KTH ROYAL INSTITUTE
OF TECHNOLOGY

SCHOOL OF ELECTRICAL ENGINEERING 2016

2016

Creating organs-on-a-chip
Harvesting energy from WiFi
Talking: robot to robot
Tracking tricky stem cells
The 'green dream'

Where the future lies

SCHOOL OF ELECTRICAL ENGINEERING

Creating foundations for the future

In last year's introduction to the annual report, I wrote about 2016 as the year when our school would invest in digitalisation. I am now delighted to see that our brand new Ph.D. school in digitalisation, which intends to join the worlds of electric power and ICT, is in place.

Our Ph.D. school is entirely self-funded, we do not depend on external fundings. That gives us a rare chance to do something for which we usually don't have the capacity. Today, twelve Ph.D. students have arrived, of which many are from the industry. The graduate school gives these students the exclusive opportunity to be part of both the academic and industrial world. Each student has two supervisors – one from the energy field and one from the area of ICT – a set-up that looks promising.

The theme of the Yearbook 2016 is 'Where the future lies'. It is my personal belief that an attractive university aiming to create ground-breaking research and teach up-to-date educational programmes depends on a constant influx of new talent, both in terms of students and researchers. The KTH tenure track system is created for this very purpose. Exceptional young researchers are recruited to the position of assistant professor with the clear goal of them being considered for promotion to associate professor within four years. Successful associate professors then have the possibility of being promoted to professor. In this edition of the yearbook we meet Anna Herland, an excellent example of the talent we wish to attract.

KTH has an impressive history, dating back to the founding of the university in 1827. A key milestone was the construction of our main campus at Valhallavägen, located in the heart of Stockholm. This year, Campus Valhallavägen will mark its one-hundredth anniversary, a celebration that gives us an opportunity to look at our own history. It is fascinating and inspiring to see the achievements of the people who have sat in our classrooms and walked on our campus before us.

I hope that our school will continue to be a place to learn, play and discuss every aspect of electrical engineering for many, many years to come.

Professor Stefan Östlund
Head of School
School of Electrical Engineering

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"It is important for students to know that with an education at KTH, there are no limits to their success."

Oscar Quevedo Teruel,
Assistant Professor

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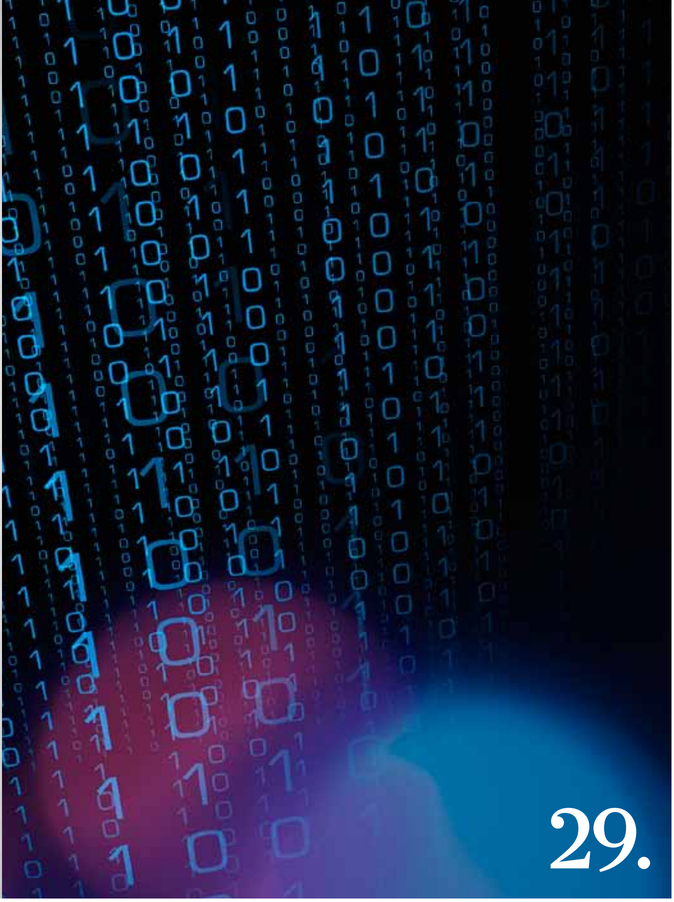


Contents

TWO'S COMPANY *but three's a team*

Researchers have discovered that when it comes to robots carrying out tasks, three is definitely the magic number.

TEXT: *Antony Riley* PHOTOS: *Susanne Kronholm*

Dimos Dimaroganas with his team in KTH's Smart Mobility Lab.

DIMOS DIMAROGONAS is confident that three or more is the magic number of robots it takes to get a task done in a decentralised way.

Dimarogonas is Associate Professor at the department of Automatic Control and has since 2013 been the project coordinator for the FP7 Programme European project RECONFIG (Cognitive, Decentralized Coordination of Heterogeneous Multi-Robot Systems via Reconfigurable Task Planning) working together with a consortium of partners from Sweden, Finland, Greece and France. The project terminated in mid-2016 having realised its ambition of bringing robots together to successfully, independently accomplish a task.

For three years Dimarogonas and his team at KTH have worked on one of the most important aspects of multi-robot development: coordination. Just how do you get two or more robots to communicate and coordinate with one another to complete a task? To understand this problem you only have to consider how we, as humans, work together to get things done. How do we communicate? We speak, we gesture. We can evaluate the task and our surroundings to communicate how best to do the job. But how does a robot do this?

Although sensory perception is not an area that Dimarogonas' team works on (other project collaborators have been working on this), there is still much to do when it comes to coordination.

"IMAGINE you have a team of robots", says Dimarogonas "in RECONFIG's final demonstration multiple robots were tasked with retrieving or picking up objects from a workspace [such as a factory space with trash]". The KTH team worked on the robot's ability to achieve this task.

"They had to periodically survey the area to see whether they could identify an object of interest". Finding and retrieving one object did not prove to be a difficulty however, "if you have two robots and two objects simultaneously and each object needs to be carried by both robots you have a problem because each robot may first go to each object separately and then realise it needs help.

The robot will broadcast a signal that it needs a 'helper' but that is not possible. Since each robot is doing the same thing, you have a deadlock". Dimarogonas explains that the robots have a limited sensing capability and in order to bridge the communication gap a third robot is needed.

"Our solution was what we call a 'connectivity maintenance algorithm'. We added a third robot which acted as a hub to maintain the connectivity between the two". The algorithm helps the robots individually to decide which task to prioritise.

It has been 15 years since Dimarogonas began his Ph.D. studies (The Development of Decentralized Hybrid Control Methodologies with Application to the Collision Avoidance Problem), now coming to the end of the RECONFIG project he considers how his working process has developed.

Although he comes from an electrical engineering background, he doesn't believe that using exclusively electrical engineering knowledge is the way forward.

"More recently I have been using tools from computer science, especially when we consider software task specifications, that's when we use what's called 'formal verification' from computer science. It helps organise the sequence of tasks a multi-robot system has to implement in order to fulfil a high-level objective."

Dimarogonas feels that this less multi-disciplinary way of thinking is increasingly necessary as we move forward. Just as we have realised that it pays to network robots to achieve their tasks, it seems we have also realised the value of approaches from different fields to achieve ours.

It is most likely that the technology being pioneered by the RECONFIG project will find use in service or industrial settings without human interaction. Whether being used in the air by drones, or in our offices and factories by service robotic systems, the multi-robot coordination being done by Dimarogonas and his team is helping to enable robots to work better together. It is truly helping robots help themselves, help us. •

RECONFIG

RECONFIG was a research project (2013-2016) funded by the EU. Its aim was to enable a team of robots to collaborate by getting them to register object around them, to communicate through symbolic messages and to plan and re-plan their actions based on changing information. The project was carried out with partners at Aalto University in Finland, the National Technical University of Athens, Greece, and the Ècole Centrale Paris in France.

THE FUTURE IS GREEN *and almost here*

Lennart Söder has been Professor in Electric Power Systems at KTH since 1999. As political will is increasingly influenced by environmental concerns, his field has been generating more attention than ever.

TEXT: *Antony Riley* ILLUSTRATION: *Ingrid Henell* PHOTO: *Håkan Lindgren*

LENNART SÖDER is committed to his work. It is at once obvious that the subject of renewable energies, promoted by poster-boy tech heroes such as Elon Musk, have long occupied Söder's professional life.

Irrepressibly positive and with the kind of energy that comes only from those who are on a mission, the Professor begins the conversation by bringing us up-to-date with where we stand on renewable energy sources, and it may surprise some unfamiliar with the subject.

"We are moving towards 100% renewable energy systems," he states. Many of us may have an interest in the subject of renewable energy systems, but not everyone appreciates that we are so close to getting 100% of our power supply from renewable energy sources.

Söder has long been at the forefront of research in this field, which encompasses a broad range of aspects, including studies of power system stability, electricity price formation, smart grids, the impact of wind and solar energy, the regulation of hydro power, the effect of economic regulation and studies of electric vehicles, to name but a few.

Söder is also busy outside of KTH, having participated in several national studies and having been the government's sole investigator for the "Grid ➤➤

"Sometimes people think what I am saying is futuristic but it's not."

Inquiry", promoting the development of renewable energy in Sweden. He is also active in several international collaborative projects in Sweden (SamspEL, Energisystem, NEPP), the Nordic Region (Flag Ship project Flex4RES), the European Union (SETS-program, ERA-Net Smart Grid+) and with the International Energy Agency (IEA-Wind Task 25).

AS SÖDER explains: "100% renewables means large amounts of wind and solar power. You will sometimes have very little sun and therefore little solar power, or alternatively in the summer you may have very high levels of solar power or you may have a lot of wind. The question is: how do you handle these situations where you have variable renewable energy sources? That in general is the area we are working in."

For Söder it is ultimately a question of how we deal not just with the demand but, essentially, with the fluctuations in supply.

"In Germany, for example, they have had 50% more solar power than they have had demand in certain areas. In such situations, you are sending more back into the grid than what is supplied by the grid. You have to work out how to deal with that."

TO GET A better understanding of how to balance the variation in wind and solar power, Söder leads a project concerning the optimal use and limits of how to use hydro power as a balancing resource, as well as providing accurate estimations of and market solutions for how consumers could be active in the required balancing process.

However, Söder is not enthusiastic about the energy sources we currently rely on.

"From the Swedish perspective our nuclear power stations are getting rather old. In addition to this we have a very limited amount of fossil fuels, and in Sweden we have a lot of hydro power, biofuel power, wind power and some solar power.

"Sweden is going to close four of our nuclear power stations. New nuclear power is more expensive than new wind power. There will be absolutely no new coal power in Sweden, while gas has many problems associated with it. What is left? An extremely high percentage of renewables."

