

# SAFER ANNUAL REPORT

# 20 20

YEAR 2/5 IN STAGE 5  
JAN 1<sup>ST</sup> – DEC 31<sup>ST</sup>, 2020  
SAFER'S 15<sup>TH</sup>  
OPERATIONAL YEAR







**SAFER Vehicle and Traffic Safety Centre** at Chalmers is a competence centre where about 40 partners from the Swedish automotive industry, academia and authorities cooperate to make a centre of excellence within the field of vehicle and traffic safety.

Research at SAFER spans a broad base, covering several disciplines and encompassing both safe mobility and vehicle safety in real environments. The centre’s activities engage the very elite in

the field of safe transport solutions, and the results contribute to increasing the competitive advantages of the partner companies and organisations. Chalmers University of Technology hosts the centre. By using the multidisciplinary scientific competence available within the centre, we make it a hub for excellent research and knowledge dissemination.

**SAFER conducts borderless research to save lives!**

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# INTRO- DUCTION

Welcome to our annual report!  
The purpose of this report is to present the effects and outcome of the second operational year in SAFER's fifth stage, extending between January 1<sup>st</sup> and December 31<sup>st</sup> 2020.

**T**HIS YEAR HAS BEEN SPECIAL in many ways due to the ongoing Covid-19 pandemic. To fight the virus, our homes have been our war zone and our patience has been our weapon. But despite the worldwide pandemic, activities at SAFER and our mission to bring people together to create research and knowledge that save lives and prevent injuries have nevertheless developed in a positive way. We have not been able to meet in person as much as we use to, but with some creativity we have found new means and tools to collaborate without meeting physically. And we are growing! Four new partners joined SAFER during the year, our project portfolio has been enriched with another 38 projects and the number of researchers involved in the network has increased by almost 100, from around 350 to close to 450 people.

It is also with great pleasure that we look back on the global UN-conference on road safety, which was held in Sweden in February. In addition to the exchange of knowledge and experience, the conference resulted in the Stockholm Declaration, a strategic agenda on how to improve road safety globally. The Stockholm Declaration was adopted by the United Nations General Assembly to a UN resolution in August, a major step for improved road safety all around the globe. We note that Vision Zero is more clearly identified

focused than ever and that the resolution proclaims the period 2021–2030 as the Second Decade of Action for Road Safety, with a goal of reducing road traffic deaths and injuries by at least 50 per cent from 2021 to 2030. At SAFER, we are now looking into how we in the best possible way together can utilize the outcome from the UN-conference. We see a great opportunity to take advantage of our strengths to both contribute to the global sustainable development goals and to be inspired and guided in our research to meet our common challenges and needs.

SAFER was also highly involved in the UN-conference by hosting a pre-event “Borderless research to save lives – an experience on how Vision Zero can be addressed by collaboration”. The purpose was not only to present our world leading research, but also to share knowledge about how SAFER manages to perform collaboration and work in strong partnerships in practice. The event was well-attended, and we would like to thank all SAFER partners who were involved and contributed to this work.

It is not only the UN-conference that has engaged us, we have also been active in the formation of EU's new research programme, Horizon Europe. SAFER has continued to be a strong speaking partner in the processes shaping the upcoming research programmes in Sweden and the EU. For instance, in the formation of the CCAM (Connected, Cooperative and Automated Mobility) partnership in Europe, several SAFER partners have been instrumental in safeguarding the road safety aspects in the strategic research and innovation agenda. The result of this work is now evident in the draft work programme for Horizon Europe with several calls based on this input. A main focus for our collaboration in 2021 is for start forming strong consortia with SAFER partners to submit applications to the first calls.



Our SAFER-pre-study program was launched and finally we have an effective measure in place to get started with strategic knowledge creation that can be leveraged e.g. by using a unique, new competence as a basis for national funding or an entry ticket to prestigious international collaborations. No less than seven pre-study projects have been granted in 2020 and several of them have generated interesting results for a second step and applications for larger projects.

At SAFER, we see a great potential to take advantage of AI as a tool to improve our road safety research. During the year, we have carried out a number of activities with the aim of getting closer to an understanding of how we efficiently can use AI in our research to add value to our partners. As a result of the workshops conducted three prioritized areas have been identified that we now would like to explore further and create opportunities for the partners to turn these areas into concrete projects and solutions. Several funding opportunities have been identified and we have a strong engagement and interest from the partners to continue this work. We have also found that the availability and quality of data is crucial to be successful. SAFER has a great potential and a unique edge to be able to meet this need since useful data is already available within the network. This opportunity will be explored further in 2021.

Our focus on knowledge building has also continued through new competence networks that we have started up; Perception, sensing and communications and also Structures and materials, which have been without leaders for some time. Our connected research resources have also been developed further; Reverse, our vehicle lab for active safety and autonomous driving, celebrated its five years anniversary in November. The opportunity for researchers to be offered a steppingstone with cutting-edge expertise between theoretical models or simulators and full-scale tests has proven to be extremely important for efficient and

successful research. Our databases are undergoing a major modernization to enhance the datasets by extracting features from the interior recorded video and adding parametric data. When the upgrade is completed, we will be able to use the database to a much higher degree than today.

We have continued to work with the strategy to make even better use of the ecosystem around us through even better collaboration with closely connected initiatives and centra, you are welcome to read more about it on page 23. We are also proud of the positive development of our recently started collaboration with India through the SITIS platform. Through this collaboration, we do not only share our knowledge about road safety to a country where many people lose their lives in the traffic every year, but we can also learn, for example about accident data and road user behavior that in turn will contribute to valuable knowledge in our future research. You can read more about our activities in India and other international collaborations on page 22–24.

The life at SAFER has also carried on unabated with thought-provoking seminars, project presentations, project applications, new grants, conferences and dissertations. It is impressive and gratifying to see all the research that is taking place within the broad community of SAFER. We are a unique organisation, well positioned to conduct collaborative research that is of great value for national and international stakeholders as well as its industrial partners. We have a strong commitment for a continuation of SAFER throughout the fifth stage and we look forward to progress even further to deliver on the strategic workplan and new research activities.

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Best Regards,  
SAFER Board and Management team



# THE MANIFESTO

The Manifesto presents our human-centric vision, mission and what SAFER's partners want to achieve together.

**S**AFER IS CONTINUOUSLY on a bold journey towards zero fatalities and injuries in road traffic. This is achieved through open, collaborative research projects where traffic safety is key for the creation of a safe, sustainable, connected and, where suitable, automated, transport system. SAFER's holistic traffic safety approach covers people, vehicles and infrastructure. This also means that SAFER is part of a bigger societal project: the design and realisation of smart, adaptable, sustainable and resilient transport systems in our cities and beyond. SAFER's role is to be a thought leader in safe mobility of people and goods, offering world-leading knowledge. SAFER creates knowledge and value beyond what a single partner can achieve on its own.

## VALUES AND IDENTITY

SAFER has a unique identity with clear values such as openness, mutual respect, curiosity and joy of discovery. We are passionate to make a difference, contribute to society, build relevant knowledge and we understand the benefits from interdisciplinary expertise and talents. Collaboration is a hallmark and thrives on diversity in all aspects and borderless networks seeking and attracting expertise where it is to be found.

## OVERALL OBJECTIVES

Together, we want to create new knowledge and research findings that enable people and goods to be transported safely, effectively and sustainably. Vision Zero is our guiding star and we want to make significant contributions to this bold vision and save lives and reduce traffic injuries. Our research has a human centric approach. Protecting people is our primary goal, although there are secondary positive effects of our research that also contribute to a sustainable society, for example, reducing the number of traffic accidents contributes to lower environmental impact and more cost-effective freight transport. During SAFER Stage 5 we aim to fulfil our defined research targets, as well as work according to the four cornerstones in our strategy.

Of course, it is also a matter for SAFER to contribute with research results and knowledge striving to contribute to the global Sustainable Development Goals (SDG:s). The SDG:s are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate, environmental degradation, prosperity, peace and justice. The work of integrating the sustainability goals in a clearer way has been a focus area during the year. The global UN-conference on road safety that was held in Sweden in February 2020 and its outcome in the form of the Stockholm Declaration and the recommendations in the book "Saving Lives Beyond 2020 – the Next Steps", have created engagement and inspired us in our research, read more about this work on page 48.

## SAFER'S VISION

All road users travel safely in the road transport system.

## SAFER'S MISSION

We bring people together to create research and knowledge that save lives, prevent injuries and enable safe mobility for people and goods.



# STRATEGY

TO SIGNIFICANTLY CONTRIBUTE to the vision and mission as well as being a well renowned international centre of excellence, SAFER will deliver results, build competence and create strong networks in selected areas. Furthermore, SAFER shall create value for the partners beyond what a single partner can achieve on its own.

SAFER’s strategy consists of three different conceptual parts – SAFER Core, the SAFER Research and project portfolio and SAFER Assignments and investigations, see figure 1. SAFER Core is the name for the driving function of SAFER with its operational team including communication and support systems, research areas and their reference groups, the connected research resources, networks and the physical working and networking environment. To realise our vision, our strategy is based on four inter-linked cornerstones that direct our actions: *Create and share knowledge, Express identity and influence as a thought leader, Utilize the multidisciplinary research platform, Connected research resources.*

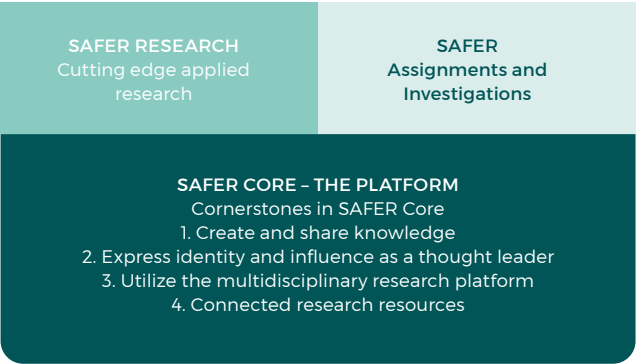
### 1. CREATE AND SHARE KNOWLEDGE

The basic task for SAFER is to create and share knowledge and to further develop the strong academic base. New knowledge and relevant facts should be made available and visualized. Furthermore, networks should be created and maintained to the benefit of all partners. SAFER should be promoting project generation and coordination and act as a catalyst for joint projects. By creating strong connections to world class research environments and nurturing an international reputation for outstanding collaboration between industry, society and academy, it is possible to influence the international research agenda. The research results should help facilitate innovation at our partners.

### 2. EXPRESS IDENTITY AND INFLUENCE AS A THOUGHT LEADER

The name SAFER should mean excellence in vehicle and traffic safety research and be of value to all partners to be associated with. This identity is built, expressed and made visible through different ways – the office, website, seminars and conferences and other activities. By communicating what SAFER represent and the achieved results we will attract international stakeholders, collaboration projects and funding. As a thought leader, SAFER should define strategic research agendas based on needs and trends, create and drive SAFER’s research projects and develop road maps. The conclusions and needs of the SAFER community should be made visible and known.

FIGURE 1: OUR STRATEGY



### 3. UTILIZE THE MULTIDISCIPLINARY RESEARCH PLATFORM

A cornerstone in the strategy is to have a multidisciplinary research environment that serves as a physical meeting place, open to all partners. The networks and meeting place we create together will provide added value to partners. The community will generate new knowledge and project ideas as well as develop the people involved, both on a professional and personal level.

### 4. CONNECTED RESEARCH RESOURCES

The concept of connected research resources is a hallmark for SAFER and we facilitate the access and utilization of different assets available within the network. These comprise the following: the collaboration setup with *the physical environment* providing workspaces, meeting and analysis rooms, support for seminars etc; *field data*, with databases of real-world data including their collection, storage and analysis tools are strong assets and SAFER will further develop business models to maintain them. *Revere* – Resource for Vehicle Research, the full-scale vehicle laboratory at Chalmers, which is increasingly important for active safety research, automated driving and a connected, sustainable transport system; the *AstaZero* test environment, co-owned by RISE and Chalmers, which provides a world class facility where SAFER supports research activities; *simulators* of different kinds exist in the network, most notably at the Swedish National Road and Transport Research Institute (VTI). *SAFER’s Human Body Model* encompasses a scalable, tuneable, human body models that can be used for predicting injury outcome in any impact situation. SAFER provides a competence platform for SAFER partners as well as a natural contact point for external cooperation. SAFER’s partner, the road safety organisation NTF Väst, gives our researchers the possibility to use a very closely located traffic training site, *Stora Holm*, offering various test tracks and a skid pad for tests and events.



### MONITORING PROGRESS AND KPI:S

A number of criteria will help prioritise our research efforts and how we should work to reach SAFER’s objectives.

**01. IMPACT:** The added value for the SAFER partners as well as the society as a whole is a key to our continued success and is an integral part of the strategic plan. This is primarily created through collaborative work where different partners contribute according to their needs and competence, the result is that we conduct excellent and relevant research with real-life applications and impact.

An example is SAFER’s project portfolio, to which e.g. 38 new projects have been added during this operational year. Also, we have started up two new competence network to build even more knowledge within specific areas.

**02. CONTINUOUS RELEVANCE:** In the ever-changing landscape of road transport systems, new types of vehicles and ownerships etc, it is of utmost importance that SAFER understands the needs and the context in which we work in order to put the focus on the right topics and issues. SAFER is continuously requested to contribute both on a national and an international level.

SAFER has continued to be a strong speaking partner in the processes shaping the upcoming research programmes in Sweden and the EU during 2020. For instance, in the formation of the CCAM (Cooperative, connected Automated Mobility) partnership in Europe, several SAFER partners have been instrumental in safeguarding the road safety aspects in the strategic research and innovation agenda. The result of this work is now evident in the draft work programme for Horizon Europe with several calls based on this input.

### 03. COHERENCE WITH THEMATICALLY RELATED INITIATIVES:

The global research environment in which we operate is changing continuously and new initiatives are created to which we need to relate to and make sure to benefit from and provide input to when applicable. By doing so, we are perceived as a major player in sustainable and safe transport, we consider safety as one of the main prerequisites. We are well-connected to, and cooperate with, other relevant organisations.

During 2020, apart from continued strengthening of the Drive Sweden link, several other activities have been ongoing, such as a joint initiative for research proposals with K2, the centre for public transport, as well as the Swedish cycling research centre, and an ongoing dialogue and exchange of knowledge and activities with AI Sweden.

**04. EFFICIENCY:** Our operation needs to be efficient in order to use our limited resources as efficiently and effectively as possible; we need to be experts in streamlined working processes and our multidisciplinary research platform enhances research, networking and make work easier for our partners.

SAFER made the final downscaling in terms of office space during the spring. This year has been extraordinary in many ways due to the pandemic, so the utilisation rate is of course lower than planned, but we strongly believe that the size is right for the future. The use of different digital tools has increased, with all seminars, workshops and other meetings held fully, or in a few cases partly, digital. Overall, the attendance has increased, which is very positive. We do however start to see some effects of the lack of (semi)spontaneous meetings, especially in the creative process when forming new project consortia.

The overall objectives and criteria are regularly monitored and evaluated. Also, the key performance indexes and measures help the partners to evaluate the strategic and operational workplan.



INDICATORS FOR THE SECOND YEAR  
IN SAFER STAGE 5  
(JAN 1<sup>ST</sup> – DEC 31<sup>ST</sup> 2020)

2020	2019	ACTIVITY
70 <sup>1</sup>	52	Total number of projects ongoing
38	12	New projects
20	21	Finalised projects
78	59	Publication volume
74 <sup>2</sup>	49	Number of seminars and other knowledge sharing activities
N/A <sup>3</sup>	07	Number of visits by external stakeholders
4 <sup>4</sup>	10	Invitations to international projects
15	18	Visibility/references in conferences <sup>3</sup>

2020  
<sup>1</sup>Read more about our project portfolio on page 32 and all the projects are listed in appendix 6.  
<sup>2</sup>See complete list of activities in appendix 7.  
<sup>3</sup>No visits have been made due to the Corona pandemic.  
<sup>4</sup>HI-DRIVE, STARLOG, SITIS, HEADSTART II  
<sup>5</sup>See complete list in appendix 5.  
<sup>6</sup>A survey was performed among level 1 and 2 partners to answer the question "The overall benefit of the partnership?". The scale was 1-6, 6 was very good.

“SAFER is growing! Four new partners joined us during the year and our project portfolio has been enriched by another 38 projects and we will start 2021 with as many as 58 projects in the portfolio. In total we have concluded 20 projects in 2020”

Magnus Granström  
SAFER's director





# THE FRAME- WORK

The framework is the context in which we work; the partners' agreement, the operational plan, financing, working processes, the operational team, partnerships and connected research resources.

## ORGANISATION AND MANAGEMENT OF THE CENTRE

**S**AFER'S VEHICLE and traffic safety research is completely based on partnership. The partners govern SAFER via the shareholders meeting and the Board, consisting of eight members. The Board meets 5–6 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, the secretariat and the management team. These teams consist of a few persons paid by SAFER and some partner employees' in-kind. Four Research areas create the formal arena for partners to meet and identify key issues and initiate needs-driven research. Each group is led by a Research area director and a Co-director who are supervising the project

portfolio. The Research area directors are also members of the management team. The Competence networks, led by respected scientists, gather SAFER partners to share and develop new knowledge within their respective field. This ensures contact with centres and organisations with similar or complementary research, both nationally and globally. See appendix 2, 3 and 4 to read more about the Board, management team, and Competence networks. More information about the four Research areas and their research result during the second year of SAFER Stage 5 can be found on page 34–35.

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. During this year, there have been about 450 researchers active in the community. In a creative and open research environment, diversity is an important aspect and a conscious concern. Other diversity aspects at organizational 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 and junior researchers, etc. SAFER consciously promotes a good gender balance and SAFER management team as well as the SAFER Board are close to a 50/50 balance.



## PARTNERS

Safe mobility of people and goods in a sustainable system can only be realized when talented and dedicated people work together with a clear vision, shoulder by shoulder. The development of knowledge in vehicle and traffic safety is essential, and by applying results from collaborative research the SAFER partners create visible and measurable results in practice. The partners access – and contribute to – a unique competence and research collaboration platform. In SAFER's Stage 5, 35 partners joined the collaborative research agreement and during this year four new have joined the partnership and two have left. Transport & Roads at **Lund University's** core expertise stretches over evaluation of infrastructure designs and solutions, driver assistant systems and automated vehicles. **Zenseact**, replacing Zenuity due to a new company structure including a split, develops a software platform for advanced driver assistance systems and autonomous driving functionality targeted at

personal mobility vehicles. **Asymptotic** is a cross-industry tech startup focusing on the development and integration of Artificial Intelligence (AI) applied to business. Their mission is to enable reliable AI by offering easily accessible big data analytics with a complete AI toolchain both as a product and as a service. **4S** is a consulting company whose expertise is to build safe systems through the SEVS method (Safe, Efficient Vehicle Solutions). The company has its roots in SAFER and works methodically with sustainability as an overall holistic subject, taking both social, global, economic and technical aspects into consideration. Mediamobile has left SAFER due to a new business focus. Together, they all contribute to create new knowledge and research findings that enable people and goods to be transported safe, efficient and sustainable. See the complete list of partners in appendix 1.



