a selection of projects

Innovative solutions

designed by EngD trainees

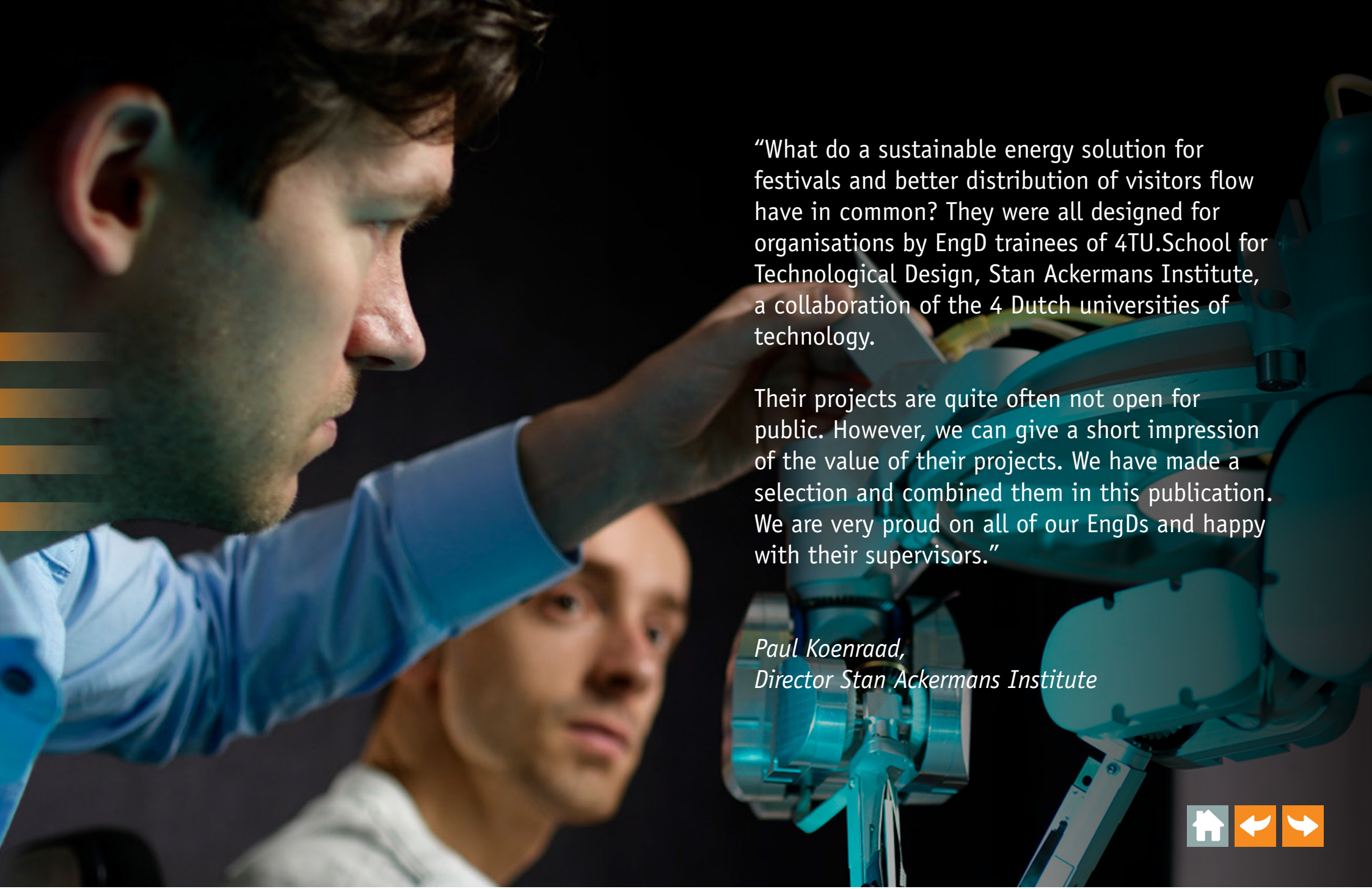
2022

TU Delft Delft University of Technology

TU/e Eindhoven University of Technology

University of Twente.

Wageningen University & Research



"What do a sustainable energy solution for festivals and better distribution of visitors flow have in common? They were all designed for organisations by EngD trainees of 4TU.School for Technological Design, Stan Ackermans Institute, a collaboration of the 4 Dutch universities of technology.

