PROFILE 2019

DEPARTMENT OF ENGINEERING

RESEARCH
EDUCATION
IMPACT

RE-INVENTING AN 80-YEAR-OLD REVOLUTION

The ordinary bendy straw is one of history's first examples of universal design.
Now researchers are bringing the invention into the future.

AARHUS UNIVERSITY
DEPARTMENT OF ENGINEERING

SOLIDUM PETIT IN PROFUNDIS · UNIVERSITAS ARHUSIENSIS

DAILY MANAGEMENT AND ADMINISTRATION 2019

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Morten Dam Rasmussen, Deputy Head of Department
Jens Kargaard Madsen, Head of Electrical and Computer Engineering
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Engineering a better world

Since pre-industrial times, engineers have been frontrunners in the technological revolution. With their solid technical insight and deep theoretical understanding, they have bridged the gap between research and real life. No other discipline has such a strong link between the comprehension of deep technology and its creative application. It is a trademark of engineering. Our DNA.

At the Department of Engineering at Aarhus University, we believe that the future is technology. We believe that the foundations for a sustainable tomorrow are rooted in the innovative, creative and research-based source code of engineering. Engineers build and invent technology to push problems aside. Technology that not only benefits individuals or society, but the entire world.

2018 was a great year for us. Once again, we raised the bar for engineering science at Aarhus University, and we were involved in a record-breaking number of new national projects. And we produced 438 peer-reviewed publications.

A sizeable improvement. But that's not all.

Our new 2,100 m^2 research facility, the Deep Tech Experimental Hub, officially opened in December. The facility boasts state-of-the-art experimental laboratories: a maker-space for some of the world's leading experts in the classical engineering disciplines.

This development is continuing at full speed in 2019. As part of a major strategic focus on the technical sciences, Aarhus University will launch new, five-year master of science in engineering programmes in 2019. The goal is to bring the engineering sciences at Aarhus University into the European elite. To that end, by 2025, we work on doubling the number of enrolled students, tripling our turnover and recruiting 180 new senior engineering scientists.

The future is disruptive, and change is placing unprecedented demands on engineering universities. We have to be agile and ambitious. The world needs it. So, in 2019 we will be starting up a series of new and exciting projects that could have an enormous impact on the global megatrends driving the transformation of society.

I am proud to highlight some of our latest engineering projects in our brand new 2019 profile engineering magazine. All of them are examples of the innovative and creative DNA characterising our engineering science.

Thomas S. Toftegaard,
Head of Department of Engineering
Aarhus University

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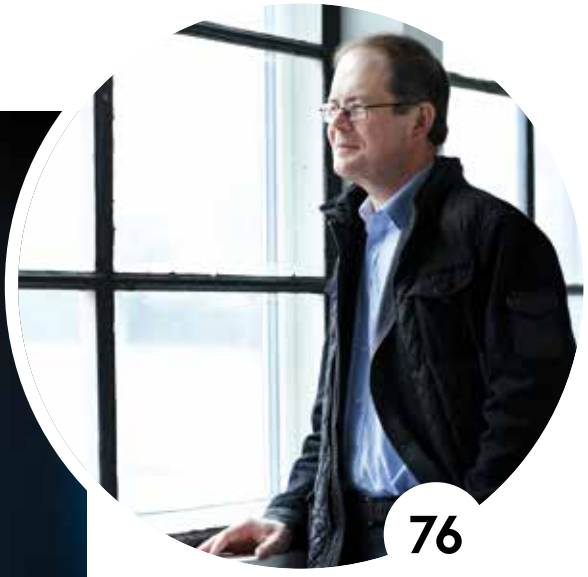


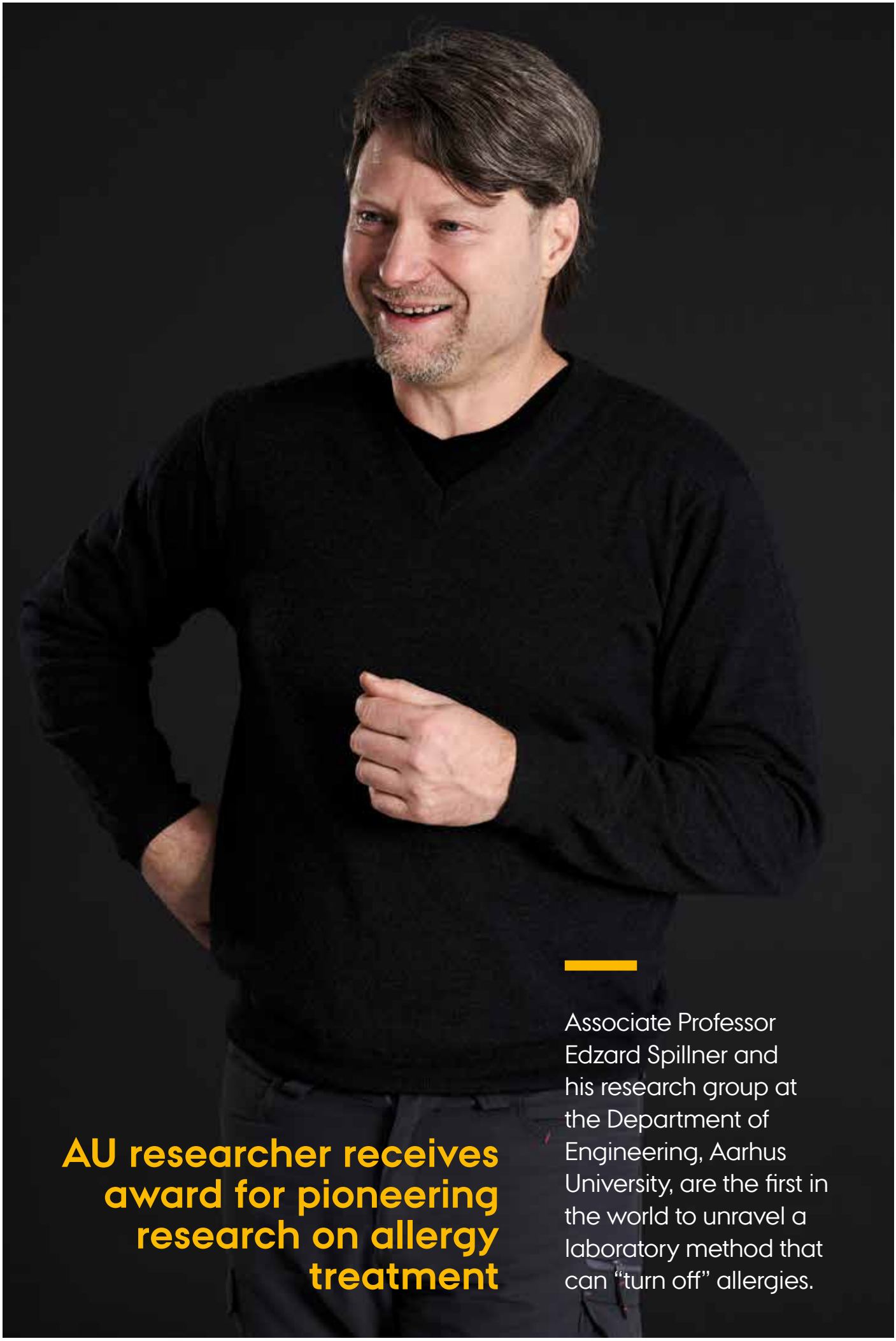
Photo: Maria Randima

AU Engineering, Campus Navitas, Aarhus

ENGINEERING DISCIPLINES

- **Biological** Engineering
- **Chemical** Engineering
- **Civil** Engineering
- **Architectural** Engineering
- **Electrical** Engineering
- **Computer** Engineering
- **Mechanical** Engineering

Photos: Peer Klercke



AU researcher receives award for pioneering research on allergy treatment

Associate Professor Edzard Spillner and his research group at the Department of Engineering, Aarhus University, are the first in the world to unravel a laboratory method that can "turn off" allergies.

Every year, the Astma-Allergi Danmark organisation awards the Grethe Stampe Award to a researcher, in recognition of a special contribution to allergy research. In 2018, Associate Professor Edzard Spillner received the prestigious award for his work to describe mechanisms of antibodies that can be exploited to treat allergies.

Together with his research group and long-time collaborators from MGB, Aarhus University, and Germany, Edzard Spillner has found a new antibody mechanism that could prevent allergic reactions in a large number of patient groups. In a way, the antibody can "turn off" an allergy, and this is, without doubt, a scientific breakthrough that could pave the way for effective new allergy treatments.

"When you work in basic research, there's often a long way from bench to bedside. Therefore, we're very pleased about this award and the attention it brings, because it's important to us that health-policy organisations can see the potential in our results," says the Associate Professor on behalf of the researchers.

And there is good reason to be optimistic. The research group discovered the effects of the antibody in early 2018, and it is nothing short of ground-breaking, as it might pave the way for a highly effective allergy drug that will help millions of people worldwide.

Actually, the research team was just hoping to find a way to improve the existing options for dealing with the rapidly growing number of allergy sufferers.

However, instead they discovered that the completely new properties and mechanisms of action in a specific antibody make it possible to block the immune effect behind allergic reactions.

The antibody turned out to interact in a complex biological process in the body, by which it prevents the allergy molecule (IgE) from attaching to other cells and removes already bound IgE.

This means that the researchers can now not only relieve the allergy symptoms – they could actually prevent them from arising.

"We can define the structure of the antibody binding to its target very accurately, and thus describe how it inhibits the interaction between IgE and the specific receptors in the relevant cells of the body that are responsible for producing histamine in the context of an allergic reaction. It's a scientific breakthrough with a great potential for further research in allergy medicine," says Associate Professor Edzard Spillner.

The discovery of the mode of action of the antibody is good news for approximately one-third of the population in the West who are currently living with allergies.

Their scientific results have been published in the prestigious journal, Nature Communications.

> *"When you work in basic research, there's often a long way from bench to bedside"*
>
> Associate Professor Edzard Spillner

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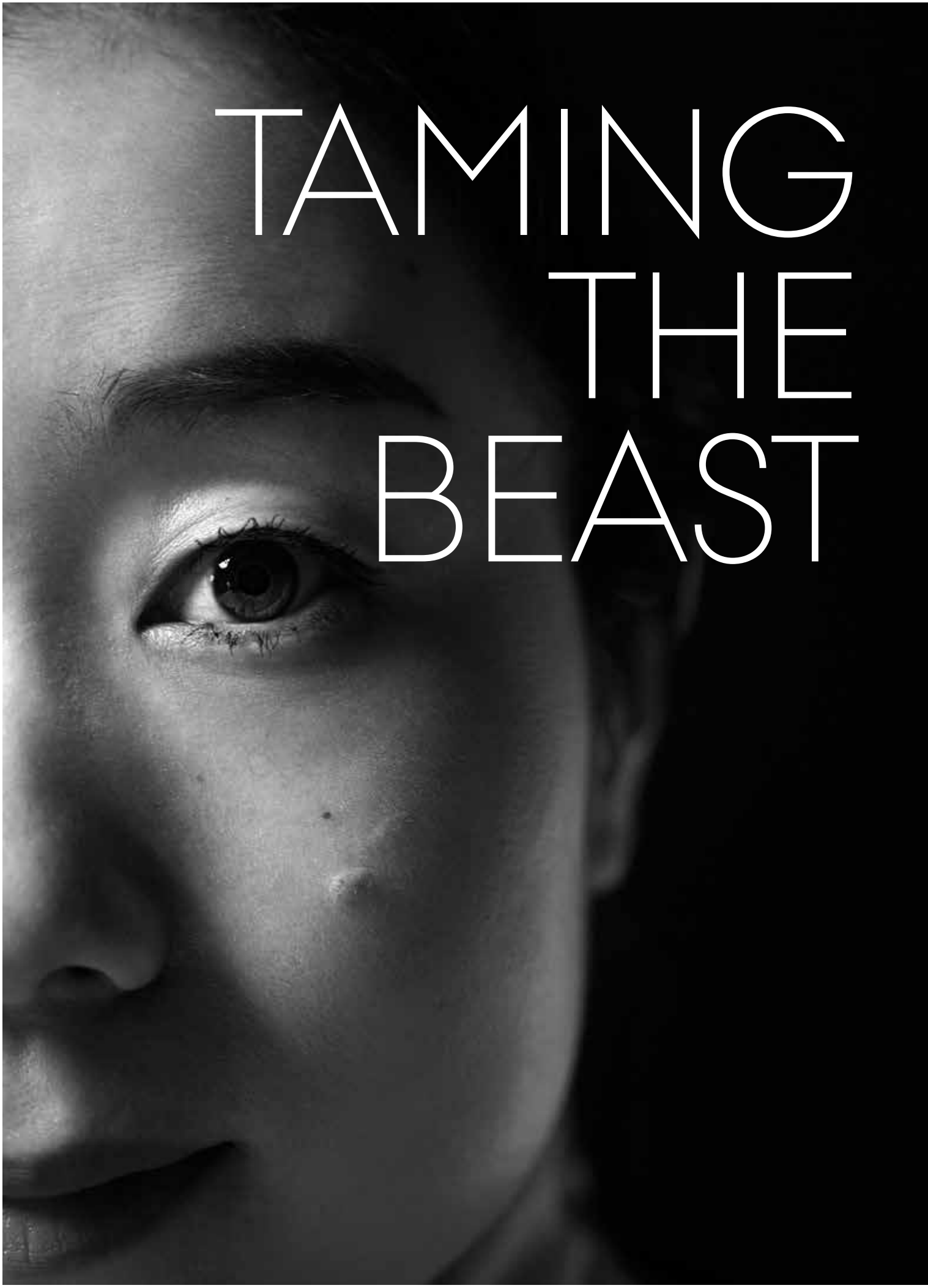
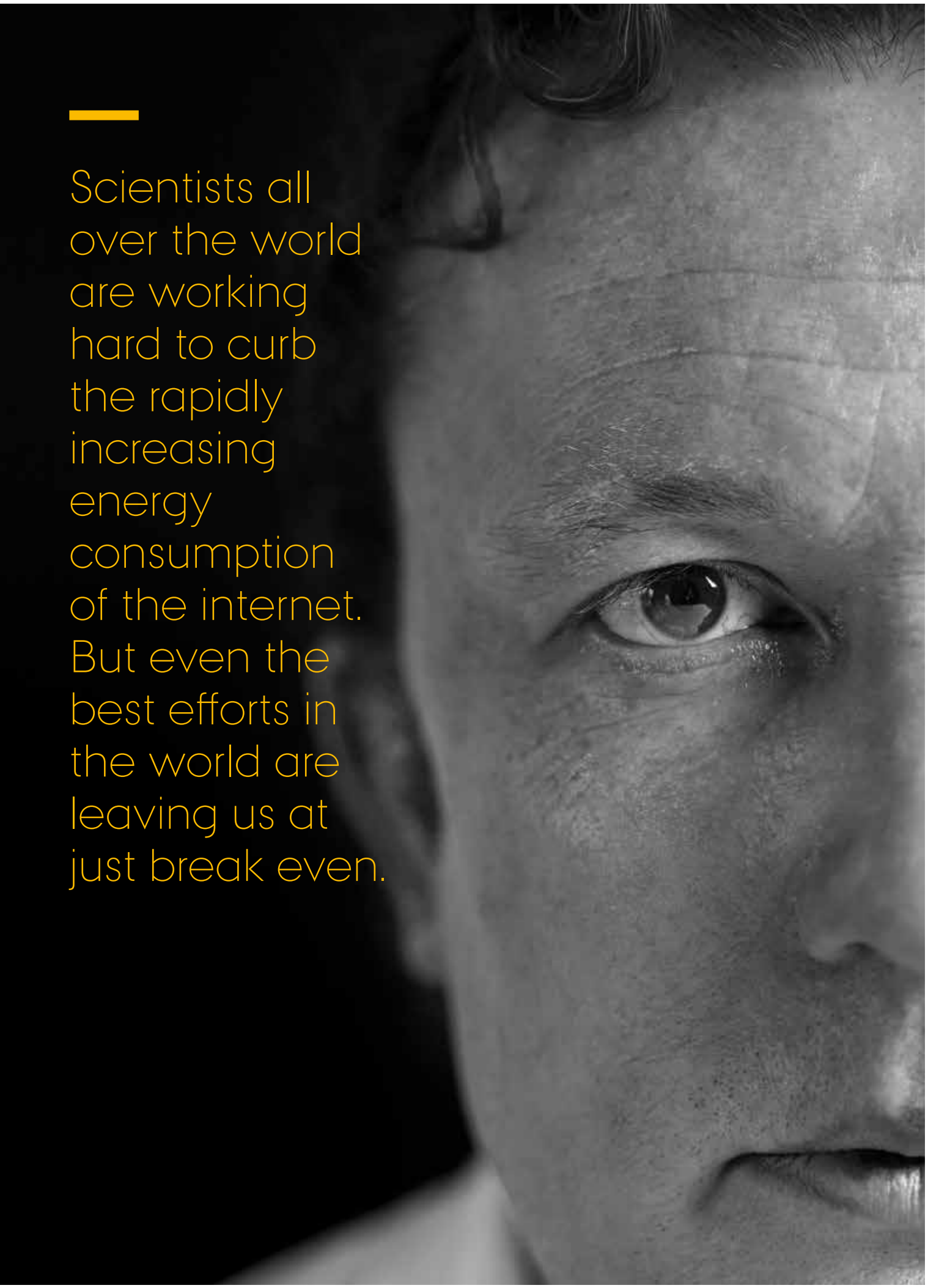


TAMING THE BEAST

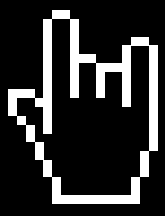
Photo: Lars Kruse



Scientists all over the world are working hard to curb the rapidly increasing energy consumption of the internet. But even the best efforts in the world are leaving us at just break even.

“WE’RE WORKING HARD JUST TO PREVENT THE WHOLE THING FROM BLOWING UP”

Traffic on the internet has increased a thousand-fold since 2000. The number of devices connected to the net has increased dramatically, and the future only offers more of the same. All this requires energy. Masses of energy. And the internet already accounts for almost 10 per cent of global electricity consumption.



Project title:
INCOM—Innovative Solutions for Next Generation Communications Infrastructure

Investment from Innovation Fund Denmark:
DKK 60 million

Total project budget:
DKK 100 million

Duration of the project:
3 years

Partners (alphabetically):
Accelink Denmark A/S
Bifrost Communication
Chocolate Cloud Aps
Comcores Aps
Danish Optical Fiber Innovation
Develco Products
DTU (coordinator)
Mellanox Technologies Denmark Aps
Napatech Aps
NKT Photonics A/S
OFS Fitel Denmark Aps
Telia Danmark
Zeuxion Aps
Aarhus University

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In 2020, the internet will connect more than 20 billion devices. Not only mobile devices and computers used by most of the world's population, but also sensors and 'smart' objects connected in the Internet of Things, which have caused a veritable data tsunami over the past few years. And this tsunami shows no sign of abating in the future.

Today, global data communication emits 2-3 per cent of all anthropogenic CO_2. Furthermore, traffic is increasing by 25 per cent every year. If we continue with the same infrastructure as we have been using up to now, it won't be long before the internet is the worst CO_2-emitter on Earth.

"The internet is growing so explosively that if we were to do nothing, in 10 years the energy cost of running the internet would double the global carbon footprint," says Associate Professor Martijn Heck from Aarhus University.

Therefore, he is working with several other researchers from Aarhus University on the three-year Grand Solutions project INCOM, which aims at forging energy-efficient solutions for the dramatically increasing global data communication.

