

# ALWAYS AN INNOVATOR

LINKÖPING UNIVERSITY





Always an innovator

# CREATING HISTORY



When I was ready to go to university some 40 years ago, I couldn't decide whether to study electrical engineering or engineering physics. So I was very happy to discover that innovative Linköping University had a programme that combined the two areas. My goal after graduation was to work in the private sector; I was hoping to be accepted to a trainee programme at a major Swedish industrial company. However, before I went to CERN in Geneva to do my thesis work, a professor from LiU asked if I was interested in pursuing research studies. The rest is history.

I am very proud of Linköping University. It is a fantastic knowledge-based organisation with an enormous capacity for paving new paths in both research and education, as well as in innovation, where a considerable amount of excellent work is under way. During my time at LiU I have heard many exciting stories of successes and breakthroughs and, just like challenges, they continue to come. Here we present a small selection.

If you'd like to find out more about LiU, just get in touch. Perhaps you'll be part of one of the stories of the future.

A handwritten signature in black ink, consisting of a large, stylized 'H' and 'D' followed by a long horizontal line.

**Helen Dannetun, Vice-Chancellor**

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# RESEARCH THAT CROSSES BOUNDARIES

Research at LiU is conducted within a variety of disciplines and there are several strong internationally recognised research environments, including materials science, information technology and disability studies. In the three most important global university rankings, the university is among the top 2% in the world.

Collaboration across boundaries is a LiU hallmark. Linköping University was first in Sweden to introduce interdisciplinary thematic research. When the Department of Thematic Studies was created in 1980, it organised research into interdisciplinary themes, such as technology and social change, and water and environmental change. The idea of thematic research spread to other parts of the university and the model with graduate schools became a national success.

The university hosts a number of notable research programmes, including the Wallenberg AI, Autonomous Systems and Software Program, which is one of the largest ever in Sweden. In this programme, research within artificial intelligence, autonomous systems and software development is carried out together with other universities and leading Swedish industrial companies.



"The chance to participate in forming the research at the university and to be part of a larger network with like-minded individuals was extremely attractive. I have been given the opportunity to build something from scratch."

**Stefan Koch, senior lecturer at the Wallenberg Centre for Molecular Medicine**



"You have to work crosswise to solve complex problems. Everyone knows this, but only an interdisciplinary, humanistic, social science setting like ours has the potential to do it."

**Stefan Jonsson, professor at the Institute for Research on Migration, Ethnicity and Society**



"I've deliberately built a research group with expertise within different fields. The mixture brings a new way of approaching questions. We have extremely interesting discussions and find it easier to adopt techniques from other research fields."

**Anna Eklöf, senior lecturer at the Department of Physics, Chemistry and Biology**





# Electronic roses – a world first

**P**rofessor Magnus Berggren and his research colleagues in organic electronics have an idea. They want to see if it's possible to insert electronics into a living plant. But the research funding agencies are sceptical. Why invest in a relatively eccentric project like this? Could it lead to anything of value?

But they finally get a chance to start experimenting, thanks to a use-as-you-wish research grant from the Knut and Alice Wallenberg Foundation. In 2012 three researchers are employed – and they become regular customers at Hummelgrens, a florist in Norrköping. They buy cut flowers which they put in water containing electrically conductive polymers, a type of plastic. After a couple of hours the material has been soaked up and has spread through the plant.

At first, roses and tulips die after absorbing the foreign substances. Piles of wilted flowers are discarded. But the group perseveres, testing new materials. They purchase mainly roses, which have proven hearty and easy to deal with. One day there's a breakthrough, with

a material the flowers tolerate. The rose is filled with an electronic system, which the researchers can use to control the rose, and change the colour of the leaves from green to blue-green.

Still, the important thing here isn't the ability to change the colour of the leaves. The LiU discovery gets worldwide attention and opens up a completely new research field. In the long term it could be possible to get plants to produce new materials, use photosynthesis to produce energy and create refined plants without having to genetically modify them.

Electronic plants, e-Plants, today have their own research group at LiU. It is led by Assistant professor Eleni Stavrinidou, one of the researchers who has been in since the first experiments. The e-Plants group is expanding with additional funding and the work continues.

Who knows – in the future we might be able to charge our mobile phones by sticking them into a tree. Or have a rose garden that supplies electricity to the household.

# A new focus on the allergy epidemic

**M**ore and more children have allergies. Today, one of three children in Sweden are allergic to something. What is causing this, and what can we do about it?

