2018

Innovative technological solutions designed by PDEng trainees

TU Delft Delft University of Technology

TU/e Eindhoven University of Technology

University of Twente.

Wageningen UR For quality of life

A selection of projects

4TU. School for Technological Design STAN ACKERMANS INSTITUTE

What do a new steering system for trailers, a web-based personal dashboard for doctors and an imaging catheter, which provides real-time, cross-sectional, in-depth tissue images to detect bladder cancer have in common? They were all designed for organisations by PDEng trainees of 4TU.School for Technological Design, Stan Ackermans Institute. A collaboration between the universities of technology of Delft, Eindhoven, Twente and Wageningen. Is your company facing a challenging technological design issue that needs unraveling? Our trainees may be an attractive option.

Introduction

Our best MSc students are trained to become a technological designer, during a full time two year traineeship. After successfully completing the programme they are entitled to use the academic degree Professional Doctorate in Engineering (PDEng). The different PDEng programmes all fall within the 3rd cycle of higher education, as do the doctorate PhD programmes.

Putting theory into practice

The trainees spend their first year following a dedicated curriculum, which involves courses, interactive workshops and group and practical assignments. Often in close cooperation with industrial and health care partners. In the second year the trainees carry out an in-company design assignment. University experts act as supervisors, providing state-of-the-art technology, advising on the structure and execution of the project and monitoring that the goals of the project are realised. During the design project, the trainees demonstrate their skills in being able to turn knowledge into innovative business solutions for the high-tech industry or health care sector. In some programmes courses and design project run parallel.

Selection of interesting design projects

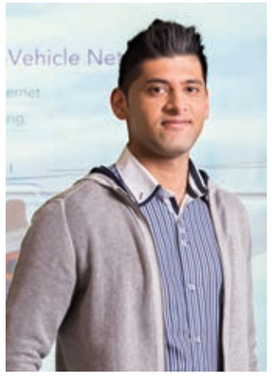
To demonstrate the value of the outcome of the PDEng design projects, we've made a selection of the latest design projects for you and combined them in this publication. We hope you enjoy reading about the projects produced by our talented PDEng trainees. For more information about our programmes please visit www.4tu.nl/sai.

With best regards,

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

Company: NXP Semiconductors
Project: A step forward in vehicle automation: the Lane Centering Assist System
PDEng trainee: Rameez Ismail

Automotive Systems Design



The technology for self-driving cars is on the verge of emergence and has the potential to revolutionize mobility. However, there are various challenges that need attention and one such challenge is the robust perception of the immediate environment. Self-driving cars need to reliably perceive their environment, in real-time, to drive around safely. The underlying perception algorithms are rapidly evolving but one limiting factor is the amount of processing power available inside the vehicles. This design assignment showcases a lane-centering system, which is built over a state-of-the-art perception algorithm. The system is implemented and optimized on NXP's low-cost, resource-constrained and small form factor platform called BlueBox.

The project provides a step forward in vehicle automation. It establishes guidelines for designing and realizing advanced automated systems for a vehicle using low-cost embedded technology. The major tangible result of the project is a system that provides real-time information on the position of the vehicle in the 'ego' lane. The system is also able to automatically steer the car, when required, to keep it centered in the driving lane. Such automated systems also play a key role in preventing accidents caused by momentary driver distraction.

Company: Janssen Biologics BV
Project: Design of reduced scale bioreactor models
PDEng trainee: Roman Agustin

Bioprocess Engineering

Monoclonal antibodies used for medication against auto-immune diseases are produced in large manufacturing scale bioreactors. In an effort to continuously manufacture product reliably and robustly, the enhancement of cell culture performance to obtain higher yields while maintaining product quality is pursued through input changes and process optimization. However, testing at manufacturing scale is impractical and cost-intensive. Therefore, the use of representative experimental models such as reduced scaled laboratory models that mimic production scale, in terms of cell culture performance and product quality, is essential for continuous improvement.

