2023

Innovative solutions

designed by EngD trainees

a selection of projects

4TU.SAI

TU Delft Delft University of Technology

TU/e Eindhoven University of Technology

University of Twente.

Wageningen University & Research

"What do mozzarella cheese making, rainwater harvesting and fish health monitoring have in common? They involve design projects for organisations by EngD trainees of 4TU.School for Technological Design, Stan Ackermans Institute, a collaboration of the 4 Dutch universities of technology.

These projects are quite often not open for public. However, we can give a short impression of the value of their projects. We have made a selection and combined them in this publication. We are very proud on all of our EngDs and happy with their supervisors."

Paul Koenraad,
Director Stan Ackermans Institute

Introduction

As part of an increasing intensive cooperation, the four Dutch universities of technology (Eindhoven University of Technology, University of Twente, Delft University of Technology and Wageningen University & Research) decided in 2006 to combine their technological designer programmes in the 4TU.School for Technological Design, Stan Ackermans Institute.

One of the goals is to educate and deliver excellent engineers and technological designers for the needs of society. With the EngD programmes, joined in the Stan Ackermans Institute, we have been succeeding in delivering technological designers for a long time. We are very proud of our cooperation and look forward to further increasing the importance of delivering excellent technological designers.

Engineering Doctorate

EngD trainees are selected from highly qualified MSc graduates and are doing a full-time, two-year traineeship to become technological designers, ready to face the tough challenges in industry or public organisations. After completing the programme they obtain the Engineering Doctorate (EngD) degree, an academic degree on a similar level as the PhD.

Putting theory into practice

Our trainees receive one year of training according to a well-designed curriculum, which involves courses, interactive workshops, and group and practical assignments. They often work in close collaboration with industrial, public and healthcare partners and carry out a one-year in-company design assignment. University experts act as their supervisors, providing access to state-of-the-art technology, advising on the structure and execution of the project, and watching over the project's goals. During the design project, our trainees demonstrate their skills in turning their knowledge into innovative business solutions for the high-tech industry or public or healthcare sector. In this brochure you will find recent projects that were successfully completed by EngD trainees within the 4TU cooperation.

After their degree

Our graduates immediately start working for outstanding companies but also for public organisations, hospitals or other health institutes. This proves our relevance for industry and society.

More information

For more information about our EngD programmes, please visit **www.4tu.nl/sai**

With best regards,

Prof.dr. Paul Koenraad
Director 4TU.School for Technological Design,
Stan Ackermans Institute

Programmes and tracks

Delft University of Technology

- Civil & Environmental Engineering (CEE)
  Track: Sanitary & Environmental Engineering (SEE)
  Track: Structural & Railway Engineering (SRE)
  Track: Subsurface Construction & Engineering (SCE)
- Designer in Bioprocess Engineering (BPE)
- Process & Equipment Design (PED)

Eindhoven University of Technology

- Automotive Systems Design (ASD)/ Mechatronic Systems Design (MSD)
- Clinical Informatics (CI)
- Data Science (DS)
- Design of Electrical Engineering Systems (DEES)
  Track: Healthcare Systems Design (HSD)
  Track: General Track (GT)
- Designing Human-System Interaction (HSI)
- Process and Product Design (PPD)
- Qualified Medical Engineer (QME)
- Smart Buildings and Cities (SBC)
- Software Technology (ST)

University of Twente

- Business & IT (BIT)
- Civil Engineering (CE)
- Energy and Process technology (EPT)
- Maintenance(M)
- Robotics (R)

Wageningen University & Research

- Design for AgriFood and Ecological Systems (DAES)

Delft University of Technology

Civil & Environmental Engineering (CEE)

Track: Sanitary & Environmental Engineering (SEE)
Sanitary & Environmental Engineering focuses on water management challenges related to, amongst others, water collection and conveyance, water treatment, and resource recovery from watery streams and sludges.

Track: Structural & Railway Engineering (SRE)
The section of Railway Engineering deals with the physical assets of the railway system, including track, embankment, rolling stock and catenary, as well as the interfaces and dynamic interactions between them. The research, innovation, development and education of the section concern the whole life cycle of the assets, from design, construction, degradation, monitoring, maintenance to retrofit, as well as the data-driven intelligent management of the assets, taking into consideration of the performance of the whole railway system.

Track: Subsurface Construction & Engineering (SCE)
Subsurface Engineering focuses on every aspect concerning the use of underground space. This includes infrastructure for traffic as well as utility systems, underground storage, multiple use of land and space, safety, legal aspects, trenchless technologies for the construction of utility systems and various building techniques (for example boring techniques, immersed tubes and trenchless techniques).

Designer in Bioprocess Engineering (BPE)

The two-year Designer in Bioprocess Engineering programme develops MSc graduates in (Bio-)chemical Engineering or related academic backgrounds into multidisciplinary specialists with a strong background in Biosciences and Engineering subjects required for innovative bioprocess design, in preparation for their career in the industry. In this way, students can boost their career by following deepening and broadening courses in the area of bioprocess design in close relation to industry. As a result, the EngD trainees become a valuable asset for biotech industry by translating academic knowledge into industrial application.

