LIGHTING ENGINEERING CENTER – LEC
CENTRUL DE INGINERIA ILUMINATULUI – UTC-N

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Lighting Engineering Center - LEC – was created following the Tempus-Phare programme CME-03551-97 [15 December 1998 – 14 March 2000] – see the web site
http://bavaria.utcluj.ro/~lec.

The LEC activity was presented in the previous issues of the journal (1 – 13), beginning with **25 April 2000** when its establishment was approved by the University Senate Council until **September 2004,** the editing date of the issue no. 13 (Summer) 2004

3 November 2004 ***GEWISS*** ***–*** *Global sistems of electrical installations for residential, commercial and industrial sectors,* Seminar organised in cooperation with S.C. PRAGMATIC Comprest S.R.L. and S.C. MEDIROM S.R.L. – Romanian Agency for GEWISS products. There were presented the activity of PRAGMATIC – Mr. Vasile RUSU, manager, Lighting Engineering Center – Dr. Florin POP, Professor, GEWISS - general presentation – Mr. Cristi BĂLAN, manager, Electric systems EURODOMO, EURODIN and EUROBLOC, EUROBOX and EUROPASS, EUROLITE and Software package for electric installations design.

18-20 October 2004 *The IVth International Symposium on Energy Efficiency,* Electrica S.A. Transilvania Nord, Cluj-Napoca. LEC members contributed with two papers: The rehabilitation of pedestrian lighting in residential areas of Cluj-Napoca, authors Dr. Dorin BEU and Dr. Florin POP - Universitatea Tehnică din Cluj-Napoca, Lighting Engineering Center, eng. Nicolae CIUGUDEANU and eng. Speranța NEDELCU – ELECTRICA local branch FDFEE Transilvania Nord; Architectural lighting, daylighting and artificial lighting, some thoughts concerning trends and costs, author Dr. Florin POP.

Round Table ***Energy Efficiency in Lighting*** chairman Dr. Florin POP:

- *Building interior lighting with daylight – requirements, efficiency, costs*, Dr. Florin POP, Universitatea Tehnică din Cluj-Napoca
- *Comparative study of the energetics and economics criteria in the anlaysis of the technical accepted systems in exterior lighting*, Corina MARTINEAC, Virgil MAIER, Sorin G. PAVEL, Universitatea Tehnică din Cluj-Napoca
- *Regarding the new lighting norm NP 061-02 apply in interior lighting of the office buildings*, Dr. Dorin BEU, Universitatea Tehnică din Cluj-Napoca
- *Evaluation of the light sources efficiency for the streets lighting*, Marilena MĂIEREAN, Energobit Schrèder Lighting, Cluj-Napoca
- *Fuzzy, fuzzy-neural and neural control of interior lighting depending on daylight contribution. Comparative study*, Horațiu Ştefan GRIF, Adrian GLIGOR, Universitatea "Petru Maior" Târgu Mureş
- *Energy-efficiency approach of the lighting electric installations projects and their implementation* **-** Presentation of some electric and lighting designers, constructors and dealers on the local area.

Dr. **Florin POP** and Dr. **Dorin BEU** contributed to The Bucharest 2004, International Lighting Symposium, Quality Solutions for an Efficient Lighting, Bucharest, 30 September – 2 October 2004, The 5th National Lighting Congress, Istanbul, 7-8 October 2004.

Professors Dr. Florin POP and Dr. Marc FONTOYNONT were nominated to Report to the Ph.D. thesis of Mrs. Oana DOBRE, Contribution au calcul et à la conception des systèms d'éclairage intérieur par tubes de lumière, 17 December 2004, Université de Savoie, France. The thesis was elaborated under the coordination of Professors Cornel BIANCHI and Gilbert ACHARD.

INGINERIA ILUMINATULUI – Lighting Engineering journal, with a half-yearly appearance, is edited by the consortium of the Technical University and MEDIAMIRA Printing House. Its scientific presentation and content is targeted to the continuing education in the lighting field, without any insertion of the commercial advertisings inside of its pages.

LEC members are involved in working-out of different **lighting systems optimization studies** and **lighting design projects** for local owners. Two interesting projects were designed to the rehabilitation of pedestrian lighting in residential areas of Cluj-Napoca and Dej.