SÖDER reinforces his argument by saying: "What has happened in the past five years is that we have moved

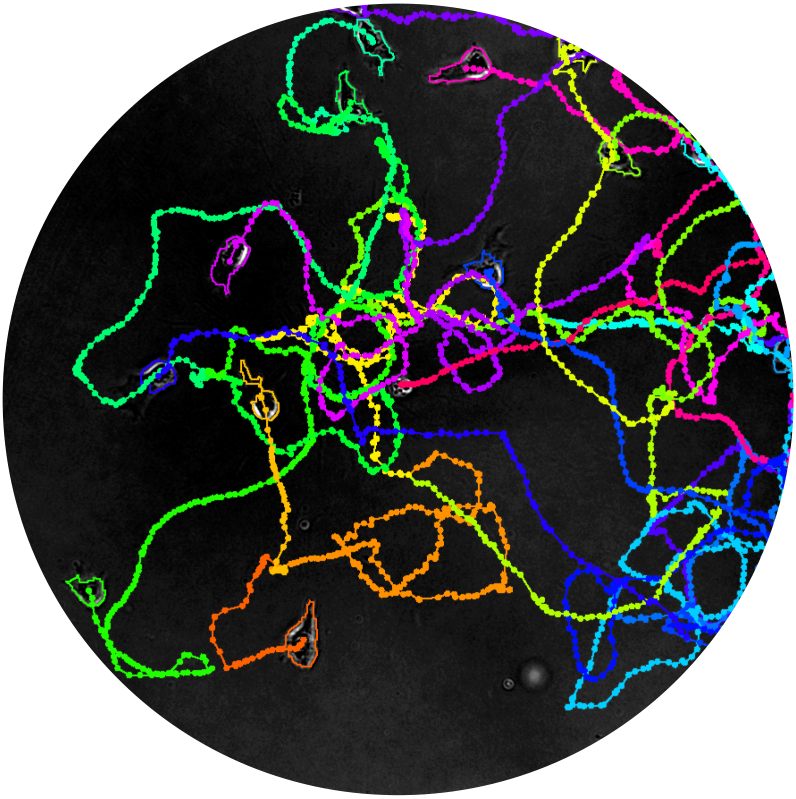
Professor Lennart Söder is currently leading a project concerning the optimal use and limits of power as a balancing resource.

from seeing 100% renewables as some kind of obscure 'green dream' to something that everyone says 'yes we are going in this direction'. The question is what are the real challenges and how do we solve them?"

HE LOOKS pleased as he explains that: "We finally have support for projects which are looking into these questions. One new project is a study of how to minimise wind power curtailments in a system with significantly higher amounts of wind power than today. In the same way as water is spilled in hydro power stations today, this will happen with a high share of wind power."

SÖDER ADDS "Sometimes people think what I am saying is futuristic but it's not. Texas is a conservative, oil-producing state but they have a huge amount of wind power, while the biggest wind power country in the world is China, where they have a huge amount of wind power and solar. This is not futuristic, this is reality. Globally we had more investments in renewables than we did in coal power last year. Coal consumption is going down."

Although Söder is positive, he is also apparently frustrated at times, frustrated that we don't awake from what we believe to be a 'green dream' and realise that it is no dream at all, but rather a practical reality. •



AUTOMISING STEM CELL RESEARCH

Easier said than done

There's nothing an engineer enjoys more than having a problem to fix. The more complex the problem, the more intriguing it becomes. And so it was for Ph.D. student *Klas Magnusson* who wanted to automate stem cell research.

TEXT : *Antony Riley* ILLUSTRATION: *KTH* PHOTO: *Kyriaki Sarampasina*

Left: An example of analysed microscope data from muscle stem cells grown in a 600 micro meters larger well over 33 hours. The advanced algorithm makes it possible to do fast and precise analysis of movement patterns, morphology, cell-division and cell-death. The colored lines show the pattern of movement during the entire experiment, as well as morphology of every cell at the end of the experiment.

NECESSITY really is the mother of invention. In 2009, when biologists working on muscle stem cell research at Stanford University were asked to add a significant amount of substantiating data for their recently submitted science paper. They baulked at the fact that they would have to return to more laborious annotating of their raw image data. A chemist in the laboratory realised this was going to use up valuable research time and felt sure there might be another way forward.

THE GOAL of the project was to make cell tracking practically useable for biologists who need it for their research.

"When they presented this project, I thought it looked pretty simple. I thought I could cope with that in an afternoon or something, but that wasn't really the case", reflects Ph.D. student Klas Magnusson.

The process of annotating the image data from the research being carried out in the lab needed to be automated and Magnusson was confident he could do it. He just wasn't quite sure how.


Klas Magnusson

"I thought I could cope with that in an afternoon or something, but that wasn't really the case."

"I was new to computer vision and the field held a lot of challenges for me", he says.

We are in the realm of stem cell research. More specifically, the automation of stem cell research. Magnusson recently and successfully defended his doctoral thesis *Segmentation and Tracking of Cells and Particles in Time-Lapse Microscopy*. It is the culmination of his enquiry into how to help automate biological research while doing his master's degree at Stanford University.

By using time-lapse microscopy (time-lapse photo or video capture through a microscope) cells can be viewed and their behaviour can, over time, be studied. When biologists experiment on cells it is essential to record this information in order to see how the cells react to certain drugs or other external factors. The annotation and interpretation of this information is vital, ➤➤

and very labour intensive.

Joakim Jaldén, Associate Professor at the department of Signal Processing and Magnusson's supervisor powers up his computer.

"SIGNAL processing, at its core is very abstract, but this particular work has a very clear application which is also very visual", says Jaldén as he gestured towards the screen. "This is work done from where Klas did his master's thesis". To the untrained eye, the screen is filled with a seemingly random assortment of coloured dots within a circle. To both Jaldén and Magnusson however, they reveal something very important.

To automate the research the outlines of the cells needed to be defined. Movement and behaviour needs to be tracked and the data must be recorded.

As Jaldén explains: "You can just study the video or image sequences to figure out "do they move, do they die, do they interact" but that's not enough. You want statistics, you don't want one single sequence, so hundreds are generated which you would normally have to go through and analyse somehow. At the start, this was typically the work of professors and is now done by Ph.D. students and masters students who go through, annotate and write notes on what they're doing in a particular experiment. Obviously the next step is to fully automate it, to have a computer analyse the work".

Jaldén further explains that the real difficulty is tracking the cells.

"AT ITS CORE it's a target tracking problem, but it's rather more difficult to prior target tracking problems because in addition to tracking the cells we are interested in their morphological properties, and the state of the cells. Are they alive or dead? Could they be undergoing a cell division?" says Jaldén.

He also makes comparisons with other objects we typically track.

"IT IS SIMILAR to others problems in video sequencing: people like to track people for surveillance applications for example, so there is research going on of multiple object tracking in the same scene. This project presents interesting engineering challenges because people do not typically divide. The objects that you track have behaviour that hasn't been considered in the signal processing or engineering literature before, so there was a lot of method development", he says.

Magnusson decided to open the field up a little, and the group developed open source software containing all the necessary tools to analyse

image sequences with cells or particles. The software has tools for segmentation and tracking of objects, optimization of settings, manual correction and analysis of outlines and tracks. The software was developed together with biologists and has already been used for data analysis in a number of biology journals.

This has been a true challenge, typical of the most difficult, but also amongst the most rewarding. The algorithms have been turned into software tools that are easy enough for researchers with little or no background in computer science.

HOWEVER, both Jaldén and Magnusson acknowledge that unsolved problems remain and more work needs to be done. Now that he has defended his thesis, Magnusson will move on and a position will be open for a new researcher to work alongside Jaldén. Their main work will be the analysis of the recorded data and still, as Jaldén points out "The better the software or the analysis tools get, the subtler the questions that can be answered will become.

The next steps will be to investigate how deep learning can be incorporated into our methodology". •

"The better the software or analysis tools get, the subtler the questions that can be answered will become."

Bright sparks:

100 YEARS

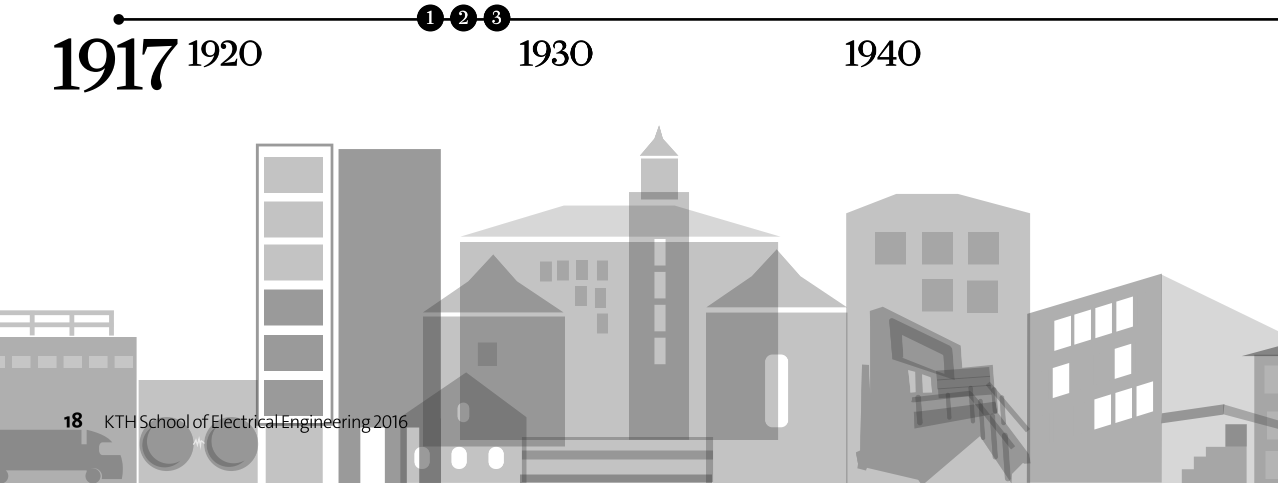
OF ELECTRICAL ENGINEERING AT KTH

Electrical Engineering at KTH dates back to the end of the 19th century. During this time, the subject and our EE alumni has made a substantial contribution to creating the modern society and technical solutions we use today. In honour of the 100th anniversary of KTH Campus Valhallavägen, we review some of our greatest moments.

TEXT: *Louise Gustafsson* ILLUSTRATION: *Ingrid Henell*
PHOTOS: *ABB, Herman Ronninger (Stockholms stadsmuseum), Tekniska Museet, Ericsson, KTH and Janne Danielsson*


Greta Woxén 2


3 Uno Lamm



❶ Ernst Alexandersson
Alumni Ernst Alexandersson was a pioneer in radio and television. He is famous for inventing the Alexanderson Alternator, one of the world's first devices for transmitting modulated audio over radiowaves. The first television broadcast in the United States took place during 1927 at his home in Schenectady, N.Y.

❷ Greta Woxén (1928)
Alumni Greta Woxén was Sweden's first female engineer. She studied Electrical Engineering and graduated from KTH in 1928.

❸ Uno Lamm (1929)
Alumni Uno Lamm is known as "The Father of High Voltage Direct Current" power transmission, a title he earned by creating the high-voltage mercury arc rectifier and its controls. In 1929, he managed a project to develop a high-voltage arc valve. Lamm has more than 600 patents to his name.

❹ Christian Jacobæus
Alumni Christian Jacobæus is known for his contributions to teletraffic engineering, especially his work on designing the modern crossbar switch. It was used for telephone switching which came on the market in 1950.

❺ Conrad Palm (1950)
Alumni Conrad "Conny" Palm is known for his large contributions to teletraffic engineering and queueing theory. Palm was one of the creators of BARK (1950), the electromechanical computer that paved the way for BESK, Sweden's first electronic computer.

❻ Hans Werthén (1952)
Alumni Hans Werthén was a pioneer in TV development and the creator of Sweden's first television transmitter (1952), which paved the way for the introduction of TV in Sweden. He did broadcasts from KTH's campus even before Sweden's Television started broadcasting officially.

❼ Billy Klüver
Alumni Billy Klüver is best known for founding the Experiments in Art and Technology in 1967, a non-profit and tax-exempt organisation established to develop collaborations between artists and engineers.

❽ Tolvan (1969)
Since 1969, Tolvan has been the home of Konglig Elektrosektionen and is to this day an important point for interaction between students. Tolvan was KTH's first locale entirely devoted to a students' association.

❾ Nobel Prize (1970)
Professor Hannes Alfvén is KTH's first and only Nobel Prize winner. He received the Nobel Prize in physics in 1970 for "fundamental work and discoveries in magnetohydrodynamics with fruitful applications in different parts of plasma physics".

❿ Östen Mäkitalo (1981)
Alumni Östen Mäkitalo is considered to be the father of the Nordic Mobil Telephone system due to his efforts in the development of the first generation cellular systems (1981). Mäkitalo was also a part of developing HD TV and the world's first countrywide paging system, commonly known as a beeper.