Process & Equipment Design (PED)

The PED programme trains MSc graduates to become qualified designers capable of designing 'fit for purpose' and 'first of a kind' sustainable (chemical) products, processes, equipment and systems. These innovations are of high demand in the chemical, energy, food, health and wider industries for the energy transition, circular chemistry, and novel food and health products. Industrial partners cooperate with this EngD programme by providing real-life challenges that will be addressed by the EngD trainees supported by TU Delft scientific and design experts. The EngD trainees are trained to apply appropriate design methodologies and tools, in an international setting, and with ample attention for developing their business, personal and teamworking skills.

Eindhoven University of Technology

Automotive Systems Design (ASD) / Mechatronic Systems Design (MSD)

ASD focuses on systems architecture and design for modern high-tech automotive systems in the context of Smart and Sustainable Mobility. The programme aims at a systems approach to problems around mobility and fuel efficient automotive systems, including communication systems and electrical driving, with emphasis on the multidisciplinary design aspects of project based research and engineering and the challenges that are faced by the automotive industry. The MSD programme aims at system synthesis and design of complex equipment, instruments, robotic and manufacturing systems and systems-of-systems, by combining in-depth understanding of the classical engineering fields, with multidisciplinary, model based systems engineering to conceive, predict and verify cutting-edge system functionalities and architecture. The programme is closely connected to the TU/e High Tech Systems Center. Officially, MSD is positioned as a sub-track of ASD. After successfully completing the programme, you will receive a diploma of ASD mentioning that you specialized in MSD.

Clinical Informatics (CI)

The Clinical Informatics programme is geared towards the design and implementation of information systems in healthcare. IT knowledge, but also knowledge of clinical and business processes are crucial to the design of optimal solutions, which really support the professionals in healthcare. The programme is provided by the School of Medical Physics and Engineering (SMPE/e) and carried out in close cooperation with hospitals and other care institutions all over the Netherlands. All trainees in the programme are required to be fluent in Dutch.

Data Science (DS)

The Data Science programme trains professional data scientists capable of understanding and solving intricate industrial and business challenges. EngD DS trainees integrate statistics, mathematics, and computer science with design theory to analyze extensive datasets, design data science methods, and implement data products in business environments. Emphasizing professional skills development, the DS programme equips graduate data scientists to thrive in multidisciplinary, dynamic environments. Furthermore, we instill awareness of ethical and legal considerations, promoting responsible and informed decision-making in the ever-evolving landscape of data science.

Design of Electrical Engineering Systems (DEES)

Track: Healthcare Systems Design (HSD)
Healthcare industry requires a new generation of professional designers who can design new prototypes of healthcare systems or well-being devices within multidisciplinary teams. The HSD trainees develop in-depth understanding of the technical and user requirements in the health domain so that they are able to bridge the gap between high-tech technology and the health area.

Track: General Track (GT)
The DEES-GT programme trains designers in specifying, designing, building, testing and evaluating complex multidisciplinary systems in Electrical Engineering. Examples include embedded software for fault detection and imaging, monolithic integrated (opto-)electronic circuits in the field of telecommunications, optical wafer metrology, car radar systems, pulsed-power systems for plasmas and electric vehicle charging, particle removal in industrial applications, and biological particle detection and or removal in medical applications.

Designing Human-System Interaction (HSI)

The mission of the new HSI programme is to train professionals to develop competences in designing and evaluating interactive intelligent and innovative systems, services, and products. The HSI programme pays special attention to the frontier of the complex systems enabled by artificial intelligence, data science and other emerging technologies in high-tech systems, health applications and smart mobility, and its impact on individuals, organizations, and society. The goal is to ensure positive user experiences that support their values and needs. >

Process and Product Design (PPD)

The success of the chemical, energy, food, and pharma-ceutical industries relies significantly on highly skilled chemical process engineers. These professionals need the ability to comprehend and lead intricately structured multidisciplinary projects within a highly dynamic environment, all while seamlessly integrating various technical disciplines. The PPD programme places a concentrated emphasis on both process design and product-driven process design. The programme is crafted to provide the market with knowledgeable and adept young process engineers. These emerging professionals demonstrate the capability to seamlessly assimilate into the fast-paced, project-driven landscape of the current industry. They are well-equipped to immediately contribute to and thrive in this high-tempo professional environment.

Qualified Medical Engineer (QME)

The Qualified Medical Engineer programme trains engineers to become effective designers in a clinical/ healthcare environment. Of course, engineering skills and clinical knowledge are relevant. But also adequate communication with both healthcare professionals and medical technology professionals is crucial to really get clear what the needs in healthcare are and to determine how design and implementation of existing and new technologies can improve patient care. The programme is provided by the School of Medical Physics and Engineering (SMPE/e) and carried out in close cooperation with healthcare institutions and medical companies all over the Netherlands. All trainees in the programme are required to be fluent in Dutch.

