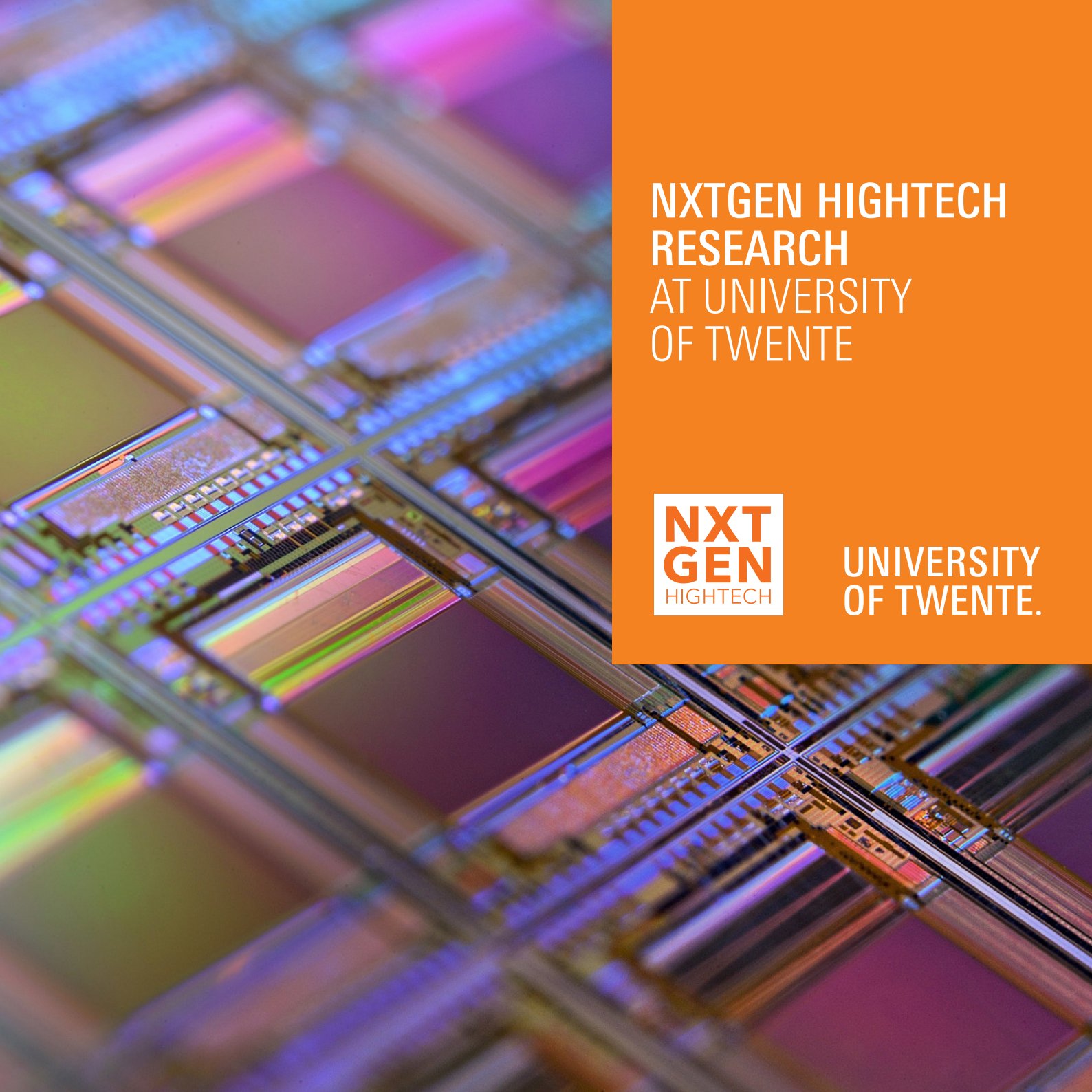


NXTGEN HIGHTECH RESEARCH AT UNIVERSITY OF TWENTE

NXT GEN HIGHTECH

UNIVERSITY OF TWENTE.