The object of INCOM is to turn a great many small knobs that each contribute directly or indirectly to a lower energy consumption for the internet, and with a large number of other national and international players, the project will find solutions for the next generation of communication infrastructure.

Among other things, the plan is to compress the total amount of sensor traffic significantly by using novel security and compression algorithms at the end user. At the same time, as another example, the number of light sources that operate the internet will be reduced, so that one laser can replace hundreds of lasers, which, in addition to significant energy savings, will also enable higher processing speeds.

The INCOM project consists of several large individual work packages, each with its own area. Martijn Heck is developing new chip-based laser systems based on existing integration technologies, and his colleagues, Associate Professor Qi Zhang and Associate Professor Rune Hylsberg Jacobsen, are working with wireless communication and security for IoT devices.

"IoT devices generate vast amount of data every second of every day. The ever-increasing data generated by all the sensors far exceeds all the storage on the planet. Sensors have been installed everywhere already, and we've really only just started on the wave of digitalisation. In my opinion, it's not a sustainable solution to store all the data we collect. There's no room for it. Massive sensor data is seriously stressing the global communications network infrastructure. We need smart solutions while expanding the network capacity," says Associate Professor Qi Zhang.

With her work package, which is about developing a lightweight security system

> *"The internet is growing so explosively that if we were to do nothing, in 10 years the energy cost of running the internet would double the global carbon footprint"*
>
> Associate Professor Martijn Heck

that is also scalable and energy-efficient, Associate Professor Zhang expects to be able to cut away up to 90 per cent of all data traffic, and clearly this will ultimately have a huge impact on internet energy consumption:

"In our project, we're compressing and encrypting the data simultaneously and with very low complexity. We can compress the data to only 10 or 20 per cent of its original size, and that could have a huge influence on the storage and traffic needed – both in the access networks but also in the core network," she says.

The traffic hubs in the information age are data centres connected by intercontinental optical cables that transmit information at high speed from machine to machine and from person to person. Half of the world's population has become connected to the internet in just 30 years.

More people and more devices will obviously require better infrastructure. However, it is unlikely that many of us realise that even simple searches on the internet require relatively large amounts of data exchange and power consumption.

"When you send one bit of data into a data centre, there's a factor of 10 or 100 more bits going around inside the data centre. And for every server inside the data centre, that data is again multiplied by a factor of 10 or more. And every server has a processor and a memory where more factors are added. Tens of thousands of bits are exchanged for every single bit going into the data centre, and that requires a huge amount of energy. A simple Google search, for example, triggers a large number of internal processes, which is very energy intensive," says Martijn Heck.

Therefore, the project is basically not to make the internet greener, he explains:

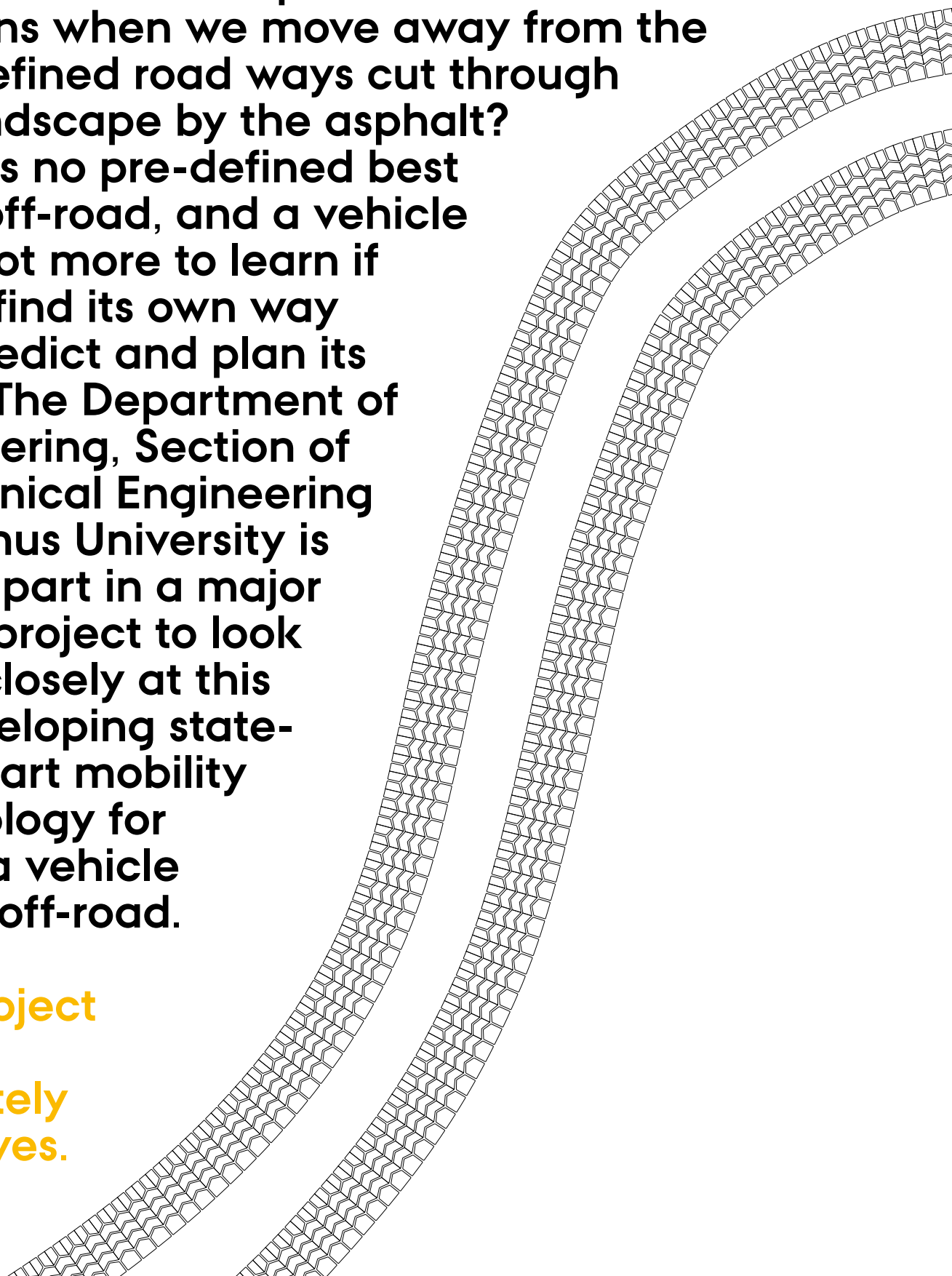
"All the newer data centres out there have 40 Gb/s connections to the servers. The newest top 1 per cent have 100 Gb/s, moving into 200 Gb/s. In two to three years, the standard will be 400 Gb/s, and in five to seven years from now we'll have 1 Tb/s. When you talk about Moore's Law in electronics, you have the exact similar growth in communications. The point is that what we do this year with 100 Gb/s, we have to do next year for 200 Gb/s at the same cost and the same energy consumption. Not the same energy consumption per bit but the same overall energy consumption," he says and continues:

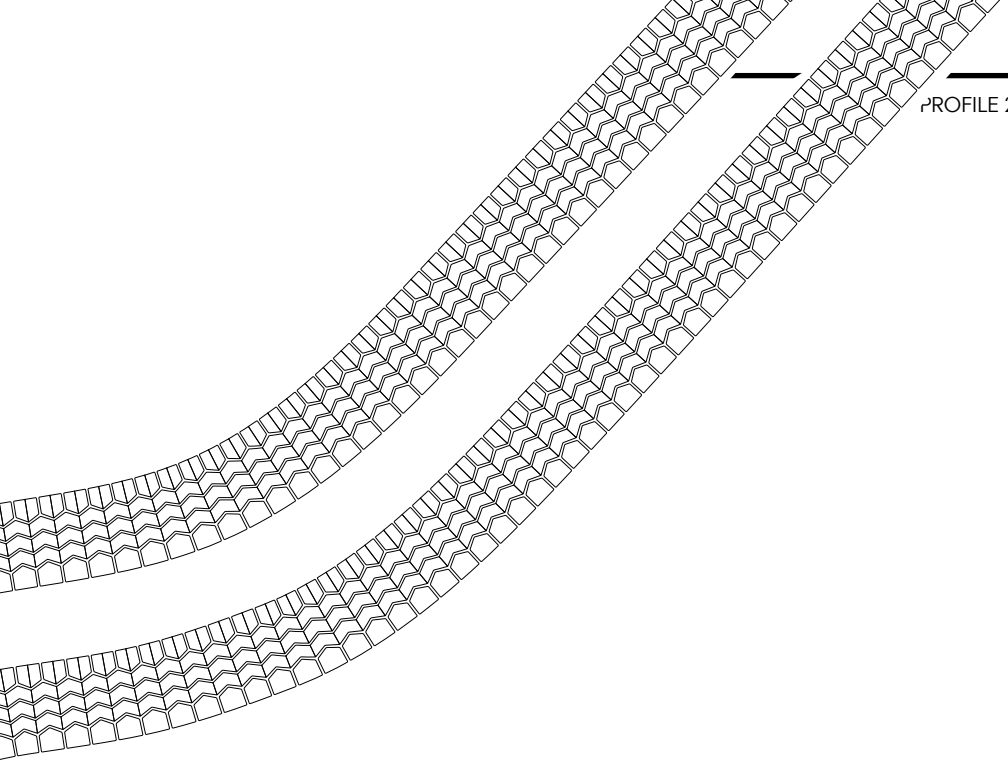
"INCOM is not going to make the internet any greener whatsoever. It will make the internet greener per bit, but not in total. In this project, we're working hard just to prevent the whole thing from blowing up. We're just trying to tame the beast a bit – but the beast is still there and it's getting more and more furious by the minute. The best we can do is break even. And if we do break even, we're still doing the best job in the world."

Photo: Lars Kruse

The future is self-driving, but autonomous transport is about much more than just making sure that vehicles keep to the road and do not run into pedestrians. What happens when we move away from the well-defined road ways cut through the landscape by the asphalt? There is no pre-defined best route off-road, and a vehicle has a lot more to learn if it is to find its own way and predict and plan its route. The Department of Engineering, Section of Mechanical Engineering at Aarhus University is taking part in a major NATO project to look more closely at this by developing state-of-the-art mobility technology for when a vehicle heads off-road.

The project could ultimately save lives.





Project title:
Next Generation NATO Reference Mobility Model, NG-NRMM.

Partners:
Canada
Croatia
Czech Republic
Denmark
Estonia
Germany
Italy
Netherlands
Poland
Romania
Slovakia
South Africa*
Turkey
United Kingdom
United States

* Not a NATO member

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July 1917, Ypres, Belgium. The 1st World War is raging, and on the Western Front Field Marshal Douglas Haig and the allies are planning to retake the town of Passchendaele from the Germans. The plan is to break through in Flanders and bring the war to an end. Haig had promised victory. But the Battle of Passchendaele instead became a synonym for the full horror of the 1st World War. It epitomised the slaughter of the trenches, and half a million soldiers paid the highest price in this "Battle of Mud", as the battle was dubbed.

More than a century later, we are still struggling in the mud when we move off the asphalted infrastructure our society has built.

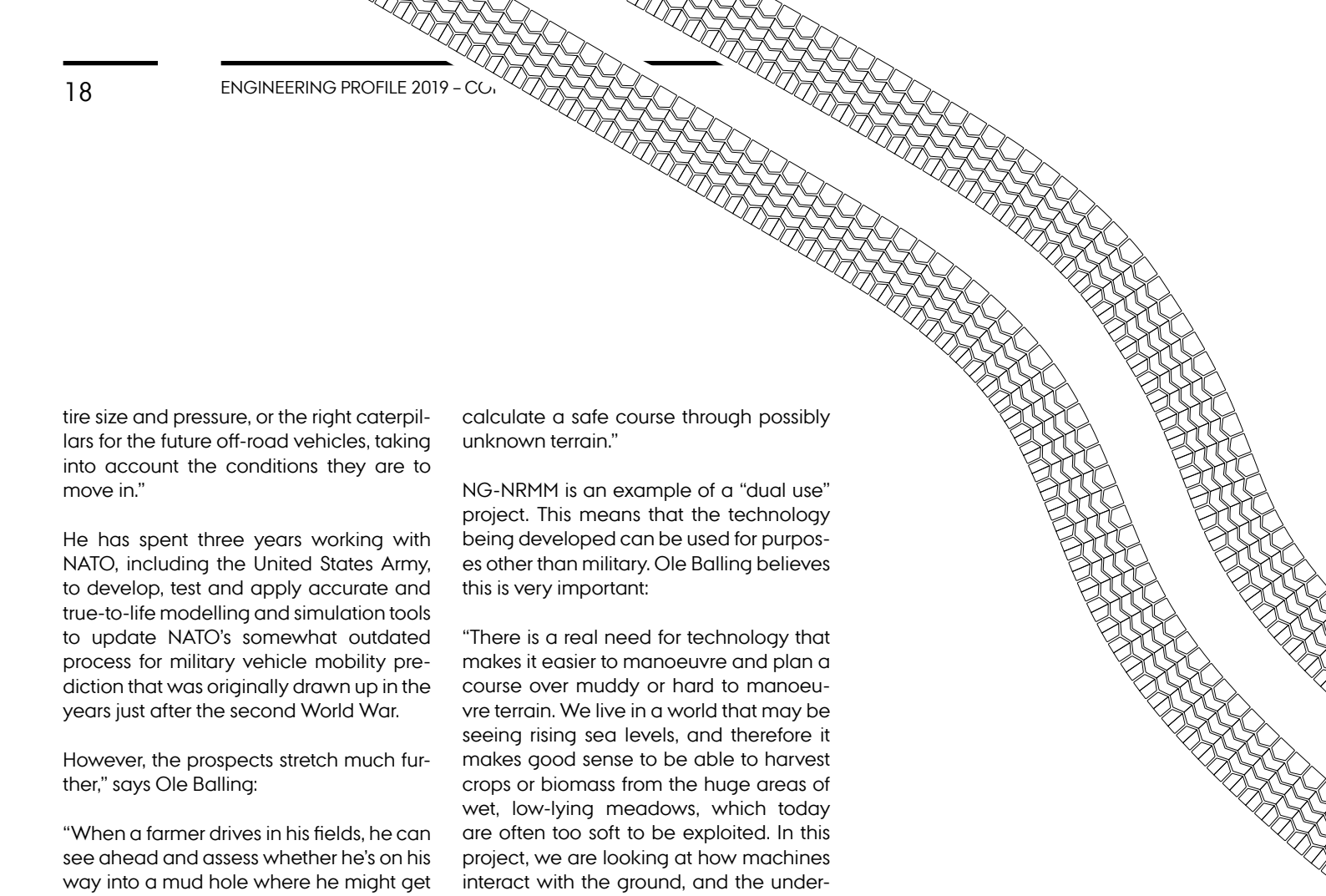
It is still difficult to design vehicles that can cope with all the different types of challenging terrain in the world. For example when farmers have to drive over ploughed fields, or when military vehicles have to drive through mountain ranges to secure peace.

Even the most hardy Land Rover grinds to a halt when the water content of the soil is too high, and soldiers are still losing their lives when heavy armoured vehicles move out into difficult and impassable terrain.

Therefore, the Department of Engineering at Aarhus University is participating in a NATO-led project, Next generation NATO Reference Mobility Model (NG-NRMM), which aims to introduce, standardise and demonstrate the latest 3D simulation technology that can predict the ability of a vehicle to move over certain terrain conditions.

"We're trying to find out about the performance of different machines at given sites on the basis of all kinds of geospatial data such as ground inclination, soil type, water content as well as obstacles such as rocks, trees, ditches, buildings, etc. What's interesting in the project is how the machines interact with soft, muddy ground: How can we best move on this type of ground, without getting stuck and without damaging the ground unnecessarily?" says Professor (Docent) Ole Balling, and he continues:

"This makes it easier to choose the right



tire size and pressure, or the right caterpillars for the future off-road vehicles, taking into account the conditions they are to move in."

He has spent three years working with NATO, including the United States Army, to develop, test and apply accurate and true-to-life modelling and simulation tools to update NATO's somewhat outdated process for military vehicle mobility prediction that was originally drawn up in the years just after the second World War.

However, the prospects stretch much further," says Ole Balling:

"When a farmer drives in his fields, he can see ahead and assess whether he's on his way into a mud hole where he might get stuck. How can an autonomous tractor do this? When we talk about the self-driving vehicles of the future, we're always talking about driving on asphalt. But there's a huge difference between asphalt and off-road, and if we want a truly self-driving future, clearly we'll have to take this into account."

Asphalt is far more navigable than when you move out into terrain, he explains:

"Perhaps it's easy for us humans to see whether we are going down into a mud hole, but not for a computer that has to calculate a safe course through possibly unknown terrain."

NG-NRMM is an example of a "dual use" project. This means that the technology being developed can be used for purposes other than military. Ole Balling believes this is very important:

"There is a real need for technology that makes it easier to manoeuvre and plan a course over muddy or hard to manoeuvre terrain. We live in a world that may be seeing rising sea levels, and therefore it makes good sense to be able to harvest crops or biomass from the huge areas of wet, low-lying meadows, which today are often too soft to be exploited. In this project, we are looking at how machines interact with the ground, and the underlying numerical models are the same whether you look at it with military or humanitarian eyes. "

Aarhus University acknowledge support for our work from the following organizations:

NATO Science & Technology Organization, Collaboration Support Office, Danish Ministry of Defence Acquisition and Logistics Organization and NASA Jet Propulsion Laboratory, DARTS Lab, California Institute of Technology.

"

When we talk about the self-driving vehicles of the future, we're always talking about driving on asphalt. But there's a huge difference between asphalt and off-road"

Professor (Docent) Ole Balling

Photos: Ole Balling

Following a visiting faculty research stay in the Spring 2016 at NASA's Jet Propulsion Laboratory (JPL) at California Institute of Technology Ole Balling and his team decided to participate as a software developer in collaboration with Dr. Jain, JPL, by modifying the JPL's Mars Rover simulation software ROAMS to model the NG-NRMM demonstration vehicle, the FED-Alpha.

From left: Abhinandan Jain, Senior Research Scientist, DARTS Lab, NASA Jet Propulsion Laboratory, California Institute of Technology. Ole Balling, Senior Associate Professor, Department of Engineering, Section of Mechanical and Materials Engineering, Aarhus University. Louise Bendtsen AU (Engineering MSc Student). Morten Haastrup AU (AC-TAP). Frederik Homaa AU (Engineering MSc Student). Steen Søndergaard, Chief of Defence Research Center and NATO Science Technology Principal Board Member and Jesper Holm, Senior Scientific Advisor, PhD and NATO STO National Coordinator Denmark (both from the Danish Ministry of Defence Acquisition and Logistics Organisation).

DEEP TECH EXPERIMENTAL HUB

On 14 December 2018, the new 2,100 m^2 Deep Tech Experimental Hub research facility of Department of Engineering, Aarhus University, officially opened. So far, the facility boasts one of the largest indoor drone cages in Denmark, a climate lab, an engineering makerspace, experimental wind tunnel laboratories and a foundry for concrete trialing. The Experimental Hub is due to be complete in 2019 with the inclusion of new robotics projects.

We are happy to showcase the facility for interested parties – please see page 43 for details.