Their 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

One of our goals as 4TU (Federation of 4 Dutch universities of technology) – is to educate and deliver excellent engineers and technological designers for the needs of society. With our 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. This year the joint Executive Boards of the 4 TU's decided as of 1 September to change from the degree PDEng to Engineering Doctorate (EngD). We changed our degree because the Universities of Applied Science in the Netherlands will start with Professional Doctorate (PD) trajectories.

EngD trainees

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.

After their degree

Our graduates immediately start working for outstanding companies but also for public organisations, hospitals or other health institutes. This proofs 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

Company: Van Gogh Museum
Project: Virtual Unaging of Van Gogh's Paintings
EngD trainee: Ram Parvethaneni, Eindhoven University of Technology

Automotive Systems Design

Fading of the original colors in the paintings of Vincent van Gogh is an immense challenge that the Van Gogh Museum is facing. Several factors are responsible for the undesired color change. These factors include natural aging, light-induced color change of paints, past preservation treatments and deposited surface dirt. The Van Gogh Museum, in collaboration with the University of Amsterdam, RCE (Dutch Cultural Heritage Agency) and ASML, have set the goal to digitally reconstruct the original colors of paintings by Vincent van Gogh using various measurements on the paintings and a limited number of existing digital reconstructions. Based on this, the project "Virtual Unaging of Van Gogh's Paintings" was created and performed as part of the Engineering Doctorate in Automotive Systems Design Program under the Department of Mathematics and Computer Science.

In this project we leverage the power of artificial intelligence to provide a practical solution to the challenge of reconstructing Van Gogh's original colors. The project is sponsored by ASML and M2i. Maxim Pisarenco (Data Science Department) is one of the supervisors in this project from ASML. Sasha Pogromskiy (Mechanical Department) is the other supervisor from the University. I will be starting my new job at ZF Automotive, Germany as a Senior Systems Engineer from 1st of July.

Company: Heineken N.V.
Project: Conceptual design and economic feasibility of an adsorptive flavor removal unit
EngD trainee: Andrea Kurtinović, TU Delft

Bioprocess Engineering

Increased health-consciousness, responsible alcohol consumption and religious views are only some of the reasons why beverage market is currently exhibiting a fast growth in sales of alcohol-free drinks. Alcohol-free beer (AFB), being one of the fastest growing market sectors, is of particular interest for HEINEKEN as a global leader within the beverage industry. In addition to closing the existing taste gap between AFBs and their alcoholic equivalents, there is a strong sustainability and cost reduction drive to replace commercialized dealcoholisation process for AFB production.

As an alternative, the combination of cold contact fermentation (CCF) and zeolite-based adsorption technology is investigated at HEINEKEN. The adsorption unit is used to remove undesired wort flavor originating from Strecker aldehydes in biologically produced AFBs and thus enables improving the sensory characteristics of the product.

Based on the conceptual design of a large-scale adsorption unit performed in this project, a reduction of 50-70 % in annual operational costs compared to the dealcoholization unit was estimated, in addition to a significant reduction in utility usage.

The results prove the feasibility of implementing adsorptive unit for wort flavor removal and represent a step forward towards more effective and more environmentally friendly processes for production of alcohol-free beverages.

Company: Deltares, Royal HaskoningDHV, Rijkswaterstaat, Port of Rotterdam, CiTG - ChemE TU Delft
Project: Design of a Gel Product for sedimentation control in the Rotterdam port area
EngD trainee: Atha Bampatzeliou, TU Delft

Chemical Product Design

Sediment tends to accumulate in small channels in port of Rotterdam which obstructs daily ship navigation and requires maintenance with high-cost dredging operations. The goal of this project was to design a gel product that helps in the sedimentation control in the Rotterdam port area and contributes to the reduction of disposal costs, by offering a feasible, stable, and eco-friendly solution.

The design approach followed included:

1) Techno-economic evaluation to identify the materials and recipe
2) Stability trials to determine critical rheological factors and provide data for CFD study
3) Product and application concepts
4) Feasibility investigation for the use of Kaumera as a gelation agent and other applications

After evaluating different concepts against set criteria, Xanthan gum (XG) and fine sediment were combined to provide a stiff gel in port areas with speed currents <0.1 m/s for 4 weeks. A sensitivity analysis took place, considering material, manufacturing, application, and transportation costs.

