



# LIGHT

the official

# NEWSLETTER

of the **indian society of lighting engineers**

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## SECRETARY'S MESSAGE

### Friends and Readers

It is my proud privilege to address you all. This is my first interaction with you through the medium of the Light Newsletter, although I have been entrusted with the post of Honorary General Secretary of ISLE about 2 years ago.

For some years now it has been the tradition in our organization that the President has a column in the newsletter to address the members and readers on important issues. However, it has now been decided that other office bearers of the Society will also use this column by rotation to address members on current topics of interest.

It has become clear that today both nationally as well as globally there is a serious crisis involving the two interlinked issues of energy and the environment – on the one hand there is the exponential growth in energy demand and on the other the serious negative impacts that this demand is having on the environment, to the extent that there is serious concern for the future of the species and the planet.

Since lighting comprises a substantial and essential component of the energy demand, it is important that there is close interaction between the illumination and environmental fraternities to address these concerns.

As our contribution, in our role as the only technical lighting platform in the country, the first step is to spread awareness of the urgent need for energy efficient and environmentally friendly illumination. To this end your Society has been organising periodic seminars, workshops and conferences. We will have to work harder in collaboration with nodal bodies, educational institutions, professional institutions and industry to spread the message to a larger number of people at all levels of society.

From the last two issues of the newsletter as well as from the brochures you must all be aware of the mega-event of the decade Lii 2005 being organised by ISLE.

# Lumilux Range of Lamps comes with Tri Band Advantage.



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It is with pride that I find that the preparations for the upcoming Lii2005 are going well. Space is filling up at the exhibition with an impressive list of exhibitors and for the conference we have succeeded in assembling an all star cast for the Lighting Masterclass sessions.

I would like to make an earnest appeal to all members to help make this event the outstanding success that it deserves to be. All of you must have now received the conference brochures giving information about each of the six speakers. Let us share this information with our friends and acquaintances who have an interest in lighting to ensure that this unique opportunity is not wasted.

I would also like to ask those of you who have contacts with potential exhibitors both in India and abroad to help fill up the balance space at the exhibition. We need to make this same effort to ensure that the Directory is more comprehensive than in earlier editions as well as to ensure that this source of funds for the Society is fully utilised.

To those of you who have yet to clear your pending membership dues I make an earnest request to attend to this immediately. After all, the health of the Society is dependent on the active support of its membership.

I am delighted to notice that almost all the State Centres have been very active during the tenure of this GB. Three of the functions were path breaking – the one held for the first time in the Northeast at Guwahati and the second was also a first educationalist-industry meet at Manipal University. Both these were well planned by our Director Education and Training, Dr. Biswajit Ghosh. The third was the first lighting design seminar organised by the Mumbai State Center jointly with IIID. All these functions were well attended and very successful.

Thank you ISLE members for your support and encouragement. Please continue to be in touch with the undersigned. I will be happy to offer my fullest cooperation.

H. Mukherjee  
Hon. Gen. Secretary

## EDITORIAL

As we draw closer to Lii2005 we can feel the excitement in the air. All six Lighting Masterclass speakers are in place and we can look forward to a unique and outstanding event. The exhibition too promises to be even more exciting than three years ago at Lii2002.

In every issue of the newsletter we carry information on the new technical publications released by CIE. These are invaluable to the serious lighting practitioner since they give access to the latest global information on the entire range of lighting issues covered by the seven CIE Divisions. In this issue we give information on three new

publications (see page 8) These CIE publications are available at a discount to ISLE members. Please write to us at the Delhi Secretariat in case you would like more information.

We are carrying an article from the ILR on office lighting that looks at issues beyond just lighting “surfaces” and discusses the need for the lighting treatment of “spaces”. There is also a paper that examines the question of retinal illuminance instead of only horizontal illuminance as a parameter for lighting design. Another paper looks at an innovative and practical tubular daylighting system for multistory buildings. Both these papers were presented at the CIE Session in San Diego.

You will find that there is a new edition of the R&D Update column from Dr. V.D.P. Sastri after a gap. And we have our second WebWatch column from Anool Mahidharia.

In conclusion, I would like to express our deep gratitude to Philips India for their generous sponsorship of this issue of the newsletter.

H.S. Mamak  
Editor

## ISLE ACTIVITIES



### Lii UPDATE

Conference September 12-14

All six Lighting Masterclass speakers have now confirmed their participation. To get an idea of who these six “Gurus” are and what is in store for you see page 12.

Also of great relevance and interest to the conference delegates will be the four workshops planned for the mornings of the 13<sup>th</sup> and 14<sup>th</sup>, two on each day. One of the workshops will be on City Beautification – an approach to the lighting of Delhi for the 2010 Commonwealth Games. This workshop will cover different aspects of the lighting issues involved in City Beautification with special emphasis on the lighting of monuments. It will analyse the negative and positive impacts of such projects – light pollution, energy consumption, heritage protection, security, traffic, tourism, cultural activities etc.

With the rapid pace of development in the field of solid state lighting, LEDs are also an appropriate subject for a workshop. It is becoming increasingly clear that when we speak of LEDs as “the light source of the future”, that future is not really all that far off and for all of those involved in lighting it will be essential to understand this new technology.



## DIRECTORY

Since 1991 the Lighting Directory has been an invaluable source of information on the Indian lighting scenario, as well as a peep into the world of lighting.

The Indian lighting industry has moved from a local activity for local industry to an outward looking ambitious phase where the aspirations for exports and the success it has achieved have resulted in confidence levels hitherto unknown in Indian lighting. The Directory has therefore attempted to meet this need for information and data on world trends.

The need for information on quality standards and requirements to enable exports has found a place in the Directory.

Over the last two years we have noticed that Market Research Organisations in India and abroad as well as foreign companies have shown increasing interest in purchasing the Directory. The Lighting Directory has become a reference publication reflecting not only data on the industry but also the trends and aspirations of the lighting fraternity.

The Directory attempts in this 5th edition to project the place for high-end lighting projects and lighting designs. The need for specialized lighting in Malls, 4 and 5 Star Hotels, airports, Heritage Monuments etc. are being increasingly realised. There is also a need for awareness of the place of lighting controls for the savings in power consumption that they can effect.

International buyers have now put India on their tour circuits and the International lighting companies are keen to know about Manufacturers, Markets, Channels of distribution, etc. The Lighting Directory can meet this requirement.

Full Page (black & white)	Rs. 25000
Full Page (colour)	Rs. 35000
Listing (rate per 2 column cm)	Rs. 2500

*Previous advertisers in the Directory get a discount of 10% on advertisements and Rs. 500 on entries for payments made before April 30, 2005.*

### Secretariat for Exhibition and Conference

For any information on the Light India International Exhibition and Conference and the Directory please contact the Secretariat at the address below.

Promotional literature on the Exhibition and Conference as well as the Directory of the Lighting Industry in India is available for distribution. Copies are also available at your State and Local Centres.

#### Secretariat

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## KARNATAKA STATE CENTRE

### Seminar On Solid State Lighting

March 22, 2005, Bangalore



*Mr. Tom Thomas lighting the lamp*

The Hotel Atria in Bangalore was the venue of a seminar on Solid State Lighting, an Emerging Trend organised by ISLE Karnataka State Centre on 22nd March.

The main speaker for the evening was Ms Alison W.P.Chiu, Manager Solid state lighting, Philips Hong Kong. She made a detailed presentation on the subject of solid state lighting covering the fundamentals of LEDs, different aspects of the manufacturing technologies, comparison of colour characteristics and the emerging scenario of the high lumen/watt LED's of the future.

To give the audience a better understanding of the subject, there was a display of products including the newer varieties.

The eminent architect, Mr. Tom Thomas was the Chief Guest. He expressed his whole hearted support to ISLE since he felt that lighting was definitely becoming one of the most important aspects of modern buildings and there was a great need to keep all stake holders updated with latest trends and technologies .

The other main speaker was Mr Nandakishore of Philips India who gave a brief overview of the various



*Ms. Alison Chiu*

advances that have taken place in the development of light sources and improved efficiency in the lumen/watt ratio. He stressed the need for correct use of the sources and energy efficient design. He spoke of the future and the emergence of LED's as an alternative.

Mrs. Simi Pandeya from the Light India International Secretariat in Delhi made a curtain raiser presentation on the Lii2005 Exhibition and Conference to be held in Delhi in September this year. Her introduction of the speakers (the six Guru's of Lighting) at the conference created great interest among the Architects present and after the seminar many approached her to get details of registration for the conference.

The meeting had started with the Invocation by Smt. Shanthamani Dattatri and Lighting of Lamp by the Chief Guest.

Mr. A.P. Joshi, Chairman welcomed the gathering and informed them about the forthcoming events including the Training Programme being undertaken by the State Centre. Mr. Mathew Kurien gave a brief introduction to ISLE and its objectives. Mr. M.G Sathyendra gave a vote of thanks.

The seminar was attended by nearly 200 participants, which included many leading Architects, Contractors, Consultants, Engineers of BSNL, Railways, MES, CPWD and other major industries.

The programme was coordinated by Mr. M.S.N. Swamy, Secretary, Karnataka State Centre and was sponsored by Philips India.

## **Seminar On Energy Conservation**

March 28, 2005, Bangalore

In collaboration with the Small Industries Service Institute (SISI), Government of India, ISLE KSC held a half day technical meet on Energy Conservation in Industrial Lighting together with an Exhibition at the SISI auditorium in Bangalore.

