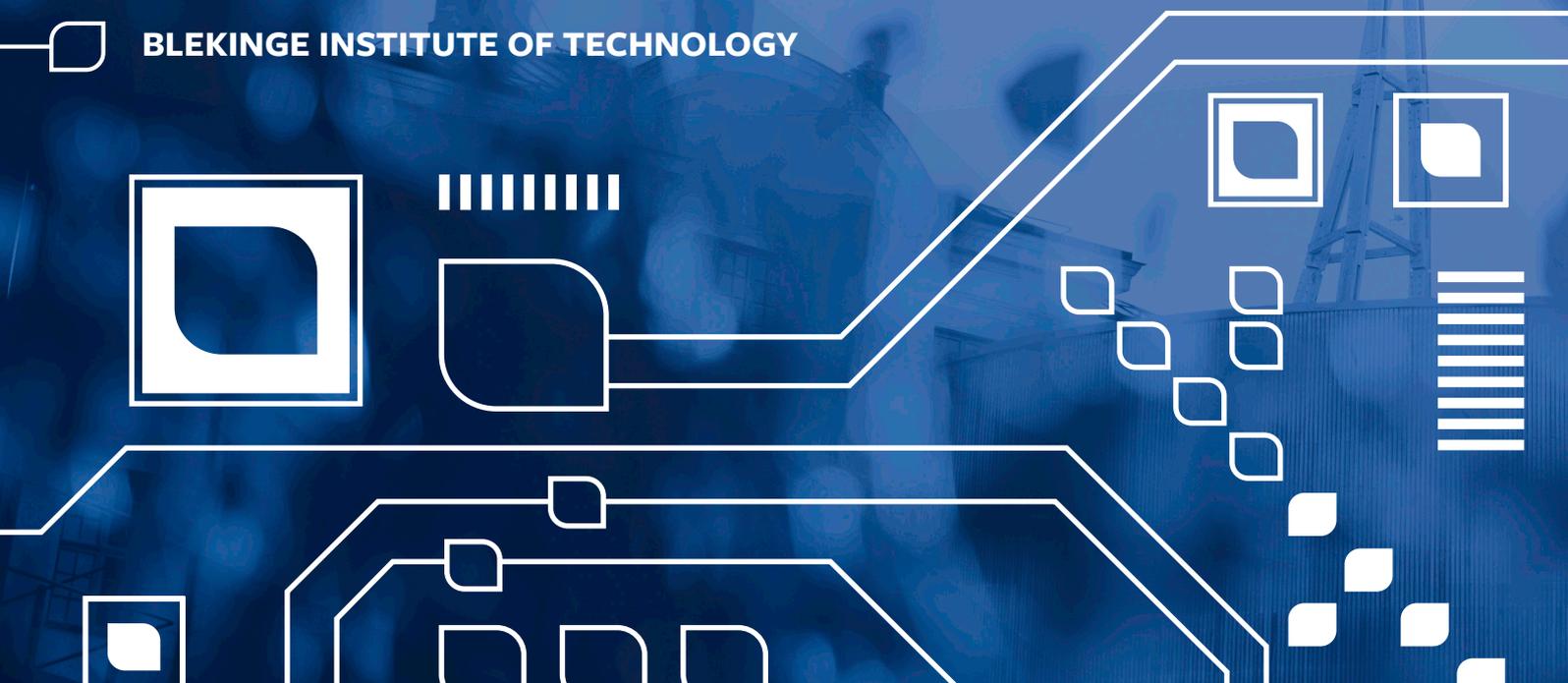




RESEARCH AT BTH

# FOR SOCIETAL CHALLENGES

BLEKINGE INSTITUTE OF TECHNOLOGY



# RESEARCH THAT MAKES A DIFFERENCE

As an institute of technology, we have great opportunities to contribute to a sustainable future for our society. We achieve this by carrying out research that makes a real difference.

To succeed, BTH aims for close collaboration with industry and society, and for high quality in everything we do. The research concentrates on strong fields, where there are good conditions to be of benefit to society. BTH has high ambitions – and within some fields, such as software engineering and strategic sustainable development, we are already world class. Currently, research accounts for a third of BTH's activities and we have the ambition to increase this proportion even more.

## Digitalisation and sustainability

BTH's profile is digitalisation and sustainability, which supports and is supported by our research in subjects such as computer science and software engineering, signal processing, telecommunications, mechanical engineering, systems engineering, strategic sustainable development, industrial economics, spatial planning and health technology. In practise, many research projects are interdisciplinary in nature and therefore not easily classified in one overarching subject.

## Research leading to knowledge

The research at BTH is beneficial in many ways. For example, it leads to new methods, tools, products and services for our partners, often with increased sustainability and efficiency as a result, or to the creation of new companies. The research also contributes to new knowledge that results in regulations or policies and, by extension, to policy choices. However, the biggest benefit of the research comes via its contribution to education.

BTH is a university characterised by closeness. There are short distances between researchers and students and between research groups. We are proud of the international collaborations but also of the local relationships that help us to create benefits more quickly. Wider society inspires us and, together with our partners, we contribute to the global sustainable development goals. Imagination is the only limit to what is possible.



Mats Viberg, Vice-Chancellor



**BTH's research is strong in fields  
of great importance to industry  
and society.**

Mats Viberg, Vice-Chancellor

## CONTENTS

<b>Sustainable development – how is it achieved?</b>	4
More than just fossil-free vehicles required On the hunt for the city's healing power Company sustainability journeys	
<b>Software to make things possible</b>	6
<b>Unique clinic for health technology research</b>	8
Clinic for innovative collaboration How AI reinforces the status of the patient Smart glasses for better care	
<b>Online safety</b>	10
<b>From ping pong to home runs with AI and big data</b>	12
<b>Researchers who see the ocean as a resource</b>	13
<b>Virtual applications in which humans and machines come together</b>	14
<b>Digital product development for a sustainable future</b>	16
<b>Your place in the city</b>	17
<b>Better results from complex measurement</b>	18
<b>Signal processing – enabling smart technology</b>	20
<b>It starts with an idea – our labs</b>	22
<b>Research fields at BTH</b>	23

# SUSTAINABLE DEVELOPMENT - HOW IS IT ACHIEVED?

In the field of strategic sustainable development we develop methodology that helps companies, municipalities and other organisations to contribute to societal transition to sustainability in a way that reinforces the success of the individual organisation. Here are some examples of application areas and collaborations.

## MORE THAN JUST FOSSIL-FREE VEHICLES REQUIRED

It is possible to adjust the transport system to become fossil-free and sustainable, says Henrik Ny, associate professor in strategic sustainable development. He is positive but aware of the challenges. To combine the high and the low, systems decisions and practical solutions, new work methods are needed. This is where BTH comes in.