PREFACE

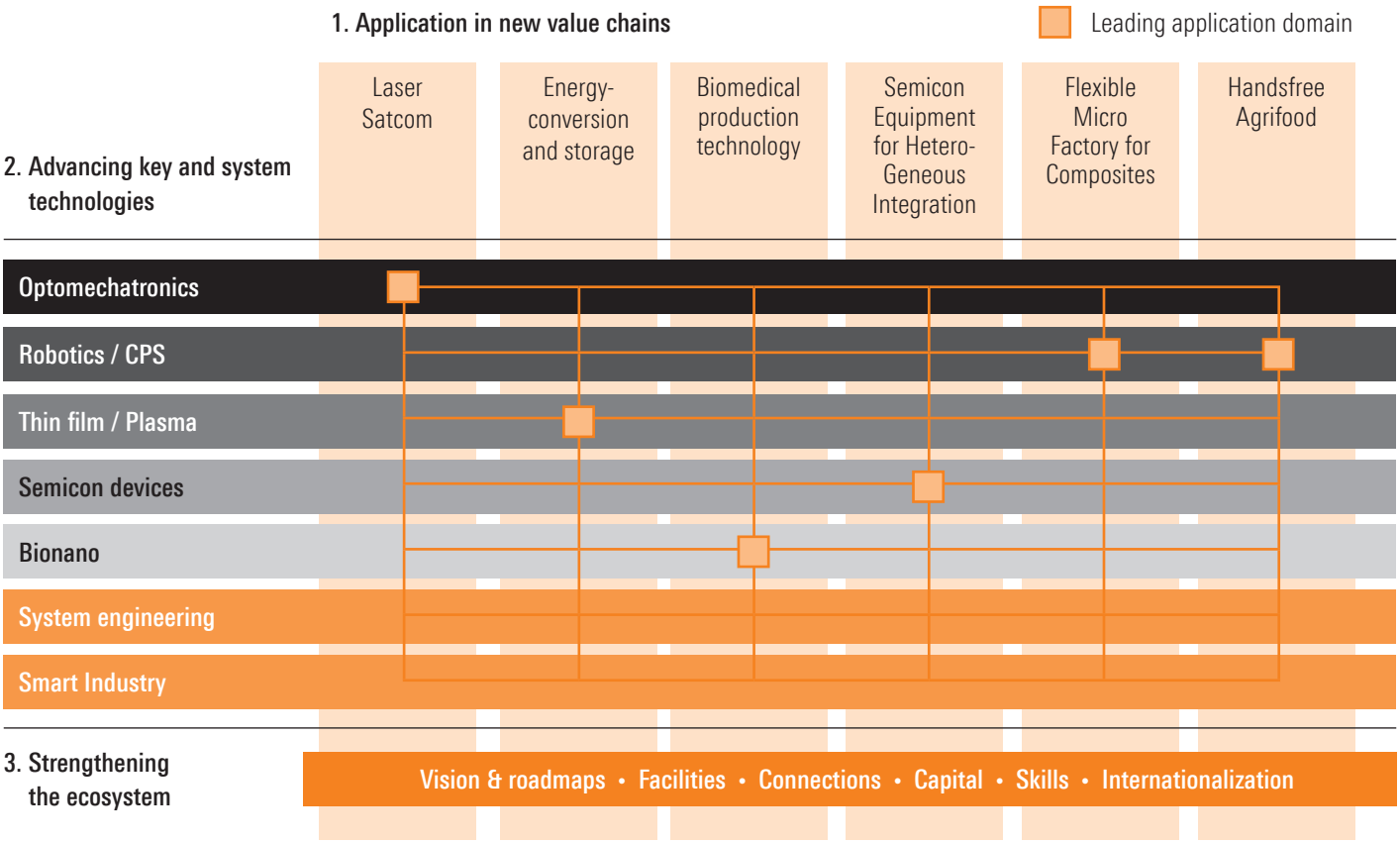
THE NEW GENERATION OF HIGH-TECH EQUIPMENT FOR FUTURE GENERATIONS

The production of high-tech equipment in the Netherlands is world-class and accounts for a large share of our exports. High-tech equipment also contributes to solutions for complex societal challenges, such as the energy transition, affordable healthcare, safe communication and a sustainable food chain. Our strong position in high-tech equipment is due to the expertise and entrepreneurship of our players in this ecosystem and their close cooperation with companies, knowledge institutes and governments.

However, competition in the world is growing, and our societal challenges are becoming even more urgent. Therefore, substantial investments are required to keep us in the front position and contribute significantly to the solutions for the grand societal challenges. Consequently, we have to act now.

