Profile Area
# Smart Cities and Communities

2018

# Annual Report

HÖGSKOLAN
I HALMSTAD

# Contents

# Welcome!

The profile area Smart Cities and Communities is an initiative at Halmstad University including research, education and collaboration with the surrounding society. When working with external collaborators, one of our strengths is that we can tackle societal and research challenges with an inter-disciplinary approach. Moreover, the profile area is a tool for profiling the university. This is the first annual report for Smart Cities and Communities and summarises activities since the inauguration in 2016, but with a focus on 2018.

*We wish you a nice reading!*

*Magnus Jonsson, Programme Manager*
*Kristian Widén, Deputy Programme Manager*

# Management Group

Smart Cities and Communities Management Group (from the left): Maya Hoveskog (CIEL), Vaike Fors (ITE), Magnus Jonsson (Programme Manager), Kristian Widén (Deputy Programme Manager), Pernilla Ouis (CVHI), Marie-Helene Zimmerman Nilsson (CLKS), Urban Persson (RLAS). NB. Cristofer Englund (RISE/Viktoria) (absent from this photo) is also a member of the Management group. After the photo was taken, Vicky Long has replaced Maya Hoveskog as CIEL representative.

**Research environments at Halmstad University**

CIEL: Center for Innovation, Entrepreneurship and Learning Research
CLKS Research on Education and Learning
CVHI: Center for Research on Welfare, Health and Sport
ITE: Information Technology
RLAS: Rydberg Laboratory for Applied Sciences

# About Smart Cities and Communities

Our definition of Smart Cities and Communities follows the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), which includes solutions for better transport, intelligent use of information and communication technology solutions, better planning, a more participatory approach, higher energy efficiency etc. We aim for cities and communities to be sustainable through the use of information and communication technologies, with sustainability from the three perspectives of economically sustainable, socially sustainable and environmentally sustainable. The SCC profile area at Halmstad University builds upon several years of strong research and education at Halmstad University, and there are two main directions in SCC: Smart Mobility, and Smart Energy. Both are well connected to education and research. Smart Cities and Communities was initiated as a profile area in 2016, with university-wide seminars during 2016, and a work group on our strategy in SCC during 2017. A programme director (Magnus Jonsson, Professor in Real Time Computer Systems) and a deputy programme director (Kristian Widén, Associate Professor in Innovation Sciences with focus on the Built Environment) were appointed 2018.

In addition to Smart Mobility and Smart Energy we also have competences and activities in, e.g. smart education, smart citizens, and smart buildings. Obviously, there are also many areas of the other profile area at Halmstad University, Health Innovation, that connect well to Smart Cities and Communities, e.g. intelligent homes for elderly living and health promotion through smart outdoor gyms. We are working closely with the surrounding society, which relates to the vision of Halmstad University.

## Smart Mobility within Smart and Sustainable Cities and Communities has three focus areas:

- Self and situation aware vehicles and infrastructure for smart mobility solutions.
- Human-centric service design and innovation for smart mobility solutions.
- Enabling communication, sensor and software technologies for smart mobility solutions.

## Smart Energy within Smart and Sustainable Cities and Communities has three focus areas:

- Smart energy system solutions for sustainable cities on the basis of local contexts.
- Sustainable components within and for a locally-based smart energy system.
- Sustainable management and maintenance practices and technologies in locally-based smart energy systems.
- Digital solutions enabling the transformation to locally-based smart energy systems.

We will utilise our opportunities to tackle societal challenges with an interdisciplinary approach by combining our competences, i.e. doing things that independent research groups cannot do on their own. In comparison with mainstream smart city initiatives, our main focus is on medium-sized cities and their surroundings instead of large and mega cities.

# Advisory Board

The profile area Smart Cities and Communities has an advisory board with external representatives that meets biannually to review the development. The advisory board consists of:

**Catharina Elmsäter-Svärd**, chair, (CEO for the Swedish Construction Federation, former Minister for Infrastructure, 2010–2014)

**Margareta Friman** (Professor and Pro Vice-Chancellor of Karlstad University, member of a national expert group on transport challenges in H2020, for 10 years manager for the Vinnova funded VinnExcellence Center SAMOT, the service and market-oriented transport research Group, in Karlstad)

**Margriet van Schijndel-de Nooij** (EARPA Secretary General, TNO, and EU independent expert cooperative and automated transport)

**Annemie Wyckmans** (Professor and leader for NTNU Smart Sustainable Cities at NTNU Norwegian University of Science and Technology, Faculty of Architecture and Design)

**Tord Hermansson** (CEO for Lindholmen Science Park, formerly responsible for academic relations at Volvo Cars)

**Thorsteinn Rögnvaldsson** (Programme Director for Research for Innovation at Halmstad University)

# Smart Cities

**SEK 5.7 Million for the Digitisation of Halmstad**
*December 2018*

Vinnova has awarded Halmstad University, Halmstads stadsnät and RISE a total of SEK 5.7 million for the continued development of smart, technological solutions that can meet some of the societal challenges of the future. Read more on page 8



**Smart Energy in Practice**
*November 2018*

The Smart Energy in Practice conference gathered top academics and representatives from companies who work in the cross section of energy applications and artificial intelligence (AI). New energy infrastructures, enabled by and producing large amounts of data, are around the corner to improve citizens lives in smart cities world-wide. The addition of renewable energy sources, increasing electricity-powered transportation, smart buildings and deepened involvement of end-users in energy decisions brings numerous new challenges but also opportunities. A key issue spanning all these areas is how to leverage the available data to improve planning, operations, maintenance and business decisions for maximum gains. The conference provided matchmaking opportunities and a roadmap for going forward, with the target audience including managers, service developers and engineers interested in applications of AI to the energy sector.
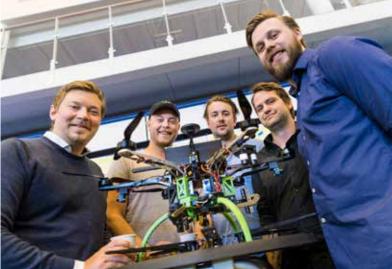
# and Communities – a Glance

