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SkyLux

Using Light to Improve Health and Wellbeing

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# Contents

1. Contents
2. Abstract
3. Acknowledgements
4. Notes to the Reader
5. Inspiration
6. Introduction

**9. UNDERSTAND**

11. Circadian Rhythms
13. Mal-illumination
15. SAD and Bright Light Therapy
17. Design Opportunity

**19. EXPLORE**

21. Prior Research (BDES)
23. The Research process
25. Background Research
27. Expert Interviews
29. Survey
31. In-Context Immersion and Observation
33. Draw The Experience
35. Photo Journal
37. SAD Forums
39. Bright Light Therapy

**41. DEFINE**

43. Refining the Focus
44. Target User

**45. DEVELOP**

47. Design Group
49. Early and Developed Concepts
51. Exploration
53. Development

**55. THE FINAL DESIGN**

57. The Final Design
59. The Form
61. The Interface
63. The Light Rhythm
65. The Set Up
67. The Technology

**69. REFLECT**

71. Reflection
73. Glossary
75. References
77. Bibliography
85. Appendices
Abstract

My project aims to explore the conflicting demands between the increasingly indoor-based urban lifestyle and our innate biological connection to nature, with a focus on using light to support physical and mental wellbeing. By intertwining the fields of industrial design, health, and science, the project aims to enhance workplace lighting beyond the scope of visual performance to support our internal biological rhythms.

The project seeks to address our biological need for brighter, dynamically changing light by utilizing a variety of qualitative and quantitative research methods, including a collaborative design group and an ongoing connection with circadian scientists. Alongside providing light that supports our biological needs, the final design aims to reconnect indoor workers with the subtle qualities and cycles of nature, whilst raising awareness around the impact of light on our health and wellbeing through experiential discovery.

By applying scientific knowledge through design, my project aims to improve public health and life quality, whilst also promoting a greater social shift towards enhancing our lifestyles with better awareness around the vital role of natural light for our health and wellbeing. The following project is a small step towards addressing a much larger issue that I believe is at the forefront of future lighting design.

1 Circadian Science is a field of study concerned with the circadian rhythm, a daily internal cycle that controls many important biological processes such as sleep, alertness and energy. This rhythm is directly regulated by bright light.
I would like to acknowledge the immense generosity of those I could not have developed my project without:

The research team at the Sleep Wake Centre, especially Rosie Gibson, Karyn O’Kieffe, Philippa Gander.

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My supervisors Lyn Garrett and Antony Nevin for their guidance and encouragement.

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Julieanna Preston for her encouragement and support.

Whilst my project is situated in a design context, my research process has required a balance between both science and design, which has come to define the nature of this project as a cross disciplinary exploration into the impact of light on our health and wellbeing. As Arthur Koestler describes: “The common element in scientific and artistic discovery is seeing something in a new way, or making a new connection… as the bisection of one framework of experience by another… leads to something new and unexpected.” (as cited in Hartmann, 1998 p.161-162).

I have used footnotes as a supplement to the APA referencing style to aid in clarity for introducing and detailing key terms and individuals.
Inspiration

Paradoxically, my inspiration for this project has grown largely in the absence of sunlight. Although I have always known how important the sun was for my emotional wellbeing, I didn’t realize that it was also vital to my physical health until I moved into the city, where the demands of work and study shifted my lifestyle increasingly indoors. I felt fatigued and uninspired, and struggled to maintain my sense of vitality, especially in winter. My desire for more sunlight led me to examine lighting as my major project of my Bachelor degree, where I came across bright light therapy as a treatment for Seasonal Affective Disorder (SAD). I felt an immediate affiliation to the idea of supplementary ‘sunlight’, but was disappointed to find that most products are currently limited to clinical SAD, with few options for those with winter blues. I recognized this as an opportunity to develop a product to extend the benefits of bright light therapy to a much wider audience by addressing subclinical winter blues, alongside resolving common issues of the traditional light therapy experience including stigma, isolation, and poor integration.

Whilst developing my final design, I became increasingly aware of the vast potential of light therapy beyond its current application for SAD. I realized that the issue of light deprivation [see Mal-illumination] is part of a greater picture beyond seasonal fluctuations, which has been described as a “silent epidemic” (Cedar, Mathis, Viar, 2007, p. 1) that affects the majority of the western population. However, as scientific attention has been mainly focused on SAD, most of us remain largely unaware of the impact light deprivation has on our vitality and quality of life. My Master’s project presented an ideal opportunity to further explore how a proactive and preventative application of light can improve vitality and life quality for those who are unable to get sufficient natural light throughout the seasons. This decision was affirmed whilst attending a lecture by Anna Wirz-Justice, a world renowned circadian scientist, in early 2012. I was deeply inspired by her work and concern about our unmet needs for bright, natural light in indoor environments, as these reflected my own observations and desire to bring the benefits of sunlight inside. Her foresight and vision has affirmed my ambition to translate these ideas into reality.

Left: Sunlight, the final design of my BDES.

2 Winter Blues ia is a milder, sub-clinical form of SAD.

3 Dr. Anna Wirz-Justice is a leading circadian scientist, working at the University of Basel as an emeritus Professor and Research Fellow. She has more than 20 years experience in bright light therapy and SAD, and has won several prestigious awards for her exceptional achievements in the field including the Anna-Monika-Prize, and the Scholar’s Prize of the City of Basel.
Since the earliest known civilizations, humans have worshipped the sun as a powerful giver of life and vitality (Hyman, 1990). Although we are still coming to understand the scientific complexities behind the relationship of light and our biology, we have long known of its restorative effect on our mind, body, and spirit, and its central role to life on earth. Our physiology has evolved over millions of years with the rhythmic cycle of light and dark, which has shaped many of our biological processes. As described by Jane Hyman, “light coordinates the body chemicals that govern the way we sleep, feel, and behave.” (Hyman, 1990, p.14). Although our bodies have an internal ‘clock’ that controls our biological processes throughout the day, it relies on light cues to stay in tune with the 24-hour day. As described by researchers at Licht.de “every cell and every organ has a rhythm of its own that needs to be synchronised regularly with the outside world.” (Licht.de, 2010, p.6).

Until very recently, our lives have been closely connected to the gradual daylight cycle (dawn, bright daylight, dusk and night), which has formed and supported our biological needs throughout our evolution (Cedar et al., 2007; Debow, 2007). However, in the short space of just over 100 years, the advent of Thomas Edison’s electric light bulb has altered our lifestyles dramatically (Cedar et al., 2007). Especially in urban environments, we now spend increasingly more time under artificial light, and often miss out on the natural light signals our bodies need for maintaining physical and emotional health (Cedar et al., 2007). In the words of Kenneth Cedar, “we have become “contemporary cave dwellers” (Cedar et al., 2007, p.4).

Our reduced exposure to natural light can lead to day-time fatigue, low mood, and decreased sleep quality (Licht.de, 2010), and in severe cases to chronic disease (Debow, 2007). Unfortunately, this hormonal imbalance is a frequent result of our urban lifestyle, where we often move from home to work and back again with little more than a few borrowed moments in bright natural light in between (Kripke, 2012). As noted by Daniel Kripke, a leading researcher in the bright light therapy field: “There are an impressive number of people who are in daylight only ten or twenty minutes a day or even less.” (Kripke, 2012, p.3). The issue of natural light deprivation continues to grow as our lifestyles become increasingly distant from the natural environment.

Although awareness around the importance of natural light exposure has grown with the discovery of SAD, most people remain largely unaware of its critical biological role. As described by Charmane Eastman, director of the Biological Rhythms Research Laboratory in Chicago:

I remember when people didn’t know that smoking was dangerous, and people didn’t pay as much attention to their diets. I think the next step will be for people to realize that the amount of light they get and when they get it is another important component to health...people will watch when they get light just as they now watch their diets and the amount of exercise they get. [As cited in Hyman, 1990 p.171].

My project therefore aims to explore how biologically supportive light can be reintroduced into our everyday lives, whilst also raising awareness about its impact on our emotional and physical health. Thereby, this project is part of a greater social shift towards integrating new scientific understanding into our everyday lives to improve life quality on a wide scale.

4 Dr. Jane Hyman is a researcher and author specializing in mental health.
5 The Internal Clock (Suprachiasmatic Nucleus, SCN) is the ‘master clock’ of the brain, which synchronizes our circadian rhythms daily and depends on signals of light and dark to coordinate biological processes in the body (Wirz-Justice, Benedetti, Terman, 2009).
6 Licht.de is an non-profit organization dedicated to research and education around good lighting practices.
7 Dr. Kenneth Cedar is the CEO and Research Director at the Circadian Health Institute. He is passionate about improving public awareness around light and circadian disorders, and has worked in collaboration with John Ott to develop light therapy devices that address our need for brighter light.
8 Dr. Daniel Kripke established one of the first sleep clinics in the United States. He published the first controlled clinical trial of bright light treatment in 1981, and is a leading researcher in light therapy.

Right: Fig.1 Female Fundamentals. (2011). Hands Holding The Sun At Dawn. Retrieved June, 2, 2012 from http://femalefundamentals.com/blog/?attachment_id=1070. Permission for reprint has been sought and is pending at time of print.
“Light is nothing short of miraculous. Light makes our world luminous, dazzles our senses and quietly controls the chemical tides in our bodies.”

[Brainard, as cited in Cedar et al, 2007, p.11]
Circadian Rhythms

Our adaptation to the planetary cycle of light and dark has defined many of our internal rhythms, such as sleep, alertness, energy and mood, which follow a pattern of around 24 hours (Hyman, 1990). This Circadian Rhythm (from the Latin ‘circa’ meaning ‘about’, and ‘dian’, meaning ‘day’) coordinates our hormones and other processes so we feel alert and energized during the day, and sleepy at night (Hyman, 1990). Circadian rhythms are not only present in humans, but also appear in plants and animals as a fundamental property of life on earth (Gander, 2003). Although our circadian rhythm is controlled by our internal clock (SCN), it is slightly longer than 24 hours and therefore relies on external light signals to stay in tune with the earth’s daily cycle of day and night (Hyman, 1990).

For millions of years, these light cues came from the sun; we awoke to the rising dawn, which signaled our bodies to switch gradually from night to day time mode, and adjusted our hormones accordingly so we felt alert and energized (Licht.de, 2010). The bright daylight synchronized our circadian rhythms with the external environment, increasing our energy, alertness, and vitality (Hyman, 1990). The setting sun shifted our bodies back into ‘night time’ mode, helping us to wind down and facilitating restful sleep (Cedar et al., 2007). Thereby, the changing pattern and intensity of natural light acts as an important Zeitgeber 1, which tells our bodies when to produce the right hormones (Hyman, 1990). Without this Zeitgeber, our internal circadian rhythms can become increasingly disrupted as our bodies fail to produce hormones at the right times, leading to daytime fatigue, low mood, and upset sleep (Cedar et al., 2007).

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1 Zeitgeber is German for “time-giving”, as light signals act as an important time keeping cue that influence our SCN, the internal clock. Bright light is the most important Zeitgeber (Wirz-Justice et al., 2009).
As we now spend increasingly more time indoors, our exposure to the sun’s Zeitgeber cues has been dramatically reduced (Cedar et al., 2007) and replaced by static artificial light on an unprecedented scale (DeBow, 2007). We begin our day awakened by alarm clocks rather than the gradual dawn, and our bodies don’t get the light cues that produce the ‘day time’ hormones that help us feel alert and energized (Hyman, 1990). The dim fluorescent lighting in most offices further disrupts our internal clock, as it is only a small fraction of the intensity of natural light (DeBow, 2007). As described by Matt DeBow (2007), an author and expert in the bright light therapy field:

In addition, we turn on more artificial light when the sun has set, leading our internal clock to believe it is still day, delaying the release of night-time hormones and causing difficulties falling asleep. John Ott termed this condition “Mal-illumination” (Ott, 1973, p.1) to describe the adverse effect of the biological imbalance of too little natural light and too much artificial light, which is inadequate for our biological needs, both in intensity and spectral quality. In his words: “Mal-illumination is to light as mal-nutrition is to food” (Ott, 1973, as cited in Cedar et al., 2007, p.2). Ott discovered the importance of full spectrum light^4 accidentally during his work as a time-lapse photographer for Walt Disney. By using careful light and temperature controls, he was able manipulate plant growth to make pumpkins and primroses “waltz” to music. After several experiments using regular fluorescent lamps, he observed various hormonal disruptions, and found that full spectrum light was vital for healthy plant development. These discoveries led him to conduct pioneering studies into the adverse effects of artificial light on animal and human health (Cedar et al., 2007).

There is a strong correlation between full spectrum light and an improvement in subjective measures of health, wellbeing, performance and eye comfort (Lighting Research Centre, 2010). Although awareness around the importance of regular natural light exposure is gradually increasing (Veitch, 2011), the implications of artificial light on our health and wellbeing (Mal-illumination) remain largely unaddressed (Ceder, et al., 2007).

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2 Melatonin is the “darkness” hormone that makes us sleepy. Light inhibits the production of melatonin.

3 Serotonin is the “happiness” hormone which gives us our sense of vitality. Light boosts the production of serotonin.

4 Full spectrum light is the range of color contained in natural light. This can be observed in a rainbow or prism. This spectral balance of light can be replicated artificially, and has been shown to have a similar biological impact as natural light (Ott, 1973).
“Increasingly we find ourselves cut off from natural forces such as sunlight which sustain the earth as well as all life on the earth...Our lives spent inside buildings and automobiles, under artificial light, with little time outside in sunlight and in nature is actually one of the major causes of depression as well as other mood disorders and diseases.”

