration
RIOH	Research Institute for Highway safety
SHRP2	Strategic Highway Research Program 2
Sim IV	VTI driving simulator Sim IV
STINT	The Swedish Foundation for International Cooperation in Research and Higher Education
TUAT	Tokyo University of Agriculture and Technology
UMTRI	University of Michigan Transportation Research Institute
V2X	Vehicle-to-Wireless Communication

Photographers: Dick Gillberg, Niklas Maupoix, Frida Winter, Jan-Olof Yxell, Henrik Johansson, SAFER, Lindholmen Science Park

SAFER Partners

A partner's name may have changed during the ten year period.

Stage 1 (2006-2009)
Autoliv
Chalmers University of Technology
Epsilon
Folksam
Imego
Institute of Transport Economics (TØI)
Lindholmen Science Park
Region Västra Götaland
Saab Automobile
Saab Microwaves System
Scandinavian Automotive Suppliers (FKG)
Scania
SP Technical Research Institute of Sweden
Swedish National Road and Transport Research Institute (VTI)
Swedish Transport Administration
Swerea SICOMP
Telia Sonera
University of Gothenburg
Viktoria Institute
Vinnova
Volvo Car Corporation
Volvo Group

Stage 2 (2009-2012)
Autoliv
Chalmers University of Technology
City of Gothenburg
Epsilon
Folksam
Imego
Institute of Transport Economics (TØI)
Lindholmen Science Park
Region Västra Götaland
Saab Automobile
Saab Microwave Systems
Scandinavian Automotive Suppliers (FKG)
Scania
SP Technical Research Institute of Sweden
Swedish National Road and Transport Research Institute (VTI)
Swedish Transport Administration
Swerea IVF
Swerea SICOMP
Telia Sonera
University of Gothenburg
Viktoria Institute
Vinnova
Volvo Car Corporation
Volvo Group

Stage 3 (2012-2016)
Acreo Swedish ICT
Autoliv
Chalmers University of Technology
City of Gothenburg
Cycleurope
Folksam
Halmstad University
If P&C Insurance
Institute of Transport Economics (TØI)
KTH Royal Institue of Technology
Lindholmen Science Park
Lund University (LTH)
Region Västra Götaland
Scandinavian Automotive Suppliers (FKG)
Scania
SP Technical Research Institute of Sweden
SWECO
Swedish National Road and Transport Research Institute (VTI)
Swedish Transport Administration
Swedish Transport Agency
Swerea IVF
Swerea SICOMP
University of Gothenburg
Viktoria Swedish ICT
Volvo Car Corporation
Volvo Group
ÅF

Associated partners, Stage 3 (2012-2016)
iRezQ
Malmeken AB
Mälardalen University
Trivector
Umeå University
University of Borås
University of Skövde
University West

SAFER Boards

Each large partner is represented by one board member (except for Chalmers). Occasionally a partner has changed its representative within a Stage.

Stage 1 (2006-2009)

Anna Dubois	Chalmers
Lennart Josefson	Chalmers
Urban Karlström	VTI
Per Lenhoff	Saab Automobile
Pontus Matstoms	VTI
Hans Nyth	Volvo Cars
Jan Olsson	Autoliv
Ove Pettersson	Vinnova
Ingrid Skogsmo	Volvo Cars
Jan-Eric Sundgren	Volvo Group (Chair 2006-2009)

Stage 2 (2009-2012)

Jan Andersson	VTI
Anna Dubois	Chalmers
Per Lenhoff	Saab Automobile
Per Lövsund	Chalmers
Pontus Matstoms	VTI
Hans Nyth	Volvo Cars
Jan Olsson	Autoliv (Chair 2009-2012)
Jan Smith	Chalmers & University of Gothenburg
Karin Svensson	Volvo Group
Claes Tingvall	Swedish Transport Administration
Joakim Tiséus (adj)	Vinnova

Stage 3 (2012-2016)

Jan Andersson	VTI
Ola Boström	Autoliv
Anna Dubois	Chalmers
Maria Krafft	Swedish Transport Administration
Cecilia Larsson	Volvo Cars
Per Lövsund	Chalmers
Pontus Matstoms	VTI
Erik Norrgård	Swedish Transport Administration
Mikael Nybacka	KTH
Hans Nyth	Volvo Cars
Jan Olsson	Autoliv
Magnus Olsson	Volvo Cars
Magnus Rilbe	Volvo Group
Jan Smith	Chalmers & University of Gothenburg
Karin Svensson	Volvo Group (Chair 2012-2016)
Claes Tingvall	Swedish Transport Administration
Eric Wallgren (adj)	Vinnova

SAFER Management Group

Members of the Management groups may have changed during a Stage, thus all members listed have not been active at the same time.

