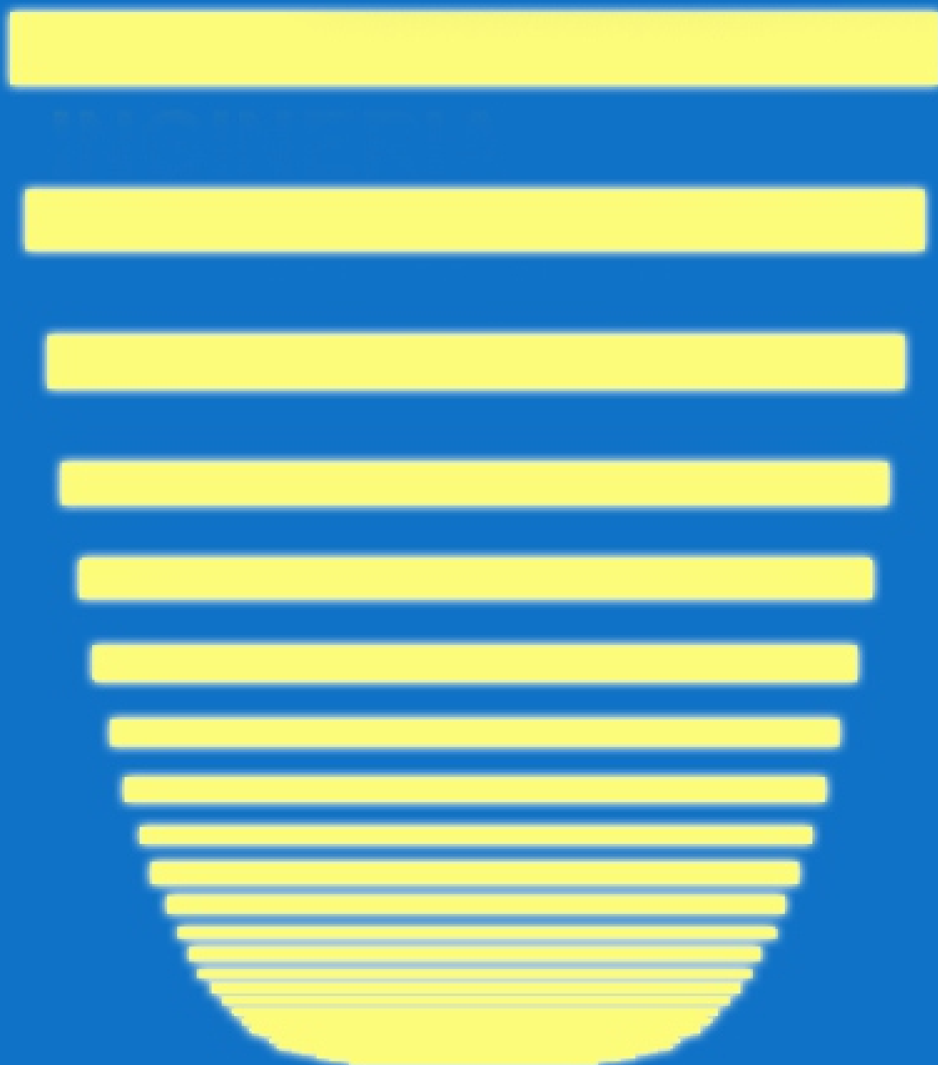
INGINERIA ILUMINATULUI

JOURNAL OF LIGHTING ENGINEERING



VOLUME 14, NUMBER 1, 2012

ISSN 1454-5837

INGINERIA ILUMINATULUI
Journal of Lighting Engineering

Volume 14, Number 1, June 2012

Papers

Conferences and symposiums

Theses and Dissertations

Information

This issue is sponsored by The Lighting Engineering Laboratory UTC-N

Universitatea Tehnică din Cluj-Napoca
Lighting Engineering Laboratory
INGINERIA ILUMINATULUI - Journal of Lighting Engineering
ISSN 1454-5837 print ISSN 2968-9853 online

Editorial office
UTC-N – Universitatea Tehnica, 28, Memorandumului Str., RO-400114 - Cluj-Napoca, Romania
Phone: +40 264 597254 • Fax: +40 264 592055 • e-mail: lec@mail.utcluj.ro
http://users.utcluj.ro/~lec/journal
Contact person: Dr. Dorin BEU

INGINERIA ILUMINATULUI – Journal of Lighting Engineering - is a publishing media for valuable original scientific papers in the field of lighting engineering. The papers proposed for publication are considered based on their originality, meaningfullness and area of interest. In order to be accepted, the papers have to be remarquable in their field. The papers are evaluated by two independent reviewers. The contributions have to conform to the generally accepted practices for writing scientific papers, with respect to paper organization and style of writing.

The journal is published every six month, in June and December. Two issues form a volume. It has its own web page, covering the editorial policy, publishing criteria, information for authors, as well as all papers, available in PDF format, with open access.

The journal is classified by CNCSIS, code 244.

The journal is indexed by Index Copernicus Journal Master List (ID 5747) and DOAJ - Directory of Open Access Journals (index no. 14545837).

The journal was created following the EU program: "Lighting Engineering Centre - LEC - consulting and continuous formation, 1998/99 Tempus-Phare CMS - Compact Measures Project - CME-03551-97", presented on the web site http://users.utcluj.ro/~lec

INGINERIA ILUMINATULUI – Journal of Lighting Engineering - is affiliated to the CNRI – CIE National Committee of Romania, member of the CIE – Commission Internationale de l'Eclairage.

INGINERIA ILUMINATULUI - Journal of Lighting Engineering - has a scientific presentation and content, targeted to the continuing education in the lighting field. The objectives of the journal consist of the presentation of results of lighting research activity, dissemination of lighting knowledge, and education of interested people working in public administration, constructions, designers, dealers, engineers, students and others.

Its content is organised in six parts: Editorial, Papers, Theses and Dissertations, Conferences and Symposiums, Information, Anniversary.

Subscription Information

The 2012 annual subscription rate is €50, including mail taxes.
Orders and payment should be made by Editorial office.

LIGHTING EDITORIAL 3.0

Dorin BEU

Being in Light & Building 2012, I was looking for new books, but could not find real scientific ones. Only few specialists have the courage to write a lighting scientific book and the reason is very simple: the speed of change in the industry is so high that by the time someone finishes a book, it's already outdated. Plus, there is political influence, as was the case of incandescent lamps phase out or the future European legislation concerning directional lamps. A solution will be an e-book, where every six months (or less) the authors will make changes.

This speed of change is also a problem for the client when buying a LED system; if he will wait for some time he will buy a better product for less money – a wait-and-see policy. This has become as complicate as the stock exchange: if one knows when it's the best moment to buy, he is a genius. I am not, unfortunately. In the former 2009 EU Ecodesign directive we were supposed to move from 60 W to 12 W, and now we are talking about another step to 10 W. But with a cost: transition from incandescent lamp to CFL has raised the cost till 10 times, so a new raise will create problems for many peoples.

Elder professors are gone. Those who can check a standard, review a book or a PhD thesis for weeks and do hundred of annotations. Being a professor these days means more to be a good manager. Beside science part, they have to earn contracts, have social skills for a worldwide network, political abilities to negotiate with university or companies top management and participate to endless webinars. Plus they have to motivate their team and students, to understand new legislation and travel a lot. So, in some cases, paper reviews are done between flights, presentations in trains, or they have to bring work with them to conferences. Good old times are only memories.

As mentioned before, I visited Light & Building 2012 but can't say that I saw something exceptional. On one hand, you had big companies with LEDs and, eventually OLEDs; but, most were old luminaires that were converted to LEDs. There were remarks about digitalization of lighting; it is possible, but we have to determine how far we want to go. A 0.60x0.60 m luminaire have hundreds of individual LEDs, but do we really want to control each of them. Some will say that is good for tunable white (controlling 6500 K white LED and the red LED), but this is group control.

On the other hand, there were chandeliers producers for whom nothing seems to be changed. They were still using incandescent candle shape lamps, it was very hot in their stands, but business seems to go as usual. Not everyone wants to be trendy, and it will be interesting to find the percentage of population who will go for classical solutions.

Talking about exterior lighting: for the moment, LED had a problem to compete with high pressure sodium, but hawe won against metal halide. Plus, when you take into the account that the re-switch time, color rendering, and the dimming capacity, we have a clear winner. Too many solutions with LED relamping of luminaires and few are really based on all the opportunities of this new type of lamps. I am still waiting for a new way of thinking where you can adapt the luminaires to on site situation (on a street pole distances, road width, vegetations may vary from season to season). But then we have another discussion about triggers: starting with an exterior presence detector and finishing with a reflectance detector.

Many companies have gone in the so called media-façade lighting. At first glance, it looks impressive, but then one can realize this is not lighting but advertising. Technically you need RGB LED with IP 65 and the possibility to control it with Video Control Unit. Obviously this is not a green solution as we are talking about something which is not necessary for ease to view, safety or comfort of people. A few years ago, we were discussing about RGB luminaires, a technical achievement but a useless one. I know the argument that we are in a world that is obsessed by images, but the idea that we won't see soon architecture but images seems like an oxymoron.

The lighting industry is moving with influences from technical, political and sustainable issues. But we have to take care as not all are in the right direction. There are a lot of new opportunities and challenges, but also errors that can be avoid through information exchange and that is the role of scientific review like Ingineria Iluminatului - Journal of Lighting Engineering.

Dr. Dorin BEU
Director of Lighting Engineering Laboratory
Technical University of Cluj-Napoca, Romania
dorin.beu@insta.utcluj.ro

HYBRID LIGHTING SYSTEM BASED BY TUBULAR DAYLIGHT GUIDANCE SYSTEMS AND PHOTOVOLTAIC SYSTEMS

Călin CIUGUDEANU, Bogdan MONDOC, Dorin BEU
Technical University of Cluj-Napoca

Abstract: *The hybrid model obtained from the fusion of TDGS (Tubular Daylight Guidance System) and PV (Photovoltaic System) for converting sunlight into electricity, has a real potential for future use. Hybrid systems for solar lighting double the efficiency and availability of solar power, especially for commercial buildings. Solar radiation is collected through a primary device, while the visual spectrum is separated by a second optical device. The visible spectrum of solar radiation is used for direct indoor lighting, whereas UV and IR are used for generating electricity. The present paper puts forward an original hybrid lighting system that combines a passive tubular daylight guidance system with a photovoltaic and LED system. If wise chosen, the new system has the potential to be used alone with no electrical lighting as backup. The design principles and technical features of the system are provided, as well as its potential for saving electricity used for lighting. The present paler also includes a comparison of the overall system efficiency to the electrical receptors for the original system presented here. In conclusion, hybrid lighting systems will potentially offer a higher efficiency than the most efficient daylight devices currently available on the market, in addition to a much higher flexibility. Compared to TDGS, the new system can be used as well in areas with no electricity supply.*

Keywords: tubular daylight guidance systems, hybrid lighting system, climate change, energy efficiency.

1. Introduction

Hybrid solar lighting systems are designed to increase efficiency and availability of solar energy [1]. Based on a research study conducted by Oak Ridge National Laboratory [2], a proposal was made to integrate two solar lighting technologies (TDGS and photovoltaic), a concept addressed to the private companies.

A proposal for such a system including a brief overview of the technical characteristics of TDGS, and also a presentation of some combined lighting options, including cost related aspects, for rooms with different destinations (offices, conference rooms, hallways and storage areas) was conducted [3].

Due to cost issues of the hybrid systems [4], it is proposed the implementation of an original lighting system, composed of a

Ingineria Iluminatului 2012; **14**, 7-12

passive tubular daylight guidance system combined with a photovoltaic and LED system. The new system compared to the TDGS is not dependent of the electric network system.

2. Hybrid lighting system design

The proposed system consists of TDGS 300 mm SunPipe type, photovoltaic module (Helios H750 - 75 W), charge controller (Steca PR1515 5 A/12-24 V LCD), solar battery (Sonnenschein dryfit Akku Solar S12/17 A 12 V), a Luxmate Basic daylight controller to adjust the flow of artificial light depending on the contribution of natural light and three HB40LED 5xLED BBG490 Philips LED lighting devices, with a total power of 3 x 10 W, 45 lm/W energy efficiency, direct current powered. The new system structure is shown in Figure 1.

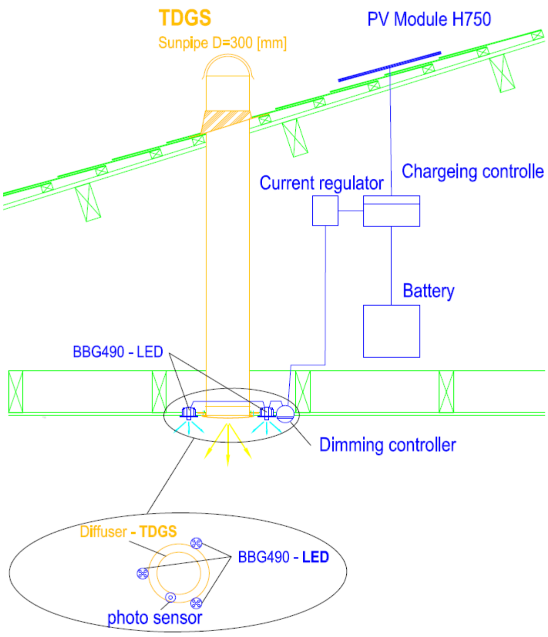


Figure 1 Composition of the proposed hybrid system

For the sizing of the photovoltaic component (PV panel, charge controller, battery) of the proposed hybrid model, PVSOL 4.0 software was used. PVSOL is photovoltaic systems analysis software developed by Valentin Energy Software in Germany.

The city of Cluj-Napoca and the 15th of October was considered in order to estimate the available solar radiation. The tilt angle of solar module was considered 30˚, and south orientation.

The system was sized for a maximum power of 30 W operating four hours a day, 365 days a year and with one day autonomy.

Estimated daily consumption of 0.12 kWh/day was associated with the system functioning in the morning for one hour at 100%, and one hour at 50%, and in the afternoon for two hours at 100%, and one hour at 50%.

Crt no.	Components	Price without VAT [RON]
1	**300 mm standard SunPipe Solar tube** system comprising: capture higher dome, the roof support plate, gasket sealing and anti-condensation, 610 mm solar tube length, plywood support the roof, extension end drag, and ceiling speaker circlip finished in white kit	1457
2	Basic Daylight Luxmate **Controller** to regulate the flow of artificial light according to daylight contribution, so as to ensure a constant level of lighting	900
3	**Photovoltaic panel** HELIOS H 750–75 W;	1800
4	Steca PR1515 5 A/12-24 V **Load Regulator**;	176
5	Solar-Akku S12/17 A 12 V **Solar Batteries**;	440
6	Spot luminaire type, easily adjustable, **LED** 11 W, 3 pcs.	965
7	**TOTAL**	**5738**

Figure 2 The cost of the proposed hybrid system (exchange rate on 10th May 2012, 1 Euro = 4,42 RON)

The system cost detailed in Figure 2 was calculated based on the offers on the market for each component. This cost could be reduced if the product (system) would be produced in series.

Also the payback period could be reduced than in the passive tubular daylight guidance system case, a system that is dependent on the existence of electric lighting.

For a more precise assessment of the new hybrid system lighting characteristics, multiple simulations were performed using the software DIALux 4.10.

Calculations were made for the proposed system used inside a 4x4 m room and a height of 2.5 m, located in Cluj-Napoca city. TDGS was assimilated to a traditional skylight with similar geometric and lighting characteristics.

Three Philips BBG490 5xLED-HB40LED type luminaires were arranged concentrically to the TDGS diffusor. Although the lighting equipment used did not provide high level of uniformity, but it was chosen because they can be oriented towards different areas of the room that we want to be more intensely illuminated.

The lighting levels were calculated for four different characteristic days (15.04, 15.07, 15.10, 15.12), for overcast conditions and taking into account a contribution of electric lighting ranging from 0% to 100%.

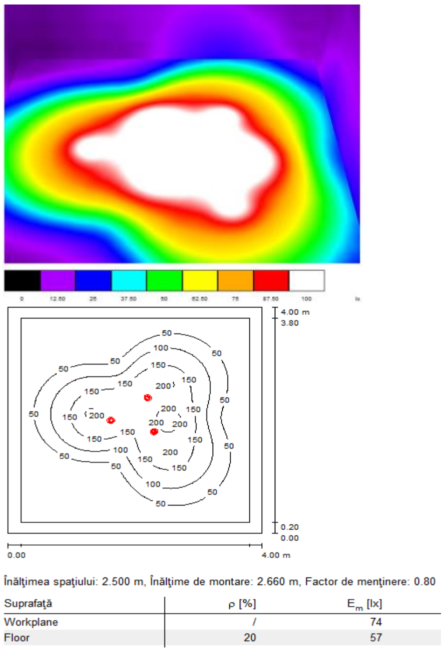
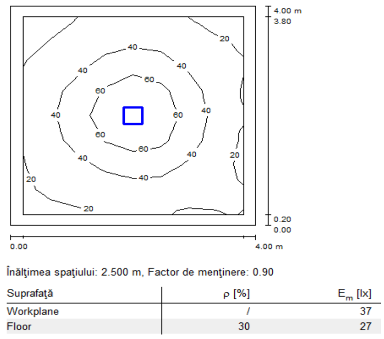
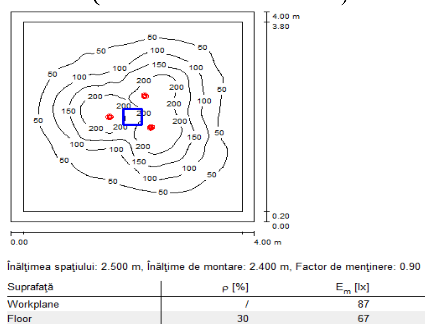


Figure 3 Lighting levels - electric 100%, natural 0%

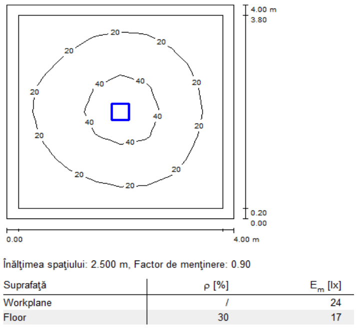


Natural (15.10 at 12:00 o'clock)

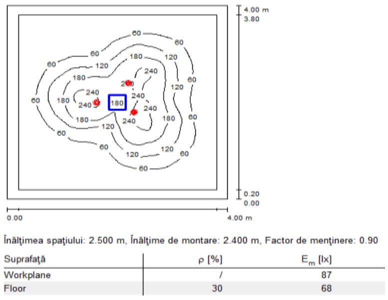


Natural (15.10 at 12:00 o'clock) + Electric 55%

Figure 4 Lighting levels 15.10 TDGS/Hybrid System

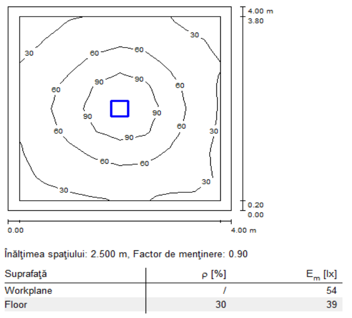


Natural (15.12 at 12:00 o'clock)

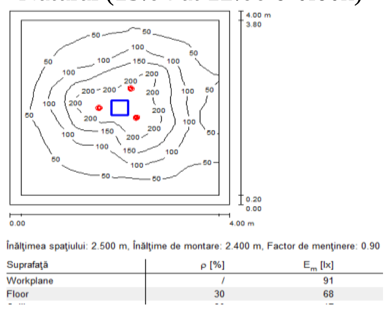


Natural (15.12 at 12:00 o'clock) + Electric 70%

Figure 5 Lighting levels 15.12 TDGS/Hybrid System

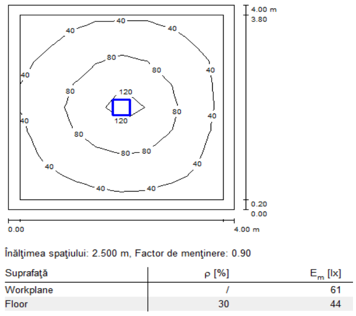


Natural (15.04 at 12:00 o'clock)

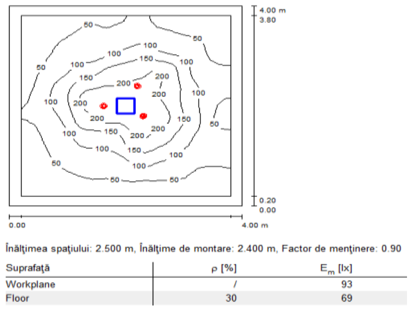


Natural (15.04 at 12:00 o'clock) + Electric 40%

Figure 6 Lighting levels 15.04 TDGS/Hybrid System



Natural (15.07 at 12:00 o'clock)



Natural (15.07 at 12:00 o'clock) + Electric 35%

Figure 7 Lighting levels 15.07 TDGS/Hybrid System

Figures 4, 5, 6 and 7 show simulated results of the lighting calculation, compared for TDGS and the new hybrid system. In the first case, it is presented the variation of illumination level depending on the time of year and the time of the day, thus emphasizing the dependence of the TDGS to conventional lighting. A constant average lighting level is realized for the hybrid system, approx. 90 lx, by dimming the electrical light output at 35%, 40%, 50% and 70% depending on the contribution of natural light provided by TDGS. If the hybrid system is well conceived and designed, the conventional electric light is no longer necessary.

