Our selection of recent designer projects

The innovation degree

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Although innovation should be everybody’s concern, only a few can really make a difference. Universities have traditionally two tasks: research and education. The last decade a third task has been added, namely: innovation or knowledge valorization. Innovation is the right expression from the perspective of industry or society. However, for universities it is a way to transfer knowledge into value, which explains the term knowledge valorization.

The programs of the 3TU.School for Technological Design, Stan Ackermans Institute train the best young engineers. In the first year of the program the trainees receive an extensive training, which prepares them to develop an innovative artefact during the one-year design project in the second year of the programme. The trainees work on these design projects under supervision of the university staff and with active participation and guidance of the university staff and an industrial mentor. These trainees do not only become top-engineers, they also realise a real contribution to industry or society in the form of the outcomes of a design project.

To demonstrate the value of the outcome of the design projects executed by our trainees, we’ve made a selection of our recent industrial projects for you and combined them in this publication. We hope you enjoy reading about the projects produced by our talented trainees.

With best regards,
3TU.School for Technological Design, Stan Ackermans Institute
The Vehicle Follow Control (VFC) is an assistance function that reduces the workload of the driver by automatically following the preceding vehicle. This is particularly useful in congested traffic situations, where the speed has to be constantly adjusted. The VFC function has the potential to improve safety, comfort and fuel efficiency by partly taking over the driving role.

A specific systems engineering approach (CAFCR) was used to transform the customer needs to a set of system requirements. These were used as an input to design the functional and control architecture. The design of the VFC controller consists of a supervisory logic and a dynamic controller. The Controller was designed using a model-based approach using Matlab/Simulink. The Verification and Validation phase was performed according to the V-cycle model; firstly by a component level, second by an integration level and finally by a function level, where the function was implemented in a prototype vehicle by Rapid Control Prototype (RCP) techniques.

The RCP platform created during this project allows the company to explore more possibilities for longitudinal control and integration with existing functions.

"Not only did Antonio develop a convincing supervisory control and dynamic control, but also he managed to solve the very challenging system-interaction-puzzle in order to get the Rapid Control Prototype vehicle running. Driving the vehicle and experiencing the Vehicle Follow Control in action was a fantastic experience that definitely proved its value."

ing. Rutger-Jan Kolvoort
DAF Trucks N.V.

The RCP platform created during this project allows the company to explore more possibilities for longitudinal control and integration with existing functions.

Supervisor: ing. Rutger-Jan Kolvoort, Senior Engineer Functional Integration at DAF Trucks N.V.
Trainee: Antonio Colin MSc PDEng
Clinical Informatics
Information Management around Medical Devices, a case study in Cardiology, Tergooiziekenhuizen, 2013

“A solution to the increased complexity is standardization of information.”

Ir. Guido Zonneveld
Tergooiziekenhuizen

Tergooiziekenhuizen currently has more than 7500 medical devices, used for the examination, treatment and care of patients. While more and more medical devices are able to generate results digitally, the hospital has not yet developed a policy regarding structural processing, accessing and archiving this information. The goal of the project was to come to a information architecture, which includes the medical devices. The cardiology department was taken as the first implementation pilot.

When using a medical device, the following steps are applied: planning, identification, acquisition, storage, processing/reporting, distribution in the hospital and information exchange with external parties. Presently the execution of these steps differs per device. The goal is to come to one common workflow (while some deviations will probably always exist).

By studying the present situation through observation, interviews and analysis, current generic bottlenecks were identified. The knowledge and insights obtained throughout the curriculum were combined to define a vision and recommendations to eliminate these bottlenecks.

At the Cardiology department the following steps have been taken, which brings it significantly closer to the desired state:

• Application of standardized HL7- and DICOM connections to implement a fully system-supported workflow for catheterization and ultrasound procedures,
• Application of a singular platform for storage of cardiac images,
• Distribution of catheterization and ultrasound reports as part of the general hospital information system,
• Agreement on the assignment of responsibilities and duties for information and configuration management,

In addition the pilot set up has been generalized into guidelines for implementation in the whole hospital.

Supervisor: Ir. Guido Zonneveld, RVE manager klinische fysica en medische techniek at Tergooiziekenhuizen
Trainee: Maayke Klinkenberg PDEng
Dimethylcarbonate (DMC) is a highly versatile and eco-friendly product. DMC can be used as a solvent in coating formulations, as a substitute of phosgene in polycarbonate production and as a methylation reagent. The state-of-the-art is Asahi Kasei technology which produces DMC from ethylene oxide (EO) and CO₂ as starting materials.