One of the people working to combat the allergy epidemic is Maria Jenmalm. Her interest in the field starts early; she has a relative with a serious allergy, and notes how much it affects that person's life. In the mid 1990s she gets a PhD position at Linköping University, and works on a study that compares how Swedish and Estonian children develop allergies. The researchers already know that allergies are less common in Estonia, but this is the first time two groups of children are studied in parallel from birth to five years of age.

The researchers study the environments where the children grow up. They find for instance that the dust collected in a home in Tartu, Estonia contains far higher levels of endotoxins, potentially poisonous immunostimulants that exist on the surface of some bacteria. Still, the children there have fewer allergies. Everything indicates that they must have better protection from the start. Perhaps even from the womb.

It appears that children who develop allergies later in life have less diversity in the bacteria and other micro-organisms that occur naturally in the gut. The LiU researchers start to ponder the gut flora's significance. At this point it's a little-researched field, but this will soon change.

Maria Jenmalm continues on this track. More specifically, how important it is that bacteria are trans-

ferred from mother to child, thus protecting the child from allergies.

She continues her research career, beginning a study of children born by caesarean section. The study shows that their gut flora has a very different composition until the age of two. When the results are published in 2013 they receive considerable attention, both nationally and internationally.

Parents-to-be get in touch. "We are planning a caesarean. What can we do to ensure our child doesn't develop allergies?" Maria Jenmalm is still not able to give any recommendations. But in 2018 a large study is under way, where LiU researchers collaborate with colleagues in Uppsala, Jönköping, Örebro, Umeå and Norrköping. They plan to transfer bacteria from mothers to their caesarean-born children, to see if this can protect the child from allergies.

Another on-going study concerns giving mothers probiotics – dietary supplements that may improve the gut flora – early in the pregnancy. This could reduce the risk of the children developing asthma and allergies later in life.

Today, Maria Jenmalm is professor. She leads a research group at LiU that is looking for ways to predict and prevent allergies in children. Much work remains to be done, in Sweden and worldwide. In countries transitioning to a western lifestyle, allergies are increasing dramatically. The LiU researchers continue their work to solve the mystery of the allergy epidemic, so that more children can be healthy.



Handwritten notes and printed documents scattered on the desk. One document has a blue pen resting on it.

Grattis till...  
förskning...

Peer Review

Cellulose Antigen  
Mikroskop  
CD 8 Non-C...  
second edition

IMMUNOLOGY  
Molecular Biology of the Cell





# Protecting the black rhino with technology

**T**he rhinoceroses in Africa are in danger of extinction. They have very poor eyesight and are easy prey for poachers who can make huge profits from their horns. The horns are said to have medical value, and can be carved into handles for traditional daggers.

For the park rangers in the national parks of Africa, the situation resembles a war, where they, as well as the poachers, use automatic weapons. And it's not only the rhinos that are being killed – many humans have died too.

One person who is fighting to change this is Professor Fredrik Gustafsson from LiU. He researches on security and emergency management, and has seen that the technology used to protect critical infrastructure can also be used to save the great animals of the savannah. He becomes one of the project managers of Smart Savannahs, a project where businesses,

international organisations and others are partners. It will make use of new technology to make national parks more secure.

First in line is the Ngulia Rhino Sanctuary in Kenya, where a refuge has been created for the critically endangered black rhino. The park rangers get smartphones and tablets with newly developed software. Using these they can easily enter their observations of the rhinos, and of possible threats, and communicate with other rangers and with the management. The phones will be connected with radar and sensors, to make surveillance even more effective. Prior to implementation, all technology is tested in Sweden's Kolmården Wildlife Park.

The idea is that the surveillance will be so secure that the poachers will not even dare to enter the sanctuary. And that it will soon be possible to use the technical solutions in national parks worldwide, to protect endangered species.

# First digital hearing aid boosts quality of life

**P**eople with hearing loss have trouble following a conversation. They tire more quickly and misunderstandings easily arise. A good hearing aid can't deliver normal hearing, but it can make a big difference.

It's the late 1970s and Thomas Lunner is in secondary school. A girl in his class has a severe hearing impairment. Thomas is interested in both technology and medicine, and is fascinated when she explains how her hearing aid works. He thinks it should be possible to improve it, so that it amplifies the sounds she wants to hear, and blocks the rest.

Years later, his interests lead him to studies in applied physics and electrical engineering at Linköping University, which he chooses for its interdisciplinary approach. He does his graduation project together with his classmate Johan Hellgren. Their algorithms and mathematics software form the foundation of what will be the first digital hearing aid, and they soon realise that they are onto something huge.