The inline preparation of the gel barrier was the most economically feasible application strategy. With the proposed application method, the CO2 emissions associated with dredging can be reduced by 40%, saving up to 2400 t CO2/y. Building a barrier in the port seems a promising application for cost and CO2 reduction and cost-effective trials could be made to validate the barrier's efficiency in reducing incoming mud. A roadmap for the project development includes prolonging the efficiency of the gel in reducing dredging costs, performing large-scale trials in Deltares flume to test the efficiency and finally a pilot scale trial in port of Rotterdam.

Company: Princess Maxima Center
Project: Better use of clinical guidelines in the Prinses Máxima Center through standardization and formalization in computer interpretable guidelines
EngD trainee: Rinke Riezebos, Eindhoven University of Technology

Clinical Informatics

Healthcare practitioners apply clinical reasoning processes when caring for their patients. Thereby they make use of clinical guidelines and (research) protocols. Often these are only available as natural text documents readable for humans. Usage in this format is insufficiently effective: They are ambiguous, have no standard structure, are implicit, not computer interpretable, not interoperable and are obsolete by the time they are applied in practice.

In the Princess Máxima Center for Pediatric Oncology, clinical guidelines and protocols are widely used and they often change. To overcome the forementioned deficiencies we designed and developed a scalable approach to standardise and formalise text guidelines in computer interpretable guidelines (CIGs) and use them in a newly developed Clinical Decision Support System (CDSS).

We designed an information model that represents the structure of guidelines and helps in the translation process. We made use of Nictiz' interoperability model, Health and Care Information Models (HCIMs) and open (source) standards like Python and openEHR. We choose for standards with a well documented ecosystem what makes the chosen approach shareable and future proof. As a result, we designed a sustainable, shareable, scalable, semantic and syntactic interoperable low-cost solution that could be adopted by other hospitals (inter)nationally. The CDSS is currently developed further.

Company: University of Twente (Campus Facility & Management) and DigiGo
Project: BIM integration in the circularity assessment
EngD trainee: Li Jiang, University of Twente

Construction Management and Engineering

As a resource- and waste-intensive sector, the construction industry is responsible for a large amount of materials depletion and waste generation in the Netherlands. The concept of a Circular Economy (CE) has emerged to promote continuously resource reuse in a closed loop rather than materials extraction. Project stakeholders require an appropriate circularity assessment method to guide them in the right direction towards a CE, with actual insights rather than educated guesses. Moreover, Building Information Modelling (BIM) has rapidly developed in the construction industry as an information management system, to provide possibilities for incorporating circularity assessment.

Therefore, this EngD project aims to provide new insights into how to measure the performance of construction projects regarding circularity, with a BIM-based circularity assessment tool (BCAT). The BCAT has been developed and evaluated iteratively during a large-scale renovation project located at the University of Twente. It can provide insights into the degree of circularity of a project through project phases from early design phases to construction phases. These insights are displayed both numerically and visually in a user-friendly manner, with the aim of supporting construction projects to achieve material efficiency and circularity. Using existing open BIM standards, the EngD project also contributes to information recording and sharing among various chain partners.

Company: Fokker Elmo
Project: Wireless Technologies in Future Aircraft
EngD trainee: Asterios Souftas, Eindhoven University of Technology

Design of Electrical Engineering Systems

Aviation is undergoing a major transition. Future aircraft are expected to be CO2 neutral and energy efficient. Wireless technologies are a key enabler for this transformation.

A reliable wireless network can be used instead of wiring to interconnect all the electrical systems within an aircraft. This allows for significant weight reduction and a configurable and flexible design. To reap the rewards of a wireless network many challenges need to be overcome. Such challenges include the high safety requirements and time-constrained nature of avionics data, the shared nature of the wireless propagation medium and the extremely constrained transmit power levels and frequency bands limitations. To face these challenges and guarantee the required quality of service, pioneering methods need to be developed to offer ultra-high reliability and low communication delays.

I have been investigating possible solutions to make wireless inter-aircraft communication a reality. My work has resulted in a helpful framework to understand the complexity of designing wireless aircraft data networks as well as practical solutions to increase network reliability and offer predictable performance. These solutions were put into practice through the development of a proof-of-concept demonstrator, showcasing the potential of wireless avionic networks.