“The transport sector is key for societal change, however, it has to be viewed in the context of other sectors such as industry, energy, agriculture, spatial planning and social systems”, says Henrik Ny.

“Replacing fossil-driven vehicles with electric vehicles is not enough”, he argues. Other aspects in the system must be questioned and changed. What triggers the need for transport and how can this be reduced? How should cities be developed? What mode of transport is the most effective in different circumstances? Systems approaches are often difficult to describe. However, BTH has come a long way and is working closely with

the regional decision processes, with companies and on joint development projects with the Energy Agency for Southeast Sweden, among others.

“The collaboration with BTH enables us to directly benefit from the research, with increased knowledge and perspectives which contribute to increased capacity to further support our owners in their climate and energy work”, says Annika Öberg, project manager at the Energy Agency for Southeast Sweden.

Blekinge and Småland have come together on a systematic work method concerning vision, current situation, solutions as well as



**With leadership and innovation we change society and make it sustainable.**

Göran Broman, professor

scenarios and policies. The BTH researchers also led the development of ‘On Track for 2030’ – a regional roadmap for a fast transition to sustainable personal transport.

“We should be able to become a model and testbed for how to efficiently transition an entire region. The model can be adapted to other regions – both nationally and internationally”, says Henrik Ny.



Annika Öberg



Henrik Ny

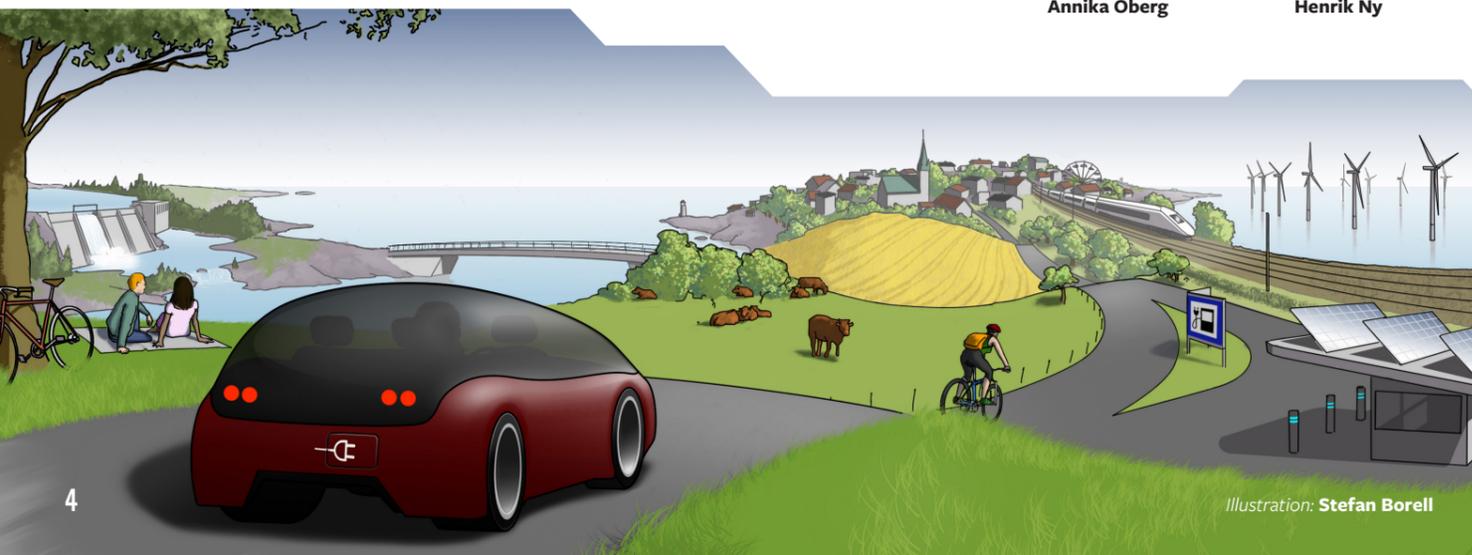


Illustration: Stefan Borell

## ON THE HUNT FOR THE CITY'S HEALING POWER

More and more of the world's population live in cities. Cities that may have been sustainable when they were created may be far from that with current lifestyles.

The future and the significant transition that is needed places demands on the districts and cities we create today, but also on reducing the negative impact of existing urban environments.

“We need to plan, build and rebuild creatively for future needs. Densification is often desirable, but it also needs to promote a positive lifestyle. For example, in increasingly densified cities, how can green spaces be increased in innovative ways? Increasing the healing power of the city and potentially reaching a point at which the city contributes positively to the earth's healing is my mission”, says Giles Thomson, researcher in strategic sustainable development.

In practice, sustainable development requires a profound and comprehensive collaboration between research fields and

societal functions. It is not easy and goes against much of the existing planning process. Abdellah Abarkan, professor of spatial planning, highlights the need for clearer tools and more good examples of practical applications to change the planning process.

Peter Schlyter, also a professor of spatial planning, adds that the sustainability of a city cannot be separated from the surrounding rural area; instead, these links need to be reinforced.

“The mutual dependency between urban and rural areas is a positive challenge to develop and at BTH there is a diversity of expertise to handle the complexities”.

All sustainable transitions end up in spatial planning at some stage and it is at BTH that Sweden's spatial planners are educated.



Giles Thomson



Peter Schlyter



Abdellah Abarkan



## COMPANY SUSTAINABILITY JOURNEYS

A sustainability perspective must be introduced early on in product development if it is to result in cost effective and long-term competitive solutions.

Associate professor Sophie Hallstedt and her research group support companies making the journey toward sustainable solutions.

The research in sustainable product development takes place in close collaboration with industry.

“Step by step we are producing a methodology for sustainability implementation. The goal is a sustainable solution and it is necessary to understand how an individual change affects the whole. Should we replace materials? What waste is created and how do we make the most of it? How should transport be carried out? The method provides guidance on the best global solutions and indicates the right direction”, explains Sophie Hallstedt.

Close collaboration with companies is important in order to have real case studies on which to work.

Jesko Schulte is a doctoral student who describes how to reinforce the practical application of sustainable product development while developing the theory.

“We connect all parts of the process, sustainability is complex. You have to go through the entire journey from knowledge to concrete design and product choices with life cycle perspectives. Cooperation is necessary to formalise the process and we have that opportunity at BTH”, says Jesko Schulte.

The next step is to create a package with digital tools that companies can use.

“There is a wealth of information and we produce tools to make it usable, among other things to be able to measure the sustainability of a product at an early stage. We call it the product's fingerprint. It indicates a global perspective and whether you are on the right track”, says Sophie Hallstedt.