Smart Buildings and Cities (SBC)

The Smart Buildings & Cities programme is educating engineers with different backgrounds (architecture, mechanical engineering, electrical engineering, building physics and services and ICT) to become technological designers, who excel in their own discipline and who can work in multidisciplinary design teams. SBC trainees contribute to the development of intelligent and energy efficient building components and concepts, renewable energy generation and storage in the built environment, designing buildings and cities that mitigate the effects of climate change, are based on the principles of circular economy, promote healthy living and improve quality of life in the built environment.

Software Technology (ST)

The development of software for advanced systems has many different aspects. The ST programme focuses on the project based design and development of software for software-and data-intensive systems from the high-tech industry. The trainees get acquainted with the important concepts from diverse knowledge domains such as System Design, Data Science, Model Driven Engineering and Networked Embedded Systems, and learn how to use these to solve the actual industrial problems that our industry partners present to us.

University of Twente

Business & IT (BIT)

The Business and IT programme aims to raise the level of competence in IT of professionals to empower them to deal with the opportunities and challenges posed by IT-based innovations. Technology is changing fast, and professionals need to keep themselves up to date. At the same time, some of the problems of business-IT misalignment, legacy software and global cooperation remain relevant, so that modern IT professionals need to work in multidisciplinary teams to manage these problems. The mission of this programme is to deliver professionals who are able to understand and design robust and economically sustainable IT-enabled networks, such as social networks, online markets, business networks and public service networks, which balance economic opportunities and online IT risks to attain business goals.

Civil Engineering (CE)

Industry requires highly qualified designers in the field of civil engineering, with knowledge of the different technical (design, construction and maintenance) and non-technical aspects of actual civil engineering issues (such as project and process management, economics, policy, law and business administration, but also knowledge on project and process management). These designers need to have the skills to play a key role in multi-disciplinary design teams that are concerned with solving these complex technical, management and human capital challenges.

Energy and Process Technology (EPT)

The Energy and Process Technology programme shapes the innovative technological future for energy, process, and material industry by applying multidisciplinary and intersectoral approach. The EngD trainees skilled within the EPT programme deliver high-quality designs with in-depth understanding of the requirements given by the professional market and impact to the society. Functionality of the solutions, their quality, innovative and groundbreaking character combined with environmental friendliness, sustainability, and recyclability are the key features of designs implemented within the EPT.

Maintenance (M)

The programme Maintenance educates designers who create efficient and effective maintenance processes from a multi-disciplinary perspective. The design has to comply to technical, financial, logistics and organizational specifications. A sound understanding of the physical mechanisms is key, as the basis for failing systems and components is in nature physical. By addressing both technical and operations aspects during the programme, a necessary link is established between these two fields of expertise.

Robotics (R)

The technological designer in Robotics creates innovative robotic solutions for medical, industrial and safety purposes. The programme focuses on mechatronics and control design aspects of robots (for example rehabilitation, welding or inspection robotics) as well as system-level design of industrial robotics and automation environments. Therefore, a multi-disciplinary approach is required with components from mechanical, electrical, computer and control engineering. The EngD programme in Robotics allows the trainee to deepen and broaden their knowledge and to gain advanced application experience through a challenging assignment in industry.

Wageningen University & Research

Design for AgriFood and Ecological Systems (DAES)

DAES trainees will be able to create high-value, creative, and innovative designs to improve sustainability in an independent and multi/ interdisciplinary way under the supervision of the university and experts outside academia. At WUR, the EngD programme is tailor made, so DAES trainees select most of the courses themselves, fitting their individual background and specific design assignment. The final result will be a design that will, directly or indirectly, contribute to increasing the sustainability of agri- or horticulture, livestock farming, or the living environment in general. ■

Company: Sycada
Project: Energy consumption prediction for battery electric buses – Design, implementation and validation of a cloud-based software
EngD trainee: Berend van den Berg, Eindhoven University of Technology

Automotive Systems Design

An important step for reducing global warming is to realize zero-emission transportation. In public transport, the trend is to shift from fossil fuel to battery electric buses. The challenge is that electric buses have a smaller range than fossil fuel buses. In addition, the range of an electric bus is variable due to extra battery loads, for example the climate system, as well as battery degradation. To cope with this variability, fleet operators ensure that buses arrive at the charger with a relatively large remaining charge buffer, which is costly.

Project 'Destination Zero!', funded by the Netherlands Enterprise Agency, focused on realizing an energy consumption prediction system for electric buses. This allows us to forecast the remaining battery charge when the vehicle reaches the charger. This can be used for improving the operation as follows:

- More efficient use of the battery - the most expensive component - through improved usage and sizing. This allows driving more trips before recharging or driving the same trips with a smaller battery.
- Optimizing the charging planning, since we know exactly how much energy is needed for a full recharge.