# CONNECTED RESEARCH RESOURCES

## STRONG ASSETS FOR REAL-WORLD TRAFFIC SAFETY RESEARCH

As a SAFER partner you get access to SAFER’s open research arena and, through relevant projects, research resources available within the network. Also, expertise to use these research resources is available in the community. The overall idea – and one of our strategic cornerstones – is that research should be easier, better and more efficient through collaborative partnerships. This unique set of platforms includes full-scale road traffic safety test environments, simulators and a research lab for active safety and autonomous driving. SAFER also provides physical work areas as well as a world-class naturalistic driving data platform. Together, these resources allow borderless research with outstanding opportunities of real-world testing and validation.

### LINDHOLMEN SCIENCE PARK – THE SWEDISH HUB FOR FUTURE MOBILITY

Lindholmen Science Park, in which SAFER is located, is both a dynamic area and an arena for collaboration across geographical borders. It is home to several of Sweden’s leading development projects, with a focus on mobility for tomorrow. Lindholmen Science Park has become the most knowledge-intensive and expansive area in Gothenburg, and an important hub for automotive and mobility research. About 375 companies have elected to locate offices in the science park, as have two universities and six secondary schools. Some 25,000 people now spend time here every day, a figure that is expected to double over the next five years. The location is full of life and energy that allows you to meet and learn about each other’s ideas. Lindholmen Science Park was celebrating its 20 year anniversary in 2020, read more about the celebrations and how the science park has contributed to global utilization and innovations on page 46.

In 2019 the previously co-located researchers from Chalmers department for vehicles safety moved to a nearby closely connected building at Lindholmen to come closer to other researchers within their department. As a result, SAFER’s premises area has decreased during 2020 to optimize the area based on the partners’ needs and at the same time release funds for research and other value-creating activities. We have also upgraded the IT-technology in our meeting rooms to better facilitate online meetings and



SAFER is located at Lindholmen Science Park in Gothenburg, the Sweden’s hub for future mobility.

conduct webinars, which has been very useful during the period, which was largely characterized by Covid-19 and restrictions on people meeting physically. We feel that the environment at Lindholmen definitely is right for a collaboration platform like SAFER and the venue as such is a contributing factor to our successful way of researching and collaborating across borders and between different disciplines.

### SAFER NATURALISTIC DRIVING DATA PLATFORM

The SAFER Naturalistic Driving Data platform is a secure, world-class platform for handling data from naturalistic driving data collection. Providing state-of-the-art data management, several large datasets and a leading research competence regarding naturalistic driving data, this platform gives unique access to naturalistic data derived from more than 8 million driving kilometres. The SAFER partner researchers also have access to the in-depth crash databases INTACT and IGLAD.

Since summer of 2020, a work to transform the SAFER Naturalistic driving data database to a more modern architecture has started. SAFER has been granted research funding for a major investment in developing the FOT databases by adding e.g. an improved eye tracking and body position features, to even better understand human behaviour in vehicles. The development will be conducted with the help of machine learning – powerful computers will track different driver states and behaviour in the database, instead of a real person doing the work. The result will thus be obtained faster, and probably also with a more precise result. These new features are needed to evaluate some of the research questions in L3Pilot (read more about L3Pilot on page 36). When the upgrade is completed, the database will be able to support research to a much higher degree than today, e.g. to validate safety systems in future vehicles that keeps track of the driver’s attention and drowsiness.

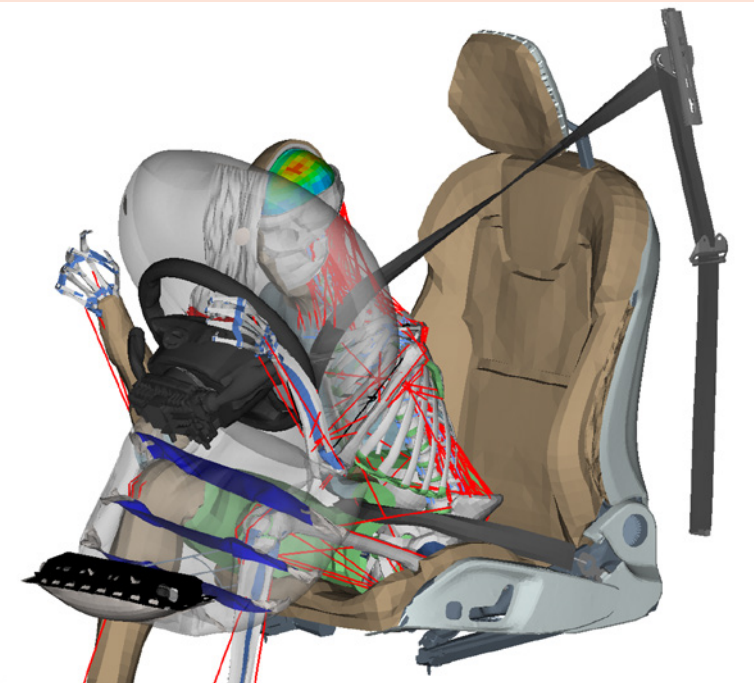


The simulator at VTI is a connected research resource at SAFER and often used in various research projects as a valuable tool.

IGLAD (Initiative For The Global Harmonisation Of Accident Data) was initiated in 2010 by European car manufacturers and is an initiative for harmonisation of global in-depth traffic accident data to improve road and vehicle safety. A database containing accident data according to a standardised data scheme that enables comparison between datasets from different countries is every year extended with around 900-1000 cases. In 2020, a fourth phase of IGLAD started and SAFER was elected as continued administrator for the project for three years. The advantages for SAFER in participating in the initiative are the access to the accident data on a global scale and the network with the 23 partners from all around the world. SAFER partners in the consortium are Autoliv, Volvo Group, Volvo Cars and Chalmers.

### SIMULATORS

Sim IV at the Swedish National Road and Transport Research Institute has an advanced motion platform system and permits significant linear movement along both x and y axes. It is useful when simultaneous longitudinal and lateral acceleration is important or if a wide field of vision is prioritised. Cabs and passenger compartments can be exchanged quickly. The simulator’s imaging system has a camera-based calibration system, making it easy to switch between different driver positions. The simulator is used regularly by SAFER’s partners, to name one example, the pre-study project The role of road design to support bicyclists yielding behaviour at T-intersections on segregated paths: A feasibility study in bicycle simulator, has used this particular simulator. The study was set up out to identify the effective amount of information conveyed by road markings and signs to support the bicyclist’s cognitive and behavioural tasks. The project Smart-Loop (Design of multi-modal human-machine-interaction system for



SAFER’s HBM is one of the most advanced human body models in the world, being developed and used by SAFER’s partners.

keeping the driver in-the-loop in automated driving systems) has also used the simulator. In this project our researchers used the simulator to better understand how the human driver reacts to different kind of feedback while riding in self-driving mood in a vehicle. A study has also been carried out at SAFER to look into the question of how tests involving humans, for example in a simulator, need to be adapted during a pandemic such as Covid-19. All these three studies have been pre-studies in our strategic investment to help support project creation, read more about the research program on page 28.

### SAFER HUMAN BODY MODEL

Within human body modelling (HBM), SAFER provides a competence platform for our partners as well as a natural contact point for external cooperation. SAFER’s HBM vision encompasses a scalable, tuneable, human body model with omni-directional injury prediction capabilities, suitable for use in high-g and low-g events and as any road user, occupant or vulnerable group. This means a virtual human substitute that can be used for predicting injury outcome in any impact situation and direction of loading, able to be morphed to replicate a large proportion of the population, standing or sitting, with humanlike kinematics in crash events as well as pre-crash manoeuvres. The SAFER HBM research combines several projects, all developing the existing model towards the overall goal of performance. The research is moving towards an open-source model, to enable wider use of the tool. On page 40 you can read more about the SAFER HBM and its development during 2020.





At Stora Holm, a connected research resource at SAFER, various test tracks and a skid pad are available for tests and events.

**STORA HOLM –  
A CLOSELY LOCATED TEST TRACK**

SAFER’s partner, the road safety organisation NTF Väst, offers our researchers to use a very closely located traffic training site. Here you can drive on different surfaces such as gravel, asphalt, slippery surface and in hilly terrain. The facility’s off-road course is located in a naturally area at the facility. There are also possibilities to practice driving in transverse upward and downward slopes as well as in a water-filled ditch.

**REVERE –  
RESOURCE FOR VEHICLE RESEARCH**

Revere contains a research lab with resources including technical equipment, several test vehicles, both light and heavy, and supporting personnel. The vehicles can be fitted with different types of sensors, equipment for data logging, communication technologies and other testing equipment. The Revere laboratory provides a complete research platform for development testing and verification of theoretical models, algorithms and technologies both in real traffic environments and in simulators. Tests in different traffic environments can be carried out in close cooperation with the test facilities AstaZero, Stora Holm and on public roads. Real vehicle tests provide more credibility for the researcher’s theories and Revere’s set-up helps support interaction between researchers from different disciplines. The opportunity for researchers to be offered a steppingstone with cutting-edge expertise between theoretical models or simulators and full-scale tests is extremely important for efficient and successful research. In November 2020 Revere celebrated 5 years and you can read more about the key achievements during these years on page 18.



**KEY HIGHLIGHTS  
REVERE 2020**

- Positive contribution to setting up the Sweden-India collaboration SITIS. Revere is involved in the project Safe and Secure Transport corridors in India. In close collaboration with partners in India, Revere has developed and built the data logging platform used in the test vehicle in India (read more on page 24).
- Continued tests with the A-double combination (trailer combination 32 meters long) in collaboration with AB Volvo and several tests performed at Hällered test track, including low and high speed vehicle dynamics tests.
- The vehicle test platforms have been upgraded for higher data capacity and remote monitoring. Also, a new vehicle test platform is under construction, including a scale model truck with two trailers (scale 1/14) to be used for automated driving research.
- Revere has been involved in the SAFER Open research program by e.g. supporting test set-ups at the proving ground.
- An in-house computation cluster has been set up at Revere, for example enabling running machine learning algorithms on collected test data.
- A fruitful collaboration with the new SAFER partner Asymptotic on data collection for development of future AD functions has started up.
- The lab continues to expand its activities to the growing interest of automation in the maritime sector, for example, in close collaboration with RISE equipping a full scale pilot boat with sensors and computers.



**ASTAZERO REAL-WORLD PROVING GROUND**

AstaZero (Active Safety Test Area Zero) is one of the most advance full-scale test environments in the world for a safe, sustainable and connected automated road traffic future. Different traffic environments make it possible to test advanced safety systems and their functions for all kinds of traffic and situations – in city environments as well as on rural, multi-lane and high-speed roads. This enables a broad range of research, development and validation. AstaZero also serves as an international testing area open for stakeholders within industry, society and academia. AstaZero is owned by RISE Research Institutes of Sweden and Chalmers University of Technology. AstaZero has in 2020 expanded its operations, including the inauguration of a cross roads track. The reason why the track has been built is that the forthcoming EuroNCAP test protocol (2022) will require tests to be carried out at intersections. The new track also provides an increase in capacity, which is welcomed as the demand for larger surfaces increases every year. AstaZero is today a leader in the work of defining today’s and tomorrow’s test methods in various research and customer projects. AstaZero is also an important partner in several global collaborations and participates in

working groups, e.g. in EuroNCAP to develop and define test methods. During the year, construction of likely the world’s longest and largest indoor track has begun. The track will measure 700 meters long and 40 meters wide, with a central part of 140 meters that will be 60 meters wide. To be able to carry out tests with trucks, buses and ordinary cars, the indoor track has an internal ceiling height of 4.6 meters. With the new indoor track, testing will be possible in all weather conditions, at all times of the day.

SAFER, together with AstaZero, has since 2017 conducted a program to make the test track available for curiosity research. SAFER has been responsible for the coordination of calls for open academic research that need to use the AstaZero facilities in research projects. The program was ended in the latter part of 2020 and you can read more about the main results from the program on page 20. The aim of the research program has been to attract international researchers to the test facility and also connect the research to SAFER’s project portfolio.



# REVERE CELEBRATES FIVE YEARS OF VEHICLE RESEARCH

Since the start in autumn 2015, Revere has established itself as a full-fledged research infrastructure for academia and the automotive industry in western Sweden. Originating from road traffic research, the scope of Revere now also includes marine vessels and electrified vehicles.

**S**ELF-DRIVING VEHICLES, active safety and vehicle dynamics are the three areas in focus for Revere, Resource for Vehicle Research at Chalmers.

“Vehicle researchers and companies in the transport sector are welcome to contact us with their ideas and projects to get help to transform them from theory to reality”, says Fredrik von Corswant, Director of Revere.

In collaboration with Revere, technologies, theoretical models and algorithms can be developed and tested on real vehicles and in real traffic environments, or on the test track AstaZero.

“We write research applications in collaboration with researchers and industry partners, enabling a tailor-made test phase that gets the most out of the results”, he declares.

## FULL-SCALE VEHICLES AND MODELS

In the lab at Lindholmen in Gothenburg, Revere has several vehicles of different kinds that are used in the research activities, for example a full-scale truck as well as cars and also smaller radio-controlled model vehicles. The smaller vehicles are often used in the teaching of students.

By adapting the vehicles to the current projects and providing them with different types of sensors and equipment for data logging, communication technology and more, data can be collected and the theories refined and verified.

“Our flexible, in-house developed software platform OpenDLV is our greatest asset”, says Fredrik von Corswant. “Only imagination sets the limits for what it can be used for in vehicle research, I would say. For example, it is possible to connect remotely to the vehicles while test driving, in case there is something that you immediately want to adjust in the software. Another advantage is that the platform can handle large amounts of data and is able to compress video, without losing data that is important to the algorithms.”

## REAL TESTS GIVE MORE RELIABLE RESULTS

Revere often works with long vehicles and combinations of vehicles, for example a tractor unit that is connected to two semi-trailers and a converter dolly forming a High Capacity Transport, HCT vehicle. Such a combination is longer than what is normally allowed to drive on public roads in Sweden today. In the vehicle lab, research and tests are performed on, for example, how to stabilize long vehicle combinations so that they do not tip over.

“We are also developing protocols for the communication between vehicle units”, Fredrik continues. “For example, if the tractor uses the brakes, a connected electrical dolly should not continue to propel forward.”

Conducting tests in real life provides supplementary and more reliable information, than computer simulations alone can supply.

“Only full-scale tests cover all the factors that affect the vehicle. For example, there are often disturbances that interfere with signals from sensors, inertia due to the weight of the vehicle, and also effects such as delays in the system, limitations in computer capacity, and more. Tests can provide answers to questions concerning how sensors act in bad weather or how the grip of the tires on the road surface behave depending on road conditions. This is often very difficult to determine with theoretical models alone.”

Revere’s software platform can also be used to perform simulations. Real traffic data can be mixed with simulated data. For example, how would a self-driving car behave if there is an unexpected object like a dustbin, or other obstacle, on the road?

“We also compile datasets, such as film sequences, that are collected and created by our sensors in traffic situations of various kinds. We then share the data as open source with those who want to test their algorithms.”

Data created in the test vehicles is automatically uploaded to Revere’s cloud server. The latest addition is data from a bus, that in early 2021 will run in regular traffic between two

“

Today, Revere is a venue where researchers and developers from various organizations and disciplines meet. That provides exciting cross-border connections and creates ideas for new innovations.”

cities in India. In connection with the cloud server, Revere also offers analyses of data in a computational cluster, which enables, for example, training of systems for machine learning.

At the lab, more humanistic aspects are also studied, such as research into driver behavior and how surrounding road users perceive the interaction with self-driving vehicles since there is no driver to make eye contact with.

## RESEARCH ALSO IN MARINE SETTINGS

For a couple of years now, Revere has entered the field of marine vessels, mainly in collaboration with RISE. A pilot boat in the port of Gothenburg is available for research projects, and also a catamaran platform and some models.

“The sensor technology used does not differ much from land to sea, apart from the radar systems. We have transferred a lot of our existing systems into marine applications”, says Fredrik. “I think there is a great need and demand for research on automation in the marine settings, from academia as well as from the industry. This is definitely an area for further expansion in the future.”



## A VENUE TO BE PROUD OF

Looking back at the first five years of the lab, what is he as a Director most proud of?

“We have successfully carried out a number of demonstrations of cutting-edge research, and our in-house developed software platform stands out well compared to the equivalents being developed at vehicle companies”, says Fredrik von Corswant. “Today, Revere is a venue where researchers and developers from various organizations and disciplines meet. That provides exciting cross-border connections and creates ideas for new innovations.”

The demand for a vehicle research infrastructure remains stable for the foreseeable future. We have probably only entered the first phase of the societal development that self-driving cars and electrified vehicles of various kinds are bringing.

“I hope that Revere in the future can attract more researchers and companies to be active collaborating partners. Our goal is to continue to build competence in automation and active security in the region, to provide a good recruitment base for industry and research institutes”, concludes Fredrik von Corswant.

**Text:** Yvonne Jonsson



# OPEN RESEARCH AT ASTAZERO



**A**STAZERO IS WELL KNOWN as the world’s first full-scale independent test environment for future road safety. It’s frequently used by vehicle manufacturers and suppliers to test advanced safety systems and their functions in different traffic environments for certification. However, the test site is not exclusively designed for testing but also used for research and development. It serves as an international arena which is open for the industry and even legislation, universities, and technical institutes.

But how do you ensure to stay at the forefront of technology development, keep track of relevant research going on, get fresh and new ideas for constant further development and keep the leading position in the active safety test area? In 2016 the program “Open Research at AstaZero” was launched to address exactly this question. AstaZero owners RISE and Chalmers decided to jointly finance this program that opened up the test site for curious researchers from Sweden and around the world.

Researchers from universities or research institutes, but also small and medium-sized enterprises (SME’s) were welcome to come and test their small and big ideas. An independent review committee evaluating scientific quality, feasibility, timing, qualification, and dissemination plans for results and data ensured a high quality among granted research projects. Using spare times efficiently and making test tracks, workshop, support (e.g. testing engineers, or drivers), and equipment accessible for enthusiastic young people and learn from them has led to added value both for customers, and the test environment itself. Open Research should form one of the main pillars of AstaZero stimulating and facilitating open, independent, and world-leading research, generating publicly available results and data, and creating an inspiring network between researchers.

The program had a budget of 10MSEK during the last four years. Nine open calls resulted in a total of 14 funded projects of which 12 were national collaborations, while two had non-Swedish partners from Catalonia and Austria. Project applications within road transport and automobile research were mainly expected but projects from other related scientific disciplines were most welcome as well. E.g. one of those “special topic” projects was on emergency care during ambulance transport. Revere lab at Chalmers were a competent and valued partner in a few projects where additional vehicles, equipment and support was needed for testing and not available at AstaZero.

SAFER has been responsible for the program creation and coordination using our unique research network to attract international researchers and connect the projects to the project portfolio. All project information, reports and publications are available on SAFER’s homepage. Beside numerous scientific publications, presentations at conferences and seminars, published films, and project reports the program fortunately led to two licentiates (Ekman F, 2020; Johansson M, 2020) and were an essential part of two PhD theses (Zavala E, 2019; Ajanovic Z, 2020). Some projects are highlighted below.