AkzoNobel has been investigating different alternative routes to produce DMC from CO₂ and alcohols without the use of ethylene oxide. A low equilibrium conversion demands for a smart separation process to isolate the product. Separation of carbonates from alcohols by distillation is hampered by either high energy consumption or azeotropes. The main goal of the work is to investigate the feasibility of alternative separation methods, such as extraction and extractive distillation, for two selected DMC synthesis routes.

One of the routes involves the separation of A (an intermediate carbonate) from B (an alcohol). To reduce energy consumption, extraction was selected to separate A from B. An extracting agent was selected. The results of the rigorous simulations show that it is technically feasible to separate A from B by extraction. The total energy consumption is then 33% less than that of a traditional distillation process. A rotating-disk contactor (RDC) was selected as the most suitable extractor.

Another route involves transesterification with methanol and another compound to synthesize DMC. It was proposed that DMC and methanol should be separated by extractive distillation using phenol as an entrainer. Extractive distillation was revealed to be more energy efficient than commercial pressure swing distillation. Heat integration and optimization of the operating conditions led to 21% further reduction in energy consumption.

 Supervisor: dr.ir. Thijs de Groot, Innovation Technologist at AkzoNobel Industrial Chemicals
Trainee: Si Zeng MSc PDEng
Philips Healthcare is market leader in Interventional X-ray (iXR) equipment. Hospitals are more and more managed as regular businesses; therefore, fast and reliable service of this equipment is crucial. The main indicator for measuring serviceability is Elapsed Time To Repair (ETTR), i.e., the time from the customer’s call indicating a problem until the moment that the problem is resolved. The business objective of this project is to reduce the ETTR and therefore lower the service costs and improve the service quality, by focusing on diagnosability of the systems.

The Design for Diagnostics (D4D) team in Philips Healthcare is developing and deploying a method that takes serviceability structurally into account during the design phase of a system and provides a way of diagnosing a failure in the system. However, this method has several severe constraints that limit its practical side and scalability.

The goal of this project was to create a prototype of one possible solution for overcoming those problems. The designed solution provides a mechanism for composing the diagnostic models, which broadens the scope for performing diagnostics from a group of components to the system level. Also, by making a clear distinction between the physical structure of the system and the logical propagation of failures through the system, support for different system configurations is provided. The final product of this project is the Diagnostic Reasoner, which is a graphical user interface that guides the field service engineer stepwise to the root cause of the problem in the system.

This project was a study aimed for the D4D team to learn what possibilities exist for improving the method of diagnosing failures in the medical systems. It was the first attempt of extending and optimizing the D4D design method which serves as a proof of concept for a solution that can be applied in the context of Philips Healthcare iXR systems.

"In her nine months project, Ivana delivered an impressive amount of work, which has deepened our insights in the challenges of creating a solution for Diagnostic Reasoning."

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**Supervisor:** dr.ir. Marcel Boosten PDEng, Solution Architect Diagnostics at Philips Healthcare  
**Trainee:** Ivana Kostadinovska MSc PDEng
Dredging is crucial to maintain commercial waterways for ships and barges around the world. The in-line density of the water-sand mixture created during dredging is crucial for the efficiency of this process. At IHC an innovative density measurement method was developed, using a radio wave (RF) propagating across a pipeline. Laboratory measurements were successful, however real life trials revealed that salt content of estuary water seriously disturbs the measurement.

The task of the project was to investigate and tackle the problem caused by salty water, including the development of an operational prototype. First a series of carefully designed experiments were performed on the existing prototype. We investigated all aspects of the signal path, followed by physical modelling of the influence of salinity on the signal propagation. The main experimental actions were performed using a dedicated pump setup.

It was discovered that not only the signal level and phase accuracy but also the frequency spectrum are crucial for correct determination of the density. A vast body of experimental data was obtained, and a measurement algorithm was derived, allowing for real time measurements of density, regardless of the variations of salinity of the mixture.

A working prototype of the RF density meter was delivered. The results obtained show that the RF method has a potential to outperform the current density measurement methods. As a result, IHC Systems is ready to build a first device which can be offered to customers and revolutionize the market of inland dredging vessels.

Supervisor: dr.ir. Martijn van Eeten, Product Manager Hydrographics at IHC Systems
Trainee: Kris Zych MSc PDEng
“The PDEng degree not only shows the right characteristics of a design engineer like the motivation to broaden their knowledge, developing themselves, pro-activity, a self-steering attitude and the will to be successful. You also know that these persons have already gone through a tough selection procedure.”

dr. ir. Marcel Boosten, Solution Architect Diagnostics at Philips Healthcare (Alumnus Software Technology)

“I work with trainees from the technological designer programme MI in Eindhoven. Why? Within our field, we work on the edge of the (im) possible. This requires exceptional design engineers who can establish exceptional results, people who want to change the world. You will find these people at the technological designer programmes at the Stan Ackermans Institute.”

dr. Katya Vladislavleva, Chief Data Scientist at Evolved Analytics Europe BVBA. (Alumna Mathematics for Industry)
“The ICT programme was the smoothest transition from the theoretical world of the university, to the competitiveness of Industry.”

