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To:

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Center for Future Mobility Solutions: Notification of Interest

A research **profile** proposed by Halmstad University to the Knowledge Foundation within the 2016 call.

I. Research Orientation

Mobility in the sense of transportation of people and goods has been and will continue to play a pivotal role in the development of the Swedish society in general and of Swedish industry in particular. To a large extent the well functioning of society and industry depends on people and goods getting to their destinations safely and timely. Also, a substantial part of the Swedish industry is dedicated to various components in the mobility landscape; examples include transport and logistic companies, the vehicle industry, including cars, trucks, busses, construction equipment, boats, airplanes, and their suppliers at different levels.

We observe a forthcoming paradigm shift in the landscape of mobility, caused by a number of developments including the introduction of connected and autonomous vehicles, electrical vehicles, the social awareness of and the legal requirements for safety and sustainability, and the introduction of various integrated and digitalized mobility services. Future mobility solutions will involve complex integration of digital, physical and social systems.

The consequences of this paradigm shift are manifold and range from making mobility more accessible (e.g., removing age and ability limits by using autonomous vehicles), more efficient (e.g., providing smooth integration of mobility services through connectivity), safer (e.g., improving active safety through autonomy and cooperative connectedness) and a better experience (e.g., allowing for various types of infotainment in future vehicles).

The main challenge is to innovate the traditional engineering practice of mobility solutions (based on practices from mechanical engineering, electrical engineering and control, and transport engineering) to integrate it with information and communication technology engineering and form new connected and automated mobility services, steered by user experience. This will inevitably lead to new business models and ecosystems.

Our over-arching research target in this new landscape is “to define **agile engineering** processes (encompassing tools and techniques) for creating **mobility solutions** that are informed of and driven by **user experience** and **business models**.”

Much of the ongoing innovation in mobility solutions is steered by digitalization: physical products will be entrenched in ecosystems of digital services and the mobility solutions will involve a complex integration of cyber-physical systems. Digitalization brings about challenges in the innovation and **development process, systems development and engineering** practice, and **service design** and **business models**. CERFUM will respond to these challenges by coproducing results in the following areas:

- Agile innovation: A challenge for the industries involved in mobility is to adapt their innovation process in order to embrace the level of agility required for successful adaptation to the digitalized landscape and its prominent ingredient, namely computer systems and software. Agile processes are recognized as one of the key facilitators in developing software and systems with reduced waste, short innovation cycles, and short time to market. CERFUM aims at coproducing research with its partner companies regarding agile process design, modeling, analysis, and innovation.
- Agile engineering with Human in the Loop: the complexity of future mobility products and services will be unprecedented as vehicles and mobility services are increasingly autonomous and connected. We need to come up with new design, verification and validation processes regarding the embedded systems, the communication protocols, and software and their interconnection. An aspect that is becoming increasingly important in this regard is the role of users in steering the engineering process from the very early stages to minimize waste and ensure usability, safety and security. To this end, we propose devising model-based techniques and tools that integrate the engineering design of such solutions with the user experience analysis using the latter to guide the former. This will reduce waste through rapid and effective prototyping, validation and verification of innovative ideas.
- Agile Business Models and Digital Service Design: Future mobility is bound to be about connected services rather than dispersed products and this will require the knowledge and expertise about service design as well as the knowledge of innovating business models to fit the service oriented setting. To this end, we investigate digital service design for mobility and business model innovation for mobility as a service.

Figure 1 summarizes the above-mentioned research orientation of CERFUM. We aim at combining the two strands building common demonstrators or test beds that serve as a way for integrating our research, our partners products and services and also are used in both education, training, and outreach programs to disseminate the results of our research to our students, industrial collaborators, and the society at large.

Our vision of CERFUM is a center that integrates these aspects and become an internationally renowned research center for **system-level** methods that enable the design of **safe** and **secure mobility solutions**.