The results from the PVSOL 4.0 software indicate a particular photovoltaic system efficiency of 4.4%. According to the results calculated for a passive TDGS [5], Velux TWR 14 system efficiency is about 29%. We can estimate the overall value of the proposed hybrid system efficiency between 4% and 30%, depending on use schedule and the time of the year.

Figure 8 LED light source for PMMA fibre optic [6]

Figure 9 Luminaires for PMMA fibre [6]

An alternative to the hybrid model proposed would be to use a single artificial light source, with LED (Figure 8) and for the light transport a PMMA (polymethyl metaacrilat) optical fibre connected to a specialized luminaire (Figure 9). Similar it can be used a luminaire with linear fluorescent lamps, coupled with an optical fibre with dual role, transport and diffusor of light.

3. Conclusions

Hybrid lighting systems have the potential to be less cost effective than the most efficient day lighting systems available on the market, while providing much higher flexibility [7]. Furthermore it was argued that hybrid systems will compete effectively with today's solar technologies. Similar but independent variants of the proposed model, used for either natural lighting or for power generation, are commercially available today.

It is proposed the implementation of an original hybrid lighting system consisting of a tubular daylight guidance combined with a photovoltaic and LED. Interior lighting level is measured with the help of the DIALux 4.10 software, for different scenarios, taking into account the contribution of natural light provided by light tube.

The efficacy of white LED lamps used for directional or general lighting is still not competitive compared to fluorescent lamps. Because of the rapid development of LED technology, these lamps effectiveness will exceed that of fluorescent lamps in the near future for which they were regarded as artificial light source in the proposed hybrid system.

Overall effectiveness of the proposed hybrid system has values between 30% and 4%, depending on time of use, making it comparable with the proposed hybrid system efficiency in the study.

References

1 Jeff D. M., *Hybrid solar lighting doubles the efficiency and affordability of solar energy in commercial buildings*, Energy efficient lighting – Newsletter no 4, Oak Ridge National Lab., December 2000;
2 Oak Ridge National Laboratory, November 21, 2008, www.ornl.gov;
3 Ciugudeanu C., Pop F., *Propunere realizare sistem de iluminat combinat*, Lighting Engineering Center UTC-N, November 2006;
4 Grosuleac D., Ciugudeanu C., Pop F., *Sisteme hibride de iluminat*, Conferinţa Internaţională Stiinţa Modernă şi Energia, Editura RISOPRINT, 2008, Cluj-Napoca;
5 Ciugudeanu C., Pop F., *Passive tubular daylight guidance systems, design methodology*, Proceedings of the 6th International Conference EEDAL'11, Copenhagen, Denmark, 24 May 2011;
6 Betonia, CM Data S.R.L., March 2, 2012, www.betonia.ro;
7 Sunlight Direct LLC, January 3, 2011, www.sunlight-direct.com.

Călin N. CIUGUDEANU
Ph.D.
Ph.: +4 0752 193 890
E-mail:
calin.ciugudeanu@rpe.ro

He graduated the Technical University of Cluj-Napoca (Faculty of Building Services) in 2004. His fields of interest are lighting and power distribution design services. He attended research traineeship sessions in Romania (Cluj-Napoca) and abroad (Ispra–Italy).

Bogdan MONDOC
Ph.D.
Ph.: +4 0740 127 539

E-mail:
mondocbogdan@yahoo.com

He graduated the Technical University of Cluj-Napoca (Faculty of Building Services) in 2009. His fields of interest are renewable energy systems, especially photovoltaic systems for buildings.

Dorin BEU
Ph.D
Ph.: +4 0723 661 536
E-mail:
dorin.beu@rogbc.org

He graduated the Technical University of Cluj-Napoca in 1990. Between 1993 and 1999 he attended several teaching and research grants at Liverpool, Grenoble, Helsinki, Barcelona and Budapest. Ph.D. in lighting in 2000. Reader at Technical University of Cluj-Napoca. Participant at several European research programmes. Chairman of Romanian Lighting Convention 2011 and president of Transilvania Chapter, Romanian Green Building Council. Member of the Lighting Certificate Committee of the Romanian National Committee on Illumination.

Received: 10 May 2012
Revised: 25 May 2012

PUBLIC LIGHTING PERCEPTION
(opinion public poll conducted in Cluj-Napoca)

Marilena MĂIEREAN
Energobit Schréder Lighting

Abstract: *The accomplishment of a Light Master Plan at the level of a city scale involves the action of different key factors, like: architects, designers, historians, politicians, sociologists, all working in multidisciplinary teams. Each Light Master Plan, in the initial stage, should include a check of the habits, behaviors and perceptions of the public lighting system's users. This type of investigation helps to highlight and estimate the psychological impact of the existing lighting: dominant atmosphere, personal perceptions, vibes of the day and night life.*

The current article presents a perception study of the residents of Cluj-Napoca, regarding the public lighting of the city, an analysis of dependences, appreciations and perceptions of different population segments , generated by different socio-demographic factors as: gender, age, educational level, the fact of being or not a driver or a parent.

The survey confirms that it is impossible that a lighting project to get the undivided agreement of the entire population. The gender, the age and the educational level are the three socio – demographical factors generating obvious segmentation of the city population on the subject of the lighting quality and the evaluation of the unsafe areas. The women and university segment are generally the most severe ones.

Keywords: Public lighting, opinion, poll.

1. Introduction

Getting and analyzing the perceptions of the Cluj-Napoca's residents concerning the public lighting is the primary aim of this study. To get to this point, three main objectives were formulated:

- The set-up of a general appreciation of the inhabitants regarding the public lighting and the way this one fulfils its major functions.
- The set-up of the preferences, concerning the choice of colour and style.
- The set-up of the perceptions that connect lighting with the safety feeling.

In order to realize this, in September 2011 a public survey was conducted on the area of the city of Cluj-Napoca. A sample of 200 subjects answered a handed-out questionnaire.

Ingineria Iluminatului 2012; **14**, 13-22

2. The methodology

The survey questionnaire was built up in order to achieve the three main objectives formulated. A different section of the questionnaire corresponds to each objective.

The first section aims to get a general estimation of the lighting perception and to determine the way public lighting fulfils its major functions.

The second section aims to determine the preferences concerning colour and style for the lighting and for the lighting systems. The subjects chose between white and yellow lighting for the central area, the residential areas and parks. The respondents expressed their opinion about using or not the coloured light for the architectural lighting and about the style of the lighting.

The third section, linked on the safety, aims to establish the way public lighting increases the safety feeling during the night movements in the city and to detect the habits and the frequencies of these movements. The subjects had to rate from 1 to 10 the lightings of some areas considered as dangerous or having a poor lighting, as: vacant areas, paths and alleys, building's back yards, the proximity of public and private buildings and transit zones.

The last section, related to the personal identification of the respondents, aims to obtain different segments and population groups, based on the following socio-demographic factors: gender, age, educational level, being or not a driver or a parent.

The statistical *treatment* of *data was made using SPSS* (Statistical Package for the Social Sciences) *version 17, well-known software* employed for surveys and statistic analysis. Descriptive statistics as cross tabulation, frequencies, descriptives and bivariate statistics like means, t-test, ANOVA, and correlation were used [1].

The professional poll treatment practice of data, applicable also for the treatment within SPSS involves generally a confidence interval, which indicates the reliability of the estimation, of 95%.

3. Sample description

Among the 200 respondents of the handed-out questionnaire, there are 95 males and 105 females, representing 47.5% males and 52.5% females. The sample reflects well the existing gender percentage in the studied population.

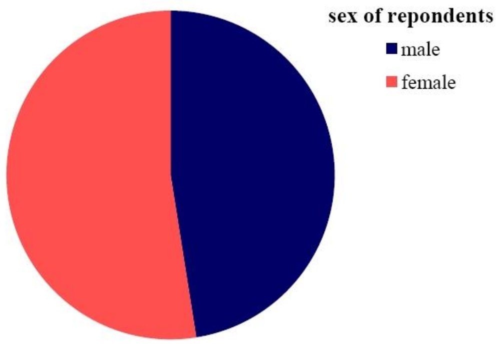


Figure 1 The gender segmentation

The following table shows the age group partition of the sample.

Table 1 Sample breakdown on age groups

	Frequency	Percent	Cumulative percent
18 to 35 y.o.	65	32.5	32.5
35 to 50 y.o.	55	27.5	60.0
50 to 65 y.o.	50	25.0	85.0
65 + y.o.	30	15.0	100.0
Total	200	100.0	

For the studied population:

- 61% of the respondents are parents of have at least one child in charge;
- 56% of the respondents are car drivers.

The following chart highlights the big number of male drivers.

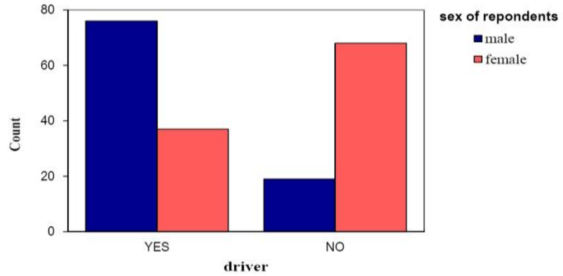


Figure 2 The driver's partition according to the gender

The Table 2 shows the population segments created by the educational level factor.

Table 2 The education level partition of the sample

	Frequency	Percent	Cumulative Percent
Secondary level	40	20.0	20.0
High School	123	61.5	81.5
College and University	37	18.5	100.0
Total	200	100.0	

It is visible among the secondary level segment that the non driver percentage is higher than the one of the drivers.

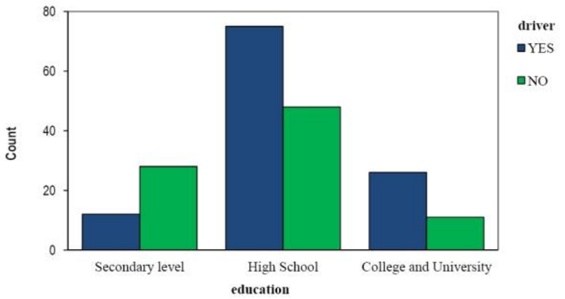


Figure 3 The drivers' partition according the educational level

For the interviewed population, the majority of the nocturne movements are made till midnight.

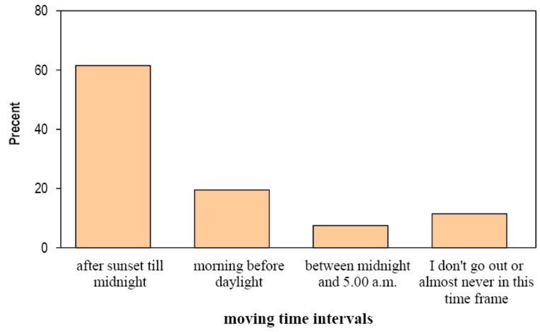


Figure 4 The nocturne movement's segmentation according the time period

The males represent the majority of those moving after the midnight and in the morning before daylight.

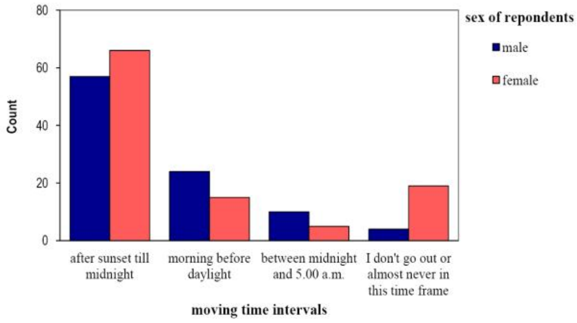


Figure 5 The gender night movements partition on time period

The car is the preferred mean of transportation during the nocturne movements.

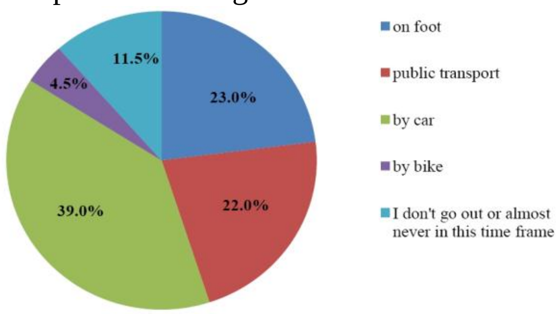


Figure 6 The means of transport partition during nocturne movements

4. Analysis and the interpretations of results

The general appreciation of the inhabitants regarding the public lighting and the way this one fulfils its major functions.

A general positive perception regarding the city public lighting is observed among the majority of the population.

64% of the population considers that the existing lighting is good.

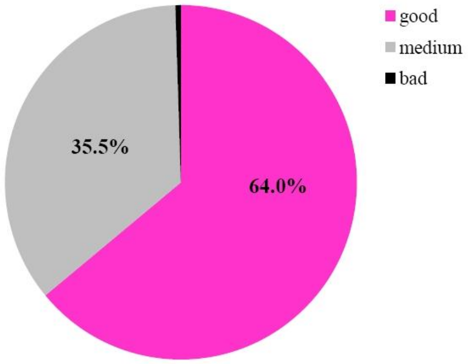


Figure 7 The general perception of the inhabitants regarding the city public lighting

The majority of the city population expressed an agreement or a strongly agreement regarding the fact that the existing lighting system fulfils its functions. The majority of the city population considers that the four essential functions of the public lighting are fulfilled. The four functions considered are: facilitate the nocturne driving traffic, facilitate the nocturne pedestrian movements, increase the safety feeling and enhance the beauty of the city.

Those who agree and strongly agree that the public lighting enhances the central area represent the highest percentage, more than 80% (Figure 8). On the opposite only 53% of the population agrees and strongly agrees that the public lighting underlines the architectural elements and 38% has a neutral attitude regarding this matter (Figure 9). Regarding the role of underlining the monuments 62% expresses an agreement or a strongly agreement. Those having a neutral attitude regarding this issue, decrease to 32.5%.

A fragile majority considers that the public lighting creates public socializing areas (Figure 10.).

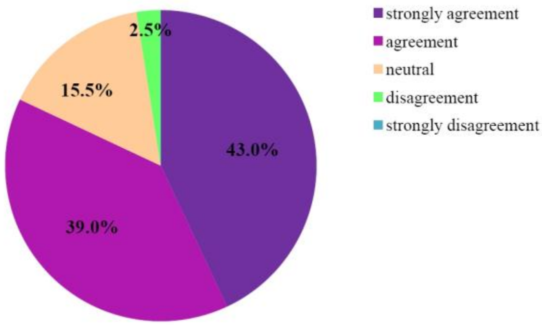


Figure 8 Lighting enhances the central area

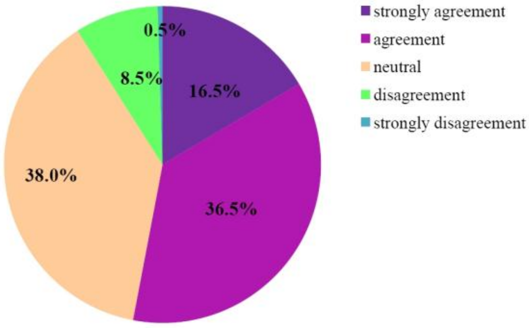


Figure 9 Lighting underlines the architecture

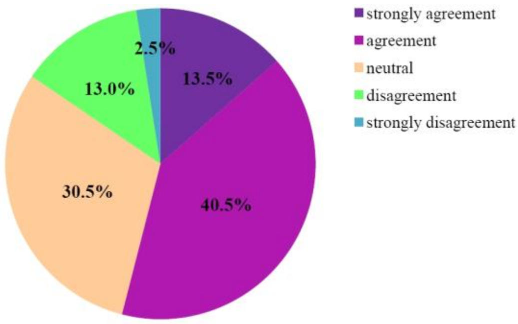


Figure 10 Lighting creates public socializing areas

The males, the drivers and the parents are the segments with the biggest impact of the perception regarding making easier the nocturne driving traffic. The men and the drivers are the most severe segments regarding this topic.

The parents represent the highest numbers of those expressing a strongly agreement regarding the public lighting impact on the nocturne car traffic. The gender and the fact of being a parent create segments having a statistical dependence on the nocturne driving traffic.

The gender, the age, being or not a parent or a driver are the factors that have an impact on the perception regarding the public lighting impact on the nocturne pedestrian movements. The level of education generates a wick dependence on this matter. The secondary level segment considers generally that the public lighting influences the nocturne pedestrian movements. Oppositely the university segment is more severe on this matter.

The independence between socio-demographic factors and the perception regarding the public lighting role on the safety feeling is observed.

The only factor generating an impact on the central area lighting is the educational level. Again, the university segment is more severe than the others segments.

Regarding the perceptions that public lighting enhances the beauty of the city and underlines the monuments and the architectural elements once more the university segment is the most severe.

The gender, the age and being or not drivers, generate segments with different opinions concerning the perception that lighting creates public socializing areas. The women, the seniors and the non drivers are the segments that consider lighting as an important issue in the conception of public socializing areas.

5. Colour and style choice

The white light was the choice of the majority (63.5%) for the central area lighting (Figure 11.a). The yellow light is preferred for the lighting of the city residential areas (56%) (Figure 11.b) and of the parks (57%) (Figure 11.c).

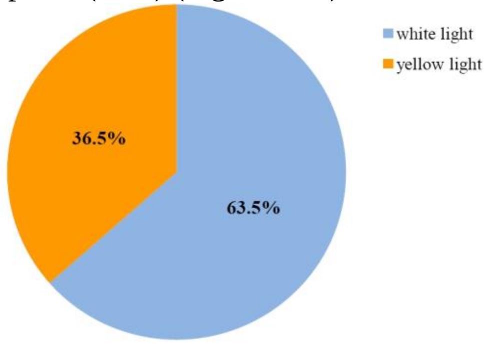


Figure 11.a The colour choice for the central area lighting

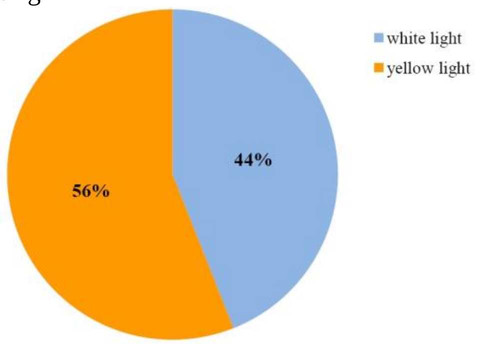


Figure 11.b The colour choice for the residential areas

54.5% of the population expressed the disagreement about using the coloured light for the architectural lighting (Figure 12).

65.5% of the population chooses a combination between the classic and the modern for the lighting style (Figure 13).