Seasonal Affective Disorder (SAD)

Sunlight is not only vital to our physiological health, but also plays an important role in our mental wellbeing. Most of us can relate to feeling glum and uninspired on grey days, which is a natural response to missing out on bright sunlight, which boosts our serotonin levels [Licht.de, 2010]. Over a prolonged time, this can develop into a condition known as the ‘winter blues’ – a mild form of winter depression [Licht.de, 2010]. This is thought to affect up to 25% of populations in far latitudes where winters are much longer and darker [Rosenthal, 1993]. The most severe form of this condition is called Seasonal Affective Disorder (SAD), which is characterized by seasonal depression, anxiety, less energy, social withdrawal, poor concentration, sleeping problems and weight gain (SAD.org, 2012). Although women aged 20 - 40 are most prone to developing SAD [Cheevers & Marshall, 2002], the condition affects a wide demographic, and also occurs in children [Kripke, 2012]. As described by Norman Rosenthal: "One million kids out there are potentially treatable...meanwhile, they have problems in school, withdraw from friends and sleep too much." (Rosenthal, as cited in More, 1994, p.1)

Bright Light Therapy

Since SAD was first identified by Norman Rosenthal in 1980, scientists have made important discoveries around the use of bright light as a treatment alternative to anti-depressant medications. By artificially replicating the spectrum and intensity of sunlight, bright light therapy supplements the natural light we often miss out on during winter, thereby rebalancing our hormone production [Kripke, 2012]. Bright light therapy has now become the first line treatment for SAD [Lam & Levitt, 1999] as a safer alternative to medications, whilst acting up to eight times faster [Allergy Matters, 2011]. Although bright light therapy has been studied extensively for its application in SAD, early studies have shown that it could also benefit several other conditions including sleeping problems, post natal and non-seasonal depression, chronic fatigue, bulimia, dementia, shift work and jet lag [Lam & Levitt, 1999].

5. Dr. Norman Rosenthal is a world-renowned psychiatrist who is responsible for having defined the Seasonal Affective Disorder condition. His pioneering research in bright light therapy has benefited millions of people.

How is Light Therapy Used?

To be optimally effective, light therapy should consider intensity, colour, time of day, duration and distance, as detailed below.

- Intensity: 2500-10,000 lux brightness
- Colour: Full spectrum white or 465-485 nm blue light
- Time of day: Morning (before 9 am) → sleep rhythm advance, mid-morning (9-11 am) → synchronize to 24 hour day, afternoon/evening → delay
- Duration: 30-60 min
- Distance: 30-180 cm

How Does Bright Light Affect Us?

Bright light therapy works by closely replicating the effect of sunshine on our internal clock, as detailed below.

- Immediate effects:
  - Pupil response
  - Serotonin boost
  - Melatonin suppression
  - Increased sense of wellbeing
  - Alertness

- Long term effects:
  - Enhanced sleep quality
  - Improved overall mood
  - Increased vitality
  - Stronger immunity

Above: Correct Use of Bright Light Therapy.
Right: Fig. 3. How Does Bright Light Affect Us? Adapted from Harvard Medical School. [2010]. Seasonal affective disorder: Brains that don’t like it dark. Retrieved November 2, 2010 from http://174.120.190.8/~abhccom/index.php?option=com_content&view=article&id=81:seasonal-affective-disorder&catid=1:latest-news&Itemid=1. Permission for reprint has been sought and is pending at time of print.
Existing Technologies

**Bright light therapy (Light Boxes)**
Currently, several bright light therapy technologies exist. Full spectrum light at 10,000 lux\(^6\) has been most widely researched, however the recent discovery of ganglion cells [Licht.de, 2010] has spurred a new generation of blue light devices, although their efficacy and safety is still under debate [Sliney, n.d.]. As most bright light therapy devices require a high level of user commitment, the relapse rate is high (P. Gander; personal communication, November 2, 2012). Common user complaints include isolation, poor daily integration, and stigma (M. Stopa, personal communication, September 24, 2010). This highlights the potential for improvement on both aesthetic and experiential levels.

**Dawn Simulation**
Although light boxes are the most common treatment for SAD, early research suggests that dawn simulators maybe equally beneficial [Wirz-Justice, et al., 2009]. These devices recreate the gradual dawn signal to awaken users naturally, whilst resetting the circadian rhythm to ‘summer time’ to improve mood and energy [Terman & Terman, 2005].

**Full spectrum light**
Spectrally balanced light is available as a replacement for overhead luminaires, however current products do not supply light at a biologically effective\(^7\) intensity, as they are designed only for general lighting purposes. Despite increasing scientific evidence, there is currently little awareness around the health benefits of full spectrum light [See Mal-illumination], and the lights are slow to be adopted into workplaces, likely due to cost.

**Dynamic Lighting**
Manufacturers Phillips, Osram and Fagerhault have recently developed lighting systems that adjust dynamically to simulate the natural daylight curve using a variable colour and intensity pattern. Although these lighting systems are a strong step forward from fluorescents, they have been critiqued for their “one size fits all” approach, as described by Anna Wirz-Justice: “...enhanced lighting regimens will need to be tailored to the needs of individual workers by the use of local area controls, in distinction from ceiling installations for entire floors.” [Wirz-Justice et al., 2009 p.80].

Design Opportunity

In combination, these technologies hold great potential to address our need for the brightness, dynamic change and balanced spectrum of natural light:

**Bright Light Therapy**
Although bright light therapy has been most widely researched for its application in SAD, it also holds potential to be applied in a biologically supportive context as a Zeitgeber to synchronize our circadian rhythm with the external day/night cycle [see Expert Interviews].

**Dawn Simulation**
Dawn simulators offer a further opportunity to support our biological needs by recreating the sun’s Zeitgeber signals.

**Full Spectrum Light**
As full spectrum light is important for hormonal balance (Ott, 1973) and eye comfort (Lighting Research Centre, 2010), it is a useful aid in supporting our overall health and wellbeing whilst replicating the high quality if natural light.

**Dynamic Lighting**
Dynamic lighting holds potential to recreate the important Zeitgeber cues of natural light (dawn, bright noon, dusk), whilst providing the bright light that our bodies need throughout the day.

By proactively addressing the cause rather than the effect, the incidence of Mal-illumination could be significantly reduced, alongside helping to prevent more serious circadian disorders from developing. Although awareness needs to grow before we can address the underlying cause of natural light deprivation, education and preventative supplementation are a step in the right direction.

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6 Lux is measurement of light at the point it is received, rather than the point at which it is emitted- for example, the brightness that reaches the eye from a lantern. One lux is roughly equivalent to one candle flame.

7 Biologically Effective is a term used to describe an intensity of light strong enough to influence our circadian rhythms—generally around 1,000 lux or above (Wirz-Justice & Fournier, 2010).

8 Biologically Supportive is a term used to describe light that supports the biological needs of our body. In the context of this project, this term describes the application of full spectrum light peaking at 2000 lux between 9-11 am, alongside dynamic adjustment throughout the day to replicate the rhythm of natural daylight.
Primary Opportunities

Using biologically supportive light to address Mal-Illumination, prevent winter blues whilst supporting mood, energy and alertness.

Secondary Opportunities:

Using biologically supportive light to improve specific environments:

- Rest homes - improving life quality, sleep, and dementia care (Gibson, 2011)
- Hospitals - improving sleep and life quality for bedridden patients (P. Gander, November 2, 2012, personal communication)
- Schools - reducing hyperactivity and improving concentration (Olszewski, 1999, Licht.de, 2010)
- Offices - reducing stress and sick leave whilst enhancing productivity (Licht.de, 2010)
- Airports - reducing jet lag (Lam, 1998)
- Shift work - reducing fatigue, improving alertness (Lam, 1998)

Developing an improved treatment experience for individual conditions (as detailed in Bright Light Therapy)

Above: The biological lighting market as represented in a bipolar graph
INDIVIDUALISED LIGHTING

IMPROVING THE LIGHT THERAPY EXPERIENCE

ACCESSIBILITY

PREVENTION

SOCIAL FOCUS

CIRCADIAN SCIENCE

BIOLOGICALLY SUPPORTIVE LIGHT

BUILDING A CONNECTION BETWEEN IN AND OUTDOORS

ADDRESSING MAL-ILLUMINATION

SOCIAL CHANGE THROUGH EDUCATION

CREATING MEANINGFUL EXPERIENCES

ACCESSIBILITY AND SAFETY

INDIVIDUALISED LIGHTING

BUILDING AWARENESS

ADDRESSING MAL-ILLUMINATION

MDES

BDES

ACCESSIBILITY AND SAFETY

CIRCADIAN SCIENCE

INDIVIDUALISED LIGHTING

BUILDING A CONNECTION BETWEEN IN AND OUTDOORS

ADDRESSING MAL-ILLUMINATION

SOCIAL CHANGE THROUGH EDUCATION

MDES

SOCIAL FOCUS

IMPROVING THE LIGHT THERAPY EXPERIENCE

BUILDING AWARENESS

ACCESSIBILITY

PREVENTION

BDES
Prior Research (BDES)

Briefly, the research of my undergraduate project explored the following:

- How can the bright light therapy experience be made more enjoyable, accessible, and be smoothly integrated into average daily routine?
- How do illumination intensity preferences vary throughout the day?
- What are the practical and functional constraints the design will need to consider?

I used a range of qualitative and quantitative research methods [see Appendices: Prior Research] to explore these key questions, which yielded several interesting results, detailed right.

Key Findings:

- Brighter indoor lighting is desired, especially in the morning and afternoon.
- Lighting preferences vary between individuals, and change throughout the day (300 - 3,600 lux).
- Energy efficiency, quality of light, adjustability, and ease of use are important considerations.
- Natural light (especially sunshine) is preferred over artificial light.
- Most time in the average routine is spent at work.
How can biologically supportive light be used to benefit a wide audience safely?

What is the bigger picture behind the light deprived condition?

How can light therapy be applied in a preventative context to support our biological needs?

What does the bright light therapy experience feel like first hand, and how can it be improved?

What are the most effective way to raise awareness and curiosity around the physical and psychological benefits of light?

What is the “lived experience” of mal-illumination?

What are the key user needs and desires?

What are the most enjoyable and intuitive forms of interaction?

How can the biologically effective light be automatically integrated into the average urban lifestyle?

What elements are desired in the lighting experience?

market analysis
literature review
expert interviews
first hand experience
survey
observation / in context immersion
photo/journal/interviews
draw the experience
online forums
design group
experience prototypes
The Research Process

By overlaying the findings from my earlier research with the key concerns of my MDES, I identified gaps and opportunities for further exploration. This led to my key research question: “How can light be used to support our biological needs whilst raising awareness around its impact on our health and wellbeing?” My research methodology is designed to interface scientific and design-led research approaches to address my questions from diverse perspectives (detailed left).

My methodology was inspired by the Human Centered Design approach, developed by several key thinkers including Liz Sanders, Bill Buxton and Bill Moggridge as means to transcend the limitations of traditional research approaches (designing for the user) by striving for empathy and active user involvement in the development process (designing with the user). Although my research was primarily focussed on innovation through design led research, the questions around safety, a biologically supportive application of light, and lighting ergonomics required more traditional research methods. Thereby, my methodology is balanced between established and innovation driven methods, reflecting the science/design balance of the project.

I have categorized my research into Hear, See, Feel and Try. This multi-layered approach is an iteration of IDEO’s Learn, Look, Ask, Try, which is used to describe four ways of empathizing with participants using the Human Centered Design approach (IDEO, 2002). I have redefined this model in a manner I felt was more suited for the experience focus of this project.

Hear: Asking questions and using a reflective process to identify underlying issues, needs and opportunities

See: Observing and exploring user experiences to understand and visualize how they can be improved

Feel: Immersion into the experiences of the user to develop intuitive understanding and empathy

Try: Exploring ideas using a design led process to test out experiences and practical constraints on a tangible level

Limitations

I have chosen largely qualitative methods, as I felt they were most suited for developing my design from a Human Centred approach to question, explore, and design with the target users. As qualitative methods may not reflect a mass perspective, I have been careful to include only reoccurring themes expressed by several individuals across separate studies in the key criteria.

Due to ethical considerations, I have recruited participants with an advertisement designed to appeal only indirectly to those with Mal-illumination rather than overtly, which would identify and potentially stigmatize respondents (see Appendices: Ethics). As Mal-illumination is widespread, I found that this approach was sufficiently defined to gather the information I needed.
circadian disorders

- hormonal imbalances
- lack of clear daytime signal
- upset internal clock
- damaged SCN

- phase delay / advance
- upset internal clock

- depression
- Alzheimer's / dementia
- worker fatigue
- ante natal / post partum depression

- jet lag
- winter depression
- upset sleep rhythms

- full spectrum light
- bright light therapy
- dawn simulator
Background Research

As my project aims to translate scientific knowledge into a design solution to improve public health, I felt it was essential to gain an in-depth understanding of bright light therapy, circadian disorders, lighting ergonomics and the emerging science of dynamic lighting.

