ILI GLOW

Intelligent Lighting Institute | Edition 4, November 2015

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TU/e Technische Universiteit **Eindhoven** University of Technology

Technische Universiteit Eindhoven University of Technology

Intelligent Lighting Institute

Harold Weffers | Operational manager

Welcome

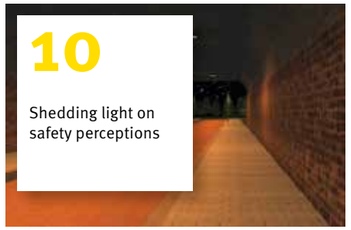
I am extremely pleased to present you the 4th edition of our magazine and I hope that the various contributions to this magazine will provide you with a glimpse of the many exciting and promising developments that have been happening.

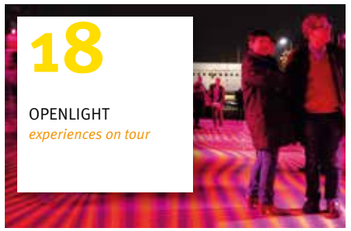
In this edition, we present relevant results of a number of projects that researchers/research groups affiliated with ILI have been involved in. In particular, we present the Enlight (ENIAC) and the IOLS (EIT Digital) projects. In addition to these European projects, we also present the PhD projects of Leon van Rijswijk and Katharina Biljman.
In this edition, we also have an interview with professor Yvonne de Kort who will present her inaugural lecture on 13 November 2015.

This edition also has a special focus on Glow. This year we do not only have a number of new contributions at Glow-next, but you can also find a professional version of WAVES at Glow itself. WAVES was originally developed for Glow-next in 2013 and in 2014 an improved version was used at the Dutch Design Week. If you would like to learn more about the various research programs and their projects, please joins us at our annual outreach event on 8 December 2015.

Pleasant reading!

ILIGLOW CONTENT





Editorial // ILI GLOW is an annual edition of ILI for ILI members, colleagues, collaboration partners, policy makers and related companies. ILI GLOW is published in November. // Editorial staff - Harold Weffers, Samantha Sperling // Design - Volle-Kracht concept, ontwerp en organisatie // Illustrations - ILI // Article contributions - Moesasji & ILI // Photography - Bart van Overbeeke Fotografie, Philips Communications, ILI // Contact - P.O. Box 513, 5600 MB Eindhoven The Netherlands T: +31(40)247 5990 E: ili@tue.nl //

Ingrid Heynderickx | Scientific Director

Let Light Lead: Further shaping the research mission

Inheriting the Intelligent Lighting Institute with the leading theme "Let Light Lead" as its scientific director is challenging, and at the same time extremely inspiring. It is always challenging to maintain the high performance and good spirit in a team that one inherits from a renowned predecessor. I would like to take this occasion to gratefully thank Emile Aarts for his outstanding contributions in building up the Intelligent Lighting Institute and in setting its directions for the last seven years. He succeeded in establishing an institute that by now is well-known in the Brainport region as well as within the Netherlands and Europe for its innovative lighting solutions.

At the same time it is inspiring to become scientific director of such an institute. I fully believe in its mission of improving people's health, well-being, productiveness and feelings of safety and in improving sustainability in society at large through informed and substantiated design, control and application of lighting technologies. I will fully support the scientific community in and around the institute such that it can proceed with the scientific and application-based approach to create intelligent lighting solutions. I will maintain and further establish partnerships with stakeholders in the public-private domain in order to valorize our multidisciplinary and evidence-based research. Finally, I will support the use of human-centric real-life Living Labs to facilitate our research and to provide evidence that our lighting solutions have value in real-life conditions.

During the last half year we made considerable progress in our three new Living Labs. On July 7th, we officially opened the Lightbase as the new lighting design lab in the Laplace building of the TU/e campus. On December 8th we will officially open the Markthal, being the semi-open area in front of the Metaforum building on the TU/e campus, in which we mounted lighting sensing and actuator equipment to facilitate studies on crowd management and to involve end-users in co-creating lighting solutions. End of October we received approval of the TU/e Board to establish a Living Lab in the Main building of the TU/e campus that currently is under reconstruction. We will install a “digital lighting infrastructure” in the new building, including facilities to, at the one hand, design comfortable as well as sustainable lighting distributions, and at the other hand, improve employee's performance and well-being through high-dose, spectrally tuned light at the appropriate time of the day. With these facilities we will enlarge our options to create and validate new intelligent lighting solutions.

Calendar

November 7-14, 2015 Glow Festival
Location: Eindhoven
Includes ILI OPENLIGHT installations at GLOW AND GLOW NEXT

November 12, 2015 LEDTalks
Location: TU Eindhoven, Zwarte Doos
www.ledtalks.nl

November 13, 2015 Inaugural Lecture
Prof.dr.ir. Yvonne de Kort
Light on and in context
Location: TU Eindhoven, Auditorium

November 16, 2015 Conference on the approach of violence an innovation by the CCV and Ministry of Security and Justice
Location: MediaPlaza Utrecht

December 8, 2015 ILIAD-15 Outreach Event
Location: TU Eindhoven, Zwarte Doos

December 11, 2015 Public Symposium SOLG: Light-Dark-Sleep The effect on wellbeing, health and performance by Karin Smolders
Location: Amsterdam, Beurs van Berlage

January 21, 2016 Shedding light on appraisals of environmental safety
Dissertation defence Leon van Rijswijk
Location: TU Eindhoven, Auditorium

Intelligent Lighting Institute
Annual outreach event

During the 2015 edition of our annual outreach event on 8 December, we will show the results of the recent research & innovation projects related to our research programs Sound Lighting, Bright Environments and Light by Design as well as our creative art program Open Light.

At the end of the outreach event we will officially open the new Living Lab in the “Markthal” as part of the MetaForum building that will be used by the various departments collaborating in the Intelligent Lighting Institute as well as by others.

OPENLIGHT @ GLOW

Author: Rombout Frieling

Light has to be experienced firsthand in order to appreciate its true value and characteristics.

In the OPENLIGHT program, we truly believe in this. This is why we develop installations where new possibilities of light can be experienced directly by the public. These usually come together in collaborations between students from various disciplines, our team and industrial partners, and always for a particular event. We call this the 'festival model'. And although various events and light festivals are platforms for our experiences, our own GLOW forum for light and architecture in Eindhoven continues to be the main springboard for our installations.

