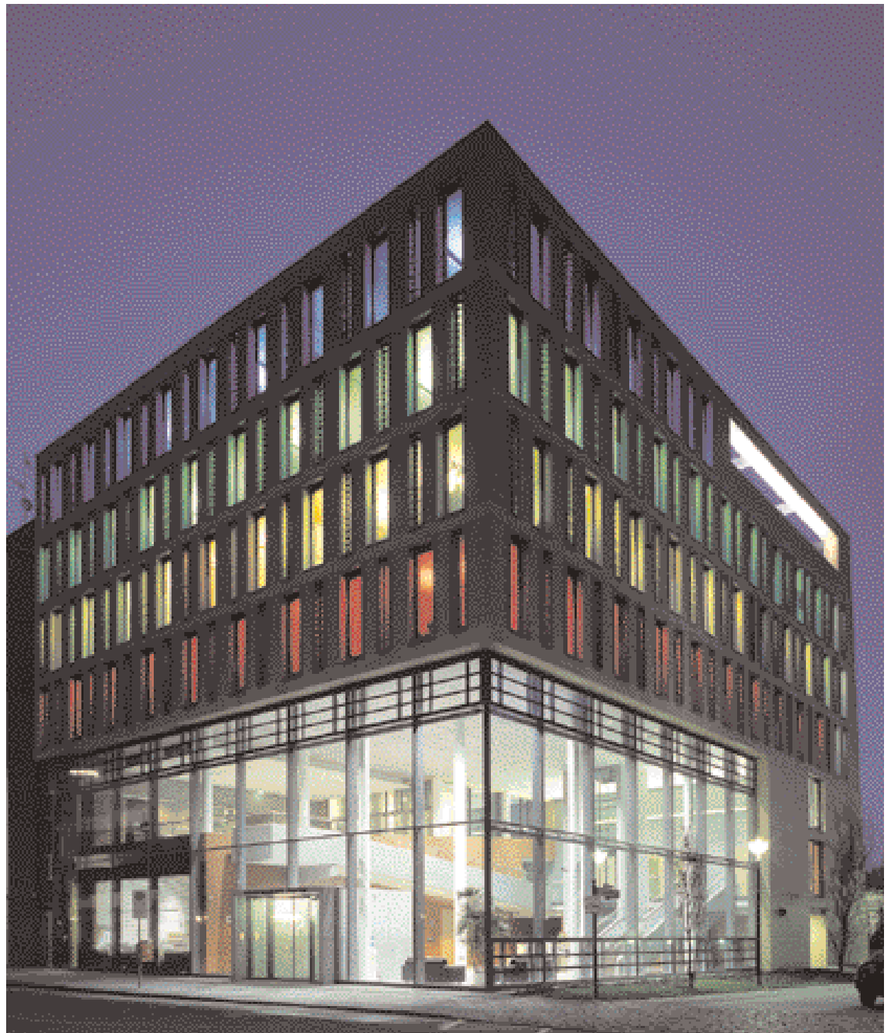
Effects of individualised light and colour design at the workplace

A pilot study and analysis of the impact of coloured light on the psycho-physiological well-being of humans in the office building of the Berlin Medical Society, Berlin/D.

With the advent of electricity and electrically activated light sources, work has become increasingly independent of daylight. This move towards artificial light sources has led to the alienation of our natural predetermined circadian rhythms and has been imbibed so well in our daily lives that it appears that we have forgotten previous diurnal cycles. And yet, despite numerous technical innovations and developments, daylight is still preferred to artificial light – a fact that continues to baffle many experienced lighting specialists, especially those with an engineering background.

The new office building for the Berlin Medical Society is located in the heart of Berlin/D.

The concept of dynamic colour changing office lighting is the brain-child of Michael F. Rohde, L-Plan/Berlin. Individualized choice light and colour design is exhibited at its artistic best on the façade, imbuing the building with a 'life force'. This force draws people to itself.



Almost since the beginning of workplace design, humanisation of the work sphere through better lighting concepts has been a major issue of concern. Though a number of research findings in terms of visual comfort have been recorded, very little investigation has been carried out on the positive effects of coloured light. Due to lack of adequate sophisticated technical devices and software such a design was not possible in the past. But with modern technology and the increased interest to develop a positive work environment the 'LUGH' – Project research team for Light, Health and Environment has carried out a pilot study to understand and analyse how the visible light spectrum enhances the proper functioning of the human body and emotional experience.