At the beginning of 2020, several people promoting enabling technologies in The Netherlands, including myself, joined forces to discuss the possibilities of setting up a large growth-fund proposal for the next generation of high-tech equipment. The enthusiasm was enormous, but the traction we created was even more significant. In no time, many collaborators from industry, governments and knowledge institutes were on board to shape a growth-fund proposal on high-tech equipment. One and a half years later (October 2021), we submitted the "NXTGEN HIGHTECH" growth-fund proposal. In April 2022, we received the positive news that our proposal was provisionally granted.
But, unfortunately, this was under the condition that we had to reduce the budget to €450M subsidy. In the months that followed, we all worked hard to make this happen, with, as a result, a final project of almost € 1 billion (of which €450M subsidy) with a duration of 7 years, where 340 companies and 20 knowledge institutes are going to collaborate in more than 60 large subprojects, supported by the national and local government.

The NXTGEN HIGHTECH programme aims to establish a **coherent, viable and internationally leading ecosystem in high-tech equipment**. To achieve this objective, NXTGEN HIGHTECH consists of 3 pillars, namely the application pillar (1), the technology pillar (2) and the ecosystem pillar (3); see the figure below.



THE NXTGEN HIGHTECH PROGRAMME AIMS TO ESTABLISH A COHERENT, VIABLE AND INTERNATIONALLY LEADING ECOSYSTEM IN HIGH-TECH EQUIPMENT

The goal of the application pillar (first pillar) is to strengthen and stimulate (new) high-tech equipment applications in the six selected application areas. The aim of the technology pillar (second pillar) is to enhance the knowledge base for seven prioritised key technologies. The ecosystem pillar (third pillar) aims to strengthen, broaden, and connect the existing domain-specific ecosystems to encourage cross-fertilisation.

The University of Twente is very well represented in the NXTGEN HIGHTECH programme as the second largest party. This gives us the opportunity, but also the responsibility, to make this programme successful.

In this magazine, you will find a small anthology of a selection of subprojects within the programme NXTGEN HIGHTECH where the University of Twente plays a role.

I am proud to be one of the co-founders of the NXTGEN HIGHTECH programme. It was, and still is, a dynamic, challenging and extensive journey I enjoyed every minute. I look forward to continuing this journey and having a fruitful collaboration in the upcoming seven years within the framework of NXTGEN HIGHTECH. I thank you all for your contributions so far!

Sincerely,
Timo Meinders
Chief Technology Officer NXTGEN HIGHTECH programme
Business Director MESA+ Institute

NXT GEN HIGHTECH

UNIVERSITY OF TWENTE.

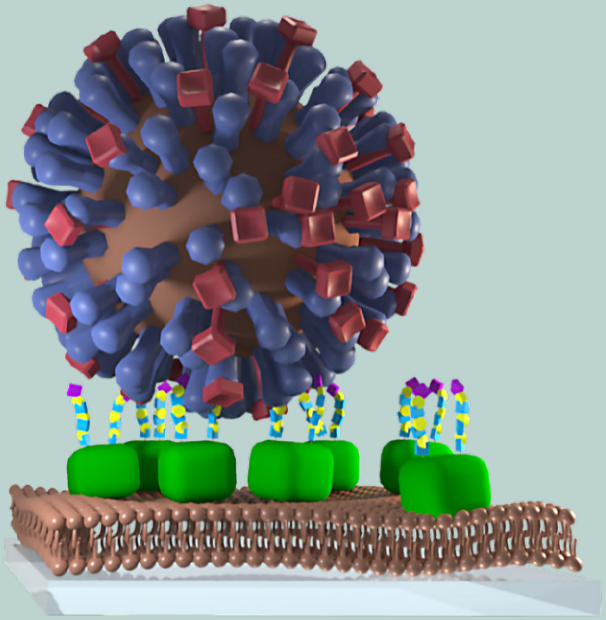
BIOSENSING: ESSENTIAL FOR FUTURE DIAGNOSTICS

APPLICATION AREA

BIOMEDICAL PRODUCTION TECHNOLOGY

KEY ENABLING TECHNOLOGY

BIONANOTECHNOLOGY



A virus binds to a platform using surface chemistry for optimal selectivity, sensitivity and sensor activity of the layer.

Prof. Dr. Ir. Jurriaan Huskens is full professor Molecular Nanofabrication

"I am involved in the application area of Biomedical Production Technology. Within this area, we mainly focus on the key technology of Bionanotechnology. Within our project 'Biosensors', we focus on two subprojects, namely the development of a biosensor for veterinary diseases on the one hand, and biosensors using optical response of enzymes on the other hand".

