A Soft Focus
Japanese design principle-based study luminaire
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Revati Bheemarao Limbavali
Tutor: Diana Joels

Architectural Lighting Design, KTH Royal Institute of Technology
Abstract

The primary objective of this thesis is to create a study lamp based on research into the Zen aesthetic principles and visual perception. Visual perception is impacted by important aspects, especially vertical illumination, it is addressed here in terms of luminaire height. The design makes use of classic materials while adhering to Koko and Kanso's ideas of simplicity and utility.

The luminaire's design incorporates soft illumination and flexibility for different desk arrangements in student rooms based on survey data. The design prioritizes glare reduction in form of shielding the light source and offers ambient lighting for screen-contrast, coinciding with research on digital eye strain, considering the widespread vertical illuminance from displays and the related eye strain.

User habits relating to time and screen usage provide significant data, defining vertical illuminance concerns and the incorporation of an adjustable sub-body for controlled light distribution. The challenge is to reconcile simplicity with Austere Sublimity while including user demands such as flexibility, glare reduction, and diffused lighting. Natural materials such as wood and paper improve the intrinsic qualities and aging process of the luminaire while also remaining sustainable. The result is a luminaire that successfully combines visual perception, Zen Aesthetic principles, and user requirements.

Keywords: Study Luminaire, Design, Zen Aesthetics.
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1 Introduction

“There is a gap between lighting design and luminaires” as Rehm Gerhard, Lecturer at KTH School of Architecture, stated in the lighting planning lecture [1]. One of the purposes of the interior luminaires is to make lighting usage according to user need using variable ways to combine these ideas, which was the initial thought leading to the project. This thesis involves working with something engaging and motivating for me.

New concepts throughout the course of studies were also an inspiration, like vertical illumination, an aspect of visual perception. As I reflect on my journey, I have found that Japanese culture has subtly influenced and enhanced my approach to various aspects of life. After being exposed to Japanese animation series and delving into the book Ikigai, I came across a quote that deeply resonated with me: "It is much more important to have a compass pointing to a concrete objective than to have a map" [2]. This quote highlights the idea that simple tasks can often be intricate, but with time and experience, we learn to simplify and work towards them. Often while studying, Zen inspired music was a background which led me to discover Zen Aesthetic principles.

The research question for this thesis is, how can visual perception of light for a focused task like studying be incorporated with the Zen aesthetic principles while having the luminaire remain functionally balanced? Specifically, it explores the connection between visual perception and vertical illuminance, considering the modern era where computer screens also serve as vertical sources of illumination. To delve further into this subject, a survey will be conducted, followed by user testing of the luminaire, aiming to gain insights into the relationship between vertical illuminance and the computer screen. The Zen Aesthetic principles have case studies which allow for a deeper understanding with respect to how it is used, which allows me to integrate it in the appropriate way. The luminaire will strive to be functional with understanding and incorporating the aforementioned aspects.

I will explore luminaire design for study purpose taking inspiration from the Zen aesthetic principles while tending to the aspect of visual perception of light. While lighting design is a vital component of architecture and space planning, luminaire design plays a role within the whole environment for the same. It refers to the process of designing and creating light fixtures that serve both functional and aesthetic purposes. I will be working with the traditional materials used in Japanese lamps, while taking inspiration from their designs. I will consider the various factors involved in designing a lamp, including its function, form, and materials. The target audience for the lamps is students, which is designed keeping in mind for the usage and time of usage.

The incorporation of Washi Paper and wood in study lamp design achieves multiple UN Sustainable Development Goals. It supports responsible consumption and production (SDG 12) by using sustainable materials and promoting a circular economy. The design contributes to climate action (SDG 13) through resource efficiency. Furthermore, it aligns with the goals of preserving terrestrial ecosystems (SDG 15) and building sustainable communities (SDG 11) by responsibly sourcing wood and promoting environmentally conscious design. Lastly, the use of Washi Paper’s diffused light properties enhances user well-being, supporting the goal of good health and well-being (SDG 3) [3].
1.1 Background research

1.1.1 Zen Aesthetic Principles

Zen Aesthetic Principles, based on Zen Buddhism, are principles to promote the ability to foster a deeper appreciation of the present moment, promote inner reflection, and encourage a mindful engagement with the world. Incorporating these values into the design process can cultivate a sense of balance and serenity. Zen aesthetics offer an alternative to the fast-paced modern society, providing a pathway to reconnect with the natural world, find beauty in simplicity.

There are 7 Zen Aesthetic principles as shown in Figure 1 below [4].