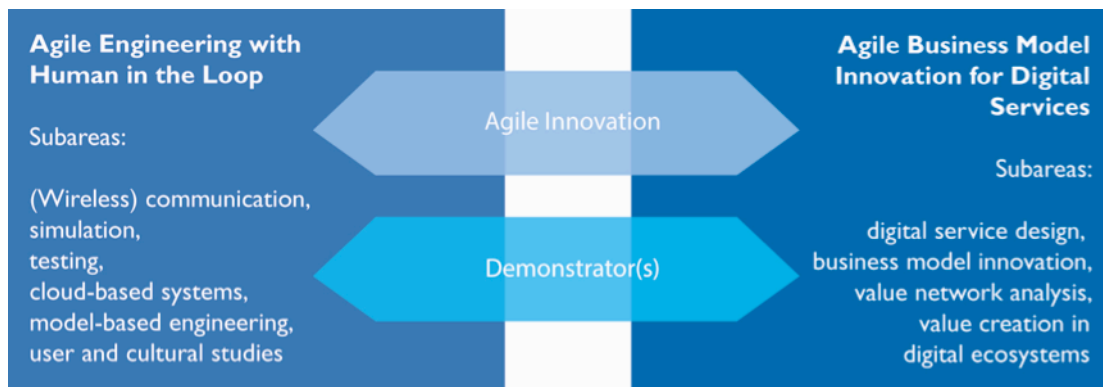


Figure 1. CERFUM's Research Orientation

2. Alignment with Strategy and Development of University

A large part of the University's strategic planning is done in the context of the KK-environment Research for innovation. The University has identified two areas for addressing societal and industrial challenges in co-production with Swedish industry and society at large: Health Innovation and Smart Cities and Communities. The current application fits in the development of the latter and has been commissioned by the management of the University and it is included in the current plan of operation for the KK-environment.

To address the societal and industrial challenges within the area of Smart Cities and Communities, Halmstad University aims at integrating a number of contributing areas in multidisciplinary initiatives that can tackle industrially relevant challenges in unique ways. Mobility, in the sense of transport of people and goods in ways that create value, is a major constituting component of Smart Cities and Communities and Halmstad University has embarked on founding the Center for Research on Future Mobility Solutions (CERFUM), which is a multi-disciplinary research center focusing on multi-disciplinary research and coproduction in mobility.

Future mobility concerns large ecosystems involving various product- and service-developers as well as different parts of the society and the policy and regulation authorities. Many actors involved in the production of infrastructure, vehicles and services for the transportation of people and goods are challenged by the opportunities that come with the digitalization of both products and services. Responding to these challenges and creating value from these opportunities can only be achieved by consolidating the different perspectives and CERFUM consolidates engineering-, user- and business-perspectives under one roof by building upon the strong existing research areas at Halmstad University and also expanding them through strategic recruitments.

With CERFUM we will establish a platform for developing research that can support the Swedish transport sector under the transformations caused by digitalization. The center will bring together existing competences at Halmstad University in four different areas: enabling ICT technologies (e.g., wireless communication, simulation, testing, cloud-based systems, model based engineering); user driven innovation (e.g., user studies, video ethnography, User Experience (UX) design, living lab methodology); digital service design (e.g., design of systems, applications and platforms for digital services); and business model innovation (value creation in digital ecosystems, business innovation and internationalization). With its focus on digitalized and service oriented mobility – mobility

as a service – the center will be able take a position in the Swedish strategic innovation landscape defined by e.g. DriveSweden. Initially CERFUM will cluster coproduction around two initiatives: agile engineering and user innovation; and agile business model innovation for digital services. To ensure integration of results we will create one or several real life demonstrators to bridge the two activities. However, gradually during the center’s development the two initiatives will bridge.

Our vision is that CERFUM, in 10 years, designates Halmstad as the most prominent Swedish industrial research and coproduction center in the area of mobility solutions with strong expertise, worldwide network of collaboration, and tailored and up-to-date educational and training programs.

2.1. Building on Our Strengths

Halmstad University has a long tradition of co-production with the automotive industry, a key actor in the mobility landscape, now and in the future. In collaboration with the automotive industry in a number of projects since 2006, with the start of CERES (the center for research on embedded systems, , ceres.hh.se) with a focus on cooperating embedded systems and later with CAISR (the center for applied intelligent systems research, caisr.hh.se) with a focus on awareness Halmstad University. The results of these projects range from contributions to communication protocols for V2V and V2I, contributions to the definition of adequate standards (ETSI), the highly successful experiments with autonomous vehicles (the GCDC challenge and the autonomous trucks), and tools for increasing uptime in bus fleets. Both CERES and CAISR started as research profiles financed by the KK foundation and have later attracted other external grants, for example as part of the ELLIIT strategic funding, from Vinnova, from VR, from SSF and from the EU. Recently a Vinnova financed an FFI project with Volvo Cars on human expectations and experiences of autonomous driving (HEAD) was successfully launched. The University has also developed internationally leading research in business model innovation and internationalization which will be integrated into the new Center.

