



PROFILE 2015
DEPARTMENT OF
ENGINEERING

RESEARCH
TECHNOLOGY
IMPACT

DAILY MANAGEMENT AND ADMINISTRATION 2015

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FRONT COVER

The artwork on the front cover, is a graphic interpretation on Moore's Law, an observation that, over the history of computing hardware, the number of transistors in a dense integrated circuit doubles approximately every two years. The observation is named after Gordon E. Moore, co-founder of the Intel Corporation. Original seen at the Heinz Nixdorf Museum, Paderborn, Germany.

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Accelerating, Thinking Strategically



Reflecting on the past year as Head of Department of Engineering I can't deny it has been a challenging year with cut-backs and organisational adjustments. Despite that, it has also been a year that has justified my great expectations to what we can achieve and how far we can go. Our strategy and focus on building deep, technical, discipline-oriented engineering skills to support this are already unfolding like a spring flower. Our accelerating progress provides unbelievable possibilities within both excellence and growth. For our core business - education and research - we have accomplished things previously believed impossible. During the last 3 years the uptake in engineering master students has almost doubled and the annual external research activities have consistently increased by almost 20 percent.

One of the greatest engineering strengths is the ability to anticipate and embrace change with a willingness to break new ground and transform established fields. Noticeable advances in knowledge are shaping today's society with incredible opportunities for engineers from all disciplines. We see how disruptive technologies have a remarkable influence on our global society and how exponential growth comes out of young, innovative, high-tech companies that are able to exploit the new technologies even in markets dominated by large well-established global companies.

We have initiated even more research activities within technological fields generally believed to have enormous societal impact in the coming decades, like precision agriculture, sustainable energy, healthcare technology, advanced materials and manufacturing. Our early multidisciplinary focus has stimulated and allowed us to initiate an impressive number of projects in these fields, projects ranging from national to European, from basic engineering science to applied strategic research, funded by public institutions as well as private companies.

2015 will take us the next step towards achieving our long-term ambition of bringing Aarhus University into the European elite within engineering. Based on the deep engineering disciplines, we are in the process of shaping the 2025 engineering strategy. A strategy anchored in a culture focused on excellence in everything we do, with a strong desire to support our society nationally, regionally as well as locally.

In this Profile 2015, I am proud to highlight some of our latest engineering achievements and impacts accomplished by our researchers.

Sincerely yours,

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

Department of Engineering at Aarhus University creates innovative and sustainable solutions to some of the major problems humanity face. We keep a strong focus on technology's impact through-out all our engineering activities – in deep research, applied and strategic research, partnerships with industry, education, development of PhD programmes, and in our public sector consultancy services.

ENGINEERING DISCIPLINES

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

COMPUTER SYSTEMS AND NETWORKS

Continued exponential growth performance within digital technologies accelerates societal impact from disciplines like cyber-physical systems, Internet of Things, cloud computing, mobile Internet, big data and artificial intelligence.

Improved interaction between virtual and physical worlds

With a new EUR 8 million research project, Aarhus University will spearhead a project that aims to develop a new form of interaction between physical objects and their computer control using different software models. The technology will make it easier to develop credible cyber-physical systems (CPS) which will be important for industry's ability to innovate in the future.

Among the growing number of physical objects that surround us, small computers control a considerable number of different functions. Development has exploded in recent decades and this has placed new demands on industry. The main challenges can be described with two central questions: What do you do when the many computers need to talk to each other? And how do you ensure that they adapt as well as possible to the context in which they will be used?

Fewer physical prototypes

In a major European research project called INTO-CPS, with a diverse consortium made up of 11 partners from industry and academia, researchers will spend the next three years creating new methods and tools that will make it both easier and cheaper to validate computer-based products. And there is an urgent need to get started, according to Professor Peter Gorm Larsen who is the coordinator of the project.

"We're used to taking it for granted that things work. And if they don't, we have

to find out what's wrong. But we now find ourselves in a reality with so many computer-based systems that it can be almost impossible to take in. Industry in particular is facing an acute challenge with more and more 'cyber' control of physical objects, and we therefore need to develop new tools that are capable of combining different models of both 'cyber' and 'physical' elements in a virtual world to design and validate new products in the innovation process long before investments in physical prototypes come into question," he says.

Physical prototypes are often extremely expensive, and it is therefore hoped that the new tools can eventually reduce their numbers significantly.

100 computers in your car

TWT in Germany is one of the project's case companies, and it helps car-manufacturers such as BMW and Audi with simulations and models of prototypes. Professor Larsen specifically mentions the car industry as an illustrative example of this technological development.

"If you're driving a car built around the turn of the millennium, there probably aren't many computers controlling its functions. If you buy a modern car, however, you can be pretty sure that it involves more than 100 different small computers that control everything from the keys and brakes to cruise control and automatic parking functionality. It is clear that this development provides the car industry with completely new challenges in both the development and the test stages," says Professor Larsen.

Quite specifically, the researchers will design a new development and test platform for the project's four European case companies. In addition to TWT, these include a manufacturer of train doors, a manufacturer of air conditioning systems and a manufacturer of agricultural machinery. Common to all the companies are products that have close integration between their 'cyber' and 'physical' parts, with development activities that are extremely expensive – particularly due to prototype development and tests.



With a large research grant from the European Union, Aarhus University is now strengthening its research activities in cyber-physical systems. This project is producing a cyber-physical modelling technology that in the coming years is expected to have great significance for the way people can interact with the physical world around us and for industry's innovation processes. The photo shows the international project consortium gathered at Aarhus University.

Faith in computer-controlled products

The test platform will be based on technology that makes it possible to produce different models that can be simulated together and providing virtual 3D model videos of both specific prototypes and their application contexts.

In the example of the car, this could be a virtual prototype of a vehicle linked to a physical prototype of a new type of wheel. In this way, the researchers hope to gain more knowledge of the interaction between a product's physical parts, its computer systems and its surroundings.

"A new technological approach is required if we're to have complete faith in our computer-controlled products. For example, how do the many computers in the car react to the new wheels?

What does it mean for their ability to communicate with each other? How do the wheels work if you're driving at 200 kilometres per hour and suddenly brake? And what if the road is dusty or wet? There are so many different possible failure scenarios and situations that we need to have better tools for developing, testing and carrying out quality assurance," says Professor Larsen.

The researchers aim is to use the tools to try out many scenarios and describe and clarify how different types of products behave in different surroundings and usage situations in a virtual world. This is the first step on the way towards a more systematic method for prototype development and failure prevention, which could be extremely valuable in a considerable number of industrial contexts.

project facts

TITLE

Integrated Tool Chain for Model-based Design of Cyber-Physical Systems

SCHEDULE

2015-2017

FINANCIAL FRAMEWORK

8 million EUR, Horizon 2020, EU

PARTNERS

Newcastle University, University of York, Linköping University, Controllab Products, ClearSy, TWT GmbH - Science & Innovation, Kongskilde Industries, United Technologies, Softeam

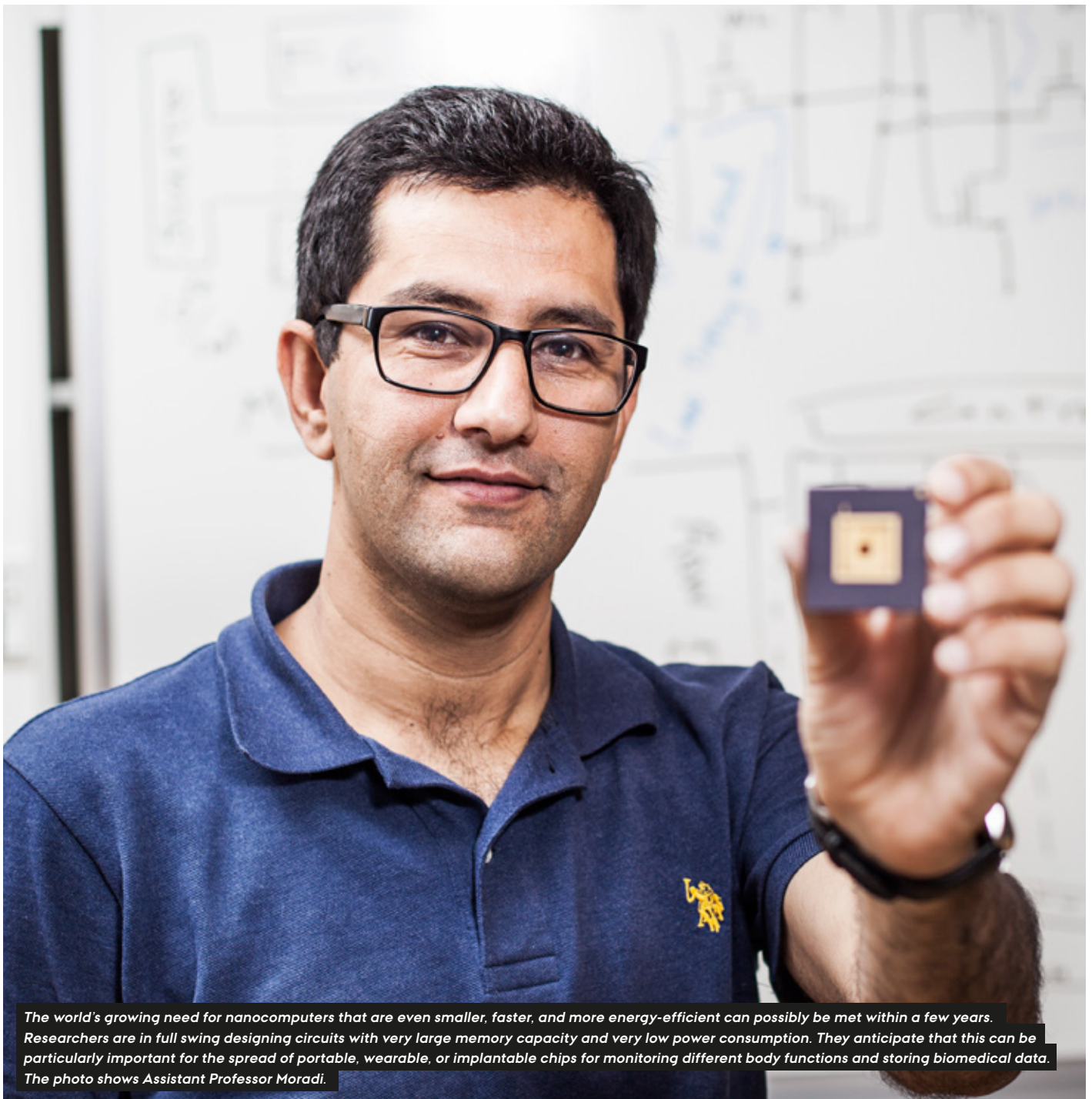
CONTACT

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Next generation computer chips

In a new international collaboration, engineers at Aarhus University will play a key role in designing integrated circuits using new transistors. These can be used in nanocomputers with super memory capacity and ultra-low power consumption.

Photo: Anders Trostrup



The world's growing need for nanocomputers that are even smaller, faster, and more energy-efficient can possibly be met within a few years. Researchers are in full swing designing circuits with very large memory capacity and very low power consumption. They anticipate that this can be particularly important for the spread of portable, wearable, or implantable chips for monitoring different body functions and storing biomedical data. The photo shows Assistant Professor Moradi.

project facts

TITLE

Low Voltage/Low power design in future nodes (FinFET and nanowire based devices)

SCHEDULE

2014-2017

PARTNERS

Imec

CONTACT

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Researchers at Aarhus University have entered into a formal three-year collaboration with the Interuniversity Microelectronics Centre (imec) to develop and test a completely new and potentially ground-breaking technology.

Imec is a strong partner and a world leader in new developments in microelectronics and nanoelectronics.

Industrial restructuring in sight

In the coming years, researchers will look at opportunities for a new type of electrical circuit that could very well pave the way for a historically large industrial restructuring, according to Assistant Professor Farshad Moradi.

He has been working extensively for years with digital and analogue circuits in nanoscale technologies, and he has a privileged insight in the latest computer technology trends.

"Development in computer technology has been exponential for more than forty years where the number of transistors in microprocessors has doubled about every second year according to what computer scientists know as Moore's law. There's much to indicate that we're at a turning point and that – with the latest technology – we can develop chips with properties that could pave the way for a new chapter in the world history of electronics," he says.

Microprocessors are traditionally manufactured using a so called complementary metal-oxide-semiconductor (CMOS) technology. One of the major disadvantages of using this technology in its nano-scale regime is that the leakage current of the electronic device increases significantly. This means, in practice, that whether referring to a mobile

phone, an ECG monitor or some other sort of device, it will relatively quickly run out of power because it uses the battery's capacity even when on standby mode.

Low power consumption and super memory

As computer technology gets used in new contexts in which battery capacity is crucial, this leakage current becomes a bigger and bigger problem. In other words, the current technology does no longer match the world's expanding need for small computer chips with low leakage and high scalability. It applies particularly within the field of biomedicine where very small computers can be sewn into clothes or implanted in the body.

Here it is memory and power consumption that represent the major innovation challenge by far.

"Just to take an example, if you want to measure brain activity over a period of time via a small computer surgi-

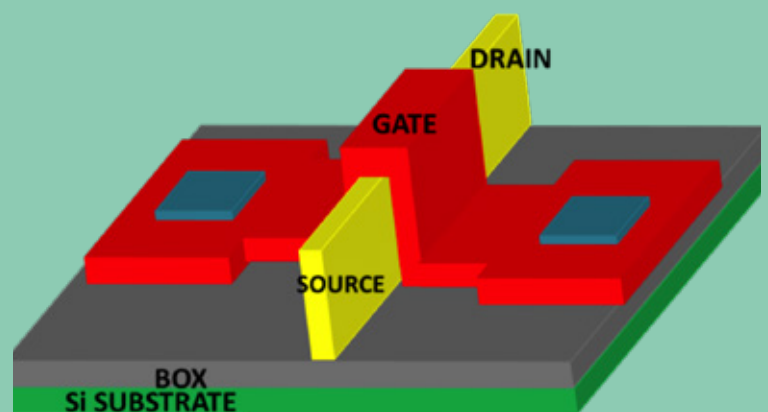
cally implanted under the scalp, then it's obvious that it must be capable of saving battery power and storing large amounts of data," explains Assistant Professor Moradi.

Three-dimensional transistor structure

The technology that can make this a realistic scenario is called FinFET and, fundamentally it is based on a three-dimensional transistor structure that conducts the power.

According to Assistant Professor Moradi, this can reduce power consumption in digital circuits by several orders of magnitude, at the same time as making it possible to provide smaller units with more functionality and memory.

The Aarhus University researchers have the task of testing and further developing the technology and preparing for an industrial conversion to new nano-sized circuits.



FinFET Transistor

The traditional transistors in microprocessors are planar structures. The next generation of transistors has an advanced geometric pattern in three dimensions, and this provides considerably better control of the channel, less leakage current, low-voltage memory, and lower power consumption. As the illustration shows, the scientists are designing new types of transistors where the gate is controlled from all sides.

The human body and the Internet

Researchers at Aarhus University are working on new solutions for Wireless Body Area Networks, making them reliable, secure, lightweight and energy efficient so it will not be necessary to change the batteries so often.

project facts

CONTACT

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PhD student
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The idea of Wireless Body Area Networks (WBAN) is close to becoming reality. Before long it will be possible to wear electronic devices with multiple sensors, computing capability and radio transmitters.

This can be used to record and report details of your movements, your health or your surroundings in a wireless network carried on your body – or even implanted into your body, for that matter.

The technology is predicted to play an important role in the health services of the future, as well as elderly care, the entertainment industry, sport and a wide range of professions.

Using WBAN, doctors can keep an eye on a heart patient's vital signs even while the patient is at home, a diabetic can be notified immediately if blood sugar levels are too low or too high, athletes can optimise their training, and a fireman's uniform can send an alarm to both the firefighter and the commander about high temperatures and hazardous gases.

WBAN also provides numerous options for interaction with machines. Computer games, robots and drones can be controlled by body movements and provide feedback that can be felt by the operator or player on their bodies.

A hot topic

It is only close to becoming a reality, however. Using current technology, it is certainly possible to build WBANs, but they still demand so much energy that they are not particularly practicable. They either require large batteries or they have to be recharged too often. In addition, when electronic components use a lot of power, they get hot so called tissue heating problem – so no one wants to have them close to or inside their bodies.

In order to develop truly applicable WBANs, the researchers must meet the crucial requirements of optimal energy efficiency and low complexity – and at the same time overcome the challenges of a highly dynamic channel with inconsistent propagation characteristics due to body tissue, mobility and randomness.

Those are the problems that the researchers at Aarhus University are trying to solve. Their tools are primarily mathematical equations, formulae and algorithms.

"We address the algorithmic and theoretical part of the problem while we are concerned about the practical and technological constraints. We try to make everything as efficient, agile and simple as possible without compromising the system's fidelity or consuming extra resources such



Associate Professor Qi Zhang (right) and PhD student Mohammad Sadegh Mohammadi are working on new solutions to improve Body Area Network Technology. They want to make it more reliable, secure, lightweight and energy efficient.

as spectrum, energy and computational power at the sensor nodes,” says Associate Professor Qi Zhang.

The researcher’s solutions span in both physical and medium access control layers in the network protocol stack, as well as the sensor’s hardware such as analogue to digital converters.

Fewer errors mean less power

The project is focused on subjects from coding theory, signal processing and wireless communications.

“The conventional methods in designing wireless systems are based on assumptions that do not fit well to WBANs. They are usually not designed for optimal energy efficiency and minimum complexity and do not take into account channel issues imposed by near-body operation,” says Associate Professor Zhang.

Together with her research group she is trying to develop advanced coding techniques to boost the system’s performance, combined with the latest

techniques in signal processing such as *Compressive Sensing*. Basically, the aim is to send data packets through the network as efficiently as possible.

“We propose a system that reconstructs an accurate picture of the sent information, although some of the received packets are damaged or missing bits due to for example noise and interference. A conventional system discards such packets and asks for re-transmission, which reduces the speed and costs energy. Our system, on the other hand, only needs to receive enough coded packets to fix the damaged parts and recover the whole “picture”. The recovery procedure is the main challenge,” explains Zhang.

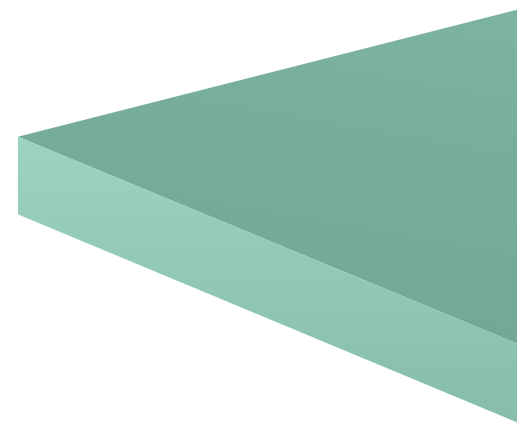
The right transmitter

The researchers work is not completely limited to the theoretical work. The new protocols and ideas are of course tested in models and computer simulations or implemented using the available software defined radio platforms.

“We are looking at all the ways we can optimise WBANs. We have, for example, developed techniques to improve Ultra Wideband systems (UWB). This is interesting because the UWB transmitter is very simple, its signal is low energy, almost immune to fading, and provides excellent ranging capabilities,” says PhD student Mohammad Sadegh Mohammadi.

It is still too early to say when the technology will become a reality.

“This is an emerging field of research. We’re discovering new challenges all the time,” he says.



project facts

TITLE

mmW-SPRAWL: Millimetre wave silicon photonics for remote sensing and wireless links

SCHEDULE

2014-2017

FINANCIAL FRAMEWORK

6,5 million DKK

The Danish Council for Independent Research

PARTNERS

Technical University of Denmark (DTU).

CONTACT

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The future is arriving at the speed of light

The increasing demand for wireless Internet necessitates new technology. Now researchers are challenging the art of the possible by creating new applications for extremely fast data transmission systems and networks. Along with the changes in technology development, we can expect that many more of our electronic devices will be linked to cyberspace.

It is expected that 50 billion devices will be connected to the Internet in less than 10 years, many of them wirelessly. However, the present day technologies are, by far, not able to deliver this sort of capacity.

One bright solution might lie within the field of photonics which includes several great engineering tasks such as design and characterisation of optical nano-scale components.

Silicon based optical chips

Photonics is the study of light particles, i.e. photons, and photons are already being used with great success in telecommunications where optical fiber cables transfer data at much higher speeds than copper cables could ever dream of.

"You only succeed if you can do it well. If you cannot do it well, basically you have a useless technology," associate professor Martijn Heck says.

With this particular project Martijn Heck aims to expand the use of photonics into wireless communications. The goal is to invent silicon based optical chips that are cost-effective, high-speed and also environmentally friendly compared to the conventional technology of electronics, thus providing a technology to deal with the increasing demands of future ubiquitous Internet connections.

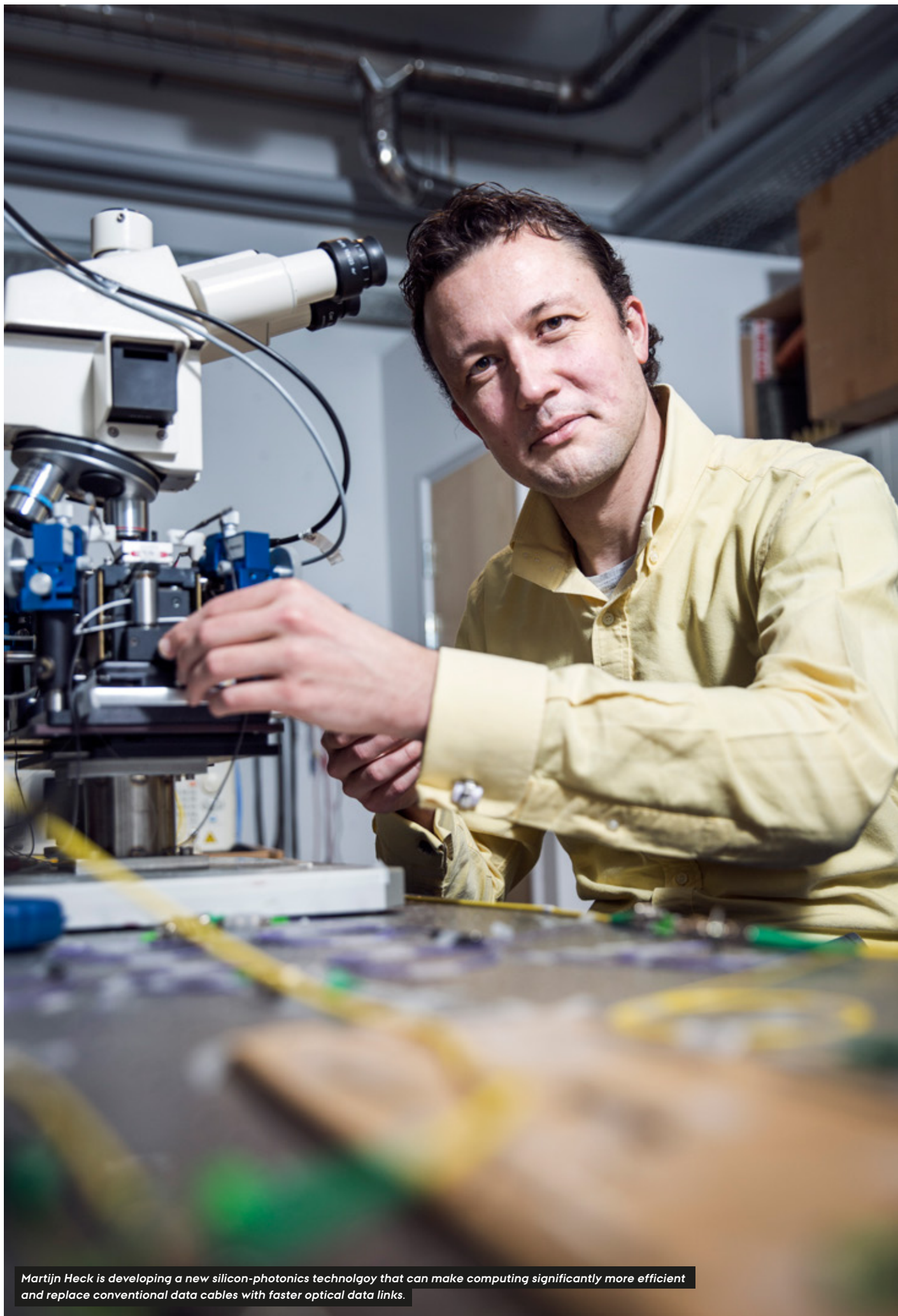
Silicon has dominated in microelectronics for several decades. Due to its transparency in the range of optical wavelengths, silicon can be used for optical Internet solutions with larger bandwidth, lower power consumption, smaller delay and better resistance to electromagnetic interference than conventional electronic connections. Silicon based transmission of data is carried by light and can be integrated with microelectronics.

Photonics beat electronics

Creating a working technology is of course just one of the things on Martijn

Heck's list and his collaborators at the Technical University of Denmark (DTU). The photonic technology will also have to be able to compete with present technologies.

"In principle we know that we can make photonics beat electronics. But when a scientist says 'in principle', it means that at the moment we can't. Hopefully, in three years, we can. What we know is that this is big. The development of new wireless network technologies is spreading rapidly. This makes it possible to include more and more embedding sensors and actuators in machines and other physical objects to a degree that will not only transform the way we communicate but also our life and the global economy," Martijn Heck says.



Martijn Heck is developing a new silicon-photonics technology that can make computing significantly more efficient and replace conventional data cables with faster optical data links.

ADVANCED MATERIALS AND PROCESSES

Materials that encounter novel and improved engineered properties within weight, strength and formability, created through the ability to characterise and synthesise even down to nano-scale. One facilitator is advanced manufacturing through specialised processes and new techniques like high-precision micro-scale 3D printing.

project facts

CONTACT

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Farewell to conical flasks

Imagine a small machine about the size of a suitcase. You put some carefully selected chemical ingredients in one end and a little later the finished medicine comes out the other end as pills. This is just one of the prospects for a new chemical technology that handles all reactions and purifications in a closed system.

Photo: Anders Trørup



In flow syntheses, chemical productions take place in a closed system where it is possible to regulate temperature and pressure, thereby improving the reaction conditions in a safe environment. The photo shows Assistant Professor Anders Thyboe Lindhardt in his laboratory.

The field of organic chemistry is constantly renewing itself and industry requires new synthetic methods for constructing increasingly complex molecules. We are on the threshold of a new chapter in the world history of chemistry, where we can possibly say farewell to conical flasks, fume hoods and batch processes, and bid an entirely new method of chemical reactions welcome to the laboratory and to industry in the ton scale.

Industrial paradigm shift on the way

The method is called flow chemistry which is a new approach for manufacturing large quantities of chemicals and – as the name implies – in a continuous reaction sequence. The principle is simple. You feed the necessary precursors or chemical 'building blocks' into a machine that uses pumps, tubes and small reactors to carry out a chain of reactions in a closed system where you can very accurately regulate pressure and temperature with no limitations regarding safety.

Flow chemistry is a developing scientific field, and something of an international research race is in full swing. This is because the technology is promising and heralds an industrial shift in which virtually all chemical processes can be taken out of the laboratory, made cleaner and more efficient, and be carried out on a far greater scale than anyone dared dream of just a few years ago.

"Everything we know about good chemistry and good chemical batch processes can be turned upside down

by flow chemistry. The technology provides some completely new reaction conditions and thus makes it possible to take some decisive innovation steps towards new products with new properties in areas such as the pharmaceutical or material industries," says Assistant Professor Anders Thyboe Lindhardt.

No toxic fumes or danger of explosion

Safety is another obvious advantage of flow chemistry processes. There is no danger of toxic fumes, dangerous gases or explosion. In contrast to traditional organic synthesis that chemists carry out in round-bottomed flasks in fume hoods with exhaust fans, flow chemistry takes place in a small machine with no human contact.

The advantages of flow chemistry – in addition to increased safety – include the possibility to work with more rapid exchange of heat and cold and at a higher pressure, thus enabling reaction conditions that have not previously been possible. In other words, researchers can safely and accurately take all the good aspects of the traditional chemistry laboratory and use them in a production context.

"Flow chemistry is really a shortcut from basic research to application. Only a few years ago, we were pottering around with good chemistry and good chemical processes in flasks in the fume hoods, but we had no chance of scaling up the production of compounds in large amounts," says Assistant Professor Lindhardt.

"Today it's possible to upgrade the reactivity of the chemical ingredients and thereby increase the amount of the substance you want to produce. But this requires a special flow chemistry machine – and we have one at Aarhus University," he adds.

Chemical chain in a closed system

It does not look anything like a high-technology wonder, but looks can be deceiving. It is built from scratch with advanced equipment for every tiny part of the chemical chain and with a clear engineering focus on creating the best possible reaction conditions for the substances being put in the system.

According to Assistant Professor Lindhardt, one of the main architects of the machine, it works as intended. It converts the chemist's technical batch procedure into a continuous process and works, in principle, as a small chemistry factory. It can mix, cool and heat precisely in one and the same process, and thereby reduce the reaction time significantly.

To start with, the researchers are investigating how flow synthesis could improve on already known batch processes. They will subsequently develop chemical processes that can only be carried out in a flow machine, and thereby produce new chemical entities or everyday commodities in a better and more energy efficient way.

Super strong plastic on the way

Researchers will develop a new type of strong plastic using graphene. The aim is to use a 3D printer to produce prototypes in specific shapes. The technology has great potential in the wind and plastic industries.

Graphene is a new type of carbon with some unique properties that make it the thinnest and strongest material in the world. It will now come out of the research laboratories and enter the industrial world where researchers and companies will join forces to demonstrate the value of graphene and 3D printing in connection with developing advanced technology products.

"Graphene is a material with an enormously large theoretical potential. We'd

like to investigate how to use graphene in the plastic industry for manufacturing new products and developing new production processes," says Industrial Postdoctoral Fellow Bettina Brøgger Jensen.

In the coming years, she will work with other partners in the project to research areas including graphene modification and production. The aim is to develop a method to strengthen plastic with graphene, use it for 3D printing, and

thereby create entirely new opportunities for optimising and developing a number of advanced technology products.

Using graphene for 3D printing of plastic material is new in both the wind and the plastic industries, and the project's partners hope to demonstrate new full-scale application potentials in the coming years.

project facts

TITLE

3D printing of graphene reinforced PUR

SCHEDULE

Start 2015

FINANCIAL FRAMEWORK

1 million DKK

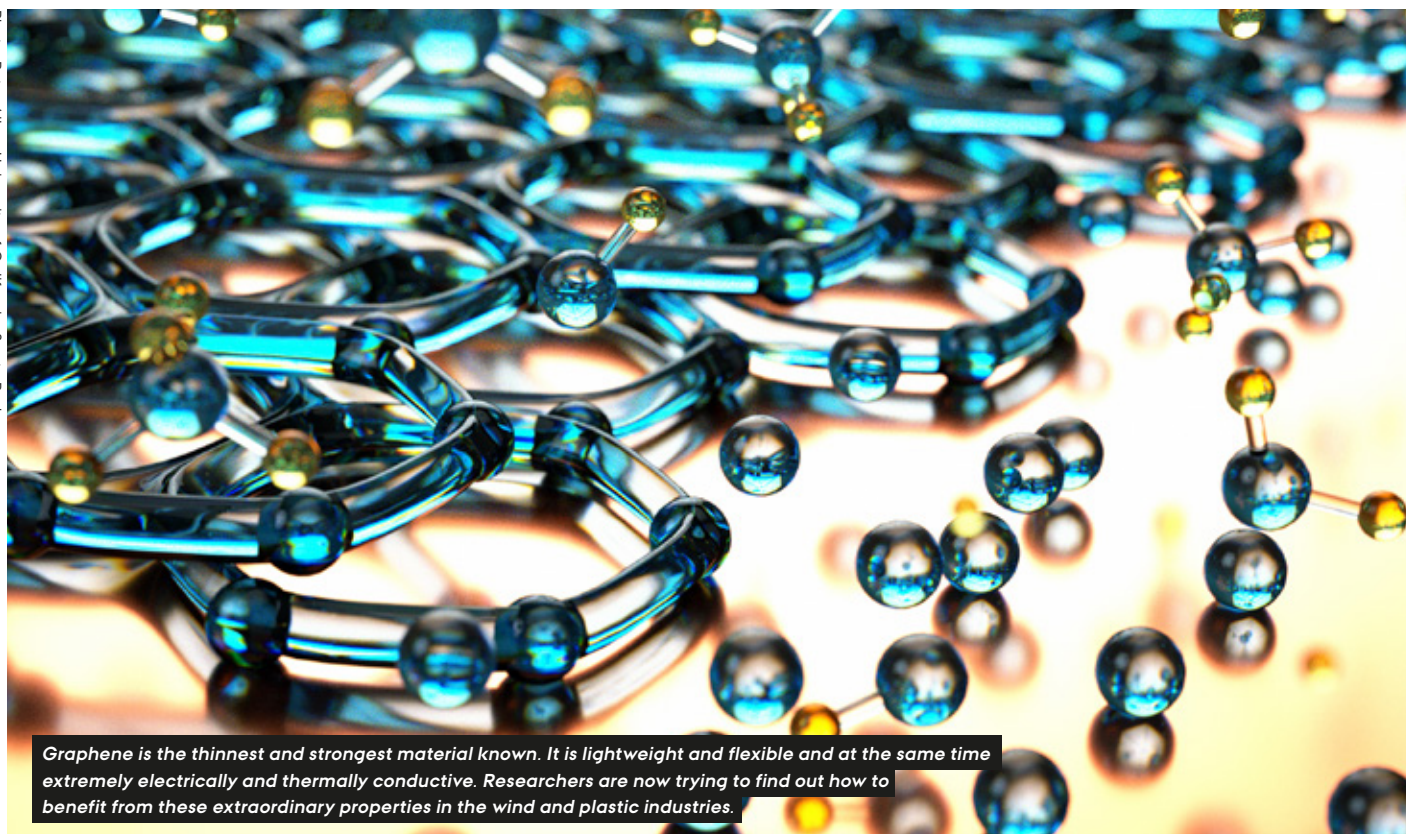
PARTNERS

SP-Group A/S, Vestas Wind Systems A/S

CONTACT

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Photo: Peter Allen, University of California, Santa Barbara



Graphene is the thinnest and strongest material known. It is lightweight and flexible and at the same time extremely electrically and thermally conductive. Researchers are now trying to find out how to benefit from these extraordinary properties in the wind and plastic industries.

Mobile robots for the wind turbine industry

Researchers and companies have come up with an idea that could have far-reaching implications for the wind turbine industry. They will make a portable robot that can process the largest wind turbine cast steel components. If successful, it could save billions.

Why let the mountain come to Mohammed when Mohammed can come to the mountain? Transferred to the wind turbine industry, this saying could very precisely describe the ambitions for a new Danish research project called InnoMill.

The situation today is such that large wind turbine components are transported to centrally located large machine shops. This is both a time-consuming and costly part of the production chain.

Mobile robot can provide huge savings

Many Danish motorists have been witness to large road trains transporting wind turbine cast steel components. In the future, this could be a rare sight because the researchers and companies involved in the InnoMill project will develop mobile machining robots that have unique properties and can be moved and placed directly near or on large wind turbine components.

The challenge is to make the robot system so accurate that components measuring several metres can be machined on site with such precision that they comply with the very stringent quality standards demanded by the wind turbine industry. And talking about precision, this also means vibration.

"One of the greatest challenges in the project is to gain constant knowledge of the current stiffness and vibration level in the overall processing system. It involves controlling the cutting forces that arise when you're working with the largest wind turbine components. We're trying to solve this by combining mathematical models of the material mechanical properties and dynamics of the flexible structure with continuous process monitoring," explains Professor (Docent) Ole Balling.

Wind turbines are getting bigger

The consortium behind the InnoMill project is an amalgamation of industrial companies and universities led by DAMRC – the Danish Advanced Manufacturing Research Centre.

The trend in the wind turbine industry is that the wind turbines are constantly larger increasing in size. This is adding pressure on the current production chain and logistics.

"In a few years, the cast steel structures that make up the load-bearing elements in large offshore wind turbines will increase from 3x3x3 metres and a weight of 15 tons to at least twice as much. This will make it next to impossible to place the large components into the milling machines that are currently used for processing," says Professor (Docent) Balling.

The InnoMill project aims to develop mobile robots that can be easily transported and placed on the very large components, thereby changing the machine shop concept that dominates the industry today.

According to Professor (Docent) Balling, this will make wind turbine production much more efficient, and thereby cut a significant amount of production costs.

project facts

TITLE

InnoMill

SCHEDULE

2015-2018

FINANCIAL FRAMEWORK

25 Million DKK, Innocation Fund Denmark

PARTNERS

DAMRC F.M.B.A., CNC Onsite ApS, Global Castings A/S, Ide-Pro Engineering & Software A/S, DTU Mekanik, Bila A/S

CONTACT

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Photo: Anders Trærup

Print-on-demand body implants

Researchers are giving birth to a new method for the manufacture of bones, cartilage and joints to cure or ease tissue injuries. The method involves the printing of 3D implants for the human body to stimulate the growth of different cell types.

Musculoskeletal diseases affect an increasing part of the population, and they cause pain, functional loss, sick leave or, in the worst cases, the disability of approximately 120 million people in the European Union alone.

This is a trend that is expected to continue concurrently with the demographic development in the number of older people and the fewer young people in the Western countries.

“From a social point of view, we are extremely challenged by a growing

population of old people. With age, our physical abilities are weakened as a result of the biological changes in our bodies and external influences through our lifestyle. Our locomotor function is reduced, and our capacity to withstand loads on muscles, tendons and joints also becomes lower. For the individual person, this often causes fewer years in good health and loss of life quality. For society, it results in many costly operations and loss of work power,” says Associate Professor Jens Vinge Nygaard.

Nanostructure determines type of stem cell

Associate Professor Nygaard works with the development of new types of surgical implants for worn or damaged body parts. In the print lab at Aarhus University, he and his research team have created some of the most significant results within the field of tissue engineering, and this indicates that you may have to look in the direction of nanotechnology and materials technology to find new solutions to the increasing number of cases of osteoarthritis, rheumatoid arthritis and osteoporosis.

project facts

TITLE

CartigenPro

SCHEDULE

2013-2017

FINANCIAL FRAMEWORK

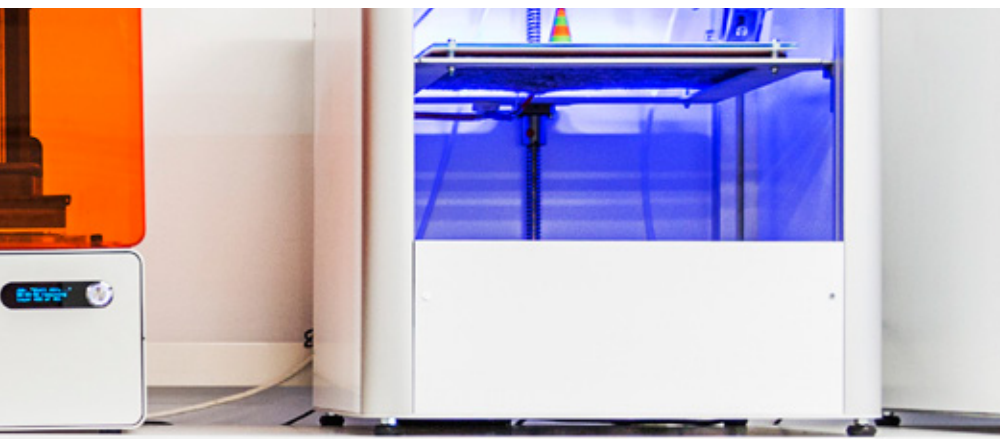
14 million DKK, The Danish National Advanced Technology Foundation

PARTNERS

Davinci Development A/S and LevOss ApS

CONTACT

Associate Professor Jens Vinge Nygaard
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Aarhus University has established a new 3D print laboratory, where researchers carry out experimental design of implants for the body.

NEW METHOD FOR TISSUE ENGINEERING

The special feature of using the printing technique in tissue engineering is that the mechanical properties of the implant material, defined by the specific nanostructure of small holes, determine the type of stem cell to grow on the implant.

Within a period of a few years, the researchers hope to be ready with a new method for the treatment of tissue damages based on a combination of nanotechnology and modern 3D printing technology.

So far, it works as expected in experiments with rabbits and pigs, and with a new six-digit grant from the Danish National Advanced Technology Foundation, the researchers will adapt the method for surgical treatment of humans in the coming three years.

Researchers print an implant in 3D, which in size and shape corresponds to the damaged tissue of a patient. This could for example be a piece of cartilage for the knee.

They perforate the bone marrow in the body near the implant to ensure full access to stem cells.

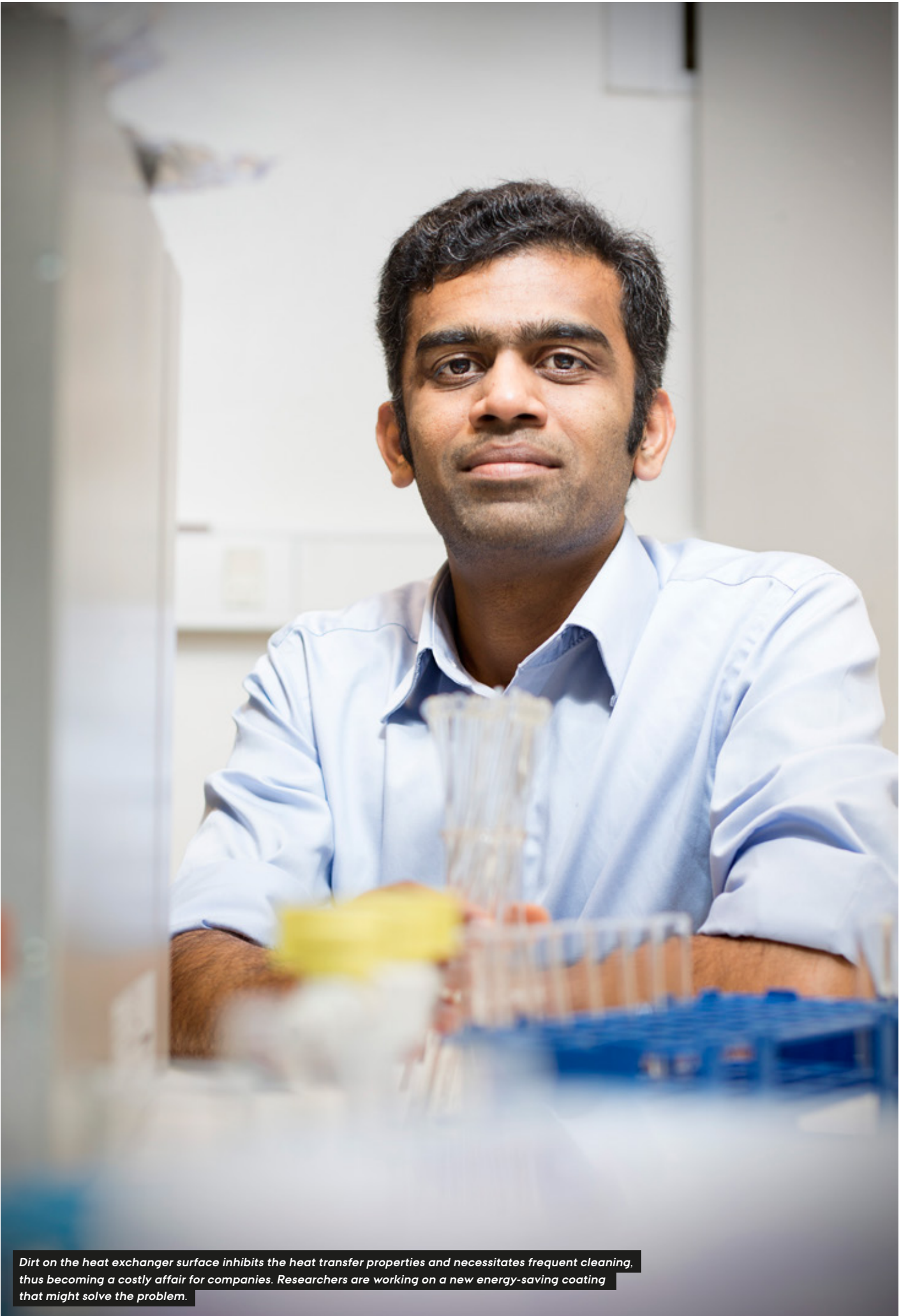
The specific nanostructure of the implant is designed to attract the patient's own stem cells and activate them to create new tissue such as cartilage, bone, skin or fat.

The implant then disintegrates as the new, healthy tissue is formed.

The principle of using the mechanical properties of the implant instead of chemicals to stimulate the growth of cells is a breakthrough in tissue technology.



Photo: Lise Balsby



Dirt on the heat exchanger surface inhibits the heat transfer properties and necessitates frequent cleaning, thus becoming a costly affair for companies. Researchers are working on a new energy-saving coating that might solve the problem.

Huge savings on the surface

Researchers in the fields of surface chemistry, surface structuring and biofouling are teaming up with industrial partners to develop energy-saving coatings for heat exchanger surfaces that may last up to four times longer than normal.