This year we will present four installations at GLOW, which will take place from Saturday 7 – Saturday 14 November. Two of those are the outcomes of work by students in our honors programs: a talented set of students from disciplines ranging from chemistry to electrical engineering and from architecture to business, a collaborative project with Philips and version 2.0 of the WAVES installation we developed earlier. The first three projects are shown at the experimental GLOW NEXT part at the Strijp-S area, whereas the WAVES 2.0 installation can be experienced in the central GLOW route.

Frederik

Frederik is a site-specific installation developed for the steel structures between the Anton & Gerard buildings on the Strijp-S area in Eindhoven. While the buildings are named after the Philips brothers, the students decided to name their 'bridging' installation after their father, poetically referring to the fact that their father was always in their shadow – and the concept of shadows being the main element in the installation:
Installing a giant screen in front of the structure, students play with the shadows of the structure that are created by lamps behind it. These lamps fade in and out and move around, creating a dynamic play that reminds us of the industrial dynamics in the 1930s, at the time the buildings were first used. The installation is an experiment to see how with relatively simple means, one can convey more complex meanings through dynamics.

Unique in the project is also the way it was developed: A 3D model was made of both the buildings, the structure, the screen and the lamps, using Blender software. In this manner the students could start from the movements they like to see and 'reverse engineer' the position of the lamps and their corresponding movements. Another novelty is that the system is controlled straight out of the Blender software, reconciling their virtual model with the physical reality.

Scopofobia

The perception of light obviously starts with the eye. And as light is important to us, eyes are too. We carefully watch each other eyes. They tell us if somebody pays attention if we talk, or if they are distracted by something else. In this small and experimental Scopofobia installation students experimented with ways we can perceive where Eyes look too, and they show how our eyes are always attracted by light.

Natural Elements

A last installation is based on very innovative algorithms developed by Philips which mimic natural lighting effects like reflection of light on water, or flames in a fire. A group of honors students who gained experience making an installation for GLOW in 2014, now helped Philips researchers to turn their technology into an interactive installation.

Waves 2.0

WAVES, a novel installation visualizing sounds through light, developed back in 2013, will be shown in a much larger setting this year, as we wanted to challenge ourselves if the unique interaction capabilities can also work for very large audiences (of hundreds of people). The installation will be installed in the central GLOW route, at the Smalle Haven. See elsewhere in this magazine for more information on why we developed WAVES 2.0.

For more information on GLOW see **www.glow-eindhoven.nl**

For more information on OPENLIGHT see **www.openlight.nl**

Shaping light for human wellbeing

“The influence of light needs to be researched in its context. You can wake somebody up at night using a blue light, enhancing alertness and focus. However, if you apply blue light during daytime, it is doubtful you will get the same effects,” indicates Prof. Dr. Ir. Yvonne de Kort, manager of the research programme Sound Lighting at ILI. “Remarkably, environmental psychology has done very little research on the influence of light on the wellbeing of humans. We intend to change that.”

From a scientific background in Mechanical Engineering and Medical Technology, Yvonne de Kort has now established a position as environmental psychologist. With effect from January 2015, she was appointed full professor ‘Contextual perspective in Human Technology Interaction’ at TU/e. Due to her broad personal quest ‘What drives people and how are they wired?’ she is not coincidentally involved in ILI’s research programme ‘Sound Lighting’. Yvonne de Kort: “Some 6 years ago, during the foundation of ILI, I was asked to manage this programme. Ever since then I have been studying light and its influence on the wellbeing of people. It is a very rich field and I was surprised that environmental psychologists like me had spent so little attention to it. The field focusses on the way we see our environment, paradoxically through light. However, light itself has always been perceived as obvious. We don’t think about it much. Possibly, the hesitancy towards this type of research might also be rooted in its complexity. It requires deep knowledge of technology, physics, psychology and biology.”

Programme line structure

Light has proven to be of great influence on the wellbeing of people. Light is applied in the treatment of more and more psychiatric conditions, including major depression, winter depression, bipolar depression and even burnout. The question arises: Can we also use light to prevent these syndromes? The Sound Lighting programme at ILI dives into the effects of light on human beings and aims to deliver valuable input for the development of effective lighting systems. It comprises five domains:

- The first domain centres on perception; how light enters the human eye and creates a pleasant and accurate visual image.
- The next line considers the preventive and protective potential of healthy light regimes.
- The third wave focusses on cognitive performance. How can light help to boast alertness, concentration and mental performance?
- The fourth considers the atmospheric effects of light and the consequent behaviour of people.
- The last programme line aims to translate these psychological and physiological insights into valuable input for designing optimal lighting systems.

Real-life conditions

Yvonne de Kort: “Research in this area shows many challenges. You can tease apart the psychological and chronobiological effects to perform fundamental quests, but in the end all has to come together. We cannot separate the stimuli and processes in the human psyche if we want to produce reliable results. In this perspective, lab-studies are valuable, but clearly show their limits. We have to study the effects in real-life situations as well.” The latter is complicated, but through the usage of smart technology, increasingly adequate. Yvonne: “We use a combination of physiological measurements, performance tests and questionnaires to reveal the effects of lighting conditions on the human mind and body. In Living Lab situations, such as the Stratumseind where we look into the effects of lighting on crowd behaviour and aggression reduction, we also combine it with observations and incident-data. However there is still a world to win, for instance in the application of sensor data.”

Towards valuable applications

Yvonne de Kort: “The use of light offers numerous possibilities. And the good thing is, it is easily applicable once we develop that deep understanding of lighting conditions. As an institute, ILI provides us the means and the contacts to progress with our quests. With the industry, for example, but also with other TU/e departments such as Built Environment. It is great to work with multiple disciplines towards discoveries about what light can bring us. Inevitably, light has a major impact on people. Understanding can bring us better and more valuable applications.”

Shedding light on safety perceptions

Author | Leon van Rijswijk

The substantial increase in novel and technology-driven public lighting solutions (e.g., intelligent dynamic street lighting), aimed at reducing societal issues around energy waste and lighting pollution, raises important new questions with respect to the design of public lighting. For example, while novel technologies may facilitate efficient and well-targeted lighting, as of yet it remains unclear where people need light, or indeed how much light they actually need in order to feel safe. Current public lighting recommendations, developed within the context of conventional lighting systems and often based on scant empirical evidence, may not be sufficient any longer in the context of these new type of questions, thus presenting us with a momentum for reconsidering the adequacy and empirical foundations of these recommendations.

Against this backdrop, Antal Haans and I have focused on better understanding the pedestrian's safety appraisal process and the role of lighting. What is the environmental information that people use to form an accurate judgment of the safety of an environment? How does lighting affect this safety appraisal process? In addition to addressing these questions, the work described in my thesis addresses the question whether local information is more important as compared to distal information as well as the temporal aspects of safety judgments, thus providing a more in-depth examination of the appraisal process.

