2024

TU Delft Delft University of Technology

TU/e Eindhoven University of Technology

University of Twente.

Wageningen University & Research

Innovative solutions

designed by EngD trainees

a selection of projects

4TU.SAI

4TU. School for Technological Design STAN ACKERMANS INSTITUTE

Preface

"What do cloud-based ultrasound systems, 3D plant photography, and maintenance feedback loops have in common? They are design projects for organisations by EngD trainees of the 4TU.School for Technological Design, Stan Ackermans Institute, a collaboration of the four Dutch universities of technology.

These projects are often not publicly available. However, we can provide a brief overview of the value they bring. We have selected a few and gathered them in this publication. We are very proud of all our EngDs and grateful for their supervisors."

Paul Koenraad,
Director Stan Ackermans Institute

Table of contents

Introduction

As part of an increasingly intensive collaboration, 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 design programs into the 4TU.School for Technological Design, Stan Ackermans Institute. Started on 1 September 2024, the University of Groningen has added two more Engineering Doctorate (EngD) programs, bringing the total number of programs within the Stan Ackermans Institute to nineteen.

One of the main goals is to educate and train outstanding engineers and technological designers who can meet the needs of society. Through the EngD programs, joined in the Stan Ackermans Institute, we have been successfully delivering technological designers for many years. We are very proud of this collaboration and look forward to further increasing to deliver excellent technological designers.

Engineering Doctorate

EngD trainees are selected from highly qualified MSc graduates and complete a full-time, two-year traineeship to become technological designers, ready to tackle the complex challenges in industry or public organizations. Upon completing the program, they are awarded the Engineering Doctorate (EngD) degree, an academic degree at a level equivalent to a PhD.

Putting theory into practice

Our trainees receive one year of training according to a well-designed curriculum that involves courses, interactive workshops, and group and practical assignments. They frequently collaborate with industrial, public, and healthcare partners, and undertake a one-year in-company design project. University experts act as supervisors, offering access to state-of-the-art technology, providing guidance on project structure and execution, and ensuring the project's goals are met. Throughout the design project, trainees demonstrate their ability to turn theoretical knowledge into innovative solutions for the high-tech industry or the public and healthcare sectors. This brochure features recent projects successfully completed by EngD trainees within the 4TU collaboration.

After their degree

Our graduates quickly begin working for leading companies, as well as public organizations, hospitals, and other healthcare institutions. This demonstrates the relevance of our programs to both industry and society.

More information

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

With best regards,

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

Programs and tracks

TU Delft

Designer in Bioprocess Engineering (BPE)

The two-year Designer in Bioprocess Engineering program 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.

Civil and 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).

Process & Equipment Design (PED)

The PED program 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 co-operate with this EngD program 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 program 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** program 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 multi-disciplinary, model-based systems engineering to conceive, predict and verify cutting-edge system functionalities and architecture.
The program 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 program, the awarded EngD ASD-diploma will mention a specialization in MSD.

Clinical Informatics (CI)

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

Data Science (DS)

The EngD program Data Science prepares engineers to tackle complex industrial and business challenges by combining expertise in statistics, mathematics, and computer science with practical design thinking. Trainees learn to develop advanced data science tools and solutions, with a focus on real-world application. The program also emphasizes working in multidisciplinary teams, fostering professional growth, and ensuring ethical and legal awareness. Graduates are equipped to deliver impactful data-driven solutions in dynamic, ever-evolving environments. The EngD program Data Science is located at Jeronimus Academy of Data Science in 's-Hertogenbosch.

Design of Electrical Engineering Systems (DEES)

The DEES program trains designers in specifying, designing, building, testing and evaluating complex multidisciplinary systems in the discipline of electrical engineering. More recently, we have also taken the trainees from applied physics on board, and we have welcomed the occasional trainee from mechanical engineering. Our trainees develop an in-depth understanding of the technical, stakeholder and user requirements so as to bridge the gap between state-of the art techno-logy and commercial (or societal) applications.