While the last projects are still running, reports are written, and publications are still dropping in, the program reached its preliminary end. Outcome and lessons learned have been evaluated by the program’s steering group. There is the clear ambition to find new forms and a stable financing model to continue with Open Research at AstaZero following one of the main recommendations of the program evaluation: Dare to invest in fresh and new ideas!

## KEY HIGHLIGHTS FROM PROJECTS



### SMART SELF-DRIVING VEHICLE (SALI)

SALI aims at providing an open software engineering solution to integrate self-\* capabilities, e.g. self-healing and self-optimization, to self-driving vehicles in order to deal with runtime factors such as unpredictability, faults and limited resources. It utilizes machine learning techniques over thousands of heterogeneous runtime data gathered through sensors, cloud services and vehicle-to-vehicle communications for providing resilient and just-in-time monitoring to self-driving vehicles. A series of experiments have been run on AstaZero: a sensor fault, low battery level and a road accident. Vehicle’s monitoring has been successfully adapted at runtime, e.g., activating alternative sensors, deactivating unnecessary sensors, or changing parameters in case of route recalculation. The results of the experiments are promising in terms of both functionality and response time.

“We still have work to do, but the test ground was a great experience with great results and a great team!” Edith Zavala, Universitat Politècnica De Catalunya, Barcelona



### VALIDATION OF OPTIMAL MOTION PLANNING FOR AUTOMATED URBAN DRIVING

Closed-loop validation of autonomous vehicles is an open problem, significantly influencing development and adoption of this technology. The main contribution of this paper is a novel approach to reproducible, scenario-based validation that decouples the problem into several

sub-problems, while avoiding to brake the crucial couplings. First, a realistic scenario is generated from the real urban traffic. Second, human participants, drive in a virtual scenario (in a driving simulator), based on the real traffic. Third, human and automated driving trajectories are reproduced and compared in the real vehicle on an empty track without traffic. Thus, benefits of automation with respect to safety, efficiency and comfort can be clearly benchmarked in a reproducible manner. Presented approach is used to benchmark performance of SBOMP planner in one scenario and validate Super Human driving performance.

“Thank you for the opportunity to test at AstaZero. It was the highlight of my PhD research!” Zlatan Ajanovic, Virtual Vehicle Research GmbH, Graz, Austria



### SAFETY DATASET FOR TRAINING AND VALIDATION OF AI PERCEPTION FUNCTIONS IN AD AND ADAS

AI, in particular, deep learning algorithms, are becoming the state-of-the-art technology used in AD and ADAS. However, the interpretability and reliability of these algorithms are known to be worrisome due to their data-driven and hence black box nature. This is not acceptable for automated systems deployed on the road, where guarantees on safety are required. Since these data-driven AI algorithms are to a large extent determined by the training dataset, it is very important to create a dataset such that it is fully aware of the safety requirements. This project will provide an initial version of a public dataset of driving scenarios relevant for safety studies, which contains ground truth labels on all sensor data that is ready-to-use for state-of-the-art AI algorithm training and validation.

“The dataset will support researchers to have easy access and utilization of data to trigger research and development on safety aspects and improve the robustness of AI perception systems used in AD/ADAS. It can help in removing the last barriers for a wider introduction of AD and thus improve overall safety and contribute to the roadmap towards Vision Zero.” Jörg Bakker, Asymptotic, Sweden



# SAFER'S ECOSYSTEM, LOCAL AND GLOBAL COLLABORATIONS



**A** CORNERSTONE IN THE STRATEGY is to have a multidisciplinary research environment that also serves as a physical meeting place, open to all partners. This also contributes to the development of larger clusters and SAFER is an important part in the open research and innovation ecosystem around sustainable automated transport systems and smart cities. The purpose is to form an extended safety research environment, which connects researchers from academia, industry, institutes, and the public sector and which combines and enhances work carried out within SAFER with research activities financed through other programmes.

## NEW LINKS ESTABLISHED IN THE ECOSYSTEM

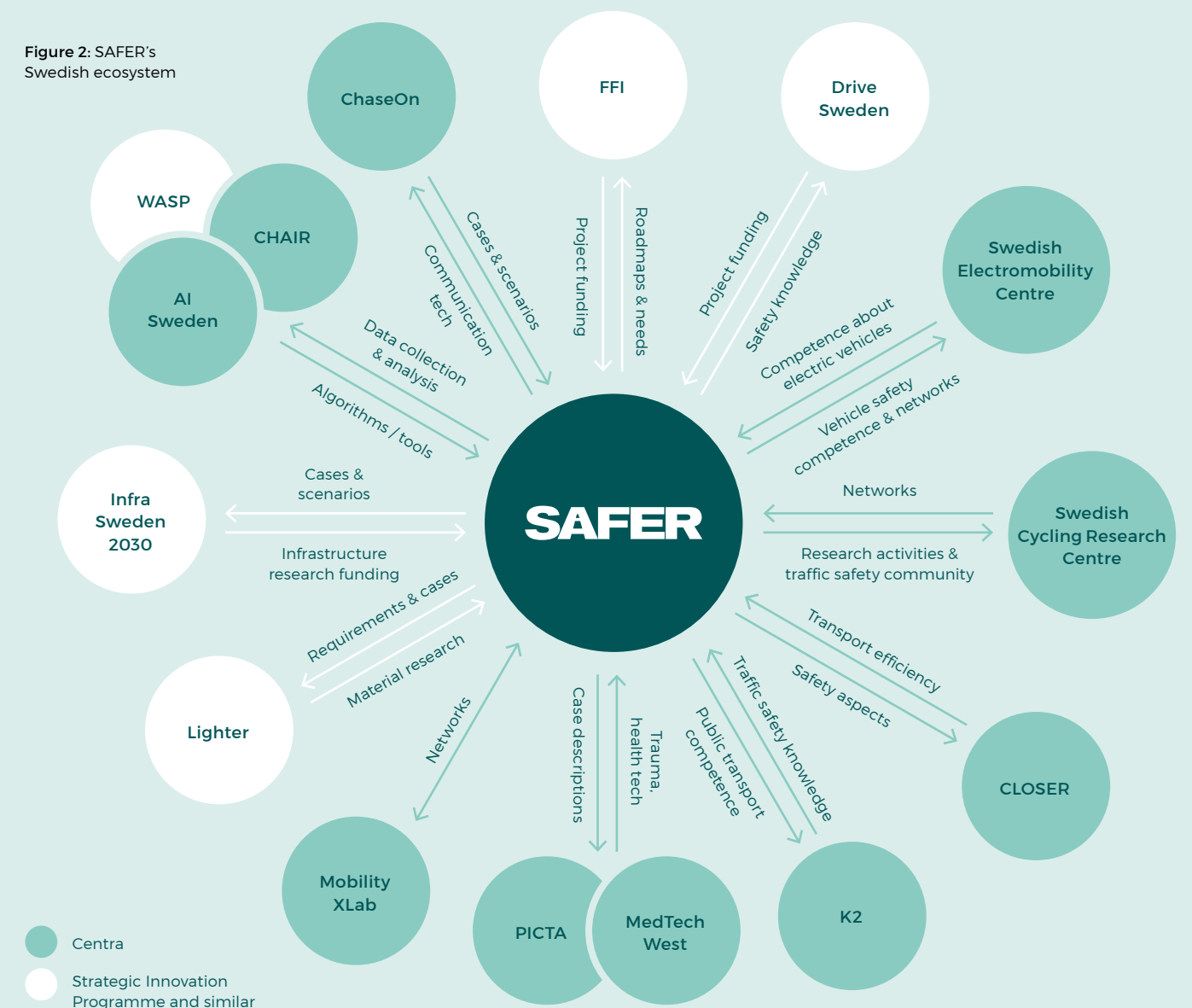
In SAFER Stage 5 the aim is to take even more advantage of the ecosystem and world around us in order to leverage the efforts put in by the partners. During the year, the ecosystem was developed, and new links were established, see the complete ecosystem in figure 2. Below is a selection of collaborations initiated and further developed in 2020.

A collaboration that has started off well is together with Cykelcentrum (The Swedish Cycling Centre). Cykelcentrum is a national knowledge centre for research and education about cycling. Cykelcentrum and SAFER intend to jointly contribute to increased cycling safety in Sweden through a closer cooperation. We will do this by, for example, sharing knowledge between us, such as publications and other research results generated within our respective centres.

We aim to arrange various knowledge-building activities, gather around common research questions to create projects and inspire each other to think more broadly. Another purpose is to support our researchers with access to a wider network of expertise and to find project funding. The two centres also want to encourage financiers and demonstrate the needs of continuously creating relevant knowledge, in-depth research and implement safe solutions for increased cycling. In November a well-attended webinar was co-arranged; "We share the space – bicyclists and motor vehicles interacting; challenges and solutions".

Another example of a new link in the Swedish ecosystem is K2; Sweden's national centre for research and education on public transport. We see great potential for collaboration in public transport, for example to include and contribute with knowledge in the safety aspect and to clarify and resolve goal conflicts in various solutions for public transport. During the autumn, a workshop was conducted with researchers from our respective centres. The purpose was to discuss common problems in the border between us with the aim of finding a number of common research questions that could be taken on in a concrete project as a next step. Another secondary purpose was to get to know each other for future deeper collaboration and to find further areas where collaboration could add value and inspire each other to think more broadly. The workshop generated a next step in the form of a second creative workshop to set up a project to learn more about various perspectives, including safety, exchange points along a metrobus line.

Figure 2: SAFER's Swedish ecosystem



A national center for AI was launched in 2019, AI Sweden, which has the task to promote the development and use of artificial intelligence in selected areas, where transport is one. AI Sweden provides resources, knowledge, data and capabilities that will accelerate applied AI research and innovation. The centre is involved in SAFER's work to start using AI as a tool in traffic safety research (see page 31).

The project portfolio within Care and Rescue, a former research area within SAFER, was moved to PICTA, the Prehospital ICT Arena at Lindholmen Science Park, in 2019. In this context, research can be conducted more efficiently because the arena has access to additional, crucial community actors to achieve results. SAFER's partners still have the opportunity to conduct post-crash research through SAFER, but the project portfolio is placed at PICTA. This approach has proven to be effective and several projects

have been started up, including TEAPaN (Traffic Event Assessment, Prioritizing and Notification). The objective of this project is to improve traffic safety for everyone in the event of an accident or sudden illness by means of early identification and more accurate assessment, prioritization and deployment. This necessitates the establishment of fundamental conditions for collaboration between the public sector, private sector and individuals, e.g. in an open interface and permanent connection to alarm and deployment resources. A second project recently started up is Connected Occupant Physiological Evaluation, COPE, aiming to develop and test smart monitoring of health data in real time with a focus on sleep detection in drivers. As a result of the collaboration with PICTA a knowledge sharing group with members from many different disciplines, meet regularly to map the needs for knowledge in safety linked to accidents with electric vehicles.



SAFER's director Magnus Granström is Profile leader for traffic safety within the Area of Advance for Transport at Chalmers which supports a closer collaboration with top researchers at the university, as well as a closer link to education and students. The Area of Advance provides funding for research projects and the possibility to employ post docs within the area, and it is also an important contact between the SAFER partners and the research community within Chalmers, both for knowledge exchange and project creation. In the autumn of 2020, one focus topic for the area of advance has been the urban development and how the transport issues are dealt with (or not) in the planning process. Here, safety is one of the crucial aspects to address.

Drive Sweden is one of Sweden's Strategic Innovation Programs (SIP) financed by Vinnova, addressing opportunities and challenges with the next generation mobility system for people and goods. SAFER's director is a member of Drive Sweden's program committee. This, in turn, can contribute to SAFER's project creation and funding, as well as more knowledge building in the development of a sustainable transport system in a broader context. From a SAFER perspective, this collaboration provides both possible funding opportunities, but also an extended network of partners, something that has been very useful in the ongoing AI for traffic safety activities.

#### PROCESS IN JOINT RESEARCH WITH CHINA

CTS (China Sweden Research Centre for Traffic Safety), with the Swedish partners Chalmers, Autoliv, Volvo Cars, Volvo Group and the Swedish National Road and Transport Research Institute (VTI) and the Chinese partners Tongji University, RIOH Institute for Highway Safety, Tsinghua University in Beijing and Geely Automotive Research has also developed in 2020. SAFER constitutes the Swedish research platform in this collaboration. Joint projects are ongoing as well as other activities to enhance road safety in China, for instance through road mapping workshops and development of joint project proposals. In 2018, a first bilateral call for research projects was launched in both China and Sweden and during the past year no less than three SAFER projects were granted funding. A second call was held in 2019, where three projects were approved, all with SAFER partners involved. The continuation of the program is currently being negotiated, hopefully leading to a new call in 2022.

#### STRONG PARTNERSHIP WITH INDIA IN PLACE

SITIS (Sweden-India Transport Innovation and Safety Partnership) was launched in Stockholm in February on the third global conference on road safety within UN with the vision to leverage the know-how of India and Sweden to accelerate progress and deployment of safe and sustainable transport solutions and actionable policies, contributing to significant progress of Indian transport system. One of the first projects within the partnership, "Safe and Secure



Magnus Granström  
SAFER's director

Transport corridors in India", is about collecting naturalistic driving data from buses in India. The project entails a long-distance coach over a corridor in customer service. The aim is to collect data e.g. about the driver, the vehicles, the passengers, the infrastructure as well as the surroundings like other vehicles, weather and road conditions. Example of research questions to be addressed are related to data analysis of traffic behaviour, weather conditions, driver behaviour, overall logistics, deploying connectivity solutions for critical moments, emergency response systems and the ability to communicate with the infrastructure. In the collaboration, Sweden also shares the Vision Zero and how to build a successful structure for implementing traffic safety-enhancing measures at several different levels in society in a strategic and systematic way. More joint activities and projects are planned to start in 2021. SAFER partners include Autoliv, Volvo Group, Chalmers University of Technology, RISE Research Institutes of Sweden, Swedish National Road and Transport Research Institute (VTI) and the Swedish Transport Administration.

See the complete list of the  
SAFER Ecosystem in appendix 5.

# INFLUENCING THE EUROPEAN RESEARCH FRAMEWORK



**T**HE HORIZON 2020 PROGRAMME has now run for seven years and the final calls have closed. This doesn't mean that the programme has ended though, some of the final projects within Horizon 2020 has not even started yet. This is the normal way in the transition period between the European research frameworks, and one of the final FP7 project was finalized during 2020. This means that we will continue to have focus on Horizon 2020 from an ongoing projects' perspective and in parallel work within the Horizon Europe framework, covering calls within 2021-2027.

During 2020, SAFER has continued the long-term efforts securing the traffic safety content in Horizon Europe. This has been done through active participation in selected organisations, such as ERTRAC (the European Road Transport Advisory Council), EARPA (the association of automotive R&D organisations), ERTRAC (European Council for Automotive R&D), ECTRI (The European Conference of Transport Research Institutes) and CLEPA (the European Association of Automotive Suppliers). For instance, the work initiated in 2018 to update the ETRAC roadmap for SAFE Road Transport has proven instrumental in the dialogue with the European Commission regarding the content of the calls opening 2021 and 2022.

Another substantial effort during 2019 and particularly 2020 has been to contribute to, and comment on, the strategic research and innovation agenda, SRIA, of the CCAM (Connected, Cooperative and Automated Mobility) partnership which has been developed during the past year.

Several SAFER partners will be members in this, creating a strong Swedish platform within this area. The content of the first version of the SRIA, the creation of which some SAFER partners have been very active, has been the basis of the CCAM-labelled section of the work programme.

One thing to remember in this kind of work is that it is of utmost importance to be persevering and have a long-term vision (as well as a good overview of ongoing activities) as the processes leading up to the work programme content stretches over several years. Several position papers, roadmaps, meetings, and workshops are required to make sure that the desired topics are included in the final version. Also, having a platform such as SAFER means that we have a clear advantage in this kind of work, being able to communicate easily and also share the workload in an efficient way.

We are now looking forward to the first set of calls, including topics such as:

- Testing safe lightweight vehicles and improved safe human-technology interaction in the future traffic system
- Radical improvement of road safety in low and medium income countries in Africa
- Cyber secure and resilient CCAM
- Common approaches for the safety validation of CCAM systems
- More powerful and reliable on-board perception and decision-making technologies addressing complex environmental condition



# FINANCIAL REPORTING

SAFER HAS TWO main types of financing, one being SAFER Core which is the base for the core activities in terms of the secretariat, the office and open research area and base funding for the seminar and dissemination activities, the other being the project financing for research and project activities.

## SAFER CORE – THE CENTRE FINANCES

SAFER Core is financed through funding from Västra Götalandsregionen and partners’ cash contributions according to the overall partner agreement for the fifth stage of SAFER. The framework agreement stipulates an annual contribution of:

- LEVEL 1: A total contribution to SAFER Core amounting to 1 MSEK per year, 650 kSEK in cash for industrial and public partners and 125 kSEK for other universities and research institutes. The remaining amount is provided through in-kind contributions. Chalmers, as the host of the centre, has a commitment of 1 MSEK in cash and 450 hours in-kind.
- LEVEL 2: Contribution to SAFER Core funding in an amount of minimum SEK 125 KSEK in cash contribution per year for industrial partners and public partners. Other universities and institute partners contribute with 75 KSEK/year.
- LEVEL 3: The cash contribution is 10 KSEK/year.

The contribution from Västra Götalandsregionen (VGR) is 2,5 MSEK per year. The total funding sums up to about 40,5 MSEK cash and minimum 25000 in-kind hours for the entire stage five (April 1, 2019 to December 31, 2023). Partners on level 1 contributes with 450–950 hours per year in-kind to SAFER Core, depending on type of partner. The roles/ functions that the in-kind hours are used for are e.g. Research area directors, Competence network leaders and other management group members.

The result for the SAFER Core finances for the second operational year in SAFER Stage 5 (January 1<sup>st</sup> to December 31<sup>st</sup>, 2020) is shown in figure 3.

The total result for the first two operational years in SAFER Stage 5 (2019–2020) is positive. 2020 has of course been a special year in many ways, meaning a shift to digital meetings including some necessary updates to the technical equipment in the office. Revenues were higher than budget partly thanks to more partners being added and some having stepped up one partnership level, and partly due to revenues relating to 2019 being booked in 2020. Also, the VGR reporting period ran over the turn of the year and we received payment this year for costs accrued for

Figure 3  
The expenses and income of SAFER

EXPENSES (KSEK)	
Personell	4 892
Premises	1 251
Running costs office	482
IT costs	108
Knowledge sharing and communication activities	259
Other costs, e.g. travel etc	47
SUM	7 039
INCOME (KSEK)	
SAFER Partner cash contribution	6267
Funding from Region Västra Götaland	3520
SUM	9787
RESULT	2748

previous year. The costs for the current year were higher than budget, although it is balanced for the whole period, 2019–2020, as some costs were moved from 2019 to 2020 and the outcome is in total slightly under budget. During the year, a new Think & Talk room was established, and investments were made in new computers and other equipment needing upgrading. The shift to smaller premises also gave somewhat lower cost than budgeted.

The cash resources for SAFER are governed by the Board, who has continuously monitored the budget and decided on changes in expenditure when required.

