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SkyLux

Using Light to Improve
Health and Wellbeing

Lisa Gabel, MDES 2013

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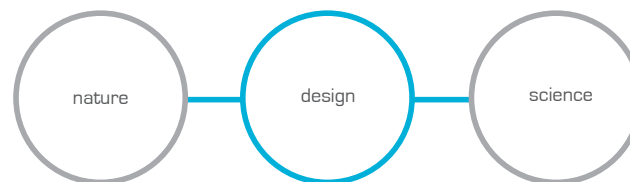
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Abstract

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 scientists¹. 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.

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I would like to acknowledge the immense generosity of those I could not have developed my project without:

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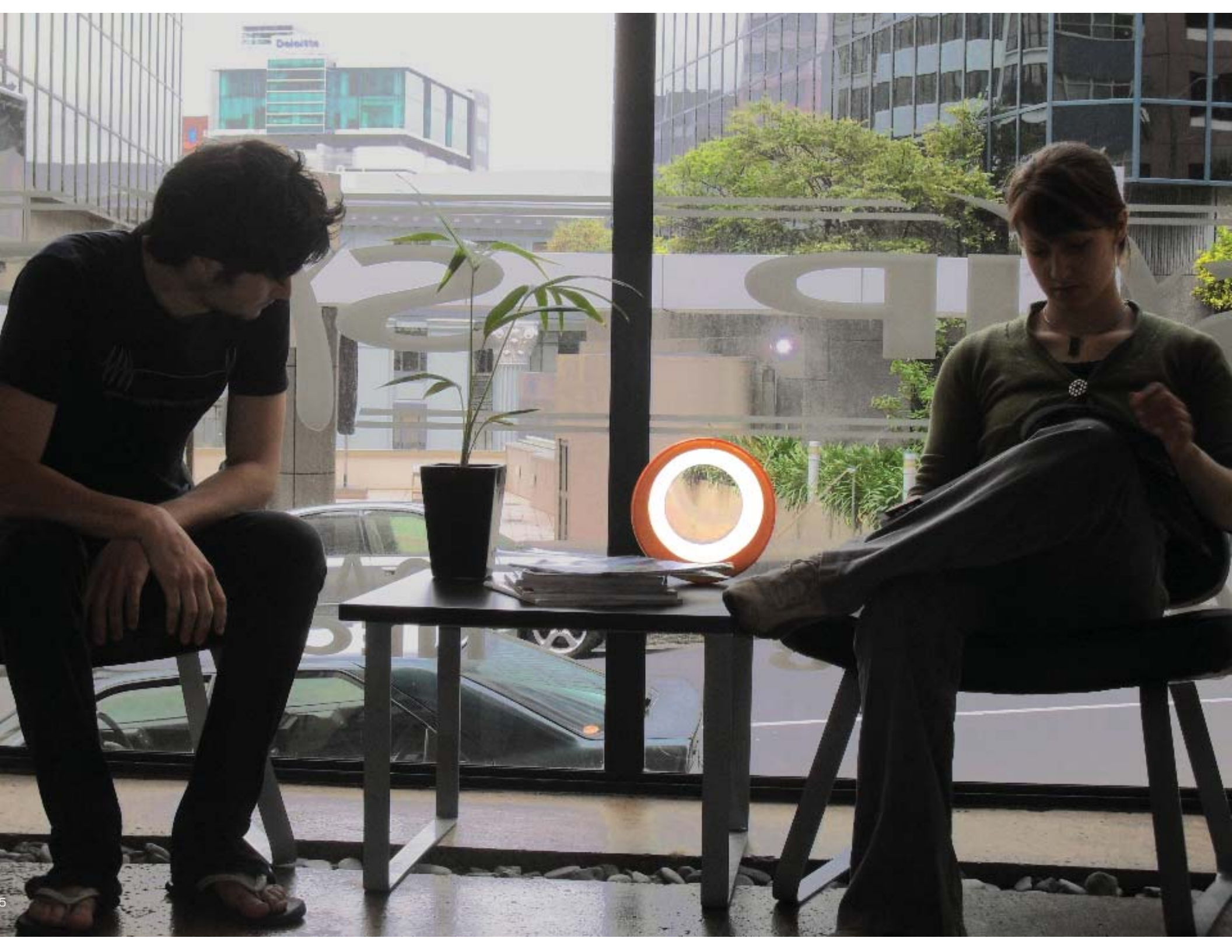
Julieanna Preston for her encouragement and support.

Notes to the Reader

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 blues². 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-Justice³, 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 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.

Introduction

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,⁴ “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’⁵ 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.de⁶ “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 Cedar⁷, we have become “contemporary cave dweller[s]” (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 Kripke⁸, 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]





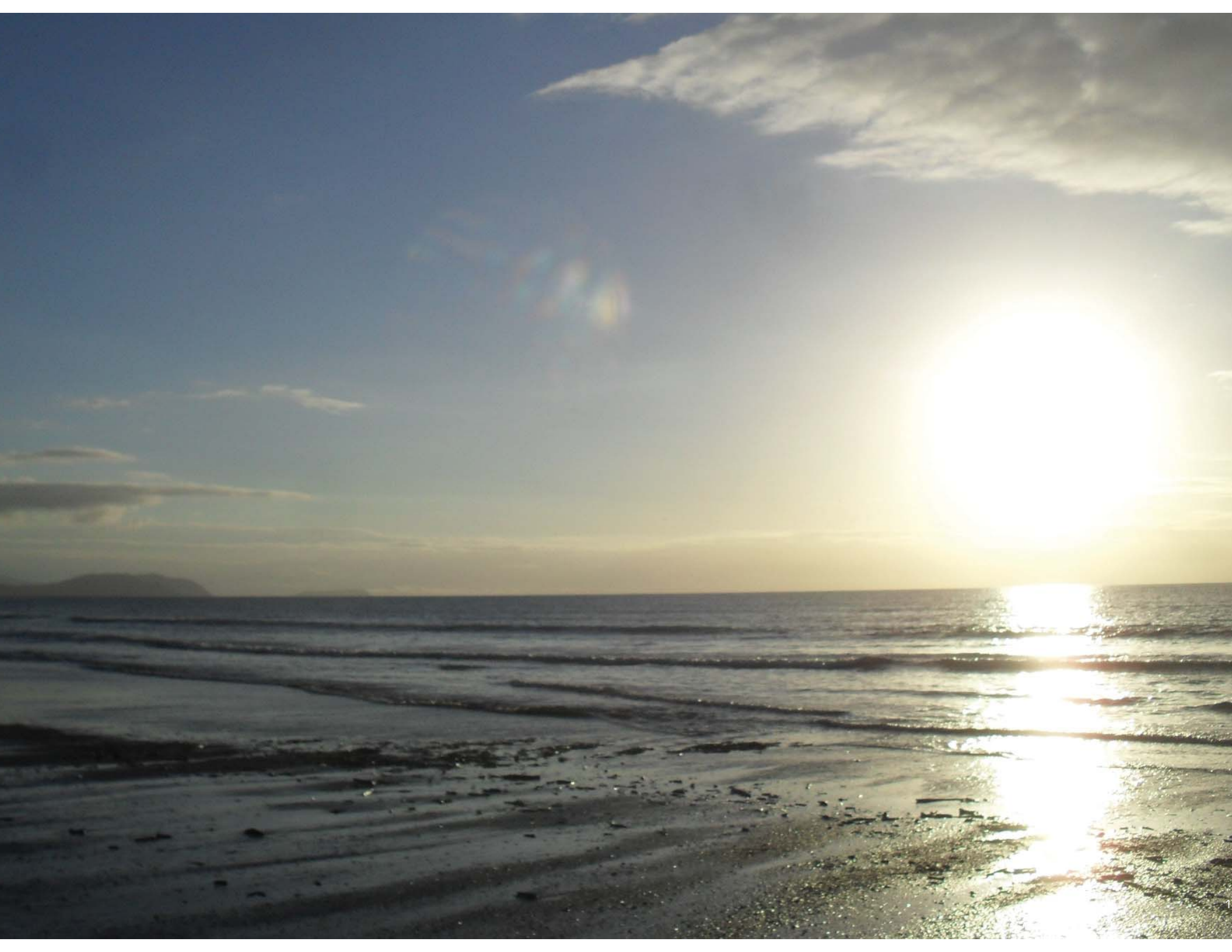
UNDERSTAND

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 Zeitgeber¹, 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).

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).



Mal-Illumination

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 to start producing 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:

The biology of the brain cannot determine if it is night or day because of weak light, thus activating the release of serotonin² and melatonin³ simultaneously which has never before occurred for extended periods of time in human evolution. The combination of these improper biological functions could lead to long term physiological problems. (p.3.)

In addition, we turn on more artificial light when the sun has set, leading our internal clock (SCN) 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 light⁴ accidentally during his work as a time-lapse photographer for Walt Disney. By using careful light and temperature controls, he was able to 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 (Cedar, et al., 2007).

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).

A low-angle photograph of a city street. The sky is a pale, overcast grey. Several tall buildings are visible, their facades dark and textured. In the foreground, a street lamp with a classic, ornate design is visible on the right side. The overall mood is somewhat somber and urban.

“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.”

[Phillips, n.d., p.1]



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 Rosenthal⁵: "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

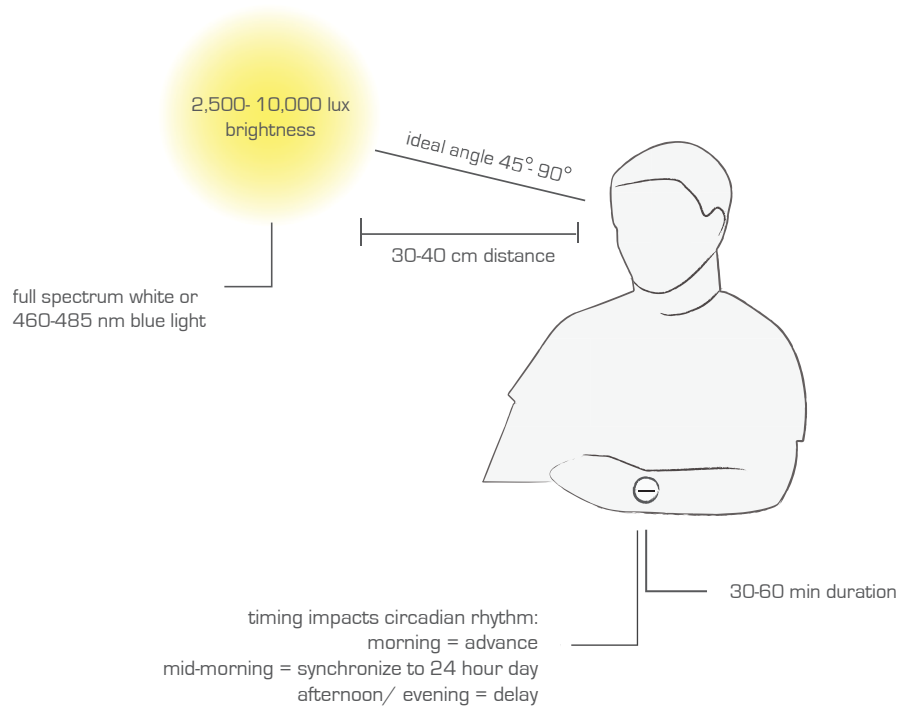
Since SAD was first identified by Norman Rosenthal in 1980, scientists have made important discoveries around the use of bright light as a treatment alternative to anti-depressant medications. By artificially replicating the spectrum and intensity of sunlight, bright light therapy supplements the natural 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.

Fig 2. Home Renovation Guide. (n.d.). *Girl With Light*. Retrieved October 4, 2012 from <http://www.homerenovationguide.com/articles/600-lighten-up-seasonal-affective-disorder-light-therapy>. Permission for reprint has been sought and is pending at time of print.

How is Light Therapy Used?

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

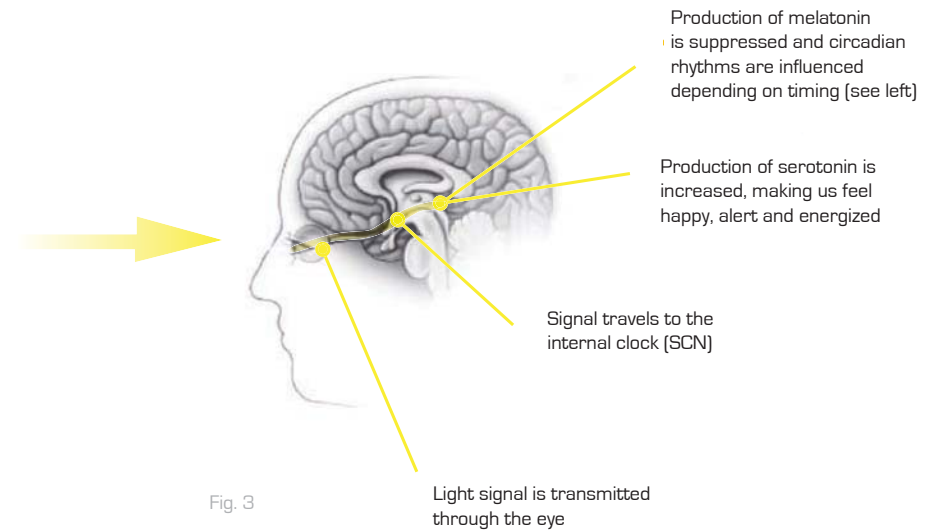


Above: Correct Use of Bright Light Therapy.

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.

How Does Bright Light Affect Us?

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



Sunlight also affects our long term health (Cedar et al., 2007, DeBow, 2007), 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

Existing Technologies

Bright light therapy (Light Boxes)

Currently, several bright light therapy technologies exist. Full spectrum light at 10,000 lux⁶ 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 (Slaney, 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 effective⁷ 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 supportive⁸ 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 of 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.

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

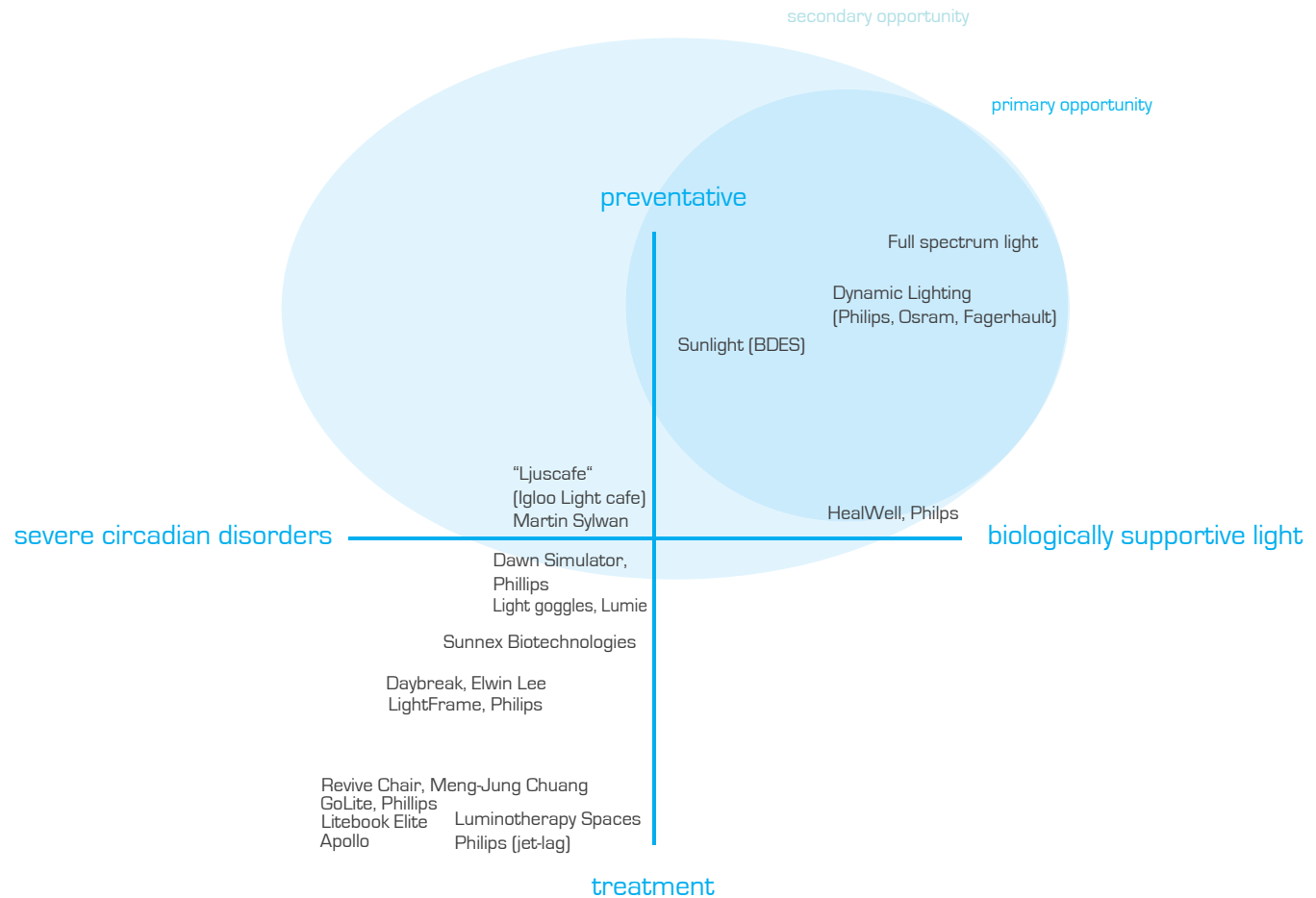
Using biologically supportive light to address Mal-Illumination, prevent winter blues whilst supporting mood, energy and alertness.