The technology is developed and refined in a research group led by Professor Stig Arlinger. They also need private sector involvement, and the Danish hearing aid manufacturer Oticon joins in.

It becomes a race; other people are working on similar ideas. But in the autumn of 1995 the LiU researchers and Oticon are able to present a digital hearing aid.

It's a world first – by one week.

Today, digital technology is standard for all hearing aids. The earlier analogue models amplified all sounds, even those you didn't want to hear. With digital it's much easier to separate speech from background noise, and to adapt the unit to the individual user. However a hearing aid still can't amplify only the desired sounds. To do this, it has to know *which* sounds you want to hear.

This is something Thomas Lunner is exploring further, as he continues his work on hearing and hearing aids. Today he leads a large research group at Oticon, while keeping one foot at Linköping University, as a part-time professor. Among other projects, he is working on the development of a new super hearing aid, which will be controlled by the brain, and will allow the user to hear a particular person more clearly – simply by thinking. This could become a reality thanks to new research that has identified how the brain's signals help us focus on a specific sound.

Hearing research is an area of strength at Linköping University, and a completely new research field has emerged: cognitive hearing science. It brings together researchers from fields that include cognitive psychology, medicine and engineering, with the aim of making life easier for the many millions of people who have trouble hearing.



# INNOVATIVE EDUCATION

Linköping University is one of the Swedish universities that offers the largest number of professional degree programmes, in fields such as medicine, education, business, economics and engineering. The student body consists of 27,000 individuals, of which 2,000 are international students.

LiU has broken new ground in Sweden with several innovative study programmes that give cross-disciplinary knowledge. An early example is the *Master of Science in Industrial Engineering and Management*, which is today offered at several universities and is one of the most popular engineering programmes in Sweden.

Student life at LiU is vibrant. Linköping University is among the best in Europe at social activities, according to the International Student Barometer. Linköping is the only Swedish city to have received the award University City of the Year twice (Norrköping, where LiU also has a campus, has been awarded once).

Characteristic of LiU is the strong dialogue with the surrounding business sector and the community at large. This is one of the reasons why LiU's graduates rank first for quickly finding employment, compared to other Swedish comprehensive universities.



"The most important thing I learned at LiU was how to solve problems and not to be afraid of it. This has been extremely useful for me."

**Sofie Lindblom, CEO and co-founder of ideation360**



"I believe that most companies associate LiU with quality. By 'quality', I mean students who are knowledgeable and have a personal drive to continuously learn new things and never stop improving themselves."

**Razmus Lindgren, software developer at Attentec**



"As a LiU student you will not only grow academically but also as a human being. Being in connection with people from all corners of the world is something that goes far beyond any university degree."

**Jesús Martín Toribio, Quality Manager at Airbus Group in Spain**





# New methods in health sciences training

**W**hen the first medical students start in Linköping in 1969, they only receive the latter part of their training here; the first two years are at Uppsala University. It later becomes clear that there are two options. Either close the Linköping part, or convince the Swedish government that a complete medical programme should be started in Linköping.

To succeed in this, LiU has to present something innovative. A few universities around the world have implemented an exciting new method called problem-based learning, PBL. In PBL, students face different cases, and have to formulate what they need to know, and search out the knowledge they need. There are no given right or wrong responses, and different sources can contradict each other. The teachers shift from giving answers to asking questions and posing challenges.

LiU believes in the method, and wants to use it in its programmes for medicine and healthcare. Lots of people are sceptical to the new approach; some are very critical. After consultation, one response goes so far as to say that if this is implemented, it will be “a threat to the quality of our future doctors”. But the proponents battle on, and in 1986 Linköping University’s own faculty of health sciences is inaugurated.

When the first students come in contact with problem-based learning, there is confusion and intense debate. But the method delivers clear benefits.

In studies from other programmes, students rewrite an exam a couple of years after they originally wrote it. Those who have had PBL fare much better. Similarly, doctors with a background in PBL get far better test results after their internship than those who studied traditional programmes. When students have actively sought out and reasoned their way to knowledge, their recall is simply better. More educators have realised this, and today PBL is used in nearly all Scandinavian medical and healthcare training, and in other programmes as well.

LiU is also a pioneer when it comes to training students from different health sciences programmes together. In the first semester, all new students study the same introductory course. This is good, but not good enough. Because they have to work together after graduation. It’s as if actors would learn their roles separately, and not interact until opening night.

“What the heck, why don’t we start a ward where the students get to care for patients together, based on their professional roles,” says Mats Hammar, head of the medical programme in the early 1990s. Orthopaedic surgeon Ola Wahlström suggests it should be orthopaedics, because the field includes important duties for all the student groups.