A DEES trainee carries out a 15-month industrial design/development project that runs concurrently with a tailor-made 9-month curricular training program. DEES trainees work on projects in such diverse fields as healthcare systems, well-being devices, wireless and electro-optical communication, embedded software, integrated (opto-)electronic circuits, flexible electronics, optical and electromagnetic sensing, molecular biosensing, AI-assisted image analysis, pulsed-power plasma generation and plasma cleaning, EV charging, electric motor design, nano-scale wear particle generation, automotive radar systems, antenna array design, material characterization, electromagnetic compatibility, and control systems.

Designing Human-System Interaction (HSI)

The mission of the new HSI program is to train engineers to develop competences in designing and evaluating interactive intelligent and innovative systems, services, and products. The HSI program 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.

Qualified Medical Engineer (QME)

The Qualified Medical Engineer program 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 program is provided by the School of Medical Physics and Engineering Eindhoven (SMPE/e) and carried out in close cooperation with healthcare institutions and medical companies all over the Netherlands. All trainees in the program are required to be fluent in Dutch.

Smart Buildings & Cities (SBC)

The Smart Buildings & Cities program 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 program 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, AI, 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 program 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 program 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)

The civil engineering industry requires highly skilled designers with expertise in technical areas like design, construction, and maintenance, as well as non-technical fields such as project management, economics, policy, and business. As the profession evolves with new technologies, sustainability demands, and more complex projects, future civil engineers will need a broad range of skills to succeed. They must be prepared to tackle modern challenges and work effectively in multidisciplinary teams, playing key roles in solving complex problems that involve both technical and management aspects.

Energy and Process Technology (EPT)

The Energy and Process Technology program shapes the innovative technological future for energy, process, and material industry by applying multidisciplinary and intersectoral approach. The EngD trainees skilled within the EPT program 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 (MT)

The program 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 program, a necessary link is established between these two fields of expertise.

Robotics (ROB)

The technological designer in Robotics creates innovative robotic solutions for medical, industrial and safety purposes. The program 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 program 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 program 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.

University of Groningen

Autonomous Systems (AS)

The EngD program Autonomous Systems focuses on the integration of technologies and classic techniques of model-based engineering to create autonomous systems. This includes areas of mechanical engineering, robotics, computing science, AI, among others. It aims to strengthen the design methods and tools for development of high-tech software-intensive systems (such as mechatronics, smart manufacturing systems, Internet of Things (IoT) and robotics systems).

Sustainable Process Design (SPD)

Sustainable Process Design describes concepts or strategies for the replacement of non-efficient and non-renewable production processes. The goal of this EngD program is to develop sustainable solutions for the industry, such as new process techniques and/ or materials that significantly minimise the ecological footprint (transition to sustainable production.

Company: Siemens Industry Software B.V.
Project: DITM: Control-oriented sensor fusion for bus platooning
EngD trainee: Prabhat Kumar Sharma, Eindhoven University of Technology

Automotive Systems Design

The growing population is putting a lot of pressure on the existing mobility infrastructure. Disruption in public transport is common nowadays. Cooperative, Connected, and Automated Mobility (CCAM) systems are becoming the need of the hour to improve traffic efficiency. In addition, these CCAM solutions are supposed to improve road safety and reduce fuel consumption. To that end, a use case of city bus platooning is included in the 'Digital infrastructure for future-proof mobility' (DITM) project, where both the longitudinal and lateral motion are fully automated, employing on-board sensors and vehicle-to-vehicle communication.

Our work aimed to develop lateral and longitudinal control for the follower buses in a platoon such that they can follow the lead vehicle, which is manually driven, closely in a safe and comfortable manner. To implement these control algorithms, the motion states of the preceding vehicle are required. However, no single sensor can measure all the required motion states directly with sufficient accuracy. Thus, a track-to-track fusion (T2Tf) algorithm called inverse matrix fusion was designed to estimate the required states by combining the object-level track data from different sensors.