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)

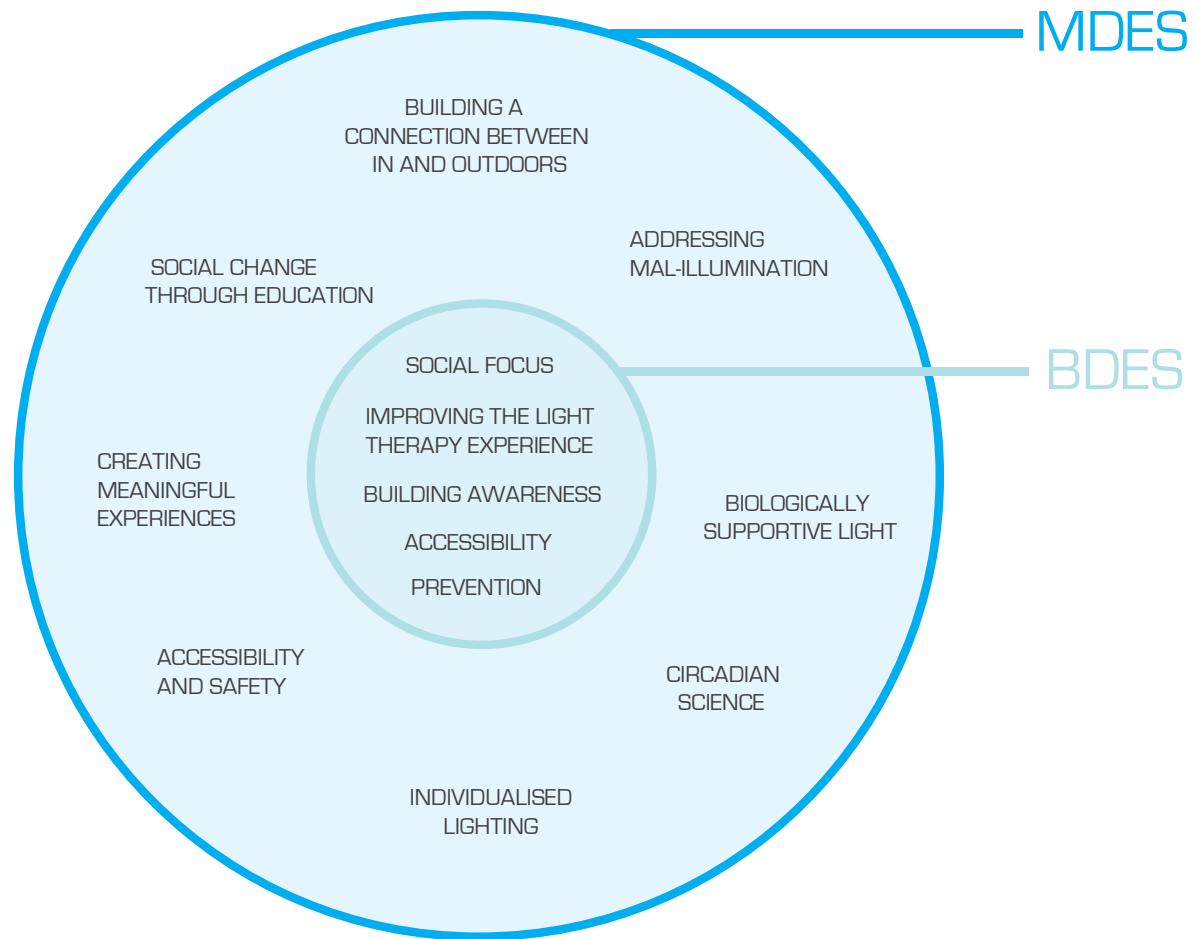
Developing an improved treatment experience for individual conditions (as detailed in *Bright Light Therapy*)



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



EXPLORE



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?

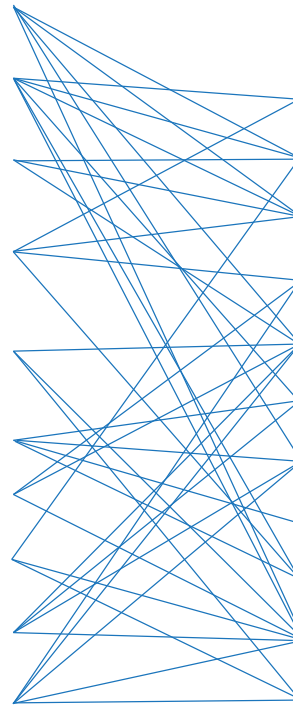
What is the "lived experience" of mal-illumination?

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 interlace scientific and design-led research¹ approaches to address my questions from diverse perspectives (detailed left).

My methodology was inspired by the Human Centered Design approach², developed by several key thinkers including Liz Sanders³, Bill Buxton⁴ and Bill Moggridge⁵ 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.

Left: Research Questions and Methods

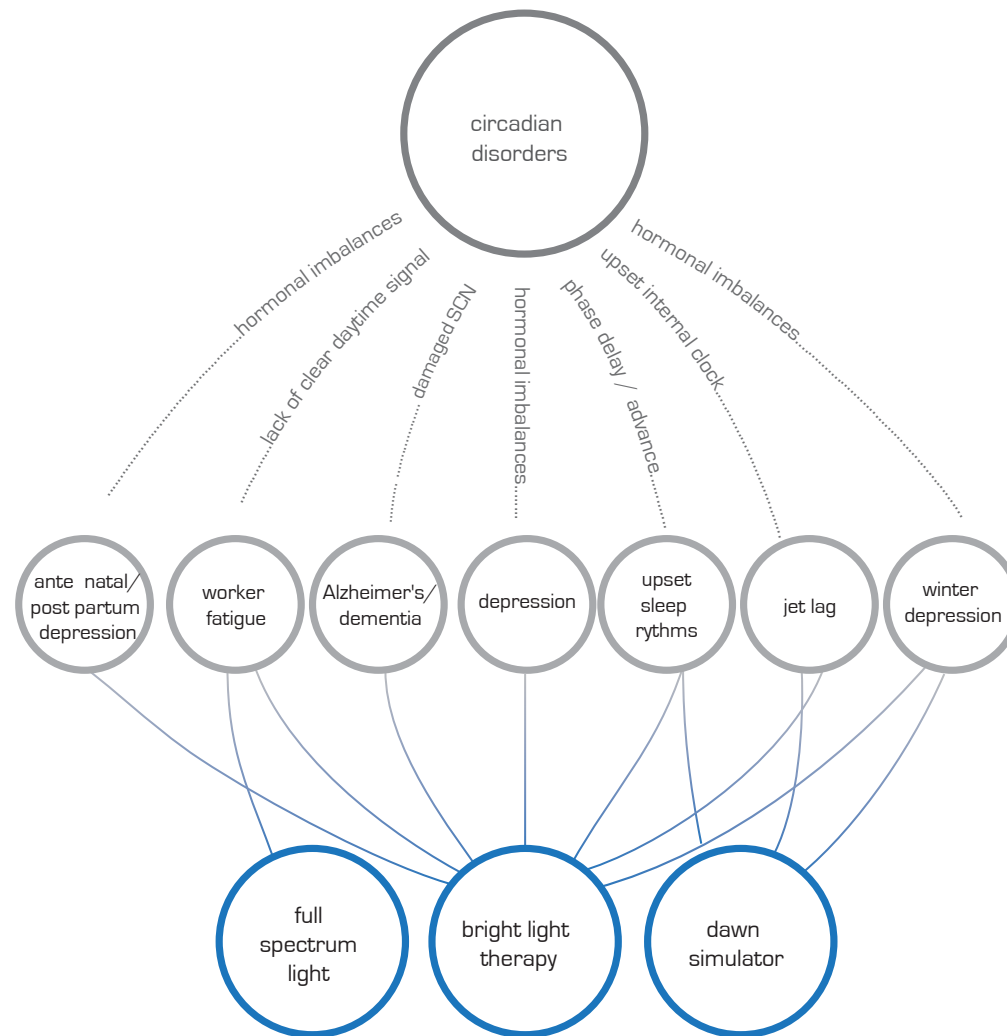
¹ Design- Led Research is a term to describe innovation driven research methods that strive for understanding through design (Sanders, 2008). Examples include experience prototypes and co-design.

² Human Centered Design is 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).

³ Liz Sanders is a pioneer in innovation driven research, and teaches human-centered design around the world. She has an Honorary Professorship in the School of Design at the University of Dundee and is an Advisory Board Member for the School of Design at Carnegie Mellon University.

⁴ Bill Buxton is a principal researcher at Microsoft Research, and is a pioneer in the human-computer interaction field. His innovative work has been honoured with several prestigious awards, including the SIGCHI Lasting Impact Award and Lifetime Achievement Award.

⁵ Bill Moggridge is a co-founder of IDEO, and was a pioneer in utilizing the human centered design approach. His work has been pivotal in establishing the interaction design discipline, earning him the prestigious National Design Lifetime Achievement Award.



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 recommended 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 and Peter Turner⁶, a specialist in lighting ergonomics .

In my interviews with Dr. Philippa Gander⁷, Dr. Karyn O’Kieffe⁸, and Rosemary Gibson⁹, 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.

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

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 Alzheimers Wellington.

Keywords

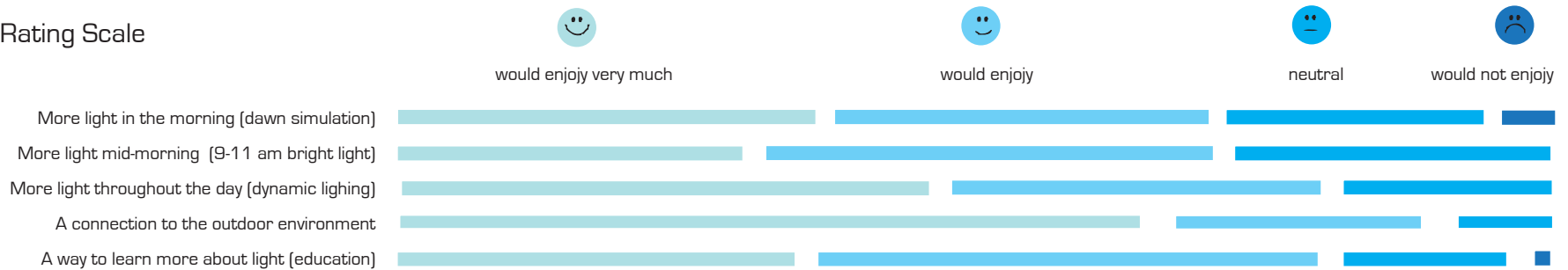
Outdoors

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

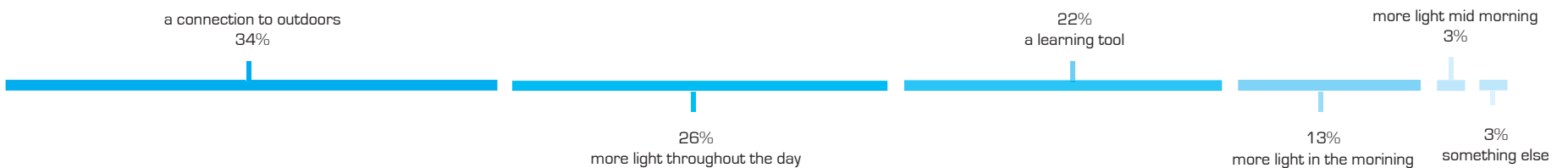
Indoors

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



Priority



Survey



I conducted a survey to identify how Mal-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

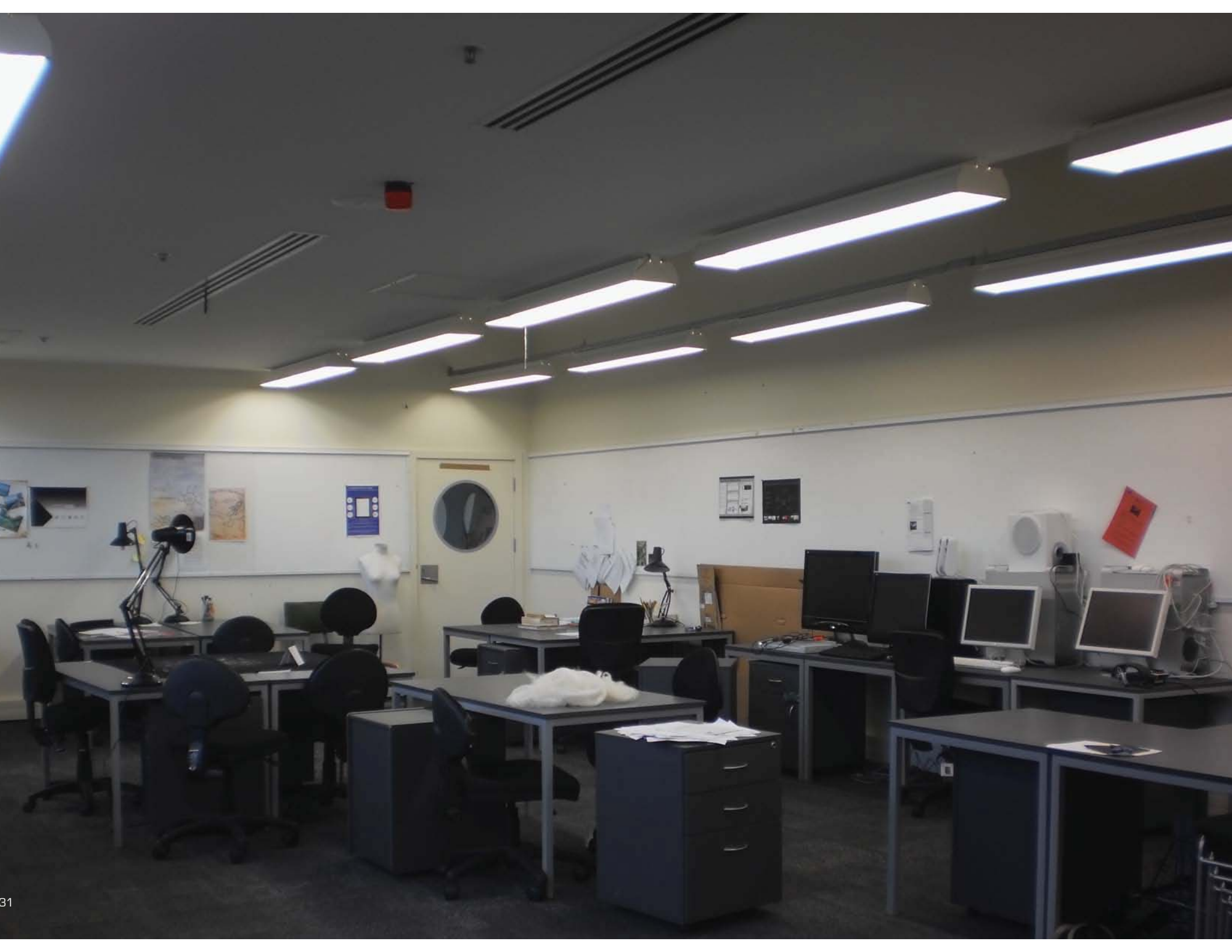
Insights

- 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



In Context Immersion & Observation



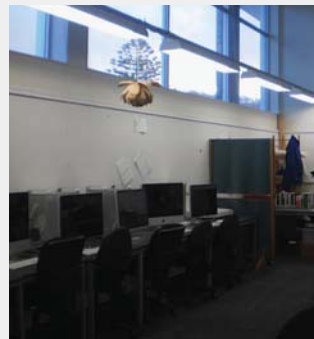
I visited several low light environments to understand the lived experience of those living and working in low light conditions. I observed the individuals using them and noted my own response to the experience.

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.