Biosensor for veterinary diseases

"In both projects, we will develop the surface chemistry of the layer, optimizing selectivity, sensitivity and sensor performance. In the first project 'develop a sensor to detect biomarkers in milk,"

Biosensors using optical response of enzymes

"In the second project 'Development of biosensors using optical response of enzymes', we will work together with the companies Lionix and ChiralVision. We target an ultrahigh sensitivity biosensor based on integrating enzyme recognition on an optical platform."

"WITH BOTH PROJECTS, WE HOPE TO CREATE A SIGNIFICANT SOCIETAL IMPACT. AFTER ALL, BIOSENSING IS ESSENTIAL FOR FUTURE DIAGNOSTICS, BOTH FOR VETERINARY AND HUMAN APPLICATIONS."

IMPROVING TREATMENT THROUGH EARLY DISEASE DETECTION

APPLICATION AREA

BIOMEDICAL PRODUCTION TECHNOLOGY

KEY ENABLING TECHNOLOGY

SEMICON DEVICES
LITHOGRAFICAL SYSTEMS
BIONANOTECHNOLOGY
SYSTEMS ENGINEERING

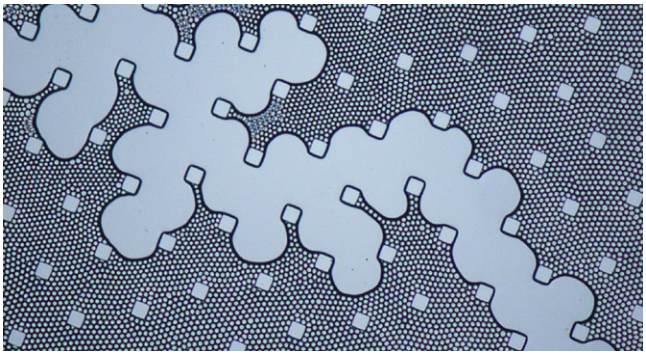
Prof. Dr. Loes Segerink is Full Professor Biomedical and Environmental Sensorsystems

Lab-on-Chip project

"Early detection of diseases has a lot of benefits, not only for the individual - since the chance of a successful treatment increases - but also for the population in the case of pandemic diseases. At the University of Twente, within the Lab-on-Chip project, we will develop microfluidic devices that can be used for virus detection and early cancer diagnostics. This serves as a starting point for translating this technology to the market, which will be done in close collaboration with companies."

New technologies for virus detection and early cancer diagnostics

"We expect to have new technologies for virus detection and early cancer diagnostics at the end of the programme. Expertise in surface chemistry and microfluidics is key for this. For the University of Twente, research in this area will continue with a clear application in mind, which can be translated to the field in close collaboration with companies. Society will notice the positive consequences as diseases can be detected earlier, improving the treatment of the individual and reducing the impact of a pandemic disease on the general population."



Even some failures in research can lead to a positive result: a prize at the MESA+ photo contest (2022) for air cleaning droplets.

INEXPENSIVE GREEN HYDROGEN AND NEXT GENERATION OF ELECTROLYSERS

APPLICATION AREA

ENERGY

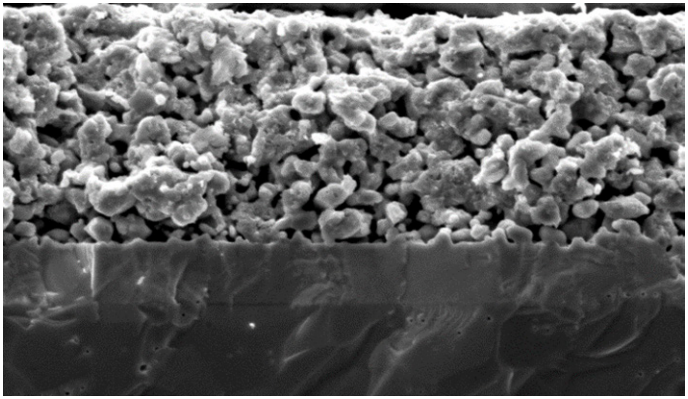
KEY ENABLING TECHNOLOGY

THIN FILM

PLASMA TECHNOLOGY

SYSTEMS ENGINEERING

SMART INDUSTRY



Scanning electron micrograph of the cross-section of a solid oxide cell.

Next-generation electrolysers

In the "3rd Generation Electrolysers" project the development of highly innovative components for electrolysers and the high-tech manufacturing technology required to make them, go hand-in-hand. Both the effectiveness of these novel components - when applied in an electrolyser and their manufacturability - still have to be proven. Dr. Banerjee highlights the role of the UT in this project: "One milestone in this project is to deliver an intergrated AI-assisted dynamic multiphysics electrode-to-system design tool for next-generation electrolysers. In addition, a validated model of solid oxide electrolyser degradation will be developed. The project will enable the next-generation electrolysers, including solid oxide, leveraging novel thin-film deposition and 3-D printing technologies that will be developed simultaneously and scaled up by the end of the project. As a final result, several pilot installations will be built to manufacture high-tech components."