I collated data from treatment guidelines for a range of circadian disorders into a graph to visualize the larger picture of interconnections between circadian disorders and light (left). I found that although the causes and symptoms of circadian disorders vary widely, they are treated similarly using a strong light signal [bright light therapy] to retrain the circadian rhythm as required. I learnt that individual timing and responses vary widely, and therefore require a personalized approach and professional monitoring (Wirz-Justice et al., 2009). Although bright light therapy is safe for most users, extra care is needed for those with schizophrenia, bipolar disorder and dementia. Bright light therapy is not recommend for those with photosensitivity (Kripke, 2012). Although bright light therapy is generally well tolerated, possible side effects include eye strain, headaches and hyperactivity (Kripke, 2012).

After looking into lighting ergonomics, I became increasingly aware of their shortfalls in addressing our biological light needs (Licht.de, 2010). Studies have consistently shown that higher lighting levels are not only preferred, but also have a positive impact on productivity, alertness, and mood (Gonika, 2008, Licht.de, 2010). Light colour is also an important consideration, as cool light has an alerting effect, whereas warm light has a relaxing effect (van Bommel, 2006). Thereby, current dynamic lighting systems commonly use cool light from morning to midday to improve alertness, with increasingly warm light towards evening to promote relaxation. Although the guidelines for biologically supportive lighting are not yet clearly defined, studies have established 1,000 lux as the minimum intensity for circadian influence (Wirz-Justice & Fournier, 2010).

These findings enabled me to identify the key considerations of light intensity, timing, and safety as a starting point for developing a biologically supportive application of light.

### Key Findings

The design should:

- Peak at a minimum of 1,000 lux
- Consider appropriate use of warm and cool light throughout the day
- Screen for those with conditions that can counter-indicate the use of bright light
Expert Interviews

My expert interviews were designed to set the parameters for a prevention-based application of biologically effective light, as well as reality-testing ideas and ensuring a high standard of safety. I was fortunate to establish an ongoing connection with the circadian scientists at the Sleep Wake Research Centre, Massey University, and Peter Turner, a specialist in lighting ergonomics.

In my interviews with Dr. Philippa Gander, Dr. Karyn O’Kieffe, and Rosemary Gibson, I learned that bright light (2,000-3,000 lux) exposure between 9-11 am essentially replicates the role of natural daylight, by supporting and synchronizing our circadian rhythms to the 24-hour cycle, and can safely be used to benefit a wide population. The controlled timing and lower intensity also extends accessibility to conditions that usually require increased caution (see Background Research). However, as this intensity is significantly brighter than current lighting standards, a screening process would still be required for those with photosensitivity.

My discussion with Mr. Turner highlighted the complexities of individual lighting needs, which I learned differ depending on age, task, and context. However, several key aspects included:

- Intensity of light - higher for detail tasks, diffused for ambient lighting
- Direction of light - downwards angle reduces glare
- Distribution of light - the larger the light beam, the dimmer the intensity
- Quality of light - colour accuracy reduces eye strain - full spectrum light is best

My interview findings enabled me to establish several starting points for an application of biologically supportive light, alongside developing the foundation of my early criteria, detailed right.

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Expert Interviews

6 Peter Turner is an Optometrist and Industrial Designer with a special interest in designing products to improve lighting ergonomics, as well as optical testing devices. He is also a Human Factors Technologist, specializing in lighting ergonomics and eye safety.

7 Dr. Philippa Gander is the Director of the Sleep Wake Research Centre at Massey University. Dr. Gander is a leading circadian scientist with a particular interest in sleep and the circadian clock. Much of her work has an applied focus, developing strategies to minimize the health and safety risks associated with circadian disruption. Dr. Gander was elected to the Fellowship of the Royal Society of New Zealand for her innovative research on the science of sleep and fatigue risk management in 2009.

8 Dr. Karyn O’Kieffe is a specialist in sleep disorders. She is passionate about education around light, and is particularly interested in the treatment provision around the economic impact of sleep disorders. Karyn teaches both undergraduate and postgraduate papers around circadian rhythms, sleep, and fatigue.

9 Rosemary Gibson (BSc, Doctoral Candidate) has a background in psychology and clinical sleep medicine. She holds a Massey PhD scholarship, and has recently conducted a pilot study of light therapy for improving the life quality for those with dementia in collaboration with Alzheimer’s Wellington.

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Criteria

To be safe, accessible and effective, the design should integrate the following:

- 2,000-3,000 lux intensity
- Use between 9-11 am
- Screening of those with photosensitivity

Ergonomic considerations include:

- High quality (full spectrum) light
- Diffused, downwards angle
- Adjustable for varied activities and diverse user needs
Keywords

Outdoors
Fresh air, grass under your feet, hearing birds, seeing people, move around healthy change uplifting energised refreshed peaceful, gentle free

Indoors
strain feels so gross claustrophobic disconnected like I was in a prison square, hard, fluorescent, stuffy stuck fake and edgy, loose track of time forced

Rating Scale

More light in the morning (dawn simulation) would enjoy very much would enjoy neutral would not enjoy

More light mid-morning (9-11 am bright light) would enjoy very much would enjoy neutral would not enjoy

More light throughout the day (dynamic lighting) would enjoy very much would enjoy neutral would not enjoy

A connection to the outdoor environment would enjoy very much would enjoy neutral would not enjoy

A way to learn more about light (education) would enjoy very much would enjoy neutral would not enjoy

Priority

A connection to outdoors 34%

More light throughout the day 26%

A way to learn more about light 22%

More light in the morning 13%

Something else 3%
I conducted a survey to identify how Ma-illumination could be addressed from a user focus, whilst prioritizing the focus of further exploration and identifying key experience desires.

The survey was distributed through local community networks as a means to gather feedback on the applications of biologically supportive light I had identified in my theoretical groundwork [see Expert Interviews, Design Opportunity], alongside two possible directions for further exploration: using light to build a connection to the outdoors, or as a learning tool to increase awareness around its impact on our physical and mental wellbeing. Respondents were asked to rate the options, and then to choose just one, and explain why. This process was designed to identify which elements of each concept were most enjoyed, as well as to prioritize which options were most needed. With a total of 77 responses, the results represented diverse age groups, genders, cultural backgrounds, and lifestyles [see Appendices: Survey].

The most striking result was the issue of disconnection to natural qualities when working indoors. Respondents greatly disliked artificial light, lack of colour, and static atmosphere, highlighting a clear need for more natural qualities indoors, such as movement, colour, organic form, and gradual change. Above all, respondents wanted to spend more time outdoors, however were often unable to due to work schedule and weather. More high quality light throughout the day was also highly rated, reflecting the scientific perspectives that we need brighter light to support our circadian rhythms [Licht.de, 2010]. Respondents were also curious to learn more about the biological impact of light, highlighting the opportunity for education.

As a result of the survey, I decided to explore possibilities for creating a connection to the outdoors, brighter light throughout the day, and education around light [see Design Group, Exploration].

Observations
- People feel trapped in closed spaces
- People feel they need brighter light throughout the day
- People are curious about light and want to learn more

Insights
- People need natural qualities of change and movement
- Current lighting is too dim
- There is an opportunity for the design to educate users whilst supplying light

Key Findings
The design should:
- Create a connection to the day passing outside using natural elements of colour, movement and slow change
- Supply bright light throughout the day
- Raise awareness and educate users about the biological impact of light
I visited several low light environments to understand the lived experience of those living and working in low light conditions. I observed the individuals using them and noted my own response to the experience.

**Observations**
Artificial light has a clear impact on mood and energy. Across all environments, users looked glum, tired, and uninspired. Even a small connection to the outdoors, such as a small window made a big difference.

**Insight**
There is a need for brighter, changing natural light in workplaces, universities and rest homes. Connection to the outdoors is important.

**Observation #1**
Masters studio room
Dim fluorescent light, High windows

**Keywords:**
Static dim hard to stay focused
Windows make a big difference
Tired, tense, serious

**Comments:**
"I need a cigarette"

**Observation #2**
Computer lab 11A25
Dim fluorescent light, No windows

**Keywords:**
Disconnected, bored, stressed, tense, glary, static, empty, cold

**Comments:**
"I need to move"

**Observation #3**
Rest home
Fluorescent overhead light
Natural light from windows

**Keywords:**
Static, enclosed, isolated, lonely, dull, weary

**Comments:**
"It becomes my world"
Above Left: Draw the Experience: Grey Days
Above Right: Draw the Experience: Fatigue
Draw the Experience

In order to examine the emotional experience of life in dim environments with a focus on fatigue and winter blues, I invited respondents to "draw the experience" of these conditions. The most intriguing result from this study was the diversity of expression in the responses, which challenged my assumption that fatigue and grey days affected everyone similarly. Although there were common themes amongst the responses, the study highlighted the difference in our individual experiences. The results of this study enabled me to understand the complexities within the emotional experience of these conditions on a deeper level, and affirmed the need for individualized lighting to accommodate diverse users [see Design Group; Appendices: Design Group 6 & 7].

Common Themes (fatigue):
- Heaviness in head, shoulders and legs, gunkiness, consuming, blue and red.

Common Themes (grey days):
- Heaviness, droopiness, cold, oppressive, blue and black.

Insights
- Although there are common themes, the experience of fatigue and winter blues is unique to each individual.
- Not all grey days are the same.
- The design should be adjustable to meet individual needs.
Photo / Journal

After observing and experiencing artificially lit environments, I used a photo-diary and journal to gain a deeper understanding of the long term lived experience from a variety of individual perspectives. I distributed the photo-journal to a small group of respondents who had expressed interest in partaking in further studies through the survey. I asked participants to capture their average daily routine using the camera, and record thoughts, feelings and events in the journal over a one week period. The journal was designed to gain insight on a internal level, whereas the photo-diary was designed to frame an external picture of the respondents’ daily realities. I held a short follow up discussion after collecting the materials to understand their experiences more fully, as well as what aspects they considered most important in the final design.

I was surprised to find there was a striking coherence between the results. Respondents consistently wanted more light in the morning, as it made them feel more alert, optimistic and energized to start the day. Natural light qualities were greatly enjoyed, especially sunlight. Notes from sunny days were often much more cheerful than those from cloudy days, which often described tiredness and low mood. As reflected in the survey and observation, key elements that were most desired were natural qualities of light, smooth daily integration and a connection to the day passing outside. These findings affirmed the priorities I had set for the design, whilst building on the criteria for my design exploration.

Key Findings:

The design should:

- Supply more light in the morning
- Be adjustable for more light on grey days
- Create a connection to the day passing outside
- Be well integrated workplace and home hold most potential
- Be enjoyable to use
I looked into anonymous public user forums to gain insight into the experience of SAD without identifying or stigmatizing any individuals. I found that SAD is often difficult to diagnose, as the symptoms are easily attributed to other factors, and the condition is often not taken seriously due to lacking awareness. Therefore, many suffer in silence, and often feel misunderstood by their friends, family and even their doctor (Bravenet, 2012; Psychoforums, 2012; Mental Health Forum, 2012). Although many of those affected by SAD realize that light is an important factor, only those who were severely affected used bright light therapy. These findings affirm my perceived need for increased education around the biological impact of light deprivation.
GoLITE (2,500 lux, blue light)

**PROS**
- Small
- Portable
- Practical
- Timer was useful
- Easy to pack away
- Less exposure time
- Dimmer light

**CONS**
- Complex interface
- Narrow beam of light
- Hard to maintain time commitment
- Isolating
- Stigmatizing
- Unnatural - “neon” quality

**Overall Experience**
I didn’t notice any marked improvement in sleep or mood, although it is difficult to assess accurately within the short time frame with only a mild winter blues condition.

Daylight (10,000 lux, full spectrum fluorescent)

**PROS**
- Easy to turn on / adjust
- Wide beam of light
- High quality of light, good for detail activities
- More “natural” feel of light
- Very bright- but low glare as light is directed from above
- Useful tilt adjustment
- Option for “ambient light” - but not clear if this setting is biologically effective

**CONS**
- Difficult to set up
- Not potable
- No timer
- Hard to maintain time commitment
- Isolating
- Stigmatizing
- Difficult to pack away
- Large physical size
- Heavy
- Longer exposure time, but more can be done alongside

**Overall Experience**
The Daylight had a positive effect on mood and energy. Immediately after using, I felt more energized and alert- almost like after sitting in the sun. I also noticed a slight subjective improvement in sleep quality.
I tried bright light therapy first hand to understand how the experience could be improved, alongside identifying the practical constraints I would need to consider in my design.

I was able to borrow two light boxes from the Sleep Wake Centre:

- Phillips goLITE (2,500 lux blue light)
- Daylight (10,000 lux full spectrum light)

I used the light boxes every day for two months [one month per product], and rated them on their usability, effectivity and overall experience (detailed left).

When using the lamps, I was acutely aware that their brightness attracted attention, which made me feel exposed as an SAD sufferer. I was disappointed to find that despite enjoying the light quality, I felt self conscious using it. I found that light boxes involve a significant commitment, requiring users to remain stationary for a minimum of 15 minutes every day at a scheduled time. Despite feeling a noticeable improvement in my mood, energy, and sleep quality, I found this commitment was hard to maintain. This highlights the need for better integration, and helps to explain the high relapse rate for bright light therapy [P. Gander, personal communication, November 2, 2012].

The results of this research highlighted the key issues of stigma, poor integration and practicality. These findings enabled me to define the key experience criteria for developing a successful design solution, detailed right.

**Key Findings**

**Must be:**
- Easy to use
- Well integrated
- High quality light
- Wide beam
- Light angled from above (minimizing glare)
- Non-stigmatizing

**Ideally:**
- Portable
- Not restricted to one user
Refining the focus

After reflecting on the common themes emerged throughout my research process, I was able to identify several key issues:

- The adverse impact of static artificial light on our health and wellbeing
- Our biological need for brighter, dynamic lighting with a balanced spectrum
- The need for a connection to the day passing outside
- The desire for natural elements such as slow change, movement and colour
- The need for improving public awareness around the impact of light on our mood, energy and health.