From the engineering side, we build upon the strong expertise in CERES, which has strong ties with the automotive and transport industries and has several successful (past and ongoing) projects with industry. Also, we will work towards collaboration with CAISR with strong expertise and industrial collaborations in the areas such as data mining and signals and systems. Both centers jointly provide an established and well-known masters education in Embedded and Intelligent Systems as well as Ph.D. education. CERFUM will contribute to these programs and also provide tailored training programs for its involved partners.

From the user side, we incorporate the expertise from the Swedish Center for Applied Cultural Analysis (SCACA, http://bit.ly/SCACA_HH), which was established through a strategic investment of Halmstad University. SCACA has ongoing collaboration with the automotive industry, particularly regarding autonomous vehicle. SCACA has recently been integrated into the Man and Information Technology Laboratory (MI-Lab, http://bit.ly/MILab_HH), which incorporates both user and cultural aspects and the digital service design aspects.

Regarding business models and digital service innovation, we bring in the expertise from the Center for Innovation, Entrepreneurship, and Learning (CIEL, http://bit.ly/CIEL_HH) and the Man and Information Technology Laboratory (MI-Lab, http://bit.ly/MILab_HH).

2.2. Funding Structure

The Center will be proposed as a *profile* to the Knowledge Foundation. This proposal, if granted, will provide a seed funding to run the center for the coming 8 years. In parallel to

that we have initiated several other proposals towards different financiers to attract complementary funding to the center. Hitherto, we have a funded research project (HEAD) in the area of autonomous vehicles from Vinnova and we are negotiating direct investment from a public authority to fund a smart city living lab. Overall, we aim at a balanced funding structure that involves a broad spectrum of financiers (such as KK Foundation, the SIP Drive Sweden, Vinnova, EU, and direct industrial and public investments).

3. Business Group's Involvement, Motives, and Qualifications for Participating in the Research Profile

Efficient transport and mobility are keys to the productivity of Swedish industry and society. Also, a substantial part of Swedish most successful industries concerns products, enabling technologies and services related to mobility. Examples of such industries include the automotive- (along with their suppliers) and the transport and logistic companies.

However, the landscape of mobility is facing a major paradigm shift, caused by digitalization, including autonomy. To survive and prosper in this paradigm shift, the Swedish industry needs to innovate itself and this timely need for innovation is emphasized in various strategic documents such as the Strategic Innovation Program DriveSweden as well as the Swedish Government's Future Travel and Transport Target document.¹ In the Swedish Government's Innovation Goals, the first 2 collaboration areas are: next generation travel and transport and smart cities.²

Hence, there is an interest in a broad network of companies to do research and innovation in order to survive and prosper in this changing landscape. The range of companies involved in CERFUM covers the value network of mobility solutions from: OEMs (Volvo and NEVS) to their suppliers (Autoliv and Gutech) to tool providers (Fengco and Quviq) to transport and logistic companies (Transdev), to service and solutions companies (Combitech.).

We have organized some 20 interviews with the above-mentioned companies and visionaries to identify challenges and organized 2 workshops with 8 of them to define project ideas and to position the center in the Swedish and international research landscape. The result have been summarized in terms of 4 initial project ideas that are being developed in collaboration with our partners.

4. Name of the Research Profile, Keywords, Abstract

Title

Center for Research on Future Mobility Solutions

Abstract

The mobility landscape is facing a drastic paradigm change due to digitalization, autonomy, and connectivity as well as changing attitudes regarding ownership and the expansion of electrical vehicles. The Centre for Research on Future Mobility Solutions (CERFUM) responds to this paradigm shift by consolidating the engineering-, user- and business-perspectives into a multi-agent view of the innovation process. We carry out research in multi-disciplinary teams involving expertise in embedded systems, software and process engineering, user studies, digital service design and business model innovation. Our research

¹ For the DriveSweden SIP, please see: <http://bit.ly/DriveSweden>
For the Government's Future Transport and Travel Target document, please see: <http://bit.ly/FramtidensTransportResande>

² Goals for Innovation: <http://bit.ly/MalForInnovation>

orientation is characterized by agile engineering processes that are guided by user experience on one side, and agile business model innovation for digital services on the other side. These two lines of research are connected by the research in agile processes, which will be the future area of strength within CERFUM. All research projects will be contribute to demonstrators that will be used to disseminate the results of the projects to our students, industrial partners, and the society at large. CERFUM will contribute to our advanced educational programs in Embedded and Intelligent Systems, and also provide tailored training programs for our industrial partners.

Keywords

Mobility Services, Transport, Automotive Industry, Connected and Autonomous Vehicles, Intelligent Transport Systems, Cyber Physical Systems, Agile Innovation, Sustainability, User-Centered Design, Innovation Ecosystems, Value Networks.

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