Intelligent Lighting Institute | Edition 12, November 2019

ILIGLOW

> **HYPAR INTERACTIVE LIGHT INSTALLATION**

> **NEW PROJECT LIGHTCAP**

> **PROPER LIGHT AT THE PROPER TIME**

> **MOVING LIGHT:** THE NEXT STEP

TU/e
EINDHOVEN UNIVERSITY OF TECHNOLOGY

Content

ILI GLOW 2019 is a biannual edition of ILI for ILI members, colleagues, collaboration partners, policy makers and related companies - ILI GLOW 2019 is published in November

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HAROLD WEFFERS | OPERATIONAL MANAGER

Welcome

I am extremely pleased to present to you the 12th edition of our ILI Magazine. In this edition we introduce you to various new researchers that recently joined the ILI community at TU/e as well as to various new research projects that recently started or that will start on short term. We also present details on the 2019 edition of ILIAD, our annual public outreach event that this year will again be organized in combination with the Holst Memorial Symposium and Holst Memorial Lecture that this year are also dedicated to Light.

Pleasant reading!

I am pleased to present to you the 12th edition of our ILI Magazine!
Harold Weffers
Operational manager

ILI PhD theses

Performance of intelligent lighting sensor networks : analysis, modeling and distributed architectures Charikleia Papatsimpa, May 27 2019. Advisors: prof. dr. ir. J.P.M.G. Linnartz and dr. ir. T.J. Tjalkens.

Occupancy-based lighting control – Developing an energy saving strategy that ensures office workers' comfort Christel de Bakker, June 4 2019. Advisors: Alexander Rosemann, Helianthe Kort and Myriam Aries.

Lighting in multi-user office environments – improving employee wellbeing through personal control Sanae Chraibi, June 6 2019. Advisors: Alexander Rosemann, Evert van Loenen, and Myriam Aries.

Designing for the internet of lighting Thomas van de Werff, September 11 2019. Advisors: prof.dr.ir. J.H. Eggen en dr.ir. H.A. van Essen

PLANNED DEFENSE:

- Juliëtte van Duijnhoven, Building Lighting Group, will defend her thesis with the title *"Personal lighting conditions of office workers; Input for intelligent systems to optimize subjective alertness."* on 29 November 2019 13:30h. Advisors: prof. dr. H.S.M. Kort (first promotor), prof. dr.-Ing. habil. A.L.P. Rosemann (second promotor), prof. dr. M.B.C. Ariës (Co-promotor)

"ILI has used the last months to put a lot of effort in an update of its program roadmaps"
Ingrid Heynderickx
Scientific Director

INGRID HEYNDERICKX | SCIENTIFIC DIRECTOR

ILI updates its programs

Even in organizations with a focus on long-term research, as universities are, roadmaps of research need to be living documents that are regularly updated. The industrial and societal context changes, and with that trends in research might become rusty if they don't move accordingly. For these reasons ILI has used the last months to put a lot of effort in an update of its program roadmaps.

Together with its most important industrial partner Signify, ILI started to revitalize its research plans in its three programs. There will be continued focus on modeling the shape of more complex refracting and reflecting surfaces, and on understanding the impact of light on human performance and well-being. In addition, there is an increased focus in trying to design smart lighting systems that understand their environment and adapt accordingly, and in a more fundamental understanding of what exactly happens with light in the human eye and brain. Building upon those roadmaps ILI will submit a project making use of TKI funding together with Signify; with this project each of the three ILI programs will be expanded with one PhD. In addition, Prof. de Kort and Prof. Rosemann received an EU European Training Network grant, with which ILI can hire four new PhDs that will investigate in more depth how (blue) light actually affects humans in their cognition, affection and performance.

To further create funding for future research ILI has contributed to the development of new research agendas. It used its roadmap input to define one of the program lines of the new longer-term research agendas for the Topsector on New Technologies. Additionally, it will use its yearly outreach event ILIAD to discuss with interested partners and visitors the research topics that should appear on an update of the Knowledge and Innovation Roadmap of the High Tech Systems and Materials sector.

With these initiatives the future research of ILI has hopefully plenty of opportunities to move in industrial and societal relevant directions.

MILOU WEERTS | TEAM IGNITE TU/E

Interactive light installation

Hypar is an interactive light installation where technology and nature come together as one. There is an active atmosphere of sound and light surrounding Hypar, perceivable for everyone around and inside of the installation. Team IGNITE showcased a preview of their modular cubes during GLOW 2018 and are going to make heads turn during this year's edition.

For GLOW 2018, the team created an installation for research purposes. This installation, Loop, tested the best working concepts for future interaction. Visitors were able to control the speed of the light as well as the colours of the light with their movement. Several types of scenario's were tested during GLOW and were analyzed afterwards. Loop consisted of 20 modular cubes, that will also be used for Hypar.

Freedom in creativity and flexibility in construction were the main motivators behind the creating of the modular cube. The design now exists of homologous aluminium modulus that can be used over and over again for the execution of new concepts. Not only light festivals, but also music festivals and stage design lie within the capabilities of the team. All cubes have LED strips running on the inside of all 12 sides of the cube. The construction and light interaction collaborate to provide its visitors with a fully immersive and interactive experience of the installation.

For GLOW 2019 the team decided to go big with an installation of 160 modular cubes. Together they form a giant arch, that reaches six metres at its highest point. The inspiration behind the shape is a hyperbolic paraboloid, an infinite surface in three dimensions. The term hypar itself was introduced by the architect Heinrich Engel in his book Structure Systems. Bulky aluminum cubes form a contrast with the organic shape of Hypar, which is the base for the interaction.

The interaction modules on opposite sides are representing on one hand 'technology' and on the other hand 'nature'. If one module is full of energy it is possible to steer it towards the installation through a swiping interaction. By this energy transition the visitor influences the aura of Hypar with light. All other visitors can walk beneath the installation to experience the magical field of energy. If two modules of one element collaborate together seamlessly a more powerful stream of energy can be directed to the installation. When both elements, nature and technology, are collaborating it is even possible to activate a short light show.

Every interaction with the modules is enhanced by sounds. 'Nature' has light and natural sounds, while 'technology' makes use of bleeping noises. Each swiping movement to the installation not only sends light, but also sound of the corresponding element. Hypar's aura fills more and more with these contrasting sounds, as well as light. From a distance, the passive audience can see the cubes lighting up the whole installation in the tempo the active, interacting, audience determines. People walking beneath the installation get treated to an intensifying experience, as the light and sound increases with each stream of energy that gets send to the installation.

With this installation Team IGNITE wants to emphasize the importance of collaboration, in order to achieve greater goals. Together, the audience of GLOW 2019 can send impulses that will make Hypar come alive. You can find Hypar on the market square during GLOW, number 24 on the route.

At GLOW 2019 the audience can send impulses that will make Hypar come alive.

NOVEMBER 2019 - NOVEMBER 2020

Calendar

November 9-16 GLOW Festival Eindhoven. You can find team Ignite at the Markt. ILI is also active near the PSV stadium.

November 12 OVLNL/NSVV symposium OVL. Location: Corona auditorium TU/e campus

November 12-14 LED + ELEKTRO 2019. Location: Brabant Hallen 's Hertogenbosch. You can find ILI at Stand K10 with demos from Thijs Kruisselbrink (Bee-Eye), team Ignite and the LEDFlckr box. TU Delft joins us in the stand with some mock-ups from the Perceptual Intelligence Lab of the Department of Industrial Design. Gosia Perz (Signify) and Thijs Kruisselbrink (ILI PhD candidate) wil do presentations.