Non-representative reduced scale bioreactor models at the 3.5L scale for two biopharmaceutical product lines were present at Janssen Biologics. Therefore, the aim of this project was to troubleshoot, design, and experimentally qualify the existing models.

The approach was divided into three phases: data compilation and analysis, iterative design and experimentation, and knowledge transfer for system qualification. In the first phase, historical data at production scale and the 3.5L scale was obtained and compared through regime analysis. Regime analysis is a methodology wherein underlying mechanisms which dictate

process parameter values are compared across the scales. In the second phase, a bioreactor design at the 3.5L scale was made based on regime analysis results to maintain critical mechanisms across the scales. This design was tested experimentally, and the results were used to improve the design and perform further tests iteratively. Finally, the third phase involved the knowledge transfer of experimental fermentation data and statistical analysis for system qualification of the 3.5L reduced scale model.

This project involved the collaboration between various departments to create an integrated bio product and engineering design approach which resulted in experimentally-proven 3.5L reduced scale models for two biopharmaceutical product lines.
Ultimately, the main lessons learned is that "understanding the underlying mechanisms that affect the critical function, and how each mechanisms is affected by (often the same) parameters, is central to the proper design of a bioreactor."

Company: Keolis Netherlands
Project: Identifying suitable locations for alternative public transport services
PDEng student: Sander Veldscholten

Civil Engineering

Keolis Netherlands is transforming from a classical public transport company, which is organized more or less top-down when it comes to providing public transport, into a provider of mobility services which is far more client, or bottom-up orientated. To make this transformation possible, it is mandatory to invest in knowledge of travel patterns. This PDEng project is about providing a good estimate of the direction and timeslots in which people in a distinct area travel. This information is interesting for a provider of mobility services because when there is enough mass on a corridor, a specific type of public transport can be introduced.
This project has its focus on chances for alternative public transport modalities in areas with a low population density as in these areas regular public transport is highly inefficient. With enough information on travel behaviour in these areas, alternative public transport services can be introduced in these low-urbanized areas such as flex- or rush hour services, neighbourhood operated (mini-) buses or shared cars.

Results
A decision support system is being designed using data on demographics and travel behaviour from different open and closed sources. This data is stored in a data warehouse and processed using data mining and machine learning techniques to generate enriched origin-destination matrices. These matrices will be used to feed a system which dynamically shows travel relations on a map. This system can be used by Keolis to base proposals for new services on.

Sander: *"As a PDEng programme is a co-operation between the university and business, it gives me the opportunity to broaden and deepen my knowledge while conducting a design project which has value for Keolis. I take full advantage of the possibilities to learn more about data processing while I'm designing a system which has the potential to enhance society with tailor-made mobility solutions."*

Company: Equipe Zorgbedrijven
Project: Score, see and speak: bringing valuable health information to light
PDEng student: Mariska de Kort

Clinical Informatics

In this project a web-based personal dashboard for medical doctors has been designed. The dashboard combines patient reported outcome measures with operational data about the patient and the medical intervention. This holistic approach, together with a well-supported learning cycle, adds new value to the daily work routine of medical doctors.

As a result of this project a working prototype of the dashboard has been delivered. This prototype processes data from two source systems. A method to extract, transform and load the data is designed as well as a data model. Also the key performance indicators and the way they are presented are defined.

The cooperation with medical doctors towards the design of the dashboard led to a future perspective on health care delivery. In addition to the dashboard, this project delivered an advisory report. This particular report emphasizes the relevance of patient engagement in health care delivery and provides advice on information objects related to patient engagement.

Company: SABIC
Project: Product and process design of an injection molded lab-on-chip device
PDEng trainee: Muhammad Hussam Khaliq

Chemical Product Design

There is a lot of ongoing research in the field of microfluidic (lab-on-chip) devices, especially on their use for different applications such as drug testing, in-vitro diagnostics and precision medicine. A portion of this research is focused on the exploration of different manufacturing processes for fabricating lab-on-chip devices. SABIC is currently developing a unique manufacturing process to mold lab-on-chip devices from thermoplastic polymers, eliminating the need of secondary operations. This project concentrates on the design of a generic lab-on-chip device and the development of a novel injection molding process for manufacturing.