We can accelerate the transition by reducing the risks and costs for a zero-emission operation. During this project, we evaluated a variety of modeling methods, including Machine Learning. Additionally, we realized a scalable cloud-based software that predicts the energy consumption for over 40 buses. In my current job at Sycada, I continue developing the solution into a mature product.

Company: Ziekenhuisgroep Twente (ZGT hospital)
Project: Optimizing digital breast cancer information design based on individual patient preferences
EngD trainee: Lianne Tolboom, University of Twente

Business & IT

When a patient is diagnosed, a challenging and emotional journey is started. Being informed is key for navigating this period. Cancer patients experience difficulties with getting adequate information about their illness, in a manner that fits their personal preferences and needs. The lack of personalised patient education for breast cancer patients results in, amongst others, serious mood problems, a distorted risk perception, decisional regret and a lower quality of life.

To empower breast cancer patients to participate in shared decision making, information should be made more understandable. Efforts have previously been made to personalise information content. However, personalisation of information presentation (including amount, timing, complexity, perspective, style and navigation) is relatively unexplored.

We are designing personalised presentations of digital information for and with breast cancer patients. The project uses a human-centred design approach that includes not only patients by focus groups, questionnaires, co-design sessions and evaluation, but also digital information providers. The final results will be evaluated prototypes including design guidelines that can be applied to different information topics as presented on the platforms of our partners.

Company: Tetra Pak
Project: Alternative curd making process design for mozzarella cheese
EngD trainee: Han Wu, Delft University of Technology

Chemical Product Design

Cheese making has been done batch-wise in cheese vats for centuries, from the manual cheese making process in the old days until fully automated cheese production lines that dairies currently have, the process principals are still largely the same. The objective of this project was to design an alternative way of producing mozzarella cheese curd without cheese vats but in a continuous process, while still meeting cheese quality demands.

The design of the process follows that approach of Delft Design Method, including needs analysis, literature research, concept generation and selection, and economic analysis. The newly designed alternative curd making process provides possibility to source native whey, increased yield, increased process control while remaining the same final product quality, and is possible to be applied to other cheese applications.

Five scenarios were compared based on the economic performance including profitability analysis and sensitivity analysis, taking into consideration of different production capacities of the customers, and it provided suggestions and guidance for the future development of the project.

Company: University Medical Center Groningen (UMCG)
Project: The design of a Learning Health System to facilitate continuous learning from data and clinical practice using AI
EngD trainee: Geertje de Boer, Eindhoven University of Technology

Clinical Informatics (NL)

The use of technology is common practice within the Dutch healthcare system. For example, every health organization uses an Electronic Health Record (EHR) or specialized Health Record System. These systems were previously used as an administrative tool, but is now also being expanded with more advanced functionalities. One of these functionalities is the addition of Clinical Decision Support Systems. These systems aim to provide relevant information in the right place at the right time and to the right healthcare professional.

To ensure that the use of decision support becomes part of the EHR, the University Medical Center Groningen (UMCG) has chosen not to focus solely on the development or implementation of AI or decision support, but to tackle the entire system as a whole. This is also referred to as the Learning Health System (LHS). The result is a number of building blocks needed to successfully implement decision support to facilitate a Learning Health System. The use-cases are currently being implemented at the hospital with the use of the LHS model and architecture.

A Learning Health System approach was adopted at the UMCG to fully support our healthcare professionals to show them the right information in the right place at the right time. The information provided is also a result of (predictive) analytics to help support the decision making process.

Company: Rijkswaterstaat
Project: Semantic modelling for asphalt failure modes
EngD trainee: Inga Maria Giorgadze, University of Twente

Construction Management and Engineering

Efficient transportation is crucial for a country's social and economic development, and in the Netherlands, the extensive road network plays a vital role in connecting industries and facilitating the transport of goods. However, the current global approach to monitoring road conditions lacks consistency and fails to address the causes of road failures. To move towards a proactive and predictive strategy, it's essential to study road failures in relation to their origins. This involves collecting, storing, and analyzing road condition data throughout the asset's life cycle, integrating information from design, construction, and usage phases.

The concept of lifecycle Digital Twins, successfully applied in various sectors, involves interlinking data from different phases to create a virtual model reflecting the asset's current condition. Unfortunately, the coherence required for road condition data is currently lacking, especially in the representation of asphalt distresses. Presently, distresses are only geometrically stored, hindering detailed analysis of failure causes.

The design problem identified is the inconsistent and isolated storage of pavement condition data during the Operation & Maintenance phase, hindering the development of a comprehensive lifecycle Digital Twin for pavements. To address this limitation, the research proposes a methodology for the semantic representation of asphalt distresses during the O&M phase, aiming to fill the existing gap and improve the predictive management of road assets. The project seeks to introduce coherence by defining and representing Failure Modes not just graphically but semantically, allowing for more effective monitoring and understanding of failures and their root causes.