Company: Crest Cool Consortium – CrestCool B.V., RBK group of companies
Project: Designing optimum conditions for cooling of meat carcasses with electrostatically charged sprays
EngD trainee: Vishal Venkatesh, University of Twente

Energy & Process Technology

I am Vishal Venkatesh, EngD Trainee in the Energy & Process Technology track. I am part of the Thermal and Fluid Engineering group. Currently, as part of my EngD program, I am working on my design project which is titled – "Designing optimum conditions for cooling of meat carcasses with electrostatically charged sprays". This project is part of the CrestCool consortium with industrial partners – CrestCool B.V., RBK group, Frontmatec, GRACO Inc., and EKRO.

Traditional meat chilling is found to be ineffective, as using cold dry air leads to moisture evaporation. As a result, meat loses its tenderness and weight - the former reduces meat quality, and the latter corresponds to financial loses (€5.0/kg). On a worldwide scale, the net weight loss is about 3 million tons of meat. Intermittent water spraying aids in maintaining moisture, but available spray systems have poor deposition. They also spray too much on the surrounding materials in the chill room, causing maintenance and contamination problems. CrestCool project utilizes electrostatic spraying, as charged water droplets are found to have enhanced moisture deposition and coverage over a target surface.

The main objective of my design research is to optimize the performance of electrostatic spray cooling module. For this purpose, Computational Fluid Dynamics (CFD) is used as a tool to analyse the system. The focus is primarily on improving the interaction between airflow and water spray. The developed CFD model was found to show good agreement with experimental observations. With such a reliable model, a systematic Design Of Experiments (DOE) - based optimization was performed. The work has culminated in the development and of a 'novel aerodynamic channel' that is focussed upon improving spray transfer and (almost) eliminating maintenance issues. Preliminary designs showed superior performance and resulted in two times higher deposition than that of the existing configuration.

With this newly developed channel + electrostatic spraying, weight losses are estimated to be reduced by 1%, i.e., equivalent to €1.8 Million/year in savings.

Company: Consortium project with NIZO, DSM, Arla, Cosun, HAS and Ripple
Project: Design of a tongue equivalent for astringency assessment in plant-based proteins
EngD trainee: Shari S. Gamaniel, University of Twente

Maintenance

Global transformation towards more sustainable food has led to increasing demand for plant-based proteins as an alternative to animal protein sources. However, several plant-proteins contain polyphenols, a compound which when ingested causes an oral sensation of astringency. Astringency refers to a sensation of dryness, shrinking and puckering of the oral epithelium after exposure to phenolic compounds. This has been regarded as unpalatable at high intensities for food consumers and resulted in the initiation of studies towards understanding and diminishing the unwanted effects of astringency.

In this project, the nature of interactions of oral surfaces is considered to be a tribology problem, focusing on the system dependence of oral friction in relation to astringency. Loss of lubrication on oral surfaces as a result of astringent compounds binding to the proteins in saliva has previously been simulated using surfaces such as glass, steel and rubber as representative of oral surfaces. As several factors including the chemical composition of the salivary (boundary) layer, structure and function of interacting surfaces determine the outcome of astringency sensations, it is clear that a surface is to be designed that behaves equivalent to the tongue from a tribological point of view. This project adopts a systematic method for the design and maintenance of equivalent surfaces and materials used to investigate the interaction of astringent foods on oral surfaces.

Company: The Port of Rotterdam
Project: Techno-economic evaluation and Life Cycle Assessment of a large-scale plant for accelerated CO2 mineralisation
EngD trainee: Anlly Espinosa Cardona, TU Delft

Process and Equipment Design

The Port of Rotterdam is the largest seaport in Europe and the world's largest oil and chemicals centre. The industrial activity that surrounds the port is important, therefore its CO2 emissions correspond to a significant percentage of the total value in the Netherlands. At the moment, the port is working to reduce its emissions by 50% in 2030 and to become carbon-neutral by 2050. Carbon mineralisation was evaluated as one of the possible options to capture CO2 from flue gases and obtain carbonate products that can be used in the cement industry, flame retardants industry, and refractory industries.