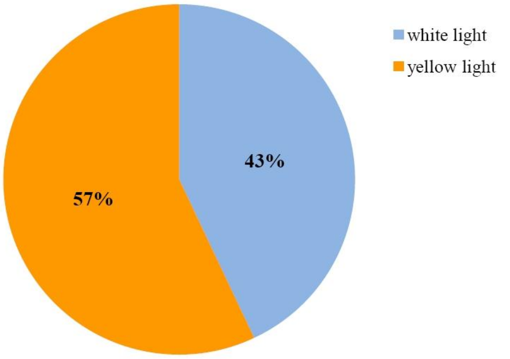


Figure 11.c The colour choice for the parks

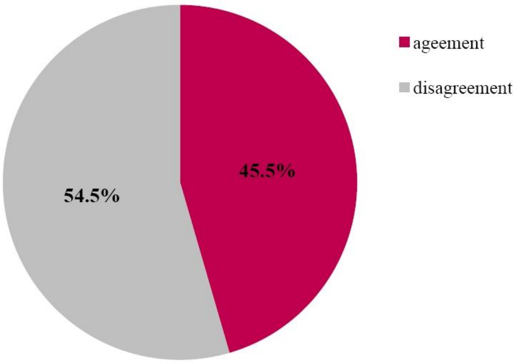


Figure 12 The colour choice for the architectural lighting

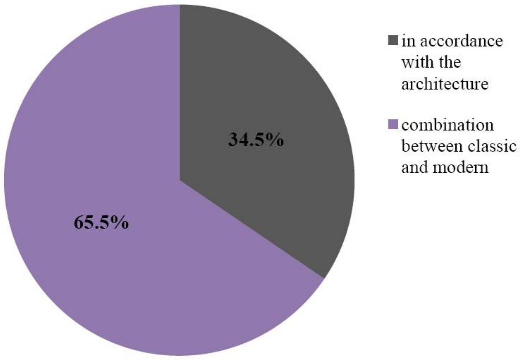


Figure 13 The lighting style choice

Concerning the intensity of the architectural lighting for buildings and monuments, the opinions are almost equally divided 49.5% wants a discreet, adapted underline lighting and 50.5% wants a strong, emphasizing lighting (Figure 14).

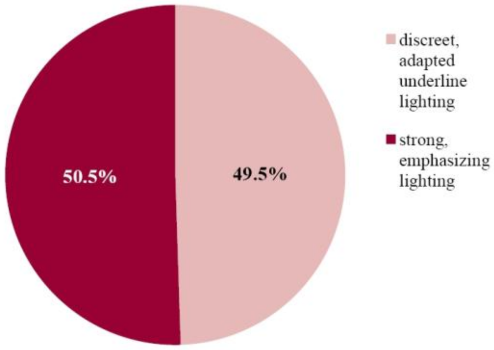


Figure 14 The intensity of the architectural lighting choice

Regarding the white and yellow light choice for the central area, the residential areas, and parks the poll results bring to light the subsequent conclusions:

The gender factor is significant for all the three types of areas.

The dependence to the gender factor has a high intensity for the parks, a medium one for the central area and wick one for the residential areas.

The yellow light is preferred by the women for all three type of area:

– Central area 74% (*Cramer's V Test=0.33*);
– Residential areas 59% (*Cramer's V Test=0.17*);
– Parks 79.8% (*Cramer's V Test=0.63*).

The age factor creates a significant dependence (*Cramer's V Test=0.26*) in the case of the color choice for the residential areas. The only segment that prefers the white light (52.7%) is one between 35 and 50 years old. The choice for the other segments is the white light. In the 65+ segment 86.7% expressed the predilection for the white light.

The age factor doesn't create significant dependence in the case of color choice for the central area and the parks. Even that the dependence is not significant for the central area all the segments except the 65+ prefer the white light. For the 65+ the choice between white and yellow light is almost fifty-fifty. For the parks all the segments, except the one between 35 and 50 years old, prefer the yellow light.

The educational level factor creates a weak dependence (*Cramer's V Test=0.24*) regarding the colour choice decision for central area. The secondary school segment (85%) and the high school segment (61%) prefer the white light for the central area. In the university segment only 48.5% has this preference. The educational level factor doesn't create significant dependence on the topic of the color choice for the residential areas and parks.

The gender factor create a medium dependence concerning the architectural lighting of the buildings and monuments (*Cramer's V Test=0.48*). The women choose for the most part (72.4%) a discreet, adapted, underline lighting, and the men (75.8%) want a strong emphasizing lighting.

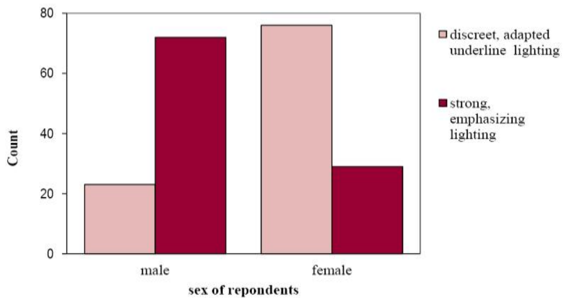


Figure 15 Intensity of the architectural lighting choice partition - Gender

Only 16.7% of the 65+ segment agrees with using the coloured light for the architectural lighting projects. The 35 to 50 years old and the 50 to 60 years old segments prefer the coloured light for this purpose (*Cramer's V Test=0.296*).

The educational level is the only socio-demographical factor generating a strong dependence (*Cramer's V Test=0.52*) regarding the lighting style choice in connection with the surrounding public space architecture.

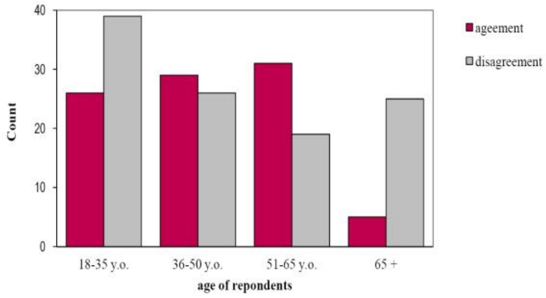


Figure 16 The use of coloured light for architectural projects partition - Age

Secondary level segment (80%) and high school level segment (76.4%) choose a mix between classic and modern. For the university segment 86.5% of the respondents want the lighting to be in accordance with the architecture of the surrounding public space.

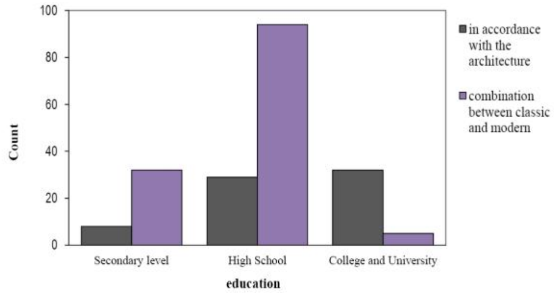


Figure 17 The style choice partition - Educational level

6. The public lighting and the safety feeling perception

61.6% of the city population moves in the gap between the sunset and midnight but only 7.5% of the same population moves in the period after midnight till 5 a.m. Those traveling before midnight and in the morning before the day light represent in cumulative percent 81% of the city population. 11.5% of the city population doesn't move at all during the night or they do it hardly ever.

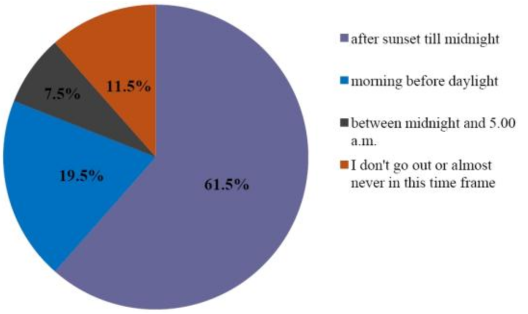


Figure 18 Nocturne movement partition on time intervals move

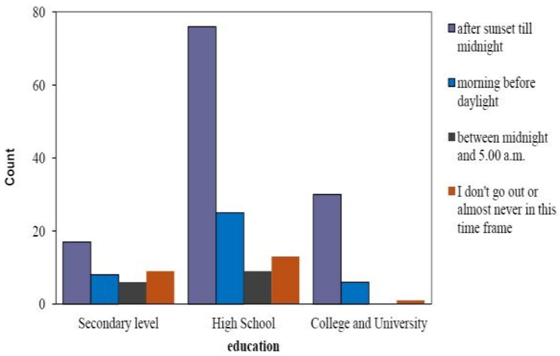


Figure 19 The nocturne movement partition - Educational level

The gender is a factor generating a significant dependence regarding the nocturne moving hours. The women represent the majority of those moving before midnight or never getting out during the dark hours. The university segment avoids moving in the gap between midnight and 5 a.m. (Figure 19).

The 65+ segment avoids moving in the gap between midnight and 5 a.m. and represents the majority of those never getting out during the dark hours.

Being or not a driver is an important factor creating a significant dependence on the nocturne movements. The drivers segment stands as the majority regarding nocturne moving.

39% of the city population uses the car for nocturne movements, 22% the public transit company and only 4.5% the bike.

28% of the city population has to make a detour during the nocturne hours comparing to the diurnal route because of the poor lighting.

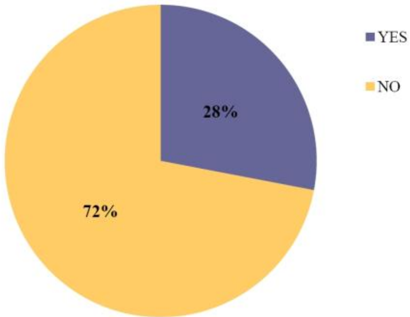


Figure 20 Make a detour during the nocturne movements - Segments

The gender and the age are two socio – demographical factors generating significant dependences regarding the detour of the path. Generally, the women make detours in order to avoid poor lighted areas.

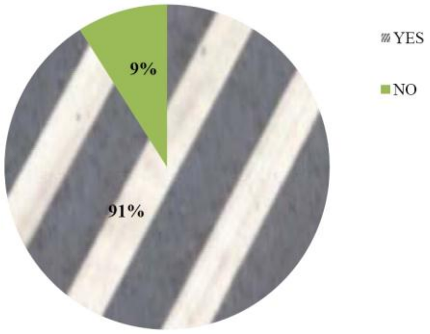


Figure 21 Improvement of the zebra street crossing lighting

91% of the city population wishes an improvement of the zebra street crossings lighting.

63% of the city population agrees and strongly agrees that the public lighting generates a safety feeling during the nocturne movements. Those manifesting a strong disagreement on this matter represent only 1.5% of the population, but a pretty high percentage 25.5% of the city population, has a neutral attitude.

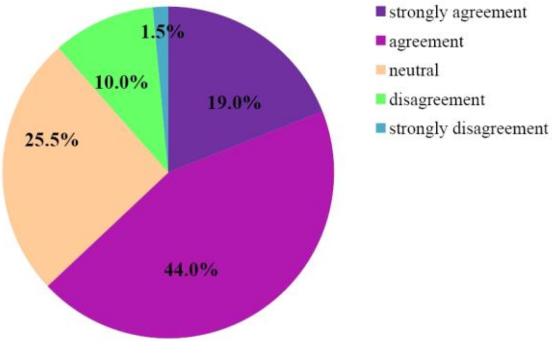


Figure 22 The public lighting generates a safety feeling during nocturne moving

Table 3 The scores obtained after the rating of some unsafe considered areas

	Min	Max	M*	SD**
Score for lighting of vacant areas	1	10	**6.06**	2.11
Score for lighting of path, drive way	1	10	6.40	2.11
Score for lighting of packing areas	1	10	6.44	2.23
Score for lighting of back side buildings	1	10	6.18	2.14
Score for lighting of proximity of building	1	10	7.20	1.76
Score for lighting of transit areas	1	10	**8.19**	1.39

*M = Mean; **SD = Standard Deviation

No socio-demographic factor of this poll generates significant dependences regarding the relation between public lighting and the safety feeling. In order to get a better image of the relation between the lighting and the safety feeling, the population was asked to evaluate the lighting of some unsafe considered areas by rating them from 1 to 10 (10 for excellent lighting and 1 for very poor lighting). Vacant area, paths, parking areas, building's back yards, the proximity of public and private buildings and transit zones were evaluated (Table 3).

7. Conclusions

The majority of the Cluj-Napoca's residents consider that the public lighting system fulfils its functions and the city is well lit.

The educational level is the factor that generates an obvious segmentation of the city population on the subject of the lighting quality. The university segment is the most severe one.

There is room for improvement concerning the architectural lighting and the creation of public socializing areas.

The poll determined the preferences of the majority about the color choice in public lighting. This analyze reveals the areas where the white or yellow color is preferred. The use of colour lighting for architectural elements is appreciated only by a fragile majority of the city population.

The majority of the city population chooses a combination between the classic and the modern for the lighting style. The university segment prefers a lighting style according to the architectural style of the area.

The opinions are almost half-and-half divided about using a discreet, adapted, underlining lighting style or a strong emphasizing lighting.

The survey confirms that it is impossible that a lighting project to get the undivided agreement of the entire population. The gender is the factor that determines the two segments having the most different opinions on this matter.

63% of the city population agrees and strongly agrees that the public lighting generates a safety feeling during nocturne moving. Only 23% of the city population makes pedestrian nocturne activities.

The poll highlights the small percentage of those moving in the gap between midnight and 5 a.m. This could lead to an additional mean of efficiency of the lighting system via controlling the lighting flux during this interval by:

– reducing the lamps flux used for lighting.
– turning off the architectural lighting during this interval exception the days representing special events for the city.

The residential buildings proximity requests a special attention and a lighting improvement. The drivers stand for the most severe segment concerning the parking and the proximity of public and private buildings lighting.

28% of the city population has to make a detour during the nocturne hours comparing to the diurnal route because of the poor lighting. The vacant areas, the side paths and alleys, the parks and the back side areas of the buildings require important lighting improvements. The educational level is a factor that generate different opinion segment regarding this matter. The university segment is the most severe one concerning the evaluation of the unsafe areas. The women represent the most severe segment particularly for the rating of the vacant areas. The seniors' segment is less severe one, concerning the evaluation process of the potential risk areas. This could be explained by the lighting standards development in time, during years. 91% of the city population requests an improvement of the zebra street crossings lighting.

8. References

1 Alalouf, S., Méthodes statistiques École des Sciences de la Gestion, Ed. Université du Québec à Montréal, 2008, Montréal

Marilena MĂIEREAN
Energobit Schréder Lighting
47/11, Tăietura Turcului Str., RO- 400221, Cluj-Napoca, Romania
Ph.: +4 0722 347 683

E-mail: marilena.maierean@energobit.com

She graduated Power Engineering Faculty, University Politehnica Bucharest. Professional experience in energy efficiency studies, at the Institute for Studies and Power Engineering Bucharest. Since 1995 has been working with Energobit, in the outdoor lighting projects. Beginning with 1998, the establishment of Energobit Schréder Lighting as a joint-venture between Energobit and Schréder Group GIE, began to work with this company. She developed important lighting projects for the public space.

Received: 15 May 2012
Revised: 30 May 2012

MODELING OF TWO LAMP-BALLAST ASSEMBLIES USED IN PUBLIC LIGHTING BASED ON EXPERIMENTAL MEASUREMENTS AND INTERPOLATION

Răzvan-Bogdan VASILIU, Mircea CHINDRIŞ, Andrei CZIKER, Daniel GHEORGHE
Technical University of Cluj-Napoca, Romania

Abstract. *Complex methods of modeling either the lamp or the ballast exist in literature. Certain models are able to describe some level of approximation of the lamp operation under different conditions while other models are able to describe complicate ballast circuits. These approaches are based either on the V-I curve, on the description of the lamp conductance or on specialized software. The common point of these methods is that they treat the lamp and ballast as separate devices and not as an assembly.*

The main goal of this paper is to study and model the behavior of two lighting assemblies when the light output is dimmed in order to implement them in a telemanagement program that was developed as part of a PhD thesis. The study focuses on a series of experimental measurements that were taken in order to determine the variation of the main electrical and photometrical parameters of these lighting assemblies. The cubic spline method from two programs is used in order to interpolate the results of the measurements. For the first assembly, the V-I characteristic of the lighting assembly was obtained by regulating the level of the main voltage. However, because this is an obsolete technology the implementation was not further studied. In the case of the second assembly, the measurements were obtained by variation of the ballast´s DC control voltage using 0.5 V steps in order to obtain data points which could then be used to obtain the graphical characteristics of the main parameters of this assembly.

Keywords: public lighting, experimental measurements, cubic spline interpolation

1. Introduction

A public lighting assembly consists of electromagnetic or electronic ballast and a non-linear element as a high intensity discharge lamp. The study of such a complex system requires a competence combination from several disciplines. Complex physical models have been developed for almost any type of discharge lamp, models that can be found in the existing literature. To the other side, power electronics engineers have described complicated electronic circuits by means of specialized software (PSpice, Simulink, Simplorer and others). However, in many cases the lamp models developed are incompatible with the software used. Thus, electrical engineers tried to create simple lamp models based essentially on experimental V-I characteristic of the lamp [1].

Unfortunately all these methods found in literature have one point in common: they analyze and simulate separately the discharge lamp and the ballast. A high intensity discharge lamp needs ballast in order to function, so these equipments need to be studied and modeled as an assembly.

In this paper, a method based on a series of experimental measurements and cubic spline interpolation is used in order to describe the behavior of two public lighting assemblies when the light output is dimmed. First, some general aspects regarding the cubic spline interpolation method are presented. Further on, the paper presents the studied lighting assemblies, the setup scheme, the V-I characteristic of the main assembly and the obtained results for the second assembly. Finally the graphical characteristics of the second assembly obtained using the measurements values are compared with the one provided by the manufacturer. The results were satisfactory for the second assembly and this lead to a further implementation in a telemanagement program.

2. Cubic spline interpolation

The computing time is very important in dynamic and control calculations in real-time energy management processes. Often, advanced mathematical tools are used even if they ultimately translate into programs that achieve several basic arithmetic or logic operations. Among numerical methods, a special place is occupied by interpolation functions that are currently used in various types of measurements and data processing. Using cubic spline, a series of unique cubic polynomials are fitted between each of the data points, with the stipulation that the curve obtained be continuous and appear smooth.

One method to implement cubic spline interpolation is using the *cspline* function from Mathcad. Its cubic spline function creates a curve through a set of data points, giving you a set of coefficients that can then be used with Mathcad's *interp* function to generate a single y-value for every x-value. The *cspline* (cubic spline) function assumes that the first and second derivates are equally distributed, and creates a curve for every point. It then interpolates a curve between the points, giving a final cubic polynomial. Mathcad's cubic spline relies on data without a lot of variation.

The spline function is a new concept closely related to polynomial interpolation. This function can also be found in Matlab and achieves a cubic spline interpolation and can be implemented using the syntax:

$$yy = spline\ (x, y, xx) \qquad (1)$$

where x represents the data points through which the function is given, y is the function values or the function itself and xx represents an internal division[2].

3. Measurements and implementation

As it was mentioned earlier, a public lighting assembly is mainly comprised of ballast and high intensity discharge lamp.

The first studied lighting assembly consists of standard electromagnetic ballast and the ceramic metal halide lamp 70 W City White CDO-TT from Philips.

A series of measurements were taken in order to achieve data points which could then be used to raise the graphical V-I characteristic of this lighting assembly. The experimental setup is presented in Figure 1.

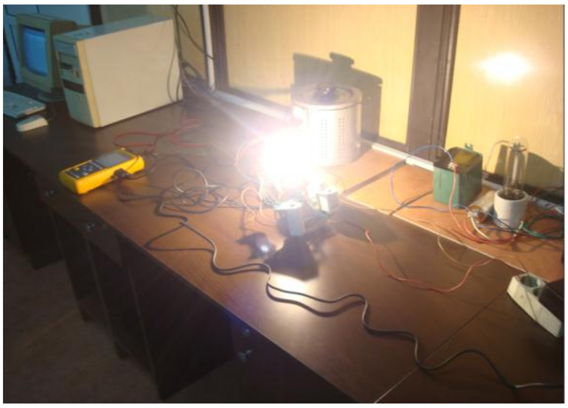


Figure 1 Experimental setup

Measurements were taken by reducing the supply voltage from 230 V down to the value that determined the lamp to turn off using thresholds values of 5 V. The setup consists of a Fluke 43 power quality analyzer (used for the analysis of single-phase systems), an autotransformer, a PC station and the lighting assembly. Figure 2 presents the experimental setup scheme.

Based on the values obtained from the measurements and using the cubic spline interpolation function from Mathcad the V-I characteristic of the lighting assembly was obtained and is presented in Figure 3.

The technology of dimming the light output of HID lamps by regulating the level of the main voltage for the entire segment at the power supply cabinet is an obsolete technology and it is not considered to be optimal for energy savings [3].