## PROJECT FINANCES

The project financing comes from a variety of sources, primarily national programmes such as the FFI programme (Strategic Vehicle Research and Innovation), different strategic innovation programmes funded through Vinnova, Trafikverket and Energimyndigheten. Also, Skyltfonden, Stiftelsen för Strategisk Forskning (SSF), and others are providing project funding from a national perspective. The other important project funding source is the through EU’s Horizon 2020 programme. In addition to this, internal funding from all partners play an important role, whether it’s academic, institute or industry partners. The overall budget for the projects in SAFER’s second year of Stage 5 sums up to 1.900 MSEK for all project partners and 620 MSEK for SAFER partners. That clearly shows the benefit for the partners to join in the SAFER projects that generally have a high hit rate in the competitive programmes. Also, the leveraging factor of collaboration projects is clear, especially when accessing the knowledge and financing power on the European arena.



# THE RESEARCH

Entering SAFER Stage 5, we focus our research primarily in four areas, representing world-class, multidisciplinary research – all with the single-minded vision to save lives, prevent injuries and enable safe mobility:

- Systems for accident prevention and automated driving
- Road user behaviour
- Human body protection
- Safety performance evaluation

Our research areas also create an open arena where our partners meet and identify key issues to initiate new research, based on real-world needs.

## RESEARCH SCOPE

**S**AFER'S RESEARCH includes road traffic, for example, pedestrians, cyclists, various vehicles and goods services. However, rail traffic is not included in our scope of work. We cover a “complete-travel-perspective”, from door to door, in which a human is interacting with a vehicle in the road traffic environment. For example, our research does not generally include single pedestrian accidents. However, there is no obstacle if there are a number of partners who want to start a project that is beyond the scope of the above.

## THE SAFER PRE-STUDY PROGRAM

One of the news in the collaboration agreement for SAFER Stage 5 is that we offer research funding to pre-studies and seed-projects. The aim is to support strategic knowledge creation that can lead SAFER forward and contribute to the continued development of the joint collaboration platform.

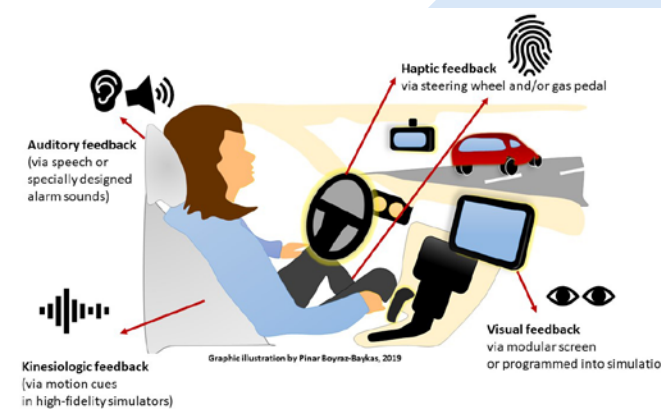
The main idea is to bring together a strategic group of partners to create unique, new competence as a basis for e.g. national funding or an entry ticket to prestigious international collaborations. The goal is to offer funding for 6–8 pre-studies per year, to a total value of about 600 KSEK. The first call was opened in 2019 and in 2020 we have continued with four additional pre-study calls. All in all, in 2020, 15 project ideas have been submitted and seven pre-studies have been funded. The first call for 2021 projects closed in November 2020, approving an additional pre-study to be completed in 2021.



## SAFETY CULTURE FOR AUTOMATION

PARTNERS: TØI, VTI, VOLVO GROUP

In this study, our researchers will investigate the safety culture of companies that handle automated vehicles. Existing studies indicate a close relationship between safety culture and safety outcomes. However, the role of safety culture in transport companies with automated vehicles is yet to be examined. It is therefore important to bridge the gap between technology and human behavior at organizational levels and link to the zero vision with practical applications.

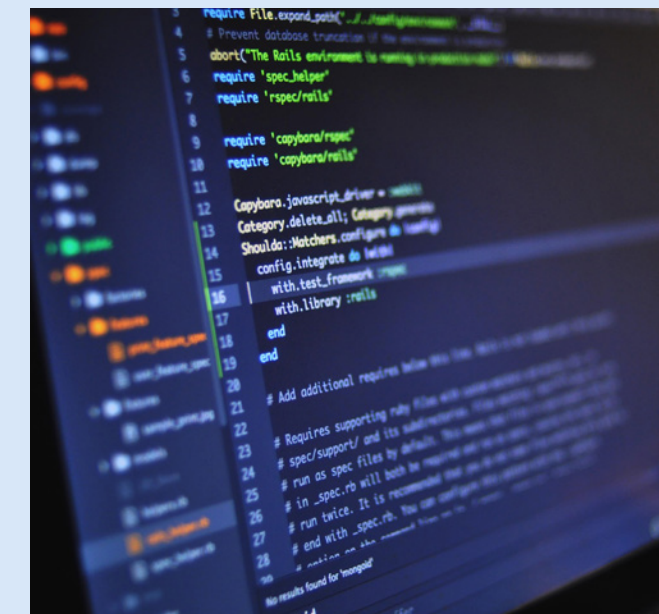
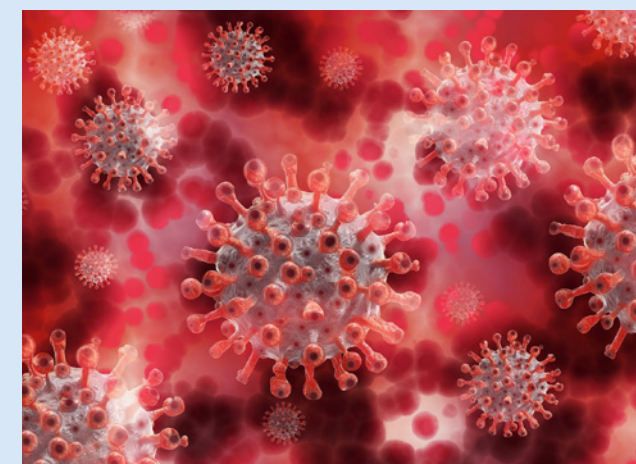


## SMART-LOOP

### DESIGN OF MULTI-MODAL HUMAN-MACHINE-INTERACTION SYSTEM FOR KEEPING THE DRIVER IN-THE-LOOP IN AUTOMATED DRIVING SYSTEMS

PARTNERS: VTI AND CHALMERS

The problem the project team have been trying to solve is the ‘out-of-the-loop’ condition associated with Automated Driving Systems (ADS). ADS are currently not as effective as they could be in terms of how well a human can interact with it, unhindered. The driver of a vehicle with an ADS is tasked with supervising it as well as the surrounding traffic. But they are not always in control. The Smart-Loop focuses on increasing the driver’s awareness and strive to increase the comprehension of context and situation. This, as well as providing clear and logical actions procedures when the take-over-requests or warnings (in case of fully autonomous vehicles) are issued, are the very foundations of this project.



### MULTIMODAL DATA FOR ROAD USER BEHAVIOR ANALYSIS TO SUPPORT SAFE DRIVING PATTERNS

PARTNERS: UNIVERSITY OF SKÓVDE, SMART EYE

The overall aim is to propose a rationale for multimodal data consideration in order to analyze road user behaviour for determining safe driving patterns and diagnose unsafe driving behaviours. The investigation includes fusing multichannel and multidisciplinary data sources with an application to detect driving patterns that could be used to discriminate unsafe driving situations. A machine-learning based classification methodology is then proposed and its precision degree is analyzed. Follow up works include a scalable database platform that is kept synchronized with its channel sources.

### HYGIENE PROCEDURES IN TEST WITH RESEARCH PERSONS

PARTNERS: VTI, AB VOLVO, AUTOLIV, VEONEER, RISE, SCANIA

Now, under and after the corona pandemic, health concerns are put in focus and we must take appropriate measures also in our research and testing activities. How can experiments involving test persons still be conducted sharing an enclosed cabin or VR equipment? What might standard safe hygiene procedures be? Will we have to require drivers to wear masks? How do we implement distancing while being in preparation or post-experiment interviews? These are questions that will be worked through in this study.



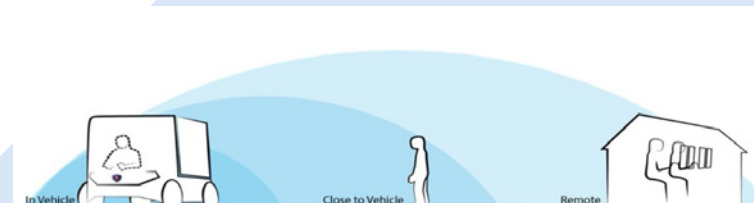


## SAFER CYCLING

### FROM CRASH AVOIDANCE TO INJURY REDUCTION – INCREASED VISIBILITY AND REDUCTION OF INJURIES BY SMART CLOTHES AND MATERIALS

PARTNERS: CHALMERS, FOLKSAM, VTI, UNIVERSITY OF BORÅS

This pre-study will push the development towards a reduction of injuries for bicyclists and at the same time aid a more sustainable mode of transport by making cycling safer. One target is to better understand how the ability of drivers to detect cyclists in daylight conditions can increase by using smart materials and technology. Furthermore, knowledge about how shoulder protection could be developed will also be created.



## HUMAN FACTORS RELATED TO REMOTE CONTROL OF AUTOMATED HEAVY VEHICLES

PARTNERS: SCANIA, RISE

Currently, most highly automated vehicles still require the presence of a human safety operator in the vehicle, and it is evident that automated driving without human “fallback” might be distant. On the other hand, having a human safety operator in the vehicle jeopardizes one of the major anticipated benefits of automated driving – productivity. To bridge this gap, stakeholders are exploring teleoperations technology, which enables highly automated vehicles to be remotely controlled if necessary. This pre-study increased knowledge on potential safety challenges regarding remote control of automated trucks and help framing a larger research project that will explore these challenges in more detail and develop solutions for them. This study generated a larger project; Heavy Automated Vehicle Operation Center (HAVOC) – Requirements and HMI design, with additional partners with funding from the FFI program, which will begin in 2021. The goal is to compare and contrast different needs and requirements posed on the human operator in different applications of remote operation: diagnosis, assistance and emergency driving.

## THE ROLE OF ROAD DESIGN FOR VULNERABLE ROAD USERS AT INTERSECTIONS

PARTNERS: UNIVERSITY OF GOTHENBURG, VTI

This project aims to identify effective design countermeasures to support the vulnerable road users’ perceptual and cognitive tasks and also to give them support to make better behavioral choices in critical complex traffic situations, i.e., segregated shared space on intersections. The project would constitute the stepping-stone for next studies in the area of road safety behavior; thus, we expect to provide promising results enabling to introduce a new methodology to investigate the VRUs-environment interaction via a genuine multidisciplinary work.

# AI AS A TOOL IN TRAFFIC SAFETY RESEARCH

**A**RTIFICIAL INTELLIGENCE (AI) is emerging as the key technology for innovation, growth of new jobs and societal development. Countries around the world are investing vast sums in infrastructure, research, education and innovation. Investments are also being made in incentives to support industry competitiveness, solve societal challenges, maintain standard of living, and secure their country’s share of international investments and access to products, services and talent. As all industries, the mobility industry will be highly affected by AI. Most obvious trend is of course autonomy, i.e. self-driving vehicles, but AI will influence in a much broader sense and drive competitiveness for the private sector and next generation solutions for society. During the next 10–20 years AI will substantially transform society in many ways, including the mobility and transport system.

At SAFER, we see great potential to take advantage of AI as a tool to improve our road safety research. During the year, we have therefore carried out a number of activities with the aim of getting closer to the understanding of how we can efficiently use AI in our research to add value to our partners. Three workshops have been conducted with the targets to better understand the partners’ needs and form a strong strategy forward to utilize AI in the best possible way. Mapping existing initiatives as well as potential challenges have also been included in the work.

As a result of the workshops conducted three prioritized areas have been identified that we now would like to explore

further and create opportunities for the partners to turn these areas into concrete projects and other activities. Several project ideas were presented on a digital brokerage event in November and funding opportunities have also been identified. We have a strong engagement and interest from the partners to continue this work. We have also found that the availability and quality of data is crucial to be successful. SAFER has a great potential and a unique edge to be able to help meet this need since useful data already is available within the network. This opportunity will be further explored in 2021.

SAFER’s AI initiative fits very well into the strategic project AI driven mobility recently approved by the Drive Sweden board and by joining forces, we create synergies for everyone involved, not least for partners and funding agencies. To further create synergies, we will continue to work closely with Drive Sweden, AI Sweden, CHAIR (Chalmers’ AI centre) and other relevant stakeholders in the SAFER ecosystem. Together with the SAFER-partners we have identified the following three use-cases that can be of value to develop within the SAFER research platform to help create a more efficient traffic safety research:

- Identify and assess external objects and safety conditions
- Finding risks in the traffic environment by combining data
- Detection and classification of driver state and driving patterns



# THE PROJECT PORTFOLIO

**T**HE PROJECT PORTFOLIO is the base for the SAFER collaboration, comprising of different types of project, but all focusing on one or more of the issues addressed in our joint strategic research agenda, created through the multidisciplinary research. The project portfolio is created, maintained and developed through the joint efforts in the research areas and among the partners. Throughout 2020 the focus has been to secure a solid foundation of projects and related activities through various sources of funding. The research areas have had to focus even more on suitable available funding from various national and international (primarily EU) research and innovation programmes.

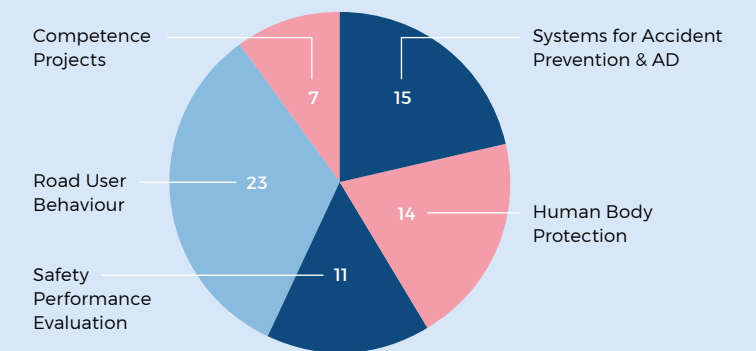
A research project at SAFER relates to one or several of the four research areas. Projects that cover multiple research areas or focus on general questions are called Competence projects. The distribution of projects between the research areas is illustrated in figure 4. The primary forum for initiating and discussing projects at SAFER is the research areas, which recommend project proposals to the Management team 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 research areas and on conferences, seminars and international collaborations and calls. The Reference groups include representatives from all level 1 and 2 SAFER partners and are the base for establishing world class competitive project portfolios. Each Research area hosts a mix of projects; pre-studies for future projects, 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 into the SAFER environment (“associated”) where it can thrive and benefit from the presence of other projects and researchers. A SAFER associated project can also be an externally funded larger projects that has had a previous successfully performed pre-study, financed by SAFER.

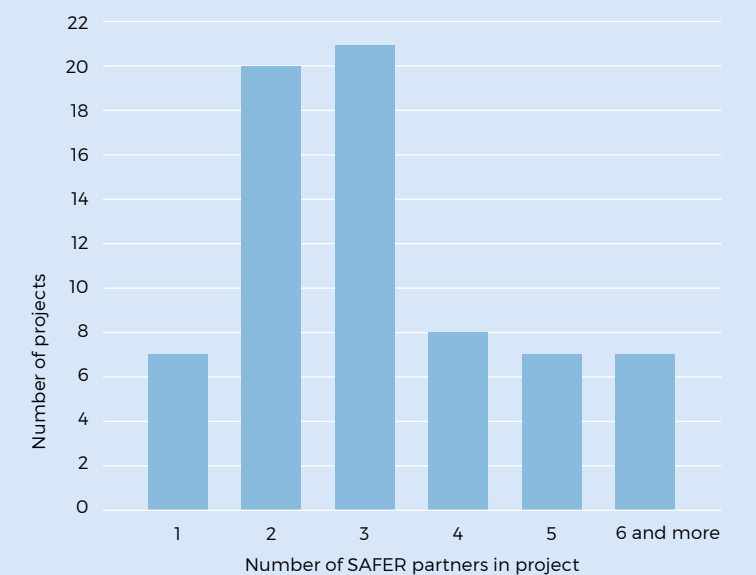
Since interdisciplinary collaborative research is a key approach to excellence and successful dissemination, we encourage projects to involve at least two partners, preferably from different stakeholders. Some projects, however, have only one part for natural reasons, e.g. PhD students’ projects and special investigations and assignments. The majority of the projects involve 2-3 SAFER partners and some 20% involve 5 or more, see figure 5.

During operational year 15, 6 SAFER funded pre-studies and 32 projects with external funding have been added to the project portfolio adding up to a total of 70 projects that have been ongoing during the year. 63 of them belong to one of the four research areas whereas 7 projects were competence projects (complete list in appendix 6). 20 projects have been successfully finalized during the year and SAFER will enter its 16<sup>th</sup> operational year with 58 ongoing projects.

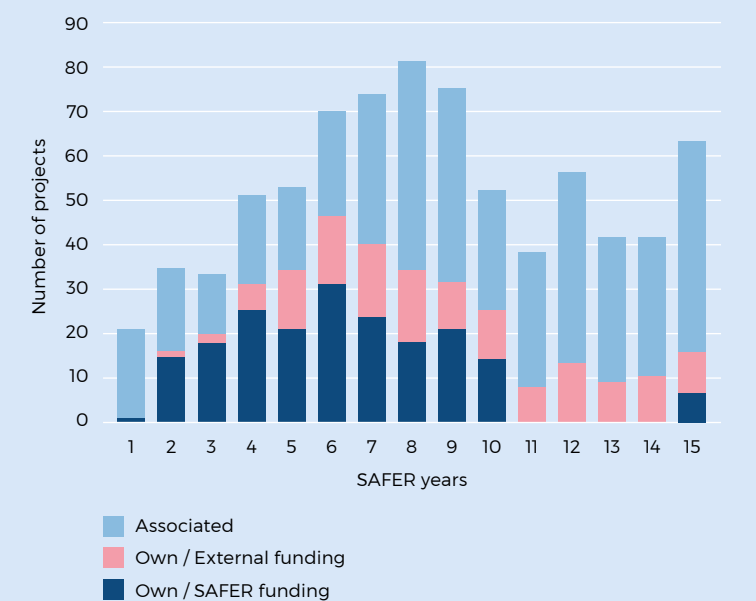
**Figure 4**  
Ongoing projects during stage 5, year 1.  
The distribution of projects between the research areas.