Sophie Hallstedt



Jesko Schulte

# SOFTWARE TO MAKE THINGS POSSIBLE

Software makes digitalisation possible, in practice. Software connects different kinds of energy in an energy network as well as the functions in a car, banking transactions or the 1177 healthcare guide. Tony Gorschek conducts research in software engineering, in which BTH is among the world leaders.

Software is abstract in the sense that it is not visible when it works. Think about flying, water, electricity, traffic lights, mobile telephone services – they are part of the everyday infrastructure and the functions are constantly increasing and improving. Tony Gorschek says that companies often build on the same software and add more program code and functionality when products and services are to be improved and developed. Risks of mistakes and unpredictable consequences arise, and it is difficult to trace errors in large amounts of program code.

## So much more than just code

“Carrying out effective software development is about so much more than knowledge of program code. How do you organise teams of thousands of people who program millions of lines of code while the function is to deliver 24 hours per day, all year round? How do you create an overview and ensure that errors do not occur when code is changed and further developed?”

“At BTH, we help companies to produce, use and further develop software. We use an applied work method that builds up unique breadth and expertise”, says Tony Gorschek.

## Experienced problem solvers

Researchers at BTH study everything from machine learning for quality assurance and ways to organise large amounts of data to methods for efficient collaboration in groups.

“There are many components in the process that need to be optimised in an integrated ecosystem informed about market value, technology and human beings”, says Tony Gorschek.

Collaborations with several national and international technology companies provide the researchers with a large knowledge base that they systematise and utilise.

“We can produce and introduce better methods thanks to our overview and experience. We are experienced in problem analysis and it is always possible to find new and improved ways without starting from scratch”.

## World-ranked researchers

Tony Gorschek describes software development as archaeological digging that results in the choice of relevant solutions for the fundamental problem, reusing what others have done and measuring that what has been done is actually correct. The development combines software engineering with intelligent automation and machine learning, value-based business administration and behavioural science. BTH is ranked among the best in the world and number one in Europe when it comes to research in applied software engineering.

“We see the bigger picture and are good at unpretentious collaboration. Co-production is difficult, but we know how to do it – it is a success factor. We have also formed a creative environment to attract expert staff internationally. Here, there is room to create an individual research identity and to continue developing”, says Tony Gorschek.



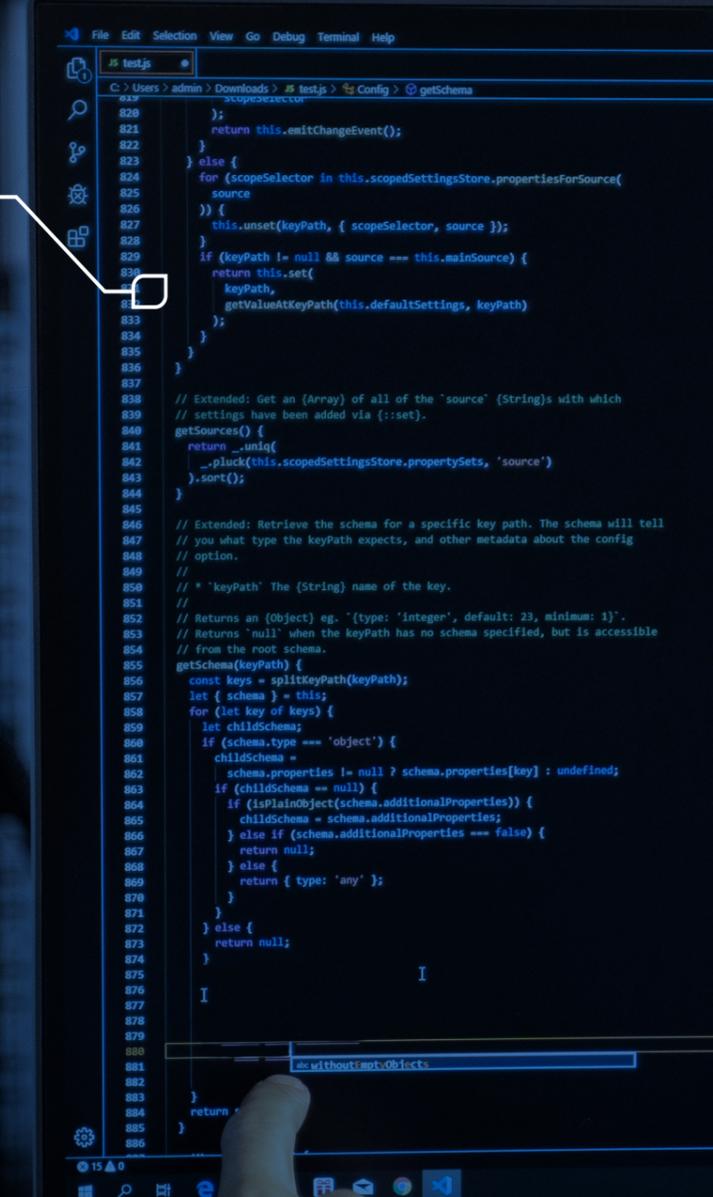
**My job is to delve into and find solutions that can be applied in many areas.**

Tony Gorschek, professor



**In order to maintain our leadership in the areas we operate in, we need to collaborate with, among other things, the research environments that have the right expertise - and BTH has that.**

Helena Olá, head of development unit, Ericsson



# UNIQUE CLINIC FOR HEALTH TECHNOLOGY RESEARCH

## CLINIC FOR INNOVATIVE COLLABORATION

BTH has the only clinic in northern Europe where solutions can be developed from an idea all the way through to practical implementation.

The unique clinic is a strategic initiative in which BTH draws on its combination of health, nursing and technology. Here, links are created between research, education, innovation, technology development and practical implementations in areas with potential for significant societal gain.

“Innovative and boundary-crossing collaborations can be carried out to tackle significant societal challenges, which concern an aging population and conflicts between needs and resources”, says professor Johan Sanmartin Berglund, director of the clinic.

He argues that a large part of the solution is to work more intelligently and to have good everyday decision-making support.

“Digital technology should be used for what it is best at, that is, to do the same thing many times, to learn gradually and to not be dependent on mood. Experts can be accessed digitally regardless of where they are in the world and AI could improve the flow at hospitals so that places and resources are used more efficiently. That is the sort of thing we can develop here”, says Johan Sanmartin Berglund.

Other important areas in which technology development is needed include support for different types of dementia, self-care and preventative care as well as oral health.

“Oral health is more significant in health and disease than previously realised. At the

clinic, we create specialised knowledge and are unique in the combination of equipment and expertise for research in healthcare both for oral health and the rest of the body. Here too, there is great potential for development and studies”, says Johan Sanmartin Berglund who welcomes all project ideas to the clinic, both national and international.