The project research team comprising Michael F. Rohde (Architect/Lighting Designer), Thomas Braedikow (Feng Shui Consultant), Dr. Michael Essers (Naturopath), Karolina M. Zielinska (Architect), Christine Pesch (Business consultant) and Amardeep M. Dugar (Architect/Lighting Designer) have pooled their experiences from their respective fields to carry out this study.

Their research is firmly grounded on the knowledge of: ancient sciences of healing and design (Ayurveda, Yoga, Pranic healing and Feng-Shui), modern medical sciences (Spectro-Chrome Colour therapy) and bio-physics (Fundamental Harmonical Research) in aspects relating to colour and human health. The office space of the Berlin Medical Society building has been used as a case study for this research.

A basic fact defined by this team is that Homo Sapiens are phototropic in relation to the complete light spectrum, which is an important property of daylight. This does not only depend on the time of the day, but factors like changing seasons, cloud movement and the course of the sun.

Based on these cognitive theories the research that is still in progress in the office space has shown that the value of light, luminous colour, and the colour rendering index have a considerable impact on the mood, motivation and physical well being of the employees. The idea was to give the user the option to modify – according to individual preference – the luminous colour in his space from the full spectrum of light. By applying additive colour mixing, which is possible with a specially designed RGB luminaire, every individual is able to choose the primary and subsequent mixtures of colours in the indirect component of the luminaire.

History of health and coloured light

For centuries, colour and its therapeutic values have been used by different civilizations to heal various kinds of diseases and ailments. Although times have changed, this concept still remains.

'Light metabolism' of human beings

Traditional Chinese Medicine (TCM) and ancient Indian health lore – Ayurveda and other superior levels of Yoga, have specified seven main energy points known as Chakras which affect main energy processes in the human body. Dr. Benoytosh Bhattacharya has stated that human kind depends on seven cosmological rays that are present in every matter. Also every individual cell in our body consists of seven rays. Based on the Chakra colour theory, a colour from the rainbow is present in each of the cells.

During their research in 1975 the scientific team headed by German biophysicist Dr. Fritz-Albert Popp (University of Kaiserlautern/ Germany) discovered astonishing facts about the light in our cells. Their findings have radically changed our understanding of the human body image. This unexpected research issue is still questioned today, but since 1975 biophysicists use the term, "bio-photonic radiation" to describe the fact that human bodies possess measurable "internal light". Some well known bio-scientists like Rupert Sheldrake describe additional morpho-genetic structure-forming biophysical fields around living beings called auras.

Today one component of the human energy field and also small fractions of Chakra vibration have already been proven scientifically through laboratory measurements. About twenty years ago Japanese scientists Dr. Hideo Uchida and Dr. Hiroshi Motoyama (University of Tokyo), stated that Chakras can be proven physically. The location of the Chakras has been investigated at the IBF (Institut für Biokybernetik und Freedback-Forschung) in Vienna during research tests. While measuring the electro-potential points along the spine that were exactly placed where the Indian Chakras are located, it was observed that there was a sudden change in the potential values when progressing downwards, which might explain the Chakra phenomenon.

Pranic healing

Pranic healing is a highly developed and tested system of energy-based healing techniques that utilize "prana" to balance, harmonize and transform the body's energy processes. 'Prana' is the Sanskrit word for 'life-force'. This invisible bio-energy keeps the body alive and maintains a state of good health. Pranic healing works on the principle that the healing process is accelerated by increasing the life force or vital energy on the affected part of the physical body. This healing is applied on the bio-electromagnetic field known as the aura. This bio-plasmic body absorbs life energy and distributes it to the organs and glands. Here one works with coloured prana which is targeted at the specific diseases or irregularities in the body. The healer extracts coloured prana (red, orange, green, yellow, blue, violet) from the primary white prana and targets it to the patients.




The primary aim of this project was to produce 'good individualized office lighting.' The idea of the RGB luminaire was to replicate the dynamic quality of daylight through the variable composition of luminous colours and light intensities with a high-tech luminaire design. The pictures depict different "lighting moods" produced by indirect lighting components.