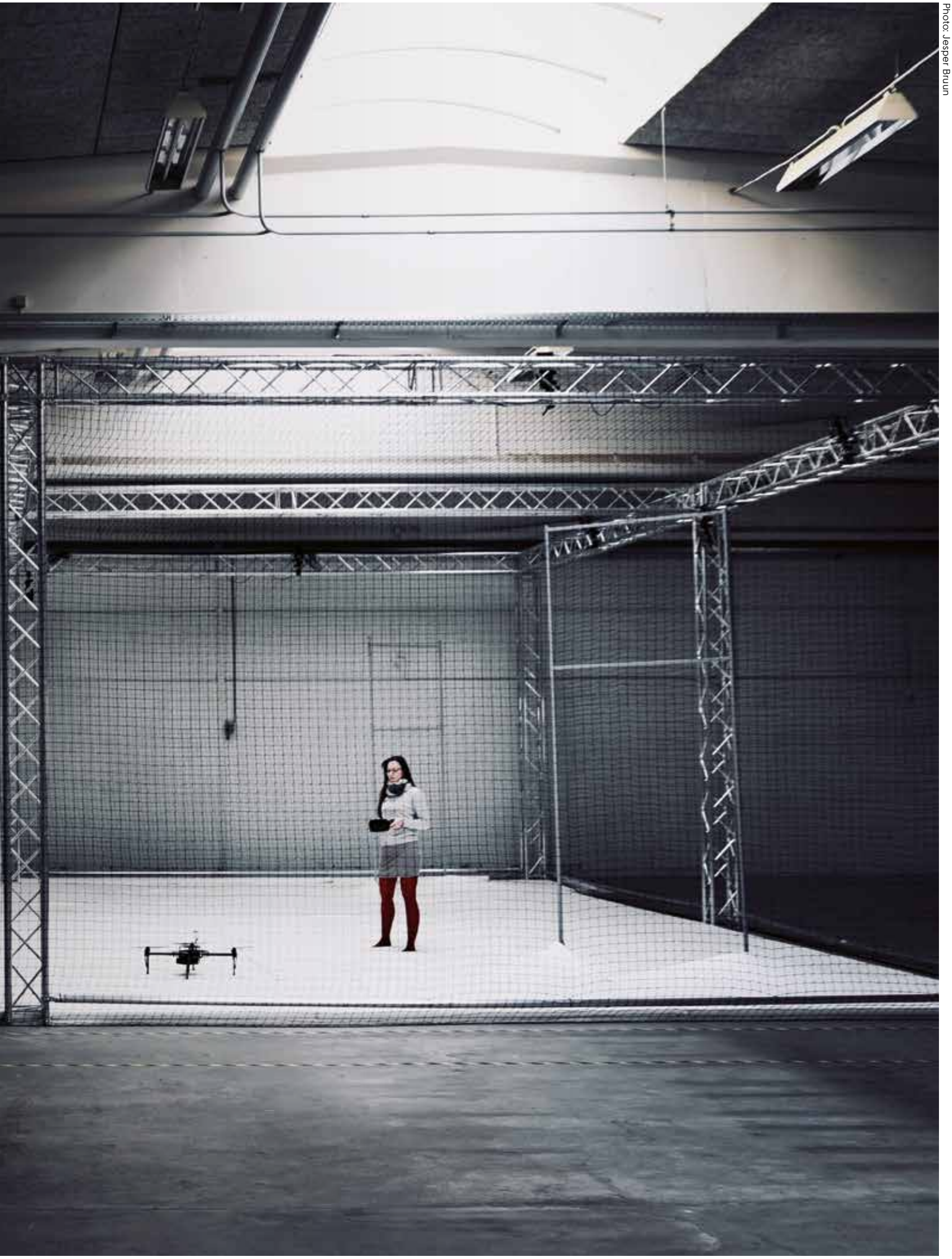


Photo: Jesper Bruun

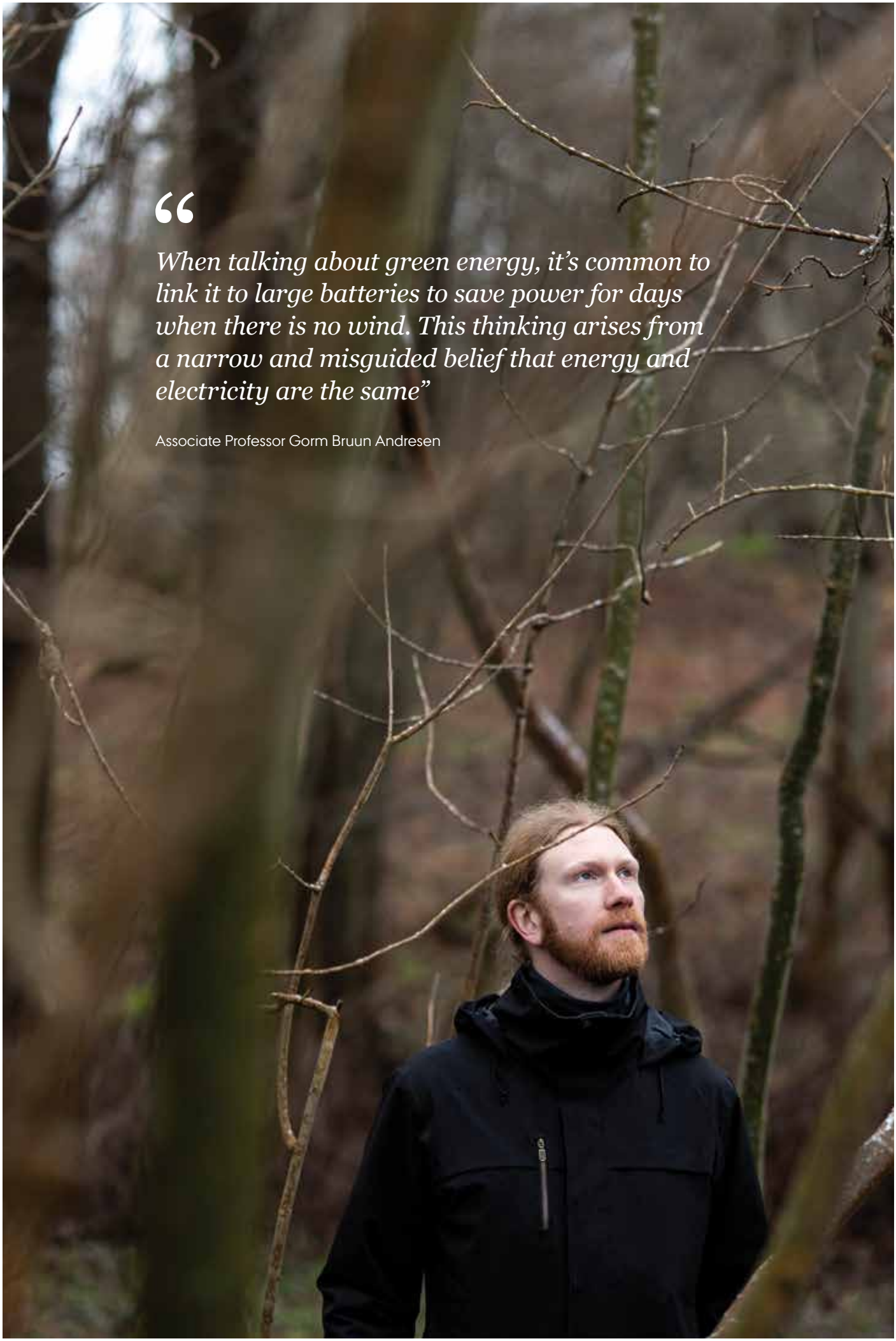
BLOG:
The climate won't wait for the cheapest solution

(This blog post was previously published in the Danish newspaper Altinget)

On 29 June 2018, the Danish Government concluded a new energy agreement with all parties in Parliament. The agreement marks a new chapter for integration of the electricity and heating sectors, but we need to be more ambitious and not only encourage the cheapest and most convenient solutions, says Associate Professor Gorm Bruun Andresen

Photo: Lars Kruse

Photo: Lars Kruse



“When talking about green energy, it’s common to link it to large batteries to save power for days when there is no wind. This thinking arises from a narrow and misguided belief that energy and electricity are the same”

Associate Professor Gorm Bruun Andresen

By Gorm Bruun Andresen
Associate Professor, Department of Engineering, Aarhus University

The energy agreement primarily concentrates on the cheapest solutions.

However, global warming won't wait for the cheapest solution, and only a drastic reduction in global CO_2 emissions over the next decades will curb the extent of the climate crisis with any certainty.

The agreement contains no unpleasant measures, or measures that could trigger resistance, such as the car-free Sundays introduced during the oil crisis in the 1970s.

The world needs ambitious Danish solutions
Currently, Denmark has the potential to lead the way to carbon-neutral energy supply that could limit the serious consequences of climate change.

Denmark has been working on the green transition for a long time, and we're well on the way to achieving the international goals.

The rest of the world is also catching up. Therefore, Danish politicians have to be even more ambitious.

The world needs new Danish solutions that can be applied internationally in the same way as the long-standing Danish focus on wind power, which today means that many other countries can implement the technology rapidly.

Good thing that the energy agreement focuses on different forms of energy
Denmark has good potentials to develop the solutions required, and in the following, I would like to point to some of the positive elements of the agreement, which I believe may form the necessary basis for continuing the significant increases in the amount of renewable energy.

It is a good thing that the energy agreement focuses on different forms of energy. When talking about green energy, it's common to link it to large batteries to save power for days when there is no wind. This thinking arises from a narrow and misguided belief that energy and electricity are the same.

In reality, we use large amounts of energy on other things than electricity, for example on heating and transport. The agreement takes note of this.

New chapter for sector coupling, but doubt about the adequacy of the various measures
There is considerable focus in the agreement on making wind energy and surplus heat from various energy-intensive companies play a much larger role in the heating sector. Recent research shows that, with a reasonable coupling between the electricity and heating sectors, it would be far more cost effective to integrate more renewable energy in the overall energy system.

The agreement paves the way for a new chapter within the non-fuel coupling between the electricity and heating sectors. This would allow for greater flexibility in the energy system, which could even-out the fluctuations in weather-based production.

However, one could question whether the specific political and economic instruments in the agreement are sufficient to achieve a rapid transition that will give Denmark the necessary competitive edge internationally.

Significant investments in biogas, but competition is fierce
The significant investments in biogas that are also included in the agreement could be considered in the context of coupling the sectors.

The technology is still relatively expensive, but in the long term, biogas could be an attractive green technology, because the gas can be used for heavy transport and other hard-to-electrify energy needs. In addition, bio-based electricity, heating and CHP plants could even-out the variable production from wind and solar energy in particular.

It is easy to imagine that the already significant Danish expertise within the area will eventually bear fruit. But in this area, the international competition seems to be tougher than it is for integrating electricity and heat.

Danish knowledge should be applied more ambitiously
The examples show that the authorities who drew up the agreement have a good understanding that an energy system based on wind and solar energy demands new market mechanisms and technologies, working across traditional sectors.

I believe that this knowledge could be used more ambitiously, so that these technologies can be brought into play in the global market more quickly.

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Mimicking nature to produce green chemicals using the power of light

Nine universities across Europe are working together to produce green, sustainable and biodegradable chemicals using light as the fuel and generating absolutely no waste at all.

Photo: Melissa Bach Yilderim

Photo: Melissa Bach Yilderim

Associate Professor Selin Kara is leading work package No. 3 of the Horizon 2020 project that could be ground-breaking for an industry that today belong amongst the most polluting in the world.

What if you could create 100 per cent biodegradable plastic and chemical compounds using only natural ingredients and light, generating no waste at all, and 100 per cent sustainable?

That's actually the vision of an international research team currently working towards the synthesis of green chemicals for our daily life; chemicals such as polymers, pharmaceuticals and fine chemicals – an industry that today actually belong amongst the most polluting in the world, not just because of what ends up in nature, but also because of production processes that traditionally produce a lot more waste than product.

The EU Horizon 2020-funded project is called PhotoBioCat, and it brings together the brightest minds in the fields of biology, chemistry and engineering from nine different universities across Europe.

"The project is aiming to mimic nature to produce the chemicals we need. Clean, sustainable and biodegradable chemicals produced without the use of hazardous materials, and at a fraction of the cost of present production methodologies," says Associate Professor Selin Kara from the Department of Engineering, Aarhus University, who's leading one of the six work packages in the PhotoBioCat project.

The process entails designing optimal cyanobacteria hosts for enzymes, optimising cyanobacteria cultivation, and identifying novel enzymes. Protein engineering is involved for light-driven reactions, and reaction and medium engineering are also part of the project. And all the time, it is vital to ensure the right amount of light for the process.

Selin Kara is leading work package No. 3 of the H2020 project, which is called "Reaction optimization and up-scaling of photobiocatalysis". This particular work package aims at identifying and optimising the key physiological parameters in individual projects. It covers, for instance, cultivation concepts for cyanobacteria, reactor type and operation modus for microbial and enzymatic applications, adaptation of light intensity, etc.

Selin Kara is convinced that it will be possible to apply the synthesis routes designed in PhotoBioCat very soon and commercially produce chemicals using enzymes as nature's powerful catalysts, and light as fuel for the enzymes.

And that would indeed be ground-breaking, as it could significantly lower the cost, environmental impact and arable land needed for chemical production, which is why industry is also a big part of the project. Seven corporations from across Europe are participating, including the second largest pharmaceutical company in the world, British GlaxoSmithKline.

The consortium offers a unique graduation programme leading to double-degrees for 12 PhD graduates at the highly complementary European academic institutions. The strong corporate involvement adds exposure to industry research, and transferable skills prepare the graduates for employment in the European biotechnology sector.

The entire project is being coordinated by Graz University of Technology in Austria, by Professor Robert Kourist.

Overall Budget:
EUR 3 million

Timeline:
2018-2022

Academic Partners:
Graz University of Technology (Coordinator)
Aarhus University
University of Graz
Aix-Marseille University
University of Porto
Ruhr University Bochum
Wageningen University
Delft University of Technology (associated partner)
Technical University of Denmark (associated partner)

Industrial Partners:
GlaxoSmithKline
Chiracon GmbH
Subitec GmbH
EntreChem S.L.
Arkema
Cyano Biotech GmbH
innoPhore GmbH

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Aarhus University invests heavily in new master of science in engineering programmes in 2019

Read article here

Photo: Lars Kruse


ONLY
ONE-THIRD
OF
THE
WORKING
HOURS
IN
CONSTRUCTION
ADD
VALUE

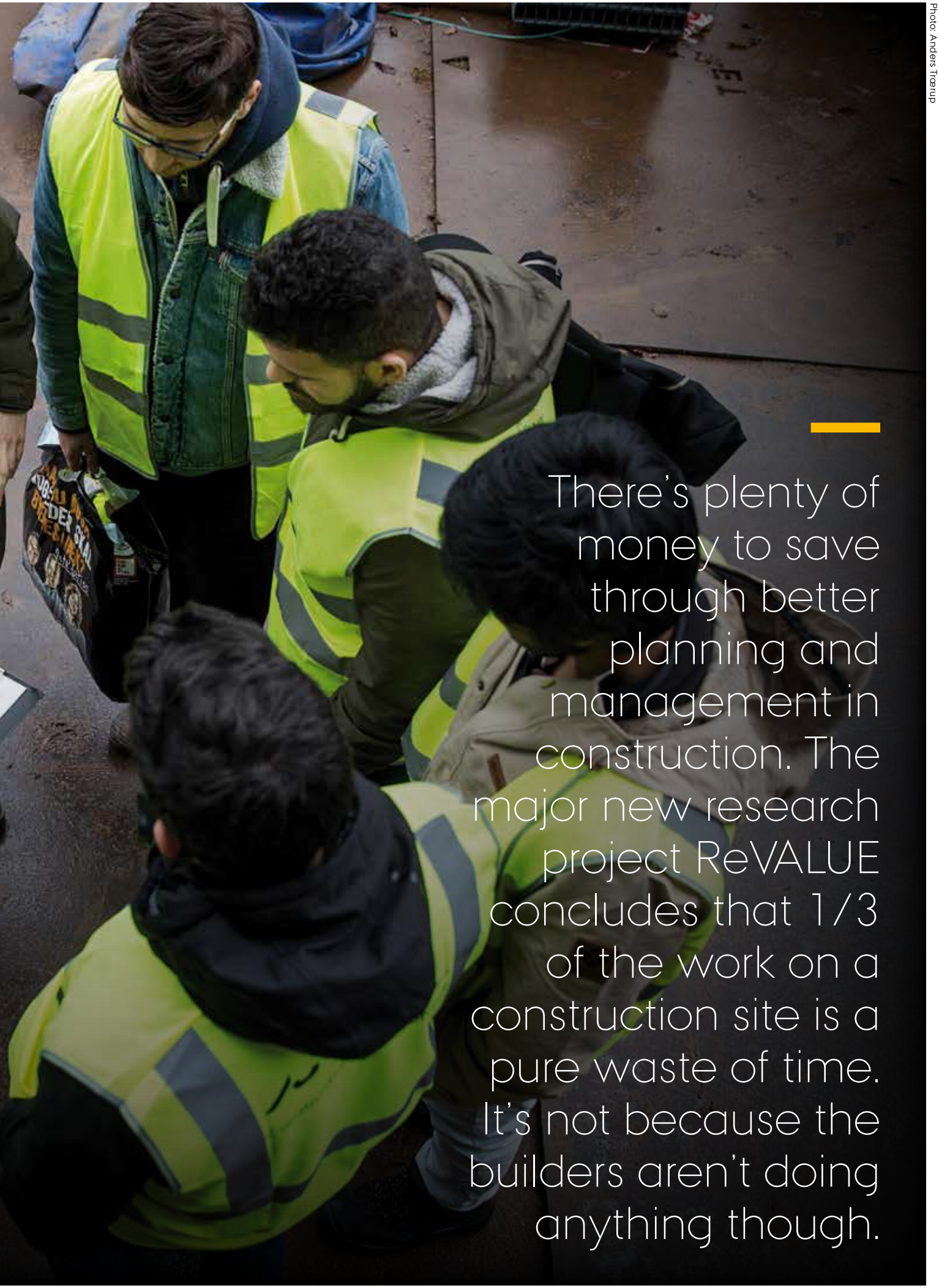

Photo: Anders Trærup

There's plenty of money to save through better planning and management in construction. The major new research project ReVALUE concludes that 1/3 of the work on a construction site is a pure waste of time. It's not because the builders aren't doing anything though.

Massive rewards from better management in construction

Better planning and management in renovation projects could save society an annual DKK 3,300 million (EUR 450 million). This is one result from the ReVALUE research project at Aarhus University, which has quantified for the first time how much money can be saved in the construction sector.

Title:
ReVALUE

Budget:
DKK 21.2 million

Time frame:
2016-2019

Partners:
Brabrand Boligforening
Enemærke & Petersen A/S
AART Architects
Racell
DEAS A/S
Amplex Denmark A/S
Develco Products
Wicotec Kirkebjerg A/S
Airmaster Holding A/S
IdealCombi A/S
MT Højgaard A/S
Aarhus University

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Hasse Neve
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There is a lot of money to save through better planning and management in construction. This is demonstrated in the major ReVALUE research project, which, based on extensive data collection, concludes that 1/3 of the work on a construction site is a pure waste of time.

This may sound like a criticism of the builders working there, but it is not. Far from it. On the contrary, it is due to inadequate and poor planning on construction sites.

For the first time, the project has now shown just how much money society can save on renovation projects, if improvements are made: DKK 3.3 bn.

"Only one-third of the working hours in construction add value. Previous studies have also shown this, but this new study is more comprehensive than anything we've done before, and it confirms previous results unequivocally. Moreover, we can now look deeply into the study and see the causes of the dead time," says Professor Søren Wandahl.

Big differences between trades

The project shows that the reason why these enormous potential savings have not yet been realised is the "lack of knowledge and focus on the flow in building construction and inadequate planning and management".

The project observed builders at four different construction sites for more than 1,000 hours to measure their productivity. Measurements were made of sixteen different specialist trades within construction, and even though the average productivity is just one-third, there are large differences between the individual specialist trades. This reinforces the conclusion that there is unrealised potential for increased productivity.

