A Day in the Light

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The research is embedded in the Sound Lighting program line of the Intelligent Lighting Institute (Eindhoven University of Technology)

Research plan for project at Eindhoven University of Technology

The recent discovery of a third type of photoreceptor in the human eye has spurred a mass of research investigating light's potential to affect human functioning. We have now begun to understand better how and why light exposure affects our biological rhythm and impacts psychological functioning. The lighting industry has already picked up on these insights in the design and development of new lighting systems, bringing more intense and/or blue-enriched light in offices, schools and hospitals. Indeed, alerting and vitalising effects of light have been established in empirical research. Most of these studies have investigated effects during the night, but recently also during daytime. Diurnal effects are typically explored during (bright) light exposure. Little is known about the effects of prolonged periods of exposure and the after-effects of bright light exposure during daytime. There is therefore, a great need for research with a more continuous and interactive diurnal perspective on light and human functioning.

In the current project we aim to explore light's role in cognition and affect during daytime,

- how do the dynamics of daily light exposure relate to daily curves in vitality, alertness, and cognitive performance?
    - does the effect of light depend on time of day?
    - does the effect of light depend on mental status?
- do individuals experience after-effects of diurnal exposure to extremely light or dark settings?
- can we optimise performance (& human functioning in general) by dynamically tailoring light settings to an individual's circadian rhythm and incidental fluctuations in alertness and mood.

In a series of studies, we will be

- collecting psychophysiological data, light exposure data, self-reports and task performance, to explore statistical relationships between the respective curves
- exposing participants to different light settings and tracking their cognitive and affective state throughout the remainder of the day
- sensing individuals' cognitive and/or affective state and offering specific light settings to explore their effectiveness in the short and longer term.

Keywords: light; psychology: cognitive functioning, affect; psychophysiological measurement; longitudinal perspective

The research is clearly interdisciplinary. We require that the candidate should be skilled in several of the domains below and has a demonstrable keen interest in the other ones.

- psychology
- psychophysiological sensing
- lighting
- advanced statistics (mixed models, time series)

Few-body systems with strong interactions

Experiments with strongly interacting ultracold atoms have discovered an effect which was predicted 40 years ago in the context of nuclear physics. This is the Efimov effect, where three particles can be bound together in a scenario of infinitely many bound states converging onto the dissociation threshold. Universal relations, as well as the tunability of the interaction, make that this effect can be studied conveniently in atoms physics. However, not all observations reveal universality, and some experiments are contradicting each other. For this research programme, the Ph.D student will investigate the transition from universal to non-universal three-body physics by manipulating two-body interactions, and study the discrepancies in the experimental observations. Part of the project is also to study how few-body systems such as Efimov trimers, which are very unstable to collisions, can be associated and stabilized by putting them in optical lattices, using radio-frequency techniques. Realization of stable few-body objects allows for a direct experimental observation of such systems. This project will be also of interest to other research fields, such as nuclear and cluster physics, as well as to many-body physics of ultra cold gases and condensed matter systems.

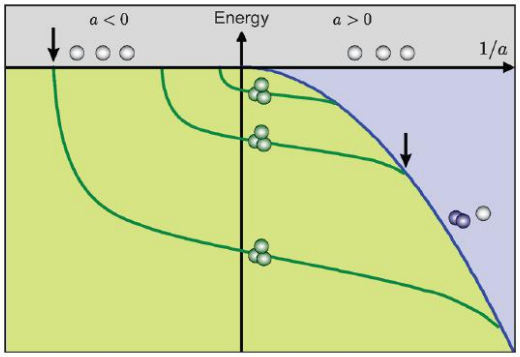

Figure 1: Molecular dimer and Efimov trimer states as a function of the inverse scattering length $1/a$. The horizontal line indicates the threshold to the three-body scattering continuum (gray). The purple region marks the atom-dimer continuum for $a > 0$, and the green zone indicates the trimer region. A Feshbach resonance controls the dimer binding energy that scales as $-1/a^2$. The arrows mark the intersection of an Efimov trimer with one of the thresholds.