Mr. M.G.Sathyendra of ISLE welcomed the delegates and outlined the objective of the seminar.



Mr. S.S. Dhillon addressing the delegates



Mr. Pradeep Nettur examining the exhibits

Mr Dhillon, Director SISI, Presided over the meeting. He expressed his happiness with ISLE's involvement and promised that they would closely associate themselves with ISLE for the future programmes on training the industries in various aspects of lighting. He also expressed that he would like to have a vendor development programme involving the Lighting Industry.

Mr Swamy presented to the audience the salient features of the forthcoming international exhibition and conference 'Light India International 2005' at Delhi and the special attractions of the event. He made an appeal for the participation from the delegates.

The chief guest and keynote speaker was Mr Pradeep Nettur, Chief Engineer BSNL. In the context of the horrors of green house gases, dwindling resources like coal and oil he stressed the need for 'Intergenerational equity' to be maintained by us for the well being of the next generation. He also gave many thought provoking tips to the industry on the philosophy of energy saving and energy audit. He suggested that industries bring down their consumption through the use of energy efficient lamps, use of timers and also the use of motion sensors. These efforts could bring down energy consumption by more than 20% and also save Industry a lot of money.

The Technical session that followed was chaired by Shri Riaz Kagalwala of ISLE.

Capt Sharma of Best Choice presented in his paper, Electronics in lighting, the importance and efficient use of low loss electronic ballasts, timers etc as energy savers.

Mr K.P. Somasunder of ES Electronics presented a new product which when used in series with the installation wiring provides up to 25% energy saving.

Mr Senthil Kumar of TERI discussed the salient features of energy auditing and also provided actual case studies to show how the cost of the product could come down.

Mr B.T. Ajwani of Light Forum Marketing talked about various options for energy saving keeping the cost in

control and talked about retrofits such as T5, low loss inductive ballasts etc. He also provided a write-up with tips for the common man on energy saving in lighting.

There was an Exhibition showcasing various energy saving products held to mark the occasion and it was inaugurated by Mr. Dhillon, Director SISI. The exhibition was open to public.

Mr. B.K.Sudhakar, Asst. Director SISI presented a vote of thanks.

The Technical meet was attended by 105 delegates from Small Scale Industries, HAL, BEL, BSNL, HMT, BEML etc.

## CIE ACTIVITY

### BLV-LCC, Tunesia Joins CIE as Supportive Member

Supportive members benefit from the right to use the CIE Supportive member logo on their letterhead and in their publications so as to show that they are fully up to date with the latest information on world wide lighting trends, research and standards, and, depending upon membership category, the internal or external exploitation right of CIE publications. Supportive Members of the CIE also provide additional support that helps CIE to carry out its work. Supportive Membership is open to companies and organisations working on an international or regional scale, having an interest in light and lighting and wishing to support the work of the CIE. Such organisations may include equipment manufacturing companies, commercial organisations, consultants and lighting designers, local government and government departments, educational organisations, etc.

The level of support is classified by the amount of annual membership fees and benefits received.

- Supportive Member : € 500
- Silver Supportive Member : € 3000
- Gold Supportive Member : € 8000

More information on this membership scheme can be obtained from the CIE Central Bureau (ciecb@ping.at).

### New TC

The following new TC was established:

**TC 6-58** A recommendation on lower limits for UV exposure (Chair: Wim Passchier, The Netherlands)

*Terms of Reference:* The fact that man cannot do entirely without UV is accepted by most scientists active in this field, but is not as well known as the widely accepted view that UV exposure should be limited to a sensible level thus avoiding or minimizing risks. The TC will formulate recommendations for a lower limit of UV exposure commensurate with good health.

  
**ATTENTION LUMINAIRE SPECIFIERS/  
LUMINAIRE BUYERS**  
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**Mid-Priced Louvre** made from imported anodised aluminium of lower grade. Uniformly bright surface but with moderate iridescence, 0.3 to 0.35 mm thickness, low to moderate strength, low to medium louvre height. Other constructional features similar to above.

**Standard Louvre** made from imported anodised aluminium of medium grade, low iridescence, 0.4 mm thick, good strength, deep cell height to ensure correct photometry as per international standards. Manufactured as per prevailing standards in U.K./Europe, using special purpose imported CNC machines, designs and tools.

**Premium Louvre** made from imported anodised aluminium of high grade, very low to nil iridescence, 0.4 mm thick, sturdy, deep cell with minimum opening behind lamp to ensure high efficiency, glare-free performance, optimum photometry. Very satisfactory lux levels at working plane. World Class Product, complying with International Standards e.g. Cat. 1, 2 or 3 as required.

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## Hollow Light Guide Technology and Applications CIE 164:2005

CIE initiated a Technical Committee "Hollow Light Guides" for the purpose of developing new terminology and dissemination of information in the field of illumination with hollow light guides. This report is a first step in that direction, representing the state of the art at the time of its substantial completion in 1999.

It includes a brief history of the field of hollow light guides, reviews the different solutions and describes the basic physics behind them. The pros and cons of each of the solutions are summarized and the terminology is given. System design and the photometry of hollow light guides are detailed. Finally, a review of four example projects is given.

The report is written in English, with a short summary in French and German. It consists of 37 pages with 13 figures and 6 tables. In the course of April you will be able to obtain it via the new CIE online webshop ([www.cie.co.at](http://www.cie.co.at)).

## Proceedings of the CIE Symposium '04 on LED Light Sources: Physical Measurement and Visual and Photobiological Assessment CIE x026:2005

LED light sources are now widely used in illuminating engineering as well as in information technology and are expected to be one of the major light sources in our future life. Despite the wide and rapidly growing use of LEDs, reliable methods for physical light measurement and visual and photobiological evaluation are still in question. The CIE had organized two successful symposia on LEDs in 1997 and 2001. However, there are still many questions left unsolved such as measurement of partial flux and radiance, visual evaluation such as colour rendering, or requirements for photobiological safety.

To discuss these issues, CIE Divisions 1, 2 and 6 organized this expert symposium on LED light sources, held from 7 to 8 June 2004 at AIST (National Institute of Advanced Industrial Science and Technology) Tokyo Waterfront, Japan, with support from the Japanese National Committee of the CIE and AIST Japan.

The meeting was divided into four main sessions:

- colour rendering
- vision
- photobiological safety
- measurement.

Keynote papers were read on "Physical and visual requirements for LEDs to be used for future lighting systems" and "White light from light emitting diodes". The symposium also included a poster session. The Proceedings contains the peer reviewed versions of the 30 papers presented, as well as a summary of the discussion sessions. CIE x026:2005 is the 2nd edition of the proceedings and includes all full papers that were submitted.

The publication contains 155 pages with 138, mostly coloured, figures. A CD-ROM with all papers in a searchable form is included in the Proceedings.

## CIE 10 Degree Photopic Photometric Observer CIE 165:2005

The  $V(\lambda)$  function accepted in 1924 is valid for photopic vision. It was long recognized that for para-foveal vision this function does not describe luminance perception correctly. In 1964 the CIE accepted a large field colorimetric observer, but this system had no photometric counterpart. Subsequent research has shown that  $\bar{V}_{10}(\lambda)$  function can be used as the spectral luminous efficiency function of a 10° photometric observer. The present report provides guidance when and how this large field photometric observer could be used, especially if luminance has to be determined para-foveally.

Based on the detailed evaluation of the available literature data TC 1-59 came to the conclusion that the adoption of a 10° photopic photometric observer [ $V_{10}(\lambda)$ ] can be recommended to the CIE and that this system should be based - according to the original recommendations of the CIE Colorimetric Committee - on the  $\bar{V}_{10}(\lambda)$  function of the CIE 1964 standard colorimetric observer.

The report is written in English, with a short summary in French and German. It consists of 23 pages with 3 tables.

In the course of April you will be able to obtain it via the new CIE online webshop ([www.cie.co.at](http://www.cie.co.at)).

## FORTHCOMING EVENTS

### Illuminat 2005 3rd and Balkan Light 2005 June 2-3, 2005, Cluj-Napoca, Romania

The 3rd international conference Illuminat & Balkanlight 2005 at Cluj-Napoca, Romania will provide a unique regional forum to discuss and debate the latest developments in energy and environmental impact of lighting systems, the policies and programmes adopted and planned, the strategies to be implemented to further

progress, as well as the technical and commercial advances in the dissemination and penetration of energy efficiency in lighting. The target audience represents the community of lighting professionals from Romania, Balkan countries, European Member and Associated states in and outside from EU area, including lighting and building science researchers, engineers, system designers and project managers, academia and experts, architects and urban planners, local community and government representatives, policy makers, national and international organizations and agencies, manufacturers and retailers organizations, students. The participation of young researchers will contribute to the success of the conference and to the improvement of their knowledge.

The two-day conference will include plenary sessions where key representatives and senior specialists will present their views, programmes and research to advance energy efficiency in lighting.

Parallel sessions on specific themes and topics will allow in-depth discussions among participants. Round tables organized by the official sponsors will present the latest economic and technology achievements of national manufacturers and retailers in the electric and lighting fields. The conference will allow the best knowledge of new policies and strategies to increase energy and economic efficiency, to mitigate climate change and to foster sustainable development, to build international partnerships among lighting professionals, to emphasize the regional Balkan cooperation.