Johan Sanmartin Berglund

## HOW AI REINFORCES THE STATUS OF THE PATIENT

Can AI be a tool to improve healthcare in the meeting of people? An exciting collaboration project at BTH is deepening the analysis and knowledge of abuse in healthcare, as basis for development.

“We use healthcare data, with the help of self-learning clustering algorithms, to detect patterns and deepen knowledge so that abuse can be corrected”, says Martin Boldt who conducts research in artificial intelligence. Initially, the data source in the project is reports made to the Patient Advisory Committee in Blekinge, where patients, friends and family can turn. In the future, the method could be extended to a national analysis of all reports in Sweden.

Lisa Skär is a researcher in nursing, and she contacted Martin Boldt to discuss how

all this information could be structured and analysed. It resulted in a unique study.

“The content of the reports are subjective descriptions of experiences and largely unstructured. They often concern how they have been approached, a feeling of not being believed or understood, or of being victimised or accused.”

Blekinge views itself as a test pilot and hopes to be given the opportunity to use the technology in other regions, and for national and international authorities.



**The research reinforces the status of the patient.**

Lisa Skär, professor



Martin Boldt

“Good patient contact in healthcare is equivalent to good quality. There is significant societal benefit in listening to patients and improving based on their experiences”, says

Lisa Skär.

## SMART GLASSES FOR BETTER CARE

Charlotte Romare’s research focuses on smart glasses and this innovation is to be tested at the clinic.

“When caring for a patient, you can select which parameters are to be visible in the glasses, maybe ECG, blood pressure, oxygen levels or something else depending on which decision-making support is required. The glasses provide a quick overview while enabling the user to focus completely on the patient instead of on different screens”, says Charlotte Romare.

The glasses may also be used to allow for someone to participate remotely, perhaps for training purposes or for expert assistance. As it is also possible to record what is happening, they provide material for self-evaluation and further development.

“For example, surgery have been live-streamed to students and provided them with the opportunity to ask questions during the operation. However, in my project I have

focused on the field of application in which you can see the patient’s vital parameters during the actual care”, says Charlotte Romare.



Charlotte Romare

Charlotte Romare works in healthcare practice while conducting research on the smart glasses in a project with BTH.

“We have used focus groups from healthcare to get as close to the needs as possible and to ensure that what is seen in the glasses is easy to recognise based on what they are used to seeing on their screens. The information from the focus groups has then been the basis for the software developers who have produced an app for the glasses”, says Charlotte Romare.





**We can be of great benefit in the prevention of attacks and sabotage in vital societal functions, it is an important research contribution.**

*Dragos Ilie, researcher*

## ONLINE SAFETY

Increasing computing power and the number of interconnected functions – many opportunities but unfortunately also risks of malicious attacks. Dragos Ilie conducts research in computer science to make it harder and more expensive to carry out cyber-attacks.

“The incentive for those who carry out attacks is often money, for example, by locking data that you recover if you pay or by selling on large amounts of personal data they have gained access to, and attacks are carried out in an organised manner. We increase the knowledge on attacks and find vulnerabilities in systems and functions”, says Dragos Ilie.

### **Simulations of cyber-attacks to find countermeasures**

An important part of our work is a cloud-based test environment in which researchers and students study cyber-attacks in a closed environment to understand vulnerabilities in systems, access points and developments of attacks and how countermeasures should be developed. Network security, trusted computing and test environments are areas in which BTH contributes to many collaboration projects.

“One of my lines of research focuses on detecting malware. For example, we study a special type of software that remains hidden by modifying its own code. To detect it we use deep learning, an advanced AI method”, says Dragos Ilie. He asserts that a general security issue is the major operative systems that the whole world uses without having any or very little insight into the development. Many attacks exploit vulnerabilities in these specific systems, despite the manufacturers working hard to keep the product in good condition.

“The international systems are sensitive from a security point of view, we have to live with that, and instead create preparedness in society with an increased knowledge of network and computer security. It is an important function for the research and education at BTH”, says Dragos Ilie.

### **Online safety – a question of knowledge**

Alongside technology development, increased knowledge and awareness among users is the most important measure for

safety. Program codes that are created for malicious purposes search for vulnerabilities and are sent out automatically and widely, no user is unimportant, anyone can be affected. The source is everything from individual hackers to organised crime.

“Our general advice to the public is to use antivirus software, not to click on unknown files in emails and to choose long passwords that are hard to guess. That goes a long way to protect from common attacks directed at the user’s computer. However, a connected and unprotected electricity meter can also provide access to your home WiFi”, says Dragos Ilie.

Security architecture is often BTH’s contribution in different development projects. For concrete solutions, BTH participates in parts of the development.

“We are a public actor and our results are not classified. We contribute with expertise, education, testing, and the creation of prototypes but it is the company that owns the problem and has the holistic perspective of their security-classified systems”, says Dragos Ilie.

### **AI can contribute to increased safety**

BTH also collaborates internationally on increased safety. For AI functionality to be easily accessed by developers, a European marketplace for AI is being created that is similar to existing marketplaces for apps. BTH contributes with knowledge and methods that prevent or make it difficult for users to bypass component licences and to make unauthorised modifications to the AI components.

“Protection is required to ensure the AI modules are not copied and misused”, says Dragos Ilie.

A dream project for Dragos Ilie and his colleagues would be to broaden the work on the protection of critical social infrastructure such as electricity, water, trains, ports and telecommunications.



**At BTH we are developing the systems of the future and algorithms for AI and large-scale data analysis. When we collaborate, we see how they can be applied in practice.**

**Håkan Grahn**, professor

## FROM PING PONG TO HOME RUNS WITH AI AND BIG DATA

In collaboration with Telenor, a wireless provider, BTH has developed technology that streamlines and improves customer service. Artificial intelligence screens support requirements, questions and suggestions, which leads to a shorter response time and increased quality.

Anton Borg is a researcher in computer science. With the help of applied AI and machine learning, together with Telenor, he has improved the customer service process for the telecommunications company.

“Text and speech are interpretable data and we thought a lot about how we could use this data to improve the process”, says Jim Ahlstrand, innovations developer at Telenor.

### Learning how to interpret content

Anton Borg explains how they have used machine learning to interpret the information in customer emails.

“We tested our way forward to see what works and arrived at producing a subject classification so that customer service officers get the questions they are most suited to answering more quickly”, says Anton Borg. The classification takes place firstly by searching for selected subject words and secondly by interpreting the whole email, to obtain an understanding of what it concerns. The development has taken place with close collaboration between BTH researchers and the customer service officers at Telenor who

have experience in how the emails should be interpreted.

