Research Report, Design Proposal & Design Justification

Lighting Effects in an Industry Setting

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Abstract

Poor lighting in an industry setting can impede worker wellbeing and performance. This results in workers performing to a lower level, while their dissatisfaction of the workplace environment due to glare or poor lighting conditions can lead to tampering and underutilised work areas. As workers perform tasks throughout their shift, it is the lighting design and the level of illuminance on the work area which determines the speed and time which a task can be performed. As an example, if a worker is performing a visual task and the lighting solution is to bright it will cause glare off the work surface and hinder the worker in their duties, while also causing headaches impeding the wellbeing of the worker.

This study looks at the influences lighting and lighting effects has in an industry setting. Through testing and observation of ten people during a controlled lighting test, it was found that participants preferred light levels of 500 LUX when performing work tasks. These results as so indicated that workers have similar lighting preferences and react to both negatively to lower 50 LUX and brighter 1000 LUX levels of illuminance. These results demonstrate that lighting does have an influence on workers, affecting both the performance and wellbeing. The results discussed in this research paper have identified design implication for industry lighting system, with applications in both lighting re-design and new industry settings.

Contents

2018

DESIGNED AS PART OF THE 2018 FINAL YEAR PROJECT, VISION WORK LAMP, IS AN INNOVATIVE STEP IN WORK LAMP TECHNOLOGY

Vision's goal is to improve worker wellbeing and performance, with the aim of increasing workplace satisfaction.

Through research in to industry Lighting, it was found that poor lighting condition have an impact on workers performance due to reduce worker wellbeing. It was from this premise the theory that healthier lighting can improve worker wellbeing, thus improving performance.

Meet Vision Work Lamp

Size

The Vision Is the size of a

of a standard work lamp full Height of 600mm.

A pivot point of 180 degrees of movement, three axis lamp

mount to accommodate any position.

Arm Reach

450mm fully extended at 100mm off the desk

Weight

3kg

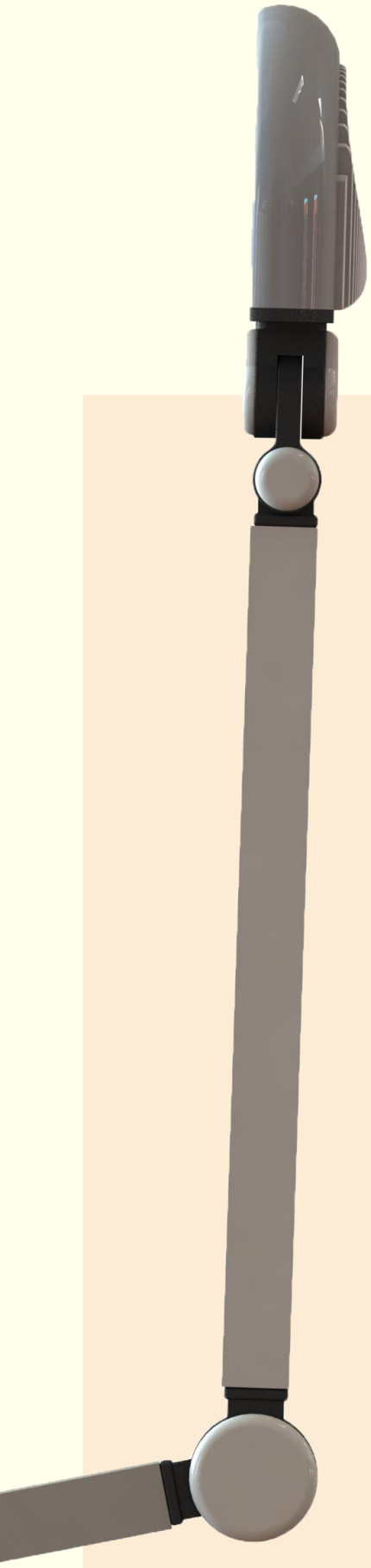
Features

The Vision has a multi-colour LED array, automated colour

phase shift from 6000k to 3500k, manual controls,

selectable range of colour, selectable

range of LUX output.



Introduction

Over the past fifty years numerous research studies have been performed on lighting in an office environment. However, industry lighting in fundamental parts of the work environment such as food packing, manufacturing and line assembly shift work lighting is overlooked (Boyce, 2004; Juslén, 2007; Joines, 2015). Office lighting fundamentals look at daylighting and how this contributes to the overall lighting system. In an industry environment daylighting may not be available due to circumstances like shift work or the work environment being more task orientated as seen in Figure 1 (Juslén, Wouters and Tenner, 2007; Bogatishchev, 2014). The research presented here looks at those industry environments where the day lighting factor is missing and artificial lighting systems are used, industries such as food packing and assembly work where twenty-four hour shift work is employed (Boyce, 1997; Juslén, 2007; Hawes, 2012; Sadeghniiat-Haghighi, 2011). This research paper looks at how different artificial lighting factors influence workers with a focus on workers performance and wellbeing (Kretschmer, Schmidt and Griefahn, 2011; Wilhelm, 2011)

To achieve this firstly, this paper will perform a literature review of journal articles on lighting in industry, to help gain an understanding of how lighting impacts worker performance and wellbeing. Secondly, using a twostep process, step one: Interviews of people who work in lighting design or perform research aimed at the lighting industry. Step two: An academic study to determine if illuminance levels can have an impact on the worker in both a negative and positive way affecting their performance.

Through this study determine what benefits can be obtained from improved lighting in industry, which would lead to improved worker performance levels translating into improved productivity and increased wellbeing.

Lighting Levels in Industry

The importance of good lighting in an industry setting has been validated through many studies (Boyce, 1997; Sadeghniiat-Haghighi, 2011). As early as 1948 Simonson and Brozer highlighted the importance of illuminance on visual work performance and the need for different lighting depending on the tasks being performed. It is these effects on the worker which need further study, as not all research in this area agrees on Santhi, Aeschbach, Horowitz, Czeisler (2008) findings of increased performance with increased lighting levels (Kretschmer, Schmidt and Griefahn, 2011 p. 317). Particularly when it comes to task lighting, a focused light source separate from the surrounding lighting system as seen in Figure 1. The increase in illuminance above certain levels has been shown to

have negative effects on workers performance, due to eye strain and visual fatigue (Juslén, 2005; Bellia, 2011). In addition,

the spectral qualities of the light produce from the artificial lighting system was also shown to influence the worker equally, when compared to illuminance factors (Juslén, 2007; Bellia, 2011).

Figure 1: An Industry Workstation with Task Lighting (Juslén, Verbossen and Wouters, 2007)

Though the illuminance levels of a work environment are today apart of the work place standards and regulations. These standards do not require the measuring of worker visual comfort as part of the set standards (Mills and Borg, 1999, p. 160). Making it more important than ever to re-evaluate the lighting levels of an industry environment and determine if the increased want for brighter lighting is needed, while gaining a better understanding of its effects on the worker (Juslén, 2005; Bellia, 2011). The most effective way to measure for a preferred lighting level is through task analysis and the number of errors made because of incorrect illuminance levels (Sivaji, 2013, p. 646). While including a before and after examination to record the persons physical attributes, such as eye strain and level of fatigue (Juslén, Verbossen and Wouters, 2007 p.615). Combining this information to determine the preferred lighting for the work task being performed (Joines, 2015, p.472).

This relating to the premise that certain work tasks requires identifying of fine details and such need a higher illuminance as shown in Figure 2, while other less detail orientated operations are needing of reduced illuminance of the work area (Joines, 2015; Jayawardena,

Duffy and Manahan, 2016). Calling for a variety of lighting levels to be used with in the industry setting. While lighting standards referring to appropriate lighting as task appropriate, it is seen as more of a metric to measure against, rather than the optimal requirement for a worker (Bellia, 2011; Mills & Borg, 1999)

The outline of this report as seen in Figure 3, is as follows; Section two reviews the key issues such as how lighting affects worker performance in areas of safety, performance and errors. As well how deficient lighting causes eye strain, headaches and fatigue, impacting worker wellbeing. Section three will discuss the research methods used to investigate the theories found in the literature review. Section four displays the results and findings, with insight to the research and review. Section five, discusses the key points from the review and results findings, to provide recommendations for improvement of lighting design within an industry setting.

Figure 2: Workstation with Overhead Lighting System

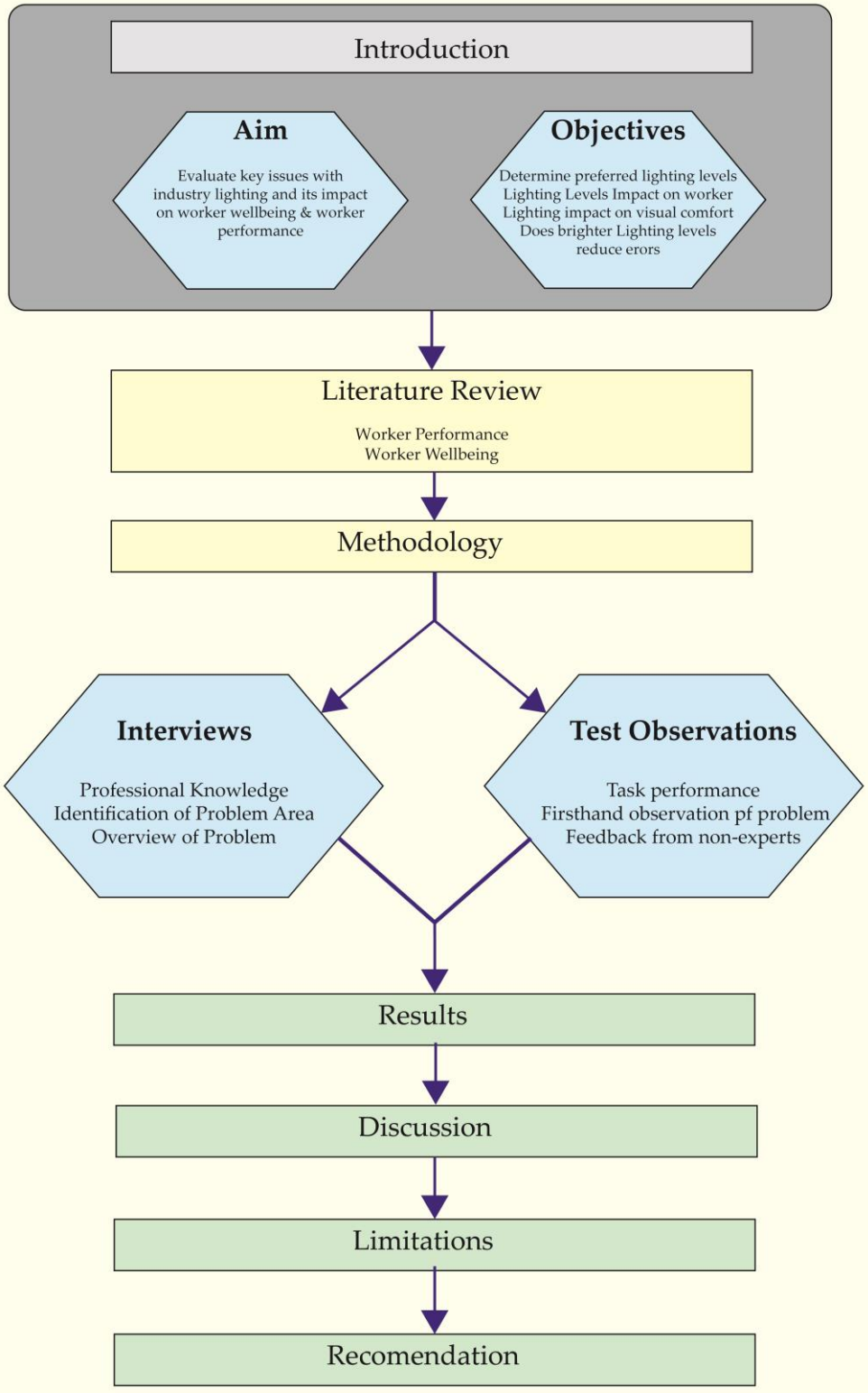


Figure 3: Thesis Plan

Aims and Objectives

The aim of this study it to determine the lighting requirements for workers in an industry setting. Main point being the visual effects lighting illuminance has on worker performance and wellbeing under predominately artificial light as seen in Figure 4. To determine whether current lighting designs is appropriate, this study will measure the visual performance and preferred lighting level across three lighting levels 50Lux, 500Lux and 1000Lux with 10 people. Furthermore, interviews with lighting industry academics will be performed to help answer questions and gain a better understanding of the problem at hand.

The objectives are:

- Identify the how lighting levels impact the workers ability to perform a task.
- Understand how inappropriate lighting influencing the wellbeing of the worker.
- Determine if brighter lighting levels above the regulatory standards reduces errors.
- Determine what factors lead to visual discomfort of the worker.

Figure 4: Workstation Assembly of Fine Detailed Parts

Literature Review

Industry Lighting: Introduction

Light is an important part of our daily lives, be it natural light from the sun or artificial light. It is everywhere in our homes and workplaces. It allows people to perform tasks all hours of the day, while providing comfort and safety at night (Bellia, Bisegna, & Spada, 2011). Most of the light people use throughout the day is artificial light, be it in our home or work environments. while the increased use of artificial light does add convenience, it is the over exposure to inappropriate light which can have a negative impact on people (Haim & Zubidat, 2015; Gaston, 2015). Industry workplaces are one area where artificial lighting has become more important with the main use being found in shift work, where factory's run twenty-four hours a day. Thanks to the use of artificial lighting, allowing industry workers to work into the evenings and throughout the night without downtime (Juslén, Wouters and Tenner, 2005; Leichtfried, 2015; Sadeghniiat-Haghighi, 2011; Kretschmer, Griefahn and Schmidt, 2013). Good lighting is described as enabling good visibility of the surrounding environment, while providing the appropriate illuminance of the work area, ensuring visual tasks can be performed to an appropriate level (Juslén, Wouters and Tenner, 2005; Sivaji, 2013). The research looks at two areas where lighting has an impact on the worker, these areas are worker performance and worker wellbeing, with regards to safety, performance, errors and visual comfort (Juslén & Tenner 2005; Shamsul, 2013). Further research has shown that different lighting system do effect people and that the right lighting design may improve the two areas mention (Bellia, Bisegna and Spada, 2011; Sivaji, 2013). To achieved this, the use of a variety artificial lighting and lighting effects within industry environments are needed.

Research finds that poor lighting can have a negative effect on a worker's wellbeing and performance, highlighting that poor lighting can lead to reduced safety, eye strain and fatigue (Hawes, 2012; Juslén, Verbossen, & Wouters, 2007; Bommel, 2006). These conditions could be from exposure to the poor application of a new lighting systems, as well the continued use of an old outdated lighting system (Jayawardena, Duffy, & Manahan, 2017, p. 55). Existing research finding that poor lighting is one of the greatest negative impact on worker's

performance and wellbeing in the workplace (Juslén, 2007; Bommel, 2006). As industry increases its use of artificial lighting combined with extended work hours, the effects of artificial light on workers will need to have further research performed.

The scope of this review is to look at the effect of different lighting levels on workers, with a focus on the illuminance of the work area and how this impacts worker performance and wellbeing. For example, how poor application of lighting systems, could impede worker performance and their ability to perform visual tasks with minimal errors. Existing Literature highlights two main areas of focus; these are 1,) the impact on worker wellbeing and 2,) the impact on worker performance. These two will form the main areas of this review, first however the review provides an introduction to the types of lighting used in the industry.