The effect of varying different process and product related parameters is studied and linked to the dimensional stability of the micro channels for achieving optimal micro channels in the final lab-on-chip device.

A general comparison of SABIC's patent pending injection molding process versus other established manufacturing technologies (injection molding & hot embossing with secondary operations) is performed. Furthermore, a detailed economic analysis (cost modelling), comparing these different manufacturing technologies is also performed.

Company: Innoluce B.V. / Scinvivo B.V.
Project: Developing a catheter to improve bladder cancer diagnostics
PDEng student: Maaike de Jong

Design and Technology of Instrumentation

Problem
Bladder cancer is the most expensive disease from diagnosis to death. Every year over 340,000 new patients are diagnosed worldwide, and over 160,000 will die. As bladder cancer has a high recurrence rate, most patients need lifelong follow-up. Current diagnostic methods are sub-optimal, as urologists have to base their decision on incomplete visual information.

Solution
An imaging catheter, which provides real-time, cross-sectional, in-depth tissue images was developed. Using this catheter, the urologist can see what is going on behind the bladder wall surface and provide a more accurate diagnosis. This leads to a decrease in expenses and patient burden. The catheter uses Optical Coherence Tomography (OCT). This is a technology analogous to ultrasound, but uses light instead of soundwaves. OCT provides high resolution imaging (1-50 µm) over a depth range of ~3mm. The catheter uses innovative MEMS mirror technology to enable scanning of the tissue.

Result
During my PDEng project, the company I worked for (Innoluce) was taken over by Infineon. Infineon gave us the opportunity to start a dedicated company around this OCT catheter: Scinvivo. This meant that apart from developing the catheter, I also was involved in building the business case around Scinvivo. Currently, Scinvivo has filed for its first patent and is preparing for the first clinical animal studies with the catheter.

Company: PAQUES BV
Project: Designing a process for recovery of acids from fermented waste water
PDEng student: Chiel van Beek

Energy and Process Technology

As the global awareness for the need of sustainable and renewable processes increases together with the increasing concern on the depletion of (easily accessible) fossil resources, new routes for the production of bio-based chemicals is researched. One of these routes is the production of bio-based chemicals via fermentation. Different groups of bio-based chemicals can be produced through fermentation such as volatile fatty acids (or VFAs). VFAs are versatile carboxylic acids, such as acetic acid and butyric acid, which van be utilized in the production of bio-based plastic, bio-energy and are even used in the food industry. Synthesis of valuable chemicals from the VFAs starts with the production and purification of the VFAs in an economically viable process. As the fermentation broth has a complex composition which contain different components like salts (Cl-, K+, Na+, and SO42-) and acids (Acetic acid, Propionic acid, Butyric acid and Lactic acid) in a diluted solution (≈0.25wt% for each acid), separation and purification of the VFAs is challenging.

An economically viable process requires an efficient solution for the separation of the VFAs, the research in the extraction and purification of VFAs still continues and this is where the current PDEng-project comes into play. As part of a larger research project of the companies PAQUES BV and NWO the recovery of VFAs from fermented waste water and the conversion of VFAs is researched by PhD students at the University of Twente (recovery) and the University of Utrecht (catalytic conversion). The goal of the PDEng project is combining the research on extraction and conversion into a working technology in the form of a continuous working bench scale set-up in which extraction of VFAs is combined with the conversion of the VFAs.