The main topics of the conference are "Energy Efficiency and New Trends in Lighting" on subjects encompassing:

- Vision and Colour
- Lighting Design and Interior Environment
- Outdoor Lighting
- Day-Lighting and Integrated Systems
- Lighting Supply Installations
- Architectural Lighting Design

*For further information please contact:*

Conference Chairman  
Dr. Florin Pop  
Professor, Technical University of Cluj-Napoca  
Vice-president of CNRI  
E-mail: florin.pop@insta.utcluj.ro

## **ISAL 2005 International Symposium on Automotive Lighting September 27-28, 2005, Darmstadt, Germany**

Since the last PAL 2003 the progress in automotive lighting has been very intense and fast. Meanwhile, we see the first white LED application on the road. ISAL is the continuation of the International PAL Symposium. It

is the ideal forum for car manufacturers, suppliers, international government agencies, universities, testing organizations, engineers, scientists, designers and government employees who wish to learn about the new technologies and trends.

The symposium covers various topics including:

- Visual performance of drivers (glare, spectral sensitivity of the eye, contrast sensitivity, etc.)
- Automotive lighting (LED headlamps, Daytime Running Lights, light sources, etc.)
- Driver assistant systems (night/computer/artificial vision, human-machine interface, etc.)
- Regulations, directives, standards
- Styling trends, influence of technology on styling
- Stimulation
- Road equipment
- Active and passive safety
- Lighting and environment
- Optical data transfer

*For further information, please contact the*

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<http://www.isal-symposium.de>

## **InterLight 2005 11th International Trade Fair for Lighting, Light Technology and Intelligent Building Technology Nov. 30 - Dec. 3, 2005, Moscow, Russia**

The economic data for Russia plus all the relevant statistics for the industry continue to give clear positive signals for the Russian lighting market. The expected growth in the Russian GNP that this year topped 7 percent, plus a great deal of promise for the coming year combine to make the Russian market an even stronger attraction for the future. The boom in lighting and lighting technologies continues.

Interlight 2005 will show the new technologies and directions in lighting.

*For further information, please contact:*

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**Retinal Illuminance, A New Design Parameter?**

M.B.C. Aries, S.H.A. Begemann, A.D. Tenner, L. Zonneveldt

**Abstract**

Nowadays the horizontal illuminance on the desk is the dominant lighting design parameter. For an office environment with healthy lighting we suppose that not only is the horizontal illuminance an important parameter but also the retinal illuminance. Current designs for facades and office rooms do not meet all demands for healthy office lighting simultaneously. Retinal, vertical and horizontal illuminances have been measured in two test rooms as a function of several parameters. The results show that the amount of light entering the human eye is not proportionally related to the horizontal illuminance. By designing healthy office lighting both the horizontal illuminance and the retinal illuminance should be used as design parameters.

Keywords: Lighting, Daylight, Retinal illuminance, Horizontal illuminance, Psycho-biological effects

**1. Introduction**

Light is an important regulator of human physiology. There are two modes of photoreception. In the first place the visual photoreception enables us to see. Secondly the non-visual photoreception affects the circadian rhythm and stimulates directly parts of the brain that are influencing for example the cognitive functions and operating capacity [1]. Current lighting recommendations for office lighting are based on visual criteria and require horizontal illuminance levels of 200-500 lux [2]. During the day it is important for humans to receive enough light at the eye (retinal illuminance). At present there are no criteria for the retinal illuminance. The stimulation by light of psychobiological effects demands high retinal illuminance levels [3]. Since exact values are not yet known, the minimum value for the retinal illuminance

will be assumed here to be  $E_{retinal} = 1000$  lux. Healthy lighting is lighting that meets both human visual and psychobiological demands. For an office environment with healthy lighting not only is the horizontal illuminance an important parameter but also the retinal illuminance.

**2. Method**

Several parameters in the office environment that influence the retinal illuminance are discussed on the basis of two test rooms. To measure the retinal, facial and horizontal illuminance a mobile, experimental set-up is used. This experimental set-up simulates a person sitting at a desk. Detectors are mounted at eye-height (1.25m). Behind the detectors a board has been placed that screens the light like a human body would do (see fig.1).  $E_{retinal}$  is measured with a specially developed instrument, the Retinal Exposure Detector [4]. Other illuminances are measured with standard, cosine corrected Hagner SD 2 detectors. There are several measuring positions in the room (see fig.1), all with two body positions (1=upright, looking straight ahead and 2=25° inclined forward as for reading and writing). Position A is located in the window zone parallel to the window, facing the right sidewall At the end of the desk, in the middle of the room, position B is located perpendicular to the window. There is a table for conversations in the back of the room, where two seating positions are identified. In position C (only in test room 1) a person is seated with his/her face directed to the back wall and in position D facing the window (only in test room 1). Position E (only in test room 2) is located opposite to position A, facing the left sidewall.

The first test room is a one-person office room on the first floor, facing east (standard dimensions 6.4 x 3.6 x 2.7 m). The facade consists of 67% glass (wall-to-wall from sill h=0.9 to ceiling h=2.7m, see fig.2). Illuminances have been measured in this experiment as a function of position in the room (position A, B, C and D; see fig.1), position of the users body and lighting type (daylight only and daylight with electric lighting).

*Continued on page 20*

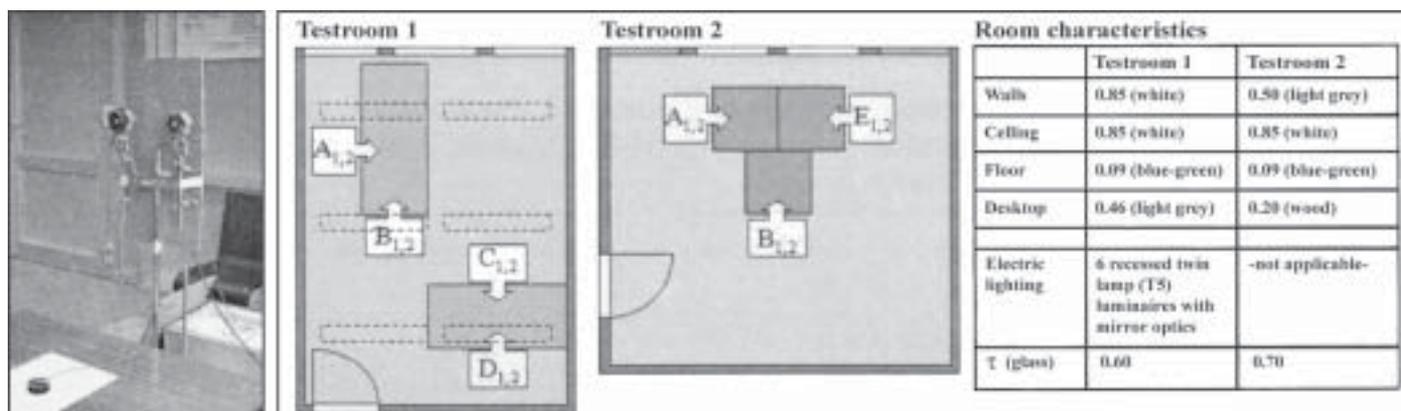
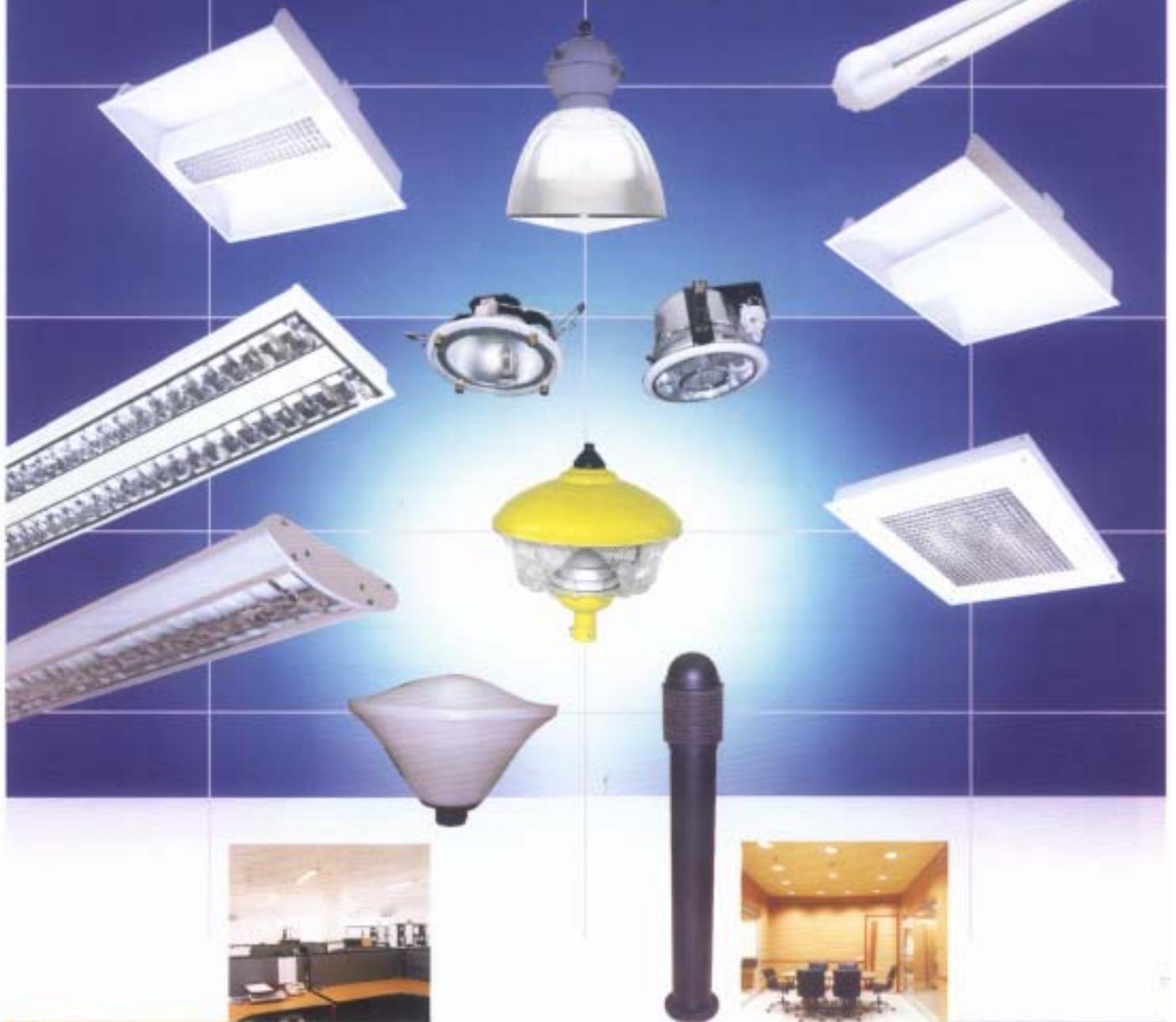