“Previously, the emails bounced like ping pong balls between the customer service officers – now they get to the right place straight away”, says Johan Svensson, innovations expert at Telenor.

### More efficient work and better service

To begin with, the system has been implemented in customer service for companies. It has a high success rate and has led to Telenor being able to do more with the information they receive by automatically selecting the right customer service officers and providing support for prioritisation. The customer service officers have freed up time to work more on problem solving and less on administration. The development is now focused on also being able to sort emails that contain more than one question.

This is an example of how BTH works with applied AI. There are many more areas and solutions for which it is possible to use the amount of data that is available in the form of text, images and speech.

“BTH uses an applied work method, it is important to start with organisational needs and conditions. We carry out the analysis together. AI also needs to be combined with traditional development of work methods and procedures or the packaging of proposals and offers. We contribute to a holistic approach”, says Anton Borg.



**Anton Borg**



**Johan Svensson**



**Jim Ahlstrand**

## RESEARCHERS WHO SEE THE OCEAN AS A RESOURCE

BTH has participated in producing Sweden’s first national innovation agenda for underwater technology and the researchers see many areas of use – outside the marine industry too.

“Energy and security are two major societal challenges where we can play a part”, says Oskar Frånberg, researcher and representative for the National Centre for Underwater Technology at BTH.

At BTH, technology and applications are developed for the demanding environment under the ocean surface. Oskar Frånberg says that BTH is an important part of the region’s unique environment and offers expertise in underwater technology with comprehensive research activity and engineering programme in marine technology.

“BTH’s strength is that everything is close by and we work in a region with a naval base, shipyards, naval academy, coast guard, industries like NKT, SAAB and Blue Science Park, which together provide a fantastic environment for experts in underwater technology”.

### Potential in marine technology

Solutions from collaboration projects also lead to applications for entirely different environments such as, for example, water-filled mines, AI and data security, decontamination and customs. The brackish water of the Baltic Sea means that shipwrecked vessels are preserved for a long time and technology to find and explore old shipwrecks is another area in which BTH’s Centre for Underwater Technology contributes expertise.

“The ocean is, largely, an unexploited resource and there is a lot to be developed. The activities at BTH have three main specialisations: security and armed forces,

energy and marine construction. Marine technology is not a subject, it is an application. The three research areas are integrated, for example, digitised divers need expertise from all three”, says Oskar Frånberg.

Safety for people on ships, in submarines and out diving are areas in which BTH is world leading.

“We build on the strengths we have. The combination of BTH’s knowledge of the human/system relationship and our technical expertise is a strong contributing factor to the fact that we have come so far in marine safety”, says Oskar Frånberg.

### Ocean drones

The development in the energy area is often focused on systems engineering to develop underwater sensors and digitalisation under water, particularly for the extraction of wind and wave power, oil and gas. The ocean also plays an increasingly important role in connecting different forms of energy and energy networks with cables along the ocean floor.

“Minesweeping the ocean floor before the laying of cables is a challenge; there are plenty of sunken naval mines left from both world wars. Another is to detect the location and depth of cables prior to maintenance work”, says Oskar Frånberg.

In marine construction, the research takes place together with large companies in the region, and here BTH builds on its expertise in product development. Sweden’s production of submarines and submarine rescue



**BTH is world-leading in marine safety.**

**Oskar Frånberg**, associate professor

systems is internationally prominent, and parts of the development take place in close collaboration with BTH.

### Submarine force is more than sinking battleships

Ida Pählman is the engineering systems manager for submarine rescue at the Swedish Armed Forces. She explains that the collaboration with BTH focuses on, for example, the formation of knowledge on underwater work environments or the air environment in a damaged submarine. It is a complicated environment under the surface of the ocean, a bit like space in some aspects. Those who have their workplace under water are cut off and left to their own resources.

“Increased knowledge of, for example, the air environment in shipwrecked submarines provides answers to how we can safeguard the crew until rescue and afterwards”, says Ida Pählman.



**Ida Pählman**





**The mixture of the physical and digital world redefines how we can interact with new technology.**

Diego Navarro, researcher



## VIRTUAL APPLICATIONS IN WHICH HUMANS AND MACHINES COME TOGETHER

The research in visual and interactive computing is often associated with gaming technology, however, that is only one part of all the possibilities that exist. For example, it can be used for surgeons to practise an intervention, for training for disaster responses or to use everyday objects in the 1500s.

The research focuses on how technology is used by humans to interact effectively and creatively with computers.

“The expertise at BTH in the interaction between humans and technology enriches everything we do, and the research can be divided into three areas; computer graphics and visualisation, digital game development and methods and technology for human-computer interaction”, says Veronica Sundstedt, associate professor and researcher in computer science.

### Technology that creates presence

In the VR lab at BTH, research experiments are carried out with participants who, among other things, are able to test and evaluate visual perception and quality of digital virtual applications. Sometimes for games but also in entirely different areas of application.

“Visual and interactive technology creates a feeling of presence in digital experiences, for example, in education, entertainment and communication. It is like being there, and sometimes more than that”, says professor Hans-Jürgen Zepernick.

A collaboration is underway with Blekinge Museum in which the VR technology enables us to see museum objects virtually in an environment typical of their era.

### Let your eyes steer

Using handheld controls to navigate in a digital world is just the beginning, your body will become the tool instead, says Diego Navarro, doctoral student in computer science.

“We use virtual reality tools to understand, entertain and educate. Researchers

have made advances particularly when it comes to knowledge and technology for eye tracking, that is, using the human gaze as an information source and tool”, he says.

“It not only involves an understanding of how a user generally moves their gaze to be able to improve the application, it is also about calibrating technology for individual eye tracking and improving the experience”, says Veronica Sundstedt.

“Eye tracking in 3D is more difficult but very interesting. It is one of the puzzle pieces to create new interactions in virtual environments. In the future, digital applications will be adapted to humans by analysing what and how they see”, says Diego Navarro.

### Great potential in many areas

There is great potential in better understanding the link between technology and what happens physically in the body.

“Not just sight but also other senses and bodily functions may become part of the analysis, such as heart frequency or impulses from the brain”, says Diego Navarro.

The combination of different sensors and the ability to use this data in applications within the most diverse areas is an interesting part of the research, which also opens doors for many collaboration opportunities.

