Urban Lights
Sustainable Urban Lighting for Town Centre Regeneration

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1. Introduction
This project aimed to bring together a multi-disciplinary team of engineers, physicists, social scientists, planners and lighting designers to carry out major intervention studies in order to quantify the economic, social and environmental impact of modern town centre lighting. The study sought to investigate the impact that improved lighting can have on the public sense of security and on the social and economic activity in exterior urban environments. Preliminary results from this work were presented at Lux Europa 2001, Reykjavik.

1.1 Background
The UK lighting industry is currently valued at 400 M GBP (570M Euro) and contains some of the world-leading component manufacturers and lighting designers. Urban lighting is one of the fastest growing sectors of this industry with major developments in both exterior lamps and luminaries. UK lighting designers are also involved in the development and implementation of lighting master plans for some of the major cities in the world eg. Sydney, Cape Town, Cambridge, London and Edinburgh. One of the challenges facing lighting manufacturers and designers is to further develop novel lighting technology and its appropriate application to regenerate town centres while minimising the environmental impact of such lighting. Street lighting in the UK alone accounts for some 450 MW of installed load, resulting in CO_2 emissions of 1 million tonnes per annum and is responsible for considerable light pollution.

1.2 Previous Research
There has been little research into the impact of lighting on urban centres and on the pedestrians using those spaces. There is however a significant volume of research on the impact of lighting on crime in residential areas. The best overall summary of this work has been put together by Pease [1]. The general conclusion of this report was that improved lighting under certain circumstances can reduce crime and the fear of crime. However, the mechanism by which lighting reduces crime is not clear as there is some evidence to show that crime during the day can be reduced by better lighting at night.

Anecdotally there is some evidence for the commercial benefits of urban lighting plans, leading to better architectural lighting closely integrated with pedestrian-friendly streets and amenity lighting. The city of Lyon, for example, which has been implementing its city lighting plan since 1990, to broad acclaim, has apparently experienced huge growth in its night-time economy; however the exact role lighting played in this growth has not been quantified [2]. In 1996 Liverpool John Moores University conducted an economic impact assessment study of the future implementation of a comprehensive lighting plan by the Lighting Design Partnership for the city of Chester [3]. This predicted a substantial increase (1.4 M GBP (2 M Euro) per annum) in city-centre business as well as numerous other tangible benefits as a result of the improved lighting.

There is some theoretical research to link the ability to recognise the faces of fellow pedestrians at a distance and the sense of security that the average pedestrian has using the street. The basic concepts involved were developed by van Bommel and Caminada [4] based on original work by Hall [5]. The work by van Bommel and Caminada went on to assess the lighting requirements to ensure good facial recognition.

1.3 Theoretical Position
It was recognized that lighting, just like any other aspect of the physical environment, can change subjective and behavioural responses of people. Can contemporary luminaire designs and luminaire installation techniques produce urban lit environments that increase a sense of security in the public and encourage social and economic activity? This research question was tackled by undertaking intervention studies on two sites, Swinton and Sutton Coldfield. Some 27 new street lighting points, 10 relampings and 105 new luminaries have been installed in the two sites and over 3 500 interviews have been undertaken with visitors to the sites *before* and *after* re-lighting.

2. Pilot Study: Swinton, South Yorkshire, UK
This intervention study (the re-lighting of a small town centre) formed a pilot for a second larger intervention study (the re-lighting of a town centre area). Both sites were identified, with the assistance of the Institution of Lighting Engineers, as having the potential for re-generation of its after-dark economy after the re-lighting. Figure 1 shows part of the Swinton site after re-lighting.

Figure 1: Swinton site

2.1 Methodology
Studies were undertaken on the site *before* re-lighting, then the new lighting was installed and then studies were undertaken *after* the intervention. The lighting performance of the new scheme was measured to ensure that it met the requirements of the then British Standard BS 5498 Part 3. It also enabled a comparison to be made between the lighting levels achieved and those predicted during the design process. Two types of survey were carried out *before* and *after* the intervention. People visiting the site were asked a set of 9 multi-part questions from a standard form and businesses in the centre took part in a face-to-face structured interview. The first survey was to assess people's reactions to the new lighting and the second survey was to assess the impact of the new lighting on business trends in the centre.

2.2 Results
2.2.1 Visitor Survey
A total of over 500 questionnaires were completed in the *before* and *after* surveys. The surveys covered a number of topics including night-time use of the site, night-time appearance of the site and security and safety after dark.

2.2.2 Business Survey
Discussion ranged from business performance to customer numbers and reports of crime.

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2.3 Findings

2.3.1 Visitor Survey

There was a small increase in the night-time use of the site after the re-lighting. The new lighting was regarded as attractive but not sufficient to compensate for the run-down appearance of the buildings due to vandalism and graffiti. Crime statistics indicate that this is an area of high crime with young people loitering and acting rowdily seen as the main problem. People felt unsafe after dark on the site even after re-lighting.