The culture and design principles of Japan heave a steadfast interrelation between them. The temple Ryoan-ji garden at Kyoto, Japan is an example of Shizen which mean naturalness. The temple is a rock garden of 15 rocks placed by groups. which is meant to be viewed from a position in the veranda. When viewed from a seated position, not all stones are visible simultaneously. The backdrop of the garden is a wall made of clay and has a very significant role. The rocks placement intentionally lacks symmetry representing the principle of fukinsei (asymmetry) and the structure of the rocks embodies the principle shizen (naturalness). The wall contributes to the aesthetic appeal, embracing wabi-sabi and acquiring rustic beauty with age [5]. The temple is renowned for its simplicity, natural elements, and balance of light and shadow.
Drawing inspiration from these principles and incorporating minimalist design and natural materials like wood and paper, I aim to create a serene studying environment. The lamp’s adjustable light distribution ensures a sense of spaciousness while avoiding excessive dominance that could cause distractions in the surroundings.

Lomas et al. (2017) characterised the Zen Aesthetics by simplicity, naturalness, and a focus on the present moment [4]. This aesthetics are reflected in Japanese art, design, and architecture by focusing on essential elements, incorporating natural materials, and embracing imperfections which are also a core component of Zen Buddhism. The article argues that adopting Zen aesthetics and mindfulness practices can have several health-enhancing benefits such as stress reduction by promoting a calm and focused state of mind. It can help individuals cultivate a sense of well-being by promoting gratitude, acceptance, and contentment. The study lamps based on minimalist and uncluttered designs have a possibility to reduce visual distraction and promote a balanced, comfortable lighting setup which potentially might minimise eye strain.
Japanese lamps have a unique and recognizable design language influencing designers all over the world and are characterized by their simplicity, elegance, and use of natural materials. With rich history spanning over centuries, their design has undergone evolutionary changes to reflect cultural values and requirements. Categorized in three types: Toro (cultural outdoor lighting), Andon (Indoor lighting), And Chochin (ambient and functional lighting) [7].

These lamps were popular during the Edo period (1603-1867) [8]. The historical advancements in controlling light distribution found in Japanese lamps are fascinating. For example, Ariake Andon lantern, which features a wooden casing with intricately cut-out moon shaped patterns. The wooden casing serves a dual purpose: when the casing is removed, the lamp emits light in all directions, making it suitable for daytime and night-time activities. Conversely, when it is time to sleep, the casing can be placed on top of the lamp, effectively blocking most of the light while allowing a soft glow to emanate through the cut-out patterns [9].

Another intriguing variation of the same had a suspended candle inside enclosed by a paper on the exterior. It also had a wooden base with a hole, in which a lens was placed for the light to pass through. By adjusting the height of the candle within the lamp, the focus and distribution of the light could be
modified. As the candle was elevated, the light distribution would extend higher, albeit with a more diffused intensity. Conversely, bringing the candle closer to the lens resulted in a smaller, more focused and crisp light distribution [9].

These designs allowed for versatility in lighting options, enabling users to adjust the lamp’s settings according to their specific needs and preferences. The study lamp’s ingenious construction exemplifies the resourcefulness and adaptability often seen in traditional Japanese lamp designs, where functionality and control over lighting were carefully considered. The above study serves for design inspirations. I look forward to using these methods to create a simple and functional light by referring to the applications in a minimal yet meaningful way.
1.1.3 Visual perception for current age

For a modern study luminaire, the vertical illuminance is a major factor since there are computer screens alongside traditional books that necessitate horizontal illuminance. It becomes crucial to comprehend how visual perception, particularly concerning vertical illuminance, can be integrated into a design that caters to the evolving needs of studying in a technology-driven world. Exploring and establishing this connection within the broader scope of the project is essential.

In a study conducted by Zhang et al. (2022), various tests were conducted to examine the effects of illumination fluctuations on individuals. The findings revealed that sudden changes in vertical illumination significantly influence the level of comfort people experience when viewing objects [10]. The understanding here is that vertical illuminance does have an impact on visual comfort and perception. To understand the connection of this with regards to screen, the luminaire testing would enable me to gain more insights about this topic better. The design will try and incorporate elements to minimise discomfort and promote a visually comfortable environment. By adopting this holistic approach, the overall study experience can potentially be enhanced, leading to improved concentration, focus, and productivity during study sessions.
2 Methodology

Figure 8: Methodology chart
2.1 Case studies relative to the selected design principles.

The Zen Aesthetic principles incorporated in the project are: Kanso and Koko. Kanso emphasises on simplicity and minimalism, creating a focused study environment. Luminares designed with Kanso avoid unnecessary ornamentation and clutter, reducing visual distractions that can hinder concentration and productivity. Koko enables me to think of the lost connection to all thing aging and how beautiful they are. Study lamps designed with Koko tend to have a timeless appeal and can seamlessly fit into various study environments, making them long-lasting solutions. Case studies below on the use of Zen Design Principles is useful as it helps me to relate and study the factors which relate principles and modern-day products.

2.1.1 Kanso (Simplicity)

Apple, in 2007 launched their first iPhone breaking the market which was dominated by keyboard and stylus interaction. The iPhone introduced a touch screen interface that allowed users to control most functions with their fingers [11]. The simplicity in design, with a sleek and flat surface in contrast to traditional keypads, brought about a significant change. As Hisamatsu said, “Simplicity as the negation of clutter, can be linked to a ‘boundless’ state, unrestricted like a cloudless sky” [12].