**Figure 5**  
The number of partners in SAFER's projects.



**Figure 6**  
Number of projects in SAFER's project portfolio (competence projects are not included in this diagram)





# RESULTS FROM THE RESEARCH AREAS

## SAFETY PERFORMANCE EVALUATION

**T**HIS RESEARCH AREA is critical to all the other research activities at SAFER and is a cornerstone of future safety research, i.e. SAFER uses the research area to orient future research activities. It is considered the strongest collaborative area at SAFER by the partners and is an important knowledge resource for all regarding road accident prevention. The fundamental studies determine road safety priorities and examine safety benefits through statistical analyses of road traffic data, including accident, incident, and near-miss data. Development and standardisation of methods regarding all aspects of road traffic data analysis, also recording and sharing of data, are other important tasks. It can thus be considered complementary to all SAFER research areas and is in fact integrated in many different SAFER research projects on new safety strategies. Results of the safety performance evaluation studies are critical for securing the utility of new safety systems and providing confidence in their market introduction. The safety performance evaluation area gives SAFER a strong identity and a position in the global research community. For instance, SAFER's world leading cluster of researchers connected to naturalistic data activities has an internationally acknowledged reputation to a large extent due to conscious strategic choices and activities throughout all years from the start of SAFER. The datasets available cover over 8 million km of real-world driving in different contexts, countries and vehicle types. The databases with field data have a long history at SAFER and have continuously evolved together with the kind of data collected and the analysis to be performed. These activities have made it possible for SAFER partners to take leading roles in international research projects on data activities and SAFER has become a data node for in-depth naturalistic driving data. The main current ongoing projects are described in the following part of this chapter.

### WELL POSITIONED FOR THE FUTURE

The introduction of advanced driver assistance systems has increased the need to understand how they are used and how they perform in real world traffic, and eventually understand how these systems should be improved further. The need to understand technologies for accident prevention goes together with the need to understand the underlying complex system of factors behind crashes, which has

made the interest for FOT and NDS studies even stronger – an area in which SAFER is deeply committed and will continue to develop spearhead competence and leadership. These activities bring new research collaborations, which in turn is an effective mechanism for SAFER to expand its access to larger amounts of data, providing opportunities for new research insights for the partners. Data collection is expensive and is typically limited to specific regions. Hence, international collaboration makes research for instance on socio-geographical differences possible. During the past year, among other things, projects within a strategic collaboration with India have started. Within the framework of this platform, data collection is ongoing, giving valuable information about the traffic environment back to the researchers, read more on page 24. Also, a major upgrade of SAFER's data bases has started up, with the goal to enable us to use the database to a much higher degree than today, for example to validate safety systems in future vehicles that keeps track of the driver's attention and drowsiness.

In our ongoing work to further explore how AI can be used in our research we have found that the availability and quality of data is crucial to be successful. SAFER has a great potential and a unique edge to be able to help meet this need since useful data already is available within the network. This opportunity will be further explored in 2021.

The approval of the Horizon 2020 project Hi-Drive secures funding for SAFER's FOT databases for a number of years to come. Hi-drive builds on the ongoing project L3Pilot, which is one of our current largest projects, engaging several SAFER-partners. Hi-Drive will test and demonstrate high automation driving by taking intelligent vehicles technology to conditions neither extensively tested nor demonstrated earlier in European and overseas traffic. The project concept builds on an extended and continuous ODD (Operational Driving Domain) making it possible to operate vehicles longer periods compared to the state-of-the-art and stay interoperable across borders and brands.

Other challenges that will be in focus for the years to come if to further investigate how the FOT databases can be of even better value for more SAFER partners. How to relate to open sources and other data sharing initiatives are others.



“

In 2020 a major upgrade of SAFER’s data-bases has started up, with the goal to enable the researchers to use the database to a much higher degree than today.”

Algorithms and technology for efficient real-time traffic data collection are other interesting areas of research, as well as how we can best link our research to the global sustainable development goals. ITS and connectivity means new security challenges; in this area we need more knowledge and new competence. The important question “How safe is good enough?” is of course also an important research question that goes across the entire research platform. Other new research questions to address are safety in big number, Swedish micro-cultural differences and definition of the concept of road safety, due to people asking for safety which is a broader concept than “absence of personal injuries in a collision”. SAFER is well positioned with multidisciplinary research to take on board new challenges regarding accident prevention, based on a profound know-how regarding all kinds of road traffic data analysis.

## KEY HIGHLIGHTS FROM PROJECTS

### ROAD DATA LAB

Road data lab is a new SAFER associated project that supports improved road safety by making data sets accessible. There are many potential benefits and opportunities for innovation if data from different sources in the traffic environment are combined and made available to others, e.g. more accurate road maintenance planning, better understanding of traffic flows and improved road safety. However, integrating and merging data from different stakeholders is tedious and time consuming – sometimes with legal obstacles as well. The goal is to provide a platform that supports contribution and integration of data from various sources. The aim is to work on such integration, by establishing a collaboration platform, providing a technical infrastructure enabling innovation and learning as well as a legal baseline supporting various licenses. It will also serve as a knowledge foundation for how to work with the different data sources related to roads.

### STRADA IN-DEPTH STUDIES

In May 2020 SAFER started a pilot study to investigate how data can be used to develop a national in-depth database for

traffic accidents. To accelerate the development of a safer transport system, researchers, authorities and vehicle manufacturers need access to detailed information on traffic accidents. In this pilot-study, the project will use existing Swedish data bases; the STRADA database and Fatal Accident databases. The pilot will add more variables and reconstructions, for accidents involving fatal and seriously injured people. The plan is that the in-depth studies will cover not only fatal accidents but also serious injuries (AIS2 +). This will create opportunities for better follow-up of the traffic safety situation in Sweden. The data format developed will be designed to be able to make comparisons with existing European and global accident databases.

### MIDAS – ANONYMISING DATA COLLECTION FOR TRAFFIC SAFETY

To create a safe and sustainable transport system, researchers need to analyze large amounts of data to find problems, solutions and understand how, for example, humans interact with the traffic environment. Being able to access video data without at the same time having access to sensitive personal information is therefore an important factor for successful research. MIDAS aims to solve the problem of anonymity regarding video data collected in real traffic environments by develop machine learning algorithms to replace sensitive information in images, so that they can be saved for future use while complying with the GDPR. The purpose of MIDAS is to investigate the possibility of creating anonymized but unique faces and number plates in video data to replace personal data in pictures. The results from MIDAS ensure that as much as possible of the real environment and interactions are retained in data collected in road safety-related research projects.

### L3 PILOT: 11 COUNTRIES, 100 VEHICLES AND 1000 DRIVERS

SAFER’s increasingly strong position regarding NDS data analysis is demonstrated in the European project L3Pilot (Piloting Automated Driving on European Roads), which is the largest FOT supported by EU. The project started in 2017 and is a common European undertaking to evaluate the potential of more than 20 different self-driving features, as



well as to investigate attitudes of the drivers, and drivers in surrounding vehicles, towards self-driving cars. The project aims to demonstrate how the self-driving cars operate in a realistic environment, to identify remaining technology gaps, to shape relevant policies and to raise awareness about the true potential of the self-driving technologies. The result, and the processes developed, will help guiding the introduction of self-driving vehicles. SAFER has been given the responsibility for the data management tools and procedures, and is leading the analysis of naturalistic driving data, which is one of the key tasks in this exciting project. During the past year all data have been collected and the analysis has started up successfully.

### FOT-E

In 2019 SAFER was granted research funding for a major investment in developing its large databases with naturalistic driving data to a more modern architecture. The project FOT-E (Field Operational Test dataset Enrichment for the development of safety and highly autonomous vehicle functions), aims to accelerate the development of automated vehicles and ensure that these are safe once they reach the market. The project aims to enhance the datasets by extracting features from the interior recorded video and adding parametric data describing the driver pose and gaze with the goal to build a world class dataset for interior

sensing combined with exterior sensing. When the upgrade is completed, we will be able to use the database to a much higher degree than today, for example to validate safety systems in future vehicles that keeps track of the driver’s attention and drowsiness.



### RESEARCH OBJECTIVES FOR RESEARCH AREA SAFETY PERFORMANCE EVALUATION

- **Identified safety gaps**, e.g. long-term injury types.
- **Identified critical use cases**, e.g. driving a heavy truck in fog among vulnerable road users.
- **Identified new critical load cases**, e.g. multiple impact car crash.
- **Evaluation of implemented safety systems performance**, i.e. safety benefit analysis.
- **Prediction of safety benefits** of new safety systems.
- **Prediction of future safety critical scenarios**, automation included.
- **Determination of required safety level** for automated drive.



# SYSTEMS FOR ACCIDENT PREVENTION AND AUTOMATED DRIVING

**T**HE CHALLENGE OF putting self-driving vehicles on the roads is enormous. Automation affects everyone and the potential social benefits are huge, partly through increased traffic safety, but also increased efficiency. Everyone in the system must collaborate and take the steps forward in the process together. It is not just technology that needs to work, but also the conditions for implementation, such as the regulations and public acceptance.

Some of the most important research challenges we work with at SAFER are to:

**UNDERSTAND THE ROLE** of the driver or rider.

**DESIGN AND PROVE** sufficiently safe technology.

**SCALE APPLICABILITY** from somewhere / sometimes to everywhere / always.

During the past year we have been working to strengthen the expertise in this research area, meeting the challenges ahead of us regarding safety aspects of vehicles, road users and infrastructure when we are moving towards higher degrees of automation, in most cases in a mixed environment. Also, the scientific base for verification and validation is of utmost importance in order to ascertain that correct methods are used in an area that is much more complex than previously. This base is also required to create a foundation for future standardization of test methodologies. Another important area we have focused on developing is our connection to Artificial Intelligence, which is gaining momentum in society.

## HOW TO EVALUATE RISKS IN AUTONOMOUS MODE

We have built a lot of new knowledge through our ongoing projects, but also through our competence networks. The network Automotive safety assurance, led by Fredrik Sandblom, also Research area director for Systems for accident prevention and Automated driving, has kept together a valuable discussion about methods and nomenclature for how to show that autonomous vehicles are

acceptably safe. The network has been the “place to go” for SAFER partners to discuss how to make safe automated vehicles and to show that they are. The group’s work has been intensive and very constructive; for example, the group now has a much clearer picture of what constitutes a useful operational design domain (ODD), and what it should and can be used for. The group has also made use of the term User Expectation Domain (UED), which makes it possible to separate discussing where nominal driving may never fail from a safety perspective (the ODD) and the domain in which 9x% availability is a really good achievement. Also, the Safety Norm, meaning and definition is made clear. We know even better how to apply a risk norm and we have been able to move on to the interesting topic of how to meaningfully evaluate that a risk norm is met and is predicted to be met. In the creative dialogues paradoxes that emerges when applying methodology are discussed and often straightened out, albeit sometimes after long discussions. The group is also aware of ongoing standardization activities and members are informed. The members also see a great value in being able to ask questions and discuss in a way that helps in their daily work.

## PERCEPTION, SENSING AND COMMUNICATIONS

Another value-creating competence network has been launched during the autumn; Perception, sensing & communication. The competence network leader is Lars Hammarstrand, Chalmers. Sensors and communication enable technologies for a plethora of safety systems. The scope of this group is to create and share research ideas around vehicular communications, sensors systems, and signal processing. Testing and validation of perception algorithms and systems, Machine learning methods and new approaches to driver state estimation, e.g., pose, gaze, inattention, fatigue, etc. are included in the group’s main interest. Communication technology, like applications for 5G and beyond 5G for intelligent transport as well as cyber security will also be included in the knowledge building agenda. In January 2021 yet another competence network will start up, including the aspects on functional safety that also will add cross-functional value to this research area.

## KEY HIGHLIGHTS FROM PROJECTS

### ESPLANADE AND SALIENCE4CAV

The ESPLANADE project was finalized in March 2020 and has been targeting the complex question of showing that an autonomous road vehicle is safe. One of the key issues investigated in the project has been how the communication between the car and the driver will be set up, for example, by clarifying who is responsible for conveying the vehicle in different situations. The ESPLANDE project has provided a methodology that can be applied to increasingly complex tasks in order to ensure a safe introduction of more and more advanced self-driving vehicles. A continuation of ESPLANADE is SALIENCE4CAV. This project will focus on enabling iterative development for safety-critical products.

### STATE-OF-THE ART VALIDATION IN VALU3S

The project aims to evaluate the state-of-the-art verification and validation (V&V) methods and tools and design a multi-domain framework to create a clear structure around the components and elements needed to conduct a complete V&V process. The main expected benefit of the framework is to reduce the time and cost needed to verify and validate automated systems with respect to safety, cybersecurity, and privacy requirements. VALU3S brings together a consortium with partners from 10 different countries, amounting to a mix of 25 industrial partners, 6 leading research institutes, and 10 universities to reach the project goals. The project started in May and will be ongoing for three years.

### REALSIM FOR AD

One of the main problems when developing autonomous vehicles is the availability of real-life driving data and testing of the new functions. Therefore, in SAFER’s project “Real-SIM for AD”, tools for simulation, based on SAFER’s unique databases with real-life driving data, has been developed. The challenge has been to make the simulation tool look similar to the reality, and here have SAFER’s databases, which contain more than 8 million kilometers of data, been an important asset. The results indicate that synthetic data is highly useful, but will probably not replace the logged data completely. Cost and time savings from using a subset of synthetic data can be huge; it is possible to generate about 2000 synthetic images with annotations for the same cost as one manually logged and annotated image. This project ended in March 2020.

### DEFINING TESTING AND VERIFICATION IN HEADSTART

One of the main challenges for the implementation of self-driving vehicles is the testing and validation. The project HEADSTART (Harmonised European Solutions for Testing Automated Road Transport), a project in the Horizon 2020 framework program, takes on the challenge to define testing and validation procedures of functions including its key enabling technologies, i.e. communication, cyber-secu-



ity, positioning, by cross-linking of all test instances such as simulation, proving ground and real-world field tests to validate safety and security performance according to the needs of key user groups, e.g. technology developers, consumer testing and type approval. SAFER is in this project the joint research unit and its partners RISE, Chalmers, AB Volvo, Veoneer and AstaZero are involved in the project. The SAFER team will set up the requirements for testing and perform demonstrations at AstaZero. The project started in 2019 and will last for three years.



## RESEARCH OBJECTIVES FOR RESEARCH AREA SYSTEMS FOR ACCIDENT PREVENTION AND AUTOMATED DRIVING

- **We can evaluate different ways to act** in the traffic situation and decide upon how to progress safe and efficiently.
- **We have developed a methodology** to verify and validate assisted and automated systems in cooperation with international researchers in this area.
- **We have obtained knowledge** essential for development of new perception components that enable high-performance, reliable information about the vehicle environment and the driver/riders in the vehicle.
- **We have developed prediction models** for human cognition and behaviour in the areas of “driver engagement”, transitions between manual and automatic driving, and interaction between humans and Advanced Driver Assistance.



# HUMAN BODY PROTECTION RESULTS

**T**HE RESEARCH AREA Human Body Protection encompasses research to understand injury risks arising from transport collisions and events. This understanding is intended to support the development and evaluation of countermeasures to prevent injuries or at least to mitigate them. Focus for the research area is on emerging challenges in transportation, creating a knowledge base as well as a tool box for human body protection evaluations and enablers. Responding to this, Human Body Protection covers biomechanical injury mechanisms, responses and consequences, the principles for protection, including safety system usage and the immediate pre-crash period, as well as mechanical and mathematical occupant and vulnerable road user models for use in complete crash sequences. In addition, it includes research to develop new simulation models and methods needed for the development and assessment of novel crashworthy structures. SAFER partners have a world leading position in the area of applied biomechanics research; exemplified by child safety and whiplash injury research, development of crash test dummies and human body models. SAFER has pioneered this research area for car occupants. However, we also see that the transport system contains more varied types of vehicles, such as electric scooters and other personal mobility transport means. Therefore we aim to continue this journey considering those less-well or un-protected road users outside of the car as well.

The growing focus on sustainability emphasises the importance of low-weight materials, and the challenges simulating novel structures. Within the area of traffic safety related composite research, SAFER and its partners are currently one of the world-leading groups developing modelling and simulation tools for composite structures in crashes. Many aspects of which are still unresolved and will require significant research efforts for years to come. Of particular interest, are new material models, efficient numerical crash simulation methods and system design optimisation tools targeting lightweight vehicles, including their compatibility aspects.

Future challenges for human body protection also include vehicles with a higher degree of automation, likely leading to fewer collisions, but with those remaining collisions

potentially being further from conventional crash testing scenarios and norms of today. As vehicles increasingly become more and more automated, it opens opportunities such as for the car’s seats to be placed in other ways: facing each other or diagonally. Chasing safety improvements in diverse circumstances requires more detailed methods for evaluation, which are based on more refined biomechanics research. It calls for further development of tools and methods for the safety evaluation. It might also add complexity to the methods and tools, by including vehicle pre-crash dynamics to account for the effect of the automated systems before the in-crash phase starts.

These targeted research objectives are being addressed through focused activities and projects, see a selection of recent examples presented below.

## FUTURE IN-VEHICLE SEATING POSITIONS

Assuming the inexorable research continues, vehicles of the future will be self-driving and therefore all occupants will be passengers with an increased span of activities available to them within the car. The project “Assessment of Passenger Safety in Future Cars”, that was concluded in 2020, has addressed these challenges. This project has produced, so far: one licentiate thesis and 19 publications, whereof nine are peer-reviewed; several pioneering studies paving the way for novel research; and 13 masters theses, involving 21 students from four universities, ranging from “elderly in cars”, “child HBM”, “seating in AD” to “rib fracture risk prediction”. Each element or student has contributed to the knowledge built through this project. Within the same project, one international child occupant protection workshop and seminar have been given. Also, the project has resulted in input to SAFER HBM v10.0 update 2020 as well as other tools and knowledge for product development.

## WORLD LEADING HUMAN BODY MODEL FUNCTIONALITY

Within human body modelling (HBM), SAFER provides a competence platform for SAFER partners as well as a natural contact point for external cooperation. The growing activity in human body modelling has already placed SAFER amongst other well-known organisations, and the interest shown by other universities proves its high academic relevance globally. SAFER’s HBM vision encompasses a scaleable, tuneable, human body model with omnidirectional injury prediction capabilities, including high-g and low-g events. This means a virtual human substitute that can be used for predicting injury outcome in any impact situation/ direction, able to replicate a large population of people, standing as well as sitting, with humanlike kinematics in impacts as well as vehicle-manoeuvre events. The human body models, including the knowledge obtained in the pre-competitive joint research, are used by the industry in safety developments. The SAFER strategic investment more than ten years ago, together with funding mainly from the FFI programme, has helped to speed up the process of industrial implementation significantly, provid-

ing the SAFER partners with a state-of-the art human body model. The development of SAFER’s human body model and knowledge building in the field of biomechanics and human body protection continues through the start-up of the latest project Car Passenger Protection – To the Next Level. The project started in November and will continue until October 2023.

Another way to take advantage of simulation tools is through the project “Application for Automated Design & Optimization of Vehicle Ergonomics (ADOPT!VE)”. This associated project aims to study physical vehicle user interactions and develop a methodology for advanced vehicle ergonomics analyses within simulation tools. The ADOPT!VE project is focussing on assessment and optimisation of vehicle interior geometries. The process looks at user accommodation levels of alternative design solutions by enabling fast, objective, and automated simulations of virtual driving test routines, performed with a family of manikins, and generates subsequent ergonomics evaluations as the output. These accurate posture prediction models, together with improved virtual human models, can serve as input for human body models used in crash analyses. As such, they provide another bridge between the increasing relevance of the pre-crash phases to the injury predictions coming from the in-crash interactions.