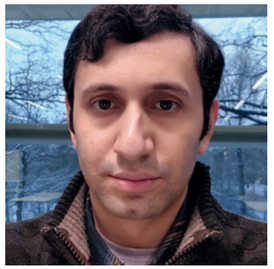
The complete pipeline of T2Tf-based perception, path planning, and control of the follower buses was implemented in the Siemens Prescan simulation environment. Prescan was also used for verifying the performance of these algorithms in various scenarios. The simulation results show that the presented algorithms are capable of not only achieving the control objective of following the leader closely but also doing it in a comfortable manner for the passengers.

Company: TNO
Project: 3D digital twin of steel bridges
EngD trainee: Ali Sabzi Khoshraftar, University of Twente

Business & IT

Most steel bridges in the Netherlands, built predominantly after the 1960s, are experiencing aging-related issues which is a primary cause of bridge damage, necessitating increased and more effective maintenance to ensure safety and reduce costs. Traditional bridge inspections rely on manual methods and can be slow, expensive, and prone to errors.

The SUBLIME project aims to address these challenges by reducing the impact of fatigue and corrosion on steel infrastructures, thereby reducing societal costs such as unexpected maintenance and infrastructure collapse. As part of this effort, we are developing Digital Twins (DT) for steel bridges. DT of a steel bridge is a dynamic replica of the asset that utilizes the past, present, and future (through prediction) of the steel bridge and integrates cutting-edge technologies into the maintenance process. Also, DT records the history of the bridge and facilitates decision-making through visualization.



Our contribution is to design a DT for the maintenance of steel bridges and includes creating a digital 3D model of the bridge using data collected from a myriad of sensors including cameras. Also, Extended Reality (XR) technologies will be explored for visualization and facilitating inspections. These components alongside analysis modules, such as a module for performing predictions through AI, form the backbone of a 3D DT of steel bridges.

Company: FrieslandCampina
Project: Fractionation of whey proteins by cascade membrane filtration
EngD trainee: Henrique de Avelar, TU Delft

Bioprocess Engineering

Cheese manufacturing processes generate whey as a significant byproduct. Whey is utilized in various applications and comprises approximately 20% of the total milk proteins. Among the proteins present in whey, alpha-lactalbumin and beta-lactoglobulin constitute about 70% of the total whey proteins. Alpha-lactalbumin is the most abundant protein in human milk, making it particularly valuable, while beta-lactoglobulin, absent in human milk, can lead to intolerance in infants.

These proteins can be separated through ultrafiltration; however, a single-stage process often falls short in achieving the desired productivity and selectivity. This project aimed to design and optimize a two- or three-stage ultrafiltration cascade for the fractionation of whey proteins into alpha-lactalbumin-enriched and beta-lactoglobulin-enriched fractions.

To design the cascade ultrafiltration process, various membranes were initially screened at the laboratory scale, leading to the selection of one optimal membrane. Subsequent pilot-plant trials were conducted with this membrane to optimize the process parameters.

The data collected from these trials informed a model developed in gPROMS to assist in process design. Ultimately, different designs were evaluated based on productivity, selectivity, and cost. The desired selectivity was achieved, and recommendations for further process development were provided.

Company: TNO
Project: Multi-objective decision-making for sustainable construction
EngD trainee: Susan Groenia, University of Twente

Civil Engineering
Construction Management and Engineering

Sustainability and circularity are becoming more important in the civil engineering sector. Both public and private parties in the sector are increasingly concerned about the impact of civil engineering projects on the environment, society, and the economy. In the Netherlands, the national objectives are to reduce CO2 emissions by 50% in 2030 and to have a fully circular economy by 2050. Coupling CO2 emission reduction objectives with circularity objectives can enhance and accelerate the sustainable development of the civil engineering sector. However, a major barrier for meeting sustainability and circularity objectives is that they have to compete with other objectives such as costs, safety and quality, in decision making processes.