Keyword: Minimal

2.1.2 Koko (Austere Sublimity)

As Junichiro Tanizaki says In Praise of Shadows that “We love things that bear the marks of grime, soot, and weather, and we love the colours and the sheen that call to mind the past that made them” [13]. For example, when looking at the tea ceremony culture of Japan, the teacups exhibit imperfections and a natural, rustic aesthetic, featuring natural colour showing a connection with nature [14]. The imperfections and connection to past gain materials a special place in cultural consciousness.

Keyword: Colour and Material oriented.
2.2 Questionnaire based on habits of study and Luminaire Investigation.

This survey is aimed at understanding the study habits of students and how lighting can be designed to cater their needs. Few of the modern-day features in a study lamp are as follows:

- User friendliness.
- Adjustability in terms of direction
- CCT adjustability.
- Flexibility of the luminaire to be able to change the orientation.
- Light distribution adjustability.
- The aesthetic value of the luminaire.
- Compactness
- Portability
- Sustainability

The survey encompasses a mix of close-ended and open-ended questions. The open-ended questions are intentionally designed to allow users to freely express their concerns and share their experiences, providing valuable insights into the respondents’ perspectives. The close-ended primarily focuses on user’s habits, including study patterns, time spent on table, and preferred lighting while studying. The questions are framed in such a way to understand their preferred environment for studying. The survey had a total of 50 participants.

Once the prototype was completed, a series of experiments were carried out to evaluate the visual perception of the luminaire. Five participants were involved in these experiments, which aimed to assess factors such as glare and visual discomfort. The experiments focused on lighting levels for book and computer screens, aiming to determine if the lighting provided was sufficient for the participants tasks. The goal was to avoid both insufficient and excessive lighting, as they can both lead to visual discomfort. The caps (Figure 24) were investigated by allocating a time for each of them, which allows me to try and understand their effects on visual perception. To also confirm the materiality and how it is perceived, a question on the diffused or sharp lighting quality was added.
2.3 Case studies relative to existing study lamps

Below is a selection of lamps from the past which will be evaluated in the terms of two matrices, namely Design and Technology. While comparing the lamps based on Design, their Flexibility, Sharpness or diffused nature, and glare factor are investigated. For the technological aspect, the brightness and the Correlated Colour Temperatures are compared. The selection of the below lamps, the light distributions are from my understanding from the web with the help of images and videos. To note that this case study also has another consideration: light source, luminaire details, Zen Aesthetic principles comparison.

For the light source details. It is the same for all the products.
Light Source:
- Incandescent light source.
- Intensity of light: These lamps were designed with a fixed light output and did not incorporate dimmer switches or controls to change the brightness levels.
- Correlated colour temperature: The constant CCT for incandescent light was around 2700-3000k. The CCT could not be adjusted during the period.

2.3.1 Harrison D. McFaddin- Emeralite banker’s lamp, 1909 [15]

![Emeralite banker’s lamp](image)

*Figure 11: Emeralite banker’s lamp*
2.3.2 Paul Henningsen ph table lamp – 1927 [16], [17]

Figure 12: PH table lamp

- Circular Distribution
  - Due to shade
- Diffused Distribution
  - Due to shade material.
2.3.3 George Carwardine - Anglepoise lamp type 75, 1931 [18], [19]

Figure 13: Anglepoise table lamp
2.3.4 Isamu Noguchi Cylinder table lamp – 1944 [20]

Figure 14: Cylinder table lamp

- Circular distribution
- Sharp inside, diffused outside
2.3.5 Bill Curry – Limelight lamps, 1960’s [21]

![Limelight lamp diagram]

**Figure 15: Limelight lamp**

<table>
<thead>
<tr>
<th>Luminaire</th>
<th>Direction of Illumination</th>
<th>Materiality</th>
<th>Flexibility</th>
<th>Light sharpness or diffused</th>
<th>Glare factor</th>
<th>Simplicity</th>
<th>Austere Sublimity (Color and Materiality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harrison D. McFaddin - Emeralite banker’s lamp, 1909</td>
<td>Majorly Downwards, but multidirection possible.</td>
<td>Dark green glass shade, Brass metal body. [21]</td>
<td>The shade could move up and down to direct light to an extent.</td>
<td>Diffused light downwards.</td>
<td>No glare when shade covers light source.</td>
<td>Minimilistic shade with sleek design; intricate design for framework</td>
<td>Framework perceived as aged, lamp shade does not.</td>
</tr>
<tr>
<td>George Carwardine - Anglepoise lamp, 1931</td>
<td>Changeable via shade</td>
<td>Aluminium [17].</td>
<td>Adjustable height and direction.</td>
<td>Sharp Light.</td>
<td>Dependent on the shade position.</td>
<td>Very Minimilistic</td>
<td>Not true</td>
</tr>
<tr>
<td>Isamu Noguchi Cylinder table lamp – 1944</td>
<td>All</td>
<td>Tactile Fabric Shade and organically shaped wooden legs[22].</td>
<td>Fixed.</td>
<td>Diffused through shade, sharp through top and bottom.</td>
<td>Not a concern.</td>
<td>Very Minimilistic</td>
<td>Appears to age well.</td>
</tr>
</tbody>
</table>

**Table 1: Comparison of the Lamps**
2.4 Design and light

The factors considered here to design the luminaire is Flexibility, Glare control and Diffused light. The Japanese Aesthetic Principles will play a major factor behind the selection of materials, which will be selected considering the colour and properties of the materials.