Hard work and pride

Hasse Neve, a PhD student at the Department of Engineering was responsible for the fieldwork. He believes that lack of planning and coordination are very much behind the challenges facing builders.

"We already have a very accurate picture of productivity in construction. We've collected more than 50,000 data points in our field studies, and each data point is an observation of a workman," he says, and continues:

"It's not because the builders aren't doing anything. They're working hard and have great professional pride, but a lot of their time is wasted."

Hasse Neve talks about an example where a painter shows up for work but cannot start painting because rubbish from the previous job hasn't been cleared away. As things haven't been made ready, the painter has to clear up and perhaps get extra equipment to help.

This isn't very productive, and actually it's something you can plan your way out of," he says.

> *It's not because the builders aren't doing anything. They're working hard and have great professional pride, but a lot of their time is wasted"*
>
> PhD Student Hasse Neve

Great potential even with small initiatives
Overall, the project concludes that about 1/3 of the work on a construction site is concentrated work, approx. 1/3 is indirect work like preparation or transport, while the last 1/3 is just dead time.

Hasse Neve has interviewed a range of different builders in connection with the project to hear what they think could be done to optimise the processes on site. Among other things, following these interviews he has been able to calculate a total optimisation potential of DKK 3.3 bn. for renovation projects.

Professor Søren Wandahl believes that it is possible to increase productivity to about 50-60 per cent, if you use the right tools and lean processes that focus on flow rather than just transformation. He points to simple measures such as whiteboard meetings, morning meetings, location-based planning and lean tools such as the Last Planner System.

The ReVALUE project aims to examine productivity and implementation of lean processes within building renovation. ReVALUE is a research project supported by Innovation Fund Denmark, and it is headed by Professor Søren Wandahl.

Photos: Anders Trærup

Researcher behind a new building survey:

You'll be happier if you work smarter

(This article was previously published in Fagbladet 3F)

There can well be a certain scepticism among seasoned construction workers when Hasse Neve from the university shows up on site to look over their shoulder. However, Hasse was a carpenter, and he knows about their frustrations regarding dead time and inefficient work.

> *"People often think that such small initiatives can't change anything, but we can see that the companies using lean processes also have a high level of productivity"*
>
> PhD Student Hasse Neve

Photo: Anders Trærup

At a time when demand for labour in the construction industry is a major issue, reducing wasted time and improving productivity are becoming ever more important.

For companies, this will lead to a faster construction process and substantial cost savings, with resulting effects on their bottom line.

But for Hasse Neve, who is researching productivity in the construction sector at Aarhus University, there is also a more fundamental motivation behind his work on lean processes.

As a former carpenter, he has experienced himself how dead time can suffocate job satisfaction.

"I was surprised that things couldn't be done more efficiently. For example, I've never understood why everyone has to work in the same space. So it didn't take long before I began taking an interest in construction processes, and how they can be improved," says Hasse Neve.

This interest led Hasse Neve to study structural engineering, with a Master's thesis in construction management. Today, the 30-year-old PhD student at the Department of Engineering is researching into how construction firms can become more efficient and get more out of their workforce.

It's not about working harder, it's about working smarter

In a new study, Hasse Neve and his colleagues have visited four large construction sites to measure productivity over more than 1,000 hours. Their conclusion is that up to two-thirds of Danish builders' workday is dead time.

According to Hasse Neve, this type of survey is not about having the builders work harder or faster.

"But they need to work smarter," he says and continues:

"It may sound a bit like management-speak, but it does make a lot of sense. The idea is to train people to take part in planning and to help structure the work. It may be small initiatives such as a ten-minute morning meeting where they review the work for the day. People often think that such small initiatives can't change anything, but we can see that the companies using lean processes also have a high level of productivity."

And the increased productivity also affects job satisfaction, says Hasse Neve.

"I myself have experienced that the more smoothly the work goes, the happier you are too. Work becomes easier and more enjoyable," he says.

Hasse Neve often uses his background as a carpenter to open a conversation with builders on the sites where he is doing his fieldwork, and he has a trick up his sleeve if the seasoned workers are sceptical about his message:

"When there's less wasted time and good coordination between the various trades, people work more efficiently too. There's money to earn for builders if they work smarter. That message really gets through," he says.

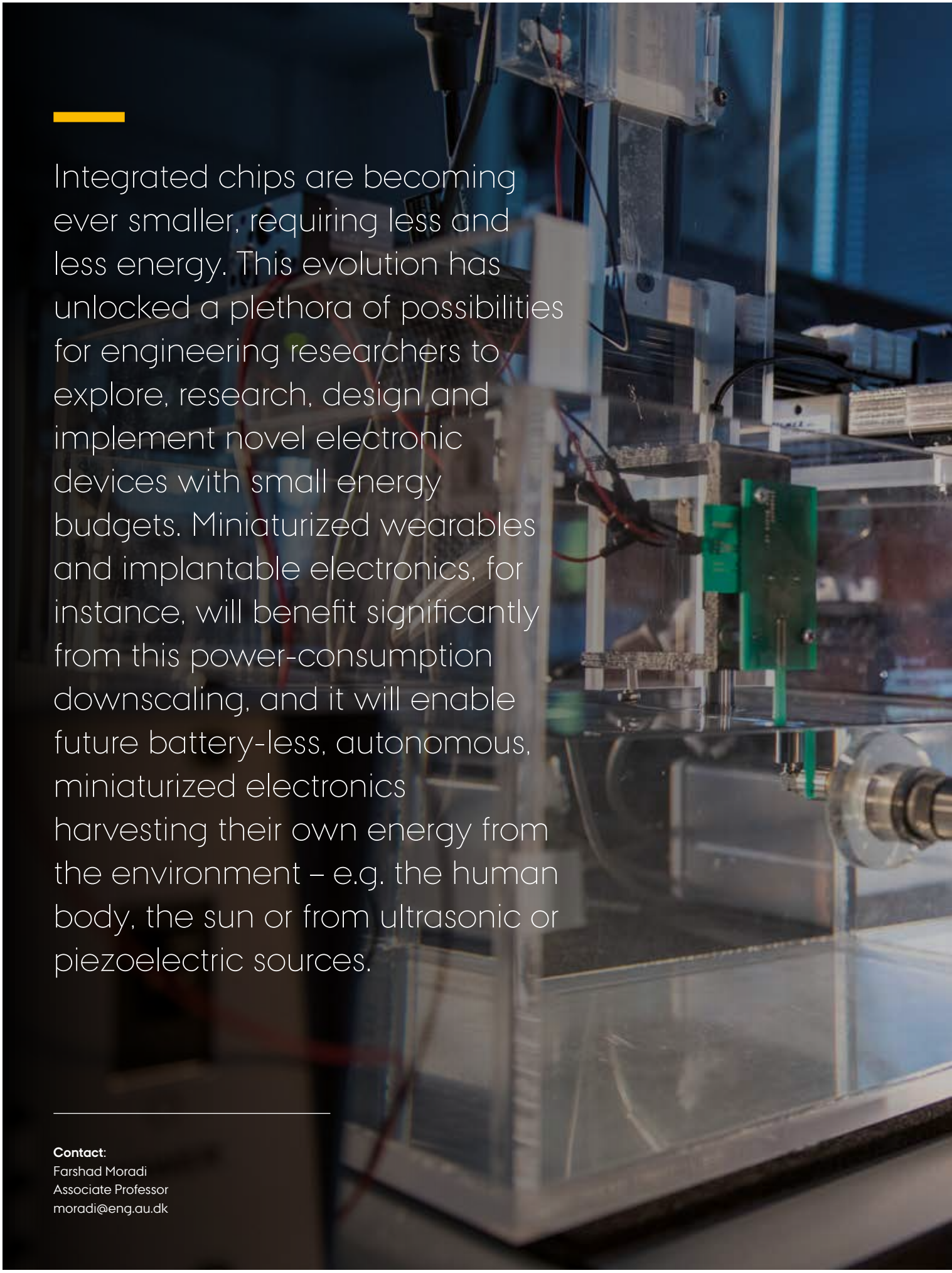
Union chairman: our members must be more involved

According to researchers and experts in lean, initiatives that can increase productivity on construction sites include short coordination meetings, strong construction management and the involvement of employees with technical expertise.

Kim Lind Larsen, chairman of the Construction Group in the 3F trade union, which represents just under 60,000 builders fully agrees that higher productivity and less dead time is the way to increased job satisfaction.

"Especially at the moment, with the strong demand for labour, employers can benefit from being able to retain happy employees. For us, the goal is to get our members involved in the construction process even more, so that they feel they're adding more value than their pay," says Kim Lind Larsen.

In a survey of 2,500 members of the 3F Construction Group in autumn 2016, more than half responded that dead time was the biggest problem in their jobs. The survey also shows that many builders lack relevant information from the management in order to plan their work, and that builders would like to be more involved in the construction process.



Integrated chips are becoming ever smaller, requiring less and less energy. This evolution has unlocked a plethora of possibilities for engineering researchers to explore, research, design and implement novel electronic devices with small energy budgets. Miniaturized wearables and implantable electronics, for instance, will benefit significantly from this power-consumption downscaling, and it will enable future battery-less, autonomous, miniaturized electronics harvesting their own energy from the environment – e.g. the human body, the sun or from ultrasonic or piezoelectric sources.

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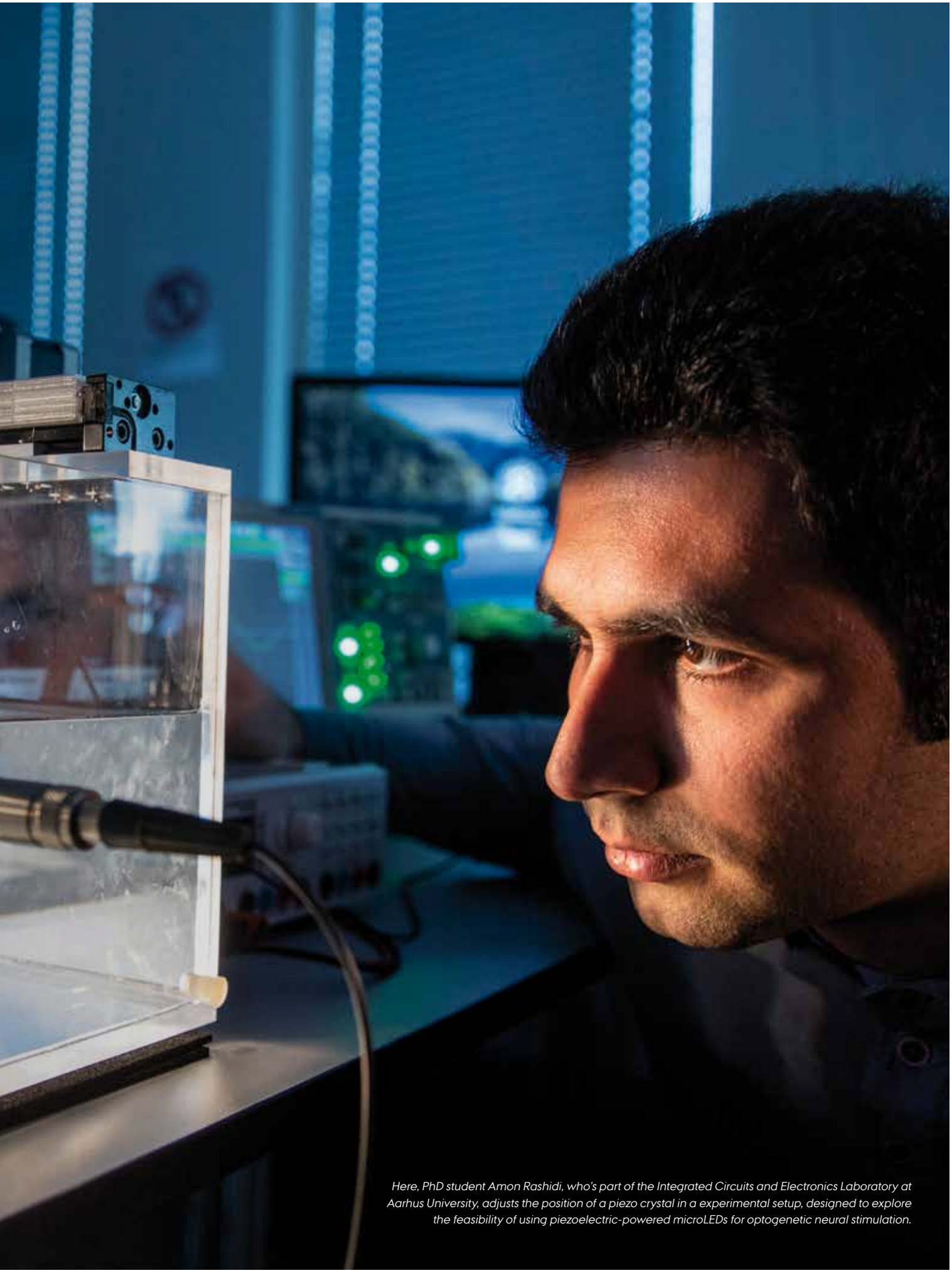

Photo: Lars Kruse

Here, PhD student Amon Rashidi, who's part of the Integrated Circuits and Electronics Laboratory at Aarhus University, adjusts the position of a piezo crystal in a experimental setup, designed to explore the feasibility of using piezoelectric-powered microLEDs for optogenetic neural stimulation.

Terahertz:

New researcher paves the way for special light technology at Aarhus University

Pernille Klarskov Pedersen is a new assistant professor on the photonics line at the Department of Engineering at Aarhus University where, among other things, she will conduct research into the solar cells of the future.

For decades, electronic circuits have been getting smaller and smaller and faster and faster, and the question is approaching as to whether there is a lower limit for how small the technology can be and still function. That is precisely what 32-year-old Pernille Klarskov Pedersen will be researching in her photonics laboratory at the Department of Engineering on Finlandsgade in Aarhus.

Via an advanced technology called terahertz light, she can physically visualise conductivity. She can actually see how good a circuit is at directing current, by illuminating the circuit with light at terahertz wavelengths.

"Terahertz technology is one of the only ways you can visually see the current flow in a circuit, because this kind of light has a wavelength that interacts with electrons. You can use this technology to see whether there actually is a current, whether the current is flowing smoothly, and whether the current is flowing in the right direction, and you can do this without touching the sample. This makes it a great way to understand how things work," says Assistant Professor Pernille Klarskov Pedersen.

She emphasises that the technology is still at the research stage and not very widespread. The technique is rather specialised, particularly because the wavelengths are actually far too large to use under the microscopic conditions relevant for present and future electronic circuits.

Therefore, she has built special equipment that makes it possible to use terahertz-wavelength light sources to interact with the electron flow in a current.

"Regardless of wavelength, light sources 'settle' under sharp metallic objects, for example a needle. By shining a light on the needle and letting the needle run for a few nanometres over the surface of a circuit, I can use the technique to make terahertz near-field images. All electronics are low-frequency compared with light, but by using very low-frequency light, the light and electrons in the current can "talk", because their wavelengths match. This makes it possible to visually actually light up conductivity," she says.

Pernille is currently in the process of setting up the photonics laboratory, and she has just been awarded research funding from the Aarhus University Research Foundation to use her technology to research into materials for future solar cells: What is the potential, and how do you find the best compromise between cheap solar cells and efficiency?

Pernille Klarskov Pedersen was born and raised in Frederiksværk in Nordsjælland. After upper secondary school, where her physics and chemistry teacher strongly encouraged her interest in the natural sciences, she trained at the University of Copenhagen and the Technical University of Denmark. After her PhD, which was a mini study on photosynthesis concerning vibrations in sugar crystals, among other things, she has researched terahertz light at the Ivy League University Brown University on Rhode Island and the University of Rochester in New York.

Photo: Lars Kruse

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Photo: Lars Kruse

WORK WITH US

The Department of Engineering at Aarhus University cooperates with a wide range of organisations and companies on research and development projects. For example, we help large and small businesses to join the Industry 4.0 wave, we establish innovative partnerships for exploring technological challenges and we cooperate internationally to create insight into international trends. We work with the latest technologies to help companies build or develop new products or components and to process-optimise production chains.

Are you interested in working with the region's leading knowledge institution? We offer various cooperation models.

Collaborative R&D projects and programmes:
Our researchers are involved in a large number of national and international research projects in collaboration with companies and universities throughout the world. Therefore, your company can tap into the latest technological knowledge within the engineering sciences and the opportunities this offers your industry. If your company has an idea or a need you want help with, you can collaborate with our researchers on developing your company's technology.

Scientific and innovation networks:
Aarhus University is active in almost every innovation network in Denmark, and in many other scientific, technical and business-related networks. It may be advantageous for your company to learn more about these networks and what they can offer. You can solve your business problems in collaboration with others, and this is an excellent way to profile your company. You can also develop long-term strategic collaborations with other companies or knowledge institutions.

Innovation collaborations:
We have (The Department of Engineering at Aarhus University) launched a number of initiatives to help companies, especially SMEs in Denmark. For example, our "Smart Industry" programme targeting SMEs with the potential to develop new smart products, services or processes. This is a specific initiative to strengthen growth and innovation for SMEs through more teamwork between companies and knowledge institutions. We also offer cross-disciplinary cooperation combining engineering expertise with researchers from other departments in Aarhus University's strategic research centres. Combined with a strong and proven approach in applied innovation, we lead and facilitate processes to create new possibilities and new needs. We transform the latest research findings into useful knowledge, products and methods for a huge variety of different companies in different branches and of different sizes, ranging from entrepreneurs to SMEs, and from medium sized companies to large organisations.

Get involved
If you would like to explore the opportunities of working with us, contact Business Relations and Partnerships for further information about how we can connect relevant researchers and your interests.