Lighting in Industry

Artificial lighting in industry contributed to about 35% of the worlds power consumption, furthering the need for more efficient lighting systems (Jayawardena, 2017; Omer, 2008). Juslén, Wouters, & Tenner, (2005) found that with a better understanding of what a worker's requirements are from the lighting system, industry could achieve better productivity from their worker. Further implying improved cost savings for industry because of well designed lighting systems, resulting in improved performance by the worker and reduce power consumption (Sivaji, 2013; Bogatishchev 2014; Leichtfried, 2015)

Lighting in industry utilises several types of lights or lamps, the types being fluorescent, metal halide, high intensity discharge and lighting emitting diode, with the main two types shown below in Figure 5(Hawes, 2012; Jayawardena, 2017). Each of these sources of light have their own unique application and characteristics, which when used in an industry setting aim to provide visible light efficiently throughout the work area and visual comfort for the worker (Jayawardena, 2017; Küller, Ballal, Laike, Mikellides, & Tonello, 2006).

Figure 5: Two Types of Lighting in Industry, LED Bay Fixture and the HID Bay Fixture (Jimmy Hovey, 2011)

Worker Wellbeing

Worker wellbeing in the context of lighting in industry is describes in terms of visual discomfort. Visual discomfort is caused by eye-strain and can result in fatigue and headaches (Henri & Juslén, 2007; Boyce, 1997; Leichtfried, 2015). The literature on worker wellbeing highlights three areas where poor lighting has the greatest impact on worker wellbeing and visual discomfort: Identifying 1) low light levels, 2) over bright lighting and 3) sources of glare. A study by Sadeghniiat-Haghighi (2011) looked at 94 workers in a ceramic's factory and how changes in lighting condition impacted workers on rotating 12-hour shift. Results showed that the right illuminance levels do improve a worker's wellbeing (Sadeghniiat-Haghighi, 2011; Chinoy, 2016). Similar studies found, indicated that visual comfort of the

worker is a combination of the right illuminance levels on the work surface and surrounding work area (Joines, 2015; Juslén, 2007).

Bellia (2011) discussed the interaction between the worker and their surroundings, explaining that light interacts with the eyes as they gather visual information about the surrounding (Bellia, 2011, p. 1985). If the lighting levels are too bright or poorly lit the worker will feel discomfort, this can be in the form of eye strain from the poorly lit room or glare produce from the area being overly bright (Bellia, 2011; Henri, Juslén, 2007). These factors influence by the quality of light all impact the worker health and wellbeing and should be considered early in the lighting design process.

However, Wilhelm, Weckerle, Durst, Fahr, & Röck, (2011), argued, that the correct lighting intensities throughout a work area, does not guarantee a better work experience for the worker (Boyce, 1997; Leichtfried, 2015). Their research found, attributes like colour and placement of the lighting in the work place also impacts the worker, “The utilisation of higher illuminances in the workplace should be carefully considered before being implemented as visual acuity, colour vision and contrast sensitivity similarly showed no significant differences between illumination conditions” (Wilhelm et al, 2011 P. 185).

Further adding to the research findings that industry lighting needs to be accounted for prior to the building or redesign process. Taking in to account the worker’s needs and requirement for the task being performed, to reduce the impact on the workers wellbeing (Küller, 2006; Liu, Lin, Huang, & Chen, 2017; Wilhelm, Weckerle, Durst, Fahr, & Röck, 2011).

Worker Performance

A great deal of research goes in to industry lighting intensity and the relationship between worker performance and production in relation to the use of artificial lighting (Kretschmer, Schmidt, & Griefahn, 2011; Sivaji, Shopian, Nor, Chuan, & Bahri, 2013). Jayawardena, Duffy, & Manahan, (2016) further discussed in their research the impact workplace lighting levels had on workers ability to perform tasks with reduced errors, while also indicating that the wrong lighting intensities had a direct impact on safety (Jayawardena, 2017; Bommel, 2006). The study performed by Jayawardena, Duffy, & Manahan, (2016) surveyed 20 people working in the oil and gas industry a predominantly automated environment, where the work is less physical but required the worker to be alert and focused (Jayawardena, Duffy and

Manahan, 2017 p. 62). It looked at how the use of high illuminance levels are used to improve the safety and reduce errors. Results showed that due to these high illuminance levels the worker while experiencing improved alertness and safety, did feel fatigued after long exposure impacting their performance (Wilhelm et al, 2011; Jayawardena, Duffy and Manahan, 2017) Related research, indicated that increased illuminance did see improvements in performance in the short term, but the long term exposure to the higher illuminance levels had a negative impact on the worker reducing the speed and accuracy at which the task can be performed (Jayawardena, 2017; Juslén, 2007; Bommel, 2006).

Figure 6: New LED Industry Light Design, Even light on all surfaces and surrounding areas (EmmlightBV.com, 2018)

Consequences of poor lighting in industry are reduced safety of the worker, with findings from research looking at worker injuries from slips and falls reporting the main cause being inadequate light (Jayawardena, 2017; Hawes, 2012). Poor lighting impacts the visual system of the worker causing an inability to identify hazards, such as wet floors and sharp edges, this is due to the eyes inability to adapt to the changes in lighting condition leaving the person unable to fully see the danger in front of them (Hawes, 2012; Jayawardena, Duffy and Manahan, 2016). Additionally, research found in an industry work environment increasing illuminance unto itself may not be the total solution needed to improve worker performance,

with a requisite for workers needs to be assessed according to the circumstances and the tasks performed (Juslén, 2005; Bellia, 2011; Wilhelm, 2011; Hawes, 2012). These findings highlight a need for lighting design to consider other attributed of lighting during the light design process, to ensure worker performance is not impacted.

Research shows a well-designed lighting system which achieves a comfortable lighting levels for the worker, shown in Figure 6, Would not be the same for every situation or setting and should take in to account worker task requirements in that particular area (Juslén, 2007; Sivaji, 2013; Bogatishchev, 2014). This research was taken further by other studies stating that good lighting with proper illuminance in an industry space is required for both good worker performance, but more importantly it should provide an environment which is user friendly and reduce worker risk found in poor lighting conditions (Sivaji, 2013; Jayawardena, 2017; Juslén 2007; Hawes, 2012). With these findings further confirming the need for early consideration in the design/redesign stage, to best mitigate lighting deficiencies in the industry setting, which could impact worker performance.

Research Gap

This research review looked at studies on the effects of lighting and light intensity on workers and assessed worker impact in relation to the performance, while also investigating the impact of poor lighting design and its effects on the workers' wellbeing. Further studies are needed to be done to better identify other factor of poor lighting.

While, other articles have reviewed the issues with lighting in the workplace and the effects of on worker productivity and associated costs, this review focused on two factors worker wellbeing and worker performance. Illumination of the work area and lighting intensity were identified as having the greatest impact on visual comfort, performance, reduced errors and safety (Bommel, Beld and Ooijen, 2002; Küller, 2006). Several articles indicating a relationship between these factors and worker performance and wellbeing. This review also suggests a clear interaction between poor lighting design and poor worker performance (Bommel, Beld and Ooijen, 2002; Hawes, 2012).

Furthermore, this review also highlighted illuminance of the work area and how increased illuminance could impact performance in both a positive and negative way. These issues were categorised in to lighting intensity, visual comfort and varying task requirements of the worker (Bellia, Bisegna and Spada, 2011; Hawes, 2012).

However, the limitation of this review includes the excluding of other lighting condition such as lighting colour and day lighting, as these areas where not the focus of this literature review but were considered as possible problem areas. This review does also note the need for early lighting design to be included in to the building development or re-development. As the complexity of understanding the workers needs and work environment can be a challenging task, when trying to achieve the optimal lighting experience. The review gives an analysis of how lighting intensity affects workers in an industry setting. Through a better understanding of workers need in relation to workplace lighting design, a better designed work environment would improve productivity of the workplace and wellbeing of the worker, leading to a happier workforce (Küller, 2006 p. 1505).

Summary

This literature review builds an understanding of how lighting intensity affects worker performance and wellbeing in an industry setting (Wilhelm, 2011). Discussing how the use of lighting can work for some industry settings but not for others (Küller, 2006; Wilhelm, 2011). Recommending early lighting design in an industry environment look at a variety of factors within a workplace to best accommodate the task performed by the worker within the given setting (Hawes, 2012; Jayawardena, Duffy and Manahan, 2017). The literature recommends a review of traditional standards to improve the current lighting strategies. As studies showed maintaining an optimal lighting levels leads to improved performance and wellbeing of the worker (Bommel, Beld and Ooijen, 2002; Juslén and Tenner, 2005; Hawes, 2012).

Research Methods

To best understand the lighting needs of people in an industry setting, a variety of research methods were undertaken, as seen in the research plan Figure 7; To help answer the question of how lighting levels affects workers performance and wellbeing. To achieve this understanding of the topic, a literature review was performed, to help get an overview of the topic and challenges faced in furthering the research already performed.

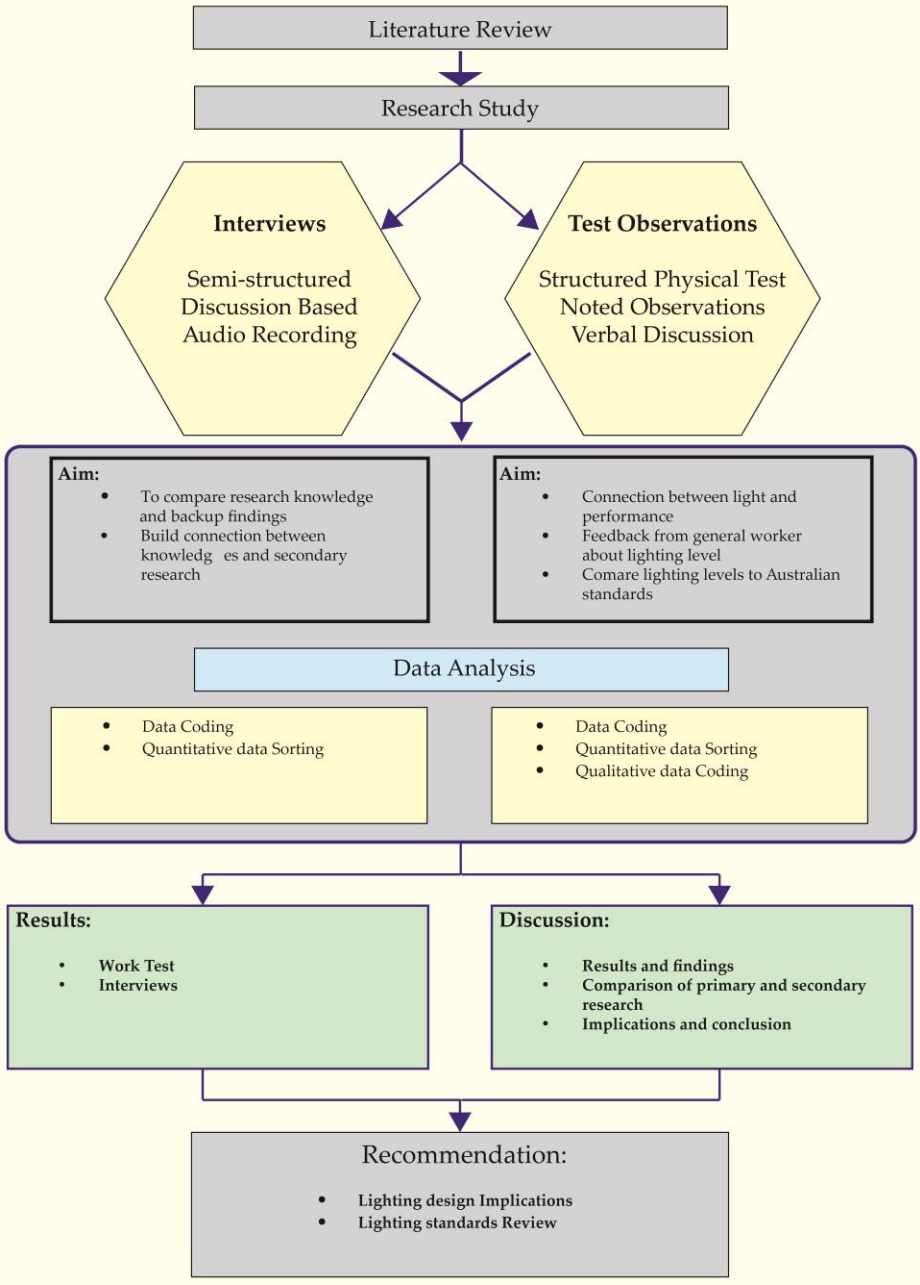


Figure 7: Research Plan

The primary research employed interviews and visual testing to help gain further understanding of the problems found in the literature review. Interviews were conducted with two professionals who work and perform research in the lighting field of study. The interviews provide rich qualitative data helping backup the literature review and further the knowledge and understanding of how lighting affects workers. The interview used a semi-structured approach with questions on the topic of illuminance of the work area and worker performance to gain a deeper level of understanding, while helping to further identify areas of lighting which need more investigation. Interviews are described in detail in (Section 3.2) below.

To also better identify the problems face with poor lighting conditions a visual lighting test was performed. This test is a work-related task oriented test and provides quantitative data on worker performance. Simonson and Brozer, (p.385, 1947) describe the test as a visual task recognition and response of the worker at different lighting levels. The test has been adapted by other researchers to suit modern studies (Juslén, Verbossen and Wouters, 2007; Hawes, 2012). The test has seven fundamental qualities (Brozek, Simonson, and Keys, 1947 p. 519):

1. A standardised work tasks.
2. Easy quantitative evaluation.
3. An easy identifiable fundamental visual function.
4. Elimination of auxiliary functions, such as manual skill or verbal intelligence.
5. Elimination, as far as possible, of uncontrolled factors affecting performance.
6. Practical applicability of results.
7. Possibility to vary critical factors of performance

For the purpose of this research, the test designed from these fundamentals will use a word jumble and three different lighting levels to show how illuminance of a work area influences performance. The test is a combination of three functions performed by the person during a

word finding test: 1) identifying the word, 2) finding the word in the word jumble and 3) the eyes ability to recognise the task being performed at the set illuminance level. This test is described in detail in (Section 3.3) below.

Hawthorne Effect

An important point raised by multiple articles was the Hawthorne effect. This is the increase in performance by an individual, caused by a feeling of being observed or cared for. Leading to an improvement in performance by the individual. The Hawthorne effect was reported in a study by Henry A. Landsberger, in 1958. The study reported that through intense observation a group of women were observed during test conditions and improvements in performance where recorded without any change to the environment. It was also discussed that the effect was minimised in closed testing conditions as people where more motivated to do well. While stating that such studies in normal industry setting would be at less of a risk, from the Hawthorne effect. As workers in an industry setting are adapt at working in a controlled environment and are less likely to be affected by further observations or testing (Juslén and Tenner, 2005 p. 845; H. Juslén, Wouters and Tenner, 2007 p.616; Wilhelm, 2011 p. 192; Sivaji, 2013 p.646)

Interviews

To help answer and gain a better understanding of the problems found in the research, an interview will be performed using a semi-structured approach. Using industry professionals to discuss how the different lighting levels improved or impeded the abilities of a work in an industry setting. This discussion will take 30 minutes and will discuss the questions in Appendix A, with the qualitative data broken down using talk data analysis (Patton, 2002).