After looking into these issues in further depth through primary research, I was able to narrow the focus of my project:

**What**  a lighting device that supports our biological light needs

**How**  - dawn/dusk simulation
        - bright light (2,000 - 3,000 lux) between 9-11 am
        - variable full spectrum light throughout the day, peaking as above

**Why**  to prevent winter blues and address Mal-illumination whilst raising awareness around the impact light on our health and wellbeing, alongside addressing our need for a connection to the outdoors

**Who**  Indoor workers with Mal-illumination (detailed right)

**Where**  artificially lit environments such as offices, homes, and residential facilities, or public spaces such as cafes and transport
I used the key findings from my primary research to define the characteristics of my “target user”:

Profile:
Full time office worker performing largely sedentary tasks at computer with little natural light, aged between 20-50.

Symptoms:
Mal-illumination:
• Daytime fatigue
• Stress
• Low energy
• Poor sleep quality
• Low mood
• Disconnection to outdoors.

Light needs/desires:
• Energy efficiency, practicality and ease of use are important.
• The lamp should be enjoyable to use and create a connection to the day passing outside by recreating natural qualities (slow change, movement, colour).
• The lamp should supply bright, high quality light throughout the day, and provide an experience that allows users to learn about the impact of light on health and wellbeing.
• The design should be adjustable and be smoothly integrated into existing routine.
'Siestas' - more acceptance
Purpose lighting = light for selling, not so much light for health.

Venetian blinds with mirrors, outdoor light inside reflect light. Brighter.Circuits need to be heated, furniture curtains get lighter gradually with dark - you could be set.

Warming light - what we miss out on in winter - but rain, cold, grey, want sun, warm, back to normal mental health.

For hibernation: making work less, it is a big part of life. Maintaining and awareness of depression as a medical condition. Some not accepted as normal response, greyness/natural rather than normal response.

- People don't want to admit it's a big part of their lives

Association - sensory experiences like hearing birds, smell of food.
After my exploration of user needs, I was keen to start designing. I used the concept of participatory design\(^1\) (Sanders, 2008; Buxton, 2007; Moggridge, 2006; IDEO, 2012) to maintain a strong user focus, as well as enriching the project with a diversity of perspectives, knowledge, and creative insights. Although my design group began as a co-design group, I found that an approach halfway between participatory design and a focus group was most effective for developing and testing ideas, utilizing the co-creative process to prioritize issues, ideate, and explore, whilst developing, refining and testing with a more directed approach. Whilst initiating and leading this group was exciting, it was also a steep learning curve, as I’ve never facilitated groups before. Throughout this process, I was greatly encouraged by the enthusiasm, openness and dedication of my team. We met once a fortnight for five months, starting with a brainstorm, which raised several key points:

- There is a cultural dimension to light, and differences in cultural attitudes. Eastern and European cultures are generally more open to the idea of using light for health, whereas New Zealanders tend not to appreciate its impact, with our “tough” mentality to grit our teeth and get on with it.

- Awareness needs to grow before products can be marketed on light benefits alone. Allowing users to experience the impact of improved lighting through an enjoyable and meaningful product may be more effective than a directly informative approach.

- We have a resistance to accepting the biological impact of winter on our bodies. Although we know that our energy levels are different in winter than in summer, there is a cultural expectation to work to the same schedule and workload throughout the seasons.

- Use of light during daytime feels wasteful. Energy efficiency is an important consideration.

Our initial discussions highlighted potential starting points, alongside building on the key criteria for further design exploration, detailed right.

\(^1\) Participatory Design/Co-Design recognizes the user as the expert in their own needs and desires (Sanders, 2008). The participatory design approach actively involves the user in the design process, by giving them the tools to develop their own solutions in close collaboration with the designer.
a. Light and warmth
b. Accessibility
c. Morning light (9-11 am)
d. More light throughout the day
e. Motivation to go outside more
f. Connection to outdoors
g. Awareness/education
Early Concepts

I used these insights and my early criteria as a basis for developing solutions, and made small scale models of the most promising concepts. These gradually expanded into a ‘concept village’ (left). By building the concepts in 3D, I was able to communicate easily to my design group and show how each concept could fit into daily life.

We discussed the early concepts in the next design group, where several elements stood out:

- Combined light and warmth
- Re-introducing natural qualities (slow change, movement, colour)
- Capturing and storing ‘sunlight’
- Accessibility: public integration of biologically supportive light (e.g. transport)
- Modular lighting that can be personalized
- Dynamically changing light rhythms as a connection to the outdoors.

I used these aspects as a basis for developing four main concepts, detailed right.

**Transport Integration**

*Bus or Train*

(accessibility, integration)

This concept uses primarily natural light in a therapeutic way to reach those who need it most on their way to work. The shell is designed to collect light using solar cells to power the OLED windows which adjust dynamically to the weather and supply extra light on grey days. It is smoothly integrated into existing routines, promotes public transport, and is available to all regardless of income or demographic.

**Sunlight Container**

(bringing users outside more, playful experience)

A container for capturing and storing ‘sunlight’ for re-use on grey days using a solar panel. This concept is designed to bring users outside more, so they can enjoy the benefits of natural light when the weather is good, and to enjoy stored ‘sunlight’ on grey days. The design also encourages users to enjoy using extra light during the day without the feeling of “wasting” electricity.

**Fire Sticks**

(customization)

This modular concept is designed for use in offices, where biologically effective light is achieved through the “fire sticks” coming together during break times, multiplying light intensity alongside building a connection between users. The sticks can be used individually throughout the day. The and are pre-programmed with slowly changing light patterns based on the natural daylight curve to connect users to the day passing outside.

**Indoor Sun**

(outdoor connection, natural qualities)

A floating indoor sun designed for the staff room, with an optical fibre that transports outdoor light indoors to re-connect users with the changing qualities of natural light. The design encourages social interchange, and offers users a place to relax and revitalise. The optional grass add-on creates a multi sensory experience to enliven users during break times.
I explored the central aspects of my developed concepts further with my design group using experience prototypes.

**a/ Light and Warmth**
This experiment evoked several interesting reactions, especially around the psychological conflict of a fireplace without warmth, and the coziness of a communal huddling experience. My design group really enjoyed the poetic elements, but concluded that as a fireplace was a seasonal experience, it was best to explore more versatile options for addressing Mal-illumination throughout the year.

**b/ Natural Qualities**
I used a projector to play a user selected video of a nature scene behind a workstation. This experience was greatly enjoyed, especially the gradual change of light and subtle movements. However the projection technology limited this concept to workstations with adequate wall space, so would need to be developed further to consider workstation variables.

**c/ Capturing Sunlight**
I asked my design group to make solar powered 'sun boxes', which they were surprised to find did convey a feeling of capturing and storing sunlight. Although they really enjoyed the poetic elements of this concept and thought it would help in winter, it wasn’t well integrated, and consequently often used at the wrong time. However, the concept of solar energy is useful to consider in the final design.

**d/ Portable Light**
In conjunction with the “light and warmth” experiment, we tried out potable modular light sticks. The initial reaction was very positive, and the group really enjoyed having a personal light they could use individually. Although my group really enjoyed the playful elements of the sticks, they noted that this novelty might wear off, and weren’t sure how much they would use it in the long run. This was reflected in my second portable light experiment, where I carried a light with me for a day. Although it was nice to have extra light, I found it rather tedious over time, and concluded that the integration should be as automatic as possible for the design to be used consistently.

**e/ Changing Light**
We used test rigs to try out changing light colour and intensity, first manually [1], then automatically [2]. The group really enjoyed being able to control their own lighting. We then tried out software that automatically adjusted the monitor brightness and colour temperature to correspond with the passing day outside. Users really enjoyed the subtle change, and were reluctant to go back to regular lighting after the study.

The findings from my exploration led me to further explore versatile form, subtle change, playful interaction, and customization (see Final Design; Appendices: Design Group 6 - 9).
In our next design group, we reflected on the criteria that had emerged throughout the research process (detailed left and right), and how these could best fit into one single design. We focussed on the indoor workplace as this presented an ideal opportunity for smooth integration into existing routine, whilst addressing the issue of Mal-illumination at the source.

We developed several concepts to visualize how biologically supportive light could be integrated into the variability of office workstations (left), and discussed ideas for how the design could create a meaningful and enjoyable experience. After reflecting on our exploration with experience prototypes, we established that playful interaction (fire-sticks, sun-boxes) and customization (nature scene, adjustable light), were the most successful means of creating engaging and meaningful experiences. We applied these findings to our concepts, and integrated the key experience criteria of connection to outdoors (slowly changing nature scene) and brighter light throughout the day (dynamic light rhythms). We found that overhead concepts worked best, as they were not restricted by computer size, desk or wall space. We tried out several iterations, gradually building in the key criteria to form the basis of the final design.

Development

**Performance**
- Biologically supportive light:
  - Full spectrum light
  - 2,000 - 3,000 lux
  - 30 - 40 cm distance
  - Peak between 9-11 am
  - Dynamic lighting that replicates the key Zeitgeber cues (dawn, midday, dusk)
- Diffused light
- Adjustable brightness
- Customizable - allows for individual settings
- Energy efficient
- Safe for a wide audience
- Wide beam of light
- Downwards angle
- Accessible
- Affordable

**Experience**
- Smoothly integrated - automatically fits into the average urban lifestyle for consistent use
- Non-stigmatizing
- Educational - raises awareness around the impact of light on our emotional and physical wellbeing
- Enjoyable and meaningful experience to ensure consistent use
- Versatile aesthetic
- Holistic, preventative approach
- Unobtrusive to other activities
- Intuitive and easy to use
- Creates a connection to the natural environment using gradual changes in light, slow movement and colour
- Brighter light throughout the day that reintroduces the qualities of natural light
FINAL DESIGN
SkyLux: The Final Design

My final design synthesizes the key criteria from my research process to address the key issues I had identified:

- Our need for bright, dynamic lighting throughout the day that provides Zeitgeber light cues
- Our need for a connection to the natural environment that creates a sense of time passing and alleviates the static atmosphere in workplaces
- The need for education around the impact of light on our health and wellbeing, as most affected by Mal-illumination are not aware of their condition as the symptoms are often subtle and easily attributed to other factors
- Our need for adjustable lighting that can be customized to individual needs

The design aims to bring the benefits of natural light indoors by replicating the qualities and dynamic change of the day-light curve (see The Light Rhythm ). The subtle transformation of light throughout the day creates a connection to the day passing outside, and supplies important Zeitgeber cues that support our mood, energy, alertness and sleep quality.

The virtual sky moves slowly in real time, and can be customized by users to suit their individual needs by moving ‘clouds’ to adjust the ‘weather’ and brightness level (see Interface), thereby creating an enjoyable and meaningful experience by enabling users to create their own ‘sky’ to work under. The slow moment, colour, and subtle change aims to enhance static workplaces whilst allowing for personalized lighting. The lamp is designed to be accessible for a wide audience, with a screening process that ensures a high level of safety for those with photosensitive conditions (see The Set Up Process ). The lamp is designed to fit into a range of work spaces, with options for overhead suspension or table based attachment.

By allowing users to discover the benefits of good lighting experientially, the design promotes a gradual shift in our understanding of the role of lighting beyond the current visual focus. The design is a base model, which holds many opportunities for future development, such as allowing users to choose skies from different countries (e.g. a home country or holiday), create their own cloud shapes, or stream real-time weather from the local web cam. The lamp could also run user-made videos, or grow open source with the creativity of its users, potentially beyond the context of office spaces.
The Form

After looking into metaphorical and emotive meanings behind clouds (see Appendices: Form), I experimented with foam, paper, fabric, clay and wire to explore sweeping, twisted and stylized cloud formations. The most successful forms were very simple, as I found the virtual sky beneath added a complexity that would have been overwhelmed by a more detailed form. The sweeping forms worked especially well as they allowed for a large ‘sky’ surface without bulkiness, whilst creating a sense of lightness. Twisting formations adds a sense of movement, whilst directing the light inwards to reduce cross lighting between nearby individuals.

I then experimented with scale (a), as the design needed to be large enough to create an immersive experience, yet small and light enough to be practical and easily fitted into individual work spaces. Full-scale models were very useful, and also revealed how the curvature affected the picture - how one curve could create a sense of immersion (c), whilst another an unnatural distortion (b).

The final form (d) is designed to create a sense of immersion through the curved surface, whilst appealing to both genders as a versatile form that fits into a range of workplaces. The edge detail (d, top) represents a subtle metaphorical link to the daylight curve.
a. Various stages of weather adjustment.  
b. Brightness adjustment (brighten)  
c. Brightness adjustment (dim)  
d. Colour adjustment  
e. Swipe: changing sky scene
I was curious to explore ways of creating an intuitive interface, and was inspired by the work of Bill Moggridge (2006), Phillip Ross (2010), and Bill Buxton (2007) on challenging the traditional input/output interaction approach. After experimenting with several possibilities for brightness adjustment themed around sun and sky (below), my design group found that interactive clouds were the most engaging as they added a new dimension of ‘weather adjustment’ that allows users to create their own ‘weather’, from clear sky to thunderclouds.