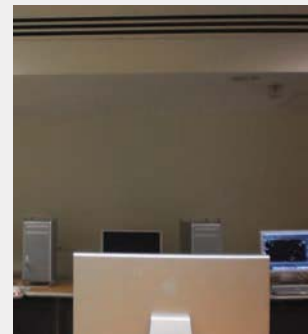
Observation #1

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"



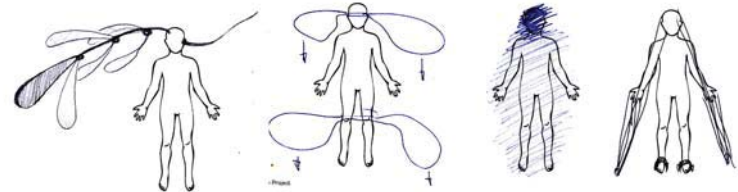
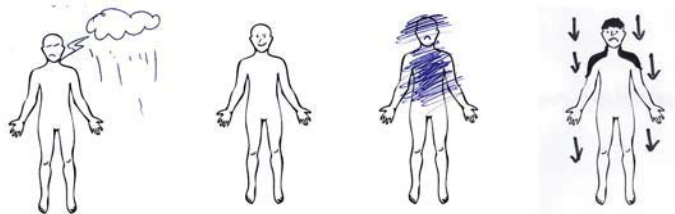
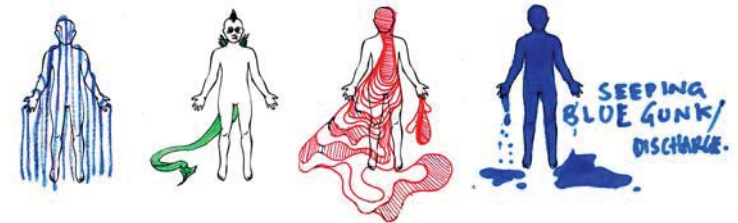
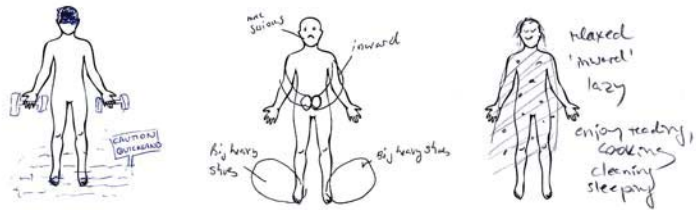
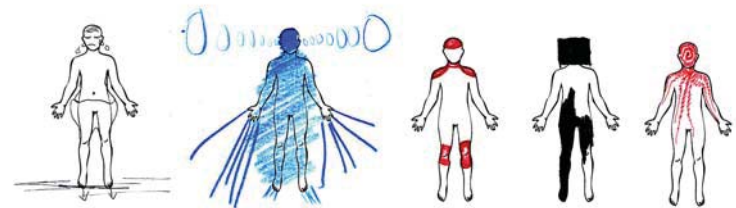
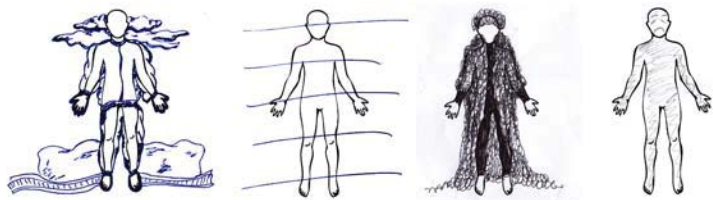
Observation #3

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

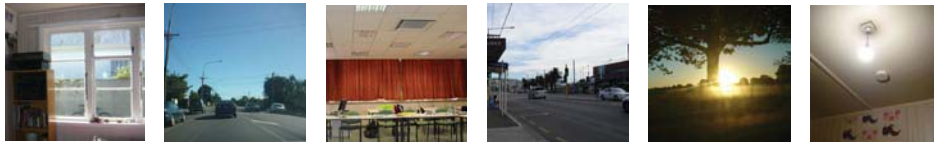
- Although there are common themes, the experience of fatigue and winter blues is unique to each individual
- Not all grey days are the same
- The design should be adjustable to meet individual needs



Photo / Journal



After observing and experiencing artificially lit environments, I used a photo-diary and journal to gain a deeper understanding of the 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:

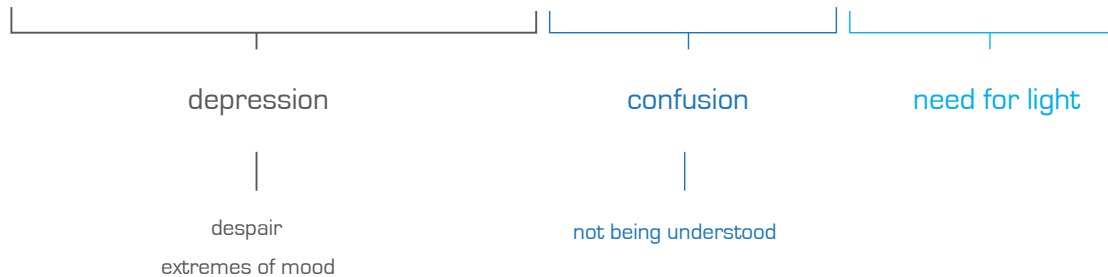
The design should:

- 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

SAD Forums



why get out of bed?
 can't face my to-do list overwhelmed world doesn't seem real
 very emotional I HATE WINTER hate the world high anxiety I did not know what it was
 crying spells, fatigue and a constant background feeling of anxiety and fear for no apparent reason need to face a sunny window
 general despair and amplification of negative emotions Eating Season. like placing a Chihuahua up north or a Husky in Mexico
 fly off the handle easily lethargic, weepy, irritable, and hungry inability to make decisions need to keep my mind busy summer sun and long days
 nauseous and tired panic alone dread it's like i'm two completely different people I want the days to be longer, have longer daylight, more sun
 I think a lot of people suffer from SAD but don't realize they have it



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; Psycheforums, 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 portable
- 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.

Bright Light Therapy



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



DEFINE

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





Target User

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.



DEVELOP

Design Group



After my exploration of user needs, I was keen to start designing. I used the concept of participatory design¹ (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 Zealander's 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.

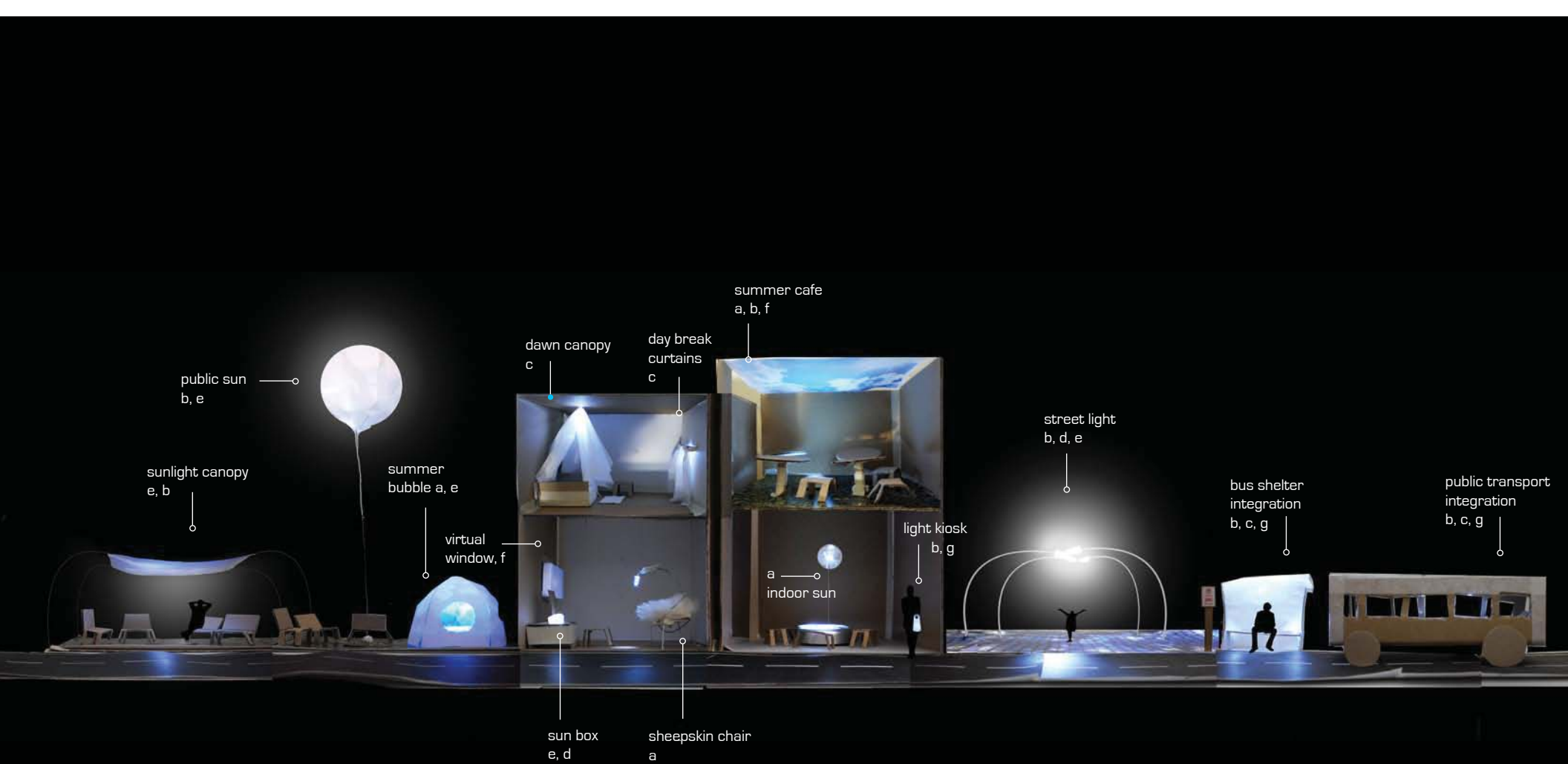
Insights

- An enjoyable, engaging and meaningful experience should be the primary means of raising awareness. Information could be available as a supplement for those who wish to learn more.
- The design needs to appeal beyond light benefits alone, as awareness is lacking. By creating a meaningful experience that appeals to those with Mal-illumination, the light could raise awareness around the impact of light in an experiential manner that allows users to discover the impact of light on their health and wellbeing first hand.
- The design should help users understand how their biological rhythms change throughout the day.
- The design should consider different contexts of use (social/ personal, time of day and year).

Criteria

- Easy to use
- Energy efficient
- Adjustable intensity
- Accessible
- Enjoyable, meaningful experience that raises awareness around the biological impact of light

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.

Developed Concepts



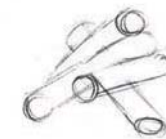
**Transport Integration
Bus or Train
(accessibility,
integration)**

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.



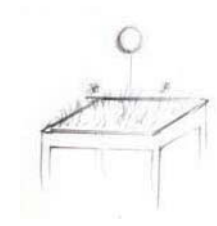
**Sunlight Container
(bringing users
outside more, playful
experience)**

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



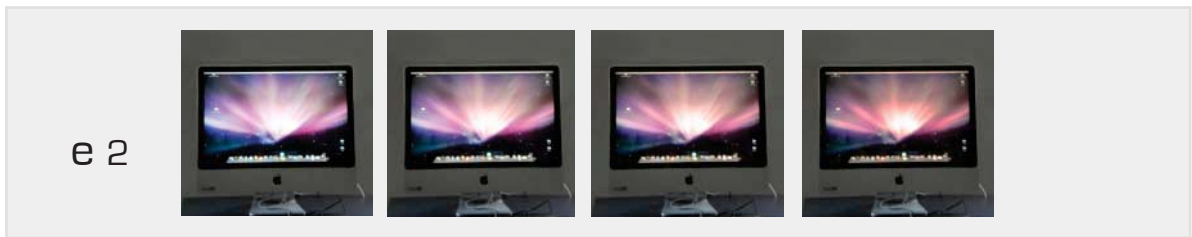
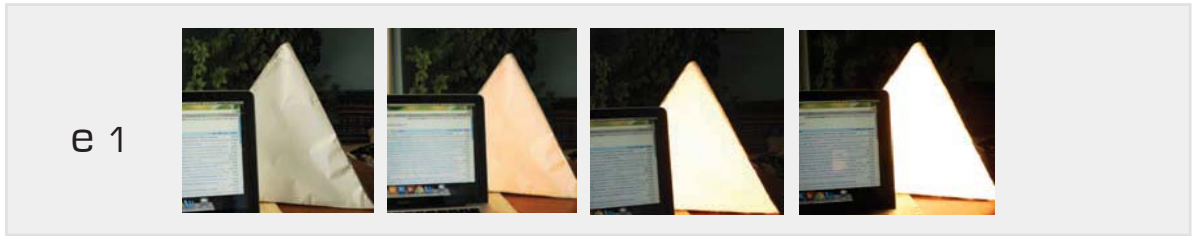
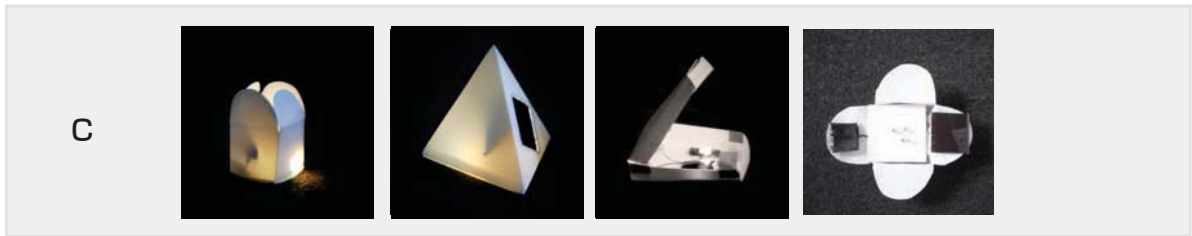
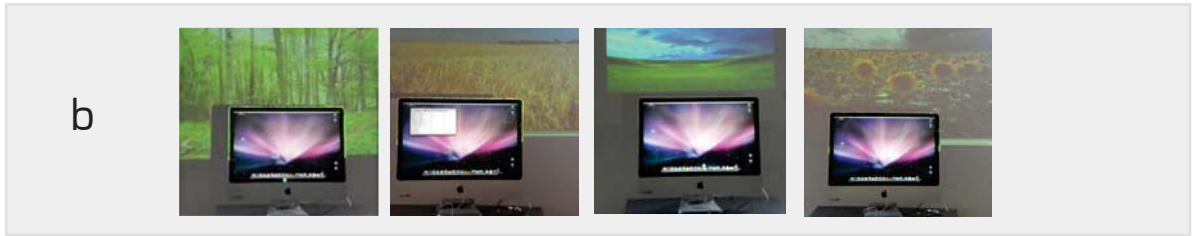
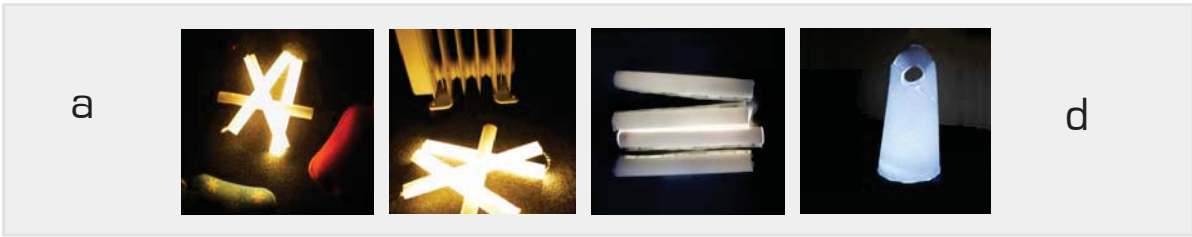
**Fire Sticks
(customization)**

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.



Exploration



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.

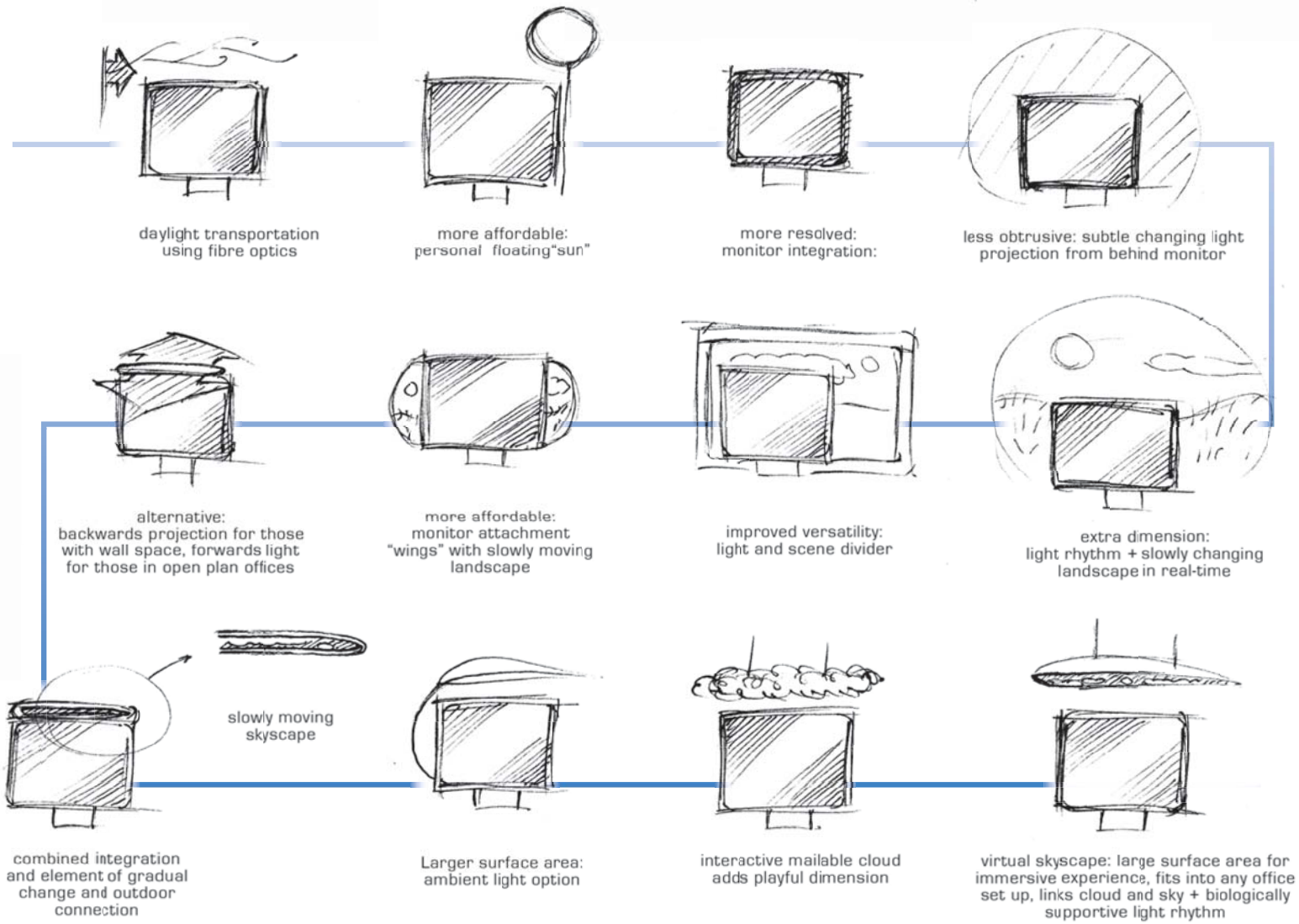
d/ Portable Light

In conjunction with the "light and warmth" experiment, we tried out portable 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*).



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 they 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

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 a 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.