Chiel: *Translating fundamental research which is done in batch wise to a working continuous process is challenging. My process is for that matter unique as it requires experiments to get additional process parameters which can be used for the development of the process. I have learned a lot on how to interpret and translate experimental data and what is needed to design a process.*

Company: Medintec BV
Project: Realizing a VR head mounted display (VR HMD) for MRI applications
PDEng student: Edwin Nam Chun Mui

Design of Electrical Engineering Systems
Track Healthcare Systems Design

VR head mounted displays (VR HMDs) are becoming increasingly popular especially in the entertainment industry. Today, there are myriads of tethered and standalone VR HMDs in the market such as the Oculus Rift, HTC Vive, Oculus Go and Lenovo Mirage Solo. In fact, with just a simple cardboard housing, even mobile phones can be readily transformed into a VR HMD! Hence, it is evident that the growth of VR has been so tremendous that it has found uses in aerospace, military and many other industries.

Medintec BV was founded with the idea to incorporate the use of VR technology in medical practices, particularly on MRI applications. The ambition of its founders is to realize a VR HMD that can provide an immersive experience to the subject undergoing MRI scans. Additionally, the same VR HMD may be adapted to generic medical use cases.

The project is to realize such a VR HMD which can address the above. To that end, an ARM platform running Android is designed as the VR HMD's embedded hardware. Linux device drivers are interfaced to Android's HAL to enable the functionalities of the VR HMD's peripherals such as the gyroscope, battery and camera. Various VR contents can then be developed using game engines such as Unity and are easily installed to the embedded PC as Android apps.

Company: Omni radar
Project: Design and development of a MIMO radar technology demonstrator with single-chip radar nodes
PDEng student: Rabia Zainab Syeda

Design of Electrical Engineering Systems
Track Information and communication Technology

Autonomous Driving Assistance Systems (ADAS) and/or self-driving cars need a number of sensors in the cocoon of the car that act as the eyes, ears and brain of the car. Most of these sensors cannot handle harsh conditions. Millimeter-wave radar (i.e. 60 GHz) offers better performance in various environmental conditions. Furthermore, recent technological advancements in the development of semiconductor technologies, highly integrated transceivers and integrated mm-wave antennas have granted the opportunity to develop a low-cost, low-power single-chip mm-wave radar with on-chip antennas. These facts give rise to an opportunity to design multi-node radar systems for low-cost applications, for example a MIMO (Multiple Input Multiple Output) radar system that is state-of-the-art in radar technology.

The PDEng project MIRACLE (MIMO Integrated Radar with wide-scan On-chip Antenna Co-Location Efficiency) focused on the design and development of a MIMO radar technology demonstrator with single-chip radar nodes, which include a complete transmitter and receiver front end with antennas on-chip, placed on non-regular sparse array grid on a printed circuit board with a distance between the elements that is larger than half a wavelength and an interface with a host PC.

Based on the design and functional requirements, a prototype (named REVEAL) has been realized with a set of two linear arrays of radar chips, chirp-generator section and data-acquisition section. The demonstrator can operate in different modes of MIMO radar.

Company: ASML
Project: Designing a stock-optimisation software tool for ASML
PDEng student: Rutger Bakker

Industrial Engineering

Every hour an ASML machine is down has a significant financial impact on ASML's customers. These customers minimize the downtime costs by having service contracts with ASML. To achieve the required service agreements, ASML operates a service network where spare parts are stored worldwide. The innovative nature of ASML challenges the planning of the service network. ASML continuously develops new systems and upgrades, which lead to improved versions of an individual parts, also known as engineering changes. Over the last years, the number of engineering changes has doubled and their complexity has increased. When a newer version of a part is introduced and the old version is still usable the combination of both parts needs to be managed as one product chain.

At the tactical planning level the stock settings are determined on a high level. The operational planning is responsible for fulfilling these settings while taking all relevant and complex engineering change aspects into account. During my PDEng project we developed a planning tool together with planners that screens the entire service network and proposes solution directions when needed. In addition to this screening function, the tool visualizes the service network and presents the relevant information in a user friendly way. This new way of working leads to a higher service level, lower inventory holding costs and a more efficient planning process.