Figure 16: Mind map of connections between Zen Aesthetic principles and Task luminaire
3 Results

3.1 Survey Results

The data from the survey will be mentioned below. There were 50 respondents to the questionnaire on google forms which was distributed via web to students and professionals. The form also included a set of images to help picture scenarios better for a question presented. The Questionnaire starts with a data of the age group of the participants.

To summarise, students were the main responders to the questionnaire, amounting to 80% of the respondents, out of which almost 64% preferred to study sitting on a table every day. Their preferred mode for studying was studying over a screen and writing on a notebook or a combination of both.

![Survey Question 1](image1)

When asked about what their ideal study lamp would look like, most of them prefer the use of a flexible light, a lamp that would avoid glare, change, or control the direction of light, the CCT and brightness. There were quite a few responses which wanted the lamps to be compact, use less space and be aesthetically pleasing.

When asked about adjustable lighting options, the respondents majorly wanted to have a control over the brightness and the direction of the light. However, for the change of colour of the light from the lamp didn’t matter to most of the people. The respondents had the same preferences when asked about what control over the light would they like to have when they were studying. This resulted in me coming up with an idea for a study lamp where the direction of the light and the distribution can be changed by the user.

![Survey Question 2](image2)
As far as getting an insight about how the users would change the light characteristics through the day, which offered information about how their usage of light gets affected with time. Their preferences for the lighting scenario depended a lot on their usage of laptop screens. They preferred a more diffused, soft, and indirect lighting scene when studying during night-time whereas they preferred to have a more natural lighting scene during daytime while studying. This was important point while giving my prototype a feature to change the distribution of the light. Almost 50% of the users preferred to have the study lamp in a corner, whereas people also preferred to have the lamp face the wall and behind their computer screen.

And when asked about choosing the lighting the scenario from where they want their study area to be lit or not based on the scenarios shown below in Figure 20 to Figure 22; they preferred their study area to be lit so that they can be more focused on what they are studying and avoid any unnecessary distractions. Thus, it was for important for me to have a light where the light distribution can have a focused feature.
Figure 22: Scenario 3: Where the surrounding is lit, and the study area is dimmer.
4 Luminaire Design

4.1 Concept

The design concept for the luminaire drew inspiration from the Ariake Andon mentioned in the previous background research. The goal was to achieve a controlled light distribution, which was an essential aspect of the project. The cap of the luminaire had different variations, including a circular cut-out that created a focused area of light. On the other hand, an open side with filleted square cut-outs allowed the emitted light to create an ambient surrounding. This design also enabled smooth movement of the pivot without any hindrance. The below Figure 23 depicts the concepts used from the data collected.

To facilitate the placement of the bulb, a soft-edged rectangular body was chosen. The intention behind using familiar shapes, such as rectangles, was to create a sense of familiarity and ease of use.
Figure 24: Sketch of the concept.

Figure 25: Side View

Figure 26: Light Source Placement
Below images are the concept visualisation in 3D.

The envisioned dimensions for the luminaire are as below. The measurements are in Inches. The dimension of the model height was considering that the light source placement will be higher than the computer screen to create contrast. The body measurement is majorly to facilitate the light source placement.

Figure 27: Model Vision 1
Figure 28: Model Vision 2
Figure 29: Model Vision 3
Figure 30: Model Vision 4
Figure 31: Model Vision 5
Figure 32: Model Vision 6

Figure 33: Dimensions Front View
The luminaire consists of two components, a main body and a sub-body. To ensure a balanced and diffused lighting quality, the main body is constructed using lightweight wood and incorporates washi paper in the upper half. This design allows for illumination in multiple directions, with a slight emphasis away from directly below the lamp. Two wooden pillars provide support and enable the main body to pivot for adjusting the direction of light.

The sub-body is a solid shape that can be placed on top of the lower half of the main body when not in use, and on the upper half to control the light distribution. By combining the sub-body with tilting of the main body, the luminaire can focus light on specific areas as needed. The sub-body features two types of openings: a circular cut-out and a rectangular edge cut-out. The rectangular edge cut-out serves multiple purposes, including facilitating the placement of the pivot support and providing space for the light source’s wire to connect to a power supply when placed underneath. The circular cut out intends to help create a focus bubble of light.

