CV For Peter Raynham 11/12/2017

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Education / Qualifications

Date	Qualification	Institution
1976	BSc Chemical Physics	University of Sussex
1991	MSc Light and Lighting	UCL
2005	PG Cert Learning and Teaching in Higher Education	UCL

Professional History *(In Chronological Order)*

Dates	Position	Institution / Company
1976-8	Lamp Development Engineer	Osram (GEC) Ltd
1978-96	Laboratory Engineer, Lighting Design Engineer, Lighting Systems Engineer	Philips Lighting
1996-2002	Research Fellow	UCL
2002-10	Lecturer	UCL
2010-	Senior Lecturer	UCL

Other Appointments and Affiliations

Chartered Engineer (CEng)
Fellow of the Society of Light and Lighting (FSLL)
Fellow of the Institution of Lighting Professionals (FILP)
Educator Member of International Association of Lighting Designers
Member of the Chartered Institution of Building Services Engineers (MCIBSE)

Prizes, Awards and Other Honours

May 2006 CIBSE Bronze Medal
The CIBSE Bronze medal is awarded to a person who has made a outstanding contribution to furthering the aims of the organisation

May 2015 SLL Lighting Award
The SLL Lighting Award is made to a person who has made a significant contribution to knowledge transfer and education in the field of lighting.

Research Career Summary

My research interests are topics that can be applied to real world situations and thus impact lighting practice. Each of the areas of research below has been developed in response to a need for a better understanding of particular issues and the results have been fed back to the industry in the form of better guidance and changes to standards. There is a description of the discrimination activities in the section on enterprise and external engagement.

Lighting for Pedestrians at Night

One of the main areas of research has been road lighting. Road lighting is a rich area for lighting research as the amount of light provided by road lighting is quite low as to provide more light over a wide area would require a lot of additional resources and potentially have a number of negative impacts. It turns out that for most road lighting situations the amount of light provided means that the human vision in road lighting conditions is starting adapt from the Photopic (or light adapted state) to the Scotopic (or dark adapted state). In this state often referred to as the Mesopic visual performance is changing rapidly and small changes in the lit environment can make a big difference to the visibility of objects. Thus small changes to certain aspects of street lighting can make a big difference to the usability of a street. This research stream has been running for over 10 years and has generated 3 EPSRC grants in which have brought about £1 m to UCL and provided an impact case study at the last REF Interest in the are started with a project called *Urban Lights* that looked at the lighting in town centres at night. The project found that by changing the colour of the light used on streets at night it was possible to get similar results in terms of user acceptance and use with lower light levels. This work was based on use of facial recognition as a nominal visual task to assess the lighting performance. Whilst our work was not the first use of this technique, we were responsible for some innovations in the way it was used. This prompted renewed interest in the technique among the research community and the original publication on the work has been cited 44 times. The finding of the research was embodied into the British Standard for street lighting. This process was carried out quickly due to my enterprise activities in the area of standardisation. Over a period of 10 years as street lights were changed they went over to the new white light we had recommended. over 1.2 million lighting units were changed. As each point saved on average about 20w of power the overall energy saving was massive. This study was written up as an Impact Case Study at the last REF. The study was subsequently posted on the ESRC website as it one of the top 3 impact studies (in terms of size of impact) for research projects funded by them. This just illustrates the potential for large impact when studying lighting in the mesopic.

My next study in this area looked into glare on roads. I was PI in a project where we were able to take advantage of a number of new techniques that for example could measure the amount of like scattered in a subject's eye and the use of fMRI to look at activity in the brain. We discovered in road lighting conditions glare did not limit impair vision as much as expected. We also discovered that retinal illuminance seems to govern the threshold of discomfort glare. There are big inter subject differences in the retinal illuminance at the discomfort glare threshold. In an experiment using fMRI we were able see differences in brain activity between subject who were particularly sensitive to glare and subjects who were less sensitive. This was the first ever study in this area and concept developed of cortical hyperexcitability and its role in visual discomfort has formed the basis for further research particularly in the area of problems with flicker.

The next project was Mesopicly Enhanced Road Lighting (MERLIN). This project brought together researchers in vision science and lighting to advance understanding of mesopic vision and to optimise lighting in residential streets. Our part of this project was an attempt to understand what pedestrians actually look at on the road at night. To investigate this area we eye-tracked a number of pedestrians walking un-accompanied along a series of

residential roads. The key finding from this part of the project was that most subjects spend a lot of time looking at the footpath, however, it appears that they only look at the footpath when they have scanned the rest of the environment and ensured that they are safe. To follow on this work we applied for a funding for the MERLIN II project

Our work on MERLIN II has so far focused on a re-analysis of exiting eye tracking video from which we have extracted images every 100 ms. In this analysis we have been looking at the location of the point of fixation relative to the direction of travel of the subject, this information is necessary as knowing where people look will guide us to determine which parts of the street scene should be included in any measure of adaptation illuminance. However the study has revealed there are major differences in the distribution of fixation between night and day.