On the university cooperation field, there is a continuity under the frame of the UE institutional university programmes with the Helsinki University of Technology (Professor Liisa HALONEN, Lighting Laboratory), Universitat Politecnica de Catalunia (Professor Ramon SAN MARTIN, Estudios Luminotecnicos), and University of Liverpool (Dr. David CARTER, Reader, Lighting Research Unit).

The Lighting Engineering Center LEC is developing its activity on the Lighting and Electrical Installations Laboratory of the Building Services Department of the Technical University of Cluj-Napoca. The rehabilitation and technical modernization of its space was partially financed by the Tempus-Phare programme, the university resources, the funds received on the research grants, and postgraduate courses and sponsorships of lighting/electric installations companies and former students:

PHILIPS Romania/FLASH Transilvania
OSRAM Romania
TOTAL Quality/ACI Constructions and Installations
LEGRAND Romania/Electro Daniella
PRAGMATIC Comprest
ABB Romania
ELBA

LIGHTING IN THE NEW WORLD

Cristian SUVAGAU
BC Hydro, Vancouver

Lighting and health

In today's world, economical engines of modern societies are functioning continuously, without any stop. Globalisation is twisting time zones, internet and satellite communications have virtually eliminated distances, pushing economies around the world to a stage of "perpetum mobile". And many workers have to adopt the same functional patterns. However, these employees can not perform like machines, constant over the 24-hour day; rather their productivity, alertness, and mental performance diminishes on the night shift.

For thousands of years, humans have awakened with the sun and slept at night. It has only been during the past century that we have broken with what nature dictates. And artificial light is the key factor. Indubitably, one of the most pushing forward inventions for humanity, electrical lighting is showing its limits when human activity patterns are becoming too "artificial":

- In western societies, people spend up to 90% of time indoors
- We are destined to be a 24-hour society even though human physiology intends us to be awake during the day and asleep during the night. In North America, up to 25 million people work irregular shifts, with the majority forced to work through the night shift.
- Lighting design in buildings addresses mostly the horizontal illumination levels and not the qualitative factors that define the well being of the occupants: visual comfort, aesthetics, productivity and communication, energy efficiency, architecture integration.

The old emphasis on lighting for visibility alone has given way to a more comprehensive model of lighting quality, in which lighting must meet many human needs while being integrated with the architecture, the environment and the economic conditions. Lighting for good health is part of this definition.

The Circadian Cycle

And we thought we knew (almost) everything about how light interacts with the eyes and the brain. That is still true for the visual process: light reaches the retina, and rods and cones transmit the information via the neural connections to the visual cortex.

However, recent research showed new findings about the second light related process: non-visual, or photobiological. Thus, light signals received at photosensors in the retina are transmitted to other areas in the brain (like the hypothalamus) and leading to a cascade of hormonal changes in the pituitary, pineal, adrenal and thyroid glands. The resulting series of neuroendocrine changes are responsible for regulating the human body's daily biological rhythms - also known as circadian rhythms - including the sleep-wake cycle, alertness, and hormone production.

The circadian rhythm is probably the area of most of the ongoing research on non-visual lighting impact. The oscillation of hormones the circadian rhythm induces has a profound effect on most physiological functions in the body including the immune system. When this process is disrupted through environmental light changes, it may lead to some of the more damaging emotional and physiological effects associated with seasonal depression (SAD), jet lag, and shift work.

Researchers have found some of the light factors that determine the adjustment of the circadian cycle in humans:

- ***light intensity and duration***; research found that higher intensity levels in work environments during dark hours could be beneficial. However, more study is required to establish adequate levels of light intensity and duration.
- ***timing***; because of circadian fluctuation of immune responses, it is possible to adjust the time of day a particular disease is treated to optimise the immune response. This is known as chronotherapy. For instance, researchers have found that treating cancer in the evening, when the cancer-fighting immune cells are activated, is much more effective than administering the treatment at random times of day. Chronotherapy is now being considered as an adjunct to treatment of disorders other than cancer, for instance autoimmune disorders, heart disease and diabetes, which have circadian components.
- ***wavelength***; recent research (see next) finds that the blue light is more effective in suppressing melatonin.
- ***pattern and contrast***
- ***light history;*** previous light exposure may influence light sensitivity of the human circadian system. A lower light sensitivity may facilitate a phase delay, which has been associated with increased daytime sleepiness and sleep difficulties.