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

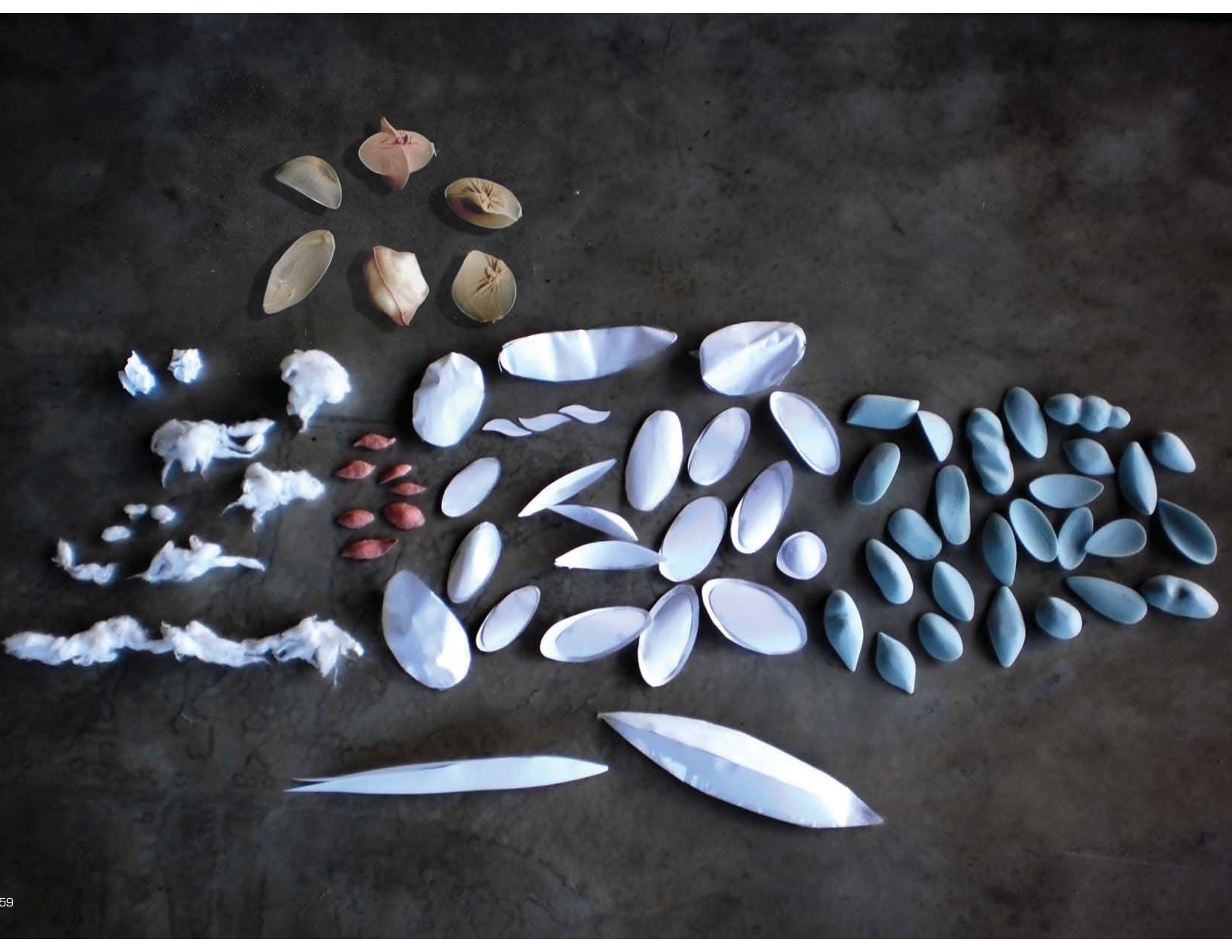
My final design synthesizes the key criteria from my research process to address the key issues I had identified:

- 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.

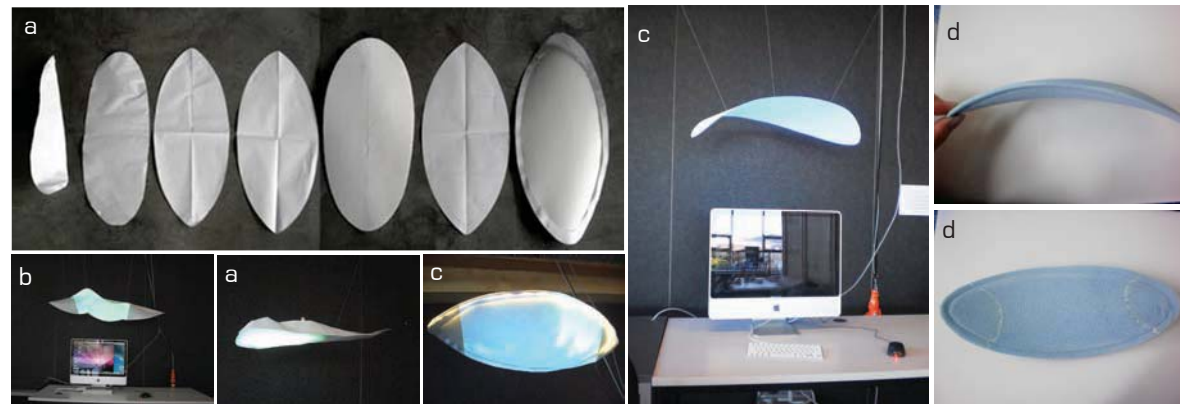
By allowing users to discover the benefits of good lighting experientially, the design promotes a gradual shift in our understanding of the role of lighting beyond the current visual focus. The design is a base model, which holds many opportunities for future development, such as allowing users to choose 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).



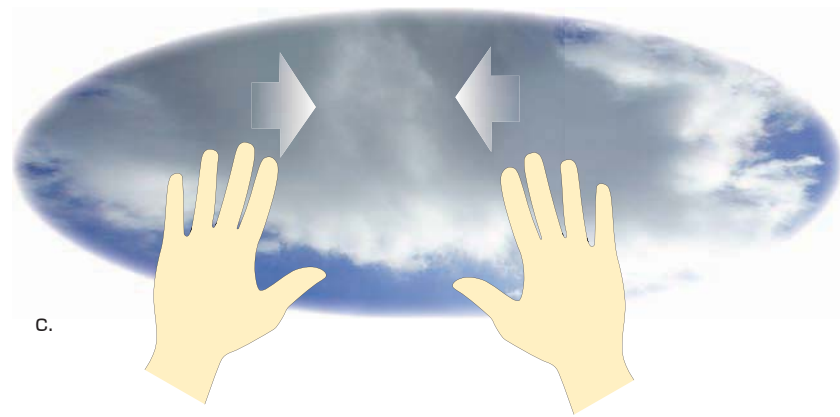
The final form (d) is designed to create a sense of immersion through the curved surface, whilst appealing to both genders as a versatile form that fits into a range of workplaces. The edge detail (d, top) represents a subtle metaphorical link to the daylight curve.



a.



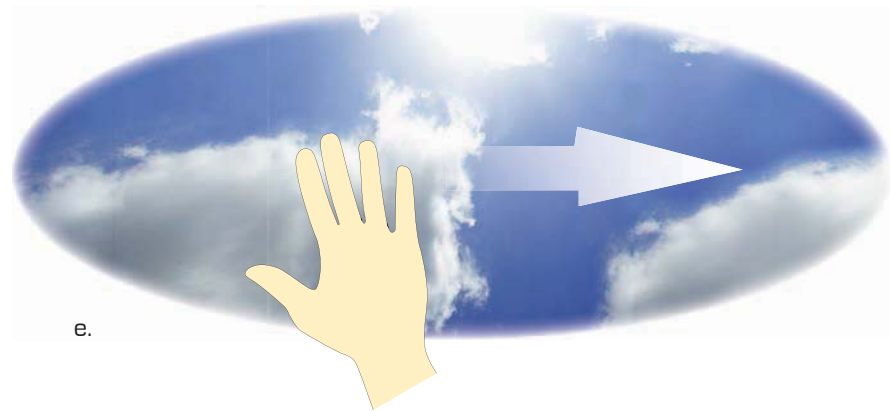
b.



c.



d.

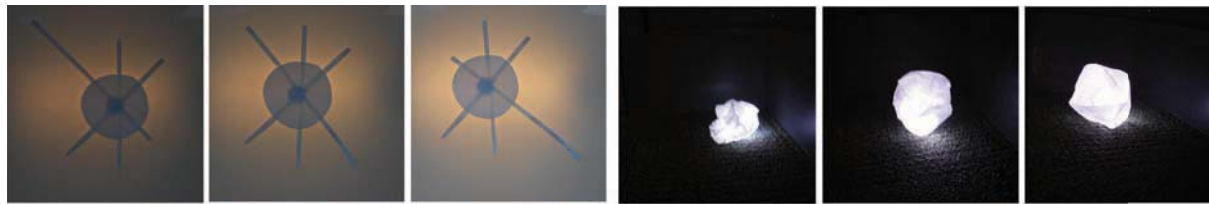


e.

a. Various stages of weather adjustment. b. Brightness adjustment (brighten) c. Brightness adjustment (dim) d. Colour adjustment e. Swipe: changing sky scene

The Interface

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.



Pulling sun 'rays' to adjust brightness and colour

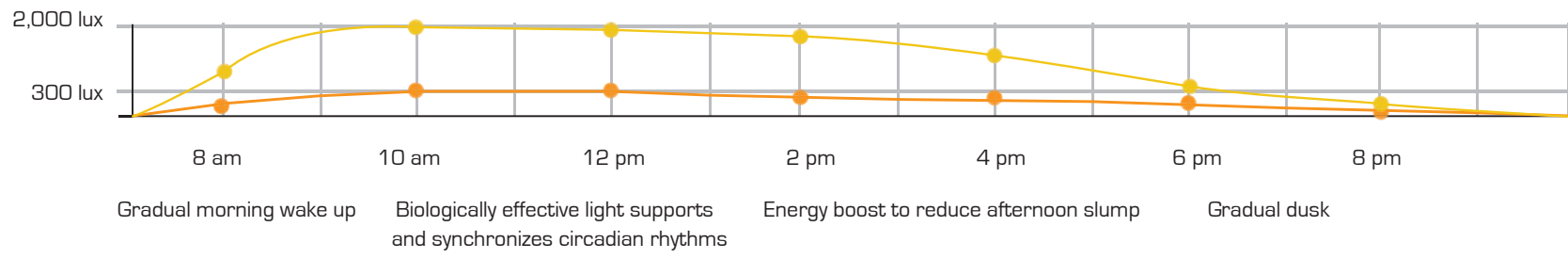
Shrinking and expanding malleable clouds / sun



Opening the 'sun' to release light

Arranging 'clouds' to let more or less light through

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.



- Standard intensity for those without photosensitive conditions
- Low intensity setting for those with photosensitivity (Eye conditions, photosensitizing medications)

The Light Rhythm

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 ensure 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



Night-time shift workers,
Alzheimer's/ dementia



Bipolar disorder
Schizophrenia
Circadian disorders



Settings can be updated
anytime through linked computer

check box (Y/N)



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

No photosensitivity: standard setting (2,000 lux)

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

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



default

future opportunity:
linked smartphone



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

in addition to manual functions, apps could be used to inform users more dynamically by gathering info about user such as sleep/ wake times



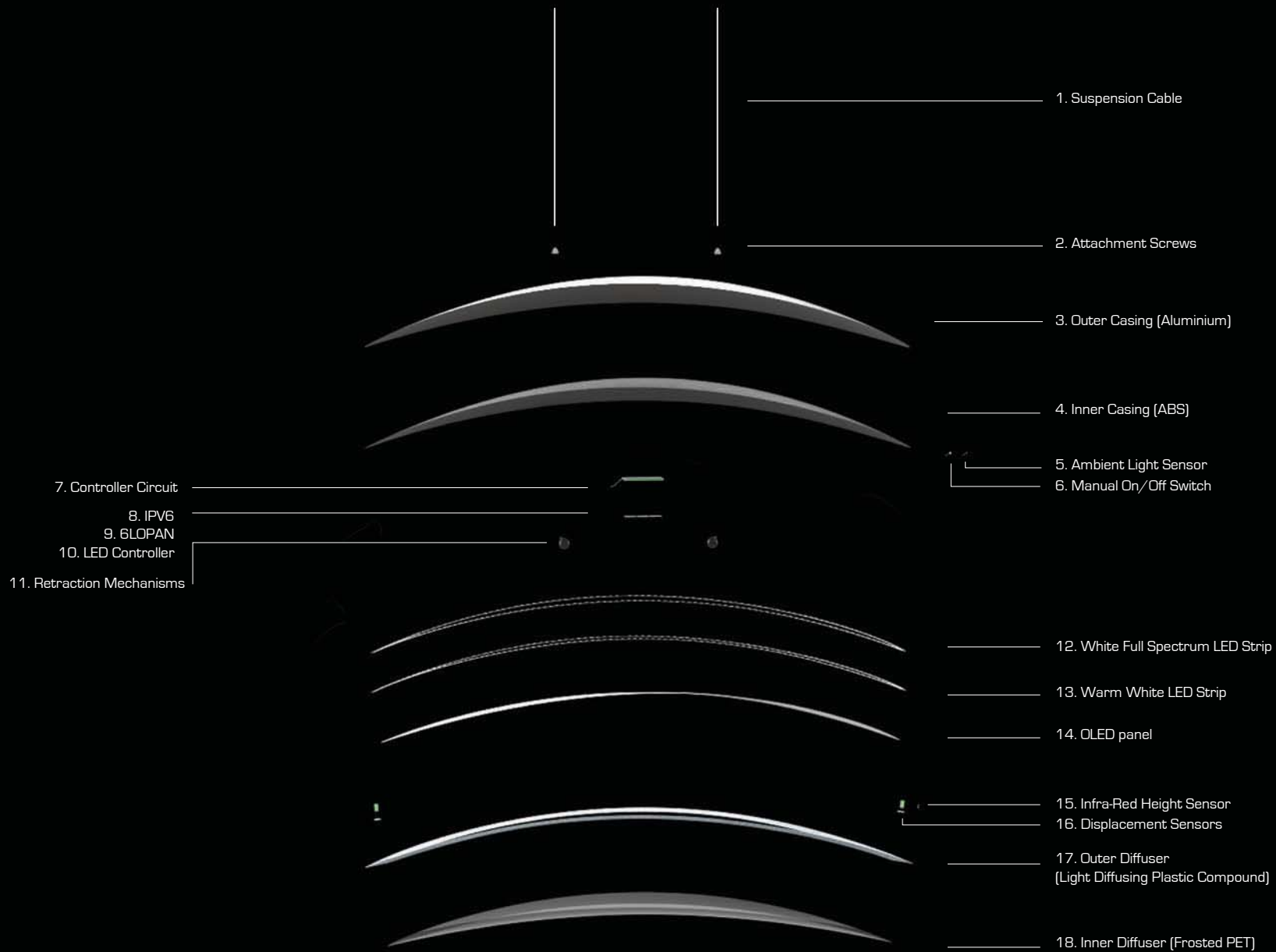
opportunity for educative pop up messages through computer, e.g. light increases our serotonin, so we often feel better on sunny days

opportunity for personalized pop up messages, e.g. morning light may be beneficial for those who fall asleep very late.

The Set Up Process

The initial set up process is designed to be simple and 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.





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.



REFLECT

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.

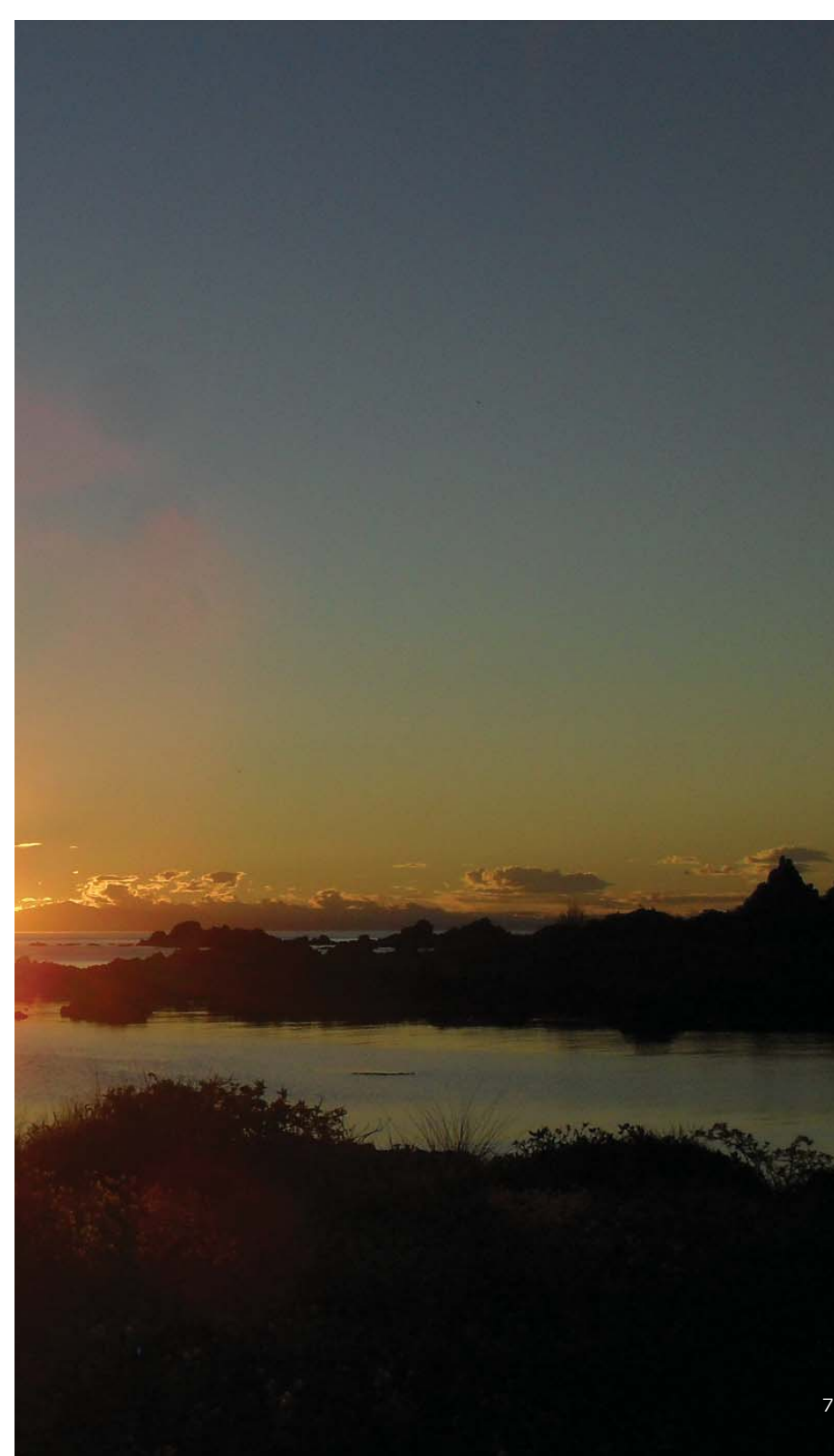
The journey has been one of many unexpected twists and challenges, which have increased my confidence to extend myself beyond my comfort zone, and helped me learn to embrace uncertainty and to trust the process. This has not only advanced my creative practice, but also helped me to grow on both professional 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).