This gestural interface (left) builds on the familiar language of smart phones, integrating primary movements such as sweeping that have been developed over several decades by leading interaction designers at Mitsubishi, Apple, Microsoft, and Samsung (Buxton, 2007b). This interface is designed to be easy to use for a wide audience, and holds great potential to be further diversified and adapted.
Gradual morning wake up
Biologically effective light supports and synchronizes circadian rhythms
Energy boost to reduce afternoon slump
Gradual dusk

- Standard intensity for those without photosensitive conditions
- Low intensity setting for those with photosensitivity
  [Eye conditions, photosensitizing medications]
Although the science around biologically supportive light is rapidly developing, the guidelines are not yet fully defined and still developing. I therefore decided to base my design as closely as possible on natural daylight patterns to simulate the conditions our biology has evolved with, alongside expert advice.

The light rhythm of my final design replicates the subtle qualities of natural light to help connect users feel more connected to the day passing outside, whilst supplying biologically effective light at the correct time and duration to recreate the Zeitgeber cues of sunlight. In consultation with circadian scientists, I have designed the light rhythm to peak at 2,000 lux. Whilst 1000 lux has been established as the minimum intensity for circadian impact, findings from my BDES and well as my MDES suggest that users desire brighter intensities throughout the day, which is affirmed by recent studies in workplace lighting [Licht.de, 2010]. Although the light rhythm follows a pre-set pattern between 300 and 2000 lux, peaking between 9 - 11am, it can be adjusted anytime to suit individual needs and preferences [see Interface]. The colour temperature similarly replicates the patterns of natural daylight, gradually transitioning between warm morning light, white midday light and warm evening light. This allows users to wake up gradually, feel alert and energized throughout the day, and slowly wind down towards evening.

The design addresses key safety issues by carefully regulating the timing of the maximum intensity to ensures the light is supplied at the correct intensity and timing for our biological needs. This increases accessibility to a wide audience, including those for whom the use of traditional light therapy may be restricted [P. Gander, K. O’Kieffe, November 2, 2012, personal communication]. Although the standard light setting (yellow) is safe for most users, those with eye sensitivity may be adversely affected by this intensity. Therefore, the lamp is designed with an additional low light setting (orange) for photosensitive users, which is determined during the installation [see The Set Up Process]. Thereby, photosensitive users can still enjoy the visual qualities of the design such as connection to outdoors, individual light settings, and weather creation.
Wireless signal: prompts set up and brings up information screen.

Screening:
- Eye conditions
- Photosensitizing medications

Setting can be updated anytime through linked computer.

No photosensitivity: standard setting (2,000 lux)

Light set to lowest setting (300 lux max) as a safety precaution.

Advises users with photosensitivity to consult medical professional before using at high intensity.

Light intensity fades to 300 lux in the evening, eliminating the risk of inadvertent sleep phase shifting.

Future potential to develop a light rhythm to re set individual sleep cycles. This would require further considerations around timing and monitoring of response.

Future potential to develop a therapeutically effective device to improve the bright light therapy experience for those with clinical circadian disorders. This would require further considerations around timing and monitoring of response.

Future ‘add-on’ possibilities
- skies from different countries
- real time weather streaming
- paint/ design your own clouds
- upload new videos
- open source software to grow with users

Wireless signal: prompts set up and brings up information screen.

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- skies from different countries
- real time weather streaming
- paint/ design your own clouds
- upload new videos
- open source software to grow with users

Bipolar disorder
Schizophrenia
Circadian disorders

As light rhythm effectively performs the same role as daylight in supporting existing circadian rhythms using controlled timing and intensity, it is unlikely to cause adverse effects and could even be beneficial for promoting circadian health.

As light rhythm effectively performs the same role as daylight in supporting existing circadian rhythms using controlled timing and intensity, it is unlikely to cause adverse effects and could even be beneficial for promoting circadian health.

Builds a profile of user preferences over time using Bayes’ Theorem. Adapts intensity pattern, ‘weather’, and clouds accordingly.

Builds a profile of user preferences over time using Bayes’ Theorem. Adapts intensity pattern, ‘weather’, and clouds accordingly.

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Future potential to develop a therapeutically effective device to improve the bright light therapy experience for those with clinical circadian disorders. This would require further considerations around timing and monitoring of response.

Future ‘add-on’ possibilities
- skies from different countries
- real time weather streaming
- paint/ design your own clouds
- upload new videos
- open source software to grow with users

Night-time shift workers, Alzheimer’s/ dementia

Default

Future potential to develop a light rhythm to re set individual sleep cycles. This would require further considerations around timing and monitoring of response.

Future potential to develop a therapeutically effective device to improve the bright light therapy experience for those with clinical circadian disorders. This would require further considerations around timing and monitoring of response.

Future ‘add-on’ possibilities
- skies from different countries
- real time weather streaming
- paint/ design your own clouds
- upload new videos
- open source software to grow with users

Builds a profile of user preferences over time using Bayes’ Theorem. Adapts intensity pattern, ‘weather’, and clouds accordingly.

Builds a profile of user preferences over time using Bayes’ Theorem. Adapts intensity pattern, ‘weather’, and clouds accordingly.
The initial set up process is designed be simple easy to use, whilst addressing key safety issues (detailed left). The set up manager runs through a wireless link to the assigned computer, and determines the correct light setting for individual needs by screening for eye conditions and photosensitizing medications. The manager then installs the device software, which enables users to adjust the light setting (standard or low) anytime through the computer, whilst allowing for future add-on possibilities, such as user uploads, sky galleries, and web-cam streaming.
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<thead>
<tr>
<th>1. Suspension Cable</th>
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<tbody>
<tr>
<td>2. Attachment Screws</td>
</tr>
<tr>
<td>3. Outer Casing (Aluminium)</td>
</tr>
<tr>
<td>4. Inner Casing (ABS)</td>
</tr>
<tr>
<td>5. Ambient Light Sensor</td>
</tr>
<tr>
<td>6. Manual On/Off Switch</td>
</tr>
<tr>
<td>7. Controller Circuit</td>
</tr>
<tr>
<td>8. IPv6</td>
</tr>
<tr>
<td>9. 6LoPAN</td>
</tr>
<tr>
<td>10. LED Controller</td>
</tr>
<tr>
<td>11. Retraction Mechanisms</td>
</tr>
<tr>
<td>12. White Full Spectrum LED Strip</td>
</tr>
<tr>
<td>13. Warm White LED Strip</td>
</tr>
<tr>
<td>14. OLED panel</td>
</tr>
<tr>
<td>15. Infra-Red Height Sensor</td>
</tr>
<tr>
<td>16. Displacement Sensors</td>
</tr>
<tr>
<td>17. Outer Diffuser (Light Diffusing Plastic Compound)</td>
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<tr>
<td>18. Inner Diffuser (Frosted PET)</td>
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</tbody>
</table>
The Technology

“Good design is often invisible”
(S. Foster, October 10, 2012, personal communication).

The technology is designed to minimize manual input and adapt dynamically to individual needs to aid in creating an enjoyable user experience, as well as prioritizing energy efficiency.

Using Bayes’ Theorem 1, the controller [7] is able to interpret patterns of user interaction to predict future preferences, creating a quietly intuitive user experience tailored to individual needs. An infra-red sensor [15] adjusts the lamp height automatically to suit each individual, ensuring optimal illumination and position and allowing several workers to use the same workstation at different times. Although the lamp is set to turn on and off automatically with the linked computer, it can also be controlled manually through a slide switch [6]. The full spectrum LED strip [12] is positioned around the parameter of the design as the main light source, supplying a biologically effective intensity between 9-11 am as well as high quality task lighting throughout the day. This LED strip adjusts dynamically throughout the day in conjunction with a warm white LED strip [13] to recreate the dynamic changes in natural light colour throughout the day (see The Light Rhythm).

The design features an ambient light sensor (5) to increase energy efficiency by adjusting light output in accordance with the conditions of the external environment. Although OLED (14) is not yet widely used in mass manufacture, it is expected to become more affordable in the foreseeable future (Harris, October 24, 2012, personal communication) and could intermittently be substituted with transparent LCD. In the more distant future, it may be possible for the lamp to be powered by sunlight using a transparent solar cell film on windows.

The interface utilizes displacement sensors [16] to detect hand gestures, which are interpreted by the controller to adjust the ‘cloud’ position and light intensity accordingly. For more detailed gesture recognition with individual finger controls, the technology could be also adapted to incorporate Leap Motion.²

The lamp is fitted with an IPV6 (8), allowing for separate user profiles, which are activated through login. Although computers are the default user identification, smart phones could also serve as an alternative. As these devices are able to register general sleep/wake cycles using accelerometers, they provide a further opportunity to educate users through pop up messages tailored to their individual circumstances. For instance, users who go to sleep late (‘night owls’) may benefit from early morning light exposure if they would like help with adjusting to an earlier bedtime. Thereby, users are able to gain a more detailed understanding of how they can use light to their advantage on a dynamic journey tailored to their current needs.

1 Bayes’ Theorem is a formula that predicts user needs by collecting data from previous interactions (Harris, October 24, 2012, personal communication).
2 Leap Motion is an optical tracking system that allows for precise gesture based control of digital devices.
Reflection

Within the wider field of biological lighting, my project illustrates how a design approach can be utilized to translate scientific knowledge into a practical application to improve public health on a large scale.

The project began as an open question about how light affects our health and wellbeing, with a focus on how the benefits of biologically supportive light can be made more accessible. I started with a scientific focus to understand how light could be applied in a biologically supportive context in a way that is safe and accessible for a diverse user group. My connection with circadian scientists was critical for helping me understand and define the biological and safety aspects of my design, as the science behind this application of light is still developing. Through my expert interviews and background research, I identified mid-morning light, full spectrum light and dynamic lighting as the most promising options.

This formed the basis for further exploration from a user focus, utilizing a human centred design approach to gain a deeper understanding of my target user needs and to visualize solutions intuitively and emphatically. Although this research was largely qualitative with small groups, several common themes stood out consistently, which highlighted a need for:

- A connection to the day passing outside
- Natural qualities indoors such as movement and subtle change
- Brighter light throughout the day, especially in the morning
- Increased awareness around the biological impact of light
- Smooth integration and an enjoyable experience to ensure consistent use

These findings formed my key criteria, which I investigated further with the help of a design group. We used a collaborative process to explore and develop potential solutions and identified accessibility, individualization and the need for a meaningful experience as further criteria.

My early concept development aimed to translate these core findings into possible solutions. Through critical reflection we were able to identify several promising starting points, including customization, dynamic light rhythms, and recreating natural qualities such as slow change. We used experience prototypes to develop these aspects further, and to identify how they could be successfully translated into a design solution. This process led us to gradually develop the basis of the final design, as a synthesis of the learning and understanding we had developed throughout our five month collaboration. The final design addresses the key criteria that have emerged through the research process:

- Slowly changing sky with real time clouds
- Customizable settings
- Brighter and dynamic light throughout the day, replicating the day light curve to support our biological needs
- Raising awareness through experiential discovery, with options for more direct education if desired
- Automatic integration and playful interface create an enjoyable user experience for consistent use
- Accessible and safe for a wide audience

In retrospect, I feel this process has been very successful, and am excited about the result we have accomplished. Although my early deep-dive into the scientific aspects was perhaps too expansive, it has enabled me to build a solid basis, and potentially extend this learning to future projects in the light therapy field. My exploration into the lived experience of Mal-illumination could similarly have been simplified, which would have allowed for more time to explore and develop the final design more fully. This project has taught me important skills in research design prioritizing and time management, and has greatly extended my learning.

The journey has been one of many unexpected twists and challenges, which have increased my confidence to extend myself beyond my comfort zone, and helped me learn to embrace uncertainty and to trust the process. This has not only advanced my creative practice, but also helped me to grow on both professional and personal levels.
As the design is currently at concept stage, it would require further development for manufacture, including detailed resolution of technology, parts and interface, marketing, and additional testing to certify the application of biologically supportive light in this context. Although the design is not yet feasible for mass manufacture, the technology could be simplified to address cost. As there are many unaddressed needs in this area, the concept of biologically supportive light holds many opportunities for future development, from enhancing life quality in rest homes and recovery rates in hospitals to supporting concentration in schools and healthy circadian rhythms in astronauts (Gander, November 2, 2012, personal communication).

The design aims to promote a shift in the way we understand the role of lighting to include its biological influence. It is thereby not intended as a final solution to a single problem, but rather as a suggestion of how we can begin to address the wider issues associated with Mal-illumination to benefit a broader population. This shift is already underway, as described Anna Wirz-Justice (2009):

> Federal and industrial lighting standards are beginning to extend their purview beyond safety and minimum requirements for visual comfort and performance, to include circadian rhythm function. If this effort is to succeed, we will need an intensive R&D partnership between chronobiology researchers, clinicians/chronotherapists, standards agencies, architects, lighting designers and manufacturers. (p. 80)

It is my hope that through increased awareness a larger part of our population will have the ability to enhance their lifestyle in a manner that acknowledges the vital importance of natural light for our health and wellbeing.
Glossary

Biologically Effective
An intensity of light strong enough to influence our circadian rhythms—generally around 1,000 lux or above (Wirz-Justice & Fournier, 2010).

Biologically Supportive
This term describes an application of light that supports the biological needs of our body. In the context of this project, this term describes the application of full spectrum light peaking at 2000 lux between 9-11 am, alongside dynamic adjustment throughout the day to replicate the rhythm of natural daylight.

Bright Light Therapy
A supplementary light source commonly used for the treatment of SAD.