New Retinal Photoreceptors

Let's start analysing the connectivity between circadian rhythms and light, by starting with the retina. Very recent research introduced another set of retinal photoreceptors beside the well-known rods and cones: the intrinsically photosensitive retinal ganglion cells (abbreviated ipRGC). These ganglion cells are the ones that carry the light stimulus to the photobiological neural pathway, to control the circadian rhythm (as well as other metabolism responses). More evidence about this role of ipRGC has been supplemented by findings that special strains of rodents genetically bred to have no rods and cones are active still following a light-dark cycle. Moreover new research proposes that there may also be secondary photoreceptors in the skin that control alternative circadian mechanisms.

The ipRGC contain a chemical called melanopsin, similar to the photopigments in the rods and cones. Melanopsin is then instrumental in determining the pineal gland to produce or suppress melatonin, a hormone closely related to the body's master clock. Under normal circadian conditions, there is a small peak of melatonin production every afternoon at about 4PM and a much larger peak released later in the evening between approximately 10PM and 3AM. Darkness conditions also stimulate the melatonin production.

To conclude, melatonin levels remain high for most of the night while we sleep, then drop in the morning as we awaken.

Analysing the characteristics of ipRGC, one can conclude that these are ideal for simple "day or night" detectors:

- Peak sensibility in the blue colour (near 480 nm), matching the spectral distribution of the diurnal sky.
- Slow reaction speed (about 10 seconds compared with milliseconds for cones and rods) makes them insensitive to rapid changes in ambient lighting.
- Spaced sparsely throughout the retina (estimated at about few thousands compared with millions of cones and hundred millions for rods) ipRGC can not identify details as cones do.

So, ipRGCs seem to help regulate circadian rhythms in response to light (daytime or nighttime). Also they may be responsible for the eye's "blue" sensitivity (for example towards cars with MH headlamps and high colour temperature-above 5000K-fluorescent lamps). It could also explain why daylighting seems to increase visual and well-being comfort levels for office workers, increase retail sales and boost education results in schools, as recent research from the Heshong-Mahone group has found.

If these hypotheses could be proved scientifically, it would lead to major transformations in lighting equipment and design. To obtain the same visual comfort and performance, designers could use lower wattage, high colour temperature fluorescent systems and save energy. Moreover, these savings could be augmented by using integrated controls for daylighting and artificial lighting.

Blue Light Suppresses Melatonin

In recent years, researchers have learned that bright white light suppresses melatonin. Previous studies have also suggested that melatonin suppression reacts differently to light of varying wavelengths, specifically showing a maximum sensitivity to short-wavelength ("blue") light.

A study published in NeuroReport by LRC (Lighting Research Center, New York), shows that 18 lux of blue light from light-emitting diodes (LED) is more effective at suppressing melatonin levels than 450 lux of clear mercury white light because a "spectral opponent mechanism" likely contributes to the circadian system's response to light. LRC researchers found that a form of opponency photo-process is involved in the suppression of melatonin by light in humans, making white light found in buildings much less effective at suppressing melatonin than thought.

Let's explain this "opponency". For colour vision, three types of cones (short, middle and long wavelength) process colour information in the retina corresponding to blue, green and red spectrums. The visual system separates cone responses into colour information processed by two opponent channels, the red vs. green and the blue vs. yellow. This is how we "see" colour.

In these opponent channels, light in one wavelength region (e.g., blue) increases a neural response, while light in the opposing region (e.g., yellow) decreases it. For example, colour of the ocean has a strong energy in the blue wavelength and an almost null one in the yellow spectrum. The neural response is then very high, so we end up seeing the ocean as "blue". When the energy in the opposing wavelength regions is balanced, the resulting response in that channel will be null, signalling that there is no colour, and hence no light at all. Similarly, in the case of the circadian system, a sufficient balance of light in each wavelength region results in a null response by the circadian system, just as if there is no light at all.

Until now the human circadian system was considered additive (if a certain amount of blue light and a certain amount of yellow light each produced the same level of melatonin suppression, then half of these amounts of blue and yellow added together would produce the same level of melatonin suppression). However, this theory is contradicted by recent study results showing a small amount of blue light producing a stronger suppression than a much greater amount of white light (blue plus yellow), suggesting the existence of spectral opponency in the human circadian system.

That explains why the circadian system in diurnal (active during the day) humans is preferentially sensitive to blue light, presumably the blue sky.

These findings show promise for a number of practical medical applications, including improving sleep quality in patients with Alzheimer's disease, advancing treatments for seasonal affective disorder, and studying effects of light on night-shift workers and premature infants.