In this EngD project we collaborate with TNO in their ERP Circular Structures project. The Circular Structures project aims to accelerate the transition towards sustainable and circular concrete in the civil engineering sector, via resource-based engineering and multi-objective design optimization of concrete structures. Methods, models and tools are developed within the project to increase the reuse of construction and demolition waste, and to support decision-making for simultaneously researching an optimum in circularity, environmental impact, costs and structural safety.

We develop an interactive method in this EngD project, to support stakeholders with multi-objective decision-making, based on multi-objective design optimization for sustainable and circular structures. Therefore, we adopt a user-centric approach to aid stakeholders with interpreting design optimization results, (re)formulating design preferences, and selecting their most preferred design solution in a multi-actor setting. In the end, we aim to have developed a method which enables stakeholders to make informed, well-balanced decisions with a diverse group of decision-makers, in a collaborative and structured way.

Company: ProRail
Project: Application of an extended Kalman filter for the wheel-rail normal contact force estimation
EngD trainee: Bente de Leeuw, TU Delft

Civil and Environmental Engineering

Knowing the braking distance of a train is essential for safe and reliable train operation. Since the braking distance depends on the friction level of the rail surface, which is generally indicated by the coefficient of friction, it is important to measure this coefficient using a train-tribometer. Several attempts at a train-tribometer have been completed with limited success. Therefore, the Delft University of Technology and University of Twente started a research project to develop a train-tribometer. This project attempts to determine the friction level from the measurement of the wheel-rail contact forces.

Although several methods exist to determine the wheel-rail contact forces, these methods are not suitable for passenger trains. This is because these methods are either very expensive or inaccurate. Therefore, a more suitable method must be selected, so that ProRail and the NS can continuously monitor the wheel-rail contact forces.

I completed my master's degree in Railway Engineering at the KTH Royal Institute of Technology, I worked at KTH for a year. I looked forward to spend two years working for ProRail to find an accurate but affordable method to determine the wheel-rail normal contact force. In my research project I applied an extended Kalman filter, tested it using multi-body dynamic simulation and validated it in an experimental setting using the V-Track of the TU Delft. Working for ProRail with support from the TU Delft provided me with both the scientific guidance and insight into the Dutch railway industry and how my project can contribute to ProRail's goals.

Company: Project executed at Wageningen University
Project: Design of a moist feeding system for poultry
EngD trainee: Salma Rian, Wageningen University & Research

Design for Agrifood & Ecological Systems

In the quest for more sustainable and efficient nutrition, the poultry industry is increasingly betting on a moist feed diet. Using moist feed is healthier, better for animal welfare and increases the chickens' performance. By using waste streams from the food industry, a moist diet also adds circular value and reduces feed-food competition.

One of the challenges for poultry farmers is the lack of proper systems for storing, mixing and distributing moist feed. When feed is wet, it often gets stuck in machinery. As a result, disruptions occur, and feed is wasted. In addition, high temperatures in the barn mean that contamination can occur when wet feed is in the feeders for too long.

For her EngD, Salma Rian developed a feeding system in which ingredients are stored separately and then efficiently mixed and distributed around the barn. A special cleaning system with acidified water ensures that the machine is cleaned regularly. The used water can then be reused in the feed mixing system.

Salma came to her design based on discussions with stakeholders from across the chain, from poultry farmers to material producers. After fine-tuning her prototype, she hopes to work with a manufacturer to market a working machine for different types of poultry farms.

Company: Project executed at Wageningen University
Project: Bucher and Brouwer Environment for Time Traversing Experiments (BABETTE)
EngD trainee: Johan Bucher, Wageningen University & Research

Design for Agrifood & Ecological Systems

Studying a plant's development can help identify valuable traits. For example, traits that make a plant more resilient to stress factors, such as drought. To properly observe a plant, researchers can use time-lapse photography, a sequence of images captured over a certain time-period. One of the limitations of current systems for this is that images are shot from the same viewpoint, hiding occluded parts.