November 21 ILIAD and Holst memorial lectures. Location: Auditorium, Blauwe Zaal, TU/e campus

November 28 LED Lighting & Technology Conference Location: Van der Valk hotel Eindhoven

March 8-13, 2020 Light and Building. Location: Frankfurt am Main, Germany

August 26-27, 2020 CIE/ICNIRP symposium "measurement of optical radiation and impacts on photobiological systems". Location: TU/e campus

September 7 - 11, 2020 European Optical Society Annual Meeting (EOSAM). Location: Porto, Portugal

November 12-13, 2020 Experiencing Light. Location: Ketelhuis Eindhoven

YVONNE DE KORT | ILI PROGRAM LEADER SOUND LIGHTING AND PROJECT LEADER LIGHTCAP
ALEXANDER ROSEMANN | ILI THOUGHT LEADER AND CO-RESEARCHER LIGHTCAP

New project LIGHTCAP:

Training the light experts of the future at TU/e

Cognition, Attention and Perception (CAP) are crucial for professional success, core to educational success, essential to productive, safe and healthy functioning. Yet cognition is hard work, attention is fragile, and perception is selective.

Recent research has shown that light directly and indirectly helps CAP, in particular via the activation of a recently discovered photoreceptor in the human eye. Light triggers this photoreceptor, but large-scale migration to cities, increased time spent indoors, and our 24-hour economy have impacted on our light exposure. Disturbance of sleep/wake cycles, fatigue and cognitive failure, mood disorders and even cancer pathologies may be the consequences of ignoring findings on human light processing.
The urgent message is that light can make or break health, social and cognitive functioning. Given the rapid technological developments in light sources (LED, OLED) and the proliferation of intelligent infrastructures (IOT, data science), we are in a crucial period for the realization of truly human-centered lighting.
LIGHTCAP aims to address this challenge by providing a strong, innovative and necessary impulse to our insight in the intricate and complex relationship between light, perception, attention and cognition. The goal of LIGHTCAP is to prepare the next generation of experts able to deliver on the promise of truly intelligent, human-centric lighting. We promise an international, interdisciplinary, cross-sectional and translational training program. It unites experts from neurobiology, cognitive neuroscience, chronobiology, psychology and lighting technology. It will train a generation of researchers who can look beyond the borders of their discipline and understand the implications of their findings for other fields.
This project gives us an unprecedented opportunity to take an enormous step forward in our understanding of what good light is for people, together with experts from very different, relevant disciplines and with people from the work field. Coordinating this project fits in perfectly with our mission: multidisciplinary research on the interface between people and technology.

MARIE CURIE

The grant for the LIGHTCAP project is covered by the Marie Sklodoskowska-Curie program of the European Union. The aim of this program is to stimulate innovative interdisciplinary university masters in Europe, in which universities and other research institutions collaborate with companies. In this project, TU/e collaborates with Signify (formerly Philips Lighting) and research institute Kempenhaeghe, among others, mentioned below.

PARTICIPATING ORGANIZATIONS

Universities
University of Technology Eindhoven
University of Manchester
University of Sheffield
University of Liège
University of Basel
École Polytechnique de Lausanne
Techniche Universität Berlin

Partner Organisations
Signify
Zumtobel
KEMPENHAEGHE
CSEM SA
Ove Arup & Partners International Ltd
Emmlight BV
Regent Lighting
Balder
Siemens Healthcare NV/SA
Liège Univ. Hospital
ETAP
Velux A/S
Lucimed
LightingEurope AISBL
NSVV

ILI SHORT

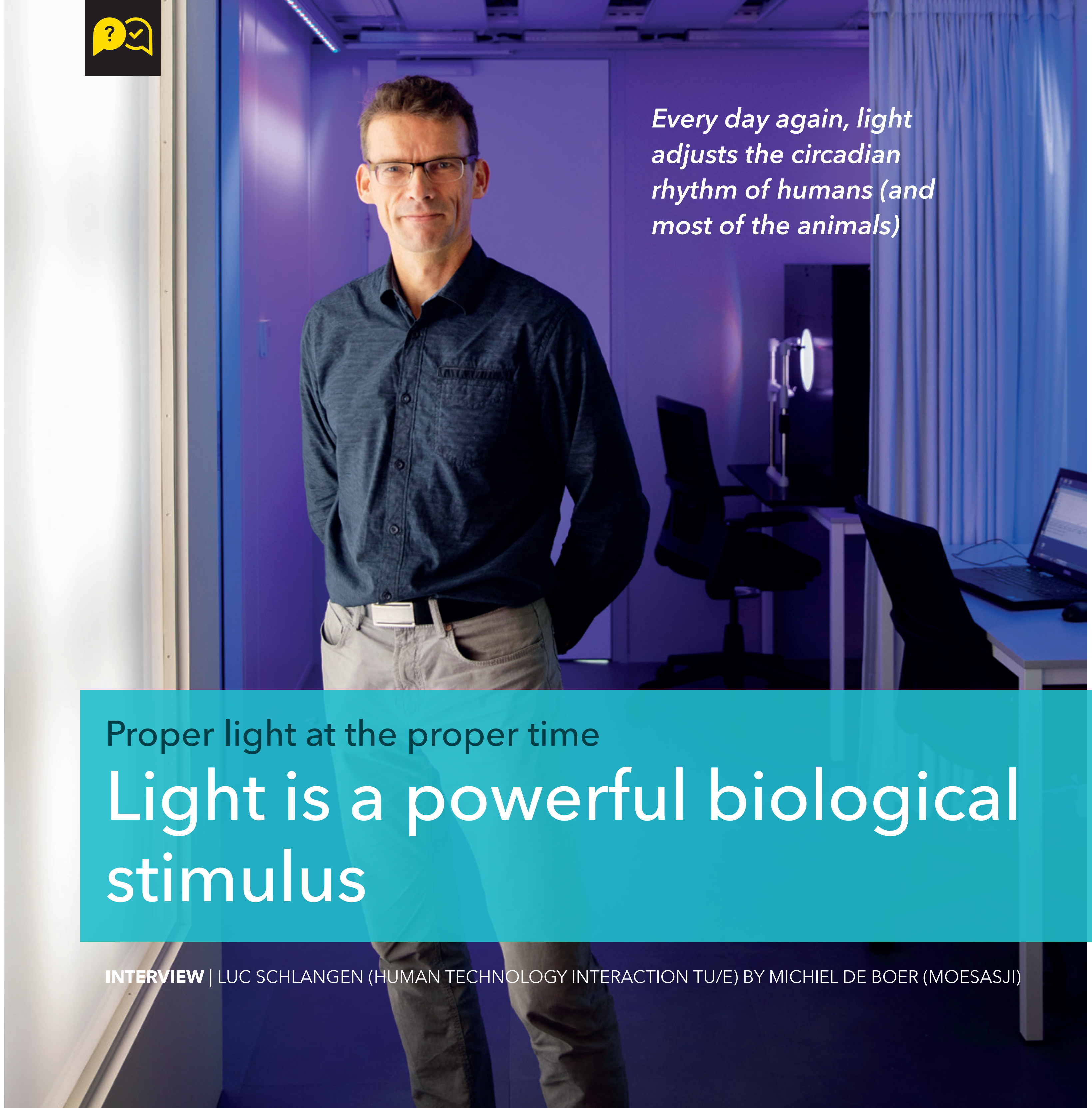
Yvonne de Kort on Dutch national television

Het Klokhuis, a daily show for young viewers, did a special on Light and Color. You can watch several info-items and experiments that were recorded in our light lab. Yvonne was interviewed on the effect of warm and cold light on people's behavior.

www.hetklokhuis.nl/tv-uitzending/4111/Kleur

New Erasmus+ Project

The Building Lighting group is participating in a new Erasmus+ (Capacity Building in the field of Higher Education) project. This cooperative project aims to promote energy efficient and smart lighting in Vietnam and Myanmar. Other universities involved are: *Aalto University, Univerza v Ljubljani, Eastern International University, Vietnamese-German University, Mandalay Tecnological, Thu Dau Mot University and BK TP.HCM*



Every day again, light adjusts the circadian rhythm of humans (and most of the animals)

Proper light at the proper time

Light is a powerful biological stimulus

INTERVIEW | LUC SCHLANGEN (HUMAN TECHNOLOGY INTERACTION TU/E) BY MICHIEL DE BOER (MOESASJI)

In modern society humans spend around 90% of their time indoors. This has all kinds of impact on our lives, but it is only since recently that we started to discover how a lack of daylight can compromise our physiology, wellbeing and functioning. Luc Schlangen - Senior Researcher at TU/e and Division Director "Photobiology & Photochemistry" within the International Commission on Illumination (CIE) - is studying the visual and non-visual effects of light on humans since 2005. After years of research within Signify (Philips Lighting), he continues his journey at TU/e in collaboration with ILI since March.