Circadian rhythm
The circadian rhythm controls many important biological processes such as sleep, alertness and energy. This rhythm coordinates the release of hormones throughout the day so we feel alert and energized during the day and tired at night. Circadian rhythms are directly regulated by bright light, and require daily exposure to natural light signals to stay synchronised to the 24-hour day (Hyman, 1990).

Co-Design/ Participatory Design
This approach recognizes the user as the expert in their own needs and desires (Sanders, 2008). The participatory design approach actively involves the user in the design process, by giving them the tools to develop their own solutions in close collaboration with the designer.

Design- Led Research
A term to describe innovation driven research methods that strive for understanding through design (Sanders, 2008). Examples include experience prototypes and co-design.

Full Spectrum Light
Full spectrum light is the range of color contained in natural light. This can be observed in a rainbow or prism.

Human Centered Design
A term used to describe research methods that build empathy and understanding from a holistic and user focussed perspective. (IDEO, 2012, Sanders 2008; Moggridge, 2006; Buxton, 2007).

Mal-Illumination:
A term created by John Ott to describe the adverse biological impact of too much artificial light and too little natural light, resulting in fatigue, eye strain, reduced wellbeing and loss of vitality (Ott, 1973; Cedar et al, 2007).

Melatonin
The "darkness" hormone that makes us sleepy. Light inhibits the production of melatonin.

Lux
A measurement of light at the point it is received, rather than the point at which it is emitted— for example, the brightness that reaches the eye from a lantern. One lux is roughly equivalent to one candle flame.

Seasonal Affective Disorder (SAD)
A condition characterized by major depressive symptoms following a seasonal cycle. SAD is believed to be caused by lack of sunlight (SAD.org, 2010).

Serotonin
The "happiness" hormone which gives us our sense of vitality. Light boosts the production of serotonin.

The Internal Clock
This part of the brain (Suprachiasmatic Nucleus, SCN) is the body’s ‘master clock’, which synchronizes our circadian rhythms daily and depends on signals of light and dark to coordinate biological processes in the body (Wirz-Justice et al, 2009).

Winter Blues
A milder, sub-clinical form of SAD.

Winter Depression
General term to include the symptoms associated with reduced light levels in winter, ranging from winter blues to SAD.

Zeitgeber
German for "time-giving", a Zeitgeber is an external cue that influences our SCN, the internal clock. The most important Zeitgeber is sunlight (Wirz-Justice et al., 2009).
References


**Figures**


Bibliography


abstract


Dunn, R., Kremsky, J. S., Murray, J. B., Quinn, P. J. (1985). Light up their lives: a review of research on the effects of lighting on children’s achievements and behavior. The Reading Teacher, 38(9), 863-869


Appendices
Prior Research (BDES): Key Methods and Findings

(a) Light and lighting
[online questionnaire]

- what are the most important features?
- when is more light wanted?
- what type of light is most enjoyed?
- when is more light wanted?

(b) Light intensity
[adjustable test rig]

- what is the level of light (on average) enjoyed throughout the day?

(c) The daily routine
[photo - documentary]

- primary activities and environments: average hours

(d) Glare and diffusion
[adjustable test rig]

- what illuminance directions create most and least glare?
- how effectively can diffusion be used to counter glare?
the daily routine
light and lighting
form / aesthetic
illuminance
interaction
performance

photo - documentary
online survey
discussion / brainstorm
models / sketches
test rig
Circadian Disorders and Treatment
NOTIFICATION OF LOW RISK RESEARCH/EVALUATION INVOLVING HUMAN PARTICIPANTS

 Điền các tiêu chí cần thiết để xác định mức độ rủi ro của nghiên cứu.

SECTION A:

1. Project Title: Design Thesis (97818)

Projected start date for data collection: 08/08/2011
Projected end date: 08/08/2012

2. Applicant Details (Tick the appropriate box and complete details)

ACADEMIC STAFF NOTIFICATION

Full Name of Staff Applicant
School/Department/Faculty
Region (north only)

STUDENT NOTIFICATION

Full Name of Student: Applicant
Local Identifier
Postal Address
Telephone
Email Address

GENERAL STAFF NOTIFICATION

Full Name of Applicant
Section
Region (north only)
Telephone

Name:
Project Title:

This questionnaire should be completed following, or as part of, the discussion of ethical issues.

Part A

The statements below are being used to determine the risk of your project causing physical or psychological harm to participants and the ethical nature of the harm. If you are in any doubt you are encouraged to submit an application to one of the University's ethics committees.

Does your Project involve any of the following? (Please check appropriate boxes. Please circle one: YES or NO for each question)

Risk of Harm:

1. Situations in which the researcher may be at risk of harm.
   - YES
   - NO

2. Use of questionnaires or interviews, whether oral or written, which might reasonably be expected to cause discomfort, embarrassment, or psychological or spiritual harm to the participants.
   - YES
   - NO

3. Processes that may be potentially disadvantageous to a person or group, such as the collection of information which may expose the person/group to discrimination.
   - YES
   - NO

   - YES
   - NO

5. Collection of data on body fluid, issue samples or other samples.
   - YES
   - NO

6. Any form of exercise regime, physical examination, observation (e.g. a sleep, dietary).
   - YES
   - NO

7. The administration of any form of drug, medicine other than in the course of standard medical procedures, placebo.
   - YES
   - NO

8. Physical pain, beyond mild discomfort.
   - YES
   - NO

9. Any Massey University teaching which involves the participation of Massey University students for the demonstration of procedures or phenomena which have a potential for harm.
   - YES
   - NO
Survey Advertisement

Missing the Sun?

I am currently working on my Masters in Design, which explores how light can be used to improve physical and mental wellbeing. As our society is spending increasingly more time indoors under artificial light (especially during the darker months), we often miss out on the natural light cues that guide many of our biological rhythms, resulting in upset sleep, low mood, decreased immunity and less energy. My project aims to bring these light cues inside to support our biological needs whilst making winter more fun. I am currently running a survey to understand and prioritize options for how we could use light to support our everyday wellbeing, and would love to hear your thoughts! You can access the survey through the following link: https://asia.qualtrics.com/SE/?cid=SV_dnz8XJdU18bCz2b&Preview=Survey&Br andID=qasiatrial

Co-Design Advertisement

Missing the Sun?

I am currently working on my Masters in Design, which explores how light can be used to improve physical and mental wellbeing. As our society is spending increasingly more time indoors under artificial light (especially during the darker months), we often miss out on the natural light cues that guide many of our biological rhythms, resulting in upset sleep, low mood, decreased immunity and less energy. My project aims to bring these light cues inside to support our biological needs whilst making winter more fun. I will be running several interactive workshops for all sunshine fans over the next few months (anticipated from late June-Sept) at the Newtown Community Centre. We will meet for 1-2 hours once a fortnight (likely Wednesday evenings) to play with prototypes, brainstorm, and discuss thoughts and ideas. If you would like to be involved, I’d love to hear from you! You can contact me at lisagabel@hotmail.com or 021 251 2456.

Above : Template for the Confidentiality Form and Information Sheets used for the Photo Journal and Design Group Studies.
Expert Interviews

Early meeting with Phillipa Gander
Date: 28.02.2012

- General discussion around light therapy – raising awareness – shared interest, invitation to come by the Sleep Wake centre sometime to see what they do

Q: any ideas on using dawn simulation for preventing circadian disorders?
A: Look into Boeing dreamliner cabins

Q: what are your thoughts on lighting light in a preventative way to help people with sub-clinical winter blues feel better in winter?
A: Potentially a good idea- important to understand how light affects the circadian rhythms before.

Q: Are there any light related projects you will be working on this year?
A: We will do a study into Alzheimer’s and Dementia, using light to regulate the sleep rhythms. Also get in contact with Sarah Jane Paine, who did studies with blue light therapy last year- she is on leave until the middle of the year.

Meeting with Sleep Wake Centre #1
Date: 18.04.2012
Present: Dr. Kara Mihaere, Karyn O’Keeffe, Dr. T. Leigh Signal, Kan-chana Pathirana

Q is it foreseeable to come up with a design that would work for many people?
A: Each person has slightly different circadian rhythm, so it would be difficult to design a “one-fits-all” solution for many. However, they were interested in the idea of using light cues throughout the day to support healthy circadian rhythms in a similar way as natural daylight.

Q: What area do they see holding most potential for development?
A: sleeping problems
- alzheimers/ dementia
- non seasonal depression
- shift work / jet lag
- post/ ante natal depression
- SAD winter depression
A: the areas where most studies have been done are sleep, SAD, Shift work, jet lag. Should look into Phillips book “sleep in the 24 hour society” to understand how light affects sleep phase shifts.

Q: How effective is dawn simulation in preventing circadian disorders?
A: weren’t sure

Q: Possible to borrow a light box?
A: Best to talk with Rosie Gibson – r. Gibson@massey.ac.nz

Q: Would it make sense to develop a learning device to help people understand how light can be used to its best biological advantage?
A: difficult to say- as people have different light needs, would first need to establish what is “good” light exposure. Light cues may be a good start. Look also into Rosie’s hypothesis of midday light exposure

Q: do you know if blue light is safe for long term eye exposure?
A: weren’t entirely sure- some thought yes, others had read it wasn’t.

Meeting 3: Karyn O’Kieffe, Rosemary Gibson
26.08.2012

Q: Screening process- safety, what is most important to consider?
A: Eye sensitivity, Mood disorders (Alzheimers, Bipolar, Schizophrenia, Demania- should be specific), Photosensitizing medications, Sleep disorders (should also be specific by condition rather than general heading. Refer to doctor)
Q: Minimum brightness levels for preventative application?
A: Melatonin suppression starts at 180 lux, but would be much more to shift rhythms around 2000 lux.

Tips:
Define tolerances—what the product can and can’t do—best to use only for supporting existing sleep rhythms, shifting dramatically forwards or back becomes tricky and needs expert monitoring. Avoid shift work resetting, as this is similar.

The design could also educate users—if their sleep is shifting slowly forwards or back, it could give them tips like “you may benefit from morning light exposure” if mild delayed sleep.

Meeting 4: Karyn O’Kieffe, Philippa Gander
Date: 02.11.2012

Q: Maximum intensity for photosensitive conditions?
A: Depends on severity, generally 300-500 Lux should be fine

Q: Screening process—comments?
A: Can remove many of the conditions, (sleep and mood disorders) as they should not adversely be impacted by 1000-2000 lux intensity. Shift workers should have low light setting, so keep in.

Comments:
Philippa: Really liked concept, and could see enormous future potential—not only as a means to substantially decrease relapse rates for those using bright light therapy, but also in space shuttles where the day/night pattern is severely disrupted.

Meeting with Peter Turner, optometrist, designer, and human factors engineer. Date: 30.04.2012

Q: how does the eye change as we age?
A: the lens thickens and becomes more yellow. This means that less light enters the lens, and we need more light. Also, blues are not perceived as well, and colour perception changes quite significantly. Lighting needs vary a lot with older people.

Q: what are the key elements that define good lighting?
A: -High quality light has a high colour rendering index—that is, as close to daylight as possible, which has a CRI close to 1,000.
-Diffused light is also important—direct light, objects are illuminated too brightly, and can cause glare on screens and magazines. Light can be diffused using mirrors, or refractive shades. Also, hanging lamps with upwards lighting are much better than downwards cast ceiling lighting.
-Energy efficiency is also important. Eco bulbs are terrible—more about using clever planning to get the most out of bulbs—halogen very dim and energy dense. High contrast is important for detail tasks—usually achieved by good quality, bright light.
-Full spectrum light costs about 50% more, but much better CRI than fluorescent.

-suggested I look into the spectral response curve of the eye

-Showed me his product for edge detection design—tests for how the eye responds to glare and subtle shades of grey. Also a reading stand for the elderly, directing light at the ideal angle for reading magazines with adjustable glare protection and mirrors that reflect light evenly across the page.

-Lent me a book on lighting guidelines for the Illumination Engineering Society.
Observation #1: Masters Studio Room

Time: 10 am until 4 pm (6 hours)
Light level: dim, some natural light from high windows
People present: 6-8

Activities:
- Working at computers—typing, clicking
- Reading
- Voice recording

Interactions:
- Talking
- Moving to see other people’s screens—working together

Postures:
- Hunched forwards
- Leaning backwards

Expressions:
- Tired
- Stressed/tense
- Serious/concentrated

Breaks: approx every 40-60 minutes

Comments: “I need a smoke, wish I could quit but great for stress”

Feelings:
Static, “empty” light, hard to stay focussed long.
Windows make a big difference to see outside, make it much more bearable.

Observation #2: Computer Lab 11A25

Time: 2-6 pm (4 hours)
Light level: dim, yet glaring
People present: 15-20

Activities:
- Working at computers—typing, clicking
- Listening to music—headphones on
- Eating
- Getting up to stretch

Interactions:
- Talking
- Moving to see other people’s screens—working together

Postures:
- Hunched forwards
- Leaning backwards

Expressions:
- Focussed
- Concentration
- Bored
- Stressed/tense

Comments: “I need to exercise”

Feelings:
Complete disconnect with time, very dim light that feels glarey, static, empty. Tired, unmotivated, hard to focus.

Observation #3: Rest Home

Time: 9 am-12 pm
Light level: dim—fluorescent light
Natural light from windows

People Present:
One, then shifted to another room with 8 people

Activities:
Talking, in communal space other were watching TV and reading.