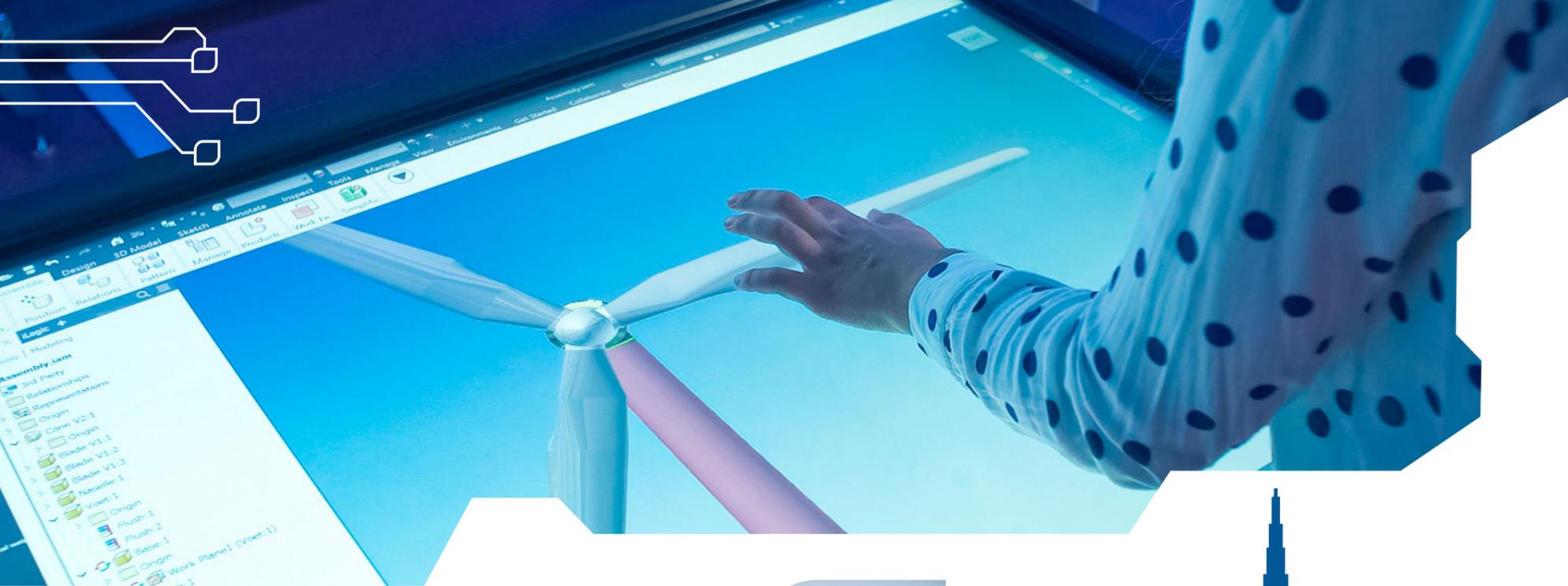
“We have a suitable environment and expertise to conduct useful and applicable experiments, and we are very interested in increasing our collaborations, for example, in healthcare and tourism”, says Veronica Sundstedt.



Hans-Jürgen Zepernick



Veronica Sundstedt



## DIGITAL PRODUCT DEVELOPMENT FOR A **SUSTAINABLE FUTURE**

The only thing around us that is not consciously developed is nature – everything else is developed by the human hand. Product development is the deliberate process to create those things we use in our daily lives. Cars, aeroplanes, milk cartons, everything is product developed. Professor Tobias Larsson is a researcher in product development and leads the area on model-driven product-service development at BTH.

To deliberately create products is a characteristic that has been fine-tuned throughout human history. The ability to develop new and innovative ones is a critical ability in which needs, new technology and expectations are transformed into products and services that create value for the user and society.

Technical construction is at the core of product development and it is vital for those who develop products that they are efficient and create desirable, possible and sustainable solutions. The pace of change in society when it comes to technology development, business opportunities and

societal challenges is dramatic. The product development ability must adapt to societal trends while benefiting from the advances in technology as well as tackling new challenges.

### **Understanding and prediction thanks to models**

By working with digital model-driven development, companies at an early stage, even before the product is produced, can simulate the effect a potential solution will have on its life cycle with the help of a digital twin. Tobias explains the process:

“You have a model for how the product behaves and then models for how the product is to be used and developed in different

ways during its life cycle. With internet of things and sensors you can connect a live stream of data from products directly into the production. Will the product survive all scenarios that may arise? With the methods and visualisation tools we have produced it is possible to simulate this and thereby predict what could happen”, says Tobias Larsson.

### **The value lies in understanding the customer**

“We use very applied working methods and help companies to manage to balance effectiveness in what they are already doing with the ability to produce new innovative solutions. Today, many companies are starting



**The research in value-driven development in mechanical engineering at BTH is unique.**

*Tobias Larsson, professor*

to re-evaluate the traditional approach to product development. There is an increasing understanding that it is not only the technology in itself and to keep costs down that are important. To get closer to the user and understand what they value and what their expectations and needs look like, is at least as important as to be able to compete with the increased range of products and services.

### **Support in the product development process**

It is against this background that BTH has decided to invest in model-based value-driven

design, sustainable product development and simulation-driven design in an integrated environment, to achieve new innovative and sustainable solutions.

“For example, we collaborate with companies in the transport industry that work hard to develop new more environmentally friendly alternatives to gain an understanding of the environmental aspects during both product development, production (e.g. via industry 4.0) and lifecycles. Here, we support the transition from fossil fuels to electrical solutions with all relevant aspects”, concludes Tobias Larsson.

## YOUR PLACE IN THE CITY

Annika Olofsdotter Bergström researches and develops the playable city. With play and games, she wants to move hindering structures and increase human relationships and room for movement in physical places.

Game design has an obvious place in urban planning, according to Annika Olofsdotter Bergström. Her research focuses on how people intra-act with their surroundings, that is, the relationship between people and place, objects, weather, experiences and other material things. With non-digital play and games, she wants to move constricting structures and increase human relationships and room for movement in physical places.

“A city enables relationships between people and places in which games can be viewed as social technology. I want to create relationships between people and cities through playful processes that raise questions about who is allowed to be seen, how we occupy

space and who uses different places. With the help of game design in cities, we can test more possibilities of how we want to live”, says Annika Olofsdotter Bergström.

Designing actions in the city in a gaming process is to explore how space is occupied in different places and how specific actions can increase the room for movement and belonging. One example is immigrant women creating games in different places in Ronneby.

“In the square, one player came up with the idea to measure the whole area, and that we should count trees, lampposts and benches. That led to the players asking

themselves how many people could fit in the square at the same time. The activity led to an invitation for the citizens of Ronneby to come and take their place in the square.”

“By so tangibly investigating, touching and being in the square, the players created a relationship with the square. The experience of belonging is affected by what we do in places, it is powerful”, says Annika Olofsdotter Bergström.



**Annika Olofsdotter Bergström**

# BETTER RESULTS FROM COMPLEX MEASUREMENT

BTH is developing an expert research team in industrial economics and management. BTH is already strong in measuring the effects of change, such as political change, but the field of efficiency and productivity analysis is relatively new and BTH now aims to become the leader in Sweden and an important player internationally.