The light distribution is controlled by the wooden box cut out. The diffused light is due to washi paper qualities as illustrated by the image below. The wood being an opaque material hides the light source’s glare.
The below images visually represent the concept and the application of it.

Figure 37: Model Lighting Qualities

Figure 38: Model Features

Figure 39: Model Materiality
The images below show the aspect ratio with respect to the laptop, light distribution of the luminaire.

Figure 40: Model Materiality

Figure 41: Light Distribution - Top View

Figure 42: Model with cap and computer screen off.

Figure 43: Light Distribution - Front View
4.2 Prototype testing:

The prototype differs from the initial model by material, height and design wise. Material aspect the prototype is made of cardboard boxes for both the bottom and the cap of the luminaire. The top was covered by Japanese paper. The side stands of the luminaire were pringles boxes covered by brown paper, which design wise was a different aesthetic to look at from the supporting pillars being thin to thick. The total height of the model is 14 and a half inches which was initially to be 20 inches. After trying out the initial design cap, I saw that it was not completely the intended distribution. To test more there were three other variations made. The variations were made from white cardboard. The gift-wrapping brown paper was used for T2 (top 2), Japanese paper was used for T3 (top 3). And T4 has the sides closed. These are shown in the below figure number 46, 47 and 48.
The bulb specification for the prototype test was a Deltaco, E27, 9W -806lm, CCT – 2700 to 6500K, Dimmable LED light source. The experiment was set up with a fixed scenario, which was that the bulb was set at 4000k and at 50% intensity.
4.3 Experimental Results

After building the prototype and the 4 tops. The experimental area was set up in a student room at Lappis campus in Sweden. The experiment consisted of a room lighting and then the luminaire lighting. This was with respect to the most used scenario as mentioned in the initial questionnaire which is Figure 21. The light source of the Room lighting is LEDVANCE, E27, 9W-800lm, CCT – 2700k. Due to the non-adjustable light intensity of the Room lighting the Japanese paper is used as a diffuser as the light was brighter than the luminaire for figure 21 to be mimicked.

The experimental set up was a 50-minute session and 10 minutes to fill the survey following. There are 5 settings, so each setting is 10 minutes in length, it is further divided in two parts which is 5 minutes each. The first minutes is for book reading and the five minutes is for working on computer screen. After each setting the survey will be presented to be filled. The first setting was no top and then the setting followed the order from T1 to T4. The experiment was conducted with 5 participants in total.

Questions related to visual perception such as lighting nature (diffused or sharp) vertical illuminance level, the glare and comfort level experienced are enquired through the process. A summary of the results is discussed below. The 5 scenarios will be compared with respect to the book sessions and then the computer screen sessions. The complete questionnaire is added in the Appendix B.

**Book session:**

- **Diffused or sharp perception:** The perception of the light being diffused or sharp varied from each setting. With no top it varied between sharp and fairly diffused. For T1 it leans more to the scale of being diffused. T2 had similar results leaning more to the diffused scale. T3 had variations of being diffused and neutral. T4 had the majority being diffused and one perceived it as fairly sharp.

- **Visual comfort for readability:** For no top and T3 it was found easy to read through the book. T1 had results from yes (2 participants), maybe (2 Participants) and No (1 participant). Top 2 and Top 4 was agreeing to being easy to read and manageable (maybe).
• Glare: For no top and T3 the glare was neutral to least glare seen. T1 and T2 ranged to least glare on majority. T4 ranged from least glare majorly to one participant rating it fairly glary.

• Visual discomfort: For no top majority did not experience discomfort with one answer being maybe. T1, one participant was sure to experience discomfort, and another selected a maybe option. T2 had 2 participants experience visual discomfort. T3 and T4 had one participant experience discomfort.

• Light rating: For no top, T2, T3 and T4 the light rating was between the good scale to neutral. For T1 the light rating, 2 participants rated it bad.

Computer session:

• Diffused or sharp perception: The perception ranged from neutral to fairly diffused for no top, T3and T4. T1 Had it on the scale of being diffused and fairly diffused. T2 had one participant mentioning it was fairly sharp and the rest being fairly diffused to diffused.

• Visual comfort for readability: For no top majority could find it easy for reading while one participant opted for maybe. T1, 2 participants found it difficult to read. For T2, T3 and T4 one participant found it difficult to read.

• Vertical illuminance: For no top the light was high, with one participant rating it on the lower scaler. For T1 and T3 the responses ranged from fairly low to high. T2 ranged from lowest to highest. T4 ranged from fairly low to fairly high light level.

• Glare: For no top the response ranged from least glare to neutral. One participant marked fairly glary, and the rest was marked as least glary for T1. Two participants marked fairly glary, and the rest was marked as least glary for T2. T3 ranged from least glary to fairly glary. T4 rated between least glary on the scale.

• Visual discomfort: For no top one participant marked maybe and the rest was no visual discomfort. For T1 3 participants marked yes for discomfort. Two participants experienced discomfort for T2. For T3 and T4 one participant marked yes for discomfort.