Malillumination:

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

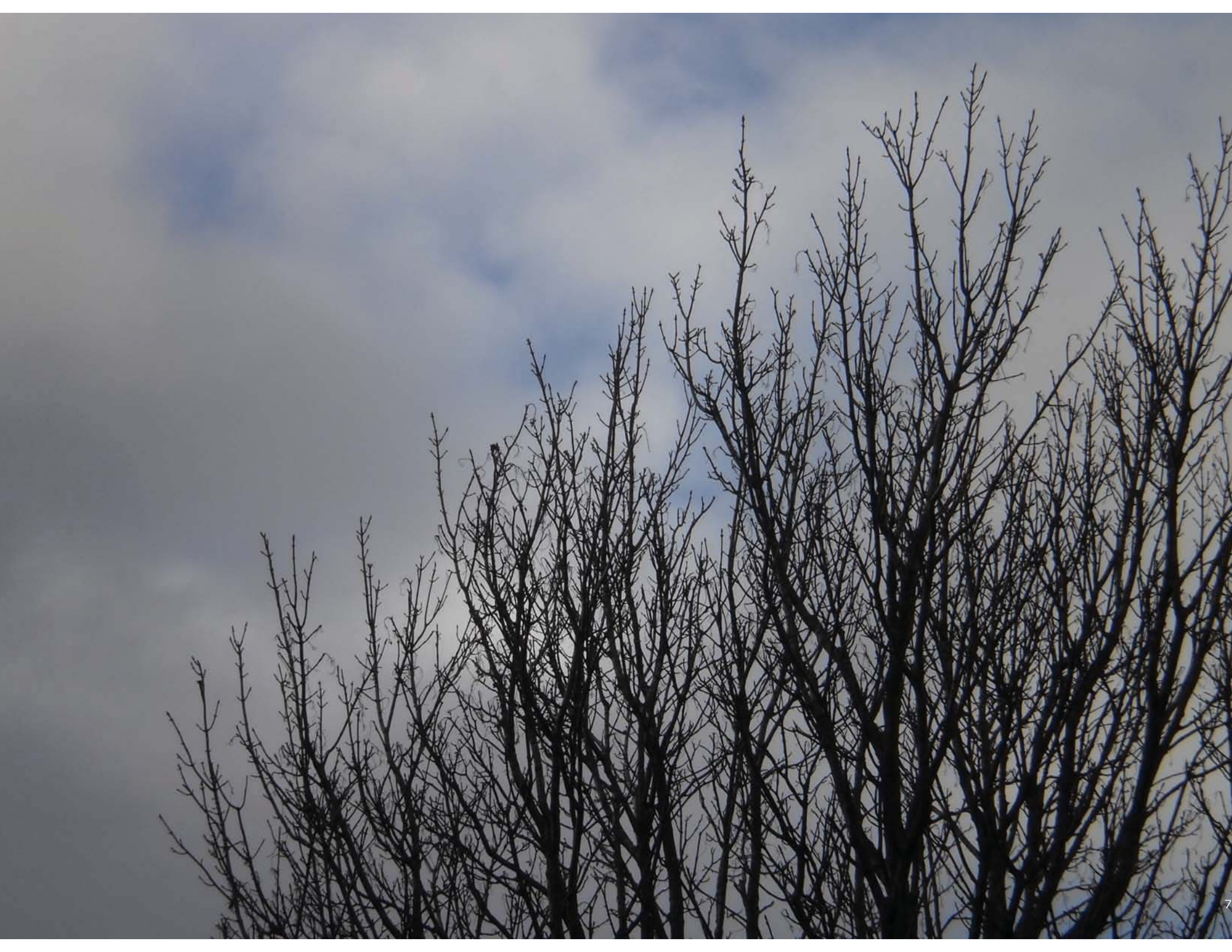
A milder, sub-clinical form of SAD.

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).



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Fig.1 Female Fundamentals. (2011). *Hands Holding The Sun At Dawn*. Retrieved June, 2, 2012 from http://femalefundamentals.com/blog/?attachment_id=1070.

Fig 2. Home Renovation Guide. (n.d.). *Girl With Light*. Retrieved October 4, 2012 from <http://www.homerenovationguide.com/articles/600-lighten-up-seasonal-affective-disorder-light-therapy>.

Fig. 3 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.

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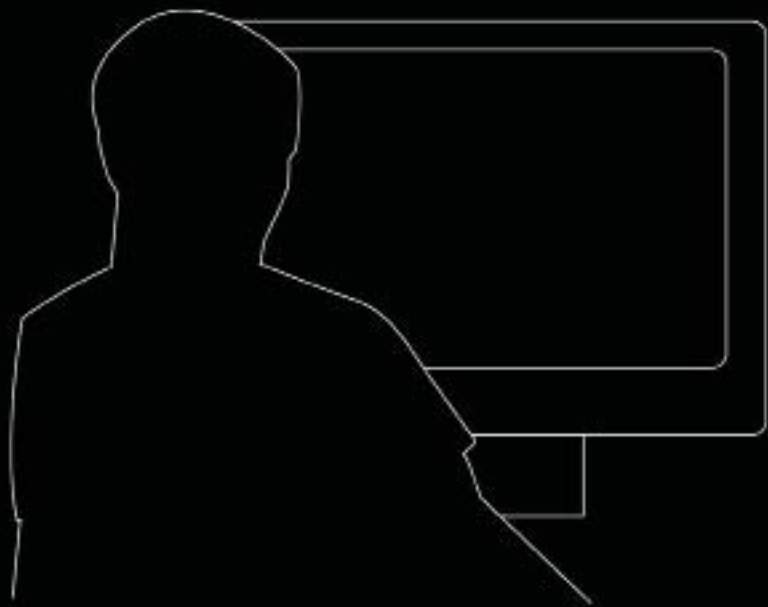
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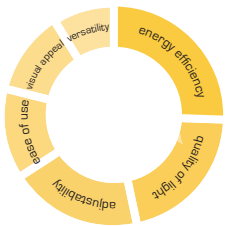
Appendices



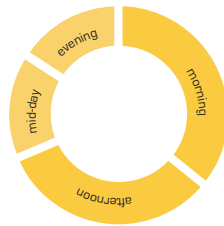


Prior Research (BDES)- Key Methods and Findings

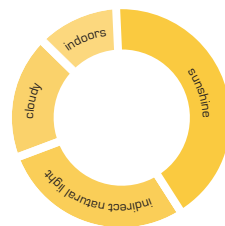
(a) light and lighting
(online questionnaire)



what are the most important features?

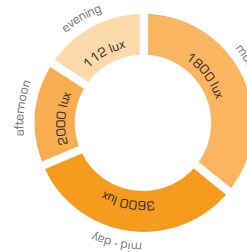


when is more light wanted?



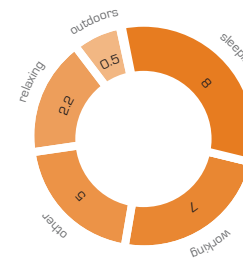
what type of light is most enjoyed ?

(b) light intensity
(adjustable test rig)



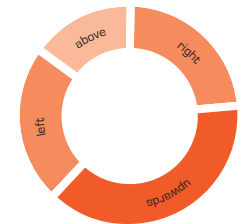
what is the level of light (on average) enjoyed throughout the day?

(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

<p>Sleeping problems</p> <ul style="list-style-type: none"> -insufficient natural light exposure -stress, anxiety, depression, drugs, fear, anger -shift work -upset biological rhythms -advanced or delayed onset of melatonin production (the "darkness" hormone) 	<p>medication</p> <ul style="list-style-type: none"> - dawn simulation -lifestyle alterations -light therapy -advanced sleep phase syndrome: Evening exposure -delayed sleep exposure: morning exposure <p>"For DSPS, the light must be provided as spontaneous awakening as possible to achieve the desired effect, as shown by the phase response curves for light in humans. Morning use may also be effective for non-24-hour sleep-wake syndrome, while evening use is recommended for advanced sleep phase syndrome."</p>	<p>Light affects the circadian rhythms and is used to correct the sleep onset of melatonin production- delayed sleep syndrome (light at morning)</p> <p>Advanced sleep syndrome (light at night)</p>	<p>Practice Parameters for the Use of Light Therapy in the Treatment of Circadian Rhythms, Andrew L. Chesson, Jr., Michael Linner, David Della Porta, Andrew L. Chesson, Jr., Michael Linner, Kristyna Hirtle Stephen Johnson, Merrill Vlas. SLEEP, Vol. 22, No. 5, 1999</p> <p>Blaves, A. J. (2008). S.A.D. and Circadian Rhythms Retrieved from http://www.healthcentral.com/sleep-disorders/article/6865987/age-discarded</p> <p>Cieslarczyk, K., Pracki, D., Pracki, T., Tali-Klawe, M., Kowalski-Kochan, M. (2004). Sleep Quality And Mood Disorders Under The Influence Of Phototherapy In Patients With Seasonal Affective Disorders. <i>Psychiatr Pol.</i> Nov-Dec;38(9):1105-14.</p> <p>Haukka, J., Leppamäki, S., Lönnqvist, J., Meesters, Y., Partonen, T. (2007). Effect Of Simulated Dawn On Quality Of Sleep- A Community-Based Trial. <i>BMC Psychiatry</i>, Oct 27;3:14.</p> <p>Terman M., Lewy AJ, Dijk DJ, Boules Z, Eastman CI, Campbell SM. Light treatment for sleep disorders: consensus report. IV. Sleep disorders associated with circadian disturbances. <i>Journal of Biological Rhythms</i> 10 (1995): 135-147.</p>	<p>Aschberg, B., Partonen, M., Partonen, T. (1993). Effects Of Light Therapy On Sleep Quality In Patients With Seasonal Affective Disorder. <i>Eur Arch Psychiatry Clin Neurosci.</i> 242(5):310-3.</p> <p>Light box dawn simulator</p>
<p>Demerital/ Alzheimer's</p> <ul style="list-style-type: none"> -upset biological rhythms -irregular production of melatonin <p>"Sometimes the ability to control (sleep disturbance) can make the difference between a well-adjusted one at home or in an institution. Too often we shut people with dementia up in dark rooms, with little opportunity to see the sun and get bright light, which can make their symptoms worse."</p> <p><i>degenerated SCN (body clock of brain)</i></p>	<p>Light therapy: morning (early stages)</p> <ul style="list-style-type: none"> -medication -dawn/sunrise simulation <p>Potentially bright light therapy- studies used bright light therapy at 10,000 lux for 1 hour in morning</p> <ul style="list-style-type: none"> -Anti-depressant medication -Psychotherapy 	<p>Regulates sleep pattern and melatonin production, natural timekeeping in the body, increasing serotonin production.</p> <p>Effect of Bright Light and Melatonin on Cognitive and Noncognitive Function in Elderly Residents of Group Care Facilities. Rixt F. Riemersma-van der Lek, MD, Dick F. Swaab, PhD, Elin M. Hol, PhD, Witte J.G. Hoogendijk, MD, PhD, Elis J.W. Van Someren, PhD. <i>JAMA</i> Vol. 299, No. 22, June 11, 2008</p> <p>Deegan, J.F.; Moss, D.E.; Rienzi, B.M.; Sumaya, I.C. (2001) <i>Bright Light Treatment Decreases Depression In Institutionalized Older Adults: A Placebo-Controlled Crossover Study.</i> <i>Gerontol. A Biol Sci Med Sci.</i> Jun;35(6):1435-60.</p> <p>Effect of light therapy upon disturbed behaviors in Alzheimer patients. <i>Journal of Alzheimer's Disease.</i> Vol. 13, No. 5, 291-295 (1998)</p> <p>Ladislav Volczer, MD, PhD, American Journal of Alzheimer's Disease and Other Dementias, Vol. 13, No. 5, 291-295 (1998)</p> <p>Norbeck, U. (2007). Light therapy for postnatal depression. <i>BMJ</i>. 2007; 335(7693):1033-304. doi: 10.1136/bmj.327.7422.1003</p> <p>An Open Trial of Morning Light Therapy for Treatment of Antepartum Depression. Dan A. Oren, M.D.; Katherine L. Wisner, M.D.; Margaret Spinelli, M.D.; C. Neill Epperson, M.D.; Kathleen S. Perind, Ph.D.; Juan SU Terman, Ph.D.; Michael J. Fava, M.D. <i>Psychiatry</i> 2002; 159:666-669. doi: 10.1176/appi.app.159.4.666</p> <p>Corral M, Kuan A, Kostaras D. Bright light therapy's effect on postpartum depression (letter). <i>Am J Psychiatry</i> 2000; 157:303-304</p> <p>Even, C.; Friedman, S.; Rouillon, F.; Schroder, C.M. (2008). <i>Efficacy Of Light Therapy In Nonseasonal Depression: A Meta-Analysis.</i> <i>Review J Affect Disord.</i> May; 106(1-2):11-23. Epub 2007 Oct 22.</p> <p>Kjellman, B.F.; Merikid, L.; Thälén, B.E.; Wetterberg, L. (1995). <i>Melatonin In Light Treatment Of Patients With Seasonal And Nonseasonal Depression.</i> <i>Acta Psychiatr Scand</i> Oct92(4):274-84.</p> <p>Mickler, A., Müller-Odehagen, B., Siegelts, R.D., Vob, H.P. (1980). <i>Effect Of Bright White Light Therapy On Non-Seasonal Depressive Disorder.</i> Preliminary Results. <i>J Psych Education.</i> (2009). <i>Light Therapies For Depression.</i> Retrieved from http://www.psycheducation.org/depression/LightTherapy.htm</p> <p>Wirz-Justice, A. (1986). <i>Light Therapy For Depression: Present Status. Problems and Perspectives.</i> <i>Psychopharmacology.</i> 19 (Suppl 2):138-41.</p> <p>Kipke DF: Light treatment for nonseasonal depression: speed, efficacy, and combined treatment. <i>J Affect Disord</i> 1998; 49:109-117</p> <p>Effectiveness of Combining Light and Non-Light Treatments for Seasonal Sleep Disorders. National Heart, Lung, and Blood Institute (NHLBI) (2009).</p>	<p>Light box dawn simulator</p>	
<p>Post natal depression/ Antipartum depression</p> <ul style="list-style-type: none"> -Over production of melatonin (the "darkness hormone") - hormonal imbalances 	<p>Bright light therapy: morning exposure</p> <ul style="list-style-type: none"> -Anti-depressant medication -Psychotherapy 	<p>Bright light regulates hormonal disruptions often caused by pregnancy, regulating production of melatonin and increasing production of serotonin, thereby lightening mood and increasing wellbeing</p>	<p>Light box dawn simulator</p>	
<p>Non seasonal depression</p> <ul style="list-style-type: none"> -insufficient daily light exposure -genetic factors, etc -upset biological rhythms -Over production of melatonin (the "darkness hormone") 	<p>Bright light therapy: morning exposure</p> <ul style="list-style-type: none"> -Anti-depressant medication <p>Psychotherapy</p>	<p>Bright light reduces the production of melatonin and increases production of serotonin, thereby lightening mood and supporting a healthy sleep rhythm.</p>	<p>Light box dawn simulator</p>	
<p>Jet lag</p> <ul style="list-style-type: none"> - Crossing two or more time zones, resulting in upset circadian rhythms 	<p>Bright Light therapy- morning exposure</p> <ul style="list-style-type: none"> -Medication 	<p>Used to advance the sleep rhythms to match the destination time zone in advance for easier transition.</p>	<p>Light box dawn simulator</p>	
<p>Chronic fatigue syndrome</p> <ul style="list-style-type: none"> -Upset biological rhythms -Genetic factors -Brain abnormalities -A hyper-reactive immune system -Viral or other infectious agents -Psychiatric or emotional conditions -Over production of melatonin (the "darkness hormone") 	<p>Cognitive-behavioral therapy (CBT)</p> <ul style="list-style-type: none"> -Graded exercise -Medication -Sleep management techniques -Potentially bright light therapy: morning exposure (early stages research) 	<p>Bright light therapy is used to regulate sleep cycles, encouraging a balanced and properly timed production of melatonin- supports the body's natural "time keeping" rhythm.</p>	<p>Light box dawn simulator</p>	
<p>Worker fatigue</p> <ul style="list-style-type: none"> -insufficient natural light exposure -Stress -Low immunity -Chronic illness 	<p>Bright light therapy: morning exposure</p> <ul style="list-style-type: none"> -Full spectrum lighting throughout the day 	<p>Bright light in the morning/ midday regulates the body clock and helps workers to feel more alert for longer. Full spectrum light reduces eye strain and promotes healthier sleep.</p>	<p>Light box dawn simulator</p>	