## GENDER EQUALITY IN TRAFFIC SAFETY

Does one size fit all? Just as clothes need to accommodate the various sizes and shapes of the population, maybe the same is true for crash-safety systems. We have been working to map in more detail how well the crash dummies that are used today represent the population as a whole. The study “Are crash test dummies representative of the population?” shows that although men are overrepresented in motor vehicle collisions, the risk of sustaining an injury is higher for women – given the same severity exposure. Females, elderly and the obese are poorly represented by existing dummies. Hence there is a need for dummies of both men and women, of different sizes and ages for robust assessment. The study also concludes that human body models will provide a powerful extension to the crash test dummies as we develop the capability to scale and tune a model to represent any sex, size and age of road user. Whilst female dummies exist for frontal or side impact testing, the largest cause of impairment due to traffic collisions are whiplash associated disorders and women are more likely to suffer long-term. The overall aim of ViVA II has been to reach gender equality in traffic safety and SAFER’s researchers have taken steps in that direction and developed tools for the evaluation of injury preventive systems for both men and women. Despite the larger risk of whiplash-related symptoms for females, current whiplash protection assessment is adapted to the average male. ViVA II addressed these discrepancies by world leading research on female injury biomechanics.



## RESEARCH OBJECTIVES FOR RESEARCH AREA SYSTEMS FOR ACCIDENT PREVENTION AND AUTOMATED DRIVING

Building towards the research needs in Human Body Protection, these objectives still have primary relevance for this area:

- **Human body models** with enhanced omnidirectional injury prediction capability, and posture adjustments, capable of serving as an industrial and research tool; and furthermore, also addressing the needs arising from increased vehicle automation.
- **Methods to scale and tune** human body models, accommodating the need to simulate the variety of humans in a crash, including preceding events.
- **An increased understanding** of how pre-crash factors and individual differences influence injury outcome, by monitoring and quantifying sitting postures and behaviour in vehicles and other road users together with the research area Road User Behaviour.
- **Biomechanical investigations** addressing future challenges which require more in-depth understanding of injury occurrence and tolerances. For car occupants, the pelvis area is one key area in which significant steps will be taken.
- **Modelling challenging materials**, e.g. fat tissues and complex structural composites.
- **Expanding the application** of tools and knowledge on road users beyond vehicle occupants, such as the different interactions for pedestrians, two-wheelers, scooters, boards and other emerging transport trends.



# ROAD USER BEHAVIOUR

**H**OW DO PEOPLE BEHAVE in traffic and how can they be stimulated to a safe behavior? In an era where traffic complexity is increasing as quickly as the technology is evolving, answering this question becomes vital. Taking a broad multidisciplinary approach, the research area Road User Behavior at SAFER focuses on developing scientific methods and attractive solutions that facilitate safe behavior in traffic. It covers a variety of topics, from understanding pedestrian behavior to developing algorithms that enable assessment of vehicle occupant behaviors, as well as exploring safety implications of new mobility means such as electric scooters.

## IMPRESSIVE RESULTS FROM OUR PROJECTS

Several projects within the Road User Behavior area have during the past year delivered impressive results that are in line with the objectives of this particular area. To start with, the results have extended our understanding of how new technologies such as driver and passenger monitoring systems can be used to gain a deeper knowledge of driver and passenger state and behavior. This, in turn will help stakeholders design new, or improve existing, safety systems in vehicles. It is also useful in determining drivers' fitness to drive in automated vehicles.

A significant contribution has also been made in the field of interaction principles, e.g., it has been demonstrated how nudging can be used as a means to stimulate safer behaviors, both when it comes to drivers and pedestrians and bicyclists. In addition, our researchers have used a novel evaluation tool – the bicycle simulator Sim IV – to study how road infrastructure affects bicyclists' behavior. An insight here is that a moderate amount of information (centerline and edge lines) might be enough to generate significant improvements for bicyclists.

Furthermore, several experiments on interactions between automated vehicles and other road users in their vicinity have been carried. This has extended our knowledge on evaluation methodologies and tools (e.g., VR) as well as deepened our understanding of what factors affect such interactions. On top of this, we have tackled a rather neglected topic in the research community – human factors in remote operation of automated vehicles. In a prestudy, we identified research gaps in the field, and we are now addressing a portion of these in a continuation project.

Also, in light of Covid-19 pandemic, a task force on hygiene procedures in test with research persons was conducted, read more on page 29.

## ENRICHED PROJECT PORTFOLIO WITH 9 NEW PROJECTS

During the past year, the focus of Road User Behavior group has been on enriching the project portfolio with new projects. In total, 9 new projects have been associated.

In addition to these recently associated projects, our portfolio hosts additional 14 projects. Two of the Horizon2020 projects, MEDIATOR and Drive2theFuture, explore driver interaction with and acceptance of advanced driver support systems (ADAS) and automated vehicles. In MEDIATOR, a system is being developed that will constantly evaluate driving context, driver state and vehicle automation status in order to personalize its technology to the driver's general competence. The Drive2theFuture project, on the other hand, models the behaviour of different automated vehicle "drivers" and predicts acceptance for various driving scenarios. The project portfolio is also hosting two projects addressing safety of new electric vehicles for personal mobility (ePVMs), Characterizing and classifying new ePMVs (funded by Trafikverket via Skyltfonden) and SAFE-ePMVs (funded by Chalmers Transport Area of Advance). As implied by its name, the first one aims at evaluating and comparing different new e-vehicles for personal mobility in an exploratory study. The vehicles will be equipped with loggers and various sensors and compared to bike and e-bikes in relation to their stability, maneuverability and comfort. The SAFE-eMPVs leverages on the interdisciplinary approach and the complementary methodologies to study the safety needs of e-PVMs users and non-users. Notably, the main objectives of the project are to: 1) support the design of infrastructure and regulations, and 2) guide the technological development of e-PVMs. These objectives will be achieved through three main activities: a) analysis of e-PMVs' crashes in STRADA database, b) quantitative evaluation of the stability and manoeuvrability of e-PVMs in field trials, and c) qualitative assessment of the safety and ease-of-use of e-PVMs. Our completed projects in 2020 were MeBeSafe, ADAS&ME and SÄMO.

## COMPETENCE NETWORK HUMAN BEHAVIOR

At SAFER, there are several competence networks that contribute and inspire to build and spread knowledge, capture good ideas and create cross-functional projects. Under 2019, a new competence network related to the research area Road User Behavior has emerged. The new network is named Human Behavior and is led by Dr. Giulio Bianchi Piccinini, Chalmers. Combining knowledge from different disciplines, this competence network aspires to be a forum to discuss methodologies and challenges for the research on human behavior, with the final aim to improve the safety of the road transportation system. The network has successfully conducted a seminar series on ethical applications and considerations in traffic safety research assessing human behavior that will continue under the coming year.

## KEY HIGHLIGHTS FROM PROJECTS

### FRAGRANCE SYSTEM

The Fragrance system project explores novel countermeasures for driver fatigue. Several previous and ongoing projects have focused on fatigue detection and warning, whereas countermeasures have received less attention. In this proof-of-concept study, it is investigated whether an alerting fragrance can effectively wake up a drowsy driver and support sustained driving performance.

### SÄMO

Getting more people to cycle, and make cycling safer, is a suitable measure for sustainable mobility, fully in line with the UN's sustainability goals. In SAFER's project SÄMO (Safe mobility by bike – for a sustainable aging – Säker mobilitet på cykel för ett hållbart åldrande) special attention has been given to how to get older people to maintain their mobility through cycling. The project is now finalized and results show that older people prefer to continue to ride bicycles for increased health, but that the vehicle needs to be adapted in order to feel safe and then continue to use the bicycle for a longer period of time. The study shows that a supplementary electric motor on the bike is appreciated since the bike then can be used for more activities, for example when shopping.

### GLAD

The GLAD project focuses on goods delivery with small electric autonomous vehicles under the first and last mile, and how to ensure safe interactions between these vehicles and other road users around them. A recent study conducted within the project shows a range of new requirements when it comes to goods loading and unloading that have emerged due to the fact that the vehicle is autonomous and not accompanied by a human driver.



## ADAS&ME

The EU Horizon 2020 project ADAS&ME (Adaptive ADAS to support incapacitated drivers & Mitigate Effectively risks through tailor made HMI under automation), coordinated by VTI was finalized in 2020. The project aimed to develop Advanced Driver Assistance Systems that incorporate driver/rider state, situational/environmental context, and adaptive interaction to automatically transfer control between vehicle and driver/rider and thus ensure safer and more efficient road usage for all vehicle types (conventional and electric car, truck, bus, motorcycle). To achieve this, a holistic approach has been applied which considers automated driving along with information on driver/rider state and the environment. Within the ADAS&ME project, systems were developed with the aim to accurately detect when the driver/rider is not capacitated to drive, and consequently mitigate these states and avoid dangerous situations using adapted HMI and automation modes.



## RESEARCH OBJECTIVES FOR SAFER STAGE 5

- **Study road user behaviour** in their door to door travels.
- **Monitor driver and passenger** state and position.
- **Diagnose driver fitness** based on monitoring data.
- **Ensure safe interactions** between automated vehicles and other road users.
- **Develop and evaluate** novel interaction principles, including nudging.
- **Define and measure** user experience indicators related to safety



# NUDGING ROAD USERS TO BEHAVE MORE SAFELY IN TRAFFIC – WITHOUT THEM BEING AWARE OF IT

**W**E ALL KNOW how to drive a car or walk around in traffic, and will therefore make the decisions we need without being fully aware of them. We are so trained in how to behave in traffic, that our decision-making process has been transferred to our subconscious mind. But many classic road safety approaches circle around information or active symbols we have to interpret while driving. These appeal to our conscious mind, which could make them less effective or at least take longer time to work, as we have to switch from subconscious to conscious thoughts.

It could therefore be more effective to communicate road safety on a subconscious level. In the last few years, nudging has risen up as a popular way to affect people's behaviour. A nudge is an alteration of the choice-architecture, presenting the choices we could make in such a way that the safest or best choice becomes more likely to be made. It classically works on a subconscious level, without forbidding anything or using financial incentives. A classic nudge is rearranging a restaurant menu so the vegan options are highest up, which in turn makes people more likely to choose them.

This was the foundation for MeBeSafe. MeBeSafe was a €7.1 million EU-project with partners all across Europe, aiming to make traffic safer by nudging and other soft measures. For 3.5 years, the project has investigated, developed and researched numerous soft ways to make people behave safer in traffic. And now the results have come.

Eight soft measures have been revealed, each one thoroughly developed and researched from both a technological point-of-view as well as to the attitudes of people subjected to them. And both are very positive.

The first measure aims to help cyclists get more aware and reduce speed before really dangerous intersections. It is based on a number of totally flat stripes across a biking lane, getting closer and closer together as the cyclist

approaches the intersection. This leads to an illusion of going faster than they really are, which in turn makes them reduce their speed. Long-term studies in Gothenburg show that twice as many cyclists slow down before the crossing, and that it has an almost universal approval. Reactions studies indicate that the illusion appeal to a subconscious level, as there is an equal effect if the stripes are noticed or not. Equally important are the results that haptic stripes, that can be felt when biking over them, have very low acceptance as well as low effect on speed.

The second measure aims to make car drivers slow down, especially when exiting a fast motorway. The nudge is based on two rows of lamps embedded in each side of the road. If the driver is detected to be speeding, lamps light up in such a pattern that the light seems to be moving towards the driver. This also creates an illusion of speed, and is found to decrease the number of speeding drivers by 40%. The nudge was also very well-received by drivers who passed it by.

The lights are noticed by the conscious mind, although they may not processed there. There is a similar effect with a nudge to warn drivers when cyclists are about to pass. A novel prediction-detection system scans out the surroundings, and does not only categorise the various objects around it, it also predicts how they will behave. This is combined with a static risk of cyclists when an intersection is blocked from view. If a cyclist will pass, a green road-line in a head-up display turns red, and gets a notch from the side where the cyclist comes from. This led to 64% of drivers decreasing their speed and 56% looking more to the correct direction.

Two other in-vehicle nudges to increase distances between cars by increasing the use of Adaptive Cruise Control has been developed. One relies on people's love for order, and is made of circles on a screen moving around randomly. The more ACC you use, the more orderly do the circles behave. The other nudge is a list of the drivers using ACC the most. These nudges led to increases in ACC use by 46% and 118% respectively, and affected slightly different types of people.



“By using a nudging approach, road users will instead be encouraged to make a safe choice without even thinking of it.”

An ACC coaching app was also developed to help drivers get aware of the features in their car. But the main coaching app was developed for truck drivers. The app collects driving data from the phone and gives out insights to the driver, without sharing the results with a boss. It also suggests that two truckers should meet and coach one another – because the person with most knowledge to coach a trucker is another trucker. To help with this, it also provides reading material. The scheme was appreciated, but no effectiveness can be given due to COVID-19.

A reward scheme was also developed to help tired drivers take a break. If the car detects drowsiness, it will tell the driver that they will get a secret reward if they stop to take a break. A random voucher will then be given out. This led to 87% more drivers stopping to take a break.

But what do the results mean in terms of saved lives? The changed behaviour was assessed with an enormous German accident database, containing precise details of all accidents. Each accident in the database was evaluated manually, to see whether a changed behaviour would lead to a different outcome. This was combined with an assessment of how much the measures are likely to be implemented. The results show that somewhere between 150–500 lives could be saved, and 21 000–65 000 injuries could be prevented per year in the EU. The most likely adoption would lead to 366 lives saved, 40 000 injuries avoided and 3 billion euros saved in societal costs per year.

For more information about MeBeSafe, visit [mebesafe.eu](https://mebesafe.eu)



# KNOWLEDGE DISSEMINATION & RESEARCH OUTREACH

**P**ART OF THE SAFER MISSION is to disseminate results and knowledge to the partners and be a well renowned international centre of excellence. To achieve this SAFER regularly arrange activities for knowledge sharing. SAFER has arranged and participated in a wide range of events over the year – primarily to present results and findings of the research and knowledge production activities. A complete list of engagement to share knowledge and research findings is listed in appendix 7.

## SAFER SEMINARS AND PROJECT CREATION WORKSHOPS

SAFER is acknowledged as a meeting place and the various seminars are appreciated by the partners as efficient means to share knowledge and create visibility among SAFER researchers on current topics, as well as offering great opportunities for networking.

Since March, our networking and knowledge sharing activities have taken a new approach due to the Corona pandemic, which have meant that people have not been able to meet physically. However, we have found ways to still conduct a close dialogue and arrange knowledge sharing events together with our partners, e.g. through online meetings, webinars and even project-creating workshops. Our online activities have worked very well and been appreciated, we have, for example, become more national and have also had the opportunity to invite more international speakers to seminars. Our Thursday seminars, primarily for internal cross-fertilization and exchange of knowledge and ideas, have transformed into well-attended online webinars, with more participants than ever.

## 20 YEARS ANNIVERSARY AT LINDHOLMEN SCIENCE PARK

In September, Lindholmen Science Park, that turned 20 years in 2020, was celebrating with a three-day online activity during Lindholmen Open Days. Under the title “Global benefit for this decade”, both flashbacks were given to what shaped this productive innovation hub and future outlooks. It was three festive days with many exciting presentations. SAFER’s director Magnus Granström, together with Lotta Jakobsson, Volvo Cars, presented SAFER’s main contributions during these decades as well as giving some examples of success factors on how to collaborate in traffic safety research under the title SAFER – the piece of the puzzle that contributed to the world’s safest transport system. The female crash test dummy, originated from SAFER, participated in the online seminar.

## REGULAR REPORTING TO STAKEHOLDERS

SAFER’s partners has been kept informed about the research results and ongoing activities and opportunities through regular newsletters and social media seedings. More formal meetings with partners through the research areas has been performed six times during the period, including one Shareholders meeting. Nine board meetings have been held, including a two-day strategy meeting. Regular newsletters about projects, research results and other updates have been distributed from the research centre.



**Lindholmen Science Park turns 15 years.** The overall idea with SAFER is to together create value and knowledge beyond what an individual partner can do on their own. The environment here at Lindholmen Science Park, which is Sweden’s hub for future mobility, has since its inception been the natural meeting place for developing research and knowledge in sustainable traffic safety, says Malin Levin, deputy director of SAFER.

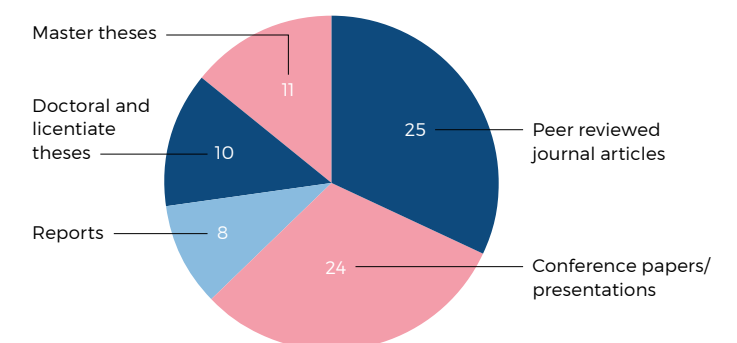
## PUBLICATION VOLUME

SAFER’s research projects have produced more than 78 publications during the second year in SAFER Stage 5, including peer reviewed journal articles (32%), conference papers and posters (31%), reports (10%), master theses (14%) and doctoral and licentiate theses (13%). Publications which are still listed as “in preparation/in press” 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. Research results are being disseminated through the website as well as through news articles and communication in social media and through newsletters. In the SAFER Knowledge library, [www.saferresearch.com/library](http://www.saferresearch.com/library), you’ll find most of the our public project publications that have been produced since the start in 2006.

## SAFER DOCTORS AND LICENTIATE SEMINARS

During SAFER’s 15<sup>th</sup> operational year three students working in the SAFER environment have written their doctoral theses and six have written a licentiate thesis, see appendix 9.

**Figure 7**  
Publication Types



As part of Lindholmen Science Park’s anniversary, a book “En historia om framtiden” was published in which SAFER’s contribution to the science park was presented.



# A NEW UN RESOLUTION FOR IMPROVED ROAD SAFETY



“

By the new UN resolution on traffic safety, we together at SAFER sees a great opportunity to both contribute to the global sustainability goals and to be inspired and guided in our research to meet our common challenges.”

## TRAFFIC SAFETY'S ROLE IN GLOBAL SUSTAINABILITY

**T**HE SUSTAINABLE DEVELOPMENT GOALS are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate, environmental degradation, prosperity, peace and justice. Working with sustainability is a complex matter that involves all sectors of our globalized society. Trying to do it alone is a monumental task and not even preferred. One of the ground pillars of the Global Sustainable Development Goals is number 17, which is about cooperation, collaboration, partnership and knowledge sharing.

SAFER supports the UN goals and will continue to integrate these important perspectives in the research and strategic work. The aim is, in addition to the obvious contribution to a holistic approach to sustainable mobility, to find new perspectives, create awareness, find new research questions and open up for dialogues in closely connected areas, e.g. health, climate change and spatial planning. By doing so, there is also a potential for increased funding and new areas of collaboration.



The host of the conference, the Swedish Minister for Infrastructure Mr. Tomas Eneroth, welcomed everyone at the opening ceremony by stating our new joint target: "We recognize our shared responsibility and call on the Member States to help reduce road fatalities by at least 50 percent from 2020 to 2030".