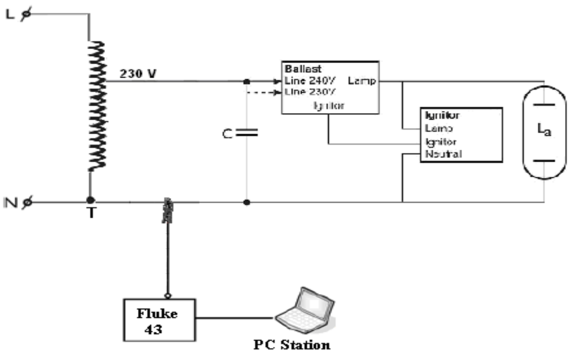


Figure 2 Experimental setup scheme

Furthermore, due to voltage drops the lamps at the end of the segment will be supplied at lower voltages. In terms of lighting this will mean different light outputs and the absence of illumination uniformity.

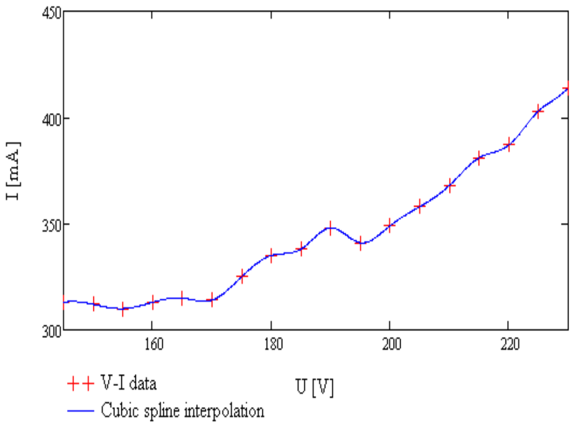


Figure 3 V-I characteristic of the studied lighting assembly

The light output of lamps driven by modern electronic ballasts is not influenced by the variation of the supply voltage. Thus, the light output is the same for all lamps regardless of their position in the segment.

In order to reduce the energy consumption in a lighting network the light output of lamps is dimmed. If the lighting network is controlled by a telemanagement system then the light output of the lamps will be continuously dimmed as an automatically response of this system to external parameters.

Experimental measurements were taken for an assembly that allows remote control of the light output using the analog 1-10 V interface. The assembly consists of a high pressure sodium SON-T 150 W lamp and the DynaVision SON 1-10 V electronic ballast. Ballasts with 1-10 V input dim the light output according to the voltage level of there set point input in a range of 1-10 V, (10 V - max, 1 V - min).

In order to obtain the needed data, 19 measurements have been conducted by lowering the DC control voltage with 0.5 V steps. The data then was used to obtain the graphical characteristics of the main electrical parameters related to the 1-10 V DC control voltage. Also these measurements were used in order to implement the cubic spline interpolation function from Matlab in the program.

As it was mentioned earlier the assembly consists of electronic regulating ballast that has an analogue input of 1-10 V and a high pressure sodium lamp. The operating frequency for the lamp is 130 Hz and by means of high-frequency switching, the light level can be regulated between 20% and 100% (power between 35% and 100%). The constant power regulation makes the lamp power independent of the mains voltage and lamp voltage [4].

Table 1 presents the value of the main measured parameters related to the control voltage obtained using the experimental setup from Figure 4. First the values of current measurements (*I*) for the assembly are presented. Because the lamp is independent from voltage variation, the dimming is achieved by reducing the current. The current drop is almost linear related to the 1-10 V scale. The power consumption (*P*) of the assembly decreases from 159 W to 85 W, which means a consumption reduction of 53%, while the reactive power (*Q*) variation is insignificant. The power factor (*PF*) value is high (over 0.95) for the entire control voltage interval. The value of the total harmonic distortion factor (*THD*) for current grows from 9% to 13.5% due to the presence of new harmonics in the lower part of the control interval, like the 13th, 15th and 17th harmonics besides the 3rd, 5th, 7th and 9th. Another parameter presented is the light output (Φ). Its values decrease almost linearly from 100% to 35%. The fact that the light output drops more drastically compared to the active power consumption is reflected in the values of the total luminous efficacy (e_g), from 100% to 66%.

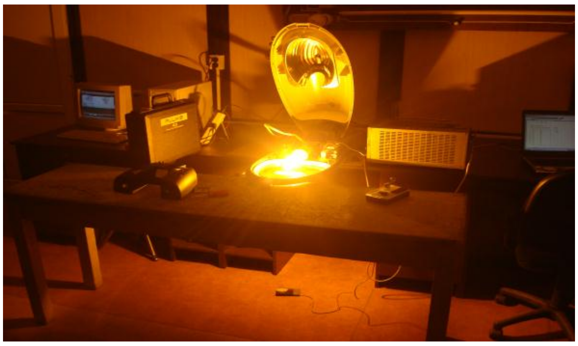


Figure 4 Experimental setup

Based on the measurement results and the implementation of cubic spline interpolation in Figure 5.a the characteristic of light output variation thus obtained is presented. Figure 5.b presents the general characteristic offered by the producer for high pressure sodium lamps [4].

Figure 6.b presents the active power variation related to the control voltage as presented by the manufacturer. By analyzing graphs 5.b and 6.b it can be observed that the assembly can be dimmed down to 20% light output that corresponds to 35% output power. Moreover, using these graphs, energy savings thus obtained can be calculated at different lighting levels which lead to financial benefits. Figure 7.b presents the power factor variation related to the DC control voltage. As it can be seen the graphs are similar but not identical partly due to measurement errors and partly to the fact that the graphs provided by the manufacturer are more with a guidance approach.

Table 1 Measurements results

DC control voltage [V]	***I* [mA]**	***P* [W]**	***Q* [Var]**	**PF**	***THD* [%]**	***Φ* [%]**	**e_q [%]**
10	704	159	30	0.98	9	100	100
9.5	707	159	30	0.98	9.2	97	97
9.0	697	157	29	0.98	9.3	94	95
8.5	672	150	28	0.98	9.7	90	96
8.0	647	145	29	0.98	9.6	87	96
7.5	622	139	28	0.98	10.4	81	92
7.0	594	132	26	0.97	10.4	74	89
6.5	569	126	28	0.97	10.2	69	88
6.0	534	118	26	0.97	11.1	61	83
5.5	503	111	26	0.97	11.5	56	81
5.0	469	103	26	0.96	11.8	50	77
4.5	438	96	26	0.96	12.4	44	72
4.0	428	94	26	0.96	12.5	42	71
3.5	423	93	26	0.96	12.4	41	71
3.0	414	90	25	0.96	12.5	39	68
2.5	407	89	26	0.95	13.2	38	67
2.0	404	88	25	0.95	13.4	37	67
1.5	402	87	25	0.95	13.4	36	66
1.0	395	85	25	0.95	13.5	35	66

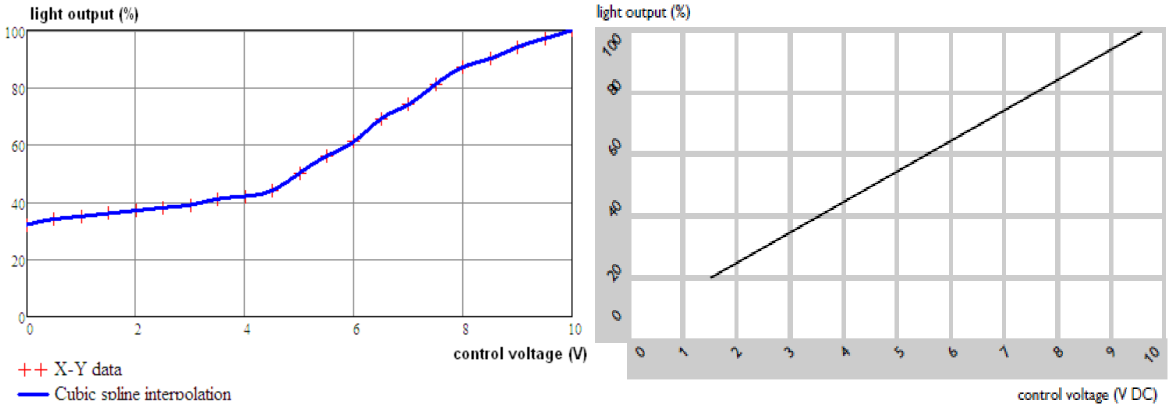


Figure 6 Light output variation related to control voltage:
a – interpolation for the 150 W SON-T lamp; b – provided by the manufacturer

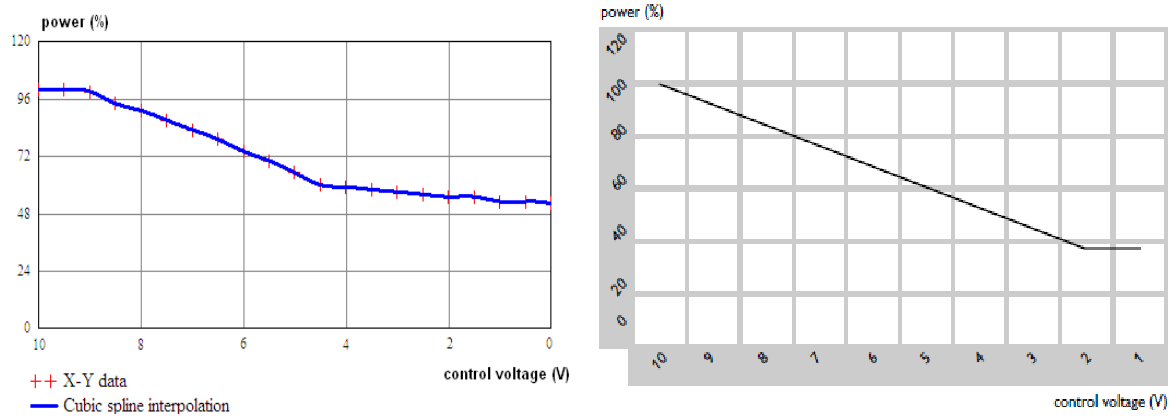


Figure 7 Active power variation related to control voltage:
a – interpolation for the 150 W SON-T lamp; b – provided by the manufacturer

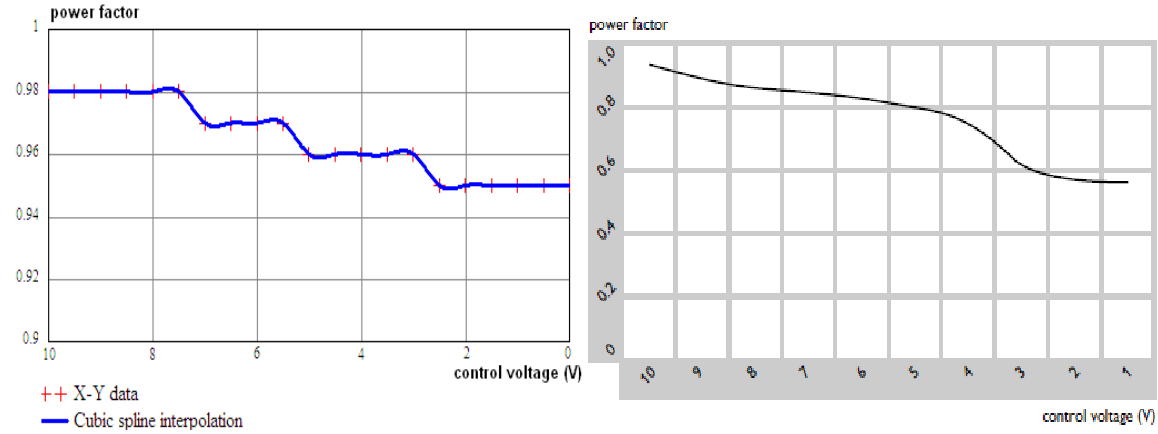


Figure 8 Power factor variation related to control voltage:
a – interpolation for the 150 W SON-T lamp; b – provided by the manufacturer

4. Conclusions

An approach of modeling the behavior of two public lighting assemblies when the light output is dimmed is presented. The method is based on a series of experimental measurements and the use of cubic spline interpolation. For the first assembly the first set of measurements and the cubic spline interpolation function *interp* from Mathcad was used and the results are presented in a graphical form.

The results for the first assembly were obtained by regulating the supply voltage. However, this method is obsolete and not considered to be optimal for energy savings. This is way the implementation of this assembly was not further developed.

In the case of the assembly with electronic ballast, the second set consisting in 19 measurements was used along with the cubic spline interpolation function (cspline) from Matlab and the results are also presented in a graphical form. Because the results were satisfactory and plus the fact that the ballast has a 1-10 V interface which allows a continuous dimming of light output lead to a further implementation as part of a telemanagement software.

5. Acknowledgments

This paper was supported by the project “Doctoral studies in engineering sciences for developing the knowledge based society - SIDOC” contract no. POSDRU/88/1.5/S/60078, project co-funded from European Social Fund through Sectorial Operational Program Human Resources 2007-2013.

6. References

1 Zissis, G., Damelincourt, J.J., Bezanahary, T., Modeling discharge lamps for electronic circuit designers: A review of the existing methods, 2001 IEEE.

2 Laboratorul de Sisteme de Programare pentru Modelare şi Simulare (S.P.M.S), Sisteme de programare pentru modelare şi simulare: Notiţe de curs, Universitatea Politehnica Bucureşti, 2008.

3 Walraven, H., E-street Initiative - Market Assessment and Review of Energy Savings, Work Package 2, July 2006.

4 Philips, Application Guide to HID Lamp Control Gear, June 2002, www.lighting.philips.com

Received: 24 April 2012
Revised: 29 May 2012

Răzvan-Bogdan VASILIU,
PhD Student
Technical University of Cluj-Napoca,
Power Systems Department
28, Memorandumului St,
RO-401248 Cluj-Napoca, Romania
Ph.: +40.264.401408
e-mail: razvan.vasiliu@eps.utcluj.ro

Răzvan-Bogdan VASILIU received the License Degree in Electrical Engineering from the Technical University of Cluj-Napoca, Romania in 2009. Since 2009 he is working towards his Ph.D. at the Electrical Power System Department of Technical University of Cluj-Napoca. Major research area is energy management of public lighting installations.

Mircea CHINDRIS,
Professor
Technical University of Cluj-Napoca
Power Systems Department
28, Memorandumului St,
RO-401248 Cluj-Napoca, Romania
Ph.: +40.264.401451
e-mail: mircea.chindris@eps.utcluj.ro

Mircea CHINDRIŞ received the M.S. degree and the Ph.D. degree from the Technical University of Cluj-Napoca, Romania, all in electrical engineering. In 1974 he joined the same University where he is presently Full Professor in the Electrical Power Systems Department. His technical interests are in power quality, energy management, end use of electricity and artificial intelligence.

Andrei CZIKER,
Associate professor
Technical University of Cluj-Napoca,
Power Systems Department,
28, Memorandumului St,
RO-401248 Cluj-Napoca, Romania
Ph.: +40.264.401451
e-mail: andrei.cziker@eps.utcluj.ro

Andrei CZIKER received the M.S. degree in Physics from the Babes-Bolyai University of Cluj-Napoca, Romania in 1995 and the M.S. degree in power engineering from Technical University of Cluj-Napoca in 1998. He is presently associate professor with Technical University of Cluj-Napoca. His technical interests are in energy management, power quality and artificial intelligence.

Daniel GHEORGHE,
PhD Student
Technical University of Cluj-Napoca,
Power Systems Department
28, Memorandumului St,
RO-401248 Cluj-Napoca, Romania
Ph.: +40.264.401408
e-mail: daniel.gheorghe@eps.utcluj.ro

Daniel GHEORGHE received the License Degree in Electrical Engineering from the Technical University of Cluj-Napoca, Romania in 2009. Since 2009 he is working towards his Ph.D. at the Electrical Power System Department of Technical University of Cluj-Napoca. Major research area is studying the power quality parameters.

INTER-PERSONAL JUDGEMENTS FOR PEDESTRIANS AT NIGHT: EXPLORING INFORMATION PERCEIVED AT DIFFERENT DISTANCES

Biao YANG, Steve FOTIOS
School of Architecture, The University of Sheffield, UK

Abstract. *Lighting in residential roads is designed to meet primarily the visual needs of pedestrians rather than those of motorists. These needs include enhancement of their safety and perceived safety. One aspect of safety is the ability to make judgements about the intent of other pedestrians, whether or not they present a threat. A current basis of guidance is that lighting should enable facial recognition at a minimum distance of 4 m, suggested to be the minimum distance at which an alert subject would be able to take evasive or defensive action if threatened. The literature however does not conclusively support this assumption, and there are clear variations in comfortable interpersonal distances with light level and with the procedure used to measure the desired inter-personal distance. This article reports a study carried out to explore the visual information extracted about other pedestrians at a range of interpersonal distances (15, 35, 66 and 135 m). An open task was used in which test participants were instructed to report all the information they could about a target pedestrian, and these were photographs of unknown people printed at different sizes to represent different inter-personal distances. The results appear to fall into three categories according to the relationship between frequency of identification and inter-personal distance. These data provide some clue as to what features of other pedestrians might be important and whether these features are distinguishable at different distances.*

Keywords: road lighting, reassurance, interpersonal judgements, comfortable inter-personal distance

1. Introduction

Street lighting is provided to meet the needs of road users such as motorists, cyclists, and pedestrians. Pedestrians are regarded as one of the most vulnerable user groups of roads in residential areas [1] and thus road lighting should enhance their safety and perceived safety at night-time.

One element of safety is making judgements about the intent of other pedestrians (i.e. whether or not they present a threat): these are inter-personal judgements. Past studies have been carried out to investigate how lighting affects facial

Ingineria Iluminatului 2012; **14**, 31-44

recognition and thus how parameters such as the spectral power distribution (SPD) of lighting might be optimised. The results of six known studies are mixed [2], [3], with three suggesting that SPD does affect facial recognition, and thus that facial recognition can be gained at a further distance when using lamps of better optimised SPD, while others reported there is no effect. One limitation of these studies is that they have not addressed the inter-personal distance at which it might be desirable to make judgements about other pedestrians. It is possible that at near distances any effect of SPD is not significant because the face is of a large size. At further distances, where the face is smaller, then an improvement due to SPD may be of benefit.

Caminada and van Bommel [4], [5] proposed a foundation for the requirements of lighting in residential areas which has informed subsequent lighting guidance. They identified visual needs including facial recognition, obstacle detection, visual orientation, pleasantness and comfort, and hence the lighting criteria to meet these needs. For facial recognition they suggested a requirement to recognise the face of an approaching pedestrian at a distance of 4 m. This was rounded from the minimum *public distance* proposed by Hall [6], a distance of 3.7 m (12 feet) suggested to be the minimum distance at which an alert subject would be able to take evasive or defensive action if threatened.

Hall [6] introduced a series of desirable distances for personal space according to social needs by integrating visual, auditory, olfactory and other perceptual parameters. There were four zones including an *intimate* distance (less than 0.5 m) at which the presence of the other person is unmistakable, *personal* distance (from 0.5 to 1.2 m) which forms a protective sphere, *social* distance (from 1.2 to 3.7 m) as a limit of domination, and *public* distance (3.7 m or more). For defining the public distance, it appears that Hall considered visual and auditory factors to matter. Visual definition of public distance includes: the ability to see the entire central face on the fovea, thus giving detailed vision, and Hall suggested this is possible at 3.7 m (12 feet); ability to see the faces of two people on the macular region; and the whole of a seated person in a 60° field of view. Other cues to judgements of safety include body language and action [7], [8] which might include posture and gait and these may present larger visual targets.

While Caminada and van Bommel suggest that facial recognition is needed at inter-personal distances of at least 4 m in order to permit ability to evade threat, Townsend [9] suggests that once inter-personal distance is reduced below 15 m, the space in which we have time to react to avoid trouble, or simply an undesirable situation, becomes reduced beyond comfortable levels. Further evidence has therefore been sought to confirm the minimum distance at which it might be comfortable to make decisions regarding the intent of other pedestrians.

2. Studies of Inter-Personal Distance

Gibson [10] used the hypothetical example of an ancestor *genus homo* in order to illustrate the relationship between inter-personal distance and comfort:

For example, one conceivable object to which he must have been sensitive was a sabre-toothed tiger or some beast of equal ferocity. His conduct must have been rather nicely adjusted to distance when he encountered one in open country, varying as the retinal image varied in a precise way. To the tiger at a mile he could react by going about his business. To the tiger at 400 yards he should have reacted by going in another direction. To the tiger at 10 yards he must have reacted (if he was one of our ancestors) by running like the wind. His behaviour was graded in relation to a variation of his retinal images. [Gibson, 1950, p. 197].

Clearly, distance affects perceived safety. Judgements of desirable interpersonal distance are made in order to maintain a certain level of reassurance, the difference between an approaching tiger and an approaching person being the relative distances for the different levels of perceived safety.