Work Test

The exercise involves a word-finding task. The task will be performed under three different light illuminances. The three lighting levels are 50 lux, 500lux and 1000lux and were provided by an LED down lamp in a closed space with black walls to best isolate the subject

from outside influences. The lamp used had a colour correction of 4000k and a colour reference of 95%, as this simulated a typically used metal halide bay light in an industry setting shown in Figure 8.

The word puzzles will consist of standard Arial 12pt font with identical contrast, but different orientation of the words shown in Appendix B. At each lighting level the participant will be asked to find three words within the word jumble. To measure the task performance, a timer will be used for 1 minute per lighting level, with the quantitative data collected and placed in to a spreadsheet for analysis.

Part 1: - To measure of performance: Each participant will be given three words to find. The time is recorded in seconds on completion of each task at the set lighting level, with test stopped at 1 minute if words not all found. Word puzzles used are in Appendix B.

Part 2: - After the test is performed the participants, will be asked two questions.

Figure 8: Industry Environment, using a Metal Halide bay lighting system at 4000k (Huntington Homes, 2016)

1. What was your preferred lighting level during the test?
2. Did any of the lighting level bother you?

Results

The results section will discuss the finding from the work test and the interviews performed. Each of these tasks were performed at Queensland University of Technology. The participants in the work test did not need to be of a specific age or required to fit a specific audience, as the intention was to capture a generic workforce.

To gain industry and academic inside in to the fundamentals of lighting in the workplace interviews were performed. This started by emailing known professionals and academics in the lighting industry, these participants having academic knowledge of lighting and lighting in a work space could help fill in the gaps found in research, further details for the research findings can be found below in the results section.

Work Test

The visual work test included ten participants between the ages of 20 to 40 years of age. Testing was performed at Queensland University of Technology with participants from the student body. Results analysis of the work test are in Appendix C.

Figure 8 shows that a comparison of illuminance levels to task performed in the allotted time. Data analysis shown in Figure 8 displays an equal number of test completions under the 500 lux and 1000 lux test conditions. The times of completion the 1000 lux did have a lower average time with faster and more consistent time shown, but only to a slight amount. This illustrates that while the 1000 lux lighting level increased the person's performance during the test it was not a significant amount.

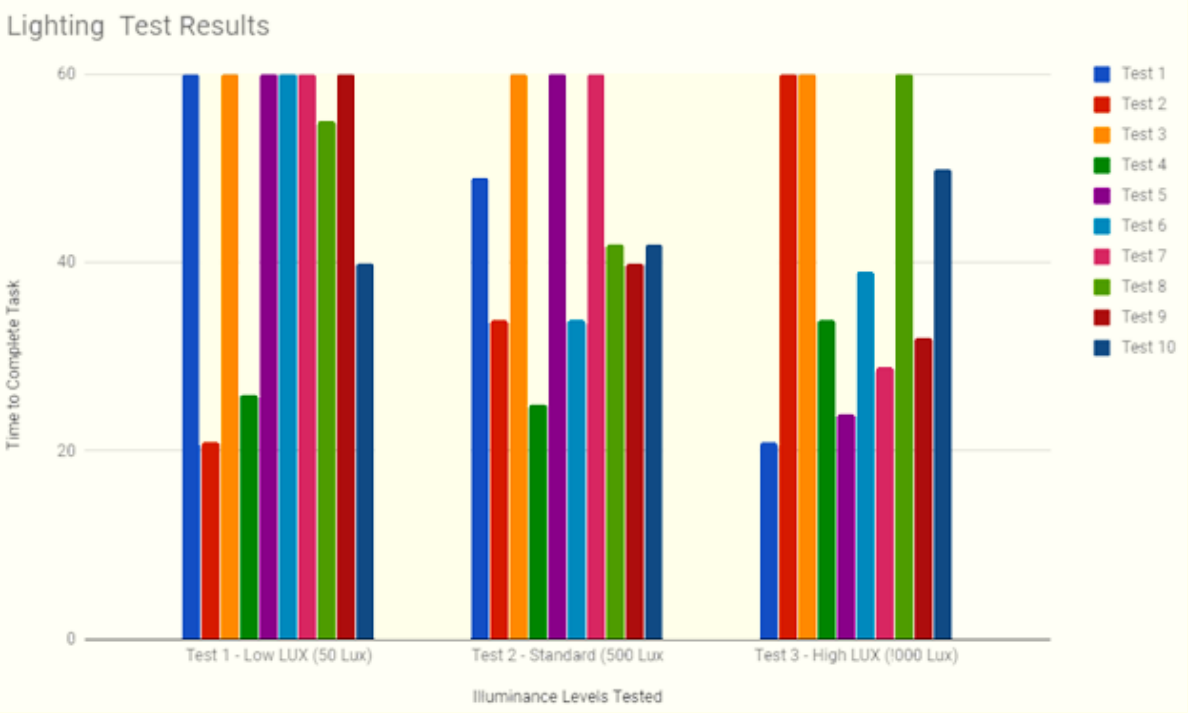


Figure 9: Lighting Levels in Comparison to Task Performed in Allotted Time Frame.

Figure 9 shows a comparison of words found during the three different lighting conditions within the allotted time of the test. The word finding test, people working under the higher

1000 lux light responded better finding more of the words within the 60 seconds allotted for a total of 24 words found. Followed by the standard 500 lux lighting level, having found 23 words, but at a slower rate as seen from the time recorded in Figure 10. Finally, for people under the low level 50 lux conditions only 20 words were found.

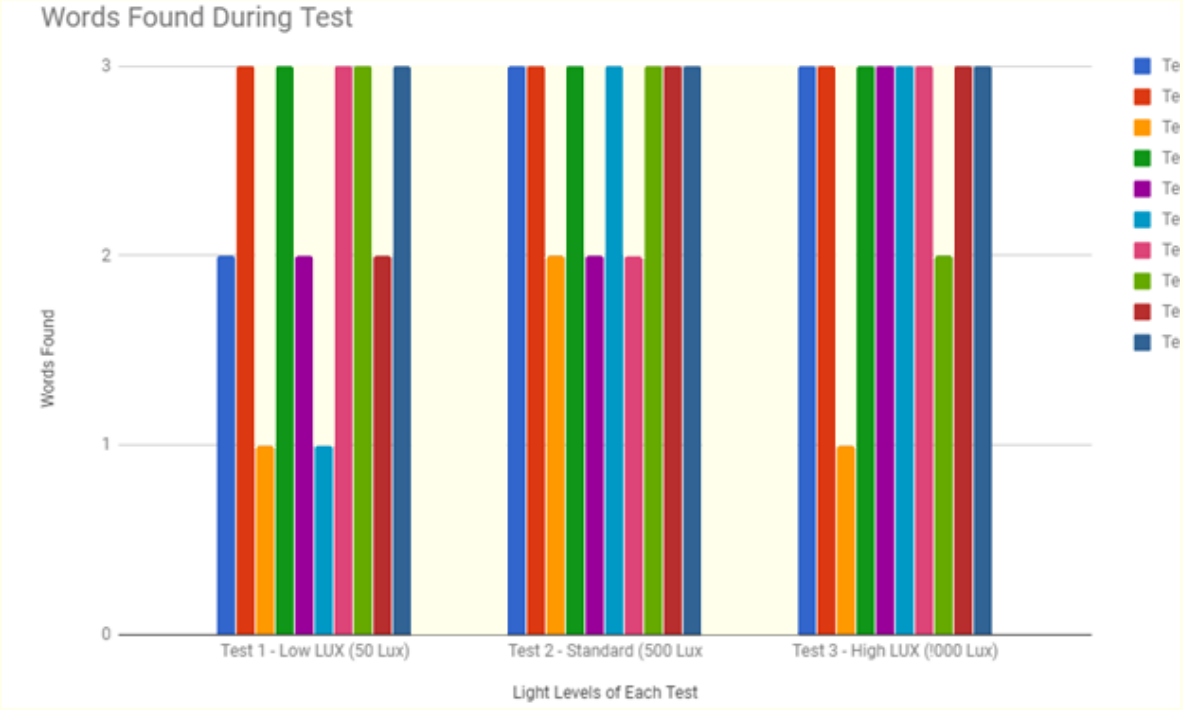


Figure 10: Lighting Test: Words found during allotted time

Further analysis of the results shown in Table 1Table 1: Comparison of Mean Score for Words Found Under the Three Lighting Levels, looks at the differences between the people during the test, while under the three different lighting levels and compares the mean scores. As shown the overall mean scores shown have minimal differences between them. It is for this reason a comparison of the overall words found to the completed test results is needed.

Table 1: Comparison of Mean Score for Words Found Under the Three Lighting Levels

Number of Words Typed under the three lighting levels	Incomplete Test Words Found	Completed Test	Total Words Found	Mean Score
50 Lux	8	15	23	11.5
500 Lux	6	21	27	13.5
1000 Lux	3	24	27	13.5

Table 2 is showing that at the higher lighting level of 1000 lux, when compared to the completeness of the overall test shows that people respond to the higher lighting levels with improved performance, when compared to the other lighting conditions tested.

Table 2: Comparison of completed tests to words found given as an overall percentage

Total Number of Tests Completed compared to Words Found	Words Found on Completed Tests	Tests Completed	Percentage of the Overall Completed Tests
50 Lux	15	5	50%
500 Lux	21	7	70%
1000 Lux	24	8	80%

VISUAL COMFORT AND LIGHTING PREFERENCE

Following the visual work test participants answered two questions; 1) preferred lighting level and 2) least preferred level, along with short response was recorded. Results analysis of questions answered are in Appendix D.

Table 3 shows the comparison of acceptance for each of the three lighting levels by the participants. At the 500 lux level most, people preferred this level of light, with six of the test subjects stating it as their preferred lighting level.

Table 3: A comparison of the three lighting level with the person visual comfort

Comparison of Lighting levels to visual comfort	**Dislike of lighting level by subject**	**Conditional approval of lighting level by subject**	**Preferred lighting level by subject**
50 Lux	8	1	1
500 Lux	0	4	6
1000 Lux	4	3	3

When asked after the test participant One stated:

“Could use 500 lux on a daily basis: Had Trouble with 1000 lux as it caused glare and caused problems with my eye hurting. “

With participant Seven similarly stating:

“Preferred 500 lux as it was not too overpowering and could work under for longer without getting sore eyes”

Though the findings did show participant preferences did vary throughout the three lighting levels with other participants choosing the brighter 1000 lux lighting levels as it was found to suit the task at hand. With participant Nine stating:

“Preferred the 1000 lux, was able to see better, but would not be able to work under for long. 500 lux would be ok for reading”

The different illuminances chosen were participant preferences only as the work task did not change between illuminance levels.

Interviews

The interviews were conducted with two research professionals within the lighting industry, both with extensive knowledge and professional experience in the field of lighting in an industry setting. Appendix A outline the interview questions asked during the interview process. Each interview lasted approximately 30 minutes, was audio recorded and transcribed for analysis. An example of this analysis is provided in Appendix E. Three key themes were identified from the analysis 1) performance, 2) design considerations and 3) lighting standards.

PERFORMANCE

Participants in the interviews relate worker performance to visual comfort, In the interviews both participants said that visual comfort was a priority and how the light was applied to the work area could indeed have an impact on the worker performance. Both participants identified that poor or improper lighting can cause workers to become physically uncomfortable, which would in the strictest sense be the measurement of visual comfort. Interviewee One stated,

“Visual comfort I would think that poor lighting can give someone a situation where they are physically uncomfortable with the lighting their experiencing, either they can't perform the task, or it could be insufficient, and they can't see the task they're working on well enough to perform the tasks to the best of their ability.”

With corresponding comment from Interviewee Two stating,

“Some workers performance is associated with the delivery of enough lighting levels at the work plane for task visibility. in addition, the inability to see due to glare, performance can also be diminished.”

It was discussed further during the interviews how lighting levels are dependent on the performance of the worker. It was suggested by the participants that there is a minimal level which was need, but this again would depend on the task performed. Giving examples of activities where the use of a screen based applications. Other factors also apply such as glare and reflection of the lights in the screen. These factors cause further visual discomfort and reduced performance of the worker.

DESIGN CONSIDERATIONS

The participants both identified that lighting design was important and that factors such as 1) lighting fit for the task performed, 2) sources of glare and 3) appropriate lighting levels. Needed to be address during the light design process.

The participant’s points being made in the interview, all focusing on the importance of lighting and how a good lighting design suited to the situation such as in an industry setting, would increase the benefits for the people working within the industry environment. Both participants felt that a well-designed lighting system within an industry space would have benefits to the worker. Such benefits as visual comfort and feeling safe promote worker wellbeing and performance, all of which would help the worker complete their work task more effectively. While a deficiency in any area of the lighting design would directly impede

the workers ability to perform their work tasks. When asked their opinion on effective lighting design Appendix A Question five, participant One said.

“Lighting that’s fit for purpose, so I think when we're thinking about assessing lighting and what I think quality lighting is, I think about what the place is and the activities that take place in that space. I think about the people who are in it and I think about the space itself. So, the three components are; the space, the activities and the people”

Interviewee Two when asked about what the challenges are in creating an effective lighting design. Also stated that lighting of the work area was not the only factor which needed consideration. Identifying glare as a possible design issue which can be overlooked during the design process causing problem for the worker, with Interviewee Two stating.

“The glare and the discomfort situation could also mean that people kind of make the decision to move. With the Intelligent thing to do when you are in that kind of experience is trying to manage it in some ways intervening in the environment to try and get back to a place where they are comfortable.”

LIGHTING STANDARDS

The interviewed participants both referenced that lighting design was more about the workers need and the type of work being performed. It was stated many times during both interviews that lighting conditions varied between people and the tasked they are performing and would change throughout the day. Because of these difficulties, making a one fits all lighting environment was not possible. Referring to question seven in Table 5 above, both participants agreed that the Australian lighting standard are a good base for lighting in industry. With Interviewee One stating

“yes and no so that they are generally fairly simple - they provide some kind of that it’s a hard number at the end of the day on the other hand I do think they tend to focus solely on visual performance”

This was taken further by both participants stating that there is room for improvement, but that these improvements need to be fairly simple, so implementation can be successful.

Discussion

The results collected in this research report show a link between lighting levels, worker performance and visual comfort. The research shows that different lighting levels influence task being performed. These finding were also similar to the literature reviewed, finding that while an increased illuminance can influence the works performance, the workers requirements needs to be assessed according to the particular circumstances and the tasks performed (Hawes, 2012 p.127). Similar results collected from the study did agree with the previous studies in that people during the test did state they felt more alert while working under the 1000 lux light level (H. Juslén, Wouters and Tenner, 2007 P. 42). The visual test demonstrated that at the brighter levels of light the worker did experience an improvement in performance. However, the test also showed that there was a level of discomfort associated with that level of light. Similar arguments made, that the increase in lighting intensities throughout a work area, does not guarantee a better work experience for the worker (Küller, 2006 p.1505)

At the standard lighting level of 500LUX, it was found that participants felt comfortable and able to perform the tasks asked. Though this light level was still found to be deficient and does underestimate the need of the worker. Which was supported in the previous research, arguing that illuminance unto itself was not the complete solution and other factors such as colour and light placement does play apart in influencing worker performance and wellbeing (Juslén, Wouters and Tenner, 2005; Bellia, Bisegna and Spada, 2011; Wilhelm, 2011).