The work of Schlangen is ignited by the discovery of a new photoreceptor in the human eye in 2002 by scientist David Berson at Brown University. Next to the well-known rods and cones, the human eye is equipped with the retinal photoreceptor ipRGC, an intrinsically-photosensitive retinal ganglion cell. This photoreceptor senses light via its blue-light-sensitive photopigment melanopsin. Schlangen: "We now know these ipRGCs play a major role in the regulation of our sleep-wake cycle and the daily 24-hour/circadian rhythm of our body clock and physiology."

DEPENDENT ON LIGHT

Every day again, light adjusts the circadian rhythm of humans (and most of the animals). Light in the morning helps the body to "wake-up" and get ready for action. Schlangen: "Paradoxically, our internal clock tends to tick a little slow: by itself, it needs longer than 24 hours to make a complete cycle. We use the daylight to adjust and reset our clock as to secure entrainment to the 24 hour rhythm of day and night. Studies show that spending a day in settings with bright light helps to feel more awake, alert and energetic across the day. Moreover, it facilitates a good night's sleep. Sufficient daytime light exposure is a powerful biological signal and important to secure our wellbeing, productivity and vitality."

NEGLECTING NATURAL CONDITIONS

In modern life however, we tend to neglect the natural conditions that have been our circadian guides for a hundred thousand of years. Today we spend most of our lives indoors, under light conditions that are much less bright than the natural light conditions outdoors. Office lighting is typically designed to deliver around 500 lux, which is deemed sufficient to perform office tasks, and lots of offices don't even make it to 500 lux. However, the typical illuminance outdoors on an overcast day reaches 10.000 lux easily. Direct sunlight brings the meter up to 100.000 lux. Our daytime light exposure under these natural (outdoor) circumstances is therefore a factor 20 to 200 higher than in indoor settings. Next to this, the widespread use of electrical light and electronic devices has resulted in an excessive exposure to light in the late-evening hours and at night. These unnatural lighting conditions compromise our sleep quality, circadian rhythm, performance, wellbeing and health.

CHALLENGES IN RESEARCH

Scientists, the lighting industry, lighting designers, lighting practitioners and stakeholders are actively developing insights, products and solutions that effectively combine the visual and non-visual effects of lighting in a beneficial way. The difficulties in this field are many. First, good lighting field studies are complex, time consuming and expensive to run. Second, while

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the beneficial effects of light on mood and sleep are relatively well established, it is much more difficult to quantify such effects in economic terms and to substantiate return on investment for lighting installations that are more supportive for health and wellbeing. Furthermore, there are large interindividual differences in sensitivity to light and in light exposure history: more prior light exposure (for instance by spending more time outdoors) typically reduces sensitivity to subsequent light exposures.

A good field study usually involves several weeks of data collection

Schlangen: "A good field study usually involves several weeks of data collection, in which one test group with an active lighting condition is compared to a control group with a standard lighting condition. Preferably, this is done in a crossover design and without too much interference of daylight. When daylight is too abundant, this reduces the contrast between the active lighting condition and the control lighting condition, thus reducing the chance of finding a difference between the two lighting conditions. In a study by Gimenez et al (J Sleep Research, 2017), we installed a dynamic lighting system in patient rooms of a cardiology ward at the Maastricht University Medical Center. The system offered bright and blue rich light in the mornings and gradually dimmed and used warm light in the evenings. For the patients in the test group, their amount of sleep improved. Although better sleep can be expected to support recovery, we were unable to substantiate any effects of the test lighting on patient wellbeing or hospital length-of-stay. This underscores how difficult it is to scientifically prove such positive effects of light. It also explains why so many companies and care institutions are unwilling to invest in lighting systems that provide more illumination than the minimally prescribed value of 500 or 300 lux. Things would be much simpler when we could just state: Install a 2,000 lux system and you will gain a 12% productivity in a workplace, or an 8% reduction in medication prescription on a hospital ward.

STANDARD

Another point is that we are merely at the beginning of standardization of the non-visual effects of light for human (and animal) health and wellbeing. Recently, CIE has published an international standard (CIE S 026:2018) that defines a good metrology to measure and quantify light for its ability to stimulate each of the five photoreceptor classes (rods, cones, ipRGCs) that can contribute to eye-mediated non-visual responses to light. In the CIE committee that wrote this standard, we decided to express the activation of every photoreceptor type by a (test) light condition, in terms of the amount of lux of standard daylight (D65) that produces the same photoreceptor activation. For the melanopsin-encoded photoreception of ipRGCs, this new quantity is called "melanopic equivalent daylight illuminance" or melanopic EDI, and it is expressed in lx (of standard daylight D65). In many cases, light settings with a high melanopic EDI produce stronger non-visual responses as compared to light settings with a low melanopic EDI."

HEALTHY BUILDINGS

The importance of having the right quantity and quality of light at the right time is underestimated, while potentially this is as important as indoor air quality. In order to realize so called Healthy Buildings, lighting installations should be made more health and sleep friendly by providing dynamic changes in intensity and spectrum across the day, mimicking the outdoor light conditions as much as possible. Schlangen: "We are discovering more and more about the non-visual effects of light and the metrology behind them. This will improve the design and implementation of lighting systems as critical instruments to create healthy indoor environments for human beings."

On October 3rd 2019, a new edition of the CIE position statement on "proper light at the proper time" is published.
Find it at: bit.ly/2Vlq62P

ABOUT LUC SCHLANGEN

Luc Schlangen received his PhD from Wageningen University in 1995. He has worked for more than 20 years at Philips Research Laboratories and Philips Lighting/Signify in Eindhoven. March 2019, he accepted a researcher position at the Eindhoven University of Technology, reinforcing the ILI research activities in the Human Technology Interaction group. Luc actively contributes to various standardization processes in CEN, DIN, CIE and ISO. He has chaired the CIE JTC9 committee which recently published a new global standard with light metrology for ipRGC-influenced responses to light. Per June 2019 Luc is director of CIE Division 6 "Photobiology and Photochemistry".

Current activities with ILI:

- Grant-project author 'To improve sleep by reducing evening blue light exposure'
- Discussing research plans with GGzE (mental health institution) on light therapy and lifestyle \ interventions in clinical and non-clinical populations.
- Mentoring ongoing student research project in VieCuri Hospital Venlo, effects of a dynamic lighting installation on quality of sleep and wellbeing in a Coronary Care Unit
- Initiator and co-author of the 2019 CIE position statement on "proper light at the proper time"
- Actively participating in research projects (in lab and field settings) exploring the effects of dynamic indoor environments (lighting and temperature) on comfort wellbeing, health and performance
- Organization of CIE/ICNIRP symposium "Measurement of Optical Radiation and Impacts on Photobiological Systems", probably end August 2020 at TU/e.