Necessity for inexpensive green hydrogen

"A very important societal challenge addressed in the project is the need for inexpensive green hydrogen as a key element in a sustainable energy system and energy-intensive industry. For the Dutch economy, with traditionally a strong representation of energy-intensive industries resulting from the availability of fossil fuels (Rotterdam as an oil port, large natural gas resources), it is critical to make a transition to an industry using renewable energy as a source. Whether imported or generated locally, green hydrogen is expected to play an essential role in the greening industry."

Dr.-Ing Aayan Banerjee is Assistant Professor Catalytic Processes and Materials

IMPROVE THE HEALTH AND QUALITY OF LIFE OF PATIENTS WITH END STAGE KIDNEY DISEASE

APPLICATION AREA

BIOMEDICAL PRODUCTION TECHNOLOGY

KEY ENABLING TECHNOLOGY

BIONANOTECHNOLOGY

> WE FOCUS ON DEVELOPING, TESTING AND LARGE-SCALE PRODUCTION OF MEMBRANE DIALYSERS FOR ARTIFICIAL KIDNEY SYSTEMS."

Membrane dialyzers

NEXT-GENERATION MEMBRANE DIALYZERS

"Our group is focused on advanced organ bioengineering and therapeutics and we will coordinate this project in close collaboration with the Dutch Kidney Foundation and Aspen OSS B.V. The project aims to develop new artificial kidneys which combine filtration and adsorption for improved removal of a broad range of uremic toxins."

NEXT-GENERATION FACILITIES FOR IMPROVING HEALTH

"We also aim to develop in the University of Twente a facility for pilot production of artificial kidneys and a complete infrastructure for medical device testing. This project is expected to have high societal and economical impact. The new dialyzers could be applicable in the current dialysis systems at the hospital, as well as being applicable to portable and/or wearable artificial kidney systems. This could provide improved health and quality of life of patients with End Stage Kidney Disease."

Prof. Dr. Dimitrios Stamatialis is Full Professor Advanced Organ Bioengineering and Therapeutics


LAF 3
UNIVERSITY OF TWENTE

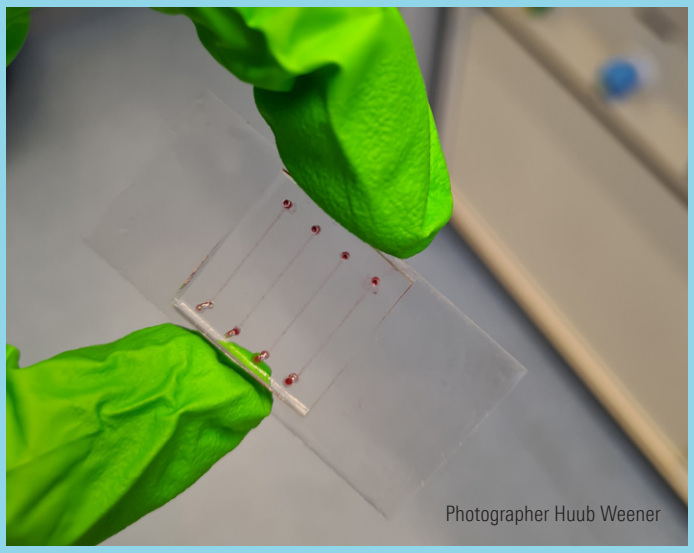
A LEADING INTERNATIONAL POSITION THROUGH THE IMPLEMENTATION OF ORGAN-ON-A-CHIP SYSTEMS

APPLICATION AREA

BIOMEDICAL PRODUCTION TECHNOLOGY

KEY ENABLING TECHNOLOGY

BIONANOTECHNOLOGY



Blood vessels-on-a-chip.

Prof. Dr. Andries van der Meer is Adjunct Full Professor Applied Stem Cell Technologies

"Within our Organ-on-a-chip project, I will collaborate with multiple partners to develop a demonstrator prototype of a 'multi-organ-on-a-chip' system, in which we use microfluidic tissue culture models to study organ-organ interaction in the lab. In addition, I will work with **Prof. Odijk** of the BIOS/Lab on a Chip group to contribute innovations in microfluidic valving technology. This will be instrumental in strongly improving the manufacturability of automated 'multi-organ-on-a-chip' systems. Moreover, I am involved in establishing the facilities and infrastructure that will be available to all partners to fabricate and test their components for the proposed demonstrator prototype."