Fouling on heat exchangers involves the gradual build-up of undesired materials of diverse origin – microorganisms such as bacteria, organic matter and inorganic minerals – on surfaces that are in contact with liquid.

This layer of dirt on the heat exchanger surfaces inhibits the heat transfer properties and necessitates frequent cleaning, thus becoming a costly affair for companies.

Conventional solutions cannot handle the heat

Conventional antifouling coatings used in marine installations are unsuitable for heat exchanger applications because they are so thick that they reduce the heat transfer efficiency to an unacceptable level.

The aim of the new research project is to develop a new genre of antifouling coating technology for heat exchanger applications without compromising heat transfer efficiency. Due to the complex types of fouling matter, the coating chemistry will be optimised to incorporate anti-adhesive, anti-scaling and anti-microbial properties.

Good for the pocket and the environment

Developing antifouling solutions for heat

exchangers in water installations will not only provide a competitive advantage for industrial partners, but will also lead to significant financial and energy savings for many industries that use heat transfer processes. Such savings are expected to apply to maintenance and energy costs in particular.

The researchers believe that the proposed coating technology could achieve a three- to four-fold decrease in maintenance time without compromising the heat transfer property. This means dramatic financial savings for companies while the reduced energy consumption benefits the environment as well.

Knowledge for the future

The project will also include systematic studies of mineral fouling on metal surfaces to gain a fundamental new understanding of the phenomenon. The new knowledge will be published in scientific papers and will also be included in future teaching material.

“It’s important to save energy and money, but it’s just as important for us to make knowledge available for future generations,” says Assistant Professor Joseph Iruthayaraj.

project facts

TITLE

Heat transfer effective antifouling solutions for heat exchange surfaces

SCHEDULE

2014–2017

FINANCIAL FRAMEWORK

15 million DKK, The Danish National Advanced Technology Foundation

PARTNERS

Grundfos, Acccoat and Alfa Laval Corporate AB

CONTACT

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ENE RGY

The substantial transformation of the global climate and energy system calls for new sustainable technologies designed for a resource-limited and carbon-constrained world. Combined solar and wind power distributed intelligently through a smart grid are key drivers for this as well as novel energy storage technologies.

The dream of changing the energy consumption of the Europeans

In the coming years, Aarhus University will be the head of a large European energy research project and thus be examining patterns in the energy behaviour of private consumers. The goal is to make the Europeans better to use power when there is plenty of it.

Today, the production of electricity from renewable sources such as solar and wind power is very large. This means that sometimes we cannot use the amount that we have at our disposal from our energy system. This is one of the biggest climate-technological challenges, explains Associate Professor Rune Hylsberg Jacobsen from Aarhus University.

"We have an electricity production which we are unable to use in a way that is environmentally or economically optimal. If we want to succeed with our climate visions in Europe, it is crucial that we create a better balance between our electricity consumption and our electricity production from renewable energy sources."

As the wind blows

Especially through the latest decade we have become much better at utilising the energy from sun and wind. This has a large number of environmental benefits, but at the same time the drawback that it has become significantly more difficult to plan our total production of electricity.

Electricity must be used immediately when it is available, and since the re-

searchers after all do not have the power to change the weather conditions, they will now try to affect the consumption of the Europeans:

"Solar and wind energy is fluctuating, and the more we have at our disposal in our energy system, the more difficult it is to plan and manage our production. For the individual country or area, this means that there is often a surplus of electricity production. If we want to reduce the emission of greenhouse gases, we need to find out how to make people use the energy when it is available from the renewable energy sources," says Rune Hylsberg Jacobsen.

A better understanding of energy behaviour

This is the background for the European research project in which Rune Hylsberg Jacobsen and his research colleagues abroad in the coming years thoroughly will study the private consumers' energy behaviour and find new opportunities for balancing the electricity consumption with the electricity production from fluctuating energy supplies in the future.

"Basically it is all about, getting better understanding of the consumers and

their needs. We have to provide detailed knowledge about when, how much and in which way the energy is used in households and in which way we can influence the consumer behaviour. Is it, for instance, possible to move electricity consumption to the time of the day where it is most accessible and thus also cheapest? How much is it possible to relocate? And what needs to be done to make the individual family begin create new habits?" says Rune Hylsberg Jacobsen.

Among other things, researchers will develop an information technological system to be installed in 200 European households. The purpose of the system is to gather consumer information and correlate it with information about both the immediate and the expected electricity production.

"It will become one of the most detailed studies so far in which the consumption of each and every power socket in the individual homes in principle can be monitored. The potential is very large. If we succeed in creating a solution which can actually move some of the consumption without inconveniences for the consumer, it can provide huge savings



Aarhus University will be the head of one of Europe's largest investments so far - to change the public's energy consumption. The objective is to develop an energy management system which can make the future use of electricity more flexible. The photo shows Assistance Professor Rune Hylsberg Jacobsen.

in the total CO₂ account," says Rune Hylsberg Jacobsen.

Less surplus production of electricity

The present energy system in Europe is dimensioned with a capacity for the most extreme demand from the consumers, and it may get expensive if we look just a few years into the future where our energy consumption is expected to be further increased.

"If we are to provide Europe with energy according to the same model as today, we need to implement a costly expansion of the infrastructure. That is why we would like to find an alternative solution that can change our energy habits. And thus, the technology plays an important role", says Rune Hylsberg Jacobsen.

The researchers expect to have a finished prototype of an information technological system within three years, which can help the private consumer to move his energy con-

sumption to other parts of the day when the energy is far more available.

"We will get a unique insight into why people use electricity as they do and where it pays to change their practice. Much of this will take place automatically. Maybe you turn on your washing machine when the electricity is cheapest. And when you turn on your oven, you may be informed about the fact that the electricity is expensive at the moment, and maybe you will be asked whether you want to wait for an hour because the electricity prices are expected to be lower. Actually, it is a question of identifying the many small contributions that might grow bigger when it comes to how much electricity is consumed by the households in Europe," says Rune Hylsberg Jacobsen.

project facts

TITLE

SEMIAH – Scalable Energy Management Infrastructure for aggregation of serve

SCHEDULE

2014-2017

FINANCIAL FRAMEWORK

3.7 million EUR, EU's 7th Framework Programme for Research

PARTNERS

Agder Energy (NO), Center Suisse D'Electronique the Microtechnique (CH), Develco Products (DK), Devoteam Solutions (NO), EnAlpin (CH), Fraunhofer IWES (DE), Haute Ecole Specialisee the Suisse Occidentale (CH), Misurio (CH), netplus (CH), SEIC Teledis (CH) and the University of Agder (NO).

CONTACT

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Today, a lot of the sunlight is lost in standard solar cells because the wavelength is too long. In the SunTune project researchers want to develop techniques to convert more of the rays into usable light.

project facts

TITLE

SunTune

SCHEDULE

2015-2019

FINANCIAL FRAMEWORK

23 million DKK, Innovation Found Denmark

PARTNERS

Mads Clausen Institute, University of Southern Denmark, DTU Mechanical Engineering, Technical University of Denmark, International Solar Energy Research Center, Konstanz, Racell – Sapphire Group, and EnergiMidt A/S.

CONTACT

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On wavelength with the Sun

If we could convert the energy of all sun rays into electricity, we would be able to cover the world's power consumption many times over. The SunTune project aims at boosting efficiency of solar cells so that far more of the Sun's energy can be exploited in the future.

The Earth is enveloped by a vast blaze of light from the Sun, supplying all the energy we could ever dream of. Every year, the Sun provides us with an amount of energy that is almost 10,000 times as much as our annual global energy consumption. Currently it is possible to use solar cells to harvest sunlight and convert it into electricity but with a loss of more than 70 percent. This loss could be reduced if we were to succeed in getting solar cells to utilise a larger part of the solar spectrum. More efficient solar cells would be an important step towards Denmark's goal of being independent of fossil fuels by 2050.

Changing the color spectrum of sunlight

A research team based at Aarhus University will now try to 'tune' into the Sun's wavelength. The consortium behind the project consists of a unique collection of Danish and foreign researchers and representatives from Danish companies. Some of these actively manufacture solar cells while others would like to use them for electricity production.

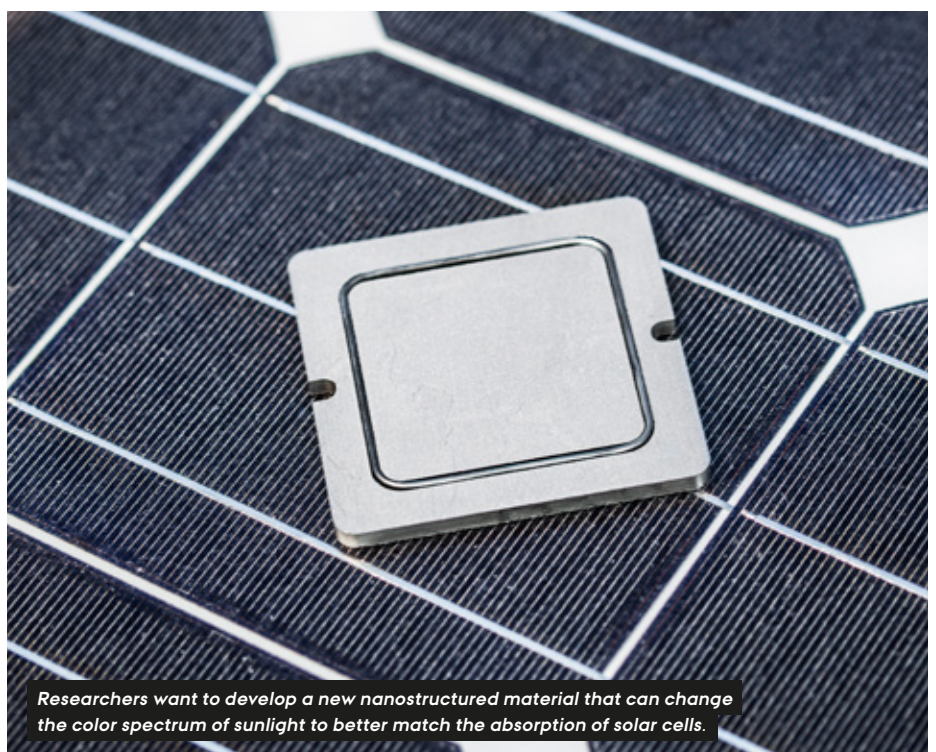
One reason for the low efficiency of standard solar cells is that a large part of the solar energy is in long-wavelength light, which is not converted to electricity in solar cells. If we want to make solar energy more cost-effective in the future, the trick is therefore to capture a larger portion of the light's energy.

"We want to develop new nanostructured materials that can change the color spectrum of sunlight to better match the absorption of solar cells. This can boost the efficiency of the existing technologies," says Associate Professor Søren Peder Madsen.

The ambition of the SunTune project is to find ways to utilise long-wavelength light from the Sun. This will take place by

changing the color spectrum for sunlight in the cell so that it better matches the area where power generation is effective.

The researchers hope to be able to increase efficiency by as much as 4 per cent points for silicon solar cells, and potentially even more for other types of solar cells.



Researchers want to develop a new nanostructured material that can change the color spectrum of sunlight to better match the absorption of solar cells.

Sustainable construction in Indonesia

In cooperation with Danida, researchers and lecturers will help establish a knowledge environment on sustainable construction in Indonesia.

Indonesia is one of the world's most rapidly growing economies and is in the midst of a historically large building boom. There is therefore an urgent need to create a sustainable construction culture, and there is enormous potential in making savings on the CO₂ account.

Aarhus University researchers within the field of civil and architectural engineering have entered into collaboration with Bakrie University to integrate more knowledge about energy technology in research environments and education programmes. They are teaching the Indonesians to work with a sustainable principle at all stages of the building process.

Knowledge will transform the building culture

The collaboration will strengthen the Indonesian engineers' knowledge about how to optimise energy efficiency throughout the entire life cycle of the building, from production of materials to design, construction and disposal. At the same time, they will gain basic knowledge about how to construct buildings that can operate with low energy consumption, particularly regarding ventilation, cooling and heat recovery.

"It's basically all about transferring knowledge across borders. We're well ahead in Denmark in terms of sustainable construction, and we've got some interesting cases. You need to understand energy processes at all stages of construction – this is

essential if you want to change a culture. And it's fundamentally about building up knowledge, which means the university collaboration is a good place to start," says Professor (Docent) Søren Wandahl.

New engineers as change agents

Researchers from Aarhus University are helping Bakrie University to make adjustments to the curriculum for civil and environmental engineers. The first group will graduate during the course of the coming years. They will meet the labour market with a significantly enhanced environmental profile, and Professor (Docent) Wandahl hopes that early action in the degree programmes can contribute to a change of mindset in Indonesia – not only in terms of technology, but also at the economic and social level.

"It's very likely that the next generation of civil and environmental engineers will get to boost more sustainable construction. They'll be the agents of change in the Indonesian building branch and put the environment on the agenda with more solid technical knowledge of building construction. This can lead to a crucial shift in consciousness in a society experiencing an extreme level of industrialisation and a culture that is different from the Danish because it has never experienced a shortage of fossil fuels," he says.

So far the Aarhus University researchers have identified the problem areas in the Indonesian building culture

with a focus on the content of the civil and the environmental engineering degree programmes, and they will use this to design new courses.

In addition to acquiring technical core competences, the Indonesian engineering students will learn completely new procedures, and the Danish researchers will train their teachers in using some of the educational and didactic methods that characterise the engineering degree programmes at Aarhus University.

project facts

TITLE

Educational Strengthening and Capacity Building of the Energy Efficient Building Sector in Indonesia

SCHEDULE

2013-2014

FINANCIAL FRAMEWORK

750.000 DKK, Danida's DBP programme

PARTNERS

Danish Energy Management
Bakrie University (Universitas Bakrie)

CONTACT

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*Indonesia is a growth economy that is experiencing an historically large building boom.
But is it possible to create a sustainable building culture in a society that has never experienced a shortage of fossil fuels?
In any case, that is the intention of the Danida project in which Aarhus University is participating.*



Complete DNA profiles for biogas bacteria

New knowledge about microorganisms is set to increase the output from biogas production. Researchers have begun a momentous study of the role of bacteria in the conversion of manure, plant fibres, wastewater sludge and food waste to green energy.

Photo: Anders Trørup



Many chapters in the story of microbiological evolution still remain to be written. With the help of new technology, researchers have begun the monumental task of mapping microorganisms at DNA level. This will produce new knowledge about ways to optimise biogas production. The photo shows Associate Professor Lars D.M. Ottosen in front of the biogas plant at Aarhus University, Foulum.

project facts

TITLE

Nomigas

SCHEDULE

2014–2017

FINANCIAL FRAMEWORK

16.7 million DKK, Innovation Fund Denmark, Danish Council for Strategic Research

PARTNERS

Aalborg University (Project management), University of Queensland, University of Vienna, Lund University, Krüger, Billund Vand (Billund Water), Primozone, Maabjerg Bioenergy, Danish Technological Institute

CONTACT

Associate Professor
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It is possible that neither expensive processing methods nor advanced technology will pave the way for economically viable biogas production. It appears that we can achieve a much greater gas output by closely studying bacteria and fine-tuning the conditions at the biogas plant to create the right environment for the microbiological processes.

“We’d like biogas production to be both energy-efficient and cheap, and this means getting microorganisms to work better. We’d therefore like to acquire new knowledge about the type of bacteria that exists in the biogas reactor and how they behave. It’s essential for us to increase the current level of methane yields in the reactor,” says Associate Professor Lars D. M. Ottosen.

Analytical work of historic proportions

Today, organic waste and residual products are converted into biogas in large tanks mainly based on practical experience with what works. In recent decades, science has been able to describe parts of the microbiological processes that influence biogas production, but this is far from sufficient if we want to optimise the output on the basis of evidence.

Over the coming years, researchers at Aarhus University will therefore map in great detail the complex interplay between the microbial processes involved

in biogas production in the hope of making energy production more effective.

The task involves analysing the composition of microorganisms and mapping the genomes of relevant species – something that was impossible only a few years ago. Today, Aarhus University has access to new DNA sequencing technology, and the researchers can use specialised equipment to extract an individual bacterium from the mass and study its entire genome.

“It will require extremely detailed knowledge of the microbiological processes that take place in the biogas plants if we’re to become better at controlling these processes. This is where the technological development can help us. In principle, we can currently identify a complete DNA profile for each and every microorganism and thereby describe their specific properties and how they work in the methane-producing food chain. We can also test how they react when we feed them different types of substrates or use different pre-treatment methods,” says Associate Professor Ottosen.

Good and bad microorganisms

The researchers aim to optimise the conditions for the bacteria in biogas plants, and the research project therefore includes comprehensive analyses of the composition of the microbial community under different operating conditions.

Initial results are promising and make it possible to begin identifying indicator organisms for good and bad biogas production.

“We can conclude that some biogas plants perform better than others. We just don’t know what the exact reasons are, and we need to get much better at troubleshooting to ensure a reliable and high level of gas production,” says Associate Professor Ottosen.

According to the associate professor, it is currently more or less coincidental that some biogas plants end up with a better composition of microorganisms than others and thus a higher methane yield.

Once the researchers have a comprehensive understanding of the microbial processes, they can begin much more targeted work on process control at biogas plants, including temperature regulation, addition of nutrients and groups of bacteria.



Bacteria convert CO₂ and wind power to methane

Researchers have succeeded in getting bacteria to convert CO₂ to methane in the laboratory. This discovery may constitute a step on the way towards storage of excess energy from wind turbines.

When bacteria convert biomass to methane, they produce a relatively large amount of carbon dioxide in the same process. This means that the finished biogas often consists of approximately 40–50 percent CO₂, which is a residual product lowering the energy density of biogas. However, a group of researchers have now described how excess power from wind turbines can convert carbon dioxide to biogas in anaerobic microbial processes with a possibly 100 percent methane yield. The next step is to study options for creating economically viable and safe full-scale operating solutions.

What do we do with the excess power?

Our current energy system is based on demand-controlled energy production that always has the capacity to meet the most extreme user demands. This entails increased implementation of renewable sources that depend on immediate wind and sun conditions, which means that we often have an excess of energy that we have to waste or export to other countries at a price that might be much lower than average production costs.

“This excess power constitutes one of the main challenges in the conversion to a sustainable energy society, and there’s an urgent need for new ways to store power from fluctuating energy sources,” says Associate Professor Lars D. M. Ottosen.

Together with his research colleagues, he has identified a new solution that may make it possible to store wind power at biogas plants.

Using hydrogen to feed bacteria

The principle is quite simple. The researchers take the surplus power from wind turbines and use it to split water into oxygen and hydrogen by means of electrolysis. The hydrogen is used to feed the bacteria that can then convert CO₂ to methane.

“By adding hydrogen to the reactor, we can shift the microbial balance and significantly increase the methane yield from a given amount of biomass. Today, biogas from standard plants consists of CO₂ and methane in equal proportions. In the laboratory, we can increase the methane proportion to almost 100 percent by adding hydrogen,” says Associate Professor Ottosen.

Using hydrogen to produce methane is nothing new. The method has previously been used in connection with fuel cells, but this technology is so expensive that it is unlikely to be used outside the laboratory.

“We use the excess power and let the bacteria do the work for us. All we really do is use a process that’s been around for billions of years. The challenge we’re facing is to fully understand this process in detail and create a system that allows us to control it,” says Associate Professor Ottosen.

The researchers expect that the new microbiological method for methane production can be implemented within the next five years and become an important technology for the storage of electricity within the existing energy infrastructure.

project facts

TITLE

Hycon

SCHEDULE

2011–2015

FINANCIAL FRAMEWORK

16.1 million DKK, Innovation Fund Denmark, Danish Council for Strategic Research

PARTNERS

Aalborg University, University of Queensland, Xergi, Novozymes, Danish Technological Institute

CONTACT

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More energy out of the wind

Small sensors on wind turbine blades reveal how to reduce downtime and produce more power from the same amount of wind.

By recording vibrations in wind turbine blades, researchers can acquire previously unavailable data about wind turbine performance and thereby new knowledge about how to optimise wind power. The researchers have entered into an agreement with Vestas Wind Systems A/S, the world's largest manufacturer of wind turbines. In the years ahead, they will further develop a sensor-based measuring method that can be used for purposes such as monitoring operating conditions and wear and tear, as well as predicting durability.

"Our fundamental ambition is to gain more detailed knowledge about what goes on in the blades when the wind blows and the turbine produces electricity. We want to know more about the factors that have an impact on wind turbine durability and the turbine's ability to boost its output of wind energy. We hope to be able to use the sensor technology to learn about the vibrations and gain a better understanding of what's required to maximise power production for the same cost," says Professor Rune Brincker.

Vibrations reveal damage

Vibrations occur all the time in all constructions. They originate from sources such as ordinary seismic

activity in the ground surface and from wind. By following the development in the vibration patterns, the researchers can provide precise characteristics of the main properties, such as mass and rigidity, and thereby determine the start of structural damage.

"Today we actually have to over-dimension our wind turbines to ensure that they can withstand years of wear and tear. But it's a strategy the wind turbine manufacturers have used for want of a better solution. Using the sensors, we can not only learn something new about the structure's wear and tear, but we can also predict damage long before it becomes visible or is symptomatic. This means that we can carry out maintenance and repair with higher accuracy and thereby save on materials," says Professor Brincker.

So far the researchers have documented that sensor-based monitoring of wind turbines can provide material savings of 20 percent in the tower's expensive steel construction alone.

No more ice on the blades

The same method has proved to be useful for detecting ice on wind turbine blades, and this solves a major problem – especially in the Nordic

countries where layers of ice impair the wind turbine's aerodynamic properties and cause a risk of dangerous ice throw.

In low temperature conditions, wind turbines stand still for approximately 10 percent of the year because of ice. This percentage is significantly higher in arctic or mountain regions.

The researchers will use computer-based models to study how to reduce the number of sensors on the wind turbine and thereby make the technology cheaper.

project facts

TITLE

Mass detection on stationary wind turbine blade

SCHEDULE

2014-2015

PARTNERS

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CONTACT

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Using sensors Professor Rune Brincker can record vibrations in wind turbines and thereby learn more about the conditions that affect energy conversion.



The researchers are carrying out experiments with sandbags on the blades to investigate the effect of a change in mass on the vibration pattern. This can help reveal factors such as layers of ice or wear and tear.

New oil extraction technology could yield gigantic profits

The Danish subsurface consists of limestone, which makes it particularly difficult to extract oil. However, researchers are spearheading the development of a potentially game-changing technology.

Photo: Anders Trørup



It takes a good deal of technological innovation to get access to more oil from the calcareous Danish subsurface. Associate Professor Mogens Hinge is working on promising new nanotechnology that could prove to be the first chapter of a new fuel adventure.

Billions in profits could be the result if the new – as yet unnamed – enhanced oil recovery (EOR) project succeeds at Aarhus University. The project deals with extracting more oil from limestone oil fields.

Today we only benefit from a small percentage of the oil as it is difficult to extract it in limestone using current technologies. However, things might look very different in the future because research at Aarhus University has already showed promising laboratory results which could have a significant impact on Denmark's oil recovery.

New oil adventure in the North Sea?

The research group behind the EOR project makes no secret of the fact that the North Sea subsurface is enormously complex with porous calcareous layers, which means that a good deal of technological innovation is required to increase the level of extraction. On the other hand, not much more oil is needed to make the project a success.

"Even if we only increase recovery by 1 percent, this alone will cover about ten whole years of spending in Denmark, which is worth about DKK 50 billion. So just imagine a success rate of 10 percent or – for that matter – 60 percent. It would be huge," says Associate Professor Hinge.

Nanomaterials to change the water flow

Danish oil is currently extracted by pumping water into the oil field and thereby pushing out the oil. However, quite a lot of oil remains in the Danish subsurface because the water makes channels in the limestone and bypasses the oil. The new technology currently being developed by engineering specialists in analytical chemistry and geology is intended to change the channels with nanomaterials so that the water is forced to take another route through the limestone – the oily route – thus pushing out more oil.

"Our idea is to make nanomaterials that can change the permeability of the calcareous layers, and thereby make it more difficult for the water to pass the empty channels. This will force it to push the oil up," says Mogens Hinge.

The researchers are planning to develop their own nanomaterial for the purpose.

"Extremely high precision is required when you're working with the subsurface. We'd like to design nanomaterials that can trickle down and create changes where the water runs in the calcareous layers, which means they need the right properties to be attracted by the limestone at exactly the right strength," explains Associate Professor Hinge.

If the nanomaterials are attracted too strongly, their intended function might be reduced. In addition, it is crucial that the nanomaterial can be removed afterwards for environmental reasons.

project facts

TITLE

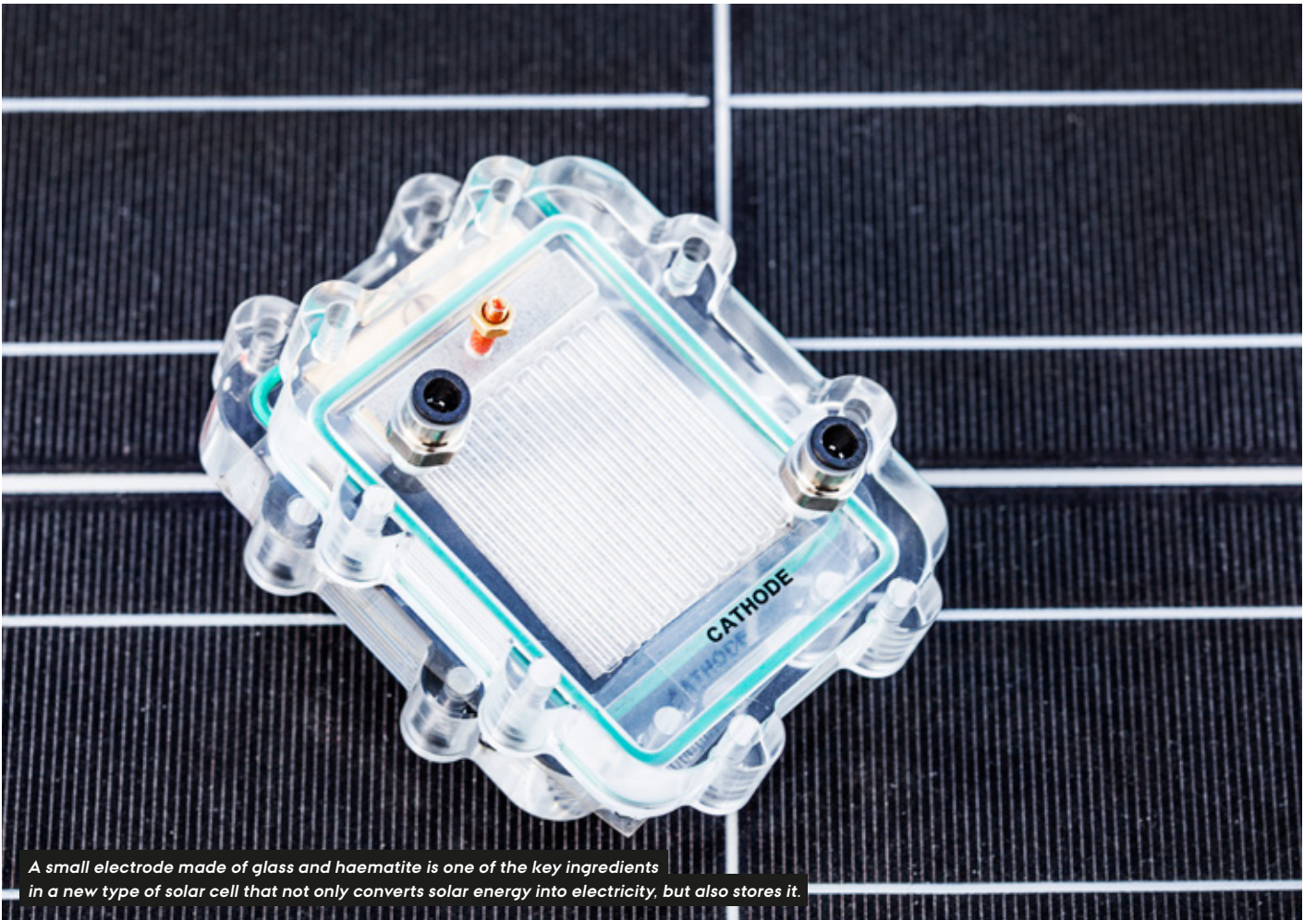
Enhanced Oil Recovery (EOR)

CONTACT

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Can you store solar energy and retrieve it again when you need it? And can you do it in a way that is not only inexpensive, but also energy-efficient and environmentally responsible? Researchers have developed a new technology for charging flow batteries with solar power. It looks as though this could be very significant for the supply of electricity to private consumers in the future.



A small electrode made of glass and haematite is one of the key ingredients in a new type of solar cell that not only converts solar energy into electricity, but also stores it.

Storage capacity in new solar cells

A new type of solar cell converts light into chemical energy and stores it in tanks containing liquids so it can be taken out again when required. The idea is simple, but it has wide-ranging potential. Researchers are testing a new method for charging flow batteries with solar power.

There is much to indicate that a technology capable of storing energy from the sun and subsequently converting it into electricity can be a reality. The key to its success is a new technology for charging flow batteries with solar power, developed by researchers at Aarhus University in collaboration with a group at the University of Porto. In the coming years, they will improve the technology in international collaboration, making it cheaper and more efficient.

“Storing solar energy currently involves such large costs that it’s far from being profitable. We’ll change the way we use energy and therefore work with a new technology that can charge flow batteries with solar energy. Flow batteries are interesting because they make it possible to store and convert energy from sustainable sources. The question is just how efficiently it can be done. We’re looking at some specific photoelectrodes and liquids that seem promising,” says Associate Professor Anders Bentien.

A flow battery basically works the same way as a fuel cell, but with the difference that the electricity is stored in liquids as opposed to hydrogen and oxygen in fuel cells.

Solar energy stored in two liquids

Today, solar cells immediately convert the energy available from sunlight into electricity. The disadvantage is that solar energy varies depending on the time of day and the weather conditions. It has to be used while it is there – or else it goes to waste. And this is precisely the problem the researchers are trying to solve with

the new type of solar cells which can charge a flow battery directly.

They are using a technology based on photoelectrochemical principles to store the energy in two liquids. These liquids can subsequently be pumped into a flow battery where the energy is converted into electricity. The technology works according to the same principle as fuel cells where hydrogen and oxygen are produced photoelectrochemically from water, and can subsequently be converted into electricity in a fuel cell.

The advantage of using liquids is that it makes it possible to store electricity much more efficiently in the flow battery. The technology for solar charging is also both simple and inexpensive because the flow battery’s photoelectrode is made of ordinary glass, and the solar-active material simply consists of a thin layer of hematite – also known as rust.

The initial laboratory experiments have demonstrated that the principle of charging flow batteries directly with solar power works, but it is still too early to say anything about the degree of efficiency the researchers can achieve.

The perfect match

The key issue in relation to efficiency – and the really great challenge faced by the researchers – is to identify a liquid that matches a specific photoelectrode in order to optimise the charging of flow batteries with solar power. The researchers have a handful of different photoelectrode materials in their sights, and even

more liquids that look interesting.

“Until now, we’ve shown that it’s possible to directly charge flow batteries with solar power, and the major challenge in terms of research is to identify the optimal match between the liquid and the material for the photoelectrode. We’d like to reach a solution that provides the greatest effect and the lowest energy loss, and that is both cheap to produce and environmentally responsible at the same time,” says Associate Professor Bentien.

For the time being, it appears that a special combination of water, sulphuric acid and organic molecules could be the answer to this challenge.

During the course of the next four years, the researchers in the project will spend time studying how to make the technology for charging flow batteries with solar power as efficient as possible in the laboratory.

project facts

TITLE

Photo-electrochemical charging of redox couples for conversion and storage of solar energy

SCHEDULE

2014–2018

FINANCIAL FRAMEWORK

6.4 million DKK, Danish Council for Independent Research

PARTNERS

University of Porto, Portugal

CONTACT

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READY for a historically large energy project

With a large European Commission grant researchers are going to explore new solutions to how housing areas can reduce energy consumption.

With a total investment of DKK 144 million, the European Union is now focusing massively on a demonstration project that aims to determine how to reduce as well as possible the overall energy consumption in private households in a residential area.

The project involves 1,000 houses and apartments in the city of Aarhus, which in the coming years will function as a full-scale laboratory for researchers at the Department of Engineering.

Entire neighbourhoods as energy laboratories

It is currently possible to calculate how individual households and private consumers can conserve the most energy. However, very little is known about what works best if the aim is to reduce CO₂ emission in an entire housing area.

The researchers will use the large grant to find answers to this overall question. They are now moving out of the laboratories and will spend the next three years establishing the largest ever full-scale experimental set-up, consisting of several suburban streets and apartment blocks.

This is a crucial step towards acquiring the necessary knowledge to create the intelligent energy supply of the future, according to Assistant Professor Steffen Petersen who is the energy specialist on the project.

"We need to think more holistically and look at ways to optimally reduce energy consumption in entire residential areas and not just in individual households. We must go all the way round and consider

behavioural consumption, materials for energy renovation and new technology for energy storage in homes. As researchers, we now have a great chance to put our knowledge into play in real circumstances and thereby demonstrate how to convert to sustainable energy as well and economically as possible in an existing housing area," he says.

The project is called READY and it involves more than 1,000 households in Aarhus, as well as approximately 30,000 square metres of multi-family houses in Sweden. The Department of Engineering will carry out energy analyses and identify the potential for energy savings and a reduction of greenhouse gas emissions. At the same time, several private companies are involved in the project because the hope is to develop new technologies with commercial potential.

The optimal mix for green cities

One of the project's greatest challenges is to handle the surplus production of electricity from sustainable energy sources such as solar and wind power. The researchers will therefore demonstrate how to manage the supply and demand of electricity on a neighbourhood scale.

They will also study whether the energy renovation of homes is possible so that district heating suppliers can lower the flow temperature.

"In reality, the energy renovation of residential areas is a jungle. Nobody really knows the optimal combination of efforts. What is most worthwhile – adding 10 centimetres of extra insulation to the houses, establishing heat pumps or

project facts

TITLE

Resource Efficient cities implementing ADvanced smart ciTY solutions (READY)

FINANCIAL FRAMEWORK

33 million EUR, The European Commission

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investing in smart control of electricity consumption so that it matches energy accessibility as well as possible? Naturally we've got some theoretically well-founded hypotheses, but there's no evidence-based foundation to say how to achieve optimal energy reduction," says Assistant Professor Petersen.

Approximately nine out of ten households in the European Union need energy renovation in the course of the coming decades if the member states are to live up to the target of fossil-free energy supply.

New model for energy renovation

One of the aims of the READY project is therefore to design a universal model that can be used to calculate optimal energy renovation efforts for neighbourhoods with specific issues throughout Europe.

"Nowadays, we're seeing a trend towards trying to save on energy in all ways possible. Our expectations are that we need to make greater efforts in connection with using energy when it's available and building small energy stores in our homes. We now have a unique opportunity to try out our hypotheses in full-scale demonstration trials," says Project Manager Peter Harling Lykke who is the administrative manager of READY at Aarhus University.

The researchers will carry out experiments such as converting food waste to biogas by installing kitchen waste disposal units in the households involved, and using electric car batteries to store power in houses.

Energy reduction for residential areas

- The project aims to provide new knowledge about the most optimal energy renovation of residential areas to prepare them for the intelligent energy supply of the future.
- The project's experimental platforms are Aarhus City Council and Växjö in Sweden. This involves two residential areas with almost 500 houses and 413 apartments.
- The European Commission has awarded the project a grant of DKK 144 million and the overall budget is DKK 250 million.
- READY is supported by a consortium of 23 different public and private partners.



How can we achieve optimal energy reduction for residential areas? In the coming years, the Aarhus University will provide research for READY – the historically large EU project. This photo is taken from the top of the Navitas Building looking towards Aarhus.

Navitas Building as a laboratory

The Navitas Building at the Port of Aarhus is also a building laboratory, which makes it unique in a Danish context. The supporting structures are equipped with sensors and the energy systems are freely accessible to researchers and students.

Navitas opened in 2014 and now it houses Aarhus University's education and research activities in civil and architectural engineering and mechanical engineering.

The building is fitted with highly specialised laboratory facilities and experimental equipment and constructed as a full-scale energy laboratory. Here the supporting structures, energy management systems, and cooling and ventilation systems are fully accessible to researchers and students.

In addition, the building's energy monitoring system is an extended user interface that continually visualises the building's operating status with particular focus on the indoor climate and energy consumption.

- Navitas complies with all principles for integrated energy design. This means that the building intuitively adapts to the needs of its users with the lowest possible energy consumption.
- A total of 1280 solar cells mounted on the roof provide the building with energy.
- Sea water is used to cool the lower floors.



HEA
LTH
CARE

Digital medicine can potentially reduce inefficiencies in healthcare delivery, improve access, reduce costs, increase quality and make treatment more personalised and precise. Disciplines like telemedicine, communication systems, biomedical sensors, wearable electronics, tissue engineering and neuro engineering empower this.

project facts

TITLE

Anti-angiogenic antibodies

FINANCIAL FRAMEWORK

Different foundations: Danish Council for Independent Research, European Research and Technological Development 6th Framework Programme and 7th Framework Programme, and private foundations

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New antibodies for cancer treatment

Out of a library with billions of artificial antibodies, researchers have identified ten that can possibly prevent cancer tumours from growing.

A research team at Aarhus University has developed ten new antibodies that can possibly be used in the battle against cancer. They work by inhibiting the body's blood vessel formation close to the tumour which is thereby cut off from oxygen and nutrient supply.

Up to now, the researchers have tested some of the antibodies on mice and, in the laboratory, they have succeeded in using them to stop the development of malignant tumours.

"The antibodies we've found prevent a cancer tumour from growing. They appear to work perfectly in the laboratory and this means, of course, that they've got incredibly interesting therapeutic potential that we'll investigate further. However, we're still quite early in the experimental stage," says Associate Professor Peter Kristensen.

He is the main architect behind the new antibodies, but he stresses that the results are preliminary.

Antibodies stifle cancer

The antibodies neutralise the effects of signal substances released by carcinoma cells to get blood vessels to repli-

cate, thus cutting off the blood supply to the tumour.

A cancer tumour deprived of oxygen and nutrients becomes dormant and is thereby made harmless. If it receives a supply from the bloodstream, however, it grows and spreads, and the researchers appear to be able to prevent this deadly process.

They are among the world's leading specialists in developing artificial antibodies for cancer treatment and, in recent years, they have worked on compositions of genes for a collection of several billion new types of antibodies. To date, they have actually identified ten that appear to be able to impede the development of cancer.

A small number of therapeutic antibodies already exist, some of which have the same effect as the antibodies developed by the Aarhus University researchers. However, the existing antibodies are extremely expensive to produce. The new antibodies are easier to extract, and they also appear to be more effective because they hit other – and possibly stronger – signal molecules from the cancer cells. The demand

for therapeutic antibodies for cancer treatment is steadily increasing. In 2013 alone, worldwide sales amounted to more than DKK 340 billion.

The art of finding a needle in a haystack

Establishing an extensive library of artificial antibodies is no major research achievement in itself. The difficulty is singling out the few that work, and this is something the Aarhus University researchers are good at.

"We've got a large library of antibodies that can supplement the body's own fight against disease. The major engineering challenge is identifying the ones that are relevant regarding the specific purpose. In this case, we've found those that have an inhibitory effect on blood vessel formation, and this is crucial for our better understanding of disease mechanisms and possibly developing new forms of therapy," says Associate Professor Kristensen.

The researchers isolated their antibodies from a library consisting of billions of different antibodies, and they subsequently analysed the ability of the individual antibodies to inhibit blood vessel formation.



A research team has succeeded in identifying ten new antibodies that can keep cancer dormant. From the left: Associate Professor Luis Alvarez-Vallina, Associate Professor Peter Kristensen and Associate Professor Edzard Spillner.

This sounds like incredibly extensive laboratory work, and it would have been far from possible just a few years ago. However, they used a biological technology for this purpose that they developed and published in Nature Protocols three years ago. It helps them to identify and extract the antibodies with specific binding properties regarding the surface proteins in blood vessel cells.

In the coming years, the researchers will work on gaining a more in-depth understanding of the ten antibodies.

“We’re at the stage where we’ve identified some antibodies that bind something or other that makes blood vessel replication behave differently. In the coming years, we’ll study how they behave in different test systems. This will provide us with insight that can be valuable in the long term when developing new cancer drugs,” says Associate Professor Kristensen.

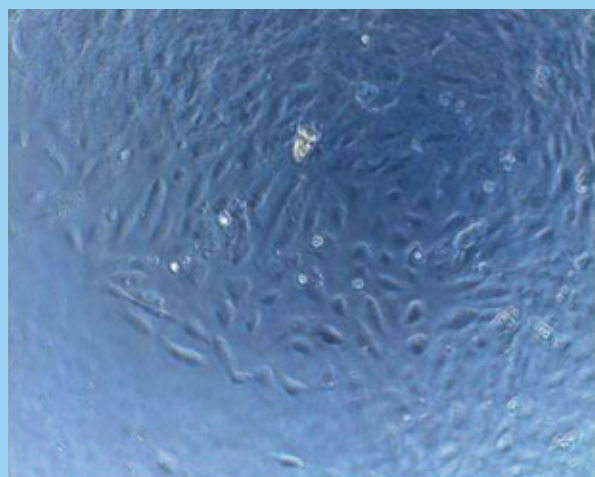
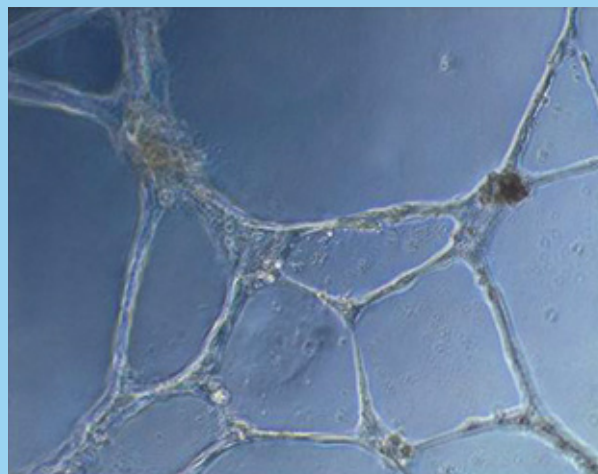
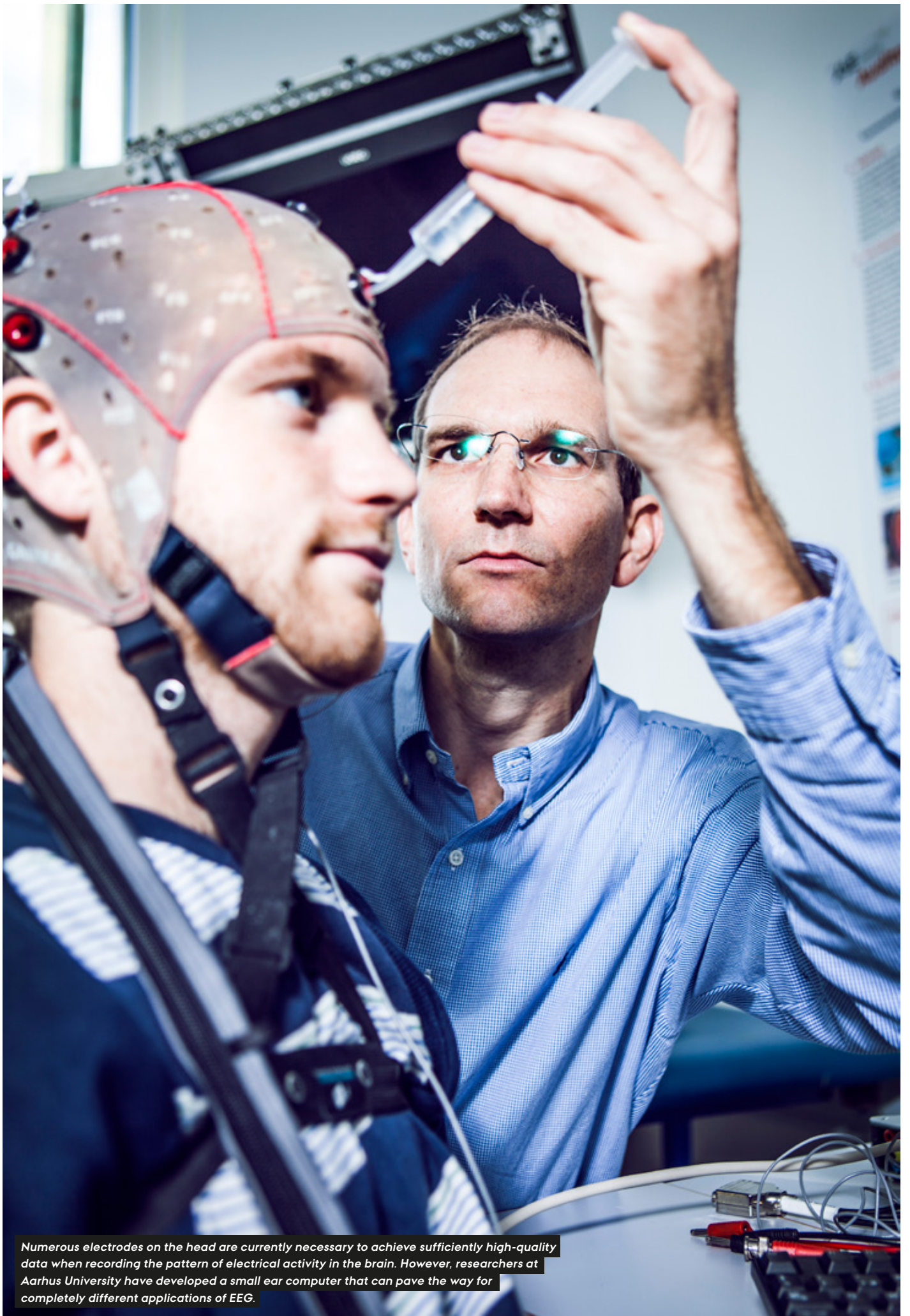


Photo: Peter Kristensen



Illustrated here is one of the antibodies that bind to blood vessel cells and prevent them from forming new pathways into cancer cells.