### SEK 85 Million is Invested in Health Innovation and Smart Cities and Communities
*December 2018*

The Knowledge Foundation, Halmstad University and the business community jointly strive to meet societal challenges in healthcare and the transport system in a sustainable and innovative way. The contribution entails a powerful investment in interdisciplinary research projects within the University's two profile areas: Health Innovation and Smart Cities and Communities. In total, the Knowledge Foundation, Halmstad University and the business community jointly invest 85 million in projects and recruitments over the next four years.



### Second Place in International Drone Competition
*May 2018*

Six engineering students from Halmstad University were runners-up in an international competition for autonomous drones, which took place in Arizona in the US on May 15–17, 2018.



### Halmstad University Team Wins Volvo Hackathon
*December 2018*

In a 72-hour hackathon arranged by Volvo, a group from Halmstad University won the Best Build Team award with its smartphone prototype app Intelligent Probe. "We created a smartphone app for automatic inspection of the undercarriage system of excavators. By using the smartphone camera, pictures of various excavator parts are analysed through computer vision methods to measure sizes of, for instance, steel shoe and rolling bodies in the undercarriage system. The analysis will, for example, determine the need for repair and can reduce the workload of Volvo Technicians," says one of the winning team members Eren Erdal Aksoy.



### Victory in GCDC 2016
*May 2016*

At the end of May 2016, six students from Halmstad University competed in The Grand Cooperative Driving Challenge 2016 (GCDC) and won. The students turned an ordinary car into one that is self-driving and has the ability to talk to other vehicles in traffic. **www.hh.se/gcdc**

Vinnova has awarded Halmstad University, Halmstads stads-
nät and RISE a total of SEK 5.7 million for the continued
development of smart, technological solutions that can
meet some of the societal challenges of the future.

# SEK 5.7 Million is Awarded to a Project for the Digitisation of Halmstad

Halmstad University, Halmstads stadsnät and RISE (the Research Institutes of Sweden) have jointly initiated a project for innovation initiatives in IoT (Internet of Things). The project was awarded SEK 5.7 million by Vinnova, the Swedish Innovation Agency, until the year 2021. The aim of the project is to create better conditions for companies and the public sector to implement development initiatives within IoT. These investments will be of paramount importance to our ability to meet some of the future challenges our society now faces. The project's priority areas are climate and the environment, health and increased digitisation.

"We're very excited about this project, which enables Halmstad to position itself both nationally and internationally in this field. For Halmstad University, the project is entirely in line with the Electronics Centre's profile in the area of smart cities and communities, which has been adopted by the entire university. Our expertise in developing IoT services will be strengthened," says Magnus Clarin, Director of the School of Information Technology at Halmstad University.

**Development towards a smarter municipality**

"This entails a very welcome opportunity to accelerate the work of transforming Halmstad into a smart municipality. With this investment in digital infrastructure, both the municipality and the local business community will gain completely new tools that allow them to work more efficiently with modern working methods and use their resources in the best possible way," says Jonas Bergman (M), Chair of the Executive Committee of Halmstad Municipality.

Over the course of many years, Halmstads stadsnät has built up a fibre-optic infrastructure that serves the municipality's citizens, entrepreneurs and municipal operations. As digitisation and technological development offer major opportunities for enhanced efficiency and new services, Halmstads stadsnät will drive the digitisation of Halmstad Municipality.

"For us, it's a natural and obvious step to play an active part in driving the development of IoT, both within the municipal group, but also for the municipality's society as a whole, including its businesses, university, and other public activities. This project offers us increased opportunities to drive the development towards a smarter municipality," says Yngve Kihlberg (C), CEO of Halmstads stadsnät AB.

Hassan Nemati's research focuses on estimating the reliability of underground power cables by using historical data. This means, estimating how reliable a cable is without installing additional sensors in a power grid.

# Mining Historical Data Enables Power Companies to Predict and Prevent Power Outages

"My research is a collaborative project with Halmstads Energi och Miljö AB (HEM Nät), the electricity distribution company in Halmstad. The aim is to reduce the number and duration of power outages on HEM's electricity grid. We investigate and implement data mining techniques to discover patterns in previous outages, and model the power cables' remaining lifetime," says Hassan Nemati, who is a doctoral student at the Embedded and Intelligent Systems Industrial Graduate School (EISIGS) at Halmstad University.

As an EISIGS student, he works both at the University and at the industrial research partner, HEM Nät. In his licentiate thesis, historical data is used for failure pattern discovery and reliability evaluation of power cables.

Hassan Nemati's method can be used to prevent failures of cables. The reliability is estimated based on different factors such as previous failures, number of cable joints, and geographical position. The cables are then ranked for prioritising maintenance actions.

The partner HEM Nät believes that the research collaboration is good for both the company and their customers. The project now focuses on deviation detection of power components by using data collected from smart meters. HEM receives a huge amount of data and through the collaboration the data can be used to predict problems before they occur.

"We have several ongoing collaborations with Halmstad University, using research to increase sustainability and improve services for our customers. Hopefully we can spread Hassan's knowledge, and also give him all the help he needs to reach great results," says Alexander Örning at HEM.

The method has received attention from other electricity distribution companies in Sweden. These companies asked Hassan Nemati to analyse their data too and they found the results very beneficial.