• Light rating: For no top and T4 the light rating ranged majorly between good and fairly good, with one being on fairly bad. For T1 the light rating ranged majorly between good and fairly good, with two being on fairly bad. T2 and T3 ranged from fairly bad to good.
5 Discussion

The project aims to work with Zen principles in the design of a luminaire and investigate its visual perception. Kanso emphasizes a simple and functional design approach. Koko is applied by using materials that evoke a sense of age and value, maintaining their presence over time. Balancing user needs, such as flexibility, glare control, and diffused lighting, with the aesthetic principles posed a challenging task. The concept of Austere Sublimity is achieved by working with natural materials like wood, which ages beautifully over time, and paper that exhibits similar qualities.

The luminaire design incorporates wood and washi paper, both of which are recyclable materials, aligning with the project's sustainability goals. While wood pulp used for paper production can contribute to deforestation and environmental issues, washi paper production avoids tree felling by utilizing fresh branches that are a year old [25]. Wood has various beneficial uses, such as fuel, paper pulp, mulch, and building material. By recycling and reusing timber, there is a reduced need to cut down forests, promoting sustainability [26]. The value of a composite attribute like wood colour depends on the chemical make-up of the material [27]. And as a result, changes in the chemical components should be the cause of any discolorations [28]. It was discovered in the natural aging study that over the very extensive study period, all papers lost optical characteristics. The paper began to darken (lose brightness) and yellow as a result of this [29]. The luminaire is specifically designed for student rooms and can be placed on a desk, providing soft lighting and flexibility. The design allows for placement anywhere on the table, addressing the preferences expressed in the survey. Results from the experiment indicate that, on average, the light emitted by the luminaire is perceived as diffused in nature.

In today's digital era, the impact of vertical illuminance from screens on visual tasks has become significant. Design considerations must now include this factor, as excessive brightness from screens can potentially strain the eyes over time. As Amy et al. mentions according to estimates, the prevalence of digital eye strain (DES), also known as computer vision syndrome, may be 50% or more among computer users. It includes a variety of ocular and visual symptoms [30]. To address this issue, the luminaire design aims to reduce glare and provide soft lighting, acting as ambient light to create a comfortable contrast between the computer screen and the surrounding environment. The glare is attempted to be reduced by placing the light source behind the wooden covering, which would only make the light emitted to be visible. The soft lighting is due to the property of washi paper.

The experiment results indicate that glare experienced by users is generally minimal, and overall visual comfort is good. However, further improvements can be made in this aspect of visual comfort, such as investigation on why few participants experienced visual discomfort could give more insights on what could be different. The variability of vertical illuminance in the experiments highlights the need for more research in this field to better understand its impact on visual perception and eye strain. The adjustability feature of the model could be tested out more to gain more insights into it. Due to time constraints the aspect was least explored.

The model to prototype has a difference due to material constraints. The concept testing was done when the prototype was made, there was difference between the expected distribution and the distribution seen. The expected distribution was that the circle would be the highlight and the other side would be ambient lighting. But due to the opening being wider on the other side the roles were neutral. The model to prototype also had a difference of height due to material constraints, it can also be solved with proper material to hold the weight at the height.

There could be more control over the distribution with respect to shape of the top, which is what led to the trying of the different top for the model. Without heavily relying on the technology such as the
change in CCT and to control the light intensity, which are now available in the modern ages, to work with constrained elements has been engaging. The process has enabled me to try and integrate different aspects to be integrated into one product on different scales. Each aspect works on different efficiency levels.
6 Conclusion

The project’s goal was to design a study luminaire that incorporates Zen aesthetic concepts and investigates its visual perception. The project aimed to strike a balance between the desired concept and the available resources within a specified timeframe. The concept was inspired by the realization that modern tasks are becoming increasingly reliant on vertical lighting, especially with the prominence of computer displays, which have various impacts and visual impressions that study lamps should address. The product successfully incorporates Zen ideals by using materials that are compatible with their natural qualities and colour spectrum. The inclusion of washi paper has proven to be a perfect addition, while wood was sourced and utilized for prototyping purposes.

The investigation of visual perception has provided important insights into elements such as glare and lighting conditions in the given setting. However, further research is needed to fully understand the influence of vertical illuminance. Questions have been raised about the subjectivity of vertical illuminance and its consequences, highlighting the need for more research in this area.

Future development will allow for the exploration of new aesthetic concepts and luminaire designs, building on the wealth of information and results gained during the process. Depending on the time and resources available, including users in luminaire testing and research might give significant insights. Exploring modifications in the model's wooden covering might improve control over light dispersion. Delving deeper into visual perception can help identify specific user discomforts, enabling the design of an improved product that addresses these concerns.

7 Acknowledgement

I want to thank Diana Joels, my tutor, for all her knowledge, kindness, and understanding. Throughout this process, she has been a huge support and has constantly provided me with knowledge that has allowed me to go forward.