Figure 1. Mobile, experimental set-up, floor sections of the test rooms and room characteristics

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# Lighting Masterclass ...

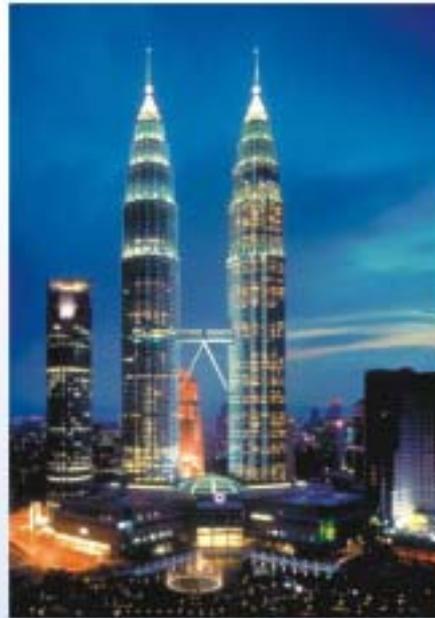


## Howard Brandston

Has more than 40 years experience in lighting design, engineering and electronics, designing illumination for more than 2500 commercial, institutional, residential and government projects. Honoured as an initial inductee of the Lighting Design Hall of Fame, he has received the International Lighting Designers Lifetime Achievement Award, AIA Institute Honors Award for his contribution to architecture and the IESNA medal. He has been inducted in the Interior Design Hall of Fame, the only lighting designer to be awarded this honour.

Teaches at LRC. He is also a light sculptor and his work is displayed in several museums.

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## George C. Brainard

Is a Professor of Neurology and a Professor of Biochemistry and Molecular Pharmacology at Jefferson Medical College, Thomas Jefferson University in Philadelphia. Dr. Brainard is the Director of Jefferson's Light Research Program. Over the past twenty years, his academic work has been concerned with the effects of light on biological and behavioural responses of animals and humans.

Dr. Brainard has actively worked with industry and different branches of the government on lighting education and standards.

His current work concerns the regulation of the human circadian system by the wavelength, intensity and timing of light. Results from these studies are being applied to the development of new lighting products and architectural designs. In addition, he is currently supported by the National Space Biomedical Research Institute of NASA to develop lighting applications for the Space Shuttle, International Space Station and future exploration-class space environments.



## Gert Hof

He doesn't like to be called a "light designer". He could be called a pyroartist or lighting architect. 'I approach every light show as if it were one of Shakespeare's play', says Gert Hof. His works include the lighting of the Acropolis to the music of Mikis Theodorakis, dedication of the millennium monument in Beijing, Berlin Millennium celebrations, the 1000<sup>th</sup> Anniversary of Budapest and the Anniversary Lights at the Red Square in Moscow. Hof told Mike Oldfield who wrote the music for the Berlin show that he needed "monumental music because I will be shooting a week's worth of Berlin's electricity consumption into the sky on one of your chords".

[www.mega-events.net](http://www.mega-events.net)



Acropolis

# ...at Lii 2005



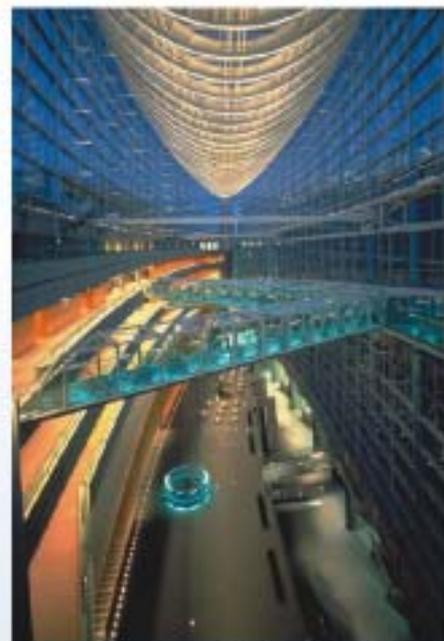
## **Kaoru Mende**

Was attracted to architectural lighting and has been involved in such superb projects as Tower of Winds, Chapel on the Water, Frankfurt Opera House, Tokyo Design Center, Shinjuku Takashimaya, Tokyo International Forum, JR Kyoto station and Sendai Mediatheque.

The awards he has received include the IES (Illuminating Engineering Society) International Lighting Design Award of 1989, Award of Distinction for "Chapel on the Water", and many Awards of Excellence, '97 IALD (International Association for Lighting Designers) Award of Excellence for "Tokyo International Forum", '96 Japan Culture Design Award and '97 Mainichi Design Award and many others.

He has been teaching lighting design at Musashino Art University, Tokyo University, Tokyo University of Art and others.

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*Tokyo International Forum*



## **Behr Champana Gagneron**

Vice President and Principal of TVS International, Behr Champana Gagneron is a talented design architect and has won many international design competitions. Mr. Champana Gagneron is a recognized specialist in the areas of master planning and site analysis, architectural design, programming, construction documents and administration.

He was one of four national experts selected for a special design think-tank on energy efficient and sustainable environments by the world-renowned Rocky Mountain Institute in Colorado. He was also later involved in 1994 in the Regional Urban Design Action Team for the planning of the 1996 Olympics. As a lead strategic visionary of TVS International he is presently gaining a reputation as a futuristic planner in 'tomorrow's world' being created in Dubai and the Middle East.

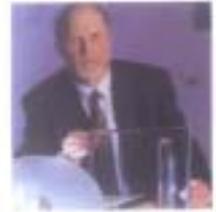


## **Dave Irvine Halliday**

Dave Halliday is the Founder Director of the Light Up The World Foundation, an international humanitarian organization affiliated with the University of Calgary dedicated to illuminating the lives of the world's poor. It is the first humanitarian organization to utilize solid-state lighting technologies to bring affordable, safe, healthy, efficient, and environmentally responsible lighting to people currently without access to proper lighting. Dr. Halliday laid the foundation for the development of LUTW into a global lighting initiative.

[www.lightuptheworld.org](http://www.lightuptheworld.org)

The lighting and spatial arrangement of the modern office environment should be designed to facilitate efficient working and also take into account the needs of the person



# Mastering Office Lighting

Heinrich Kramer

An increasing number of people are performing activities that in the broadest sense of the term can be described as office activities. They spend their working time sitting at a desk in an office environment. Linking up these work stations with others in the same firm and throughout the world means that each has to meet new requirements. Some are already being designed as teleworking or job-sharing workstations, utilising modern communication systems (telephone, fax, e-mail, computer networks) to transmit and receive various types of information from databases world-wide. Face-to-face communication is becoming less important.

Office work can be understood as comprising a host of frequently varying activities, involving the processing of 'files', communicating with other workstations, operating the communication media, communicating with other members of staff, thinking, organising, and so on.

Each activity imposes different requirements on the office space, workstation, surroundings, furnishings, equipment, and also the lighting. Equally, each activity demands a different relationship with other rooms in the building or elsewhere. As every company or public authority differs in structure and organisation, so does the emphasis put on each specific activity, therefore affecting these relationships. The result is that individual workstations have to meet very complex requirements. Irrespective of the requirements that have already been discussed above, a number of basic human needs have to be taken into account in the design of office workstations.

These human needs reflect a person's desire for:

- orientation in space and time (*genius loci*, culture, tradition, spirit of the times, biorhythm)
- privacy and communication
- information and familiarity
- variation and surprise (not monotonous)

These human needs can be incorporated into a scheme for lighting designers: The eight commandments of good lighting design.

## The eight commandments of lighting design

1. The lighting should facilitate orientation and definition of a person's location in space and time.  
Spatial location refers not only to the physical co-ordinates in metres and centimetres, but also to people's location in society and culture - their relationship with history and tradition.
2. Lighting should be an integral part of the architecture and interior design, viz. planned from the beginning and not added as an afterthought.
3. Through the choice of form, colour and material and in its design and details, lighting should support the intentions of the

architecture and interior design rather than function independently.