# The Heat Detective

Reusing heat is both economically viable and environmentally friendly. The technology to do so has been around for a long time – district heating has been used to distribute heat for several hundred years. Yet there is still tremendous room for improvement, and great potential to develop district heating technology. Sweden is a world leader in the field, but needs to export its knowledge to the rest of the world. This is the assertion of one of the most prominent figures in this field of research, the district heating expert Sven Werner, who is a professor at Halmstad University.

"District heating entails major socio-economic gain. If by 2050 Europe has as much district heating as Sweden has now, the long-term profits would be an estimated SEK 1 trillion per year," says Sven Werner, who became a professor at Halmstad University in 2007, and has devoted his entire professional life to district heating. Now he is retiring but intends to continue to contribute to the development of district heating.

"We're in a very exciting period now, as several of the research group's results have made an international impact. One example is the research project Heat Roadmap Europe, in which we collaborated with Danish colleagues to contribute to the dissemination of knowledge about district heating. This has inspired the EU to develop a completely new heating strategy based on our research findings."

Over the last decade, Sven Werner and his colleagues have been involved in some 30 research projects, with a corresponding investment of approximately SEK 3 million per year.

"Our research is a continuous activity, in which the projects interconnect. We spearhead several interdisciplinary projects, both within the University and together with other actors. The research group and our projects have grown, and I feel confident that, following my retirement, my colleagues will continue to carry out groundbreaking research".

The first modern district heating systems were built in the United States at the end of the 19th century, and were steam-based. The New York City district heating network from that era is still in operation today. Since then, technological development has made great strides, and today the heat source varies. What is common to all district heating systems is that they are based on the distribution of heat that has already been generated – in this way, the heat is recycled.

"There is so much surplus heat in our society that can be reused. Through district heating systems, residential areas can be heated with heat that would otherwise have been

> *"You have to be a 'heat detective' and track down the surplus heat in our society. Through district heating, we can take advantage of the heat and reuse it."*

*Sweden is far ahead of the game in its development of district heating, but we're bad at telling others about it. There is an incredible amount of potential in district heating, and it's a necessary part of future sustainable communities," explains Sven Werner.*

wasted. This heat is generated by power plants, waste incineration plants, factories, computer centres and crematoria, among other sources. To take advantage of this resource, you simply have to be a 'heat detective' and track down the heat.

### Sweden leads – but must disseminate its knowledge

Sweden is far ahead in its development of district heating, but we need to improve our exportation of district heating knowledge to other countries as well as getting better at developing district heating technologies and systems in Sweden. This calls for 'fourth generation' district heating systems. Above all, these can be introduced in new residential areas that are under construction.

"We can also be better about making the most of renewable energy. Surpluses generated by wind turbines or solar cells can be incorporated into the district heating system using large electric boilers or heat pumps."

### Training engineers for the energy conversion of the future

At Halmstad University, energy engineers learn about the latest knowledge in the field.

"The strength of a university is that research and education occur in the same place. The same people conduct both research and teaching, and new knowledge from research is incorporated directly into education programmes. This provides students with the knowledge they will need over the next 30 to 40 years. We can't use old knowledge of fossil fuels in our courses when we have new knowledge necessary for the creation of a new energy system."

**Latest news: Research results in the international journal Energy**

In a recently published scientific article, Sven Werner and his PhD student Helge Averfalk write about the technical improvements that should be made in order to adapt district heating systems to future market conditions.

**Future reconnaissance: What will the heat supply in a medium-sized Swedish town look like in 2050?**

- freestanding homes use heat pumps

- district heating in all densely populated cities

- biomass is converted into new materials and the waste heat generated by this process is used for district heating

- surplus from wind power and other renewable electricity powers heat pumps that heat water in a heat storage facility.

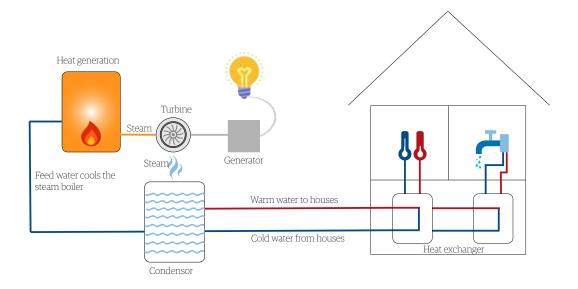# Heat Roadmap Europe Remaps the Energy Supply Systems of the EU



Halmstad University, in collaboration with Aalborg University in Denmark and Europa-Universität Flensburg in Germany, conducts world-leading research within the fields of heating market analysis and district heating. The project Heat Roadmap Europe, which is funded by the European Union, is coming to an end after three years of great success.

Urban Persson, Senior Lecturer in Energy Engineering at Halmstad University, is one of the forces behind the project Heat Roadmap Europe.

"District heating is a convenient and efficient way to supply heating and hot water to buildings. In Sweden, Denmark, Finland and the Baltics, district heating systems are rather well-developed compared to other parts of Europe, where the main sources of heating are electricity and natural gas. As a result of the major environmental challenges that Europe is facing, the European Union is now looking to reduce its energy use and its emission of greenhouse gases, and a viable way to do that is by an expansion of district heating systems. Already at the beginning of the project Heat Roadmap Europe, we were able to show that it would

be cost-efficient to triple the extent of existing systems. That would mean an increase in district heating from today's level of 20 percent, up to as much as 60 percent in urban areas."

**Large-scale mapping of fourteen EU countries**
A substantial part of the project Heat Roadmap Europe has come to revolve around spatial analysis and geographical information systems (GIS). Together with Professor Bernd Möller, Europa-Universität in Flensburg, Urban Persson has been involved in the development of new methods for mapping and geographical analysis of the European heat market. Their joint efforts have made available new perspectives and extended knowledge on the issue, which has been a key to the success of the project Heat Roadmap Europe.