2.3.2 Business Survey

The street lighting improvements did not seem to reduce business owners' perception of crime or improve business performance. The re-lighting appeared to have failed to reduce the declining trend in the centre's economy. Business owners reported that the street lighting improvements exacerbated youth nuisance by encouraging larger gangs to congregate.

2.4 Conclusions

The impact of re-lighting alone in an area which is declining is likely to be insignificant and may even increase crime or the fear of crime. However, increased visibility of dingy surroundings and threatening gangs was a marked effect here and perhaps lighting improvements would be beneficial in tandem with other environmental improvements.

3. Main Study: Sutton Coldfield, West Midlands, UK

A larger intervention study was undertaken in the north end of the shopping parade in Sutton Coldfield. Figure 2 shows part of the Sutton Coldfield site. A similar study was undertaken on a control site in Lichfield, West Midlands.

Figure 2: Sutton Coldfield site

3.1 Methodology

A novel lighting design technique was used to communicate the lighting design options to various concerned parties and obtain feedback to develop a better design for the lighting intervention. Virtual Reality (VR) images were created by constructing a 3D model of the site in *Radiance* [6] lighting rendering software, texturing the model with images gathered digitally from the site and, with the proposed luminaires added, compositing the final image.

Figure 3 shows the preferred lighting scheme.

Figure 3: Sutton Coldfield preferred lighting scheme

The lighting installation on the main site was the responsibility of two organizations: the local council and the shopping centre owners. Severe difficulties were encountered over a 2 year period with budget and installation issues before the re-lighting commenced in December 2003. Two types of survey were carried out *before* and *after* the lighting design intervention. People visiting the site were asked a set of 9 multi-part questions from a standard form to assess their reaction to the new lighting. Information about economic activity on this site was collected by the shopping centre management company.

The delays during this period allowed the research team to proceed with a laboratory study (the Facial Recognition Study) suggested by one project partner's interest in the impact that white light sources made on pedestrians at night. The results from the pilot study at Swinton had also suggested investigations of this type. The following subsection describes this study.

3.1.1 Facial Recognition Study

3.1.1.1 Introduction

One of the key tasks for a pedestrian walking along a road at night is to recognize other pedestrians and determine if they present a threat before they are so close that no evasive action can be taken. There have been several reports [7] on the benefits of white light in preference to yellow light for street lighting and an experiment was designed to explore these claims.

3.1.1.2 Methodology

The experiment used facial recognition distance as a measure of lighting performance, a concept developed by van Bommell and Caminada [4]. A disused office (23 m x 6 m in plan) was converted into a simulated street and was blacked out using theatre drapes around the walls (see Figure 4). Lighting was provided by 4 x 0.5 m diameter opal sphere luminaires mounted on 2.4 m columns. The luminaires were able to house a range of lamps and dimming gear was available for high pressure sodium (SON) and compact fluorescent (CFL) lamps. A small group of observers, individually, were invited to walk towards a person until their face could be recognized, under the different light sources and the facial recognition distance was recorded.

Figure 4: The Experimental Space (CFL Lamps)

3.1.1.3 Results

The average facial recognition distance, for a small group of observers (n=8), is plotted against semi-cylindrical illuminance for three different light sources in Figure 5. The original results from van Bommel and Caminada are also shown (marked vB & C). The main finding of the work is that white light is much better for facial recognition than the yellow light currently used for most of the UK's street lighting.

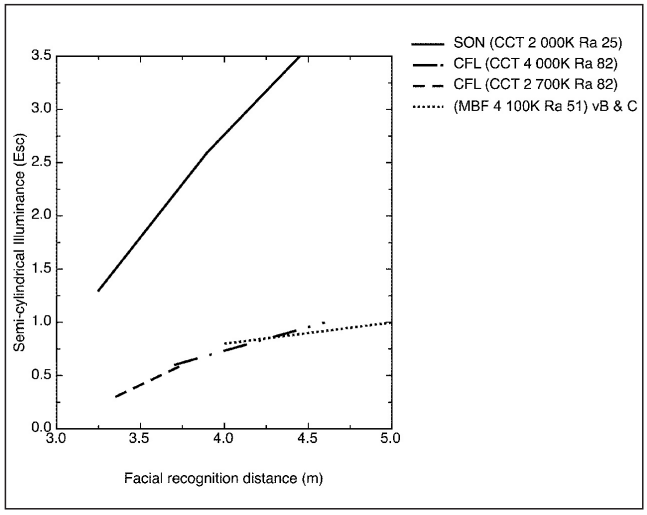

Figure 5: Facial recognition distance under three light sources

3.1.1.4 Conclusions

The requirements of the old British Standard for road lighting were based on the work of van Bommel and Caminada without, however, taking into account light source colour. As a result of *this* study, the British Standard has been changed and now requires a minimum colour rendering of Ra 60 for light sources when lighting for pedestrians. Standard high pressure sodium lamps therefore no longer meet the requirements for this type of lighting.