The challenge of this project was to design a large-scale mineralisation plant using serpentinite, ammonium sulphate (AS) and the flue gases coming from four companies in the port as main raw materials. The objective of this project was to develop a conceptual design of the mineralisation process at large scale, starting from the knowledge of a laboratory-scale process developed by Abo Akademi University in Finland. In addition, the process was studied in detail with the aim of identifying the main energy needs, the potential for CO2 utilisation, the environmental impacts, and the potential to invest in the project in economic terms.

Company: Jeroen Bosch Ziekenhuis
Project: Design of a system to monitor patients at home after colorectal surgery
EngD trainee: Roberto Garcia van der Westen, Eindhoven University of Technology

Qualified Medical Engineering

Bowel cancer is among the most common diagnosed types in the Netherlands. Because complications after surgery are difficult to predict, this often results in unnecessarily long hospitalization duration for low-risk patients.

This project was performed at the JBZ in collaboration with IMEC. The goal was to design a tailored system for bowel cancer patients that enables safe recovery and monitoring from home after surgery.

The proposed design relies on a unique combination of accurate predictions of the chance of complications before surgery (i.e., machine learning models) and timely identification of deterioration at home (i.e., wearable smart sensors and digital questionnaires).

This design focussed on the patients. The most important benefit is an overall improved recovery experience and better outcome. This is mainly achieved by merging a trusted environment surrounded by loved ones, better sleep (and healing), stimulating independency and reducing the chances of hospital acquired infections.

Simultaneously, a positive outcome for the hospital translates to a safe reduction of hospitalization duration. Also resulting in satisfied patients, optimal usage of the available capacity or financial savings.

Currently the system is being tested by real patients outside the hospital. With small modifications the system could also be tailored to benefit other patient groups.

Company: Raad voor Arbeidsverhoudingen in de Schoonmaak- en Glazenswassersbranche (RAS)
Project: Responsible Implementation of Technology in the Cleaning Sector
EngD trainee: Roy van Zijl, University of Twente

Robotics

Working in a clean office is beneficial for work enjoyment and productivity. Cleaners are an important part of this. However, their work is often seen as 'inferior' to other jobs. This stigma is causing mental problems within the cleaners' community with a significant group of cleaners stating that their work is underrated and underappreciated.
Furthermore, many suffer from physical injuries due to the intensive labor. Repetitive tasks and challenging working positions put a lot of stress on their bodies.

There are many questions relating the implementation of technology into this sector, which is naturally conservative and wishes to be kept 'simple'. The main goal of this project is to create a technological solution that improves the mental and physical working conditions of cleaners whilst also accepted by them.

The project uses a systems engineering approach by looking into the system architecture of the technology under design, as well as its relationship with the cleaner that will use it and its surroundings. Thorough research into sociotechnical relations and human-machine interactions is required. The final results will be prototypes of technologies that can ease cleaning tasks, as well as a future vision on how technology can be further implemented in the sector.

Company: Eindhoven University of Technology
Project: Sustainable business model for facilitating public value creation of living lab innovation ecosystems
EngD trainee: Pegah Kheiri, Eindhoven University of Technology

Smart Building and Cities

User-Centric (Open) Innovation. Co-Creation. Real-Life Experimentation. Public Value Creation. They all come across in one context: A Public Living Lab. A sustainable and viable Public Living Lab is a breeding ground for innovations that can address real-life challenges, create Public -social, economic, environmental, and individual- Values, and bring health and wealth to societies.

However, Public living labs are not sustainable and viable yet. They lack a Sustainable Business Model that can align and coordinate the efforts of multiple heterogeneous stakeholders involved in their innovation ecosystem.

We tried to fill this gap, by introducing a business model that includes:
1) Living Lab 'value proposition',
2) All 'activities' for the ecosystem's 'value proposition' to be realized,
3) All the 'actors/personas' who should participate to accomplish the 'activities',
4) The 'governance' model and mechanisms to coordinate the efforts and manage the expectations of all the 'actors',
5) The 'structure' of the business model which shows the links between the 'activities', and therefore the 'actors' associated with each activity.

In addition, we bridged the fields of Innovation Management and Human Computer Interaction to offer a prototype (of a digital platform) that supports implementation of the proposed business model. We received TU/e BOOST fund to build and roll out the platform in the TU/e Innovation Space.