Heat generation

Turbine

Steam

Steam

Generator

Feed water cools the steam boiler

Warm water to houses

Cold water from houses

Condensor

Heat exchanger

"We have mapped EU's land area as regards heat demands and supplies. The geographical data has been combined with national data considering energy infrastructure, and used in an application for energy system modelling developed by Professor Henrik Lund, Aalborg University. The basic idea is that district heating systems, as opposed to electricity and gas systems, are local phenomena. Thus, it is only by mapping local conditions and including these in the modelling that the advantages of district heating become visible and quantifiable. The model is also temporal, with a high resolution by the hour, and, combined with highly resolved spatial mapping per hectare, it provides the prerequisites for creating detailed descriptions of alternative solutions to Europe's energy supply."

### Research that influences EU laws

International attention was drawn to the project Heat Roadmap Europe at an early stage. The pilot studies that came to create, at least partially, the foundation for the project, were noticed by the European Commission, which is the legislative body of the European Union. Part of the Energy Efficiency Directive stems from research results from one of these pilot studies. The directive came into force in 2012, and is aimed at establishing a shared framework in order to promote energy efficiency within the European Union.

### An onward journey

Heat Roadmap Europe can be described as nothing less than a success story, but the fact that the project is now coming to its end doesn't mean that the journey is over. Urban Persson and his fellow researchers in the so called 'district heating group' at Halmstad University have their aim set forward. Several new projects are on the blocks,

one of them being the project sEEnergies, which will study the potential for energy efficiency in the European Union by using methods derived from the project Heat Roadmap Europe.

**ReUseHeat.** Urban Persson is also working together with Senior Lecturer Kristina Lygnerud and PhD student Helge Averfalk, both at Halmstad University, on the EU project ReUseHeat. Here, they examine the possibilities for EU countries to use excess heat from low temperature sources such as waste-water treatment plants, data centres and subway stations. They also evaluate market terms and business models adapted to this kind of heat reuse.

# Service Design and Architecture
## Create the Smart Cities of the Future



What can a service designer and an architect learn from each other? The intersection of two different disciplines yields new ways to design the physical environments of the future – ways that address modern wishes and needs. A new residential area is the first to be sketched out in collaboration between the service designers at Halmstad University and an architectural firm.

In the project 'Participatory Urban Design', associate Professor Pontus Wärnestål, an expert on service design, actively participates in the work of the architectural firm Krook & Tjäder. One of the methods used is 'impact mapping' – a common service design method – in which the behavioural patterns and needs of the target group are analysed. The mapping is based on in-depth interviews with potential users about what they appreciate in life, dreams, and factors crucial to a move. The answers vary, but certain similarities can be identified, e.g. proximity to nature and the possibility of cultivating oneself.

Architects do not normally conduct in-depth interviews. They usually rely on quantitative and demographic analyses ('what'), which may not always reflect the lifestyle and desires of the users ('why').

One challenge in urban development projects is that the actors involved often have differing time perspectives. The municipality plans several decades in advance. Construction companies want to complete their commissions as quickly as possible. The architects fall somewhere in between. The method used provided the architect group with a good basis for discussions with the other actors involved.

"The impact map gave us the opportunity to support our proposals for the new residential area", says Lina Lindegren of Krook & Tjäder.

The project has now entered a new phase, which involves focus on the borderland where artificial intelligence, health and physical environments collide. One example is services that facilitate the transport of people and goods.

"I believe that interdisciplinary collaboration is the key to building the smart cities and communities of the future," Pontus Wärnestål concludes.

> ## *"I believe that interdisciplinary collaboration is the key to building the smart cities and communities of the future."*

*Pontus Wärnestål, an associate professor at Halmstad University, believes and hopes that service designers and architects will collaborate more and more in the future in order to digitally reinforce physical environments.*

## About the Participatory Urban Design project

The research project 'Participatory Urban Design' (PUD) is one of a number of research projects under the same umbrella, all led by Jens Nygren, a professor of Health Innovation at Halmstad University. Pontus Wärnestål, an associate professor of Informatics at Halmstad University, is the Project Manager for PUD. The project runs from 2016 to 2019 and is financed by the KK Foundation. It is well in line with Halmstad University's professed focus on smart cities and communities.

The primary purpose of PUD is to investigate how methods and tools commonly used in the service design of digital solutions can be applied to the design of new physical environments. One of the methods tested is impact mapping, which is based on in-depth interviews and qualitative analysis.

**The research group has noted three distinct effects from the project:**

1. Methods commonly used in the service design of digital solutions can be advantageously applied to the architects' projects. The group's mapping and prioritisation of behavioural patterns defines target groups in a different way from the more traditional demographic methods on which the architects have previously relied.

2. Through the impact mapping, the group was able to formulate measurable goals that are based on end-user behaviour and what these users consider valuable. These goals also embody the sustainability objectives of the municipality and make them easier to address and measure.

3. The architects were able to successfully use impacting map in discussions with other players involved in the planning of the new Östra Nyby residential area in Laholm.

# Timing and Customer Focus are Crucial to the Dissemination of Construction Innovations

*Derome construction site in Kvillebäcken, Gothenburg. Photo: John Lindgren.*

What capacity do companies have to disseminate or embrace an innovation? A thesis examines the innovation capacity of the construction industry. John Lindgren has studied two complex processes – the construction of wooden multi-storey buildings and the introduction of digital solutions in the construction industry.

*"My study gives concrete examples of the construction industry in particular. Companies working with the dissemination of innovations that affect several parts of the construction process can learn from the results of this research."*

"The construction industry – like all industries – is in great need of innovations. Among other things, both the construction process and the housing itself consume a lot of energy, so energy efficiency is always in demand," says John Lindgren, senior lecturer in Industrial Organisation.