The solution: a camera system that can move around, capturing a full 3D representation of the plant. During his EngD at WUR, Johan Bucher built a professional version of his previously designed demonstration version of this device, called BABETTE. Within a year, he and colleagues at WUR realised a high-tech system with several high-resolution cameras.

With this camera system BABETTE visualises the plant in great detail from every angle, including the spaces between leaves and very thin parts of a plant. Using specific software, all these images are put into a model which together creates a fourth dimension (4D): time. A digital reconstruction of the plant in time makes it possible to record the growth and development of the plant even more accurately. Johan's aim is to make BABETTE available for research and education in plant science, also outside WUR.

Company: Philips
Project: Real-time cloud-based ultrasound system for advanced image formation and image settings autotuning
EngD trainee: Beatrice Federici, Eindhoven University of Technology

Design of Electrical Engineering Systems

Ultrasound imaging is becoming increasingly essential in medicine, with software advances rapidly improving image quality and, with that, the clinical value. However, the deployment of these advanced methods necessitates substantial computing power, driving up system costs and limiting access to premium-quality ultrasound for many users.

To democratize premium ultrasound, this project proposes to move all computational hardware off-device, onto the cloud. By doing so, users can leverage computing resources as needed, bypassing the purchase of expensive high-performance hardware upfront. This approach reduces the entry barrier to advanced ultrasound technology, ultimately expanding its accessibility.

We showcase the viability of the proposed architecture for latency-sensitive applications by developing a cloud-native ultrasound imaging demonstrator. The prototype features: (1) live streaming of ultrasound channel data to the cloud, (2) asynchronous cloud-based image formation, (3) image rendering to a web application, and (4) runtime parameters control.

To address the challenge of transmitting large data volumes to the cloud within critical latency constraints, we propose to add a local processor and a smart rate controller that ensure functioning even with interruptions of connection or with a time-varying network throughput.

The work conducted in this project initiates a new generation of ultrasound systems with the potential to disrupt the medical imaging industry.

Company: NXP
Project: The development of an application to predict memory usage for High Performance Computing
EngD trainee: Fernando Piris Font, Eindhoven University of Technology

Data Science

Although they may seem small, semiconductor products are incredibly complex. The design process is lengthy and involves extensive testing and simulations. These simulations often entail computationally intensive tasks that require High Performance Computing (HPC) systems, which consist of powerful computers. Efficiently managing the millions of simulations submitted weekly is a significant challenge.
One of the main difficulties is accurately reserving the necessary resources for each simulation. Incorrect estimation of resources can lead to longer run times for simulations and increased wait times for incoming tasks.

In this project, an application was developed that utilizes Machine Learning models to learn from historical HPC data from NXP and improve accuracy of memory reservations for simulations. A shadow deployment was implemented to demonstrate the application's potential value in a production environment without directly interacting with the HPC system.

The outcome of the project is an application that has significantly improved the memory reservation for the simulations processed by HPC. As a result, the allocation of resources for simulations can be improved. This means that with the same hardware, a higher throughput of jobs can be achieved, ulti-mately shortening the timelines for chip design.

Company: Saint-Gobain Abrasives B.V.
Project: Benefits & limitations of agglomerate technology in thin grinding wheels
EngD trainee: Hidde Veldkamp

Energy & Process Technology

Irons and steels are foundational to our lives in every sector, from household commodities like kitchenware and showerheads to space travel and the Eiffel tower. Modifying the shape and surface of these materials is crucial for any of these applications, and notably every piece of unrefined metal must undergo modification before use. Abrasive grinding wheels perform the bulk of the work in iron and steel modification with an almost $10 billion market size. Developing cutting-edge grinding wheel technology can have a massive impact in tackling omnipresent challenges in global housing, the environment, economic and material efficiency, and ergonomics.