Our findings consistently highlight the importance of appraisals of safety-related environmental characteristics. Indeed, we found that as much as 75% of the variance in safety judgments over a large range of (simulated) environments could be attributed to appraisals of environmental characteristics reflecting perceived escape possibilities, perceived overview or prospect provided by a scene, and perceived environmental affordance of hiding places for offenders. Interestingly, as large as these environmental influences were across the board, participants were not equally attuned to safety-related environmental information. Instead, we identified substantial differences in individual susceptibility which we could link to individual differences in trait anxiety and perceived power.

The results from our studies that included appraisals of the quality of the lighting as predictor showed no effect of lighting on safety judgments that could not be explained by changes in the other safety-related environmental characteristics described above. In other words, the effect of lighting on perceived safety may be primarily driven by the influence of lighting on other environmental characteristics, for example through increasing the overview over a scene or by highlighting potential escape possibilities.

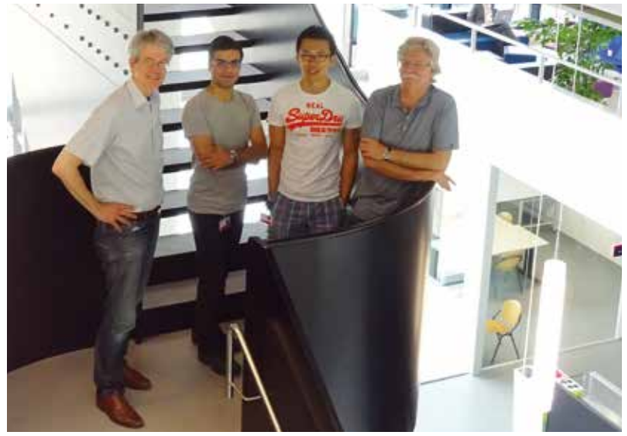
Our research provides interesting new opportunities for developing sound urban lighting recommendations. The current research is increasingly focused on determining the critical visual tasks that need to be supported for a pedestrian to feel safe (e.g., identifying intent of others at a certain distance). Our results suggest that these critical tasks may change depending on the features of the environment and thus on different lighting conditions. Thus, while our studies contribute to advancing our theoretical understanding of the environmental safety appraisal process, they are but a first step towards the development of more empirical, and thus justifiable, lighting recommendations.

Rural, urban and tunnel: "Examples of simulated environments in which we could manipulate the lighting levels"

EnLight wins ENIAC Innovation award

Author | Jean-Paul Linnartz

Participation in large European projects not only gives ILI first hand insights in the system architecture of future lighting control systems, it also is a good way transfer insights and knowledge to many industrial partners. This was particularly rewarding in the large EnLight project, with partners ranging from device suppliers, software and integration specialists to system developers. This project has been awarded with the ENIAC Innovation Award.



The EU applauded how EnLight was exemplary in bringing together key actors in a project of significant size (more than 41M€ R&D investment by 27 partners) to achieve results of genuinely high value to the partners. It highlights the importance of semiconductor technology as a core European competence, which fully delivers on its promise of innovation when taken up by leading actors along the full value chain.

In EnLight, the Signal Processing Systems group at TU/e EE cooperated closely with for instance Philips and NXP. The project had three technical objectives namely the optimization of LED lighting modules, the design of future luminaires and the use of new, intelligent lighting systems. As a result, the energy savings in office applications could be shown at 44% compared to LED retrofit and standard controlled lighting systems. The energy savings in hospitality could nearly be doubled and ended up at a figure of 81% energy reduction by using new luminary designs with intelligent controls. This motivated the journal "*LED-Professional*" to devote a full special issue to this project.

Decision rule engine

The EnLight project has given the TU/e PhD candidates Xin Wang and Amir Jalalirad an excellent view of the true problems in the future lighting installations. During the project they refined the initial specification of the rules and implemented the engine on the NXP Jennic platform. The insights they obtained in the requirements of lighting systems were augmented by the intelligent control implemented in the EnLight demonstrations in Oulu (VTT, Finland), Munich (Osram, Germany), and Eindhoven (Philips, The Netherlands).

Scientific Directions

Now in the final year of their PhD project, with the EnLight experience behind them, Xin and Amir are focusing on the next wave of innovation, particularly from the insights of data analytics and optimized control.
In EnLight, the industry has set the stage for an architecture that allows intelligent and energy saving applications to be executed. Prof. Jean-Paul Linnartz, advisor of the two PhD candidates in EnLight, sees the harmonization of a rule engine as a good step forward in EnLight. Particularly the option to adapt rules as the systems learns about its users and its environments enables further innovation towards self-adapting systems. “But in the long run, we may have to extent if-then-else rules with probabilistic optimizations”. “Practical systems will never have absolute knowledge about what human users are preferring. Hence these systems should optimize light setting according to a cost function, rather than make hard choices”.

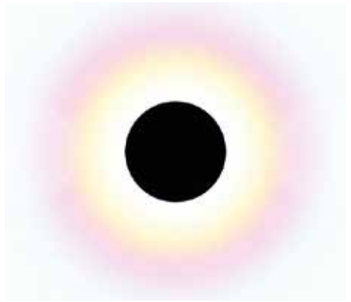
In some of his recent papers Xin Wang has worked this out by modelling of human satisfaction and, for instance, energy consumption in mathematical models. For the human experience that required the inclusion of uncertainty. This avoids to a large extent the annoying wrong decisions that current automatic systems make when sensors are not working perfectly. Dr. Tjalling Tjalkens, also coaching the PhD candidates at the faculty of Electrical Engineering sees a clear connection between machine learning, information theory and future lighting control. Yet we have to advance the scientific state-of-art, because in well-functioning lighting control, the number of human interventions should be very minimal. Hence such system have only few learning opportunities, much less than academic machine learning algorithms typically require.

http://www.enlight-project.eu/user/files/lpr48_enlight_157996.pdf

ILI Short

In collaboration with Industrial Design we realized the new Lightlab.

With this new Lightlab we make the required facilities available for students and researchers. The Lightlab provides dedicated (dark) spaces for light research and exploration and a wide variety of equipment to create light settings. The flexible set-up of the Lightlab allows users to work on multiple projects simultaneously.
We combined this event with the goodbye drink of Emile Aarts, who started his new position at the University of Tilburg last June. Ingrid Heynderickx has taken over his role at our Institute. (See the articles in the 3rd edition of the ILI magazine).