CHARA PAPATSIMPA | ILI PHD DEPARTMENT OF ELECTRICAL ENGINEERING OPTIMIZED SENSING, WIRELESS NETWORKING AND DATA PROCESSING

Imperfect Sensing and Limited Communication lead to annoying Lighting Behavior

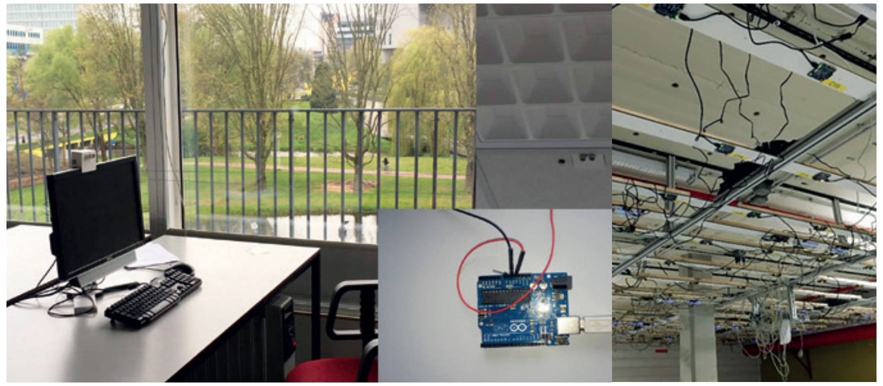
The Internet of Things (IoT) will change the way we vision lighting in the coming years. The opportunities for new applications ideas are endless, ranging from energy conservation, health and wellness, human centric lighting to enhancing retail customers' shopping experience. To accommodate the growing expectations, sensing systems need to interact and combine information to reduce sensor uncertainty, while keep the sensor infrastructure non-invasive. However, this sensor interaction is constrained by the limited resources of the sensor nodes, such as limited memory, battery power, and limited computation and communication capabilities. Especially as the number of interconnected devices is exhibiting an exponential rise towards a forecasted 50 billion connected devices by 2020, distributed architectures are becoming more relevant than ever. This also leads to severe congestion in the radio networks.

MODELING APPROACH

IoT applications should be interpretable so users can better understand how they work and improve their trust in them. To address this, Papatsimpa modeled a novel Distributed Sensing Hidden Markov Model (DS-HMM) approach. Attractively, it offers a principled framework to combining prior knowledge with data about new events, and encodes these data in a more effective and natural way than before. In here new HM-HMM, the structure of the model has an intuitive meaning, in contrast to the black box nature of the neural networks, such that setting can be understood and can easily be reused and adapted to new installations and environments. The DS-HMM delivers a fundamental solution for missing data, for instance due to latency in the network. The performance of Optimum solutions is now known, and can serve as a benchmark for practical simplications or imperfect, e.g. energy conserving data exchange strategies.
HMMs had been applied before for a wide variety of dynamic systems, however, their suitability for activity detection in smart buildings had been less studied. Papatsimpa exploits the aspect of probabilistic relationship between observations and hidden states to support the use of HMM for combining heterogeneous types of sensor modalities. In fact, her suggested HMM-based algorithm showed improved performance compared to state-of-art classifiers despite its low complexity. She extended the HMM framework to account for the dynamics of occupancy. People generally have a typical working schedule, that is, occupants in an office arrive and leave every day at almost the same time. The resulting HMM exploits this prior knowledge on office occupancy profiles to improve detection performance. For the first time, the framework of HMM was used in a decentralized architecture with communication constrains. Papatsimpa derived relevant fusion formulas to combine the information coming from various HMMs running separately and developed a novel adaptive communication strategy that reduces the communication traffic load. The feasibility of the concept was proved by building a prototype with a real-life experiment showing satisfactory results.

BREAKTHROUGH

It turns out that an Intelligent Lighting architecture can be easily separated into distinct building blocks where cleanly separated algorithms may run on different devices / entities. This separation ensures coherence, especially when combining data from different sensing modalities that typically lead to discrepancies between the various interfaces. The algorithms developed in this thesis ensure performance even when data fusion is performed in a distributed manner and communication between the sensors is interrupted or constrained. During her PhD work, she closely cooperated with Signify Research, both with teams improving wireless IoT networks and teams improving data sensing.



ILI SHORT

TU/e leads national research project INTERSECT for an Internet of Secure Things

A consortium of more than 45 universities, companies (including Signify), NGO's and government will investigate a secure Internet of Things. Sandro Etalle, professor of cyber security of Eindhoven University of Technology, will lead this project.

Devices that are connected to the internet, such as self-driving cars and intelligent thermostats pose an increasing threat to our privacy and security. Protecting against this requires a fundamental approach that is urgently needed. To get a grip on this problem we need a systematic approach with rules for the design and management of IoT systems.

In this project there could be a focus on connected lighting being a base for all kind of IoT-applications. From the cybersecurity's point of view there are potential safety risks in the hardware, software and in the integration of the systems.

The project is being subsidized to the tune of almost 10 million euros by the Netherlands Organization for Scientific Education (NWO) within the framework of the Dutch National Research Agenda.

TU/e's online magazine Cursor published the article TU/e leads national research project for a secure IoT, which you can read at www.cursor.tue.nl/search/?q=TU%2Fe+leads+national+research+project+for+a+secure+IoT

ILI SHORT

Internet of things and Li-Fi event

On 30 September Jean-Paul Linnartz, Thought leader of the Bright Environments Program of the Intelligent Lighting Institute, organized the Internet of Things and LiFi event on the High Tech Campus in Eindhoven.

Best paper ISNCC

On June 18-20 researchers from TU/e and Signify won the Best Paper Award at the 2019 International Symposium on Networks, Computers and Communications (ISNCC) in Istanbul Turkey. Srikanth Sistu, Qingzhi Liu, Tanir Ozcelebi, Esko Dijk and Teresa Zotti received this award for their paper:

Performance Evaluation of Thread Protocol based Wireless Mesh Networks for Lighting Systems.

CHRISTEL DE BAKKER | ILI PHD BUILDING LIGHTING GROUP TU/E
MARIËLLE AARTS, HELIANTHE KORT, EVERT VAN LOENEN & ALEXANDER ROSEMANN | SUPERVISORS

Occupancy-based lighting control

Developing an energy saving strategy that ensures office workers' comfort

In general, office buildings just provided occupants a sheltered place to perform their work activities. Current developments in automation and information technology start to transform these buildings into autonomous objects, with, for example, smart controlled luminaires responding to occupancy changes. Simultaneously, workers are more flexible in working hours and locations, resulting in a large variety of individual occupancy patterns. This means that the time that all desks are occupied in the large, shared open-plan office is limited. Here, automatic occupancy-based lighting control at room resolution means a waste of energy. This can be minimized by smart controlled luminaires at desk resolution. This PhD research investigated this opportunity to tailor the lighting use to the actual occupancy of the office space by developing an automatic occupancy-based lighting control strategy at this resolution, "local lighting control". By taking a user-centred perspective the comfort of the workers is safeguarded.

To define the relevant research gaps, this research started with a literature review: few studies in bullpen offices that involve users in the post-occupancy evaluation were found (de Bakker, Aries, Kort, & Rosemann, 2017).

Based on the results, we encountered a potential for a dimming approach. Moreover, it appeared that results regarding the energy saving potential of occupancy-based lighting control vary largely. Therefore, we subsequently investigated whether variance in individual occupancy patterns causes these differences. Through simulations, the energy use of the strategy at three control resolutions was calculated for a set of office cases that differed on (1) function type distribution, meaning the mixture of job functions, and office policy (2), meaning the flexibility granted by the company regarding employees' working times. The results indicated that local lighting control reduces office' energy consumption with 20–25% across these cases compared to control at room resolution, suggesting that local lighting control is relevant to apply in any office (de Bakker, Voort, & Rosemann, 2017).