5 Conrad Palm


6 Hans Werthén

8 Tolvan


9 Hannes Alfvén


10 Östen Mäkitalo

4 5 6 — 1950 — 1960 — 7 — 8 9 — 1970 — 10 — 1980

Campus jubilee event

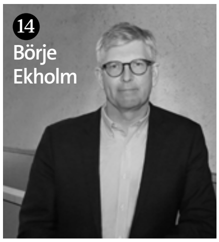
From October 17th to 19th of October 2017, KTH will mark the 100th anniversary of its Valhallavägen Campus with a 50-hour, non-stop series of seminars on the past, present and future research and education at the Royal Institute.

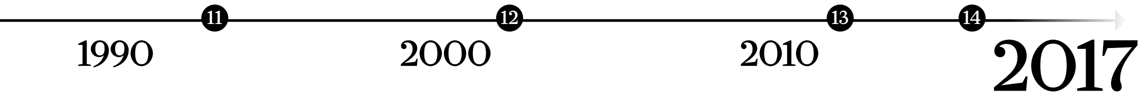
⓫ The Extrap T2 Fusion Experiment (1994)
The department of Fusion Plasma Physics obtained funding to build the larger fusion plasma experiment EXTRAP T2 in 1994. The research into this experimental device provides important contributions to the international effort to design more compact and economic fusion power plants.

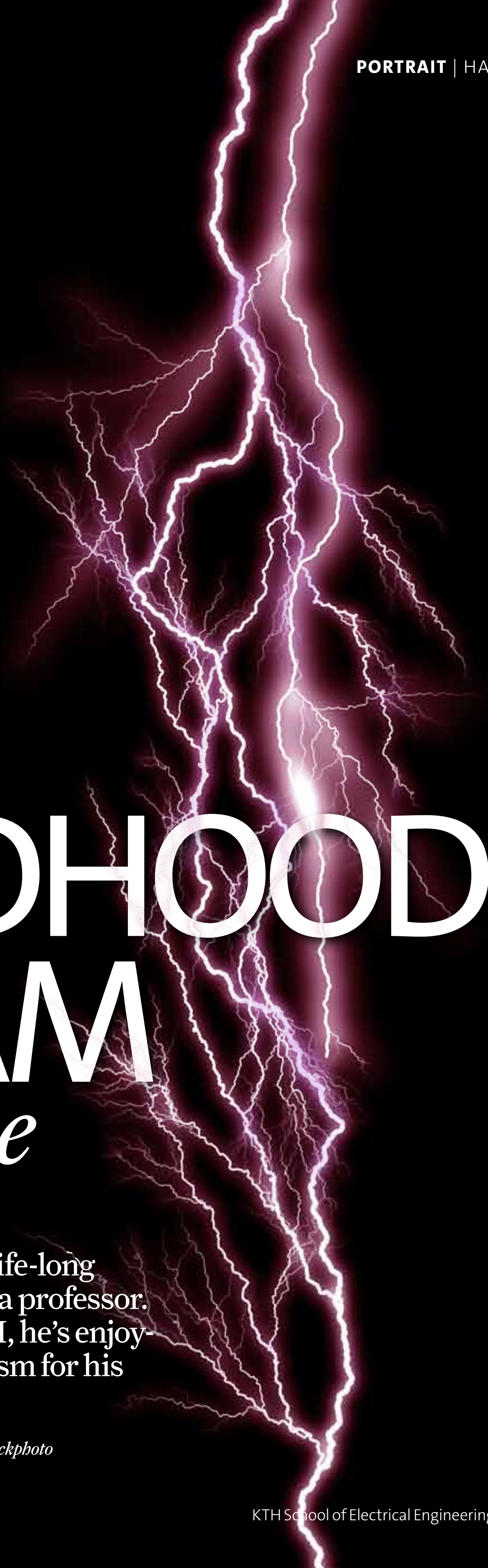
⓬ The High Voltage Laboratory (2002)
Inaugurated in 2002, the High Voltage Laboratory lab facilities contain a Marx generator that can deliver up to 400,000 V high voltage impulses, a transformer cascade for AC voltages up to 200,000 V and a DC rectifier that can provide 400,000 V DC.

⓭ Smart Mobility Lab (2012)
The Smart Mobility Lab was initiated in the end of 2012 as a model-based platform for the implementation and demonstration of intelligent transport systems as well as autonomous aerial and ground robots.

⓮ Börje Ekholm (2016)
Alumni Börje Ekholm is since 2016 the President of Ericsson, where he works alongside Sara Mazur, electro alumni and Head of Research. During his career Ekholm has maintained close ties to KTH through his position on the KTH Board.







CHILDHOOD DREAM *comes true*

Hans Edin has realised his life-long ambition, that of becoming a professor. Now, in his 27th year at KTH, he's enjoying passing on his enthusiasm for his subject to others.

TEXT: *Antony Riley* PHOTOS: *Tobias Ohls and Istockphoto*

➤➤

Professor Hans Edin in KTH's High-Voltage Lab.

"I started dreaming of becoming a professor from when I was perhaps nine or ten."

EVER SINCE he was a boy, Hans Edin hoped that one day he might become a true professor. “I started dreaming of becoming a professor from when I was perhaps nine or ten,” says Edin. Even his old classmates used to call him ‘The Professor’, and some still do. His passion used to be history: he could memorise and recount all the names and dates of the Kings and Queens. But soon his subjects became chemistry, physics and mathematics. Edin moved from Kings and Queens to pi. “I would recite it to about 50 decimal points, he recalls.

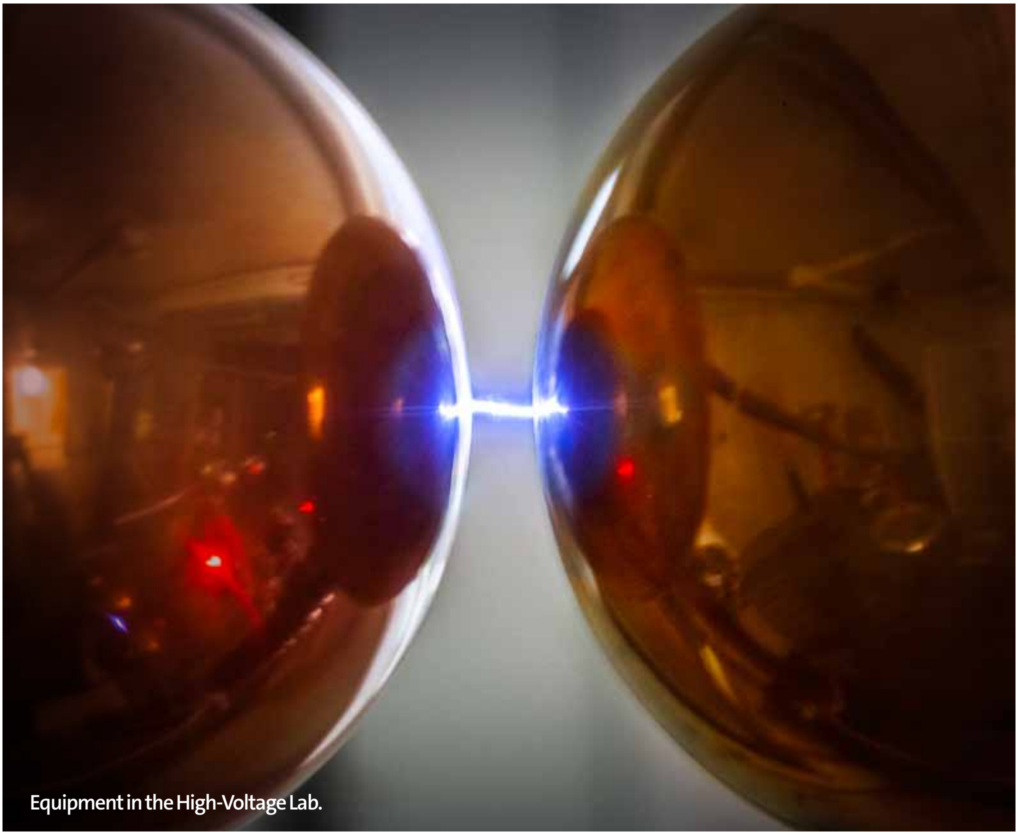
RECENTLY promoted, officially to Professor in Electromagnetic Engineering, Edin grins as he says “It means that I’ve reached my life’s career goal”. After a little thought he continues: “I don't know what happens next. I'm not sure if there will be any further ‘career steps’. My future plans are really to deliver research and education of a high quality – that is my main aim. Over the past few years I have been busy in a number of areas so it’ll be good to concentrate on research and teaching.” A ‘number of areas’ include being Chairman of the KTH trade union (2,000 members) and programme director of the SENSE programme (Smart Electrical Networks and Systems) within the EIT/InnoEnergy initiative.

Alongside his research, Edin makes it plain that delivering education in Eectrical Engineering that is truly fit for purpose is now his key aim. “I really love teaching. Unfortunately I don’t always have time to be fully up-to-date with all the modern teaching methods and technologies. As a professor you don’t always have the time.

HIS chosen field of electrical engineering was not always clear to him. Was it to be chemical or electrical engineering? He chose electrical engineering because it involved many more things, such as physics and mathematics “You can work on anything from signal processing to control systems.”

Edin entered the School of Electrical Engineering at KTH in 1990, where he joined the school’s EE programme.

“My main area is high voltage engineering, which involves all the big systems in the power grid including the high voltage lines. It’s most interesting when you come down to the specific details, such as ‘why is the distance between the power lines four metres and not half a metre and not ten metres?’ It’s about, amongst other things, the breakdown of the air. This is one parameter that is completely determined by the ionisation of single molecules, single atoms when they are stressed in an electric field. It’s about atomic physics with real technical applications. ➤➤


Equipment in the High-Voltage Lab.

"It's a passion for high-voltage electricity that drives me."

"I find this is very beautiful, the electron structure of molecules determining the distance between power lines."

Despite the amount of work in the department and other activities at the university he has a fulfilling life outside of KTH. He relishes taking on any projects no matter how small or large at home.

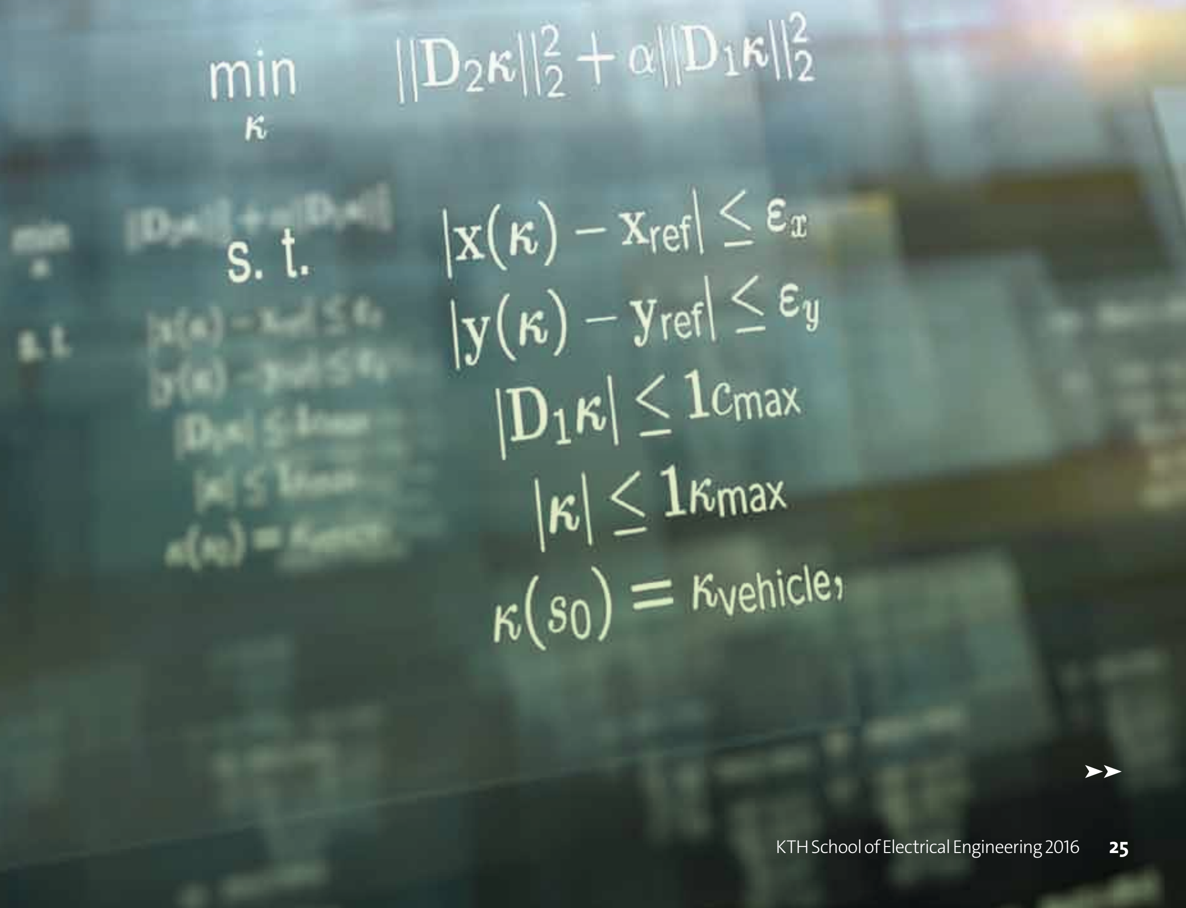
"I prefer to do things by myself, which is sometimes a drawback. I'm pretty stubborn. I'll do any tiling or plumbing or general work that needs doing at the house, including electrical connections. I think, in fact, that I'm still a two and a half year old with an 'I can do it myself' attitude."