Light and art

ILI has recently started a new collaboration with Van Abbe Museum, the artist Roland Schimmel, and scientists from various disciplines called 'Innocent Technology'. The ambition is to jointly realize an installation and publications in 2018, around the theme 'after images' and the work of Schimmel. Yvonne de Kort and Alex Rosemann are coordinating this from the ILI end and are hoping to involve honors students in this exciting and ambitious project.

U-meet

During the national VSNU university outreach event – honoring the Year of Light this time – ILI and CEC organized a fun and educational event under the newly installed lighting in the Forum. Six researchers held quizzes and brief lectures: Antal Haans, Alex Rosemann, Yvonne de Kort, Mariëlle Aarts, Harm van Essen and Tanir Ozcelebi. Philip Ross and Indre Kalinauskaite created interactive light scenarios to liven up the show.

http://www.vsnu.nl/ezine-umeet2015/tu-eindhoven.html
http://www.hetweekendvandewetenschap.nl/activiteit2015/u-meet-tu-eindhoven/
http://www.magazine-on-the-spot.nl/u-meet/phone/technische-universiteit-eindhoven.html

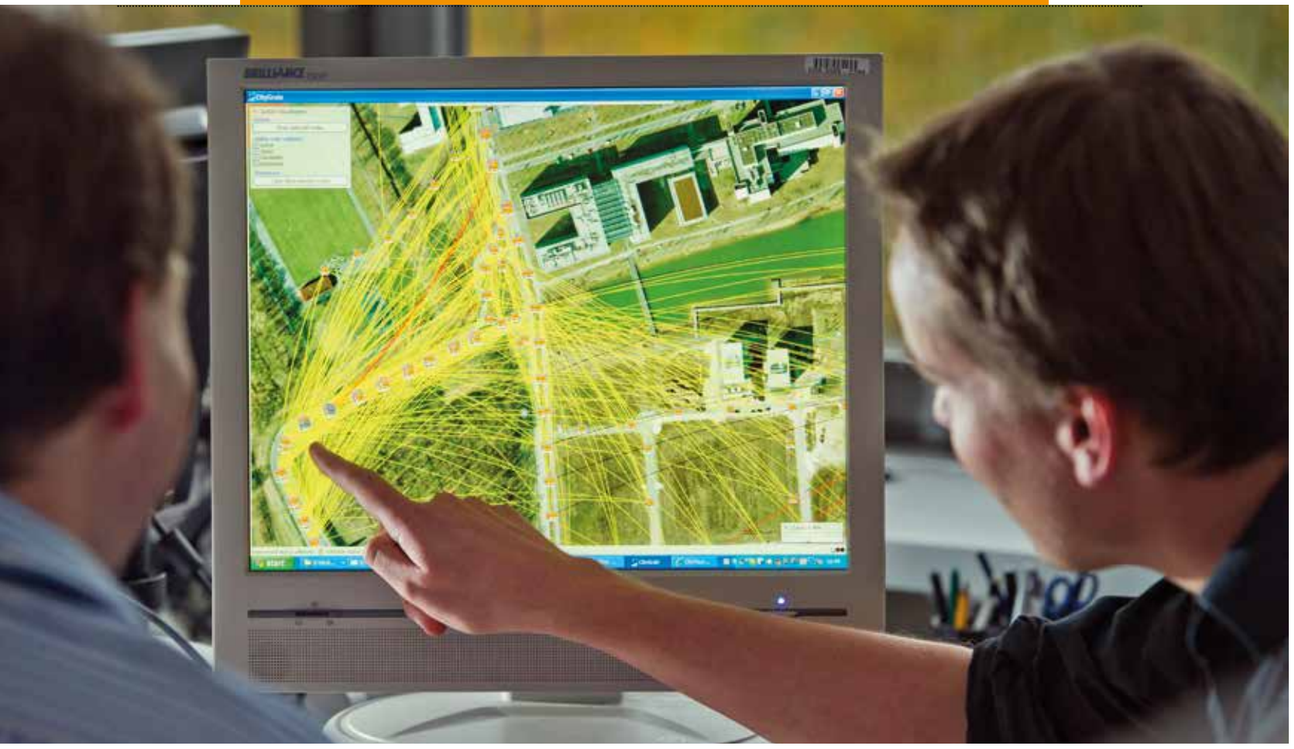
CIE Global Open Lab Day

On May 20, the Building Lighting Group has opened their doors to their research lab within the World-wide activity "Global Open Lab Days" organized by the International Commission for Illumination (CIE). During the tours, the guests received an overview of the different research activities and measurement equipment, including the various spectral and photometric measurement devices, test rooms, the daylight lab and the solar measurement station on the roof of the Vertigo Building. Participants came from the Netherlands, Switzerland, Germany and Denmark.

Danish Light Day

On September 30th, 2015 the Danish Lighting Center organised their yearly Lysets Dag and for this event multiple Danish and international speakers were invited. Dr. Myriam Aries, assistant professor in the Building Lighting group and ILI-member, was one of the invited speakers and her presentation was titled "Hvordan påvirker lys oplagthed + produktivitet I bl.a.skoler" (Daylight and productivity in learning and working environments). In total, 230 participants were present at the Danish light day.

Data-driven innovation in Smart Cities via Intelligent Lighting



Author | Mike Holenderski

The light poles illuminating the cities of tomorrow will enable the creation of new and exciting services aiming to improve the energy efficiency, safety, productivity and quality of life in smart cities. Many of these services will rely on the data being streamed from the intelligent light poles.

Modern streetlights are being fitted with LED luminaries, various sensors, and a communication infrastructure allowing to control individual luminaries. They offer energy efficient lighting with fine-grained control of color and intensity, as well as access to unprecedented amounts of data, monitoring what is happening on the streets. This data can be used to enable many interesting smart city services, such as monitoring of air and noise pollution, parking space assistance or crowd control.

The Intelligent Outdoor Lighting Systems (IOLS) project, joined by the TU/e, Philips and ST Microelectronics, investigated the feasibility of several smart city services in selected cities around Europe. In Eindhoven, it leveraged the Stratumseind Living Lab (introduced in the last issue of the ILI magazine) to validate the feasibility of a service for predicting the number of people visiting Stratumseind, based on the sensor data gathered by the intelligent light poles. Knowing the number of visitors ahead of time is valuable to several Stratumseind stakeholders for managing their resources and personnel, including bar owners, police, hospitals and cleaning services. The investigation, conducted by Weldebrhan Gebrezgabher as part of his final PDEng assignment, revealed several challenges in developing such data centric smart city services.