4. Lighting should create a mood and atmosphere that meets people's demands and expectations (e.g. formal, intimate, official, sober, cheap, bright, dim, homely, valuable, wide, inviting, unfriendly, etc.).
5. Lighting should facilitate and promote communication among people.
6. Lighting should make a statement and convey a message over and above mere brightness. It should express something.
7. Lighting should be original in its basic forms of expression. It should not be a mass product that simply reproduces what already exists.
8. And, last but not least, lighting should also facilitate perception and recognition of people's surroundings.

The requirements that a new lighting code should fulfil in terms of ambience and light could be formulated as follows.

## General requirements

The lighting and ambience of a workplace has to fulfil the users' expectations, which are determined by culture, society and education. The expectations relate to the functionality, aesthetics, ergonomics, etc. of the rooms and their furnishings. They have to be designed so as to support people's biorhythms or circadian cycles (*orientation in space and time*). People must be able to concentrate without any disruption (*privacy*) and be able to converse with their colleagues when necessary (*communication*). The work zones should be arranged so that the windows, the room, the entrances and exits, as well as the activity of others, can be observed. Everything should be visible 'at a glance' and familiar. Dark and indistinct zones should not be created (*information and familiarity*).

The rooms should offer *variation and surprise*.

Lighting must not distract as a result of being conspicuous, non-functional or ugly (*style*) or as a result of creating an inappropriate atmosphere (*dazzle, flicker, reflection*). Disruptive effects on the biorhythm are particularly serious.

During the day, lighting should be enlivening, activating and motivating in accordance with the human biorhythm. For their own well-being, people need appropriate visual contact with the outside world, with the cycle of day and night, seasons, weather and the environment (quality of the view, size/direction of windows, nature of the surroundings in the field of vision, arrangement of the workstation in relation to the window, visual protection, dimming, sun protection, openability of windows, etc.).



Typical design and lighting atmosphere of an open-plan office in the 60s and 70s — 'standard lighting'



The lighting fixtures are out of proportion and 'threatening' rather than pleasant. The nature of the material and the brightness of the ceiling are inappropriate.



Very 'misty' lighting atmosphere, the proportion of direct light from the suspended luminaires is too low. A new lighting level is created by the suspended luminaires.



Office workplaces with no visual link to the outside are 'inhuman'. Artificial light should compensate for the lack of daylight.



A daylight atmosphere at night leads to a lower acceptance of artificial lighting. The numerous standing luminaires represent visual, spatial unrest.



Typical open-plan atmosphere with no visual link with the outside. Ceiling design is poor and there is no privacy.



An office with a personal atmosphere. Artificial light ornamentation is a little too direct.



Personal atmosphere with untidiness and chaos

People have to get the biologically necessary dosage of visible radiation (2000 to 3000 lux 3 to 4 hours per day). Artificial light must not be a substitute for poor daylight; it should only support daylight. Different artificial light is expected in the daytime than at night.

At night, light has to be soothing, relaxing and restful, in accordance with the human biorhythm.

Together with the way the room is fitted out, artificial light has to create the appropriate atmosphere (festive, intimate, soothing ...) depending on function, activity and mood. It should be possible, moreover, for the user to alter this *atmosphere* according to needs.

*Atmosphere* is created through:

- View to the outside (even at night a window is important)
- Diffusion of light in the room (wall, ceiling, floor)
- Zoning of the room and the work zone in relation to the other zones
- Light and colour patterns (light and luminaire patterns in the room and on the boundaries of the room)
- Design of the luminaires and their integration in the room (type of luminaire, height of luminous point, dimensions, the way it is mounted, visibility).

The design of any office, including the organisational forms that go with it, should take these needs into account.

All the studies on the acceptance of offices in the past decades have demonstrated that lack of privacy and inadequate daylight (view of the outside) were the main causes of complaint. It would appear appropriate, therefore, to derive criteria for the design of offices from human needs, the eight commandments, and the plan for a new 'lighting code'.

### Office design

The workstation and its surroundings (i.e. the whole room) have to be designed in accordance with human needs. Particular attention

needs to be devoted to the provision of daylight and the creation of zones for privacy and communication.

There are two aspects to sufficient daylight. Firstly, people require a proper link with the circadian cycle (day and night), seasons, weather, nature and the environment. This calls for good visual contact from the workstation through a window or skylight. It is not possible to compensate for poor daylight with artificial light, because artificial light does not provide contact with the accustomed cycle of day and night. Furthermore, artificial light during the day makes us conscious of a lack of daylight.

Daylight has to provide the biologically effective dosage of visible radiation (particularly in the winter) for workstations that are continually occupied. The necessary illuminances in the visible range have already been mentioned above. We still lack proper knowledge about the dosage in the ultraviolet and infrared range of the spectrum. It is certain, however that this spectral range is also necessary for our health. If daylight is regarded in this way, then the majority of office workstations in the industrialised western nations are undoubtedly 'underlighted'.

Zoned lighting and the warm colour rendering of a table luminaire are greatly appreciated during transitional hours (mornings and evenings). Only when there is absolutely no more daylight is it desirable to have artificial light that is so differentiated that the various tasks described above can be performed and the lighting can be adjusted to the individual wishes of the user. Controlling light according to criteria other than personal ones will always be regarded by the user as patronising. For automatic control of artificial light it is necessary to know the individual wishes of the user. However, these wishes are so diverse that no control programme could do justice to them.

Privacy requires that a room or an area of a room should be sufficiently separate, optically and acoustically, from other workstations and that there should be certain rules governing access for others (e.g. having to knock or report, etc.). The area concerned



The importance of a visual link to the outside through a window at different times of year and day and night.



Desk luminaires are important components for creating 'private' ambience.

should be fitted out in a personalised fashion and should fulfil the requirements of job, activity and personality. In accordance with the individual need for privacy, an office workplace should include an area to which people can withdraw in order to work and think without disruption.

Evenly-distributed ceiling luminaires do not create light that is personal and private. Furthermore, light has to be capable of being adjusted to needs and the different activities in the office. A reduction in the average lighting level does not affect the privacy of an office. It is only changing from uniform to zoned light, from indirect to direct light, or the changing (enlarging or shifting) of the light zones that alters the atmosphere of the lighting. This means that, according to the activity and the needs of the user, we need several lighting systems present that can be adjusted to suit the current activity.

Communication is understood here to mean the exchange of information among people who are in close proximity to one another and 'communicate' with one another. Communication via telephone, fax, e-mail, etc. is a separate matter, as is the question whether improved communication via the aforementioned media can fully or partially replace the direct form of communication. What is certain is that all these media permit communication in a more or less reduced form and that restricting ourselves to only one of these forms of communication would lead to changes of perception and people may be misinterpreted. This means that for direct communication it is necessary to have a place where people meet to talk and negotiate with one another. Depending on the situation - a simple rendezvous or a company meeting - different places will be chosen.

Since office work often involves communicating with colleagues, a meeting place should be in the immediate vicinity of the workstations (in the same room). It should facilitate communication by virtue of its spatial arrangement, its furnishings and its light. The atmosphere and the furnishings of this place are extremely important. Light can help to create the right mood and to differentiate the area from the actual workstation. Communication requires that proper recognisability of the faces of those concerned should be created. This calls for very balanced vertical illuminances on people's faces. The correct illuminance on the desk or conference table is by no means a guarantee of clear recognisability of faces. Two rows of strip lighting on or mounted in the ceiling, or suspended parallel to the frontage, certainly will not create a suitable negotiating atmosphere. As people often communicate between two opposite desks, the workstation light also has to meet the requirement for good communication light. This requirement



A modern administration building with group offices during day ...



...and night.

for a 'communicative atmosphere' is particularly important in meeting and conference rooms separated from the workstations.

The size and shape of the work room, and its fittings and furnishings, have to fulfil the personal requirements of the user. It is often thought that, in order to meet these requirements, it is enough to have an ergonomic design of the office chairs and equipment. Even a shabby, poor-quality fitted carpet or failure to meet personal wishes regarding the furnishing can result in a lower work performance. Standardised offices with standardised furnishing that suggests absolute uniformity are certainly not appropriate for highly specialised, sensitive 'brainworkers'. Similarly, lighting or furnishing that suggests that 'economy' is the basic criterion shows that importance is attached to interests other than the needs of the users.

The personal touch in an office lies not only in the fact that someone has put up his or her own posters or pictures on the wall or is allowed to personalise his or her desk to some extent, but in the degree to which the user of an office personally identifies with the room, the furnishings and the working conditions. An array of hundreds of offices of the same calibre with the same furnishing and equipment and the familiar two strip luminaires (reflector grids 1 x 58 W that comply with the BAP standard) parallel to the frontage are not calculated to create a rapport between user and office workstation.

Basically, artificial light has to create the right atmosphere for work. To this end, it should be zoned (clearly noticeable concentration of light) and adaptable to personal needs. In order for light to be 'personal light', it is essential that people should be able to dispose over it and be involved in its design.

A luminaire, moreover, does not become better by the mere fact that it is controlled as a function of daylight. Nor do imitations of daylight cycles in artificial light affect the acceptance of an office workstation, because artificial light, however good, shows during the day that the natural light is not sufficient or of sufficient quality.

A room has to be designed so that it is easy to survey (no dark, visually inaccessible areas) and the workstation should make it possible to direct one's gaze to the window and to the entrances/exits. Light and ambience should not create an atmosphere of monotony and should be re-designed at appropriate intervals, since changing attitudes and fashions call for changes to the furnishings and materials.