In addition to the main stream research funded by the EPSRC I have also worked on smaller consultancy type projects funded by Highways England.

An assessment of the photo-biological hazards of "hot" changing metal halide lamps. The work was done in conjunction with Public Health England for Highways England (HE)and we were able to demonstrate that only in a few cases was there a risk to worker's health. The study developed a new method to evaluate exposure and work to produce a paper that describes the work is ongoing.

I have recently run a further project with HE looking at the visual environment in short tunnels and underpasses. This found that in many situations it is not necessary to have lightning running during the day in the core of underpasses and even in situations where visibility in a short tunnel was poor changing surface finishes in the tunnel was likely to be more effective that using additional day time lighting. There are further projects in the pipeline with HE looking at the changes that have occurred in the way people respond to the lighting of highways since LED lighting has been introduced.

Daylight in Schools

I have also carried out some research into the lighting in school classrooms. In an attempt to further investigate the potency of artificial light as a circadian regulator and compare it with that of natural illumination, a study was conducted in four classrooms of a junior school over a period of ten months. There were substantial differences in the results of reading and mathematics tests that were related to the amount of daylight in the classrooms. Therefore, it is possible to conclude from our findings that the best approach to indoor lighting is likely to provide adequate natural light in order to ensure well-being.

Flux in Space

I also have developed a research theme looking at light and its relationships to space. This theme looks the mathematics of how light is reflected around in a room and can be used to predict the flux needed for different lighting requirements. This work started when it became necessary to establish if a method of flux utilisation calculation proposed in a draft European Standard was correct. Over the years the requirements for lighting in buildings has evolved and the original concepts used for the Standard check have proved useful as a basis for developing ideas for the application of new lighting metrics. In 2014 I wrote a paper that examined the consequences of adopting a proposed the metric mean room surface exitance (MRSE) at a target value of 100 lumens per square meter in 2 sizes of room with a variety of surface reflectances and lit by an regular array of light sources with a range of distributions. The paper concluded that significant extra flux will be required to

meet the new MRSE target and that light distributions with a significant upward component will also be needed.

Light Source Colour

Since the introduction of LEDs to main stream lighting about 10 years ago it was clear that our definitions of colour rendering and colour appearance were going to be tested. The work started with a small study for the light source company Ceravision who were then looking to develop light sources that could replace conventional domestic light sources but would be better accepted by users than the compact fluorescent lamps that were then on the market. The research strand has gone on to try to understand why some light sources are preferred above others. The main finding seems to be that light source preference is very context sensitive and thus a light source that is good for an art gallery may be useless in a retail application. More recently we designed and help run a study looking at the light sources for cosmetic sales. This work was sponsored by Xicato and run in conjunction with Este Lauder. The study looked at a number of aspects of colour rendering including ability to match foundation to skin tone, perceived healthiness of appearance of the shopper and attractiveness of the merchandise (Clinique products) under the light source. This year the ideas in this area have been further developed as part of a MSc student dissertation. The work looked at the implications of applying a new American proposal for new colour metrics. The results revealed the potential uses and pit falls of the then new document. The findings have just been made public at an invited presentation at the *LuxLive* trade show and will soon be published in the *Lighting Journal.*

Enterprise\External Engagement

Before joining UCL I had worked in the lighting industry for 20 years and I was always keen to improve the way lighting was carried out. To improve my own understanding of the world of lighting I joined a number of professional bodies in the area of lighting. I found the regular meetings they held very useful as a forum where lighting issues could be discussed and I met a lot of people in the industry who have since become long term friends. At the same time (in 1991) I also got involved in the area of standards writing, initially as a UK Expert to the European Standards working group on Photometry. I was soon afterwards asked to Chair the British Standards committee on Photometry. Over the years my roles in both professional bodies and standardisation have developed this has included significant leadership roles in two lighting bodies and chairing all lighting application standardisation in the UK. Both of these activities promote my personal goal of improving the way lighting is done. The lighting societies promote good lighting in a number of ways including publishing guidance and promoting knowledge exchange and standards are a good way to remove bad practice.

As well as the work with standards and professional bodies I have also maintained a set of relationships with a number of lighting manufacturers, these have sometimes developed into formal consultancy arrangements, but often there is just a good give and take that allows our students to get product samples for their project work and makes it possible for have tours of their factories and laboratories.