His research on innovation capacity demonstrates and confirms that an interplay exists between the content of the innovation, the context in which it is disseminated, and how this dissemination occurs, and that this relationship is of paramount importance.

Two case companies have been used to study two 'systemic' innovations: multi-storey wooden buildings and the digitisation of the construction process. These innovations affect numerous parts of the construction process – from the drawing board to the choice of tools and how long the actual construction time will be, etc.

"The dissemination of the new solution becomes an iterative process in building contexts. It does not occur step-by-step; rather, it is accomplished through repetition in different groups or functions, in no particular order."

### Knowledge about the customer
But how do the builders of wooden houses break into the market? And how will the large construction companies be able to order digital solutions that work well?

John Lindgren's research highlights several crucial parts of the process. It is important to take note of the supplier's human resources – that is, the individuals in the company. And the manner in which the dissemination occurs also plays a role:

"For example, I've noticed that digital solutions may be well received if the person who presents them can demonstrate concrete benefits and effects right away, and in a manner that is adapted to the company."

### Three kinds of knowledge
One important part of disseminating innovation is to look at what kind of knowledge is central to the matter at hand. Three types of knowledge must be developed. The first one is domain-specific, and may concern how one builds and constructs. The second type of knowledge is more general. Here one can apply more existing knowledge about how IT works, but to achieve good solutions, it must still be adapted to the construction sector. The third type involves evaluation and becoming more systematic at work.

*"It's important to look at the nature of the industry"*

New research from Halmstad University shows that an increase in cooperation makes it possible for all actors in the supply chain to raise their productivity and become more innovative. In his doctoral thesis, Faisal Iddris has examined how corporate innovation capability is affected by the actors surrounding a company.

# Companies' Innovation Capability Stimulated by Cooperation

"I wanted to find out how the different aspects of the supply chain work together, and how this cooperation creates opportunities for innovation. A company needs the assistance from many other supporting actors in order to work properly. Products and services are developed through interplay," Faisal Iddris says.

**Customers vital to the innovation capability**
Faisal Iddris' study examines the innovation capability of both Swedish and Ghanaian companies, focusing on what is referred to as "the focal firm", a concept which has to do with the company positioned in the middle of the supply chain, being provided with goods, services and ideas by various supply chain members. Such a supply chain member can be another company, but it can also be a client or customer. The study shows that contributions from customers are vital for companies' innovation capability. However, there is an important difference between Ghanaian and Swedish companies.

"In the Swedish companies, I found that most of the innovation capability stemmed from cooperation with outside actors, not least from customers, for instance via customer centres."

In Ghana, Faisal Iddris found a different situation. There, innovation tend to be more centralised, and companies put a lot of faith in the cognitive ability of their CEOs. The CEO functions as a generator of ideas, as well as a driving force for development and innovation. The Ghanaian companies that Faisal Iddris studied also lack a structured department for research and development. Instead, they bring in consultants, and the CEO bases his or her decisions on their recommendations.

"The companies don't use brainstorming or team work to the same extent that Swedish companies do. That came as a surprise to me, since it deviates from the theories about innovation capability."



*"In the Swedish companies, I found that most of the innovation capability stemmed from cooperation with outside actors."*



*In his doctoral thesis, Faisal Iddris has examined how corporate innovation capability is affected by the actors surrounding a company.*

# How Digital Learning can Enhance Thinking

Does digital learning enhance our thinking? How? The term digital learning is under constant change and redefinition. After about 20 years of collaboration with Halmstad University, Jo Smedley is thrilled about the post as Visiting Professor in Digital Learning at Halmstad University. She focuses on an interdisciplinary approach and enhancing students employability.

Digital learning is any type of learning that is accompanied by technology.

"Digital learning is an ever-changing term. What students are learning now will be redundant in 10 years. Hence why it's so important to focus on the strategic elements of why and how digital learning can enhance thinking for future data, information and knowledge management. It's this filtering approach that will enable Halmstad graduates to really enhance their employability – whether in education or business", says Jo Smedley.

## Professor of Learning Innovation

Jo Smedley started her academic career, about 35 years ago with a doctoral thesis in mathematics. Until August this year, she was a Professor of Learning Innovation at the University of South Wales in the UK, and director of the University's distance education initiative, USW Online.

The recruitment of Jo Smedley to Halmstad University, School of Education, Humanities and Social Sciences, is to strengthen and develop the School's research and education concerning digital learning. It is significant that a publication she is currently working on is called "Designing a learner journey: it's all about people".

## Business emphasis

"I've done a lot of work on learning per se and have now progressed this towards a business emphasis to see the impact peoples' learning has, or can have, on their current or future organisations – irrespective of type."

Her research focuses on personal and organisational change, empowered through efficient management of data, information and knowledge – particularly using appropriate technologies.

*Jo Smedley publishes outcomes from her projects and developments at every opportunity. In a time-limited academic world where publications matter, it is important to tell the "stories" of how the academics apply the learning to push forward knowledge boundaries.*

2018–2019, Roger Säljö, University of Gothenburg, also holds a post as Visiting Professor in Digital Learning at Halmstad University

# Researchers Investigate how School can Become Excellent

In a school development projects in Halland, 'From Great to Excellent', municipalities are working together to improve the performance of preschool children and school pupils. The efforts of the teachers and others have been studied by a research team. The researchers' perspective is unique, because the municipalities' development work is being studied from the point of view of the employees.