To summarise the finding found from research and studies performed, all show that exposure to a brighter lighting solution is not the answer, instead a combination of different lighting levels which best make up the work environment. In conclusion, lighting does have an effect on an industry setting, in terms of worker performance and wellbeing, and through a better designed lighting solution a variety of lighting sources should be used depending on the tasks being performed.

Recommendation

A recommendation of a two point approach is needed to improve industry lighting, these are 1) brighter lighting solutions and 2) amendments to lighting standards.

Lighting Solutions

It is recommended that selected tasks which require the brighter lighting levels be isolated and that only used for a short time by the worker. Such applications needs being met with focused task lighting and localised lighting solution to supplement the worker's needs. In application where whole rooms need the higher lighting levels a recommendation of isolating the areas which need brighter levels of illumination so as to minimise the exposure to the surrounding workforce. While supplying the main parts of the industry space with standardised lighting requirements. With the purpose of reducing glare and cross contamination of light sources. With further research to determine the effects of long term exposure to light levels excess of 1000 lux to see if a more practical approach can be found.

Lighting Standards

It is also recommended that a review of the lighting standards within an industry setting is needed. The use of overly bright lighting was shown to have a negative impact on the worker, due to eye strain and fatigue. As new automated work environments with less physical requirements become more common, further studies in to the impacts lighting and high illuminance levels have on a less demanding work environments are needed. The outcome of these studies will need to further define the requirements the worker need within these new worker environments, while considering the worker wellbeing.

Design Proposal

Introduction

Forrer Design is a Brisbane based industrial design business, our goal is to design a lighting solution which will enhance work environments and improve the health and wellbeing of the worker. To achieve this Forrer Design is responding to a research report by Peter Forrer, which looked at lighting in industry. Particularly the workplaces with limited access to day lighting, to help find gaps were a well-designed lighting solution could fill.

Industry work spaces require good lighting of both the surrounding work environment and areas where task orientated processes are being performed (Küller et al, 2006; Juslén, 2007). This lighting should provide a level of illuminance which promotes a work-friendly environment, as well be task appropriate to the work being performed (Sivaji, 2013; Boyce, 1997). Under the current lighting standards, it may not be always possible to provide the appropriate light levels needed for achieving the optimal performance of the worker and due to the poor lighting levels, which have an impact on the worker wellbeing further diminishing their ability to perform that work tasks required (Boyce et al, 1997; Juslén, Wouters and Tenner, 2005).

This project by Forrer Design is looking to improve the performance and wellbeing of the worker in an industry setting, through the use of design thinking aiming to manufacture a product or service which will improve the work environment for people who work in a solely artificially lite work space. Aged between 20 and 65 years of age the target audience are long term employees within an industry work setting, which work both day and night on a shift work basis. Due to poor lighting levels in the work place, worker can suffer from fatigue, headaches and lowered task performance. This is unhealthy for the worker and could lead to further problems the longer their exposed to the poor lighting conditions continue.

Aim

The aim is to use the information from the research report and innovatively design a lighting solution or product to improve the performance and wellbeing of the worker and reducing the risk fatigue found in artificially illuminated work environment.

Objective

To achieve this, aim the design will:

1. Design a lighting solution for the industry workplace using the research report findings. The design must consider the industry worker needs, understanding the workers requirements and current workplace environment, to find the optimal design solution. The solution should strive to enhance worker performance through improved visual comfort.

2. The design should be appropriate for the user; industry workers 20 to 65 years of age, working day and night under artificial lighting setting.

3. The design should explore all aspects related to industry workplace environments and the worker needs with, ease of use, assembly, maintenance, installation, modular design and user experience, taken in to account thought out the design process.

Justification of Proposal

Industry workplaces requires better lighting solutions as this will improve worker performance and wellbeing. This will reduce work place costs by improve productivity and worker satisfaction of the work environment. This will be achieved through an increase in workplace safety and worker satisfaction, by implementing an improved lighting solution or system. Which improves performance by using lighting fit for task, promoting visual comfort of the worker in the industry setting.

Industry workers who work in a predominantly artificially lit work environments are limited by the lighting solution which they work under. The placement of lighting and the level of illuminance on the work area influence the workers ability to perform tasks, with poor and

insufficient lighting impacting the worker's performance (Juslén, Wouters and Tenner, 2005; Küller et al, 2006).

Further studies showed that poor lighting impacts the visual system of the worker causing an inability to identify hazards, such as wet floors and sharp edges, leaving the worker feeling unsafe in the work environment. This further reducing the safety of the worker with worker injuries from slips and falls being cause by the inadequate light (Jayawardena, 2017; Hawes, 2012).

Additionally, poor lighting in industry can have other impacts on the worker is such as visual comfort. This can be from eye-strain, which leads to an increased risk of fatigue and headaches, reducing the worker wellbeing and satisfaction of the work environment (Küller et al, 2006; Kretschmer, Griefahn and Schmidt, 2013).

By providing a well-designed lighting solutions and higher level of lighting standards in the industry setting, the reduction in worker accidents and increased performance will improve the company's profitability and maintain a safe work environment.

Limitations

It is acknowledged that possible limitations that can occur during the design process are due in part to the limits of the research performed, as it was not possible to consider all areas of the research field in the limited time frame.

Mitigation Issues

Risk management is an important part of the final design to best ensure the product produced is of the highest quality. It is acknowledging the existence of risk, and make a deliberate decision made to accept it without apply oneself to special efforts to control it. Approval of design project by project leaders is required.

- Avoid: Adjustments to concept requirements or constraints to eliminate or reduce the risk. This adjustment could in-turn change the funding, schedule, or technical requirements.

- Control: Implement criteria standards to minimize the impact or likelihood of the risk.

- Monitor: Monitor for changes that affect the design criteria and/or the impact it directly and identified risks listed in order of increasing seriousness of the risk.

Context

The context is industry workplaces; This includes factories as seen in Figure 11, machines shops, assembly lines shown in Figure 12, and workplace environments were daylighting may not be available due to circumstances like shift work or the work environment being more task orientated (Juslén, Wouters and Tenner, 2007; Bogatishchev, 2014).

Figure 11: Factory Setting - Electronics Production Area (John Darwin, 2014)

Figure 12: Car Production - Assembly Line (John Darwin, 2014)

In these industry settings the lighting choices can impact the worker's visual comfort and in doing so cause worker discomfort. Resulting in the worker perform at a reduced level, while continued discomfort can fatigue the worker causing headaches (Juslén, 2007; Hawes et al, 2012). As workers perform tasks throughout their shift, it is the lighting design and the level of illuminance on the work area which determines the speed and time which a task can be performed (Juslén, 2007; Kretschmer, Schmidt and Griefahn, 2011).

Design Criteria

The design criteria used findings from the research report, Lighting Effects in an Industry Setting by Peter Forrer. The identify criteria must be achieved in order for the new product design to resolve the problems found in the research.

DESIGN CONSIDERATIONS

- The design or service must answer a problem identified in the research.
- The design must use current industry lighting standard for power and switching.

- Design or service should integrate into the given context described in (Section 7.7)
- Standard lighting connection and fittings should be used.
- The design should aim to be modular for easy service.
- The design should be fit for the task it is being used.
- The design should aim to match or surpass the lighting standards

USER CONSIDERATION

- Must be an intuitive design with minimal to no learning curve.
- The design must support a user with in the context described.
- The design should aim to promote visual comfort.
- The design should aim to improve the worker wellbeing.
- The design must not impede worker performance.
- Should aim to enhance the worker experience.
- The design should not require learning new skills.
- The design must work within the context described
- Must not hinder the worker from perform work tasks

CONTEXT OF USE

- Must be usable in multiple work environments and industry settings.
- Must be easy to install and remove.
- Must consider the environmental parameters such as moisture, temperature and exposure.

FORM / FUNCTION

- The form must be durable and able to meet the industry environmental demands.
- Must be functional as described and require minimal instruction if any.
- Design should be adaptive to the changing industry settings.
- Function must be user tested and problems resolved
- Form must be driven by research and safety standards

MATERIALS / MANUFACTURING

Materials used for the design need to be fit for purpose in the context described in (Section 7.7) The design needs to take into account the materials used for this context with any exclusions described in the final documentation.

- Materials must be non-toxic
- Materials should aim to be recyclable
- Materials should be appropriate for use within the context described in (Section 7.7)
- Manufacturing must conform to the safety Industry Product Safety Standards AS/NZS 3820 - Safety requirements for electrical equipment
- Manufacturing should be sustainable were possible

SAFETY REQUIREMENTS

- Must be safe to use within the user context described in (Section 7.7)
- Must not have any defects that could adversely affect safe performance
- Must be tested to ensure safety of product use.
- Must adhere to Australia safety standards and regulations, workplace lighting AS1628 (saiglobal.com, 2017)

MAINTENANCE / REPAIR

The final design should only need minimal maintenance and were possible use a modular design for easy repair.

- Design should use modular replaceable parts
- Design should use locally scheduled servicing to reduce downtime.
- Design must be repairable and serviceable.
- The design should not require upgrades or further additions to perform as expected.

SUSTAINABILITY

Sustainability is an important part of the design process, with continued research to find sustainable solution to the lifecycle of the final product. Furthermore, the balance between sustainable production and cost will be a priority throughout the design process and final concept design.

Design Process

The design process will use the double diamond method with a three stage approach; 1) divergent-convergent thinking, 2) concept ideation and 3) design development. By successfully completing these three stages a comprehensive design solution will be achieved. This will include a final product design and supporting documentation to be presented for final review. This process is detailed below.

STAGE 1: DIVERGENT & CONVERGENT THINKING

The first stage of the design process will begin with divergent thinking and mapping out the wide range of problems found in the research report, Lighting Effects in an Industry Setting. The use of brain storming with further primary and secondary research will be conducted in to user requirements, context and activities, including current market solutions to identify additional opportunities. The problems identified are defined using convergent thinking, employing design thinking strategies such as data analysis, mood boards and personas to help focus in on problem areas with the greatest need.

STAGE 2: CONCEPT DEVELOPMENT

From the research stage the specific problem areas within the context of lighting in industry will be chosen, and initial concept generation can begin. This will include a divergent-convergent process which will be used to iterate the initial concepts adding to the refinement process. A further step may include low-res modelling and user testing to help gain a better understanding of how the initial concepts will answer the needs of the user and the problem being targeted. The three initial concepts chosen will effectively answer a problem found during the research stage and be support by the research report. The best three initial concepts will be presented for review, with the best one of the three chosen to take forward as the final concept.

STAGE 3: DESIGN DEVELOPMENT

The design development stage will take the chosen concept and review feedback to further progress the concept through to the final product design. This will be achieved by a multi-step process, which includes low-res and hi-res model making, user testing, context testing and research development into manufacturing techniques and materials research. Moreover, the design development stage will aim to deliver a final product design to a high level of refinement, in accordance with the design proposal parameters and standards. With the final

designed product, hi-res model and associated documentation to be presented for final review.

Program Schedule

The design schedule shown in detail below in Appendix F, consists of four stages.

STAGE 1: PROJECT AND USER RESEARCH.

The design issues found in the research study perform will be further analysed to help refine the problems found. This will also help define the target user and devise strategies to enable an effective design solution

STAGE 2: INITIAL CONCEPT DEVELOPMENT.

Using the research study and user research, develop a range of initial concepts which target problems found. These concepts will be refined, and a final three concept chosen for presentation to a review board for final concept selection.

STAGE 3: CONCEPT FREEZE

The final concepts chosen will be developed using low-res modelling techniques, user testing and an iteration process to refine and further develop the design to a minimal viable product resolution.

STAGE 4: PROJECT PRESENTATION.

The final product will be produced to a hi-res concept ready for presentation to the review board. This will also accompany a final presentation and report outlining the final design solution.

Design Justification

Introduction

New technical improvements in LED lighting and their easy adoption into workplaces has made LED Lighting the preferred solution to many industries lighting needs. As industry improves LED light performance, the advancement in the technology has seen the production of brighter lighting solutions. It is these new lighting solutions which are seen as beneficial to the business as they promote worker performance, at least in the short term. while the long term detriment to the workers performance and wellbeing are overlooked.

Figure 13: Vision Work Lamp Head and Two Way Joint

When reviewing the available lighting research, it was found that the lighting solution used for certain contexts such as workstations and detailed task lighting, used ultra-bright lighting solutions. These types of lights were found to impact the worker the most as they sat closer to the face and eyes, causing most of the problems produced by poor lighting levels. Because of this The Vision Work Lamp was Designed as shown in Figure 13: Vision Work Lamp Head and Two Way Joint, using a dimmable, multi-colour LED the Vision Work Lamp can automatically phase from a cool white light to a warm white light through the workers shift. Providing the workers with a healthy lighting solution which would adapt to the workers needs throughout the day, thus improving the worker's wellbeing and performance through reduced exposure to light shock and light fatigue.

The Vision Work Lamp Seen in Figure 14, using a dimmable multi-colour additive lighting and new LED lighting technologies; Allows workers to work under ultra-bright light for longer, while reducing the ill effects which a single colour lighting solution cannot overcome. Though the newly designed Vision Work Lamp is a successful working design, the use of these lamp has been limited, as the complexities in manufacturing and extra cost involved reduces their acceptance over conventional lamp designs.

Figure 14: Picture of the Vision Work Lamp

As industry moves with the latest technologies and more emphasis it put on caring for the worker's needs, the transition to healthier work spaces will become more important. It is because of this the use of specialty lighting such as the Vision Work Lamp will be adapted to deliver different illuminance levels and colour will become desirable. The Vision Work Lamp will provide workers with an environment which promoted performance and an aspect of wellbeing and not the latter.