Feng Shui
Feng Shui has been part of Chinese sciences for millennia and is the art of life in harmony with the visible and the invisible environment. Practitioners believe that with the flow of positive energy (Qi and Shen) it is possible to eliminate or prevent the influence of negative energy (Geo-Sha, Trans-Sha). This theory also states that each building possesses an external and internal structure-forming field, similar to the energy fields of the human body. With the support of coloured light in a space, it is possible to promote the flow of Qi energy and activate certain energy fields known as Bagua sectors, and bring them into positive balance.

Feng Shui practitioners have emphasised the significance of the variable correlation between human beings and space. Wu Xing or the "five principles of transformation" (Fire, Earth, Wood, Metal and Water) which are wrongly identified in the western world as "Elements" comprise non-real matter with abstract powers, essences or symbols for the fundamental attributes of matter. A specific colour of the rainbow (light spectrum) is assigned to each "element" and the appropriate application of coloured-light creates the harmonic balance.

Medical science and colour psychology
The latest findings in the field of social epidemiology and occupational medicine (Holick et al. 1998, 2001) have documented that lack of daylight exposure can result in de facto diseases and existential orientation disorders. Along with seasonal depression, which the people from Central Europe suffer from in winter (SAD – seasonal affective disorder), disturbances of natural bio-rhythms through work-shifts and 'jet-lag' can have adverse effects on human health. Similarly, for the modern work-sphere unpropitious lighting conditions are also responsible for the increase in the so-called "sick-building syndrome" (Flackenbach A. 1998, Rosen, C.J. 2001, Wilson N. 2002, Magnusson A. 2003, Goel N. et al 2003).

The scientific findings from a clinical light research investigation underline the importance of sufficient natural and artificial light for modern human beings. They have documented that not only heart-circulation-parameters, vegetative functions of the body, skin diseases and bone metabolism, but also mental and psychological existential orientations can be positively affected through adequate exposure to light. Effective and successful modern and future lighting design concepts should be based on or oriented towards these scientifically proven facts (Krause et al. 2001, Hönigsmann H. 2001, Hastings M.H. 2001)

Above all, serious consideration must to be given to the effect of the exertion of colour on the physiological and psychological well-being of human beings. Though scientists dealing with colour have been warning us about the importance of their theories for a long time, architectural and ergonomic concepts have unfortunately yet to implicate them. For instance, it has been proven that by accentuating the red end of the light spectrum at a workplace it is possible to increase a person's pulse and breathing rate, and by accentuating the short wave of the spectrum, i.e. the blue end, the reverse effect is invoked. Medical findings in the field of endocrinology and ophthalmology have documented that colour-related psychological phenomena have a physiological correlation. It was recently discovered that the retinal receptor for the colour blue triggers melatonin distribution in the pineal gland, with the ensuing effect of sleepiness on human beings (Brainard G.C. et al. 2001, Pache M. et al 2001).

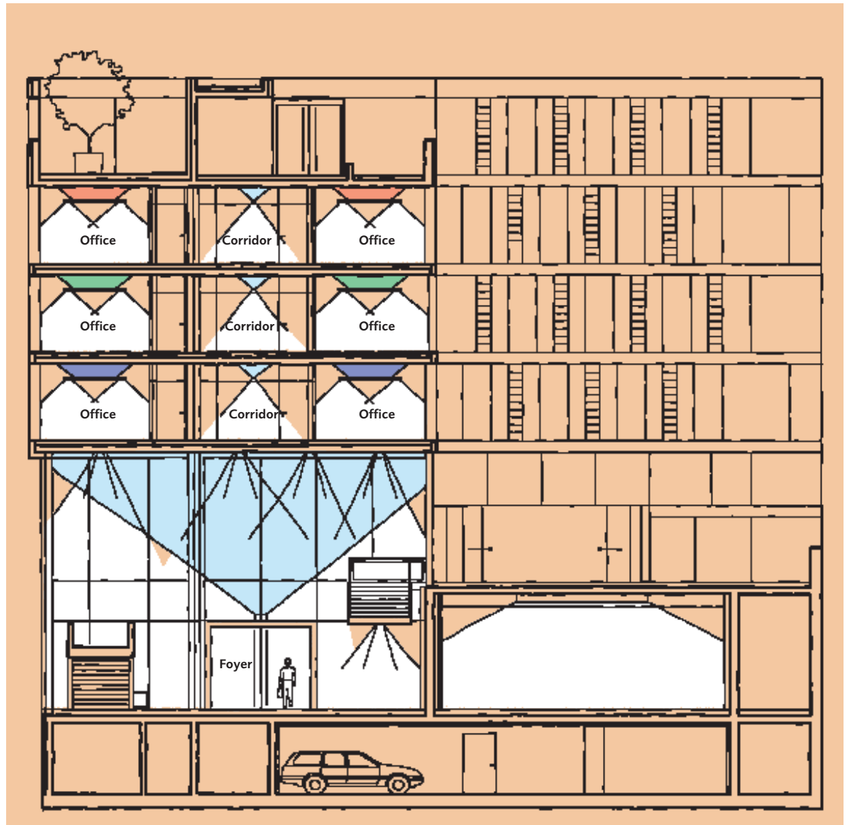
Chromo-therapy
The concept of "Spectro-Chrome Colour Therapy" was developed by the Indian doctor and research analyst Dinshah P. Ghadiali (1873-1966) during the first decade of the 20th century. This method involves the irradiation of large areas of the human skin with coloured light. Based on this research, Dinshah developed a circle of 12 colours which have therapeutic abilities. This has been used for the therapy of chronic illnesses like diabetes, high blood pressure, bronchitis, acute sicknesses of the skin, asthma, allergies and immune system disorders, cardiovascular diseases, stress and sleep disorders.