SAFER's Board member Maria Krafft gave an inspirational speech addressing the need for a mobility system that allows for human mistakes. "Safety is a boundary condition for mobility", Maria said at the UN-conference.

## THE THIRD GLOBAL UN CONFERENCE ON ROAD SAFETY

In February, Sweden hosted the 3<sup>rd</sup> Global Ministerial Conference on Road Safety. The UN conference gathered about 1,700 delegates from 140 countries. Among these were a large number of ministerial delegations as well as representatives from industry, research organisations, NGOs and others. In addition to the exchange of knowledge and experience, the conference resulted in "The Stockholm declaration", a strategic agenda and recommendations to achieve the global sustainability goals by 2030 and halve the number of fatalities in traffic between 2020 and 2030. The Stockholm Declaration also reflects the nine recommendations "Saving lives beyond 2030 – the next steps", developed by the conference's Academic Expert Group, led by Chalmers' adjunct prof. Claes Tingvall. The recommendations are based on the 2030 Agenda and puts road traffic safety on the same level of global criticality as climate, health and equity issues, and means that road safety can no longer be traded off in order to promote other needs. Inclusion among the SDGs also means that road safety is the responsibility of a wide range of stakeholders, both public and private. The Saving lives Beyond 2020 presents a new way of thinking and look upon road safety in a larger context.

The Stockholm declaration was adopted to a UN resolution in August 2020, a major step for improved road safety all around the globe.

## SAVING LIVES BEYOND 2020: THE NEXT STEPS

Recommendations of  
the Academic Expert Group

for the 3rd Global Ministerial  
Conference on Road Safety

"Saving lives beyond 2020 – the next steps" has been the base for the new UN resolution on traffic safety and will inspire and guide us in our research.





More than 150 UN delegate participated in SAFER's event Borderless research to save lives – an experience on how Vision Zero can be addressed by collaboration – in conjunction to the global ministerial conference in Stockholm in February.

## BORDERLESS RESEARCH TO SAVE LIVES – A SAFER EVENT FOR THE UN DELEGATES

More than 150 UN delegates from about 40 countries participated in SAFER's event Borderless research to save lives – an experience on how Vision Zero can be addressed by collaboration – in February. The event was listed as a pre-event in the conference program to the global ministerial conference, aiming to add additional value and knowledge to the guests.

The event started off with a number of inspirational lecturers from the academy, industry and research institutes as well as the European commission who talked about how to successfully collaborate in partnership and why it is more efficient to work in together towards a common vision. Thereafter, the guests were invited to a walking networking dinner at an exhibition where SAFER's joint research was presented, focusing on the collaborative elements that contributed to the projects' success. The purpose was not only to position our world leading research, but also to present how SAFER manages to perform

collaboration and work in strong partnerships in practice. The event also aimed to support the UN Global Sustainable Development Goals, Sweden and the Vision Zero strategy to be truly global. In the exhibition, guests were able to talk to our experts in our various research areas and seek knowledge about how to successfully work with knowledge dissemination, for example through projects such as CTS (China Sweden Research Centre for Traffic Safety) and SaferAfrica. The station for discussing future policies, legislation and regulations was also well-attended by the guests. There was a great interest in our research and it was clear that SAFER's knowledge is of value to both politicians and those who are actually working with implementation of traffic safety enhancing solutions in various parts of the world.

# 2030

## SETTING THE PLAN TOWARDS 2030

We are now looking into how we in the best possible way together can utilize the opportunities that come with the Stockholm declaration and the new UN resolution. At SAFER, we now together see a great opportunity to take advantages of our strengths to both contribute to the global sustainability goals and to be inspired and guided in our research to meet our common challenges.

As a first step to maximizing our collective and individual opportunities, a seminar was held in May to present the Stockholm declaration and its nine recommendation to our research community. Now we continue the work with a webinar series including three sessions to get an even deeper understanding of the recommendations in order to utilize the outcome and initiate the strategic work. In the webinars the members of the Academic Expert Group that developed the "Saving lives beyond 2020 – the next steps" will present their strategic thoughts behind recommendations and some ideas on how we together can take on the common challenges. The overall aim is to create a better understanding of the opportunities created with the new UN resolution to identify suitable research questions and potential projects, but also to demonstrate leadership by leading the dialogue and initiate strategic work.



# APPENDICES

## APPENDIX 1 SAFER PARTNERS

The following partners have been engaged during operational year 15:

### PARTNER LEVEL 1 & 2

- Aptiv AB
- AstaZero AB
- Autoliv Development AB
- BETA CAE Nordic AB
- Chalmers tekniska högskola AB
- China Europe Vehicle Technology AB (CEVT)
- Combitech AB
- Folksam
- Halmstad University
- If Insurance
- Institute of Transport Economics – Norwegian Centre for Transport Research (TØI)
- National Electric Vehicle Sweden AB (NEVS)
- RISE Research Institutes of Sweden AB
- Scania CV AB
- Smart Eye AB
- Swedish National Road and Transport Research Institute (VTI)
- Swedish Transport Administration
- University of Gothenburg
- University of Jönköping
- University of Lund (as of September)
- University of Skövde
- Veoneer Sweden AB
- Volvo Car Corporation
- Volvo Group AB
- Zenseact (as of September)

### PARTNER LEVEL 3 (ASSOCIATED PARTNERS)

- 4S (as of July)
- Afry
- Asymptotic (as of July)
- City of Gothenburg
- Cycleurope AB
- HiMinds Göteborg AB
- Malmeken AB
- Nationalföreningen för trafiksäkerhetens främjande (NTF Väst)
- Svanberg & Svanberg AB
- Swedish Transport Agency
- Trivector
- Zenuity

## APPENDIX 2 SAFER BOARD

The following members have been part of SAFER Board during the second year of SAFER Stage 5:

- Autoliv: Cecilia Sunnevång
- Chalmers: Sinisa Krajnovic and Angela Hillemyr
- RISE: Jan Jacobson, Stefan Nord (as of March)
- Swedish Transport Administration: Maria Krafft
- Volvo Car Corporation: Malin Ekholm
- Volvo Group: Magnus Rilbe, Peter Kronberg (as of March)
- VTI: Jonas Jansson
- Independent chairperson: Karin Svensson
- Hans Fogelberg (Region Västra Götaland) and Eric Wallgren (Vinnova) has joined the Board as observers

## APPENDIX 3 SAFER MANAGEMENT TEAM

The following members have been part of SAFER's management team during SAFER's operational year 15:

- **Arne Nåbo**, Acting Research area Director Systems for accident prevention and automated driving (April until August)
- **Azra Habibovic**, Research area director Road user behaviour
- **Fredrik Sandblom**, Research area director Systems for accident prevention and automated driving
- **Ines Heinig**, Project coordinator
- **Ingrid Skogsmo**, Senior research advisor
- **Fredrik Von Corswant**, Connected research resource leader for Revere
- **John-Fredrik Grönvall**, Connected research resource leader for Naturalistic driving data
- **Jolyon Carroll**, Research area director Human body protection (as of April)
- **Linus Wågström**, Research area director for Safety performance evaluation (as of November)
- **Lotta Jakobsson**, Research area director Human body protection (until April)
- **Magnus Granström**, Director
- **Malin Levin**, Communications and partnerships, Deputy director
- **Mats Petersson**, Research area director Safety performance evaluation (April until September)
- **Matteo Rizzo**, Research leader for Vision Zero Academy (parental leave May-November)
- **Robert Thomson**, Chalmers profile director traffic safety
- **Torbjörn Andersson**, Research area director Safety performance evaluation (until May)
- **Simon Sternlund**, Acting Research leader for Vision Zero Academy (May-November)
- **Sofia Fagrell**, Controller

## APPENDIX 4 COMPETENCE NETWORKS AT SAFER

The following competence networks have been active during the reporting period:

**Automotive Safety Assurance**  
Focus is preliminary around how to design L3-L4 automated vehicles such that the accident risk is tolerable, and how to prove that the risk is tolerable with sufficient confidence, and how to design with explainability at all times. **Competence network leader:** Fredrik Sandblom

**Human behaviour**  
By applying an interdisciplinary approach, the scope of this competence network is to understand human behaviour in traffic and develop scientific methods and tools to create prerequisites for safe driving. It is also about the interplay between humans and technical systems in different contexts; how technical systems should be designed to achieve efficient and safe interaction with the users. **Competence network leader:** Giulio Bianchi Piccinini

**Perception, sensing & communication**  
Sensors and communication enable

technologies for a plethora of safety systems. The scope of this group is to create and share research ideas around vehicular communications, sensors systems, and signal processing. **Competence network leader:** Lars Hammarstrand

**Structures and materials**  
The purpose of this competence area is to gather researchers concerned with vehicle architectures and lightweight materials suitable for future efficient vehicles with new powertrains. **Competence network leader:** Christopher Cameron

**Vehicle Dynamics**  
Vehicle dynamics is creating a collaborative arena connecting vehicle dynamics research carried out in academia/ institutes and the corresponding advanced engineering activities in the automotive industry. **Competence network leader:** Bengt Jacobson

## APPENDIX 5 THE SAFER ECOSYSTEM

- Institutes and academy**
- Children's hospital of Philadelphia
  - Japanese Automotive Research Institute Nagoya University
  - Tokyo university of Agriculture and Technology
  - University of IOWA
  - University of Michigan Transportation Research Institute (UMTRI)
  - Xiamen University of Technology

- Collaborative organisations and research programmes**
- Australia Driverless Vehicle Initiative (ADVI)
  - CLEPA European Association of Automotive Suppliers
  - CTS (China Sweden Traffic Safety Centre)
  - Cykelcentrum (Swedish Cycling Research Centre)
  - Drive Sweden
  - European Automotive Research Partners Association (EARPA)
  - European Council for Automotive R&D (EUCAR)
  - European Road Transport Research Advisory Council (ERTRAC)
  - Forum för Transportinnovation
  - K2 Centre
  - HUMANIST
  - Movéo
  - Neuroscience Research Australia
  - The Association for the Advancement of Automotive Medicine (AAAM)
  - The Group for national cooperation (GNS Väg)
  - SDNS Northern Europe (Sustainable Development Solutions Network)
  - Swedish electromobility Centre
  - WARA-CAT (Collaborative and Autonomous Transport)
  - WASP (Wallenberg Autonomous Systems and Software Program)
  - The Association for the Advancement of Automotive Medicine (AAAM)
  - The Group for national cooperation (GNS Väg)
  - SDNS Northern Europe (Sustainable Development Solutions Network)
  - WARA-CAT (Collaborative and Autonomous Transport)
  - WASP (Wallenberg Autonomous Systems and Software Program)



APPENDIX 6 / PROJECT PORTFOLIO

PROJECT	PROJECT LEADER	START	END	FUNDER	PARTNERS
Human Body Protection					
ADOPTIVE – Application for Automated Design & Optimisation of Vehicle Ergonomics	Erik Brolin	01-05-2020	30-04-2023	KK-Stiftelsen	University of Skövde, Volvo Group, Scania, VCC, CEVT, Fraunhofer-Chalmers Research Centre for Industrial Mathematics (FCC)
A-HBM – Active human body models for virtual occupant response, step 4	Linus Wågström	01-04-2018	31-03-2021	FFI	Autoliv, Chalmers, Dynamore Nordic, VCC
ASSESSMENT OF PASSENGER SAFETY IN FUTURE VEHICLES	Lotta Jakobsson	01-05-2017	30-11-2020	FFI	VCC, Autoliv, Chalmers
CAR PASSENGER PROTECTION – To the Next Level / Passenger Safety, part 2	Lotta Jakobsson	01-11-2020	31-10-2023	FFI, TSAF	VCC, Autoliv, Chalmers
DUCTILE COMPOSITE – Fiber composites with ductile properties	Martin Fagerström	06-12-2016	30-06-2021	Energi-myndigheten	Chalmers, KTH, Biteam, VCC
FFI-CRASH 2 – Modelling crash behaviour in future lightweight composite vehicles	Martin Fagerström	01-01-2017	30-09-2020	FFI	Chalmers, RISE, Gestamp, VCC, Volvo Group, ÄF, Escenda, FS Dynamics, NEVS, DynaMore, MSC Software
ICONIC – Improving the crashworthiness of composite transportation systems	Robin Olsson	01-10-2016	30-09-2020	EU H2020	RISE + non-Swedish full partners (8) and partner organisations (5) 5 Partner organisations (+ Chalmers joined Oct 2018)
INJURY HBM, STEP 4 – Pelvis and spine injury predicting models for women and men in a variety of sitting postures in future autonomous cars	Bengt Pipkorn	01-04-2019	31-03-2022	FFI	Autoliv, VCC, Chalmers, GU (Sahlgrenska)
LONG TERM CONSEQUENCES – Identification and Prediction of Injuries with Long Term Consequences	Bengt Pipkorn	09-10-2017	31-12-2020	FFI	Autoliv, VCC, KTH, POC, MIPS
OSCCAR – Future Occupant Safety for Crashes in Cars	Johan Davidsson	01-06-2018	31-05-2021	EU H2020	VCC, Autoliv, Chalmers + other EU and international partners
SAFER Pre-Study: SAFER CYCLING	Magnus Larsson	04-05-2020	01-04-2021	SAFER Pre-Study Funding	VTI, Folksam, Chalmers, Sahlgrenska Academy, Vätterrundan
VIRTUAL – Open Access Virtual Testing Protocols for Enhanced Road User Safety	Magnus Larsson	01-06-2018	31-05-2022	EU H2020	VTI, VCC, Chalmers, TØI + other EU and international partners
VIRTUAL EVALUATION TOOLS FOR PEDESTRIAN INTEGRATED SAFETY	Robert Thomson	01-04-2019	31-03-2022	VINNOVA+MOST China Sweden call	Chalmers, VTI, Autoliv, VCC + Tsinghua University, University of Science and Technology Beijing (USTB), Geely , RIOH, Brilliance Auto
ViVA II – Virtual Vehicle Safety Assessment Step 2: Open Source Digital Human Body Models and Crash Testing	Robert Thomson	01-04-2017	31-03-2020	VINNOVA	VTI, Chalmers, Folksam, VCC
Road User Behaviour					
ADAS&ME – Adaptive ADAS to support incapacitated drivers Mitigate Effectively risks through tailor made HMI under automation	Anna Anund	01-09-2016	31-03-2020	EU H2020	VTI, Autoliv, Smart Eye + other EU and international partners
AHA II – Design Ethnographic Living Labs for Future Urban Mobility – A Human Approach	Vaike Fors	01-09-2016	31-12-2021	Drive Sweden/ VINNOVA	Halmstad University, VCC, Gothenburg City, Helsingborg City, Skånetrafiken, Västtrafik
BRAVE – BRidging gaps for the adoption of Automated Vehicles	Ingrid Skogsmo	01-06-2017	28-02-2021	EU H2020	VTI (coordinator) + other EU and international partners
CHARACTERIZING AND CLASSIFYING NEW E-VEHICLES FOR PERSONAL MOBILITY	Marco Dozza	01-08-2019	31-12-2021	Skyltfonden (STA)	Chalmers
COMMUNICATING BICYCLE HELMET	Jan Andersson	01-06-2019	31-12-2020	Skyltfonden (STA)	VTI, Ericsson, POC

PROJECT	PROJECT LEADER	START	END	FUNDER	PARTNERS
Road User Behaviour					
DRAMA – Driver and passenger activity mapping	Cristofer Englund	01-03-2018	29-02-2020	FFI	Smart Eye, RISE
DRIVE2THEFUTURE	Anna Anund	01-05-2019	30-04-2022	EU H2020	VTI, TØI + other EU and international partners
EHMI – External Interaction Principles for Creating Trust in Heavy Automated Vehicles	Azra Habibovic	01-04-2020	31-12-2021	FFI	Scania CV, Halmstad University, RISE
ENHANCED ADAS – Improving drivers' experience, acceptance and trust in assistance systems	Azra Habibovic	15-10-2020	15-10-2022	FFI	RISE, Aptiv, SmartEye
EVALUATION OF A FRAGRANCE SYSTEM TO COUNTER SLEEPINESS AT THE WHEEL	Anna Sjörs Dahlman	01-04-2020	31-03-2021	FFI	VTI, VCC, KI, Moodify, WIS
FIT2DRIVE	Katja Kircher	01-04-2020	31-12-2022	FFI	VTI, SmartEye
GLAD – Goods delivery under the Last-mile with Autonomous Driving vehicles	Azra Habibovic	01-06-2020	30-09-2022	Trafikverket	RISE, Aptiv, Combitech, Clean Motion, Halmstad University
IN THE HUB – Interaction between operators and driverless vehicles in the transport system of the future	Johan Fagerlönn, Linda Meiby	01-04-2020	31-10-2022	FFI	Scania, RISE, Boliden, Icemakers
MEBESAFE – Measures for Behaving Safely in Traffic	MariAnne Karlsson	01-05-2017	31-10-2020	EU H2020	SAFER JRU (Chalmers, Swedish Transport Administration), VCC + other EU and international partners
MEDIATOR – Mediating between Driver and Intelligent Automated Transport system on our roads	Anna Anund	01-05-2019	30-04-2023	EU H2020	VTI, Autoliv and Zenuity (Germany) + other EU and international partners
QUADRAE - Quantitative Driver Behaviour Modelling	Thomas Broberg	01-01-2016	31-03-2021	FFI	VCC, Volvo Group AB, Autoliv, VTI, Chalmers
SAFE-EPMVS – Safety and ease-of-use assessment of new electric vehicles for personal mobility (e-PMVs) in urban environment	Marco Dozza	01-01-2020	31-12-2021	Chalmers AOA Transport	Chalmers
SAFER Pre-Study: HUMAN FACTORS RELATED TO REMOTE CONTROL OF AUTOMATED HEAVY VEHICLES	Linda Meiby	15-01-2020	30-04-2020	SAFER Pre-Study Funding	RISE, SCANIA
SAFER Pre-Study: SAFETY CULTURE FOR AUTOMATION IN TRANSPORT COMPANIES	Christina Stave	01-03-2020	31-03-2021	SAFER Pre-Study Funding	VTI, Volvo Group AB, TØI
SAFER Pre-Study: SMART-LOOP: Design of multi-modal human-machine-interaction system for keeping the driver in-the-loop in automated driving systems	Pinar Boyraz Baykas	01-01-2020	31-12-2020	SAFER Pre-Study Funding	Chalmers, VTI
SAFER Pre-Study: TASK FORCE – HYGIENE PROCEDURES IN TEST WITH RESEARCH PERSONS	Arne Nåbo	01-09-2020	31-12-2020	SAFER Pre-Study Funding	VTI, Autoliv, RISE, Scania, Veoneer, Volvo Group AB
SAFER Pre-Study: THE ROLE OF ROAD DESIGN to support psychological processing and safe behavior of vulnerable road users at complex intersections: A feasibility study in traffic simulators.	Debora Lombardi	15-04-2020	30-09-2020	SAFER Pre-Study Funding	University of Gothenburg, VTI
SCALE-UP – Crowdsourcing for scaling up evaluation of external interfaces on automated vehicles	Azra Habibovic	01-03-2019	31-05-2021	FFI	RISE, VCC
Safety Performance Evaluation					
ARCADE – Aligning Research and innovation for Connected and Automated Driving in Europe (CARTRE2)	John-Fredrik Grönvall	01-10-2018	30-09-2021	EU H2020	SAFER, Chalmers, Volvo Group AB
FOT-E – Field Operational Test-Feature Extraction from Video	John-Fredrik Grönvall	01-11-2019	31-10-2022	FFI	Chalmers, Autoliv and Smarteye