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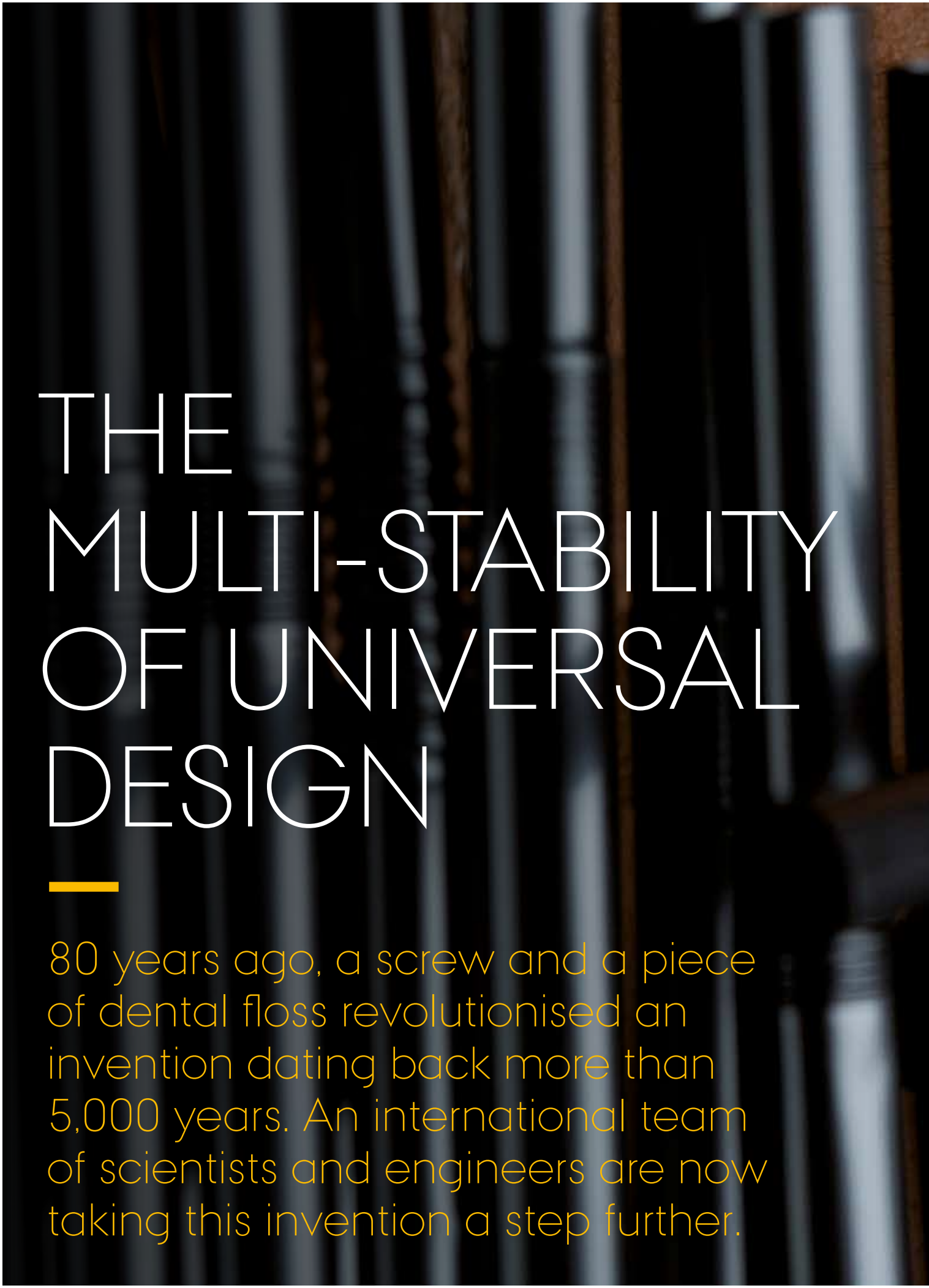

THE MULTI-STABILITY OF UNIVERSAL DESIGN

80 years ago, a screw and a piece of dental floss revolutionised an invention dating back more than 5,000 years. An international team of scientists and engineers are now taking this invention a step further.

Photos: Lars Kruse

“The very simple idea – the thing that wasn’t really appreciated before – was that pre-stress in the structure is actually the source of the multi-stability of the device”

Assistant Professor Marcelo Dias

“Arguably the most significant technological achievement in the 20th century.”

We are not talking about cars, computers, the Internet, television, or space rockets. No, we are talking about something as simple as a drinking straw. You know, a completely ordinary, bendable plastic straw that you’ll find in the kitchen drawer in any home. And yes, the invention of the bendable straw was once described in such positive terms. This description was probably not completely unbiased, as it came from Michael Fabricant – one of the inventor’s own relatives. But perhaps the bendable straw has not yet been given the credit it deserves.

Because a straw is actually more unique and offers far more opportunities than you might think at first glance.

“Even though bendy straws are used by people all over the world, no one has ever looked more closely at why the straw stays in whatever orientation it is placed by bending its corrugated part,” says Marcelo Dias, Assistant Professor at the Department of Engineering, Aarhus University.

And that’s what’s so amazing about the straw: Due to its previously unexplored built-in multi-stability, it can be placed in an indefinite number of positions along the azimuthal direction, and then remain in that particular configuration.

Originally, the bendable straw was invented by Joseph Friedman, an American inventor, in 1937. With his patent of 1 May 1951, he refined his invention to what we know today as the ordinary bendy straw.

The idea came to him when he and his little daughter Judith were visiting a candy store on 19th Avenue, north of Golden Gate Park in San Francisco. He watched his daughter drink through a straight straw – the only option available at the time and the same type of straw as had existed for thousands of years. But she was struggling, because the straw could not bend over the edge of the glass.

Joseph squeezed a screw into the straw and wrapped dental floss firmly around it, pulling the dental floss, and thereby the straw into the screw thread: Et voilá! One of history’s first examples of universal design had been created.

Project title:
Overcurvature induced multistability of linked conical frusta: how a ‘bendy straw’ holds its shape

Partners:
Nakul P Bende, University of Massachusetts
Tian Yu, Virginia Tech
Nicholas A Corbin, Virginia Tech
Christian D Santangelo, University of Massachusetts
James A Hanna, Virginia Tech
Ryan C Hayward, University of Massachusetts

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Photos: Lars Kruse

"Even though bendy straws are used by people all over the world, no one has ever looked more closely at why the straw stays in whatever orientation it is placed by bending its corrugated part," says Assistant Professor Marcelo Dias.

"We tracked down the history of the straw and the pattern that was originally proposed for patent. The straw is fabricated by extruding the plastic material, and the very simple idea – the thing that wasn't really appreciated before – was that pre-stress in the structure is actually the source of the multi-stability of the device," says Marcelo Dias.

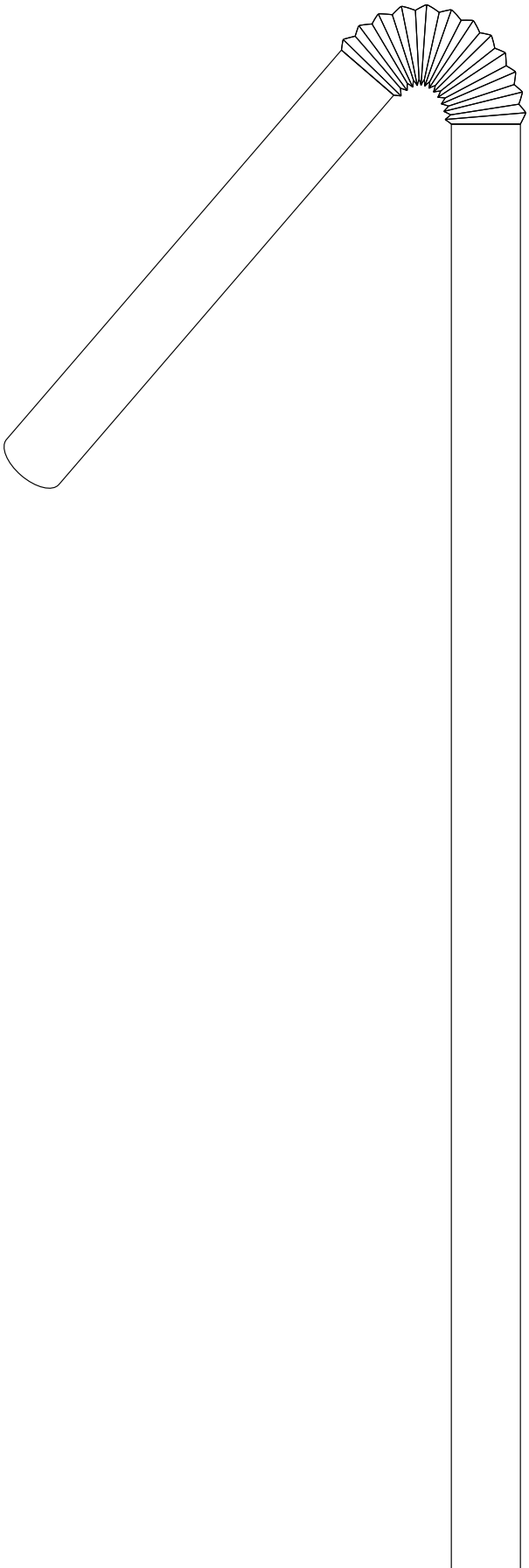
To understand the built-in stress in the structure, imagine that you cut out a small piece of the bendable part of the straw, i.e. a small plastic ring. If you try to cut this ring open, the material will open up, because the ring radius will become larger due to the pre-stress. It is only because the ring is closed that the structure maintains this built-in stress allowing multi-stability.

Marcelo Dias has contributed to the work of an international team of scientists and engineers lead by James Hanna from Virginia Tech and Ryan Hayward from the University of Massachusetts. Marcelo Dias has helped the team formulate a mathematical model for several 3D-printed versions of the ring-part of the structure in order to test the amount of built-in stress. The idea is to achieve sufficient stability in a state, without having to use too much energy to flex to other states.

"We need the exact amount of pre-stress for the structure to be multi-stable – to stay in the configuration we put it in and be able to flex to an unlimited amount of other states when forced to," says Marcelo Dias.

And how can this then be used? Well, there are actually far more practical applications than you might think. In particular, there are good prospects in the field of robot technology and in the space industry, with possibilities to control robotic arms, for example, using minimal input and minimal energy.

"What we're trying to uncover here is the mechanism; the possibility of giving an initial push to a system that then snaps into a fixed state of space and stays there," says Marcelo Dias, mentioning micro-robots as examples of this.



BLOG:
Built on instability

This blog post was previously published in Nature.
See full length blog post here:

By Assistant Professor Marcelo Dias, Aarhus University, and Daniel Rayneau-Kirkhope from Aalto University.

From hierarchical architectures to complex composites, nature's inventive use of geometry yields remarkable functionality from some rather unremarkable construction materials. This same control of geometry alongside a mastery of mechanics is used to transform elastic 'failure' into a crucial ingredient in the inner working of plants and organisms.

Nature employs elastic instability so that large-scale motions can be triggered by the smallest and most specific stimuli. The Venus flytrap is perhaps the best-known example of this design philosophy — swelling induces an elastic instability that allows its leaves to snap between two stable configurations. Using this snap-through behaviour, the plant moves quickly to capture its prey, allowing for the slow process of digestion to begin.

It is only recently that designers have started to use loss of structural stability in a similar manner. From merely being a mode of failure, buckling has become an increasingly well-trodden route to introducing novel functionality in the design of man-made structures and materials on many different length scales.

From 'buckliphobia' to 'buckliphilia'

A powerful example of this paradigm is the use of buckling to turn simple geometries into mechanical machines: buckling-unbuckling transitions in a hollow spherical shell can be used to create thrust in spherical swimmers in very viscous fluids. It was found that the asymmetry of geometries in the process of buckling and unbuckling allows for a net thrust to be created by cycling through these geometries while the structure is immersed in liquid.

Clearly, harnessing structural instability for a useful end has a parallel with the design principle observed in nature. In some cases, however, there is a deeper connection: the use of buckling as a control method for flow rates in a microfluidics device is a case where direct inspiration has been taken from nature, resulting in a functional man-made device.

The giraffes' long neck poses a unique problem in the control of blood flow to the animal's brain. In order to maintain proper blood flow and pressure, both when the animal's head is raised and lowered, the jugular vein collapses to restrict flow. This system was used as inspiration for a device that responds to a macroscale force input regulating fluid flow via elastic instability; such a system can be used to divert fluid from regions of low stress to regions of high stress.

Demanding materials' applications require human ingenuity to go beyond the ordinary mechanical properties stemming from the molecular composition; we can now design structural responses that are imparted from the geometry of the building blocks in materials known as mechanical metamaterials.

Symmetry breaking in the transition to the post-buckling regime and, more generally, deformations that result from mechanical instabilities can allow an extra degree of freedom for the designer: by programming a predetermined motion into the component parts, one can generate unprecedented mechanical properties including negative compressibility (meaning a material will get shorter under tension), negative Poisson's ratio (or auxetic materials), and materials that under load exhibit pattern transformation or shape reconfiguration. In the future, these material properties may be useful in designing mechanical sensors, auxetic fasteners, shock absorbers and actuators.

Built through buckling

The functionality of natural materials is significantly expanded by the adoption of buckling-driven morphing within an architecture. However, there is another equally profound way in which nature uses elastic instability that we are only beginning to use in man-made structures. In nature, buckling is also used as a fundamental ingredient in the fabrication of functional architectures.

Two prime examples of this construction strategy come from within our own bodies: elastic instability plays a fundamental role in the creation of the characteristic geometry observed on the surface of the human brain and gut. Both these architectures serve specialised functions within the body. The fold patterns in the brain are essential in fitting a large cortex in our skull, giving greater potential for information processing, while the increased surface area created by the architecture of the gut is important in the effective adsorption of nutrients. The appearance of the brain, with its convoluted pattern of sulci and gyri, and the small intestine wall with small finger-like villi are strikingly different in form and scale, however these architectures are generated in a similar fashion: a differential growth rate creates an energy landscape inducing buckling of the system, which in turn creates the desired geometry.

Creating complex architectures in the lab

Man-made structures utilising elastic instability as a route to complex architectures are fewer in number than their morphing counterparts, though they do exist. Buckling has recently been used as the driving force behind the creation of a self-assembled, stretchable electronics device utilising micro and nanofibres.

Using pre-strain as a critical ingredient in a fibre-substrate system, two-level wave-like geometries have been created where the substructure is a result of elastic instability; this use of instability makes the fabrication of the system much more straightforward than competing systems. This hierarchical, self-similar geometry allows for the creation of ultra-stretchable structures, with possible strain values of up to 250 per cent. Systems of this nature have clear potential for applications in wearable electronics, novel sensors and bio-integrated devices.

The authors are of the opinion that the use of buckling in the fabrication of novel geometries is currently under-utilised. The importance of geometry in fields such as adhesion, super-hydrophobicity, optics and structural optimisation cannot be underestimated; the use of elastic instability as a means to create novel, intricate geometries in a cheap, scalable manner has enormous potential to open new avenues for investigation.

Photo: Lars Kruse

Machine learning expert granted the Ørsted award

Associate Professor Alexandros Iosifidis from the Department of Engineering at Aarhus University received the Hans Christian Ørsted Forskerspirer Award 2018 for his scientific work on signal processing and machine learning.

Associate Professor Alexandros Iosifidis recieved the prestigious H.C. Ørsted Forskerspirer price 2018.

Alexandros comes from Greece and he has been in Denmark for just one year. His knowledge about the great Danish scientist and philosopher Hans Christian Ørsted is sketchy, but he is proud to receive the award for his contribution to science.

"It is recognition of my research and my work on statistical machine learning and neural networks, and on developing mathematical models that can improve the performance and efficiency of the machine learning we know today," says Alexandros Iosifidis, an associate professor at the Department of Engineering, Aarhus University.

> *"Computational Intelligence will come to play a much larger role in our daily lives. Machines will take over many automated functions, and we humans will be able to release our own resources for other purposes"*
>
> Associate Professor Alexandros Iosifidis

At an age of just 34 years, he has more than 100 publications in international scientific journals and conferences in topics of his expertise behind him.

A pioneer behind intelligent recognition of human actions

Alexandros is one of the pioneers behind the recognition of human actions through images and videos. In his academic career, he has worked on several research projects applying this technology to many different areas.

In one project for example, he has worked on prolonging the independent living for elderly based on machine intelligence solutions in their homes. In another project, he has developed algorithms for the financial sector. And in a third project, he has enabled production robots to work with people.

He is currently working with drones, and his goal is to improve the ability of these flying robots to analyse visual information from the air, understand what is going on in their environment and then make smart decisions.

All this is basically about signal processing, which makes it possible for a computer to analyse signals with a degree of precision that is simply impossible for a person to achieve.

"We train the computer to analyse information in different forms, like images, videos, sensor signals and text, to detect patterns in data, group and classify these patterns and make predictions in efficient ways," says Alexandros Iosifidis.

Wants to automate and democratize machine learning

Together with his research colleagues, he is opening the next chapter of the history of technology, in which the goal is to automate and democratize machine learning.

"A higher degree of automation. That's our goal. Today, machine learning is still controlled by input from experts. For example, take the camera in your Smartphone. It can recognise faces. This means that the camera has a method to identify different elements in the images. It's been trained, so to speak, to distinguish between the patterns of faces and patterns of objects and the background. But this doesn't happen automatically. Experts have designed all the details of the system that makes the method for this recognition and distinction possible. That's what we want to change. We want the computer to be able to automatically find all these details," he says.

Computers will take over the trivial work

This level of automation is also a technological step that will make machine learning available and usable by non-experts in everyday life. So far, we have no idea where this could lead. But according to Alexandros, the starting point for the development is very positive.

"Computational Intelligence will come to play a much larger role in our daily lives. Machines will take over many automated functions, and we humans will be able to release our own resources for other purposes. We'll escape from all the trivial work and we'll be able to apply our intellect and creativity in better ways," he says.

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Short fact:

Access speed is becoming a growing concern for many major IT companies around the world. Amazon actually measured the projected cost of slower speed. Just a change of 100 milliseconds could cost them billions in revenues, simply because customers become agitated over slower speed and cancel their subscription.

DEATOMIZING THE WEB

New project tackles the bottleneck of superfast cloud computing

Access is becoming a growing bottleneck for a speedy internet. A new project aims to help reduce the amount of storage space needed for every single file on the web.

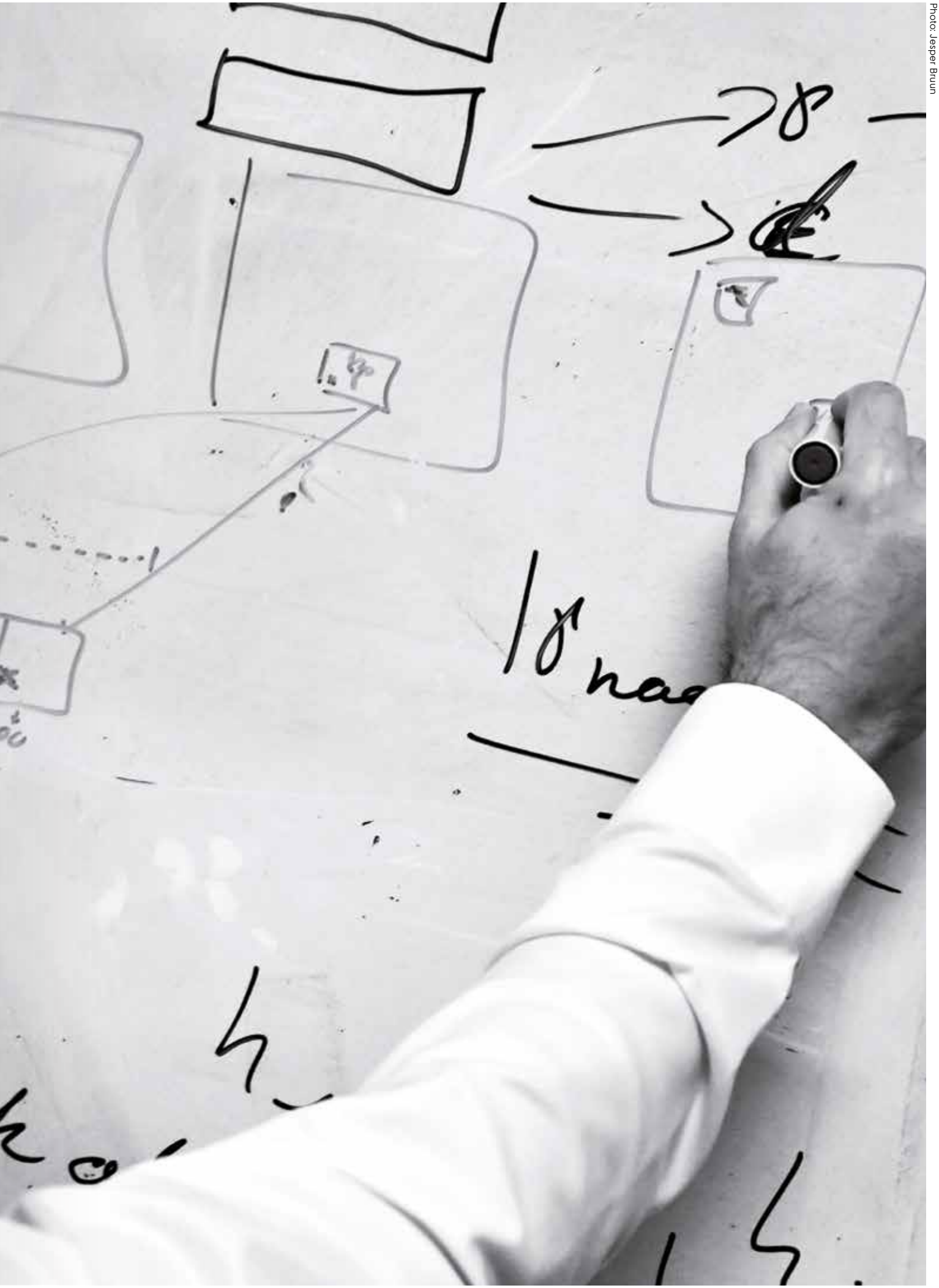

Photo: Jesper Bruun

Photos: Peer Klercke.