Fundamental Harmonical Research
Every colour of the light spectrum has its own internal wavelength and hence its own frequency. The works of Swiss scientist Hans Cousto in the field of Fundamental Harmonical Research focussed on the 'Earth Tone' (also referred as Schuman Resonance). It has already been calculated, from the measurable rotation of the earth (23 hours 56 minutes 4 seconds) that it produces (according to the octaves within our range of hearing) a frequency of 194.71 Hz. Using his theory, if one wishes to make the earth tone 'visible', the octave needs to be raised by forty times (240) to reach a frequency of 428,000,000 Hz, specified by physicists as 700 NM, which is equal to the colour bright orange. By adding another octave to this, one can resonate with the frequency of human DNA. The orange-red light thus resonates with the frequency of human DNA and the earth tone and hence results in a balance in human existence on earth.

With all these theories it is becoming increasingly obvious that using coloured light (light colour spectrum) it is possible to stimulate and promote light-induced human metabolism. We spend more than half of our lives in our respective workplaces, under artificial light sources. Henceforth, research in the area will be able to prove that coloured light can not only stimulate our working atmosphere, but can also positively influence our health.

Methodology
Architectural Lighting Design concept: the primary aim of the lighting designers (L-Plan Lighting Design, Berlin/D) was to promote a comfortable health-oriented office space for 90 work-places. A further objective was to replicate the dynamic quality of daylight through the variable composition of luminous colours and light intensities with high-tech luminaire design. The new building at Friedrich Strasse 16 has a cubical form. The lower two floors house the entrance, foyer, cafeteria and mail office, which are glazed. The upper floors comprise offices and meeting rooms.

The office design concept was totally modern in the sense that corridors were avoided and all individual office cells opened out into a single community space. The visual barrier between the cells and the community space was broken because it is made of glass, and hence allows an unobstructed flow of light through the spaces. The lighting designers developed a special RGB luminaire in collaboration with lighting manufacturer (Se'lux). As a result, each employee can set his/her own "individual" luminous colour preference using the RGB pendant luminaires designated to their workplaces.



Section showing the foyer and the colour changing lighting design for the office spaces.

The lighting in the conference rooms can respond to different working requirements. The centrally placed RGB pendant luminaire provides concentrated direct light over the table surface by the halogen down-lights. Indirect coloured light on the ceiling and wall surfaces creates a visually stimulating environment, similar to the offices.

Client – Lighting Designer interaction

Interaction between the client and the lighting designer has resulted in an innovative design solution focused on enhancing productivity for all. Quite often the lighting designer is given strict instructions to design only according to the norms (whereas it is actually far more important to design for the people using the work space!). Fortunately, the decision-makers at the Berlin Medical Society were intelligent and daring enough to grant Michael F. Rohde the freedom to design – as long as it was beneficial for the employees. This is a trend-setting attitude that every sensible client should follow if s/he is concerned about the health, well-being and productivity of their employees.