3.2 Results

To return to the main study in Sutton Coldfield, six surveys were carried out sampling over 1.500 people. Five surveys were carried out before the lighting intervention and one survey after the re-lighting. (In the control site at Lichfield, over 1.400 people were surveyed). Detailed analysis of the data is ongoing.

An example of the findings from this rich data set is shown in Figure 6 which shows the number of people expressing fear of crime to the person and fear of the dark/night *before* and *after* the re-lighting in Sutton Coldfield. Initial indications are that the re-lighting has lead to some improvement in peoples' feelings of safety and security.

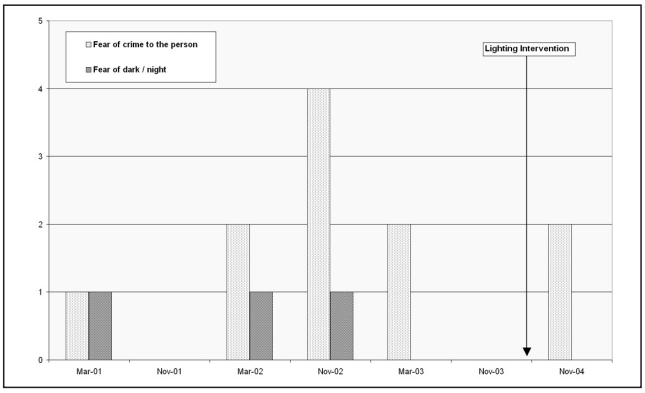

Figure 6: Responses to questions about safety and security before and after the lighting intervention

To characterise this phenomenon, a fear index has been developed, calculated from the responses to the question: *How safe do you feel when walking in the Town Centre area after dark?* The responses were scored as follows:

Very unsafe **2** A bit unsafe **1** Fairly safe **–1** Very safe **–2** n/a 0

Fear index was calculated as a mean value for each age/sex group in each survey carried out. Figure 7 shows the changes in fear index in the final survey after the lighting intervention compared to the mean of the previous surveys carried out in November *before* the intervention. It seems that there is a reduction in fear particularly in the older age groups *after* the re-lighting.

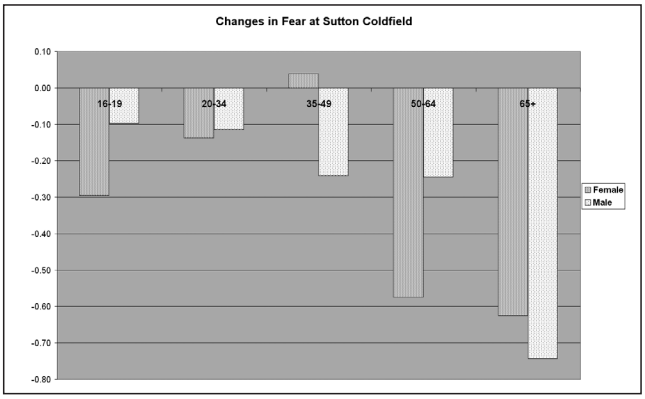

Figure 7: Change in fear index after the lighting intervention in Sutton Coldfield

4. Conclusions

The major logistical difficulty in the project was the delay in the implementation of the lighting intervention in the Main Study (Sutton Coldfield). This was due to different organizations, with their own budgetary and other constraints, being responsible for the installation. Further analysis of the dataset collected in the Main Study is continuing.

However, the useful grouping of project partners (see Acknowledgements) gave an opportunity to develop a line of research interest into the importance of light source colour in street lighting. Previous recommendations on street lighting for pedestrians required set lighting levels irrespective of the colour of the light source. This has resulted in the widespread use in the UK of high pressure sodium lighting, its high efficacy and long life providing the most economical solution. Yet the findings from this project suggest that this may be a false economy since one of the major factors facing people using urban spaces is the fear of crime and this is linked to the ability to recognize faces prior to somebody entering your "personal space". *Urban Lights* showed that previous recommendations, applied using high pressure sodium lamps, did not provide the necessary level of lighting to alleviate fear of crime. The important findings from this research have been embodied into current road lighting practice by having additional recommendations included in British Standard BS 5489-1:2003 *Code of Practice for the Design of Road Lighting* – Part 1: Lighting of Roads and Public Amenity Areas, a document, together with European Standard EN 13201-2, that provides the main source of design guidance to statutory authorities.

5. Acknowledgements

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Urban Lights was honored to supply all the lighting for the contemporary farmhouse style project. Best of all, all proceeds from the home tours directly benefit @HabitatDenver. Photos by: KJ Photography Magazine cover photo: Emily Minton Redfield. See more. Designer Showhouse 2019. 41 photos. Urban Lights.