<p>-Upset biological rhythms</p> <p>-Fighting against the bodies natural sleep rhythms</p>	<p>-insufficient natural light exposure</p> <p>-Upset biological rhythms</p> <p>-insufficient natural light exposure</p> <p>-Upset biological rhythms</p> <p>Over production of melatonin (the 'darkness hormone')</p>	<p>-Potentially Bright light therapy</p> <p>- Full spectrum light</p> <p>-Bright light therapy (mostly morning exposure is recommended)</p> <p>-dawn simulation</p> <p>-Antidepressant medications</p> <p>-Psychotherapy</p>	<p>Light also balances the female reproductive cycles and regular bright light exposure is important for fertility.</p> <p>Bright light reduces the production of melatonin, which is over produced in a depressive state and increases production of serotonin, thereby lightening mood and supporting a healthy sleep rhythm.</p>	<p>Night-shiftwork in antarctic. Sleep characteristics and bright light treatment Jonathan K. Ross, Josephine Arendt, T. Jim Horvath, Wendy Hamilton • <i>Physiology & Behavior</i> Volume 57, Issue 6, June 1995, Pages 1169–1174</p> <p>Oren DA, Terman M. Tweaking the human circadian clock with light. <i>Science</i>. 1998;279:333–334.</p> <p>Arendt J. Melatonin and human rhythms. <i>Chronobiol Int</i>. 2006;23:21–37.</p> <p>Eastman CJ, Stewart KT, Mahoney MP, et al. Dark goggles and bright light improve circadian rhythm adaptation to night-shift work. <i>Sleep</i>. 1994;17:535–543</p> <p>Sadehnia-Haghighi K, Yazdi Z, Jahanshahi H, Ameliani O. Bright light on sleepiness among rapid-rotating 12-hour shift workers. <i>Scand J Work Environ Health</i>. 2011;37:77–79</p> <p>Kogan AO, Guilford PM. Side effects of short-term 10,000-lux light therapy. <i>Am J Psychiatry</i>. 1988;145:283–294.</p> <p>Yoon JY, Song BG. Role of morning melatonin administration and attenuation of sunlight exposure in improving adaptation of night-shift workers. <i>Chronobiol Int</i>. 2005;19:303–313.</p> <p>Psychiatry Research. 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<p>-Upset biological rhythms</p> <p>-Fighting against the bodies natural sleep rhythms</p>	<p>-insufficient natural light exposure</p> <p>-Upset biological rhythms</p> <p>-insufficient natural light exposure</p> <p>-Upset biological rhythms</p> <p>Over production of melatonin (the 'darkness hormone')</p>	<p>-Light therapy, mostly morning exposure is recommended)</p> <p>-Dawn simulation</p> <p>-Antidepressant medication</p> <p>-Psychotherapy</p>	<p>Bright light reduces the production of melatonin, which is over produced in a depressive state, and increases production of serotonin, thereby lightening mood and supporting a healthy sleep rhythm.</p>	<p>Light therapy, mostly morning exposure is recommended)</p> <p>-Dawn simulation</p> <p>-Antidepressant medication</p> <p>-Psychotherapy</p>
<p>-Upset biological rhythms</p> <p>-Fighting against the bodies natural sleep rhythms</p>	<p>-insufficient natural light exposure</p> <p>-Upset biological rhythms</p> <p>-insufficient natural light exposure</p> <p>-Upset biological rhythms</p> <p>Over production of melatonin (the 'darkness hormone')</p>	<p>-Light therapy, mostly morning exposure is recommended)</p> <p>-Dawn simulation</p> <p>-Antidepressant medication</p> <p>-Psychotherapy</p>	<p>Bright light reduces the production of melatonin, which is over produced in a depressive state, and increases production of serotonin, thereby lightening mood and supporting a healthy sleep rhythm.</p>	<p>Light therapy, mostly morning exposure is recommended)</p> <p>-Dawn simulation</p> <p>-Antidepressant medication</p> <p>-Psychotherapy</p>

28 May 2012

Lisa Gabel
19 Colombo Street
Newtown
WELLINGTON 6021

Dear Lisa

Re: Design Thesis 197800

Thank you for your Low Risk Notification which was received on 14 May 2012.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research."

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail johnoneill@massey.ac.nz."

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

John G O'Neill (Professor)
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)

cc: Mr Chris Jackson
Institute of Design for Industry and
Environment
Wellington

Mr Antony Nevin
Institute of Communication Design
Wellington

Mr Rodney Adank, Hoi
Institute of Design for Industry and
Environment
Wellington

Assoc Prof Chris Bennewith, Hoi
Institute of Communication Design
Wellington

Massey University Human Ethics Committee
Accredited by the Health Research Council

Research Ethics Office, Massey University, Private Bag 11202, Palmerston North 4442, New Zealand
T +64 6 290 9572 +64 6 290 9579 F +64 6 390 3622
E humanethics@massey.ac.nz johnoneill@massey.ac.nz www.massey.ac.nz

NOTIFICATION OF LOW RISK RESEARCH/EVALUATION
INVOLVING HUMAN PARTICIPANTS

(All notifications are to be typed)
(Do not modify the content or formatting of this document in any way)

SECTION A:

1. Project Title Design Thesis 197800
Projected start date for data collection 30.03.2012 Projected end date 30.02.2013
(Low risk notifications will not be processed if recruitment and/or data collection has already begun.)

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

ACADEMIC STAFF NOTIFICATION

Full Name of Staff Applicant/s _____
School/Department/Institute _____
Region (mark one only) Albany Palmerston North Wellington
Telephone _____ Email Address _____

STUDENT NOTIFICATION

Full Name of Student Applicant Lisa Diana Gabel
Postal Address 19 Colombo St, Newtown, Wellington
Telephone (04) 9702629 Email Address lisagabel@hotmail.com
Employer (if applicable) n/a
Full Name of Supervisor(s) Chris Jackson, Antony Nevin
School/Department/Institute Institute of Communication Design, College of Creative Arts
Region (mark one only) Albany Palmerston North Wellington
Telephone ext 62220 Email Address a.nevin@massey.ac.nz

GENERAL STAFF NOTIFICATION

Full Name of Applicant _____
Section _____
Region (mark one only) Albany Palmerston North Wellington
Telephone _____ Email Address _____
Full Name of Line Manager _____
Section _____
Telephone _____ Email Address _____

SCREENING QUESTIONNAIRE
TO DETERMINE THE APPROVAL PROCEDURE
(Part A and Part B of this questionnaire must both be completed)

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 whether the nature of the harm is minimal and no more than is normally encountered in daily life. The degree of risk will then be used to determine the appropriate approval procedure.

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 answer all questions. Please circle either YES or NO for each question)

Risk of Harm

1. Situations in which the researcher may be at risk of harm.	YES <input type="radio"/> NO <input checked="" type="radio"/>
2. Use of questionnaire or interview, whether or not it is anonymous which might reasonably be expected to cause discomfort, embarrassment, or psychological or spiritual harm to the participants.	YES <input type="radio"/> NO <input checked="" type="radio"/>
3. Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose the person/group to discrimination.	YES <input type="radio"/> NO <input checked="" type="radio"/>
4. Collection of information of illegal behaviour(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.	YES <input type="radio"/> NO <input checked="" type="radio"/>
5. Collection of blood, body fluid, tissue samples or other samples.	YES <input type="radio"/> NO <input checked="" type="radio"/>
6. Any form of exercise regime, physical examination, deprivation (e.g. sleep, dietary).	YES <input type="radio"/> NO <input checked="" type="radio"/>
7. The administration of any form of drug, medicine (other than in the course of standard medical procedure), placebo.	YES <input type="radio"/> NO <input checked="" type="radio"/>
8. Physical pain, beyond mild discomfort.	YES <input type="radio"/> NO <input checked="" type="radio"/>
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 <input type="radio"/> NO <input checked="" type="radio"/>

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 dream liner 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? :

- 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- with 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 peoples 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 peoples 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 glary, static, empty. Tired, unmotivated, hard to focus.



Observation #3 : rest home

time : 9am-12pm

Light level: dim - fluorescent light
 natural light from windows

People Present:

One, then shifted to to another room with 8

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

 <p>Litebook Elite green + blue light 1,350 lux</p> <p>bright light therapy device for SAD</p>	 <p>Phillips Go Lite "BluWave" blue light, 2,500 lux</p> <p>bright light therapy device for SAD</p>	 <p>Sunnex Biotechnologies green "lo-light" 300 lux</p> <p>Light therapy device for shift workers</p>	 <p>Apollo fluorescent full spectrum 10,000 lux</p> <p>Bright light therapy device for SAD</p>	 <p>Valkee inner ear light therapy device</p> <p>alternative bright light therapy device for SAD and jet lag</p>
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Products

 <p>Dawn Simulator Philips</p> <p>Dawn simulation device for SAD</p>	 <p>Vile Kokkonen Arctic Design "White Collection"</p> <p>Bright light therapy range for SAD</p>	 <p>Feel Bright Light Visor, Northern Technologies</p> <p>Bright light therapy device for SAD and shift workers</p>	 <p>LightFrame 220XW9 monitor from Philips</p> <p>bright light therapy device for SAD and alertness</p>	 <p>Daybreak OLED light therapy device Elwin Lee</p> <p>designed to support the user throughout the day using technology that reads and adjusts to the users needs (e.g. tiredness, stress)</p>	 <p>Revive Chair Meng-Jung Chuang</p> <p>a bright light therapy integrate chair designed for women suffering from post-partum depression.</p>	 <p>Light Sleeper, Loop PH</p> <p>dawn simulator integrated in bedding to help the user awaken more naturally</p>	 <p>Light goggles, Lumie</p> <p>dawn simulator goggles, designed to awaken the user gradually with maximum efficiency</p>
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Environments

 <p>"Ljuscafe" (Igloo Light cafe) Martin Sylwan</p> <p>a "light cafe" 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, whilst absorbing the light.</p>	 <p>Bubble Tent, Pierre Stephane Dumas</p> <p>a camping experience for those seeking a "closer to nature" experience. The igloos can be hired out for a set time.</p>	 <p>Elite Choice full spectrum LED</p> <p>high quality lighting that supports productivity and simulates natural sky lights.</p>	 <p>Luminotherapy Spaces Philips Paris International Airport</p> <p>Bright light therapy igloo installation for treatment of jet lag using philips lamps.</p>	 <p>Phillips Jet Lag Pods</p> <p>Bright light therapy pods installed in airports to help alleviate the symptoms of jet lag</p>	 <p>Phillips DayWave</p> <p>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.</p>
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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 it 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 help 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 effects your entire day.

I love **waking up to the light** in summer, but my owl husband insists on having the blackout curtains closed!

I lived without light and when i lived in a house with more light I realised 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 energised

personally sunlight plays an important role in my whole wellbeing, so **sun throughout the day is important**

to have good energy for the day

High quality light that supports my mood and energy throughout the day

I would like more brighter, more **natural light** indoors, and a way to get rid of nasty fluorescent lamps

I know I'm hapier and my eyes healthier if I have access to **good light**

consistently good light (like sun light) would be great. More just seems better than a short amount. Ordinarily I like to get out for a morning jog and stretch to soak up that morning/mid-mornig light, and that tends to boost my mood and relax mt thoughts for the next day (combined with the exercise)

Consistent energy is better than bursts

because i think this would **relax my eyes** (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

A way that helps me to feel more connected to the outside environment

Offices can feel so **disconnected** to the environment

Being inside **all day**, you feel disconnected from the real world. This makes me, eventually, feel **fake and edgy**. 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 easily **lose track of time** and being more in tune with natural light would help that, maybe.

I'm a computer bound wage-slave

it is nice to feel like you are part of the outside day

Being outside always makes me feel happy. If 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 - I 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 people.** 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 inside (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**. Inside 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

I feel better when I'm outside - especially in fine weather.

A playful and intuitive way to learn how I can use light to improve my health, mood and energy

I love learning and this is a 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 hear 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 in doors. Soft natural light helps me to **feel less claustrophbic**, and this in combination with **fresh air** settles me a little. I still 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 Options
Text Response
View I would like more brighter, more natural light indoors, and a way to get rid of nasty fluorescent lamps
View pretty neutral on this
View The mornings are a time that sets up for the day ahead. If it 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.
View Offices can feel so disconnected to the environment
View Being inside all day, you feel disconnected from the real world. This makes me, eventually, feel fake and edgy. To feel more connected to the outside environment would be good.
View Waking up naturally and refreshed help my energy level throughout the day
View I dislike mornings, and find that when I'm exposed to more light it makes waking up easier.
View Personal experience - I have a bedroom with no light and have trouble waking up/getting up, and often feel down in the morning
View I believe this affects your entire day.
View because I easily lose track of time and being more in tune with natural light would help that, maybe.
View I love learning and this is a self-help way to improve quality of life
View I know I'm happier and my eyes healthier if I have access to good light
View I'm a computer bound wage-slave
View I love waking up to the light in summer, but my owl husband insists on having the blackout curtains closed!
View consistently good light (like sun light) would be great. More just seems better than a short amount. Ordinarily I like to get up for a morning jog and stretch to soak up that morning/mid-morning light, and that tends to boost my mood and relax my thoughts for the next day (combined with the exercise)
View everyone wants good health and everyone needs good lighting to function properly without damaging your health
View Consistent energy is better than bursts
View it is nice to feel like you are part of the outside day
View I lived without light and when I lived in a house with more light I realised it was so much better
View Because it sounds intriguing...and I would like to hear more!
View because I think this would relax my eyes (not having to strain) and sustain my work output/idea flow
View Being outside always makes me feel happy. If I can't go outside during the day, it would feel good to still be connected to the outside world
View 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
View Access to natural light is really important to my working environment - I have found that it is really important for me to be near a window.
View Natural resource of the sun always makes me feel more happy, balanced and productive
View I need suggestions to improve the light in my day during winter months as I am affected by SAD!
View I have observed the direct benefits on my organism in relation to its reaction to such circumstance
View Good health and a good mood are important to me
View Because I need to see the sky and to have access to sunlight, I'm a big fan for natural light, skylights etc.
View Being inside all day really makes you miss the outdoor light!
View I feel more calm when I'm in nature and this helps with focus and stress
View satisfaction and contentment being warm and dry to start the day
View So much goodness comes from being outside! Fresh air, grass under your feet, hearing birds, seeing people... it's a nice reminder that you're NOT stuck inside, for most people at a desk behind a computer. If felt more connected to the outside environment while being inside, being inside (and working) wouldn't feel so much like I was in a prison, working my life away!
View That is exactly what they achieve in traditional Japanese homes. Inside and outside are connected. It is very uplifting for the spirit.
View I find that light improves my mood and energy
View Outside feels healthy, inside is square, hard, fluorescent, stuffy, no sky or trees. Natural light feels healthy.
View The outside environment is calming
View So that I can spend time in it at any given opportunity
View Because I think it includes many of the other choices
View to enter into a interdependent creative practice using light for a source of wellbeing
View like to be outside
View outside environments make me feel good
View because I prefer to be outside
View personally sunlight plays an important role in my whole wellbeing, so sun throughout the day is important
View I am forced to spend a lot of time at a computer in doors. Soft natural light helps me to feel less claustrophobic, and this in combination with fresh air settles me a little, I still need to take some exercise at regular intervals
View to have good energy for the day
View I feel better when I'm outside - especially in fine weather.
View I don't have natural light in my working environment
View Highest chance for realization in view that I spend the majority of my time at a big company
View 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!
View Ich bin einfach neugierig, wie sich hochwertiges Licht auf mein Gesundheit, insbesondere aber auf meine Stimmungslage und Energie auswirkt. Ich würde deshalb gerne damit experimentieren.
View I feel more free and energised being outdoors

2. If I had to chose just one, this is what I would like best:

#	Answer	Response	%
1	More light in the morning to help me wake up	10	13%
2	More light mid-morning to help me stay alert and energized	2	3%
3	High quality light that supports my mood and energy throughout the day	20	26%
4	A way that helps me to feel more connected to the outside environment	26	34%
5	A playful and intuitive way to learn how I can use light to improve my health, mood and energy	17	22%
6	I would like something different all together	2	3%
Total		77	100%

Statistic	Value
Min Value	1
Max Value	6
Mean	3.57
Variance	1.70
Standard Deviation	1.30
Total Responses	77