Company: Broshuis BV
Project: Improving the steering system of trailers to reduce maintenance costs
PDEng trainee: Hendrik Spoelhof

Maintenance

Broshuis BV is a well-respected manufacturer of trailers for heavy and special transport. In this field of transportation the challenge is to use every trailer for moving both heavy and large size goods. Related to the current trend of replacing fossil power plants by for instance wind turbines, one can think of the blades, the tower sections and the top section which is housing the generator. The sector therefore demands trailers that can be used both effectively and efficiently.

The solution is found in trailers with a low loading floor, multiple axles of which most are steered and an extendable chassis. Due to regulations, the steering of the axles is achieved by a hydraulic-mechanical system. This system does not change when the chassis is extended, both enhancing reliability and preserving ease of operation.

In recent years, the industry has adopted independent suspension systems as higher axle load are allowed for trailers with such a suspension system. By upgrading the classical steering system to better suit the independent suspension system, such trailers show improved steering performance. However, due to the higher axle loads, higher lateral forces occur. This causes the mileage of the tires and lifetime of bearings to be similar to traditional trailers.

Maintenance on tires and bearings means downtime of the trailer, so this has to be decreased in order to achieve the desired increase in transport efficiency. The goal of the assignment is to further improve the steering system so that the maintenance costs and maintenance effort can be decreased.

To achieve this goal the behavior of the trailer during transport is investigated. First, the influence of vertical movement of the suspension is analyzed. Second, cornering at various speeds is analyzed and how this is influenced when the chassis of the trailer is extended. Recently trailers with an upgraded steering system addressing the first part have been delivered to the customers. Currently the second part is being addressed using vehicle dynamics and the design improvements are being created.

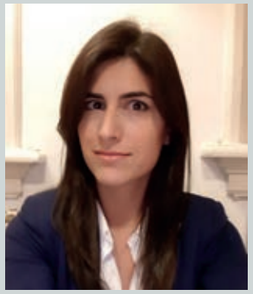
Company: Shell
Project: Energy optimization of solid sorbent CO2 capture technology
PDEng trainees: Mohammad Rusydi Fatahillah

Process and Equipment Design

Based on the 2°C temperature rise scenario of the International Energy Agency, the world needs to deploy CCS – a combination of technologies to capture and store CO^2, preventing its release into the atmosphere – to reduce 15% of the total CO^2 emissions reduction in 2050. CCS is the third largest contributor for CO^2 emission reduction after energy efficiency improvement and renewable energy.
A key role for society – and for Shell – is to find ways to provide much more energy with less CO^2. There are several strategies that Shell develops to achieve it, which includes CCS. A cost-competitive technology to capture CO^2 is desired to achieve wider uptake of CCS.
The existing solvent-based CO^2 capture technology results to a high cost of capturing CO^2 for the application of post-combustion CO^2 capture. Currently, the next generation CO^2 capture technology based on a reactive adsorption is developed at Shell. However, the new technology does not achieve the targeted cost reduction as compared to the solvent-based technology. Therefore, further performance improvement through energy optimization is desired.

Company: Corbion
Project: Crystallization Modeling and Reactor Design in Lactic Acid Production
PDEng trainees: Arancha Riquelme Piñera

Process and Product Design



The increase in the consumption of the natural resources is a fact that cannot be ignored by the different sectors in the industry. Consequently, the amount of waste generated is also growing. As a result, companies are being driven to the development of new products that could minimize this impact. PLA is one of these products, a biodegradable and biobased plastic that can be used in several applications such as packaging or in the automotive industry.

Corbion is the global market leader in the production of lactic acid, the monomer for PLA. For a better understanding of the lactic acid production process and how the design can be optimized in order to reduce manufacturing costs, Corbion proposed a PDEng project. The crystallization of a lactic acid salt is a critical step in the process to reach the desired capacity, and in this project a model of this phenomenon was developed.