Numerous electrodes on the head are currently necessary to achieve sufficiently high-quality data when recording the pattern of electrical activity in the brain. However, researchers at Aarhus University have developed a small ear computer that can pave the way for completely different applications of EEG.

Neuro-Engineering of the future

Researchers have been able to present the first version of a miniature appliance that is capable of measuring electrical activity in the brain through the ear. This enables them to bring EEG-monitoring out of hospital labs and into everyday life.

Electroencephalography (EEG) is far from being a new technique. For decades, EEG has been used to measure electrical activity in the brain in a number of diagnostic contexts, for example in connection with the investigations of epilepsy and sleep disorders, or to localise tumours.

Using a large number of small electrodes placed on the patient's scalp, it is possible to measure electrical brain signals for a limited period of time in laboratories or neurophysiology departments.

With the help of extremely advanced data processing, it is now also possible to not only study neurological disturbances, but also to acquire insight into normal mental conditions such as levels of concentration, intentions or feelings.

Out of the laboratory and into everyday life

The potential of the technology is enormous. EarEEG can be integrated into devices that can be used in everyday life situations outside the laboratory, and this provides a paradigm shift as it enables researchers to decode the signals of the brain in natural settings over extended periods of time.

Professor (Docent) Preben Kidmose, who is one of the world's leading

experts in the measurement of EEG through the ear, explains:

"In the long term, EEG measurements may become very important in our day-to-day lives. The entire field involved in studying how humans and electronic devices interact is undergoing major changes. Once this technology becomes fully available for use outside the laboratory for extended periods of time, we'll all notice the difference," he says.

Today, it is already technologically possible to establish direct communication between the brain and different computer-controlled devices.

"We've seen some of the first far-reaching examples of how EEG can be used in brand new ways. When a lame woman in the USA can control the computer mouse with her thoughts, or when she drinks her coffee using a robot-controlled arm merely by thinking of the physical movement, it's because her brain signals are registered and translated to computer instructions," he continues.

Discreet measurement though the ear

According to Professor (Docent) Kidmose, neuro-engineers have long been researching how signals from the brain

can be recorded non-invasively, with sufficient high quality, and in a manner that is discreet and does not disturb the person being investigated.

This is a large, international research field with the common goal to convert conventional EEG systems used in laboratories to new, discreet wearable systems.

At Aarhus University, researchers have specialised in measuring EEG in the ear, and so far this appears to be a promising method.

"In research contexts, it would be valuable to carry out EEG studies over extended periods of time without the test subjects being affected by the measuring equipment. It would often be a great advantage to study brain activity for longer periods of time without interruptions and outside the laboratory or clinic. Our results indicate that EarEEG is an attractive method as it is user-friendly, discreet and comfortable," says Preben Kidmose.

EEG in new contexts

The ear technology paves the way for using EEG in completely new contexts. Within the clinical field, for example, it will thus be possible to use EarEEG devices to monitor mental and neurological conditions, to optimise therapeutic treatments, or to obtain neuro feedback.



At Aarhus University, researchers have specialised in measuring EEG in the ear. They have developed a discreet wearable device that enables them to study brain activity with high signal quality for longer periods of time outside the laboratory or clinic.



As far as healthy individuals are concerned, it will be possible to use the technology to monitor stress loads and sleep, or for simple forms of controlling electronic devices in the home by means of thought.

Last year, researchers at Aarhus University received a major grant that enabled them to develop a new form of EEG technology suitable for measurement through the ear.

The first early prototype, which is no larger than an earplug, is already available. According to the plan, the small device will use three tiny electrodes and a micro-computer that can interpret the activity of the brain. It looks a bit like a normal modern hearing aid and is almost invisible in the ear canal. Processing the signals and the analogue electronics uses very little energy so the researchers are not dependent on new battery technology.

The dream of the pure signal from the brain

On the other hand, new knowledge is required to develop the optimal electrode technology to capture the faint signals from the brain. This includes both material technology for the electrodes, analogue electronic instrumentation for measuring the signals, and comprehensive studies of physiological

artefacts and the electric field lines from the brain in order to determine the optimal electrode configurations.

This is the view of Simon Lind Kappel, a PhD student at Aarhus University who is working on this very topic.

"The design of the electrode is one of our main challenges. What is the best possible position of the measuring points? And how do we identify and diminish the electrical activity produced by movements of the head or jaws, for instance, so we're left with a signal from the brain that is as clear as possible?" he says.

The way ahead is anything but straightforward and involves repeated laboratory tests.

"We're working systematically with test subjects in the laboratory. We ask them, for example, to clench their jaws or make controlled movements with their heads. That way we're able to describe the different noise components and thus optimise the electrode technology so that the signal we measure is as pure as possible," says Simon Kappel.

The initial design of the device for measuring brain activity through the ear looks promising, and the research-

ers expect to obtain the same quality data as is currently produced by traditional EEG measurements.

Better treatment of epilepsy

The researchers are currently working on using the EarEEG technology to warn diabetic patients of impending hypoglycaemia. In the coming years, they will also investigate how the technology can be used for people with epilepsy. The aim is to make the ear computer's data quality so good that it can provide the same clinical information as what can be achieved using current technology where patients are monitored over a period of several days in hospital.

"We'd like to show that we can monitor epileptic patients in their daily environment over time and with good data quality. This will save the patients from long and tedious investigations in hospital, and it provides us with a unique opportunity to learn much more about the disease at the same time," says Preben Kidmose.

The researchers will use the EarEEG technology to gain a more detailed understanding of epilepsy and the neurological variations in their seizures, thereby providing better conditions for tailoring treatment and controlling medication dosages for individual patients.



The method for measuring brain activity is interesting in a considerable number of other diagnostic contexts – such as psychological disorders – where the importance of neurology is not completely understood today.

project facts

TITLE

Neuro24/7 - Neurotechnology for 24/7 mental state monitoring

SCHEDULE

2014-2016

FINANCIAL FRAMEWORK

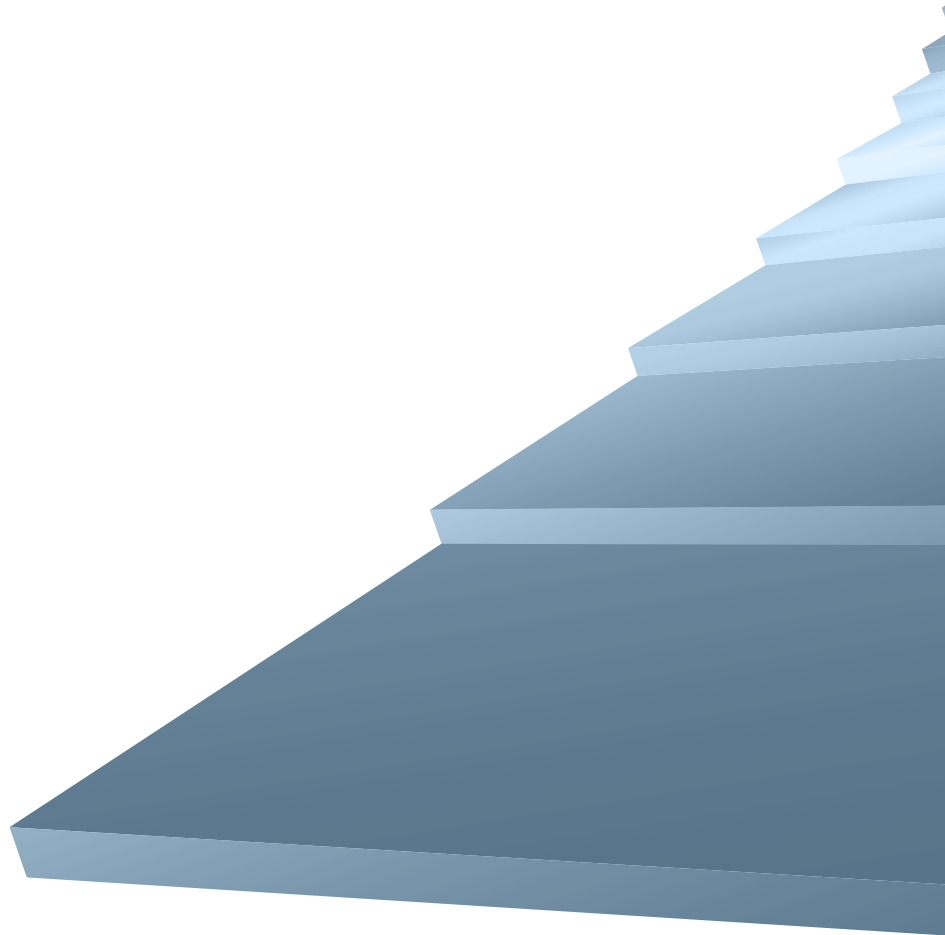
6,7 million DKK,
Danish Innovation Foundation

PARTNERS

DTU Compute, Neurophysiology
Center at Roskilde University Hospital,
Hyposafe A/S

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When medical design surpasses evolution

A new generation of biological medicines is on the way: Recombinantly engineered antibodies that are much more efficient and versatile than those produced by the body. They are also far better than conventional recombinant antibodies, which mimic the natural ones – and it will be possible to produce them much more cheaply.

Photo: Anders Trærup



The research team in the Immunotherapy and Cell Engineering Laboratory is exploring a new generation of biological medicines based on engineered antibodies.

It's a bit like breeding a hunting dog with a super-sensitive nose and extremely strong muscles – and then teaching it to shoot.

Only this hunting dog is microscopic and, instead of hunting hares or pheasants, it preys on a wide range of viruses, bacteria, parasites or cancer cells in our bodies.

Oh, and it hasn't been bred, but was designed in a laboratory at Aarhus University. Moreover, its future siblings will probably be produced in yeast tanks.

Antibodies with six arms

The super hunting dog is a multivalent antibody.

Antibodies play an important role in our immune system: they identify potentially undesirable elements (termed antigens) in the body and bind to them so that other immune cells can neutralise them – just like when a hunting dog has tracked down a prey and immobilises it until the hunter arrives.

Natural antibodies are bivalent, i.e. they have two points of interaction with the antigen. An antibody molecule is shaped like a Y in which two identical binding sites are located in the two upper 'arms' while the lower arm interacts with the immune system.

By recombining the genes in strands of DNA (hence the term recombinant), scientists have so far managed to create multivalent antibody molecules with up to six binding sites. Instead of a Y, they will thus look like a Ж.

A better grip

The extra antibody binding sites provide a great advantage because each one creates only a weak binding to the 'prey', making it difficult in many cases to create sufficiently strong interactions by means of conventional antibodies.

"An antibody with six 'arms' is more efficient than one with two arms because the cumulative binding is stronger, and because it provides a better bridge

between the targeted antigen and the immune system. This is of particular importance for the prevention of tumours which can be quite resistant to ordinary antibodies," explains Associate Professor Luis Álvarez-Vallina.

Adjustable functionalities

Not only do the new antibodies have several arms for gripping, they can also be made smaller than normal, making them more effective, particularly against cancer cells. In addition, they are much more versatile than the conventional recombinant antibodies presently used in healthcare.

Since the first usable copy of an antibody molecule was produced in 1975, 39 different monoclonal antibodies have made it into clinical use.

They are called monoclonal antibodies because they are produced by cells that are all clones of a single cell from a mammal – typically a mouse – immunised with a human molecule or cell that its antibody is supposed to react with.

The monoclonal antibodies are typically engineered to resemble human antibodies so that the patient's own immune system does not attack them. However, each one of them is still 'programmed' to bind to one specific target – namely that which was injected into the mouse.

"We now have the technology to adapt the recombinant antibodies to many different tasks. For example, we can adjust their penetration ability and their ability to inhibit growth factors (in conditions such as arthritis and other autoimmune diseases). Within the same molecule, we can also combine an antibody and a toxin, which can be aimed directly at tumour cells. It's like having a very versatile tracker dog with a rifle," says Associate Professor Álvarez-Vallina.

Expensive but good

The artificial antibodies are gaining importance in research as well as in the diagnosis and treatment of diseases. Scientists and doctors use them not only

to detect bacteria, viruses or metastases, but also to treat them.

In principle, the monoclonal antibodies can be produced in unlimited quantities. By artificially fusing the plasma cell that produces the desired antibody with a specific myeloma cell, it is possible to create a hybrid that divides into millions of cells, all of which are genetically identical to the first one. The technique is called hybridoma and it is expensive.

However, Associate Professor Álvarez-Vallina and his colleagues have caused yeast cells to produce fragments of antibodies with three binding sites. The yeast *Pichia pastoris* is often used to express the genetic information in DNA into proteins, and it does so very efficiently and cheaply.

In this case, the yield was approximately 20 times higher than with human cells.

"This way we can produce more and better antibodies more efficiently and cheaply. In a few years, the method will be ready for industrial use," predicts Associate Professor Álvarez-Vallina.

project facts

TITLE

New antibody formats for therapy

SCHEDULE

2014-2017

FINANCIAL FRAMEWORK

2.4 million DKK,
Novo Nordisk Foundation,

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New Cardiovascular Experimental Lab

With a cardiovascular laboratory facilitated with exclusive custom-built equipment, engineers and doctors can now strengthen their interdisciplinary research collaboration.

Aarhus University is noticeably stepping up its engineering research and development activities within the area of cardiac disease. Researchers and students will work in close collaboration with doctors from the Aarhus University Hospital in a new laboratory that provides the opportunity to conduct very detailed research and experiments relating to testing and developing implants and new treatments.

Collaboration between doctors and engineers has existed in Aarhus for several years, resulting in a number of scientific and commercial breakthroughs. This is mainly due to a relatively rare interdisciplinary focus on biomedical engineering, and the new laboratory will lead the

way for much more research results to come, according to Associate Professor Peter Johansen, head of the new Cardiovascular Experimental Lab (CAVE Lab).

"The new laboratory provides a facility where engineering and medicine can join forces to create significant research results for the benefit of future cardiac patients," he says.

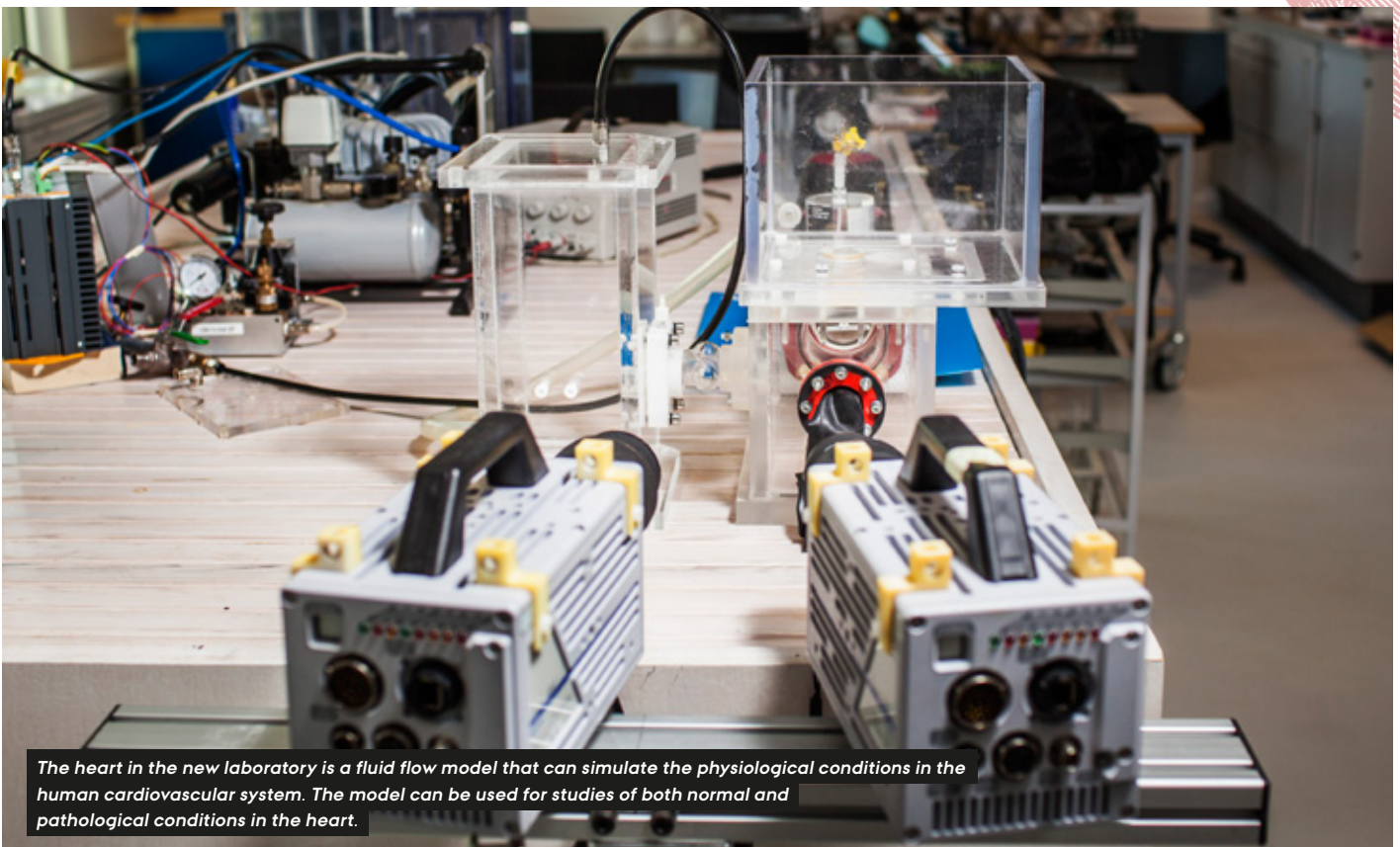
Testing new surgical procedures

The CAVE Lab is equipped with various fluid models that can simulate the pressure and flow conditions in a beating heart. This provides a platform for performing detailed testing of isolated factors that cannot be investigated to the same extent in a living heart. Such

types of investigations are important and a prerequisite for developing new types of implants with improved function and durability or for testing new surgical procedures.

Assessing the durability of various heart implants is currently performed through different types of accelerated fatigue tests. However, the actual life span of a device is first known when clinical data revealing this are available, which may be several decades after implantation. In the new cardiovascular laboratory, the researchers will work on measuring the physiological loads the implants are exposed to during short time experiments and based on this estimate the expected durability.

Photo: Anders Trørup



The heart in the new laboratory is a fluid flow model that can simulate the physiological conditions in the human cardiovascular system. The model can be used for studies of both normal and pathological conditions in the heart.

project facts

TITLE

Performance of TAVI valves

FINANCIAL FRAMEWORK

Karen Elise Jensen's Foundation

PARTNERS

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Department of Cardiac Surgery,
Georges Pompidou European Hospital, Paris

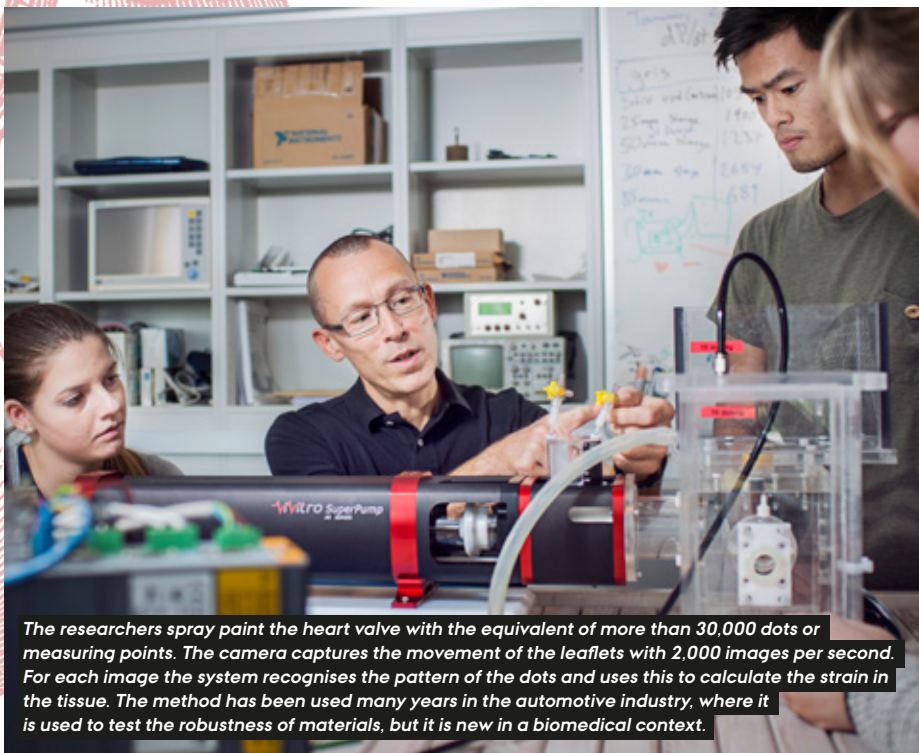
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30,000 measurement points on a single heart valve

A method to measure strain in cardiac structures with an unprecedented high level of detail is attracting international attention.

Photo: Anders Tjørup



The researchers spray paint the heart valve with the equivalent of more than 30,000 dots or measuring points. The camera captures the movement of the leaflets with 2,000 images per second. For each image the system recognises the pattern of the dots and uses this to calculate the strain in the tissue. The method has been used many years in the automotive industry, where it is used to test the robustness of materials, but it is new in a biomedical context.

How surgery affects force balance and blood flow

As a contribution to the already very thorough testing of artificial heart valves, the researchers use the model and system to carry out even more detailed measurements of the valve leaflet stress and strain during various load conditions.

"This can be used to compare the stresses in the native valves to the stresses in the prosthetic valves. Increased stress may indicate a reduced expected life span," says Associate Professor Johansen.

In the long term, the method used by the researchers – and what takes place in the new interdisciplinary cardiovascular laboratory at Aarhus University – may have a significant impact on developments of prosthetic devices and surgical procedures.

"When you know exactly how an implant or cardiac surgical procedure affects the natural force balance and blood flow of the heart, you have an indication of how the work load of the heart may be altered. Moreover, knowing the exposed stress and strain on an implant may tell you if there is a risk of reduced durability. As many implants and surgical techniques are continuously improved, it takes years of experience from now before you can document any late clinical complications and the durability of implants," says Associate Professor Johansen.

What happens when a prosthetic heart valve is implanted in a patient? What impact does it have on the hemodynamic and the biomechanical conditions? Will it affect the work load of the heart and how?

After many years of development, researchers have found a new method to measure the strain in cardiac structures with an extremely high level of detail. Combined with hemodynamic measures of pressure and flow this enables an acute assessment of the overall load conditions of the cardiac structures under investigation. Potentially, this may provide means of estimating the durability of different types of heart valve prostheses.

Cameras measure heart beats in 3D

Based on high-end high-speed cameras, it is possible to perform 3D analysis of heart valves during the entire heart cycle in the laboratory and, with advanced data processing of the images, the strain on the leaflets of the aortic valve can be measured along with motion pattern analysis. Soon new equipment will even provide visualisation of the flow through and around the heart valve.

And this is something that is attracting attention far beyond the borders of Denmark because this type of measuring tension in the heart was previously carried out using much fewer measuring points.

Simulation technology predicts late complications of surgery

Using a custom-made flow simulator, it is now possible to study how aortic surgery may affect the long-term function of the heart. This can potentially lead the way to better treatment for certain heart disease patients.

Researchers at Aarhus University can now for the first time measure how the repair of the aortic root affects the long-term stress distribution in the affected parts of the heart and the aorta. They are using a method that may lead to qualification of new surgical procedures in the treatment of patients with aortic root aneurysms or outpouchings at the aortic root.

Tommy Kragh Bechsgaard is a PhD student at Aarhus University, and he has been granted financial support from sources including the Danish Heart Foundation to complete his experiments.

"We examine how the repair techniques used by the surgeons affect the stress distribution of the heart immediately after surgery and in the long term. Once we have these data, we may be able to optimise both the surgical techniques and the geometry of the implants so that the stress distribution after surgery is as close as possible to the native setting," says Tommy Kragh Bechsgaard.

An aortic aneurysm is an outpouching on the aorta, and today it is treated by means of a surgical procedure in which the diseased tissue is replaced with an artificial tube made of a flexible material.

Surgery can affect the stress distribution of the heart

With the new flow simulation technology, the researchers hope to be able to predict how the current surgical techniques and implant materials will affect the heart.

"Maybe we will be able to predict inappropriate shifts in the stress distribution at a very early stage and long before the patient experiences any symptoms. In this context, the technology really gives us a lead since we do not have to wait for empirical evidence and long-term studies of how the patients are managing," says Tommy Kragh Bechsgaard.

Aarhus University recently established a heart research laboratory associated with the engineering sciences. Engineers and doctors collaborate here to map cardiac stress.

"In principle, you can think of the heart as a pump integrated in a closed system with an accurately balanced stress distribution. We try to identify what kind of stress is present in the healthy heart, and we use this as a reference when we carry out experiments to find out how different surgical procedures can be regulated. What will happen if we change to different sutures, for instance? Or the geometry of the implants? Or maybe the material? We are looking for new contexts and we must feel our way in the experimental stage," explains Tommy Kragh Bechsgaard.

Engineers will predict problems

At first, Tommy Kragh Bechsgaard will carry out his experiments on a pig's aorta mounted in a custom-made flow simulator that can simulate physiological pressure, flow and heart rhythm.

During the next couple of years, he hopes to be able to provide fundamental insight into how the heart is affected

by a change in the stress distribution caused by different surgical techniques—knowledge the doctors will need when they are performing surgical repairs or reconstructions of the aorta.

"We can reach new milestones in the treatment of heart diseases when doctors and engineers work together on their research. With modern technologies, we will be able to prevent the long-term complications that we do not know yet," says Tommy Kragh Bechsgaard.

project facts

TITLE

Impact of aortic valve on the stress distribution of the aortic root

FINANCIAL FRAMEWORK

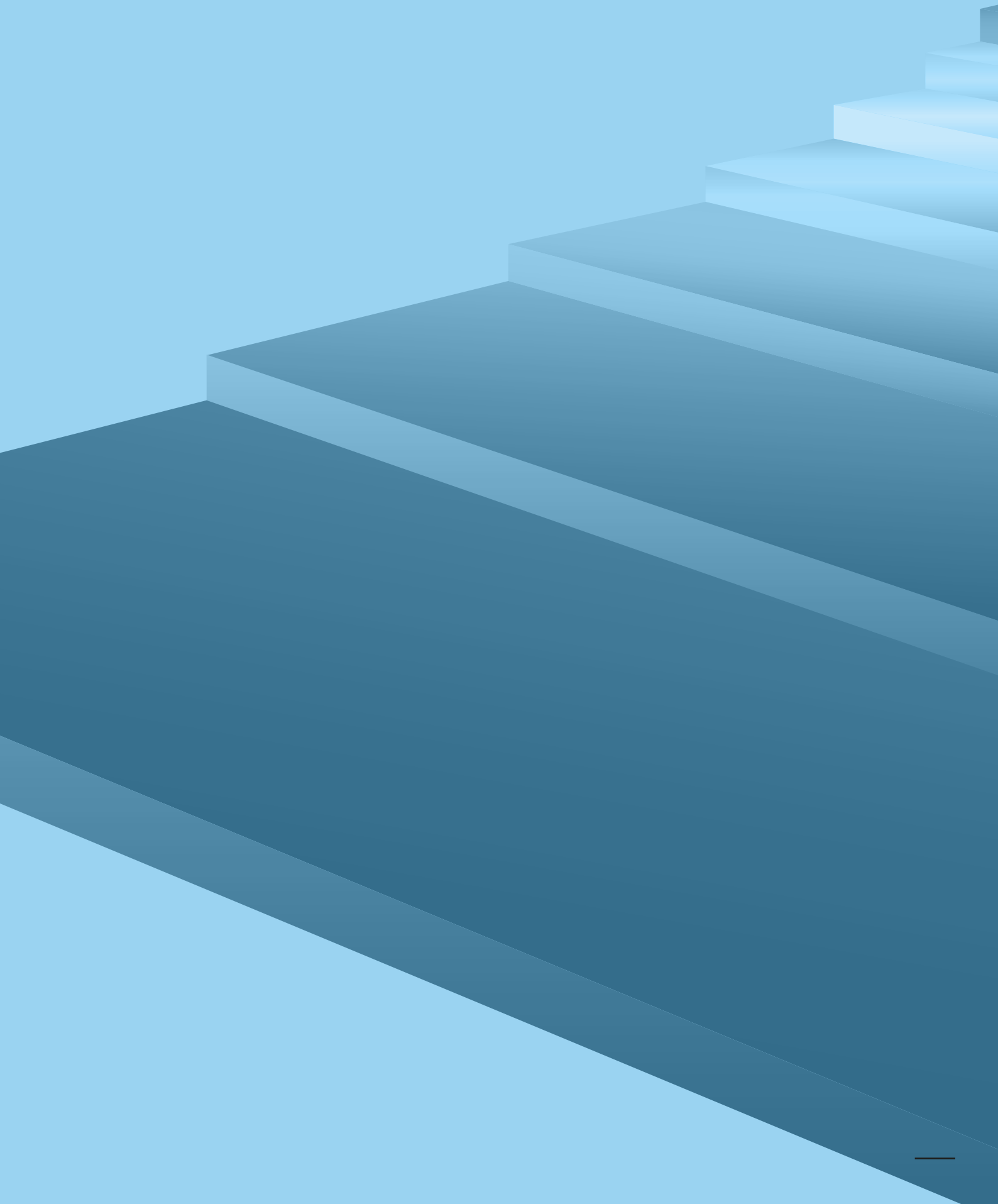
The Danish Heart Foundation, The Danish Council for Independent Research, Helga og Peter Kornings fond, Holger Rabitz og hustru Doris Mary født Philipp's Mindefond, Snedkermester Sophus Jacobsen og hustru Astrid Jacobsens Fond, Direktør Jacob Madsens & Hustru Olga Madsens Fond, Direktør Kurt Bønnelycke og hustru fru Grethe Bønnelyckes Fond, Edith og Olfert Dines Hansens Legat

PARTNERS

Aarhus University Hospital

CONTACT

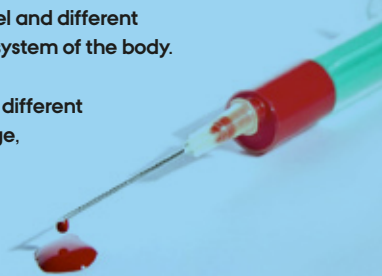
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The biological age

In the Mark-Age project researchers have conducted a population study with 3.300 probands. The biological age of a person is estimated by 50-70 unique biomarkers in the blood - for example cholesterol level and different molecules, proteins and cells related to the immune system of the body.

The result is calculated as a weighted average of the different markers relative influence on the body's biological age, and therefore it is more precise and statistically solid than any marker in isolation.



project facts

TITLE

European Study to Establish Biomarkers of human Ageing (MARK-AGE)

SCHEDULE

2008-2014

FINANCIAL FRAMEWORK

16 million EUR, EU's 7th Framework Programme for Research

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Blood reveals your biological age

What is your body's biological age?

There are various answers to this question depending on which body age test you take. However, researchers have now shown that you can measure the body's exact biological age in a blood sample. These findings will have a significant impact - both on the individual's health and on society's economy.

Your birth certificate says 40 years, but your body is perhaps 60 years, or 20 years. Until now, we have been left with a number of more or less uncertain body age-tests in e.g. fitness centres if we want to know our body's biological age, but now the researchers have succeeded in developing a more precise method.

The large EU project 'Mark-Age' with participating researchers from Aarhus University has mapped a large number of biological age markers in the blood on the basis of over 4000 blood samples from different individuals in Europe. Associate Professor Peter Kristensen says:

"We have identified 50-70 age markers in the blood, among others different proteins which combined can quantify the body's biological age. When you measure one marker, you will find that there is a major biological variation, but this biological variation will be evened out when you measure 50-70 markers. This will give you a statistically more precise expression of the biological age."

The project still needs to be implemented in practice. But the future scenario indicates that anyone can get to know their biological age by means of a blood sample taken by their general practitioner.

Towards healthy aging

When the doctor knows your biological age, it gives you the opportunity to obtain a better old age with fewer diseases. If your biological age is measured to be 80 but you in reality are only 50 years old, then your doctor can start preventive treatments of a number of age-related diseases.

"It is basically about being at the forefront and in this way creating the best conditions for healthy aging," says Peter Kristensen.

The biological age score can also tell us something about the development in society. In the future it is estimated that the costs related to the health system will increase because there will be more and more senior citizens in society. But will they actually increase?

"People will probably get older according to their birth certificate, but they will also be more and more healthy. If the biological age decreases, the costs of e.g. nursing homes will not increase," says Peter Kristensen.

Cancer or old age?

The knowledge of the body's biological age will have a significant impact on the

individual's health. One of the biological markers which the researchers have studied is the protein PSA, prostate anti-gene, which is found in men's blood.

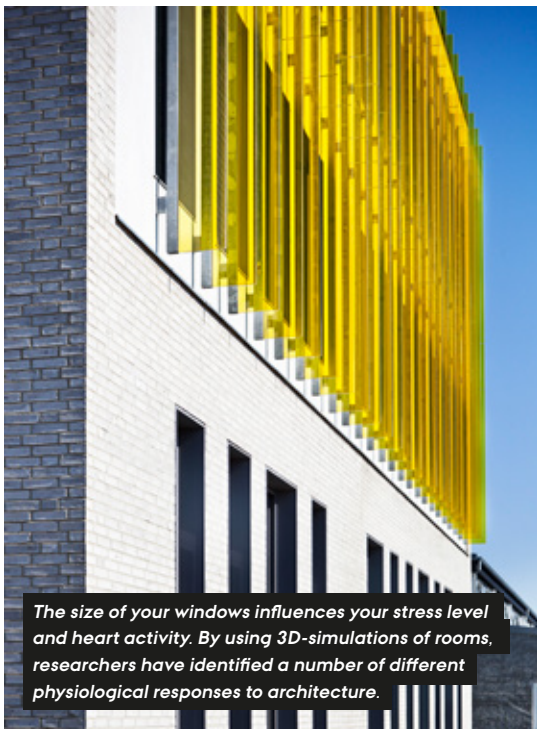
The amount of the protein in the blood can tell us whether a man will be at risk of getting prostate cancer. But the problem is that the amount of PSA will increase with age, and therefore an increased level of PSA does not necessarily mean that you have cancer.

"When you as a 50-year-old have your PSA-volume measured at your general practitioner and you are told that your PSA level is too high, it does not necessarily mean that you are about to get prostate cancer. It can also just be because your biological age is not 50 but 80 years. If the doctor knows your biological age, he or she will have a much better basis on which to assess whether you are at risk of getting prostate cancer," says Peter Kristensen.

How to measure architectural atmosphere?

There is possibly a closer connection between architecture and our physical health than we previously thought. Researchers have a suggestion as to how we can measure it.

Photo: Jesper Raas



The size of your windows influences your stress level and heart activity. By using 3D-simulations of rooms, researchers have identified a number of different physiological responses to architecture.

A new Danish study indicates that the layout of rooms has a greater impact on human well-being than previously thought. Good architecture and good design could possibly be much more than a matter of taste as indicated in initial trials with humans where researchers recorded different types of physiological responses to room conditions.

“We can see some clear signs that the quality of architecture may not be as subjective as we’d thought. The reaction of the test subjects was remarkably uniform in a physiological sense in the rooms they occupied throughout the experiment,” says Professor Poul Henning Kirkegaard.

The researchers subjected a total of sixty-five male test subjects to

two different room experiences. The rooms were identical, but the sections of windows were larger in one of them than in the other. The test subjects were asked to solve a series of tasks with a varying degree of stress load.

While they were doing so, recordings were made of their pulse, blood pressure, respiration rate, heart rhythm and cortisol level.

Large windows provide less stress

According to Professor Kirkegaard, the experiments showed a clear correlation between the physical signs of acute stress and the spatial surroundings.

“We saw a correlation between architecture and stress load. The test subjects in the room with small

Tectonic Architectural Engineering

Aarhus University has established Tectonics as a new science discipline within Architectural Engineering. It focuses on the interaction between traditional engineering and architecture. The aim is to integrate technology with aesthetics and meet society’s rapidly growing demand for knowledge about how to design functional buildings with inherent architectural qualities.

It is an ambitious initiative, which requires comprehensive interdis-

ciplinary studies of new materials, building systems, digital design methods and production processes.

Researchers focus on the early stage of the building design process in particular with a considerable number of theoretical studies of how to change the perception of building components from simply being technical elements to also being architectural features that have an impact on users.

In addition, researchers are involved in developing new advanced technology methods to test and verify the way in which building aesthetics or the overall layout of a building and its architectural qualities affect people’s physical and mental well-being.

In terms of education, the tectonic focus results in an enhanced academic profile for the graduate engineers who will make their mark in future on the existing building

windows had a stronger physiological response when we measured the cortisol levels in their blood and recorded their heart rhythm variability," he says.

None of the test subjects reacted with increased stress load in the room with large windows, and there is possibly a biological explanation for this.

"Our sympathetic nervous system is activated when we're subjected to acute stress, which quite simply makes it possible for the body to react to danger in a faster and more targeted way. We feel a strong flight instinct, and this can be one way of explaining why we react with an increased stress response in closed rooms than we do in open rooms," says Professor Kierkegaard. In many Western countries, we spend 50-80 percent of our waking hours inside and, according to Professor Kierkegaard, just a small shift in heart rhythm variability, blood pressure or the amount of stress hormones we produce can thus have serious consequences over the years.

Virtual room as a laboratory

The research project is the first of its kind to work with the physiological impact of architecture on people. And this is a difficult discipline because it actually requires the setting up of a kind of

'sterile' environment, where it is possible to measure and document responses to the physical layout of the room alone.

For this purpose, the researchers make use of an advanced virtual room simulator that can provide a completely authentic 3D experience of a room by means of techniques such as computer tracking of head and eye movements.

The computer-generated room can be varied an infinite number of times, which makes it a completely new experimental platform in architectural research. This makes it possible for the first time for researchers to isolate the effect of architecture and atmosphere, and to control all other stimuli imaginable, including light, acoustics, air and view.

"Our aim with the study is to demonstrate that we can use modern technology to create virtual rooms in our research. A considerable number of new opportunities are now opening up for gaining more evidence-based knowledge about how we physically react to our surroundings and to a specific architectural atmosphere. We've only scraped the surface and shown that the method can be used. Now it's up to our imagination to see what else we can study," says Professor Kirkegaard.

The quality of architecture can be measured in the blood

The research group's results are interesting because they show for the first time that it is possible to measure the effect of room conditions and atmosphere on human health using an empirical approach. This is a break from the dominant phenomenological tradition in architectural research and – according to the professor – it can lead to so much new knowledge in the long term that a start could be made by determining some objective quality criteria for architecture and design.

"Our study documents that virtual rooms can be used to explore the correlation between our environment and our physical health. And if you could be so bold as to push this to its logical conclusion, you could say that when you can measure the impact of architecture on people by means of a simple blood test, it's a step in the right direction away from the so-called experts," says Professor Kirkegaard.

In the coming years, the researchers will use virtual rooms for purposes such as testing human physiological responses to a number of different architectural conditions.

culture and carry their tectonic understanding out into the building branch.



How can materials be formed and used in building constructions to create a whole with the specific social and cultural context they are a part of? This is what tectonics is about. It is a new research discipline at Aarhus University within architectural engineering and Professor Poul Henning Kierkegaard is using his expertise to create optimal compromises between design and technology in new buildings.

PRECI
SION
AGRI
CULTURE

Farm yield optimisation based on advanced information and communication technologies using big data, robots and drones. Detailed understanding of crop variability, geo-located weather data and precise sensors provides the ability to benefit from automated decision-making and optimised planning methodologies.

project facts

TITLE

SAFE – Safer Autonomous Farming Equipment

SCHEDULE

2014-2017

FINANCIAL FRAMEWORK

29 million DKK,
Innovation Foundation Denmark

PARTNERS

Kongskilde Industries A/S (projektejer)
Aarhus Universitet, KeyResearch Aps,
CLAAS Agrosystems, Compleks Innovation ApS,
Syddansk Universitet og
Innovationsnetværket RoboCluster

CONTACT

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Robots invade farmland

An increasing number of farming operations in the field are taken over by robots because many agricultural implements have become so automatic that they can do the job on their own. However, the farmer is not yet completely superfluous since the robots need to be monitored and guided.

For years farmers and their machinery have been partners in shouldering the heavy jobs that have to be done in the field. Now a new type of partnership with machinery is emerging where machines are asked to not merely do the heavy jobs. These new roles are taken up by robots that are making their entrance onto farmland. Within certain limits they are able to work on their own and can thus relieve the farmer of his driving duties.

“The farmer no longer has to sit on the machine but can do other jobs that machines do less well, such as monitoring and optimising work routines and repairing components,” says senior researcher Rasmus Nyholm Jørgensen.

Conducting an orchestra

Robots are everywhere in farming, but their role is still very fixed. In the future, they will play a more emancipated role and be less directly controlled by a driver in a tractor cab. Instead, the robots will be increasingly autonomous. In this way, the farmer is freed from the cab and can instead do other jobs and also monitor

several robots at a time – like a conductor directing several instruments in an orchestra.

“We imagine that the machine operator will be physically present where the essential processing of field operations takes place. The driverless machines do not need a cab and other expensive devices because the machines are integrated with the tool or act as tool carriers. The operator can monitor several machines in interaction with virtual operators from other fields or operations. For example, for crops such as sugar beets, potatoes and carrots this will mean that more than one field operation can be carried out at the same time and by a single person,” explains Rasmus Nyholm Jørgensen.

The work on developing the next generation of field robots is already well under way and some robots have already been put to use in the field. There are robots for weed control in transplanted crops in open field plant nurseries, and in recent years the mechanical weed control in sugar beets has become possible. There

are also robots capable of weeding lettuce crops.

“The operator does not have to sit on the machine, but can walk behind it and check the quality of the work until the machine has to be manually turned in another direction,” says Rasmus Nyholm Jørgensen.

Safety first and foremost

If there is no driver in the cab, then safety is crucial. This is not yet the case with the existing systems, but it is possible to make them so if the operator can stop the machine immediately with a remote safety device. Researchers and companies are working together on developing sentient robots that can recognise people, animals and obstacles in the field.

This is achieved in the project SAFE – Safer Autonomous Farming Equipment – where Aarhus University is one of the participants.



For the past decade scientists have set milestones in the development of agricultural robots without drivers. However, safety is still an issue and must be optimised before we can take full advantage of the technology in the field. This requires more automisation of the robots so they can interact with their environment optimally.

project facts

TITLE

Off-line and on-line logistics planning of harvesting processes

FINANCIAL FRAMEWORK

10 million DKK,
Danish Innovation Foundation

PARTNERS

AGCO A/S

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Photo: Tribine.com

Computer systems optimise field operations for farmers

Intelligent computer systems can optimise farming operations by getting the different machines to work together optimally.

Field operations in today's farming involve several machines, and it is a huge logistic puzzle for the farmer to plan and coordinate a wide range of machines and operations all at once.

A considerable amount of agricultural machinery is now equipped with different information systems, and farmers are therefore bombarded with data and information about operations and crops. However, the value of this stream of information is minimal without an overall system that can make use of the data to coordinate the machines and optimise production.

Combine harvesters must work together

Scientists are now coming to the rescue of the farmers in a major research

project. They are well on the way to developing commercial computer systems for the automated route planning and management of harvest operations and the coordination of all the machines involved in the same operation. The project is financed by Innovation Fund Denmark, and is scheduled to run over three years in collaboration with AGCO A/S – the global manufacturer of agricultural machines and equipment.

The project focuses particularly on harvest operations which often require resource-intensive logistical planning of the operations involving combine harvesters, collection wagons, transport vehicles and machines for handling crops. The aim is to provide a commercial decision support system that can help farmers to plan their harvest as well as

possible, according to Senior Researcher Claus Aage Grøn Sørensen.

"Agriculture has undergone rapid development to meet society's growing demands for increased food production of higher quality and lower prices. In the complex farming operations of today, there's a considerable unexploited potential in optimising the interaction between the individual machines instead of just continuing to make the machines larger," he says.