1. If I could use light to improve my mood, health, and energy, this is how I would rate the following...

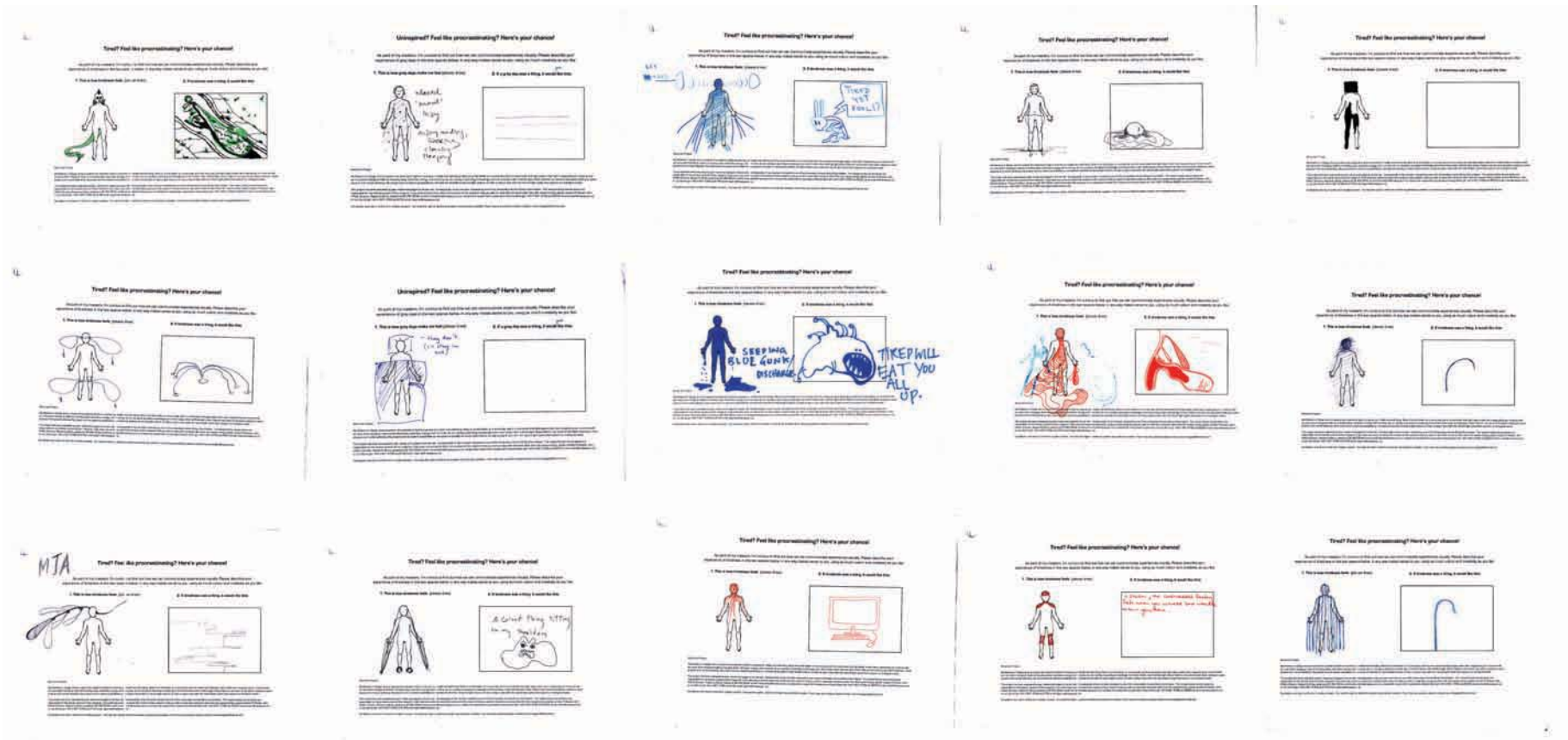
#	Question	would not enjoy	neutral	would enjoy	would enjoy very much	Responses/Total Responses	Mean
1	More light in the morning to help me wake up	5	30	29	23	77	3.04
2	More light mid-morning to help me stay alert and energized	0	22	31	25	77	3.03
3	High quality light that supports my mood and energy throughout the day	0	18	29	32	77	3.30
4	A way that helps me to feel more connected to the outside environment	0	0	18	53	77	3.61
5	A playful and intuitive way to learn how I can use light to improve my health, mood and energy	1	32	26	28	77	3.18

Statistic	More light in the morning to help me wake up	More light mid-morning to help me stay alert and energized	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	A playful and intuitive way to learn how I can use light to improve my health, mood and energy
Min Value	2	2	2	2	1
Max Value	4	4	4	4	4
Mean	3.04	3.03	3.30	3.61	3.18
Variance	0.83	0.80	0.58	0.40	0.56
Standard Deviation	0.91	0.78	0.76	0.63	0.74
Total Responses	77	77	77	77	77

4. any further comments/ideas?

Table Options
Text Response
View er... good luck
View Also important not to have too much artificial light in the evening to help prepare for sleep!
View Idea of better connection to natural environment awesome. Used to work in near dark just to have some time with the office horrid hangers off, dealing with the small amount of light from small high windows
View good luck!
View Winter sucks
View TG like a stand up move around desk, and very regular reminders to wiggle
View I had plans around the office nearby here, and a nice screen saver. Good luck with your project
View I'm interested in the research and the design link. TG favour natural light ideas (windows, skylights, clean glass, work breaks to go outside) over artificial light bulbs on alarm clock style things. I'm also interested in the idea of people in cold dark countries using sun beds to get a happy boost. I've done (cosmetic) UV light therapy on the face during winter (Dmitry) and it feels gorgeous to be under that thing for 20 mins...
View none
View its good to have light at work and a place in your house with good natural light.
View Great idea for a research project... all the best
View wish we had more sunlight and less rain, what are you gonna do? it is how it is
View TG like my life to have more 'natural' light in it, and less electrical-based light.
View Good, appropriate lighting is important for work stations, creates atmosphere and lifts moods.
View none
View Artificial light sucks (i.e. being in a mall under all those fluorescents - feels so gross.) Lovely warm natural light rules :) Good luck with your project
View not right now sounds interesting ...
View Light is very important to keep me in a good mood
View This sounds like a great research project - would love to know how it goes for you! GOOD LUCK
View Delighted to be part of your study Lisa and very best wishes for it and you. Love Michael Mortisey
View put your face towards the sun as it arises first thing in the morning
View it is also important to have the change of light and darkness
View I'm convinced that a more effective use of natural and/or artificial light can have a significant influence on the health and wellness of most of the people.
View nah

Left: Key Words. Right: Raw Data



Draw The Experience : Fatigue

Photo Journal

I used a photo-diary and journal to gain a deeper understanding of the 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.
- Something easy to use, automatic- not so much a "destination" application but more something that fits into existing life as it is
- Maybe an excuse to take a break, but would ideally like throughout the day
- Would like to use more light in home, mainly during mornings
- 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.

journal

Please use this camera to photograph your average routine over one full day (24 hours)

If possible, try to do this on a working day, documenting each major environment where you spend time. These may include:

- a place where you often spend time in the morning
- a place where you often spend time at lunchtime
- a place where you often spend time in the afternoon
- a place where you often spend time in the evening



First Hand Experience : Symptoms

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 a 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

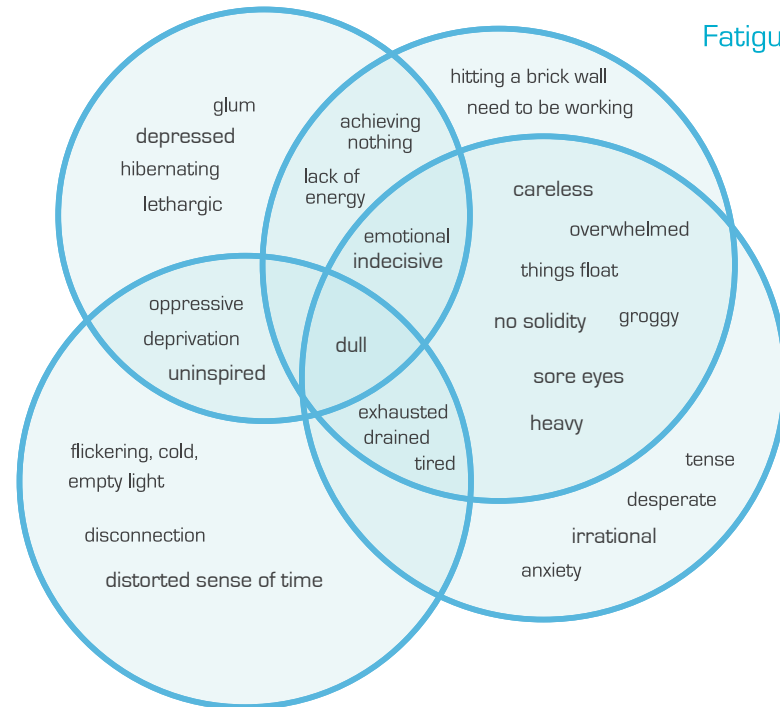
Anxiety, especially to get to sleep. Carving sleep but doesn't come, distracting thoughts keep popping up and mental to do lists and worries and problems. Heart pounds whenever the do, desperate to find a solution on the spot so I can finally let it go and relax. Tight muscles, unable to relax very long, 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.

Winter Blues

Fatigue



Low Light Environments

Sleeping Problems

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

Design Group

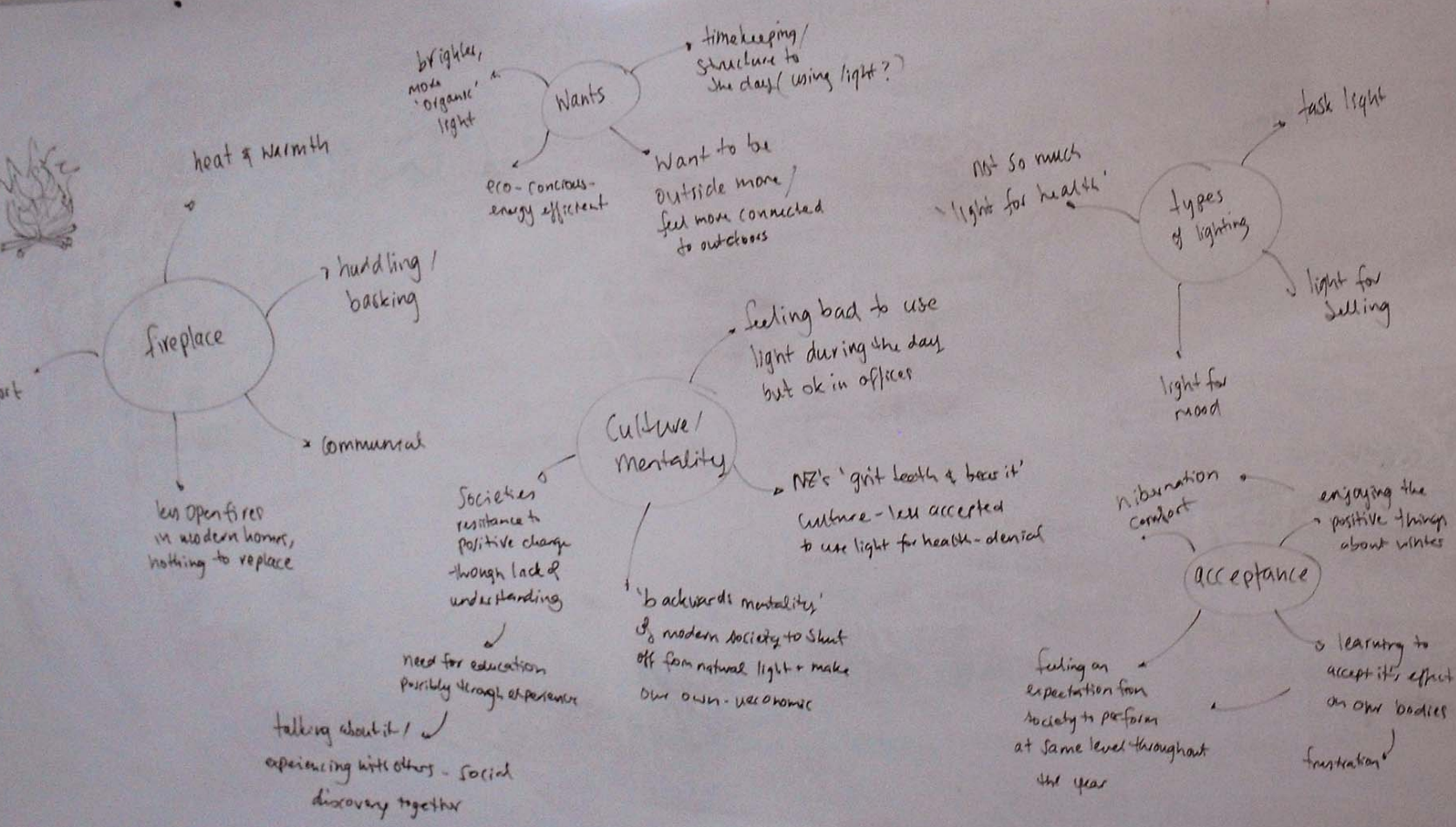
Meeting 1

- 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.



The Project...

- What - using light to improve health + wellbeing
- how - bright light between 9am-11am - dawn simulation
- When - winter time mainly, but could also be year-round
- why - indoor-based lifestyle means we don't get the light our bodies need, + to feel better in winter
- Who - people who spend a lot of time inside / dislike winter

Design Group Meeting 2 & 3

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 panels
- 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

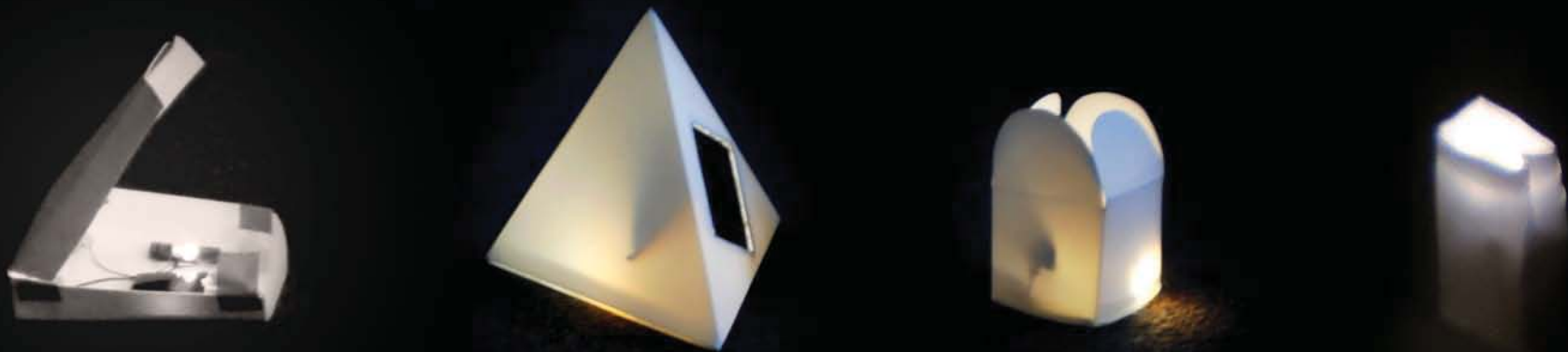


Direction of light

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 from the led’s was an important factor. The above photos demonstrate the rough experience of using the box- the more the “petals” are unfolded, the brighter the light. Below is the box after charging, at various intensities. The concept may (over long term use) lose its appeal as the ‘novelty factor’ wears off.

Findings

Solar powered “sunlight catching” does give the experience of gathering sunlight, however the light quality is vital.

Design Group Meeting 4 & 5

Meeting 4

- Final concept directions:
 1. Transport integration (accessibility, integration)
 2. Staff rom 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

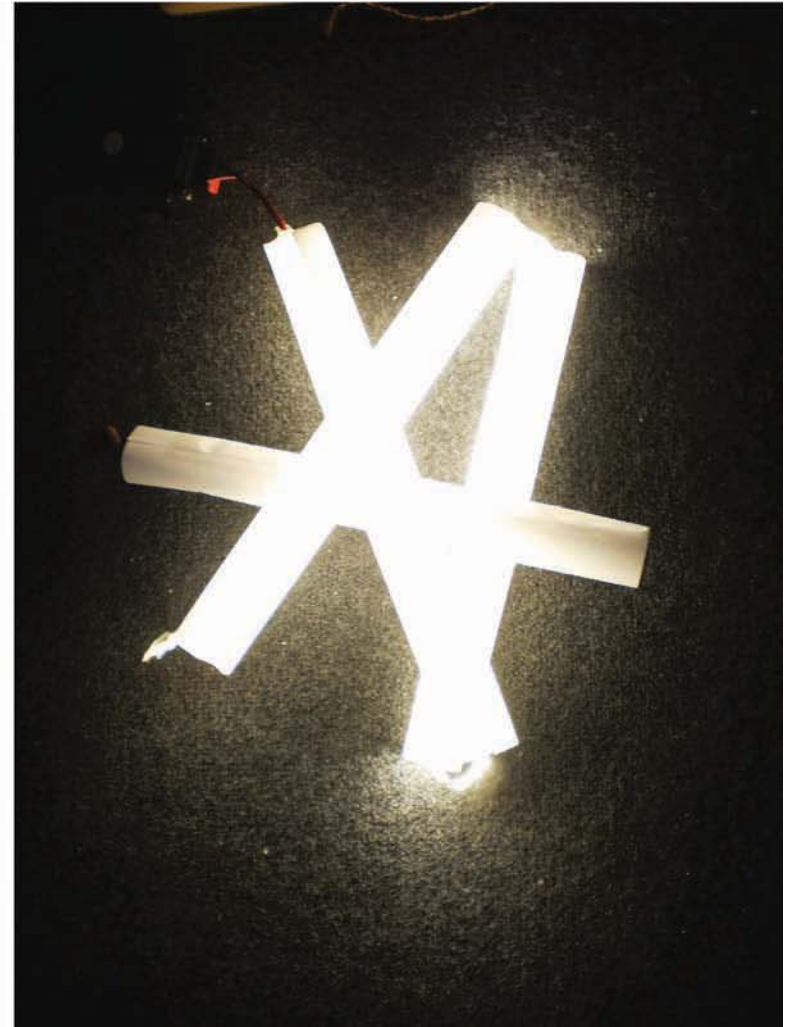
Meeting 5

- 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 form 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.



Modular Fireplace



Portable light

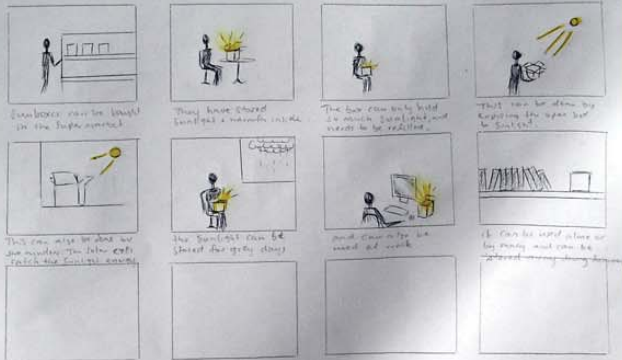
This experiment was designed to try out the idea of carrying light with the user throughout the day. The test rig was designed to be easy to carry, as a very basic tool to explore the concept. It was pleasant to have a light that sits easily in many spaces, however was prone to get dirty (e.g. in kitchen 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 through 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-repellent, versatile, and as easy to use as possible (almost automatic) with adjustable settings.