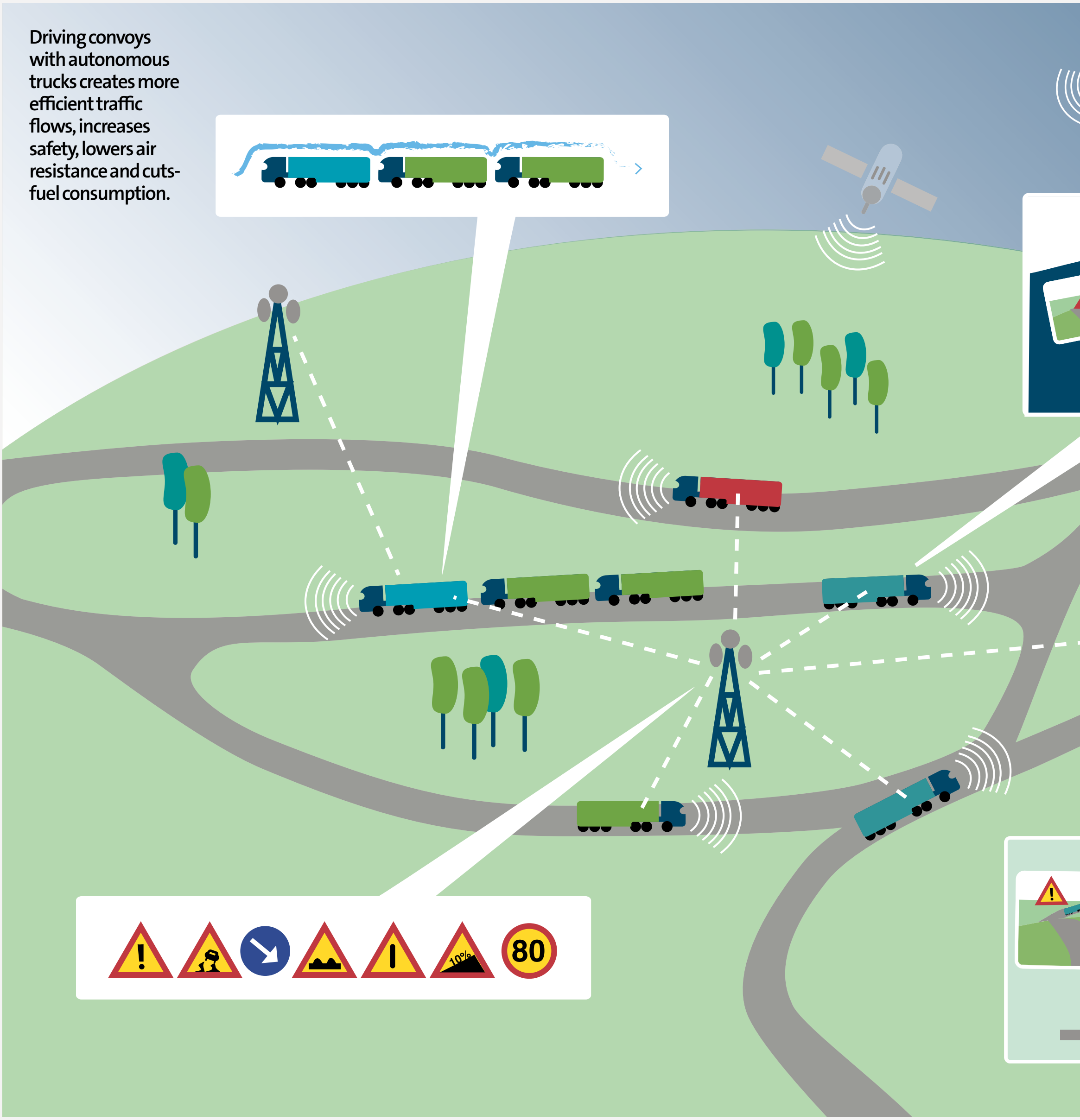
Outside of his main research work in insulation and diagnostic methods for the high voltage grid, Edin acknowledges that his life has gone full circle. "It's 27 years since I first came to KTH. I haven't gone anywhere else. As I come up the road at the start of each new term I realise how things have changed. Now it's a passion for high-voltage electricity that drives me and the students I come to work for." •

The ALGORITHM at the heart of autonomous truck safety

In their work at the department of Automatic Control, Professor *Bo Wahlberg* and Ph.D. student *Pedro Lima* are dedicated to achieving one thing above all else: safety. If autonomous trucks are going to become part of our everyday lives, they are going to be the safest trucks ever created.

TEXT: *Antony Riley* PHOTOS: *Kyriaki Sarampasina and Robert Hagström* ILLUSTRATION: *Ingrid Henell*





Driving convoys with autonomous trucks creates more efficient traffic flows, increases safety, lowers air resistance and cuts fuel consumption.

MANY ACCIDENTS on the roads today are caused by what is known as 'pilot-induced oscillation', which Bo Wahlberg says "is ultimately due to the fear induced in the driver in a dangerous situation, causing them to overact or overcompensate".

But a well-designed algorithm doesn't react like that, it computes what needs to be done and reacts accordingly, causing an autonomous or self-driving vehicle to continue safely on its way. This is what Wahlberg and his team at the department of Automatic Control are focused on creating. However, working towards such an algorithm hasn't been easy, and Wahlberg says that it would have been impossible to develop even five years ago.

"WE JUST didn't have the computational power. The ideas are not completely new, but

the ability was not there."

Pedro Lima agrees: "What we are using is Model Predictive Control (MPC), and that is not a new concept. It existed as early as the 1960s, but running a complicated optimisation algorithm this fast wouldn't have been possible without today's computers."

Lima is a fervent advocate of automated driving technology. He explains his motivation with a stark statistic.

"This week I attended a conference where I learned that 1.2 million people die every year due to road accidents. That's like a jumbo jet falling from the sky every half a day," he says, still genuinely shocked by what he has heard. Despite this disturbing picture he is far from despairing because of the possibilities offered by the project he is working on. "In the future people will look back and say 'how on earth did people actually drive a car?' It's so dangerous," he says.

THE DEPARTMENT of Automatic Control is a busy place, befitting the fact that automation is one of the hottest research subjects going, and also a much-anticipated technology by consumers and industry alike.

Along with his colleague Jonas Mårtensson, Wahlberg supervises Lima's research, which focuses specifically on control algorithms of heavy-duty construction trucks, and he has spent the past four years working on Model Predictive Control (MPC). "Using MPC a truck can stay on a narrow, winding road and drive itself smoothly," Wahlberg says.

Lima adds, "The model can predict the vehicle's movements in any given situation, on the basis of information about what direction it's being steered in, how much throttle is given and alternatively how much braking force is applied."

A lot of effort has been expended on developing the truck's control algorithm so that it is as accurate and reliable as possible. Achieving this with a heavy truck is by no mean feat. With much greater mass and much more built-in inertia than passenger cars, trucks present a greater challenge for autonomous driving technology.

WHEN IT COMES to automated vehicles in general, the question of safety is at the forefront of everyone's mind, but there is a significant cultural mind-set to overcome and many of us are scared to let go of the steering wheel. Wahlberg says that this is all a matter of public perception.

Lima's work notes that figures for 2012 from the USA's national highway safety administration (NHTSA) showed that 94% of accidents are caused by driver error. Indeed, the World Health Organisation (WHO) predicts that road traffic injuries will be the third greatest cause of disabilities by 2020. Despite those statistics the public are still wary of autonomous vehicles, preferring to have humans in control. ➤➤

Pedro Lima

Bo Wahlberg

"Using MPC, a self-driving truck can stay on a narrow, winding road and drive smoothly."

THE PROJECT 'iQMatic', led by KTH partner Scania, has the objective of developing a fully autonomous truck for mining operations by 2018. Lima spends roughly twenty percent of his time working with Scania's department for research and development in Södertälje, where he is developing the 'essential controller'.

"The essential controller is a way to automatically control the steering, gas and brakes," Lima explains. He adds that he likes to focus on the steering most of all, and the MPC technology makes it possible to minimise deviations from the driverless vehicle's intended path.

The MPC also maximises passenger comfort by reducing involuntary side-to-side movement in the steering, acceleration and braking, while finally maximising the vehicle's fuel efficiency. The team is focused on ensuring that the automated vehicle drives as smoothly and as safely as possible.