Panos Afxentis MSc PDEng trainee ICT

“The more efficient prototype was a long desired breakthrough for the organisation. Hence a request to further develop the prototype as a PhD project did not hold off for long. For me the next step in my career, for IHC Merwede the possibility to further develop the prototype into a solid and future-proof design.”

Kris Zych MSc PDEng, R&D Engineer at IHC Merwede (Alumnus Design and Technology of Instrumentation)
A properly designed bell is an acoustic body that generates a sonorous sound composed of a coherent combination of frequencies (partials). Perfect bells were created by the famous Hemony brothers in the 17th century. With their death the secret of the perfect bell died too. Even to date, that secret has not been revealed. Bell founders rely upon the expertise of craftsmen in the manufacture of bells. Driven by innovation, Royal Eijsbouts needs a software application that, with high precision, predicts the fundamental partials of a bell given its geometry. The application merges craftman experience and scientific techniques based on mathematical models.

Royal Eijsbouts seeked collaboration with Mathematics for Industry (MI) with the ultimate aim to model the whole process of bell founding. Mariana Goldak was one of the trainees of MI who worked towards reaching that goal. Her research included aspects of the bell manufacture process such as the dynamic system of bell and clapper, and the relationship between tonal structure and geometry of a bell.

Mariana formulated mathematical models and incorporated them in user-friendly software. The 2D-simulation of a bell-clapper system allows analyzing synchronization in the bell-clapper dynamics as function of geometrical and material parameters. Synchronization guarantees a pleasing sound that occurs when the clapper strikes the bell at the right moment of time and with the right time period. The other application that Mariana developed relates to the tuning process. With an iterative mathematical optimization approach, the partials of a bell can be accurately tuned by changing its inner surface. Simulation of cut-off profiles is used to instruct the tuning equipment how much material to remove in a tuning step. The result of the proposed tuning protocol is a smooth inner profile of the bell with a specified tonal structure.

Mariana showed that essential processes in the manufacture of bells allow mathematical modeling with a highly predictive power. Thus she contributed in revealing the secrets of the perfect bell using the link between music and mathematics.

Supervisor: Bert Augustus, Campanologist Royal Eijsbouts
Trainee: Mariana Goldak MSc PDEng
This design project for Shell concerned the development of Fischer-Tropsch technology: a method of converting natural gas into liquid fuel. This conversion required new, highly active catalytic converters but these generated a lot of heat. The controlled discharge of that heat was central to the project.

A conventional Fischer-Tropsch reactor contains thin tubes through which the reaction mix flows. Individual catalytic particles react with the gas and the resulting heat is absorbed by the cooling water that flows around the tubes. When the new catalytic converter is used, there is not enough heat discharge. So TU Delft is investigating a new kind of reactor in which the tubes contain thin, elongated strips (‘structured packings’) coated with the catalytic converter. While the gas flows between the strips, it reacts with the coating. The structure of the strips is such that the heat transfer can occur very specifically on the wall of the tube, making the heat transfer twice as efficient.

The concept for the new reactor already existed. The requirement was to mathematically model the entire system and optimize the design within a feasibility study. How thick must the coating on the strips be, how wide and long must the tubes be to achieve the optimum ratio between the costs and the efficiency of the system? Scientists tend to want to continue improving a design even if the economic gain in doing so is negligible.

A second objective of the project was to implement the Delft Template for Conceptual Process, developed by TU Delft. This highly structured method was developed to enable complex design processes to run as efficiently as possible. Shell wanted to know whether the template would be suitable for its design programmes. The recommendation to Shell was positive.

Supervisor: ir. Jan van Schijndel
Trainee: Fiethamelkot Emun Temeliso MSc PDEng
The last years much attention has been given to the environmental quality of school buildings for primary and secondary schools as there is a clear link between environmental quality in schools and educational performance. Research proofed that a healthy school environment has a positive effect on enhanced educational and teaching performance.

Stichting Ruimte voor Onderwijs en Kinderopvang (Ruimte-OK) offers solutions for developing, financing and managing housing for primary and secondary schools, child care organisations and municipalities. Ruimte-OK is an initiative of the Guarantee Fund Child Care, the PO-Counsel, VO-Counsel, VNG and branche organisation Child Care.

For Stichting Ruimte-OK tools were developed that manage the whole life cycle of accommodation, from setting up a programme of requirements, managing the process of development and engaging the (future) inhabitants up to the evaluation of the quality of the building and its environment. The evaluation exists from the measurement of the user satisfaction as well as the building’s performance.