“Instead of simple compression, it’s more about how to manage the data. How we can exploit the characteristics of different types of data to be able to compress it dramatically”

Associate Professor Daniel Enrique Lucani Rötter

"We just need a sort of index of how the picture is built up. Like the instructions for a Lego kit. A detailed list of how to put the picture together with bits from other pictures," says Associate Professor Daniel Lucani Rötter.

1,100,000,000. That's around the number of new Internet of Things (IoT) devices connected to the internet in 2018.

These are not mobile phones, computers or tablets. The IoT has devices such as smart TVs, wearables, security systems and other items with sensors that are connected to the internet.

The figure corresponds to more than three million new devices connected to the internet every single day throughout 2018.

The IoT is growing so fast that the internet is rapidly approaching a bottleneck. The huge amount of data generated lowers reading speed throughout the internet.

"If you look at the way things are going, there's a massive amount of data that needs to be stored, and one of the challenges is how to gain access to it. You can have a huge amount of storage space in a single disk, but your access speed remains the same. That means that, if you're running a datacentre, you run into a bottleneck. Already now, some datacentres are aiming for smaller hard drives, simply because the access speed is a bottleneck," says Associate Professor Daniel Lucani Rötter from the Department of Engineering at Aarhus University.

Therefore, he has just kicked off a project aiming to reduce demand for storage space.

"This project is about limiting the amount of data needed for storage. Instead of simple compression, it's more about how to manage the data. How we can exploit the characteristics of different types of data to be able to compress it dramatically," he says.

It's all about similarity; different data that share similarities.

Take a JPEG image for example. As soon as the picture is taken, it will be compressed. Every pixel is not usually saved because there is a lot of redundancy, so the picture is divided into parts to save and redundant parts. Daniel Lucani Rötter is aiming to use the same technique in his project.

But rather than only compressing pictures, he wants to embrace all data.

"Normally, when people think of data compression, they might think about Winzip. What happens there is that you compress a bunch of files, but if you want to read them, you need to decompress all of them. The idea behind our concept is that we basically want to be able to compress everything and still be able to read every single file without having to decompress other files every time you want to access it," he says, and continues:

"In theory we take a file and split it into many different small chunks. The critical thing is that you fragment the data into smaller chunks and try to identify similarities between the chunks in the system." And since you can compress across all the data you have, there's a good opportunity to exploit similarities, for instance when we're talking about cloud storage and datacentres, and he goes on:

"In order to save a picture, we don't need the entire file. We just need a sort of index of how the picture is built up. Like the instructions for a Lego kit. A detailed list of how to put the picture together with bits from other pictures."

Instead of searching for exact matches in the small chunks of split up data, Associated Professor Rötter looks for something that's "close enough". There may be a small error or something that's different, but then the error is stored, and the rest is indexed.

What you end up with is a number of ID blocks with associated errors. That way, you can recover your original data without errors.

"The project is not only limited to IoT and cloud data. With modifications, it can also be used for normal local data storage. What if suddenly you could get a lot more space out of your 256 GB hard disk drive, simply because data didn't take up so much space? There's a huge potential in compressing data in this way," says Daniel Lucani Rötter.

Title:
Scale-IoT

Budget:
5.9 mio. DKK

Timeline:
2018-2022

Partners:
UCLA, University of Neuchatel
Nokia Bell Labs
Kamstrup ApS
Steinwurf ApS

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Photo: Lars Kruse

DANISH PHD STUDENT TO HELP CHINA WITH GREEN POWER

Denmark has long been at the forefront of renewable energies and their system integration. Danish energy research is now helping China plan its transformation to a 100 per cent renewable power system.

Over the past twenty years, the two-digit annual growth of the Chinese economy has led to enormous increases in energy demand and consequentially air pollution due to the heavy dependence on coal-fired power plants.

Now, Danish energy expertise is helping the Chinese to find out how best to reach their goal of almost 100 per cent renewable energy. China is a huge country, and not all sites are equally suitable for solar or wind energy.

Therefore, PhD Student Hailiang Liu, who himself was born and raised in China, is now in the process of modelling the Chinese energy systems so that they can be optimised for future green energy networks.

"Here at Aarhus University, we've developed a tool that provides very high-resolution renewable power time series that can be used to model energy systems on various scales. In this project, we're using this software to quantify the advantages of a heterogeneous distribution of green energy generators among Chinese provinces," he says.

The right layout is important

The wind blows far more in some areas in China than in other areas, and the sun shines more in some places than in others. That will always be true in a country of almost 10 million square kilometres.

A smart renewable investment roll-out based on 40 years of weather data is crucial in systems of such complexity.

China is already well underway in the renewable transit, and a quick look at the stats shows that today approximately 5 per cent of the total energy comes from wind, 2.5 per cent from solar, 20 per cent from hydropower and as much as 60 per cent from coal. Therefore, there is ample opportunity to invest in renewable energy sources and limit coal-fired power.

And this is precisely what the Chinese are doing:

"China is building a solar farm as big as a football field every single hour. Renewable energy sources in China are growing at a tremendous rate, but we need smart distribution of these sources, if we are to maximize green output. Getting to 100 per cent renewable energy will be expensive, but it will be less expensive if we do it right," says Hailiang Liu.

A hot topic

For Hailiang Liu, it's almost personal. He grew up in Shandong province in the north, with almost 94 million residents, and where air pollution over the past few years has been severe, especially in winter. His early years were spent in a "small town" with just 700,000 inhabitants, and he grew up in the middle of a heated environmental debate.

"Back then, air pollution wasn't the hot topic: it was water pollution in lakes and rivers, and that played a major role in why I chose environmental engineering. China improved its aquatic environments quite fast though. And that's very motivating: when we want to change something for the better in China, we really commit to it."

According to Hailiang Liu, however, the air pollution problem will take longer:

"Air pollution is a much bigger problem, and China can't change it that fast. It'll probably take something like 20 years, but we'll get there, and I'm proud to be able to make a difference with something that will affect so many people's lives," he says.

Project name:
Future highly renewable Chinese energy systems

Timeline:
2016-2019

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Photos: Lars Kruse

Thursday 31 January 2019, at exactly 13:00, Aarhus University entered the line of universities in the world that have a satellite in space. Delphini-1 was deployed from the International Space Station, ISS, into its orbit.

Master of science in engineering Kåre Jensen helped construct the satellite.
Read his story here:

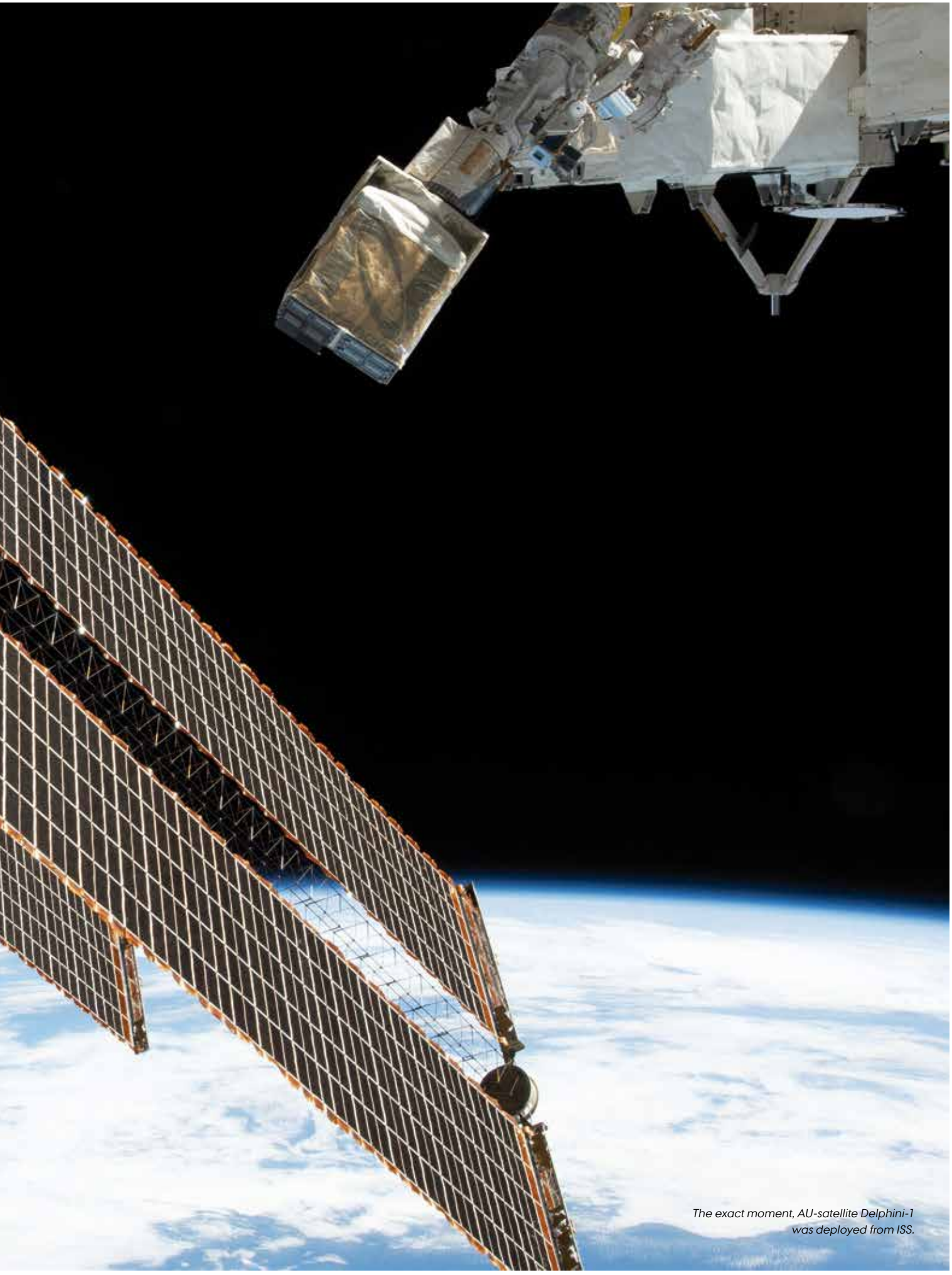

Photo: NASA and NanoRacks

The exact moment, AU-satellite Delphini-1 was deployed from ISS.

Photo: Lars Kruse

THE HUNT IS ON: USING MACHINE LEARNING, WE'RE LOOKING FOR COMPLETELY NEW ANTIBIOTICS IN NATIONAL PARKS

In about 20-30 years, bacterial resistance will be so serious that it will cost more lives than cancer, even in the West. This is the gloomy prophecy from the World Health Organization (WHO), and they are beating the drum for active, targeted efforts to find new antibiotics. Assistant Professor Thomas Tørring has an idea that could help solve this enormous problem

More than 25,000 Europeans die prematurely every year as a result of infections caused by bacteria that have developed resistance to antibiotics. These infections could previously have been cured, but now the pathogenic bacteria have mutated and developed resistance to substances that in the past were fatal for them.

The situation is serious, because not only is modern society hugely dependent on antibiotics, it is also becoming increasingly difficult to find new ones.

Assistant Professor Thomas Tørring from the Department of Engineering at Aarhus University has therefore started a new research project in which he will combine artificial intelligence and image recognition with soil samples from national parks all over the world to find new medicines in nature's own medicine cabinet.

"If you go outside and take a spoonful of soil from your back garden, just that one spoonful will contain millions of bacteria. In fact, there'll be bacteria among them that are able to produce several of the antibiotics we know today. This was historically almost the way we found new antibiotics," he says, adding that these days are long gone.

"Virtually all the classes of antibiotics we have today were found 50 or more years ago. Finding a new antibiotic today is a rare event. It happens only perhaps every 10-15 years."

However, Thomas Tørring hopes to be able to change this with his new project, in which he will couple modern computer technology with biotechnology in search of antibiotics.

"Bacteria are used to living in natural environments with millions of other bacteria and microorganisms that we may not know about. They live in environments with completely different combinations of nutrients than we can reproduce, so when we take them into the lab and grow them in controlled conditions, many bacteria will not grow. Therefore, for good reasons, we've never really taken a closer look at these bacterial colonies, but now we will," he says, and continues:

"We desperately need new antibiotics, but finding them in nature is like finding a needle in a haystack. In this project, we'll be building an incubation chamber that uses image recognition and machine learning to identify the most promising bacterial colonies."

Students from his research team have visited seven Natura 2000 national parks in Denmark to take soil samples. The group is now in the process of isolating the bacterial flora from the various sites, and it is anticipated that the diverse nature in each of them will be able to contribute unique bacterial species.

"In the old days in the 1960s and 1970s, it was common practice in large companies in the pharmaceutical industry for employees to return from business trips with a bag of soil which could be used to find new antibiotics," says Thomas Tørring and continues:

"Our plan is slightly different. We want to build a setup, which is cheap to produce and which can be used by researchers all over the world. An alternative to the extremely expensive apparatus we otherwise use in pharmaceutical technology in the West. I want to build something that can be used in Third World countries. Perhaps we could send 20 boxes down to a national park in Ghana or somewhere, so this treasure hunt can take place all over the world, and by researchers who may not have DKK 2 million or so for new, expensive equipment. We want to go back to basics, but at the same time use the very latest computer- and biotechnology."

The idea now is to take pictures of bacterial colonies collected from Denmark and in time from the whole world, and put them all together in one large database. Via artificial intelligence, using image recognition, a computer could identify rare and therefore interesting colonies.

"If I have a petri dish and sit down and look at it, I can easily see the difference between the individual colonies. But if I have 20,000 petri dishes, could I compare a couple of colonies I found in the first petri dish with number 15,000? It's not humanly possible, but the computer can help here to draw out some of the correlations that we know will be there when we look at a large data set. We'll be using the artificial intelligence to pinpoint the colonies which could be interesting. These could perhaps be colonies that only very rarely show up on petri dishes," he says.

Project title:
Image recognition in the hunt for new natural products

Budget:
DKK 1.9 million

Funded by:
Villumfonden, Villum Experiment

Timeline:
2019-2020

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Photos: Lars Kruse

Background
Antibiotics are molecules which either inhibit or kill microorganisms. The best known antibiotic is penicillin, which was discovered by accident in 1928 at St. Mary's Hospital in London.

The bacteriologist Alexander Fleming was experimenting with petri dishes with staphylococci bacteria when he accidentally contaminated a sample with mould. He observed how the bacteria could not grow near the mould, which was later identified as Penicillium notatum.

The discovery generated a veritable Klondike for researchers from all over the world. There was a race to find new types of antibiotics that could help humanity against various diseases. The gold rush culminated in "the golden age" of antibiotics in the period from the 1950s to the 1970s.

Things are different today.

Many large pharmaceutical companies have even pulled out of the struggle to find new antibiotics. It is simply too difficult, and there is no good financial incentive. The price structure for antibiotics simply means that, even if you discover an entirely new antibiotic that can kill all diseases, it would take far too long for the product to be first choice at hospitals etc. worldwide. A cancer treatment or drug to lower blood pressure can quickly become a profitable business, but not antibiotics.

But there is a huge need for new antibiotics, if society as we know it today is to survive.

The research group under Thomas Tørring has collected soil samples from seven national parks in Denmark, all of which are protected under the common European nature conservation project, Natura 2000. The sites are at

Rold Skov, Rebild Bakker, Slette Strand, Mols Bjerge, Bygholm Ådal, Råbjerg Mile and Tolshave Mose.

After the team has isolated thousands of soil bacteria from these locations, the plan is to create large-scale image material of the colonies. Afterwards, all the data will be fed into an artificial intelligence to help find visual patterns in the colonies that can hopefully be used to find new antibiotics.

New associate professor will raise Danish drone research to new heights

Dr. Erdal Kayacan from Nanyang Technological University in Singapore is a new associate professor at the Department of Engineering in Aarhus University. The main focus of Kayacan's research is guidance, navigation and control of aerial robots.

Artificial intelligence (AI) and autonomous robots are at the heart of the upcoming fourth industrial revolution. Not a day goes by where these two concepts aren't mentioned in almost every major daily newspaper.

Research and development in the information technology field have been intense for decades, but they have never been more crucial than now. Pretty much every leading technology corporation is heavily involved in the world of AI and robotics. Why?

To make things work autonomously.

That is precisely why the Department of Engineering at Aarhus University has appointed Erdal Kayacan as a new Associate Professor in robotics. His expertise in autonomous systems will help raise advanced research and development in aerial robotics and AI-based control to new levels at Aarhus University.

"This is the age of robotics and AI. For the next ten years, the transformative influence of robotics and AI will immensely impact our daily lives. European countries are investing heavily in these technologies, and Denmark is also one of the top ten worldwide when it comes to robotics and AI startups," says Associate Professor Kayacan, and he continues:

"I might say that I feel extremely fortunate that there is growing interest in my research field. Something is definitely stirring in this area, and it's easy to attract the attention of the younger generation for these technologies. Think about the results of such motivation for a second. After learning the required skills for today's sophisticated robots, students will be able to apply these skills to almost anything for the future's technologies."

Associate Professor Kayacan was born and raised in Turkey. He received a B.Sc. degree in Electrical Engineering from Istanbul Technical University in Turkey in 2003. Then, he obtained an M.Sc. degree in Systems and Control Engineering from Boğaziçi University, Istanbul, Turkey in 2006. He earned his PhD degree in electrical and electronic engineering at Boğaziçi University in 2011. Later, he moved to Belgium for post-doctoral research in KU Leuven, at the Division of Mechatronics, Biostatistics and Sensors (MeBioS), where he worked on autonomous tractors for over two years. Then, he worked for four years in Nanyang Technological University, Singapore at the School of Mechanical and Aerospace Engineering as an assistant professor.

Besides working with aerial robotics, he has developed a prototype autonomous ground robot for post quality assessment of buildings in a project that was later handed over to a startup for commercialization.

Associate Professor Kayacan is a co-author of the course book "Fuzzy Neural Networks for Real Time Control Applications, 1st Edition Concepts, Modeling and Algorithms for Fast Learning". He is a senior member of the Institute of Electrical and Electronics Engineers (IEEE). Since 1 January 2017, he has been an associate editor of IEEE Transactions on Fuzzy Systems.

Photo: Lars Kruse

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Photo: Jesper Bruun

The strange case of bored piles

Since 1977, Danish standards for foundations have been extremely restrictive with regard to using bored piles as foundations for buildings and other structures. But are bored piles really as inefficient as the standards imply? A new research project is digging into the matter.

> *“There’s long been general agreement that this matter needs looking into. It’s time for us in Denmark to get to the heart of the matter”*
>
> PhD Student Jannie Knudsen

In 1971, construction commenced on a 292-metre-long and 13-metre-wide bridge flanked by Furesø lake to the east and Farum lake to the west. The bridge was to carry the Hillerød motorway over Frederiksborgvej, a major trunk road. It was called Fiskebæk bridge, and the new bridge would take the motorway over the swampy ground around the Mølleå stream that meanders from lake to lake from Hettings Mose to the sea.