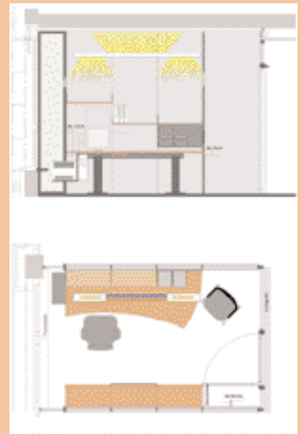
RGB office luminaire

The FX international award-winning RGB luminaire used in this project is a sharp-contoured, direct-indirect pendant luminaire of minimalist design (140mm X 55mm). The length of the luminaire depends on the room geometry and the desired light intensity. The indirect light is produced by three dimmable (red, green and blue) T5 fluorescent lamps, which means that the ceiling can be illuminated in almost any colour. The primary idea of this project is not to achieve a brightly coloured workplace but to allow the selection of an exact shade of white light (warm or cool tones) to suit individual requirements. Additionally, the light intensity and colour modulation can be adjusted dynamically to fulfil the individual needs of the user.

This luminaire allows different colour loops to be run. Even when it is switched on during the daytime, the colour changes in the seven-colour spectrum produced by the artificial light still enhance the user's feeling of well-being. Each individual employee in the office building can choose between a fixed colour and a dynamic colour-changing loop. For excellent colour rendering of the workplace warm white compact fluorescent lamps are located at the two ends of the luminaire to provide direct light on the working plane. The pendant luminaire can be installed at right angles to the wall/facade and parallel to the edge of the desk-top without generating reflected glare, which is usually problematic in the case of conventional fixtures.

The indirect light is produced by three dimmable (red, green, blue) T5 fluorescent lamps (28 watt), for excellent colour rendering at the work place. Direct light is provided by warm white compact fluorescent lamps located at the two ends of the luminaire.

The lighting in the executives' offices is "democratically identical" to the standard offices. The luminaires give users the opportunity to choose from warm white or daylight white or pure colours and programmed colour loops to support the feeling of well-being.



Typical plan and section of a combi-office with the position of the RGB pendant luminaire.

Project Phase I

Before moving into the new building, the work space situation in the previous building was documented through photographs and a detailed questionnaire on the personal preferences and expectations of the 38 (seven male and 31 female) employees. It is important to point out that the survey using the questionnaire was executed during normal working hours to achieve specific results. This basic ground work was necessary for the research and for making an analysis of the work situation before embarking on the lighting design concept phase. Project phase I lasted from March – May 2003.

Project Phase II (in process)

This phase addresses the issue of how direct innovative lighting design concepts and achieved lighting conditions can influence the working process. The main focus will be to document any noticeable changes with aspects of "before and after" the installation of the new luminaires, and also in terms of seasonal changes. This will be done with the help of a new questionnaire, together with standardised interviews. Photos will be taken to document the workspace, taking into consideration the modifications that have been made and with special attention paid to the creative architectural and lighting design aspects. A personal computer has already been installed to record and document employees' behaviour with regard to lighting. Factors such as the different luminous colours selected for work, the degree to which the lighting is dimmed by office staff, the time and the number of times the lighting is switched on are to be evaluated after approximately twelve months. The present goals are to make a detailed documentation and evaluation of the changes that have occurred within a one-year time-frame, and to analyse the behavioural patterns of employees with respect to a specified light colour and colour loops in relation to different seasonal climatic changes.

Scopes and limitations of the research study

The most important issues under investigation are:

⇒ the response of the employees to light and lighting quality before and after the implementation of the architectural lighting design concept

⇒ the relevance of light in the prevention of illnesses, such as seasonal affective disorder, winter depression, and in the strengthening of the human immune system

⇒ the influences of coloured light on the psycho-physiological factors of the work process, concentration, achievement, socio-communication skills and an overall feeling of well-being.

The researchers are well aware of the fact that apart from the new lighting scheme, the change of work atmosphere for the employees in terms of urban surroundings, building, furniture, materials, and spatial orientation may adversely influence their response to the survey. They therefore recommend that observational experiments, such as the one described in this article, be repeated in a larger group of RGB luminaire users over longer periods of time.

This pilot study has the potential to revolutionize lighting design concepts in every area of humanity. The researchers firmly believe that in a matter of years all architectural and urban lighting design projects will incorporate RGB luminaires for their positive impact on the well-being and performance of human beings.

Text: Michael F. Rohde, Thomas Braedikow, Michael Essers, Karolina M. Zielinska, Amardeep M. Dugar
Photos: Heinrich Hermes / Hermes Fotografie, Berlin/D