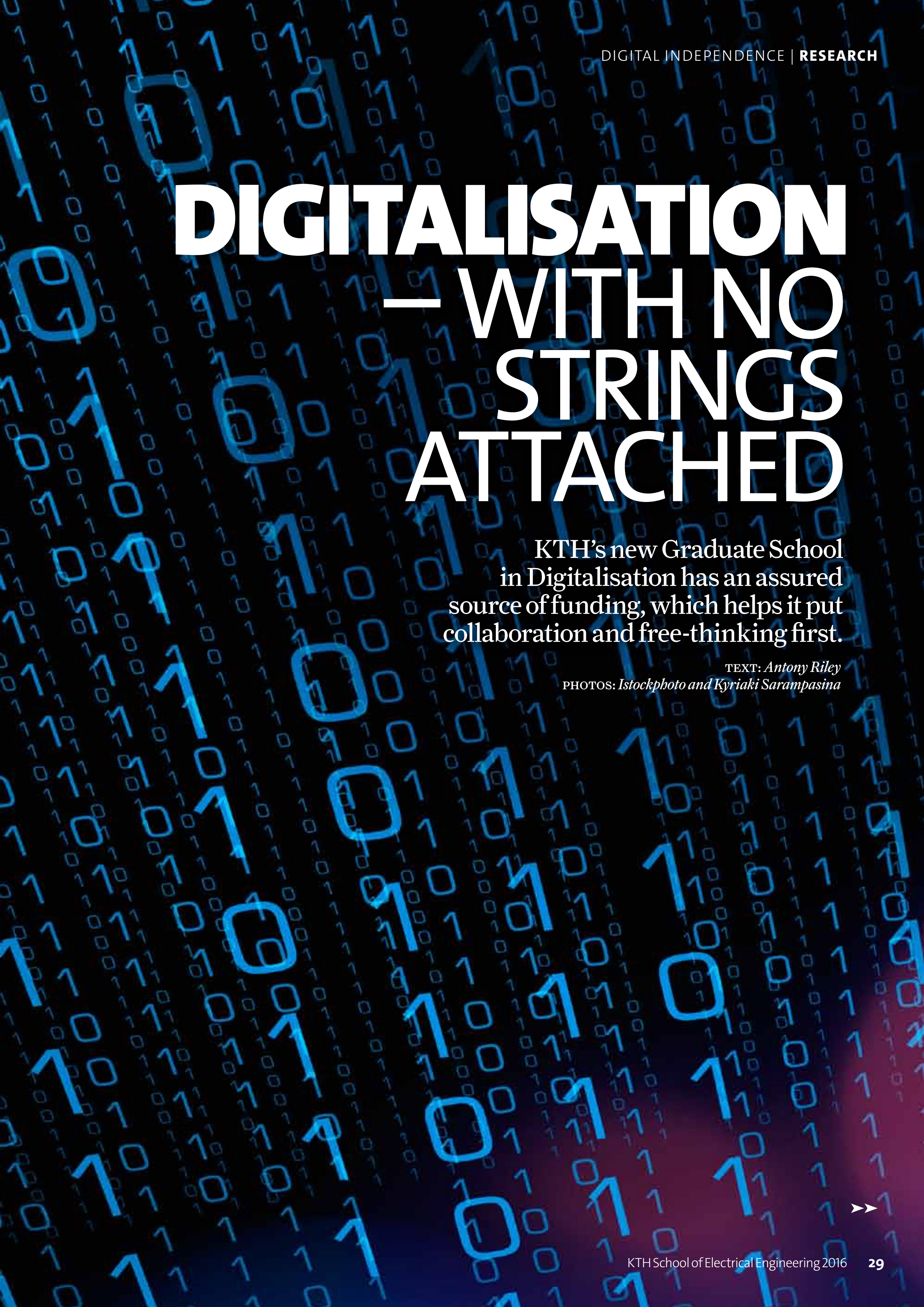
Tests so far have impressed professional drivers. The prototype, 'Astator', travelled softly and stably around a track at Scania's testing area in Södertälje, achieving its maximum speed of 90 km/h. The algorithm smooths the drive by taking in new information every 50 milliseconds, causing it to make the vehicle steer, accelerate and brake correctly.

THE GLOBAL Positioning System (GPS), LIDAR (Light Detection and Ranging, a remote sensing technology that uses light in the form of a pulsed laser to measure ranges) and multiple cameras all make an autonomous truck much more aware of its situation and position than a conventional unautomated truck with an unassisted driver. This awareness, allied to an ability to automatically assess and correct direction, speed and braking ensures that the trucks of the future will be very much safer alternatives to the vehicles currently in use.

By 2018 it will be highly likely to see autonomous trucks working in mining environments in highly controlled situations. When automated vehicles are used in mines, personnel will be placed in separate control towers overseeing the larger picture and giving the vehicle its tasks. That means that the overall risk to workers at an often busy mine would be greatly reduced. This will be a great step forward in increasing the safety.

Though automated vehicle technology is still developing, Wahlberg is already certain about the improvements in safety that it will bring.

"Although we cannot be sure of what the future holds beyond the mines and more controlled environments, we are sure that Model Predictive Control has the ability to bring not only advances in general vehicle autonomy but also in road safety overall." •



DIGITALISATION – WITH NO STRINGS ATTACHED

KTH's new Graduate School in Digitalisation has an assured source of funding, which helps it put collaboration and free-thinking first.

TEXT: *Antony Riley*
PHOTOS: *Istockphoto and Kyriaki Sarampasina*

➤➤

THE UNIVERSITY set-up is not traditionally known for being conducive to collaborations. Despite this, Professor Mikael Skoglund is keen to point out that "the Swedish system is better than most". Skoglund is Head of the Department of Information Science and Engineering at KTH, and along with Lars Nordström, Professor in Information Systems for Power System Control and Head of the Department of Electric Power and Energy Systems, he hopes to make things a little more collaboration-friendly.

"UNIVERSITIES in some countries are extremely competitive," says Nordström. "So much so that they hardly ever collaborate. They don't want to reveal their latest ideas to anyone else. Normally, you need something separate to solve the big questions, for projects such as when you put a man on the moon."

Both Skoglund and Nordström saw the need for inter-functional cooperation and an opportunity to explore a new area together.

"In every society or business, whether you are an international corporation or a hot dog stand, there is a niche for a new brand. You just have to take the risk," Skoglund says.

COMING together was just one of the motivations for the new school. Another was the major worldwide trend towards digitalisation.

"CURRENTLY, in the society around us, digitalisation is happening everywhere - media, autonomous tansport, the energy sector and so on," says Skoglund. "All industries wish to get more involved and to collaborate."

The new graduate school in digitalisation has been made possible by funding from KTH. It will intersect with information and communications technology as well as power and energy. Twelve students will be exploring ways in which using digital solutions could strengthen the power and energy sector.

WITH NO external financial backing, the school has a little more room to experiment. "The graduate school is really a free space. We can do what we want and we don't have to worry about satisfying other parties," Nordström says.

This sort of freedom is relatively uncommon these days. Nordström is conscious of the school's advantageous position, as well as the purity of its focus on digitalisation, which he believes is a must to help it make real progress.

"If we only let society be guided by low risk and consideration for the next economic quarter, we're not going to change much," he concludes. •

> "In society around us, digitalisation is happening everywhere."


Mikael Skoglund


Lars Nordström

INNER SCIENCE

When searching for fundamental answers about how our bodies work, Assistant Professor *Anna Herland* believes we should take advantage of a marriage between technology and biology. Real time testing on an organ on a chip sounds like science fiction, but it is very much a reality.

TEXT: *Antony Riley* PHOTOS: *Tobias Ohls and iStockphoto*

ANNA HERLAND'S work is complex. Despite this, she can quickly sum up her key aim, "I want to use technology to understand biology better."

At KTH department of Micro and Nanosystems, Herland works in cooperation with Karolinska Institutet to develop tools to better understand biology and pharmacology.

"The specific focus is the nervous system, the brain and the spinal cord," she says.

"I want to understand specific questions about what's happening in the brain, how it works and how we can treat problems with drugs."

While at Harvard, Herland was a part of a large team researching the ambitious 'human organs-on-a-chip' technology, and it is this model that she is working with right now, focusing on brain cells.

➤➤

"The organs-on-a-chip method allows the effects to be measured in real-time."

Human organs-on-a-chip involves growing cells from human tissue on an artificial plastic chip that contains tiny channels. Small volumes of blood-like fluid flow through the channels just like in a blood vessel. "We use this method to try to understand the cell functions at their basal state and then how they behave when they interact with other cells. Next we challenge them with drugs."

AWAY FROM animals, towards real-time testing, particularly when looking at what happens when a disease phenomenon occurs and how it can be treated.

A huge advantage is the amount of time and money that could be saved compared to the testing methods that are currently used. First of all, recreating body-like functions in the cells in the laboratory and subsequently testing substances on them, greatly reduces the need for contentious and timely animal testing. It also reduces the need for the extremely costly and timely human drug testing procedures, which regularly fail at the clinical testing stage.

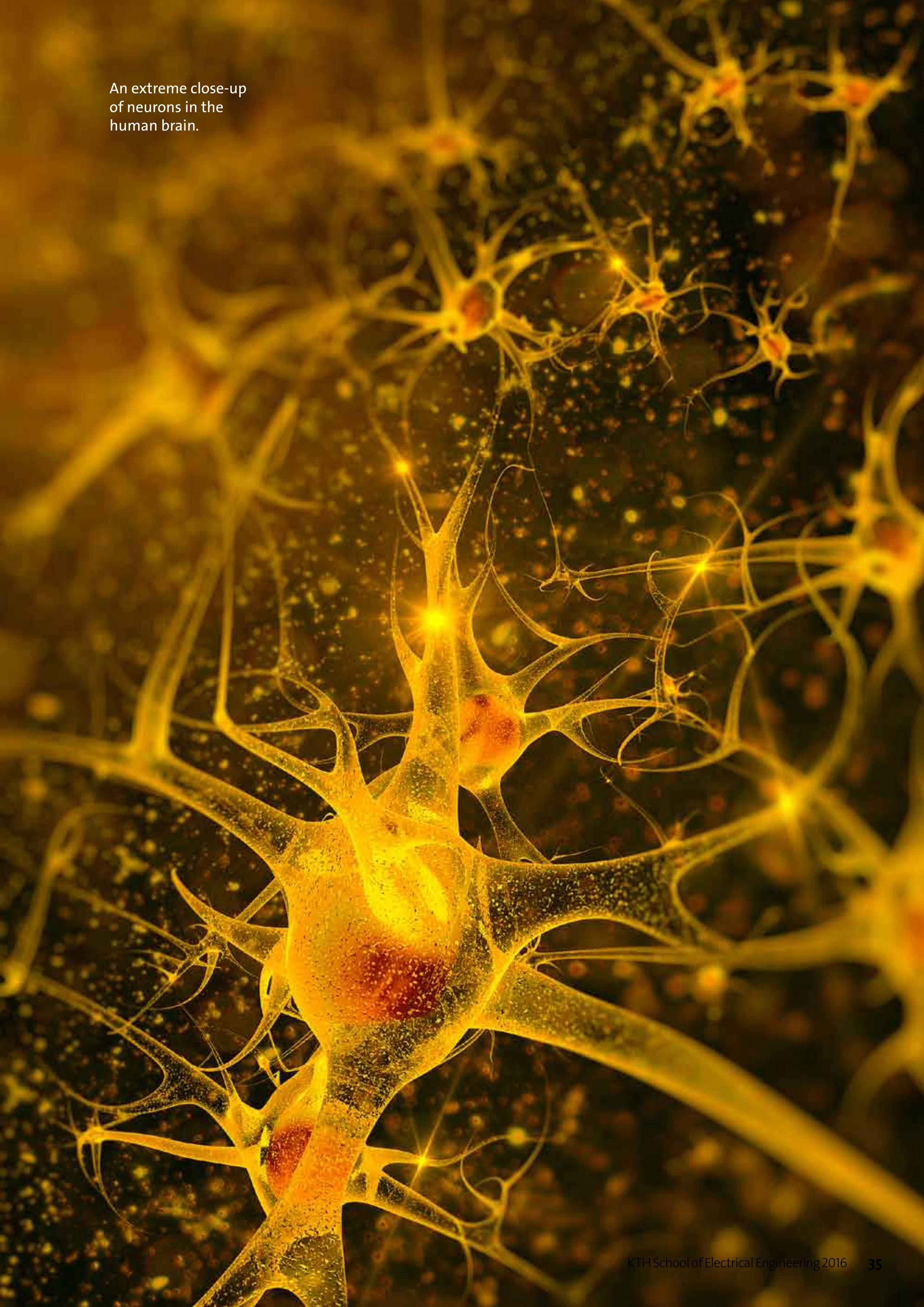
ANOTHER advantage of this in-vitro model is that the chip can have electrodes that both register signals from the cells and stimulate them. This allows for real-time results. "Using this microtechnology means that you can build flow systems like blood vessels and easily integrate measurement systems," Helland says. "Medical biologists traditionally have a system, cells or an animal from which they collect information and then measure it. But the organs-on-a-chip method allows the effects to be measured in real-time."

Herland considers herself fortunate to work alongside the experts at both Karolinska Institutet and KTH. "At Karolinska there are a lot of people who are extremely good at different aspects of the work," she says. "And here at KTH they are extremely good at the microfabrication and integrated sensing. If you define what your system should look like, what materials are suitable and what is interesting to measure KTH has all the expertise to design integrated solutions."