Context, System & Scenario

INDUSTRY LIGHTING AND ITS EFFECTS ON WORKERS

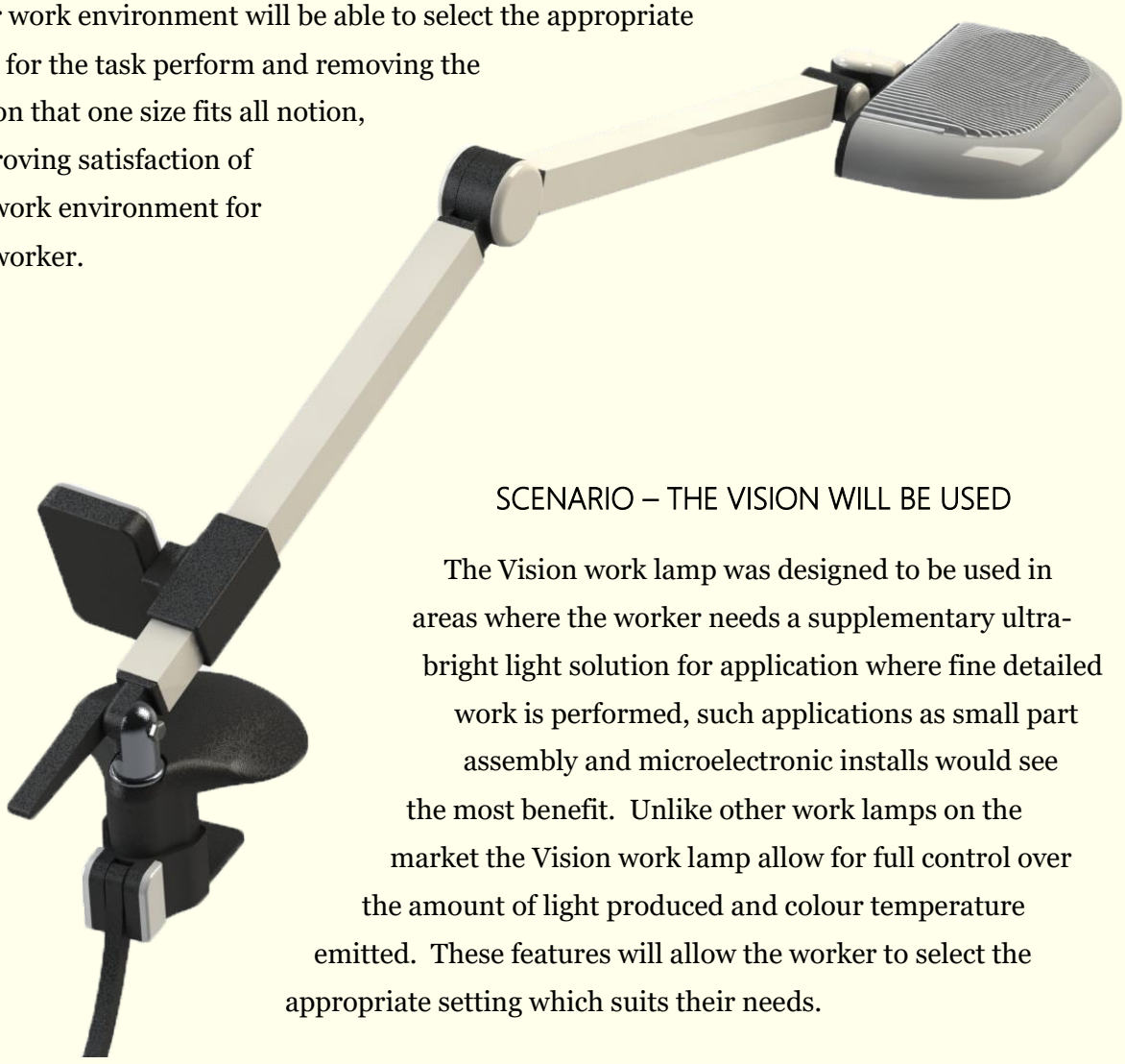
As industry workplaces start to use new lighting technologies the emphasis on a brighter lighting system has become the latest solution, with the industry lights becoming brighter more compact to fit the work spaces they are being used in. As the want for brighter lighting continues little regard is given to the workers who are working under them and the impact to their wellbeing, as companies try to find way to save and make money from their business. This over illumination of the work area can impact the worker wellbeing in many ways from

fatigue, stress and sleep problems, reducing the workers ability to perform task (Kretschmer, Schmidt, & Griefahn, 2011). As a result of the use of these new bright lighting solutions, the work place environment become hostile, negating any performance improvement the new lighting system was designed to produce.

NEW LIGHTING SYSTEM

To improve on the current lighting system used in industry, the Vision Work Lamp is purpose designed to be an adjustable work lamp to suit most industry settings . The Vision Work Lamp will take the place of the ultra-bright task lamps and overly bright fixed lamps and in doing this the worker would have the choice to turn down the illuminance of the lamp reducing eye fatigue.

The new adjustable lamp system will be used in a variety of work zones and suit a variety of jobs being performed, with task orientated workstations and technical assembly desks where detailed work is performed receiving the most benefit. As workers now able to customise their work environment will be able to select the appropriate light for the task perform and removing the notion that one size fits all notion, improving satisfaction of the work environment for the worker.

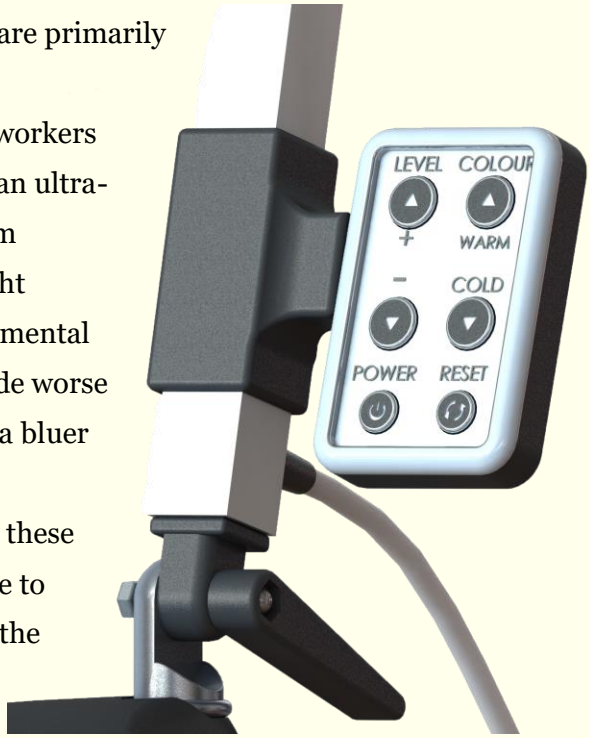


SCENARIO – THE VISION WILL BE USED

The Vision work lamp was designed to be used in areas where the worker needs a supplementary ultra-bright light solution for application where fine detailed work is performed, such applications as small part assembly and microelectronic installs would see the most benefit. Unlike other work lamps on the market the Vision work lamp allow for full control over the amount of light produced and colour temperature emitted. These features will allow the worker to select the appropriate setting which suits their needs.

P.A.C – VISION WORK LAMP

The people using the Vision Work Lamp, are primarily shift workers who work on small parts assembly or fine detail electronic. These workers can spend up wards of eight hours under an ultra-bright lamp on a normal shift leaving them exposure for long periods to the bright light source. With long exposure having a detrimental effect to their health, with side effects made worse with some new LED lamp which produce a bluer coloured lighter (Kretschmer et al, 2011). Because of the activities performed under these ultra-bright lighting, the lamp can be close to the persons face increasing exposure and the effects.



The Vision work lamp will replace the current work lamps and in doing so give the worker the ability to have more control over their environment, while reducing exposure to both the bright light and harmful blue light produced by cheaper work lamps.

People:

Shift Worker
Assembly Worker
Workstation Technician
Artist

Activity:

Fine Detailed Assembly
Micro Electronics
Repairs
Task Orientated
Localised Lighting

Technology:

L.E.D Lighting
Automation
Light Production
Heat Dissipation

Context:

Industrial
Factory
Tech Studio
Workstation

Further Research

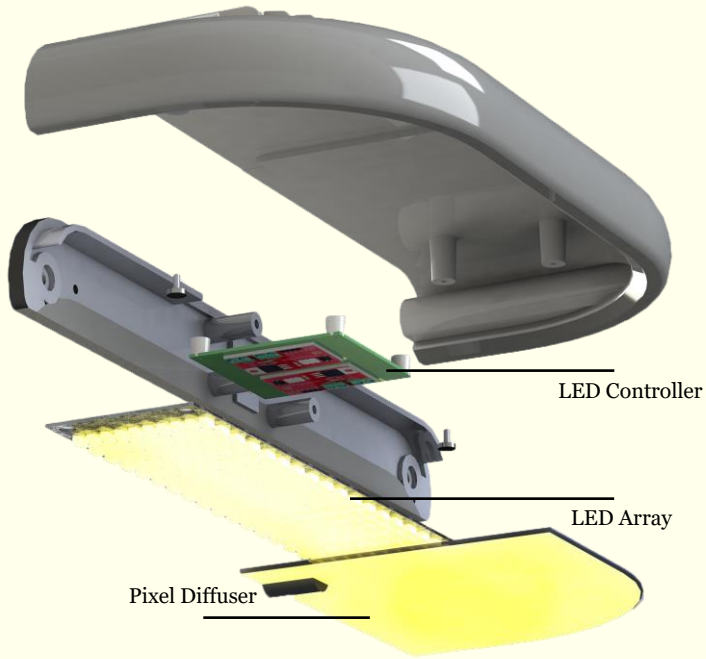


Figure 15: Exploded View with call outs and notations

TECHNOLOGY AND MATERIALS

During the design phase of the Vision Work Lamp Project, it was important to further research the latest technologies and materials being used in luminaire production to help produce a new type of luminaire for industry use. From LED arrays and new LED controllers to custom light diffusers seen in the detailed view of Figure 15. As these new advancements Influence the design process and the outcome of the final design. Throughout the Vision Work Lamp Project, it was important to maintain an innovative approach to luminaire design and strive to produce a product which would inspire lighting design for year to come.

DIMMABLE MULTI-COLOUR LED ARRAY

Dimmable multi-colour LED array has been used in light production for years shown in Figure 16, for the production of adjustable light both in illuminance levels and colour. The LED array give the ability to select a larger range of colours or mix them to produce a full spectrum white light, while the LEDs can produce a wide range of illuminance levels as needed. Making the light produced more colour accurate and able to reproduce more of the colour spectrum then a conventional light source. It is because of this the technology used in the Dimmable multi-colour LED array was a preferred choice for the Vision Work Lamp Project.

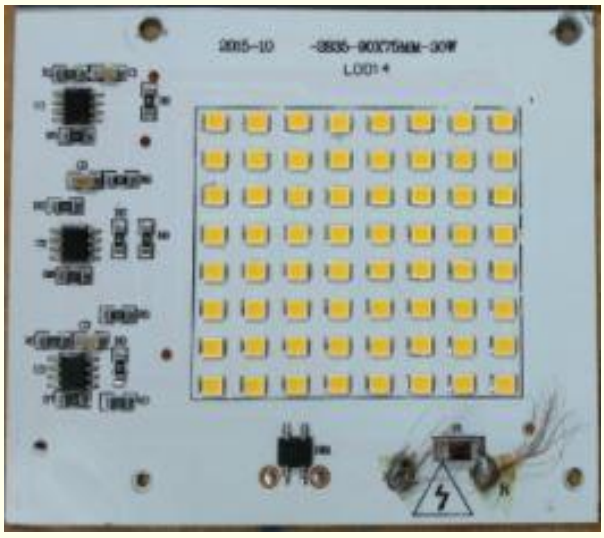


Figure 16: : LED Technology Dimmable Colour Changing Array

ALUMINIUM PART PRODUCTION

Aluminium is one of the largest structural metals in the world, with many products now taking advantage of its versatile properties as seen in Figure 17. Along with being durable and lightweight aluminium is can be up to 100% recycled, making environmentally friendly (John Dwight, 1999).

Aluminium part production in lighting has an important role as it is lighter than most other materials, along with the ability to dissipate heat with ease (John Dwight, 1999). It is these attributes that enable the production of larger lights with greater output, while also promoting sustainable manufacturing.

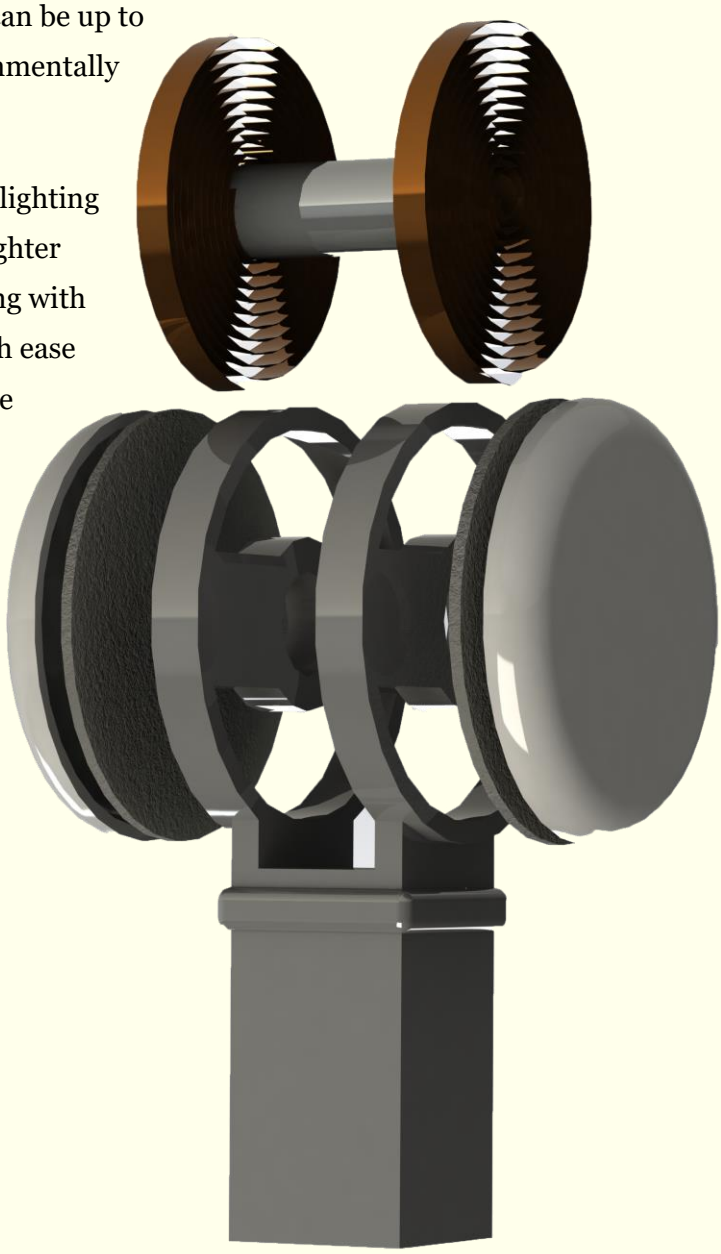


Figure 17: Cast Aluminium Joint with Retention Mechanism

Design Process

Using the Double Diamond process this project was broken down in to four stages; Discover, Define, Develop and Deliver as seen in Figure 18. The process started by looking at different area of lighting and how the different lighting condition effect people in different ways. Choosing to look primary at industry workplaces and the effect poor lighting design has on workers performance and wellbeing, with the goal of improving the workplace environment benefiting the both the business and the worker.

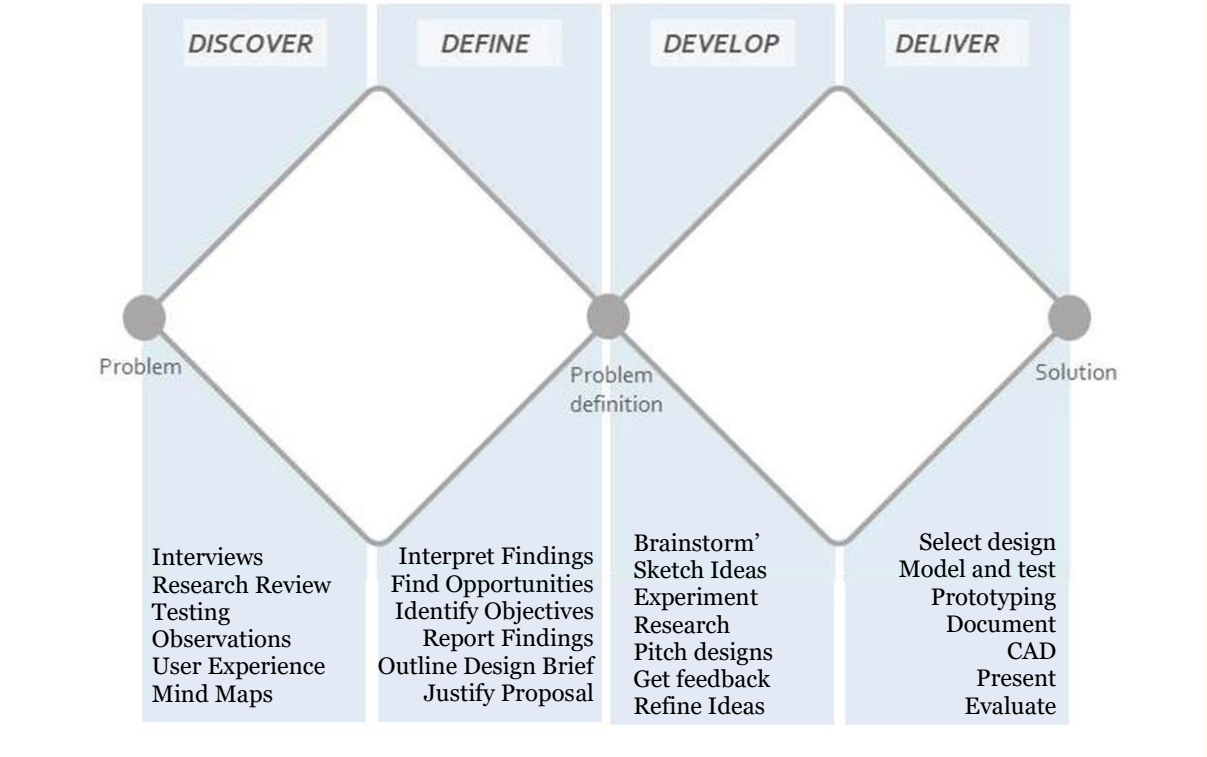


Figure 18: Double Diamond Process

Stages

STAGE 1: DISCOVER

The discovery stage involved writing a research report in to lighting in industry and problems workers experienced because of poor lighting. First a research review was performed helping to identify problem area within industry lighting, building a good foundation of information to work with.