The model, once validated, is used as an essential tool for further optimization studies and for the final design of a higher capacity section.
Several scenarios were proposed and the economic evaluation based on Capex was applied for each of them. The output is the most feasible economic scenario that will reach the desired capacity with optimized settings and a reliable tool that will allow Corbion to improve such a complex crystallization system and increases understanding of it.

Company: Epilepsy center Kempenhaeghe
Project: Designing a seizure detector for epilepsy
PDEng student: Joyce van Sluis

Qualified Medical Engineer

Tonic epileptic seizures carry a high risk for sudden unexpected death in epilepsy: all muscles continuously contract for a variable amount of time, including the respiratory muscles. When these seizures occur at night (when supervision is minimal) they are easily missed with current seizure detection methods incorporating movement detection, hearth rate detection, and video monitoring.

With a reliable seizure detection alarm, caregivers can provide medical care immediately if necessary. During this project a wearable device that measures muscle tension, heart rate and whether you're upright and active or lying down was developed. The sensor specifications were refined, clinical measurement studies were set up and performed, a first detection algorithm was developed, and now, the detection algorithm is being tested and further refined in clinical practice.

Company: Royal IHC
Project: Designing the perfect machine for the replacement of sewer systems
PDEng student: Ruud Spoor

Robotics

In the Netherlands alone, there is 111.000 kilometers of sewer system buried underground. Sewers are in general long lasting systems with some over a century old. These systems deteriorate over time and have to be replaced at some point. Sewer systems in the Netherlands are buried underneath streets and roads. Streets are broken up for extended periods of time to dig for old pipe sections and replace these sections with new pipes.

The traditional method of replacement is called trenched replacement. The closing of streets and roads with traditional methods causes great inconvenience for traffic and civil life. Especially in city centers the inconvenience is high due to limited space and high amounts of traffic. Sewers can be replaced without breaking up streets and roads completely. These methods are called trenchless replacement and solutions do already exist like pipe bursting and pipe reaming.

Ruud: *"Trenchless replacement methods do already exist for a long time. They are however not used that often in the Netherlands and are limited in their capabilities. Furthermore, there has not been any major innovation in the trenchless replacement market for over thirty years.*
In collaboration with Royal IHC, we started a project to solve difficulties of existing trenched and trenchless replacement methods. It is my job as a PDEng student to investigate and develop a new innovative prototype for the trenchless replacement of sewer pipes. Instead of improving existing replacement technology, we decided

to start system design from scratch. The municipality of Rotterdam was contacted for customer requirements and delivered a challenging use case for an ideal replacement machine based on an existing piece of sewer system in the center of Rotterdam.
It is our goal to develop an innovative and perfect replacement machine to replace sewer systems directly beneath your feet without you even noticing."

Company: SEAC
Project: Bringing Building Integrated Thin-Film PV to the market
PDEng student: Finn Vossen

Smart Buildings and Cities

Today, many people think solar panels are only ugly, grey rectangles. But thin-film photovoltaic (PV) technology can be so much more: flexible, transparent, and in any colour and size you might want. In the PV OpMaat project, we're working to get this technology to the market. It's not easy: people want well-known, efficient and proven technology, and are hesitant to try something new. I'm connecting the world of construction and the world of PV to build demonstrators so people can see the technology in real life.

Based on insights that followed from understanding TF technology and observing the market, a design challenge was defined. This resulted in the ideation of three demonstrator concepts:

1. Super flexible, custom-sized Thin Film foil from the roll on lightweight substrate for building applications
2. Thin Film Solar glazing in different transparencies for façade application
3. Custom sized and coloured Thin Film panels for solar façade application

Taking into account technology readiness level and market demand, the third concept was the most promising in terms of addressing various markets in the short term. Therefore this concept was further elaborated in the prototype phase and tested with the help of writing a business plan. This plan explains the potential route of a Solar Façade to market.