My work in with professional bodies and standardisation has been a very good route for research dissemination and when research findings are used to amend standards it can deliver significant impact.

The highlights of my activity in this area have been my Presidency of the Society of Light and Lighting, my 4 year spell as a Director of the International Association of Lighting Designers and my Chairmanship of BSI Committee EL/001 Light and lighting applications. The section below provides a short summary of my activities in this area. However, it is not fully possible to indicate the level engagement and the level of responsibility for all activities. For example as a director of the IALD I took part in 6 meetings per year, 3 by WebEx and 3 face to face two day meetings in Chicago, during my 7 years of the SLL executive I attended 8 meetings per year and during my year as president I had an additional 20 events to attend. The work at BSI requires less meetings but there are over

200 documents a year (254 from January to November 2017) that are posted to the document management system and they all need to be reviewed. In all of these activities I have strived to make a real difference to lighting practice and the profession. I believe in many ways that my work in this area is as important as my research as research that does not change the way things are done is not useful to society at large.

Standardisation

I have been active in the area of lighting standards for many years, have been on many panels and committees, and have helped to develop many standards in the area of light and lighting and related topics. At present much of the work is conducted at a European level but national committees manage inputs into standards, there is also some activity at an international level. The following is a list of the principle committees that I am a member of.

British Standards Institution (BSI)

- Chair committee EL/001 Light and Lighting applications
- Member committee CPL/034 Lamps and related equipment
- Member committee EL/001/03 Tunnel lighting
- Member committee RHE/002 Ventilation for buildings, heating and hot water
- Member committee STI/014 Colour measurement and schedules

European Standards (CEN)

- UK Delegation Leader to committee CEN TC 169 Light and Lighting
- Convenor of working group CEN TC 169 WG 11 Daylight (2011-4)
- Principle UK Expert to working group CEN TC 169 WG 7 Photometry
- Principle UK Expert to working group CEN TC 169 WG 9 Energy Performance of Buildings
- Principle UK Expert to working group CEN TC 169 WG 14 ErP Mandate Management Group

International Standards (ISO)

- UK Delegation Leader to committee ISO 274 Light and Lighting

My key standardisation role is chair of committee EL/001 which is the principle committee in the area of lighting application, the committee together with its three subordinate committees (covering emergency lighting, road lighting and tunnel lighting) are together responsible for all (~40) lighting application standards used in the UK. The committee is also responsible for all UK input into European and International standards related to lighting.

Professional Societies

The 3 main societies in the UK are the Society of Light and Lighting (SLL) which is part of the Chartered Institution of Building Services Engineers, the Institution of Lighting Professionals (ILP) and the International Association of Lighting Designers (IALD). My activities in these bodies is summarized below,

Chartered Institute of Building Services Engineers (CIBSE) and in particular the **Society of Light and Lighting** (SLL) which is part of CIBSE

- Fellow of the SLL and Member of CIBSE
- Member of SLL Council and Executive Committee (2007 - 14)
- President of the SLL 2011 - 2012
- Member of CIBSE Council 2014 - 17

Institution of Lighting Professionals (ILP)

- Fellow of the ILP
- Member of the Membership Committee
- Assessor for membership and Engineering Council registration
- Lead on the institution re-licensing with the Engineering Council
- Member of the technical panel

International Association of Lighting Designers (IALD)

- Educator Member of IALD
- Presidents selected Director (2010 - 3)
- Director of the IALD Education Trust (2010 - 3)
- Assessor for the Certified Lighting Designer programme (2014 - 7)
- Board member for the Certified Lighting Designer Programme (2017 -)

As well committee and leadership roles in these bodies, I have also made a major contribution to their publications (see list below for details). Some of the publications have involved working with small panels to draft the text in other cases I have written whole books on my own. Most notable of these has been my role working on the SLL Code for Lighting. I have been working on the code since 2000 and in that time I have created 5 editions of the guide and I am currently working on further edition to be published next year.