I would thank my co-ordinator Federico Favero for the constant support and suggestions which has always provoked me to think ahead and in aspects which have been new to me.

I would also extend my gratitude to my family and friends who have been present through the process of the thesis.
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11 Appendix

11.1 Appendix A

The data is from 50 participants answering this google form sent through web.

1. What is your Age?

   ![Age Chart]

2. What is your Profession?

   ![Profession Chart]
3. How often do you study at a desk?

How often do you study at a Table/Desk?

- Not Often
- Once a week
- Several Times a Week
- Almost Everyday

4. What way of studying do you usually take up?

What way of study do you usually take up when studying?

- Writing: 13 (26%)
- Reading a book: 6 (12%)
- Computer oriented: 28 (56%)
- Combination of the above: 25 (50%)
- Doing artworks, watching stuff as well: 1 (2%)

5. Do you Prefer Having a Lamp Nearby?

Do you study with a Lamp Nearby?

- Nearby
- No
- Yes
6. An open-ended question such as what do you think your ideal study lamp would be like? There has been lot of insightful input for this one question. Some of them are:
   - A one which is bright enough and soothing to eyes.
   - Tuneable light. No glare, no flicker, small, dimmer
   - Flexible, that can direct it and manipulate the intensity of light.
   - Light only on the book but doesn’t glare into my eyes directly.
   - Not too bright or too dull. It should be perfect for reading or writing a book with screen light without disturbing the eyes.
   - Gradual light, aesthetic, quiet, no bother to eyes

Most of the answers here suggest that the users prefer a flexible light, to avoid glare, change or control the direction of light, the CCT and brightness. Other responses also covered it being compact, using less space, being aesthetic.

7. How Important is the design of Study Lamp to you?

![Graph showing importance of design and style of study lamp]

8. How important is the adjustability of study lamp to you?

![Graph showing importance of adjustability in study lamp]
9. Do you prefer Adjustable Lighting options such as:

Do you prefer adjustable lighting options such as:

- Reducing the brightness
- Adjusting the direction
- Change of light colour

10. What time do you usually study?

What time of the day do you usually study?

- Morning: 18 (36%)
- Afternoon: 14 (28%)
- Evening: 34 (68%)
- Night: 32 (64%)

11. Prefer to change the characteristics of light while studying?

According to when you study do you prefer to change the characteristics of the below mentioned variables?
12. If the answer for the above is yes, then how would you change it through the day? This was framed to get insights from how time affects the usage of light when they are studying.

- I would change the brightness and orientation of the light depending on the time or the task that I perform. Usually, at night I prefer more diffused light, so I point the light against the wall, but if I need to draw, I point the light on the surface and try to make it brighter.
- Night-time should be indirect and with adequate light at the background almost like the intensity of the laptop.
- When I study at night it’s really that I am deep in the focus zone, I like a soft but bright light, as I don’t want my laptop to be the brightest, during the day I rather have natural light.

Main point throughout is that users adjust the lighting scenario according to their laptop screens.

13. Where do you prefer your lamp?

<table>
<thead>
<tr>
<th>Where do you prefer to place your lamp?</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 responses</td>
</tr>
<tr>
<td>Facing the wall</td>
</tr>
<tr>
<td>Behind the screen</td>
</tr>
<tr>
<td>Ahead of the computer screen</td>
</tr>
<tr>
<td>In a corner</td>
</tr>
<tr>
<td>Behind the screen, if I am working</td>
</tr>
<tr>
<td>somewhere suitable</td>
</tr>
<tr>
<td>Such way that it projects on the…</td>
</tr>
<tr>
<td>Directly facing the desk</td>
</tr>
<tr>
<td>Pointing at where I'm working</td>
</tr>
</tbody>
</table>

14. What is your ideal study scenario while studying?

What does your study scenario in terms of lighting look like?

| Option 1 - Where your surrounding is dark and only your place of study is lit up. | 17 (34%) |
| Option 2 - Your STUDY AREA IS BRIGHTER THAN THE ILLUMINATED SURROUNDING. | 23 (46%) |
| Option 3 - Your SURROUNDING IS BRIGHTER THAN YOUR STUDY AREA. | 15 (30%) |
15. Do you have any other preferences or suggestions for the current study lamps that would make it more useful for you?

- I think the lamp I use should blend in with its surroundings without attracting too much attention to itself. Since the main purpose of the lamp here is to enable better lighting conditions than the looks, I usually prefer a very simple lamp and extremely well light distribution with accessible features like brightness and colour. I also prefer to have a lamp that does not let me see the direct source of light as it is straining.
- The study lamps that we have these days, the support for the light makes it aesthetically unpleasing to look at it sometimes, if these supports were hidden, it would make the lamp good to look at, and the use of natural material is one way to get that. One way to make it useful is to make it simpler and have a clean design.

Bright surface behind the computer screen is positive, as it reduces contrast between screen and surrounding.