Subsequently, we tested two designs of local lighting control with users: a switching-off and dimming approach. The switching-off approach is typically used in cubicle offices. However, when we applied this approach in an open-plan office without partitions, occupants were dissatisfied about the lighting distribution. This can be explained by the large contrasts between switched-on

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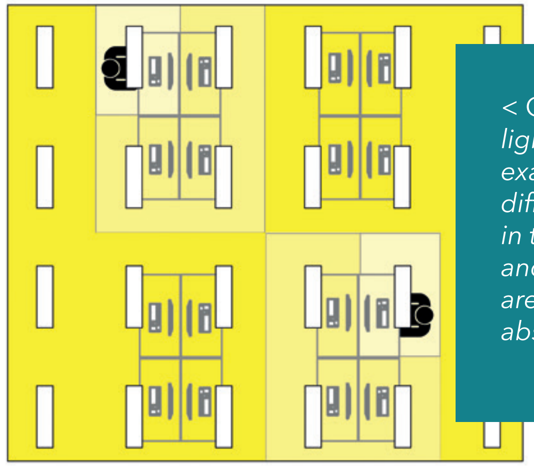
and -off luminaires (de Bakker, Aries, Kort, & Rosemann, 2016). Therefore, we developed a strategy that reduces this contrast by dividing the office space in a task, surrounding, and background area, and applying different dimming levels in these areas, as shown in Figure 1. In a controlled lab study where we used a single occupancy scenario and daylight was excluded, participants evaluated different combinations of levels across these areas. The results show that all combinations were rated positively by the majority of the participants (≥ 70% of N = 25) except the extreme combinations (de Bakker, Aarts, Kort, & Rosemann, 2018). When considering their energy use too, the combinations providing a low dimming level in the background area are recommended.

First, we investigated the influence of time-of-day and subjective alertness.

As large individual differences were encountered in this user study, we continued with studying preferences for luminance distributions in more detail in the same controlled environment. First, we investigated the influence of time-of-day and subjective alertness. Participants chose medium luminance values in the surrounding area and low values in the background area anytime during the day (N = 30). The 30 participants preferred as luminance distribution ratios mostly a uniform type, the type "task & surrounding > background", or the type "task > surrounding > background" (de Bakker, Van De Voort, Van Duijhoven, & Rosemann, 2017). The study also showed that subjective alertness caused variance in the preferences for a subset of the participants. A second study on luminance distribution preferences was conducted in a larger sized office (88 m2 compared to 28 m2) where daylight was excluded as well: here, participants preferred lower luminances, especially in the background area (N = 42), but the ratio preferences were similar to those found in the medium-sized office.

Lastly, we conducted two field studies to determine the acceptability of local lighting control in the real office. Particularly, we tested whether the lighting changes from the occupancy transitions distract occupants from their work activities (N = 9), which was the case for a few of them (de Bakker, Aarts, Kort, & Rosemann, 2017). This study in a Dutch bullpen office was repeated in a cubicle office in the US; here, occupants rated the acceptability of these distractions much lower (de Bakker, Aarts, Kort, Meier, & Rosemann, 2019). Instead of office lay-out, differences in job function and the amount of interaction between employees might have caused this.

The main finding of this PhD research is that local lighting control reduces offices' energy consumption and provides a comfortable work environment to the occupants of bullpen offices when their preferences over the day are considered.



< Concept of local lighting control for an example office case: different dimming levels in the task, surrounding, and background area when individual absences occur

ILI Top Publications

N.K. Yadav, L.B. Romijn, J.H.M. ten Thije Boonkkamp and W.L. Ijzerman, A least-squares method for the design of two-reflector optical systems, *J. Phys.: Photonics 1 (2019) 034001*

B.S. van Lith, J.H.M. ten Thije Boonkkamp and W.L. IJzerman, Active flux schemes on moving meshes with applications to geometric optics, *Journal of Computational Physics X 3 (2019) 100030*

L.B. Romijn, J.H.M. ten Thije Boonkkamp and W.L. Ijzerman, Freeform lens design for a point source and far-field target, Proceedings OSA Optical Design and Fabrication Congress, Freeform Optics, *June 10 -12, 2019, Washington DC, USA*

J.H.M. ten Thije Boonkkamp and W.L. IJzerman, Illumination freeform design using Monge-Ampere equations, Proceedings OSA Optical Design and Fabrication Congress, Freeform Optics, *June 10 – 12, 2019, Washington DC, USA*

J.H.M. ten Thije Boonkkamp, L.B. Romijn and W.L. Ijzerman, Generalized Monge-Ampere equations for illumination freeform design,Proceedings SPIE/COS Photonics Asia, *October 20 – 23, 2019, Hangzhou, China*

Ru, T., de Kort, Y. A. W., Smolders, K. C. H. J., Chen, Q., & Zhou, G. (2019). NIF effects of illuminance and correlated color temperature of office light on alertness, mood, and performance across cognitive domains. *Building and Environment, 149, 253-263. DOI: 10.1016/j.buildenv.2018.12.002*

Peeters, S., Smolders, K., Vogels, I., & de Kort, Y. (2019). NIF and IF effects of different light scenarios in a real-life office setting. *Poster session presented on 31 Annual meeting of The Society for Light Treatment and Biological Rhythms, Chicago, USA.*

Deng, X., Mardanikorani, S., Zhou, G., & Linnartz, J. P. (2019). DC-bias for Optical OFDM in Visible Light Communications. *IEEE Access, 7, 98319-98330. DOI: 10.1109/ACCESS.2019.2928944*

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van de Werff, T. C. F., van Lotringen, C., van Essen, H. A., & Eggen, J. H. (2019). Design considerations for interactive office lighting interface characteristics, shared and hybrid control. In CHI '19 Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (blz. 1-14). [410] *New York: Association for Computing Machinery, Inc.*

Kong, X., Murdoch, M., Vogels, I., Sekulovski, D., & Heynderickx, I. (2019). Perceived speed of changing color in chroma and hue directions in CIELAB. *Journal of the Optical Society of America A, Optics, Image Science and Vision, 36(6), 1022-1032.*

Van Duijnhoven J, Aarts MPJ, Kort HSM. (2019) The importance of including position and viewing direction when measuring and assessing the lighting conditions of office workers. *WORK, 64(4).*

ELKE DEN OUDEN EN RIANNE VALKENBURG | PROJECT LEADERS SMART-SPACE

SMART-SPACE

The interreg project smart-space aims to overcome current barriers that hamper the uptake of high energy-saving smart lighting systems in municipalities to achieve significant co2 reduction across north-west-europe.

Therefore, SMART-SPACE brings together end-users (municipalities and citizens) and key innovation stakeholders (research institutes, SMEs, enterprises and associations) from NL, BE, FR and IE to jointly develop and implement an interoperable smart lighting system. The total project budget is € 6.88 m, of which € 4.13 m is granted by the EU Interreg programme.
TU/e Intelligent Lighting Institute (through the Innovation, Technology & Entrepreneurship group and the Building Physics & Services group) and TU/e Innovation Experts (LightHouse) are both partner in the project. TU/e research is focusing on the following topics:

- Identifying the use cases in the four pilot cities (Middelburg in The Netherlands, Oostende and Sint-Niklaas in Belgium and Tipperary in Ireland). A series of workshops in the cities is held to identify stakeholders' needs and requirements and develop use cases to address them. These needs and use cases are the foundation of the functional requirements for the smart lighting system. Together with the companies Intemo and Spie, these will lead to the definition of the modules for the smart lighting system.

- Investigating the replication potential of the smart lighting solutions based on the identified use cases by analysing the potential in the pilot and follower cities and beyond. Replicable business models are formulated, exhibiting suitable technical performance and high replication potential.

- Developing a transition roadmap and implementation toolbox for cities. The roadmap will address existing and upcoming solutions for the identified use cases. Through a desk study on existing solutions and future opportunities in smart lighting enriched with interviews with experts in the field, a contribution is made to the catalogue of smart lighting modules, including an assess of the impact of these solutions on energy consumption and CO2 emission.

- Investigating the impact of the smart lighting system and evaluate the implementation process in the pilot cities. For this an evaluation method for assessing the perception of citizens and users is designed and assessment parameters are defined in line with the use cases. Then a base line measurement and impact assessment of the smart lighting solutions will be executed.

The project is currently in the second year and will run till May 2021. The use cases are ready, and currently the system architecture is being defined. The next months the cities will prepare for implementation and the companies will develop the system. Next year the solutions will be realised in the pilot areas and monitoring and evaluation of the results will take place.

If you are interested in more information, please visit the website (http://www.nweurope.eu/projects/project-search/smart-space-smart-sustainable-public-spaces-across-the-nwe-region/) or contact us (e-mail: ili@tue.nl) if you would like to stay updated.