Manufacturability of organ-on-a-chip systems

"We expect to make a major step in the manufacturability of organ-on-a-chip systems. I am particularly excited about demonstrating how a modular integration of components (e.g. pumps, sensors, cell culture devices) from multiple partners can be used to quickly design fit-for-purpose systems, e.g. drug development and studies of food products."

Leading international position

"The Netherlands, in general, and the University of Twente, in particular, are international pioneers in organ-on-a-chip. By using NXTGEN HIGHTECH to make a leap in the manufacturability of organ-on-a-chip systems, we get to capitalize on our leading international position by implementing organ-on-a-chip systems in relevant settings, e.g. preclinical drug development and toxicology of food and consumer products."

OPTIMIZATION OF BATTERY DESIGN AND MANUFACTURING

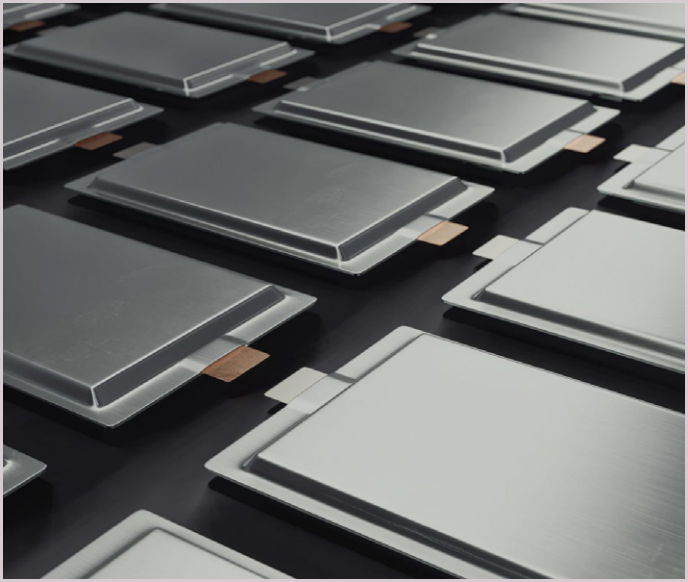
APPLICATION AREA

ENERGY

KEY ENABLING TECHNOLOGY

THIN FILM

PLASMA TECHNOLOGY



Pilot line production of battery pouch cells with next-generation cell design by novel manufacturing methods.

BATTERY PILOT LINE PRODUCTION

"In our project '3D battery pilot line production', we will work towards a roadmap for pilot production of 3D batteries with the flexibility to adapt the business model. I will focus on optimising battery materials and cell design through detailed post-mortem analysis of the solid-state battery to relate energy storage performance to current degradation processes."

NEXT-GEN EQUIPMENT FOR BATTERIES AND BATTERY MATERIALS

"In our second project, 'Next-gen equipment for batteries and battery materials', we will develop equipment and methods for producing next-generation batteries. We will set up a pilot line to produce next-generation batteries and a test facility to optimize battery performance."

Prof. Dr. Mark Huijben is Full Professor Nanomaterials for Energy Conversion and Storage

SYSTEMS ENGINEERS NEEDED TO DEAL WITH INCREASING COMPLEXITY OF TECHNOLOGY, ORGANISATIONS AND ENVIRONMENTS

APPLICATION AREA

SEMICONDUCTORS

KEY ENABLING TECHNOLOGY

SEMICONDUCTORS

The Twente solar racer is a result of systems engineering: by understanding the needs from all of the lifecycle phases, a performing car is designed, that can also be built.

COMPREHENSIVE SYSTEMS ENGINEERING EDUCATION

"Systems engineering is becoming more important in the Dutch and European industries. Only with the use of systems engineering, we can deal with the increasing complexity in technology, organisations and environments. The industry desperately needs people who can perform systems engineering, but the number of competent systems engineers is currently low. With our project 'Comprehensive Systems Engineering Education' we aim to establish a "Dutch Approach to Systems Engineering" and define a multilevel education programmes for bachelor (both at applied sciences and university), master, and post-master levels, including life-long learning initiatives. That way, the number of systems engineers can be ramped up faster."