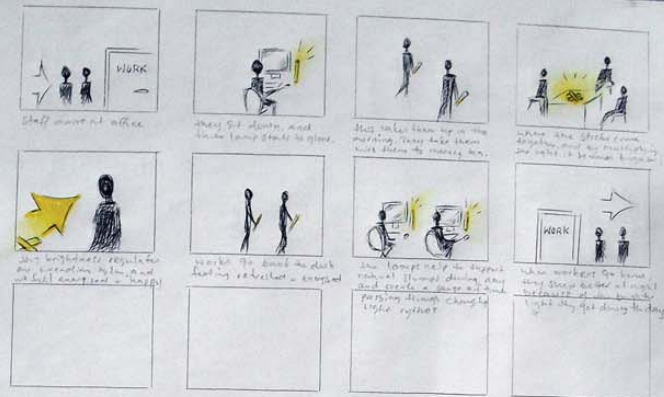
Portable Light



Sunlight

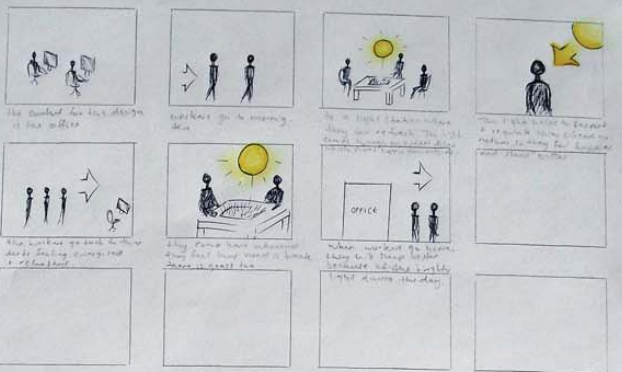
- meaning / story -
 for a product / design to be meaningful, it needs to have:

- ↳ emotional appeal
- ↳ have a personal connection / relationship
- ↳ history / significance
- ↳ could use metaphor / symbolism
- ↳ humorous + quick / fun / etc
- ↳ satisfy a need
- ↳ allow for personalization (**)
- ↳ human-centred design, human elements in the design / user-centred
- ↳ tactile interaction



- Customization / personalisation -
 how people want to use light -

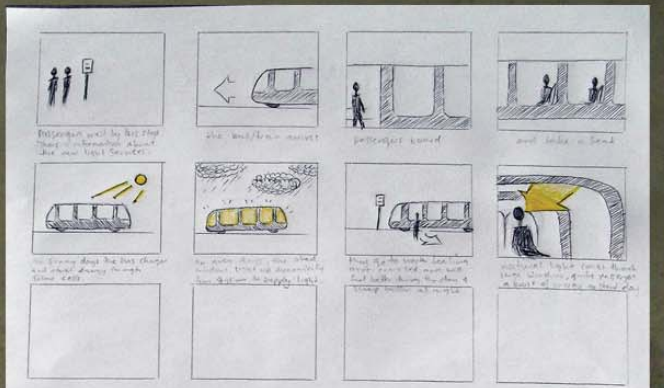
- ↳ adjustable intensity
- ↳ adjustable colour temperature
- ↳ use to support their own needs (e.g. feel better in winter / more energy)
- ↳ set their own light rhythms
- ↳ ability to choose from a larger selection of possibilities
- ↳ "make their own product" that fits their needs & can change & adapt as they develop.
- ↳ Simple to complex so users can take it as far as they like but not be restricting or too complex.
- ↳ dynamic, expandable interface



Nature

- Connection to nature -
 qualities of nature = natural light

- ↳ Slow change / rhythms e.g. light intensity during day, light colour throughout day, seasons
- ↳ movement - subtle breeze, leaves, grass, light direction, etc
- ↳ Colours - autumn / winter etc - green, blue, yellow, orange - effect on mood & psychology
- ↳ knowing what is happening outside, alleviating the disconnection + static atmosphere inside (with no windows or little natural light)
- ↳ a sense of time passing
- ↳ natural qualities of light



- Accessibility -

- available to a wide audience, regardless of income / age / demographic
- affordable
- needs to consider safety - either better but those with eye conditions / shift workers / elderly etc / bipolar, etc or have option not to use
- 'inclusive design' - not restricted to one particular audience
- fits into existing routine with no extra effort from the user - not 'destination' or novelty, but rather existing curiosity + experiential discovery

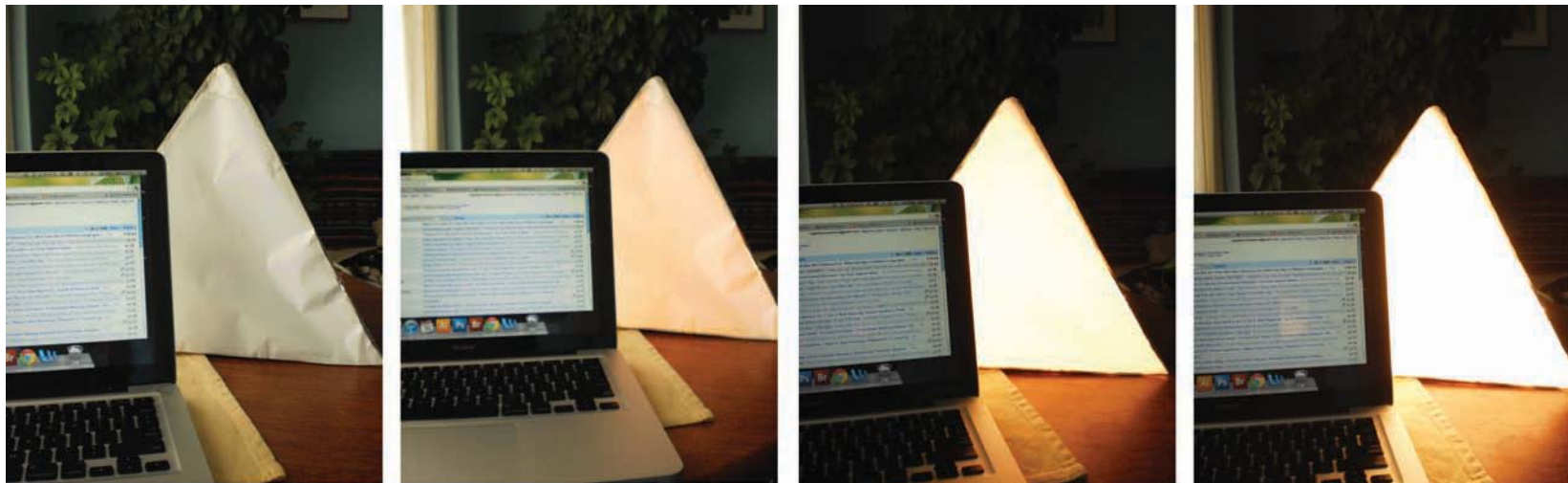
Above : Final concept storyboards & keywords.
 Right : Final Concept Matrix as rated by designer.

CRITERIA (concepts rated 1-5, least to most effective)	WIEGHTING (1= less important 5 = most important)	CONCEPT 1 transport integrated	CONCEPT 2 sun box	CONCEPT 3 fire sticks	CONCEPT 4 indoor sun
Accessibility - needs to be accessible to a wide audience	5	5 25	2 10	3 15	3 25
Integration - needs to be used consistently between the hours of 9-11 am, automatic in existing routine	5	5 25	2 10	5 25	5 25
Social- should be used in a shared context to eliminate stigma and isolation	3	5 15	4 12	5 15	5 15
Optional- should have a non-light options for those with eye sensitivity	5	5 25	5 25	5 25	3 15
Awareness- should raise awareness and educate users around the benefits of good light exposure	4	4 16	4 16	4 16	4 16
Enjoyment- should be an experience people look forward to	4	4 16	5 20	5 20	5 20
Intuitive to use	5	5 25	5 25	5 25	5 25
Non stigmatizing, versatile aesthetic	4	4 16	4 16	5 20	5 20
Preventative and holistically focused values	4	5 20	5 20	4 16	5 20
Unobtrusive to other activities	4	5 20	4 16	5 20	5 20
Clear, universal communication of function and features	4	4 12	3 12	4 16	4 16
Bring the user outside more	3	3 9	5 15	0 0	1 3
Establish a connection to outdoors	5	5 25	5 25	5 25	5 25
"Natural" feel and quality of light	5	5 25	5 25	5 25	5 25
Environmentally responsible design/ life cycle	5	5 25	5 25	5 25	5 25
Therapeutically effective : - 10,000 lux - Correct exposure distance (30 - 60 cm) - Correct exposure time (30 - 60 min) - Encourages exposure at correct time (9-11 am)	5	5 25	3 15	4 20	4 20
Diffused, high quality light	5	5 25	3 15	5 25	5 25
Adjustable brightness	3	1 3	5 15	5 15	0 0
Energy efficient- safe and effective over long and short term use	5	5 25	5 25	4 20	5 25
Safe for wide audience / varied circadian rhythms	5	4 20	3 15	4 20	5 25
Wide beam of light	4	5 20	4 16	4 16	4 16
Downwards angle (most efficient absorption)	3	5 15	0 0	0 0	5 15
Easy to use, set up and carry	4	5 20	3 12	5 20	4 16
Affordable	5	4 20	3 15	4 20	4 20
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 juts 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 detracting 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 8 & 9

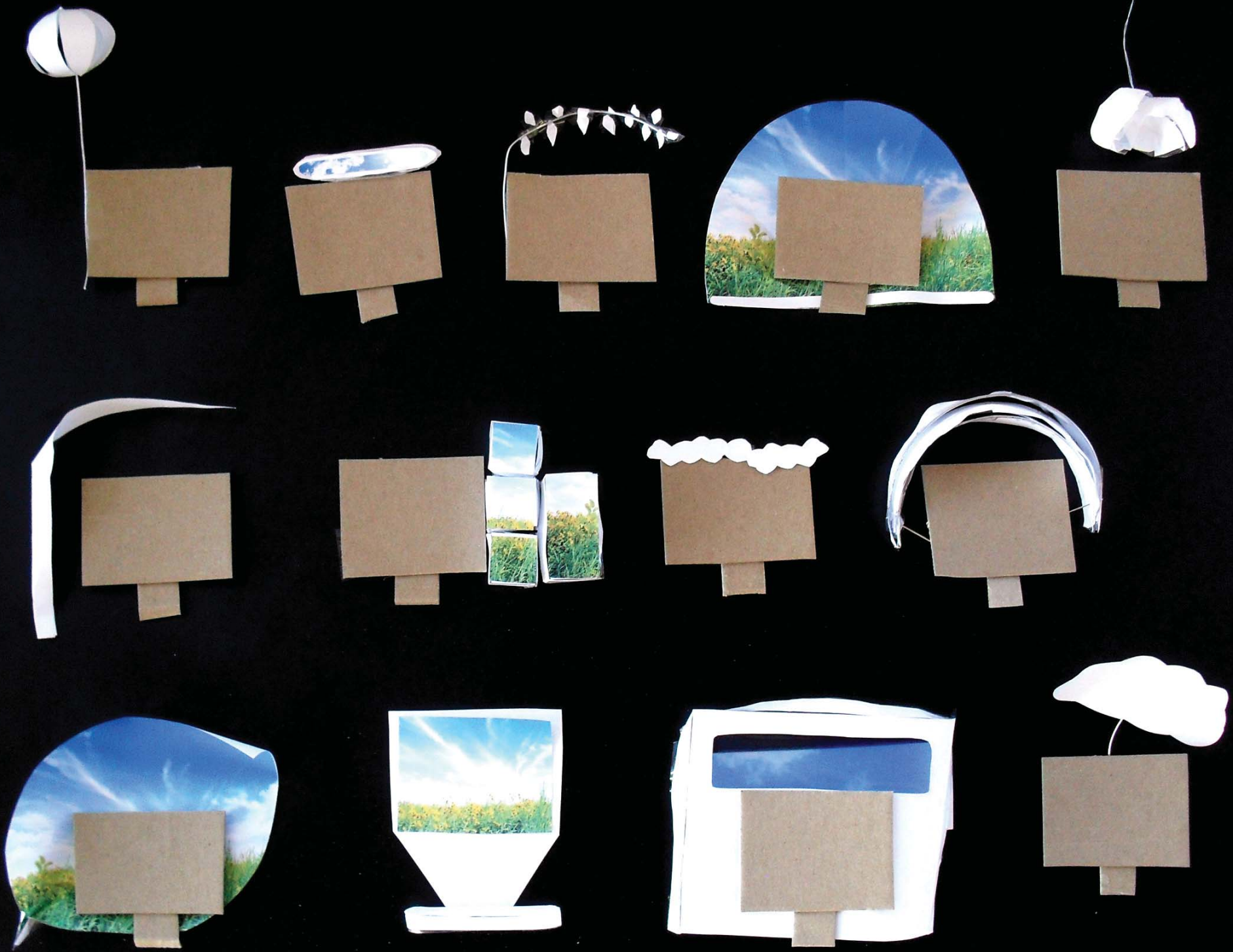
Design Group : Meeting 8

- 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



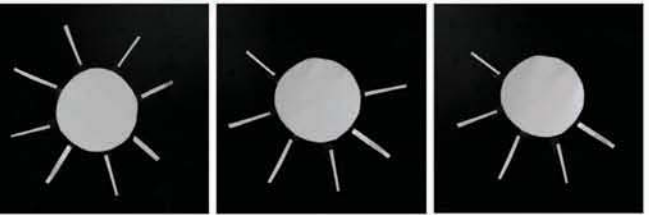
opening 'sun' orb to release light



scrunching light



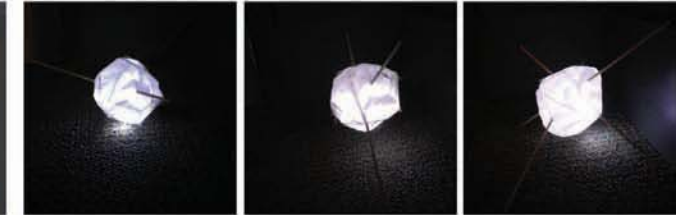
malleable 'sun'



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

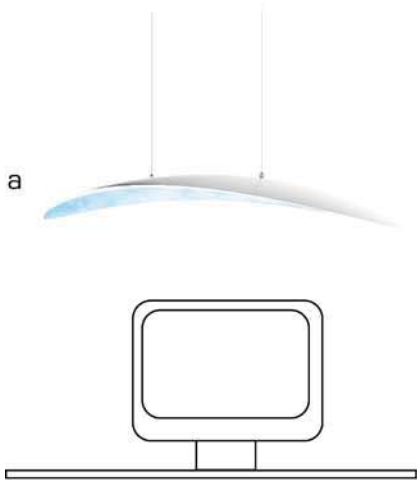
Meeting 10

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.



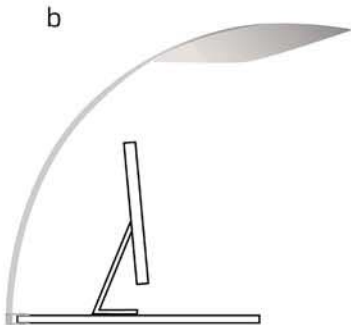
Workstation Integration Options



side view : suspended



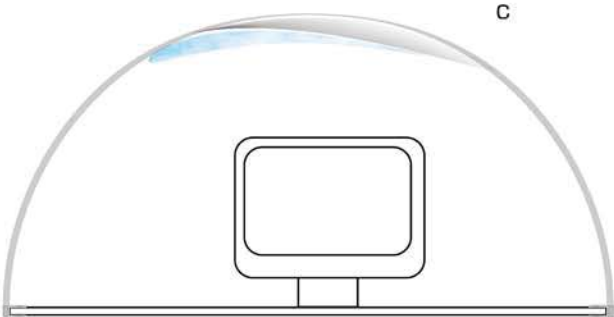
a. top view : suspended



side view : table attachment, clamped



b. top view : table attachment



front view : table attachment, clamped



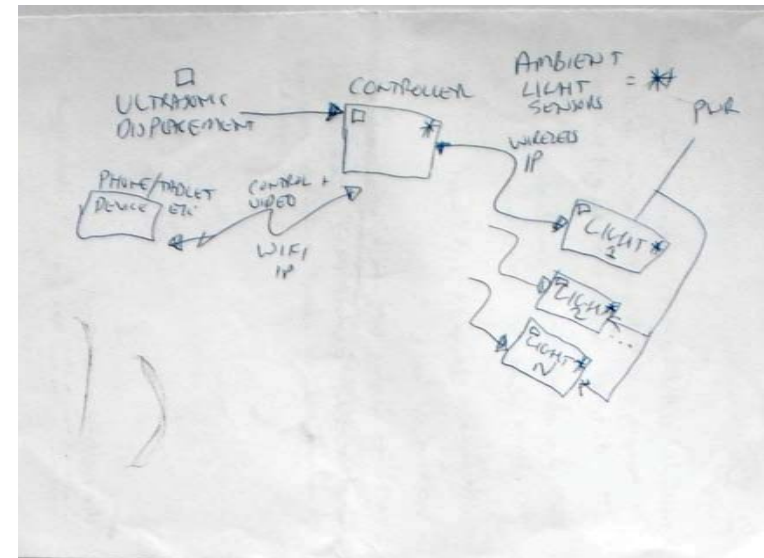
c. top view : table attachment

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

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 Kinect - 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
- GLOWPAN= controller for electronics.



Above : Basic Schematic