The decision support system that the researchers are working on continually optimises the logistics chain in harvest operations cutting across all the vehicles, machines and computers involved in the process.

Smart weed recognition reduces pesticide consumption

A novel decision support system provides farmers with an opportunity to very efficiently identify weeds in their fields and receive optimised recommendations on which herbicides to mix. This will save up to 40 percent of their use of herbicides without any additional investments in machinery.

To prevent their fields from becoming overgrown with weeds, farmers have to use herbicides. However, it is impossible for individual farmers to know and recognise all species of weeds and/or find time to visit all fields within the present time window. They therefore often end up spraying suboptimal mixtures and amounts of herbicides right across the field, even though the weeds could be eradicated with smaller doses and better mixtures.

Camera spots 105 different kinds of weeds

Researchers will now try to improve this spray behaviour by means of the RoboWeedSupport system. They have collected all the necessary information about types of weeds and recommended herbicides in an online decision support system called Crop Protection Online (CPO). And now they are taking the next step towards making it available for practical use by farmers.

"The farmer takes a photo of his fields every 100 metres using his mobile phone or by using a relatively cheap consumer drone. He then sends the photos to an expert, who determines the type of weed and registers it in an online database. The database can subsequently recommend the optimal pesticide

dosage, and the farmer receives notification within 24 hours," explains Senior Researcher Rasmus Nyholm Jørgensen, Aarhus University.

The researchers plan to further develop the system with an algorithm that can use image recognition to differentiate between 105 types of weeds.

Technology prevents resistance

If successful, the system could be a key factor in efforts to reduce herbicides consumption, thereby not only providing savings for farmers, but also protecting the environment from the emission of unnecessarily large quantities of herbicides.

In the long term, smart weed recognition can also help prevent resistance to certain herbicides in weeds.

project facts

TITLE

RoboWeedSupport

SCHEDULE

2014-2016

FINANCIAL FRAMEWORK

6.3 million DKK,
Green Development and
Demonstration Programme, GUDP

PARTNERS

Maersk Mc-Kinney Møller Institute (University of Southern Denmark), SpectroFly ApS, I+GIS, SEGES

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Bee brother is watching

And hopefully helping as well. Bees all over the world are having a hard time and a new project aims to help them.

project facts

TITLE

Application of information technologies in Precision Apiculture (ITApic).

SCHEDULE

2013–2016

FINANCIAL FRAMEWORK

1.5 million DKK

CONTACT

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Bees are dying at an alarming rate on a global scale, a problem that can have enormous consequences because bees pollinate flowers and crops. In fact, the decline in bee populations could have an impact on the entire ecosystem. However, the key to stopping the current decline could lie in a camera lens.

Sophisticated camera algorithms

A new bee project aims to create an affordable and reliable prototype of a device that can measure different parameters in the hive, such as the number of bees that come and go, the time of day at which this occurs, the temperature, sounds, outside weather, etc.

The project is a collaboration between German, Turkish, Latvian and Danish universities. Associate Professor Peter Ahrendt is the team leader for the Danish part of the project, and he is responsible for the visual aspect. He is working on creating a camera that is able to 'see' the bees, count them and recognise different attachments on their bodies, such as pollen or mites.

He will achieve this by using advanced algorithms in a camera with

an integrated computer. And this is the tricky part – making a camera that can actually make sense of what it sees.

“Our aim is to make a camera that is capable of recognising patterns and sensing whether there is something wrong in the hive – or even predicting this before it happens,” says Associate Professor Ahrendt.

Mites could be murderers

The parasitic bee mites could be responsible for the decrease in bee populations, and further research will shed more light on this matter.

“Once we’ve tested our prototype, we’ll know a lot more,” says Associate Professor Ahrendt.

This knowledge will be of great benefit to people all over the world because bees play an essential role in the global ecosystem. The new technology will be particularly valuable for beekeepers, and will provide precise data about conditions in the beehives. If a case of bee mite infection occurs, the beekeepers will know the exact amount of insecticide to use and – equally importantly – when to stop using it.



Bees play an essential part in our ecosystem. A new camera technology makes it possible to recognise patterns of behaviour, monitor whether something is wrong in the hive and even predict bee mite infection. Associate Professor Peter Ahrendt is a signal processing specialist and he might be able to play a key role in preventing the current decline in bee population.



Who would have thought that mathematics would come to play a part in balancing our ecosystem? Researchers have shown that sophisticated algorithms are extremely valuable for beekeepers when they want to handle mite infections in their hives.

Sugar in your slurry, anyone?

Agriculture can probably halve emissions of harmful ammonia by adding sugar to the slurry. New research from Aarhus University suggests that sugar can replace sulphuric acid as a method of reducing ammonia emissions - to the benefit of organic farming and biogas production.

It may sound a bit illogical that something becomes more acidic if you add sugar to it, but this is nevertheless true of slurry.

And this does in fact have a large potential. Acidic slurry (i.e. slurry with a low pH) does not emit nearly as much ammonia as neutral slurry. Acidification of slurry can actually reduce evaporation of ammonia by up to 70 percent. An increasing number of Danish farmers have therefore, over the past 10 years, started adding sulphuric acid to their slurry. In 2014, 12 percent of Danish slurry was thus acidified.

Acidification of slurry with sulphuric acid is an effective alternative to other methods that farmers use to reduce ammonia emissions, but it is not a universal tool. Organic farmers may not use it, and biogas reactors should preferably not receive more than 10 percent of their feedstock as acidified slurry - if the concentration is higher it negatively affects the production of biogas.

Now researchers from Aarhus University in partnership with the commercial sector have found out that sugar is just as effective as sulphuric acid at acidifying the slurry. And sugar does not pose a problem for organic farmers or biogas producers.

Why does slurry need to be so sour?

Ammonia emission from manure is one of the largest sources of air pollution in Denmark. Not only do emissions burden the environment with surplus nutrients to the detriment of a number of ammonia-sensitive habitats such as certain types of woodland, bogs, moors and lakes, they also impair the health of thousands of people.

Neither is ammonia good business for the farmer who would prefer instead to put the nutrients to better use in the field.

So there are good reasons why the authorities would like agriculture to reduce emissions. In Denmark, the requirements are much tougher than in most of the EU, which is probably why the technology for slurry acidification has not yet caught on outside Denmark.

Researchers track sugar alternatives

But how can sugar replace sulphuric acid?

"The sugar acts as a substrate - in other words a feed - for the bacteria that produce lactic acid. And the lactic acid has the same effect on ammonia as sulphuric acid," explains Assistant Professor Maibritt Hjorth.

She explains how the research has been conducted:

"Initially, we tested how the slurry reacted when we added a combination of lactic acid bacteria and sugar. It turned out to work very well, and we could even make the pH drop even further than was necessary. But we have since found that you do not need to add microorganisms because the organisms already present in the manure can easily manage the job themselves if you make sure to give them the right growing conditions. And this is done by adding sugar," says Maibritt Hjorth.

Sugar should here be taken in its wider sense; we are not going see tractors

queuing up at the supermarket for sugar because soya molasses, beet molasses, cheese whey, maize silage, straw and fodder beet can probably be used as alternatives. The extent to which they can replace sugar in this context is what Maibritt Hjorth and her colleague, Senior Researcher Anders Peter Adamsen, are now in the process of investigating.

"The big advantage is that the individual farmer will to a certain extent be able to use the by-products that are produced continuously on the farm. And the sugars will be easier to handle than sulphuric acid which has to be procured from a factory," she adds.

Basis for new markets

The development of the new acidification method was done in a collaboration between Aarhus University, AgroTech, SEGES (which is the new name for the erstwhile Knowledge Centre for Agriculture and Pig Research Centre), the biotech company Lallemand and JH Agro A/S, one of the world's leading suppliers of manure acidification systems.

Maibritt Hjorth estimates that the new method is quite close to being market-ready.

"We have yet to get a handle on the delicate balances: what is broken down at what speed and in what order, and how do we achieve the desired pH values without spending too much money? We will conclude soon with some laboratory tests and a pilot experiment by AgroTech, and then JH Agro can upscale and sell the technology," says Maibritt Hjorth.

project facts

TITLE

Reduced nitrogen emission by bio-addification of cattle slurry

SCHEDULE

2014 -2016

FINANCIAL FRAMEWORK

6.9 million DKK,
Green Development and
Demonstration Programme, GUDP

PARTNERS

Seges P/S, AgroTech A/S,
Jørgen Hyldgård Staldservice A/S,
Lallemand Nordic

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Ammonia emissions from manure are one of the largest sources of air pollution in Denmark. The nutrients harm the environment. Farmers therefore try to limit the evaporation by, for example, applying the slurry to fields using trailing hoses.

FOOD AND WATER

With an increasing population and a global rise in income, global food security is an enormous challenge that will require integration of technical, financial and political skills. We must be able to produce, process and distribute more food with fewer sources like water, grains and pharmaceuticals.

Mapping groundwater from the air

Using a helicopter-borne antenna system, scientists can identify underground water resources, even in areas where the subsurface is very complex.

Photo: SkyTEM



Engineers will develop a new type of signal processing that can lead to deeper and more precise mapping of groundwater resources from the air.

Data from magnetic fields

With the aid of a helicopter, it is possible to fly a frame with cables that act as a coil at a height of 15–30 metres above the ground. From here a high-strength current in the coil forms a primary magnetic field.

When the current is cut off, the primary magnetic field disappears. Eddy currents subsequently occur in the ground, creating a secondary magnetic field. An induction coil is now used to measure how long it takes for the secondary magnetic field to die out. Clay and deposits containing salt water are con-

ductive, which means that a prolonged electrical response is recorded from these layers. Aquifers, on the other hand, are found in layers of sand or gravel where the field quickly dies out. All data from the secondary magnetic field is collected and stored in a computer which carries out an interpretation of the information via advanced algorithms.

The technology makes it possible to map the subsurface and its conductivity, thereby identifying water resources.

In the coming years, researchers at Aarhus University will contribute to developing the world-renowned SkyTEM technology for mapping subsurface water resources.

SkyTEM was developed at Aarhus University in the 1990s and was one of the first technologies to enable airborne groundwater measurements. The technology consists of a large frame with highly advanced equipment that can be attached to the underside of a helicopter. This makes it possible to cover large areas in the search for aquifers or geological formations that contain or conduct groundwater.

Seeing through the subsurface

A coil is placed in the frame, and it generates a strong magnetic field that penetrates into the ground. The magnetic field disappears when the power is switched off, and this change induces eddy currents in the soil. The eddy currents give rise to a secondary magnetic field that can be measured by advanced equipment, and the rate at which it decreases provides information about the conductivity of the material in the subsurface at the specific measurement point.

Researchers currently use the technology to identify the material in the layers in the subsurface, which is enabled by more sophisticated computer modelling methods.

“When you’re familiar with the correlation between geological structures and conductivity, you can use computer modelling of measurement data to very precisely identify subsurface water resources,” says Assistant Professor Jakob Juul Larsen who works with signal processing.

Mathematical models provide new details

According to Assistant Professor Larsen, the challenge facing the engineers with SkyTEM is to identify better ways to process the signals from the magnetic field and to find mathematical models that can enable them to record more details in the eddy currents when the signal drops.

“We’d like to develop the technology and be better at characterising the ground’s response to the magnetic field we send from the air,” he says.

The researchers hope to be able to reduce noise in the signal within three years and carry out deeper and more precise mapping of groundwater resources from the air.

project facts

TITLE

Airtech4water

SCHEDULE

2014-2018

FINANCIAL FRAMEWORK

The project is supported by Innovation Fund Denmark

PARTNERS

SkyTEM

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New antioxidant protects omega-3

A new type of antioxidant can be used in connection with micro-encapsulation of fish oil and thereby protect the healthy omega-3 fatty acids against rancidification.

Photo: Lars Kruse



A PhD student from Aarhus University has developed a new type of antioxidant which can be used for micro-encapsulation of fish oil and protection of healthy active substances against oxidation. Mia Falkeborg's invention may be of great importance for the functional food industry, and she has received an international prize for her research.

Every day, millions of people worldwide take some kind of dietary supplement based on fish oil due to the omega-3 fatty acids' documented effects on human health.

Meanwhile, the researchers in the laboratories work hard to improve the encapsulation technologies and thereby the possibilities of protecting the active substances in fish oil against oxidation or the so-called rancidification.

Rancid omega-3 fatty acids lose nutritional value

Omega-3 fatty acids are in fact fragile, and they often risk to get destroyed even before reaching the shelves.

This happens when the so-called free radicals break the chemical bonds in the oil and thereby bring the fatty acids to oxidation, explains PhD student Mia Falkeborg from Aarhus University:

"We know that the active substances in fish oil have a low shelf life. Omega-3 fatty acids are destroyed in the meeting with free radicals which in small amounts exist where oxygen, light and heat are represented - both in foodstuffs and in the body's own cell metabolism. Even a very small amount of the free radicals can start a chain reaction and make the oil rancid, and this affects its nutritional value."

For this reason, Mia Falkeborg has spent the last many years of her researcher life on developing a chemical antioxidant which can be used for micro-encapsulation of fish oil with the purpose of protecting the valuable fatty acids optimally against the free radicals.

"I have designed the antioxidant so it can be used for micro-encapsulation of fish



It looks most of all like ground coffee, but make no mistake. It is a new substance that researchers will use to microencapsulate fish oil. This can solve the problem of fatty acids going rancid when they are exposed to the free radicals that are found everywhere and which are formed when chemical bonds are broken by heat and light, for example.

oil with an optimal protection against oxidation. At the same time, it makes the oil soluble in liquid by which there are far better opportunities to add the healthy omega-3 fatty acids to other foodstuff products", says Mia Falkeborg.

Today, nutritional experts assess the western food to contain too little omega-3, and therefore Mia Falkeborg hopes that her invention can make the healthy and essential fatty acids more available for more people.

Omega-3 will sneak into our food

The antioxidant developed by Mia Falkeborg should be used for encapsulation of fish oil in micro and nano scale where it will be invisible to the naked eye. The advantage of this form of encapsulation is the fact that it will be possible to add the fish oil to foodstuffs such as bread or liquid and thereby enrich our food.

So far, it has been both a difficult and a costly affair. Because when you want to merge fatty acids with another product, you need a so-called emulsifier to prevent the oil from clumping like small pearls.

The problem with the emulsifiers is that they make the fish oil oxidise much easier than it would have, and therefore the food manufacturers must add antioxidants which are both expensive and

which make the manufacturing process more difficult.

To some extent, the antioxidants can halt the attacks from the free radicals and thus the destruction of the omega-3 fatty acids. However, even the most powerful of its kind are not protecting one hundred percent against oxidation, and this affects the quality and shelf life of the food products.

Full protection of delicate fatty acids

The research results from Aarhus University attract attention beyond the borders of Denmark since Mia Falkeborg has succeeded in developing a super antioxidant which, in the laboratory, provides full protection to the omega-3 fatty acids.

"We have tested the effect of the antioxidant by means of different types of oxidation, and it behaves just as intended. It neutralises the free radicals and in this way it protects the active substances in the oil," says Mia Falkeborg.

The super antioxidant is extracted from a sugary substance of algae which is both an inexpensive and a sustainable material. In the laboratory, Mia Falkeborg has discovered an enzyme with which she can process the alga sugar. By this, the enzyme changes its molecular structure

and turns into an antioxidant with greater strength than ever.

"I started right from the ground by making a lot of reactions with enzymes. Now, it appears that finally I have found one which can convert alga sugar into a specific chemical functional group of alginate oligosaccharides. The advantage of these alginate oligosaccharides is that they have a very strong antioxidant effect and that they are soluble in water and thus easy to make immiscible," says Mia Falkeborg.

Antioxidant and emulsifier at the same time

Thus, the protection of the fish oil against oxidation is not the only great property of the antioxidant - it also functions as emulsifier. And precisely this dual capacity is totally unique and may result in a large number of new opportunities to enrich foodstuffs with fish oil.

"Some researchers focus on developing new technologies to emulsify fish oil. Others are focussing on preventing oxidation. My aim was to create a substance which was capable of doing both - and still was sustainable and inexpensive to produce," says Mia Falkeborg.

She has received a prize for her research at American Oil Chemists' Society (AOCS).

The perfect taste of sweetness

In recent decades, the artificial sweetener industry has experienced a massive boom in global demand. However, it is difficult to produce a synthetic substance that only contains a few calories as well as authentic sweetness. Scientists are now using alternative methods to create the perfect sugar substitute.

In recent years, sugar consumption has increased significantly in large parts of the world, resulting in epidemics of obesity, diabetes and other lifestyle-related diseases. The same applies to the consumption of 'light' products with alternative sweeteners. Consumers typically choose these products with regard to calorie and blood sugar balance and, in this way, they are helping to create an enormous market for the functional food industry.

This explanation is provided by PhD student Camilla Rotvel who has followed the development in consumption in recent years.

"There's a marked increase in demand for low-calorie alternatives to sugar. New synthetic or natural sweeteners are hitting the market all the time, and these have a low physiological calorific value. However, we're all familiar with the somewhat quirky sweet taste of light products, and that's because some sweetener manufacturers haven't yet succeeded in finding the perfect match to the taste of ordinary white sugar," she says.

The 'real' taste of sweetness with no calories can therefore be compared with a hidden goldmine being pursued by companies all over the world in an innovation race.

Sweetness defined by brain activity

Camilla Rotvel is possibly the woman who can lead the sweetener industry one step closer to the perfect sugar substitute. She is actually well on the way with a research project in which she uses advanced electroencephalography to study what happens in the brain when we eat or drink sugary foods.

With 128 electrodes mounted on the scalp, she records the electrical activity patterns between the neurons when we taste and recognise something sweet. In terms of pure physiology, the taste cells on the tongue are activated and they send signals to different areas of the brain – although the strongest concentration occurs around the taste cortex.

She is looking at how this brain activity is distributed in 12 test subjects when they ingest white sugar, aspartame and other

sweetener mixtures. The aim is to gain new knowledge about the way humans recognise the taste of sweetness at a preconscious level.

"We know quite a bit about what happens when we identify sweetness at a conscious level – in other words, the area where we experience pleasure. This knowledge is all about sensory information. But we know very little about what happens in the brain a little earlier in the process – where we start to recognise something as sweet. And it's here that it's interesting to monitor brain activity," says Camilla Rotvel.

According to the researcher, this pre-conscious identification of sweetness actually plays a far greater role in our overall taste sensation than previously thought. She hopes that her experiments will pave the way for a new method that can help companies to test flavours and develop new sweeteners using evidence-based principles.

"Seeing as we can characterise brain activity and its processes when white



It appears that researchers have discovered how to measure the sensation of taste in the brain at a preconscious level. This could be the key to identifying the perfect taste of sweetness without calories. Camilla Rotvel is pictured here in the laboratory. She is using 128 electrodes mounted on the scalp to record the electrical activity patterns between the neurons when we taste and recognise something sweet.

sugar is ingested, we can also begin to experiment with the development of new sweetener mixtures that can get very close to the authentic taste sensation of sugar. In principle, it's just a matter of recreating the same brain activity," she says.

The objective assessment of taste

Food companies currently use taste panels to evaluate and characterise the taste of new sweeteners compared with real sugar. This means that development in most of the light industry is based on the ability of a number of panellists to taste, and this is where Camilla Rotvel believes the EEG technology could provide the companies with an enormous innovative advantage.

"With the help of extremely advanced data processing, we can see what actually happens in the human brain during taste sensation. This way we're getting much closer to a measurable and objective assessment of taste. We can simply

study how a particular substance works compared with sucrose, and what happens when we make slight changes to the composition of chemical substances," she says.

Artificial sweeteners are often involved in complex chemical mixtures with a considerable number of synthetic or natural substances. The best possible mixture is that which comes closest to sugar in terms of taste.

For the next four years, Camilla Rotvel will collaborate with her colleagues at the university and researchers at DuPont Nutrition & Health, to further develop and validate the method for measuring the taste of sweetness. Part of the project involves work using new electrode technology so that the EEG equipment can capture the purest possible signals from the brain.

project facts

TITLE

Development of Methods for Objective EEG Analysis of Brain Activity induced by Sugar, Salt, Fat and their Substituents

SCHEDULE

2013-2018

FINANCIAL FRAMEWORK

DuPont Nutrition Biosciences

PARTNERS

DuPont Nutrition Biosciences,
University of Southern Denmark

CONTACT

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PHD
PRO
JECTS

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Michael Bjerg-Nielsen

PROJECT DESCRIPTION

As part of the NomiGas biogas project, one important aspect is to improve the utilisation of the inherent biogas potential of substrates such as animal manure.

The main components of the biogas product resulting from Anaerobic Digestion are CO₂ and CH₄. These gasses are synthesised by a consortium of microorganisms through several steps beginning with the hydrolysis of larger molecules such as celluloses, lipids and proteins. Hydrolysis of cellulose to simple sugars is considered the rate-limiting step of Anaerobic Digestion when treating recalcitrant lignocellulosic substrates e.g. straw in cow manure and pure straw for co-digestion.

The rate of enzymatic hydrolysis is determined by the species of microorganisms present, the physical and chemical environment in which they exist as well as the pre-treatment prior to the Anaerobic Digestion process.

The objective of this study is to investigate the effects of temperature

differences in Anaerobic Digesters on enzymatic hydrolysis and biogas production, isolate and examine microorganisms responsible for high methane yields as well as produce models based on a variety of physical and chemical production variables.

ABOUT THE PROJECT

Title: Optimisation of Pre-Treatment Methods for Animal Manure as a Biogas Substrate – Enzymatic Activities and Temperature Dependence

Project period: Dec 2014 to Nov 2017

Main supervisor: Assoc. Prof. Lars Ottosen

Co-supervisor: Senior Researcher Henrik Bjarne Møller

Research section: Biological and Chemical Engineering

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Christoffer Bjerremund Hansen

PROJECT DESCRIPTION

The aim of this project is to get an enhanced knowledge of high-friction polymer coatings of paper, specifically in the areas of foods, water repellent properties and time-temperature dependencies. Both micro and macroscopic interactions of the various properties will be investigated to obtain a complete understanding of the tribological process (friction, adhesion, wear, etc.).

A series of scientific methods is to result in a model for tailor-made coating design solutions. The coatings are specifically designed for the transportation sector where various situations require easily applicable packaging with high friction and low adhesion. The coatings are not intended for direct food contact but rather as a secondary packaging layer.

ABOUT THE PROJECT

Title: High Friction and Water Repellent Polymer Coated Paper for Transportation and Secondary Food Packaging

Project period: Nov 2014 to Nov 2017

Main supervisor: Assoc. Prof. Mogens Hinge

Co-supervisor: Johnny Larsen, PAL-Cut A/S

Research section: Biological and Chemical Engineering

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Bjørn Sjøgren Kilsgaard

PROJECT DESCRIPTION

Lignin is an important constituent of all biomass amounting to 15-30 wt% or up to 40% by energy. To render biorefining processes attractive, it is important to get a higher value out of this stream. Project 6 will apply an integrated conversion and refining approach, aiming at developing sustainable processes for value-added products such as phenolic binders, guaiacol, other phenols and methanol.

This project will focus on pilot-scale conversion of different waste products with a high content of lignin in sub and super-critical conditions (~300 bar, 350-450°C). The pilot plant is currently under construction and will start commissioning in the beginning of 2015 in Foulum.

The main goals are to gain knowledge on the conversion process going on in the extreme conditions and develop products to be used in industrial processes, specifically binders used in mineral wool processes.

ABOUT THE PROJECT

Title: Value-Added Products from Lignin

Project period: Nov 2014 to Oct 2017

Main supervisor: Assoc. Prof. Ib Johansen

Co-supervisor: Erling Hansen

Research section: Biological and Chemical Engineering

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Jingbo Li

PROJECT DESCRIPTION

Lipid ingredients based on vegetable oils are essential elements in modern food industry, representing high nutritional value and functionality. Present industrial refining processes and technology, however, often result in the loss of valuable accompanying minor lipid ingredients which are released as waste streams in different refining stages.

This project aims to develop industrially viable processes for a more efficient utilisation of the lipidic components in vegetable oils for the benefit of resource efficiency and economic sustainability of the industry.

Continued research and development in emerging bioprocessing methods and technology is required to ensure an increasingly more efficient and sustainable production of food ingredients and bioenergy. The ultimate goal of this project includes development of scientific and technological toolboxes covering the full production line of a vegetable oil biorefinery where the efficiency and ecological footprint of the process and the quality and physical indexes of the products are beyond state of the art.

ABOUT THE PROJECT

Title: Processing Technology for Value Proposition of Lipid Ingredients

Project period: Oct 2014 to Sept 2017

Main supervisor: Assoc. Prof. Zheng Guo

Research section: Biological and Chemical Engineering

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Steinar Birgisson

PROJECT DESCRIPTION

This project aims to develop new nanomaterials for application in Li-ion batteries.

The research is focused on synthesis methods that are industrially relevant and are based on the solvothermal reaction of the materials being studied. The main focus is on synthesis in supercritical fluids which has great potential as a new, environmentally friendly way to produce chemicals industrially.

After the synthesis, the nanoparticles are structurally characterised with the help of X-ray diffraction, neutron diffraction, TEM/SEM, SAXS, XRF, ICP, BET and potentially X-ray absorption techniques (XANES/EXAFS).

Our group has developed and implemented a novel way for in-situ measurement of solvothermal reactions with great success. Therefore, the research will focus on in-situ synchrotron X-ray diffraction measurement especially to study reaction mechanism and nanoparticle growth.

The electrochemical characteristics of these materials will also be

studied using the newly developed battery-lab at the Department of Chemistry, Aarhus University.

ABOUT THE PROJECT

Title: Li Ion Nanomaterials

for Improvement of
Large Scale Energy Storage

Project period: Feb 2013 to Jan 2017

Main supervisor: Prof. Bo Brummerstedt Iversen

Co-supervisor: Søren Dahl, Haldor Topsøe A/S

Research section: Biological and Chemical Engineering

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Jakob Ege Friis

PROJECT DESCRIPTION

Fouling is an ubiquitous and complex process in which materials of diverse origin – biological, organic and inorganic – adhere to surfaces that are in contact with a liquid medium. Fouling is detrimental in many industrial installations causing inefficient process output, reduced lifetime and thereby necessitating frequent cleaning and/or replacement of parts, leading to increased maintenance costs. One industrial installation that is often exposed to fouling is heat exchangers: a piece of equipment built for efficient heat transfer from one medium to another. The current anti-fouling coating technology offers only thick coatings, which results in poor heat transfer properties.

The purpose of this project is to develop stable heat transfer effective anti-fouling coatings for heat exchanger installations. These anti-fouling coatings are to be made by a combination of surface modification tools in order to chemically attach different types of hydrophilic polymers and/or metal nano-particles of sub-micron thickness to stainless steel surfaces. Several parameters will be studied systematically to optimise the coating performance in terms of thermal and solvent stability, anti-fouling and heat

transfer efficiency. The surface analytical techniques include: Ellipsometry, contact angle, XPS and ToF-SIMS. The anti-fouling property of the coated surfaces will be evaluated using microscopes equipped with a flow cell. The heat transfer efficiency will be tested by mimicking the relevant conditions employed at the industrial site. Finally, the optimised coatings will be tested on commercial heat exchanger installations in collaboration with industrial companies.

ABOUT THE PROJECT

Title: Anti-Fouling Coatings for
Heat Exchanger Surfaces

Project period: July 2014 to June 2017

Main supervisor: Assistant Professor Joseph Iruthayaraj

Co-supervisors: Prof. Kim Daasbjerg and
Assoc. Prof. Rikke Louise Meyer

Research section: Biological and Chemical Engineering

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Maja Nielsen

PROJECT DESCRIPTION

The government's desire and ambitious goal of phasing out fossil fuels by 2050 creates high demands on the development and optimisation of existing alternative energy sources including the production of biogas. Biogas contains a high amount of methane which is utilised as a high-energy fuel in several devices. The production of biogas is microbially catalysed during anaerobic digestion of various substrates such as household waste and organic waste from livestock production. The production process is complex and catalysed by different microbial groups. Unfortunately, the knowledge on the specific bacteria catalysing the different processes is very limited.

The goal of this PhD project is to identify and describe the involved bacteria classes. A number of Danish biogas plants have been selected for further studies. Different techniques will be applied for the examination including microbial molecular techniques. The microbial data will be compared to the process data from different biogas plants in order to determine the influence of the microbial composition on the methane yield. The data obtained in this project is expected to form the basis for

future process optimisations and design of biogas plants.

ABOUT THE PROJECT

Title: Novel Microbiological

Platform for Optimisation of
Biogas Production (NomiGas)

Project period: May 2014 to April 2017

Main supervisor: Senior Researcher Henrik Bjarne Møller

Co-supervisor: Assoc. Prof. Lars Ottosen

Research section: Biological and Chemical Engineering

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Sofie Haldrup

PROJECT DESCRIPTION

The major goal of the project is to screen among ion-conductive membranes to select the most promising ones in terms of high conversion efficiency, stability, lifetime, etc. that are suitable for electrokinetic and thermoelectric conversion processes.

The basic ideas behind the project are:

1. to study the physical transport properties, e.g. ion-conductivity, hydraulic permeability, streaming potential, Seebeck effect and thermal conductivity, of commercially available ion-conductive membranes for which no specific data can be retrieved in the pertinent literature.
2. to synthesise novel ion-conductive membranes with tuned transport properties.

Indeed, current commercially available ion conducting membranes are optimised for fuel cell or electrodialysis applications in which a large ion-conductivity is wanted. This does not necessarily hold for electrokinetic and thermoelectric membrane conversion processes.

The basic tasks of the PhD project:

- Syntheses of ion-conductive polymer membranes and in this process control the parameters: pore size from a few nm up to hundreds of nm, ion exchange capacity and water content in order to increase the water/ion coupling.
- Measurement of different transport properties with varying electrolytes and concentrations on specialised equipment.
- Estimate the electrokinetic and thermoelectric conversion efficiency of specific membranes, electrolytes and concentration, and assess the feasibility for larger scale use.

ABOUT THE PROJECT

Title: Synthesis and Characterisation of Nano Porous Ion-Conductive Membranes for Energy Conversion Purposes

Project period: Jan 2013 to Dec 2015

Main supervisor: Assoc. Prof. Anders Bentien

Research section: Biological and Chemical Engineering

Contact: haldrup@eng.au.dk

Casper Clausen

PROJECT DESCRIPTION

The ability to accurately measure velocities, concentration and size of nano- and micro-particles in liquid and gas flows is a cornerstone in many environmental, medical and industrial technologies.

The scope of the project is related to research and development of a low-cost optical sensor technology that can measure micro/nano particle size, concentration and velocities simultaneously. The overall goal is to investigate the feasibility of the optical technologies in relation to specific applications.

The tasks of the PhD project include to:

- develop integrated optical components in Aarhus University's cleanroom facilities,
- build lab-scale facilities for testing optical components,
- build functional models for test of specific applications,
- develop advanced signal processing techniques,
- use and integrate innovation models into the project in order to create specific goals with respect to applications and

specification,

- increase knowledge on innovation and know how within applications and techniques through cooperations with external partners (EU, USA).

ABOUT THE PROJECT

Title: Research and Development of Optical Components and Technologies for Simultaneous Measurement of Micro/Nano Particle Size, Concentration and Velocities

Project period: May 2012 to Sept 2016

Main supervisor: Assoc. Prof. Anders Bentien

Research section: Biological and Chemical Engineering

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Mette Birch Kristensen



PROJECT DESCRIPTION

One of the big topics these years concerns the transition from a fossil fuel based society to a society that will rely mainly, if not completely, on renewable energy resources. Many proposals on different scales (from household to whole of Europe) and with different perspectives (storage, conversion, new materials, grid, etc.) are being investigated and discussed in both academia, industry and on a political level in order to find good and responsible solutions. Renewable energy resources such as biogas, wind and solar power are well known technologies that are already implemented into society today. One of the big challenges is how these energy resources can be used in the best possible way at the time and place where it is needed. This angle towards the energy problem is the focus area of the research in the Membrane Technology group.

In this specific project, the main focus will be on synthesis of polymeric membranes for use in biogas plants with the goal of separating the different gases. The main goal will be to separate CH₄, CO₂ and H₂. The objective is to synthesise membranes with high selectivity ratios, high permeability, good stability and good chemical resistance. Depending

on the driving force for the separation different types of membranes should be synthesised. Polymeric ion conductive membranes are one option which can be used in electrokinetic processes. Another option is polymeric membranes with inorganic or metal organic frameworks. For the characterisation of the last type of membranes, a gas permeability setup will be built as part of this project.

ABOUT THE PROJECT

Title: Synthesis and Characterisation of

Nano-Porous Perfluorinated Membranes

Project period: Aug 2013 to July 2017

Main supervisor: Assoc. Prof. Anders Bentien

Research section: Biological and Chemical Engineering

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David Nicolas Østedgaard-Munck



PROJECT DESCRIPTION

Energy conversion technology plays a vital role in many industrial applications today e.g. in the conversion of energy from electric into electrochemical as in batteries, or the conversion of kinetic/mechanical into electrical energy as in generators.

Converting energy from one form into another, e.g. from electric to kinetic energy, also holds potential for creating alternatives to devices such as vapour compressors for cooling cycles.

The aim of this project is to investigate the potential use of nano-porous ion-conductive membranes in an industrial setting. The project is split into two parts. The first is the construction and use of specialised equipment for measuring the electrokinetic and thermoelectric conversion efficiency of nano-porous ion-conductive membranes with respect to electrolytes and concentration.

The second part of the project concerns the application of the membranes. The initial idea is to apply the energy converting ability of the

membranes to convert electric energy into kinetic energy and thus use the resulting set-up as a vapour compressor. When this compressor has been characterised, it will be applied in a cooling cycle where the overall efficiency of the cycle will be investigated. Ultimately, the feasibility for larger scale use of this technology will be assessed.

ABOUT THE PROJECT

Title: Characterisation and Application of Nano-Porous

Ion-Conductive Membranes for Energy Conversion Purposes

Project period: Aug 2013 to July 2017

Main supervisor: Assoc. Prof. Anders Bentien

Research section: Biological and Chemical Engineering

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Kristina Wedege



PROJECT DESCRIPTION

The European energy production is expected to change in the coming years from being based mostly on fossil fuel and into having a larger contribution from renewable energy sources such as solar and wind energy. This is a great challenge for the electrical grid as these energy sources are inherently variable in their energy output. Consequently, stationary large-scale energy storage is of great interest, which motivates research into the field of so-called redox flow batteries. In these batteries, redox couples in two separate chambers are charged electrochemically by changing their oxidation states. During discharge, the reverse redox reaction takes place and charge balance is kept by ion-exchange through a selective membrane between the chambers.

The aim of the project is to improve the efficiency and lower the cost of such a battery, e.g. by searching for new redox couples and improving the membranes. Study of various catalytic effects and possibly direct coupling of the battery with solar charging is also part of the research areas.

ABOUT THE PROJECT

Title: Energy Storage with Redox Flow Batteries

Project period: May 2014 to Aug 2018

Main supervisor: Assoc. Prof. Anders Bentien

Research section: Biological and Chemical Engineering

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Pernille Kasper

PROJECT DESCRIPTION

Emissions of odorous compounds from livestock and biogas production cause nuisance in the vicinity of the production sites and limit the development of these industries in populated areas. Part of the project is focused on abatement of these emissions with emphasis on reduced sulfur compounds which are identified as key odorants. Desulphurization with chelated iron is a well-known and proven technology in the natural gas and oil refining industries. The focus of this work is to evaluate and optimise this process for deodorization purposes.

In order to make sure that the air cleaning technique has a significant and measurable impact on perceived odor, a part of the project is focused on odor measuring and sampling techniques. Currently, common practice is to store odor samples in bags and quantify them by olfactometry with human panelists. However, due to their volatile and reactive nature, many of these compounds are lost during sampling and, hence, the results of this method may become misrepresentative. To ensure the validity and scientific credibility of odor measurements and evaluations of abatement methods, these losses are investigated and the technique

is sought improved through direct measurement of odorous compounds with Proton Transfer Reaction Mass Spectrometry.

ABOUT THE PROJECT

Title: Volatile Sulfur Compounds from Livestock and Biogas Production: Emission Control by Dissolved Iron Catalysts and Impact of Odor Removal Assessment

Project period: April 2014 to March 2017

Main supervisor: Assoc. Prof. Anders Feilberg

Research section: Biological and Chemical Engineering

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Hongqing Yao

PROJECT DESCRIPTION

Originally, Advanced Oxidation Processes (AOPs) as a set of chemical treatment procedures have been used extensively to remove organic and inorganic contaminants in wastewater treatment by oxidation.

Generally, AOPs are based on generation of high concentrations of highly reactive hydroxyl radicals. Recently, AOPs are considered to be new technologies for application in livestock buildings and industrial facilities to reduce the emissions of volatile organic compounds and H₂S.

The introduction of cost-effective AOP technologies requires new research on the function and efficiency of the process involved. Examples of AOPs for air treatment are photocatalysis based on UV radiation with catalysts and O₃ treatment and catalytic scrubbers such as Fenton's system.

The objectives of the project are to:

- explore the aqueous surface reactivity of hydroxyl radicals towards relevant volatile organic compounds and H₂S,
- investigate the efficiency of odorous compounds by using AOPs,
- assess the most promising technologies in field application.

ABOUT THE PROJECT

Title: Application of Advanced Oxidation Processes for Treatment of Air from Livestock Buildings and Industrial Facilities

Project period: Feb 2011 to May 2015

Main supervisor: Assoc. Prof. Anders Feilberg

Co-supervisor: Senior Researcher Anders Peter Adamsen

Research section: Biological and Chemical Engineering

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Daniel Girma Mulat

PROJECT DESCRIPTION

The production of methane from agricultural and industrial wastes in anaerobic digestion (AD) has been used as pollution control and for energy recovery purposes. However, the advantages of anaerobic digestion for treating organic wastes have not been brought into full play. This process is still far from optimised due to incomplete process understanding.

The overall aim of the project is to generate an in-depth knowledge about the degradation mechanisms of key intermediates and the most important methanogenic pathways for the formation of CH₄ in anaerobic digestion.

Analytical techniques based on stable isotope labelling combined with isotope ratio determination by optical spectroscopy and mass spectrometry will be developed and applied for understanding methanogenic pathways.

The aim of the project is to obtain new knowledge about the relative contribution of methanogenic pathways and the role of intermediate

precursors such as hydrogen, formate and acetate to the total CH₄ production which will be combined with a technology to optimise the production of biogas production from organic waste.

ABOUT THE PROJECT

Title: Methanogenic Pathways in Anaerobic Bioreactors by Stable Isotope Techniques

Project period: Dec 2011 to Jan 2015

Main supervisor: Assoc. Prof. Anders Feilberg

Co-supervisors: Senior Researcher Anders Peter Adamsen and Postdoc Alastair James Ward

Research section: Biological and Chemical Engineering

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Radziah Wahid

PROJECT DESCRIPTION

The aim of this project is to improve biogas potentials through pre-treatment and co-digestion processes.

Pre-treatment is important as it can increase the accessibility of microorganisms to cellulose during anaerobic fermentation, especially for highly lignified substrate, and thus increase the biogas potential. Different substrates such as agricultural crops, algae and animal manures are used in this research. Briquetting and extrusion are two main pre-treatment techniques that will be analysed in depth. Different control parameters are manipulated to find the optimal settings and configuration of the machinery for the highest biogas yield and lowest costs in terms of energy.

The influence of co-digestion of plant materials with animal manures is another focus area as it may offer a range of process benefits. Animal manures provide buffering capacity and a wide range of nutrients while plant material with high carbon content balances the carbon to nitrogen (C/N) ratio, thus reducing the risk of ammonia inhibition.

Fundamental knowledge about anaerobic digestion of animal manures is investigated first before co-digestion with different substrates is initiated. This is important to fully understand the synergies of anaerobic digestion involved in biogas production from animal manures alone.

ABOUT THE PROJECT

Title: Co-Digestion of Mixed Substrates and Its Pre-Treatment for Biogas Production

Project period: Dec 2012 to Nov 2015

Main supervisor: Senior Researcher Henrik Bjarne Møller

Co-supervisor: Postdoc Alastair James Ward

Research section: Biological and Chemical Engineering

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Theresa Meldgaard

PROJECT DESCRIPTION

The work of this project is a sub-project within an innovation consortium called Center for Cellular Sygdomsanalyse (CCS). CCS is a cooperation between six smaller biotechnological companies with complementary skills and two academic partners.

The mutual goal is the development of new technology for characterising and, in the end, analysing tumour material with a view to design individualised and effective treatment strategies. The consortium puts emphasis on breast cancer.

The objective of this particular sub-project is to discover unique or better markers of different breast cancer cell subpopulations. By employing the phage display technology in which libraries of antibody fragments are displayed on the surface of bacteria specific virus particles called phages, antibody fragments are selected against different breast cancer cells. Through the identification of antibodies showing specific recognition of different cancer cell subpopulations, their cognate antigen can be identified and applied as markers.

The intention is to apply a panel of such antibodies in the development of analysis platforms. These platforms, such as a flow based cell-capture platform, can hopefully aid in the characterisation of the composition of tumour cell sub-types within a given tumour. This will allow decisions on treatment choices to be made for a given patient.

ABOUT THE PROJECT

Title: Identification and Analysis of Functional and Cell Specific Bio-Markers supporting Individualised Treatment Strategies

Project period: April 2010 to April 2015

Main supervisor: Assoc. Prof. Peter Kristensen

Research section: Biological and Chemical Engineering

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Mathias Jørgensen

PROJECT DESCRIPTION

Cancer cells display vast amounts of genetic mutations leading them to divide, grow and invade neighbouring tissue. However, not all cancers are restrained within the adjacent tissue but can also change morphology and start to circulate via the blood. These cells are the so-called circulating tumour cells (CTCs) causing the cancer to spread to otherwise healthy tissue. CTCs are rare in a patient sample, accounting for about 5-50 cells per teaspoon of blood.

This project is concerned with isolating and characterising CTCs through a screening platform based on the phage display technique.

From the phage display technique platform, antibodies will be selected and used for coating microchips. The development of such microchips is a part of a collaboration with engineers from the fluid dynamics research group.

ABOUT THE PROJECT

Title: Screening and Selecting Antibodies against Rare Circulating Cancer Cells

Project period: Aug 2013 to July 2016

Main supervisor: Assoc. Prof. Peter Kristensen

Research section: Biological and Chemical Engineering

Contact: mlindeh@eng.au.dk





Mohamad Firdaus Bin Mohamad Yusoff

PROJECT DESCRIPTION

This project is divided into two main parts. The main goal of both parts is to investigate and possibly develop a model that describes the mechanism and kinetics of interesterification.

The first part of the project focuses on how to utilise a specific kind of lipase to produce biodiesel. The reaction using enzymes is relatively complex and because of that a unique strategy of disassembling the whole mechanism of the reaction is conducted.

The enzymatic reaction is divided into hydrolysis pathway and esterification pathway. Within these parts, an investigation of kinetics and reaction mechanism is carried out using the Michealis-Menten function.

When all the information is collected, a computer model that illustrates the whole reaction will be developed. The investigation also involves total fatty acid consumption, total water effect and enzyme concentration. The second part of the project aims at developing a chemical catalyst including Brønsted acid functionalised ionic liquid and sulfonic func-

tionised MCM-41. Several solutions will be tested to investigate their function as a catalyst for biodiesel production and also as a solvent that facilitates the reaction.

The analysis of the reactivity of the catalyst will be conducted using several analytical instrumentations such as gas chromatography, mass spectrometry, high performance liquid chromatography and UV-spectrometry.

ABOUT THE PROJECT

Title: Heterogenous Catalysis for the Production of Biodiesel

Project period: July 2012 to May 2015

Main supervisor: Assoc. Prof. Zheng Guo

Research section: Biological and Chemical Engineering

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Mia Falkeborg

PROJECT DESCRIPTION

This project aims at developing a range of new food emulsifiers which, in addition to having surface-active properties, also possess antioxidative properties. Such emulsifiers find potential applications in the encapsulation of fish oil for use in food products.

A high intake of fish oil has been associated with several health benefits, and the addition of fish oil to regularly consumed food products is believed to contribute to an increased health.

Encapsulation of the fish oil is necessary however as fish oil is very unstable and oxidizes easily. Fish oil can be encapsulated with emulsifiers, and antioxidants should be added for improved protection of the fish oil.

This project aims at developing innovative ingredients with combined emulsifier and antioxidant properties. The ingredients are developed from natural raw materials using environmentally friendly production processes. The ingredients are believed to be able to encapsulate fish oil in a stable emulsified form in which the fish oil is protected from

oxidation through the action of the antioxidants. Such a fish oil emulsion could potentially be added to various food products.

ABOUT THE PROJECT

Title: Development of Innovative Ingredients for Improved Microencapsulation

Project period: Sept 2011 to Aug 2014

Main supervisor: Assoc. Prof. Zheng Guo

Co-supervisors: Assoc. Prof. Marianne Glasius and Prof. Xuebing Xu

Research section: Biological and Chemical Engineering

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Kristian Peter Andreasen

PROJECT DESCRIPTION

The introduction of radically new technology into the market is a complex and often very costly and time consuming process.