"This is practice-based research that concerns knowledge which is directly beneficial and useful for schools. We researchers are closely examining what happens when the teachers and others work with development," says Jeanette Sjöberg, a senior lecturer in Pedagogy, who is doing research within the project From Great To Excellent (FGTE) together with Annette Johnsson, Senior Lecturer in Educational Sciences, and Pernilla Granklint Enochson, Senior Lecturer in Educational Sciences. The Research Leader is Marie-Helene Zimmerman Nilsson, Associate Professor of Pedagogy.

## Long-term regional collaboration

The school development project is a long-term regional collaboration that seeks to find answers to the question of how preschool and school can support children and pupils in a way that allows them to accomplish as much as possible in their learning. The collaboration constitutes a process for developing schools, and will yield new knowledge about successful working methods that promote the attainment of goals by children and pupils.

Kungsbacka, Varberg, Halmstad and Laholm municipalities are collaborating on the project, with Region Halland and Halmstad University as partners. The research aims to create an understanding of how the school development work of teachers, headmasters/headmistresses, school leaders and others is functioning.

## Issues relevant to schools

"We want the research to be useful to them 'in the field'. We researchers are constantly trying to ensure that we work with issues that are relevant to schools and teachers, so that we do not end up on a track from which the school can glean no direct benefits. At the same time, it's clear to us that the research must be independent and critical," says Jeanette Sjöberg.

"It's not very common to study collegial learning so closely, and the whole collaboration with FGTE is unusual in

itself, because it involves several municipalities working together to develop their school operations."



*Jeanette Sjöberg is a senior lecturer in Pedagogy and one of the researchers within the somewhat unusual project From Great To Excellent (FGTE) where several municipalities work together to develop the school operations.*

## The FDLIS Collaborative Project

As an example of Smart Cities and Communities, the FDLIS cooperation (the Future of Digital Learning in School) is a unique collaborative project with a close connection to smart education with digital technologies. FDLIS focuses on the potential of teaching and learning processes with digital resources to improve children's and pupils' engagement and learning. The primary purpose of the work conducted within the context of the FDLIS project is to contribute to the future of digital learning in school through research and development, through joint efforts supported by the combined competence of seven municipalities, Region Halland and Halmstad University. From 2018–2020, the project partners invest a total of just over SEK 8 million in the collaboration. 10 researchers from Halmstad University are involved in various sub-projects connected to teaching and learning through digital resources.

The arrival of autonomous vehicles in our society will significantly change the way we travel. But should we, and our cities, adapt to new urban mobility or can technology be tailored for us? A Drive Sweden project – AHA – hosted by Halmstad University, combines experimental prototyping and testing of intelligent services for urban development and autonomous vehicles, with participatory and human centred research. The goal is to establish new ways of developing modern vehicles and smart cities for a sustainable social environment.

# A Human Approach to Designing Future Cities and Intelligent Cars

It is very likely that semi-autonomous intelligent vehicles will drive on our streets in the near future. This offers new opportunities for the integration of intelligent vehicles into a growing digital urban service economy and infrastructure. But to be sustainable, a shift is needed in the way that smart city technologies are designed.

"We need to design with rather than for the users, and we need research models that address this shift", says Vaike Fors, Associate Professor in Pedagogy at Halmstad University.

New technology and innovation can lead to hope, but also anxiety. Technology is often expected to create improvements that benefit society, individuals, business and government. However, ethnographic research has shown that people do not always use technology as intended. This is often due to the fact that people use technology as part of their everyday life habits and routines, rather than as a result of rational decision-making. One example of this is the way people use cars.

The design ethnographic project AHA brings together technology designers, urban planners, and social researchers. Research results are used from previous ethnographic studies of how citizens perceive and use their cars and other means of transport. This is connected to urban planning and technology development with a focus on how people live their everyday lives.

The research team has created different materials to be used to fuel the discussions in the project workshops, for example insight cards and commuting routine maps. In a workshop, car designers, urban planners and social researchers gathered to identify specific points of interest in the everyday commuting routines. The workshop led to a collection of ideas of how these routines can be addressed so as to increase the value for cities and their citizens as well as business actors. These ideas will be developed further in new workshops.

"Through the workshop, people's everyday life is brought into city development, through the ethnographic research results. It's a fantastic way to bring together different stake-



holders and discuss the aspect of commuting," says Sarah Pink, Professor of Design and Emerging Technologies.

The research results will be made transferrable and scalable so they can be shared globally.

### About the AHA research project

Co-designing future smart urban mobility services–a human approach (AHA) is a Drive Sweden project. Drive Sweden is a Strategic Innovation Program funded by Vinnova (the Swedish Innovation Agency), the Swedish Research Council Formas and the Swedish Energy Agency. AHA is a proof-of-concept project to tailor and demonstrate a design ethnographic methodology that combines experimental prototyping and testing of intelligent services for urban development and autonomous vehicles, with participatory and human-centred research. As part of the project, four workshops with technology designers, urban planners, citizens and social researchers are organized as well as a round-table discussion. The project runs between April 2018 and June 2019.

A part of the project team is based at Halmstad University and consists of Adjunct and Guest Professors from Volvo Cars and Monash University, Australia, guest researchers from Aarhus University, Denmark as wells as Associate Professors, Post Docs and industrial PhD students from Halmstad University.

# Testing Complex Autonomous Systems

Autonomous vehicles can increase traffic safety, lead to reduced fuel consumption and more efficient road use. The technology for self-driving cars is developing fast, but there are still many challenges ahead. One concerns reliable data communication between vehicles. Research from Halmstad University suggests automatically testing functional and safety aspects of autonomous systems.

Benjamin Vedder did his Ph.D. at Halmstad University Embedded and Intelligent Systems Industrial Graduate School (EISIGS) in collaboration with the RISE research institute. His research shows that the key is simulating and testing the system enough, including possible faults that can be expected, so as to be confident that it reaches an acceptable level of performance with preserved safety.