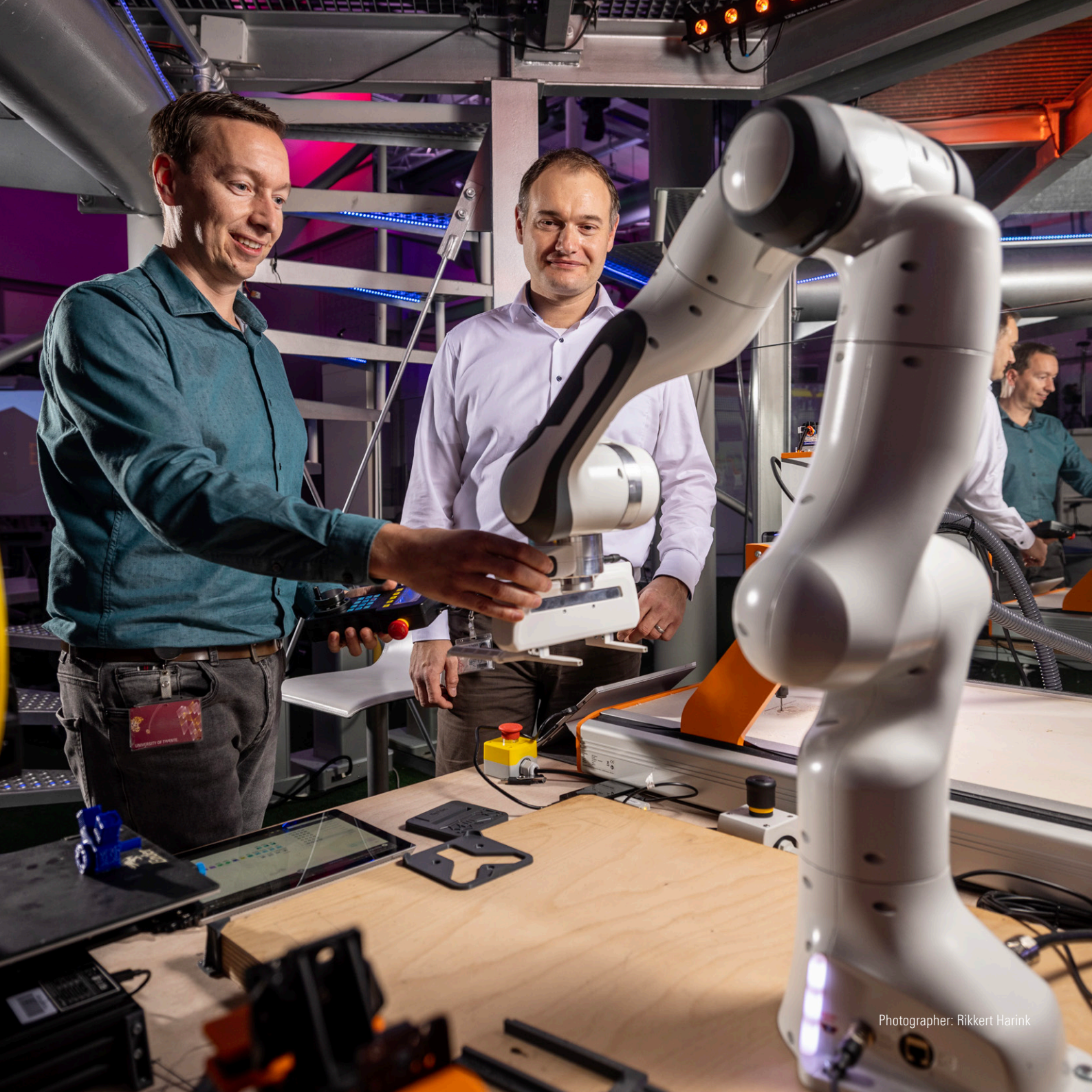
STRONGER AND MORE VISIBLE

"I am a contributor and steering committee member within this project. The University of Twente has more than 20 years of experience in systems engineering education. This is valuable input for both the approach and the curriculum. We can make our systems engineering education education even stronger and more visible. The same goes for spin-offs, such as summer courses on systems engineering at the University of Twente or in companies (beyond what we already do)."

SYSTEMS ENGINEERING URGENTLY NEEDED

"I strongly believe that systems engineering, and the systems approach in general, is urgently needed for developing and managing technology and ensuring an excellent societal and environmental embedding of technology. Stated otherwise: by ignoring the concept of systems for a long time, we have come to a state of the climate crisis and environmental problems."