In this project, the development process of the hydrogen and fuel cell innovation system in Denmark and the introduction of these technologies into the current energy system will be analysed. The hydrogen and fuel cell innovation system is comprised of the network of actors involved in research, development, production and commercialisation activities for the hydrogen and fuel cell technology.

The outcome of this research will be a set of strategic recommendations for the actors involved in the innovation system in order to benefit the future socio-technical development.

The hydrogen and fuel cell technology is a very interesting technology to follow for the energy systems of the future since it has the potential to solve many of the challenges involved in the transition to a fully sustainable energy system. This could be as an energy storage solution for intermittently produced electricity from wind power in order to be able to supply the power when consumers demand it and, hence, not necessarily when it is produced.

Another advantage is related to the transportation sector which is the largest emitter of man-made greenhouse gasses today and, hence, should be among the most important focus areas for technological transition. However, the transportation sector is also the most difficult area in which to intervene because it requires changes at all levels of society, namely at consumer, organisational, industry, society and governmental level. In time, hydrogen and fuel cell technology can potentially eliminate transportation emissions without sacrificing the benefits of the current technology.

ABOUT THE PROJECT

Title: The Future of Hydrogen and Fuel Cell Technology in the Sustainable Socio-Technical Transition Processes of the Danish Energy System

Project period: Aug 2011 to July 2014

Main supervisor: Prof. Michael Evan Goodsite/Prof. Benjamin Sovacool

Co-supervisor: Assoc. Prof. Torben René Jensen

Research section: Biological and Chemical Engineering

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Hakimeh Mohammadhosseini

PROJECT DESCRIPTION

The exponential growth of the use of mobile devices, the interconnected environment and 'smart' cities require a dramatic increase in network capacity over the next decade. By 2020, it is expected that 50 billion devices are connected to the internet, a large part of these wirelessly. The required wireless bandwidth is, however, far beyond what technologies like WiFi can deliver.

Governments all over the world have opened up new frequency bands for such wireless communications. The current level of technology is not able yet, though, to provide low cost and compact transceivers for these frequency bands, which is a crucial requirement for ubiquitous and mobile interconnected devices. Moreover, no feasible technology exists for the next generation higher frequency bands.

Optical chips are far more suitable than electronics to generate high-bandwidth signals at these frequencies, but until recently this technology was too experimental and not robust. Over the last few years, however, foundries with mature fabrication processes have been set up

to fabricate silicon based optical chips. For the first time, we can now use this optical chip technology to realise low cost, compact and high-bandwidth transceivers that enable the next generations of wireless internet. This project aims to achieve scientific and technical breakthroughs required to leverage on silicon photonics co-design of transceivers for high speed wireless communications.

ABOUT THE PROJECT

Title: Silicon Photonics for High-Bandwidth Wireless Links and Remote Sensing

Project period: Dec 2014 to Nov 2017

Main supervisor: Assoc. Prof. Martijn Heck

Research section: Electrical and Computer Engineering

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Mohammad Tohidi

PROJECT DESCRIPTION

Therapeutic and prosthetic devices have emerged as a promising candidate for treatment of patients with neurological disorders ranging from epilepsy and Parkinson's disease to motor impairments. The ability to acquire targeted neurological information from the brain is an essential requirement for the advancement of these systems. Thus, brain monitoring introduces key challenges for electronic systems in terms of both instrumentation and information extraction.

The focus of this project is to design a low-power and low-noise mixed-signal IC design in Nano-scale technologies such as CMOS, Fin-FET and Tunnel-FET (TFET). This design will be used to handle brain signal (EEG) acquisition and feature extraction from an analogue channel into the digital domain. The main focus of the project is on designing ultra-low power digital and analogue components especially for neurological disorders such as seizure in a system-on-chip (SOC).

In this system, an Instrumentation Amplifier is used to acquire the micro-volt signals from electrodes in the presence of numerous physiological

and environmental interferences. These amplified signals are processed using a DSP or custom digital/analogue circuits in CMOS technology in an extremely low power mode. In this project designing high-speed photonic Analog-to-Digital Converters (ADC) will be explored in collaboration with the photonics group.

ABOUT THE PROJECT

Title: Ultra-Low Power Device in Nano-Scale Technology for Biomedical Applications Seizure Detection

Project period: Oct 2014 to Sept 2017

Main supervisor: Prof. (Docent) Jens Kargaard Madsen

Co-supervisors: Assoc. Prof. Farshad Moradi and Assistant Prof. Farshad Moradi

Research section: Electrical and Computer Engineering

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Armin Ghasem Azar

PROJECT DESCRIPTION

The Smart Grid represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability and efficiency that will contribute to our economic and environmental health. The Smart Grid will consist of controls, computers, new technologies and equipment working together and with the electrical grid to respond to our constantly changing electric demands. Also, demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based prices. This project aims at developing a novel ICT infrastructure for the implementation of Demand Response in households. This infrastructure will enable the shifting of energy consumption from high energy-consuming loads to off-peak periods with high generation of electricity from Renewable Energy Sources.

The chief purpose of this project is to develop a novel, comprehensive and optimal scheduling strategy for varied-specific households. In this strategy, the aggregator system will optimise and manage a large number of partial loads simultaneously according to the generation of electricity from Renewable Energy Sources to shift the households' demands to off-peak hours. The scheduling strategy needs to take into account constraints from

household comfort, grid stability, market mechanisms, etc. Also, trying to optimise conflictive objectives of households and aggregator simultaneously creates a multi-objective optimisation problem. As a result, the main question is how much and when the power consumption should be shifted taking into account the inclusion of scalable and diverse-characteristic householders, different appliance types and dynamic energy price strategies. Answering this question helps the householders to benefit financially and the aggregator to balance the system optimally.

ABOUT THE PROJECT

Title: Scalable Energy Management Infrastructure for Aggregation of Households

Project period: Sept 2014 to Aug 2017

Main supervisor: Assoc. Prof. Rune Hylsberg Jacobsen j

Research section: Electrical and Computer Engineering

Contact: aga@eng.au.dk



Jakob Pilegaard Juul

PROJECT DESCRIPTION

When storing grain and other farm produce, proper drying and storage are important. Using wireless sensors distributed in the storage enables a farmer to monitor how the drying/storage is progressing and to take action if something is not as it should be. This helps to reduce losses and get a higher overall quality.

A number of challenges face a wireless sensor network deployed in such a scenario. Farm produce can contain relatively high amounts of water as well as high concentrations of salts leading to an unfavourable environment for wireless communication.

To help in the process of monitoring storages, the aim of this project is to develop a wireless sensor network capable of functioning reliably under the specific conditions. The system should also be able to localise the sensors of the network as this enables targeted intervention in problem areas.

ABOUT THE PROJECT

Title: Localisation of Wireless Sensor Network Embedded in Biomass

Project period: March 2010 to July 2015

Main supervisor: Assoc. Prof. Rune Hylsberg Jacobsen

Co-supervisor: Ole Green, Kongskilde Industries A/S

Research section: Electrical and Computer Engineering

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Søren Aagaard Mikkelsen

PROJECT DESCRIPTION

In the battle for lowering CO₂ emissions, many countries encourage and financially support the deployment of renewable energy sources for generating electricity. These energy sources are typically non-dispatchable, i.e. they do not produce energy on demand. Currently, no energy storage technology exists that efficiently store the energy when it is produced for later use. Thus, it is necessary to have an Information and Communication Technology (ICT) system that can support the grid operator in accounting for these fluctuations on the grid so the energy can be consumed when it is produced; a so-called smart grid system. This need is only exacerbated further with the advent of solar panels and electric vehicles distributed on the electric grid.

The challenge of balancing the electric grid with non-deterministic generation of electricity calls for ICT solutions that can monitor and manage consumption and production in real-time. Such solutions will be based on data generated from sensors placed e.g. in residential houses. A large majority of the data produced in residential homes is, however, directly related to the residents' behaviour within their own private sphere. If security and privacy going to and from the residential homes are not carefully considered, a possible resistance towards adapting these ICT solutions could emerge. Additionally, the solution must be economically attractive for both the

residential consumer and grid operator such that the potential benefit (such as energy cost savings) from getting the monitoring equipment outweighs the price of the equipment.

The aim of this project is to facilitate an economically viable ICT solution for both the residential consumers and the grid operators by using the existing Internet connection in the residential houses as pathway for communicating and transferring data. On top of a service-oriented architecture and an open communication infrastructure, the research will focus on preserving data privacy and enforce cyber-security for the residential consumers while not compromising robustness and service guarantees for the grid operators.

ABOUT THE PROJECT

Title: Cybersecurity and Privacy Enforcement in an Internet-based Smart Grid

Project period: Oct 2012 to Sept 2015

Main supervisor: Assoc. Prof. Rune Hylsberg Jacobsen

Research section: Electrical and Computer Engineering

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Sergi Rotger Griful

PROJECT DESCRIPTION

In the near future, there will be a higher penetration of renewable energy sources into the electrical grid. The entrance of these distributed energy resources into the system will require smarter solutions to balance the electricity production and consumption. This future grid is known as the Smart Grid.

The aim of this project is to make a large residential complex and its consumers "Smart Grid Ready" through the development and operation of a Virtual Power Plant (VPP). A VPP can be understood as a power plant which, instead of just producing electricity, is also able to modify the energy consumption of the end-user, thus providing demand response. The designed VPP will monitor and control the energy usage in the building. Furthermore, the VPP of the building will pool and offer the overall demand response to an external entity at a higher tier in the aggregation hierarchy.

The new student's residence at Aarhus harbour will be used as a test bed under the name of Grundfos Dormitory Lab. This is a 159 apartment

building with a very low consumption profile, equipped with more than 3200 sensors.

The project deals with the Information and Communication Technology (ICT) for the construction of a VPP at building level. Specifically, this involves concept development, demand response engineering, sensing and actuation technology, data mining and forecasting as well as system integration for demonstrating part of the concepts developed. The project aims at advancing the state-of-the-art in VPP technologies for the Smart Grid.

ABOUT THE PROJECT

Title: Virtual Power Plant for Residential Demand Response

Project period: May 2013 to April 2016

Main supervisor: Assoc. Prof. Rune Hylsberg Jacobsen

Research section: Electrical and Computer Engineering

Contact: srgr@eng.au.dk

Søren Rasmussen



PROJECT DESCRIPTION

The project is part of a collaboration between the company SkyTEM, the Department of Geoscience and the Department of Engineering at Aarhus University. SkyTEM is a technology leader in groundwater measurements using a helicopter-based TEM (Transient Electromagnetic Method) system for sub-surface exploration.

TEM consists of measuring the earth response to a magnetic signal generated by a large induction coil which, in this case, is towed by a helicopter.

For this project, SkyTEM is currently developing a new hardware platform that enables advanced processing of the measured signals. The purpose of this project is to explore and make use of the possibilities enabled by this new platform.

ABOUT THE PROJECT

Title: Optimised Signal Processing of SkyTEM Data

Project period: Aug 2014 to June 2017

Main supervisor: Assistant Prof. Jakob Juul Larsen

Research section: Electrical and Computer Engineering

Contact: sras@eng.au.dk

Behzad Zeinali



PROJECT DESCRIPTION

The past few decades have seen the evolution of a semiconductor industry driven by technology scaling. Miniaturisation of bulk Field Effect Transistors (FETs) along with the scaling of power supply voltage have provided the benefits of higher performance, lower power and larger integration density. However, future scaling will face considerable challenges e.g. short-channel effects (SCEs) causing the design and optimisation of circuits to become very challenging.

One approach to counter these effects is to introduce alternate devices which possess inherently better robustness to SCEs in comparison to existing technology. Among these alternatives, multiple-gate FETs such as FinFETs or gate wrap-around FETs are emerging as promising candidates. FinFETs have the potential for analogue applications as well as for improving the performance of digital circuits such as static random access memories (SRAM) which are widely used in most digital and computer systems. In this respect, Intel will use the 3-D trigate transistors commercially in 22-nm technology node and so a strong interest has emerged among semiconductor industries in forming 14 and 10-nm bulk FinFET.

In this project, FinFET devices are utilised for SRAM modules in both circuit and device level designs. Also, we will investigate FinFET and its potentials for low-power applications and design some analogue and mixed-signal building blocks by FinFET in sub 14-nm technologies using the Design Kits provided by IMEC.

ABOUT THE PROJECT

Title: Low Voltage/Low Power Design in Future Nodes (FinFET and Nanowire-based Devices)

Project period: May 2014 to April 2017

Main supervisor: Assistant Prof. Farshad Moradi

Co-supervisors: Prof. (Docent) Jens Kargaard Madsen and Praveen Raghavan, IMEC

Research section: Electrical and Computer Engineering

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Daniel Siboska



PROJECT DESCRIPTION

For most of the population, our eyes have become the primary access to the world around us. However, much of the visual stimuli that enter our eyes is filtered out before it reaches our consciousness/visual awareness. Our visual system is extraordinarily good at this filtering process, though sometimes important information is filtered away which can be devastating e.g. in traffic situations.

This project seeks to explore the mechanisms that control whether visual information reaches our visual awareness or is filtered out. We will do this by measuring magnetic signals (magnetoencephalography – MEG) generated from specific areas in the brain when this process occurs and see how these mechanisms modulate the activity in the brain.

The first such mechanism we explore is how spatial attention, i.e. where we are directing our eyes, modulates this filtering process. To do this, we need to be able to control how much spatial attention the test subjects are able to allocate to a given visual stimulus. This will be achieved through the use of a gaze contingent display which can change the

visual content on the screen depending on where the subject is looking.

The development of such a gaze contingent display with a faster response time than the human eye and which can be used while recording MEG signals is a prerequisite for the examination of the effect of spatial attention on our visual awareness.

ABOUT THE PROJECT

Title: Visual Awareness Negativity and Spatial Attention

Project period: Jan 2012 to April 2015

Main supervisor: Prof. (Docent) Henrik Karstoft

Research section: Electrical and Computer Engineering

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Thomas Jensen

PROJECT DESCRIPTION

The aim of this project is to research and develop a system for sensor based online control of the degree of tillage for a seedbed cultivator moving in the field.

The system will include a vision system for characterising the seedbed quality. The vision system will consist of a series of laser range scanners positioned on the seedbed cultivator which continuously generate a map of the raw and processed soil. The quality of the seedbed is correlated with aggregate size in the soil surface, i.e. the cloddiness of the soil. Large clods result in a too airy seedbed and thus the risk of drying out the seeds. On the other hand, a too processed seedbed has the risk of sealing the soil surface after heavy rain and thus resulting in bad germination. Additionally, it is a sign of too intensive seedbed cultivation and thus of an unnecessarily high energy consumption while cultivating.

The online control of tillage intensity is based on image analysis, and the seedbed cultivator is adjusted continuously while running in the field. Since the same field often consists of many types of soil, the system

must be able to react to the changes in soil type and adjust the tillage intensity accordingly.

ABOUT THE PROJECT

Title: Intelligent Soil Tillage using Image Sensors

Project period: Sept 2012 to Aug 2015

Main supervisor: Prof. (Docent) Henrik Karstoft

Co-supervisors: Senior Researcher Lars Munkholm and Ole Green, Kongskilde Industries A/S

Research section: Electrical and Computer Engineering

Contact: thje@eng.au.dk



Kim Arild Steen

PROJECT DESCRIPTION

The purpose of this project is to develop methods and algorithms for automation in agriculture.

The main focus is wildlife management systems where new technology could automate or improve existing methods.

The main contribution of the work is the development of pattern recognition algorithms which are capable of detecting and recognising wildlife in an agricultural setting. This includes audio and video based systems that are capable of measuring the presence and behaviour of wildlife. The expected result of this work is a proof of concept solution which can be used in further development and full-scale tests.

ABOUT THE PROJECT

Title: Pattern Recognition Methods for Reduction of Human-Wildlife Conflicts

Project period: Feb 2011 to April 2014

Main supervisor: Prof. (Docent) Henrik Karstoft

Co-supervisor: Ole Green, Kongskilde Industries A/S

Research section: Electrical and Computer Engineering

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Luis Diogo Monteiro Duarte Couto

PROJECT DESCRIPTION

Extensibility is a desirable property of many software systems. It can be defined informally as the ability of a system to support the addition of new and unplanned functionalities.

This project explores extensibility of formal methods tools, specifically the Overture tool for VDM (Vienna Development Method). I assess the extensibility of Overture through various perspectives such as tool architecture, coding patterns and underlying semantics.

My work is based on a series of extensions to the Overture tool that act as case studies and drivers for the research. Particular focus is given to extending proof obligation generation to support the Rely/Guarantee specification style.

Parallel to the above, I will also investigate a connection between extensibility and formal modelling by developing techniques for the construction of extensible models.

ABOUT THE PROJECT

Title: Extensibility and Extensions of Formal Methods Tools

Project period: Oct 2012 to Sept 2015

Main supervisor: Prof. Peter Gorm Larsen

Co-supervisor: Joey Coleman, PhD

Research section: Electrical and Computer Engineering

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José Antonio Esparza Isasa



PROJECT DESCRIPTION

An embedded system is a special purpose computing device commonly operating with low computing power and sometimes under limited energy availability.

One of the techniques that can be used to develop these kinds of systems is model-driven engineering. Under this design approach, the engineer uses modelling technologies to represent the system at a high level of abstraction. Following this initial representation, the model is progressively transformed into a final implementation.

The aim of this project is to adopt this approach to design and implement embedded systems that operate under tight energy budgets. The challenge is to incorporate the notion of energy consumption into different modelling paradigms. The reason behind applying several paradigms resides in the fact that embedded systems' energy consumption can be studied from different angles, i.e. the physical, communication or computation angle.

By using different modelling approaches, one can select the most suitable for each angle and obtain energy estimations from different points of view.

The results of this project are being applied progressively in a case study in which an electronic compression stocking to treat leg venous insufficiency is developed. The aim is to evaluate how the energy consumption predictions determined by the models relate to the actual implementation, and how the modelling process benefits system development.

ABOUT THE PROJECT

Title: System Level Power-Aware Design for Mission-Critical Embedded Systems

Project period: May 2012 to April 2015

Main supervisor: Prof. Peter Gorm Larsen

Co-supervisor: Prof. (Docent) Finn Overgaard Hansen

Research section: Electrical and Computer Engineering

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Peter Würtz Vinther Jørgensen



PROJECT DESCRIPTION

In this project, the development of software tools for efficient model-based development of Cyber-Physical Systems (CPSs) is explored. These are systems in which computational units are collaborating on controlling physical entities such as mechanical or electrical actuators in order to achieve a common goal.

I am interested in how the insight obtained during modelling can be transferred most efficiently to the implementation phase where the system is realised. I am working with automated transformation of VDM (Vienna Development Method) models into code that can be executed on the target platform of the CPS. In particular, I intend to address the general case where the target platform is distributed, i.e. the system is composed of several computers communicating across a network.

In addition, I have been considering ways to move gradually from a model to the realisation of the system. For this, I have been working with Hardware-In-the-Loop (HIL) simulation where VDM components of functionality are being transformed into implementations and co-executed

with the model. In this way, one can benefit from the abstraction mechanisms of modelling and the fidelity of using component implementations during development.

ABOUT THE PROJECT

Title: Enablers and Methodologies for Cyber-Physical Systems

Project period: May 2013 to April 2016

Main supervisor: Prof. Peter Gorm Larsen

Research section: Electrical and Computer Engineering

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Simon Lind Kappel



PROJECT DESCRIPTION

Ear-EEG is a novel EEG (electroencephalography) recording approach in which the EEG signal is recorded from electrodes embedded on an ear-piece placed in the ear canal. The ear-EEG has great potentials within continuous brain monitoring in everyday life and will have application within both medical and consumer electronics devices.

The integration of brain monitoring based on EEG into everyday life has been hindered by the limited portability and long set-up time of current wearable systems as well as by the invasiveness of implanted systems. To address these issues, the ear-EEG has been introduced which is a discreet, unobtrusive and user-centred approach to brain monitoring. The ear-EEG recording concept has been tested by using several standard EEG paradigms and benchmarked against standard on-scalp EEG.

All ear-EEG recordings made so far have been based on wet-electrode technology. In order to improve the usability and user-friendliness, this project will exploit so-called dry-contact electrode technology. This has

impact on the design of the electrode itself, the supporting mechanics and the electronic instrumentation for acquiring the EEG signal.

ABOUT THE PROJECT

Title: Characterisation and Evaluation of Dry-Contact Electrodes for Ear-EEG

Project period: Oct 2013 to Sept 2016

Main supervisor: Prof. (Docent) Preben Kidmose

Research section: Electrical and Computer Engineering

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Camilla Arndal Rotvel

PROJECT DESCRIPTION

During the last decade, overweight and obesity have become an increasing global issue. According to WHO, in 2008, around 1.4 billion people over the age of 20 were overweight, at least 500 million were obese and at least 40 million children under the age of five were overweight.

The Food Industry's response to the obesity epidemic has been to produce a number of low fat and sugar food products that enable the consumer to eat the same food while consuming fewer calories. However, an investigation conducted by the Food Administration shows that people tend to consume extra-large servings of the light products, negating any benefits the light products might offer.

A solution to the above-mentioned obesity epidemic requires a more thorough understanding of the brain's response to varying salt, sugar and fat levels and subjective satiation. Traditionally, food ingredient selection is based on physical and sensory analysis methods. However, in connection with salt, sugar and fat substitution products, objective measurement

methods lack the ability to describe what we can register with our senses. In this regard, brain recordings are particularly interesting.

The idea behind the project is to utilise EEG methods to screen salt, sugar and fat substituents when selecting new food ingredients. The goal is to compare EEG results with physical or sensory data for new food ingredients with the hope of supplementing selection criteria for new food ingredients with objective physiological EEG responses.

ABOUT THE PROJECT

Title: Development of Methods for Objective EEG Analysis of

Brain Activity induced by Sugar, Salt, Fat and their Substitutes.

Project period: Sept 2013 to Aug 2018

Main supervisor: Prof. (Docent) Preben Kidmose

Co-supervisors: Stine Møller, DuPont Nutrition BioSciences, Ole Larsen, Syddansk Universitet and Gert Christoffersen, Neural Scientific

Research section: Electrical and Computer Engineering

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Faisal Farooq

PROJECT DESCRIPTION

Brain Computer Interfaces (BCIs) are an emerging technology that uses electrical activity in the brain, measured by non-invasive electroencephalography (EEG), to enable direct communication between the human brain and external devices such as computers. Over the past several years, BCIs have become an important research topic because of their ability to help patients suffering from severe loss of motor functions such as ALS, stroke, etc. Indeed, such interfaces can increase an individual's independence leading to an improved quality of life and reduced healthcare costs.

The recently introduced ear-EEG methodology is a promising enabling technology for wearable EEG systems. Ear-EEG records EEG signals within the ear canal by embedding electrodes on a customised ear piece similar to ear-plugs used in hearing-aid applications. Ear-EEG is, compared to alternative technologies, a discreet, unobtrusive, robust and user-friendly technology.

Whereas most BCIs are based on visually evoked potentials, the objec-

tive of this project is to develop auditory BCIs based on the Ear-EEG platform. This is feasible because it has been shown that auditory evoked potentials (AEP) can be recorded with good signal quality from ear-EEG.

The aim of the project is to develop new auditory paradigms where the AEPs can be easily controlled by the user's attention, and to develop advanced signal processing algorithms for detection of the AEP modulations.

ABOUT THE PROJECT

Title: Ear-EEG and Applications to Brain Computer Interface (BCI)

Project period: Sept 2012 to Aug 2015

Main supervisor: Prof. (Docent) Preben Kidmose

Research section: Electrical and Computer Engineering

Mohammad Sadeq Mohammadi

PROJECT DESCRIPTION

Body Area Network (BAN) consists of multiple, tiny, low-power, intelligent, wearable or implanted sensor nodes which are radio-enabled and can communicate wirelessly. The sensor nodes can collect various important physiological data for diagnosis or fast emergency response, and deliver various personalised therapeutic, treatment-related applications and services.

BAN is a new emerging technology that is used in areas such as healthcare, entertainment, games and sport science. It is expected to enhance the patient health care experience by providing independent living solutions for people that need constant healthcare. Furthermore, BAN can reduce the demand on the healthcare infrastructure and medical staff in the hospitals. Essentially, there is a unique combination of four major requirements in a realistic BAN:

- Energy efficiency
- Low complexity
- Robustness against harsh fading conditions
- Protection against interference and error

The aim of this project is first to investigate the characteristics of the typical BAN applications and the corresponding difficulties and limitations. The next step is to analyse these limitations to provide remedial solutions to achieve the performance requirements. The analysis is meant to address both Physical (PHY) and Medium Access Control (MAC) layers.

ABOUT THE PROJECT

Title: Reliable Communication in Body Area Networks

Project period: Aug 2013 to Feb 2017

Main supervisors: Assoc. Prof. Qi Zhang, Aarhus University and Eryk Dutkiewicz, Macquarie University

Research section: Electrical and Computer Engineering

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Xiong Zhou



PROJECT DESCRIPTION

The need for healthcare devices for everyday life is increasing. These devices can provide a long-term, unobtrusive monitoring to prevent chronic diseases which are the biggest killers according to the statistics of WHO, e.g. heart disease, stroke, hypertension, diabetes, etc. Past devices are bulky and high-power and have limitations to the use away from specific places e.g. clinics and hospitals. Ultra-low-power, wireless, small-size and user-friendly are the basic requirements of today's healthcare system.

For a long time, there has been a continued expectation that the biomedical system can be power autonomous which can be facilitated by energy harvesting from the ambient energy sources such as thermal energy, kinetic (motion, vibration) energy, radio frequency and solar power. However, current works have not reached this point yet.

The topic of this project is the utilisation of low-voltage techniques to decrease the system's power as much as possible as the potential of low-voltage techniques to aggressively reduce power has not been well

addressed in the literature. To satisfy this task, the system's total power must decrease to $\sim 100\mu\text{W}$ including analogue front-end (AFE), μP (digital processing) as well as data transmitting and receiving via radio frequency. A potential application is the Ear-EEG.

ABOUT THE PROJECT

Title: An Ultra-Low Power Wireless Biosensing SoC Utilising

Low-Voltage Techniques for Body-Worn Healthcare Applications

Project period: June 2013 to June 2016

Main supervisor: Prof. (Docent) Jens Kargaard Madsen

Co-supervisors: Prof. (Docent) Preben Kidmose and

Assistant Prof. Farshad Moradi

Research section: Electrical and Computer Engineering

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Martin Peter Christiansen

PROJECT DESCRIPTION

This project deals with the challenges faced when designing and deploying an autonomous vehicle guidance system in the agricultural domain. Automatic guidance systems for agricultural machines, i.e. auto-steering systems, employ sensory input from the Global Navigation Satellite System (GNSS) and/or other localisation systems. The auto-steering systems can increase efficiency in terms of reduced overlap, less operational time and fuel.

Before an auto-steering solution can be operational on a given vehicle, it is necessary to calibrate several (control) parameters of the auto-steering system. These calibration parameters are dependent on the technical performance of the vehicle. We believe that better control parameters could be selected by utilising a simulated model of an agricultural machine. The simulated model will be able to execute and evaluate multiple candidate solutions using optimisation and search algorithms. The conjecture is that modelling and simulation would be less costly than selecting parameters and try to manually fine-tune an auto-steering system.

ABOUT THE PROJECT

Title: Modelling, Simulation and Evaluation of

Autonomous Agricultural Vehicle Guidance

Project period: Sept 2011 to June 2015

Main supervisor: Senior Researcher Rasmus Nyholm Jørgensen

Co-supervisor: Prof. Peter Gorm Larsen and Ole Green, Kongskilde Industries A/S

Research section: Electrical and Computer Engineering

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Morten Larsen

PROJECT DESCRIPTION

Software development for agricultural robotics is complicated and hence time-consuming and expensive.

Agricultural robots are particularly challenging with respect to the development of software due to the combination of an open, unpredictable environment and a complex, open-ended range of tasks. Model-driven software development is a systematic approach to automatically generated software within a given domain based on a model.

The scientific goal of this project is to improve and develop model-driven software techniques, domain models, underlying software architecture and code generation techniques. This will enable us to create a software platform for automatic generation of control programmes that suit the specific requirements of agricultural robots.

The developmental goal of this project is to provide systematic and automated techniques for the development of a software platform

that can be utilised for field robots in various scenarios. This software platform will be directly applicable in the development of control programmes for specific agricultural robots.

ABOUT THE PROJECT

Title: Model-Driven Software Development for Agricultural Robotics

Project period: May 2013 to April 2016

Main supervisor: Senior Researcher Rasmus Nyholm Jørgensen

Co-supervisor: Prof. Peter Gorm Larsen

Research section: Electrical and Computer Engineering

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Claus Ballegård Nielsen

PROJECT DESCRIPTION

A System of Systems (SoS) is a system type that has risen from the increased complexity found in present-day system engineering. An SoS denotes a collaborative system which consists of many independent, heterogeneous constituent systems that combine information and functionality in order to reach a synergistic functionality that is greater than the sum of the constituent systems' abilities.

The SoS Engineering field faces the challenge of its constituent systems being individually owned and developed, which means that there is no centralised authority to take action or make decisions. As a result, decisions have to be agreed on, collaboratively, between the individual owners/developers of the constituent systems. Therefore, the interfaces, data types, communication channels and interactions between the systems need to be agreed upon during development.

The purpose of the project is to research how existing and new methods can be adapted, combined and innovated to improve the foundation of SoS engineering. The research is focused on aiding collaboration by

utilising a combination between the field of software engineering and the field of systems engineering.

ABOUT THE PROJECT

Title: Well-Founded Engineering of System of Systems

Project period: May 2011 to April 2014

Main supervisor: Prof. Peter Gorm Larsen

Research section: Electrical and Computer Engineering

Contact: clausbn@eng.au.dk



Femina Hassan Aysa Beevi

PROJECT DESCRIPTION

Ambient Assisted Living (AAL) systems integrate different technologies to provide healthier and safer living environments for the elderly. The AAL systems provide AAL services such as monitoring the activities of daily living. It is important to ensure the quality of context information in the AAL system as it reacts and responds to the events that occur by making use of the context information derived from the context data. A lapse in quality could be life-threatening as it leads to a failure in anticipating and reacting to the user's needs, and a failure in adapting to the changes in the environment.

The objective of this project is to investigate how the quality of context data can be assured in high-risk physical activity contexts in the AAL systems. During this project, the context data quality in AAL systems is analysed from different data quality dimensions and novel methods will be developed for quality assurance.

The work being done in this project is part of the European FP7 Care-Store project. The CareStore project aims to develop a marketplace for

the easy deployment of applications and device drivers in a healthcare scenario, and develop an ambient assisted platform for the home to integrate the CareStore marketplace.

ABOUT THE PROJECT

Title: Quality of Context in Ambient Assisted Living Systems

Project period: Feb 2013 to Jan 2016

Main supervisor: Assoc. Prof. Stefan Hallerstedte

Co-supervisors: Assistant Prof. Christian Fischer Pedersen and Assistant Prof. Stefan Wagner

Research section: Electrical and Computer Engineering

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Lars Glavind

PROJECT DESCRIPTION

This project is in the field of fiber optical sensors for measuring the load on a wind turbine blade.

The advantages of using an optical sensor instead of typical electronic sensors in a wind turbine blade are the immunity to lightning and the longer longevity of the sensor. A system that measures the load of the blades can provide information which can be used to optimise the production and design of a wind turbine.

The focus is on applied research on a new type of sensor that can measure the load on a wind turbine blade and provide better information about the shape of a blade during operation of the wind turbine.

ABOUT THE PROJECT

Title: Fiber Optical Load Sensors for Wind Turbines

Project period: Sept 2009 to Feb 2014

Main supervisor: Prof. Martin Kristensen

Co-supervisor: Assoc. Prof. Bjarne F. Skipper

Research section: Electrical and Computer Engineering

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Gareth Edwards



PROJECT DESCRIPTION

Carrying out agricultural operations at an opportune time can have great benefits, both for the field/environment and for the farmer.

The aim of the project is to develop a system which is able to evaluate and predict the readiness of many fields, perhaps covering a large area, to determine the best time for given operations to be executed. Furthermore, based on this evaluation, another aim is to produce a system capable of planning when and where machinery is needed so that operations can be executed in the most efficient manner.

The readiness of a field can be considered as a combination of the trafficability and workability. Trafficability is the ability of the soil to support vehicles without causing irreversible damage, whereas, for harvest, the workability is the maturity of the crop and the grains' moisture level.

Knowing the readiness of all the fields which need to be harvested allows a plan to be made for the order in which the field must be harvested to produce the best results, rather than simply harvesting the nearest

field first. The system can also be used at the beginning of the season to examine the benefits of changing production to different non-traditional crops, or to see the benefit of investing in new machinery.

ABOUT THE PROJECT

Title: Development of a Field Readiness Indicator and Decision Support System

Project period: Sept 2010 to Feb 2015

Main supervisor: Senior Researcher Claus Grøn Sørensen

Co-supervisor: Senior Researcher Lars Munkholm

Research section: Mechanical and Materials Engineering

Contact: gareth.edwards@eng.au.dk

Evelien de Olde

PROJECT DESCRIPTION

The aim of the project is to analyse the application of sustainability assessment tools in farm management and governance to navigate towards a more sustainable development of food production. A wide range of sustainability assessment tools and frameworks have been developed to accommodate a shift towards sustainable agriculture. Nonetheless, utilisation of the knowledge produced is still one of the main shortcomings of research on sustainability assessments in agriculture.

Operationalising knowledge produced in sustainability assessments into farm management information systems could facilitate precision farming and enable, for example, efficient use of nutrients. Similarly, integration of sustainability assessment tools into policy-making is considered to contribute to decision-making and regional governance for sustainable agriculture. The research will evaluate the sustainability performance of different farming systems to distinguish pathways to apply sustainability assessment tools in farm management and agricultural governance.

ABOUT THE PROJECT

Title: Sustainability Assessment Tools to Navigate towards Sustainable Development of Food Production

Project period: March 2014 to Feb 2017

Main supervisor: Senior Researcher Claus Grøn Sørensen

Co-supervisors: Assistant Prof. Frank W. Oudshoorn and Imke de Boer, Wageningen University

Research section: Mechanical and Materials Engineering

Contact: evol@eng.au.dk

Martin Andreas Falk Jensen

PROJECT DESCRIPTION

The objective of this project is to provide methodologies and the corresponding software systems for the optimisation of tasks performed by vehicles involved in field operations including both primary units, e.g. combine harvesters and organic fertiliser applicators in area coverage tasks, and supporting units, e.g. transport carts in in-field and inter-field travelling tasks.

The selected optimisation criteria include the minimisation of

- fuel consumption,
- soil compaction and
- operation completion time.

Advanced research methodologies originated from the engineering management discipline are being developed in order to match the complexity of the biological systems and provide robust solutions for operations executed in a natural environment. In parallel, the practical realisation of the developing methods is of high concern.



ABOUT THE PROJECT

Title: Real-Time Optimised Path Planning for Machinery in Agricultural Field Operations

Project period: Nov 2010 to July 2014

Main supervisor: Senior Researcher Dionysis Bochtis

Co-supervisor: Senior Researcher Claus Grøn Sørensen

Research section: Mechanical and Materials Engineering

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Hans Henrik Pedersen

PROJECT DESCRIPTION

Wide span is a new tractor concept that allows you to grow crops in wide beds. The tractor is wide when driving in the field. When transported, it is long and narrow. By use of wide span, tractors' compaction of the soils due to field traffic can be reduced to cover approximately 10 per cent of the field area only.

The overall hypothesis of wide span technology on farms is that crops can be produced at lower costs and with reduced environmental impact compared to traditional growing systems. During my project, I will:

- specify design requirements for growing systems and a wide span technology. These are based on structured interviews with potential farm users from Europe, Australia and New Zealand.
- evaluate the impact of a compaction on the soil conditions through a field trial with onions.
- assess the environmental impact of the wide span growing system compared to traditional growing systems.

ABOUT THE PROJECT

Title: Wide Span Technology for Efficient and Environmentally Friendly Vegetable Production

Project period: March 2011 to July 2014

Main supervisor: Senior Researcher Claus Grøn Sørensen

Co-supervisors: Assistant Prof. Frank W. Oudshoorn and Senior Researcher Lars Munkholm

Research section: Mechanical and Materials Engineering

Contact: hansh.pedersen@eng.au.dk



Vicent Gasso

PROJECT DESCRIPTION

The general objective of the project is to explore and advance the existing methods to assess sustainability of agricultural supply chains. Specifically, it aims to shed more light on the optimum assessment scope design in terms of physical boundaries and degree of specificity for efficiently informing about the sustainability performance of agricultural systems.

To develop a design approach sensitive to a wide range of challenges present in the global agricultural market, two case studies from very different contexts are analysed:

1. The supply chain of the maize energy-crop production in southern Denmark.
2. The supply chain of the Sustainable Winegrowing framework in New Zealand.

The project results will provide an assessment framework that stimulates stakeholders' trust and learning which, in turn, will help to enhance change towards more sustainable agricultural production systems.

ABOUT THE PROJECT

Title: Assessing Sustainability of Agricultural Supply Chains: Scoping the Assessment in a Pluralistic World

Project period: June 2011 to June 2014

Main supervisor: Senior Researcher Claus Grøn Sørensen

Co-supervisor: Assistant Prof. Frank W. Oudshoorn

Research section: Mechanical and Materials Engineering

Contact: vicent.gasso@eng.au.dk



Kun Zhou

PROJECT DESCRIPTION

Most agricultural field operations, e.g. sowing, fertilising and harvesting, require a vehicle, e.g. a tractor with an implement, to drive in the field along a route such that the field area is completely covered.

The farmer is interested in finding an optimal field coverage plan in order to minimise the time, distance or fuel spent, and at the same time minimise areas with missing or overlapping treatments. In farming operations, multiple operations have to be performed during the annual production of a crop and any one of these operations may have its own operational feature e.g. working width, working speed, etc. In order to achieve the maximum field efficiency in the system, there is a need to develop an approach for predicting the overall operational performance of all machines in a crop production system and the operational costs.

The overall aim of this research is to develop algorithms and models for optimised coverage planning supported by web-based applications. This aim involves three specific challenges: The first is to find the optimal route for the agricultural vehicles to cover a field with multiple obstacles

such as trees and wet areas. The second challenge is to develop a model for simulating the machines' activities e.g. fertilising, spraying and transporting the grain. Farmers can then use the model as a decision-supporting tool. The third challenge is to develop a web-based coverage path planning system that can provide farmers with timely and helpful decisions ahead of the field operations.

ABOUT THE PROJECT

Title: In-Field Coverage Planning with Multi-Objective Optimisation in Field Operations

Project period: Feb 2012 to Jan 2015

Main supervisor: Senior Researcher Allan Leck Jensen

Co-supervisor: Senior Researcher Dionysis Bochtis

Research section: Mechanical and Materials Engineering

Contact: kun.zhou@eng.au.dk

Alex Møberg

PROJECT DESCRIPTION

The focus of this project is on the non-linear material model which can be used in calculations of fiber composite. The model has been derived analytically in 2D and has been implemented in the Abaqus finite element software package.

The further work in this project will involve testing and implementing the model in the commercial finite element software Nastran/Marc to be able to efficiently analyse real structural components to final failure. Afterwards, the model will be generalised into a 3D model.

Once the model has been built in, it can be applied to study effects such as buckling including buckling-driven delamination, elastic spring back due to residual stresses, etc.

ABOUT THE PROJECT

Title: Simulation of Composite Structures based on Micro Mechanical Modelling

Project period: Sept 2013 to Aug 2016

Main supervisor: Prof. Henrik Myhre Jensen

Co-supervisor: Prof. (Docent) Flemming Mortensen

Research section: Mechanical and Materials Engineering

Contact: alexm@eng.au.dk



Jens Lycke Wind

PROJECT DESCRIPTION

Designing with fiber composites has many good properties. In general, composites are light and stiff and, in most cases, they have a high strength as well. This all sounds very good so why not use them in any structural application? While there are many advantages, there are also many difficulties in knowing how to handle the material response of fiber composites. One of the difficulties is how to handle compression. For example, the compressive strength of an epoxy matrix reinforced by unidirectional carbon fibers in the direction of the loading is often less than 60 per cent of the tensile strength. During the years, different material models have been suggested to account for this compression complexity.

The aim of this project is to verify one of these simpler smeared out models using the finite element method. The main focus is on kink band formation which is a common failure in fiber composites in compression. By mapping mechanisms of deformation, we can better exploit the good properties of composite materials and thereby produce lighter and stronger structures.

The results of the research can be used in the development of commercial finite element software. In general, it can be applied in all contexts where composite materials are used, e.g. the wind turbine, aerospace and automotive industries, and can contribute to developing the green energy sector.

ABOUT THE PROJECT

Title: Instability of Unidirectional Fiber Composites in Compression

Project period: Aug 2011 to Nov 2014

Main supervisor: Prof. Henrik Myhre Jensen

Research section: Mechanical and Materials Engineering

Contact: jlw@eng.au.dk



Mads Krabbe

PROJECT DESCRIPTION

Hard coatings can be applied on materials to enhance their mechanical properties. The coatings can be applied on e.g. cutting tools which can be coated to enhance wear resistance, or on gears and bearings to reduce friction and enhance life.

In this interdisciplinary project between the Department of Physics and Astronomy and the Department of Engineering, the aim is to develop methods to link microstructural characterisation with measurements and calculations of the coating system including the mechanical and especially the fracture mechanical properties.

The mechanical data will be obtained by nano-indentation which yields hardness, Young's modulus and possibly creep. By comparing nano-indentation data with theoretical fracture mechanical models, quantitative values of fracture toughness are obtained. Better understanding of the fracture mechanisms in hard coating and the influence of coating/substrate interaction on the fracture mechanisms is also needed.

To understand the wear properties of a coating, it is of paramount importance to know both the hardness and the fracture toughness. It is of key interest in the project to establish a link between the mechanical and fracture mechanical properties and the wear resistance of the coating.

ABOUT THE PROJECT

Title: Optimal Mechanical Properties of Nano-Composite Hard Coatings

Project period: April 2010 to July 2014

Main supervisor: Prof. Henrik Myhre Jensen

Research section: Mechanical and Materials Engineering

Contact: makr@eng.au.dk





Per Christian Hyldahl

PROJECT DESCRIPTION

When designing complex mechanical systems, design engineers often turn to computer-aided engineering tools to help them in the design process.

If the mechanical system is dominated by large rigid-body motion rather than deformations, multibody dynamics can be used. In recent years, the multibody approach has been expanded to incorporate deformations to enhance simulation results and gain detailed insight into the performance of systems that include components that cannot be assumed rigid.

Current methods for modelling flexible components in the multibody framework are limited by assumptions of small and elastic deformations. Tendencies in later years' product development have challenged the capabilities of these methods to the utmost. Especially the design of large, slender and lightweight components such as wind turbine blades is in need of new and specialised modelling techniques. Such techniques must be able to capture complex deformations due to large and time varying loading scenarios.

This project aims to investigate current state-of-the-art research within methods for modelling components that undergo large deformations. The focus of the project is on formulation and modelling techniques but with the applicability and computational performance kept in mind.

ABOUT THE PROJECT

Title: Nonlinear Flexible Bodies for Multibody Simulation
Project period: Aug 2011 to July 2015
Main supervisor: Prof. (Docent) Ole Balling
Research section: Mechanical and Materials Engineering
Contact: pchy@eng.au.dk



Kennet Olesen

PROJECT DESCRIPTION

GEA-Liquid in Skanderborg, Denmark is developing liquid/liquid mixing equipment for the dairy, food and pharmaceutical industry.

To further develop and optimise their mixing processing equipment, it is mandatory to obtain a better understanding of the dynamics of mixing. A common mixing situation at GEA-Liquid involves two or more immiscible fluids such as water and oil. To form a stable, homogeneous emulsion, large shear forces are required which a high-shear mixer can produce.

Solution of momentum equations for complex liquids in complex geometries requires use of advanced numerical methods. A system of partial differential equations is the basis for the mathematical model used to describe the motion of fluids. Different discretisation techniques such as finite difference, finite volume and finite element methods have been developed to reduce the differential equations to an algebraic system. Although the mentioned discretisation methods are being used to solve flow problems, they suffer from inferior convergence rates compared to high order discretisation methods such as spectral element methods. It is

therefore desirable to further develop spectral methods to obtain detailed information about flow processing in complex geometries for complex fluids.

The aim of the project is to develop an in-house CFD code based on spectral discretisation techniques with an emphasis on a stable description of the in-stationary formulation. The application will be used to characterise and extract detailed information about the flow field of the high shear mixer from GEA with the objective of optimising their design with respect to energy consumption.

ABOUT THE PROJECT

Title: Liquid/Liquid Mixing of High Viscous Fluids
Project period: June 2013 to May 2016
Main supervisor: Assoc. Prof. Bo Gervang
Co-supervisors: Prof. Henrik Myhre Jensen and Marc Gerritsma
Research section: Mechanical and Materials Engineering
Contact: keol@eng.au.dk



Mads Knude Hovgaard

PROJECT DESCRIPTION

For decades, the prevailing material for very tall chimneys for power plants has been concrete. Combined, Rambøll and MT Højgaard have been involved in all phases of the construction of the very highest in Denmark.