**Benjamin Vedder, what testing methods have you developed in your research?**

"We utilize techniques from the areas of fault injection and property-based testing, and apply them to simulations, hardware-in-the-loop tests as well as on tests with full

> Cooperative automated or autonomous vehicles are terms used for intelligent cars, buses and trucks that communicate with each other and the traffic system infrastructure to navigate and drive more or less automated, by themselves.

hardware. The work is rather hands-on, and we have developed a custom quadcopter system as well as self-driving model vehicles in the process of evaluating our approach."

**What answers did you get?**

"In short, we show practical and feasible methods to automatically test functional and safety aspects of complex autonomous systems. In the process of doing so, we encountered many challenges and proposed methods to deal with them. One example of such a challenge is how to safely let a computer control a moving model vehicle with randomly generated trajectories for it in real-time. The answer to this challenge includes constraining how the random trajectories are generated, and making sure that the test scenario gives computation and communication enough headroom to finish without letting the vehicle under test run out of commands on how to drive next."

**How can your research benefit the society?**

"By making it easier to develop and test safe autonomous systems. Autonomous systems can solve many problems and increase the quality of life for all people."

# Human Interaction with Intelligent Vehicles – how do we React and when is it Dangerous?

During the past five years, PhD student Maytheewat Aramrattana has developed a simulation programme to test and evaluate functions of intelligent vehicles, including how humans act in traffic situations with such vehicles. The research has been done in collaboration the Swedish National Road and Transport Institute (VTI) with the goal of improving infrastructure and technology. Meet the young researcher who believes that intelligent vehicles will fundamentally change the way people and goods are transported – and is motivated to contribute to this change with his knowledge.

"It is important that humans are involved in testing and evaluating new transportation systems. Through the simulation I have built, we can study how human drivers use and interact with cooperative intelligent vehicles. This gives us a better understanding of how society perceives and reacts to these future vehicles", says Maytheewat Aramrattana

Cooperative automated vehicles is a term used for intelligent cars, buses and trucks that communicate with each other and the traffic system infrastructure to navigate and drive more or less automated, by themselves. The future of cooperative and more automated vehicles is by many experts considered to be near.

"Cooperative automated and partly autonomous vehicles are already today used in confined areas such as mines, harbours and warehouses. For us humans, many have predicted that we will have more car users but fewer car owners, because of the car sharing businesses. The way we move goods will perhaps not change so much, it will just become more 'automated'".

Platooning, which refers to a number of connected, cooperative and partly automated vehicles that follow each other with short inter-vehicular distance in order to save fuel and minimise road space, is already a reality on our roads. The wireless communication between vehicles in a platoon is crucial – if the communication fails for just a couple of seconds, the result can be devastating. Or if a car cuts in between two trucks in a platoon.

"There are many scenarios to be considered when evaluating safety of platooning applications. By using the simulation programme, I have performed safety analysis on situations when a normal vehicle, with no automation or connectivity, changes lane and ends up in between these platooning vehicles, a so called 'cut-in situation'."

Maytheewat Aramrattana chose to study these cut-in situations because they occur frequently and are an important hazard to platoons. The results of the simulations show that this kind of situation could be dangerous, with many factors involved from the perspectives of safety and user acceptance.

"Platooning applications should have strategies to properly deal with such situations. However, there are no standards or guidelines regarding this at the moment."

The project is now finished and several interesting results related to the simulation based method for testing of functions and scenarios in so called cooperative intelligent transport systems have been summarised and published. Maytheewat Aramrattana will continue working at VTI as a researcher and is determined to contribute to safer autonomous vehicles.

In 2016, a team of Master's students from Halmstad University won the prestigious competition Grand Cooperative Driving Challenge 2016 (GCDC). Maytheewat Aramrattana was one of the team leaders for Team Halmstad. Two years later, in May 2018, he helped six engineering students during an international drone competition. The Halmstad team came in second place. Recently, Maytheewat Aramrattana was part of a group from Halmstad University that won a hackathon arranged by Volvo. The team created a smartphone app for automatic inspection of the undercarriage system of excavators.

# The Near Future

## Halmstad University Solar Team

Students from Halmstad University are participating in the Bridgestone World Solar Challenge 2019, the world's biggest solar-powered car race. Halmstad University Solar Team (HUST) is building a car which will be aerodynamic, lightweight and safe for the drivers. The goal is to construct the most efficient electric solar car in the world.

Team HUST consists of Innovation Engineering students from Halmstad University. The project members are divided into two teams, Economy, Marketing & Sponsorship (EMS) and Engineering. The Bridgestone World Solar Challenge started in 1987 and takes place every two years. In the competition, teams from universities all over the world drive 3.022 kilometres from Darwin to Adelaide in Australia. The 2019 year competition will take place on October 13–20.

**www.husolarteam.com**

# Future Mobility Center

During 2018, we have initiated the work to establish our Future Mobility Center at Halmstad University with focus on mobility related services. Here, we intend to test a new paradigm for doing research in the intersection between academy and industry. We aim to set up all necessary functions to do state-of-the-art innovation, research, and development in one common place. Projects will follow a product-first strategy, meaning that we always start by defining real products for real-world user needs – either as conceptual products, prototypes or Minimum Viable Products (MVPs). This we do in collaboration with industrial partners, representatives from the public sector, and end-users. Along the journey of realising the product, we will attempt an agile meth-odology that balances technology content with business-model aspects and UX/eth-nography. During the coming three years, we aim to start the innovation journey of at least three independent products. Today, the "ideation" phase of two such products has been completed and we are now entering the "business-model innovation" phase. A Vinnova FFI application was approved 2018 for performing a pre-study to start the de-velopment of an MVP. The Future Mobility Center will be inaugurated in April 2019 and the director for the center is Richard Bunk at Halmstad University.