A method was developed for correcting the people counters in order to estimate the total number of people in the area. The various sensors attached to the intelligent light poles can generate data of different types. For example, monotonically increasing people counters, continuous temperature and rainfall measurements, and irregular calendar events (such as Carnival or King's day). A simple model was proposed which combines data of different types and provides an accurate prediction of the number of visitors. Smart cities of tomorrow will contain tens of thousands of intelligent light poles, offering unprecedented amounts of data. An important question is how to build the smart city services that can handle all this available data. It was shown that the proposed model could scale to large cities.

Predicting the number of visitors to an area is just one example of a smart city service that will be enabled by emerging technologies in the smart city domain. The IOLS project is currently working on co-creating data-driven innovations for smart cities and validating these through pilots (validating both the technical and commercial feasibility). A number of focus areas within the prioritized need spaces (safety, mobility, and natural environment) have been identified and the consortium is interested to partner up with European cities to co-create full data-driven service propositions and pilot them in their cities.

Acknowledgement

The Intelligent Outdoor Lighting Systems (IOLS) project has been funded by EIT Digital (Smart Spaces Action Line) since 2014.

OPENLIGHT experiences on tour

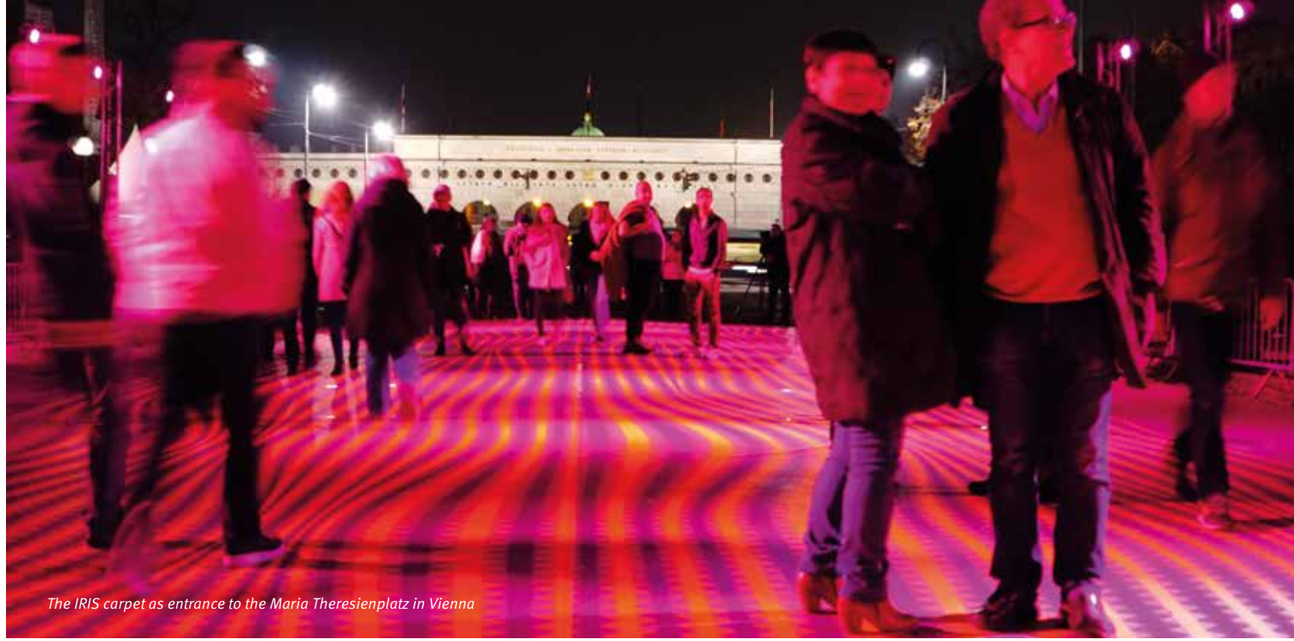
Author | Rombout Frieling

As you can read elsewhere in this magazine, at OPENLIGHT we develop light experiences. Back in 2013 we launched the IRIS and WAVES installations: IRIS, the colored carpet of 240 meters interacting with colored lighting, shows how colors can completely transform under the influence of lighting. WAVES is a novel installation visualizing sounds through light exactly at the position where sound is being made: unique because of its accuracy and mainly because it is one of the first experiences allowing very rich, 1:1 interaction even with giant audiences, over 500 people at the same time, who all feel to be interacting with one and the same system.

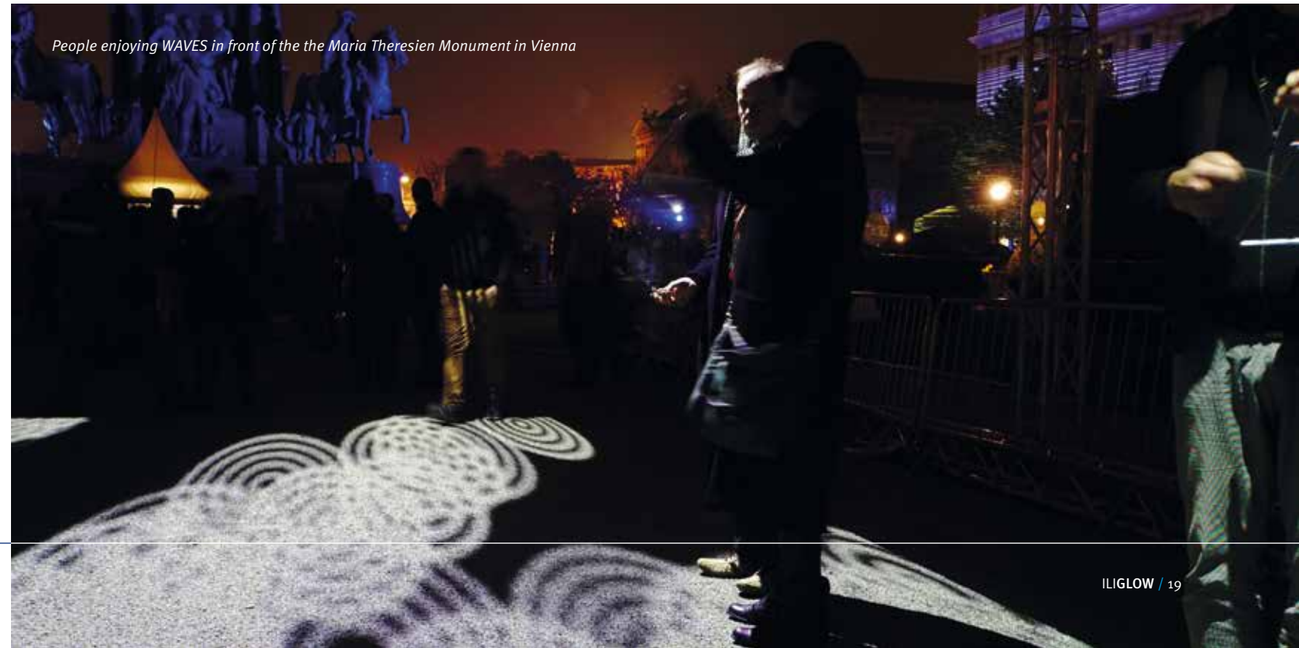
Both installations attracted a rich variety of attention by media as well as opportunities to develop the works abroad, yet back in 2013 they were still very first versions developed as temporary installations. We hence started a program to transform the IRIS and WAVES installations into solid 'plug-and-play' experiences. With the help of investment from various organizations, under which the SRE REAP fund, Pronorm and Sorama, we completed this work in the summer of 2015.