Based on the recommendations formed in this PDEng project, a demonstrator of the third concept has recently been completed (March 2018) by the consortium that was formed during the PDEng project.

In summary, the PDEng project showed how two steps of product development – 'From technology to prototype' & 'From prototype to product' – came together.

Company: ProRail B.V.
Project: An Analysis of the Benefits of EULYNX- style Requirements Modeling for ProRail
PDEng student: Linh Ngoc Bui

Software Technology

In the Netherlands, the travel density by railway is one of the highest in the world, leading to significant safety and efficiency requirements throughout the country. Therefore, ProRail always looks for innovative projects to improve these aspects. This project is part of ProRail's research in the EULYNX project about the benefit of model-based system engineering in the field of railway signaling.

This project's main focus is to analyze SysML models from EULYNX and ProRail's contexts in order to answer questions and to give recommendations to ProRail from the modeling perspective. The project developed three methodologies to serve the analysis: the methodology for comparing the ProRail and EULYNX subsystems, the methodology for implementing traceability, and the methodology for implementing simulation. Based on the current status of ProRail, the project suggested a model based approach in the future for ProRail.

This project has enabled ProRail to come up with well-founded reasons to support its conclusion about EULYNX that although EULYNX potentially shows its benefit in modeling to ProRail, it is still too soon to decide whether or not EULYNX is mature. Before that, ProRail needs to make sure that its interface requirements are aligned with EULYNX specifications.

The active involvement of ProRail in the verification and validation process of EULYNX is one of the factors. Requirements traceability played also a crucial role.

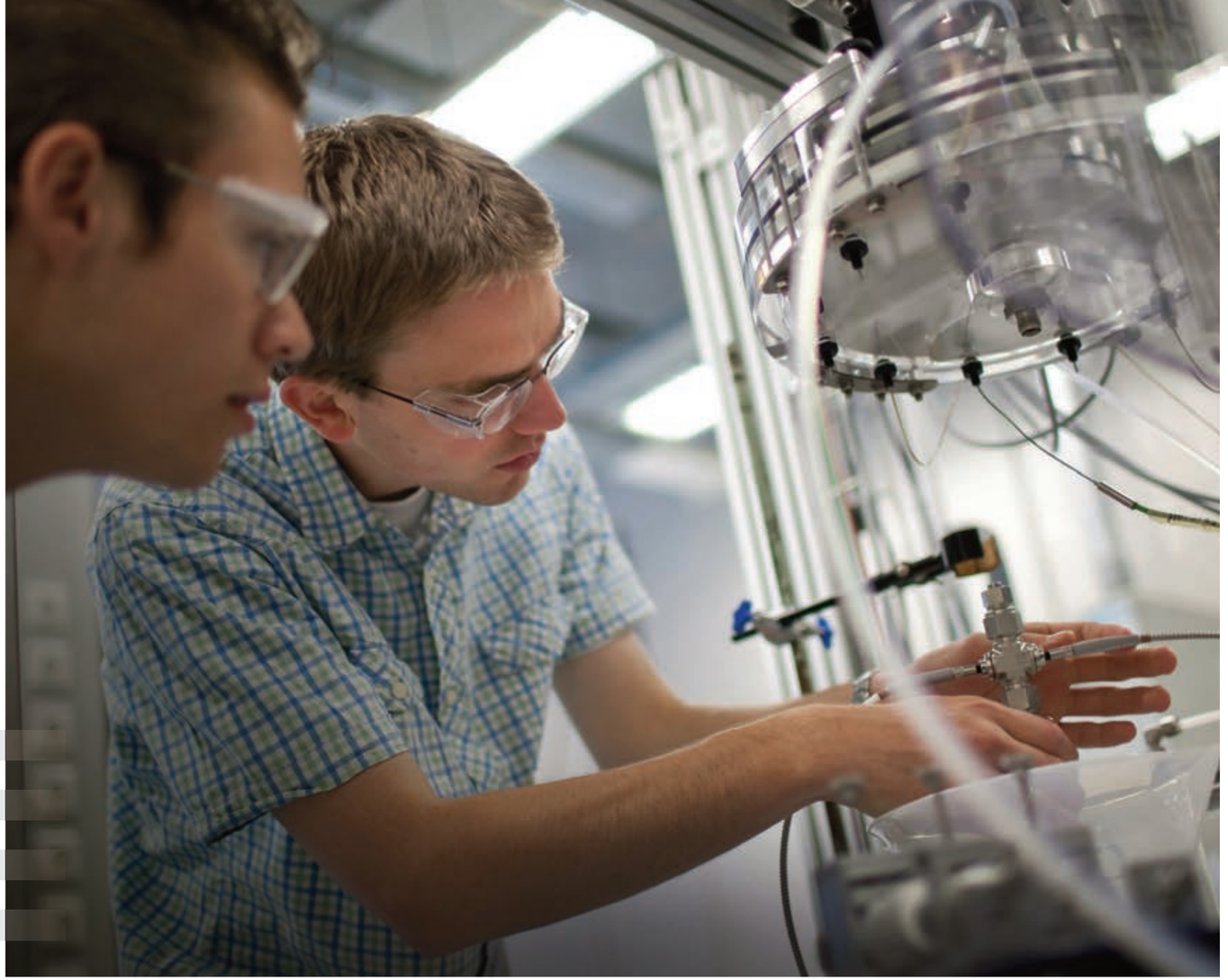
Company: Bellabeat, Inc-San Francisco, CA, USA
Project: Humanizing Bots: Personality and Social Role of Conversational Agents
PDEng student: Stefan Manojlovic