Company: CGIAR
Project: Modelling permaculture: Landscape level co-design of agroecological farming systems in Kenya
EngD trainee: Eveline Massop, Wageningen University & Research

Design for Agrifood & Ecological Systems (new)

Smallholder farmers in Sub Saharan Africa are struggling to ensure a healthy and thriving food system. Not only is there a need for sufficient and healthy food for a growing population now, it is also important to take care of the natural environment to ensure food production can take place in the future.

In Kenya, in collaboration with CGIAR (a global agricultural research institute), this is envisioned with a permaculture approach: to work with nature rather than against it. There is a focus on the reduction of food waste, conservation of natural resources, mitigation and adaption to climate change, and the inclusion of traditional farming knowledge. The aim of this EngD project is to design a landscape that harmoniously benefits both the socio-economic well-being of smallholder farmers and the natural environment, by co-designing with local farmers.

These possible landscape designs will be generated with the Landscape IMAGES model, which uses coordinates in GIS. Multiple objectives that cover both socio-economic and environmental indicators will be optimized based on Pareto optimality (an indicator cannot be improved without deteriorating the performance of one or more other indicators). The generated designs are landscape maps that give insight in how the landscape could be used and managed sustainably, and will be used to facilitate discussions with relevant stake-holders to further explore what works in practice.

Eveline works with the Landscape IMAGES model, which helps CGIAR and local farmers to get more insight in how to use and manage the landscape more sustainably. As such, there are benefits for both the socio-economic development of smallholder farmers and improvements in the natural environment.

Company: Wageningen Research Institute
Project: Design of an implantable biosensor for real-time in vivo measurements in aquatic organisms (Next level fish health monitoring)
EngD trainee: Bram Kok, Wageningen University & Research

Design for Agrifood & Ecological Systems (new)

To address challenges in fish health monitoring, Bram Kok, EngD trainee at Wageningen University and Research, is exploring the potential of advancements in sensor technology. Operating within the innovation programme Next Level Animal Sciences of th Animal Sciences Group, and collaborating with the University of Twente, this EngD explores an innovative approach using integrated optics to measure the Interleukin-6 (IL-6) concentration in fish blood.

IL-6 is a cytokine associated with the immune response in fish. Monitoring IL-6 levels would be instrumental for assessing the health of the fish, as elevated IL-6 levels indicate an inflammatory response. By utilizing microring resonators or a Mach-Zehnder interferometer, the interference with light can be determined reflecting the concentration of IL-6 in the sample. This method not only allows for accurate IL-6 measurement but presents a way to measure a whole range of different substances in the blood.

Ultimately, this project is a first big step towards the design of an implantable biosensor for real-time in vivo measurements of IL-6 and other substances in the blood circulation.

Company: Amsterdam Institute for Advanced Metropolitan Solutions (AMS)
Project: RainOasis: Enhancing climate resilience by planning rainwater harvesting for sustaining urban green
EngD trainee: Jorn de Vos, Wageningen University & Research

Design for Agrifood & Ecological Systems (new)

In response to climate change and urbanization challenges, Amsterdam confronts the equilibrium between water resources and the preservation of green spaces, especially during drought periods. Amsterdam, situated in a delta region, contends with saltwater intrusion, impacting the distribution of potable water. In addition, urbanization and increased consumption amplify water scarcity in periods of drought, demanding strategic interventions. The RainOasis project addresses these challenges by creating an interactive planning support tool for policymakers, emphasizing on rainwater as alternative water source for sustaining urban green.

As part of the RainOasis project, this EngD project anticipates future climate scenarios, guiding strategic water storage and usage. Rainwater emerges as a sustainable solution, strategically stored during wet periods to support urban green spaces in times of drought. Jorn investigates an array of rainwater harvesting measures, ranging from water storage tanks to innovative nature-based solutions like rain gardens and swales. He integrates these measures into a unified planning tool, employing Python and GIS.

The tool undergoes validation in collaboration with the municipality of Amsterdam, AMS, and Wageningen University & Research.

The project focuses on two selected case study areas in Amsterdam to ensure its practicality and efficacy. By integrating rainwater harvesting technologies, nature-based solutions, and predictive infrastructure planning, the project strives to redefine how cities mitigate water scarcity, ensuring a sustainable future for urban areas and their greenery.

Jorn de Vos, in collaboration with Wageningen University & Research, AMS (Advanced Metropolitan Solutions), and the Municipality of Amsterdam, is part of the RainOasis project.

Company: Janssen Biologics BV
Project: Capacity analysis via mathematical process modelling of the Janssen Biologics Leiden site
EngD trainee: Raquel Dias, Delft University of Technology

Designer in Bioprocess Engineering

Janssen Biologics continuously invests in research into new medicines and new applications for existing medicines. The company also continuously improves and makes the production processes more flexible, so that it is always possible to meet the current needs of patients and healthcare providers.