The reason that the Efimov effect was not discovered in nuclear systems lies in the fact that it is very difficult to manipulate the strong nuclear forces. In atomic systems, however, the atom-atom interaction can be tuned via Feshbach resonances by varying the magnetic field. The two-body scattering length diverges on resonance to infinity, and is typically described by the dispersive formula

$$a = a_{bg}\left(1 - \frac{\Delta B}{B - B_0}\right), \tag{1}$$

with a_{bg} the background value of the scattering length, B the magnetic field, B_0 the resonance position, and ΔB the width of the resonance. At the basis of a successful research project on ultracold strongly-interacting few-body systems, a thorough understanding of two-body interactions in all its complexities is required, since the few-body properties crucially depend on it. Moreover, detailed knowledge of the interaction potentials is needed to be able to perform high-precision calculations. Besides the two-body scattering length, also a three-body cutoff parameter κ is needed to capture the short range physics.

Our group is highly experienced in ultracold two-body interactions, in particular in the strongly interacting regime. For this project we will make use of numerical calculations, which are based on a coupled-channels method, which allows for an exact treatment of the scattering properties and bound state spectrum of the spin-dependent interaction problem. However, we will also use very powerful analytical methods, for instance the Asymptotic Bound state Model that we developed, and which now is widely used to analyze measured Feshbach resonance spectra.

The two main objectives of this proposal can be summarized as follows:

Objective 1: Study the role of the three-body parameter κ. Experimental observations suggest it is closely connected to the range of the two-body potentials, but theoretical understanding still needs to be developed.

Objective 2: Investigate how few-body systems such as Efimov trimers can be associated and stabilized, by using optical lattices and radio-frequency techniques. When this can be realized, it allows for direct experimental study of such systems.

Advisor: dr.ir. Servaas Kokkelmans, *Quantum gases with strong interactions*, Coherence and Quantum Technology, Department of Physics, Eindhoven University of Technology. More info: `http://crossover.phys.tue.nl`.

Healthcare Process Support and Management

Description of thesis topics

A major challenge confronting the healthcare industry is the integration of evidence-based clinical guidelines with clinical, operational (logistic) and administrative workflow models, especially if the goal goes beyond the conventional business goal of delivering high quality care. Healthcare organizations are also faced with additional challenges on a daily basis: they also have to consider efficiency, safety and accountability in their care delivery processes.

Many hospitals have successfully formalized over time the clinical practices of their medical specialists, nurses and support services into (semi)automated care task lists, care protocols, as well as drug management, test ordering and more general administration systems. Fewer hospitals have an information system architecture where an explicit workflow management layer supports the monitoring and reconfiguration of processes across the previous legacy systems of the hospital departments. How can we expect that such hospitals manage to follow the best possible care (following clinical guidelines), considering their local limitations?

Limitations are not restricted to outdated information system architectures: problems already start when generic best practices have to be made specific to a hospital-local situation, where for example a particular scanner type has to be used as an acceptable alternative for the scanner type implied by the clinical guideline. Therefore, specialized enterprise modeling techniques are urgently needed: it should be made more transparent (1) what the resources at a particular hospital are, (2) what is the workflow that medical specialists want to realize, regardless of information system details, (3) how the workflow can be supported by specific workflow and decision support systems, and (4) which decision methods and algorithms can add the most value to support the workflows.

Due to the lack of these fundamental elements, many hospitals fail to keep up with the rapidly changing environment in which they operate. For example, hospitals are increasingly just one cooperating party in a cross-organizational care delivery chain. Consider for example the treatment of child diabetes: this requires such specific expertise that many hospitals in The Netherlands are relying on specialized treatment centers, such as Diabeter[1]. Hospitals that do continue providing that type of care tend to rely on load balancing strategies in operational business networks, such as Kidz & ko[2]. This enables them to provide 24/7 care without excessive personnel costs. Managing the processes that span such business networks is even more challenging than managing processes within individual hospital enterprises. Therefore, business process management, decision support and electronic health record systems urgently need to be evaluated and redesigned in the context of such complex network dynamics and made more intelligent, so that a smart environment for the best healthcare delivery can be designed.

[1] http://www.diabeter.nl/
[2] http://www.kidzenko.nl/

The Healthcare Cluster from the Information Systems group at the Industrial Engineering department of Eindhoven University of Technology (**TU/e**) is specialized in improving the safety, effectiveness and efficiency of operational processes within and across hospitals, health and treatment centers, private clinics, and other medical institutes. In particular, the cluster has experience on successfully applying workflow, simulation, decision support, data and process mining, and transformation techniques in this context [1]. We have many ongoing projects as well as some promising recent initiatives (e.g., [2]) that have significant potential for elaboration via Ph. D. projects.