Prof. Dr. Maarten Bonnema is Full Professor in Systems Engineering and Multidisciplinary Design

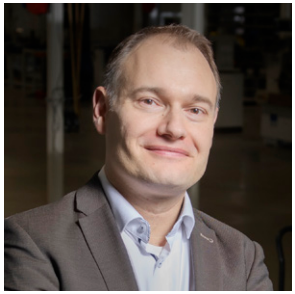


Photographer: Rikkert Harink

INNOVATIVE SOLUTIONS THAT IMPROVE THE COMPETITIVENESS OF DUTCH INDUSTRIAL PARTNERS

APPLICATION AREA
ENERGY

KEY ENABLING TECHNOLOGY
SMART INDUSTRY



Prof. Dr. Sebastian Thiede is Full Professor in Manufacturing Systems

FACTORY2023

"The Eastern industrial cluster Project "FACTORY2030" focuses on innovative smart industry solutions with special attention on the NXTGEN application domains: energy, biomed, semicon, agrifood and composites but even broader application potential beyond that. The considered, highly innovative applications require both mix (customer-specific solutions) and volume flexibility of the related manufacturing system while also ensuring the highest productivity, quality and traceability.
To address that, the Eastern industrial cluster, with its strong consortium under the lead of the University of Twente, incorporates manifold industry-driven use cases that focus on advanced manufacturing system setups and components as well as innovative digital methods and tools."

PILOT LINES IN FACTORY 2030

FACTORY2030 is also strongly connected to the planned pilot lines at the University of Twente, which focuses on Biomed and battery production. It will pick up the latest developments and take care of implementing and testing digital solutions in those pilot environments."

Prof. Thiede elaborates: "I'm the coordinator of FACTORY2030, which involves a consortium of 12 partners, all dealing with different use cases around smart industry solutions in innovative application fields. I'll coordinate and supervise several involved researchers from UT side and the interaction with the companies."

EXPECTED RESULTS OF FACTORY2023

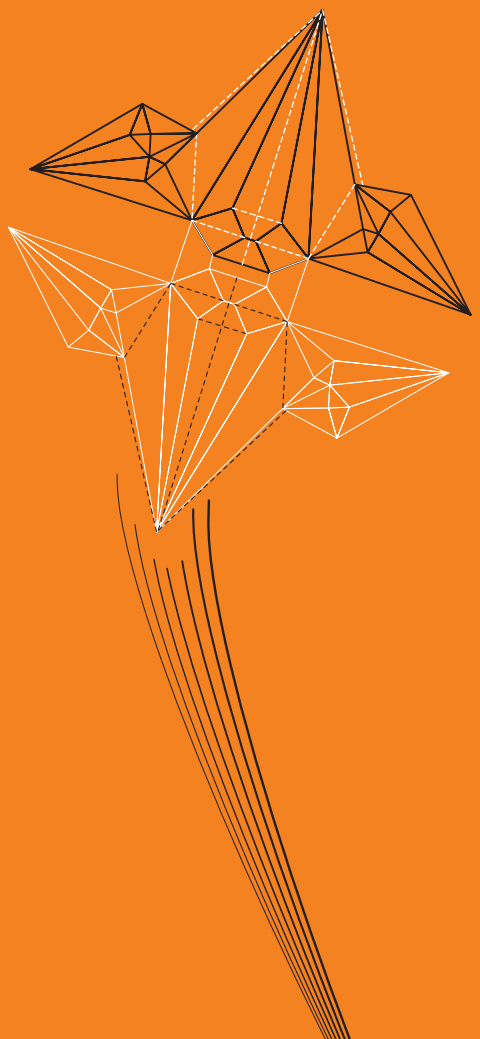
"We expect outcomes such as innovative modular manufacturing system architectures, advanced digital pipelines for product development, data-based methods for quality monitoring and control, innovative automation solutions, and the development of digital twins for products, processes or whole factories. This will result in significant advances within the specific use cases and transferable solutions to improve the design and planning of highly innovative current and future manufacturing systems.
We also foresee a strong social impact. For instance, FACTORY2023 will lead to innovative solutions that improve the competitiveness of Dutch industrial partners. Those solutions will lead to an improved cost situation, open up new business models, and increase production's sustainability and social impact.

> **"FACTORY2023 WILL LEAD TO INNOVATIVE SOLUTIONS THAT IMPROVE THE COMPETITIVENESS OF DUTCH INDUSTRIAL PARTNERS."**

UNIVERSITY OF TWENTE

P.O. Box 217
7500 AE Enschede
The Netherlands

utwente.nl/nxtgenhightech



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