The combination of multi-products in the commercial plant is a reality in Leiden and it is becoming a complex reality, since restrictions related with materials, work areas, labor, among others, are a challenge. Therefore, a digital twin of Business Unit 1 (BU1) of Leiden site was built, in order to answer capacity related questions.

Capacity models have been supporting the Capacity Taskforce Team in decision making and scenario evaluation. Using SuperPro Designer® and SchedulePro®, software tools for simulation, computer-aided process design, capacity analysis, production scheduling, and debottlenecking, the goal of this Individual EngD Project was to develop a capacity model to simulate the main production processes in BU1 – Preculture, Fermentation, Primary Recovery and Downstream Processing – and test the feasibility of what-if capacity scenarios.

Company: Twence, Ennatuurlijk, De Kleijn, FPSim
Project: Thermochemical energy storage design in improving peak shaving for district heating system
EngD trainee: Chung-Yu Yeh, University of Twente

Energy & Process Technology

The Heatlands project aims to enhance 3rd and 4th generation district heating systems (DHs) by implementing a dual thermal storage system, emphasizing thermochemical energy storage (TCES) and utilizing industrial residual heat. This approach reduces reliance on fossil fuels and enhances DH sustainability.

Beginning with stakeholder desire involving heat suppliers (Twence) and grid operators (Ennatuurlijk) in Enschede, the project aligns with regional objectives for a sustainable energy system, focusing on peak load reduction, energy system transition, and robust heat supply. The suggested dual thermal storage system combines hot water storage with TCES to minimize heat loss and offer ample storage capacity over longer periods. This setup, compatible with Twence's cogeneration power plant (CHP), aims to lower peak loads and increase energy efficiency in 3rd and 4th generation DHs. Additionally, integrating residual heat from industrial processes, notably from supermarket cooling systems, is crucial, especially for 4th generation DHs due to temperature alignment.

Simulation results confirm the feasibility of TCES implementation in 4th generation DHs, aided by access to low-temperature environmental heat sources for evaporators and a weekly-based CHP generation schedule. Coupled with TCES's ability to store

supermarket residual heat, high utilization of residual heat and long-term energy allocation for peak load becomes viable. The finalized design incorporates two base load heat sources (CHP and residual heat) and a dual thermal storage system (hot water storage and TCES) within 4th generation DHs.
A prototype TCES reactor is devised, featuring a fixed bed with an embedded heat exchanger tube enhanced with honeycomb metal fins.

Company: NXP Semiconductors
Project: Launcher in package and antenna array for self-driving car radar
EngD trainee: Rocío Molina Morero, Eindhoven University of Technology

Information Communication Technology

For some time, machines are taking over functions previously fully performed by men or women. Automation is also present on our current roads: cars are including more and more levels of assistance, facilitating driving while reducing the number of accidents. Safety, efficiency and comfort are the main drivers behind this effort. Yet, the path to full automation is long and challenging. Major difficulties come from ethics and the required legislation. Nevertheless, regarding technological development there is still work to be done. Smarter recognition and decision algorithms can only perform as good as the quality of the information provided to them.

In this project, we worked on developing a radar module, which will serve as eyes for the car, providing valuable information for these algorithms. In a collaboration between Eindhoven University of Technology and NXP, we developed an in-package waveguide transition and antenna array suitable for a 7-channel car radar integrated circuit transceiver.

Requirements for the design are pushed by electrical performance in terms of low losses, high isolation between channels, and high angular resolution. Additionally, the reduced available space, mass production manufacturability and total price were factors considered for the final design. The final concept consists of a launcher-in-package that excites rectangular waveguides feeding longitudinally polarized slotted antennas.

Company: SST, ETE, VDL
Project: Elastomer development project for load lock gate valve of lithography machine
EngD trainee: Sandesh Prasad Itani, University of Twente

Maintenance

Microchips are vital parts of our electronic devices, and they are made using a process called lithography. In this method, silicon wafers are loaded into a vacuum chamber, and extreme ultraviolet light (EUV) lithography is used to create microchips. Within the lithography system, there's a crucial part called the load lock gate valve. This component is essential as wafers are loaded into vacuum chamber and produced microchips are transported through this gate valve.

To prevent outside particles from entering the vacuum chamber, the gate valve has a seal made of fluoroelastomer (FKM). However, a problem arises as wear particles are generated when the gate valve opens and closes during the loading of wafers. These wear particles, when they reach the wafer, create defects in the microchips by blocking EUV light, impacting the chip's pattern. This issue has led to significant losses in the chip manufacturing industry.

The current EngD project aims to understand the wear mechanism of these fluoroelastomeric seals in load lock gate valves. The goal is to develop new FKM seals that are resistant to wear, preventing the generation of harmful particles on the vacuum side of lithography machines and reducing defects in microchip production.