This means that both the WAVES and IRIS installations are now ready to travel around and to touch thousands of people around Europe and the World: letting them all experience the power and value of light by themselves. The famous Maria Theresienplatz in Vienna was already a first stop in October 2015, followed by a large version of the WAVES installation in the main route of GLOW in Eindhoven in November 2015.

*For more events please have a look at **www.openlight.nl**.*
Should you be interested in a WAVES or IRIS experience at your event, please contact Rombout Frieling at rfrieling@tue.nl



The IRIS carpet as entrance to the Maria Theresienplatz in Vienna



People enjoying WAVES in front of the the Maria Theresien Monument in Vienna

ZEUS Lighting!

The university requires their bachelor students to work on a final project near the end of their three year program. Computer Science has a rather unique approach to this; it is the only department where the project is performed in teams. This project is called SEP, the Software Engineering Project, where groups of nine to twelve students work together for eight weeks to complete a job assignment. Our team, dubbed ZEUS lighting (after the ancient Greek deity of sky and thunder), consist of only six team members: Jorn Engelbart, Christian Knaapen, Tos Kuipers, Willem Mouwen, Thomas Mulder and Thomas Tiel Groenestege. The university acts as the client for the project. Our assignment: Create an application which provides an interactive demo for the ILI Market Hall Living Lab.

The start of the project consisted of getting to know both each other and the system behind the Market Hall Living Lab. The “lab” consists of 32 pairs of lights (RGB and white), three Axis cameras, and a set of Kinect sensors. The OpenRemote software platform connects the components and provides a platform for research teams to share the system without interfering with each other’s research. The possibilities and limitations of OpenRemote quickly became clear and the project moved on to the next phase.
Once we successfully extracted the specific user requirements from the client, the actual development of the project could start.

We named our application JUPITER (after Zeus’s Roman counterpart). Work progressed rapidly through the use of agile software development; after the first week we were able to control the lights by sending commands to the OpenRemote server. We also made progress on detecting the presence of people underneath the lights, using motion detection on the Axis camera video feeds. In the weeks that followed we connected these components, allowing for interactive demonstrations, which we decided to name “interactivities”.

To control it all, we created a user interface where users can select different interactivities; one consists of JUPITER sending its object recognition data directly to OpenRemote, allowing other researchers to build upon our project. A second interactivity allows for direct control of the lights, and the third, a heat map, allows for an interactive demonstration of the system. Users can define regions of the Living Lab through a web interface and set thresholds with colors for each region; when a region’s threshold is reached, the lights in that region change to the specified color. Initially, we also planned to create some simple interactive games, but time constraints forced us to abandon this part of the project. Instead, we made sure JUPITER is easily extendible, allowing researchers and other developers to create their own interactivities. The final deliverable will be supplied to a group of PDEng trainees. They will start a project based on JUPITER and will expand it with more features.

ILI introduces new PhD's

Salih Serdar Guclu

I have received my BS and MSc. degrees from Computer Engineering department of Istanbul Technical University, Turkey. I have started my PhD at the System Architecture and Networking group of Eindhoven University of Technology with Dr. Tanir Ozcelebi and Prof. Dr. Johan Lukkien at 1st of February. I am funded by a EU Horizon 2020 project named "Open Architectures for Intelligent Solid State Lighting Systems (OpenAIS)". I am conducting research on multicasting in resource constrained Internet-of-Things devices. My work is focused on enabling communication between end point luminaires with IPv6 protocol, while achieving low power consumption. To this end, I am analysing and developing efficient protocols in order to enable the Internet-of-Things paradigm for luminaires.

Christel de Bakker

I had my educational career at Eindhoven University of Technology. I received my bachelor degree in the Built Environment and recently graduated at Human Technology Interaction. The 1st of September I started with my PhD at the Building Lighting group with Prof. Dr.-Ing A. Rosemann, prof. dr. H. Kort and dr. ir. M. Aries. My project is part of the project Creating Healthy Environments in Offices. Together with 3 other PhDs I will conduct user-focused research in the Edge, the smart office building of Deloitte, and analyze the data that is collected by the smart lighting system of Philips that is installed here. I will focus on analyzing on occupants' use of lighting and presence to reveal their occupancy patterns as well as preferences for lighting and workspace. On basis of this I will develop clustering methods, lighting control strategies and guidelines for space planning. Besides I will investigate how this affects users' environmental satisfaction as well as the energy use of lighting. The aim is to develop a strategy in which both of these aspects are improved.

Thomas van de Werff

My name is Thomas van de Werff. I obtained my master's degree in Industrial Design at the Eindhoven University of Technology in 2014. I started as a PhD candidate in the User Centered Engineering group this year. My project is part of the (Horizon 2020) OpenAIS project. In this project we follow the trends of the creation of The Internet of Things and the rapid penetration of SSL based lighting in the office environment. OpenAIS aims at creating an open ecosystem to enable a wider community to deliver the smartness of light.
My research focuses on understanding what added value a connected office lighting system can bring to everyone involved, from production, to installation and usage. My main interest is in the user experience, which is why I will be designing, realizing and evaluating concepts for user interaction with networked office lighting systems in the context. **http://www.openais.eu/**

Thomas Meyfroyt

Thomas Meyfroyt received both his Bachelor's and Master's degrees in Industrial and Applied Mathematics from Eindhoven University of Technology, The Netherlands. Since September 2013 he has been a Ph.D. student at Eindhoven University of Technology under the supervision of Sem Borst, Onno Boxma and Johan Lukkien. His interests are mostly in applied probability, in particular in stochastic networks and queueing theory.
His Ph.D. project, titled "Meshed lighting networks", deals with the performance evaluation and design of communication algorithms for optimally controlling large wireless systems. These algorithms need to be able to maintain and disseminate data quickly, efficiently and reliably in a distributed fashion. The goal of this project is to analyze the performance of existing algorithms with the focus on lighting applications and use the acquired insights for optimizing the design and usage of these algorithms. Analyzing the performance of such algorithms asks for theoretical tools from networks, probability theory, graph theory and operations research, and this project combines expertise from all these fields.