One criterion may be ability to perceive details about other people, as was used by Hall. In 1877, the German architect Maertens [11] introduced the human scale into urban design. He suggested that the nasal bone is a critical feature for the perception of the individual and considered the one minute of visual angle as the smallest size of detail discernible. From this he proposed critical distances including 12 m, at which people can be distinguished, 35 m at which the face becomes featureless, and at a distance of 135 m body gesture can be discerned.

One question to ask is whether Hall's work, which did not specifically address vision at low light levels, is indeed a suitable basis for road lighting – is the minimum distance of 4 m still relevant to the situation of pedestrians walking at night under street lighting? Adam and Zukerman [12] examined inter-personal distance at low and high light levels using a stop-distance procedure. In the stop-distance procedure the test participant and/or the experimenter walk towards one another and the test participant stops walking (or otherwise indicates) at the point where the presence of the other person becomes uncomfortable. The stop-distance procedure is regarded as an attractive technique for measuring personal space since it places the subjects in a real situation [13]. It may however provide an underestimate if carried out in a laboratory where test participants are not subject to the same types of fear as they might in real streets. Adam and Zukerman used two light levels, 1.5 lx and 600 lx. The mean comfortable distance was greater (1.17 m) under low illuminance than under high illuminance (0.53 m), indicating a preference for greater separation from unknown people at night-time than at daytime.

Fujiyama et al [14] also used a stop-distance procedure to investigate comfortable distance. Under five illuminances, ranging from 0.67 lx to 627 lx, ten stationary participants were asked to say "stop" when an unfamiliar person walking towards them felt uncomfortable. The results are reported only graphically and without error bars or similar to indicate variance. Mean comfort distances lie in the region of 4.0 to 5.2 m, with a slight trend to decrease at higher light level. Fujiyama et al report only a few sample statistical analyses. Comfort distances at 0.67, 2.8 and 5.5 lx are significantly longer ($p<0.05$) than that at 627 lx, but they did not find a significant difference between comfort distances at 12.3 and 627 lx.

Figure 1 shows the results from Adam and Zukerman and from Fujiyama et al. While the results from Fujiyama et al suggest comfortable inter-personal distances similar to that proposed by Caminada and van Bommel, for both low and high illuminances, the results from Adam and Zukerman suggest much shorter comfortable distances. Both studies were carried out in interior spaces. One difference is the size of the laboratory: Adam and Zukerman used a small room of dimensions 5.18 m x 6.1 m while Fujiyama et al used the Pedestrian Accessibility and Movement Environment Laboratory (PAMELA) which is much larger (80 m^2). Thus there may be a range bias: Adam and Zukerman used a small room which resulted in a small estimate of comfort distance.

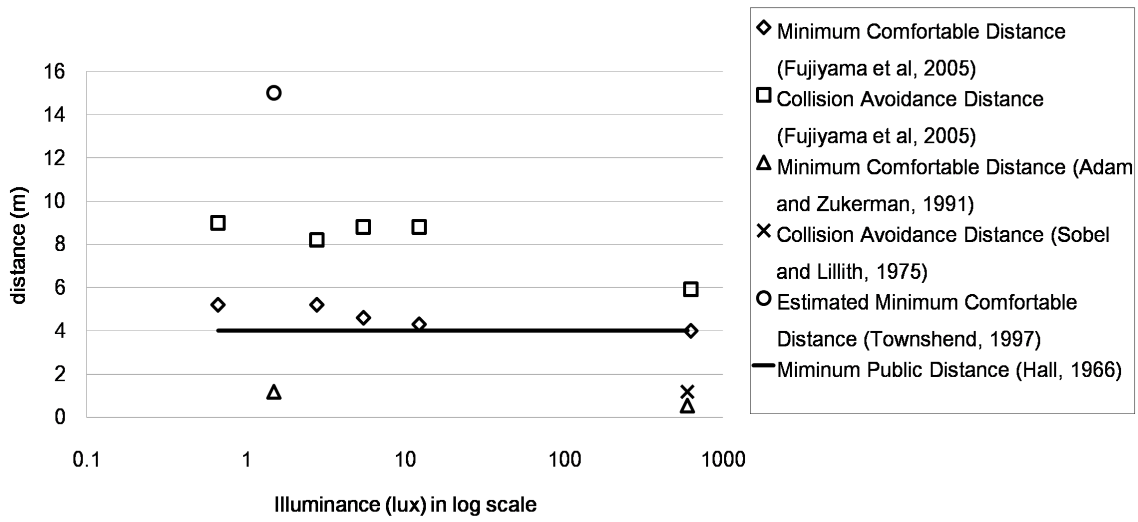


Figure 1 Minimum interpersonal distances reported in past studies.

Townshend [9] determined his estimate of a minimum comfort distance of 15 m using a field study in which he asked members of the public about their attitudes to being in a city centre, and this was done after dark. One task was to estimate the distance at which they would be comfortable about an approaching person or group of people. The average comfort distance under this dim lighting was 15 m.

Table 1 summarises past studies of desirable inter-personal distances for comfort. The available data are limited and thus further evidence was sought from investigation of collision avoidance when walking. Collision in this context means avoiding contact with another person rather than a stationary object. This avoidance may be for reasons of accident avoidance and for comfort.

Table 1. Past studies of inter-personal distances required for comfort between pedestrians.

Study	Method	Suggested Comfort Distances	
		Dim lighting	**Bright lighting**
Comfort distance			
Adam and Zukerman, 1991	Stop-distance	1.17 m (1.5 lx)	0.53 m (600 lx)
Fujiyama et al, 2005	Stop-distance	5.2 m at 0.67 lx (p<0.05)* 5.2 m at 2.8 lx (p<0.01) 4.6 m at 5.5 lx (p<0.05) 4.3 m at 12.3 lx (n.s.)	4.0 m (627 lx)
Townshend, 1997	Field interview	15.0 m	-
Maertens, 1877	Theoretical calculation based on ability to see detail.	-	12 m: distinguish people 35 m: face featureless 135 m: discern body gesture
Collision avoidance distance			
Fujiyama et al, 2005	collision avoidance response distance	9.0 m at 0.67 lx (n.s.) 8.3 m at 2.8 lx (p<0.05) 8.8 m at 5.5 lx (n.s.) 8.8 m at 12.3 lx (p<0.05)	5.9 m (627 lx)
Sobel and Lillith, 1975	Observation of public behaviour	-	1.18 m

Note: * difference between comfort distances at dim light level and 627 lx in Fujiyama et al. Note: n.s. = not significant.

Sobel and Lillith [15] carried out a field survey in which they watched the movements of unaware members of the public in a shopping street. Colleagues would walk toward approaching members of the public without changing their direction, whilst observers noted the distance at which members of the public took collision avoiding action. The average avoidance distance was 1.18 m. Fujiyama et al [14] measured collision avoidance distances between pairs of pedestrians in a laboratory. Test participants were used in pairs, simultaneously walking towards one another, and the distances between the two points at which participants started avoidance manoeuvres were recorded. Mean collision avoidance distances were in the region of 8.0 to 9.0 m for the four lower illuminances (0.67, 2.8, 5.5 and 12.3 lx), reducing to 6.0 m for the higher illuminance (627 lx). Statistical analysis of differences suggests a mixed pattern and may suffer from the small sample size. Again, there are no reported variance data for these results.

Caminada and van Bommel suggested a minimum inter-personal distance of 4 m following the work of Hall. While the experiment reported by Fujiyama et al also suggested minimum comfort distances of 4.0 m to 5.2 m, they used a very small sample size and the results are incompletely reported. Adam and Zukerman suggest a smaller comfort distance (1.2 m at their low light level) but this may be a range bias caused by the small size of their test room. Townshend suggested a longer distance (15 m) than Fujiyama et al. This may be because Townshend was asking about perceived comfort distance whereas Fujiyama et al employed a more objective test procedure. Data from collision avoidance studies also do not provide consistent evidence. It is not possible to propose from the literature a minimum comfort distance at which inter-personal judgements are desirable.

One result that does appear to be consistent is that estimates of comfort distance under dim lighting tend to be longer than estimates of comfort distance found under bright lighting. Furthermore there is a clear effect of methodology, and the greater the amount of perception in the task then the greater the estimated minimum comfort distance.

The aim of this work is to investigate how lighting can be optimised to enhance inter-personal judgements. Before doing so, there is a need to identify what visual features are used to guide such judgements, and at what distances we might desire to make them. This article presents a pilot study carried out to explore inter-personal judgements.

3. Method

A test was carried out to identify what features of target pedestrians at different distances would be mentioned in an open response task. Test participants were asked to describe features of target people, these being presented at different sizes to represent different distances, and the task was carried out without time restriction.

Four target images were used (Figure 2). These were photographs of four different people on a neutral background; they were standing upright and were asked to hold particular objects. One target was female, three were male; all were aged approximately 20 years old; one male was Chinese, the other three were European. Each target person was asked to hold/wear specific items and these are described in Table 2.

Figure 2 The four target images used in trials (Target 1 to 4 from left to right).

Table 2 Specific objects worn or held by the four target people

Target	Number of objects	Objects held in hands	Objects worn
Target 1	5	book in right hand, metal bottle in left hand	scarf, hair ornament, black earphone
Target 2	2	a pair of scissors in right hand	headphone set
Target 3	6	fruit knife in right hand, beer bottle in left hand	headphone, glasses, bracelet on right wrist, watch on left wrist
Target 4	4	tripod held horizontally in both hands	shoulder bag, glasses; watch on left wrist

The aim of the experiment was to determine what features of the targets would be reported at different distances from the test participant. The four distances were 15 m, 35 m, 66 m, and 135 m, The shortest distance, 15 m, was derived from Townshend [9] who suggested that an interpersonal distance of 15 m was required for comfort at night time; according to Maertens' [11] 35 m is the distance at which human faces becomes featureless and 135 m is the maximum distance at which we are able to distinguish gender and body gesture under daylight. The 66 m distance was included to provide an intermediate point between 35 m and 135 m. Using these distances in an experiment would be impractical and therefore the targets were observed at constant distance (3.5 m) with real distance simulated by target size (Figure 3). Each of the four targets was presented at all four distances, thus giving 16 target images, and these were printed on A3 size paper.

The tests were carried out in a laboratory. During trials the laboratory was lit using indirect lighting (6500 K fluorescent), with the luminaire placed behind the test participant and aimed toward the ceiling. The wall surrounding the target images was painted white and this had a mean luminance of 1.0 cd/m^2. The luminance of the neutral surround on each image was approximately 0.5 cd/m^2.

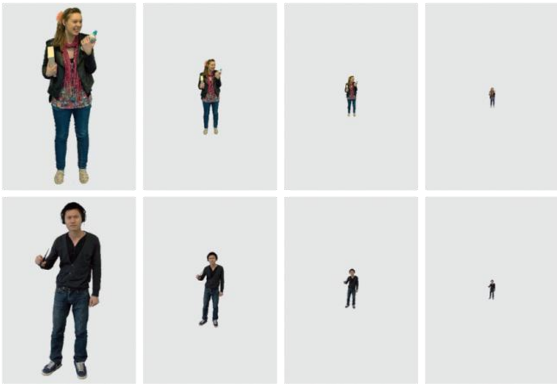


Figure 3 Example of target people at the four different sizes representing four observation distances. At full size these were printed on A3 paper.

4. Procedure

The experiment was carried out by individual test participants, and these were seated facing the target images (Figure 4). Each trial started with 15 minutes for adaptation to the low light level. Test participants observed four images in sequence: each of the four target images was seen at one of the four target distances, and these were presented in a semi-random order, balanced so that each target image was the first to be presented for an equal number of trials. The test participants were instructed to report all the information they were able to provide about the target person on the poster. This was done without a time limit. The experimenter recorded which items were correctly reported. For example, stating (correctly) that the target wore a red jumper would be recorded as a correct response for type and colour of upper clothing, but stating (incorrectly) that the target wore black trousers when they wore yellow trousers would be recorded as a correct response for type of lower clothing but an incorrect response for colour of clothing. A practise image was presented before any trials: this was a photograph of a target person at 15 m, but was a different target to those used in trials. The practice trial was carried out to inform participants of the type of information that was sought and so that they were familiar with the response format.

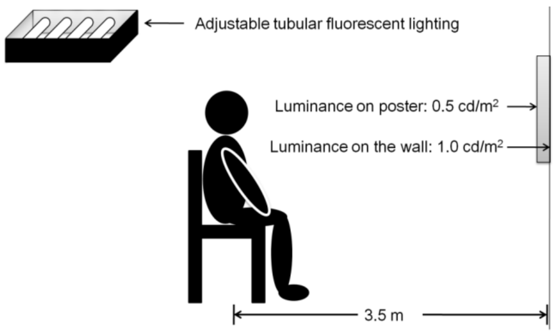


Figure 4 Schematic diagram of test procedure

Twenty test participants carried out the test. These were recruited from staff and students at the University of Sheffield and were paid a small fee for their contribution. Nine were male and 11 were female; they were drawn from European, Middle East and Asian populations; 15 were young (aged 18-34 years old) and five were in the 35-54 age group.

5. Results

Reported features were placed into 14 categories. Table 3 shows the frequency by which each feature was correctly identified during trials, summated across targets for each distance and summated across distances for each target. The data in Table 3 excludes the specific objects identified in Table 2 and which are analysed separately below because these were not consistent between Targets.

Table 3 does not suggest a significant difference between the four target people and the feature frequencies within each Target tend to follow the same trend as with the total frequency. Subsequent analyses therefore do not distinguish between the Targets.

Table 3 shows that the frequency by which features were reported decreased as distance increased. Figure 5 suggests a linear relationship with log distance. At 15 m most features (except for hair colour, facial expression and facial feature) were mentioned correctly in at least 50% of trials. Facial expression was mentioned at 15 m but not at greater distances. At 35 m only half of the features were correctly reported in more than 50% of trials, and at 66 m, only gender, hair length, type of lower clothing and build were correctly reported in more than 50% of trials. At 135 m no features were correctly reported more than 50%.

Table 3. Frequency of correctly reported features summated across targets and test distances

Feature	Frequency at each distance				Frequency for different targets				Total
	15 m	**35 m**	**66 m**	**135 m**	**Target 1**	**Target 2**	**Target 3**	**Target 4**	
Gender	20	19	19	9	14	18	18	17	67
Hair Length	19	19	16	4	15	13	15	15	58
Type of clothing: lower body	20	16	13	7	13	16	16	11	56
Build	19	16	15	5	15	14	13	13	55
Colour of clothing: lower body	19	15	9	6	9	15	13	12	49
Type of clothing: upper body	20	16	10	1	11	9	16	11	47
Colour of clothing: upper body	16	11	8	3	10	9	16	3	38
Age Group	19	8	5	0	8	9	9	6	32
Shoe Colour	14	8	4	1	8	9	3	7	27
Ethnic Group	11	3	4	0	5	7	5	1	18
Shoe Type	10	3	0	0	2	5	4	2	13
Hair Colour	5	5	2	0	3	6	2	1	12
Facial Expression	9	0	0	0	5	4	0	0	9
Facial Feature	0	0	0	0	0	0	0	0	0
Total	201	139	105	36	118	134	130	99	481

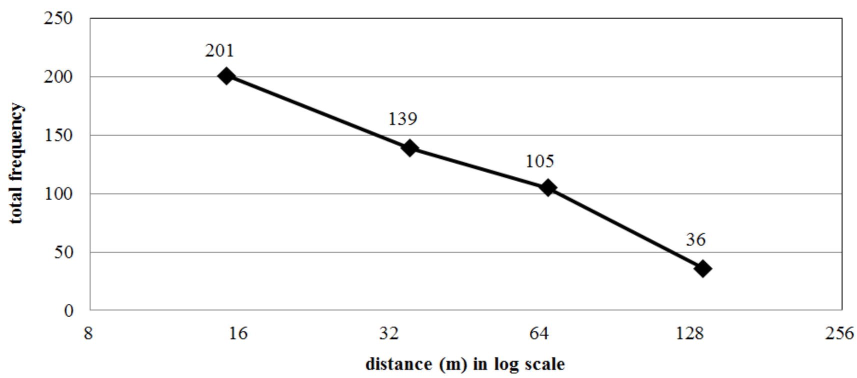


Figure 5. Frequency of correctly mentioned features at different distances, summated across the four Targets.

Figure 6 shows the relationship between distance (log units) and frequencies by which individual features were mentioned, and these have been grouped according to the apparent trend. For three features (gender, hair length, and build) correct responses were gained at an approximately consistent level of between 75% and 100% for the nearer three distances. It was only at the longest distance, 135 m, that a large reduction was found. For six features (type and colour of clothing on upper and lower body, age group, and shoe colour) there is an approximate linear relationship between log distance and frequency of correct mention, and for all six items there is a high frequency of correct identification at the nearest distance. For three features (ethnic group, show type, and facial expression) correct mention at the nearest distance is only approximately 50%, and subsequently decreases to less than 25%. For the final two features (hair colour and facial feature) there was a poor frequency of correct mention at all distances.

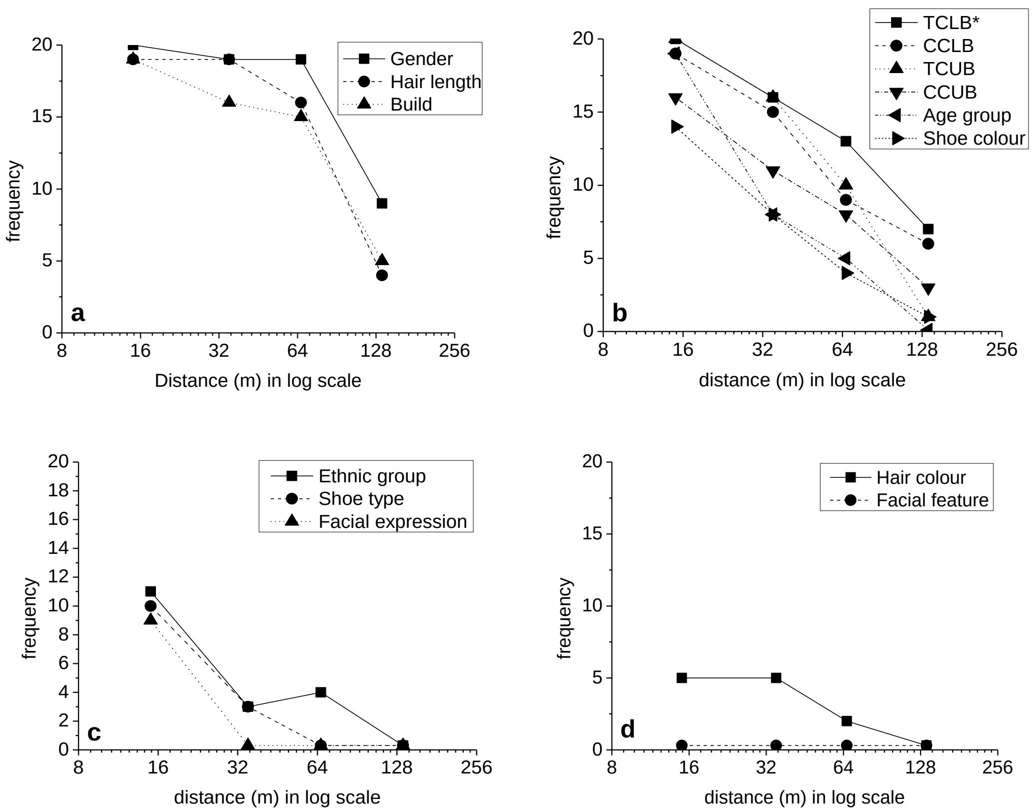


Figure 6 Four groups of frequencies of individual features at different distances. (Note in 6b: *TCLB = type of clothing: lower body; CCLB = colour of clothing: lower body; TCUB = type of clothing: upper body; CCUB = colour of clothing: upper body)

6. Individual Objects

The results of the target-specific objects are presented in Table 4. The numbers and types of objects worn and held by the four target people were not identical and are thus incomparable with other features. To enable comparison between Targets these are reported in Table 4 as the mean percentage of the total objects associated with each Target. Thus the score of 56% for Target 1 at 15 m indicates that each test participant mentioned approximately 2.8 of the five objects that were held or worn.