Interactions:
Talking, passing things around

Postures:
Sitting, occasionally slumped

Expressions:
Tired, weary

Keywords:
Static, enclosed/closed off, isolated, placid, empty, cold

Comments: “it becomes my world”

Feelings:
disconnections, tired, trapped
Technologies

- *Le Dobson Elite*
  - green + blue light
  - 1,050 lx
  - bright light therapy device for SAD

- *Philips Go Lite “Blu Lite”*
  - blue light, 2,500 lux
  - bright light therapy device for SAD

- *Sun Sun X-Ray Technologies*
  - green “X-Ray”
  - 300 lux
  - light therapy device for shift workers

- *Apollo*
  - fluorescent, full spectrum 10,000 lux
  - bright light therapy device for SAD

- *Vilavo*
  - inner ear light therapy device
  - alternative bright light therapy device for SAD and jet lag

Products

- *Glow Simul’Dear - Philips*
  - Elevation simulation device for SAD

- *Vitek 4K Diverge Design - Philips*
  - Bright light therapy range for SAD

- *Real Bright Light: View, Northern Technologies - Philips*
  - Bright light therapy device for SAD and shift workers

- *Lightmood 2000W - Ronan Egan*
  - Bright light therapy device for SAD and alcoholics

- *Daylight*
  - S200 light therapy device
  - Elevation E.L.L.

- *Revue Dear - Mimi Long/Chang*
  - A bright light therapy range designed for women suffering from post-partum depression.

- *Light Keeper, Loop H2 - dawn simulator integrated headlights to help the user wake most naturally.

- *Lightoogles Luma - dawn simulator goggles*
  - designed to awaken the user gradually with high-quality fading.

Environments

- *“Le Jardin” (light and café)*
  - Martin Dykeman
  - A light café based on the principles of bright light therapy. Users pay a fee to enter and put on a white overcoat. They can socialize and drink coffee with friends while absorbing the light.

- *Bubba Tent - Pierre Boffrand Domas*
  - a cozy experience for those wishing to “sleep with nature”
  - The canopy can be hired out for a set time.

- *Elatio Device - full spectrum LED*
  - high quality lighting that supports productivity and improves natural day lights.

- *Luminotherapy Seats - Philips Paris International Airport*
  - Bright light therapy devices for treatment of jet lag using philips lamps.

- *Philips Daylight*
  - One of several designs in an emerging market of dynamic lighting. This overhead luminaire uses shifting patterns of light colour and intensity to replicate natural light rhythms throughout the day.

Market Research

Key Technologies, Products and Environments
More light in the morning to help me wake up
The mornings are a time that sets up for the day ahead. If I could generally be said that a day continues how it began then waking up peacefully, gently, perhaps time for meditation is the best foundation to the day.
Waking up naturally and refreshed helps my energy level throughout the day.
Personal experience - I have a bedroom with no light and have trouble waking up getting up, and often feel down in the morning.
I believe this affects your entire day.
I have waking up in the light in summer, but my husband insists on having the blackened curtains closed.
I lived without light and when I lived in a house with more light I realized its was so much better.
satisfaction and contentment being warm and dry to start the day.
It's a great start to the day, spring out of bed after waking to sun pouring in. More natural than regular alarm and warmer. Less tempting to stay in bed during cold winter months.

More light mid-morning to help me stay alert and energized
Personally sunlight plays an important role in my whole wellbeing, so sun throughout the day is important to have good energy for the day.
I would like more brightness, more natural light indoors, and a way to get rid of accidentally fluorescent lamps.
I know I'm happier and my eyes healthier if I have access to good light consistently good light like sun light would be great. More but even better than a short amount. Ordinarily like to get out for a morning jog and stretch to soak up that morning mid-morning light, and that tends to boost my mood and give me thoughts for the next day (combined with the exercise).
Consistent energy is better than bursts because I think this would relax my eye (not having to strain) and sustain my work output & idea flow.
Natural resource of the sun always makes me feel more happy, balanced, and productive.
So that I can spend time in it at any given opportunity.
I don't have natural light in my working environment.

High quality light that supports my mood and energy throughout the day
A way that helps me to feel more connected to the outside environment.
I would like to feel less disconnected to the environment.
Being inside all day, you feel disconnected from the real world. This makes me, eventually, feel tired and dry. To feel more connected to the outside environment would be good.
I dislike mornings, and find that when I'm exposed to more light it makes waking up easier.
Because I only lose track of time and being more in tune with natural light would help that, maybe.
I am a computer bound wage earner.
It is nice to feel like you are part of the outside day.
Being outside always makes me feel happy. I can't go outside during the day. It would feel good to still be connected to the outside world.
Access to natural light is really important to my working environment.
Have found that it is really important for me to be near a window.
Being inside all day really makes you miss the outdoor light.
Because I need to see the sky and to have access to sunlight, I'm a big fan for natural light, Skylights etc.
I feel more calm when I'm in nature and this helps with focus and stress.
So much goodness comes from being outside. Fresh air, grass under your feet, hearing birds, seeing wildlife. It's a nice reminder that you're NOT stuck inside, for most people at a desk behind a computer. If I felt more connected to the outside environment while being inside, being outside and working wouldn't feel so much like I was in a prison, working my life away.
That is exactly what they achieve in traditional Japanese homes. Outside and outside are connected. It is very uplifting for the spirit.
Outside feels healthy, inside is square, hard, fluorescent, stuffy, no sky or trees. Natural light feels healthy.
The outside environment is calming.
Because I think it includes many of the other choices.
Like to be outside.
Outside environments make me feel good.
because I prefer to be outside.
Feel better when I'm outside especially in the weather.

Survey

A playful and intuitive way to learn how I can use light to improve my health, mood and energy
More learning and this is self-help way to improve quality of life.
everyone wants good health and everyone needs good lighting to function properly without damaging your health.

Because it sounds intriguing... and I would like to learn more.

Quite difficult to assess I think as there are many other factors that affect mood so I am not sure if I could directly pick one option with direct reason, just one that looks interesting.

I need suggestions to improve the light in my day during winter months as I am affected by SAD.
Good health and a good mood are important to me.
I find that light improves my mood and energy.

I am forced to spend a lot of time at a computer. Soft natural light helps me to feel less claustrophobic, and this in combination with fresh air sustains me a little. I need to take some exercise at regular intervals.

Highest chance for realization in view that I spend the majority of my time at a big company.
3. And this is why:

<table>
<thead>
<tr>
<th>Task Response</th>
<th>Word</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Be realistic.</td>
<td>Be realistic.</td>
<td>Be realistic.</td>
</tr>
<tr>
<td>3.2</td>
<td>Be optimistic.</td>
<td>Be optimistic.</td>
<td>Be optimistic.</td>
</tr>
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<td>3.3</td>
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4. And this is what:

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Draw The Experience : Grey Days
Draw The Experience : Fatigue
I used a photo-diary and journal to gain a deeper understanding of the long term lived experience from a variety of individual perspectives. The journal was designed to gain insight into internal thoughts and feelings, whereas the photo-diary was designed to frame an external picture of their daily lives. I held a short follow-up discussion with respondents after collecting the materials to understand their daily realities more fully, as well as what aspects they considered most important in the final design.

I distributed photo-journal parcels to a small group of respondents who had expressed interest in partaking in further studies through the survey. I asked participants to capture their average daily routine using the camera, and record thoughts, worries or events in the journal over a one week period.

I was surprised to find there was a striking coherence between the results. Respondents consistently wanted more light in the morning, as it made them feel more alert, optimistic and energized to start the day. Natural light qualities were greatly enjoyed, especially sunlight. Notes from sunny days were often much more cheerful than those from cloudy days, which often described tiredness and low mood. As reflected in the survey and observation, key elements that were most desired were natural qualities of light, smooth daily integration and a connection to the outdoors. The common links between my research so far affirmed the priorities I had set for the design, whilst building on the criteria for my design exploration.

Key Findings:

The design should:
- Supply more light in the morning
- Be adjustable for more light on grey days
- Replicate the qualities of natural light
- Be well integrated
- Be enjoyable and playful to use

must not be:
- Flickering
- Cold
- Dim

Keynotes from follow-up interviews:

Interview #1
- Light and warmth is nice together, miss both in winter
- Something that gives a sense of time passing too
- Maybe an excuse to take a break, but would ideally like throughout the day
- At work would be nice too, but windows are best of all! In an office with closed off walls it would make a big difference.
- Noticed mood is closely related to weather. Difficult to be happy on grey days.
- Not always able to go out when sun shines, this is hardest of all
- Would like own sun inside for when real one is absent.

Interview #2
- Enjoy morning light, helps to wake up
- Feel more optimistic and energetic, ‘bounce’ after sitting in sun, makes a big difference
- Nature views make a big difference also, especially in the workplace
- Nice to have light box, finding time to do things I don’t normally have time for – invites me to slow down!
- Would like to see in public transport, or light and warmth together
- Need freedom to adjust brightness, average needs are not always best
- Lunchtime light experience would be really nice or adjustable lighting in the workplace
- Seeing sky and weather changing would be nice too, to get a sense of time of day
- Quality of light is also important- very different in morning than evening
- Observations: often wrote “didn’t realize how tired I was”

Interview #3
- Seeing sky and weather change- time of day
- Quality of light in the morning is very special, also evening. Warm light nice in morning and evening
- Morning light is needed- sunny days wake me up more optimistic, energy
- Nice to be able to use the light for other things too
- Light needed more in the workplace than the home.

Further details available on request.
Having experienced the common symptoms of mild circadian disorders myself, I noted key words of my own experiences (detailed right). By mapping the correlations between these conditions, I was able to understand their interrelationship more clearly. These insights also highlight why the SAD condition can be difficult to diagnose, especially when symptoms are mild and occur over a long-term period.

SAD
Glum, depressed, lack of energy and motivation. Everything seems grey and dim, no inspiration, difficult to get up in the morning. Oppressive. Need for sunlight, feeling of deprivation, almost like an addiction! Feel like hibernating and eating chocolate.

FATIGUE
Eyes stinging, headache. No concentration, mind wanders when associated with uni, often feel convinced I need to be working, that I am productive even when I’ve spent hours achieving nothing. Mental fatigue - working on identifying it so I can go for a walk when I need to refresh, rather than keeping on hitting a brick wall. Physical fatigue - tired, no energy, dreaminess, can’t concentrate. Nothing is very “solid” - things float, thoughts fluid and vague. Extreme fatigue - hyper-mania, feeling like laughing a lot and things swim around. Feels like in a dream, nothing really matters or has consequence, very emotional.

SLEEPING PROBLEMS
Anxiety, especially to get to sleep. Carving sleep but doesn’t come, distracting thoughts keep popping up and mental to do lists and worries and problems. Heart pounds whenever the do, desperate to find a solution on the spot so I can finally let it go and relax. Tight muscles, unable to relax very long, tense. Feel groggy in the morning, exhausted, drained. Similar feelings to the above during the day.

LOW LIGHT ENVIRONMENTS
For two weeks I worked full time in a low light office with small windows. I felt a strong disconnection to the outdoors, and found it really hard to go in when the sun came up, miss out on it all day and leave when the sun was down again. The fluorescent lights were awful, flickering, cold, empty light that made me feel tired and uninspired. Often lost track of time completely. Loved being outside, and cherished the lunch breaks highly always made sure to sit in the sun whenever the opportunity arose.
First Hand Experience: Bright Light Therapy

Philips GoLite: cool "neon" quality of light, dimmer, but high glare front on

Daylight: warm light creates a glowing "sunlight" effect, especially on dark days
Meeting 1

- Introductions/ people/ project/ light boxes
- brainstorm- key aspects:
  - how do we want to use light?
  - experiential desires?
  - how/ when/ where/ how?
  - do people want more light indoors? How can we get people to go outside more often?
  - How can we raise awareness around the biological impact of light?

Discussion points:

- light and warmth/ huddling/ communal experience/ comfort/ hibernation
- learning to accept winter for what it is and the impact it has on our bodies- we do notice it, but very little acceptance. Need more sleep, less energy
- important this winter blues isn’t put across as a medical condition- the product shouldn’t be a treatment device or stigmatize, as winter blues is very natural response to grey days, most people experience it. “I don’t want to identify myself as having something wrong with me” very negative viewpoint. Should be positive, how we can enhance our mood and energy
- backwards mentality of society to shut ourselves inside and create our own inferior lighting
- functional lighting vs. lighting for health- lacking awareness, cultural differences. Nz’ers have a cultural tenancy to “grit our teeth and get on with it”
- mentality of society- resistance to positive change through lack of understanding, could change by education and talking about it

- (similar to considering teenagers lazy for sleeping late, when actually their circadian rhythms usually undergo a shift at this age, and better to restructure schooling times to allow for this)
- education through showing people, and allowing them to talk about it in a social context is more effective than direct informative approaches
- education should be dynamic and allow people who want to know more access more detailed information, whilst supplying only basic info/ (maybe through experience?) to users at start. Shouldn’t be overwhelming. Should be playful and enjoyable.
- feels wasteful to use light during the day, but only in home, its normal in workplaces, and ok.
- eco awareness- energy efficiency is important
- ease of user in important
- organic forms are much nicer than square ones- Japanese lighting is a good example
- quality of light is important- natural high quality, non flickering, ideally natural light.
- Ideally would like to get out more, but this often restricted by work schedule and weather. Would not enjoy a pop up type motivation to “take a break” more often, feels like dictatorial without understanding why important. Important to show why, and then people can make it a higher priority through understanding
- Would prefer natural light source over artificial- more windows. Need greater social change/ architecture, or day lighting using fiber optics
- integration- finding ways to put light where people are already (e.g. public spaces)
- would like connection to outdoors, sense of time passing, what the weather is doing. Dappled light is nice.
- nice to have some kind of timekeeping system- like in childhood, there was dinnertime, time to sleep, time has a purpose. In adulthood often work late and ignore time. Nice to have time cues to know time to wind down, etc.
Meeting 2

- Models/ concepts/ ideas: what do we like/ not?
- Which concepts are we most excited about?
- How could these be improved?
- What are some other ways we could go about achieving this?
- Key aspects:
  - Connecting in and outdoors- a way to make being outdoors more enjoyable in winter- a warm, dry public space
  - Warmth and light together
  - Dawn simulation
  - Social and private contexts of use- depending on mood. Social use also reduces stigma
  - A personal “sanctuary”
  - Changing light throughout the day- light pattern
  - Roundness and organic form
  - Integration- needs to be where people are already to be used consistently. Could be a break time experience to look forward to at workplaces.
  - Brighter light throughout the day is best.