# Looking Forward to 2019

For Smart Cities and Communities at Halmstad University 2019 will be an important year. It will be the first full year with the infrastructure support-ing the profile area, we will continue to develop and sharpen the strategies for Smart Mobility and Smart Energy, and we will engage in several part-ner workshops for jointly defining research needs. All of this is important in creating a viable and vibrant frame for the future of Smart Cities and Communities at Halmstad University.

Importantly though, the profile area will not have any effect without the research projects and their results. Not forgetting the projects that are already ongoing, it is important to get new projects started. We have several projects that are planned to start during 2019 funded by a breadth of funding agencies, for example the KK Foundation and EU, to name two. There are several projects under development within the next work plan for Research for Innovation. Similarly, there are several pro-jects developed or already submitted for other funding agencies. The ongoing KK profile CAISR is to be planned and developed for continuation as a profile+, i.e. CAISR+.

The build-up of the Future Mobility Center will continue and events are planned. Moreover, we will plan for how the profile area can enrich our education programmes and vice versa. To begin with, we will focus on the PhD education, but already after the summer of 2019, a new two-year master's programme called Energy Smart Innova-tion in the Built Environment will start. Moreover, several PhD defences within Smart Cities and Communities are planned for 2019. In September, Halmstad Universi-ty's yearly Innovation Day will be devoted to the area of Smart Cities and Communities, which we look very much forward to!

Halmstad University has several top modern laboratories where education as well as research takes place in adjusted enivronments. The labs are used by students as well as teachers, researchers and our collaboration partners. In addition to being invaluable in connection to graduation projects and research tests, the labs are also great study areas whenever you want to work together and get inspired in a creative environment.

# Many Modern High

### Digital Laboratory Centre

The Digital Laboratory Centre (DLC) is a creative, high-tech laboratory environment focusing on learning and culture. DLC is intended for researchers, teaching staff, students, organisations and companies, and is a regional meeting place at the forefront of digital society. At DLC, you will find the latest equipment in visualisation, simulation and design – technology that creates opportunities for new and visual ways of communicating complex or abstract information. There is also VR equipment, digital lab environments, a creativity space and a communications studio.

DLC is used in education, research and development projects, and serves as a 'makerspace' – a workshop-like environment that encourages the sharing of knowledge, tools and ideas. The physical environment of DLC is also designed to promote creativity and offer flexible ways of meeting and communicating, as well as space for both digital and analogue creation.

### Electronics Centre in Halmstad

The potential growth of the electronics field is huge. It is estimated that the development of the "Internet of things" means that there will be over 50 billion connected electronic units globally in 2020. Electronics Centre in Halmstad (ECH) is an innovation arena created by Halmstad University in collaboration with regional companies. The focus of ECH is integration of electronics in everyday products to make them 'smart', which provides substantial added value and competitive advantages, and represents an important innovation potential of the traditional Swedish manufacturing industry.

Applied research, innovation and knowledge building in the field of electronics integration is a prerequisite to become successful within the global ecosystem that is emerging around these new 'smart' products. Identified research subjects in focus at ECH are next generation electronic building practice, electromagnetic compatibility

# Tech Labs

(EMC) and low power design. A multidisciplinary collaboration with for example Health Technology Centre (HTC) will enable interesting and potentially ground-breaking intellectual combinations leading to new research as well as to development of innovative education programmes.

## Fab Lab

Digital production is fundamentally changing the industrial landscape. 3D technology is therefore of great significance in terms of regeneration opportunities for established companies, the formation of new companies and novel ways to produce products. Fab Lab Halmstad is part of a global network and an accredited affiliate of the Massachusetts Institute of Technology, MIT. The prototype workshop is a creative environment and resource for several of the University's engineering programmes and research in the field. The workshop has everything from 3D printers, 3D scanning equipment and laser cutters to computerised embroidery machines.

## Health Lab

New knowledge of people, technology and society enables the creation of innovative working methods for communication, counselling, examination, treatment and training. Health Lab offers advanced opportunities to train the skills and develop the technology needed in future healthcare.

The lab houses, among other things, the Home of Health (Hälsans hem) – a complete two-bedroom apartment for simulation and practice of professional skills in healthcare. At the Health Lab, you will also find the Health Centre (Hälsocentralen) – a new type of healthcare clinic where researchers and students from the nursing or health education programmes, for example, can develop new forms of reception. The lab is also an environment where innovative solutions for everything from elite athletes to rehabilitation are developed.

## Health Technology Centre

Health Technology Centre Hallland is a space for health innovation. Companies and organisations within the healthcare sector work with our students and researchers to develop products and services for the future healthcare industry. We live in a fast-paced society where technology very quickly changes the way we work. This gives us great opportunities to create sustainable solutions for our future societies.

Students are an important part of the Health Technology Centre Hallland testing environment. They are often part of different development projects and many of them choose to do their graduation projects within health innovation.

## Rydberg Core Laboratory

The Rydberg Core Laboratory (RCL) is an interdisciplinary laboratory at Halmstad University used by both students, teachers, researchers, companies and external organisations. Research conducted at the laboratory includes the natural sciences, associated applied sciences and maths.

RCL is made up of several smaller units, the Environmental Sciences Lab, Movement Lab, Energy Lab, Microscopy Lab, Photonics Lab, Mechanics Lab, Tribology Lab, and Fab Lab. Basic and applied research are carried out here, often in collaboration with partners from industry and wider society. All together, these environments are important resources for both students, teachers and researchers, as well as the University's collaboration partners. By using RCL, innovative experiments and projects can be conducted in a stimulating and modern environment.

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