[1] http://is.ieis.tue.nl/?page=research/healthcare&subpage=publications
[2] https://sites.google.com/site/myphrmachines/

Group leader: prof.dr.ir. U. Kaymak

Uzay Kaymak is professor of healthcare information systems at the Information Systems (IS) Group of the School of Industrial Engineering of Eindhoven University of Technology. His research is on intelligent decision support systems, business intelligence, data mining and computational modeling methods. He has been a partner in various EU funded projects. Currently, he is leading the healthcare cluster of the IS Group. Prof. dr. ir. Kaymak has authored more than 150 scientific publications in the fields of intelligent systems and computational intelligence. He serves in the editorial board of several journals such as IEEE Transactions on Fuzzy Systems, Fuzzy Sets and Systems, and Soft Computing. He is also a member of the various technical committees of the IEEE and served in the program board of multiple international conferences.

Chinese scolarship council topics group Schouten "Chemical Reactor Engineering", Department of Chemical Engineering and Chemistry, TU Eindhoven

Topic title: **Direct epoxidation of propene using gold catalysts in a microreactor**
Name supervisor: Dr.ir. T.A. Nijhuis
E-mail address: T.A.Nijhuis@tue.nl

Summary
Gold-titania catalysts are capable of directly epoxidizing propene with high selectivity in a single step using a mixture of hydrogen and oxygen. Before these catalysts can be applied commercially however, their activity needs to be improved as well as their hydrogen utilization efficiency. Using kinetic and mechanistic knowledge of this reaction, in this project we are working to develop both novel catalysts and reactors for this system. Microreactor technology allows us to safely operate with gas mixtures within the explosive regime, which has already resulted in a significantly improved conversion.

Topic title: **Spinning disc-assisted crystallization**
Name supervisor: Dr.ir. J. van der Schaaf
E-mail address: J.vanderSchaaf@tue.nl

Summary
Spinning disc contactors use high shear and high gravity to obtain high heat and mass transfer rates. This technology is therefore superior for mass- and heat-transfer limited processes. Until now, application for multiphase reactions has been investigated, i.e. gas-liquid processes with and without heterogeneous catalyst In this project we will study the opportunities for application of the spinning disc contactor in crystallization, which is in essence a mass and heat transfer limited process. Different types of crystallization will be investigated. The resulting engineering correlations will be used to optimize the design and control of the spinning disc crystallizer.

Topic title: **Butadiene-based synthesis route to nylon-6**
Name supervisor: Prof.dr. J. Meuldijk
E-mail address: J.Meuldijk@tue.nl

Summary
The possibilities of synthesis of nylon-6 from butadiene will be explored. The activities will contain catalyst development, selection, development and testing for the different synthesis steps in the process. The design, testing and control of reactors and the complete process will be made based on the outcome of the catalyst studies. Establishing the economic and technical feasibility of the new process will finalize the project. A catalytic and an engineering position will be available.

Unstable operation of mixed-flow and axial flow pumps

Research project for Chine Scholarship Counsel (CSC) PhD candidate

Section Process Technology
Department of Mechanical Engineering
Eindhoven University of Technology
Contact: dr. B.P.M. van Esch

Synopsis of the research

Unstable operation of mixed-flow and axial flow pumps is characterised by a reduction of the pressure head of the pump and the occurrence of fluid flow pulsations and vibrations. It greatly reduces the safe operating range of these types of pumps which are, for example, widely used in pumping stations for water-level control and flood prevention in both the Netherlands and China.

In this project, the unstable operation of mixed-flow pumps is studied both by experimental research and numerical calculations (CFD). It covers (*A*) measurements of fluid-induced forces on the impeller and pressure pulsations in a commercial mixed-flow pump, and (*B*) transient CFD calculations of the flow including fluid-structure interactions.

The aim is to understand how flow instabilities develop and cause vibrations and head reduction, and to propose design improvements to diminish or even remove these adverse effects.