In this effort, Saint-Gobain Abrasives B.V. has joined with the University of Twente to connect fundamental understanding of tribology and abrasion with the development of thin grinding wheels at an industrial level. Thin grinding wheels are typically used in hand-held grinding machines to remove large amounts of metal from hard-to-reach surfaces. However, development of the rate of removal has reached a plateau only broken through by using expensive abrasives such as artificial diamond and rare earth metal doped ceramics. Thus, a bottom-up approach to wheel building is devised that redefines the 3D structure of grinding wheels entirely to enhance the output of globally accessible abrasives such as corundum.

In this work, heterogeneous agglomeration of abrasive crystals are employed in thin grinding wheels to achieve greater efficiency of grinding, which in turn reduces material consumption and emissions. Navigating this rigorous paradigm shift in grinding wheel construction is enabled by combining industry with science in the EPT EngD program.

Company: SWARCO Netherlands
Project: Design of an asset information management procedure to establish maintenance feedback loops
EngD trainee: Bodhi Buurman, University of Twente

Maintenance

The Dutch transport and water management infrastructure is reaching a critical point. Much of the infrastructure of the Netherlands was built in the 1950s and 60s and is reaching the end of its life. This means that the Netherlands is currently facing a large renewal challenge, coming with a large price tag of an estimated 260 billion euros needed in the coming 75 years.

For asset managers, a key challenge is gaining insight in the condition of the infrastructure, especially since maintenance is outsourced to maintenance contractors. Currently, significant gaps exist in the feedback mechanisms between maintenance contractors (responsible for the execution of maintenance) and asset managers (responsible for long-term asset planning). Without feedback on maintenance outcomes, monitoring data, and risk assessments, critical data on asset condition does not flow back to the asset managers. This obstructs asset managers in efficient renewal planning and increases overall maintenance costs.

To address this issue, my design project focuses on establishing maintenance feedback loops at the maintenance contractor SWARCO. The mechanisms underlying these feedback loops are captured in an information management procedure and implemented within the maintenance management system of SWARCO. Ultimately, these feedback loops enable SWARCO to optimize their maintenance efforts across all contracts and ensure that collected maintenance data supports the renewal of Dutch infrastructure.

Company: Shell
Project: Integration of CO2 capture and conversion
EngD trainee: Amsalia Barus, TU Delft

Process and Equipment Design

The rising CO2 concentration in the atmosphere has become a serious global challenge over the past decades. One promising strategy to mitigate this issue is Carbon Capture and Utilization (CCU), which involves capturing CO2 from relevant sources and using it as a feedstock for production of chemicals and fuels. This approach not only reduces CO2 emissions but also helps to decrease reliance on fossil fuels and promote circular economy. By integrating CO2 capture with conversion, the need for transportation and storage is eliminated, thus improving process efficiency and reducing costs.

In this project, two integration approaches were investigated. The first approach, serial integration, refers to a process where the CO2 capture and conversion are done in separate systems. The second approach, direct integration, uses a Dual Functional Material (DFM) to combine the sorbent regeneration process with the catalytic conversion of CO2, allowing both capture and conversion to occur within a single system. DFM is a novel material composed of basic sites to capture CO2 and active catalytic sites to convert the captured CO2.

Techno-economic analysis was performed on both approaches to identify the most cost-effective approach for further development. The study reveals a clear trade-off: novel technologies offer great potential but carry high development risks, whereas conventional technologies present lower risks but also yield lower economic gains.