Company: TNO
Project: ELEON – Integrated CO2 capture and electrochemical conversion process design
EngD trainee: Themistoklis Neokosmidis, Delft University of Technology

Process & Equipment Design

Towards decarbonisation of the process industry, CO_2 capture from flue gases and its electrolysis using renewable energy have gained attention as a carbon-efficient means to produce valuable chemicals. In the conventional CO_2 capture – electrolysis process, CO_2 is removed via absorption and then desorbed in a thermally intensive solvent regeneration process.

The desorbed CO_2 is converted in an electrolyser, where excess electrical energy needs to be provided, which eventually dissipates as waste heat, reducing the energy efficiency of the process. To overcome this bottleneck, ELEON, a process conceptualised by TNO, utilises the waste heat of electrolysis for solvent regeneration by integrating these two processes into a novel CO_2 electrolyser.

For this project, different heat-integrated electrolyser configurations patented by TNO were designed and modelled for the first time. Furthermore, the ELEON process was conceptually designed and assessed for its economic and sustainability potential in producing commercial-grade carbon monoxide and formic acid. This novel design demonstrates that integration improves the energy efficiency by 20-30% leading to substantial energy cost savings and a reduction of at least 30% in carbon intensity, improvements that pave the way for efficient CO_2 utilisation on an industrial scale.

Company: Catharina Ziekenhuis Eindhoven
Project: Design of an automated process for creating breast cancer treatment plans, with Artificial Intelligence
EngD trainee: Nienke Bakx, Eindhoven University of Technology

Qualified Medical Engineer (NL)

Radiotherapy treatment planning is a time-consuming and iterative process. Currently, target volumes and surrounding organs are delineated manually on CT scans. Afterwards, a treatment plan is created which contains the dose distribution to be irradiated, which is a trade-off between enough dose to the target volumes and sparing of healthy surrounding organs. Artificial Intelligence can be used to automate both processes.

In this project, two AI models were developed and clinically validated for breast cancer patients. A model to automatically delineate target volumes (breast and lymph nodes) and surrounding organs (heart, lungs, esophagus, humerus and thyroid) has shown to reduce time by an average of 40% (8 minutes) to almost 60% (25 minutes) for respectively organs and target volumes, including manual adjustments by the medical professional when needed. A second model to predict the dose distribution resulted clinically acceptable treatment plans in 95% of the cases, showing time efficiency when compared to manual treatment planning.

During the runtime of the project, the auto-planning model (automatic dose prediction) was successfully implemented in clinical practice. The auto-segmentation model (automatic delineation) was clinically implemented shortly after. Currently, both models are already successful used in the treatment of over 50 patients.

Company: Thermoplastic Composites Research Center
Project: Hot gas welding of thermoplastic composite T-joints
EngD trainee: Mauryn de Graaf, University of Twente

Robotics

Usage of composite materials has grown widely over the past few decades, mainly due to the possibilities these materials offer for high performance in lightweight constructions. In most cases, a composite material consists of a polymeric matrix material, reinforced with fibers. Due to the possibility of reheating and reshaping of thermoplastic composite materials, sophisticated joining methods like welding can be achieved.

The Production Technology department at the University of Twente and the Thermoplastic Composites Research Center proposes a new method to assemble a horizontal laminate to a vertical skin using additive welding following a hot gas welding technique, where the laminates are pre-heated, a filler is extruded in molten state and the assembly is consolidated to form a fusion bond. Nevertheless, this process is not automated yet.

A systems engineering approach is used to design and assemble a lab-scale research set-up, able to weld a skin to a stiffener (T-joint) in a controlled and automated manner, having control over the weld parameters. The final set-up integrates automated double sided welding and will be used to establish the relationship between the input process parameters and the mechanical performance of the joint. In addition, multiple joint designs and geometries can be validated using this research set-up.

This project is a step towards incorporating a similar weld head on a serial robot for large scale welding of stiffeners in thermoplastic composite assemblies and adds to the toolbox of the thermoplastic composite design engineer.

Company: Kropman Installatietechniek BV
Project: Fault detection and diagnosis of the low ΔT syndrome in cooling coils of chilled water systems
EngD trainee: Ananad Thamban, Eindhoven University of Technology

Smart Buildings and Cities

With the rising global temperatures around the world due to climate change, there is an increasing demand for cooling in indoor spaces to ensure that occupants can live and work in a comfortable environment. To ensure this, the chilled water systems in buildings are operated more frequently than usual in order to comply with the comfort requirements. With the prolonged and more frequent use of the equipment, the chance of faults occurring in the system increase.

One such phenomenon which affects the performance of the chilled water system in buildings/distribution plants is the low ΔT syndrome. The low ΔT syndrome can have drastic consequences for the cooling system leading to an increased energy consumption and/or inability to meet the cooling requirements leading to discomfort. To avoid both issues, a fault detection and diagnosis tool has been developed to detect the low ΔT syndrome using machine learning models and Bayesian networks.

The tool is intended for use by multiple types of end users including HVAC experts, facility and building managers and machine learning experts, hosting special features for each kind of user. It provides a simple alarm system to detect the low ΔT syndrome providing multiple to-do actions and interactable graphs to assist the user in the final decision-making process.