PARTNERS AND CO-FINANCERS

- City of Oostende, Belgium (Lead Partner)
- City of Sint-Niklaas, Belgium
- City of Middelburg, Netherlands
- County of Tipperary, Ireland
- Spie Infratechniek B.V.
- Intemo Special Products B.V.
- Katholieke Universiteit Leuven - Light & Lighting Laboratory
- Université de Picardie Jules Verne
- Eindhoven University of Technology - Intelligent Lighting Institute
- Eindhoven University of Technology - Innovation Experts BV
- LUCI - Lighting Urban Community International

STAFF INVOLVED AT TU/E

- Rianne Valkenburg (IE-LightHouse)
- Elke den Ouden (IE-LightHouse)
- Sjoerd Romme (ITEM)
- Madis Talmar (ILI-ITEM)
- Sam Khabir (ILI-ITEM)
- Ed Nijsen (ILI-ITEM)
- Swagata Chakraborthy (ILI-ITEM)
- Evert van Loenen (ILI-BPS)
- Marielle Aarts (ILI-BPS)
- Sila Akman (ILI-BPS)
- Steef Blok (IE)

Interreg
North-West Europe
SMART-SPACE

PHILIP ROSS | STUDIO PHILIP ROSS, ILI PROJECT LEADER GLOW 2019
FEDERICO TOSCHI | FULL PROFESSOR AT THE DEPARTMENT OF APPLIED PHYSICS (TU/E)

Moving Light: The Next Step

At Glow 2017, the TU/e Crowdflow Dynamics group, Signify and ILI jointly conducted the Moving Light experiment: a ground-breaking study on the influence of light on routing decisions in crowds. This year at Glow, a follow up experiment takes place, featuring a more naturalistic setting and live adaptation of light to improve crowd flows.

Let's first look back at the Moving Light experiment in 2017. Glow visitors walked through a 23-meter long and 6-meter wide tunnel-like construction. An obstacle at the end of the installation, in the middle of the path, imposed a choice for the pedestrians: to pass it on the left or the right side. The test conditions included varying light levels at the right and left side of the obstacle and lighted arrows on the front face of the obstacle. In total eighteen different conditions were activated in a pre-determined order throughout the eight Glow nights. 140.000 trajectories of pedestrians were captured using depth-map cameras directly observing the crowd from above. Analysis of the pedestrian tracks in relation to the test conditions showed that light indeed had significant influence on the route choices: The brighter one side was lit in comparison to the other, the more people passed the obstacle on that side. The influence of light was approximately as strong as that of arrows, up to a certain crowd density.
These promising results motivate us for a follow-up experiment at Glow 2019. We are interested to what extent lighting can influence route choices in a more naturalistic, less symmetrical setting. Because in everyday life, route options are often not as similar as in the Moving Light setting. Furthermore we are interested to test interested to test whether crowd flow could be improved with adaptive lighting: Light conditions that vary based on real-time crowd measurements. The first step in setting up this experiment was finding the right location. Glow has offered an interesting point on the route with a real need for crowd management. Near the PSV stadium the crowd needs to pass a 2m wide pillar. The shortest route is on the right side, but this opening of 3m is too narrow to let through a high-density crowd without clogging. An exit at the left of the pillar is also available but looks less obvious. Pedestrians have to walk over a bicycle path that is closed for bikes but still looks like a non-pedestrian area. A crowd management steward is present at the location at all times to divert the crowd if the location gets too crowded.

We added extra elements to the scene for the experiment. Low fences guide the crowd towards the point where a choice to pass the pillar left or right has to be made. Individually dimmable lights under the walking bridge, near the pillar, allow us to vary light intensities in the left and right areas close to the pillar. Depth cameras register the walking paths of people at the moment of choice, without collecting personal data. On six Glow evenings, we use a fixed schedule for the light conditions, similar to Moving Light 2017. On the two remaining evenings, we pilot an adaptive system that changes the ratio of light levels left/right, based on real-time crowd density measures. Fully in line of the Open Data Criteria for public space in Eindhoven, we will make the experiment data available to the public. In case you have questions or are interested in the results, please contact us via ili@tue.nl.

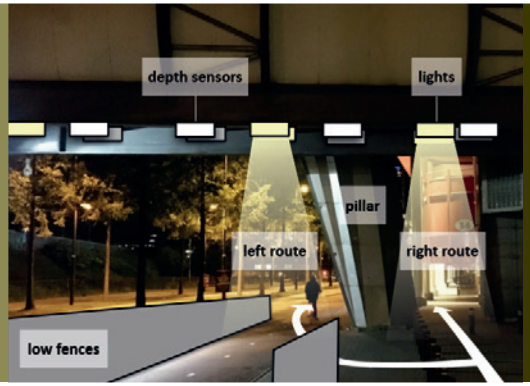
*This experiment is a joint effort of **Alessandro Corbetta (TU/e), Maurice Donners (Signify), Antal Haans (TU/e), Cas Pouw (TU/e), Philip Ross (Studio Philip Ross) and Federico Toschi (TU/e)**. This effort is supported by the Intelligent Lighting Institute*

RELATED PUBLICATION

A. Corbetta, W. Kroneman, M. Donners, A. Haans, P. Ross, M. Trouwborst, S. vd Wijdeven, M. Hultermans, D. Sekulowski, F. vd Heijden, S. Mentink and F. Toschi, "A large-scale real-life crowd steering experiment via arrow-like stimuli," in Pedestrian and Evacuation Dynamics, 2018

^ The setup of the Moving Light experiment at Glow 2017. The obstacle is visible in the back. Picture by Matthijs Hoekstra.

Sketch of the 2019 Crowdflow experiment set-up at the location. The arrows indicate the walking routes left and right around the pillar. >



LAURA HUIBERTS | HUMAN TECHNOLOGY INTERACTION TU/E

Light up and dim down:

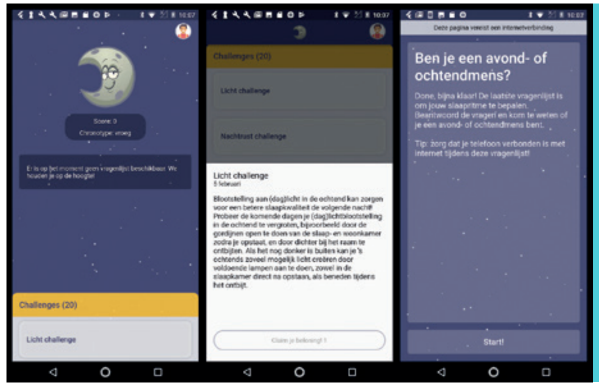
promoting healthy light exposure patterns in adolescents

For many adolescents it is a challenge to get up early in the morning, stay alert at school and get enough sleep, while also engaging in social activities and processing the continuous information flow of social media. Both the increase in light exposure from screen use in the evening as well as a state of hyperarousal around bedtime due to (social) media use may negatively influence sleep and feelings of alertness and vitality during the day. Time to explore new and effective ways to reduce evening screen time and improve light exposure patterns during the day in this target group.

This is exactly the goal of an upcoming research project that will be conducted at the Human-Technology Interaction group. For this project, an interactive mobile coaching app named 'Sleephacks' has been developed which sends out challenges to increase (natural) light exposure during the day, and decrease artificial light exposure in the evening. The application also has a so-called gamification component. That is, app users can receive points when they read the challenges, install new apps that help them to reduce screen time, and visit informative links to websites or movie clips. The app shows a ranking list with scores from all participants who are using the app at the same time. In the study, the three participants with the highest score at the end will receive a nice prize.

Fifty Dutch high school students aged 16 or 17 years old will participate in this study during a period of three weeks. They will complete a daily sleep and social media diary which asks them about their sleep timing, sleep quality, and social media use during the previous evening and night. In addition, by using an actiwatch, sleep timing and efficiency will also be measured objectively by tracking arm movements. Daytime levels of alertness and vitality will be measured using six short questionnaires that are send out during the day. Last, hourly light exposure patterns will be tracked with a wearable light sensor. The app challenges to improve light exposure patterns will be send out during the final two weeks of the study to half of the participants. After the study, data on social media use, sleep indicators, light exposure, alertness, and vitality will be compared between adolescents who have been using the app and those who have not.

