HUMAN RESPONSES TO LIGHT

TO DO OR NOT TO DO?

THAT IS THE QUESTION
What is Human Centric Lighting?
WHAT IS HUMAN CENTRIC LIGHTING?

• Brings the **human** in to focus

• Adaptation of the lighting to individual needs
  
  – Age
  – Time of day
  – application
Human Centric Lighting
HUMAN CENTRIC LIGHTING

SIMPLIFIED

Experience

Health

Activation

Relaxation
DYNAMIC LIGHT

Natural light changes in intensity, colour temperature and direction...
A DAY IN YOUR LIFE

• See how much light you receive today
• Go outside at lunchtime
• Maybe try a bit of physical exercise
• Make a note if you feel sleepy
Theoretical Background
CIRCADIAN RHYTHMS

Time interval of approx. one day
CIRCADIAN RHYTHMS

- Highest testosterone secretion: 09:00
- Bowel movement likely: 08:30
- Melatonin secretion stops: 07:30
- Sharpest rise in blood pressure: 06:45
- Lowest body temperature: 04:30
- Deepest sleep: 02:00
- Noon: 12:00
- Best coordination: 14:30
- Fastest reaction time: 15:30
- Greatest cardiovascular efficiency and muscle strength: 17:00
- 18:00
- 18:30: Highest blood pressure
- 19:00: Highest body temperature
- 21:00: Melatonin secretion starts
- 22:30: Bowel movements suppressed
- Midnight: 00:00
DEVELOPMENT AND SYNCHRONISATION OF SLEEP

- Infants and toddlers “learn” circadian rhythm from parents and environment
- Schooldays
- Teenage years / “party time”
- Early start for work
- Retirement: fewer psychosocial zeitgebers, lack of movement, dementia-related weakening of circadian rhythm

Based on: Prof. Dr. Jürgen Staedt, Prof. Dr. Dieter Riemann (2007): Diagnose und Therapie von Schlafstörungen, Stuttgart

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CIRCADIAN RHYTHMS

- **Wakefulness**
- **Body Temperature**
- **Melatonin**
- **Cortisol**
MELATONIN SUPPORTS GOOD SLEEP
MANY ASPECTS OF LIGHT EFFECT OUR HORMONE PRODUCTION

- Spectral composition
- Illumination at eye level
- Exposure time

- Direction of light
- Surface size
- Light history
CAN WE INFLUENCE THIS BIOLOGICAL EFFECT?

- Ideal conditions are daylight, preferably in the summer
- Artificial light can supplement this indoors
- We can deliberately increase alertness, concentration and delay sleep.
- Conversely we can improve wellbeing and improve sleep
THE MORAL QUESTION

• When is too much?

• Are we messing about with people’s natural rhythms?

• Can we help the people we already ask to lead very unnatural lives?
SHIFT WORKERS
SHIFT WORKERS
SHIFT WORKERS
WHAT CAN WE DO?

• We can advance the circadian rhythms by an hour fairly easily

• It is harder to delay them

• For people with an erratic shift pattern we might be able to provide melanopic supporting lighting
IS LIGHT THE SAVIOUR?
• Assessment of a new dynamic light regimen in a nuclear power control room without windows on quickly rotating shift workers -- effects on health, wakefulness, and circadian alignment; A pilot study by ARNE LOWDEN, Stress Research Institute, Stockholm University

• Prevention of fatigue and insomnia in shift workers-a review of non-pharmacological measures RICHTER K, ACKER J, ADAM S, NIKLEWSKI G

• Improving wellbeing with blue enriched light in rotating shiftworkers. MIDDLETON B, VANDENBOSSCHE E, MORGAN PL, ROUSSEAU A, KANTERMANN T, HAUBRUGE D, SCHLANGEN LJM, KERKHOFS M, SKENE DJ.

• Returning from night shift to day life: Beneficial effects of light on sleep. THORNE CH, HAMPTON SM, MORGAN LM, SKENE DJ, ARENDT J.
RESEARCH

- Shift work: health, performance and safety problems, traditional countermeasures, and innovative management strategies to reduce circadian misalignment.

By Mark R. Smith, PhD & Charmane Eastman, PhD, Nature & Science of Sleep, 2012
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RESEARCH - SLEEP AND LIGHT SCHEDULE TO REDUCE CIRCADIAN MISALIGNMENT IN NIGHT WORKERS

5,000 Lux                       1,200 Lux                         250 Lux
RESEARCH - SLEEP AND LIGHT SCHEDULE TO REDUCE CIRCADIAN MISALIGNMENT IN NIGHT WORKERS
"OLIVE" RESEARCH PROJECT
WHO THE PARTICIPANTS?

- Highly efficient modules, ECGs and luminaires for dynamic light
- Measurements on LEDs, modules, ECGs and luminaires
- Software and hardware for a sensor network system
- Norms and standards, coordination and publicity work

- Chronobiological parameters from a single blood test determine
- This principle is reliable in most light situations

- Develop process for determining the non-visual effect of light across the day
- Characterising key figures for biologically optimised light
- Energy savings via biologically optimised light

- Calculation of light distribution in a room based on sensor data
- Light simulation with manual user input (gestures)

- User requirements, behaviour and acceptance for house installations
- Market-compliant living room luminaires for dynamic light

- Systematic recording of user requirements for professional applications
- Spatial and gesture-controlled technologies for light control
- Algorithms for context-specific dynamic light

- LED modules with static emission spectra
- LED modules with dynamic emission spectra
OUR OWN RESEARCH
MEASURABILITY

• Actiwatches 24 hours per day
• Sleep diaries
• Mood/alertness VAS
• KSS – Karolinska sleepiness scales
PROFESSOR DEBRA J. SKENE

Chronobiology
Faculty of Health and Medical Sciences
University of Surrey, Guildford, UK
AN EXAMPLE

Light profile

**Explanation**

In the morning at the beginning of the early shift, the daylight-synchronous, activating sequence starts.

Noon – decreasing activation at the end of the early shift. Activation for the late shift starts during the afternoon. The melanopic effectiveness is reduced during evening-time. Modifying the light colour to warm white with increased illuminance leads to higher alertness levels and less impact on the suppression of melatonin.

Decreasing activation with the late shift in late evening.

Start of the night shift, increase in alertness only by modifying lighting intensity.
CONCLUSIONS

• There are several possibilities for the use of light in the workplace, depending on the time schedules.

• There is still a lack of standardised recommendations for light use, however research has shown that light in the workplace mitigates sleepiness, lifts the mood, and improves the mental status in general.

• Effective use of light may lead to an adaptation to the extended night work period and facilitate the subsequent re-adaptation to daytime life.

• Much research is still needed but should also canvass the genetic predisposition for maladaptive circadian phase in night shift workers.
ARE YOU STILL FEELING AWAKE?