If one compares the lighting design criteria referred to in this article with current practices, one finds considerable differences. Given the ever-growing importance of the service sector, it would appear to be urgently necessary to reconsider current lighting and design practices in workplaces and to create a working environment that does greater justice to people. ■

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A conference room with a good daylight atmosphere.



Lighting design in corridors.



Office lighting details. Finely distributed light in the coffered ceiling and architecture-oriented indirect light and direct light for specific zones.

Excellent daylight, the clear ceiling and lighting design, together with personal touches in the workplace design, result in good working conditions.



Figure 2. Test rooms (left: test room 1, middle: interior test room 2, right: exterior test room 2)

The second test room is a rotating office (dimensions 5.4 x 5.4 x 2.7 m). The room is located on the top of a two story building (see fig. 2), with an unobstructed view in all directions. To the north there is located a high reflective building (one story). The window area is smaller than in the other test room. The facade consists of 35% glass (from sill  $h=0.8$  to ceiling  $h=2.7$ m with two closed parts of 1.35m on both sides). Additional parameters varied in the second test room are orientation (north, east, south and west), sky condition (overcast sky and sky with sun) and the effect of reduction of the height of the window top (window top at  $h=2.7$  and  $h=2.4$ m).

### 3. Results And Discussion

In a previous publication [5] we have shown that the retinal illuminance in an office room is dependent on the working position. Figure 3 shows that the required amount for healthy lighting (1000 lux) is not reached at any of the working places for window illuminances varying between 2000 and 4000 lux for an overcast day in February (in test room 1). This figure also shows that supplementary electric lighting is necessary because the daylight contribution is generally too low.

Nearly all offices in Western Europe are equipped with vertical daylight openings. When designing daylight openings one of the main points of interest is to make use of as much daylight as possible. Currently used calculation methods [2] are based on the horizontal illuminance in the open field under an overcast sky. The final window design is checked for the minimum lighting levels at a horizontal area (on visual criteria).

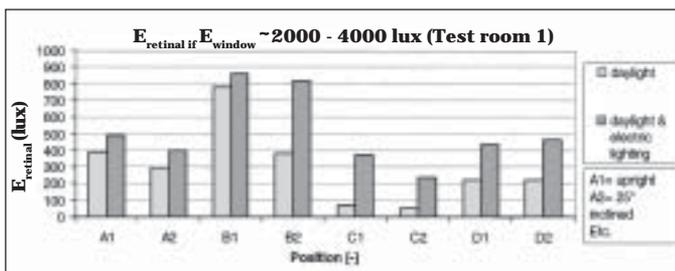


Figure 3. Measured  $E_{retinal}$  for different positions and body inclinations if  $E_{window} \approx 2000 - 4000$  lux

Normally an office design is based on minimum daylighting levels (worst case) that occur when the sky is overcast. In the Netherlands approximately 20 % of the year the sky condition is overcast [6]. Designing a daylight opening in an office to meet healthy lighting (psycho-biological) criteria means that enough light should reach the eye. Assuming that  $E_{retinal} = 1000$  lux is needed for psycho-biological effects in the brain the minimum required values for  $E_{window}$  for the tested positions, sky conditions, orientations and a lowered window height, are shown in figure 4. From the measurements in test room 2 (overcast sky condition) the minimum value of light on the window is calculated for the requirement of  $E_{retinal} = 1000$  lux (fig.4) and for the requirement of  $E_{hor desk} = 500$  lux (fig.5).

As already stated a dark overcast sky condition is the worst-case situation but fortunately during on average 80 % of the year the Dutch climate has days with sunshine (clear sunny days or days with clouds and sun). On a clear day with sun and a few clouds the illuminances at the user positions in test room 2 are measured for

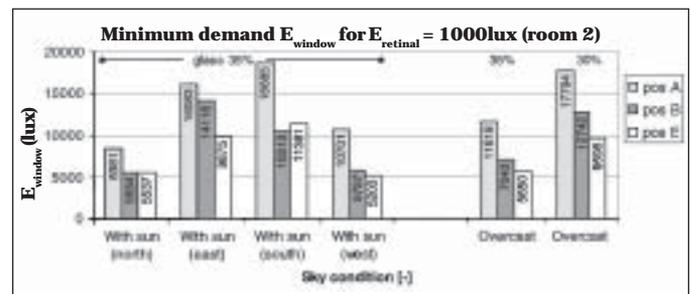


Figure 4. The minimum required values of  $E_{window}$  for  $E_{retinal} = 1000$  lux

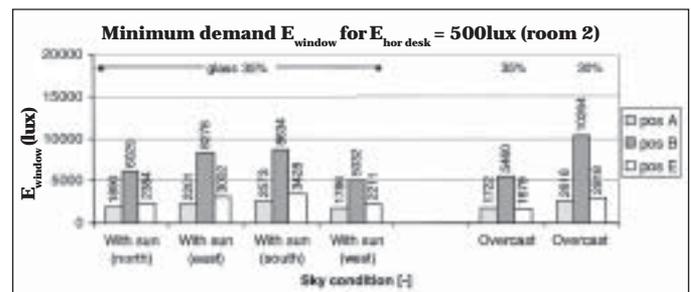


Figure 5. The minimum required values of  $E_{window}$  for  $E_{hor desk} = 500$  lux



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four orientations. In the morning in July, when the experiments were done, the east and south facade received direct sunlight. Diffuse daylight entering through a vertical window causes a higher vertical illuminance than direct sunlight. Especially in summer the direction of direct sunlight is more vertical (downward) and less effective to cause high retinal illuminances. Although  $E_{\text{window}}$  might be high enough on sunny days usually this causes visual discomfort and sunscreens will be used that reduce the amount of daylight entering the room. More daylight at the facade does not always mean higher retinal illuminance. Results for the north orientation (fig.4) show that reflections from clouds and high reflective areas are more effective in increasing the amount of light at the eye than direct sunlight at the facade.

For a window with a window top at ceiling height between 5500 and 12000 lux is needed at the window (dependent on the position in the room) to get sufficient light (1000 lux) at the eye (fig.4). To obtain 500 lux at the horizontal desk between 1600 and 5500 lux is needed (fig. 5). When lowering the height of the window top from  $h=2.7$  to  $h=2.4$ m (glass area reduction from 35 to 30% of the facade) much more light, between 2600 and 10000 lux is needed to reach the demand of  $E_{\text{retinal}} = 1000$  lux (see fig.4). In the case of sufficient daylight to obtain the required retinal illuminance the horizontal illuminance at the working plane increases from 1300 to 4900 lux. The horizontal illuminance in the test room will largely exceed the standard required 500 lux. Too high horizontal illuminances may cause visual discomfort. Current designs for facades and office rooms do not meet simultaneously all demands for healthy office lighting.

For a north orientation (wall-to-wall window from sill  $h=0.9$ m to ceiling) the percentage of the time between 8 and 18 hours that the daylight level at the desk exceeded 500 lux has been plotted in figure 6. In the same figure the percentage of the time that the daylight level at the window exceeded 10000 lux has been plotted. With this window design there will be enough light at the desk during more than 80% of the time from March to September.

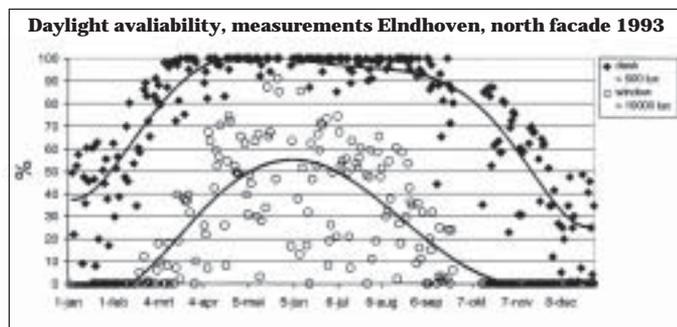


Figure 6. Exceeding levels for  $E_{\text{hor desk}}$  and  $E_{\text{window}}$  [7]

High illuminances at the window necessary to get 1000 lux at the eye (with daylight only) are available at least 50% of the time from May to July. Especially in the dark period (October-March) when biological light stimulation is particularly relevant, daylight levels are much too low to achieve  $E_{\text{retinal}}$  values  $> 1000$  lux and additional electric lighting is required.

#### 4. Conclusions

- Designs for a daylight opening, facade and/or office room based on visual criteria for sufficient light on the horizontal working plane do not (automatically) meet criteria for healthy office lighting;
- In the case of sufficient daylight to obtain a retinal illuminance of 1000 lux the horizontal illuminance at the working plane increases to very (maybe unacceptable) high values;
- Diffuse daylight entering through a vertical window causes a higher vertical illuminance than direct sunlight. Because of the angle of incidence the contribution of direct sunlight on the retinal illuminance is low;
- The amount of light entering the human eye is not directly related to the horizontal illuminance on the working plane. Therefore when designing healthy office lighting both the horizontal illuminance and the retinal illuminance should be used as design parameters.

#### Acknowledgements

The authors thank the lighting company Etap for their collaboration in making their test room (test room 2) in Malle (Belgium) available for the measurements described in this paper.

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## **New Efficient Tubular Daylighting System for Multi-Floor Buildings**

*L. Whitehead, A. Kotlicki, D. MacKay, J. Schultz, E.J. Lee*

### **Abstract**

We have developed and tested a concentrator-based tubular daylighting system that combines new features to reduce capital expense and enable multi-floor illumination. At each floor, this system employs sun-facing multi-function glazed canopies in the building envelope. The canopies run horizontally along the south wall, above the windows and adjacent to the ceiling cavity.