WITH ITS ability to speed up the testing time and reduce costs, the human organs-on-a-chip technology could have a significant impact on how diseases are treated.

In the not too distant future it may even result in personalised medicine, tailor made to each individual's specific needs, as with the right diagnostic tools each patient would get a tailor made type and amount of medicine. Herland says that while this idea has been talked about in theory for some time, the reality is getting closer and closer.

When fully realised it is possible that organ-on-a-chip technology will be a disruptive form of technology with much broader medical applications than realised today. •



An extreme close-up of neurons in the human brain.

THE END IS JUST THE BEGINNING

During his eight years as Head of the School of Electrical Engineering (EE), Stefan Östlund has seen the school develop into world-leading in its area. He is proud of its culture, in which individual performance and a healthy climate of collaboration are both very much present.

TEXT: *Louise Gustafsson* PHOTO: *Håkan Lindgren*

STEFAN ÖSTLUND first set foot on KTH's campus 36 years ago. Since then he has received education and conducted research in electrical engineering, become Professor in Electrical Power Engineering and taken the role as Head of School at EE. Östlund has had many good experiences during his time at the helm, but one memory feels exceptional.

"In 2015 I received an e-mail from QS World University rankings where they congratulated KTH on ranking 16th in the world for the subject Electrical and Electronic Engineering. I received it just before a management meeting, and to announce that we had achieved such a high ranking was fantastic. It was better than we imagined and it felt extremely good for our operation," says Östlund.

The success was followed by 17th place in 2016. After many years at KTH, Östlund has realised that good results are based on thoroughness, focusing on details and persistent work toward long-term objectives.

"You can have great visions and and make big investments, but it is the details that make the difference in the long run. Our school's philosophy is "Better to do two things rigorously than to do five with less care. We continuously strive to be a little bit better", says Östlund.

HE HAS been at the EE-school since its start during the reform of 2004/2005, when three departments were merged into one school. A lot of things have changed since means of expression. Since then the school has settled down, creating coherence in our goals and what we stand for. We have gotten to know each other and our operation very well."

AS OF 2016, Östlund is Vice President of global relations at KTH and will leave his position as Head of School. "Over the years I have stood on the sidelines, seeing things I would like to do. KTH is good at internationalisation, but there is potential

for improvement. I want to take an overall approach, and ensure that we are clear about our long-term goal: to strengthen the KTH brand."

Stefan hopes to build an understanding and consensus in what will lead KTH in the right direction.

"This is essential, and in this area I will be driving hard. We must ensure that our programmes, student exchange, work in international networks and work with our partners are all of the highest quality." •

"It is the details that make the difference in the long run."

CUTTING THROUGH THE (RESEARCH) NOISE

In a society where the flow of information is constant, making oneself heard and seen is a challenge. The School of Electrical Engineering has launched a video project to increase awareness of research results.

TEXT: *Louise Gustafsson* PHOTOS: *Kyriaki Sarampasina*

The videos are shot in a professional recording studio provided by KTH Media Production.

IN 2015, Head of School Stefan Östlund wanted to find new ways of making the school's research reach a wider audience. With support from the school's management group, Östlund made the decision to introduce video as a new means of communication for Ph.D. students and docents.

"We require all of our graduating Ph.D. students and new docents to record a video pitch about their research. It can be a challenge to present one's work to a wider audience, which makes practising it all the more important," Östlund says.

"Communication has never been more important than today, and that is why we initiated this project. We need to become better at telling society about what we do and in marketing ourselves. Our researchers have to practise using new means of communication."

The project aims to increase the general public's knowledge about the research being done at the school, acting as well as acting as a modern CV. It also aims to increase the knowledge of video as a communication tool as it is often used in teaching at university level and when marketing research to KTH's industry partners. The initiative is a local one and is financed by the school's departments themselves.

THE PROJECT is a collaboration between the EE-school and KTH Media Production. It gives the speakers the possibility of recording in a professional studio and receiving expert advice on video communication.

Ph.D. student Klas Magnusson from the department of Signal Processing recently made his recording, an experience he found both exciting and a bit daunting.

"The recording was interesting. It was fun to try something new, but it was a bit stressful at the same time," Magnusson says. "I ended up doing four recordings. In the beginning, it was hard to get everything right and I was nervous, but I was a lot more relaxed by the fourth take because I knew that we had something acceptable already."

VIDEOS ARE recorded with a single-shot camera and a prompter from which the speaker reads his or her text. Prior to the recording, Magnusson had had very little experience of using a prompter and having a word-by-word script.

"Reading from a screen was different from what I have done in the past. It will be a useful experience to have next time I work with prompters or word-by-word scripts. Now that I've done my recording, I think I'll be able to relax more when doing similar things in the future. I will also be able to use the video itself with my CV and my online profiles." •

The videos can be found on the school's webpage: kth.se/ees.

From left: Gustaf Silver, Oskar Dahlberg and Oskar Björkqvist.

ENERGY FROM WIFI AND 3G SIGNALS *took them to Puerto Rico*

Oskar Björkqvist, Oskar Dahlberg and *Gustaf Silver* took the advanced course in theoretical electrical engineering and won an international student competition run by the Institue of Electrical and Electronics Engineers (IEEE). Their design: a device that obtains energy from WiFi and 3G signals.

TEXT: *Gabriella Hernqvist* PHOTOS: *Kyriaki Sarampasina*

LET'S GO back to the beginning. Oskar Björkqvist explains what happened when Ph.D. student Christos Kolitsidas from the department of Electromagnetic Engineering introduced them to the competition.

"We were studying an advanced course in theoretical electrical engineering last year, where Christos led the practical exercises on the course. Mostly it was just the three of us there, so we had quite a personal relationship with Christos, who was very encouraging and enthusiastic."

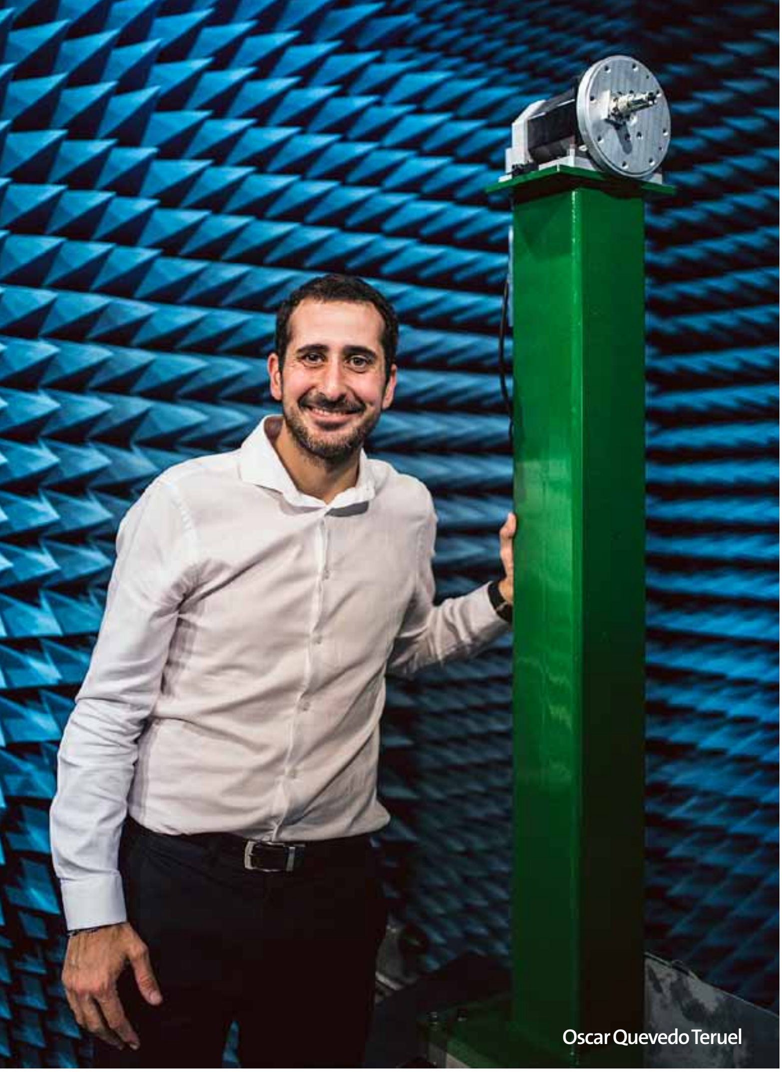
After the course, they stayed in contact and Kolitsidas introduced them to antenna design. Come the autumn term, he suggested that the students could try for a competition where the goal was to "design and build a device that can convert radio waves into direct current". The students' idea was one of six applications selected, and earned them the opportunity of presenting their concept at an IEEE conference in Puerto Rico.

The students developed a circuit that can obtain energy from WiFi and 3G signals. The system has a total of 16 antennas aimed in different directions for maximum coverage. The output goes through rectifier circuits that convert alternating current (AC) into direct current (DC).

"THE TECHNOLOGY in itself is nothing new, but it has attracted more attention in recent years due to the huge increase in radio waves being transmitted. This gave rise to the idea that we could run small circuits independently, avoid the maintenance and the need for environmentally-hazardous batteries," says Björkqvist.

The project has awakened an interest in an area which they previously knew little about.

"I think that my general ➤➤


Oscar Quevedo Teruel

“Devote a great deal of effort to a project, and you can beat anybody in the world.”

interest in electrical engineering has grown, at the same time as I've learned about microwave technology which I had hardly heard of a couple of years ago.

All three of us are planning to apply for the master's programme in electrophysics in the autumn, which is directly related to our project. I think it has been an important influence in that choice,” Björkqvist says.

Several teachers at the department have supported the students with their project. Assistant Professor Oscar Quevedo Teruel, director of the master's programme in Electrophysics, is one of them and he is enthusiastic about the students' work.

“THESE KINDS of projects are very beneficial for students. In this project, the students were able to apply the theoretical knowledge they acquired in their bachelor studies to solve a real problem. This shows students that their studies are of great value when solving realistic engineering challenges,” Quevedo Teruel says.

In Puerto Rico the students participated in an exhibition, where their contributions were demonstrated to a jury. The KTH trio ended up winning the entire competition.

“IT WAS really fun to meet the other teams and see their contributions, but also to show what we had done and discuss with professionals in this research field. We are very grateful for the opportunity and are of course very happy to have won,” says Björkvist.

Quevedo Teruel, who went with the team to Puerto Rico, says that this kind of student success shows that KTH provides a strong educational foundation.

“It is important for students to know that with an education from KTH, there are no limits to their success. This team demonstrate that if you apply the strong educational foundation gained at our school and devote a great deal of effort to a project, you can beat anybody in the world.” •

SEK 64 million in research grants

SSF HAVE awarded grants worth a total of SEK 64 million to two projects at the School of Electrical Engineering. The projects are led by Dimos Dimarogonas and Karl-Henrik Johansson, respectively. In total, KTH received almost SEK 250 million from SSF in 2016 for research within smart systems and materials science.

KTH scored third place in the GCDC

ON THE 28th and 29th of May 2016, the Dutch city of Helmond was the home of the international event 'The Grand Cooperative Driving Challenge' (GCDC). The event was one of the highlights of the i-GAME project, a European research project supported by the European Commission, in which the next step towards the cooperative automation of vehicles is being taken. With ten student teams from six European countries competing, one of KTH's two vehicles finished in the top three.

Student awarded 'Lilla Polhemspriset'

IN 2016, Japanese exchange student Hiroki Yasuga received the Swedish award 'Lilla Polhemspriset' for creating a new syntactic microfluid paper. The paper is to be used in medicine for tests and analysis when diagnosing diabetes, heart disease and cancer. Lilla Polhemspriset is a national student award given annually by the Swedish Engineering Association to the best master's thesis in engineering.