Table 4 Percentage of correctly reported specific objects

Target person	**1**	**2**	**3**	**4**	***Average***
Number of objects held/worn	5	3	6	4	
Number of trials per distance	5	5	5	5	
Distance	**Percentage of correctly identified individual objects, %**				
15 m	56	27	30	50	*41*
35 m	20	0	7	20	*12*
66 m	0	7	0	5	*2*
135 m	4	0	0	0	*1*
Average	*20*	*9*	*9*	*19*	

Table 4 shows that the objects were rarely reported at distances beyond 15 m. The relationship with distance follows a similar trend to that of ethnic group, show type and facial expression (Figure 6c) as is shown in Figure 7. Target 3 held a knife, an object which would likely be interpreted as threatening. Target 3 was seen by five test participants at each test distance, of whom only one participant reported the knife at 15 m and 35 m and no participants reported the knife at 66 m or 135 m.

Boyce and Bruno [16] carried out an object identification task in which their 15 test participants were asked to identify the object held by an experimenter walking back and forth at a distance of approximately 10.5 m. This was repeated using five different objects, chosen at random from a set of ten.

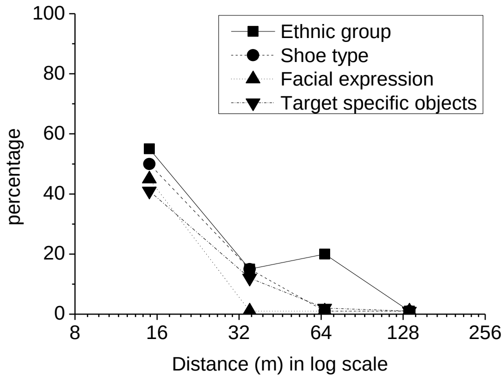


Figure 7 Percentage of correct identification of the target-specific objects at different distances presents a similar trend to that found for ethnic group, shoe type and facial expression.

At the lower light levels (2-5 lx) Boyce and Bruno found mean correct identification of approximately two of the five objects (40%), increasing to approximately 3 (60%) at the higher illuminances (22-50 lx). It is interesting that the identification rate (40%) reported by Boyce and Bruno at their low illuminance is similar to the average across targets found in the current study (41%) at a similar distance (15 m).

7. Conclusion

This study was carried out to explore how inter-personal distance affects visual information for pedestrians when making inter-personal judgement under low light levels. This was done because the literature does not offer any conclusive evidence as to the distance at which such decision is desirable, and these data would be of use in determining where lighting may be of benefit.

A test was carried out to question the inter-personal features that are observed. The 14 types of features were categorised according to the relationship between frequency and distance, in particular whether a linear or non-linear relationship. These data are limited, being an open response task with only 20 observers, but provide some clue as to what features of other pedestrians might be important (those mentioned with high frequency at near distance) and whether these features are distinguishable at different distances.

8. Further Work: Consistency

An aim of this project is to determine how lighting affects the judgements we make of the intent of other people, i.e. whether or not they are considered to be threatening, and the distances at which these judgements can be made. A fair trial requires that such judgements are consistent: if a person is considered to present a threat, they should still do so when that judgment is made at a different occasion under the same visual conditions. It has been suggested that facial expression and body posture may contribute to judgements of intent. Therefore further work is being carried out to determine whether judgements of intent based on facial expression and body posture are repeatable.

Figure 8 shows a sample of the faces used in trials, and these were drawn from the FACES database [17] at the Max Planck Institute for Human Development. FACES is a set of images of naturalistic faces of 171 younger, middle-aged and older women and men displaying each of six facial expressions: neutrality, sadness, disgust, fear, anger, and happiness.

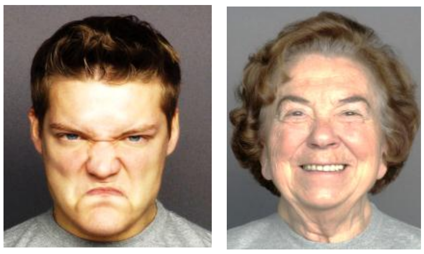


Figure 8 Sample of facial expressions from the FACES database [17]. Pilot studies suggest the left-hand image to be threatening and the right-hand image not to be threatening.

Figure 9 shows body postures from the Bodily Expressive Action Stimulus Test (BEAST) [18], a validated set of whole body expressions termed bodily expressive action. The database comprises 254 whole body expressions from 46 actors expressing four emotions - anger, fear, happiness, and sadness.

In pilot studies we asked test participants (n=24) simply to state which people are considered to present a threat. There are 12 target people in each set with six facial expressions and four body postures. To avoid familiarity, each participant is presented with 12 faces and 12 bodies, this being one expression or posture per target. The aim is to identify which targets are consistently found to be threatening or non-threatening, both within and between subjects. If consistent judgements are found these targets will be used in further studies exploring the effects of lighting.

Figure 9 Sample of body postures from the BEAST database [18]. Pilot studies suggest the left-hand image to be threatening and the right-hand image not to be threatening.

Acknowledgement

This work was carried out through support from EPSRC (EP/H050817) as part of the MERLIN project, a collaboration with UCL and City University London.

References

1 World Health Organization (WHO). Global Status Report on Road Safety: Time for Action. Geneva: WHO; 2009.

2 Fotios S, Goodman T. Proposed UK guidance for lighting in residential roads. Lighting Research and Technology. 2012; 44 (1): 69-83.

3 Fotios S, Raynham P. Correspondence: Lighting for pedestrians: Is facial recognition what matters? Lighting Research and Technology. 2011; 43 (1): 129-30.

4 Caminada J, van Bommel W. New Lighting Considerations for Residential Areas. International Lighting Review. 1980; 3: 69-75.

5 van Bommel W, Caminada E. Considerations for the Lighting of Residential Areas for Non-motorised Traffic. CIBS National Lighting Conference. 1982. p. 158-67.

6 Hall E. The Hidden Dimension. New York: Anchor Books; 1969. p. 123-4.

7 Baldwin DA, Baird JA. Discerning intentions in dynamic human action. Trends in Cognitive Sciences. 2001; 5(4): 171-8.

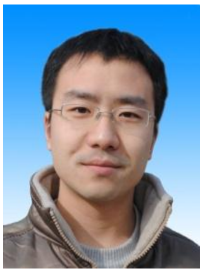
8 Meeren HKM, van Heijnsbergen CCRJ, de Gelder B. Rapid perceptual integration of facial expression and emotional body language. Proceedings of the National Academy of Sciences of the United States of America. 2005; 102 (45): 16518-23.

9 Townshend T. Safer City Centres: The Role of Public Lighting. In: Oc T, Tiesdell S, editors. Safer City Centres: Reviving the Public Realm. London: Paul Chapman Publishing Ltd; 1997. p. 119-29.

10 Gibson JJ. The Perception of the Visual World. Carmichael L, editor. Boston: Houghton Mifflin Company; 1950. p. 197.

11 Moughtin C. Urban Design: Street and Square. Amsterdam: Architectural Press; 2003.

12 Adams L, Zuckerman D. The Effect of Lighting Conditions on Personal Space Requirements. Journal of general psychology. 1991; 118 (4): 335-40.
13 Hayduk LA. Personal Space: An Evaluative and Orienting Overview. Psychological Bulletin. 1978; 85 (1): 117-34.
14 Fujiyama T, Childs C, Boampong D, Tyler N. Investigation of Lighting Levels for Pedestrians - Some questions about lighting levels of current lighting standards. London: Centre for Transport Studies, 2005.
15 Sobel RS, Lillith N. Determinants of Nonstationary Personal Space Invasion. The Journal of Social Psychology. 1975; 97 (1): 39-45.
16 Boyce PR, Bruno LD. An evaluation of high pressure sodium and metal halide light sources for parking lot lighting. Journal of the Illuminating Engineering Society. 1999; 28 (2): 16-32.
17 Ebner, N. C., Riediger, M., & Lindenberger, U. (2010). FACES - A database of facial expressions in young, middle-aged, and older women and men: Development and validation. Behavior Research Methods, 42, 351-362. doi:10.3758/BRM.42.1.351
18 de Gelder, B. & Van den Stock, J. (2011). The Bodily Expressive Action Stimulus Test (BEAST). Construction and validation of a stimulus basis for measuring perception of whole body expression of emotions. Frontiers in Psychology 2:181. doi:10.3389/fpsyg.2011.0018



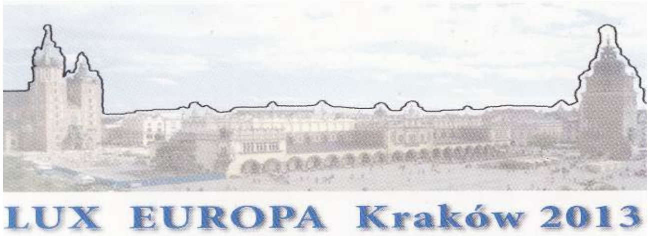
Biao YANG
PhD Student
School of Architecture
University of Sheffield
The Arts Tower,
Western Bank,
Sheffield, S10 2TN
biao.yang@sheffield.ac.uk

Biao YANG started studying for his PhD at Sheffield University in September 2011. He received his M.Sc. degree in physical electronics from Department of Illuminating Engineering and Light Sources, Fudan University in 2008, and his B.Eng. degree in bioengineering from School of Life Science and Technology, Xi'an Jiaotong University in 2004.

Steve FOTIOS
Professor of Lighting and Visual Perception.
School of Architecture,
University of Sheffield,
The Arts Tower,
Western Bank,
Sheffield, S10 2TN
+44(0)114 22 20371
steve.fotios@sheffield.ac.uk

Steve FOTIOS gained his degree in Building Services Engineering in 1992, subsequently graduating with a PhD in 1997 following a study of lamp spectrum and visual perception. He joined the University of Sheffield in 2005 where he leads research of lighting in the School of Architecture.

Received: 25 May 2012
Revised: 11 June 2012



LUX EUROPA 2013

12th European Lighting Conference
12. Europäischer Lichtkongress
12e Congres Europeen de la Lumiere

LUX EUROPA KRAKÓW 2013

KRAKOW

September 17th – 19th, 2013

Application meets Technology in Lighting
Anwendung trifft Lichttechnik
L'application Rencontre la Technologie dans l'Eclairage

First Invitation
Voreinladung
Première Invitation

INVITATION

Dear Colleagues,

On behalf of the Polish Committee on Illumination and the Organizing Committee of the LUX EUROPA 2013 Conference, I have the pleasure to invite you to the 12th European Lighting Conference in Krakow. We hope that the conference will provide an opportunity to present the latest scientific and technical developments as well as to broaden existing contacts and to make new acquaintances. It will also enable participants to visit some attractive places in Krakow and in Southern Poland.

Krakow is the former capital of Poland. The 13th-century merchants' town has the largest market square in Europe and numerous historical houses, palaces, churches including the Gothic cathedral where the kings of Poland were buried and ancient synagogues, as well as the Polish oldest Jagiellonian University. Its new compound will be the venue of the conference. The city historic centre together with the nearby Wieliczka salt mine were two of the first 12 objects included in the UNESCO World Heritage List. The Tatra Mountains situated ca. 100 km south of the city, together with the popular ski resort Zakopane, provide an excellent opportunity for relax at any time of the year.

Włodzimierz Witakowski

LUX EUROPA is a society of 20 European illuminating associations, with a task to spread lighting ideas, lighting knowledge and lighting expertise by holding European lighting conferences every four years.

The 12th European Lighting Conference will be held in Krakow on 17th – 19th September, 2013.

The Conference will be organized by the Polish Committee on Illumination SEP.

On behalf of LUX EUROPA Council and of the Conference Organizing Committee, I have the pleasure to invite you cordially to take part at the event.

Conference Subjects:

- Lighting Technology
  - LED and OLED
  - Lighting Controls
- Daylighting
- Interior Lighting
- Exterior Lighting
- Lighting for Transport
- Light and Architecture
- Human Aspects of Lighting
  - Vision and Physiology
  - Light and Health
  - Psychological Aspects of Lighting
- Photobiology and Photochemistry
- Measurements and Standardisation
- Economics of Lighting
- Light and Environment
  - Sustainability
  - Energy Efficiency

Presentation Types

- Presentation (15 min)
- Poster with a short presentation (5 min)
- Poster

  Please indicate the preferred type of presentation.

Conference Languages

- English
- German
- French

  With simultaneous translation.

Call for Papers

Abstracts should be mailed to the Organizing Committee by June 30th, 2012

POLSKI KOMITET OŚWIETLENIOWY
CIE POLAND

LUX EUROPA 2013 Organizing Committee

Włodzimierz Witakowski – Chairman
Jan Grzonkowski
Piotr Pracki
Narcyza Bartczak
Bożena Ciupińska
Marek Łasiński
Jan Strzałka
Romuald Wojtkowiak

Conference Secretariat

Klaudia Skupińska

Organizing Committee Adresses

Polski Komitet Oświetleniowy SEP
Zakład Techniki Świetlnej PW
ul. Koszykowa 75, 00-662 Warszawa
tel. (48 22) 234 56 15, fax (48 22) 234 56 16,
e-mail: vitax@witakowski.eu
e-mail: jan.grzonkowski@ee.pw.edu.pl
e-mail: piotr.pracki@ien.pw.edu.pl

Belgrade, October 3-6, 2012

BALKAN LIGHT 2012 The 5th Balkan Conference on Lighting

First announcement and Call for papers

Organized by
СРПСКИ КОМИТЕТ ЗА ОСВЕТЉЕЊЕ
SERBIAN LIGHTING COMMITTEE

Conference venue
The BelgradeUniversity - Faculties of Architecture, Electrical and Civil Engineering
Belgrade, Bulevar kralja Aleksandra 73


photo by Vladimir Vasic, Leonardy Studio

About Balkan Light

The Balkan Light Conference has been held since 1999. The conference serves as the premier Balkan and international forum covering all areas of light, lighting design, lighting engineering and lighting technology. Previous Balkan Light conferences were held at the following locations:

1999 – Varna, Bulgaria
2002 – Istanbul, Turkey
2005 – Cluj Napoca, Romania
2008 – Ljubljana, Slovenia

Scope of the conference

Areas of interest include, but are not limited to:

1. Technology (lamps, luminaires, control gear, luminous flux control devices,…)
2. Lighting calculations and measurements
3. Energy efficiency in the field of lighting
4. Standards and legislation in lighting
5. Health and lighting
6. Lighting quality
7. Lighting in architecture
8. Daylighting

Schedule- October 3-6, 2012

October 3rd – Welcome reception
October 4th – Conference sessions
October 5th – Conference sessions
October 6th – Post session tours

Important dates

April 1st – Extended one page abstract, to be sent to **kostic@etf.rs**
May 1st – Notification of acceptance and start of early bird registration period
May 15th – Announcement of Conference program
July 1st – Full manuscript and end of early bird registration period
September 1st – PowerPoint presentation

Further information

For further information and contacts use the conference website **www.balkanlight2012.rs**or the following contacts:

Prof. Dr Lidija DJOKIC
Faculty of Architecture
e-mail: lidija@arh.bg.ac.rs
phone: +381-64-2708-651

Prof. Dr Miomir KOSTIC (Conference chairman)
Faculty of Electrical Engineering
e-mail: kostic@etf.rs
phone: +381-63-366-089

"In Color We Live – Color and Environment"
22-25 September 2012
Chinese Culture University, Taipei, Taiwan
Organized by the Color Association Taiwan
on behalf of the International Color Association

CALL FOR PAPERS

AIC 2012 "In Color We Live – Color and Environment"

Interim Meeting of the AIC International Color Association
22-25 September 2012, Chinese Culture University, Taipei, Taiwan

Understanding the effects of colors in natural and man-made environments contributes to creating healthier living spheres through color applications.

The aim of the conference is to explore and examine how color interacts with or influences our daily life.

The following list of Topics and Subtopics is non-exhaustive, and suggests a variety of topics and subtopics that could be addressed:

1. Color Culture Aesthetics, history, philosophy, transportation, food, medical & personal care, warning systems	**2. Color Communication** Interpretations, color codes & symbols, language, semiotics, visual communication & design, color naming, color categorization, color order systems
3. Color & Environment Nature, lighting, interior design, architecture, landscaping & horticulture, urban design & planning	**4. Color Education** Pedagogy, curriculum design, electronic media applications, teaching aids
5. Color Science and Technology visual models, color physics, color chemistry, image reproduction, color management system, high dynamic range imaging, multispectral imaging, computational photography, multimedia in color imaging, 3D color imaging, virtual reality (VR) and augmented reality (AR), display and printing, colorimetry, industry applications	**6. Color Psychology** color perception, color preference, physiology & psychophysics, light & color interaction, color vision and aging, vision illusions and effects, defective color vision
7. Color in Art and Design fashion design, performance, painting, sculpture and installations, ceramics & glass, jewellery and metalwork, art conservation	**8. Color Synesthesia & Visionary Projects** color in cross-modal contexts, interactions between color and other senses, synesthetic color perception

Please visit www.aic2012.org for updated information.

ALMA MATER STUDIORUM
UNIVERSITA' DI BOLOGNA
DIPARTIMENTO DI ARCHITETTURA
E PIANIFICAZIONE TERRITORIALE

ALMA MATER STUDIORUM
UNIVERSITA DI BOLOGNA
FACOLTA DI INGEGNERIA

VIII CONFERENZA DEL COLORE

13-14 September 2012 - BOLOGNA
Università di Bologna, Engineering Faculty
Viale Risorgimento, 2 - 40136 Bologna
www.gruppodelcolore.it - SIOF

Aim of the conference is to encourage multi and interdisciplinary aggregation of the research centres and people that deal with color and light from a professional and scientific point of view. Conference will be opened (in early morning) by a series of tutorials about different color related topic. Works will continue with the presentations of the submitted works.

Themes Of Interest For The Conference

1. COLOR AND MEASUREMENT / PRODUCTION. Colorimetry, photometry and color atlas: method, theory and instrumentation.
2. COLOR AND DIGITAL. Reproduction, management, digital color correction, image processing, graphics, photography, printmaking, video production, artificial vision, virtual reality.
3. COLOR AND LIGHTING. Metamerism, color rendering, adaptation, color constancy, appearance, illusions, memory color and perception, color in extra-atmospheric environments, lighting design.
4. COLOR AND PHYSIOLOGY. Mechanisms of vision in their experimental and theoretical aspects, deficiencies, abnormalities, clinical and biological aspects.
5. COLOR AND PSYCHOLOGY. Phenomenology of color, perceptive, emotional, aesthetic and diagnostic aspects.
6. COLOR AND PRODUCTS. Foods and beverages, textiles, plastics, ceramics, paints.
7. COLOR AND RESTORATION. Archaeometry, painting materials, diagnostics and techniques of conservation, restoration and enhancement of cultural heritage, coloring and architectural syntax, territorial identities.
8. COLOR AND BUILT ENVIRONMENT. Urban planning, plans of color, architecture.
9. COLOR AND DESIGN. Furniture, design, fashion, textiles, graphics, communication, packaging, lettering, cosmetics.
10. COLOR AND CULTURE. Art, history, philosophy, anthropology, sociology, aesthetics, representation and design, lexicology, semantics.
11. COLOR AND EDUCATION. Pedagogy, color's didactics, aesthetic education, artistic education.

Organizing Committee

Marco Gaiani
Fabrizio Ivan Apollonio
Maurizio Rossi

Program Committee

Fabrizio Ivan Apollonio
Federico Fallavollita
Veronica Marchiafava
Renata Pompas

INDOOR LIGHTING TUBULAR DAYLIGHT GUIDANCE SYSTEMS

Călin Nicolae CIUGUDEANU, Technical University of Cluj-Napoca

The Thesis Advisor: dr. Florin POP, professor, Technical University of Cluj-Napoca.
The Ph.D. thesis was presented in a public debate at the Technical University of Cluj-Napoca, Romania, on 31 May 2012. His author obtained the scientific grade of Ph.D. in Civil Engineering.

The Ph.D. thesis analyses the indoor lighting with tubular daylight guidance systems (TDGS), by focusing primarily on the passive TDGS category. The dissertation covers the technical-economic characteristics, methods of modelling and performance indicators of these systems. The area of investigation is based on the author's bibliographic study and the European research programmes he was recently involved in. The author has produced in-depth analyses of the characteristics and the methods of modelling and optimization of such a system of indoor lighting with TDGS installed in a residential building in Cluj-Napoca. The obtained results were compared to the recommendations of CIE 173:2006, and additionally with software simulations using DIALux and CalculatorLux. A new original hybrid lighting system is herewith presented, consisting of a tubular passive daylight system combined with a photovoltaic module and LED lamps. Other line of research was based on the statistical data available for the period 1998-2012, by studying the electricity consumption for residential lighting in Romania in order to estimate its reduction potential, through nationwide use of passive TDGS.