But on 8 February 1972, the day before the official opening, the bridge collapsed. Without warning, the western motorway flyover fell into the bog. Fortunately, no one was hurt in the accident, but the collapse may have made its mark on later Danish standards.

The contractor, C.T. Winkel, had used so-called Franki piles (pressure injected footings); a piling technique by which the pile is established by displacing the soil rather than driving the piles down into it. C.T. Winkel subsequently went bankrupt, and since then, Danish standards have not been well disposed towards bored piles.

Makes no sense

As early as the 1970s, Denmark had noted the experience in the UK, where trials showed that bored piles were unlikely to have such a large load-carrying capacity as driven piles.

But that was then. Even though the geology has not changed much over the last few thousand years, piling technology has developed, so that in Denmark today there is a widespread understanding that bored piles can probably carry a lot more than the standards indicate: only 30 per cent of the surface resistance for corresponding driven piles.

Therefore, the Department of Engineering at Aarhus University and COWI have joined forces to quell the myth in a project that will once and for all clarify the issue of bored piles.

“The Danish standard is very restrictive regarding bored piles. It says that a bored pile can only apply 30 per cent of the surface resistance applied for a corresponding driven pile. However, no one in the industry knows where this very restrictive standard text comes from. A look at the measurements and trials conducted in recent years reveals that this doesn’t really make sense,” says Professor (Docent) Kenny Kataoka, who is managing the project for the university.

Title:
Soil-pile interaction for bored cast-in-place piles in stiff clays and soft rocks

Budget:
DKK 3 mio.

Timeline:
2018-2021

Partners:
Aarhus University
COWI
Per Aarsleff A/S
Innovation Fund Denmark
The COWI Foundation

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On 8 February 1972, the day before the official opening, the Fiskebæk bridge collapsed. Without warning, the western motorway flyover fell into the bog. Even though no one was hurt in the accident, the collapse may have made its mark on Danish foundation standards. Photos: Vejdirektoratet.

Bored piles:
Usually established by drilling a lined hole in the ground, in which the piles are reinforced and cast with concrete in situ. The lining is usually removed at the same time as the casting takes place.

Driven piles:
Pre-cast piles struck directly into the ground using a pile driver. Driven piles can be used in both mini-scale and up to major construction projects, but there are noise and vibrations when the machines drive the piles into the soil.

Franki piles:
Displacement piles, where the soil is displaced in connection with establishment of the pile. First a closed steel pipe is driven down to the desired depth, after which the concrete plug at the bottom is released to form an enlarged pile foot. Then the pile is reinforced and cast with concrete, while the steel pipe is pulled up.

A treasure hunt for data

He is being backed up by PhD Student Jannie Knudsen, who is working on the project, and who so far has been buried in detective work to try to find out exactly why it was decided to introduce such strict restrictions on bored piles.

"It's been something of a treasure hunt. Among others, I've contacted the Danish Society of Engineers (IDA), Danish Standards and the Danish Geotechnical Society, and I've reviewed old memos and minutes of meetings to find clues in the case. So far, I've found data from seven different trials with bored piles from the 1970s, but we're talking about very different methods. Some are made with drilling towers and others are hand-drilled; some are made with linings and others without. However, they've all been pigeon-holed as 'bored piles', so it's hardly surprising that we've had problems with the load-carrying capacity of some of them," she says, and she stresses that the way piling work is done means a great deal for load-carrying capacity, particularly with regard to bored piles.

"There's long been general agreement that this matter needs looking into. It's time for us in Denmark to get to the heart of the matter," she continues.

Typically Danish

Actually, this is something of a Danish thing. A country where we alone are in the habit of using driven piles. It is cheapest, and the piles are mass-produced. This makes them quick and easy to manufacture.

But pile driving may have impacts on the surrounding environment. It makes a noise, vibrations and can lead to displacement problems that can cause damage to surrounding buildings. In fact, other countries hardly ever use driven piles. At least not for structures in major cities, explains Kenny Kataoka.

"It would be unthinkable to drive piles for a new building in the centre of London. The disturbance for the surrounding environment would be just too great. And this is the way things are going. Increasingly, there are requirements regarding noise and vibration, and therefore, in future, we'll simply need far more bored piles in Denmark," he says.

Furthermore, the large loads from the tower blocks often demand bored piles as there are physical limits on the dimensions of piles you can drive. But with bored piles, you can sink piles of even very large dimensions.

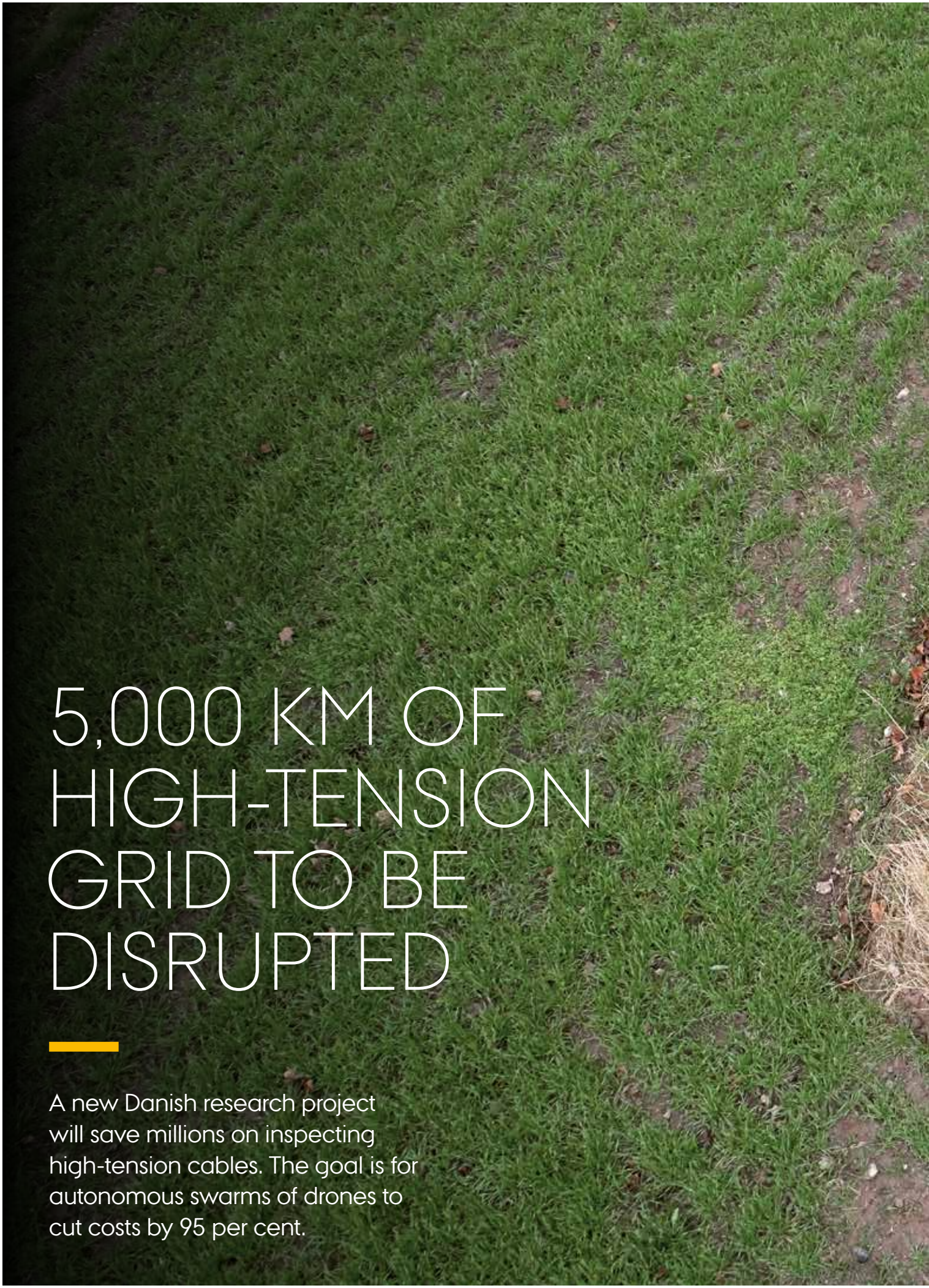
The project will collect data from test piles already drilled in place, and it will measure several piles to be installed at a site near Randers. On the test field, new piles will be bored into place with embedded fibre optics that will make it possible to test and measure the piles afterwards.

The project will also be monitored by a group of contractors, who will share experiences with different types of bored piles.

"Everyone's been very helpful and interested in the project, and I think there's widespread belief that we've been missing information on the area for some time," says Jannie Knudsen.

The project is being conducted in cooperation with COWI and Per Aarsleff A/S with funding from Innovation Fund Denmark and the COWI Foundation.

Photos: Peer Klercke



5,000 KM OF HIGH-TENSION GRID TO BE DISRUPTED

A new Danish research project will save millions on inspecting high-tension cables. The goal is for autonomous swarms of drones to cut costs by 95 per cent.

> *Our task is to look at communication between the drones, so that we can make an autonomous swarm of drones that can work together. You let them loose, and then they have to be able to work together on their task without human intervention"*
>
> Associate Professor Rune Hylsberg Jacobsen

It sounds like science fiction. A swarm of drones fly like birds from pylon to pylon, settle on the cable to charge up, and then fly on, while watchful lenses capture and report irregularities. With no human involvement whatsoever.

This is what a new Danish research project is aiming at, with DKK 19 million (EUR 2.5 million) in funding. Inspection of the high-voltage grid is a costly undertaking today, and drones have long since shown their value as inspectors in the construction industry.

"Cables need to be inspected for corrosion and the like. It's an important job, and a cable break is a high-risk affair. We do the job today with a camera operator in a helicopter. And that's hugely expensive. Afterwards, inspectors sift through thousands of images, making the process even more costly. So we propose using drones. Drone inspection already exists, but here we're taking it a giant leap forward," says Associate Professor Rune Hylsberg Jacobsen.

Much better and far cheaper

The Danish transmission grid consists of about 5,000 km of cables. Inspection by helicopter costs DKK 1 million (EUR 132,000) per week, so there's money to save if the project is successful. A lot of money.

The drones will be able to control themselves without human interaction. They will be able to recharge themselves by latching onto the high voltage cables, and they will autonomously be able to avoid collisions with everything from pylons and cables to other drones and birds. By cutting out the helicopter, the pilot and the photographer, drones can save 95 per cent of inspection costs and provide much better quality images.

By means of artificial intelligence, a computer can automatically filter the images, so that the human inspectors can concentrate on looking at the images that actually show irregularities.

Robust technology

Rune Hylsberg Jacobsen is heading the communication part of the project. This is the part dealing with how the drones contact each other: and there's a lot to do:

"Our task is to look at communication between the drones, so that we can make an autonomous swarm of drones that can work together. You let them loose, and then they have to be able to work together on their task without human intervention. This entails a lot of communication challenges. The drones have to know where they are in relation to each other, they mustn't fly into each other, and they need to know which part of the work has already been done, etc. So the communication must be robust. Therefore, we're looking at what wireless technologies we

Title:
Drones for Energy (Drones4Energy)

Budget:
DKK 18.8 million

Timeline:
2018-2021

Partners:
University of Southern Denmark
Aarhus University
Fraunhofer Institute for Microelectronic Circuits and Systems
GeoPartner Inspections
DEVELCO A/S
Science Ventures Denmark A/S

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Photos: Peer Klercke

The project aims to shave off 95 per cent of the high-tension cable inspections, that today is done by helicopter.

can use for the project," he says, and then gives an example:

"We're looking at different sensors we can fit on the drones so that they can "see" like bats. We can also use different types of navigation technology such as GPS, and to avoid collisions with cables, we can use other sensors that tell the drone when it's getting too close to the magnetic field formed by the high voltage."

Can be used in many other places

So far, the project will run over three years, and the plan is for the drones to be able to fly their missions independently and completely automatically. They'll get a start signal and then fly off from their base, find the cables, follow and inspect them, take pictures, recharge, and then fly home when they've finished their day's work.

Even though such a swarm of drones can save enormous sums on cable inspection, this is far from the only use for the technology. Inspections of other installations constitute a huge area, where this type of autonomous drone technology could have far-reaching consequences.

And parts of the technology can be used elsewhere. For example, as Rune Hylsberg Jacobsen explains, the communication system between the drones is similar to what is being developed for autonomous agricultural machinery.

MILLIONS FOR PURELY ORGANIC

It may well be a nice idea to buy organic, but you can never be sure that the products you buy really are 100 per cent organic. A large new EU project is tackling this problem by making organic farms more organic.

Photo: Peer Klercke

Organic isn't just organic. In fact, there can be considerable variation in just how organic an organic product really is.

The fact is that organic farms throughout Europe are not actually 100 per cent organic. They may well not spray crops with pesticides, but quite often a farm may use some other substances that don't belong in nature. Take copper for example, which is prohibited in Denmark, but which is still used in several places in the rest of Europe.

"With this project, we're trying to get organic farms in Europe to approach 100 per cent," says Claus Grøn Sørensen, senior researcher from the Department of Engineering at Aarhus University about the EUR 4.1-million Horizon 2020 research project, OrganicPlus.

Phase-out and consequences
Among other things, the project is focusing on a long list of substances that should not be used in organic farming. What happens if we try to phase them out? What alternatives are there, and what are the consequences of using them?

"We're looking at whether there are other, safer alternatives. For example, sulphur is often used in orchards because it is an effective treatment against various diseases such as scab. Of course, sulphur is not directly a pesticide but, in principle, it's still a foreign agent in organic farming," says Claus Grøn Sørensen.

And it's not just about orchards. The research project is examining all aspects of the many different types of European agriculture: for example fertilizers, plant protection, livestock production and alternatives to synthetic vitamins and antibiotics.

"Our specific work package is about finding out what happens if you phase out these substances. Will it make production more difficult, for example? Will it mean more work? Will it be more expensive? Or perhaps more livestock will fall ill? Others in the project are looking at the consequences for the sustainability of the entire farm," says Claus Grøn Sørensen.

New guidelines for all of Europe
The project is using modelling based on a wide range of trials already completed, as well as full-scale trials, where farms across Europe will phase out various substances and learn from their experiences.

"For example, a farm in Italy producing cheese from milk wants to replace antibiotics with something plant-based. In this case, we're looking at real alternatives and we're modelling future scenarios for what these may mean for the farm."

The aim of the project is to develop guidelines for agricultural organisations across Europe. Including in Denmark, where organic farming is not 100 per cent organic either.

"In my opinion, we have a reasonably strict regulation in Denmark for organic farms, but the organic label doesn't mean that the product is 100 per cent organic. For example, Danish organic farms often use livestock manure from livestock farms that are not organic. And you could say that this influences how organic the farm is ," says Claus Grøn Sørensen.

The knowledge and the results harvested by the project will help raise the standard of organic farming so that methods more than meet the current guidelines for organic food production. This, in turn, could raise the credibility of organic farming in terms of the ecological principles of balance between the environment, ethics and profitability.

Title:
OrganicPlus

Budget:
EUR 4.1 million

Timeline:
2018 –2022

Partners:
Coventry University
Panepistimio Thessalias
Institut National de la Recherche Agronomique
Universita Degli Studi de Padova
Universitaet Hohenheim
Politechnika Czestochowska
Danish Agriculture and Food Council
Institut de Recerca i Tecnologia Agroalimentaries
Instituto Andaluz de Investigaciony Formacion Agragia Pesquera Alimentaria y de la Produccion Ecologica
Ministry of Food Agriculture and Livestock
Ekolojik Tarim Organizasyonu Dernegi
Norwegian Centre for Organic Agricultre
Eidgenoessische Forschungsanstalt WSL
Sveriges Lantbruksuniversitet
Unversita Degli Studi de Parma
Aberystwyth University
Institut d Enseignement Superieur et de recherche en Alimentation Sante Animale Sciences Agronomiques etde l Environment Vetagro Sup
Leibniz-Institut fuer Agrartechnik und Bioekonomie EV
Royal Horticultural Society
The Soil Association Ltd
Unversita Degli Studi de Catania
Hogskolen i Oslo og Akershus
Centre de Capacitació Agrària de Manresa
Forschungsring fur Biologisch-Dynamische Wirtschaftsweise EV

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Photos: Peer Klercke

The new project has partners from all over Europe, and Senior Researcher Claus Grøn Sørensen anticipates, the project will contribute to fewer foreign agents in organic farming.

> *Sulphur is often used in orchards because it is an effective treatment against various diseases such as scab. Of course, sulphur is not directly a pesticide but, in principle, it's still a foreign agent in organic farming"*
>
> Senior Researcher Claus Grøn Sørensen

Photo: Lars Kruse

Over the past 50 years, Danish and foreign sows have developed significantly in terms of size and number of piglets per litter. Productive sows today have up to 18 piglets per litter – almost twice as many as just a few decades ago.

During gestation, the many embryos generate additional heat in the mother's body, and without sufficient cooling this may increase the risk of heat stress in the mother.

Heat stress is a major problem in subtropical and tropical regions, and the consequences can have major economic and animal welfare impacts.

A new ventilation project led by Senior Researcher Guoqiang Zhang will tackle this issue.

Read full article here:

New consultation table makes difficult conversations with patients easier

A Danish study has highlighted a number of problems and possible solutions for consultations between physicians and cancer patients. Now, researchers have designed an interactive table that can improve these conversations.

The first consultation after a cancer diagnosis is important. This is where the patient is informed about the disease, treatment options, medication plan and possibly also the chances of survival.

International studies show that, after the first consultation, cancer patients remember just 40-80 per cent of what they have been told, and that half of the information they remember is wrong.

A research group from the Department of Engineering at Aarhus University has therefore investigated the possibilities for improving cancer consultations by means of technology-based tools, and they are now ready with a prototype interactive table that could improve the quality of communication about diagnosis and treatment.

"Our observations of consultations and our design processes with patients, relatives and physicians show that there are significant benefits to be gained from interactive tools and interiors that can support the difficult conversation," says Professor Peter Gall Krogh, Department of Engineering at Aarhus University.

Interactive table structures and saves the conversation

Professor Krogh and his research group have conducted a series of studies of consultations between physicians, patients and relatives. Working with the Department of Oncology at Herning Hospital, over a six-month period Professor Krogh has collected data, completed user-inclusive design processes, designed and finally tested a prototype interactive table for the difficult conversation.

"We have made a prototype table that can give better consultations between physicians, patients and relatives. Our basic design intention has been to change the balance in consultations between healthcare professionals, patients and relatives, and create a greater degree of reciprocity, trust and dialogue," says Peter Gall Krogh.

The tabletop is designed as a quarter circle with a number of interactive blocks which allow all the parties to influence the content and process of the consultation. The blocks are marked with the typical topics and structure of the conversation such as 'treatment', 'side effects' and 'everyday life'.

The blocks are placed so that the physician, patient and relatives can all decide and structure the content of the consultation.

In addition, the table has an integrated microphone so that an audio recording of the conversation can be taken and saved; indexed corresponding to the markings on the blocks.

After the interview, the patient will receive a subject-indexed audio file to help access the information. The audio file can also act as a supplement to the information about the patient filed with the physician.

"The interactive table solves two challenges. Firstly, it's possible to establish a better informed and differentiated dialogue between the parties around the table; a dialogue that takes its outset in the individual patient's specific needs and disease and the patients' ability to manage information. Secondly, it's possible to store and organise important information in an audio file format," says Peter Gall Krogh.

The process of designing the interactive table is described in a scientific article, which was awarded the Best Paper Award at the world's largest and most important research conference on interaction design (CHI 2018).