Daylighting is achieved via a new solar concentrator design which is compatible with these solar canopies. The key concentration element in each canopy is a light-weight, cylindrical Fresnel lens whose axis runs horizontally along the length of the canopy, and whose orientation is adjusted, by means of low cost electric actuators, to track the solar elevation. Next, the focused light is captured and re-directed by a curved, flexible, dielectric waveguide that adapts to the changing orientation of the Fresnel lens. The light is then deflected into a light guide running along the length of the canopy, which conducts the light toward, and deflects it into, the input apertures of light guides running above the building interior. Because these interior light guides occupy only a small fraction of the ceiling cavity, they are modest in terms of both space and cost. The cost effectiveness of these interior guides is further enhanced by their simultaneous role as highly efficient luminaries for fluorescent lamps that operate whenever sufficient daylight is not available.

We believe this combination of features has the potential to yield truly economical daylight-based energy savings in a substantial fraction of the floor area of conventional multi-storey buildings.

**Keywords:** daylighting, light guides, solar concentration, Fresnel lens concentrator

## **1. Introduction**

For some time, a variety of systems have been proposed in which daylight is captured at the exterior of a building [1-3] and subsequently piped [4-11] into interior regions in order to facilitate a reduced electrical lighting load. Although these systems provide a number of benefits, it is important to consider the required capital expenditure per GJ/yr of energy savings, and unfortunately until now such costs have been prohibitively high in comparison to alternative capital investments for energy savings.

In this regard, it is helpful to divide tubular daylighting systems into two basic categories -those that first concentrate and then guide daylight and those that guide un-concentrated daylight. In the former case, the capital cost of the concentrators has been prohibitive, because they require complex moving parts in large weatherproof enclosures, but the subsequent light guides are relatively small and therefore cost-effective. Conversely, in the case of non-concentrating systems, the intensity of the guided light is low, which requires larger, more expensive light guides that occupy considerable valuable building space. Thus, in both cases, the capital costs have been too large, relative to the resultant energy savings, for these systems to be justified in purely economic terms. As a further difficulty, the daylighting systems that are closest to being cost-effective generally work well only for space near the roof of the building and thus offer little benefit in multi-floor buildings.

In this paper, we present a new style of concentrator-based tubular daylighting that combines two unique attributes to reduce capital expense while being amenable to multi-floor application. The first new attribute is the inclusion, in the building envelope, of sun-facing multi-function glazed canopies. For each floor, a canopy runs horizontally along the south wall, above the windows and adjacent to the ceiling cavity. This structure intercepts and admits most of the sunlight that would otherwise fall on the window, and the structure can be economically justified by the inclusion of three additional well-established solar energy features, namely shading, photovoltaic electricity, and heat. In terms of shading, a substantial energy benefit during high temperature weather conditions comes from the reduction of glare and heat load as a result of shading by the canopy. As well, most of the light that enters the canopy strikes photovoltaic cells, which are inexpensive because they need not be weatherproof and the resultant electricity is used in the building or fed back to the grid. Finally, as most of the energy incident on the photovoltaic cells is converted to heat, the hot air in the structure can be drawn into the building during low temperature conditions.

The second new feature of this system is a solar concentrator design which will fit in the confines of the

solar canopies while not interfering unduly with the other canopy features, and which is amenable to low cost mass production.

We also present a related efficiency improvement to increase the cost effectiveness of these interior guides through their simultaneous use as luminaries for fluorescent lamps that operate when sufficient daylight is not available.

## 2. Solar Canopy Design

Figure 1 shows a typical building cross section, viewed from the west. As depicted, the solar canopies are located just above the windows on each floor, adjacent to the

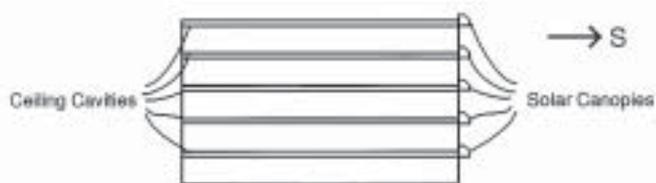


Figure 1 Example Building Cross Section Depicting Location of Solar Canopies

ceiling cavity. They are large enough to substantially prevent direct sun from striking the window during the hottest period near solar noon, but they still allow a reasonable view of the sky, which is important to building occupants.

Figure 2 schematically depicts the cross sectional arrangement within one solar canopy. The canopy has four solar energy related functions, the first of which is its ability to shade the windows from direct sunlight. The second function is the inclusion of photovoltaic panels to absorb most of the incident solar flux and feed power to the building and/or the electrical grid. Since most of the incident flux eventually becomes heat, the canopy can also direct the heated air within the canopy structure into the building under low temperature conditions. The fourth solar energy function is daylighting, which is achieved by capturing and focusing a portion of the incident flux on the canopy using a cylindrical Fresnel lens, as shown in Figure 2.

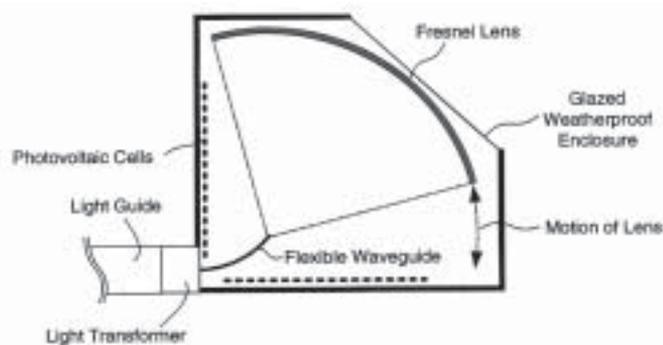


Figure 2 Schematic Drawing of a Solar Canopy

The incoming direct daylight is first focused by the Fresnel lens to a strip about 25 mm wide, running the length of the canopy. This light is captured by a curved, flexible, dielectric waveguide, as also shown in Figure 2.

## 3. Solar Flux Transformer

The concentrated light leaving the flexible waveguide is deflected into a narrow gap running along the length of a rectangular hollow light guide lined on the inside with multi-layer dielectric reflector, and oriented such that its axis is parallel to the long dimension of the solar canopy. The guide conducts the luminous flux toward, and then deflects it into, the input apertures of the light guides running into the building interior.

This distribution light guide, which we call the solar flux transformer, operates in three stages - input, linear diffusion, and output. In the input stage, a deflector prismatic sheet refracts the incident light into a range of directions near the guide axis direction, so that it can be guided efficiently. In the subsequent linear diffusion stage, the light guide distributes the light in the axial direction. On the side of the guide opposite the input aperture, exit apertures, measuring 10cm wide by 20 cm high are spaced 3 m apart. These apertures are aligned with the interior guides and contain a prismatic film whose job, in the output stage, is to intercept a portion of the light within the flux transformer and deflect it into the guide, in a useful range of directions.

## 4. Hybrid Solar - Fluorescent Luminaires

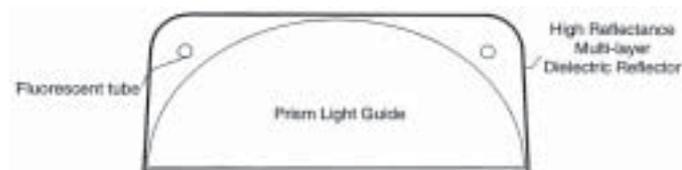


Figure 3 Cross Section of the Hybrid Solar - Fluorescent Luminaire

The interior light guides are conventional prism light guides, but with a modified cross sectional design that allows the incorporation of fluorescent lamps. In this way, the polymeric light guide structure functions both a guide and as a luminaire, which adds to its cost effectiveness.

## 5. Photometric Testing

We have constructed and tested the efficiency of all components of the systems described above, prior to the inclusion of automatic control, and installation in an operational building.

Using Monte Carlo Ray tracing we predicted the expected flux input to the interior light guides, and we also predicted the efficiency with which the interior light guides delivered the solar flux and the flux emanating

from the fluorescent lights, into the room below. We verified these values by manually integrating the multiple illuminance readings over the test area. We found substantial agreement between these methods, to within the approximate 20% accuracy of these tests. More accurate tests are planned for the next stage of the project.

To summarize these results, for each interior light guide (responsible for a 3m width of floor), we found that the prototype solar concentration system delivers approximately 9700 lumens of sunlight to the interior guide, during the period within +/- 3 hours of solar noon. The efficiency of the interior guides is 65% for the solar light, and 85% for the flux from the fluorescent lamps. (The difference is due to guidance losses in the guide.) It should be noted that our prototype solar concentration had a light loss of about 45% in the flexible guide due to absorption by the polymer used in this demonstration. In the next stage of this project, we intend to reduce this loss to less than 10%. With this and other improvements, we expect the final system to deliver 20,000 lumens of solar flux to the guide, sufficient to illuminate a region lying within 10 m of the building perimeter with conventional levels of illumination.

## 6. Economic Considerations

We believe it is reasonable to expect that the three conventional solar energy features of shade, photovoltaic power and solar heating will largely justify the capital cost of the glazed canopy. This means that the canopy can provide, essentially free of charge, a weatherproof enclosure for the solar input of the tubular daylighting system. Because the interior light guides double as fluorescent luminaires, their capital cost can also be largely justified. As a result, the portion of capital expense which must be justified by the daylight-related electrical power savings is restricted mainly to that of the Fresnel lens concentrator. While it is premature to draw a conclusion, these early considerations bode well for overall system cost effectiveness.