The author has benefited from a research internship with the European Commission's Joint Research Centre (Ispra - Italy), under the guidance of Paolo Bertoldi 2004-2005. Additionally, he has promoted power efficient lighting actions endorsed by the Lighting Engineering Centre (UTC-N). He has played an active role in European programmes such as: ENERLIN – co-authoring the study "Power Efficiency in Residential Lighting" (2006-2008) and CREFEN – a campaign consisting of a survey, collected data analysis and drawing conclusions on the possibility of using CFL in order to reduce residential electricity consumption in Romania (2006-2007).

The initial chapters - **1 Introduction** and **2 Daylight** present the current level of knowledge attained on indoor lighting with tubular systems, by covering the characteristics of daylight, its physical spectral and colour features, daylight sources, atmospheric phenomena, as well as the effects of daylight on the human body. On the basis of the potential for solar energy in Romania, estimates are provided on the level of outdoor lighting (average value of critical lighting). In order to underline the influence of daylight on the general level of room lighting, a DIALux 4.9 simulation was run for a room situated in a residential building from Bucharest.

Chapter **3 Tubular Daylight Guidance Systems** synthesizes the data available in technical studies on indoor tubular lighting systems. It also provides the structural indications for passive tubular daylight zenithal systems, the most common in this category, grouped according to collector types, light conduction/guidance elements or diffusors. The active and passive zenithal systems are described, as well as horizontal light guidance systems, beam/lens systems, hollow mirrored or prismatic guides, solid core systems, combined transport and output or discrete output diffusors. The third chapter also covers details related to the maintenance, thermal performance, cost, value and ROI for these cutting-edge systems. An analysis of the consumers' opinion clearly points out the fact that the light spectrum of TDGS is considered to be identical to that of daylight, with all its inherent benefits.

Chapter **4 Modelling Methods and Performance Indicators for Tubular Daylight Guidance Systems** initially analyses the conclusions of a technical study [Ţicleanu, 2007], subsequently enhanced and reassessed by the author [Ciugudeanu, 2009]. On the basis of the hypothesis of perfect diffusion of the TDGS diffusor, we hereby put forward a model for the calculation of direct punctual lighting determined on the working plan, with the help of Levenberg-Marquardt numeric modelling for solving non-linear regression. Given the resulting precision, is provided alternative methodologies and designing techniques CIE 173/2006, for both active and passive daylight guidance systems, using the basic working principles of lighting-technical calculations, where the lighting-technical characteristics of each component are available. Operative design techniques for passive systems are presented here through table methods, based upon the author's experience with such system implementations. The methods vary in complexity, as does the input data for each version. The selection of a specific calculation method depends upon the desired result accuracy, and the author also points out the implications of the necessary input data on design. Several problems related to the lighting-technical features of these systems are identified as well, such as the lack of local photometry data, or from specific geographic areas, or the lack of a standard light source suitable for testing these daylight systems, as the natural sky does not fit this purpose. Provided that the above-mentioned issues are clarified and producers give clear specifications on the lighting-technical features and TDGS performance indicators in their catalogues, specialists will be able to make better equipment choices.

Chapter **5 Hybrid Lighting Systems based by Tubular Daylight Guidance Systems and Photovoltaic Systems** presents the hybrid model obtained from the fusion of TDGS and PV systems for converting sunlight into electricity, which has a real potential for future use. Solar radiation is collected through a primary device, while the visual spectrum is separated by a second optical device. The visible spectrum of solar radiation is used for direct indoor lighting, whereas UV and IR is used for generating electricity [Oak Ridge National Laboratory, 2008]. The current chapter puts forward an original hybrid lighting system that combines a tubular daylight guidance system with a photovoltaic and LED system. The design principles and technical features of the system are provided, as well as its potential for saving electricity used for lighting. The chapter also includes a comparison of the overall efficiency of electrical receptors in hybrid systems, conventional photovoltaic systems and the original system presented here. In conclusion, hybrid lighting systems will potentially offer a lower cost than the most efficient daylight currently available on the market, in addition to a much higher flexibility.

Chapter **6 Case Study – Modelling and Optimization of a Tubular Passive Daylight Guidance System Installed in a Residential Building** covers the analysis and monitoring results of a passive tubular daylight guidance system set up in a residential building from Cluj-Napoca. The section provides full details of the system's structure and installation, as well as the features of the building/room in which it was installed. Measurements were taken over a total of 30 days, throughout a year. The results of these indoor lighting measurements are comprehensively listed and examined. An in-depth analysis was also provided for two typo-dimensions of TDGS, such as the minimum, average and maximum indoor lighting levels; the minimum, average and maximum outdoor lighting levels; the indoor-outdoor lighting ratio; the time intervals with a relatively constant lighting level; working plans at different elevations/levels; clear sky, partially covered and fully covered. There are also presented the drawbacks of installing a system with a flat collector with a north-west orientation and partially obscured by the roof ridge for periods with low Sun positions (vertical angle formed by the observer-Sun axis and the true horizon plane). Practical technical engineering solutions are provided for the highlighted issues. The profitability of the system is analysed on the basis of the GreenLight method, through a comparison with efficient lighting systems (CFL). The resulting data is further discussed and enhanced when taking into account the reduction of CO_2 emissions. Although this is a purely economic assessment, it could assist with quantifying the well-known benefits of daylight on building inhabitants. The original system presented in the dissertation was modelled with the CalculatorLux producer software, on the basis of CIE norms, and also with DIALux 4.9, through the creative and original assimilation of TDGS with a luminator with identical lighting-technical and design features. The calculation methods had various complexity levels. Results were validated through on-site measurements, while the errors and limitations of each modelling method were also underlined.

Chapter **7 Energy Efficiency in Indoor Lighting** analyses the electric lighting component in residential electricity usage from Romania, on the basis of data provided by the National Statistics Institute, Electrica (national distribution), as well as studies made through the Lighting Engineering Centre UTC-N (survey-based measurements and evaluations). While highlighting the lighting residential electricity consumption on the total electricity usage in order to assess the potential for TDGS implementation, the author correlates various statistical data taken from different electrical engineering fields or demographics with the aim of extracting and validating relevant information. The section also points out the importance of the results obtained by the author while participating in European programmes on lighting power efficiency, such as the GreenLight, ENERLIN and CREFEN. By collecting and analysing the data obtained through these programmes, conclusions were drawn pertaining to the average lighting electricity consumption and the national levels of different lighting devices. Based on the above-mentioned information, statistical data and solar radiation values for Romania, the study successfully offered an estimation of the electricity savings achievable through replacements by tubular daylight guidance systems.

Chapter **8 Conclusions and Personal Contributions** presents the final findings and main personal contributions of the author:

– proposal for an original hybrid lighting system consisting of a TDGS combined with a photovoltaic and LED system, supported by DIALux 4.9 simulations;

– on-site study for an indoor lighting installation based on a passive TDGS installed in a residential building;

– a TDGS profitability calculation model;

– analysis of a passive tubular daylight guidance system and modelling with CalculatorLux and DIALux software, as well as on the basis of CIE 173:2006 regulations;

– analysis of the electric lighting on residential electricity usage from Romania (data provided by Electrica, the National Statistics Institute and the measurements made by the Lighting Engineering Centre UTC-N);

– evaluation of the electricity-saving potential of passive TDGS for Romanian residential consumers.

Călin Nicolae CIUGUDEANU
Ph.D.

Ph.: +4 0752 193 890
E-mail: calin.ciugudeanu@rpe.ro

He graduated the Technical University of Cluj-Napoca (Faculty of Building Services) in 2004. His fields of interest are lighting and power distribution design services. He attended research traineeship sessions in Romania (Cluj-Napoca) and abroad (Ispra–Italy).

LIGHTING OF URBAN PUBLIC SPACES

Marilena MĂIEREAN, Technical University of Cluj-Napoca

The Thesis Advisor: dr. Florin Radu POP, professor, Technical University of Cluj-Napoca. The Ph.D. thesis was presented in a public debate at the Technical University of Cluj-Napoca, Romania, on 1 June 2012. Her author obtained the scientific grade of Ph.D. in Civil Engineering.

Assumptions of the PhD thesis

A. Theoretical premises

The PhD thesis approach was developed around two relations: first - Light and Humans and second - Light and Objects.

Light, by its definition, is associated to the Humans, representing an electromagnetic radiation received by the visual system and which produces visual perception.

The inter-conditionality between architecture and light having has effect at individual level an immediate representation of the space where he moves and lives, becomes thus relevant at the perception and cognitive consignment by the individual of all the dimensions and characteristics of this space: the individual builds psychological representations of the immediate space.

On the other hand, Light is not visible by itself, but through the illuminated objects, through the light reflection on their surface, which become physically visible. In this thesis, the illuminated objects are the materials used for the building facades and for road surfaces.

Starting from these two affirmations, the approach was amplified on the place where three factors – Light, Humans, Objects – meet and have mutual influence: the urban public space. Analysing the influences, actions resulted, as it is important to assert the fact that a city without lighting would become «inexistent» by night.

B. Practical assumptions associated to the condition of urban public lighting in Romania

For a long time, the inhabitants of the Romanian contemporary city have been left to bewilder in the nocturnal reality of the public space where they evolved, already jolted by the passing from day to night, which impose them a change in their behaviour and condition.

Current practice in public lighting resumes to lighting based on car drivers needs, according to which pedestrians are perhaps offered safer when they walk close to roads. In the last 10-12 years, efforts have been made to improve the street lighting and expand the action scale to pedestrian and mixed areas in the centres of cities and residential areas. Generally, cities offer a nocturnal image concentrated on functionality, with a few luminous guiding marks here and there, realized through the lighting of public buildings. Despite all these efforts of humanization of lighting, the city, as a whole, has appeared with a heterogeneous, discordant lighting, without identity.

The thesis is developed in six chapters, references and appendixes.

Introductive chapter presents the premises and the actuality of the work. It also reviews briefly in a reflexive-critical manner the present context of public lighting in Romania. It introduces a new approach undertaking of public lighting from the perspective of the human factor as main actor in addressing the public space and opens the way to the future possibilities of approach of public lighting through LMP.

Second chapter fathoms the relation between Light and Humans by two different approaches:

- The theoretical approach related to light and vision, lighting, visibility, street lighting and visual task, mesopic vision in the perspective of the CIE 191:2010 standard and the influence of the mesopic view theory on the design of the public street lighting.
- The study of the perception of the inhabitants of the city of Cluj-Napoca regarding the public lighting in their city, the analysis of the dependence of their assessments, preferences, and perceptions function on some socio-demographic factors: gender, age, education, possession of a driving license, or the quality of being a parent.

Chapter three is dedicated to the theoretical research on the behaviour of the 45 coloured surfaces (regarded as objects) under the influence of the usual light sources in the outdoor lighting.

It has been determined the chromaticity coordinates (x, y) for those 45 surfaces types grouped into 6 typical categories, as it follows: brick (9 samples), shingle (6 samples), metallic surface (five samples), stone (five samples), granite (10 samples) and surfaces covered with paint-type email (10 samples).

In determining the chromaticity coordinates of the surfaces under discussion it has been used 15 light sources: 7 discharge lamps (one high pressure sodium discharge lamp, three metal halide with warm white light and three neutral white light), four LED sources with whit light and different light temperatures and four LED monochromatic light sources.

In order to determine the results, it has been defined a working platform, using a mathematical pre-defined tool, i.e. Microsoft Office Excel. Considering the inherent facilities – mathematical and graphical ones – of the previously mentioned tool, and furthermore the accessibility of it to each individual and circumscribing all those facilities to the purpose of the theme, it became possible:

- The use of the mathematical functions of vectors multiplication, which allowed the calculation of those three stimuli X, Y, Z, that, subsequently, by performing normalization operations, allowed to determine the chromaticity coordinates x, y.
- To draw the CIE 1931 chromaticity diagram of standard colorimetric system.
- To position the chromaticity coordinates for the used surfaces, correlated with the spectral diagram CIE 1931.
- To import the colour images of the CIE 1931 diagram, keeping the proportions, so that the position of the chromaticity coordinates be accurate.
- The achievement of the quantitative analysis of association between the chromaticity coordinates and of the degree of association between chromaticity coordinates of the analyzed surfaces and light sources.

The theoretical research generated a mathematical model of association between the chromacity coordinates of materials and chromacity coordinates of the white light sources. The mathematical model appears in the form of a chromatic straight line, concentrating the results in the form of longer or shorter segments depending on the attributes of the material. The linear model conducts to prediction possibilities of the results in the case of using white light sources other than those analyzed.

Knowing the apparent colour of the lighting surface in the initial phases of the design eases the «in situ» experiments, reducing costs and simplifying the process.

Chapter four refers to the lighting of road surfaces and the manner that these influence the lighting systems.

The importance of knowing the characteristics of the reflection of the road surfaces for a public street lighting system results from the fact that the present quality criterion for the lighting of public roads is average luminance, which should exceed a certain minimum level, imposed by the needs of traffic safety and vision comfort. The average level depends not only on the luminous flux, but on the relation between the distribution of the light intensity, the lighting appliance and the diagram of the reflection on the road surface.

The PhD thesis proposes and argues a global evaluation indicator of a street lighting system – the energy efficiency indicator, $\boldsymbol{\eta_i}$, - which takes into consideration both the energy efficiency of the lighting system, and the compliance of its quality lighting parameters (the uniformity of luminances expressed by the general uniformity) and discourages the over sizing a lighting system in its design phase.

The indicator can be used in the design phase of a lighting system for the energy evaluation of the possible solutions.

The efficiency indicator is calculated for the street lighting system which accomplishes, for the selected lighting class, all the performance criteria in accordance with the CIE 115:2010 standard.

The indicator, being calculated in the design phase, is a static indicator from the perspective of the evolution in time of the reflection properties of the road surfaces.

The thesis proposes an evaluation system using energy label in order to encourage the energy efficiency for the end user.

Energy label aligns to the context of the concerns for the efficient use of energy resources in compliance with the Eco-design principles.

Chapter five raises the problem of the relation between public lighting – public spaces – population, starting from the role of lighting in a city where the environment issues are marked out in connection with the lighting regarded as a product and as a system.

The thesis proposes the steps to follow in establishing a Lighting Master Plan, a framework document, with the role of guiding the future undertakings in the lighting of a city. This could represent a first step to reconsider the role of lighting in urban planning.

Chapter six presents the final conclusions and the author's contributions in this thesis and the possible directions to follow on the approached subjects.

The main personal contributions are:

- The study of the perception of the inhabitants of the city of Cluj-Napoca regarding the public lighting, the analysis of the dependence of the assessments, preferences and perceptions function of a few social-demographic factors: gender, age category, education, holding a driving license, or being a parent.

- Definition of a working platform in order to establish and read off the behaviour results of certain coloured surfaces under the influence of different light sources.
- The study of the behaviour of 45 types of materials frequently used in the area of constructions, under the influence of 15 light sources.
- The theoretical research generated a mathematical model of association between the chromacity coordinates of the materials and the chromacity coordinates of the white light sources.
- Measures of the *q* luminance factors were performed for 6 types of non-standard road surfaces de and their influences on the designed lighting measures.
- The proposition and the arguing of a certain global evaluation indicator of a street lighting system – the energy efficiency indicator, η_i – which takes into consideration both the energy efficiency of the lighting system, and the compliance of its quality lighting parameters.
- The proposal of an evaluation system using energy labelling in order to encourage energetic efficiency for the end user.

Directions to follow the research:

- The continuation of the study regarding the conduct of the frequently used materials in the area of constructions under the influence of the light sources, by initiating a designing guideline.
- The development of a database regarding the reflection properties of the road surfaces frequently used in Romania, which should take into consideration the changes caused in time.
- The research of the influence of the time evolution of the reflection properties of road surfaces on the energy efficiency of a lighting system.
- Quantifying the effect produced by the implementation of remote management systems for the street lighting on the energy efficiency indicator, η_i.

Marilena MĂIEREAN
PhD
Ph.: +4 0722 347 683

E-mail: marilena.maierean@energobit.com

She graduated Power Engineering Faculty Bucharest, University Politehnica Bucharest. Professional experience in energy efficiency studies, at the Institute for Studies and Power Engineering Bucharest. Since 1995 has been working with Energobit, in the outdoor lighting projects.

Beginning with 1998, the establishment of Energobit Schréder Lighting as a joint-venture between Energobit and Schréder Group GIE, began to work with this company. She developed important lighting projects for the public space.

LIGHTING IN THE NEW WORLD

Cristian ŞUVĂGĂU
BC Hydro, Vancouver

Codes and Standards: The Difference between Lighting and Wall Street

From a lighting practitioner perspective, looking at the financial world-wide turmoil that started with the huge, public funded bank bailouts in 2008 one thing becomes clear: had the financial system been governed by same rigor of codes and standards as the lighting industry, the world would be a better place.

It is not the intended scope of this article to engage in a polemic about the balances and checks that rule the North American financial market, but rather show the complexity of the regulation processes in the lighting industry. Moreover, lighting regulations in US, Canada and Mexico follow a similar path used worldwide.

1. Electrical and Fire Safety Certification

Testing laboratories do not 'approve" products but test them and list the products that comply with their safety standards.

- **UL** (Underwriters Laboratories) was established in 1894 and is the US Nationally Recognized Testing Laboratory and conducts certification testing of every electrical appliance. Although adopting the UL certification system is basically on a voluntary basis, many U.S.-made electrical appliances have obtained the certification. The UL certification can be acquired as *Listing* certification (for a final product) or *Recognition* certification (for a part or a component built into a product).
- **CSA** (Canadian Standards Association) is also a non-profit organization established in Canada in 1919 and is recognized by the national health and safety authority as a Nationally Recognized Testing Laboratory (NRTL). Based on the MRA (Mutual Recognition Agreement), cross-certification has been granted between the U.S. and Canada. When a product is certified by UL using the Canadian standards (CSA Standards), the product will have the C-UL certification mark expressing the conformity to the CSA Standards.

2. Standardization Associations

Standard coordination organizations are non-profit membership-based associations serving business, industry, government and consumers in US, Canada and the global marketplace. American and Canadian National Standards are usually referred to as "open" standards. The open and fair process ensures that all interested and affected parties (manufacturers, regulators

Ingineria Iluminatului 2012; **14**, 59-62

and consumers) have an opportunity to participate in a standard's development. It also serves and protects the public interest. Standards are required to undergo public reviews when any member of the public may submit comments.

- **ANSI** (American National Standard Association) was established in 1918 and administers and coordinates the standardization system in the U.S. In principle, ANSI does not create standards by itself and stays in a position to approve the standards created by other specialized organizations or associated committees of the ANSI Standards, as UL for example.
- **CSA** (Canadian Standards Association) administers and coordinates the standardization system in Canada.

An ANSI or CSA standard is usually consistent with the law but goes into much greater depth. It provides the technical, nuts-and-bolts details that the statutes and even the regulations leave out. For example, if the Occupational Safety and Health laws and regulations state that employers must maintain the physical premises of the workplace in safe condition by mandating adequate lighting, ANSI and CSA standards might then set out precise illumination standards, specify which bulbs to use and say how often they must be changed.

ANSI and respectively CSA promote the use of North American standards internationally, advocates U.S. and Canadian policy and technical positions in international and regional standards organizations, and encourage the adoption of international standards as national standards where they meet the needs of the user community.

3. Industry Standard Associations

- **NEMA** (National Electrical Manufacturer Association) is the trade association of choice through which the US electroindustry develops and promotes positions on standards and government regulations, and through which members acquire information on industry and market economics. NEMA was founded in 1926 and has over 450 member companies that manufacture electrical products. NEMA also advocates the industry's interests in new and developing technologies (such as SSL).

Through NEMA, member companies are able to develop and implement tailored, industry-specific market and statistical programs that benefit participating companies. The association also conducts economic analyses on the impact of legislation and regulations on member products, and monitors and reports on key industry market indicators. NEMA has 8 electrical divisions, with Lighting being one of the most important one. NEMA has an important role for the US Lighting Industry also because is secretariat for the ANSI lighting standards (lamps, ballasts, lamp-holders).