Company: Philips Research
Project: Automated transformation of Picture Archiving and Communication System reporting templates to HL7® FHIR® models
EngD trainee: Shubham Rawal, Eindhoven University of Technology

Software Technology

The wealth of medical data collected in electronic information systems has the potential to further medical treatment workflows and health outcomes for patients. These data can directly benefit applications such as clinical dashboards and Artificial Intelligence algorithms. However, the interoperability and reuse of the data is hindered because these data are often recorded as natural language text or locked behind proprietary standards.

In radiology, a Picture Archiving and Communication System (PACS) is utilized for storing and reporting on radiological imaging data. The project aimed at the development of a system for transforming existing reporting templates (a reporting guide utilized by radiologists) from a proprietary system to Fast Healthcare Interoperability Resources (FHIR®): an open and progressive standard for healthcare data exchange. This can liberate existing data for utilization in state-of-the-art health applications.

The design of the system focused on extensibility as a pathway to support the varied radiology reporting standards adopted by different hospitals. A secondary focus was the inclusion of missing clinical semantical information from recognized medical standards bodies to standardize the transformed data. The results were validated by utilizing real-world reporting templates.

The tool is intended for use by multiple types of end users including HVAC experts, facility and building managers and machine learning experts, hosting special features for each kind of user. It provides a simple alarm system to detect the low T syndrome providing multiple to-do actions and interactable graphs to assist the user in the final decision-making process.

The programmes in brief

	Diplomas 2023	Influx 2023
TU Eindhoven		
Automotive Systems Design (ASD) / Mechatronic Systems Design (MSD)	15	16
Clinical Informatics (CI)	9	12
Data Science (DS)	16	17
Design of Electrical Engineering Systems (DEES)	4	5
Human-System Interaction (HSI)	0	7
Process and Product Design (PPD)	25	21
Qualified Medical Engineer (QME)	4	11
Smart Buildings & Cities (SBC)	15	10
Software Technology (ST)	20	19
Total	**108**	**118**
TU Delft		
Bioprocess Engineering (BPE)	7	7
Process and Equipment Design (PED)	10	11
Chemical Product Design (CPD)	6	0
Civil & Environmental Engineering (CEE)	6	6
Total	**29**	**24**
Twente		
Energy and Process Technology (EPT)	5	4
Maintenance (M)	1	2
Robotics (R)	4	1
Civil Engineering (CE)	6	2
Business & IT (BIT)	6	2
Total	**22**	**11**
Wageningen		
Design for Agrifood & Ecological Systems (DAES)	0	13
Total	**0**	**13**
Total 4TU	**159**	**166**

Our partners

To illustrate the companies EngD trainees work for after their degree, the top 10 employers for alumni of TU/e in the last 10 years are:

1. **ASML**
2. **Philips**
3. **TU/e***
4. **Thermo Fisher Scientific**
4. **DAF trucks**
5. **TNO**
6. **Corbion**
7. **SABIC**
8. **Punch Powertrain**
9. **Stamicarbon**
10. **Valeo**

*(mostly EngD)

Ready for the next step after your Master?

Visit us on
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4TU.SAI is a joint initiative of the four Dutch universities of technology. Together we offer 2-year full-time technological designer's programmes, all leading to an Engineering Doctorate (EngD).

Our EngD programmes offer trainees the opportunity to broaden their knowledge and experience by means of a personal and practical design assignment in and for industry, under the supervision of experienced scientific design professionals. It is a paid position with no tuition fees.

Faster track

The EngD programmes are a stepping stone to a faster successful career with (multi)national companies and healthcare institutions. In the past 25 years over 4,500 of our graduates have found challenging and exciting jobs with outstanding, (multi)national companies, including Philips, ASML and Thermo Fisher Scientific.

Earning and learning

You will be appointed for 2 years, the duration of the programme. You will also become a member of the staff of one of the universities and receive a salary.
Currently there are 19 different programmes to choose from, divided over the four Dutch universities of technology. To mention a few programmes: Chemical Product Design, Automotive Systems Design, Robotics and Design for Agrifood & Ecological Systems.

EngD in brief

- A 2-year post-master program
- Mix of theory and practice
- Broadening technical expertise and professional skills
- Kick-start for a career in the industry or healthcare
- Paid position, no tuition fees

How to apply for an EngD position?

We offer vacancies for EngD positions almost all the time! Check out the websites of the 4TU (Universities of Technology) for all vacancies:

- Delft University of Technology
  www.tudelft.nl
- Eindhoven University of Technology
  www.tue.nl
- University of Twente
  www.utwente.nl
- Wageningen University and Research
  www.wur.nl

The 4TU.School for Technological Design, Stan Ackermans Institute offers two-year post-master technological designer programmes.

The institute is a joint initiative of the four universities of technology in the Netherlands:

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www.tudelft.nl

Eindhoven University of Technology
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