The researchers are developing the measurement of effects, efficiency and productivity together with companies and project organisations, examining the factors that are beneficial or detrimental to innovation. Productivity development and technical development will be investigated together with companies, and industrial dynamics and technological change will be studied together with public authorities and policy makers.

The mathematical and statistical methods used are proven and continuously developed in international research exchanges and in collaboration with other stakeholders beyond the higher education sector. Jonas Månsson has studied efficiency and productivity in organisations as varied as rice mills in Kenya, law courts in Norway, paper mills, saw-mills and higher education institutions, etc.

– Efficiency studies are based on minimising use of resources and/or maximising production within the set parameters of the means and goals you have. But it is really about understanding the organisation you are reviewing; desk research often does not lead to equally usable analyses, says Jonas Månsson.

## Good basis for decisions

The studies are both model-based and closely related to reality. Jonas Månsson emphasises how important it is to get a hearing for the model and to be on site and talk to people in the organisation but at the same time, as a researcher, to maintain a helicopter perspective. The reasons that management think they see do not always correspond to the reasons observed by the employees, and the context is often complex.

– For example, traditions can be a factor that affects decisions. Not least in

owner-managed companies which have perhaps been passed down through the generations, but also in other organisations where preconceptions can be an unconscious factor in decision-making, says Jonas Månsson.

The basis for decisions is a key concept in this context. Jonas Månsson and his colleagues can identify shortcomings in efficiency that affect results in an organisation, but what management decides to address is beyond their power.

– For example, we can study the differences in results between units in a large holding or a sector, or the effects of political decisions in a country. We offer advice and recommendations, but above all we increase the knowledge available for making future decisions better, says Jonas Månsson.

– Not least, we can sink preconceived notions and contribute with an objective and more in-depth basis for a decision, for those who want to do more within their frameworks.

## Interaction for development

Increasing knowledge about complex measurement is important. It is only when you know what impedes or promotes efficiency and productivity that you can take the right decision to optimise cost benefits and resource utilisation in both business and society. Jonas Månsson sees it as a strength that he and others at BTH have such close links to external organisations. He uses the word interaction to describe the benefit that academia, companies and public authorities can derive from working in each other's organisations. He himself alternates between research on the one hand and assignments and employment positions on the other, in organisations like the Swedish

and Norwegian national audit offices, the Swedish Agency for Growth Policy Analysis, the Swedish Board of Agriculture and the Swedish Social Insurance Inspectorate.

– The reviews often raise questions which cannot be addressed within the assignment. I take these issues back with me to our research work and, after a few years, a solution may come up that could have an impact in research, new knowledge that can be taken back to the organisation as a solution.

– It is an important transfer of knowledge and experience which happens partly because we often have a foot in both worlds and partly because we work so closely with the organisation being studied. From us, you get not only a report, but also knowledge for your organisation, concludes Jonas Månsson.



**Behind a result, whether good or bad, there are always many determining factors. Not knowing, or thinking you know the causes without any proof, is often a source of inadequate development or incorrect governance in companies and public organisations.**

Jonas Månsson, professor





# SIGNAL PROCESSING

## – ENABLING SMART TECHNOLOGY

Signal processing enables smart cities and self-driving vehicles, the development of pacemakers and hearing aids, automatic image enhancement, mapping of the earth's surface, weather forecasts and climate models. Even the altitude variations on Venus have been mapped.

Mattias Dahl is a professor of systems engineering and Mats Pettersson is a professor of electrical engineering. Both work with systems engineering at BTH and with the adjacent subject of signal processing.

– Our partners can take measurements using radar and optic sensors from vehicles, satellites, drones and aeroplanes, for example. We receive data and build methods for generating images from the raw material, and for extracting specific information from it, says Mats Pettersson.

Mattias Dahl adds that signal processing and BTH's research are also central to the field of self-learning systems, i.e. artificial intelligence and its mathematics and statistics.

– Many of the analyses that artificial intelligence, AI, is able to do today have been made possible by signal processing research. Almost all progress in information technology

includes the processing of information from sensors to humans.

– From a stream of information, you want to extract what is relevant to the context. Get rid of the noise and excess while highlighting the desired data. Signal processing now enables us to do this in much higher resolution and in increasing depth, says Mattias Dahl.

### Hearts and weather

Increased processing power and bandwidth generate many new applications within a broad spectrum, from vehicle engineering and industry to healthcare and energy technology.

– For example, it would be completely possible to measure the heart rate of the residents of a building with radar, instead of using surveillance cameras, which can violate personal integrity, explains Mats Pettersson.

Weather forecasting is a major development area for applied signal processing. Another climate-related area that Mats Pettersson has been working with for a long time is enabling comparative studies of the ice cover in the Arctic.

### Ports and vehicles

BTH has been involved in a European project to map ports using radar measurements. Both smart ports and smart cities present many challenges involving signal processing.

– For a Swedish port, for example, we were tasked with monitoring vehicles over 24 hours on a large parking lot. The result enabled the area to be replanned and used more efficiently instead of being expanded, says Mattias Dahl.

Mattias Dahl also mentions the measurement of vehicle movement on the Swedish

road network. BTH was involved in developing a method for satellite measurement of large areas, using calculations to filter out vehicles of a certain size and to figure out average speed, length, etc.

### Voyage of discovery on a new frequency band

With higher bandwidth in a new frequency area, the THz band, more details and other materials can be detected via 5G and 6G.

– For example, in the optical infrared frequency band, you can see in the dark and with x-rays you can see inside materials. Radar on terahertz frequencies has these properties but the band is relatively unexplored; we only partly know what we can see. We hope to be able to see properties that are important for the manufacturing industry, such as surface smoothness, says Mats Pettersson.

Building transmitters and receivers for 5G and 6G is therefore extremely interesting for many more stakeholders beyond those in the telecom industry. To a great extent, research and development in signal processing entail making the most of increased possibilities and investigating what we can do with them.

– There are many new satellite systems around our planet and it is interesting to

be involved in finding out what they can do and how their capacities can be utilised in various applications, says Mats Pettersson.

### Societal benefit

In collaboration with Region Blekinge, BTH has taken part in many society-related projects. Mathias Roos, who has worked on infrastructure issues in the region, explains that he was surprised by the great opportunities offered by collaboration with BTH. One of his questions was how radar data from satellites could contribute to following up regional decisions.

– In contacts with international colleagues, I noticed that everyone has the same need for deep and comparable analyses of long-term changes, so it was natural for us to involve BTH. There we found the combination of knowledge of proven radar technology and advanced methods for mathematical analysis, says Mathias Roos.

He sees many applicable areas of analysis using radar measurements from satellites.