Leila Fatmasari Rahman

I joined the group of Prof. J. J. Lukkien, System Architecture and Networking, Dept. of Math and Computer Science, as a PhD student on 1st April 2015. My educational background includes a PDEng degree in Software Technology from the TU/e, an MSc degree in Applied Computer Science from the University of Freiburg, and a Bachelor degree in Computer Science from the University of Indonesia.
I'm investigating the programming model and infra structure of the Internet of Things. In the near future, billions of devices will be connected to the Internet and a big part of those will be lighting devices. I try to answer questions like how do we develop, deploy and update applications on these devices, and how do we manage concurrent applications and ownerships on these devices.
Evaluating existing IoT frameworks is the first step to identify different infrastructure and programming styles for IoT applications. Inspired by these styles, I can determine a suitable architecture for data collection and application deployment in connected lighting system. Implementing various lighting use cases on this architecture will allow me to identify performance optimization opportunities and their analysis.

Juliëtte van Duijnhoven

My name is Juliëtte van Duijnhoven and I started my PhD project at the unit Building Physics and Services on September the 1st. I have completed the Bachelor's and the Master's program both at the Built Environment department at the Eindhoven University of Technology.
During my PhD 'Creating Healthy Environments in Offices', I am collaborating with Philips and Deloitte. I will investigate the lighting system's impact on the (visual) comfort, health and functioning of employees in office buildings. The office building 'The EDGE' in Amsterdam will be used as a measurement environment to investigate possible effects. Experimental measurements in 'the EDGE' might:
- cause the discovery of new correlations between environmental conditions and health indicators;
- validate previous stated correlations;
- lead to a model to predict health indicators based on environmental conditions.

My promotors are Professor Helianthe Kort, Professor Alexander Rosemann and Myriam Aries.

Emy Apodoulianaki

My name is Emy Apodoulianaki and I hold a 5 year diploma of Mechanical Engineering from the National Technical University of Athens (NTUA), with a specialization in the Energy sector. After my graduation I continued my studies at UCL Energy Institute in London, UK, with a Master of Research in Energy Demand Studies.
Currently, I am doing a PhD at TU/e, entitled "Creating Healthy Environments: Hospital lighting for staff performance and patients' wellbeing", under the supervision of Prof. dr. H.S.M. Kort, Prof. dr. ir. E.J. van Loenen and Dr. ir. M.B.C. Aries. The research goal is to develop and validate a new theoretical framework and method for the lighting design of hospitals, with an emphasis on staff's performance, health and satisfaction, as well as to patients' well-being. Although the investigation of the lighting conditions will be based on hospital settings, recommendations are intended to be used generally for working conditions.

Ambience Lighting as a Way of Experiencing Music

Author | Katarina Biljman, Berry Eggen and Mathias Funk

Ever since Pythagoras first set the mathematical ground for music theory, the phenomenon of relating music and colors has continued to intrigue scientists and artists.
In collaboration with TU/e and Polytechnic University of Catalunya and under a grant from the European Commission, PhD candidate Katarina Biljman with her supervisory team consisting of prof. Berry Eggen, dr. Mathias Funk, prof. Marta Diaz and prof. Andreu Català build their research project on these ideas.

Art and technology – designing new musical environments with Philips HUE lighting

In the course of history, music found its way into the spectrum of colors. Whether explained by the related wavelength properties of light and sound, their common emotional impact, or synaesthesia - this peculiar combination has continued to inspire research from ancient times until today.

In our research we have taken the idea of translating music to colors one step further- towards transforming an ordinary room into a visual extension of musical harmonies. We asked the question – can we find a way to immerse ourselves into the colors of music each time we experience its auditory dimension?
In search of a way to translate the musical analysis into dynamic light changes, we found our research platform through the innovative Philips HUE lighting technology. The possibility of wirelessly connecting the HUE Bridge to a computer enabled us to translate musical harmony into color combinations of the high lumen output ambient lights.
The created audiovisual sensations marked for us a step forward towards highlighting an important aspect of musical structure, used by composers as a technical mean of making their emotions audible.
As observed in our EEG measurements, our physiology does not remain unaffected by such sensations- once the room turns into a multisensory world of colors and music, the subjects react by significant changes in their brains' electrical activity.

Enriched environment as an effective and sustainable mean of therapy

In designing an ambience of music and light, we aimed for enriching our emotional and cognitive experience of music and environment.

While reviewing the current research on multisensory enriched environments, we learned that besides the aesthetic experience such environment provides, its multisensory properties imply successful use in improving people's lives and wellbeing. Due to this link, as well as to the increasing demand for alternative and unobtrusive therapeutic tools, we have oriented our design application towards creating an enjoyable and sustainable supplement to health care programs.

Through the extensive collaboration with the universities and institutions in Eindhoven and Barcelona we are further investigating the therapeutic implications of the music-light environment, and will continue to report on our future findings.

ILI Top publications

April 2015 - October 2015

L.M. Huiberts, K.C.H.J. Smolders, Y.A.W. de Kort (2015).
Shining light on memory: Effects of bright light on working memory performance.
Behavioural Brain Research, 294, (pp. 234-245)

K.C.H.J. Smolders, Y.A.W. de Kort, P.J.M. Cluitmans (2015).
A higher illuminance induces alertness even during office hours: findings on EEG measures.
Lighting Research & Technology, in press.

S. Suijkerbuijk, R. Brankaert, Y.A.W. de Kort, L. Snaphaan, E. den Ouden (2015).
Seeing the First Person Perspective in Dementia: A Qualitative Personal Evaluation Game to Evaluate Assistive Technology for People Affected by Dementia in the Home Context.
Interacting with Computers 27, (pp.47-59)

H. Wang, R.H. Cuijpers, M. Ronnier Luo, I. Hendrickx, Z. Zheng (2015)
Optimal illumination for local contrast enhancement based on the human visual system.
J. Biomed.Opt. 20 (1), O15005 (Jan.27, 2015)

M.P.J. Aarts, M.B.C. Aries, J. Straathof, J. van Hoof (2015)
Dynamic lighting systems in psychogeriatric care facilities in the Netherlands: a quantitative analysis of stakeholders' responses and applied technology.
Indoor and Built Environment, accepted or in press.