Most modern wind turbine towers are tubular steel towers, and until now the high labour costs have tipped the scale in favour of steel towers. But as technology advances rapidly towards larger turbines, it is only natural to assume that concrete will be the new first choice for multi MW designs as it did for chimneys. For this scale of structures, the mechanical properties of concrete can be superior to those of steel if the experiences and know-how from concrete chimney construction are applied throughout the project.

Structural health monitoring (SHM) is the perpetual process of monitoring the structures' integrity. By equipping SHM to a civil structure, the owner is provided with decision support. So far, for the structures that have been equipped with SHM, the value in terms of total life-cycle benefits has rarely been estimated.

By associating a risk optimised decision policy, the SHM effort can be optimised and the initial target safety of the structure may be recalibrated upfront. In some cases, this translates into reductions on the Partial Safety Factors, leading to reductions on initial cost.

This project implements the risk based SHM system design, which is a research heavy topic, on the development of cast concrete wind turbine towers for multi MW turbines.

ABOUT THE PROJECT

Title: Incorporating Structural Health Monitoring in the Design of Slip Formed Concrete Wind Turbine Towers
Project period: Feb 2012 to Jan 2015
Main supervisor: Prof. Rune Brincker
Co-supervisor: Jens Christian Kirk, Rambøll
Research section: Civil and Architectural Engineering
Contact: mkho@eng.au.dk

Peter Olsen

PROJECT DESCRIPTION

In the future, the application of Structural Health Monitoring (SHM) will be a key element when considering structures such as large span bridges, high-rise buildings or wind turbines.

SHM is a network of sensors placed wisely on the structure, monitoring the physical parameters of the structure. The sensors inform the control centre or the maintenance crew if any change in the structure is detected revealing crack growth or failure of secondary structural elements. This increases the safety of the structure and makes it possible to replace parts or fix the structure before failure.

The SHM system consists of sensors and an analysis part to process the measured signals. In this process, the identification of the structures' physical parameters is essential. As it will be an enormous amount of data which have to be analysed, this procedure will have to be automated.

The focus of this project is on Automated OMA. OMA is short for Operational Modal Analysis and is used in modal testing to find the modal

parameters such as eigenfrequency, modeshapes and damping ratio of a machine or a structure. The process of automating the estimation process when working with OMA demands development of an algorithm that is stable and need no interaction from the user.

The main objective of the project is to investigate the use of well-known identification techniques in both time domain and frequency domain in combination with filtering techniques to automate the identification process. The identification of several criteria for choosing the physical parameters is another main focus of the project.

ABOUT THE PROJECT

Title: Automated Operational Modal Analysis

Project period: Nov 2012 to Oct 2017

Main supervisor: Prof. Rune Brincker

Research section: Civil and Architectural Engineering

Contact: pto@ase.au.dk



Anders Skafte

PROJECT DESCRIPTION

When measuring the dynamic properties of a civil structure, the information is always limited to the amount of sensors placed on the structure. This often results in sparse modal models and rough estimations. The main focus of this project is to develop a model that provides information about the dynamics of a structure in points where no sensors have been placed.

This is done by making a transformation between a set of experimentally obtained mode shapes and a set of mode shapes from a Finite Element Model (FE). The overall principle is that a set of mode shapes can be described as a linear combination of another set of mode shapes as long as the changes between the two models are small. This is known as the Local Correspondence Principle.

The set of experimentally found mode shapes can be found by making an Operational Modal Analysis on the measured response and has the advantage of providing "true" information in a limited number of points. On the other hand, the FE model provides a set of "fictive" mode shapes

in a large number of points. As long as the FE model doesn't differ too much from the real structure, the estimated mode shapes can be found successfully, making a linear transformation of the FE mode shapes.

The method will provide new ways of analysing structures. Displacements can be transformed to strains and stresses, which will be a helpful tool when analysing fatigue where the stress history is an important factor. Furthermore, the method will be suitable for monitoring of structures.

ABOUT THE PROJECT

Title: Fullblown ODS

Project period: Oct 2011 to Sept 2016

Main supervisor: Prof. Rune Brincker

Research section: Civil and Architectural Engineering

Contact: ask@ase.au.dk



Jannick Balleby Hansen

PROJECT DESCRIPTION

The main focus of this project is on vibration-based damage detection on civil as well as mechanical structures.

This subject can, in a global context, be classified as a "Structural Health Monitoring" (SHM) discipline. The SHM term covers a broad range of different methods and techniques with the coincident goal or purpose of detecting damage, position and magnitude in a structure.

For researchers as well as commercial companies, SHM is an area of great interest due to the fact that SHM has the potential to replace traditional damage detecting techniques which, in most cases, are mere visual inspections supplemented by material samples extracted from the structure.

It is commonly known that damage, e.g. holes or cracks, in a structure will have an impact on the global dynamic properties, in other words the modal parameters. These parameters can be extracted by means of "Operational Modal Analysis", sophisticated sensors and data

acquisition equipment, even on large civil structures. Hence, damage in a structure can be detected if modal property shifts are observed. The aim of this project is to develop a method which is able to detect and pin-point damage on an arbitrary structure.

ABOUT THE PROJECT

Title: Vibration-Based Structural Health Monitoring

Project period: Nov 2011 to Dec 2016

Main supervisor: Prof. Rune Brincker

Research section: Civil and Architectural Engineering

Contact: jbha@ase.au.dk





Michael Dahl Knudsen

PROJECT DESCRIPTION

Much can be achieved by making the energy consumption of buildings more flexible so that the use of energy takes place at times when it is most convenient for the overall energy system.

This project examines the flexibility potential in relation to controlling the energy system of a building. This is done by using a model of a building that includes weather forecasts, energy prices and occupant behaviour.

The approach is essential to finding the combination of future actuator set-points that result in the best outcome with respect to indoor climate and economy.

ABOUT THE PROJECT

Title: Smart Grid Flexibility Potential in Model-Based Building Control

Project period: Aug 2013 to July 2016

Main supervisor: Assistant Prof. Steffen Petersen

Research section: Civil and Architectural Engineering

Contact: mdk@eng.au.dk



Hao Li

PROJECT DESCRIPTION

The aim of this project is to improve animal welfare and reduce environmental impact. A new concept for monitoring the thermal and airflow conditions in animal zones will be introduced. Furthermore, we will set up a dynamic predictive model to create a precision environment control strategy at individual animal or defined zone level.

Micro-complex ventilation involves integrating precision local ventilations in animal zones and near manure fouled floors or manure surfaces within the building ventilation. In order to gain knowledge about air motion and distribution in animal occupied zones and about system effects on emission reduction, an integrated micro ventilation concept in livestock housing will be investigated.

Data will be gathered by using both Computational Fluid Dynamics (CFD) simulations and full scale experiments. After the establishment of the system, optimisations are also needed. Then, to validate the optimal system, varied techniques including local cross ventilation, heat exchange and passive earth-air heat/cooling will be investigated. The

proposed system combines the advantages of natural, mechanical and displacement ventilation, making it a technology with great efficiency and potential.

ABOUT THE PROJECT

Title: Complex Ventilation and Micro-Environmental Control in Livestock Housing

Project period: Oct 2013 to Sept 2016

Main supervisor: Senior Researcher Guoqiang Zhang

Research section: Civil and Architectural Engineering

Contact: hao.li@eng.au.dk



Xiaoshuai Wang

PROJECT DESCRIPTION

Natural ventilation is an increasingly popular approach to offer a good indoor climate without any mechanical technology aid. Comparing with the mechanical ventilation, natural ventilation has a very significant advantage in terms of energy savings. However, obvious defects such as the absence of precise control of the air movement, vulnerability to the persistent severe situation and lack of adaptability restrict the natural ventilation in becoming more widespread. Therefore, innovative design and control are needed to improve its performance to ensure optimal indoor climate.

To achieve this goal, knowledge on animal heat loss and thermal well-being influenced by air temperature, speed, radiation and evaporation effects in a space is crucial.

The aim of this project is to develop an adaptive smart (natural) ventilated barn for cattle. An investigation of integrated climate sensing methods and precision zone ventilation techniques will be conducted. Both experiment and numerical simulation methods will be applied in the project.

ABOUT THE PROJECT

Title: Adaptive Smart (Natural) Ventilation Control for Cattle Housing and Integrated Climate Sensing

Project period: Oct 2014 to Sept 2017

Main supervisor: Senior Researcher Guoqiang Zhang

Co-supervisor: Prof. Christopher Choi, University of Wisconsin, USA

Research section: Civil and Architectural Engineering

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Chao Zong

PROJECT DESCRIPTION

The ventilation system of animal houses is important in livestock production due to its significant influence on local thermal conditions, indoor air quality and emission to the neighbouring atmosphere.

Precision zone ventilation consisting of direct air supply into the Animal Occupied Zone (AOZ) and precision exhaust ventilation from the source zone can provide more efficient climate control and improved air quality. The objective of this project is to develop the knowledge of precision zone ventilation in pig production buildings, aiming at achieving more effective ventilation and improving indoor air quality as well as reducing the required capacity of air cleaning devices.

Experimental investigations are carried out both in a pig production facility and in a 2-D chamber in the laboratory. The two-dimensional Laser Doppler Anemometry (LDA) is used for measuring velocity speed and characterising flow type in the boundary layer. N₂O is applied as tracer gas. The artificial pigs developed at APL are used to simulate the heat production of pigs at different locations. Computational Fluid

Dynamics (CFD) is used for computer modelling.

ABOUT THE PROJECT

Title: Precision Zone Ventilation Design and Control in Pig Housing

Project period: Oct 2011 to Sept 2014

Main supervisor: Senior Researcher Guoqiang Zhang

Research section: Civil and Architectural Engineering

Contact: chao.zong@eng.au.dk



Michael Rosenlund Lodahl

PROJECT DESCRIPTION

Understanding the high plasticity Palaeogene clay has been a challenge for the geotechnical community in Denmark for decades. The settlement and heave potential of this type of clay exceeds what is commonly expected for Danish clay deposits. Typically, the Palaeogene clays have high strengths but a rather large settlement and heave potential, which means that they do not follow what is normal for most clays where strength and stiffness follow one another. Many relationships exist linking the plasticity index (a state parameter easy to assess) to the engineering properties for clays based on rules of thumb. However, they rarely fit with the behaviour of the Palaeogene clays.

The latest research has indicated that the clay mineral smectite may govern the behaviour of a clay, which means that the settlement and heave potential may be dependent on this content. This project investigates this theory by execution of multiple tests of clays containing smectite.

ABOUT THE PROJECT

Title: Influence of Smectite Content on the Deformation Behaviour of Clays

Project period: Aug 2014 – July 2017

Main supervisor: Prof. (Docent) Kenny Kataoka Sørensen

Co-supervisors: Helle Trankjær, COWI A/S and Niels Mortensen, nmGeo

Research section: Civil and Architectural Engineering

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Lise Kjær Andersen

PROJECT DESCRIPTION

Confinement is known to significantly improve the compressive strength and ductility of concrete, two properties which are highly desirable to exploit in practical designs. The main issue in applying the existing constitutive confinement models in practical design is the determination of the confining stress. In the most common models, the confining effect is defined as an uniform external stress which actively confines the member. In actual reinforced concrete members, the confining effect is, however, provided as a passive effect by the reinforcement.

Thus, the aim of the project is to relate the passive and active confinement to fully understand the confining effects that the reinforcing arrangement has on the concrete member.

The first step is to study the physical behaviour of the confining effect through a theoretical understanding on a micromechanical level. The knowledge of the behaviour on a micromechanical level will be compared to the already existing models which describe the effect of external confining pressure.

The principal approach to the project will be based on analytical modelling. However, experimental studies will be essential in verifying any theoretical models and to conduct parametric studies on the topic.

ABOUT THE PROJECT

Title: Ductility of Confined Concrete

Project period: Oct 2014 to Sept 2017

Main supervisor: Prof. (Docent) Lars German Hagsten

Co-supervisor: Prof. Rune Brincker

Research section: Civil and Architectural Engineering

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Annette Beedholm Rasmussen

PROJECT DESCRIPTION

Initially when designing reinforced concrete structures, focus is on the ultimate limit state (ULS), assuring the structure's strength by preventing failure from happening. Afterwards, the serviceability limit state (SLS) is investigated where stress limits as well as requirements concerning crack widths and deformations should be met. Due to the fact that stress levels and crack development are highly dependent on the reinforcement ratio and configuration, the choices made in the ULS concerning the design of the reinforcement have a high impact on the behaviour of structures in SLS.

The stiffness of a material with non-linear behaviour like reinforced concrete is closely associated with the level of crack development. Though, often, the material is assumed fully cracked or not cracked at all where the effect of tension-stiffening is disregarded. This can have consequences on the behaviour, for example in statically indeterminate structures where the static system in the elastic stage is dependent on the stiffness.

Tension-stiffening is an effect that causes the stiffness to be considerably larger than the one of a fully cracked member. The concrete between

adjacent cracks is modelled to carry tensile stresses which are transferred from the reinforcement to the concrete by means of the bond.

The aim of this project is to establish the link between ULS and SLS through understanding of the actual physical behaviour. This will be described through analytical models based on concrete mechanics combined with principles of elastic energy. Advantage is taken of numerical modelling to support experimental results as well as to investigate relevance and reliable magnitudes of different material parameters concerning tension-stiffening.

ABOUT THE PROJECT

Title: Analytical and Numerical Modelling of Reinforced Concrete including Tension-Stiffening Effects
Project period: May 2014 to April 2019
Main supervisor: Prof. (Docent) Lars German Hagsten
Research section: Civil and Architectural Engineering
Contact: abra@ase.au.dk



Jakob Fisker

PROJECT DESCRIPTION

The vast majority of concrete slabs are only supplied with longitudinal reinforcement while expensive shear-reinforcement is only placed in case of shear forces of extraordinary magnitude. Thus, in most situations, the capacity of the slabs with respect to shear-forces is provided by a combination of the concrete itself along with the longitudinal reinforcement. Unfortunately, the fundamentals of this vital mechanism that allow for such structures to be designed are still not fully understood, and most models used for design are empirical and lack a physical and rational basis.

In addition, such slabs are often designed as statically indeterminate structures. In order to achieve a certain level of robustness, the final structure must possess a certain level of ability to withstand larger deformations without failing.

It is well known that the ability of reinforced concrete to deform is due to development of cracks. Hence, in this respect, the progressive development of cracks is beneficial. However, when considering members

without shear-reinforcement, the same cracks also introduce certain "weakened" regions which effectively reduce the capacity with respect to shear.

The aim of the project is, among others, to increase the understanding of this rather delicate relation between the inevitable development of cracks and the shear-capacity of slabs.

ABOUT THE PROJECT

Title: Continuous Members in Reinforced Concrete
Project period: Aug 2012 to July 2014
Main supervisor: Prof. (Docent) Lars German Hagsten
Research section: Civil and Architectural Engineering
Contact: jafi@ase.au.dk



PUB LICA TIONS

Peer Reviewed Publications 2014/2013

2014

Abolhasani, Alireza; **Tohidi, Mohammad**; Hadidi, Khayrollah; Khoei, Abdollah / A new high-speed, high-resolution open-loop CMOS sample and hold.

In: Analog Integrated Circuits and Signal Processing, Vol. 78, No. 2, 02.2014, p. 409-419.

Aenlle, Manuel López; **Brincker, Rune** / Modal Scaling in OMA Using the Mass matrix of a Finite Element Model. Dynamics of Civil Structures . Vol. 4 Springer International Publishing, 2014. p. 263-270.

Aidas, Kestutis; Angeli, C.; **Bak, K.L.**; Bakken, V.; Bast, R.; Boman, L.; Christiansen, O.; Cimraglia, R.; Coriani, S.; Dahle, P.; Dalskov, E.K.; Ekström, U.; Enevoldsen, T.; Eriksen, J.J.; Ettenhuber, P.; Fernández, B.; Ferrighi, L.; Fliegl, H.; Frediani, L.; Hald, K.; Halkier, A.; Hättig, C.; Heiberg, H.; Helgaker, T.; Hennum, A.C.; Hetteima, H.; Hjertenæs, E.; Høst, S.; Høyvik, I.-M.; Iozzi, M.F.; Jansik, B.; Jensen, H.J.A.; Jonsson, D.; Jørgensen, P.; Kauczor, J.; Kirpekar, S.; Kjærgaard, T.; Klopper, W.; Knecht, Stefan; Kobayashi, R.; Koch, H.; Kongsted, J.; Krapp, A.; Kristensen, K.; Ligabue, A.; Lutnæs, O.B.; Melo, J.I.; Mikkelsen, K.V.; Myhre, R.H.; Neiss, C.; Nielsen, C.B.; Norman, P.; Olsen, J.; Olsen, J.M.H.; Osted, A.; Packer, M.J.; Pawlowski, F.; Pedersen, T.B.; Provasi, P.F.; Reine, S.; Rinkevicius, Z.; Ruden, T.A.; Ruud, K.; Rybkin, V.V.; Salek, P.; Samson, C.C.M.; de Merás, A.S.; Saue, T.; Sauer, Stephan P. A.; Schimmelpfennig, B.; Sneskov, K.; Steindal, A.H.; Sylvester-Hvid, K. O.; Taylor, P.R.; Teale, A.M.; Tellgren, E.I.; Tew, D.P.; Thorvaldsen, A.J.; Thøgersen, L.; Vahtras, O.; Watson, M.A.; Wilson, Douglas; Ziolkowski, M.; Ågren, H. / The Dalton quantum chemistry program system.

In: Wiley Interdisciplinary Reviews. Computational Molecular Science, Vol. 4, 2014, p. 269-284.

Andersen, Thomas L.; Caneschi, William; Ayoub, Ali; **Lindhardt, Anders T.**; Couri, Mara R C; Skrydstrup, Troels / 1,2,4- and 1,3,4-Oxadiazole Synthesis by Palladium-Catalyzed Carbonylative Assembly of Aryl Bromides with Amidoximes or Hydrazides.

In: Advanced Synthesis & Catalysis, Vol. 342, No. 8, 11.08.2014.

Andersen, Kristin Barkve; Glasius, Marianne; **Feilberg, Anders** / Gas/particle partitioning of odorants in a pig house measured by thermal desorption GC/MS.

In: Environmental Science Processes & Impacts, Vol. 16, No. 5, 2014.

Bajric, Anela; **Brincker, Rune**; Georgakis, Christos T. / Evaluation of Damping Using Time Domain OMA Techniques. Proceedings of 2014 SEM Fall Conference and International Symposium on Intensive Loading and Its Effects. 2014.

Balzer, Lukas; Pennino, Davide; Blank, Simon; Seismann, Henning; Darsow, Ulf; Schnedler, Mathias; McIntyre, Mareike; Ollert, Markus; Durham, Stephen R; **Spillner, Edzard**; Ring, Johannes; Cifuentes, Liliana / Basophil activation test using recombinant allergens: highly specific diagnostic method complementing routine tests in wasp venom allergy.

In: PLoS One, Vol. 9, No. 10, 2014, p. e108619.

Barndorff-Nielsen, Ole E.; Pakkanen, Mikko S.; **Schmiegel, Jürgen** / Assessing relative volatility/intermittency/energy dissipation.

In: Electronic Journal of Statistics, Vol. 8, No. 2, 2014, p. 1996-2021.

Basinas, Ioannis; Sigsgaard, Torben; Erlandsen, Mogens; Andersen, Nils T; **Takai, Hisamitsu**; Heederik, Dick; Omland, Oyvind; Kromhout, Hans; Schläunsen, Vivi / Exposure-Affecting Factors of Dairy Farmers' Exposure to Inhalable Dust and Endotoxin.

In: The Annals of occupational hygiene, Vol. 58, No. 6, 18.04.2014, p. 707-723.

Bechsgaard, Tommy Kragh; Hønge, Jesper Langhoff; Nygaard, Hans; Jensen, Morten Ølgaard Jegstrup / In Vivo Wireless Monitoring System of Cardiovascular Force Data.

In: Cardiovascular Engineering and Technology, 17.12.2014.

Bechsgaard, Tommy Kragh; Hønge, Jesper Langhoff; Nygaard, Hans; Nielsen, Sten Lyager; **Johansen, Peter** / New transducers to measure forces in the aortic annulus and at the valve commissures.

2014. Abstract from 24th Annual Meeting, Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Bechsgaard, Tommy Kragh; Laugesen, Sofie; Hønge, Jesper Langhoff; Nygaard, Hans; Nielsen, Sten Lyager; **Johansen, Peter** / Design and calibration of transducers for aortic root force measurement.

<http://bmesc.org/annualmeeting>, Abstracts of BMES Annual Meeting 2014. 2014.

Bechsgaard, Tommy Kragh; Laugesen, Sofie; Hønge, Jesper Langhoff; Nygaard, Hans; Nielsen, Sten Lyager; **Johansen, Peter** / Development of force transducers for biomechanical assessment of aortic root surgery.

Abstracts from WCB 2014: <http://wcb2014.com/>. 2014.

Bechsgaard, Tommy Kragh; Laugesen, Sofie; Hønge, Jesper Langhoff; Nygaard, Hans; Nielsen, Sten Lyager; **Johansen, Peter** / Platform to evaluate aortic root repair techniques based on new implantable force transducers.

Valves in the Heart of Big Apple: : <http://heartvalveconference.com/>. 2014.

Becker, Sarah; Frew, Bethany A.; **Andresen, Gorm B.**; Zeyer, Timo; Schramm, Stefan; **Greiner, Martin**; Jacobson, Mark Z. / Features of a fully renewable US electricity system : Optimized mixes of wind and solar PV and transmission grid extensions.

In: Energy, Vol. 72, 01.08.2014, p. 443-458.

Becker, S.; Rodriguez, Rolando A.; **Bruun Andresen, Gorm**; Schramm, S.; **Greiner, Martin** / Transmission grid extensions during the build-up of a fully renewable pan-European electricity supply.
In: Energy, Vol. 64, 2014, p. 404-418.

Beevi, Femina Hassan Aysha; Pedersen, Christian Fischer; Wagner, Stefan Rahr; Hallersted, Stefan / Lateral Fall Detection via Events in Linear Prediction Residual of Acceleration.
Proceedings of International Symposium on Ambient Intelligence. 2014.

Bennedsen, Jens ; Lauritsen, Aage Birkkjær / An Inverted Math Course.
Proceedings of ALE 2014. ed. / Villas-Boas Valquiria. 2014. p. 119-128.

ben Salem, N ; Jumel, J ; **Budzik, Michal Kazimierz**; Shanahan, M E R; Lavelle, F / Analytical and experimental investigations of crack propagation in adhesively bonded joints with the Mixed Mode Bending (MMB) test Part II: Investigation of cohesive stresses distribution with backface strain monitoring.
In: Theoretical and Applied Fracture Mechanics, Vol. 74, 2014, p. 222-232.

ben Salem, N; Jumel, J ; **Budzik, Michal Kazimierz**; Shanahan, M E R; Lavelle, F / Analytical and Experimental investigations of Crack Propagation in Adhesively Bonded Joints with the Mixed Mode Bending (MMB) Test Part I : Macroscopic analysis & Digital Image Correlation measurements.
In: Theoretical and Applied Fracture Mechanics, Vol. 74, 2014, p. 209-221.

Bertelsen, Lotte B; Bohn, Anja B; Smith, Mairi; Mølgaard, Brian; Møller, Bjarne; Stødkilde-Jørgensen, Hans; **Kristensen, Peter** / Are endothelial outgrowth cells a potential source for future re-vascularization therapy?.
In: Experimental gerontology, Vol. 58, 01.10.2014, p. 132-138.

Birgisson, Steinar; Jensen, Kirsten Marie Ørnsbjerg; Christiansen, Troels Lindahl; von Bülow, Jon Fold; Iversen, Bo Brummerstedt / *In situ* powder X-ray diffraction study of the hydro-thermal formation of LiMn_2O_4 nanocrystallites.
In: Dalton Transactions (Print Edition), Vol. 43, No. 40, 2014, p. 15075-15084.

Bjerg, Bjarne; Riis, Anders Legaard; **Zhang, Guoqiang** / Improved performance of partly pit exhaust systems in pig housing.
ASABE Technical Library. ASABE - American Society of Agricultural and Biological Engineers, 2014.

Blanco-Toribio, Ana; Lacadena, Javier; Nuñez-Prado, Natalia; Alvarez-Cienfuegos, Ana; Villate, Maider; Compte, Marta; Sanz, Laura; Blanco, Francisco J; **Alvarez-Vallina, Luis** / Efficient production of single-chain fragment variable-based N-terminal trimerbodies in *Pichia pastoris*.
In: Microbial Cell Factories, Vol. 13, No. 1, 2014.

Bochtis, Dionysis D.; Grøn Sørensen, Claus; Berruto, Remigio / Editorial of special issue : Agrifood and biomass supply chains.
In: Agricultural Engineering International, Vol. 2014, No. SPEC. ISSUE, 05.2014.

Bochtis, Dionysis D.; Grøn Sørensen, Claus; Busato, Patrizia / Advances in agricultural machinery management : A review.
In: Biosystems Engineering, Vol. 126, 10.2014, p. 69-81.

Bochtis, Dionysis D.; Grøn Sørensen, Claus; Green, Ole; Ibrahim, Ibrahim Abdel Fattah Abdel Hamid; Berruto, Remigio / Design of a wildlife avoidance planning system for autonomous harvesting operations.
In: International Journal of Advanced Robotic Systems, Vol. 11, No. 1, 6, 2014.

Bochtis, Dionysis; Grøn Sørensen, Claus / Special Issue: Operations management.
In: Biosystems Engineering, Vol. 120, 2014.

Brandt, Anders; **Brincker, Rune** / Integrating time signals in frequency domain - Comparison with time domain integration.
In: Measurement, Vol. 58, 2014, p. 511-519.

Brincker, Rune / Some Elements of Operational Modal Analysis.
In: Shock and Vibration, 2014.

Brincker, Rune; López-Aenlle, Manuel / Mode shape sensitivity of two closely spaced eigenvalues.
In: Journal of Sound and Vibration, 2014.

Brincker, Rune; Skafte, Anders; López-Aenlle, Manuel; Sestieri, Aldo; D'Ambrogio, Walter; Canteli, Alfonso Fernández / A Local Correspondence Principle for Mode Shapes in Structural Dynamics.
In: Mechanical Systems and Signal Processing, Vol. 45, No. 1, 03.2014, p. 91-104.

Broch Ashton, Nikki; **Zhang, Qi** / Cool-SHARE: Offload Smartphone Data By Sharing.
IEEE 79th Vehicular Technology Conference proceeding 2014. IEEE, 2014.

Bruun Andresen, Gorm; Rodriguez, Rolando A.; Becker, Sarah ; **Greiner, Martin** / The potential for arbitrage of wind and solar surplus power in Denmark.
In: Energy, 2014.

Budzik, Michal Kazimierz; Jensen, Henrik Myhre / Bonded Bimaterial Ring under Compressive Load.

In: Institution of Mechanical Engineers. Proceedings. Part L: Journal of Materials: Design and Applications, Vol. 228, 2014, p. 100-108.

Budzik, Michal Kazimierz; Jensen, Henrik Myhre / Perturbation analysis of crack front in simple cantilever plate peeling experiment.

In: International Journal of Adhesion and Adhesives, Vol. 53, 2014, p. 29-33.

Budzik, Michal K.; Jumel, Julien; Shanahan, Martin E R / Experimental investigation of mesoscale crack front triple line.

In: Applied Physics A, Vol. 114, No. 2, 02.2014, p. 495-501.

Canning, John; Moura, Lucas; Lindoy, Lachlan; Cook, Kevin; Crossley, Maxwell J.; Luo, Yanhua; Peng, Gang-Ding; **Glavind, Lars;** Huyang, George; Naqshbandi, Masood; **Kristensen, Martin;** Martelli, Cicero; Town, Graham / Fabricating Nanoporous Silica Structure on D-Fibres through Room Temperature Self-Assembly.

In: Materials, Vol. 7, No. 3, 2014, p. 2356-2369.

Catalano, Jacopo; Bentien, Anders / Influence of temperature on the electrokinetic properties and power generation efficiency of Nafion® 117 membranes.

In: Journal of Power Sources, Vol. 262, 15.09.2014, p. 192-200.

Chavez Plascencia, Alfredo; **Karstoft, Henrik** / Map Building based on a Xtion Pro Live RGBD and a Laser Sensors.

In: Journal of Information Technology & Software Engineering, 2014.

Cheng, Lixin / Evaluation of Correlations for Supercritical CO₂ Cooling Convective Heat Transfer and Pressure Drop in Macro- and Micro-Scale Tubes.

In: International Journal of Microscale and Nanoscale Thermal and Fluid Transport Phenomena, Vol. 5, No. 2, 2014, p. 113-126.

Cheng, Lixin / Boiling Heat Transfer and Critical Heat Flux Phenomena of Nanofluids.

Nanoscale Flow: Advances, Modeling and Applications. red. / Sarhan M Musa. C R C Press LLC, 2014. p. 1-31.

Chernyy, Sergey; Järn, Mikael; Shimizu, Kyoko; Swerin, Agne; Pedersen, Steen Uttrup; Daasbjerg, Kim; Makkonen, Lasse; Claesson, Per; **Iru-thayaraj, Joseph** / Superhydrophilic Polyelectrolyte Brush Layers with Imparted Anti-Icing Properties : Effect of Counter ions.

In: A C S Applied Materials and Interfaces, Vol. 6, No. 9, 14.05.2014, p. 6487-6496.

Chong, F T; **Heck, Martijn;** Ranganathan, P; Saleh, A M; Wassel, H M G / How to Help Technology Scaling keep up with the Energy Needs of Massive Data in Datacenters.

In: I E E Design & Test of Computers, 2014, p. 93-104.

Chong, F T; **Heck, Martijn;** Ranganathan, P; Saleh, A M; Wassel, H M G / Data center energy efficiency: Improving energy efficiency in data centers beyond technology scaling.

In: I E E Design & Test of Computers, Vol. 31, No.1, 21.02.2014, p. 93-104.

Christensen, Jesper Thøger ; Parigi, Dario ; **Kirkegaard, Poul Henning** / Interactive tool that empowers structural understanding and enables FEM analysis in a parametric design environment.

Proceedings of the IASS-SLTE 2014 Symposium. 2014. 49.

Christensen, Birgitte H; Andersen, Kathrine S; Pedersen, Kristina S; Bengtsen, Britt S; Simonsen, Ole; **Kappel, Simon;** Rathleff, Michael S / Reliability and concurrent validity of a novel method allowing for in-shoe measurement of navicular drop.

In: Journal of Foot and Ankle Research, Vol. 7, No. 1, 2014, p. 12.

Christiansen, Peter; Steen, Kim Arild; Nyholm Jørgensen, Rasmus; Karstoft, Henrik / Automated Detection and Recognition of Wildlife Using Thermal Cameras.

In: Sensors, Vol. 14, No. 8, 2014, p. 13778-13793.

Coleman, Joey; Lausdahl, Kenneth; Larsen, Peter Gorm / Semantics of Co-simulation.

Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. ed. / John Fitzgerald; Peter Gorm Larsen; Marcel Verhoef. Springer, 2014. p. 273-291.

Compte, Marta; Álvarez-Cienfuegos, Ana; Nuñez-Prado, Natalia; Sainz-Pastor, Noelia; Blanco-Toribio, Ana; Pescador, Nuria; Sanz, Laura; **Álvarez-Vallina, Luis** / Functional comparison of single-chain and two-chain anti-CD3-based bispecific antibodies in gene immunotherapy applications.

In: Oncolmmunology, Vol. 3, No. 5, e28810, 05.2014.

Couto, Luis Diogo Monteiro Duarte; Foster, Simon; Payne, R / Towards Verification of Constituent Systems through Automated Proof. 07 May 2014. Available from <http://arxiv.org/pdf/1404.7792.pdf>.

Dalgaard, Esben Borch; Christiansen, Philip; **Larsen, Jakob Juul;** Auken, Esben / A temporal and spatial analysis of anthropogenic noise sources affecting SNMR.

In: Journal of Applied Geophysics, Vol. 110, 2014, p. 34-42.

de Olde, Evelien; de Boer, I J M / Using games to support multi-stakeholder decision-making for sustainable development of livestock production.
Farming systems facing global challenges: Capacities and strategies: Programme and book of abstracts. Berlin : IFSA Europe, 2014. p. 21-21.

De Orué Lucana, Darío Ortiz; **Fedosov, Sergey N.**; Wedderhoff, Ina; Che, Edith N.; Torda, Andrew E. / The extracellular heme-binding protein hbps from the soil bacterium *Streptomyces reticuli* is an aquo-cobalamin binder.
In: Journal of Biological Chemistry, Vol. 289, No. 49, 05.12.2014, p. 34214-34228.

Drachmann, Nikolaj D; Olesen, Claus; Møller, Jesper V; **Guo, Zheng**; Bublitz, Maïke; Nissen, Poul / Comparing crystal structures of Ca²⁺-ATPase in the presence of different lipids.
In: F E B S Journal, Vol. 281, No. 2014, p. 4249-4262.

Esparza Isasa, Jose Antonio; Jørgensen, Peter Würtz Vinther; Larsen, Peter Gorm / Hardware In the Loop for VDM-Real Time Modeling of Embedded Systems.
Modelsward 2014 Proceedings. 2014.

Esparza Isasa, Jose Antonio; Jørgensen, Peter Würtz Vinther; Nielsen, Claus Ballegård; Hallerstede, Stefan / Modelling Energy Consumption in Embedded Systems with VDM-RT.
Abstract State Machines, Alloy, B, TLA, VDM, and Z: v. Springer-VS, 2014. p. 130-135 (Lecture Notes in Computer Science, Vol. 8477).

Esparza Isasa, Jose Antonio; Larsen, Peter Gorm; Hansen, Finn Overgaard / Energy-Aware Design of Embedded Software through Modelling and Simulation.
Proceedings of the Spring/Summer Young Researchers' Colloquium on Software Engineering (SYRCoSE). 2014.

Falkeborg, Mia; Cheong, Ling-Zhi; Gianfico, Carlo; Magdalena Sztukiel, Katarzyna; Kristensen, Kasper; Glasius, Marianne; **Xu, Xuebing; Guo, Zheng** / Alginate oligosaccharides : Enzymatic preparation and antioxidant property evaluation.
In: Food Chemistry, Vol. 164, 2014, p. 185-194.

Farkhani, Hooman ; Peiravi, Ali; **Madsen, Jens Kargaard; Moradi, Farshad** / Comparative Study of FinFETs versus 22nm Bulk CMOSs: SRAM Design Perspective.
System-on-Chip Conference (SOCC) 2014.

Farkhani, Hooman; Peiravi, Ali; **Moradi, Farshad** / A New Asymmetric 6T SRAM Cell with Write Assist Technique in 65nm CMOS Technology.
In: Microelectronics Journal, 2014.

Farkhani, Hooman; Peiravi, Ali; **Madsen, Jens Kargaard; Moradi, Farshad** / Comparative study of FinFETs versus 22nm bulk CMOS technologies : SRAM design perspective.
International System on Chip Conference. IEEE Computer Society Press, 2014. p. 449-454 6948971.

Fedosov, S.N.; Fernandes, N.A.; **Firdaus, M.Y.** / Analysis of oil-biodiesel samples by high performance liquid chromatography using the normal phase column of new generation and the evaporative light scattering detector.
In: Journal of Chromatography A, Vol. 1326, 2014, p. 56-62.

Feilberg, Anders; Liu, Dezhao; Nyord, Tavs / Temporal Variation in Odorant Composition Following Land Application of Manure.
In: Chemical Engineering Transactions, Vol. 40, 2014, p. 55-60.

Fitzgerald, John; Bryans, Jeremy; **Larsen, Peter Gorm**; Salim, Hansen / Collaborative systems of systems need collaborative design. Collaborative systems for smart networked environments: 15th IFIP WG 5.5 working conference on virtual enterprises, PRO-VE 2014, Proceedings. Vol. 434 Springer, 2014. p. 16-23 (IFIP Advances in Information and Communication Technology, Vol. 434).

Fitzgerald, John ; **Larsen, Peter Gorm**; Verhoef, Marcel / Linking Design Disciplines in Cyber-Physical System Development: The DESTECs/ Crescendo Technology.
In: ERCIM News, Vol. 97, 2014.

Fitzgerald, John ; **Larsen, Peter Gorm**; Pierce, Ken / Collaborative Development of Dependable Cyber-Physical Systems by Co-modelling and Co-simulation.
Industry and Research Perspectives on Embedded System Design. IGI global, 2014.

Fitzgerald, John; **Larsen, Peter Gorm**; Verhoef, Marcel / From Embedded to Cyper-Physical Systems: Challenges and Future Directions. Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. ed. / John Fitzgerald; Peter Gorm Larsen; Marcel Verhoef. Springer, 2014. p. 293-302.

Gassó-Tortajada, Vicent; Oudshoorn, F.W.; Sørensen, C.A.G.; Pedersen, Hans Henrik / An environmental Life Cycle Assessment of Controlled Traffic Farming.
In: Journal of Cleaner Production, Vol. 73, 2014, p. 175-182.

Gassó-Tortajada, Vicent; Oudshoorn, Frank W; de Olde, Evelien; Grøn Sørensen, Claus / Generic sustainability assessment themes and the role of context: The case of Danish maize for German biogas.
In: Ecological Indicators, Vol. 49, 2014, p. 143-153.

Giedyk, M; **Fedosov, Sergey**; Gryko, D / An amphiphilic, catalytically active, vitamin B12 derivative.
In: Chemical Communications, Vol. 50, No. 36, 2014.

Gjosaeter, T; Ulltveit-Moe, N; Kolhe, M L; **Jacobsen, Rune Hylsberg; Ebeid, Emad Samuel Malki** / Security and Privacy in the SEMIAH Home Energy Management System.
Proceedings of the Work in Progress Session : SEAA 2014, the 40th EUROMICRO Conference on Software Engineering and Advanced Applications and DSD 2014, the 17th EUROMICRO Conference on Digital System Design. Verona, Italy, 2014.

Glavind, Lars; Buggy, S.; Canning, J.; Gao, S.; Cook, K.; Luo, Y.; Peng, G. D.; **Skipper, Bjarne Funch; Kristensen, M.** / Long-period gratings for selective monitoring of loads on a wind turbine blade.
In: Applied Optics, Vol. 53, No. 18, 01.06.2014, p. 3993-4001.

Glavind, Lars; Canning, John; Gao, Shaorui; Cook, Kevin; Peng, Gang-Ding; Luo, Yanhua; **Skipper, Bjarne Funch; Kristensen, Martin** / Long-period gratings in special geometry fibers for high-resolution and selective sensors.
In: Optical Engineering, Vol. 53, No. 6, 2014, p. 066109.

Glavind, Lars; Buggy, Stephen; **Skipper, Bjarne F.**; Canning, John; Gao, Shaorui; Cook, Kevin; Luo, Yanhua; Peng, Gang-Ding; **Kristensen, Martin** / A Long-Period Grating Sensor System Monitoring Loads on a Wind Turbine Blade.
Advanced Photonics. Optical Society of America, 2014. p. BM3D.4.

Glavind, Lars; Canning, John; Gao, Shaorui; Cook, Kevin; Peng, Gang-Ding; Luo, Yanhua; **Skipper, Bjarne F.; Kristensen, Martin** / D-shape fiber with Mach Zehnder Long-Period Gratings for a High Resolution and Selective Sensor.
Advanced Photonics. Optical Society of America, 2014. p. BM4D.3.

Goodsite, Michael Evan; Skov, Henrik; Asmund, Gert; Bennike, Ole; **Feilberg, Anders**; Glasius, Marianne; Gross, Allan; Hermanson, M. H. / Pilot Study of Contaminants near Station Nord, a Military Airbase and Research Station in NE Greenland.
NATO Science for Peace and Security Series – C: Environmental Security - Sustainable Cities and Military Installations. Vol. 2 Springer, 2014. p. 177-198.

Goverdovsky, V; Looney, David; **Kidmose, Preben**; Mandic, Danilo / Multimodal physiological sensor for motion artefact rejection.
36th Annual Int. Conf. of the IEEE Engineering in Medicine and Biology Society (EMBC) 2014.

Green, Ole; Schmidt, Thomas ; Pietrzowski, Radoslaw Piotr; Jensen, Kjeld; **Larsen, Morten; Nyholm Jørgensen, Rasmus** / Commercial Autonomous Agricultural Platform - Kongskilde Robotti.
RHEA conference proceedings 2014. 2014. p. 351-356.

Grøn Sørensen, Claus; Halberg, N.; **Oudshoorn, F.W.**; Petersen, Bjørn Molt; Dalgaard, Randi / Energy inputs and GHG emissions of tillage systems.
In: Biosystems Engineering, Vol. 120, 2014, p. 2 -14.

Hajj, Raghida; Ravelo, Blaise; Cabral, Jorge; **Wagner, Stefan Rahr; Pedersen, Christian Fischer**; Mathiesen, Morten / EMI Analysis of Wi-Fi and Bluetooth RF Communication for Medical Applications.
In: Advanced Electromagnetics, 2014.

Hallerstedte, Stefan; Jastram, Michael; Ladenberger, Lukas / A Method and Tool for Tracing Requirements into Specifications.
In: Science of Computer Programming, Vol. 82, 2014, p. 2-21.

Hallerstedte, Stefan; Hoang, Thai Son / Refinement of decomposed models by interface instantiation.
In: Science of Computer Programming, Vol. 94, No. P2, 2014, p. 144-163.

Hallerstedte, Stefan / Quasi-lexicographic convergence.
In: Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), Vol. 8477 LNCS, 2014, p. 86-100.

Hansen, Søren; Bennedsen, Jens / Democratic co-determination and responsibility of lecture content.
2014. Paper presented at SEFI Annual Conference 2014, Birmingham, United Kingdom.

Hansen, Peter Thomas Kenney; Hilberg, Ole; **Pedersen, Henrik**; Nielsen, Ole Bækgaard; Sigsgaard, Torben / Nasal filters for the treatment of allergic rhinitis: A randomized, double-blinded placebo-controlled crossover clinical trial.
In: The Journal of allergy and clinical immunology, 2014.

Hansen, Michael Jørgen; Nørgaard, Jan Værum; **Adamsen, Anders Peter S.**; Poulsen, Hanne Damgaard / Effect of reduced crude protein on ammonia, methane, and chemical odorants emitted from pig houses.
In: Livestock Science, 2014.

Hansen, Michael Jørgen; Jonassen, Kristoffer E N; **Feilberg, Anders** / Evaluation of Abatement Technologies for Pig Houses by Dynamic Olfactometry and On-site Mass Spectrometry.
In: Chemical Engineering Transactions, Vol. 40, 2014.

Hansen, Michael Jørgen; Nielsen, Mai Britt F; Jonassen, Kristoffer E N / Online or Delayed Olfactometry – a Comparison Based on Results from Four Different Types of Pig Housing or Mitigation Systems.
In: Chemical Engineering Transactions, Vol. 40, 2014.

Hansen, Jannick Balleby; Brincker, Rune; Aenlle, Manuel L / Detection of Mass Change on a Glass Plate.
Topics in Modal Analysis: Proceedings of the 31st IMAC, A Conference on Structural Dynamics, 2013. Vol. 7 Springer, 2014. p. 61-66 (Conference Proceedings of the Society for Experimental Mechanics Series).

Hansen, Finn Overgaard; Jensen, Troels Fedder; Esparza Isasa, Jose Antonio / Distributed ICT Architecture for Developing, Configuring and Monitoring Mobile Embedded Healthcare Systems.
Proceedings of the 7th International Conference on Health Informatics, 2014. p. 484-489.

Hansen, C; Bay, D; Jensen, M R; Gervang, B; Jensen, Henrik Myhre; Thrysoe, S A; Nygaard, J V / Numerical simulation of LDL transport through the carotid arterial wall.
In: Computer Methods in Biomechanics and Biomedical Engineering, Vol. 17 Suppl 1, 08.2014, p. 20-21.

Heck, Martijn; Bauters, Jared F; Davenport, Michael L; Spencer, Daryl T; Bowers, John E / Ultra-low loss waveguide platform and its integration with silicon photonics.
In: Laser & Photonics Reviews, 2014.

Hedevang, Emil; Schmiegel, Jürgen / A Levy based approach to isotropic random vector fields: with a view towards turbulence.
In: International Journal of Nonlinear Sciences and Numerical Simulation, Vol. 15, No. 7-8, 2014.

Heide-Jørgensen, Simon; Taborsky, Jonas; Krishna, S. Kumaran; Zegdi, R.; **Johansen, Peter** / Non-circularTAVI deployment's impact on maximum orifice area.
2014. Abstract from 24th Annual Meeting, Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Heide-Jørgensen, Simon; Krishna, S K; Taborsky, J; Bechsgaard, Tommy Kragh; Hønge, Jesper Langhoff; **Johansen, Peter;** Zegdi, R / A new method for high resolution non-contact heart valve deformation analysis.
Abstracts from WCB 2014: <http://wcb2014.com/>. 2014.