By using these tools, executive boards of schools and child care organisations are more in control over the development, cost structure and quality of their building.

“As an independent knowledge centre these tools help us with providing excellent service to our target audience (municipalities, schools and child care organisations) which helps them controlling the quality of their school buildings.”

mr. Jan Schraven
Stichting Ruimte-OK

Integrale instrumentenreeks

Ideefase (Her)ontwikkelingsfase (Her)gebruiks fase

Scholenbouwwaaijer Gebruikersparticipatie

Kwaliteitsstandaard Processturing

Subjectieve kwaliteitsmeting: gebruikerstevredenheid

Objectieve kwaliteitsmeting: meting gebouwprestaties

Exploitatie- & investeringskosten

Supervisor: mr. Jan Schraven, Head of Stichting Ruimte-OK
Trainee: ir. Ferdie van de Winkel MSc PDEng
Transcranial Magnetic Stimulation (TMS) is a non-invasive diagnostic tool and revalidation aid for a wide variety of brain diseases such as depression and stroke. It generates electric activity in a very specific part of the brain by means of a magnetic pulse. This electric activity can change the local brain behavior for a short time, but is also used for its long term effects and is a standard method to identify the functional topology of the brain. It has been shown that TMS stimulation of the brain of stroke survivors helps speed and level of recovery.

In order to get repeatable, accurate and safe results a robot has been developed for placing the magnetic stimulator against the skull. This will relieve the physical burden for physicians to keep the stimulator of 2 kg against the patients’ head for sessions up to 30 minutes and also allow the stimulation to be exactly on the same place during different session.

The TMS robot is currently being developed in collaboration with ANT Neuro (Enschede) at the University of Twente. In the next iteration, it will be included as a component in the ANT’s clinical TMS system for use in hospitals and rehabilitation clinics.

The novel light-weight design of the robot allows safe stimulation of the motor cortex with millimeter accuracy. It uses commercially available optical-stereotactic devices to track the movement of the patients’ head. Currently the robot can be used in normal application while the patient is sitting a chair. However the goal of this project is to use this stimulation method during activities such as treadmill walking and hand reaching tasks.

Supervisor: dr.ir. Arno Stienen
Trainee: ir. J.J. de Jong
The final project took place in the FEI Company, a leading supplier of scientific instruments for industry and science. The goal of the project was to redesign the User Interface of the new FEI Transmission Electron Microscope (TEM) “Metrios”. Metrios was created to provide fast, precise measurements using automated processes and measurement procedures. The requirement was to be easily operated through a simple and highly usable interface without requiring specialized operator training.

The project was planned and executed following the User Centered Design (UCD) process. That involved four phases: context specification, user requirements specification, design, and evaluation. First, the context and requirements were identified by reviewing the FEI project documentation and through interviews with the FEI stakeholders. Then, the design cycle started with the usability evaluation of the current User Interface by means of user tests and heuristic evaluation. Subsequently, the new design was developed through an iterative process. Two working prototypes, a low fidelity and a high fidelity, were created and tested with users. A final prototype was then developed and delivered together with an explanatory document and design guidelines for future projects.
Top 25 industrial partners 2010-2013

The technological designer programmes in brief

<table>
<thead>
<tr>
<th>Programme</th>
<th>Founded</th>
<th>Graduates to date</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td>Logistics Management Systems</td>
<td>1988</td>
<td>322</td>
<td>TU/e</td>
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<tr>
<td>Information and Communication Technology (incl. Healthcare Systems Design)</td>
<td>1988</td>
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<td>TU/e</td>
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<td>Process and Product Design</td>
<td>1989</td>
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<td>Mathematics for Industry</td>
<td>1989</td>
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<tr>
<td>Software Technology</td>
<td>1990</td>
<td>370</td>
<td>TU/e</td>
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<tr>
<td>Design and Technology of Instrumentation</td>
<td>1991</td>
<td>133</td>
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<tr>
<td>Process and Equipment Design</td>
<td>1991</td>
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<tr>
<td>Bioprocess Engineering</td>
<td>1994</td>
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<td>Architectural Design Management Systems</td>
<td>1996</td>
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<td>User System Interaction</td>
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<td>BioProduct Design</td>
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<td>Comprehensive Design in Civil Engineering</td>
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<td>Automotive Systems Design</td>
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<td>Smart Energy Buildings &amp; Cities</td>
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<tr>
<td>Chemical Product Design</td>
<td>2012</td>
<td>-</td>
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</table>
3TU.School for Technological Design, Stan Ackermans Institute offers two-year postgraduate technological designer programmes.

This institute is a joint initiative of the three universities of technology of the Netherlands: Delft University of Technology, Eindhoven University of Technology and University of Twente.

More information
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