PROJECT	PROJECT LEADER	START	END	FUNDER	PARTNERS
Safety Performance Evaluation					
HANDBOOK OF ROAD SAFETY MEASURES	Alena Hoyer	01-01-2013	no	Norwegian Public Roads Administration	TØI
HETEROGENEOUS TRAFFIC GROUPS – Heterogeneous Traffic Groups Cooperative Driving Behaviours Research under Mixed Traffic Condition	Jonas Jansson	01-04-2019	31-03-2022	VINNOVA+MOST China Sweden call	VTI, Chalmers, VCC, Volvo Group AB, RIOH, Geely , Beijing Jingwei HiRain, Tsinghua University, Tongji University
L3PILOT – Piloting Automated Driving on European Roads	John-Fredrik Grönvall	01-09-2017	31-08-2021	EU H2020	SAFER JRU, VCC, Autoliv + other EU and international partners
MIDAS – anonyMising DAta collection for traffic Safety	Cristofer Englund	01-04-2020	31-03-2023	FFI	RISE, Höskolan i Halmstad, Viscando, Berge Consulting
Open Research project: SAFETY DATASET FOR TRAINING AND VALIDATION OF AI PERCEPTION FUNCTIONS IN AD AND ADAS	Jörg Bakker	01-11-2020	30-06-2021	Open Research at AstaZero Program	Asymptotic, Revere
RODL – Road Data Lab	Thomas Olsson	01-12-2019	31-12-2021	FFI	RISE, Lund University, AI Sweden, Zensact, Univrses
STRADA – Swedish Traffic Accident Data Acquisition Indepth study	John-Fredrik Grönvall	01-04-2020	01-10-2021	FFI	Chalmers, Autoliv, Folksam, IF, VTI, VCC, Volvo Group
UDRIVE Data User Group	John-Fredrik Grönvall	01-07-2017	01-10-2021	Consortium financed	SAFER, DLR, IFSTTAR, LAB, SWOV, University of Leeds
VRU – E-SCOOTER "TARGET"	Fredrik Åkesson	01-10-2020	30-09-2021	FFI	AstaZero
Systems for Accident Prevention and Automated Driving					
AUTOFREIGHT – Self-driving trucks for smarter logistics	Fredrik von Corswant	01-04-2017	30-06-2021	FFI	Volvo Group AB, Combitech, City of Borås, Chalmers
ENSEMBLE – ENabling Safe Multi-Brand pLatooning for Europe	Stephane Julien	01-06-2018	31-05-2021	EU H2020	Scania, Volvo Group AB, KTH + other EU and international partners
ESPLANADE	Fredrik Warg	01-01-2017	31-03-2020	FFI	Aptiv, Comentor, KTH, Qamcom, RISE, Semcon, Systemite, Veoneer, VCC, Volvo Group AB, Zenuity
ETAVEP – Enablers for Testing Autonomous Vehicles at Existing Proving ground	Albert Lawenius	01-04-2020	31-03-2022	FFI	VCC, Volvo Group AB, AstaZero, RISE, Chalmers, SafeRadar
HEADSTART – Harmonised European Solutions for Testing Automated Road Transport	Jonas Sjöberg	01-01-2019	31-12-2021	EU H2020	SAFER JRU, RISE, Chalmers, Volvo Group AB, Veoneer + other EU and international partners
IDOLLY – Use of i-dolly for local distribution of container trailers to logistics terminals from a dry port	Fredrik Von Corswant	26-10-2017	31-12-2020	FFI	Volvo Group AB, Chalmers, VBG, Ellos, Kerry Logistics, Speed Group, Borås Stad
MICA 2 – Modelling Interaction between Cyclists an Automobiles	Marco Dozza	01-11-2019	31-12-2022	FFI	Chalmers, Autoliv, Veoneer, VCC, IF, Viscando, VTI
Open Research project: TRACTION ADAPTIVE MOTION PLANNING FOR CRITICAL SITUATIONS	Lars Svensson	20-01-2020	20-02-2021	Open Research at AstaZero Program	KTH, Revere
Open Research project: VALIDATION OF AUTONOMOUS HIGHWAY DRIVING ALGORITHM AT ASTA ZERO	Johan Karlsson	01-08-2020	31-12-2020	Open Research at AstaZero Program	Chalmers, Revere
RealSIM – Realistic simulation of vehicles for safer, more robust and less expensive development of automated vehicles	Monica Ringvik	01-11-2017	31-03-2020	FFI	AstaZero, Chalmers, Data Intelligence, Wiretronic, Volvo Group AB
REDO – Remote Driving Operations	Maytheewat Aramrattana	01-12-2019	30-11-2022	FFI	CEVT, Einride, Ericsson, Ictech, KTH, NEVS, Voysys, VTI
SAFESMART – Safety of Connected Intelligent Vehicles in Smart Cities	Alexey Vinel	01-09-2019	31-08-2023		Halmstad University, AstaZero, Scania, H&E Solutions, Terranet, Gutec, Quviq, KPIT
SAFETYNET FOR TRUCKS	Stefan Koychev	01-10-2018	31-03-2022	FFI	Volvo Group AB, Chalmers University of Technology
SWEDEN4PLATOONING	Stefan Bergquist	01-01-2017	31-12-2020	FFI	Scania, Volvo Group AB, KTH, RISE, Schenker AB, and Swedish Transport Administration
VALU3S – Verification and Validation of Automated Systems’ Safety and Security	Behrooz Sangchoolie	01-05-2020	30-04-2023	EU H2020	RISE, VTI, KTH + other EU and international partners

PROJECT	PROJECT LEADER	START	END	FUNDER	PARTNERS
Competence					
AI DRIVEN MOBILITY	Daniel Gillblad, Marie Karlsson	01-10-2020	31-12-2021	VINNOVA, Drive Sweden pro-gram	Zenseact AB, Ericsson AB, Volvo Group AB, Polestar, Viscando, Univrses, UniqueSec, VGR, Trafikverket, Kista Science City, Örebro kommun, Chalmers, University of Borås, Malmö University, Region Örebro län, Region Jönköpings län, Sjöfartsverket, AFRY, DOKIV AB, NSR
ICLAD Phase 4 – Initiative for the global harmonisation of accident data	Ines Heinig	01-01-2020	31-01-2022	Consortium financed	SAFER (Chalmers), Autoliv, VCC, Volvo Group AB, Asymptotic + other EU and international partners
Pre-study for a SWEDEN/INDIA Multi-stakeholder Innovation and Safety Program	Peter Kronberg	03-06-2019	31-03-2020	VINNOVA	Chalmers, RISE, VTI
SMART URBAN TRAFFIC ZONES	Ines Heinig	01-09-2020	01-09-2022	FFI	SAFER/ Chalmers, Göteborg University, RISE, AstaZero, VTI, Gothenburg City, Scania, VCC + other Swedish partners
SUS – Sensor testing in adverse weather conditions	Peter Eriksson	01-10-2020	30-09-2022	FFI	AstaZero, Chalmers
TSIH – Trafic safety in Horizon 2020	Magnus Granström	01-04-2019	31-12-2020	VINNOVA, Drive Sweden program	SAFER/Chalmers, Autoliv, VCC, Volvo Group AB, VTI
TSIH Continuation EU-coordination Drive Sweden	Ingrid Skogsmo	01-11-2020	31-08-2021	VINNOVA, Drive Sweden program	VTI, SAFER/Chalmers, Volvo Group AB, Autoliv, RISE, Scania

### APPENDIX 7 KNOWLEDGE SHARING ACTIVITIES

Conducted SAFER seminars, conferences and other events during year 15 include:

- Transportforum, SAFER hosts three sessions, Jan 8–9, 2020:
- Road Safety on the European Horizon
- Women and men in traffic – are men more protected than women?
- Workshop: Ensure safety in future mobility – prospects, trends, and technology
- Human body protection workshop: New seating and ways to use future cars, Jan 10, 2019.
- SAFER Seminar: Impact and Compression After Impact (CAI) modelling of composites, Prof. Stephen Hallett, University of Bristol, January 16, 2020.
- Future Mobility: Nordic values in disruptive mobility development, Silicon Valley, Jan 15–17, 2020.
- Dissertation: Johannes Främby defended his doctoral thesis Methods for efficient modelling of progressive failure in laminated fibre-reinforced composites, Jan 17, 2020. ..
- Anna Vadeby’s docent lecture “Traffic safety evaluation – speed, crashes and statistical methods”, Jan 29, 2020.
- SAFER lunch seminar: Who’s driving the truck” and Results from the SEBRA project, Jan 30, 2020.
- SAFER Research area day, Feb 4, 2020.

- Pre-event in conjunction with the 3rd global ministerial UN-conference: Borderless research to save lives – an experience how Vision zero can be addressed by collaboration, Feb 18, 2020.
- SAFER lunch seminar: Enabling Automation-Ready Transport Planning and The use of multi-body kinematics and morphing techniques for the positioning of human body models in vehicles, Feb 27, 2020.
- SAFER seminar with NTF: Nudging - kan trafikmiljön bli säkrare med omedvetna positiva beteendeförändringar?, February 29.
- SAFER lunch seminar: Presentation of CEVT and the new Lynk & Co soon coming to Europe and A study of the VIVA model in whiplash, March 5, 2020.
- Licentiate seminar with Ron Schindler, Chalmers University of Technology: Towards an Improved Safety Benefit Assessment for Heavy Trucks – Introduction of a framework for the combination of different data sources, March 6, 2020.
- SAFER lunch seminar: Results from the Drive Me project, March 12, 2020
- SAFER Shareholders meeting, March 18.
- SAFER lunch seminar: Electric scooters are on the road: how do the riders crash and how we can protect them?, March 19, 2020
- SAFER lunch seminar: Human body models - the theme of SAFER Lunch seminar March 26, 2020
- SAFER Research area day, April 1, 2020.
- SAFER Update, webinar for the SAFER Community, April 1, 2020.

- SAFER lunch seminar: Timely V2X Communication and the Importance of Antennas & How to save lives after an accident, April 2, 2020.
- Dissertation seminar: Material modeling of adipose tissue for traffic injury prevention: A finite element study of parameters influencing lap belt to pelvis interaction, with Hosein Naseri, Chalmers University of technology, April 7, 2020.
- SAFER lunch seminar: Continuous Experimentation for the Automotive Field & LIV 4.0, April 16, 2020.
- SAFER lunch seminar: Road safety trends in Sweden 2019, Matteo Rizzi, Vision zero academy, April 23, 2020.
- Licentiate seminar with I Putu Alit Putra, Chalmers University of Technology: An Average Female Head-Neck Finite Element Model with Reflexive Neck Muscles, April 28, 2020.
- Licentiate seminar with Carolyn Oddy, Chalmers University of Technology: Modelling 3D-woven composites on the macroscale: predicting damage initiation and inelastic phenomena, April 29, 2020.
- Webinar: The outcome of the UN Conference on road safety and the Stockholm declaration, May 6, 2020.
- Licentiate seminar with Linda Pipkorn, Chalmers University of Technology: The automation effect: Investigating factors that influence the driver response process to a safety-relevant event during assisted driving and after unsupervised automation, June 2, 2020.
- AI Stakeholder inventory workshop, June 2, 2020.



- SAFER Research area day, June 4, 2020.
- SAFER Update for the community, June 4, 2020.
- Dissertation seminar: Traffic Safety potential and effectiveness of lane keeping support, with Simon Sternlund, Swedish Transport Administration and Chalmers University of Technology, June 15, 2020.
- AI Stakeholder inventory workshop, September 2, 2020.
- SAFER lunch seminar: Deep learning with automotive sensor data and introduction to 4S, Asymptotic and 4S, Sep 3, 2020.
- Physiological measurement methods with Christer Alström, VTI and Robin Palmberg, KTH Royal Institute of Technology, Sep 10, 2020.
- Anna Sjörs Dahlman's lecture for Adjunct Associate Professor at E2, titled Physiological monitoring in the real world – opportunities and challenges, June 2, 2020.
- SAFER Seminar: Human factors related to remote control of automated heavy vehicles – a SAFER pre-study, Azra Habibovic, RISE and Linda Meiby, Scania, June 10, 2020.
- Licentiate seminar with Karl-Johan Larsson, Chalmers University of Technology: Evaluation of Morphed Human Body Models for Diverse Occupant Safety Analysis, June 10, 2020.
- Master Thesis presentations, Chalmers M2, June 11, 2020.
- SAFER Seminar: Modelling Interaction between Cyclists and Automobile, June 17, 2020.
- Workshop with K2: Public transport nodes and its safety challenges, August 20, 2020.
- Workshop with Swedish Electromobility Centre: Finding knowledge gaps, August 24.
- MeBeSafe final event, Sep 3, 2020.
- SAFER lunch seminar: SAFER's new partners Asymptotic and 4S – knowledge and contribution to SAFER's research, Sep 3, 2020.
- SAFER lunch seminar: Physiological measurement methods in traffic safety research, Sep, 10, 2020.
- SAFER Research area day, Sep 15, 2020.
- SAFER Update for the community, Sep 15, 2020.
- Lindholmen Open days (20 years anniversary), Sep 15–17, 2020- SAFER participated with the presentation SAFER – the piece of the puzzle that contributed to the world's safest transport system.
- FFI result conference, including SAFER- presentation about the UN sustainable development goals and the UN conference, Sep 16, 2020.
- SAFER lunch seminar: Safety Culture For Automation In Transport Companies and Eye tracking, Sep 17, 2020.
- SAFER lunch seminar: Euro-NCAP upcoming rating scheme, Sep 24, 2020.
- SAFER Shareholders meeting, Sep 28, 2020.
- SAFER Seminar: Introduction of Lund University, new partner in SAFER, Sep 28, 2020.
- SAFER lunch seminar: Nudging traffic safety – experiences from the MeBeSafe project, Oct 1, 2020.
- SAFER lunch seminar: Automotive safety assurance, Oct 8, 2020.

- SAFER lunch seminar: China Sweden Traffic Safety Centre (CTS) – overview, outlook and projects, Oct 15, 2020.
- SAFER lunch seminar: SAFER's international collaborations, focus on China, Oct 15, 2020.
- SAFER Competence network kick-off: Perception, sensing and communication, Oct 20, 2020.
- SAFER lunch seminar: The Role of Road Design and SAFER's special project on hygiene procedures in testing, Oct 22, 2020.
- Participation in Volvo Talks – expert dialogue on traffic safety collaborations, Oct 22.
- SAFER seminar: Novel and inexpensive nudging measure to increase cyclist safety, Oct 28.
- SAFER AI Strategy – the next step and brokerage event with SAFER Stakeholders, Nov 2, 2020
- Seminar jointly with Cykelcentrum: We share the space – bicyclists and motor
- vehicles interacting; challenges and solutions, Nov 4, 2020.
- SAFER lunch seminar: Safety systems, injury detection and lessons learnt from an emergency services prospective & Safety for everyone, always –
- taking variability into account, Nov 5.
- SAFER Update for the community, Nov 18, 2020.
- SAFER Research area day, Nov 18, 2020.
- SAFER lunch seminar: Driver behavior with Tesla Autopilot and Driver engagement in assisted automation, Nov 19, 2020.
- SAFER seminar: Three Years of Open Research at AstaZero – projects, results and lessons learned, Nov 25, 2020.
- SAFER lunch seminar: Databases available for research, Nov 26, 2020.
- SAFER Introduction for Volvo Cars, Nov 26, 2020.
- SAFER lunch seminar: AI – how this tool can support our research and help improve road safety, Dec 3, 2020.
- Project creation workshop with K2: exchange points along a metrobus line, Dec 10, 2020.
- Licentiate seminar with Bo Sui: Car crashes with two-wheelers in China: Proposal and assessment of C-NCAP automated emergency braking test scenarios, Dec 15, 2020.
- SAFER's online Christmas breakfast, Dec 17, 2020.

### APPENDIX 8 CONFERENCES

Conferences in which SAFER's research has been presented:

- 9th International Conference, ICPRAM 2020, Valletta, Malta
- SAE ADAS to Automated Driving Digital Summit (virtual)
- 10th European Congress on Embedded Real-Time Systems, Toulouse, France
- 21st IFAC World Congress Berlin, Germany
- Crash Tech Conference Ingolstadt, Germany
- 23rd Euromicro Conference on Digital System Design (DSD), Portorož, Slovenia
- International Working Conference, REFSQ

- 2020, Pisa, Italy (virtual)
- 31st IEEE Intelligent Vehicles Symposium Las Vegas, NV, United States (virtual)
- IEEE International Conference on Communications, Dublin, Ireland
- 31st International Symposium on Personal, Indoor and Mobile Radio Communications (virtual)
- 10th International Conference on Localization and GNSS (ICL-GNSS), Tampere, Finland
- 24th International ITG Workshop on Smart Antennas, Hamburg, Germany
- IFIP Networking Conference and Workshops (virtual)
- 9th International Conference on Advances in Vehicular Systems, Technologies and Applications (VEHICULAR), Porto, Portugal
- 23rd IEEE International Conference on Intelligent Transportation Systems (ITSC), Rhodes, Greece (virtual)

### APPENDIX 9 THESES

#### Doctoral Theses

- Methods for efficient modelling of progressive failure in laminated fibre-reinforced composites: Johannes Främby, Chalmers University of technology, January 17, 2020.
- Material modeling of adipose tissue for traffic injury prevention: A finite element study of parameters influencing lap belt to pelvis interaction: Hosein Naseri, Chalmers University of technology, April 7, 2020.
- Traffic Safety potential and effectiveness of lane keeping support: Simon Sternlund, Swedish Transport Administration and Chalmers University of Technology, June 15, 2020.

#### Licentiate Theses

- Towards an Improved Safety Benefit Assessment for Heavy Trucks – Introduction of a framework for the combination of different data sources: Ron Schindler, Chalmers University of Technology, March 6, 2020.
- An Average Female Head-Neck Finite Element Model with Reflexive Neck Muscles: I Putu Alit Putra, Chalmers University of Technology, April 28, 2020.
- Modelling 3D-woven composites on the macroscale: predicting damage initiation and inelastic phenomena: Carolyn Oddy, Chalmers University of Technology, April 29, 2020.
- The automation effect: Investigating factors that influence the driver response process to a safety-relevant event during assisted driving and after unsupervised automation: Linda Pipkorn, Chalmers University of Technology, June 2, 2020.
- Evaluation of Morphed Human Body Models for Diverse Occupant Safety Analysis: Karl-Johan Larsson, Chalmers University of **Technology, June 10, 2020.**
- Car crashes with two-wheelers in China: Proposal and assessment of C-NCAP automated emergency braking test scenarios: Bo Sui, Chalmers University of Technology, Dec 15, 2020.



SAFER is the open research and knowledge sharing arena where researchers and expertise work together to create safe mobility. Our traffic safety approach covers people, vehicles and the infrastructure – and together we contribute to safer road transports and smarter, more sustainable cities.

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#### SOCIAL MEDIA CHANNELS



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