This is how LiU ends up with the world’s first student-managed training ward. The model spreads, and groups from all over the world come to Linköping to study what is called “the Linköping way”.

# From textile mills to vibrant campus

**U**ntil the 1960s, the textile industry is a fundamental and natural part of Norrköping's business sector. When the textile industry fails, the city's politicians identify low educational levels as one of the main problems. They want a university in the town – but the country's sixth university ends up in Linköping. Norrköping only gets a few programmes.

Norrköping's chance comes later – in the 1990s, a period of strong growth for the university sector. The government wants to see higher education in new locations, and LiU needs to grow. Norrköping has the capacity.

Once the university's plans gain acceptance, things have to proceed quickly. The committee in charge of setting up Campus Norrköping has its first meeting in the summer of 1996 – just one year before the first students are due to arrive. The Information Office knocks on the door. The programme catalogue has to be printed soon, and they need to know what it should contain. Classrooms, delivery forms, marketing – there is a lot of work to be finalised.

From day one the idea is to locate the campus in the middle of the old textile precinct – the Industri-

al Landscape. However everyone realises it won't be ready for the start of classes. Temporary venues have to be booked.

In August 1997 Campus Norrköping is opened, with a huge fireworks display – indoors, in the De Geer Hall. Innovative programmes like *Culture, Society and Media Production* and *Media Technology and Engineering* take in their first students.

However the campus doesn't really secure its place in the town's heart until a year later. Locals are curious – they want to see what happened to the old textile mills. To celebrate the return of the Industrial Landscape, plans are made for an ambitious project, "True Dreams on Uneasy Street", in conjunction with the opening of the university buildings.

More than 800 people perform in the event, which includes clubs, choirs, scuba divers, firefighters and a symphony orchestra. Laser lights play across the walls of buildings, construction cranes dance, a tram flies over the river. It's an evening that the 15,000 spectators won't forget for a long time.

So in the end, Norrköping gets its campus. And it's in an unusually beautiful location, which is sure to inspire students and researchers to greatness.





# Sweden's best reception for new students?

**T**aking up studies in a new city or country, perhaps even on the other side of the world, can seem daunting. There are so many questions. How will I find accommodation? Will I make new friends there? What am I getting myself into?

However for most new students at Linköping University, the reception period is an unforgettable experience. There are parties and presentations, barbecues and 'brännboll' tournaments. Of course there's the famous Swedish 'fika' – a break for coffee or tea, and something sweet. On campus you'll see people wearing sunglasses and strange outfits, marching back and forth. It's a couple of weeks when you'll hardly see your bedroom – but your laundry basket will end up overflowing. You won't get enough sleep – but you'll make loads of new friends.

Preparations for the activities start months in advance. Roughly 2,000 students are trained in how to be a peer student, whose job is to take care of the

new arrivals, and make sure they feel welcome. Every study programme has its own club, which offers the newbies a packed agenda. For international students there is a special peer student programme, and the international student clubs organise a wide range of activities.

The icing on the cake is Kalasmottagningen – New Students' Day – one of the largest such events in the country. It includes a fair with all sorts of special offers for students and an outdoor area with loads of activities. Topping off the day is a concert featuring some of Sweden's most popular musicians.

Compared to the other major Swedish universities, Linköping University has the highest retention rate of students continuing to year two. In other words, fewer who break off their studies, and more who feel they're in the right place. Perhaps it has something to do with the reception they get.



## FOUR CAMPUSES IN THREE CITIES

Linköping University gained university status in 1975 and has four campuses in three cities. Campus Valla is the oldest and largest, located about three kilometres from Linköping town centre. The University Hospital Campus is home to education and research in medicine, healthcare and public health. Campus Norrköping was opened in 1997 in the town's old industrial precinct alongside the Motala River. Campus Lidingö was established when Malmstens, a part of Linköping University since 2000, moved to new premises on the island of Lidingö just outside central Stockholm.



Campus Valla

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Campus Lidingö,  
Malmstens Linköping University



Campus Norrköping



University Hospital Campus

**PRODUCTION:** Linköping University, Communications and Marketing Division, 2018. **PHOTOGRAPHY:** Thor Balkhed, David Einar Nygren, Anna Nilsen, David Brohede, Wynand Uys/Unsplash, Lena Katarina Johansson, Miri Lindberg, Göran Billeson, Peter Holgersson, Cecilia Olsson, Peter Karlsson. **COVER:** Thor Balkhed. **PRINT:** LiU-Tryck. **COPIES:** 3,000.



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