As part of this research interviews were performed which helped add to the information found, while also introducing other area where lighting can impact the worker. To validate these theories, observations and test were performed, which added to the research finding.

STAGE 2: DEFINE

From the research report findings, a design brief was produced to interpret the finding in to opportunities and objectives. These criteria will help guide the final design process, while help to evaluate the success of the final design.

STAGE 3: DEVELOPMENT

The development process started with a look at the current lighting systems used within industrial spaces. Through further investigation I looked at the option available for workstations and assembly workers, with particular interest in task lighting technology's which uses LED as the lamp.

Figure 19: Model Making Development Stage

Working with the research report and design brief, brainstorm was performed to list out idea for ways to improve the lighting in industry. Further use of sketching, experimentation, low-res models as seen in Figure 19, With further research all help in the production of five good ideas which were

conceptualised and refined to become initial concepts ready for presentation. These concepts were presented, with the final design chosen to move forward to the final stage of product development.

STAGE 4: DELIVER

In the final stage the chosen design was modelled and refined as shown in Figure 20, with further research performed at each stage of the development process. This included material testing, ergonomics, electronics and light production techniques, with models produce to demonstrate size and shape of final design. As it was important to re-test models and present the different ideas for final design to a peer group for evaluation so as to refine the design to it best possible resolution. On selection of the final model the semi-working prototype was produce ready for final presentation.

Figure 20: Stage 4 - Design Development

Final Design Discussion

The research revealed a problem with using ultra-bright lighting solution within industry environments, these problems are caused by using high illuminances levels in artificially lit environments, while producing a predominately blue colour light. It is this combination of high illuminance and blue coloured light which acts as a stimulant to the user. As workers are exposed for long periods of time its effects can cause eye fatigue, nausea and reduced sleep all of which impact the workers wellbeing and performance.

The Vision Work Lamp is an innovative step for work lamp design, reducing exposure to high illuminance and blue light providing the worker with a healthier work environment.

Designed with smart technology, this work lamp aims to improve the workplace environment for the worker using task lighting. It does this by providing a stable illuminance levels on the work area, while producing blue light early on in the day and reducing it throughout the day so the worker is provided with an optimal lighting experience. This helps improve worker wellbeing and workplace satisfaction, as a result worker performance.

USABILITY

The usability of the Vision Work Lamp was found to be an important aspect of the design. Needing to be as simple as possible but not simpler, the design uses easy to understand press button controls as shown in Figure 21. Offering easy sequence of use at the press of a button, by simply turning it on the Vision Work Lamp automatically starts the optimal phase sequence from a cool blue light to a warm light shown in the picture below in Figure 22. Optional manual controls allow the user to select the illuminance levels and optimal colour for the task being performed.

Figure 21: Controls: Large Press Buttons

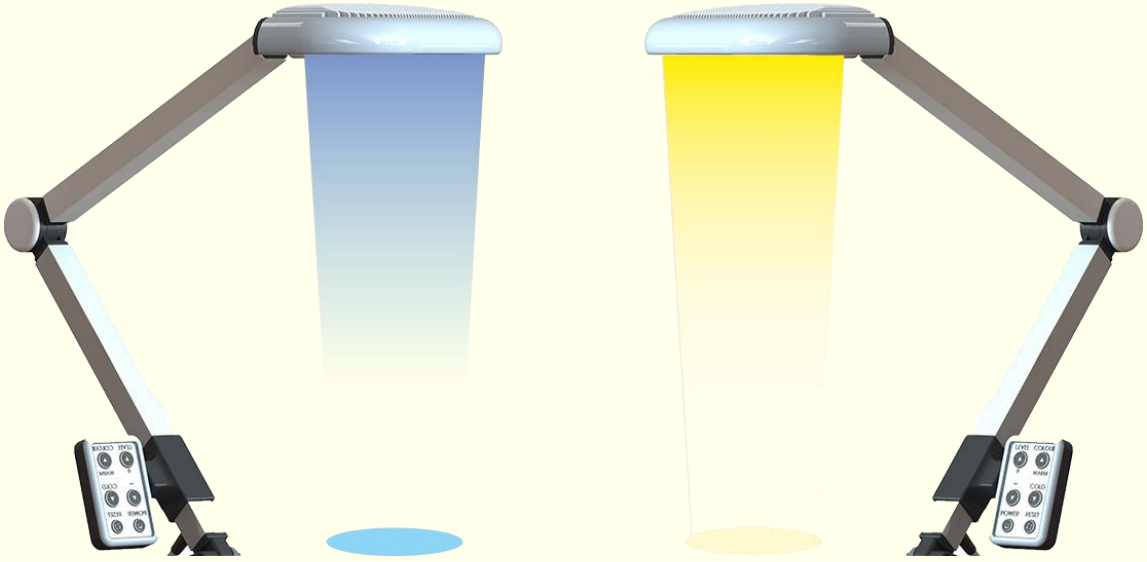


Figure 22: Phase Shift of the Automatic Lamp Sequence

SUITABILITY

Figure 23: Vision Lamp Modular Mount

The Vision Work Lamp is design with aluminium as the primary material. This adds strength and durability to the design, but it also allows for a large part of the lamp to be recycled at the end of its life cycle. Built in to the design is modular thinking, allowing the user to change the mount seen in Figure 23 and other parts of the design to better customise it to the workers needs. It is these aspects of the design which contribute to Vision Work Lamp's sustainability and long work life.

Summary

In summary the Vision Work Lamp is designed to replace current task and work Lamp solutions with a healthier light solution, which will improve worker satisfaction of the work environment. As the positive effect of the new lighting solution are felt, the increased satisfaction of the workplace promotes improved worker performance benefiting both the worker and the workplace.

The need for a new way of think when I come to lighting solution for industry are needed. As people spend more time indoors working and living, it will be necessary to produce lighting solution which can be beneficial to a healthier lifestyle. it is because of this lighting design will need to evolve and advance and produce even better lighting solution. The Vision Work Lamp is an innovative step but is a step in the right direction and a step we need to take.

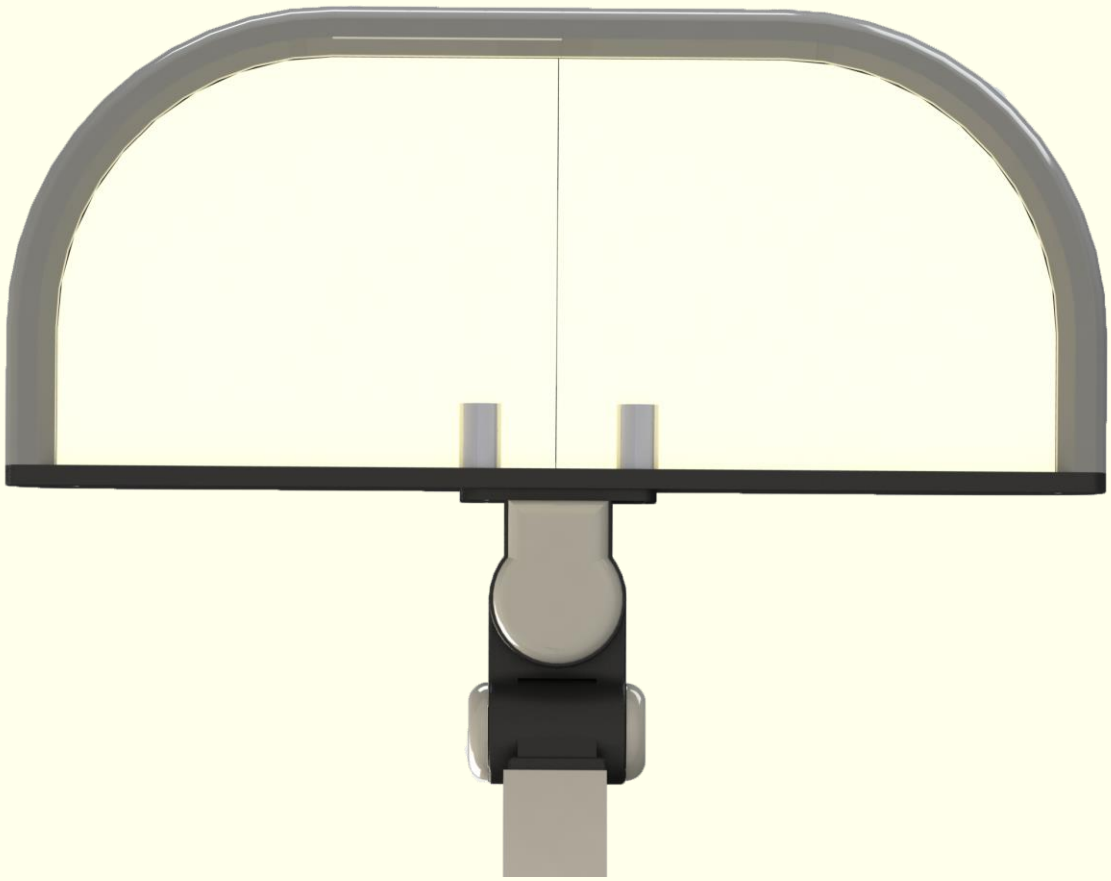


Figure 24: Vision Work Lamp Illuminated Diffuser

Conclusion

This report looked at Lighting Effects in an Industry Setting, primarily at how poor lighting can impact the worker performance and wellbeing. It was found that lighting levels are one area which can significantly impact the worker, with the effects causing health issues such as fatigue and reduced sleep. Because of these findings it was found that a healthier lighting solution was needed especially in area where the lighting solution was found to be ultra-bright. These areas were found to have the greatest impact on the worker as the lighting solution was close to the face. The solution found was to reduce the direct light exposure and provide the worker with the ability to have more control over their work environment.

In summary, finding found that exposure to the brighter task light needed to be reduced. Furthermore, a new lighting solution was needed which could be a be customisable to the worker needs instead of a one size fits solution.

Advantage of Proposed Design

Using design thinking the newly design Vision Work Lamp, provides the worker with a lighting solution which can adapt to their needs. It is the ease of uses and the lamps ability to be customised to most work situation that make give it the advantage over other lamps on the market. Along with its ability to also be customised to the users needs, makes it an all-round solution for people who work under ultrabright light or need a task light solution.

Design Implications

The main aim of this design was to produce a concept which would answer the opportunities found in the research. These being a healthier light solution which can adapt the worker needs, improving wellbeing and performance of the work. The Vision Work Lamp does this by replacing old task lighting with a light source which supports the users' needs in doing so creating a positive work environment.

Vision Work Lamp
Design Specifications

Vision Work Lamp:

Mounts to the workstation but desk mount or wall clamp. The Vision can exceed 2400 LUX and produce a white colour temperature between 6000k and 3500k.

Working in automatic mode the Vision can phase across the white spectrum over and 8 hour period to help improve the exposure to blue light to a minimum.

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Appendix A – Interview Plan

Lighting Interview – Room D332

Interview Details

Interviewee: _____ Date: 26/04/2018 Time: 12am

Interviewer Name: Peter Forrer

Interviewer Title: Design Honour Student Interviewers Student Number: n9135065

Questions to Ask Interviewee

Question #1: How can the incorrect lighting design impact a worker's performance & well-being

Question #2: How dependent is lighting levels on the tasks being performed by the worker?

Question #3: Do workers lighting needs change throughout the day? Yes/No

- How?
- At what times during the day?

Question #4: Research suggests that proper illumination has a positive influence on workers. Is this something you agree or disagree with?

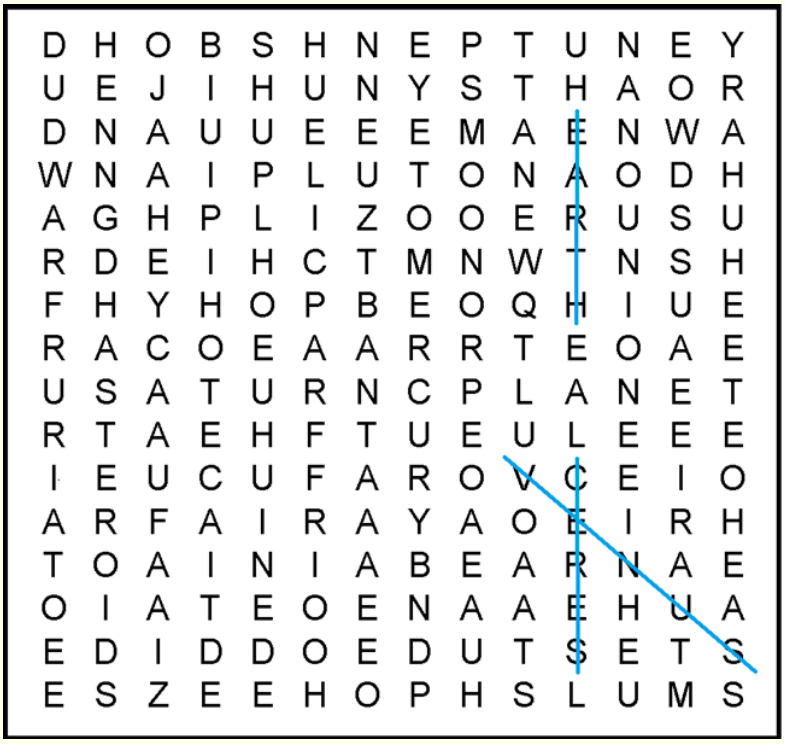
Question #5: In your opinion what makes an effective lighting design in an industry setting?

Question #6: What are some of the challenges in creating appropriate lighting design for industry?

Question #7: Do you think there are opportunities for improvement in lighting industry standards?