Meeting 3

- Criteria- narrowing focus
- Testing concepts:
  - Light and warmth
  - Direction of light [above, below, right, left, etc]
  - Sunbox- making our own using doflex and solar pannels
  - General discussion on concepts, which elements most enjoyed.
- Key aspects:
  - Light and warmth very successful- resistance to give hotties back! However not so good in summer- should be optional
  - Downwards direction of light best- most natural, less glare
  - Discussion on staff rooms- not all used the same way, and not all workplaces have them
  - Motivating people to be outside more by creating scenic places to walk by would be best option to go outside more, but how many people go to the botanic gardens in winter? A warm bubble tent could be fun, but social dynamics tricky- cafe like experience may work, with open sky so not too intimate.
Direction of Light

This experiment was designed to explore the different effects of light from various angles. Sideways lighting (a) was perceived as glaring and unnatural, especially when facing front on. Downwards lighting (b) was perceived as most natural, diffused, and enjoyable, as well as being the most efficient angle for light absorption into the retina. Upwards lighting was rated least enjoyable, as it had a high level of glare and gave expressions an eerie glow. However, as a lower light level (as in the fireplace experiment), upwards light was perceived more favorably.

Finding:
Diffused, downwards lighting is the best solution, as it reduces glare and provides the best angle for light absorption.
Capturing Sunlight

This experiment was designed to try out the act of "capturing" sunlight by using solar panels. The box was left to charge in the sun over a few hours, then opened in the evening/ grey days to enjoy the "saved" light. The experience did feel a bit like capturing light, - however the quality of light form the led’s was an important factor. The above photos demonstrate the rough experience of using the box- the more the "petals" are un-folded, the brighter the light. Below is the box after charging, at various intensities. The concept may [over long term use] loose its appeal as the 'novelty factor' wears off.

Findings

Solar powered "sunlight catching" does give the expereince of gathering sunlight, however the light quality is vital.
**Meeting 4**

- Final concept directions:
  1. Transport integration (accessibility, integration)
  2. Staff room integration (break time experience to look forward to, integration)
  3. Sunbox/light catching (motivation to go out more, huddling)
  4. Light canopy (accessibility, motivation to go out more)
  5. Light kiosk (education, accessibility)

- Testing sunboxes- really enjoyed the poetic experience, but in reality take quite a commitment to charge and to remember for grey days. Therefore would require better integration, which is tricky.
- Enjoyed the idea of modular fireplace concept, and having own light throughout the day- they liked this because it has two functions- biological and practical for lighting, it’s an easy shape to use, has creative potential and playful elements- how to position, use, uncurl.
- Easy to carry and transport.
- Like idea of light canopy, but unsure if they would get out enough to use it.

**Meeting 5**

- Tried out modular fireplace- really enjoyed experience, especially having their own personal light that they could adjust to their own needs.
- Enjoyed the portability, but commented they would likely not use much in the long run, as it requires commitment from all users to bring together daily to charge.
- Loved the playful elements- playfights, “candle light” with book, etc, but thought this novelty factor may wear off.
- Tried out indoor sun (staff room integration). Enjoyed the ‘halo’ effect of sitting underneath a bright orb, and liked the idea of having a space to refresh at work.
- Most enjoyed idea of bringing more natural light indoors using optical fibers, but likely quite expensive due to installation costs.
Warmth and Light

I was curious to explore the idea of warmth and light together, as it occurs naturally in sunshine. The fireplace seemed an easy way to start, and yielded several interesting results. A test rig was constructed from paper, a dimmable LED strip, and hot water bottles. It was interesting to note that the first reaction from the fireplace was to stretch out my hands in expectation of warmth. I was quite disappointed when there was none— it seems on an unconscious level we have certain expectations of object we recognize, and when they are not met, we feel confused. Using the hot water bottles helped somewhat, however the heat felt like it was coming from the wrong place. After using a heater, aimed from the direction of the “fireplace”, it started to feel more natural. The “fireplace” did not seem to need a flickering light to provide the desired fireplace experience, which was also interesting to note.
Portable Light

This experiment was designed to try out the idea of carrying light with the user throughout the day. The test rig was designed to be easy to carry, as a very basic tool to explore the concept. It was pleasant to have a light that sits easily in many spaces, however was prone to get dirty (e.g. in kitchen when making bread) and was easy to leave behind. It was also a bit annoying to carry, something automatic would perhaps be more ideal. Changing light is also another option, and settings for brightness and colour adjustment would enhance the experience further. On a side note it was difficult to control the exposure distance, so this issue would need to be resolved either though auto-brightness adjustment to compensate for more/less distance, or a way to encourage correct exposure, either through aesthetic or other means.

Findings.

Portable light would need to be dirt repellant, versatile, and as easy to use as possible (almost automatic) with adjustable settings.
Above: Final concept storyboards & keywords.
Right: Final Concept Matrix as rated by designer.
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<thead>
<tr>
<th>CRITERIA</th>
<th>WEIGHTING</th>
<th>CONCEPT 1</th>
<th>CONCEPT 2</th>
<th>CONCEPT 3</th>
<th>CONCEPT 4</th>
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<td>(concepts rated 1-5, least to most effective)</td>
<td>1= less important</td>
<td>5 = most important</td>
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<td>Integration - needs to be used consistently between the hours of 9-11 am, automatic in existing routine</td>
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<td>Optional- should have a non-light options for those with eye sensitivity</td>
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<td>Enjoyment- should be an experience people look forward to</td>
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<td>Clear, universal communication of function and features</td>
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<td>Bring the user outside more</td>
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<td>Establish a connection to outdoors</td>
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<td>“Natural” feel and quality of light</td>
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<td>Environmentally responsible design/life cycle</td>
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<td>Therapeutically effective :</td>
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<td>- 10,000 lux</td>
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<td>- Correct exposure distance (30 - 60 cm)</td>
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<td>- Correct exposure time (30 - 60 min)</td>
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<td>- Encourages exposure at correct time (9-11 am)</td>
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<td>Diffused, high quality light</td>
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<td>Adjustable brightness</td>
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<td>Energy efficient- safe and effective over long and short term use</td>
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<td>Safe for wide audience / varied circadian rhythms</td>
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<td>4 20</td>
<td>3 15</td>
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<td>Wide beam of light</td>
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<td>Downwards angle (most efficient absorption)</td>
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<td>Easy to use, set up and carry</td>
<td>4</td>
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<td>Affordable</td>
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**TOTALS** | 472 | 400 | 444 | 456 |
colour temperature

light intensity
Meeting 6

- Introduced random idea of monitor based light integration—changing patterns of light to give subtle time cues throughout the day and individualized settings. Same cycle as daylight: rhythm, colour, intensity, quality.
- Really enjoyed this concept, thought it would be much more feasible for consistent use than the concepts so far.
- Tried out changing colour temperature [warm/cool] using test rig.
- Tried out changing intensity using test rig—up to 2,000 lux.
- Really enjoyed being able to adjust their own light.
- Discussed personalization, how would we want to adjust it?
- Something playful, engaging, simple and easy to understand.
- Opportunity through smart technology, e.g., iPhone.
- Potential for involving other senses, e.g., sound (bird song, etc.), but this could get annoying, best as optional add-on.
- Accessibility could start as basic model, with add-on options for people who wish to customise further.
- Could use live webcam to connect users to home country, or weather outside.
- Ideally a “set up and forget” type experience.
- USB space is precious—ideally with several power options.
- Education—“would be good if I can tell it “I want to go to bed earlier” and it will adjust to help me with this.
- Could be open source to evolve with user creativity.
- Smart phones may be overrated, could get quite complex, basic model just needs on/off—need to define the basic elements and build up from there.
- Testing brightness for 2,000 lux.
- Needs to be adjustable—height, angle, size.
- OK for glare, but any brighter could get annoying.

Meeting 7

- Tried out projecting light on wall, and then with nature scene video. Enjoyed this, but distracting is scene moves too quickly. Really enjoyed subtle quantities, and being able to choose their own scene.
- What they enjoyed about this:
  - Light all day long.
  - Individual settings.
  - Personalization.
  - Connection to nature/day passing.
  - Educative potential, both direct and through experience.
  - Alleviates static feel in offices.
  - Well integrated, easy to use, automatic with computer activation.
  - Potential to expand and evolve with users and technology (e.g., add-ons, make your own, etc).
  - Advanced and simple features, dynamic so users can take it as far as they like.
  - Affordable.
  - Discussed practicality or wall space, options for open plan office without it—could have computer attachment like snap on “wings” that have a slowly moving scene without need for projection.
- Were really excited about the potential of this idea to make offices more human friendly.

Design Group 6 & 7
Design Group : Meeting 8

- Tried different shapes of scene- ellipse most enjoyed as more immersive and less like window (rectangular form)
- How to design around the variability of computers?
- Maybe two options- one basic with just light for open plan, and add on with scene feature for those with wall-space?
- Perhaps simplifying the idea will make it stronger- going back to basic instincts and literal visual language
- Scenes complicate the idea, could maybe work better in a different context where this is the main feature (scene box- idea shake to change, for hospitals and dull indoor spaces, a real time day in a selected environment
- Could use a personal sun to bring more light into offices and keep outdoor connection. Could be programmable to expand.
- How to create a meaningful experience : customisation and playful aspects are important, this gives user an opportunity to make the design their own, and look forward to using it.

Design Group : Meeting 9

- Design needs to be more 'designery' : currently mostly an experience. How can we bring form to the design?
- Metaphors and humour create meaning- playful elements, customisation are all useful tools
- The interaction (adjusting light) could serve as a playful way to create a more meaningful and product focussed design
- Tried out several ways of interacting: pull apart clouds, shrink and expand, throw light at wall, adjustable 'rays', circular rays, revealing light (see overleaf)
- Pulling apart clouds most engaging, and allows for extra dimension of weather adjustment
- Translated these ideas into concepts around computers- how could this fit into the variability of office workstations? (right)
- Overhead concepts work best- don't take up desk space and are more versatile as they don't depend on computer size/ etc.
- 'Sky window' / clouds nice metaphor for translating slowly changing nature scene into physical design
Interface Testing

- Moving 'clouds' (3D)
- Moving 'clouds' (2D)
- Forming/separating clouds
- Opening 'sun' orb to release light
- Scrunching light
- Malleable 'sun'
- Adding 'rays' (2D)
- Pulling rays for different adjustments (colour, intensity, 2D)
- Pulling rays (3D)
- Revealing elements (sound/light qualities/movement) through nature scene (e.g. rustling tree, bird song, light intensity)
Design Group 10

Meeting 10

Testing the physical aspects- size, form, image distortion

- Testing the experience of drifting overhead clouds
- Really enjoyed the experience- not distracting, as only looked at when desired
- Enjoyed simple shapes, and complex curves distort image and add too much complexity
- Inwards curve creates a sense of immersion
- If size too big it becomes too bulky and impractical. Too small and sense of immersion is lost. Around 65-70 cm X 35-40 cm is ideal
- Really enjoyed longer term experience of using the light whilst working at computer, enjoyed playful, whimsical elements.
- Tested glare with outer LED strip- difficult to get full intensity, but ok at 500 lux as sky also illuminates so reduces backlight effect.
Workstation Integration Options

Above: three integration options for the workstation. All options are designed around the same base model with attachment screws for wire or struts.

Left: 2D Form Development: Meaning of Clouds

a. top view: suspended
b. top view: table attachment
c. top view: table attachment
Technology Development

Interview with Mark Harris

- look further into:
- accelerometers
- e space
- lasers for gesture recognition- ultrasonic displacement sensor
- (can pick up signals through loose mesh fabric)
- transparent solar cells
- ambient light sensors
- highest energy efficiency so far = cree 140 lumens per watt- likely to continue increasing in future. LED most energy efficient, OLED is currently around 85-90 l/p/w. Pixel addressable OLED not yet cuttable into non- square form, but feasible in near future as non-pixel addressable versions are already cuttable
- affordability is also likely to increase, as we have seen with LED's
- wireless connection- relay of info (time, weather, user etc) through computer. This eliminates need for extra technology in the device.
- electroluminescent EL
- LED panel
- diffused/ refractive light e.g. kindle glow/ front lighting
- decrease the intensity as much as possible for energy efficiency
- IPV6 allows for separate user profiles- assigns digital address to devices
- look into Microsoft Kinnect - gesture control using displacement sensors
- Bayes Theorem can build up a pattern of user interaction to predict future preferences- a code that is programmed into controller
- 6LOWPAN= controller for electronics.