Company: Bodec
Project: Designing a new production facility for Bodec to valorize side-streams from the food industry
EngD trainee: Nienke Grasmeijer, Eindhoven University of Technology

Product and Process Development

As part of the EngD in Process and Product Design I did my design project at Bodec. Bodec specializes in elevating products from laboratory to production scale for food ingredient production. We achieve this by developing and optimizing processes and testing them in the pilot plant. My project involved designing a scale up factory which is four to five times larger than the current pilot plant. The aim of the new production facility is to produce food ingredients from various plant-based side streams from the food industry. It's a challenge to design such a multifunctional production facility, while striving to an optimized and sustainable production. The design included determining the required equipment, their quantities, and capacities, performing a cost estimation, calculating a water and energy balance and developing an initial floor plan.

After completing my EngD program and this project I continued working at Bodec to implement the design made during my project. I work at Bodec as a Process Development Engineer, and I enjoy bridging the gap between the theoretical knowledge about food products (their physical and chemical properties) and the practical aspects of process development and upscaling. If you can connect these two aspects, you can really contribute to the development of more effective and efficient production processes. And that's where my passion lies.

Company: Jeroen Bosch Ziekenhuis
Project: Continuous monitoring of vital signs at a surgical nursing ward
EngD trainee: Elin Biel, Eindhoven University of Technology

Qualified Medical Engineer (NL)

Early interception of clinical deterioration is important to prevent (re-)admission to the intensive care unit (ICU) or other adverse events. Vital signs – such as heart rate or respiration rate – have shown to be accurate predictors of patient deterioration, as subtle abnormalities in basic vital sign values can be observed minutes to hours before life-threatening complications. However, at present-day nursing wards, vital signs are measured intermittently rather than continuously with an interval of four to eight hours. As a result, chances are that clinical deterioration may go unnoticed, which can result in severe consequences for the patient.

The industry offers a solution for this issue: wireless wearables that allow for continuous measurement of vital signs in patients (both bed-ridden as well as mobilizing) at either the nursing ward, or at home. Within this project, we focused on designing an innovative healthcare process including a wireless wearable at a nursing ward within the Jeroen Bosch Ziekenhuis. An extensive multidisciplinary analysis was done in order to create a safe and effective design that was piloted at the surgical ward. Also, all 'lessons learned' were gathered in an implementation model, to enable future implementation processes to be executed systematically and swiftly.

Company: RAMLAB B.V.
Project: Design of an automated cobot system for pre/post grinding during railway repair using WAAM
EngD trainee: Sadegh Hajiabadi, University of Twente

Robotics

The Additive Manufacturing for Extra Large Metal Components (Aim2XL) program focused on metal-based additive manufacturing using laser or arc welding to create large 3D components. A key project within this program involved developing sensors and actuators to monitor and control the Wire Arc Additive Manufacturing (WAAM) process, aiming to optimise deposition process with high level of automation and reduce lead times. One challenge during large-scale component printing and on-site repairs employing the concept of additive manufacturing is that the extensive manual grinding can be involved when it is needed, which limits automative operation.

One highly potential application of the WAAM technology is on-site railway repair. As global demand for transportation grows, rail systems - one of the most energy-efficient ways to transport goods and people - are under increasing pressure to operate efficiently and reliably. This has created a need for advanced maintenance solutions, including the automation of inspection and repair processes. To address this, equipping WAAM technology with an automated grinding function can pave the way for intelligent, fully autonomous systems for on-site inspection and repair of damaged rail profiles together with other automated units that will be needed during the railway maintenance procedure.

In my EngD project, I developed both hardware and software for a portable collaborative robot (cobot) system to automate the grinding of railway tracks. A prototype was created that could localise the rail profile using a 3D vision system, perform grinding with controlled force to ensure safety, and verify final dimensions according to railway standards.

Company: KPN
Project: Linked data for smart neighborhood
EngD trainee: Sander de Meij, Eindhoven University of Technology

Smart Buildings & Cities

Cities increasingly contribute to global energy consumption, which leads to a large set of challenges. However, there is only limited integration of (energy) data on an urban level, which limits the capability of integral solutions.