User System Interaction

A potential revolution is happening in front of our eyes with developments of AI (Artificial Intelligence) technologies around the globe. Examples of these technologies are Apple's Siri, which animates our iPhones, and Google's assistant, which is heading towards being a true virtual companion. These technologies are perceived as (virtual) agents, acting on behalf of the user in a computer-based environment using natural language.

A major challenge is that these agents lack in the intuitive capability of human beings to see meaning, relationships and possibilities beyond the reach of senses. The aim of this work is to really explore human aspects, defined through personality and social role, within the confines of computer agents that go beyond correctness and intelligence.

At Bellabeat we developed Airi, a coach-bot app that helps people with their well-being by giving advice to people in a form of conversation. Five studies in total have been deployed and analyzed in this research in order to explore and understand the humanness in chat-bots. We found a weak but significant impact of humanness in chatbots, meaning the impact of an agent is slightly higher when both people and chat-bot present similar traits of human-like attributes.



The Professional Doctorate in Engineering (PDEng) programmes in brief

Programme	Founded	Graduates 1988-2016	Location
Industrial Engineering*	1988	353	TU/e
Design of Electrical Engineering Systems (Track Information & Communication Technologie, Track Healthcare Systems Design)	1988	254	TU/e
Process and Product Design	1989	428	TU/e
Mathematics for Industry*	1989	305	TU/e
Software Technology	1990	437	TU/e
Design and Technology of Instrumentation	1991	164	TU/e
Process and Equipment Design	1991	196	TUD
Bioprocess Engineering	1994	138	TUD
Architectural Design Management Systems*	1996	93	TU/e
User System Interaction	1998	320	TU/e
Automotive Systems Design	2011	50	TU/e
Smart Buildings & Cities**	2011	34	TU/e
Energy & Process Technology	2011	10	UT
Robotics	2011	7	UT
Civil Engineering	2011	13	UT
Clinical Informatics	2012	43	TU/e
Chemical Product Design	2012	13	TUD
Maintenance	2014	1	UT
Qualified Medical Engineer	2014	11	TU/e
Data Science	2016	-	TU/e

** These programmes are being built down. The current trainees will be supported during their finalisation of the programme in order to receive the PDEng degree. / ** Before Smart Energy Buildings & Cities*

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.

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