Stage 1 (2006-2009)

Yngve Håland	Autoliv
Lotta Jakobsson	Volvo Cars
Lisa Knutsson	SAFER
Per Lövsund	Chalmers
Anna Nilsson-Ehle	SAFER
Hans Norin	Volvo Cars/Chalmers

Stage 2 (2009-2012)

Yngve Håland	Autoliv
Lotta Jakobsson	Volvo Cars
Lisa Knutsson	SAFER
Daniela Michael	SAFER
Anna Nilsson-Ehle	SAFER
Hans Norin	Chalmers
Robert Thomson	VTI

Stage 3 (2012-2016)

Rikard Fredriksson	Autoliv
Christian Grante	Volvo Group
Yngve Håland	Autoliv
Lotta Jakobsson	Volvo Cars
Lisa Knutsson	SAFER
Daniela Michael	SAFER
Pia Nilsson	SAFER
Anna Nilsson-Ehle	SAFER
Hans Norin	Chalmers
Bengt Arne Sjöqvist	Chalmers
Ingrid Skogsmo	SAFER
Robert Thomson	VTI/Chalmers

SAFER Extended Management Group

Stage 1 (2006-2009)

Yngve Håland	Autoliv
Jan Jacobson	SP
Lotta Jakobsson	Volvo Cars
Lisa Knutsson	SAFER
Mathias Lidberg	AM, Chalmers
Per Lövsund	AM, Chalmers
Anna Nilsson-Ehle	SAFER
Hans Norin	Volvo Cars/Chalmers
Hans-Erik Pettersson	VTI
Erik Ström	S2, Chalmers
Mats Svensson	AM, Chalmers
Trent Victor	Volvo Group

Stage 2 (2009-2012)

Christofer Englund	Viktoria Institute
Martin Fagerström	AM, Chalmers
Helena Gellerman	SAFER
Yngve Håland	Autoliv
Bengt Jacobson	AM, Chalmers
Jan Jacobson	SP
Lotta Jakobsson	Volvo Cars
MariAnne Karlsson	PPD, Chalmers
Lisa Knutsson	SAFER
Mathias Lidberg	AM, Chalmers
Lena Nilsson	VTI
Anna Nilsson-Ehle	SAFER
Hans Norin	AM, Chalmers
Erik Ström	S2, Chalmers
Mats Svensson	AM, Chalmers
Robert Thomson	VTI
Åsa Valadi	SAFER
Trent Victor	Volvo Group
Jac Wismans	Chalmers & SAFER

Stage 3 (2012-2016)

Christian Berger	University of Gothenburg
Christofer Englund	Viktoria Swedish ICT
Martin Fagerström	AM, Chalmers
Rikard Fredriksson	Autoliv
Helena Gellerman	SAFER
Christian Grante	Volvo Group
Yngve Håland	Autoliv
Bengt Jacobson	AM, Chalmers
Jan Jacobson	SP
Lotta Jakobsson	Volvo Cars
MariAnne Karlsson	PPD, Chalmers
Lisa Knutsson	SAFER
Nicole Kringos	KTH
Lena Nilsson	VTI
Anna Nilsson-Ehle	SAFER
Hans Norin	AM, Chalmers
Bengt-Arne Sjöqvist	S2, Chalmers
Ingrid Skogsmo	SAFER
Erik Ström	S2, Chalmers
Mats Svensson	AM, Chalmers
Robert Thomson	VTI/Chalmers
Anders Wengelin	KTH
Trent Victor	Volvo Cars
Tania Willstrand	VTI
Jac Wismans	Chalmers & SAFER

PLENTYMORE

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

POSTAL ADDRESS
SAFER
P.O. Box 8077
SE-402 78 Gothenburg
Sweden

STREET ADDRESS
SAFER
Lindholmspiren 3
SE-417 56 Gothenburg
Sweden

PHONE
Lindholmen Science Park,
switchBoard
+46 (0)31 764 70 00

Chalmers University of
Technology, switchBoard
+46 (0)31 772 10 00

E-MAIL
safer@chalmers.se

WEBSITE
www.chalmers.se/safer