Hellwing, Anne Louise Frydendahl; Lund, Peter; Weisbjerg, Martin Riis; **Oudshoorn, Frank W;** Munksgaard, Lene; Kristensen, Troels / Comparison of methods for estimating herbage intake in grazing dairy cows.
In: European Association for Animal Production. Annual Meeting. Book of Abstracts, 08.2014, p. 140-140.

Hellwing, Anne Louise Frydendahl; Weisbjerg, Martin Riis; **Møller, Henrik Bjarne** / Enteric and manure-derived methane emissions and biogas yield of slurry from dairy cows fed grass silage or maize silage with and without supplementation of rapeseed.
In: Livestock Science, Vol. 165, 2014, p. 189-199.

Holst, Malene Kirstine ; **Kirkegaard, Poul Henning** / Metaheuristics for a Tectonic Development of Hospital Design Footprints.
Proceedings of the IASS-SLTE 2014 Symposium. 287.

Holst, Malene Kirstine Østergaard; **Kirkegaard, Poul Henning** / Metaheuristics for Engineering and Architectural Design of Hospitals.
Proceedings of the Ninth International Conference on Engineering Computational Technology. BHV Topping. Vol. 105 Stirlingshire : Civil-Comp Press, 2014. (Civil-Comp Proceedings).

Holt, Jon; Perry, Simon; Payne, Richard; Bryans, Jeremy; **Hallerstede, Stefan; Hansen, Finn Overgaard** / A Model-Based Approach for Requirements Engineering for Systems of Systems.
In: I E E Systems Journal, 2014.

Hovgaard, Mads Knude; Brincker, Rune / SHM based system design of a wind turbine tower using a modal sensitivity based Bayes detector.
EWSHM - 7th European Workshop on Structural Health Monitoring, 2014.

Hviid, Christian Anker; **Petersen, Steffen** / Numerical investigation of diffuse ceiling ventilation in an office under different operating conditions.
NSB 2014 - 10th Nordic Symposium on Building Physics: Full papers. Lunds Tekniska Högskola, Institut för Byggnadsteknik, 2014. p. 916-923 113.

Hyldahl, Per; Mikkola, Aki M.; **Balling, Ole;** Sopanen, Jussi T. / Behavior of thin rectangular ANCF shell elements in various mesh configurations.
In: Nonlinear Dynamics, 22.06.2014.

Hyldahl, Per Christian; Mikkola, Aki M; **Balling, Ole;** Sopanen, Jussi T / Convergence characteristics of thin ANCF shell elements in arbitrary and initially curved mesh.
Proceedings of 3rd Joint International Conference on Multibody System Dynamics. 2014.

Hyldahl, Per Christian; Mikkola, A M; **Balling, Ole** / Studies on the Kinematics of thin Shell Elements based on the absolute nodal Coordinate Formulation.
Proceedings of the ASME 2014 : International Design Engineering Technical Conferences & Computers and Information in Engineering Conference. 2014.

Ingram, Claire ; Payne, Richard ; Perry, Simon ; Holt, Jon ; **Hansen, Finn Overgaard; Couto, Luis Diogo Monteiro Duarte** / Modelling Patterns for Systems of Systems Architectures. Proceedings of the 8th Annual IEEE International Systems Conference. 2014.

Jacobsen, Rune Hylsberg; Mikkelsen, Søren Aagaard / Infrastructure for Intelligent Automation Services in the Smart Grid. In: Wireless Personal Communications. 03.2014.

Jacobsen, Rune Hylsberg; Tørring, Nikolaj; Danielsen, Brian Vestergaard ; Hansen, Morten Tranberg ; Pedersen, Erik Bøjer / Towards an app platform for data concentrators. Innovative Smart Grid Technologies Conference. 2014 IEEE PES : ISGT 2014. p. 71-75.

Jacobsen, Rune Hylsberg; Ebeid, Emad Samuel Malki / SEMIAH: Scalable Energy Management Infrastructure for Aggregations of Households. Proceedings of the Work in Progress Session : SEAA 2014, the 40th EUROMICRO Conference on Software Engineering and Advanced Applications and DSD 2014, the 17th EUROMICRO Conference on Digital System Design. Verona, Italy, 2014.

Jakob, Thilo; **Spillner, Edzard**; Lamers, Marinus / IgE als Zielstruktur für therapeutische Intervention. Allergologie. ed. / Tilo Biedermann; Harald Renz; Werner Heppt; Martin Röcken. Springer Verlag, 2014.

Jakob, Thilo; Rafei-Shamsabadi, David; Müller, Sabine; Bantleon, Frank I. ; **Spillner, Edzard** / Aktueller Stand und neue Entwicklungen in der Diagnostik mit rekombinanten Insektengiftallergenen. In: Allergologie, Vol. 37, No. 9, 2014, p. 352-361.

Jensen, Troels Fedder; Hansen, Finn Overgaard; Esparza Isasa, Jose Antonio; Mikkelsen, Peter Høgh; Hakala, T; Vuorela, T / ICT-enabled Medical Compression Stocking for Treatment of Leg Venous Insufficiency. Proceedings of the International Conference on Biomedical Electronics and Devices 2014. p. 212-217.

Jensen, Thomas; Munkholm, Lars Juhl; **Green, Ole; Karstoft, Henrik** / A mobile surface scanner for soil studies. RHEA conference proceedings 2014. p. 187-194.

Jensen, Tue Vissing; Greiner, Martin / Emergence of a phase transition for the required amount of storage in highly renewable electricity systems. In: European Physical Journal. Special Topics, Vol. 223, No. 12, 01.10.2014, p. 2475-2481.

Jensen, Kjeld; **Larsen, Morten**; Nielsen, Søren H; Larsen, Leon B; Olsen, Kent S; **Nyholm Jørgensen, Rasmus** / Towards an Open Software Platform for Field Robots in Precision Agriculture. In: Robotics, Vol. 3, No. 2, 2014.

Jensen, Jonas; Rölfing, Jan Hendrik Duedal; Svend Le, Dang Quang; Kristiansen, Asger Albaek; **Nygaard, Jens Vinge**; Hokland, Lea Bjerre; Bendtsen, Michael; Kassem, Moustapha; Lysdahl, Helle; Bünger, Cody Eric / Surface-modified functionalized polycaprolactone scaffolds for bone repair : In vitro and in vivo experiments. In: Journal of Biomedical Materials Research. Part A, 2014.

Jensen, Henrik Myhre; Veluri, Badrinath / Simulation of crack paths at three-dimensional corners of laminated structures. In: International Journal of Materials Engineering Innovation, Vol. 5, No. 2, 02.2014, p. 112-121.

Jensen, Henrik Myhre; Budzik, Michal Kazimierz; Møberg, Alex / Interface crack front perturbations. Proceedings of 17th U.S. National Congress on Theoretical & Applied Mechanics. 2014.

Jensen, Andreas B; Lindhardt, Anders Thyboe / Decarboxylative Trichloromethylation of Aromatic Aldehydes and Its Application in Continuous Flow. In: Journal of Organic Chemistry, Vol. 79, No. 3, 2014, p. 1174-1183.

Jeppesen, Jesper; Beniczky, Sándor; **Johansen, Peter**; Sidenius, Per Christian; Fuglsang-Frederiksen, Anders / New modified heart rate variability analyses as detector of epileptic seizures. In: Clinical Neurophysiology, Vol. 125, No. S1, 06.2014, p. S255.

Jeppesen, Jesper; Beniczky, Sándor; **Johansen, Peter**; Sidenius, Per Christian; Fuglsang-Frederiksen, Anders / Detection of epileptic seizures with a modified heart rate variability algorithm based on Lorenz plot. In: Seizure - European Journal of Epilepsy, 2014.

Jeppesen, Jesper; Beniczky, Sándor; **Johansen, Peter**; Sidenius, Per Christian; Fuglsang-Frederiksen, Anders / Using Lorenz plot and Cardiac Sympathetic Index of heart rate variability for detecting seizures for patients with epilepsy. In: Conference proceedings : Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2014, p. 4563-66.

Johansen, Peter; Andersen, Tina S; Hasenkam, J. Michael; Nygaard, Hans; Paulsen, Peter Kildeberg / Mechanical heart valve cavitation in patients with bileaflet valves. In: Conference proceedings : Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2014, p. 5655 - 5658.

Jonassen, Kristoffer E N; Nielsen, Mai Britt F; **Hansen, Michael Jørgen** / Online or Delayed Olfactometry – a Comparison Based on Results from Four Different Types of Pig Housing or Mitigation Systems.
In: Chemical Engineering Transactions, Vol. 40, 2014, p. 7-12.

Jusseau, Xavier; Yin, Hongfei; **Lindhardt, Anders Thyboe**; Skrydstrup, Troels / Palladium-Catalyzed Carbonylative Coupling of (2-Azaaryl) methyl Anion Equivalents with (Hetero) Aryl Bromides.
In: Chemistry: A European Journal, 2014.

Jørgensen, Peter Würtz Vinther; **Larsen, Morten**; **Couto, Luis Diogo Monteiro Duarte** / A Code Generation Platform for VDM.
Proceedings of 12th Overture Workshop on VDM, 2014.

Kappel, Simon; Looney, D.; Mandic, D.P.; **Kidmose, P.** / A method for quantitative assessment of artifacts in EEG, and an empirical study of artifacts.
Engineering in Medicine and Biology Society (EMBC), 2014 36th Annual International Conference of the IEEE, 2014, p. 1686-1690.

Kilsgaard, Bjørn Sjøgren; **Haldrup, S.**; **Catalano, J.**; **Bentien, A.** / High figure of merit for electrokinetic energy conversion in Nafion membranes.
In: Journal of Power Sources, Vol. 247, 2014, p. 235-242.

Kirkegaard, Poul Henning; Hvejsel, Marie F / Unfolding Utzon: The Nature of Utzon's Approach for Structural Design.
Proceedings of the IASS-SLTE 2014 Symposium, 2014, 281.

Krishna, S. Kumaran; **Christensen, J.**; **Taborsky, Jonas**; **Heide-Jørgensen, Simon**; **Bechsgaard, Tommy Kragh**; Hønge, Jesper Langhoff; Zegdi, R.; **Johansen, Peter** / Non-contact strain measurements with high spatial and temporal resolution on aortic valves.
2014. Abstract from 24th Annual Meeting, Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Kristensen, Martin; Russell, J; Gao, Shaorui; Cook, Kevin; Canning, John / Improved Spectral Resolution of Long-Period Fiber Grating Sensors for Ultra-High Temperature Environments Using Narrow Interferences between Regenerated Gratings.
Advanced Photonics. Optical Society of America, 2014.

Kristensen, Martin; **Maack, Johan**; **Thomassen, Andreas**; **Balle, Thomas**; **Selchau, Jacob** / Quantum Key Distribution using Phase Encoding in Double-Pass Silica-on-Silicon Circuits with Grating Reflectors.
Advanced Photonics. Optical Society of America, 2014.

Kronvang, Brian; Gertz, Flemming; Baattrup-Pedersen, Annette; Rubæk, Gitte Holton; Heckrath, Goswin Johann; Jensen, Henning; Egemose, Sara; Hoffmann, Carl Christian; Dalgaard, Tommy; Olsen, Søren; **Møller, Henrik Bjarne**; Wiborg, Irene; Stutter, Marc / Experiences gained from 2 years with mandatory 10 mm buffer strips along all Danish watercourses: do we know enough to evaluate their ecosystem services?
2014. Abstract from Wetlands 2014, Huesca, Spain.

Köhler, Julian; Blank, Simon; Müller, Sabine; Bantleon, Frank; Frick, Marcel; Huss-Marp, Johannes; Lidholm, Jonas; **Spillner, Edzard**; Jakob, Thilo / Component resolution reveals additional major allergens in patients with honeybee venom allergy.
In: Journal of Allergy and Clinical Immunology, Vol. 133, No. 5, 05.2014, p. 1383-1389.e6.

Landowski, M; **Budzik, Michal Kazimierz**; Imielińska, K / Dynamic Mechanical Behaviour of GFRP Composites with SiO₂ Nano Particles Reinforces Epoxy Matrix.
In: Advances in Materials Science (Online), Vol. 13, No. 4, 2014.

Landowski, M; Budzik, **Michal Kazimierz**; Imielska, K / Water absorption and blistering of GFRP marine laminates with nano particle modified coatings.
In: Journal of Composite Materials, 2014.

Lange, Lasse; Vaeggemose, Anders; **Kidmose, Preben**; Mikkelsen, Eva; Ulbjerg, Niels; **Johansen, Peter** / Velocity and directionality of the electrohysterographic signal propagation.
In: PloS one, Vol. 9, No. 1, e86775, 2014, p. 1-6.

Larsen, Peter Gorm; Fitzgerald, John; Verhoef, Marcel; Pierce, Kenneth / Discrete-Event Modelling in VDM.
Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. Springer, 2014, p. 61-95.

Larsen, Peter Gorm; Gamble, Carl; Pierce, Kenneth; Ribeiro, Augusto; **Lausdahl, Kenneth** / Support for Co-modelling and Co-simulation: The Crescendo Tool.
Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. Springer, 2014, p. 97-114.

Larsen, Peter Gorm / VDM-RT Language Summary.
Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. Springer, 2014, p. 313-321.

Larsen, J. J.; Dalgaard, E.; Christiansen, P.; Auken, Esben / Fast mapping and analysis of anthropogenic noise sources affecting MRS experiments.
Near Surface Geoscience 2014 - 20th European Meeting of Environmental and Engineering Geophysics. European Association of Geoscientists and Engineers, EAGE, 2014.

Lauridsen, P.K.B; **Petersen, Steffen** / Integrating indoor climate, daylight and energy simulations in parametric models and performance-based design.

Proceedings of the Third International Workshop on Design in Civil and Environmental Engineering. 2014. p. 111-118.

Laursen, Morten Stigaard; Midtby, Henrik Skov; Kruger, Norbert; **Jorgensen, Rasmus Nyholm** / Statistics-based segmentation using a continuous-scale naive Bayes approach.

In: Computers and Electronics in Agriculture, Vol. 109, 11.2014, p. 271-277.

Lausdahl, Kenneth; Nielsen, Claus Ballegård; Kristensen, Klaus / Including Running System Implementations in the Simulation of System of Systems Models.

17th Brazilian Symposium on Formal Methods - SBMF 214. 2014.

Le, Li; Bennedsen, Jens / Methodological Analysis of CDIO Papers.

Proceedings of the 10th International CDIO Conference: Sharing Successful Engineering Education Experiences. 2014.

Lescot, Camille; Nielsen, Dennis Ulsøe; Makarov, Ilya; **Lindhardt, Anders Thyboe**; Daasbjerg, Kim; Skrydstrup, Troels / Efficient Fluoride-Catalyzed Conversion of CO₂ to CO at Room Temperature.

In: Journal of the American Chemical Society, Vol. 136, No. 16, 2014, p. 6142-6147.

Li, Weina; Fedosov, Sergey; Tan, Tianwei; **Xu, Xuebing; Guo, Zheng** / Naturally Occurring Alkaline Amino Acids Function as Efficient Catalysts on Knoevenagel Condensation at Physiological pH: A Mechanistic Elucidation.

In: Applied Biochemistry and Biotechnology, 2014.

Li, Weina; Fedosov, Sergey; Tan, Tianwei; **Xu, Xuebing; Guo, Zheng** / Kinetic Insights of DNA/RNA Segment Salts Catalyzed Knoevenagel Condensation Reaction.

In: A C S Catalysis, Vol. 4, No. 9, 2014, p. 3294-3300.

Lian, Zhong; Friis, Stig D.; **Lindhardt, Anders T.**; Skrydstrup, Troels / Palladium-Catalyzed Carbonylation of Aryl Bromides with N-Substituted Cyanamides.

In: Synlett, 2014.

Lindhard, Søren Munch; **Wandahl, Søren** / A Lean Framework for Production Control in Complex and Constrained Construction Projects (PC4P).

Optimization and Control Methods in Industrial Engineering and Construction. Springer Science+Business Media B.V., 2014. p. 233-257 (Intelligent Systems, Control and Automation: Science and Engineering, Vol. 72).

Lindhard, Søren; **Wandahl, Søren** / Scheduling of large, complex, and constrained construction projects - an exploration of LPS application.

In: International Journal of Project Organisation and Management, Vol. 6, No. 3, 2014, p. 237-253.

Lindhard, Søren Munch; **Wandahl, Søren** / Exploration of the Reasons for Delays in Construction.

In: The International Journal of construction management, Vol. 14, No. 1, 2014, p. 47-57.

Liu, Dezhao; Løkke, Mette Marie; Riis, A L; Mortensen, K; **Feilberg, Anders** / Evaluation of clay aggregate biotrickling filters for treatment of gaseous emissions from intensive pig production.

In: Journal of Environmental Management, Vol. 136, 04.2014.

Liu, Dezhao; Guldberg, L B ; **Feilberg, Anders** / Dependence of Sulphurous Odorants Reduction on Loading Rates in Inoculated Biofilter Columns.

In: Chemical Engineering Transactions, Vol. 40, 2014, p. 199-204.

Looney, D; Goverdovsky, V; **Kidmose, Preben**; Mandic, D P / Subspace Denoising of EEG Artefacts via Multivariate EMD.

Proceedings of IEEE International Conference on Acoustics, Speech and Signal Processing. 2014.

Looney, D; **Kidmose, Preben**; Mandic, D P / Ear-EEG: User-Centered and Wearable BCI.

Brain-Computer Interface Research . ed. / C Guger; B Z Allison; G Edlinger. Springer, 2014. p. 41-50 (SpringerBriefs in Electrical and Computer Engineering).

Lorenzen, Søren; **Hinge, Mogens**; Christensen, Morten Lykkegaard; Keiding, Kristian / Filtration of core-shell colloids in studying the dewatering properties of water-swollen materials.

In: Chemical Engineering Science, Vol. 116, 06.09.2014, p. 558-566.

Lykkemark, Simon; **Mandrup, Ole Aalund**; Friis, Niels Anton; **Kristensen, Peter** / Degradation of C-terminal tag sequences on domain antibodies purified from E. coli supernatant.

In: mAbs, Vol. 6, No. 6, 02.11.2014, p. 1551-1559.

Mark, Søren; Pätzold, N.; Krishna, S. Kumaran; Taborsky, Jonas ; Heide-Jørgensen, Simon; Hønge, Jesper Langhoff; Zegdi, R.; **Johansen, Peter** / The impact of blocked sinus valsalva on aortic valve closing velocity and orifice area.

2014. Abstract from 24th Annual Meeting, Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Memon, Mukhtiar; Wagner, Stefan Rahr; Pedersen, Christian Fischer; Beevi, Femina Hassan Aysha; Hansen, Finn Overgaard / Ambient Assisted Living Healthcare Frameworks, Platforms, Standards, and Quality Attributes.
In: *Sensors*, Vol. 14, 2014, p. 4312-4341.

Mikkelsen, Søren Aagaard / Privacy Enforcement in a Cost-Effective Smart Grid : Electrical and Computer Engineering.
Aarhus University, 2014. 33 p.

Milkevych, Viktor / The mechanics of growth of aggregated *Methanosarcina* : PhD thesis.
2014. 120 p.

Milkevych, Viktor; Batstone, Damien J. / Controlling mechanisms in directional growth of aggregated archaeal cells.
In: *Soft Matter*, Vol. 10, No. 48, 2014.

Milkevych, Viktor; Donose, Bogdan; Juste-Poinapen, Natacha; Batstone, Damien J. / Mechanical and cell-to-cell adhesive properties of aggregated *Methanosarcina*.
In: *Colloids and Surfaces B: Biointerfaces*, 2014.

Milkevych, Viktor; Donose, Bogdan; Juste-Poinapen, Natacha; Batstone, Damien J. / Determination of mechanical properties and turgor pressure of aggregated *Methanosarcina* by atomic force microscopy : Abstract and presentation at 2nd International Conference on Biogas Microbiology ICBM, Uppsala Sweden, June 10-12, 2014.

Milkevych, Viktor; Batstone, Damien J. / Modeling the directional growth of aggregated archaeal cells : Abstract and presentation at 9th European Conference on Mathematical and Theoretical Biology 15-19 June 2014. Gothenburg Sweden.
2014.

Modvig, Amalie; Andersen, Thomas L.; Taaning, Rolf H.; **Lindhardt, Anders T.**; Skrydstrup, Troels / Two-chamber hydrogen generation and application : Access to pressurized deuterium gas.
In: *Journal of Organic Chemistry*, Vol. 79, No. 12, 2014, p. 5861-5868.

Mohammadi, Mohammad Sadegh; Zhang, Qi; Dutkiewicz, Eryk ; Huang, Xiaojing / Optimal Frame Length to Maximize Energy Efficiency in IEEE 802.15.6 UWB Body Area Networks.
In: *IEEE Wireless Communications Letters*, Vol. 3, No. 4, 08.2014, p. 397-400.

Mohammadi, Mohammad Sadegh; Zhang, Qi; Dutkiewicz, E / Channel-Adaptive MAC Frame Length in Wireless Body Area Networks.
Proceedings of the 17th International Symposium on Wireless Personal Multimedia Communications (WPMC), Sept. 2014.

Mohammadi, Mohammad Sadegh; Zhang, Qi; Dutkiewicz, E; Huang, X; Vesilo, R / Energy-Delay Tradeoffs in Impulse-based Ultra-Wide-band Body Area Networks with Noncoherent Receivers.
Proceedings of the IEEE Global Communications Conference (IEEE GLOBECOM), Dec. 2014.

Mohammadi, Mohammad Sadegh; Dutkiewicz, Eryk ; Zhang, Qi; Huang, Xiaojing / Optimal Energy Efficiency Link Adaptation in IEEE 802.15.6 IR-UWB Body Area Networks.
In: *IEEE Communications Letters*, Vol. 18, No. 12, 2014, p. 2193 - 2196.

Moradi, Farshad; Madsen, Jens Kargaard / Robust Subthreshold 7T-SRAM Cell for Low-Power Applications.
2014. Paper presented at IEEE 57th International Midwest Symposium on Circuits and Systems, United States.

Moradi, Farshad; Madsen, Jens Kargaard / Improved Read and Write Margins Using a Novel 8T-SRAM Cell.
IEEE: 22nd International Conference on Very Large Scale Integration (VLSI-SoC) 2014. IEEE Xplore.

Moradi, Farshad; Madsen, Jens K. / Robust subthreshold 7T-SRAM cell for low-power applications.
Midwest Symposium on Circuits and Systems. Institute of Electrical and Electronics Engineers Inc., 2014. p. 893-896 6908559.

Moradi, Farshad; Panagopoulos, Georgios; Karakonstantis, Georgios ; Farkhani, Hooman; Wisland, Dag T ; Madsen, Jens Kargaard; Mahmoodi, Hamid ; Roy, Kaushik / Multi-level wordline driver for robust SRAM design in nano-scale CMOS technology.
In: *Microelectronics Journal*, Vol. 45, No. 1, 01.2014, p. 23-34.

Mulat, Daniel Girma; Latva-Mäenpää, Harri; Koskela, Harri; Saranpää, Pekka; Wähälä, Kristiina / Rapid chemical characterisation of stilbenes in the root bark of Norway spruce by off-line HPLC/DAD-NMR.
In: *Phytochemical Analysis*, Vol. 25, No. 6, 11.2014, p. 529-536.

Mulat, Daniel Girma; Ward, Alastair James; Adamsen, Anders Peter S; Voigt, Niels Vinther; Nielsen, Jeppe L; Feilberg, Anders / Quantifying contribution of syntrophic acetate oxidation to methane production in thermophilic anaerobic reactors by membrane inlet mass spectrometry.
In: *Environmental Science & Technology (Washington)*, Vol. 48, No. 4, 2014, p. 2505-2511.

Møller, Henrik Bjarne; Moset, Verónica; Brask, Maike; Weisbjerg, Martin Riis; Lund, Peter / Feces composition and manure derived methane yield from dairy cows : Influence of diet with focus on fat supplement and roughage type.
In: *Atmospheric Environment*, Vol. 94, 2014, p. 36-43.

Neumann, Karoline T.; Laursen, Simon R.; **Lindhardt, Anders T.**; Bang-Andersen, Benny; Skrydstrup, Troels / Palladium-catalyzed carbonylative sonogashira coupling of aryl bromides using near stoichiometric carbon monoxide.
In: *Organic Letters*, Vol. 16, No. 8, 2014, p. 2216-2219.

Nielsen, Dennis Ulsøe; Korsager, Signe; **Lindhardt, Anders Thyboe**; Skrydstrup, Troels / A Palladium-Catalyzed Carbonylative-Deacetylation Sequence to 1,3-Keto Amides.
In: *Advanced Synthesis & Catalysis*, Vol. 356, No. 17, 2014, p. 3519-3524.

Nielsen, Claus Ballegård; Larsen, Peter Gorm / Collaborative Formal Modeling of System of Systems.
Systems Conference (SysCon), 2014 IEEE International. 2014.

Nielsen, Claus Ballegård; Lausdahl, Kenneth; Larsen, Peter Gorm / Distributed Simulation of Formal Models in System of Systems Engineering.
4th IEEE track on Collaborative Modelling and Simulation in IEEE WETICE 2014.

Ntinis, Georgios; Fragos, Vassilios ; Dados, Ioannis; **Zhang, Guoqiang** / Dynamic numerical simulation of flow through a solar air heater having two successive rectangular ribs mounted on the wall.
2014. Abstract from International Conference on Agricultural Engineering conference , Zürich, Switzerland.

Ntinis, G K; **Zhang, Guoqiang**; Fragos, V P; **Bochtis, Dionysis**; Nikita- Martzopoulou, Ch / Airflow patterns around obstacles with arched and pitched roofs: Wind tunnel measurements and direct simulation.
In: *European Journal of Mechanics B - Fluids*, Vol. 43, 2014, p. 216-229.

Ntinis, Georgios; Zhang, Guoqiang; Fragos, V P; Norton, T; Martzopoulos, G G / Turbulent Flow around a Rib: Numerical vs. Wind Tunnel Experiments.
Proceedings of 18th World Congress of CIGR. 2014.

Ntogkoulis, Panagiotis A.; **Bochtis, Dionysis D.**; Fountas, Spyros; Berruto, Remigio; Gemtos, Theofanis A. / Performance of cotton residue collection machinery.
In: *Biosystems Engineering*, Vol. 119, 01.03.2014, p. 25-34.

Nørgaard, Jan Værum; **Hansen, Michael Jørgen**; Assadi Soume, Elham; **Adamsen, Anders Peter S.**; Poulsen, Hanne Damgaard / Effect of protein level on performance, nitrogen utilisation and carcass composition in finisher pigs.
In: *Acta Agriculturae Scandinavica. Section A. Animal Science*, 2014.

Nørgaard, Jan Værum; **Hansen, Michael Jørgen**; Assadi Soume, Elham; **Adamsen, Anders Peter S.**; Poulsen, Hanne Damgaard / Nitrogen utilisation and carcass composition in finisher pigs fed different content of crude protein.
In: *European Association for Animal Production. Annual Meeting. Book of Abstracts, 08.2014*, p. 358-358.

Oudshoorn, Frank W; Lauridsen, Kirstine / Facilitating grazing for organic dairy farms with expanding herd size.
Building Organic Bridges: Proceedings of the 4th ISOFAR Scientific Conference at the Organic World Congress 2014. Vol. 1 Germany, p. 183-186.

Oudshoorn, Frank W; Stubsgaard, A; **Grøn Sørensen, Claus** / What makes organic livestock production sustainable?.
In: *European Association for Animal Production. Annual Meeting. Book of Abstracts, Vol. 20, 2014*.

Parajuli, Ranjan; Dalgaard, Tommy; Jørgensen, Uffe; **Adamsen, Anders Peter S.**; Knudsen, Marie Trydeman; Birkved, Morten; Gylling, Morten; Schørring, Jan Kofod / Biorefining in the prevailing energy and materials crisis: a review of sustainable pathways for biorefinery value chains and sustainability assessment methodologies.
In: *Renewable & Sustainable Energy Reviews*, Vol. 43, 2014, p. 244-263.

Parigi, Dario; **Kirkegaard, Poul Henning** / The Reciprocalizer : An Agile Design Tool for Reciprocal Structures.
In: *Nexus Network Journal*, Vol. 16, Nr. 1, 01.04.2014, s. 61-68.

Parigi, Dario; **Kirkegaard, Poul Henning** / Design and Fabrication of Free-Form Reciprocal Structures.
In: *Nexus Network Journal*, Vol. 16, Nr. 1, 01.04.2014, s. 69-87.

Pedersen, Christian Fischer; Bäckström, Tom / Sparse Time-Frequency Representation of Speech by the Vandermonde Transform.
2014. Paper presented at International Conference on Spoken Language Processing, Interspeech, City of Singapore, Singapore.

Pedersen, Christina O.; Hjorth, Maibritt; Hutchings, Nicholas J. / Effect of livestock slurry ozonation and separation on pH, particles, and phosphate.
In: *Journal of Environmental Quality (Online)*, Vol. 43, No. 3, 2014, p. 1043-1049.

Pedersen, C.O.; Masse, L.; **Hjorth, M.** / The effect of residual cationic polymers in swine wastewater on the fouling of reverse osmosis membranes.
In: *Environmental Technology*, Vol. 35, No. 2014, p. 1338-1344.

Peters, Gregory M; Murphy, K R; **Adamsen, Anders Peter S.**; Bruun, S; Svanström, M; ten Hoeve, M / Improving odour assessment in LCA—the odour footprint.
In: *International Journal of Life Cycle Assessment*, 07.2014.

Peters, Greg; Murphy, Kathleen; **Adamsen, Anders Peter S.**; Bruun, Sander; Svanström, Magdalena; ten Hoeve, Marieke / Improvement of odor assessment in a life cycle assessment framework. Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector : LCA Food 2014. American Center for Life Cycle Assessment (ACLCA), 2014. sp 994-999.

Petersen, Steffen / The effect of weather data on glazing U-value in building performance simulation. NSB 2014 - 10th Nordic Symposium on Building Physics: Full papers. : Lunds Tekniska Högskola, Institut för Byggnadsteknik, 2014. p. 239-246 30.

Petersen, Steffen; Bryder, J; Levinsen, K; Strunge, J. / Method for integrating simulation-based support in the building design process. Proceedings of the Third International Workshop on Design in Civil and Environmental Engineering, 2014. p. 83-89.

Petersen, Steffen; Bundgaard, K W / The effect of weather forecast uncertainty on a predictive control concept for building systems operation. In: Applied Energy, Vol. 116, 2014, p. 311-321.

Petersen, Steffen; **Christensen, Niels Uhre**; Heinsen, Caroline; **Hansen, Anne Sophie** / Investigation of the displacement effect of a diffuse ceiling ventilation system. In: Energy and Buildings, Vol. 85, 12.2014, p. 265-274.

Petersen, Steffen; **Momme, Amalie Jin**; Hviid, Christian Anker / A simple tool to evaluate the effect of the urban canyon on daylight level and energy demand in the early stages of building design. In: Solar Energy, Vol. 108, 10.2014, p. 61-68.

Petkov, K P; Puton, M; **Madsen, Søren Peder**; Veje, Chr.; Willatzen, M / Pressure drop calculation using a one-dimensional mathematical model for two-phase flow through an orifice: Comparison with experiments. In: International Journal on Heat and Mass Transfer - Theory and Applications, 2014.

Piels, Molly; Bauters, Jared F.; Davenport, Michael L.; **Heck, Martijn J R**; Bowers, John E. / Low-loss silicon nitride AWG demultiplexer heterogeneously integrated with hybrid III-V/Silicon photodetectors. In: Journal of Lightwave Technology, Vol. 32, No. 4, 6644296, 15.02.2014, p. 817-823.

Pierce, Kenneth; **Larsen, Peter Gorm**; Fitzgerald, John / Co-model Structuring and Design Patterns. Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. Springer, 2014. p. 115-137.

Pierce, Kenneth; **Wolff, Sune**; Verhoef, Marcel / Methods for Creating Co-models of Embedded Systems. Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. Springer, 2014. p. 153-183.

Rafei-Shamsabadi, David; Müller, Sabine; Pfützner, Wolfgang; **Spillner, Edzard**; Rueff, Franziska; Jakob, Thilo / Recombinant allergens rarely allow identification of Hymenoptera venom allergic patients with negative specific IgE to whole venom preparations. In: Journal of Allergy and Clinical Immunology, Vol. 134, No. 2, 2014, p. 493-494.

Rastian, Zahra; Khodadadi, Abbas Ali; Vahabzadeh, Farzaneh; Bortolini, Christian; Dong, MD; Mortazavi, Yadollah; Mogharei, Azadeh; Naseh, Masoud Vesali; **Guo, Zheng** / Facile surface functionalization of multiwalled carbon nanotubes by soft dielectric barrier discharge plasma : Generate compatible interface for lipase immobilization. In: Biochemical Engineering Journal, Vol. 90, 2014, p. 16-26.

Rathleff, Michael Skovdal; Bandholm, Thomas; **Ahrendt, Peter**; Olesen, Jens Lykkegaard; Thorborg, Kristian / Novel stretch-sensor technology allows quantification of adherence and quality of home-exercises : a validation study. In: British Journal of Sports Medicine, Vol. 48, No. 8, 04.2014, p. 724-728.

Raule, Nicola; Sevinci, Federica; Li, Shengting; Barbieri, Annalaura; Tallaro, Federica; Lomartire, Laura; Vianello, Dario; Moilanen, Jukka; Bezrukov, Vladislav; Blanché, Héléne; Hervonen, Antti; Christensen, Kaare; Deiana, Luca; Gonos, Efsthatis; Kirkwood, Tom B. L.; **Kristensen, Peter**; Leon, Alberta; Pelicci, Pier Giuseppe; Poulain, Michel; Rea, Irene M.; Remacle, José; Robine, Jean Marie; Schreiber, Stefan; Sikora, Ewa; Slagboom, P. Eline; Spazzafumo, Liana; Stazi, M. Antonietta; Toussaint, Olivier; Vaupel, James W.; Rose, Giuseppina; Majamaa, Kari; Perola, Markus; Bolund, Lars; Yang, Huanming; Passarino, Giuseppe; Franceschi, Claudio / The co-occurrence of mtDNA mutations on different oxidative phosphorylation subunits, not detected by haplogroup analysis, affects human longevity and is population specific. In: Aging Cell, Vol. ACE-13-0186.R2, 2014.

Raun, Christian; **Kirkegaard, Poul Henning** / Adaptive Mould - A Cost-Effective Mould System Linking Design and Manufacturing of Double-Curved Panels. Proceedings of the IASS-SLTE 2014 Symposium. 2014. 280.

Ravelo, Blaise; Cabral, Jorge; **Wagner, Stefan Rahr**; **Pedersen, Christian Fischer**; Mathiesen, Morten / Indoor RF Communication Modelling of a Healthcare Platform's WPAN Interface. 2014. Paper presented at IoP Conference Series: Materials Science and Engineering: 2nd Radio and Antenna Days of the Indian Ocean, Mauritius.

Ravelo, Blaise; Cabral, Jorge; **Wagner, Stefan Rahr; Pedersen, Christian Fischer**; Mathiesen, Morten / EMI and BER/PER Analysis of Wi-Fi and Bluetooth Communication for CRIP Platform.
2014. Paper presented at 17e Colloque International et Exposition sur la Compatibilité Electromagnetique, Clermont-Ferrand, France.

Rodríguez, R.A.; Becker, S.; **Andresen, G.B.**; Heide, Dominik; **Greiner, M.** / Transmission needs across a fully renewable European power system.
In: *Renewable Energy*, Vol. 63, 2014, p. 467-476.

Rolles, D.; Boll, R.; Adolph, M.; Aquila, A.; Bostedt, C.; Bozek, J. D.; Chapman, H. N.; Coffee, R.; Coppola, N.; Decleva, P.; Delmas, T.; Epp, S. W.; Erk, B.; Filsinger, F.; Foucar, L.; Gumprecht, L.; Hömke, A.; Gorkhover, T.; Holmegaard, L.; Johnsson, P.; Kaiser, Ch; Krasniqi, F.; Kühnel, K. U.; Maurer, J.; Messerschmidt, M.; Moshhammer, R.; Quevedo, W.; Rajkovic, I.; Rouzée, A.; Rudek, B.; Schlichting, I.; Schmidt, C.; Schorb, S.; Schröter, C. D.; **Schulz, J.**; Stapelfeldt, H.; Stener, M.; Stern, S.; Teichert, S.; Thøgersen, J.; Vrakking, M. J. J.; Rudenko, A.; Küpper, J.; Ullrich, J. / Femtosecond x-ray photoelectron diffraction on gas-phase dibromobenzene molecules.
In: *Journal of Physics B: Atomic, Molecular and Optical Physics*, Vol. 47, No. 12, 124035, 2014.

Rong, Li; Liu, Dezhao; Pedersen, Erling; **Zong, Chao; Zhang, Guoqiang** / Ammonia and methane emission from a hybrid ventilated dairy cow building in Denmark.
2014. Abstract from International Conference on Agricultural Engineering conference , Zürich, Switzerland.

Rong, Li; Liu, Dezhao; Zhang, Guoqiang; Pedersen, Erling / Ammonia and Methane Emissions from a Hybrid Ventilated Dairy Cow Building and Impacts of Wind Velocity and Air Temperature on Air Exchange Rate.
Abstracts of the 13th international conference on indoor air quality and climate. 2014.

Rong, Li; Liu, Dezhao; Pedersen, Erling F; **Zhang, Guoqiang** / Effect of climate parameters on air exchange rate and ammonia and methane emissions from a hybrid ventilated dairy cow building.
In: *Energy and Buildings*, Vol. 82, 2014, p. 632-643.

Rotger Griful, Sergi; Jacobsen, Rune Hylsberg / Control of Smart Grid Residential Buildings with Demand Response.
In: *Studies in Computational Intelligence*, Vol. 581, 2014, p. 133-161.

Saenz Del Burgo, Laura; Compte, Marta; Aceves, Mónica; Hernández, Rosa María; Sanz, Laura; **Alvarez-Vallina, Luis**; Pedraz, Jose Luis / Microencapsulation of therapeutic bispecific antibodies producing cells : immunotherapeutic organoids for cancer management.
In: *Journal of drug targeting*, 2014, p. 1-10.

Sarker, Shiplu; **Møller, Henrik Bjarne** / Regulating feeding and increasing methane yield from co-digestion of C5 molasses and cattle manure.
In: *Energy Conversion and Management*, Vol. 84, 2014, p. 7-12.

Sarker, Shiplu; Møller, Henrik Bjarne; Bruhn, Annette / Influence of variable feeding on mesophilic and thermophilic co-digestion of *Laminaria digitata* and cattle manure.
In: *Energy Conversion and Management*, 2014.

Shen, Yanbin; Søndergaard, Martin; Christensen, Mogens; **Birgisson, Steinar**; Iversen, Bo Brummerstedt / Solid State Formation Mechanism of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ from an Anatase TiO_2 Source.
In: *Chemistry of Materials*, Vol. 26, No. 12, 2014, p. 3679-3686.

Shimizu, Kyoko; Malmos, Kristoffer; Spiegelhauer, Susie Ann; Hinke, Jens; Holm, Allan Hjarbæk; Pedersen, Steen Uttrup; Daasbjerg, Kim; **Hinge, Mogens** / Durability of PEEK adhesive to stainless steel modified with aryldiazonium salts.
In: *International Journal of Adhesion and Adhesives*, Vol. 51, 01.06.2014, p. 1-12.

Shimizu, Kyoko; Malmos, Kristoffer; Holm, Allan Hjarbæk; Pedersen, Steen Uttrup; Daasbjerg, Kim; **Hinge, Mogens** / Improved adhesion between PMMA and stainless steel modified with PMMA brushes.
In: *A C S Applied Materials and Interfaces*, Vol. 6, Nr. 23, 2014, p. 21308-21315.

Siboska, Daniel; Karstoft, Henrik; Pedersen, Henrik / Synchronization of Electroencephalography and Eye Tracking using Global Illumination Changes.
Proceedings of International Conference on Bio-inspired Systems and Signal Processing 2014.

Singer, Josef; Fazekas, Judith; Wang, Wei; Weichselbaumer, Marlene; Matz, Mirosława; Mader, Alexander; Steinfellner, Willibald; Meitz, Sarah; Mechticheriakova, Diana; Sobanov, Juri; Willmann, Michael; Stockner, Thomas; **Spillner, Edzard**; Kunert, Renate; Jensen-Jarolim, Erika / Generation of a canine anti-EGFR (ErbB-1) antibody for passive immunotherapy in dog cancer patients.
In: *Molecular Cancer Therapeutics*, Vol. 13, No. 7, 2014, p. 1777-90.

Skaftø, Anders; Tygesen, Ulf Tyge ; **Brincker, Rune** / Expansion of Mode Shapes and Responses on the Offshore Platform Valdemar. Dynamics of Civil Structures: Proceedings of the 32nd IMAC, A Conference and Exposition on Structural Dynamics, 2014. Vol. 4 Springer, 2014. p. 35-41 [Conference Proceedings of the Society for Experimental Mechanics Series].

Spillner, Edzard; Blank, Simon; Jakob, Thilo / Hymenoptera allergens: from venom to "venome".
In: *Frontiers in Immunology*, Vol. 5, No. 77, 2014.

Spillner, Edzard; Blank, Simon; Jakob, Thilo / Mehrwert und Grenzen rekombinanter Allergene in der Diagnostik der Insektengiftallergie. Molekulare Allergologie. Springer Verlag, 2014.

Srinivasan, Sudharsanan ; Davenport, M; **Heck, Martijn**; Hutchinson, J; Norberg, Erik; Fish, G; Bowers, J E / Low phase noise hybrid silicon mode-locked lasers.

In: *Frontiers of Optoelectronics*, 04.2014.

Steen, Kim Arild; Therkildsen, Ole Roland; **Karstoft, Henrik**; **Green, Ole** / Audio-Based Detection and Recognition of Conflict Species in Outdoor Environments Using Pattern Recognition Methods.

In: *Applied Engineering in Agriculture*, Vol. 30, No. 1, 2014, p. 89-96.

Steen, Kim Arild; McClella, James H; **Green, Ole**; **Karstoft, Henrik** / Acoustic Source Tracking in Long Baseline Microphone Arrays.

In: *Applied Acoustics*, Vol. 87, 2014, p. 38-45.

Steen, Kim Arild; **Karstoft, Henrik** / The Acoustic Adaptive Frightening Device - Framework and Algorithms.

IEEE Conference Proceedings, http://www.ieee.org/publications_standards/publications/confproc/index.html ?. 2014.

Steffensen, Søren; **Jensen, Henrik Myhre** / Energy release rate for circular crack due to indentation in a brittle film on a ductile substrate.

In: *European Journal of Mechanics A - Solids*, Vol. 43, 01.2014, p. 133 -141.

Steffensen, Søren; **Kibsgaard, Rasmus Lyng**; **Jensen, Henrik Myhre** / Debonding of Particles in Thin Films.

In: *International Journal of Solids and Structures*, Vol. 51, 2014, p. 2850-2856.

Sutaryo, Sutaryo; **Ward, Alastair James**; **Møller, Henrik Bjarne** / The effect of mixed-enzyme addition in anaerobic digestion on methane yield of dairy cattle manure.

In: *Environmental Technology*, Vol. 35, No. 19, 2014, p. 2476-2482.

Sørensen, Henrik; **Wandahl, Søren**; Christensen, Randi Muff / Employee-driven innovation in large project organisations.

Proceedings of 8th Construction Industry Development Board (CIDB) Postgraduate Conference: Advancing construction industry development through innovative research and new thinking. Johannesburg : University of the Witwatersrand, Johannesburg, South Africa, 2014. p. 269-280.

Sørensen, Kenny Kataoka / Drained Residual Strength of Little Belt Clay.

GeoRegina 2014: 67th Canadian Geotechnical Conference. 2014.

Taborsky, Jonas ; **Heide-Jørgensen, Simon**; **Krishna, S. Kumaran**; Zegdi, R.; **Johansen, Peter** / The impact of deformed TAVI on valve closing velocity.

2014. Abstract from 24th Annual Meeting, Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Thorup, V. M.; do Nascimento, O. F.; Skjøth, F.; Voigt, M.; **Rasmussen, M. D.**; Bennedsgaard, T. W.; Ingvarsen, K. L. / Short communication: Changes in gait symmetry in healthy and lame dairy cows based on 3-dimensional ground reaction force curves following claw trimming.

In: *Journal of Dairy Science*, Vol. 97, No. 12, 2014, p. 7679-7684.

Tian, Jing Jing; Li, Guang Jun; **Li, Qiang** / Hardware-efficient parallel structures for linear-phase FIR digital filter based on iterated short convolution algorithm.

In: *Dianzi Yu Xinxi Xuebao*, Vol. 36, No. 5, 05.2014, p. 1151-1157.

Tohidi, Mohammad; Abolhasani, Alireza; Khoei, Abdollah; Hadidi, Khayrollah / A circuit implementation of an ultra high speed, low power analog fully programmable MFG.

In: *Journal of Intelligent and Fuzzy Systems*, Vol. 26, No. 4, 2014, p. 1823-1832.