The following non exhaustive list gives the most important publications

Publisher	Doc Ref:	Title	My Role
BSI	BS 5489-1:2013	Code of practice for the design of road lighting. Lighting of roads and public amenity areas	Supervisory
BSI	BS 5489-2:2016	Code of practice for the design of road lighting. Lighting of tunnels	Supervisory
BSI	BS 667:2005	Illuminance meters. Requirements and test methods	Panel leader, contributed text
BSI	BS 7920:2005	Luminance meters. Requirements and test methods	Panel leader, contributed text
BSI	BS 8206-2:2008	Lighting for buildings. Code of practice for daylighting	Panel leader, contributed text
BSI	BS EN 12193:2007	Light and lighting. Sports lighting	Managed UK input
BSI	BS EN 12464-1:2011	Light and lighting. Lighting of work places. Indoor work places	Managed UK input
BSI	BS EN 12464-2:2014	Light and lighting. Lighting of work places. Outdoor work places	Managed UK input
BSI	BS EN 12665:2011	Light and lighting. Basic terms and criteria for specifying lighting requirements	Managed UK input
BSI	BS EN 13032-1:2004+A1:2012	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format	Principle UK Expert
BSI	BS EN 13032-2:2004	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for indoor and outdoor work places	Managed UK input, contributed to underlying maths.
BSI	BS EN 13032-4:2015	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. LED lamps, modules and luminaires	Principle UK Expert
BSI	BS EN 14255-1:2005	Measurement and assessment of personal exposures to incoherent optical radiation. Ultraviolet radiation emitted by artificial sources in the workplace	Managed UK input
BSI	BS EN 14255-2:2005	Measurement and assessment of personal exposures to incoherent optical radiation. Visible and infrared radiation emitted by artificial sources in the workplace	Managed UK input
BSI	BS EN 14255-3:2008	Measurement and assessment of personal exposures to incoherent optical radiation. UV-Radiation emitted by the sun	Managed UK input
BSI	BS EN 14255-4:2006	Measurement and assessment of personal exposures to incoherent optical radiation. Terminology and quantities used in UV-, visible and IR-exposure measurements	Managed UK input
BSI	BS EN 15193-1:2017	Energy performance of buildings. Energy requirements for lighting	Principle UK Expert, contributed text
BSI	BS EN 16237:2013	Classification of non-electrical sources of incoherent optical radiation	Managed UK input
BSI	BS EN 16268:2013	Performance of reflecting surfaces for luminaires	Managed UK input
BSI	BS EN 1837:1999+A1:2009	Safety of machinery. Integral lighting of machines	Managed UK input
BSI	BS EN ISO 11664-1:2011	Colorimetry. CIE standard colorimetric observers	Managed UK acceptance
BSI	BS EN ISO 11664-3:2013	Colorimetry. CIE tristimulus values	Managed UK acceptance

Publisher	Doc Ref:	Title	My Role
BSI	BS EN ISO 11664-4:2011	Colorimetry. CIE 1976 L*a*b* Colour space	Managed UK acceptance
BSI	BS EN ISO 11664-5:2016	Colorimetry. CIE 1976 L*u*v* Colour space and u', v' uniform chromaticity scale diagram	Managed UK acceptance
BSI	BS EN ISO 11664-6:2016	Colorimetry. CIEDE2000 Colour-difference formula	Managed UK acceptance
BSI	BS ISO 23539:2005	Photometry. The CIE system of physical photometry	Managed UK acceptance
BSI	BS ISO/CIE 19476:2014	Characterization of the performance of illuminance meters and luminance meters	Managed UK acceptance
ILP	PLG05:2015	The Brightness of Illuminated Advertisements	Leader of task group / principle author
ILP	PLG08:2016	Guidance on The Application of Adaptive Lighting Within the Public Realm	Member of task group / preformed traffic flow analysis
SLL	SLL Code for Lighting (2002, 2004, 2006, 2009, 2012)		Principle author
SLL	SLL Lighting Handbook (2009)		Joint author
SLL	LG5: 2011	Lighting For Education	Member of task group contributed text

Research Publications

Flores Villa, L. M., Unwin, J., & Raynham, P. (2017). The effect of daylight on the elderly population.. In *Proceedings of the Lux Europa 2017 European Lighting Conference - Lighting for Modern Society*. Ljubljana Slovenia: Lighting engineering society of Slovenia, Ljubljana, Slovenia.

Raynham, P. J., & Thorns, P. (2017). Comparison of Different Methods of Distribution Factor Calculation. In *Proceedings of the Lux Europa 2017 European Lighting Conference - Lighting for Modern Society*. Ljubljana Slovenia: Lighting engineering society of Slovenia, Ljubljana, Slovenia.

Raynham, P. J. (2015). Daylighting standards: Do we have the correct metrics?. In J. Škoda, & S. Sumec (Eds.), *Proceedings of 21st International Lighting Conference (Light Světlo 2015), Czech Lighting Society*. Brno, Cz: Brno University of Technology, Faculty of Electrical Engineering and Communication, Department of Electrical Power Engineering.

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Bargary, G., Furlan, M., Raynham, P. J., Barbur, J. L., & Smith, A. T. (2015). Cortical hyperexcitability and sensitivity to discomfort glare. In *NEUROPSYCHOLOGIA* Vol. 69 (pp. 194-200). PERGAMON-ELSEVIER SCIENCE LTD. doi:10.1016/j.neuropsychologia.2015.02.006

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