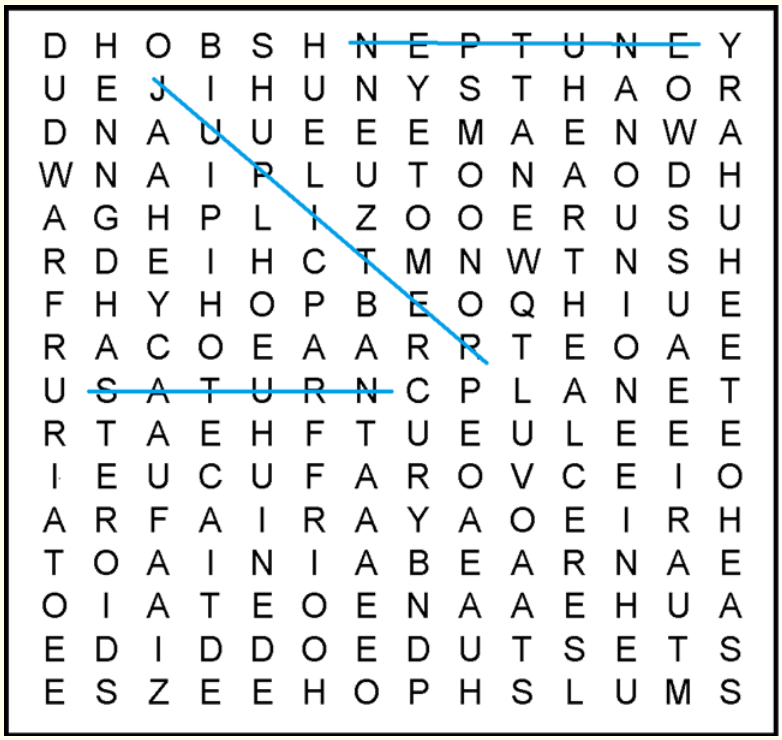
Additional Notes

Appendix B – Word Puzzles



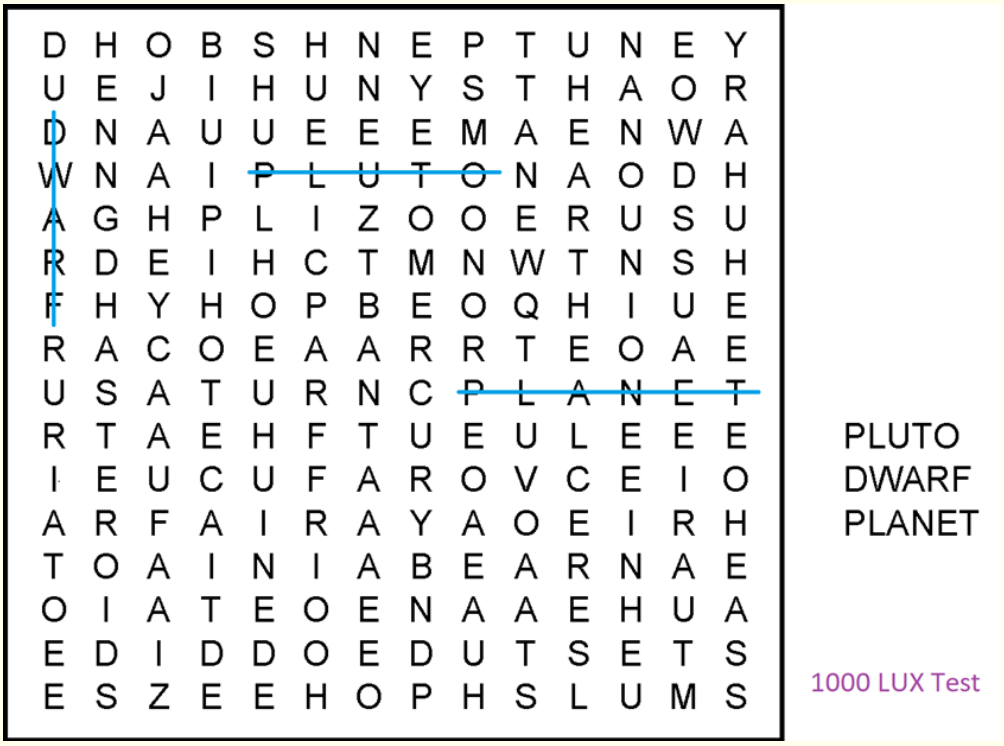
VENUS
EARTH
CERES

50 LUX Test

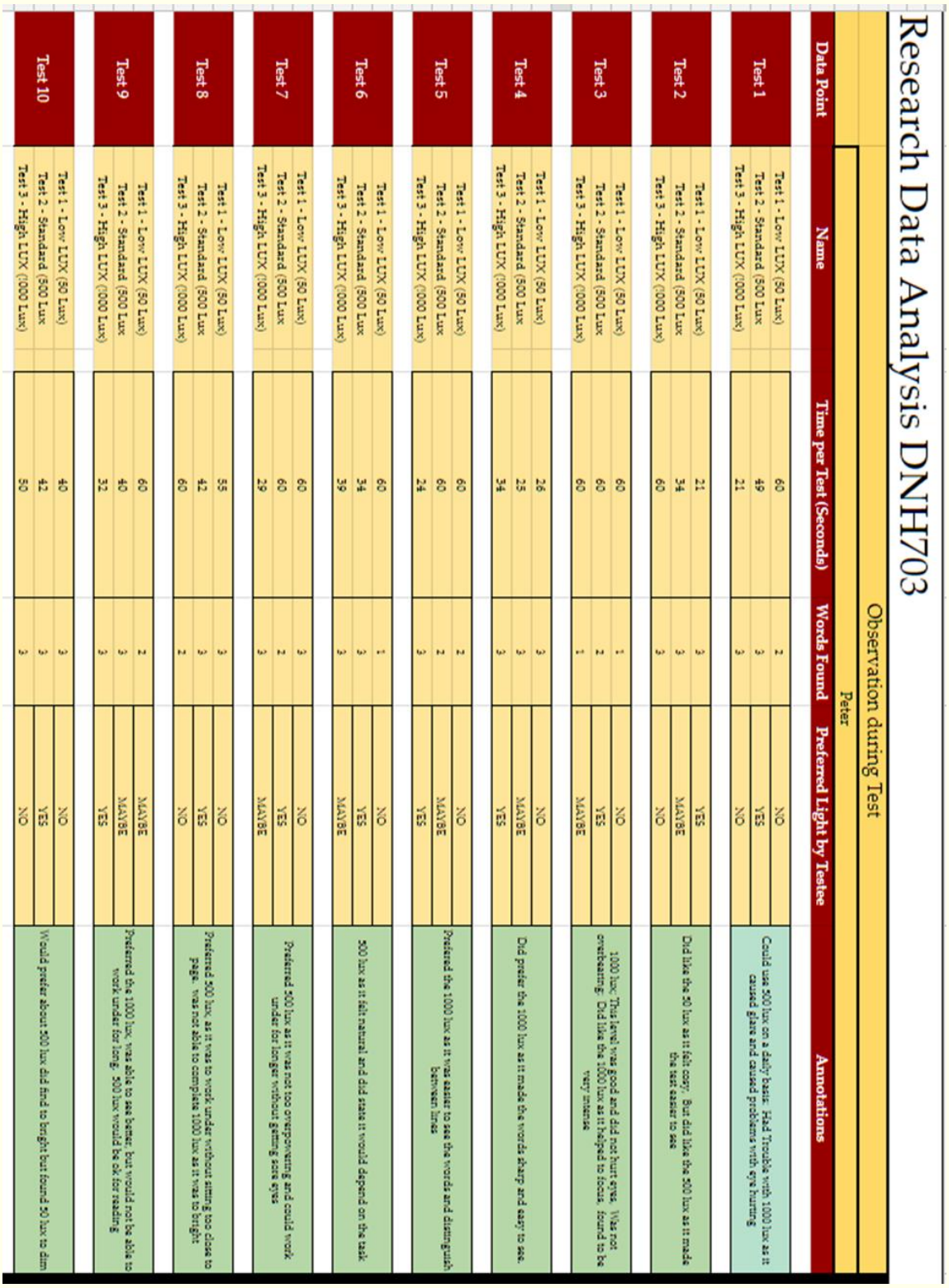


JUPITER
SATURN
NEPTUNE

500 LUX Test


D H O B S H N E P T U N E Y
U E J I H U N Y S T H A O R
D N A U U E E E M A E N W A
W N A I P L U T O N A O D H
A G H P L I Z O O E R U S U
R D E I H C T M N W T N S H
F H Y H O P B E O Q H I U E
R A C O E A A R R T E O A E
U S A T U R N C P L A N E T
R T A E H F T U E U L E E E
I E U C U F A R O V C E I O
A R F A I R A Y A O E I R H
T O A I N I A B E A R N A E
O I A T E O E N A A E H U A
E D I D D O E D U T S E T S
E S Z E E H O P H S L U M S
PLUTO
DWARF
PLANET
1000 LUX Test

Appendix C - Observation Test Data Analysis



Research Data Analysis DNH703

Observation during Test

Peter

Data Point	Name	Time per Test (Seconds)	Words Found	Preferred Light by Testee	Annotations
Test 1	Test 1 - Low LUX (50 Lux)	60	2	NO	Could use 500 lux on a daily basis. Had Trouble with 1000 lux as it caused glare and caused problems with eye burning
	Test 2 - Standard (500 Lux	49	3	YES	
	Test 3 - High LUX (1000 Lux)	21	3	NO	
Test 2	Test 1 - Low LUX (50 Lux)	21	3	YES	Did like the 50 lux as it felt cozy. But did like the 500 lux as it made the text easier to see
	Test 2 - Standard (500 Lux	34	3	MAYBE	
	Test 3 - High LUX (1000 Lux)	60	3	NO	
Test 3	Test 1 - Low LUX (50 Lux)	60	1	NO	1000 lux: This level was good and did not hurt eyes. Was not overbearing. Did like the 1000 lux as it helped to focus. found to be very intense
	Test 2 - Standard (500 Lux	60	2	YES	
	Test 3 - High LUX (1000 Lux)	60	1	MAYBE	
Test 4	Test 1 - Low LUX (50 Lux)	26	3	NO	Did prefer the 1000 lux as it made the words sharp and easy to see
	Test 2 - Standard (500 Lux	25	3	MAYBE	
	Test 3 - High LUX (1000 Lux)	34	3	YES	
Test 5	Test 1 - Low LUX (50 Lux)	60	2	NO	Preferred the 1000 lux as it was easier to see the words and distinguish between lines
	Test 2 - Standard (500 Lux	60	2	MAYBE	
	Test 3 - High LUX (1000 Lux)	24	3	YES	
Test 6	Test 1 - Low LUX (50 Lux)	60	1	NO	500 lux as it felt natural and did state it would depend on the task
	Test 2 - Standard (500 Lux	34	3	YES	
	Test 3 - High LUX (1000 Lux)	39	3	MAYBE	
Test 7	Test 1 - Low LUX (50 Lux)	60	3	NO	Preferred 500 lux as it was not too overpowering and could work under for longer without getting sore eyes
	Test 2 - Standard (500 Lux	60	2	YES	
	Test 3 - High LUX (1000 Lux)	29	3	MAYBE	
Test 8	Test 1 - Low LUX (50 Lux)	55	3	NO	Preferred 500 lux as it was to work under without sitting too close to page. was not able to complete 1000 lux as it was to bright
	Test 2 - Standard (500 Lux	42	3	YES	
	Test 3 - High LUX (1000 Lux)	60	2	NO	
Test 9	Test 1 - Low LUX (50 Lux)	60	2	MAYBE	Preferred the 1000 lux. was able to see better, but would not be able to work under for long. 500 lux would be ok for reading
	Test 2 - Standard (500 Lux	40	3	MAYBE	
	Test 3 - High LUX (1000 Lux)	32	3	YES	
Test 10	Test 1 - Low LUX (50 Lux)	40	3	NO	Would prefer about 800 lux did find to bright but found 50 lux to dim
	Test 2 - Standard (500 Lux	42	3	YES	
	Test 3 - High LUX (1000 Lux)	50	3	NO	

Appendix D – Study Questions Data

Questions After Test	
Questions	**Answer**
	Test 1
What was your preferred lighting level during the test?	500
Did any of the lighting level bother you?	50
	Test 2
What was your preferred lighting level during the test?	50
Did any of the lighting level bother you?	1000
	Test 3
What was your preferred lighting level during the test?	500
Did any of the lighting level bother you?	500
	Test 4
What was your preferred lighting level during the test?	1000
Did any of the lighting level bother you?	50
	Test 5
What was your preferred lighting level during the test?	1000
Did any of the lighting level bother you?	50
	Test 6
What was your preferred lighting level during the test?	500
Did any of the lighting level bother you?	50
	Test 7
What was your preferred lighting level during the test?	500
Did any of the lighting level bother you?	50
	Test 8
What was your preferred lighting level during the test?	500
Did any of the lighting level bother you?	50
	Test 9
What was your preferred lighting level during the test?	1000
Did any of the lighting level bother you?	0
	Test 10
What was your preferred lighting level during the test?	500
Did any of the lighting level bother you?	50