Motivation of the research

Centrifugal pumps that are used in pumping stations for water-level maintenance - both in the Netherlands and in China - are mostly of mixed-flow or axial-flow type. To ensure maximum flexibility, operators demand these pumps to have broad operating ranges. However, the safe operating range of these pumps is limited by cavitation (at high flow rate) and unstable operation (at low flow rate). Unstable operation is characterised by a reduction of the pressure head of the pump and the occurrence of fluid flow pulsations and vibrations. The aim of this research is to understand how flow instabilities emerge and develop to cause vibrations and head reduction, and to propose design improvements to diminish or even remove the adverse effects.

Scientific problem

An unstable head curve of a centrifugal pump is generally believed to be related to stalling of the impeller blades at low flow rate. Flow separation and the resulting decrease of the lift of the blades leads to a reduction of the head of the pump. At even lower flow rate, leakage flow through the tip clearances gives rise to a region of inlet recirculation, effectively blocking part of the entrance area to the impeller. As a result, the incidence angles to the blades restore to a more favourable value and stalling of the blades is reduced or even prevented. Consequently, the head will again increase at lower flow rate.

Experiments done on a mixed-flow pump with vaned diffuser by van Esch [1] revealed that fluid-induced forces on the impeller of the pump are strongly related to flow rate and show a clear correspondence with the shape of the head curve. Measurements of pressure pulsations showed that at least three different regimes of rotating instabilities can be identified, also corresponding well to the shape of the head curve. This shows that tip leakage flow, stalling of the blades, rotating instabilities, and head instability are all inter-related phenomena. The way in which they are related is still unknown, though.

Research methods

We intend to adopt the following methods to study the transient flow phenomena during unstable operation:

- A. Measurements of fluid-induced forces and pressure pulsations in a mixed-flow pump.
  The fluid-induced forces on the impeller of a mixed-flow pump are measured using an existing experimental setup. It includes a commercial pump of mixed-flow type and a specially designed force transducer which is mounted between the impeller and the shaft [2]. This co-rotating device is able to measure all six force components. At various locations in the impeller and on the casing of the pump, pressure transducers will be mounted to measure the pressure pulsations. This will enable the measurement of the frequency and the location of rotating flow instabilities. The research will focus on the influence of flow rate, shaft speed, tip clearance gap size, and spacing between impeller blades and stator vanes. A visiting senior researcher, dr. ZANG Desheng, from Jiangsu University will take care of the adaptation of the setup and will assist at the subsequent measurements in 2013.
- B. Transient CFD calculations of the flow using fluid-structure interaction (FSI).
  Numerical calculations (CFD) will be used to study the detailed velocity and pressure distribution in a mixed-flow pump under unstable operation. The analysis will focus on tip-leakage flow, inlet recirculation, blade stall and rotating vortices. The CFD method offers the possibility to study:
  - fluid-induced excitation forces and pressure pulsations. Results will be compared with measurements.
  - fluid-induced reaction forces (resulting from impeller vibration and/or deflection) after adding fluid-structure interaction (FSI)to the CFD method. This can be used to calculate hydrodynamic coefficients for stiffnes, damping and added mass.
  - the effect of bad casting of pump parts (e.g. non-symmetric impeller blades), which may prove important with respect to onset of rotating stall.

  Once CFD results correlate well with measurements, the pump geometry can be adapted and analysed with CFD again, in an iterative procedure, aiming at a design in which instabilities and head reduction are diminished, or even prevented.

Requirements for PhD candidate

- Master degree in Mechanical Engineering or Physics with a specialization in Fluid Mechanics
- Experience with CFD analyses of fluid flow in hydraulic pumps or turbines
- IELTS score of 6.5 or higher, or a TOEFL score of 90 (internet-based)

Scholarship from China Scholarship Council for Chinese PhD candidates

PhD in "Creating intelligent systems, products and related services in a social context"

The department of Industrial Design (ID) of the Eindhoven University of Technology (TU/e) is located in a highly industrialized region, known as 'Brainport'. This region is internationally recognized as a top technology area with a special focus on the integration of design and technology. The department was established in close collaboration with the technological industry, and, because of this, focuses its research on the Design of Intelligent Systems, Products and related Services in a social context. With these intelligent systems it aims at offering new, breakthrough possibilities leading to societal transformations.