Göran Gustafsson award to Cristian Rojas

THE GÖRAN GUSTAFSSON Foundation named Cristian Rojas as one of this year's recipients of the Göran Gustafsson Prize. The grants are given annually to young researchers and are worth half a million SEK. Rojas will use his grant to conduct research that targets some well-known problems within modelling for control, specifically model predictive control (MPC), which is one of the world's most popular industrial control strategies.

Researcher joins 'Young Academy'

ROBERT LAGERSTRÖM has been selected to join the Young Swedish Academia Association. Lagerström hopes to use his new position to help young researchers to be heard and taken seriously. He is passionate about equality within the technical areas and hopes to be a part of creating an equal workplace.

Extension of Wallenberg Scholarship

IN 2016, Professor Karl Henrik Johansson received a five-year extension to his Wallenberg Scholarship, along with a further SEK 15 million in funding. The initial grant was given to Johansson for his research on connected society. With the new funds, the project will explore the great challenge of understanding how to develop security systems where human interaction and decision-making have to co-exist with autonomous and self-learning systems. A current example is the challenge of having both autonomous vehicles and manual cars travelling on the same road.

With GIANTS, KTH hopes to attract more young girls and women to studies in Electrical Engineering, IT and Computer Science.

The future needs GIANTS

THE FIVE-YEAR programme in electrical engineering has struggled to attract female applicants from the outset. It is an issue that needs to be addressed in many different ways, and in an effort to raise interest in electrical engineering, computer science and IT among young women, KTH started the GIANTS project in 2015.

TAKING INSPIRATION from Isaac Newton's quote "If I have seen further, it is by standing on the shoulders of giants" , the School of Electrical Engineering started working with GIANTS in 2015. The starting premise was simple: to find and highlight famous women from the history of electrical engineering, computer science and it.

"HISTORICALLY, this is a group that has been overlooked, which means that young women and girls today who are thinking about studies within electrical engineering have no role models," says Gabriella Hernqvist, Communication Manager. "In 2015 the project was based online and consisted of videos and written articles about heroes of the past such as Ada Lovelace, Hedy Lamarr and Edith Clarke."

In 2016, GIANTS became an inspiration day consisting of workshops and lectures from pioneers of today, such as alumni Mernosh Saatchi.

The event took place in the reactor hall, and within just 48 hours of it being announced, 100 young women had signed up to attend.

"I am so excited that we are able to continue this work. This year the event will return and we hope to attract 300 female students to the student union house Nymble. Further information can be found on the website, read more and start inspiring young women to make the leap into electrical engineering," Hernqvist says.

www.kth.se/giants

Staying at the top

KTH HAS AGAIN scored highly in the pretigious QS worldwide rankings for "Electrical and Electronic Engineering", having finished in top spot in 2015.

In 2015's subject ranking, KTH placed at 16. Stefan Östlund, Head of School, is proud that KTH has once more received a prominent ranking saying this is a result of dedicated work in several areas.

"In a global world, it is extremely important to attract the very best students. This year's placement shows that last year's ranking was no fluke", says Östlund. "Being 17th in the world and 6th in Europe is a result of dedicated long-term efforts to build internationally-strong research groups and to offer high-quality education with committed teachers and students."

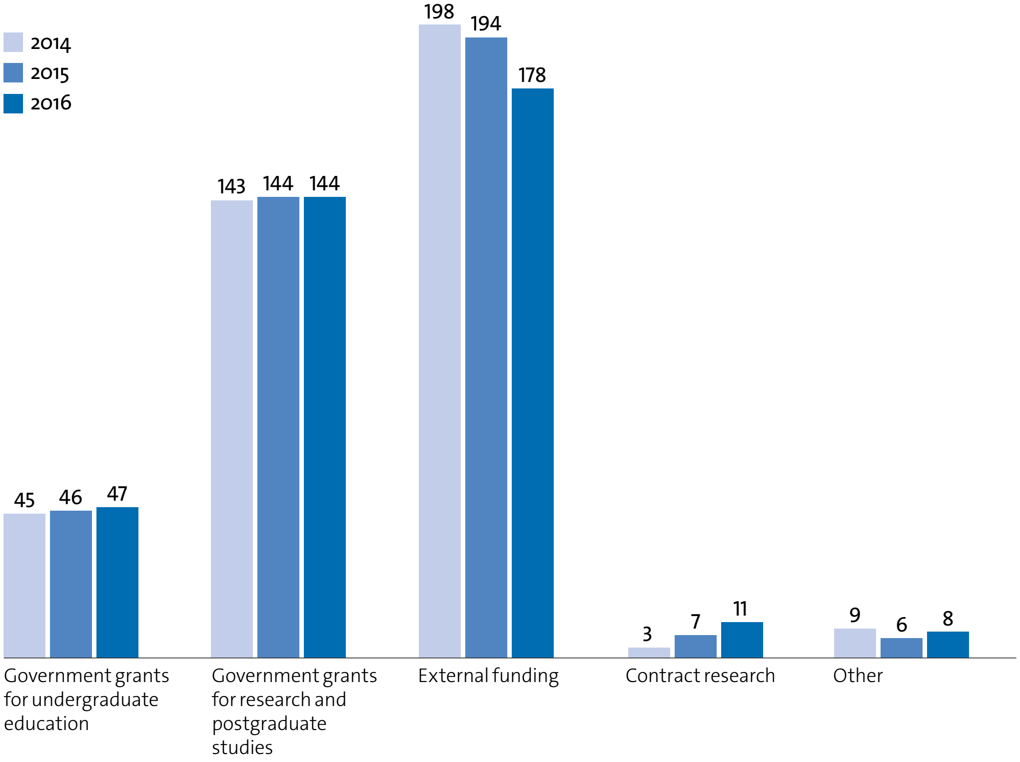
The QS ranking is one of the largest and most respected ranking systems in the world. The QS presents various annual rankings based on a combination of surveys and bibliometric data.

The year in review

2016 was a great year for the School of Electrical Engineering. We are happy to again see substantial increases in applicants for the five-year Master of Science in Electrical Engineering and our five Master's programmes. We also see great results in research areas such as field normalised citations rate, where we did well and received scores above world average.

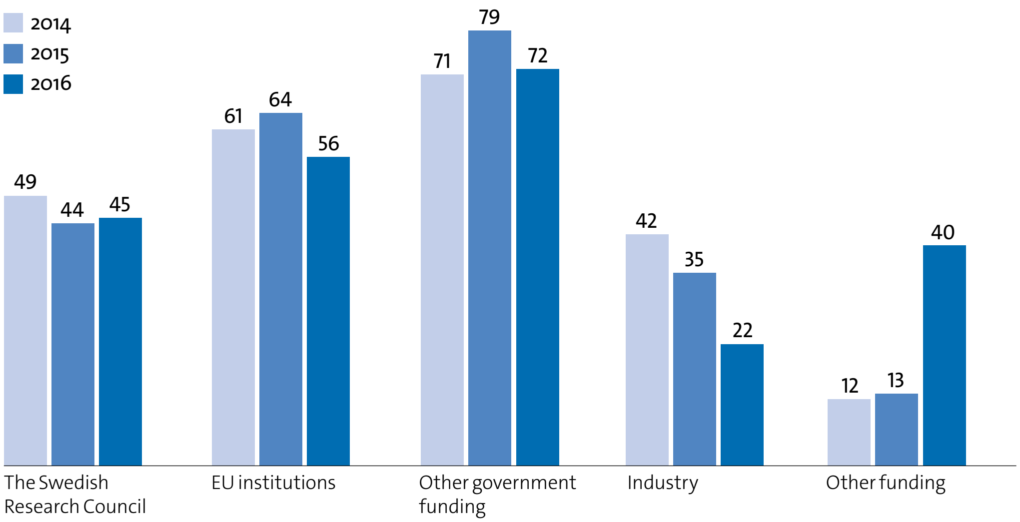
Incomes 2014-2016

In MSEK



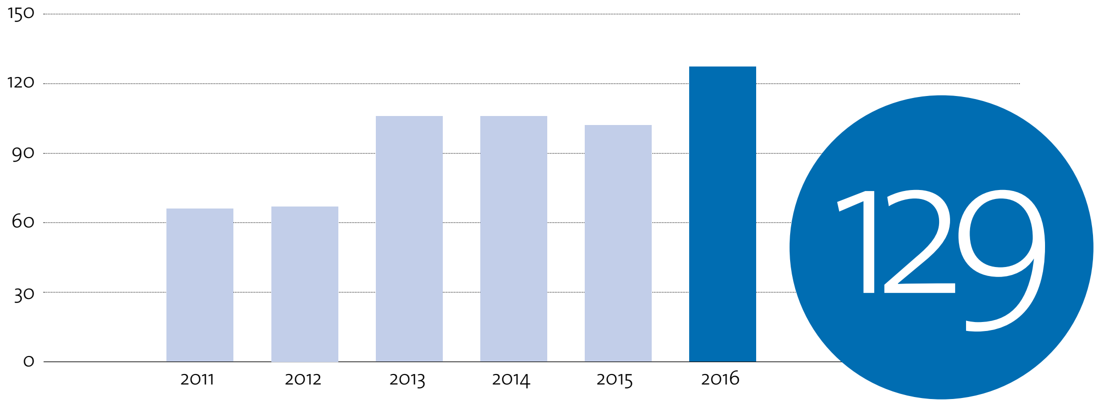
External funding 2014-2016

In MSEK



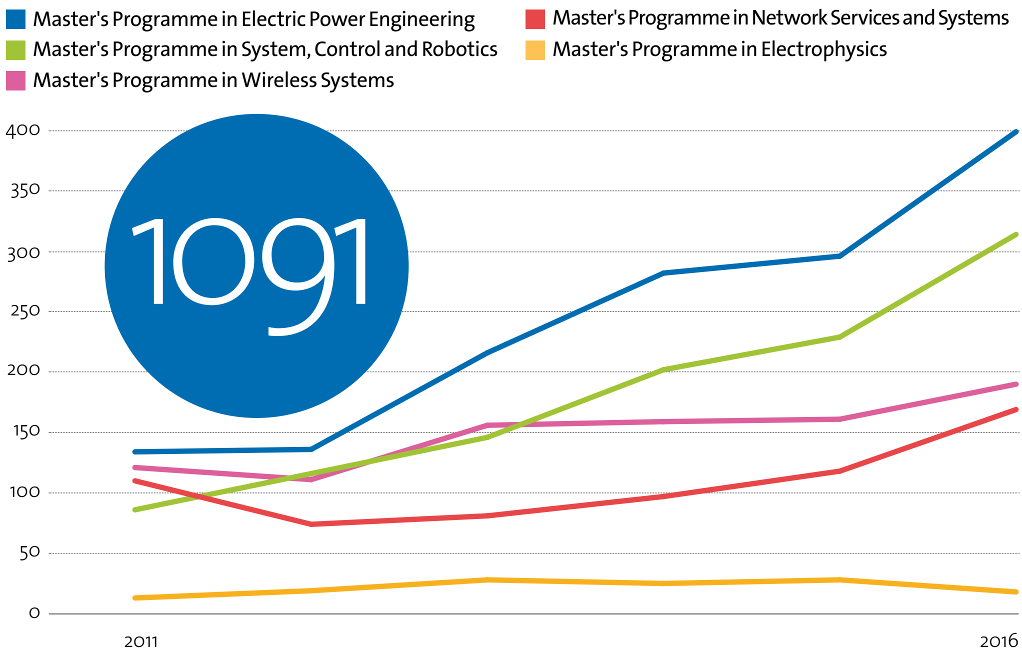
Master's of Science in Electrical Engineering

First-hand applicants for the school's Master's of Science in Electrical Engineering