A mobile app to reduce screen time, isn't that counterintuitive you may wonder? The main reason for choosing this type of intervention is because it is very accessible for adolescents and it offers a low threshold opportunity for them to learn about the effects of light exposure and social media use on sleep, and how they may improve their sleep by simple behavioral changes. Moreover, the app specifically challenges users to reduce screen use in the evening. Challenges and questionnaires are not send after 8:30PM and users are prompted to limit their phone use (and other screens) after this time. If they really need to or want to use screens in the evening, they learn some easy tips and tricks to decrease light exposure and social media use before bedtime. We hope that this will be an easy and effective way for adolescents to become more aware about what they can do to improve their sleep in the long term.



Screenshots from the app 'Sleephacks' with an example of a challenge. Text is provided in Dutch.

INGRID VOGELS AND XIANGZHEN KONG | HUMAN TECHNOLOGY INTERACTION TU/E

Modeling the perceived rate of color change

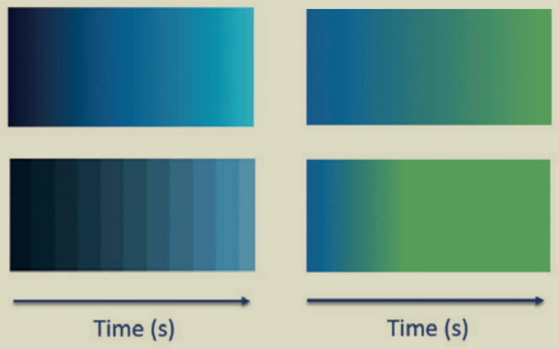
Light emitting diode (LED) technology has evolved rapidly in the past decade because it offers a number of advantages for general lighting. Two unique capabilities that differ from conventional lighting technologies are the fast response to changes in the driving current and the almost full control of the spectral distribution of the light.

This provides easy and inexpensive ways to make dynamic colored light, which is beneficial for many applications, e.g. to create an appealing light atmosphere in shops, to enhance people's alertness in offices or to enhance the immersive experience of displays such as the Philips Ambilight TV. Dynamic light should have (at least) the following properties in order to be attractive to observers: the light should change smoothly over time (see Figure 1a), and the light should change at the right rate (see Figure 1b). This is easier said than done because LEDs are digitally driven, and, therefore, the light changes in steps per time interval depending on the driving frequency of the system. Sekulovski et al. [1] already studied how large these steps may be such that the light transition still appears to be smooth. However, it is not known yet what the perceived rate of color change is for a given physical transition between two colors. So, if we want to generate a temporal light transition with a constant perceived rate of change, we need to know how to actually change the color per unit of time.

,Color science has long focused on the perception of spatial color differences or color gradients. This has led to the development of several color spaces, which is nothing else than a three-dimensional ordering of color. The most important property of a "good" color space is that the perceived difference between two colors is proportional to the Euclidian distance in the color space, which is also referred to as a perceptually uniform color space. However, since spatial and temporal properties of a visual stimulus are processed in different areas of the visual cortex, it is unlikely that color spaces defined to describe spatial color perception are accurate in predicting the perception of temporal color changes. The PhD project of Xiangzhen Kong, which started in September 2015 and will finish early 2020, aims to develop a human-vision based temporal color space.

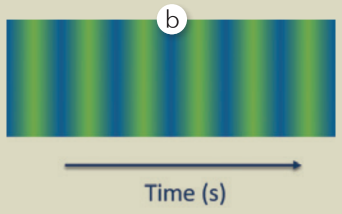
In the first part of the project, we showed that none of the mostly used existing color spaces are suitable for predicting the perceived rate of a temporal color change. For instance, the relative rate of two color transitions expressed in CIELAB had to differ by a factor ranging between 0.56 and 1.49 in order to be perceived as equal [2]. This study was performed at the Munsell Color Science Laboratory in Rochester, with which we have close collaboration.

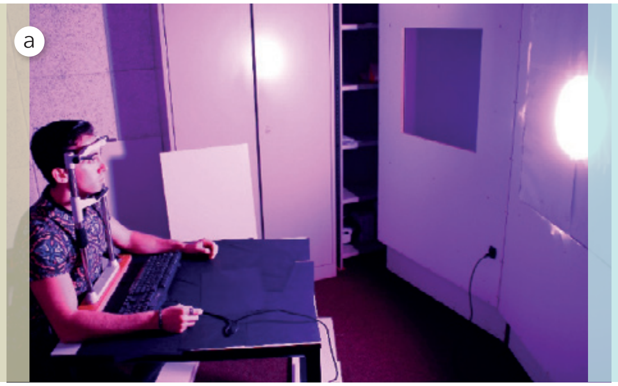
The second part of the project was performed at the Human Technology Interaction group of the Eindhoven University of Technology in collaboration with Signify. Here, we collected a large amount of data that could be used to build a new color space. Instead of measuring the perceived rate of color change we measured people's sensitivity to chromatic flicker, a paradigm that has several advantages (see Figure 2). The visibility of the chromatic modulation was found to depend on the flicker frequency, which could be modeled by an exponential function. It also varied between individuals, which encouraged us to take the individual spectral sensitivities of the cones into account. Finally, the visibility depended on the color point and the direction of the modulation, which indicates that the color space is not uniform. Currently, we are working on the first steps to build a uniform color space for temporal color changes by taking into account all our findings and existing knowledge on color processing in the retina and visual cortex. Once this color space is validated it can be used by the International Commission on Illumination (CIE) for standardization. Industry will greatly benefit from this as it enables the design of high quality lighting systems and dynamic light effects.



*< **Figure 1:** Schematic pictures of dynamic color transitions.*
***(a)** The upper transition appears as smooth, whereas the lower transition shows clear steps between successive intervals.*
***(b)** The rate of color change in the upper transitions looks more constant than in the lower transition.*

*> **Figure 2:***
***(a)** Impression of the experimental set-up used to measure the visibility to chromatic flicker.*
***(b)** Schematic picture of a chromatic flicker stimulus where the color changes sinusoidally over time between two colors.*





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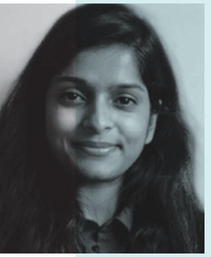


ILI New employees

SILA AKMAN ASIK
PDEng Smart Space project

I obtained a BArch degree in Architecture from the Middle East Technical University (METU) which is one of the leading international research universities in Turkey and an MSc degree in Conservation of Cultural Heritage from the same university in 2011 and 2016, respectively.
Having studied architecture provided me a solid background in design and critical thinking. During my master studies, I built on my knowledge in spatial information management, and value assessment of a multi-layered and multi-scaled cultural landscape.
I have always had a great interest in understanding the physical and social environment surrounding me and my passion has been learning from past to design for future not only for the sake of humanity but also for the future of planet.
I started working as a PDEng in SBC program in August. My project, supervised by Evert van Loenen and Rianne Valkenburg, is Interreg Smart-Space Project for outdoor smart lighting solutions, I am responsible for the evaluation and monitoring of the implementation focusing on the citizens' perspective.