Ready for market soon

The first design prototype of the table has been tested in a number of intervention studies involving patients and relatives, and the results so far are good. Herning Hospital is therefore looking at possibilities to make it a permanent fixture at a new hospital (DNV Gødstrup), which is currently under construction.

The researchers hope that in a short time they will be able to commercialise the design and technology in cooperation with relevant companies.

"Right now, the table is a research prototype, and we need a commercial partner to look at how it can be implemented profitably in the health sector. In the long term, we hope that the table can be developed further and also be of benefit at general practitioners and at other places where difficult conversations take place, for example at psychologists, banks or lawyers," says Peter Gall Krogh.

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"We shape technology, and technology shapes us: in particular in our social relations. We must therefore make sure that progress is based on a deep insight into what it means to be human. Otherwise, we risk failing. This is a perspective in engineering research that may come to mean a great deal for our future." Professor Peter Gall Krogh, Department of Engineering, Aarhus University.

Photos: Lars Kruse

RE-Invest:

Generating cheap green electricity is no longer the challenge

Denmark is set for 100 per cent independency from fossil fuels by the year 2050. That transformation will not be easy, and scientists are working hard to model the transformation to a brand-new energy grid, coupling electricity, heating, and transport in a smart way.

The RE-Invest project gathers some of the major energy-market players and researchers from some of the world's leading universities. At the Department of Engineering, Aarhus University, several scientists are involved in the project, which is being funded with DKK 27 mill. from Innovation Fund Denmark

Postdoc Marta Victoria is one of the AU scientists involved, and one of her main contributions is modelling solar photovoltaics (solar PV) at a national scale:

"Solar PV has experienced a dramatic cost reduction. It's a lot cheaper today than it was 10 years ago. Coupled with cheap wind, both offshore and onshore, the main challenge today is not to generate cheap electricity. The puzzle is to couple electricity generated from a myriad of small installations scattered across a country to the total electricity demand and the energy demand of other sectors, while simultaneously interconnecting with other countries."

She continues:
"Consequently, solar PV has changed from being a niche technology to power expensive satellites or remote isolated electrical systems, to being considered one of the key technologies to power our future low-carbon energy system. There's already more than 500 GW installed today, and since 2016 solar PV has seen the highest installation rate per year of all renewable technologies. So we really need to learn the best strategies to match variable energy generation from solar PV with demand."

Photo: Lars Kruse

Title:
RE-Invest – Renewable Energy Investments Strategies – A two-dimensional interconnectivity approach

Schedule:
2017 – 2021

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DKK 27 million,
Innovation Fund Denmark

Partners:
Aalborg University
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“A treasure hunt for something that can really make a difference”

Bachelor of science student in Biotechnology Marie Tvilum on why she chose engineering as her career path.

Read on here:

Photo: Martin Gravgaard

Huge international interest in new Danish heart valve treatment

Together with physicians from Aarhus University Hospital, researchers from the Department of Engineering have developed and characterised a gentle method to fracture old heart valve implants and make room for new ones. The method offers new hope for thousands of patients around the world who would otherwise face very intrusive heart surgery.

A new gentle technique to substitute degraded artificial heart valves proposed by clinicians from Aarhus University Hospital has been thoroughly characterized with guidelines described by researchers from the Department of Engineering at Aarhus University. The resulting article has won considerable international attention, and now tops the list of the most read and cited articles in the reputable EuroIntervention Journal.

This is good news, according to one of the researchers behind the technique, Associate Professor Peter Johansen, who believes that the perspectives are overwhelming for the large number of people who would otherwise suffer from defective heart valves:

"Defective artificial heart valves are a problem all around the world. Every year, hundreds of thousands of people have an artificial heart valve implanted, and the majority of these are so-called biological heart valves resembling our natural heart valve. But eventually they will structurally degrade and become defective so that they no longer work correctly. If a patient is not eligible for undergoing redo open heart surgery with insertion of a new heart valve, it is possible to insert a new valve into the old valve using a catheter advanced through an artery in the groin," says Peter Johansen.

The technique is all about using catheter-based heart valves to replace worn out artificial heart valves with fresh valves; a so-called valve-in-valve procedure. This avoids the otherwise customary surgical procedure for heart patients. The method uses the artery in the groin and all the way up to the heart and the degraded valve.

"Many patients will end up with a valve that needs replacement because of the changes that occur over time. Our goal has been to design an effective, safe and simple method that makes it possible to insert a new valve without re-operation, so clearly it's very pleasing to see the great interest in the method," says Peter Johansen.

The new technique will benefit patients with small hearts in particular, he explains: "If the worn-out artificial heart valve is small, there's not enough space to insert the new catheter-based valve. Therefore, to make enough space, we fracture the rigid structures in the degraded heart valve with a high-pressure balloon, and then insert the new catheter-based valve," he says.

The method has already been through an extensive series of tests, and physicians at Aarhus University Hospital are now the first ever to use the method successfully on patients.

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Photo: Lars Kruse

Researchers fracture heart valves with small high-pressure balloons in the laboratory. The photo shows (from left) Professor Jens Erik Nielsen-Kudsk, Aarhus University Hospital and Peter Johansen, Associate Professor, Department of Engineering, Aarhus University.

> *Many patients will end up with a valve that needs replacement because of the changes that occur over time. Our goal has been to design an effective, safe and simple method that makes it possible to insert a new valve without re-operation*
>
> Associate Professor Peter Johansen

Background
Today, more than 200,000 artificial heart valves are implanted worldwide every year, and this figure will increase further in line with changes in demographics due to a growing population of elderly people.

The vast majority (around 75 per cent) receive a biological artificial heart valve – i.e. tissue harvested from either a pig or a calf. Unfortunately, such heart valves only last for a limited time. They degrade and calcify, resulting in a change from soft tissue that opens and closes, to become stiffened by the calcific deposits that accumulate in the tissue. Eventually, they will behave in the same way as the original diseased heart valve and therefore need replacement. Normally, this would require open-heart surgery, but this is where the new technique presents an alternative.

Technically, replacement of the heart valve takes place by physicians inserting a catheter with a high-pressure balloon into an artery in the groin and all the way up to the heart and the degraded valve. Here, they dilate the balloon until it fractures the rigid structures in the degraded implant.

This provides a more flexible anchoring site for the new implant, which can be inserted in the same manner, avoiding open-heart surgery.

Associate Professor Peter Johansen has worked closely with Professor Jens Erik Nielsen-Kudsk, a senior hospital physician at Aarhus University Hospital, on developing and characterizing the new method.

Photo: Lars Kruse

ENVIRONMENTAL PIONEER TO STRENGTHEN AU RESEARCH ON GREEN FARMING

He became a professor in 2005. He defended his doctoral dissertation in 2013. Now, Sven Gjedde Sommer has started on the next chapter in his quest for green livestock production in Denmark.

Photo: Lars Kruse

There was no such thing as sustainability back in the 1960s, when Professor Sven Gjedde Sommer was a boy on Funen. Back then sulphur soap from dry cleaners caused foam in watercourses, and industry discharged waste water directly into the sea. And the environment debate raged on.

Sven Summer grew up in Faaborg, and he remembers how a local abattoir discharged waste water directly into Faaborg Fjord. He remembers how the water from the abattoir pushed large blood-red fans into the fjord, which he dived under with his friends.

They never thought much about it. It was just how thing were.

His interest in the environment came later. In the 1970s, when the Limfjord was dying. He was a keen angler, and he could read in the newspapers and watch on television how fish were dying everywhere. Eutrophication. This was when Sven Summer decided to study to be a biologist or agronomist. Something to do with the environment anyway. He ended with the latter.

"I wasn't the only one interested in the environment back in the '70s. There was considerable interest in keeping the land and surface water clean. You could see the effects of pollution – it was visible in nature in an entirely different way than today. But back then you never even thought that agriculture could be a possible source of the pollution. We mostly looked at industry," says Sven Sommer.

But Sven Sommer, who started his research career at the Danish Environmental Protection Agency, soon realised that agriculture accounted for a large part of the pollution. Farmers use both commercial fertilizer and livestock manure to fertilize their fields. The latter was only considered as a kind of bonus, and it was spread over fields randomly at all times of the year. It was very inefficient. There was not enough thought about when crops are best able to absorb nutrients or the size of the fertilising effect in manure. Together with the ordinary use of commercial fertilisers, this led to a huge amount of run-off from fields.

Later, Sven Summer moved to the Danish Institute of Agricultural Sciences, where he took a PhD focusing on ammonia evaporation – yet another area where agricultural impacts had been overlooked. The Professor was to be one of the first in the 1980s to describe the extent of the problems caused by agricultural ammonia emissions in nature. Today we know that agriculture accounts for 80-90 per cent of ammonia emissions.

Throughout his long career, Sven Gjedde Sommer has worked for green, environmentally friendly livestock production in Denmark. For the sake of nature, society and the farmers. His goal has been to develop new environmental technologies that can make use of manure to make livestock production better and greener.

However, this does not mean that he has finished his research. There is still a lot to be done to make Danish agriculture even more sustainable," says the professor, who in 2013 defended his doctoral dissertation on the influence of pH on the evaporation of ammonia into the environment.

Ammonia evaporation adds to greenhouse gas emissions, and in this context Sven Sommer is working on a project to get more insight into the metabolic processes taking place in manure in livestock sheds and out in slurry stores. He hopes to make system-based models to calculate exactly how much greenhouse gas and ammonia is emitted from the livestock manure.

Sven Summer is also working on a project to convert slurry into a high-value phosphorous fertiliser. Phosphorus is a limited resource dug up from mines around the world. The EU currently imports all the phosphorus used in commercial fertilizer, but Sven Sommer hopes to retain the phosphorus in manure so that it is not lost.

For many years, he has also had a passion for work with developing countries.

"I have close cooperation with Vietnam, where we're developing technologies to improve the way we exploit manure from livestock. Today much of the slurry goes directly out into recipients, but by using the slurry more effectively, we can perhaps transform it into a valuable commodity. We can do the same thing in many other places around the world, where farming is becoming more and more intensive," says Sven Summer, who will continue his work to keep Denmark at the forefront in sustainable animal waste technology and clean agricultural production.

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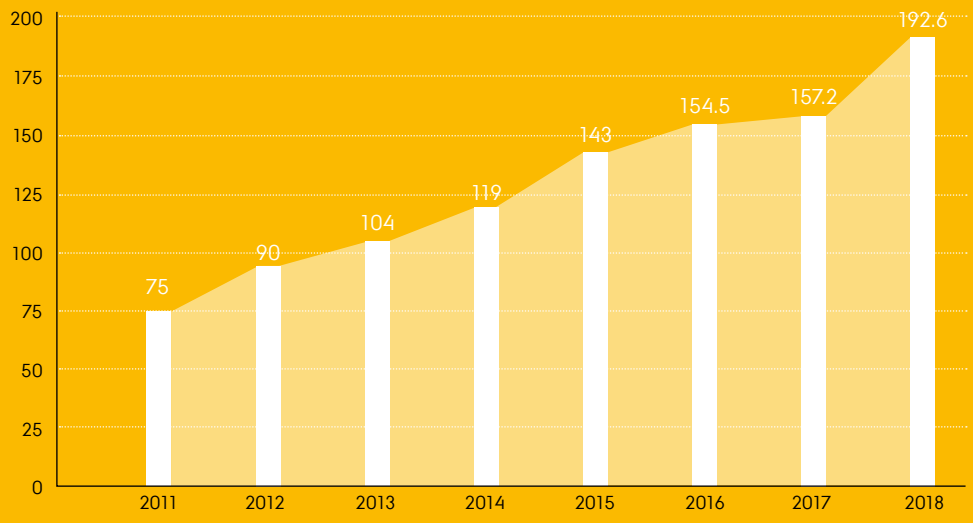
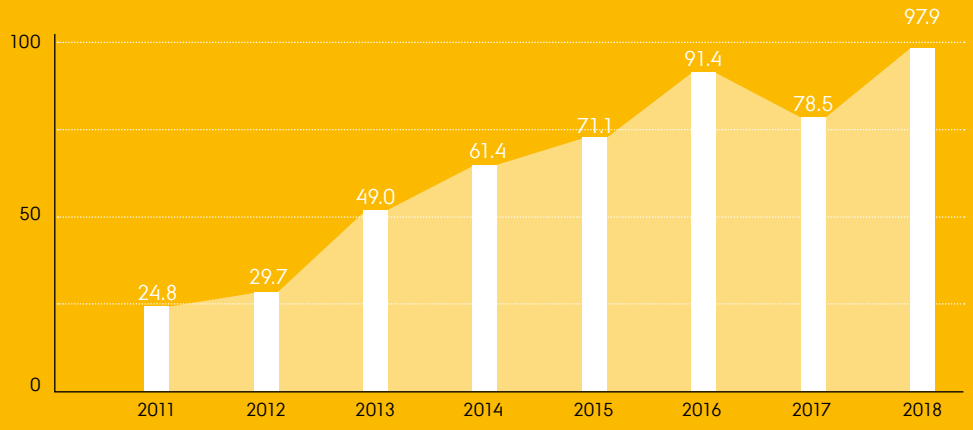
KEY FIGURES

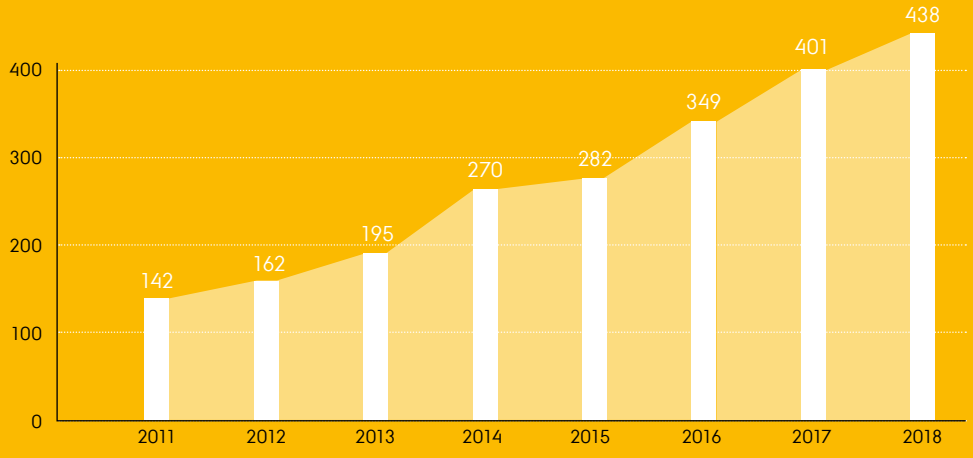
TOTAL ENG TURNOVER (M DKK)
Based on annual FC3 budget



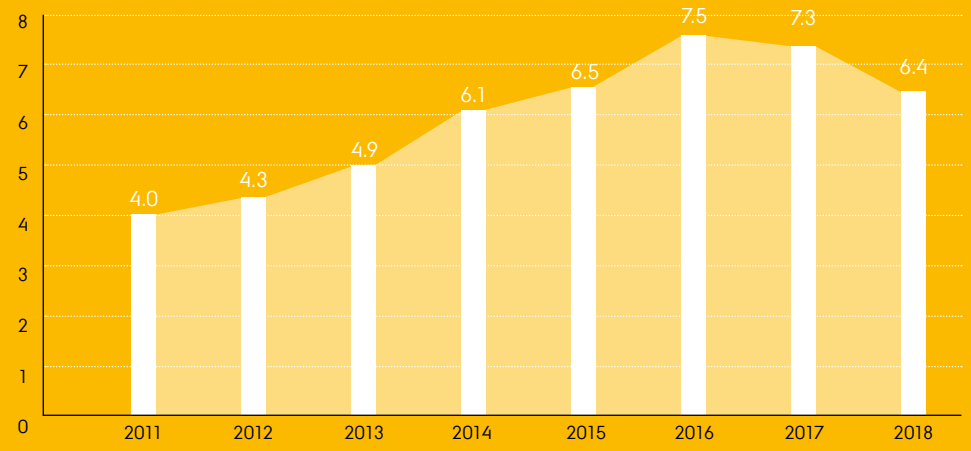
EXTERNAL FUNDING TOTAL (M DKK)
Based on annual FC3 budget



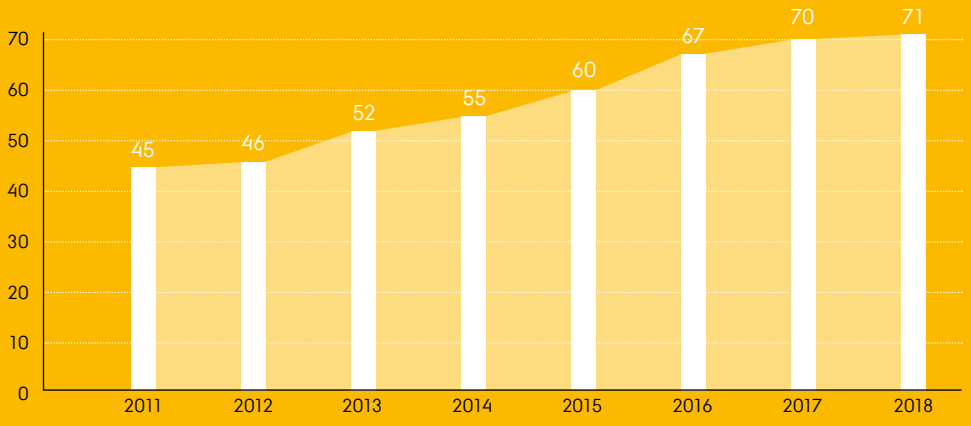
PEER REVIEWED PUBLICATIONS



PEER REVIEWED PUBLICATIONS PER RESEARCHER

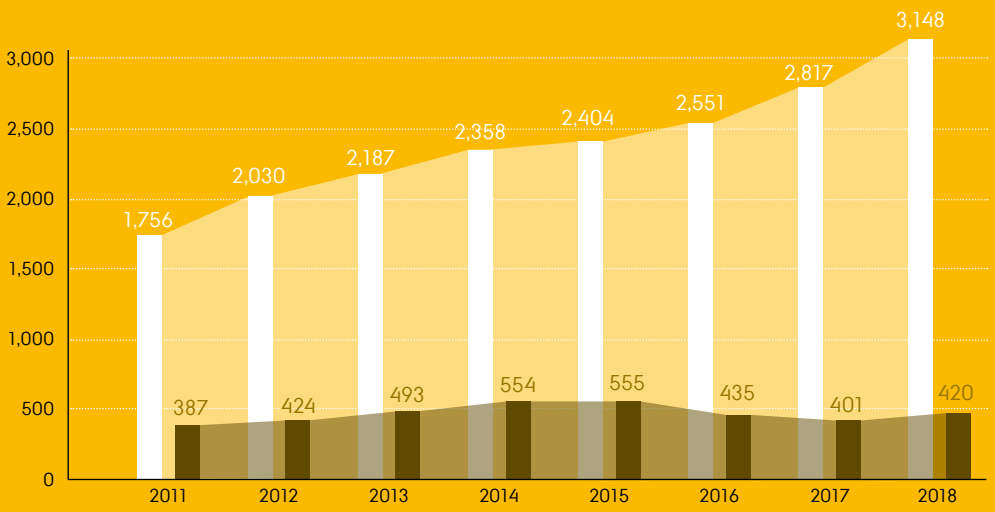


ENGINEERING PHD STUDENTS



ENROLLED ENGINEERING STUDENTS

BACHELOR
MASTER



A major new research project will revolutionise production of ammonia, which is an essential ingredient in fertilisers. At the same time, the project will demonstrate the potential of ammonia as the future carbon-free fuel.

Read the article here:

Photo: Anders Trærup

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