Tronci, E; Mancini, T; Mari, F; Melatti, I; **Jacobsen, Rune Hylsberg**; **Ebeid, Emad Samuel Malki**; **Mikkelsen, Søren Aagaard**; Prodanovic, M; Gruber, J K; Hayes, B / SmarHG: Energy Demand Aware Open Services for Smart Grid Intelligent Automation.

Proceedings of the Work in Progress Session : SEAA 2014, the 40th EUROMICRO Conference on Software Engineering and Advanced Applications and DSD 2014, the 17th EUROMICRO Conference on Digital System Design. Verona, Italy, 2014.

Tu, Gang Jun; **Karstoft, Henrik**; Pedersen, Lene Juul; Jørgensen, Erik / Segmentation of sows in farrowing pens.

In: *I E T Image Processing*, Vol. 8, No. 1, 01.2014, p. 56-68.

Tu, Gang Jun; Jørgensen, Erik / Pig video tracking methods: a review and new trends.

In: *European Association for Animal Production. Annual Meeting. Book of Abstracts*, 08.2014, p. 450-450.

van Huffel, K; **Hansen, Michael Jørgen**; **Feilberg, Anders**; **Liu, Dezhao**; van Langenhove, H / The Power of Online Proton Transfer Reaction - Mass Spectrometry (PTR-MS) Measurement of Odorous Emissions from a Pig House.

In: *Chemical Engineering Transactions*, Vol. 40, 2014, p. 241-246.

Verhoef, Marcel; **Larsen, Peter Gorm** / Industrial Application of Co-modelling and Co-simulation Technology.

Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. Springer, 2014. p. 223-258.

Vingelmann, Peter; Heide, Janus; Pedersen, Morten Videbæk; **Zhang, Qi**; Fitzek, Frank Hanns Paul / All-to-all data dissemination with network coding in dynamic MANETs.

In: *Computer Networks*, Vol. 74, No. Part B, 2014, p. 34-47.

- Wagner, Stefan**; Kamper, C. H.; **Rasmussen, Niels H**; **Ahrendt, P.**; **Toftegaard, T. S.**; Bertelsen, O. W. / Reliable blood pressure self-measurement in the obstetric waiting room.
In: *Methods of Information in Medicine*, Vol. 53, No. 3, 2014, p. 225-234.
- Wandahl, Søren**; Lassen, Astrid Heidemann; Jacobsen, Alexia; Poulsen, Søren Bolvig / Enablers of Innovation in the Construction Material Industry.
Proceedings of the 7th World Conference on Mass Customization, Personalization, and Co-Creation (MCPC 2014), Aalborg, Denmark, February 4th - 7th, 2014: Twenty Years of Mass Customization - Towards New Frontiers. Springer, 2014. p. 159-178 (Lecture Notes in Production Engineering, Vol. 2014).
- Wandahl, Søren** / Lean Construction with or without Lean – Challenges of implementing Lean Construction.
Proceedings of IGLC22: 22nd Annual Conference of the International group for Lean Construction. Akademika forlag, 7005 Trondheim, Norway, 2014. p. 97-108.
- Wind, Jens Lycke**; **Steffensen, Søren**; **Jensen, Henrik Myhre** / Comparison of a Composite Model and an Individually Fiber and Matrix Discretized Model for Kink Band Formation.
In: *International Journal of Non-Linear Mechanics*, Vol. 67, 2014, p. 319-325.
- Wittenborn, Thomas R; Larsen, Esben K U; Nielsen, Thomas; Rydtoft, Louise M; Hansen, Line; **Nygaard, Jens V**; Vorup-Jensen, Thomas; Kjems, Jørgen; Horsman, Michael R; Nielsen, Niels Christian / Accumulation of nano-sized particles in a murine model of angiogenesis.
In: *Biochemical and Biophysical Research Communications*, Vol. 443, No. 2, 2014, p. 470-6.
- Wolfert, Sjaak ; Goense, Daan ; **Grøn Sørensen, Claus** / A future internet collaboration platform for safe and healthy food from farm to fork.
IEEE Explore. 2014. p. 266-273.
- Wolff, Sune**; **Larsen, Peter Gorm**; Verhoef, Marcel / Deploying Co-modelling in Commercial Practice.
Collaborative Design for Embedded Systems : Co-modelling and Co-simulation. Springer, 2014. p. 263-270.
- Würtz, Kent; **Johansen, Peter** / A new approach for determination of cavitation at mechanical heart valves.
2014. Abstract from 24th Annual Meeting, Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.
- Yan, Zhihui ; Wang, Chaoyuan ; Li, Baoming ; **Zhang, Guoqiang**; Shi, Zhengxiang ; Li, Hao; Weng, Hao; Yuan, Yaoming / Influence of water temperature and spraying interval on cooling effect of sprinkler system in dairy barns.
In: *Applied Engineering in Agriculture*, Vol. 30, No. 4, 2014, p. 611-617.
- Yao, Hongqing**; **Hansen, Michael J.**; **Feilberg, Anders** / DMS removal in a bubble reactor by using peroxone (O₃/H₂O₂) reactions.
In: *Chemical Engineering Transactions*, Vol. 40, No. Special Issue, 2014, p. 229-234.
- Yusoff, Mohd Firdaus Bin Mohammad**; **Xu, Xuebing**; **Guo, Zheng** / Comparison of Fatty Acid Methyl and Ethyl Esters as Biodiesel Base Stock: a Review on Processing and Production Requirements.
In: *J A O C S*, Vol. 91, No. 4, 02.03.2014, p. 525-531.
- Zhang, Xuping** / Dynamic Modeling of a Macro-Micro Manipulator Using Transfer Matrix Method.
Proceedings of The 14th Mechatronics Forum International Conference Mechatronics 2014, p. 74-79.
- Zhang, Xuping**; Mills, J K; Cleghorn, W L / PZT-based Model Sensing and Compensation for Vibration Control of Moving Flexible Links.
Proceedings of 3rd International Conference on Mechanical Engineering and Mechatronics 2014.
- Zhang, Qi**; Chaturvedi, Manila ; **Jacobsen, Rune Hylsberg** / Performance Study of the Enhancement Schemes for Baseline MAC of Body Area Networks.
Medical Information and Communication Technology (ISMICT), 2014 : 8th International Symposium. IEEE.
- Zhang, Guoqiang**; Bjerg, Bjarne; **Zong, Chao** / An engineering approach for effective cleaning of exhaust air from confined livestock production housing - A Review of partial pit air exhaust techniques.
2014. Abstract from International Conference on Agricultural Engineering conference , Zürich, Switzerland.
- Zhang, Guoqiang** / Precision ventilation to improve indoor air quality and reduce emission in pig housing.
Proceedings of International workshop of IRCAEW, 2014.
- Zhang, Guoqiang** / Ammonia emissions from naturally ventilated dairy cattle buildings – a review of field measurements in European Countries.
Proceedings of 18th World Congress of CIGR. 2014.
- Zhong, Nanjing; **Cheong, Ling Zhi**; **Xu, Xuebing** / Strategies to obtain high content of monoacylglycerols.
In: *European Journal of Lipid Science and Technology*, Vol. 116, No. 2, 01.02.2014, p. 97-107.
- Zhou, K.**; **Jensen, Allan Leck**; **Grøn Sørensen, Claus**; Busato, P.; **Bochtis, Dionysis** / Agricultural operations planning in fields with multiple obstacle areas.
In: *Computers and Electronics in Agriculture*, Vol. 109, 2014, p. 12-22.

Zong, Chao; Feng, Ying; Zhang, Guoqiang; Hansen, Michael Jørgen / Effects of different air inlets on indoor air quality and ammonia emission from two experimental fattening pig rooms with partial pit ventilation system - Summer condition.
In: Biosystems Engineering, Vol. 122, 2014, p. 163-173.

Zong, Chao; Zhang, Guoqiang; Rong, Li; Li, Hao / Investigation on ventilation effectiveness in a full-scale model pig house with partial pit ventilation system.
2014. Abstract from International Conference on Agricultural Engineering conference, Zürich, Switzerland.

Zong, Chao; Zhang, Guoqiang; Feng, Ying; Ni, Ji Qin / Carbon dioxide production from a fattening pig building with partial pit ventilation system.
In: Biosystems Engineering, Vol. 126, 01.2014, p. 56-68.

Zong, Chao; Zhang, Guoqiang / Numerical modelling of airflow and gas dispersion in the pit headspace via slatted floor: Comparison of two modelling approaches.
In: Computers and Electronics in Agriculture, Vol. 109, 2014, p. 200-211.

Zou, Xiaoqiang; Huang, Jianhua; Jin, Qingzhe; **Guo, Zheng; Cheong, Ling-Zhi; Xu, Xuebing**; Wang, Xingguo / Preparation of human milk fat substitutes from lard by lipase-catalyzed interesterification based on triacylglycerol profiles.
In: J A O C S, Vol. 91, No. 12, 2014, p. 1987-1998.

Zou, X.; Huang, J.; Jin, Q.; **Guo, Z.; Liu, Y.; Cheong, L.; Xu, X.**; Wang, X. / Characterization and Oxidative Stability of Human Milk Fat Substitutes Enzymatically Produced from Palm Stearin.
In: J A O C S, Vol. 91, No. 3, 01.03.2014, p. 481-495.

2013

Abolhasani, Alireza; **Tohidi, Mohammad**; Mousazadeh, Morteza; Khoei, Abdollah; Hadidi, Khayrollah / A high speed and fully tunable MFG with new programmable CMOS OTA and new MIN circuit.
Proceedings of the 20th International Conference on Mixed Design of Integrated Circuits and Systems, MIXDES 2013. p. 169-173 6613335.

Abolhasani, Alireza; Hadidi, Khayrollah; **Tohidi, Mohammad**; Khoei, Abdollah / A new high-resolution and high-speed open-loop CMOS sample and hold circuit.
2013 21st Iranian Conference on Electrical Engineering, ICEE 2013. 6599858.

Aenlle, M L; **Skafte, Anders**; Fernández, P; **Brincker, Rune** / Strain Estimation in a Glass Beam using Operational Modal Analysis. Special Topics in Structural Dynamics: Proceedings of the 31st IMAC, A Conference on Structural Dynamics, 2013. Vol. 6 Springer, 2013. p. 375-382 (Conference Proceedings of the Society for Experimental Mechanics Series).

Ahlburg, Andreas; **Lindhardt, Anders Thyboe**; Taaning, Rolf Hejle; Modvig, Amalie Elise; Skrydstrup, Troels / An Air Tolerant Approach to the Carbonylative Suzuki-Miyaura Coupling: Applications in Isotope Labeling.
In: Journal of Organic Chemistry, Vol. 78, No. 20, 2013, p. 10310-10318.

Amirpour, Mostafa; Mousazadeh, Morteza; **Tohidi, Mohammad**; Hadidi, Khayrollah / The sundial based sun-tracking system with AVR microcontroller.
Proceedings of the 20th International Conference on Mixed Design of Integrated Circuits and Systems, MIXDES 2013. 2013. p. 625-629 6613429.

Bardini, Luca; Ceccato, Marcel; **Hinge, Mogens**; Pedersen, Steen U.; Daasbjerg, Kim; Marcaccio, Massimo; Paolucci, Francesco. / Electrochemical Polymerization of Allylamine Copolymers.
In: Langmuir, Vol. 29, Nr. 11, 2013, s. 3791-3796.

Bechsgaard, Tommy; Hønge, Jesper Langhoff; Nygaard, Hans; Nielsen, Sten Lyager; **Johansen, Peter** / Impact of aortic valve repair on the stress distribution of the aortic root.
2013. Abstract from 23rd Scientific Meeting of the Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Bennedsen, Jens; Schulte, C./ Object interaction competence model v. 2.0.
Learning and Teaching in Computing and Engineering (LaTICE) 2013 - Proceedings. IEEE, 2013. p. 9-16 6542233.

- Berruto, R.; Busato, P.; **Bochtis, Dionysis** / Expert system with cloud database for optimal management of fruit and vegetable traceability. Proceedings of FABE 2013: International Conference on Food and Biosystems Engineering. Vol. 2 2013. p. 581-582.
- Bochtis, Dionysis** / Bio-production management in the era of automation and robotics. Proceedings of FABE 2013: International Conference on Food and Biosystems Engineering. Vol. 2 Larissa, Greece, 2013. p. 603-609.
- Brunell, Cecilia; **Bennedsen, Jens.** / Multi-level graduations in double degree engineering programmes between France and Denmark. Proceedings of the iCEER 2013 conference.
- Bruun Andresen, Gorm;** Søndergaard, Anders Aspegren; Rodriguez, Rolando A.; **Becker, Sarah; Greiner, Martin** / Weather-Driven Modeling of Future Renewable Power Systems. Proceedings of the 8th SDEWES conference. Dubrovnik, 2013.
- Budzik, Michal Kazimierz; Jensen, Henrik Myhre** / Modified Brazilian Disk Test for Interface Fracture Studies. Book of Abstracts of the 2nd international conference on structural adhesive bonding AB 2013. Faculty of Engineering, University of Porto, Portugal, 2013. AB13_46.
- Budzik, Michal Kazimierz; Jensen, Henrik Myhre** / Perturbed Crack Front. Book of Abstracts of the 2nd international conference on structural adhesive bonding AB 2013. Faculty of Engineering, University of Porto, Portugal, 2013. AB13_47.
- Budzik, Michal Kazimierz; Jensen, Henrik Myhre** / A systematized study of structures with heterogeneous interfaces : IMECE2013-62341. 2013. Abstract from ASME: IMECE2013, San Diego, USA.
- Busato, P.; Sopegno, A.; Berruto, R.; **Bochtis, Dionysis** / Use of simulation models to study the dynamic of recall of non-conform perishable produce through the supply chain. Proceedings of FABE 2013: International Conference on Food and Biosystems Engineering. Vol. 1 2013. p. 487-496.
- Chen, Y; Munkholm, Lars Juhl; **Nyord, Tavs** / Selection of design parameters for a slurry injection tool. In: American Society of Agricultural and Biological Engineers. Transactions, Vol. 56, No. 5, 2013, p. 1653-1663.
- Clausen, Casper;** Han, Anpan; **Kristensen, Martin; Bentien, Anders** / Optical sensor technology for simultaneous measurement of particle speed and concentration of micro sized particles. In: I E E E Sensors. Proceedings, Vol. 2013, p. 1-4.
- Edwards, Gareth Thomas Charles; Christiansen, Martin Peter; Bochtis, Dionysis; Grøn Sørensen, Claus.** / A Test Platform for Planned Field Operations Using LEGO Mindstorms NXT. In: Robotics, Vol. 2, No. 4, 2013, p. 203-216.
- Edwards, Gareth Thomas Charles; Bochtis, D.; Grøn Sørensen, Claus** / Multi-machine coordination : Scheduling operations based on readiness criteria and using a modified tabu search algorithm. In: I F A C Workshop Series, Vol. 4, No. 1, 2013, p. 191-195.
- Finderup, Jeanette; **Wagner, Stefan Rahr;** Jespersen, Bente; Buus, Niels Henrik / A Way to Achieve Higher Quality of Blood Pressure Self-Measurement Data. 2013. Abstract from International Conference on Pervasive Computing Technologies for Healthcare, Venice, Italy.
- Giacinti Baschetti, M.; Minelli, M.; **Catalano, J.;** Sarti, G.C. / Gas permeation in perfluorosulfonated membranes : Influence of temperature and relative humidity. In: International Journal of Hydrogen Energy, Vol. 38, No. 27, 10.09.2013, p. 11973-11982.
- Glavind, Lars;** Gao, S; Cook, K; Canning, J; **Skipper, BF;** Luo, Y; Peng, G; **Kristensen, M** / Enhanced resolution of long-period grating bend sensor. In: Proceedings of S P I E - International Society for Optical Engineering, Vol. 8924, 10.2013, p. 892437-892437.
- Gregersen, Torben; Jensen, Thomas ; Andersen, M R; Mortensen, L;** Maselyne, J; Hessel, E; **Ahrendt, Peter.** / Consumer grade range cameras for monitoring pig feeding behaviour. Precision Livestock Farming 2013: Papers presented at the 6th European Conference on Precision Livestock Farming . Leuven, 2013. p. 360-369.
- Guazzone, F; **Catalano, J.;** Mardilovich, I.P.; Wu, T.; Lambrecht, R.C.; Datta, S.; Kniep, J.; Pande, S.; Kazantzis, N.K.; Ma, Y.H. / Enhancement of the long-term permeance, selectivity stability, and recoverability of Pd-Au membranes in coal derived syngas atmospheres. In: Energy & Fuels, Vol. 27, No. 8, 2013, p. 4150-4160.
- Hagsten, Lars German; Fisker, Jakob** / Investigation of Concrete Structures in Serviceability Limit State Using Energy Principles. In: I A B S E Symposium Report, Vol. 99, 2013, p. 888-895.
- Hansen, Jannick Balleby; Brincker, Rune;** Aenlle, Manuel L; Rizvan, Mensur ; Al-Ghanemi, Ali I / Mass Detection in Operational Modal Analysis. Proceedings of the 5th IOMAC International Operational Modal Analysis Conference. 2013.

Hansen, Søren; Bennedsen, Jens. / Collaboration and reflection using peer reviews and public wikis. Proceedings of the 41st Annual SEFI Conference. 2013.

Heide-Jørgensen, S; Nielsen, M H; Krishna, Kumaran; Pirk, J L; Taborsky, J; Hønge, Jesper Langhoff; Zegdi, R.; **Johansen, Peter** / The impact of non-circular TAVI deployment on valve performance. 2013. Abstract from 23rd Scientific Meeting of the Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Holm, Niels R; Kim, Won Yong; Maeng, Michael; **Thrysoe, Samuel A;** Bøtker, Hans Erik; Thuesen, Leif; Høyer, Søren; Tu, Shengxian; Falk, Erling; Lassen, Jens Flensted; Nielsen, Per Hostrup; Christiansen, Evald Høj./ Coronary edema demonstrated by cardiovascular magnetic resonance in patients with peri-stent inflammation and aneurysm formation after treatment by drug-eluting stents. In: Circulation. Cardiovascular Imaging (Online), Vol. 6, No. 2, 2013, p. 352-4.

Jensen, Henrik Myhre; Steffensen, Søren; Lynge, Rasmus./ Tensile Cracking in Particle Reinforced Coatings. 2013. Abstract from ASME: IMECE2013, San Diego, USA.

Jensen, Steffen Elmstrøm Holst; **Jacobsen, Rune Hylsberg** / Access Control with RFID in the Internet of Things. Proceedings - 27th International Conference on Advanced Information Networking and Applications Workshops, WAINA 2013. IEEE, p. 554-559.

Jensen, Steffen Elmstrøm Holst ; **Jacobsen, Rune Hylsberg.** / Integrating RFID with IP Host Identities. Radio Frequency Identification from System to Applications. red. / Mamun Bin Ibne. InTech, 2013, p. 111-130.

Jeppesen, Jesper; Beniczky, Sándor; **Johansen, Peter;** Sidenius, Per Christian; Fuglsang-Frederiksen, Anders / New modified Heart Rate Variability analysis as detector of epileptic seizures. 2013. Poster session presented at Danske Medicotekniske Landsmøde, Brædstrup, Denmark.

Jeppesen, Jesper; Beniczky, Sándor; Sidenius, Per Christian; **Johansen, Peter;** Fuglsang-Frederiksen, Anders / New modified Heart Rate Variability analysis as detector of epileptic seizures. 2013. Poster session presented at Horizons in Clinical Neurophysiology, Oxford, Great Britain.

Jin Mi , Triolo; **Ward, Alastair James;** Pedersen, Lene; **Løkke, Mette Marie;** Qu, Haiyan ; Sommer, Sven G / Near Infrared Reflectance Spectroscopy (NIRS) for rapid determination of Biochemical Methane Potential of plant biomass. In: Applied Energy, Vol. 116, 2013, p. 52-57.

Korsager, Signe; Nielsen, Dennis Ulsøe; Taaning, Rolf Hejle; **Lindhardt, Anders Thyboe;** Skrydstrup, Troels / Direct Route to 1,3-Diketones by Palladium-Catalyzed Carbonylative Coupling of Aryl Halides with Acetylacetone. In: Chemistry: A European Journal, Vol. 19, No. 52, 2013, p. 17687-17691.

Larsen, Jakob Juul; Dalgaard, Esben Borch; Auken, Esben / Noise cancelling of MRS signals combining model-based removal of powerline harmonics and multichannel Wiener filtering. In: Geophysical Journal International, Vol. 196, No. 2, 2013, p. 828-836.

Lindballe, Thue Bjerring; Kristensen, Martin Verner Gammelgaard; Berg-Sørensen, Kirstine; **Keiding, Søren Rud;** Stapelfeldt, Henrik / Pulsed laser manipulation of an optically trapped bead: Averaging thermal noise and measuring the pulsed force amplitude. In: Optics Express, Vol. 21, No. 2, 2013, p. 1986-1996.

Melander, B; **Nørremark, M; Kristensen, E F** / Combining mechanical rhizome removal and cover crops for *Elytrigia repens* control in organic barley systems. In: Weed Research, Vol. 53, No. 6, 2013, p. 461-469.

Mikkelsen, Eva; **Johansen, Peter;** Fuglsang-Frederiksen, Anders; Uldbjer, Niels./ Electrohysterography of labor contractions: propagation velocity and direction. In: Acta Obstetrica et Gynecologica Scandinavica, Vol. 92, No. 9, 2013, p. 1070-1078.
Miklos, Rikke; Zhang, Hong; Lametsch, René; **Xu, Xuebing** / Physicochemical properties of lard-based diacylglycerols in blends with lard. In: Food Chemistry, Vol. 138, No. 1, 2013, p. 608-14.

Milkevych, Viktor; Batstone, Damien J. / Mechanical approach to modeling the multicellular structure formation of Methanosarcina : Abstract and Platform Presentation at 13th World Congress on Anaerobic Digestion, Santiago de Compostela 25-28 June, 2013. 2013.

Min, Geanna; Bjerglund, Klaus Meier; Kramer, Søren; Gøgsig, Thomas; **Lindhardt, Anders Thyboe;** Skrydstrup, Troels./ Generation of Stoichiometric Ethylene and Isotopic Derivatives and Application in Transition Metal-Catalyzed Vinylation and Enyne Metathesis. In: Chemistry: A European Journal, Vol. 19, No. 51, 2013, p. 17603-17607.

Moura, Lucas; Canning, John; Lindoy, Lachlan; Cook, Kevin; Crossley, Maxwell; Luo, Yanhua; Peng, Gang-Ding; **Glavind, Lars; Kristensen, Martin** / A fluorescence study of self-assembled silica layers on D-shaped optical fibre. In: Proceedings of SPIE - International Society for Optical Engineering, Vol. 8924, 2013, p. 89241V-89241V.
Nielsen, Dennis Ulsøe; Lescot, Camille; Gøgsig, Thomas M.; **Lindhardt, Anders Thyboe;** Skrydstrup, Troels / Pd-Catalyzed Carbonylative -Arylation of Aryl Bromides: Scope and Mechanistic Studies. In: Chemistry: A European Journal, Vol. 19, No. 52, 2013, p. 17926-17938.

Nielsen, A L; Hald, A B; Larsen, S U; Lærke, Poul Erik; **Møller, Henrik Bjarne** / Potassium as a mean to increase production and NP-capture from permanent grassland on organic soils.

The role of grasslands in a green future: threats and perspectives in less favoured areas.: Grassland Science in Europe. Vol. 18 2013. p. 569-571.

Nygaard, Jens Vinge / Combining Imaging Modalities in the Modelling of Multi Parameter Devices.

ASME 2013 Conference on Frontiers in Medical Devices: Applications of Computer Modeling and Simulation (FMD2013). Vol. 2013 American Society of Mechanical Engineers, FMD2013-16124.

Olsen, Peter; Brincker, R. / Using random response input in Ibrahim Time Domain.

Special Topics in Structural Dynamics: Proceedings of the 31st IMAC, A Conference on Structural Dynamics, 2013. Vol. 6 Springer, 2013. p. 281-287 (Conference Proceedings of the Society for Experimental Mechanics Series).

Olsen, Peter; Skafte, Anders; Hansen, Jannick Balleby; Hovgaard, Mads Knude; Brincker, Rune; Ventura, C.E. / Identification of Systems with Complex Modes Using OMA.

Proceedings of the 5th IOMAC International Operational Modal Analysis Conference. 2013.

Panpipat, Worawan; Xu, Xuebing; Guo, Zheng / Improved Acylation of Phytosterols Catalyzed by Candida Antarctica Lipase a with Superior Catalytic Activity.

2013. Abstract from 104th AOCS 104th AOCS Annual Meeting & Expo, Montreal, Canada.

Papanastasiou, D K; **Zhang, Guoqiang**; Bartzanas, T; Panagakis, P; Kittas, C / Development of long time series of climate conditions inside livestock buildings – an application to study potential sheep heat-stress under hot weather.

Proceedings of the Conference of the Hellenic Society of Agricultural Engineers. 2013.

Piechotta, C.; Jensen, Adam Enø; Olsen, Martin Grooss; **Coleman, J.W.; Larsen, P.G.** / A secure dynamic collaboration environment in a cloud context.

2013. Paper presented at The 3rd International Conference on Cloud Computing and Services Science, Aachen, Germany.

Pirk, Jens Lasse ; Krishna, Kumaran; Taborsky, J. ; Nielsen, M. H.; Heide-Jørgensen, Simon; Hønge, Jesper Langhoff; Zegdi, R.; **Johansen, Peter** / The effect of bulging sinuses of valsalva on valve dynamics - an in vitro study of TAVI valves.

2013. Abstract from 23rd Scientific Meeting of the Scandinavian Society for Research in Cardiothoracic Surgery, Geilo, Norway.

Raju, Chitra Sangaraju; Sutaryo, Sutaryo; Ward, Alastair James; Møller, Henrik Bjarne / Effects of high-temperature isochoric pre-treatment on the methane yields of cattle, pig and chicken manure.

In: Environmental Technology, Vol. 34, No. 2, 2013.

Rathleff, Michael Skovdal; Bandholm, Thomas Quaade; **Ahrendt, Peter;** Olesen, Jens Lykkegaard; Thorborg, Kristian./ Home-exercises as the drug-of-choice in physical medicine and rehabilitation: Exact quantification of exercise adherence and quality using new technology.

2013. Abstract from Dansk Idrætsmedicinsk Årskongres, Kolding, Denmark.

Rathleff, Michael Skovdal; Bandholm, Thomas Quaade; **Ahrendt, Peter;** Olesen, Jens Lykkegaard; Thorborg, Kristian / Novel stretch-sensor technology allows quantification of adherence and quality of home-exercises : a validation study.

In: British Journal of Sports Medicine, 06.03.2013.

Rodias, Efthymis; Busato, P.; **Bochtis, Dionysis; Jensen, Martin Andreas Falk;** Berruto, R.; Tamvakidis, S. / The Giant Reed as an energy crop: assessing the energy requirements within its supply chain.

Proceedings of FABE 2013: International Conference on Food and Biosystems Engineering. Vol. 2 Larissa, 2013. p. 669-675.

Sestieri, A; D'Ambrogio, W; **Brincker, Rune; Skafte, Anders;** Culla, A / Estimation of Rotational Degrees of Freedom by EMA and FEM Mode Shapes.

Special Topics in Structural Dynamics: Proceedings of the 31st IMAC, A Conference on Structural Dynamics, 2013. Vol. 6 Springer, 2013. p. 355-365 (Conference Proceedings of the Society for Experimental Mechanics Series, Vol. 6).

Silveira, D.M.; **Andresen, G.B.;** Ashkezari, M.D.; Baquero-Ruiz, M.; Bertsche, W.; Bowe, P.D.; Butler, E.; Cesar, C.L.; Chapman, S.; Charlton, M.; Fajans, J.; Friesen, T.; Fujiwara, Masatoshi; Gill, D.R.; Hangst, J.S.; Hardy, W.N.; Hayden, M.E.; Hydromako, R.; Jonsell, S.; Kurchaninov, L.; Madsen, N.; Menary, S.; Nolan, P.; Olchanski, K.; Olin, A.; Povilus, A.; Pusa, P.; Robicheaux, F.; Sarid, E.; So, C.; Storey, J.W.; Thompson, R.I.; Van Der Werf, D.P.; Wurtele, J.S. / Evaporative cooling of antiprotons for the production of trappable antihydrogen.

In: AIP Conference Proceedings Series, Vol. 1521, 2013, p. 165-174.

Skafte, Anders; Brincker, Rune / Estimation of Unmeasured DOF's on a Scaled Model of a 4-Storey Building.

Special Topics in Structural Dynamics: Proceedings of the 31st IMAC, A Conference on Structural Dynamics, 2013. Vol. 6 Springer, 2013. p. 347-353 (Conference Proceedings of the Society for Experimental Mechanics Series, Vol. 6).

Sørensen, Emil Hedevang Lohse; **Schmiegel, Jürgen** / A causal continuous-time stochastic model for the turbulent energy cascade in a helium jet flow.

In: Journal of Turbulence, Vol. 14, No. 11, 2013, s. 1-26.

Tohidi, Mohammad / A New High Speed, Area Efficient 7-2 Compressor for Fast Arithmetic Operations.

In: International Journal of Natural and Engineering Sciences, Vol. 7, No. 2, 2013, p. 072-077.

Tohidi, Mohammad; Abolhasani, Alireza; Hadidi, Khayrollah; Khoei, Abdollah / CMOS implementation of a new high speed 5-2 compressor for parallel accumulations.

In: I E I C E Electronics Express, Vol. 10, Nr. 21, 20130364, 11.2013.

Tohidi, Mohammad; Mousazadeh, Morteza; Akbari, Saeed; Hadidi, Khayrollah; Khoei, Abdollah / CMOS implementation of a new high speed, glitch-free 5-2 compressor for fast arithmetic operations.

Proceedings of the 20th International Conference on Mixed Design of Integrated Circuits and Systems, MIXDES 2013. 2013. p. 204-208 6613341.

Tong, Guohong ; **Zhang, Guoqiang;** Christopher, David M; Bjerg, Bjarne; Ye, Zhangying ; Cheng, Jin / Evaluation of turbulence models to predict airflow and ammonia concentrations in a scale model swine building enclosure.

In: Computers & Fluids, Vol. 71, 01.2013, p. 240-249.

Triolo, Jin Mi; **Ward, Alastair James;** Pedersen, Lene; Løkke, Mette Marie; Qu, Haiyan; Sommer, Sven G. / Near Infrared Reflectance (NIR) Spectroscopy for rapid determination of Biochemical Methane Potential (BMP) of plant biomass.

2013. Poster session presented at International Conference on Near Infrared Spectroscopy, La Grande-Motte, France.

Tu, G.J.; Karstoft, H.; Pedersen, L.J.; Jørgensen, E. / Foreground detection using loopy belief propagation.

In: Biosystems Engineering, Vol. 116, No. 1, 2013, p. 88-96.

Wagner, Stefan; Kamper, Christina H.; **Toftegaard, Thomas Skjødeberg;** Bertelsen, Olav W. / Blood pressure self-measurement in the obstetric waiting room.

In: Telemedicine and e-Health, Vol. 19, No. 11.2013, p. 872-874.

Wivel, Helle; Flarup, Jane / Designing Process Enablers to Strengthen Professional Skills in Project Work.

2013. Paper presented at 9th International CDIO Conference, Cambridge, Massachusetts, USA.

Zou, X.; Huang, J.; Jin, Q.; **Guo, Z.;** Liu, Y.; **Cheong, L.;** **Xu, X.;** Wang, X. / Characterization and Oxidative Stability of Human Milk Fat Substitutes Enzymatically Produced from Palm Stearin.

In: J A O C S, 11.2013.

PATENTS

NTS

2014

Johannsen, Ib (Inventor). A Method for Producing Biofuel in Oscillating Flow Production Line.
Patent No.: PA 2014 70437. Jul 11, 2014.

Kristensen, Peter (Inventor). Pro- and antiangiogenetic antibodies.
IPC No.: PA 2012 70422. Jul 12, 2012.

Nygaard, Jens Vinge (Inventor); Perti, Christian (Inventor). Injectable Hierarchical Scaffolds.
Patent No.: PA/2013 70759. Nov 1, 2013

2013

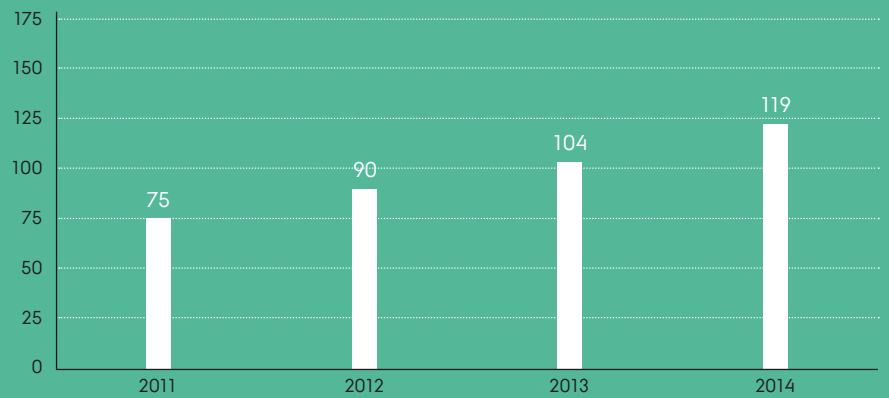
Hinge, Mogens (Inventor); Kristensen, Jens K. (Inventor); Daasbjerg, Kim (Inventor); Pedersen, Steen Uttrup (Inventor); Strange, Marianne (Inventor); Nielsen, Steen-Erik (Inventor) / Joining of polymer and surface-modified metal by laser welding.
Patent No.: WO2013139342. Sep 26, 2013.

Simonsen, Ole Højgaard (Inventor); **Karstoft, Henrik** (Inventor); Kappel, Simon Lind (Inventor); Hermann, Dan (Inventor); Rathleff, Michael Skovdal (Inventor); **Ahrendt, Peter** (Inventor) / Stretch Sensor Device.
IPC No.: A61B 5/11 (2006.01). Patent No.: PCT/DK2012/050341, WO2013041101. Mar 28, 2013.

KEY FIGURES

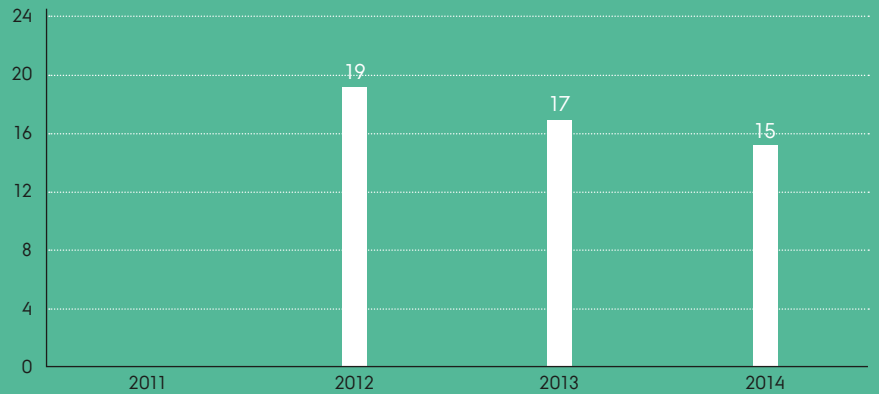
TOTAL ENG TURNOVER (M DKK)

Based on annual FC1 budget



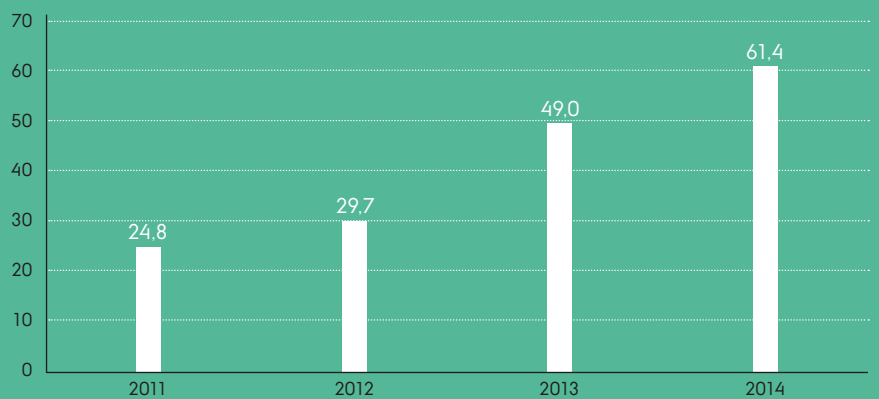
TOTAL ENG TURNOVER (%)

Increase compared to previous year

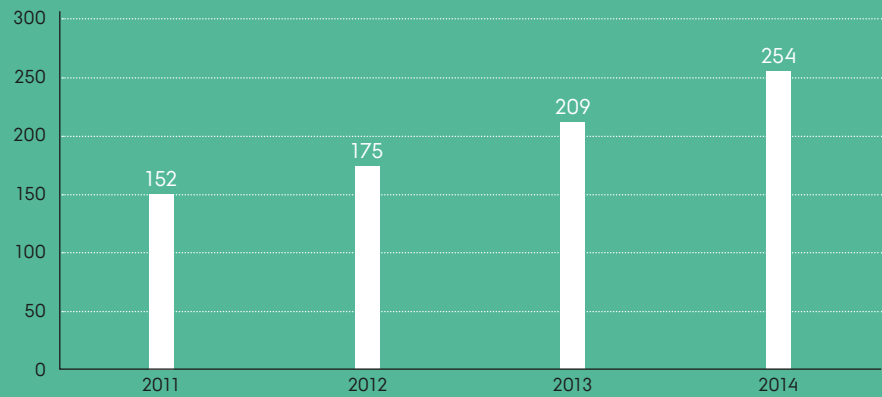


EXTERNAL FUNDING TOTAL (M DKK)

Based on annual FC3 budget

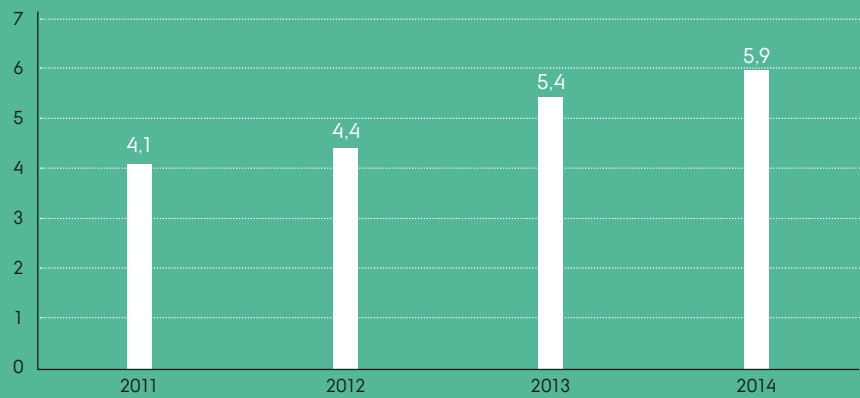


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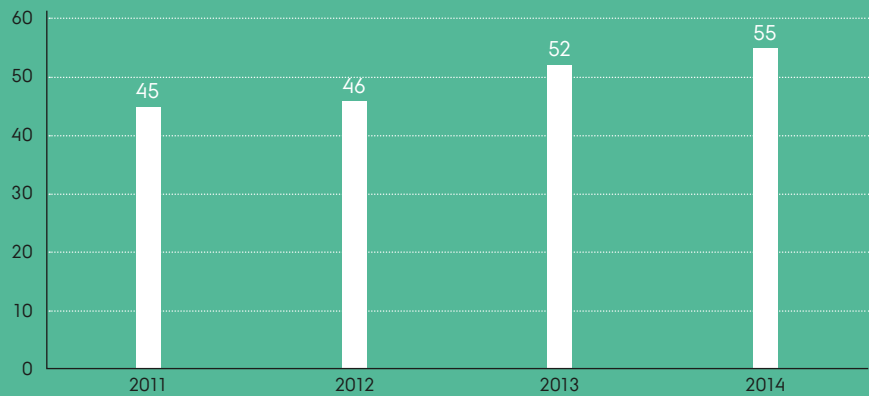


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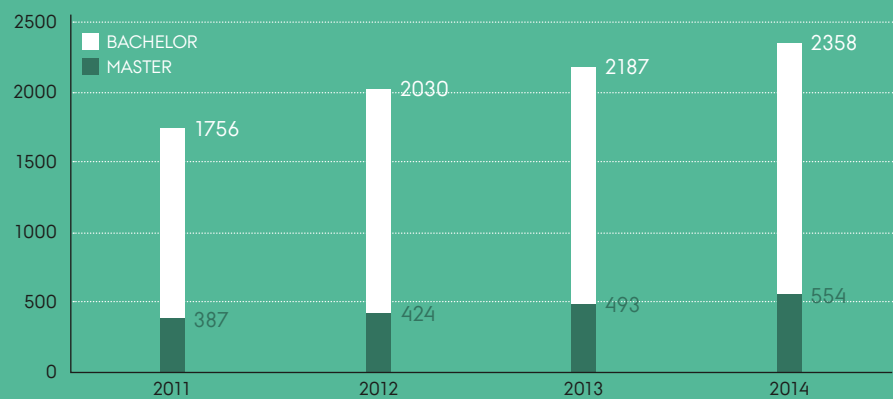
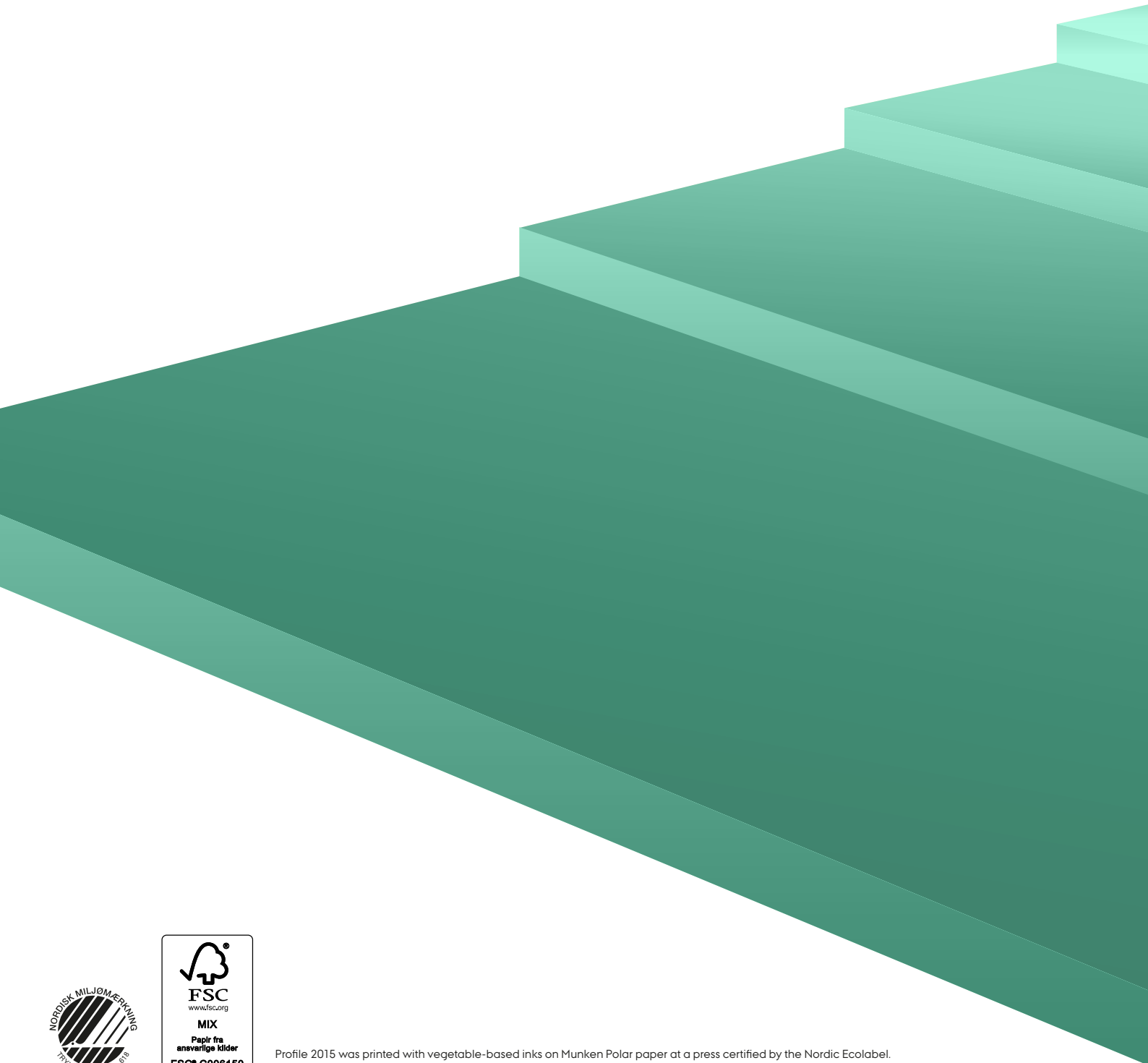






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