This project built upon existing data structures to take the first steps towards a Semantic Digital Twin of Eindhoven, which was named Neo Dash. This Digital Twin allows the end-user to meaningfully explore data from previously unconnected and inaccessible sources to assess pressing challenges. An exploration of energy poverty in Eindhoven shows how this Semantic Digital Twin can provide valuable insights into solving the challenges urban areas face today by finding areas this issue is most pressing, allowing for more efficient problem solving.

This project will serve as a foundation for further research and as proof of concept for employing semantic web technologies for solving today's urban challenges. Hopefully creating a foundation for the Semantic Digital Twins of the future.

Company: ASML
Project: Automatic and optimized hardware sequence generation and inline interpretation
EngD trainee: Georgios Evangelou, Eindhoven University of Technology

Software Technology

ASML and its flagship metrology system, YieldStar, play a pivotal role in our modern society. As the semiconductor industry advances, YieldStar aids process control, reduces defects, and improves yield, facilitating the fabrication of smaller, more powerful chips. By enabling the production of more efficient semiconductor devices, ASML and YieldStar drive advancements in fields like healthcare, communication, and renewable energy.

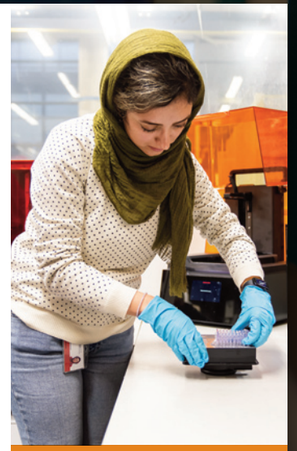
YieldStar is an optical metrology system, which means that it measures wafers by taking images of their surface in the visible light spectrum. Acquiring such nano-images is a sophisticated process. Engineers spend considerable manual effort (graphically) modelling and implementing (into code) YieldStar's behavior.

In this project, we proposed, designed, and implemented two tools that automate and optimize this development procedure. The Sequence Design and Optimization Tool (SDOT) uses requirements-based input to produce and visualize optimal action sequences for machine sensors and actuators. The Inline Sequence Interpretation Tool (ISIT) translates the action sequences into hardware commands, which are then queued to the hardware peripherals of YieldStar.

Both tools were demonstrated for the latest machine type (YS-500) and showed tangible improvements over the existing methods. Furthermore, they can be used for the software implementation of the next product (YS-550), and it is expected that they will help decrease the implementation and deployment time of the scheduling module by 50% and 75% respectively.

The programs in brief

	Diplomas 2024	Influx 2024
TU Eindhoven		
Automotive Systems Design (ASD) / Mechatronic Systems Design (MSD)	9	11
Clinical Informatics (CI)	12	12
Data Science (DS)	11	21
Design of Electrical Engineering Systems (DEES)	4	12
Human-System Interaction (HSI)	4	7
Process and Product Design (PPD)	18	6
Qualified Medical Engineer (QME)	9	10
Smart Buildings & Cities (SBC)	6	5
Software Technology (ST)	16	14
Total	**89**	**98**
TU Delft		
Bioprocess Engineering (BPE)	6	6
Process and Equipment Design (PED)	8	12
Chemical Product Design (CPD)	1	0
Civil & Environmental Engineering (CEE)	4	1
Total	**19**	**19**
Twente		
Energy and Process Technology (EPT)	5	15
Maintenance (MT)	1	1
Robotics (ROB)	3	1
Civil Engineering (CE)	5	8
Business & IT (BIT)	4	5
Total	**18**	**30**
Wageningen		
Design for Agrifood & Ecological Systems (DAES)	0	17
Total	**0**	**17**
Groningen		
Autonomous Systems (AS)	0	2
Sustainable Process Design (SPD)	0	1
Total	**0**	**3**
Total 4TU	**126**	**167**



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)

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TU Delft Delft University of Technology

TU/e Eindhoven University of Technology

University of Twente.

Wageningen University & Research

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