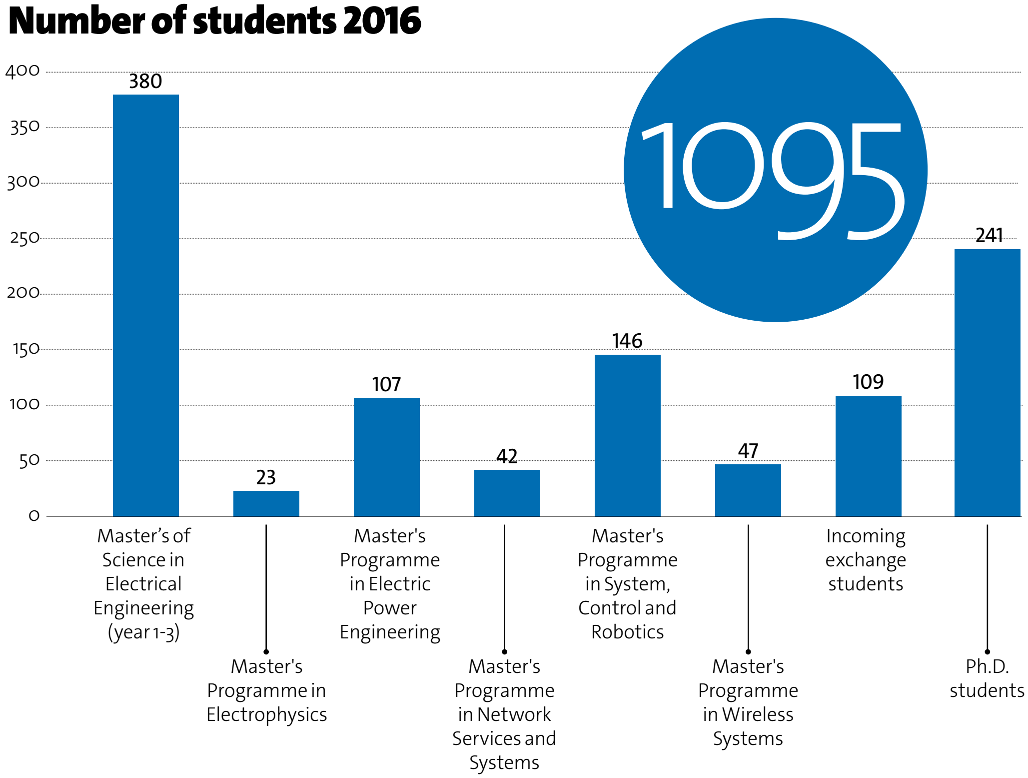


Master's programmes

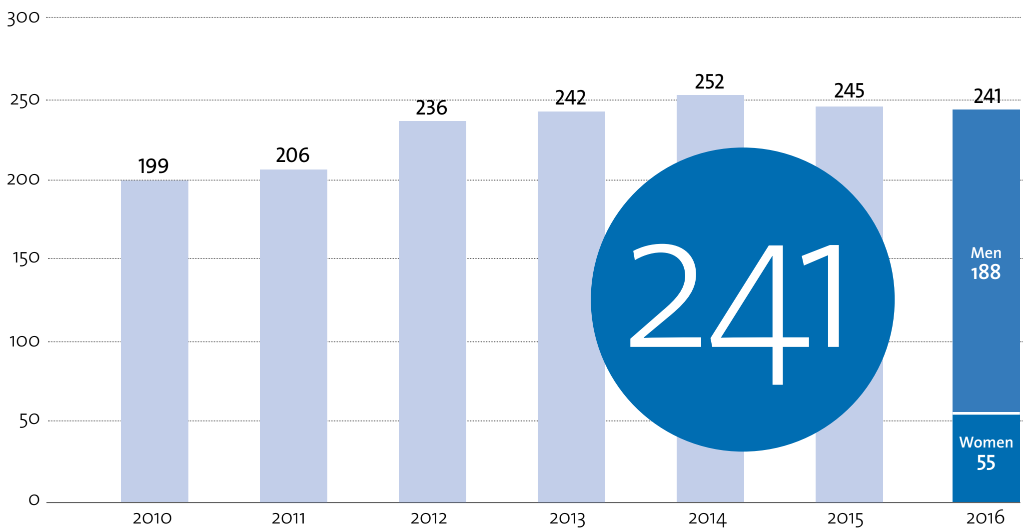
First-hand applicants for the school's Master's programmes



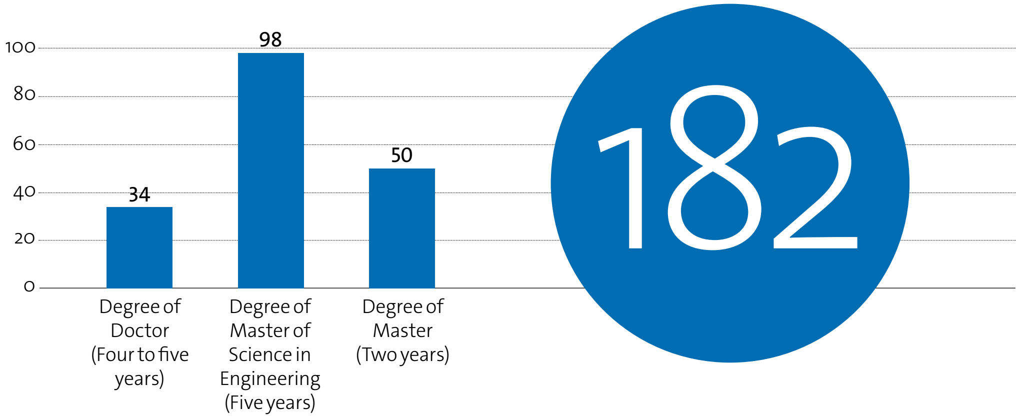
Number of students 2016



Number of doctoral students 2016



Number of received degrees in Electrical Engineering 2016



Research

Field-normalised citations

The field-normalised citation rate is widely used for research evaluation. It is a publications number of citations compared to the average number of citations for similar publications.

1.0% World average | **1.35%** EE School

Journal impact

The Journal Impact Factor is used for the evaluation of journals. It expresses the number of citations per article in a journal, or more exactly, the number of received citations per article from the current year to articles from the two precedent years.

1.0% World average | **1.51%** EE School

Executive Committee

From the left: Gunnar Karlsson, Network and Systems Engineering; Joakim Lilliesköld, Director of First and Second Cycle Education; Per Brunsell, Fusion Plasma Physics; Christelle Bourquin, Head of Administration; Stefan Östlund, Head of School; Bo Wahlberg, Automatic Control; Håkan Hjalmarsson, Director of Third Cycle Education; Göran Marklund, Space and Plasma Physics; Agneta Rune, Head of Finance; Lars Nordström, Electric Power and Energy Systems; Mikael Skoglund, Information Science and Engineering; Göran Stemme, Micro and Nanosystems

Not in the picture: Rajeev Thottappillil, Electromagnetic Engineering

Theses

With 34 doctoral theses, 23 licentiate theses and 130 master's theses in nine different areas, stretching from communication theory and networks to energy systems and space and plasma physics, the School of Electrical Engineering is committed to pushing the limits of human knowledge and maintaining its position as a world-class educational institution.

Doctoral Theses

Automatic Control

HAMID REZA FEYZMAHDAVIAN
Performance Analysis of Positive Systems and Optimization Algorithms with Time-delays

MENG GUO
Hybrid Control of Multi-robot Systems Under Complex Temporal Tasks

KUO-YUN LIANG
Fuel-Efficient Heavy-Duty Vehicle Platoon Formation

HÅKAN TERELIUS
Optimization and Control in Dynamical Network Systems

YUZHE XU
Decentralized Resource Sharing and Association in Wireless Networks

ANTONIO GONGA
Mobility and Multi-channel Communications in Low-power Wireless Networks

MARIETTE ANNERGREN
Application-Oriented Input Design and Optimization Methods Involving ADMM

Communication Theory

HAOPENG LI
Feature-Based Image Processing for Rendering, Compression, and Visual Search

Communication Networks

STYLIANOS GISDAKIS
Secure and Privacy Preserving Urban Sensing Systems

ABU HAMED MOHAMMAD MISBAH UDDIN
A Bottom-Up Approach to Real-Time Search in Large Networks and Clouds

VALENTINO PACIFICI
Resource Allocation in Operator-owned Content Delivery Systems

SYLVIA TODOROVA KOUYOUMDJIEVA
System Design for Opportunistic Networks

RERNGVIT YANGGRATOKE
Data-driven Performance Prediction and Resource Allocation for Cloud Services

GEORGIOS KOUDOURIDIS
Radio Resource Allocation and Utilization in Multiple Radio Access Networks

Electric Power and Energy Systems

PRADYUMNA BHAGWAT
Security of supply during the energy transition: The role of capacity mechanisms

JUAN COLMENARES HERRERA
Extreme Implementations of Wide-Bandgap Semiconductors in Power Electronics

DESTA ZAHLAY FITIW
Strategies, Methods and Tools for Solving Long-term Transmission Expansion Planning in Large-scale Power Systems

CHALESHTARI HASSAN POOR
Modulation of Modular Multilevel Converters for HVDC Transmission

ELTA KOLIOU
Demand Response Policies for the Implementation of Smart Grids

PAOLO MASTROPIETRO
Regulatory Design of Capacity Remuneration Mechanisms in Regional and Low-Carbon Electric Power Markets

VEDRAN PERIC
Non-intrusive Methods for Mode Estimation in Power Systems using Synchrophasors

YASER TOHIDI
Optimal Long-Term Generation-Transmission Planning in the Context of Multiple TSOs

YELENA VARDANYAN
Optimal bidding of a hydropower producer in sequential power markets with risk assessment: Stochastic programming approach

LIV GINGNELL
On Structuring and Practical Use of the Lean Product Development Concept - Based on Case Studies of Industrial Product Development Organizations

FLORES WALDO ROCHA
Shaping information security behaviors related to social engineering attacks

CLAS SANDELS
Modeling and Simulation of Electricity Consumption Profiles in the Northern Euopean Building Stock

Electromagnetic Engineering

MARIANA FRID DALARSON
Perturbation approach to reconstructions of boundary deformations in waveguide structures

KEXIN LIU
Theoretical Investigation on Propagation and Coupling of Nonreciprocal Electromagnetic Surface Waves

ROYA NIKJOO
Dielectric Response and Partial Discharge Diagnostics of Insulation Systems by Utilizing High Voltage Impulses

Micro and Nanosystems

JONAS HANSSON
From Lab to Chip - and back: Polymer microfluidic systems for sample handling in point-of-care diagnostics

Space and Plasma Physics

LADISLAS TANCRÈDE RAYMOND VIGNITCHOUK
Modelling the multifaceted physics of metallic dust and droplets in fusion plasmas

Signal Processing

RASMUS BRANDT
Distributed Coordination in Multiantenna Cellular Networks

AHMAD GHARANJIK
Transmission Optimization for High Throughput Satellite Systems

MARTIN SUNDIN
Bayesian methods for sparse and low-rank matrix problems

Licentiate Theses

Automatic Control

ADALDO ANTONIO
Event-triggered control of multi-agentsystems: pinning control, cloud coordination, and sensor coverage

NICLAS BLOMBERG
On Nuclear Norm Regularization in System Identification

PEDRO DELLA PENDADEMIA
Resource management for network-assisted D2D communication

DU RONG
Wireless Sensor Networks in Smart Cities: The Monitoring of Water Networks Case

STEFAN MAGUREANU
Structured Stochastic Bandits

PEDRO MIGUEL OTAO PEREIRA
Control of Single and Multiple Thrust Propelled Systems - With Applications to Attitude Synchronization

RICCARDO SVEN RISULEO
System identification with input uncertainties: an EM kernel-based approach

PEDRO RUSSO DE ALMEIDA LIMA
Predictive control for autonomous driving - With experimental evaluation on a heavy-duty construction truck

HOSSEIN SHOKRI GHADIKOLAEI
Fundamentals of Medium Access Control Design for Millimeter Wave Networks

MOHAMMAD SADEGH TALEBI MAZRAEH SHAHI
Online Combinatorial Optimization under Bandit Feedback

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