The social context for the PhD research in this call is carefree ageing. One of the major problems in modern society is that, due to the continuous increase in life expectancy and the decreasing number of children, we are currently faced with a situation where, if no fundamental change takes place, an increasing number of people will have to rely on increasingly expensive healthcare paid by a decreasing number of people. Many attempts to try to prevent this negative spiral, such as public education and prevention campaigns, have demonstrated only limited success. A main ambition of this research is to create agents for social transformation that enable people to maintain, for a much longer period than currently, a high quality of life against reasonable costs, and to remain or to get again in control of their home-, work-, and social network-situation without or with a minimum of additional external care.

In the intersection of information technology and life science, this research is based on four pillars:

1. Understanding motivational principles behind (un-)healthy living
2. Creating persuasive concepts that will lead to a healthier lifestyle
3. Creating supporting products and systems that support the above
4. Creating products and systems to self-control the home-, work-, and social network situation

Applicants to this PhD research shall have a background in industrial design, computer science, information technology or electrical engineering.

The applicants can apply for one of the following projects:

1. Design for Social Interaction through social computing, in the context of carefree ageing. we explore the impact of Social networks, Internet, multimedia, and virtual reality on ageing society, the impact of the bottom-up power and the much flattened structure of the social media on societal transformations, the impact of the social and systematic perspective of intelligent systems, products and related services on industrial design, and in turn, the possible impact of industrial design on these on-going societal and technical changes. The primary research areas are social computing, social interaction, linking between the virtual and the

physical, the opportunity and challenge brought up by connecting the web of people and the internet of things, and the related cultural and societal issues. For more information about this project, please contact dr. Jun Hu (j.hu@tue.nl)

2. Wearable intelligence prototyping platform. The aim of this project is to design and develop an integrated development platform that enables designers with minimal engineering skills, and especially no software engineering skills, to prototype wearable systems that combine: textile technology, wearable sensors, and actuators, computing and networking. Its aim is to relieve designers from engineering concerns they face when prototyping wearable technologies. The PhD will create a proof of concept that will be validated with the implementation of concepts typical of the range of applications we examine at industrial design, such as wearables for sport and healthcare for ageing society. For more information about this project, please contact prof.dr. Panos Markopoulos (P.Markopoulos@tue.nl)
3. Design for elderly independent living through intelligent mobility product service systems (PSS). The introduction of one child policy in 1979 in China has led to the increase of the ratio of elderly people in the total population. Increased mobility of elderly people can help maintaining their social integration within the community and allowing elderly to live much longer in their own homes. In this project we will explore the use of electronic cars as the basic carrier to integrate ICT based services to further develop collective mobility PSS proposals that aim to not only improve elderly mobility but also support their integration in the community. Cross-cultural insight will be generated and industrial and managerial implications will be obtained for companies in both the Netherlands and China. For more information about this project, please contact dr. Yuan Lu (y.lu@tue.nl)
4. Design for cultural change to sustain wellbeing (regarding e.g. social inclusion, healthy eating and safety). Design for societal transformation is intrinsically linked to cultural change. The aim of this project is to define how designers can, through their actions, convincingly shape society and thereby change culture. Research is required to define how designers can make a convincing statement regarding the envisioned change by relating the evidence of their actions to their vision. The context to explore how to design for cultural change will be regarded through the observation of social activities that are profoundly embedded in culture such as cooking and eating. Inspired by these explorations the designer researcher will envision, design and evaluate (intelligent) products, systems and related services that may contribute to cultural change in these social activities. The project will rely on an experiential approach of designing in context and requires a thorough documentation of and reflection on the actions that contribute to the development of the vision. For more information about this project, please contact dr. Miguel Bruns (mbruns@tue.nl)

More about research at ID, TU/e:

http://www.tue.nl/en/university/departments/industrial-design/research/

More examples of research projects at ID, TU/e:

http://www.tue.nl/en/university/departments/industrial-design/innovation-with-the-department/projects-and-field-assignments/research-projects/

More about the requirements in applying the Scholarship from China Scholarship Council (CSC) for Chinese PhD candidates:

- From TU/e: http://www.tue.nl/studeren/studeren-aan-de-tue/studiekosten/studiefinanciering/scholarship-from-china-scholarship-council-for-chinese-phd-candidates/
- From CSC (in Chinese): http://www.csc.edu.cn/Chuguo/acabe30a3f0b40659ea20f3a3ae86ae3.shtml

For further questions, feel free to contact Jun Hu: j.hu@tue.nl