– It proved to be very efficient. In-depth comparisons of traffic flows before and after an investment, such as a double track on a railway line or a new stretch of road, provide clear and certain answers as to whether the aim was achieved, says Mathias Roos.



Mats Pettersson



Mattias Dahl



Mathias Roos



**From a stream of information, you want to extract what is relevant to the context.**

# IT STARTS WITH AN IDEA

BTH has created environments in which students, researchers and companies can together allow ideas to flow and in which inventions and potential innovations see the light of day. At BTH, there are many different laboratory environments, such as:



## FROM IDEAS TO PROTOTYPES UNDER THE SAME ROOF MAKERSPACE

This is an open innovations environment for technology development and prototype creation where, with the help of new technology – such as 3D scanners, 3D printers and electronic building blocks – it is possible to go through the entire innovation process, from idea to final prototype, in the same environment.



## WHERE FUTURE SOFTWARE TECHNOLOGY IS DEVELOPED ERICSSON SPACE

This lab is a meeting place for students, researchers and companies where new software technology is created with the absolute best and latest methods. Here, students test the limits of what software technology can achieve.



## FOR VIRTUAL EXPERIMENTS THE VR LAB

The lab is used for assessing the quality of immersive visual computer applications, such as 360-degree video, virtual reality and augmented reality. The technology is also used in combination with eye tracking technology to analyse and interact with, for example, virtual environments and digital games.



## ENVIRONMENTS FOR INNOVATION INNOVATION LABS

Here, you can create prototypes in metal, wood, plastic or fabric. You are also able to 3D scan objects and print them with a 3D printer. The lab has two pickup robots and you can also work with an industry 4.0 kind of production line, for example in areas concerning IT security, programming, environment and mechanical engineering.



## WHERE HACKER ATTACKS ARE SIMULATED SECURITY LAB

In the specially adapted security lab, students in IT and computer security are able to work in a flexible and adaptable environment. Here, they can simulate realistic hacker attacks and simultaneously work on preventing them.



## UNIQUE HEALTH CLINIC WITHIN THREE AREAS BTH RESEARCH AND EDUCATION CLINIC

The health clinic is unique for its kind in that it combines innovation, implementation and education. Here, national and international research projects are carried out in real and virtual environments as well as clinical trials and test beds. It is also a meeting place where health technology product and methodology development. Here, students and researchers can design, test and simulate work methods for the healthcare sector of the future.

# RESEARCH FIELDS AT BTH

The research takes place in collaboration with industry and society and always has a clear focus – the research results are to contribute to solutions to societal challenges. The research fields at BTH are presented below.

## BIG DATA AND ARTIFICIAL INTELLIGENCE, AI

The researchers are studying different techniques for handling large amounts of data from a technical perspective with regard to, for example, storage and database systems as well as how AI, machine learning and information mining can be used for pattern recognition and trends in large amounts of data.

## PLANNING AND THE BUILT ENVIRONMENTS

Researchers study how planning works and which control mechanisms have an impact on spatial planning. They also study how planning processes, at different levels, are initiated and controlled and which institutions and actors are involved. The environmental and sustainability effects are also included.

## COMPUTER SCIENCE AND ENGINEERING

The research focuses on parallel computer systems, cloud-based systems and security. The research covers both practical and theoretical aspects of data processing with applications and implementations of different systems.

## PRODUCT DEVELOPMENT

The research in product development is based on the subject mechanical engineering and focuses on how a digital and model-driven work method in technical product development can lead to innovations that fit into a sustainable society.

## INDUSTRIAL ECONOMICS AND MANAGEMENT

The researchers are interested in the interaction between technology, innovation and industrial dynamics. They study entrepreneurship and its significance for sustainable growth and societal development, how institutional frameworks affect enterprise and the conditions for the commercialisation of technical innovations.

## SOFTWARE ENGINEERING

The research covers technologies, methods and processes for the development of complex software systems and the application of systematic and measurable methods for development, running and maintenance of software-intensive systems, services and products.

## MATHEMATICS AND SYSTEMS ENGINEERING

The subjects play a key role in tackling our societal and sustainability challenges as they highlight the fundamental questions needed for theoretical understanding and construction of complex systems. The research in mathematics, statistics and physics is combined with applied research on a broad spectrum – from autonomous systems, control systems, electronics and marine technology to sensors.

## STRATEGIC SUSTAINABLE DEVELOPMENT

The research focuses on methodology support for companies, municipalities and other organisations that want to work strategically with sustainable development, i.e. organisations that want to contribute to society's transition to sustainability in a way that strengthens the individual organisation.

## MEDIA TECHNOLOGY

This is an inter- and transdisciplinary field that focuses on digital technology, visual, audio and interactive expression. The research specifically focuses on digital experiences in physical environments and stretches from concept and idea development via prototype design to testing and evaluation.

## APPLIED SIGNAL PROCESSING

The research is aimed at image and video processing, feature extraction, sensors and condition monitoring, with applications in, for example, forensics, acoustics, health technology, marine technology and remote control.

## PEOPLE, HEALTH AND TECHNOLOGY

The research focuses on the areas of healthcare and health science. The common thread in the research is applied health technology, i.e. how health is affected by use of new technology and how technical research can contribute to promoting healthy lives.

## VISUAL AND INTERACTIVE COMPUTING

The research focuses on visual and interactive computing, for example, computer graphics, visualisation, game technology and human-centred computing.



### FACTS ABOUT BTH

Over 5 000 students  
Over 450 staff  
Over 40 professors  
Approximately 100 doctoral students

***BTH is among the top six in the world in software engineering and sustainable development.***



**The fact is that we should more often be fascinated by how much is working around us, instead of complaining when things go wrong.**

**Claes Wohlin**, *professor*

### CONTACT

Blekinge Institute of Technology  
371 79 Karlskrona  
[www.bth.se](http://www.bth.se)

#### **Göran Broman**

*Dean, Faculty of Engineering*

Email: [goran.broman@bth.se](mailto:goran.broman@bth.se)

Telephone: +46 455-38 55 04

#### **Lars Lundberg**

*Dean, Faculty of Computing*

Email: [lars.lundberg@bth.se](mailto:lars.lundberg@bth.se)

Telephone: +46 455-38 58 33

#### **Andreas Larsson**

*Deputy vice-chancellor for collaboration, innovation and entrepreneurship*

Email: [andreas.larsson@bth.se](mailto:andreas.larsson@bth.se)

Telephone: +46 455-38 55 55

#### **Eva-Lisa Ahnström**

*Grants Office*

Email: [eva-lisa.ahnstrom@bth.se](mailto:eva-lisa.ahnstrom@bth.se)

Telephone: +46 455-38 52 43