KYNTHIA CHAMILOTHORI
Assistant professor HTI

Kynthia Chamilothori joined the Human-Technology Interaction group in the Department of Industrial Engineering & Innovation Sciences of TU/e as an Assistant Professor in October 2019. Prior to joining TU/e, she received her PhD from the Laboratory of Integrated Performance in Design (LIPID) at the Institute of Architecture in the École polytechnique fédérale de Lausanne (EPFL), and her Master's degree (Dipl-Ing) in Architectural Engineering from the Technical University of Crete (TUC). In her doctoral research, which was funded by VELUX Stiftung, Kynthia investigated how façade designs and their interplay with daylight can affect the perception of a space, while introducing virtual reality as an experimental tool in lighting research. Her general research interests lie in the intersection of lighting, architecture, human perception and wellbeing, with a particular focus on how the characteristics of light in space can influence the subjective and physiological responses of occupants. She is also particularly interested in how these research findings can be applied in the built environment, and has been involved in multiple kinetic façade projects that use smart and composite materials to respond to both building performance and occupant needs.

SWAGATA CHAKRABORTY
PDEng Smart Space project

My academic journey began with a Bachelor's degree in Information Technology Engineering in India (St. Thomas' College of Engineering and Technology). As a software developer, I was engaged in designing technology-aided user-centric web development solutions. My first professional work experience was in India where I worked for two and a half years as an Associate IT Consultant in the ERP domain for a global IT service providing company (ITC Infotech, Bengaluru). In my full-time job, I experienced a major disruption in the management practice of integrating technology and business objectives and mutual decision making, which triggered me to pursue my Masters in E-Business and Innovation from Lancaster University, UK. A glass still half full, I was intrigued to further my academic career in Smart technology infrastructure developments to solve citizen centric problems. This interest was positively impacted by my previous work in collaboration with Lancaster University's Connected Communities Research lab on developing Smart Park infrastructure solutions to improve visitor's experience in the Lake District National Park, UK. Therefore, it was quite eventful to be hired as a PDEng trainee at TU/e for a SMART-SPACE project governed by the EU, envisioning carbon-emission reduction by 80% by the year 2050. Conforming to the challenges that necessarily arise from such implementations are large-scale technology adoption and long-term ambition of the cities towards incremental development on the existing infrastructure. For this project, I have been vested with the responsibility to develop a transition technology roadmap aided with an implementation toolbox that would serve as a guide for cities to seamlessly adapt and foresee the long-term potential based on their current infrastructure. I am fortunate enough to be guided by two amazing professors who are experts in their field, Dr. Edwin J. Nijssen, and Dr. Ir. Rianne Valkenburg, for the completion of this project.

SIMON KRONBERG
PhD CASA Mathematics and Computer Science

Simon's background is in (engineering) physics, and he received his MSc diploma from Karlstad University in Sweden early June 2019. His thesis was concerned with morphology formation as a result of phase separation of ternary mixtures upon evaporation, where a discrete-time Monte Carlo approach was applied to a two-dimensional lattice. He joined TU/e as a PhD student during the middle of September 2019.
His present research concerns free-form geometrical optics with scattering, which is a challenging and novel combination as one of the main approximations of traditional geometrical optics is precisely that the light does not scatter; it exclusively reflects and refracts. This research is part of a more ambitious effort carried out as a collaboration between several institutions and companies focused on furthering the field of non-imaging optics in the context of light homogeneity and isotropy to aid the design of the free-form scattering optical components of the future.

ROBERT VAN GESTEL
PhD CASA Mathematics and Computer Science

After receiving my Bachelor degree in Applied Physics at Eindhoven University of Technology, I continued for the Master's degree in Applied Physics at the same university, specializing on Plasma Physics and Radiation Technology. For my master thesis I focussed on numerical methods for simulating flows of multicomponent mixtures. One of my supervisors was dr. ir. Jan ten Thije Boonkkamp from the department of Mathematics and Computer Science. In May 2019 I obtained my Master of Science degree in Applied Physics.

Starting from June 2019 I started as a PhD student at the department of Mathematics and Computer Science under supervision of dr. ir. Jan ten Thije Boonkkamp and prof. dr. ir. Wilbert IJzerman. My PhD project is focussed on developing novel numerical methods for ray-tracing using Hamiltonian optics. This entails describing the movement of light through an optical system as a flow in phase-space.

PEGAH KHEIRI
PDEng Smart Building & Cities

After studying architectural engineering and urban design, I worked in architectural and light design context for about 5 years, while the aspiration to contribute in development of innovative sustainable solutions for the built environment made me to seek master of Building Engineering at Politecnico di Milano, where my focus of study was mainly on building envelope design and building energy consumption and daylight analysis.
After master studies, following the same interests, I started working on Atlas building as a cutting edge Indoor Living Lab; a breeding ground for innovative technologies to be tested and realized. My effort is to develop surrounding ecosystem in Atlas as well as analyzing if the embedded technologies within this Living Lab, might be deployed and scaled-up to a broader market setting; my research is also supported by OPZuid program which aspires to strengthen and broaden the "open innovation" system in the south of the Netherlands.

ILI SHORT

Recipients of the Walsh-Weston award

Mariska Stokkermans, Ingrid Vogels, Yvonne de Kort and Ingrid Heynderickx

The Walsh-Weston award is presented for the best paper published in Lighting Research & Technology journal, focusing on fundamental lighting matters. It recognizes the roles of J W T Walsh, who was instrumental in developing the systems of photometry we use today and H C Weston, who worked in the area of illumination leading to the first IES task illuminance recommendations.

The ILI members received the 2019 Walsh-Weston Award for a publication on the description of atmosphere in a room: "Relation between the perceived atmosphere of a lit environment and perceptual attributes of light". The paper was published in Lighting Research and Technology Volume 50, Edition 8.

ILIAD and Holst event 2019

November 21 Auditorium Blauwe Zaal TU/e

THE ILIAD PROGRAM

08:30 – 09:00	**Registration**
09:00 – 09:10	**Opening and welcome** by ILI Scientific Director Ingrid Heynderickx
09:15 – 09:45	**Lecture #1** Dr. Yu Yan (MELUNA) Overview on UPE (ultra-weak photon emission)/ biophotonics and the application on health and agriculture
09:45 – 10:15	**Lecture #2** John Peek (MSc) (jp*InnoConsult) Overview on the possibilities and challenges of laser light
10:15 – 10:45	**Coffee break**
10:45 – 12:00	**Roadmap sessions in three groups.** You are invited to give input to the roadmap (research program) of one of our three ILI research program lines. Goal is to collect ideas for new topics and to define new milestones for existing topics.
12:00 – 13:00	**Lunch**

THE HOLST SYMPOSIUM PROGRAM

13.00 – 13.30	**Registration**
13.30 – 13.35	**Word of Welcome** - Greg Nelson (Head of Research Signify)
13.35 – 13.45	**Introduction** by Symposium Chair Jean-Paul Linnartz (TU/e and Signify)
13.45 – 14.15	**Lecture #1** 'How light influences biological clocks and why we should care' - Robert Lucas, PhD (Director of the Centre for Biological Timing and GSK Professor of Neuroscience at the Faculty of Biology Medicine and Health, University of Manchester, UK)
14.15 – 14.45	**Lecture #2** 'Light for health intra-body navigation of medical devices using Fiber Optic RealShape' - Gerard Winkels (Winkels Innovation and Insights)
14.45 – 15.15	**Lecture #3** 'Disruptive chips for light' - Andrea Fiore (TU/e) (Full professor within the Department of Applied Physics at Eindhoven University of Technology. Also Scientific Director of the TU/e Institute for Photonic Integration)
15.15 – 15.30	**Wrap up**
15.30 – 16.00	**Coffee Break**
16.00 – 16.10	**Word of Welcome** and Introduction Holst Lecture - Henk van Houten (CTO Royal Philips)
16.10 – 17.00	**Holst Memorial Lecture 2019** - 'Optical imaging, the diffraction limit and methods to surpass it' - Joseph Braat (Professor emeritus TU Delft and former scientist Philips Research Laboratories, Eindhoven)
17:00 - 17:15	**Award Ceremony** - Frank Baaijens (Rector Magnificus Technische Universiteit Eindhoven)
17:15 - 18:15	**Reception**

REGISTRATION

- *For ILIAD on **iliad-2019.eventbrite.com***
- *For the Holst Symposium and the Holst Memorial Lecture at **www.aanmelder.nl/holst2019***

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