## 7. Conclusions

This system looks promising from several different perspectives. The next step in developing this concept will be to install and monitor test demonstration systems in numerous settings.

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## NEWS ABOUT MEMBERS

### P.K. Bandyopadhyay at Jadavpur University

We have been informed by Prof. T.K. Basak, Head of Electrical Engineering Department at Jadavpur University, that Mr. P.K. Bandyopadhyay, Past President ISLE and presently Director, CIE India Committee has been appointed Visiting Professor under the UGC Scheme at Jadavpur University. We wish him every success in his new assignment.

## Sunlight Without the Sun's Heat

One of the drawbacks of daylighting is the undesirable heat of the direct sun, particularly in the tropics and in the summer months. All the currently available tinted glazings absorb about equally in the visible and infrared range making them unattractive for blocking the direct sun's heat selectively.

A development by a team of scientists at the University College London, of a vanadium dioxide coated glass offers a means of blocking sun's heat selectively. This coating acts as a semiconductor up to a temperature of 70°C and transmits both visible and infrared. Above this temperature it switches to a metal-like state and reflects away the infrared wavelengths. The team at the University College London succeeded in lowering this transition temperature to 29°C by doping the material with tungsten metal. When the temperature reaches 29°C, the heat is reflected away without letting the room temperature rise due to direct sun.

They have also developed a method of incorporating the deposition of the coating into a conventional glass manufacturing process. This reduces the cost of commercial production of the coated glass.

There are however problems of durability and unattractive yellow-green colour of the glass. These problems are being addressed and it is expected that there would be available soon a window glass which can selectively reduce the heat loading inside buildings and make daylighting attractive for lighting of building interiors and effect savings on conventional energy.

## Carbon Nanotubes and Leds

Carbon nanotubes are cylindrical graphite structures discovered by the Japanese scientist Sumio Iijima in 1991. These were found to have extraordinary electrical and mechanical properties and found their way into different technologies including that of lighting.

It was found that carbon nanotubes can play a role in hastening the progress in the technology of LEDs. White light LEDs are available in the market. But for LEDs to replace the cheap tungsten filament lamp they must be more efficient and less expensive. A problem in the present day LED technology is the metal-semiconductor resistance barrier which heats up the LED and results in loss of energy and lowering of life. The use of carbon nanotubes at the junction, it was found, reduces this resistance leading to more light from the LED with less power and longer life.

The cost of carbon nanotubes is at present prohibitive but is expected to come down soon when high efficiency and cheap LEDs using carbon nanotubes can compete with tungsten filament lamps.

V.D.P. Sastri

## WEBWATCH

### Researchers Use Blue Light to Treat Sleep Disturbances in the Elderly

In a recent pilot study, scientists at the Lighting Research Center demonstrated how exposure to blue light can reduce sleep disturbances and increase the likelihood of stable, consolidated sleep in seniors. The study included subjects with Alzheimer's disease, an illness often accompanied by severely irregular sleep/wake patterns, as well as those without dementia who simply have trouble sleeping. The study built on previous LRC research conducted in 2002. "The consistencies in our research support the theory that blue light can be a powerful, non-pharmacological treatment for sleep disorders in seniors and should be considered in the design and operation of senior housing," said Mariana Figueiro, Ph.D.

Full story at <http://www.lrc.rpi.edu/resources/news/enews/Apr05/general245.html>

### Breakthrough Technology Accelerates Solid-State Lighting

Scientists at the Lighting Research Center have developed a method known as "SPE" to get significantly more light from white LEDs (light-emitting diodes) without requiring more energy.

"We have developed a technology based on a new scattered photon extraction (SPE) method that will speed up the progress of solid-state lighting and help secure our nation's energy future," said Nadarajah Narendran, Ph.D., director of research at the LRC. Compared to commercial white LEDs, prototypes of the new SPE LED technology produced 30-60 percent more light output and luminous efficacy.

<http://www.lrc.rpi.edu/resources/news/enews/Apr05/general251.html>

### Lighting Plans

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A source for contractors, lighting designers, and custom homeowners interested in energy efficient lighting for new construction or remodels. Energy efficient lighting is a wise choice for any residential home: increase lighting performance while decreasing energy costs significantly.

More info at this link:

<http://www.lightingplans.com/index.html>

## LEDs Shine on Mona Lisa's Smile

Five hundred years ago, Leonardo da Vinci painted his famous portrait entitled, "Mona Lisa."

The technology that illuminates her famous smile is totally 21st century.

Today, you can see the Mona Lisa in the colors da Vinci intended, thanks to a new LED light shining on the masterpiece in a new room in the Louvre.

Fraen Corp., which specializes in optical design, developed a complex lamp with seven LEDs. The lamp's optics optimized the color rendering outcome -which was a high priority for the Louvre museum's leadership.

Full Story here: <http://www.lighting.com/content.cfm?id=1143&sid=9&page=/>

and here: <http://www.louvre.fr/louvre.htm>

## Kuwait Public Building Case Study

**The year:** 1994, long before most lighting designers were thinking "LEDs"

**The building:** Public Institute for Social Security in Kuwait

**The challenge:** Design an exterior lighting scheme worthy of this government building's stature, while incorporating festive lighting that will change from event to event and year to year.

**The lighting designer:** Kevan Shaw Lighting Design from Edinburgh, Scotland.

**The outcome:** Dynamically changing light on this 23-story building's facade, which appears to get a "new face" when its lighting program changes.

Lighting designer Kevan Shaw outlined his experiences on this ground-breaking project at a LightFair International 2005 workshop.

Full Story here: <http://www.lighting.com/content.cfm?id=1144&sid=9&page=/>

and here: <http://www.kevan-shaw.com/projects/commercial/pifss/pifss.html>

Anool Mahidharia

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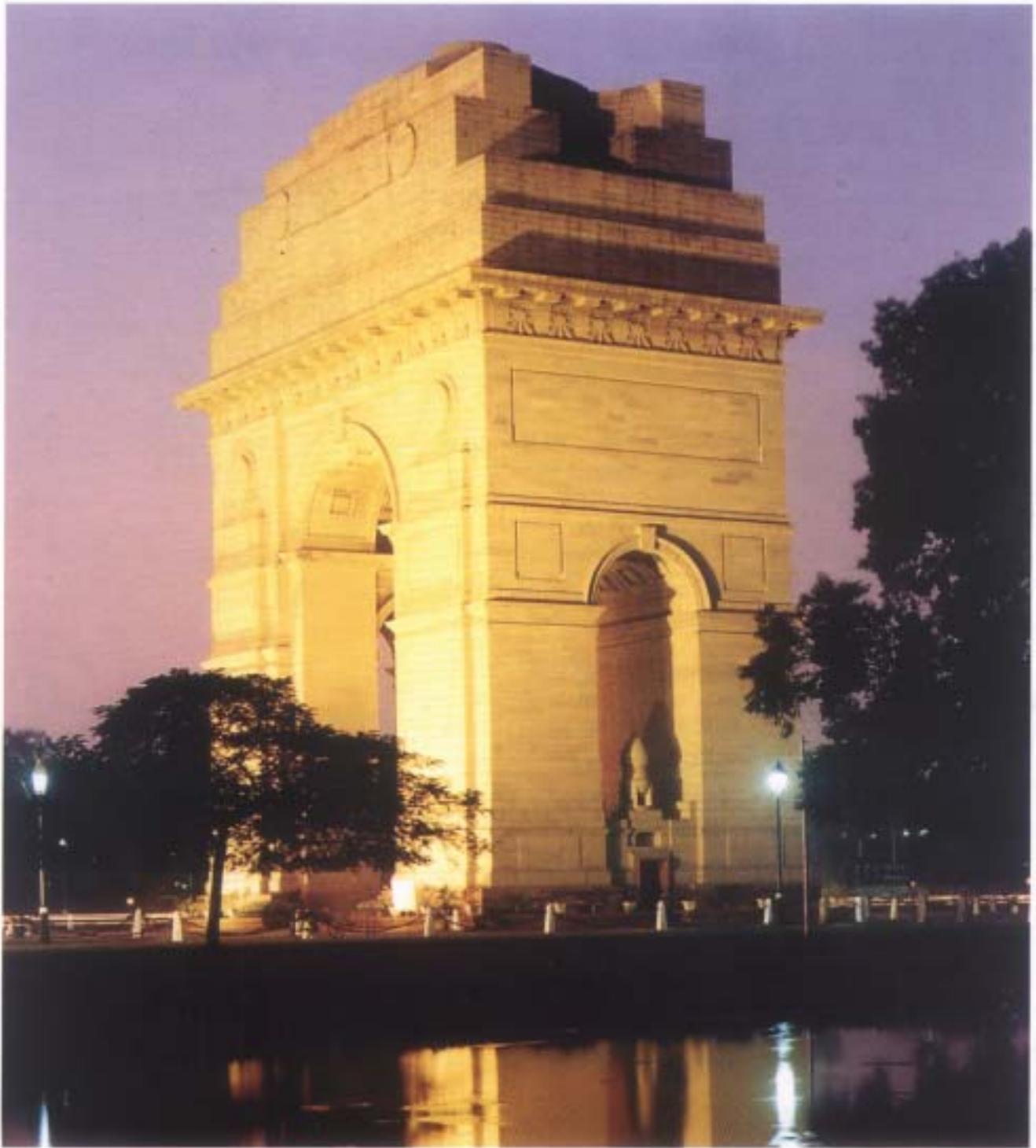
  
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