- **EFC** (Electro-Federation Canada) is the Canadian national, not-for-profit industry association representing over 330 member companies. Similar with NEMA, EFC provides a powerful nucleus around which the Canadian electrical, consumer electronics, appliance and telecommunications markets gain competitiveness in the market through representation on issues and opportunities impacting electro-technical businesses.

Both NEMA and EFC have important Lighting Divisions of whose representatives serve on the ANSI and CSA standards committees.

- **IESNA** (Illuminating Engineering Society of North America) is the recognized technical authority on illumination. Publishing books, standards, and periodicals, IES is the oldest and largest educational and scientific societies in North America devoted to lighting (since 1905).

As the North American lighting authority, IES creates technical and non-technical documents through over 100 committees and subcommittees to establish recommendations on a wide range of lighting applications. The standards are grouped in Lighting Handbooks, Recommended Practices (RP), Design Guides (DG), Technical Memorandums (TM) and Lighting Measurement Testing and Calculations Guides (LM). Especially illuminance and luminance recommended levels for various visual tasks are often enforced by regulators and safety and health authority and become mandatory compliance standards for the workplace environments as well as street and roadway lighting.

- **CIE** (Commission Internationale de l'Eclairage) remains the major international organization in charge of coordinating the management of recommendations, standards, and technical reports in the field of lighting. Although IES has developed their own standards. CIE lighting standards in North America are considered mostly for colorimetry and photometry.

4. Building performance standards and codes

Building energy codes are designed to set minimum standards for design and construction regarding the use of energy in an application. Energy codes are implemented by jurisdiction authorities (municipalities, provincial/state and federal governments) based on standards developed by standardization organizations such as CSA.

One of the most important energy standards is ASHRAE/IESNA 90.1 aimed at new buildings except low-rise residential buildings. It was developed jointly by ASHRAE and IESNA. ASHRAE/IESNA 90.1 covers the building envelope lighting, power and HVAC with the purpose to set minimum requirements for energy efficiency in new buildings, provide guidance for sound design and criteria for evaluating the energy efficiency of the design. The document does not dictate design procedure, but the maximum power (LPD) that may be used for the lighting.

Since 1992, the US Energy Policy Act (EPAct) requires states to adopt commercial building energy efficiency requirements that meet or exceed the stringency of the ASHRAE/IESNA Standard 90.1-1999. However, it does not dictate the adoption of a specific set of requirements. This drives state legislatures to adopt or develop some sort of energy code or standard to meet the EPAct ruling.

A few states, such as California (Title 24), Florida, Oregon, and Washington, have developed their own energy codes, but most choose to adopt a nationally available code or standard such as ASHRAE 90.1 or the International Energy Conservation Code (IECC) developed by the International Code Council.

Although Canadian provinces may adopt the ASHRAE/IESNA 90.1 (British Columbia), the National Energy Code of Canada for Buildings (NECB) was prepared by the Canadian Commission on Building and Fire Codes as a counterpart. The province of Ontario is one of the NECB adopters.

The new NECB (2011edition) provides minimum requirements for the design and construction of energy-efficient buildings and covers the building envelope, systems and equipment for HVAC (heating, ventilating and air-conditioning), service water heating, lighting, and electrical power systems. It applies to new buildings, as well as to substantial renovations in existing ones. The code has three compliance paths for lighting: the prescriptive path, the trade-off path for interior lighting, which provides more flexibility than the prescriptive requirements (for example, allowing trade-offs between lighting power allowances and controls) and the performance compliance route, which is the whole-building modeling approach.

The most innovative approach of NECB 2011 versus the ASHRAE 90.1-2010 is the energy compliance approach (kWh) rather the strict LPD (W).

5. Equipment performance standards

Equipment standards regulation activities are coordinated with marketing programs to transform market to go beyond net-zero. The key purpose is to eliminate shipment of inefficient, energy-using products that are either imported or manufactured in Canada and US, and transported between provinces/states for the purpose of sale or lease. ANSI and CSA standards set out minimum performance criteria that can eventually be adopted by the regulators (state or federal governments). Since 1992, the Canadian Federal Energy Efficiency Act and respectively the USA Energy Policy Act have provided the establishment and enforcement of regulations concerning minimum energy performance levels for energy–using products. These regulations are administered by Natural Resources Canada (NRCan) and respectively by the US Department of Energy (DOE).

The most current regulations refer to the elimination of electromagnetic fluorescent ballasts (2009), T12 fluorescent lamps (2012), incandescent general service lamp technology (started in 2011 and phased to remove first the 60-100W and then the 40-60W by 2014), most incandescent reflector lamps (2012) and Metal Halide electromagnetic probe-start ballast (2012).

Cristian ŞUVĂGĂU
Dr., P.Eng., LC, CEM, MIES, MCIE
BC Hydro PowerSmart, 900, 4555 Kingsway
Burnaby, BC, V5H4TB
Canada

e-mail: cristian.suvagau@bchydro.com

He holds a Ph.D. from the Technical University of Construction in Bucharest, Romania. He has been practicing and teaching architectural lighting design and energy efficiency in Europe and North America for over 25 years. He is also a member of the Canadian NC of the CIE and Past President of the BC chapter of IESNA.

UNVEILING THE HOUSE OF THE FUTURE

Cosmin ŢICLEANU
BRE – Building Research Establishment, Watford, UK

Abstract: *The Integer House is a detached dwelling situated within the Building Research Establishment site in Garston, Watford, UK. It was built in 1998 and was of innovative design at that time, being featured on the BBC as the 'House of the Future'. It is currently part of the SmartHomes Project run by British Gas and the Building Research Establishment, which aims at reducing customers' energy requirements by installing smart technologies and sustainable refurbishment solutions to homes. Fundamental to the project's success is understanding how smart technologies are used, how refurbishment solutions best perform and how these impact upon and affect occupier behaviour. Occupants appointed by the UK National Refurbishment Centre provide live-in monitoring data and feedback on the house and on the heating and energy solutions originally installed. After the first twelve months of occupancy, the Integer House will be refurbished and will become a test-bed for newly-installed hardware and control systems, providing critical data on the occupier experience and changes in behaviour as fabric improvements are installed. This article details a series of house features in conjunction with the living experience of the current occupants, stretched over a period of eight months through late autumn, winter, spring and early summer.*

Keywords: sustainable refurbishment, smart technologies, occupier behaviour

1. House design

The house (Figure 1) comprises three storeys and on the southern exposure has a large conservatory to the full height of the building that was designed to be part of the living space. The lower ground floor comprises three bedrooms and a bathroom, while the upper ground floor comprises the living room and kitchen dining areas, which connect to the conservatory via a balcony and spiral staircase. There is a shower room and the main entrance to the property on this floor. The top floor comprises an office and a lounge area which is essentially outside of the house envelope and which forms a space in the upper reaches of the conservatory. The house is made entirely from a timber frame structure, assembled on precast concrete foundations and with basement wall panels. The bathroom pods were completely factory fabricated and assembled on site. This design allowed the construction to be done in about ten weeks.

Ingineria Iluminatului 2012; **14**, 63-68

Figure 1 The south façade of the Integer House

Latest innovations in design, intelligence and environmental performance were incorporated, as well as renewable energy technologies including solar thermal and photovoltaic panels and a ground-source heat pump, and sustainable measures such as grey water recycling, rainwater harvesting, a reed bed for on-site sewage treatment, and a green roof planted with sedum. Other innovative features of the house include a whole house music system, an electrochromic glazing in the door between the office and the top floor lounge, flexible lighting controls including dimming and preset light levels, and an intelligent irrigation system with soil-mounted humidity sensors.

2. Thermal insulation and air tightness

Wall insulation consists in 190 mm recycled newsprint cellulose with a U-value of 0.2 W/(m^{2}K) that was mounted between studs. The roof is actually a north slope that was initially covered with turf.

Plenty of windows in the house provide both good daylight levels and visual connection to the outside. They seem to be reasonably insulated, except the rooflight in the office and the openable windows in the bedrooms.

Designed as glazed ventilation louvers, the latter ones can be manually opened but there are 3 mm gaps above and beneath them causing cold air draughts. An insulating tape applied in the first days of occupancy stopped the air draughts and diminished the traffic noise coming from the M1 motorway nearby.

The office rooflight is double glazed but the frame was not properly sealed against draughts. An adhesive insulation tape applied around the frame of the rooflight, in some places even in two layers, and a transparent window insulation film helped to diminish significantly the cold effect of the rooflight.

3. Heating

A ground-source heat pump extracting heat from 50 m bore holes was initially installed when the house was built. Because it failed at some point, the heating system in the house was not functional. Portable electric heaters had to be used in the occupied rooms until an alternative air source heat pump was installed and connected to the heating pipes (Figure 2). The new air source helps to keep the house reasonably warm and can be programmed via a wireless control unit to vary internal temperatures by day and time.

Figure 2 The newly installed air source heat pump

The internal temperature can also be adjusted in the rooms with wall-mounted thermostats, which command heating valves to open or close in order to provide the required temperature. Wall radiators are used in the two bathrooms, while the bedrooms, the living-room and the office upstairs use floor-recessed heating grilles.

Probably due to the lack of external walls, the bathrooms are warm. The other rooms have significant glazed areas and the grille-based heating system does not cope with the temperature requirements. Portable electric heaters can be used locally as a temporary supplement for the heat pump-based heating system.

Small size fan coil units are used for plinth heating in the kitchen and in the lower ground floor stairwell. The airflow can be adjusted to low or high rate, and the units are connected to the overall heating system which commands them when to switch on and off.

Winter temperatures could be perceived through their impact indoors. There have been a few occasions when the portable electric heaters had to be used on a minimum setting as an additional heat source to the existing heating system.

4. Passive and sustainable design

The architecture of the house is innovative, and the passive solar design can be easily noticed through the large south-facing conservatory. This brings generous natural light in the house, making it very attractive and welcoming (Figure 3). Patterns of light and shadows bring vividness to internal spaces when the sun shines. The glazed conservatory also functions like a reservoir of warm air when the sun shines. By simply opening the doors or windows of the adjacent rooms, internal temperatures can be increased by several degrees.

Figure 3 Sitting area in the glazed conservatory

The conservatory gets very warm when the sun shines, even in winter, but also gets very cold when external temperatures are low and there is no sunshine. Therefore the use of this area is limited to sunny weather during colder periods. Considering the amount of solar heat gains experienced in the winter, it is certain that overheating is a severe problem in this space during summer months.

Solar hot water panels mounted on the southern slope of the roof can provide free hot water which is then pumped to a highly insulated hot water tank equipped with additional electric immersion heaters.

Two 0.5 m x 1 m photovoltaic panels, with a maximum output of 60 W, produce electrical energy that is stored in batteries in the loft space and used to power extract ventilation. In addition, a low power wind turbine is installed near the house to charge the battery store used for extract ventilation.

A grey water system treats and recycles water used for washing and bathing and re-uses it for flushing the toilet, reducing water usage by around 30%. The water treatment plant demonstrating on-site sewage treatment is buried in the garden, avoiding any unsightly equipment around the house.

The house was designed to enable rainwater collection, which is treated and stored in an underground tank for garden irrigation and car washing. An automatic garden irrigation system was installed to water only plants which needed it, according to soil humidity monitoring, delivering the correct amount of water at the correct time.

The external walls are covered with untreated cedar cladding having a life expectancy of 80 years thanks to naturally occurring oils in the wood that resist decay.

5. IT/intelligent technologies

There are various controls installed in the house, as part of an IT infrastructure that allows for intelligent conservatory shading and venting, lighting mood settings, wired internet access at various points in the house, observation cameras, 10 telephone/ fax lines, smart keys, security devices and bathtub controls. An audio system is also installed in the whole house and there are wall-mounted controllers for the music player in most rooms.

A glazing with variable appearance is incorporated in the office door into the top floor lounge. This was designed to provide privacy by becoming opaque on operating a switch. The glass transforms itself when a small electrical charge is passed through it and polarises the liquid crystal element inside the unit.

The automatic system controlling the conservatory blinds is connected to two rotary switches that set the sun and/or wind intensity. Based on this setting, the blinds are lowered to prevent overheating or raised to allow for solar heat gains. Manual operation of the vents is currently required as the automatic controls are not functional any longer. By opening three sets of vents from the control panel, the air flow ventilates the volume of the conservatory and decreases significantly the internal temperature.

6. Lighting

The lighting system is very flexible and consists of various components (Figure 4): recessed downlights, wall-mounted uplights, track-mounted spotlights and floor-standing fittings. These can be manually controlled via wall-mounted multi-gang switches.

Multiple tungsten halogen spotlights are ceiling recessed or track mounted throughout internal spaces and the conservatory, respectively. Some of them can be dimmed, such as in the living room, dining area and main bedroom. The compact fluorescent lamps incorporated in wall-mounted uplights and a couple of ceiling recessed downlights use magnetic gear that is not dimmable and causes noise and flicker. The low voltage halogen spotlights have magnetic transformers.

Figure 4 Dining area lit by wall-mounted uplights and recessed spotlights

The tungsten halogen lamps are inefficient light sources and an initial refurbishment measure would be replacing them with more energy efficient types such as LEDs or compact fluorescent lamps.

The stairways benefit from generous lighting arrangements, including overhead and floor-level wall lights using compact fluorescent lamps. Switching on/off all these various lights may be confusing sometimes, and some switches do not function properly, which makes switching even more difficult.

Corridor and bathroom lighting cannot be dimmed or partially switched on when desired. This may be the case when using the toilet at night time. Waking up and plunging in intense, full lights is very uncomfortable and requires some time for visual adaptation, both when switching lights on and then back off. Some background, low level, ambient LED lighting would be an important component to be incorporated during the refurbishment of the lighting system. PIR-based lighting controls might also be beneficial in bathrooms and circulation areas. These would need to take into account daylight detection where appropriate.

7. House comfort

House design allows for a pleasant, warm and bright ambiance with a comfortable internal layout. The bedrooms are small sized and two of them also serve as access from conservatory to the house. Because all bedrooms are located on the lower ground floor, they tend to be colder than the other rooms above.

Discomfort glare in the living room and dining area can be an issue on sunny days. This can be diminished by lowering the blinds, but cannot be entirely avoided because blinds fabric does not obstruct the sun rays completely. The office upstairs suffers from glare on sunny days, when computer work is very difficult and uncomfortable. This is caused by the lack of any shading for the rooflight.

The bathrooms are fitted with heated mirrors that do not steam up. They also help heating in winter by radiating infrared generated by the electric lights. The open shower in the upper ground floor shower-room causes the floor to get wet, messy and dirty from water stain that is difficult to clean. The toilet flush buttons are positioned behind seats and this makes access cumbersome.

Strong winds make the conservatory metal structure vibrate, which is particularly unpleasant during the night due to cracking noise and wind whistling through some gaps. The wooden floors and internal walls do not have a proper acoustic insulation. Thanks to the conservatory, the bedrooms on the lower ground floor are better insulated against the noise caused by the traffic on the M1.

8. Health and safety

Minimal carpets were used to reduce dust mite link to asthma. Outward opening of the bathroom doors can be dangerous sometimes and requires space. Gliding doors might be an option to ensure safety and optimised use of space.

Almost all rooms are equipped with smoke sensors, and fire extinguishers and blankets are provided at key positions throughout the house. Being downstairs, the bedrooms are less exposed in case of fire, and there is immediate access to the outdoor garden through the conservatory.

9. Garden and views

The house benefits from a green area surrounded by trees and plants, with wildlife as an extra bonus. Apart from many species of birds, there are plenty of squirrels running all over the place. Deer and foxes were also spotted in the wood.

There are generous views out from the living room, kitchen and the sitting area. The conservatory balcony is also a good place to sit, relax and enjoy beautiful views of the surrounding green area.

References

Integer House Blog, available online at https://connect.innovateuk.org/web/ticleanuc/blogs

Cosmin ŢICLEANU
PhD Eng
BRE – Building Research Establishment
Building 4, Room 331
Bucknalls Lane, Watford
WD25 9XX, UK
Phone: +44 1923 66 4871
Fax: +44 1923 66 4781
E-mail: TicleanuC@bre.co.uk

He holds a PhD in lighting for his thesis on integrated daylighting and electric lighting systems. As a senior consultant in lighting at BRE, he is involved with undertaking consultancy and research into all aspects of electric lighting and daylighting. His duties include modelling the UK lighting market and the impact of policy measures, providing answers to detailed technical questions on lighting, commenting on lighting standards and drafts of legislation, drafting specifications for energy efficient lighting products, consultancy on lighting for government and private sector clients, conducting research and consultancy projects and presentations and training on lighting.

Information for Authors (revised 1st June 2012)

The journal **INGINERIA ILUMINATULUI - Journal of Lighting Engineering** has a scientific presentation and content, targeted to the continuing education in the lighting field, without commercial advertisings inside of its pages. The objectives of the journal consist of the presentation of the results of the lighting research activity, the dissemination of the lighting knowledge, the education of the interested people working in public administration, constructions, designers, dealers, engineers, students and others.

The responsibility for the content and the English language of original papers rests solely with their authors.

The opinions of the authors, references and collaborators are personal and do not necessarily coincide with those of the editor.

The journal is structured in the following parts, the same being the submitted contributions: Editorial, Papers, Theses and Dissertations, Conferences and Symposiums, Information, Anniversary.

Research papers describe original theoretical and laboratory/experimental investigations.

Manuscripts should be as concise as possible.

The editors reserve the right to reject any manuscript that is not completely legible or does not conform to the standards given in the Instructions for authors.

All papers are independently reviewed by two peer reviewers. The editor-in-chief has the exclusive right to assign papers to members of the editorial board for their peer review process. The reviewers fill in due time a standard evaluation form. The reviewers' suggestions or requests for modifications are anonymously communicated to the authors. The final acceptance of the paper is conditional on authors addressing the anonymous referee comments.

The authors will be provided with a free copy of the journal, after publication.

The journal is available as PDF file in electronic format, with all the figures in their original colour:
http://users.utcluj.ro/~lec/journal.

However, the authors are free to use their works in another publication, by notifying the Editor, and clearly refer to the original publication.

Editorial recommendations

Please use the Word more recent version. Papers should not normally be more than 5000 words long - at the Editor' discretion.

Setting page
Paper A4
Top 2.2; Bottom 7.5
Left 2.5 (Inside); Right 3.0 (Outside)
Header 1.5; Footer 6.5
Mirror margins (yes)
Page Number Outside
Two columns (except Title, Authors, Abstract and some Tables or Figures which need the entire width of page), Equal column width (Equal Width 7.5 cm)
Paragraph First line by 0.5
Font: Style Times New Roman, Size 12
Line spacing: Single (1 line)
Figure text, Table title, Text inside Figures and Tables - Size 10.
Please add the Figures file as an attached file on JPEG format.

Layout of the paper
Two lines 12 p
TITLE (14 Caps Bold) – one column
One line 12 p
Author/Authors (12 Bold), First name, Family name (CAPS), Affiliation (Company) (Size 12), without academic titles – one column
Three lines 12 p
Abstract - the summary should count 200-250 words and have a structured form, i.e. reflect structure of an article - background, material and methods, results, new information, principal conclusions and recommendations – one column.
One line 12 p
Keywords (should not repeat the title of the manuscript) – one column
One line 12 p
two columns - starting from this point
1. Chapter title – (bold, but no CAPS)
One line 12 p
text
One line 12 p
2. Chapter title ...
One line 12 p
text / and so on
One line 12 p
Acknowledgments. (if there are)
One line 12 p
References, in order - authors, title; journal - year, vol., first and last pages; books - printing house, year. References should be in Vancouver style. These should be presented in consecutive order (as they are cited in the text). The first 6 authors should be presented. Citations in the text should be marked by Arab numbers in brackets or in the upper. Each citation item should be placed in a separate paragraph.

At the end, please add the presentation of the first 6 authors.
(1) author(s) full contact address (mail, phone, fax, e-mail)
(2) short presentation of your background and personality (no more than 100 words, even more if necessary - ask Editor),
(3) attached file with your photo JPEG format 3.5/2.75.

Research works should be divided into background (introduction), material and methods, results, discussion, conclusions, references.

The paper has an even number of pages.

DOAJ DIRECTORY OF OPEN ACCESS JOURNALS

Indexed: 14545837

INDEX COPERNICUS INTERNATIONAL

Index Copernicus Journals Master List ID5747

http://users.utcluj.ro/~lec/journal

Editura U.T.PRESS, Cluj-Napoca
C.P. 42, O.P. 2, Cluj

ISSN 1454-5837 print ISSN 2968-9853 online