Company: ASML
Project: Feasibility and prototype of replacing commercial off-the-shelf pattern recognition solution
EngD trainee: Raha Sadeghi, Eindhoven University of Technology

Software Technology

In the ASML holistic lithography, YieldStar is a metrology tool that provides closed-loop feedback to scanners by measuring on-product errors such as overlay. YieldStar utilizes image pattern recognition techniques to measure the position shifts of wafer alignment marks. It uses this position information to build up a high-order wafer model to guide measure target positioning. YieldStar uses a Commercial-Off-The-Shelf (COTS) software library, which has expensive license costs and requires a hardware dongle, complicating machine build-up.

In this project, we designed and developed a new in-house solution as a replacement for the COTS pattern recognition tool in the context of wafer alignment, called RECOG. In a nutshell, we proposed a new pattern recognition algorithm, implemented using available open-source computer vision libraries, along with a GUI tool to investigate it's accuracy, performance, and flexibility. Additionally, RECOG was integrated into the YieldStar.

RECOG was validated against different patterns and images with varied qualities and contrasts during wafer alignment. Results demonstrate that RECOG can recognize patterns flexibly, with less than one sub-pixel accuracy (almost the same as its commercial counterpart), while meeting the performance specifications. What makes RECOG more special is its extensible in-house solution which can also cut the machine build-up cost reasonably.

Company: Apollo Tyres
Project: Web-based Tyre Engineering System
EngD trainee: Farideh Behtooee, University of Twente

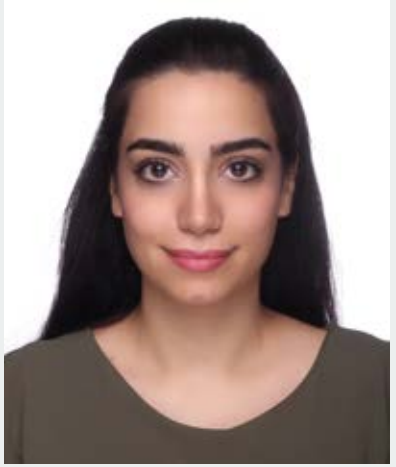
Business and IT

Apollo Tyres, one of the world's largest tyre manufacturers, has developed a tool for describing tyre specifications as part of its R&D process. However, this tool presents several usability and maintainability challenges, which limit tyre engineers' ability to perform their jobs efficiently.

Additionally, new IT solutions will soon be implemented to improve the integration of product lifecycle data and tools. Therefore, this EngD project is assigned to design the tyre specification tool's target architecture. Firstly, upon analysing the current tool and eliciting the needs of the main stakeholders, the following requirements were identified. The tool must be easily maintainable, highly secure, high performance, guide users through the process, interoperable with both legacy and new interrelated systems, and serve as a more intelligent assistant to tyre engineers via its new features, while having all of the current functionalities.

Afterwards, Farideh will develop high level solution scenarios and analyse each alternative. The best options will then be selected and modelled in the target architecture in consultation with the company experts and the university supervisors.

By the end of the project, a reliable distributed service-oriented architecture will be delivered that covers above-mentioned business requirements by providing the most suitable solutions.



The programmes in brief

	Diploma's 2021	Influx 2021
TU Eindhoven		
Automotive Systems Design (ASD)	13	16
Clinical Informatics (CI)	10	11
Design of Electrical Engineering Systems (DEES)	3	8
Process and Product Design (PPD)	20	24
Qualified Medical Engineer	4	6
Smart Buildings & Cities (SBC)	9	13
Data Science (DS)	21	16
Software Technology (ST)	18	19
Total	**98**	**113**
TU Delft		
Bioprocess Engineering (BPE)	7	7
Process and Equipment Design (PED)	6	7
Chemical Product Design (CPD)	6	5
Civil & Environmental Engineering	4	6
Total	**23**	**25**
Twente		
Energy and Process Technology (EPT)	6	6
Maintenance	3	3
Robotics	1	7
Civil Engineering (CE)	4	6
Business & IT		8
Total	**14**	**30**
Total 4TU	**135**	**168**

To illustrate the companies EngD trainees work for after their degree, the top 10 Employers for alumni of Eindhoven 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 PhD)

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: Delft University of Technology, Eindhoven University of Technology, University of Twente and Wageningen University.

sai@4tu.nl

www.4tu.nl/sai

Photography cover:
Jarno Verhoef, Catharina Ziekenhuis