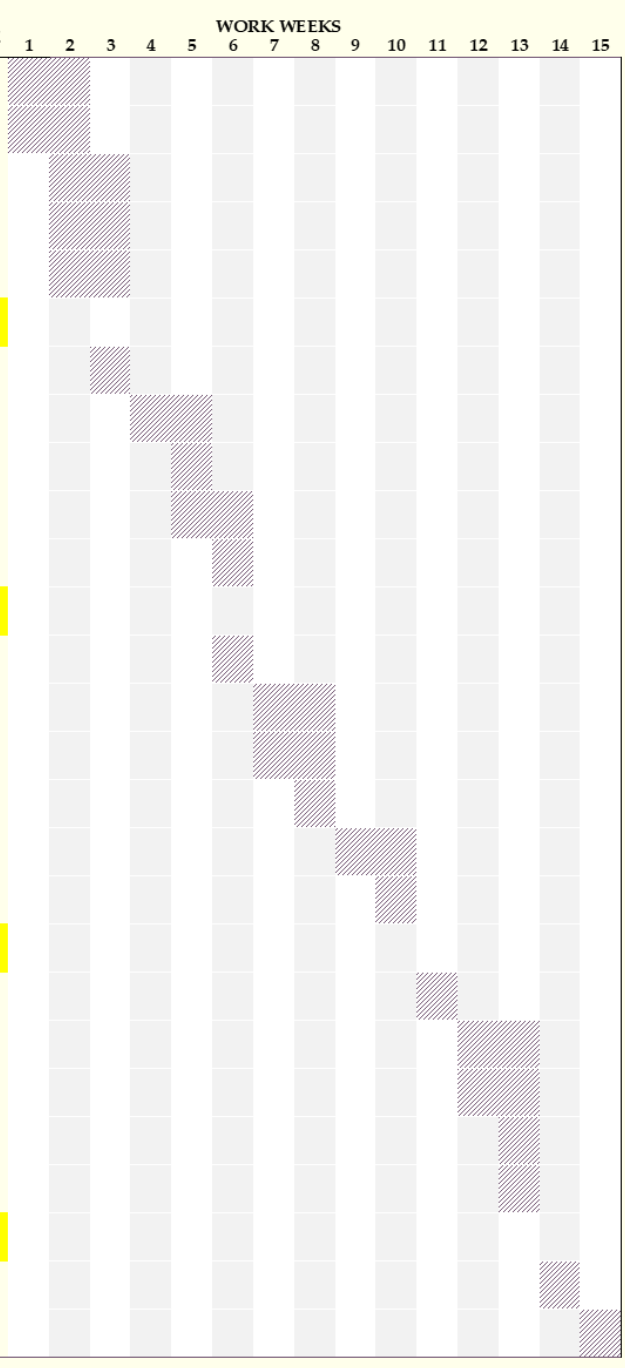
Appendix E - Interview Analysis

Interview	Statements	Identified Themes	Primary Data Point
Interview 1	I'm starting visual comfort I would think that poor lighting can give someone a situation where they are physically uncomfortable with the lighting their experiencing, either they can't it could be insufficient, and they can't see the task they're working on it well enough to perform the tasks to them to the best of their ability	Lighting does impact visual performance. this would impact worker performance	Performance
	minimal visual performance kind of situation so you got enough light to be able to do the task you need to do. need to even within that you know nightclubs at workplaces to there a kind of other constraints to their impact on that so. I think type of work that they have to do is going to have a fairly impact on it, but I think there's some kind of minimum standards.		
	yes - Throughout the day where it doesn't matter whether you are exposed to light bright light or not in terms of whether it's shifting your circadian rhythm so during the day if you were exposed to bright light it doesn't move at all in any away	Light is very important to work tasks, and this would impact the workers ability to perform a task	
	It's something I agree with - the strongest evidence that I have seen in literature for the effective good lighting, is evidence where they go out into the field and do a field experiment because it's a nice combination of experimental manipulation and a realistic setting where they can actually manipulate the lighting and see how people that's		
	Lighting that's fit for purpose, so I think when we're thinking about assessing lighting and what I got quality lighting is I think about what the place is and the activities that take place in that space.	Yes - light intensity does mate throughout the day, but this is difficult to achieve and there are not agreed upon level.	
	I think balancing practicalities like cost with the various roles that lighting has to serve it serves a whole bunch of different purposes and sometimes those purposes are at odds with each other and sometimes you might have to make decisions about what the ideal setup is and things that might be like beautiful and ideal for the circadian system could be really expensive.		Design Consideration
	yes and no so that they are generally fairly simple - they provide some kind of that it's a hard number at the end of the day on the other hand I do think they tend to focus solely on visual performance		
Interview 2	Lighting has visual and non visual effects on people. Most research/design in lighting focused in the provision of enough lighting levels to perform visual activities. So, some workers performance is associated with the delivery of enough lighting levels at the workplace for task visibility. Other issues that affects performance are flicker, and glare. So, for example, in addition to the inability to see due to glare, performance can also be diminished do to headaches, etc. No visual effects of lighting are associated with circadian rhythms, so the timing, spectrum, duration and intensity of light could affect people's rhythms. In terms of lighting and performance in the workplace, alertness and sleep are some of the most important aspects that can be influence by lighting, that could have effects on performance in the workplace, and well-being in general.	an affective lighting design does take into account the need for balance and looks for any negatives which could impact the work. examples like glare and poor lighting conditions	
	Lighting levels are very important, but also the provision of proper, glare and flicker free lighting. Some work activities are screen based, so now avoidance of glare, veiling reflections, etc, are as important as lighting levels.		
	Yes, workers do need changes throughout the day. But the best way to provide these changes in lighting is with access to natural light and windows. Mimicking spectrum, intensity, timing and duration of natural light exposure, is not easy. There are still no standards, and agreement of how best to do this with electrical lighting.		Lighting Standards
	yes, I agree with this statement	yes, the need for better lighting design in wanted, but this needs to balance the cost and need of the worker	
	Effective lighting design, is a design that achieves lighting levels, avoids glare, is aesthetically pleasing, and most importantly integrates daylighting, electrical light, and views.		
	Access to daylight is one of the biggest challenges in lighting in industry buildings. Due to accessible, cheap LED, and the idea that only lighting levels are to be achieved in industrial settings, access to daylight and views sometimes is not considered important.		
	I would imagine that yes, there is.		

Appendix F – Gantt Chart – Design Deliverables

DNH803 Design Deliverables

ACTIVITY	START	DURATION	PERCENT COMPLETE
Define the Project	1	2	0%
Research	1	2	0%
User Research	2	2	0%
Presona Development	2	2	0%
Design Research - Needs and Requirements	2	2	0%
Stage One - Project Research Finalised			
Concept Genaration	3	1	0%
Concept Iteration	4	2	0%
Low Res Models of Concepts Selection	5	1	0%
Concept Iteration Final	5	2	0%
Concept Freeze	6	1	0%
Stage Two - Concept Finalised			
Low Res Model Of Concept Freeze	6	1	0%
Model Testing	7	2	0%
Concept Refining	7	2	0%
User Testing	8	1	0%
Iterate Final Concept	9	2	0%
Design Freeze	10	1	0%
Stage Three - Design Freeze			
Manufacturing Solution	11	1	0%
Final Design	12	2	0%
High Res Model Development	12	2	0%
Final Model	13	1	0%
Presentation Stratagy	13	1	0%
Stage Four - Project Deliverables			
Final Presentation	14	1	0%
Project Report	15	1	0%



Appendix G – Ethics Forms – Interviews

Sample Approach email - Professionals

Subject Title:

Participate in a research project looking at how different lighting intensity affects performance of people working in an industry setting

Dear Sir/Madam

My name is Peter Forrer from QUT School of Design, Creative Industries Faculty and I'm doing a research project as part of my honours about lighting in an industry setting.

In this study I'm looking for people who work in lighting design or perform research aimed at the lighting industry as a researcher, academic PhD candidate or professional. Who are currently working in the Brisbane area and can participate in a 30-minute face to face voice recorded interview. To be held at Level 2 D-Block, QUT or other agreed location.

Please view the attached Participant Information Sheet and Consent Form for further details on the study.

Should you wish to participate or have any questions, please contact me via email.

Please note that this study has been approved by the QUT Human Research Ethics Committee (approval number 1500000089).

Many thanks for your consideration of this request.

Peter Forrer
DE42 Bachelor of Design – Honours Student
Email peter.forrer@connect.qut.edu.au

Dr Rafael Gomez / Unit Coordinator
CIF Honours Project Ethics Advisor
Phone +61 (07) 3138 4577
Email r.gomez@qut.edu.au

School of Design / Creative Industries faculty
Queensland University of Technology (QUT)

Queensland University of Technology
Brisbane Australia

PARTICIPATE IN RESEARCH

Information for Prospective Participants

The following research activity has been reviewed via QUT arrangements for the conduct of research involving human participation.
If you choose to participate, you will be provided with more detailed participant information, including who you can contact if you have any concerns.

DE42 Bachelor of Design – Honours Projects

Research team contacts

Principal Researcher: Peter Forrer DE42 Bachelor of Design – Honours Student

Associate Researcher: Dr Rafael Gomez - Unit Coordinator

CIF Honours Project Ethics Advisor – School of Design – Creative Industries Faculty

What is the purpose of the research?

The purpose of this research project, is to see how different lighting intensity affects performance of people working in an industry setting.

Are you looking for people like me?

The research team is looking for people in the Brisbane area who work in lighting design or perform research in the lighting industry as a researcher, academic PhD candidate or professional.

What will you ask me to do?

Your participation will involve, a 30-minute semi-structured interview. The focus of the interview is lighting in industry and how it impacts workers. The interview will take place at Level 2 D-Block, QUT or other agreed location and will be audio recorded.

Are there any risks for me in taking part?

The research team does not believe there are any risks beyond normal day-to-day living associated with your participation in this research.

It should be noted that if you do agree to participate, you can withdraw from participation during the project without comment or penalty.

Are there any benefits for me in taking part?

It is expected that this project will not benefit you directly. However, it may benefit the general community. You may request a copy of the research findings to be sent to you.

Will I be compensated for my time?

No, but we would very much appreciate your participation in this research and although it is unlikely this project will benefit you directly, it may benefit the general community.

I am interested – what should I do next?

If you would like to participate in this study, please contact the research team for details of the next step.

Peter Forrer peter.forrer@connect.qut.edu.au

You will be provided with further information to ensure that your decision and consent to participate is fully informed.

Thank You!

QUT Ethics Approval Number: 1500000089

Queensland University of Technology
Brisbane Australia

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT
– Interview –

DE42 Bachelor of Design – Honours Projects

QUT Ethics Approval Number 1500000089

RESEARCH TEAM

Principal Researcher: Peter Forrer DE42 Bachelor of Design – Honours Student
Associate Researcher: Dr Rafael Gomez - Unit Coordinator
CIF Honours Project Ethics Advisor – School of Design – Creative Industries Faculty

DESCRIPTION

This project is being undertaken as part of an Honours study for Peter Forrer.

The purpose of this research project, is to see how different lighting intensity affects performance of people working in an industry setting.

You are invited to participate in this research project because you have specialist knowledge of lighting. This includes, lighting designers, researchers, academics and professionals working the Brisbane area.

PARTICIPATION

Your participation will involve, partaking in a 30-minute semi-structured audio recorded interview. The interview will focus on lighting in industry and how it impacts workers performance.

Questions will include:

- Lighting matters in an industry setting can you explain how this affects worker performance?
- How does brighter lighting improve or impede worker performance?
- During shift work how would improved lighting affect performance of a worker?

Your participation in this project is entirely voluntary. If you do agree to participate you can withdraw from the project without comment or penalty. If you withdraw within three (3) weeks after the interview session, on request any identifiable information already obtained from you will be destroyed. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT.

EXPECTED BENEFITS

It is expected that this project will not benefit you directly. However, it may benefit the general community.

RISKS

Data reported in anonymous way, there are no risks beyond normal day-to-day living associated with your participation in this project.

PRIVACY AND CONFIDENTIALITY

All comments and responses will be treated confidentially unless required by law. The names of individual persons are not required in any of the responses.

After the session you will have the opportunity to verify your comments and responses prior to final inclusion.

Please note that non-identifiable data collected in this project may be used as comparative data in future projects or stored on an open access database for secondary analysis.

CONSENT TO PARTICIPATE

We would like to ask you to sign a written consent form (enclosed) to confirm your agreement to participate.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If have any questions or require further information, please contact one of the research team members below.

Peter Forrer		peter.forrer@connect.qut.edu.au
Dr Rafael Gomez	(07) 3138 4577	r.gomez@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.

Queensland University of Technology
Brisbane Australia

CONSENT FORM FOR QUT RESEARCH PROJECT
– Interview –

DE42 Bachelor of Design – Honours Projects

QUT Ethics Approval Number 1500000089

RESEARCH TEAM CONTACTS

Peter Forrer		Peter.forrer@connect.qut.edu.au
Dr Rafael Gomez	(07) 3138 4577	r.gomez@qut.edu.au

STATEMENT OF CONSENT

By signing below, you are indicating that you:

- Have read and understood the information document regarding this project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw at within three (3) weeks from the interview session without comment or penalty.
- Understand that you can contact the Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au if you have concerns about the ethical conduct of the project.
- Understand that the project will include an audio recording.
- Agree to participate in the project.

Please tick the relevant box below:

☐ I agree for the interview to be recorded.

☐ I do not agree for the interview to be recorded.

Name _____

Signature _____

Date _____

Please return this sheet to the investigator.

Appendix H – Ethics Forms – Lighting Study

Sample Approach email - Participant

Subject Title:

Participate in a research project looking at how different lighting intensity affects performance of people working in an industry setting.

Dear Participant

My name is Peter Forrer from QUT School of Design, Creative Industries Faculty and I'm doing a research project as part of my honours about Lighting in an industry setting.

In this study I'm looking for people of aged 18 to 65yrs to participate in a lighting test. To be held at Queensland University of Technology level 2, D-block. Your participation will involve a test looking at your ability to solve a short word quiz at 3 different lighting levels. After the exercise participants will provide feedback of their experience with responses recorded by audio recordings. This activity is expected to take no more than 20 minutes of your time.

Please view the attached Participant Information Sheet and Consent Form for further details on the study.

Should you wish to participate or have any questions, please contact me via email.

Please note that this study has been approved by the QUT Human Research Ethics Committee (approval number 1500000089).

Many thanks for your consideration of this request.

Peter Forrer
DE42 Bachelor of Design – Honours Student
Email peter.forrer@connect.qut.edu.au

Dr Rafael Gomez - Unit Coordinator
CIF Honours Project Ethics Advisor
Phone +61 (07) 3138 4577
Email r.gomez@qut.edu.au

School of Design / Creative Industries faculty
Queensland University of Technology (QUT)

Queensland University of Technology
Brisbane Australia

PARTICIPATE IN RESEARCH

Information for Prospective Participants

The following research activity has been reviewed via QUT arrangements for the conduct of research involving human participation.
If you choose to participate, you will be provided with more detailed participant information, including who you can contact if you have any concerns.

DE42 Bachelor of Design – Honours Projects

Research team contacts

Principal Researcher: Peter Forrer DE42 Bachelor of Design – Honours Student

Associate Researcher: Dr Rafael Gomez - Unit Coordinator

CIF Honours Project Ethics Advisor – School of Design – Creative Industries Faculty

What is the purpose of the research?

The purpose of this research project, is to see how different lighting intensity affects performance of people working in an industry setting.

Are you looking for people like me?

The research team is looking for people of aged 18 to 65 years.

What will you ask me to do?

Your participation will involve a test looking at your ability to solve a short word quiz at 3 different lighting levels. After the exercise participants will provide feedback of their experience with responses recorded by audio recordings. This activity is expected to take no more than 20 minutes of your time.

Are there any risks for me in taking part?

The research team does not believe there are any risks beyond normal day-to-day living associated with your participation in this research.

It should be noted that if you do agree to participate, you can withdraw from participation during the project without comment or penalty.

Are there any benefits for me in taking part?

It is expected that this project will not benefit you directly. However, it may benefit the general community. You may request a copy of the research findings to be sent to you.

Will I be compensated for my time?

No, but we would very much appreciate your participation in this research and although it is unlikely this project will benefit you directly, it may benefit the general community.

I am interested – what should I do next?

If you would like to participate in this study, please contact the research team for details of the next step.

Peter Forrer peter.forrer@connect.qut.edu.au

You will be provided with further information to ensure that your decision and consent to participate is fully informed.

Thank You!

QUT Ethics Approval Number: 1500000089

Queensland University of Technology
Brisbane Australia

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT
– Lighting Test –

DE42 Bachelor of Design – Honours Projects

QUT Ethics Approval Number 1500000089

RESEARCH TEAM

Principal Researcher: Peter Forrer DE42 Bachelor of Design – Honours Student
Associate Researcher: Dr Rafael Gomez - Unit Coordinator
CIF Honours Project Ethics Advisor – School of Design – Creative Industries Faculty

DESCRIPTION

This project is being undertaken as part of an Honours study for Peter Forrer.

The purpose of this research project, is to see how different lighting intensity affects performance of people working in an industry setting.

You are invited to participate in this research project, because you are a person aged between 18 to 65 and are currently living in the Brisbane area.

PARTICIPATION

Your participation will involve a test looking at your ability to solve a short word quiz at 3 different lighting levels. After the exercise participants will provide feedback of their experience with responses recorded by audio recordings. This activity is expected to take no more than 20 minutes of your time:

Feedback question will include:

- At the lowest light level, what difficulties did you have solving the puzzle?
- At which lighting level did you find the word quiz easier?
- Why do you think this lighting level was your preference?

Your participation in this project is entirely voluntary. If you do agree to participate you can withdraw from the project without comment or penalty. If you withdraw within three (3) weeks after the interview session, on request any identifiable information already obtained from you will be destroyed. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT.

EXPECTED BENEFITS

It is expected that this project will not benefit you directly. However, it may benefit the general community.

RISKS

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CONSENT TO PARTICIPATE

We would like to ask you to sign a written consent form (enclosed) to confirm your agreement to participate.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

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