M.B.C. Aries, A.L.P. Rosemann (2015)
Dynamic daylight and input for intelligent (day)lighting control.
Conference paper: proceeding of the 28th CIE Session Volume 1 Part 1, 28 June – 4 *July 2015 Manchester, UK, (pp. 672-679)*

M.B.C. Aries, M.P.J. Aarts, J. van Hoof (2015)
Daylight and health: a review of the evidence and consequences for the built environment.
Lighting Research and Technology 47, (pp. 16-27)

J. van Hoof, M.P.J. Aarts, A.C. Westerlaken, B. Schrader, E.J.M. Wouters, H.T.G. Weffers, M.B.C. Aries (2015)
Light therapy in smart in smart healthcare facilities for older adults: an overview. In K. Curran (Ed.), Recent advances in ambient intelligence and context-aware computing.
Hershey, PA, USA: IGI Global, (pp. 300-307)

P. Khademagha, C.P.W. Geurts, A.B. Suma, R. van Nattum, M.B.C. Aries (2015)
The value of comfort and energy in a renovation, a case study.
Conference paper: Proceedings of Healthy Buildings Europe 2015, Eindhoven

D. Ozcelik, J.M.B. Terken, J.H. Eggen, E.J. van Loenen (2015)
Effect of visual quality and animation of design representations on users' responses to early design concepts: a study on the adaptive patient room concept.
International Journal of Design, 9 (1), (pp. 91-106)

H.T.G. Weffers, A.L.P. Rosemann, Y.A.W. de Kort, J.J. Lukkien, I.E.J. Heynderickx (2015)
Intelligent lighting, smart living.
Pan European Networks – Government, (15), (pp. 130-131)

J.H.M. ten Thije Boonkkamp, C.R. Prins, W.L. IJzerman, T.W. Tukker (2015),
Freeform Optics, 7-11 June 2015, Arlington, Virginia, USA, OSA (2015).
The Monge-Amp`ere equations for freeform optics
Proceedings Imaging and Applied Optics 2015

X. Deng J.P.M.G. Linnartz, K. Arulandu, G. Zhou, Y. Wu (2015),
Effect of buck driver ripple on BER performance in visible light communication using LED.
Proceedings of the IEEE (ICC), 8-12 June, London, U.K.

A.Tsiatmas, F.M.J. Willems, J.P.M.G. Linnartz, S.P.M.J. Baggen, J.W.M. Bergmans (2015)
Joint illumination and visible-light communication systems: data rates and extra power consumption.
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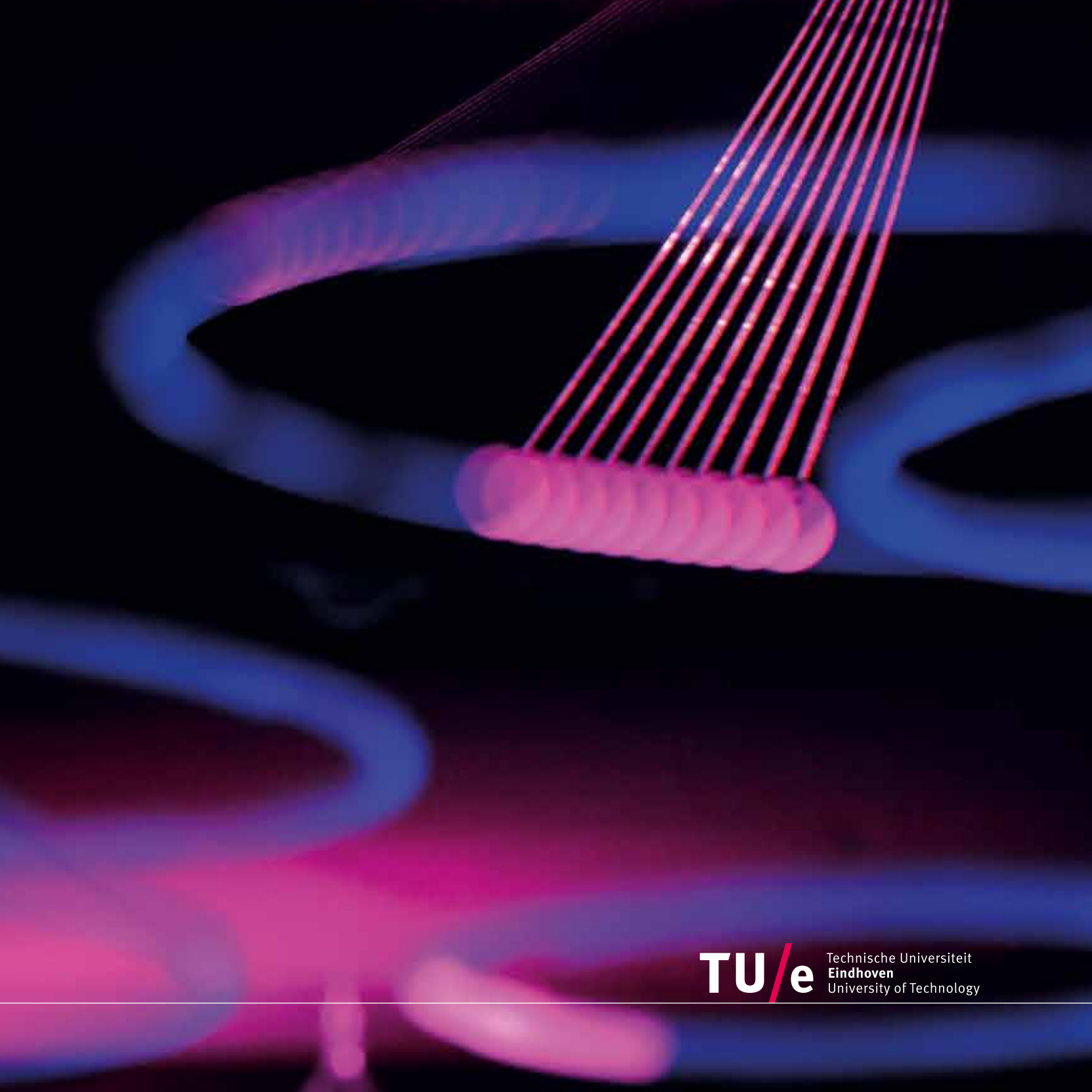
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