11.2 Appendix B

The data below is a collection from the experiment conducted with 5 participants at a student housing in Lappis Campus at Sweden.

No Top with Book

1. How was the lighting?
(Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)
2. Did you find it easy to read through the paragraph given under the lighting?

Did you find it easy to read the paragraph under the lighting?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
<tr>
<td>Suddenly</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Did you experience glare from the luminaire?

Did you experience glare from the luminaire?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suddenly</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. During the period did you experience visual discomfort?

Did you experience visual discomfort

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suddenly</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. How would you rate the lighting here?

How was the lighting?
(Was the lighting very sharp (very defined boundaries with shadows) or very Diffused (blurred boundaries with shadows)?)

T1 with Book

1. How was the lighting?
3 (60%)
2 (40%)

0 (0%)
0 (0%)
0 (0%)
0 (0%)
0 (0%)
2. Did you find it easy to read through the paragraph given under the lighting?

3. Did you experience glare from the luminaire?

4. During the period did you experience visual discomfort?
5. How would you rate the lighting here?

How would you rate the lighting here?

T2 with Book

1. How was the lighting?
(Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)
2. Did you find it easy to read through the paragraph given under the lighting?

Did you find it easy to read the paragraph under the lighting.

- Yes
- No
- Maybe

<table>
<thead>
<tr>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1.5</td>
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<tr>
<td>2</td>
</tr>
<tr>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3.5</td>
</tr>
</tbody>
</table>

3. Did you experience glare from the luminaire?

Did you experience glare from the luminaire?

5 responses

<table>
<thead>
<tr>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (0%)</td>
</tr>
<tr>
<td>1 (20%)</td>
</tr>
<tr>
<td>2 (40%)</td>
</tr>
<tr>
<td>3 (0%)</td>
</tr>
<tr>
<td>4 (80%)</td>
</tr>
<tr>
<td>5 (0%)</td>
</tr>
</tbody>
</table>

4. During the period did you experience visual discomfort?

Did you experience visual discomfort

- Yes
- No
- Maybe

<table>
<thead>
<tr>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>
5. How would you rate the lighting here?
How was the lighting?
Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?
2. Did you find it easy to read through the paragraph given under the lighting?

3. Did you experience glare from the luminaire?

4. During the period did you experience visual discomfort?
5. How would you rate the lighting here?

T4 with Book

1. How was the lighting?
(Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)
2. Did you find it easy to read through the paragraph given under the lighting?

3. Did you experience glare from the luminaire?

4. During the period did you experience visual discomfort?
5. How would you rate the lighting here?

No top with computer screen

1. How was the lighting?
(Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)
2. Did you find it easy to read through the paragraph given under the lighting?

3. How do you rate the vertical lighting to read on the computer screens?

4. Did you experience glare from the luminaire with respect to the screen?
5. During the period did you experience visual discomfort?

![Bar Chart]

Did you experience visual discomfort

- Maybe: 1 response
- No: 4 responses
- Yes: 0 responses

Number of Responses

6. How would you rate the lighting here?

![Bar Chart]

How would you rate the lighting here?

- 1 (20%)
- 2 (40%)
- 3 (20%)
- 4 (20%)
- 5 (100%)

5 responses

T1 with computer screen

1. How was the lighting?
(Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)

![Images]
2. Did you find it easy to read through the paragraph given under the lighting?

Did you find it easy to read the paragraph under the lighting.

Maybe
No
Yes

3. How do you rate the vertical lighting to read on the computer screens?
4. Did you experience glare from the luminaire with respect to the screen?

Did you experience glare from the luminaire with respect to the screen?
5 responses

5. During the period did you experience visual discomfort

Did you experience visual discomfort

No
5 responses

6. How would you rate the lighting here?

How would you rate the lighting here?
5 responses
T2 with computer screen

1. How was the lighting?
   (Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)

2. Did you find it easy to read through the paragraph given under the lighting?
3. How do you rate the vertical lighting to read on the computer screens?

4. Did you experience glare from the luminaire with respect to the screen?

5. During the period did you experience visual discomfort?
6. How would you rate the lighting here?

![Bar Chart](image)

T3 with computer screen

1. How was the lighting?
(Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)

![Images of sharp and diffused lighting](image)

![Bar Chart](image)
2. Did you find it easy to read through the paragraph given under the lighting?

Did you find it easy to read the paragraph under the lighting.

- Maybe
- No
- Yes

Number of Responses

3. How do you rate the vertical lighting to read on the computer screens?

How do you rate the vertical lighting to read on the computer screens?

5 responses

4. Did you experience glare from the luminaire with respect to the screen?

Did you experience glare from the luminaire with respect to the screen?

5 responses
5. During the period did you experience visual discomfort?

<table>
<thead>
<tr>
<th>Did you experience visual discomfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maybe</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

Number of Responses

6. How would you rate the lighting here?

<table>
<thead>
<tr>
<th>How would you rate the lighting here?</th>
<th>5 responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>2</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>3</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>4</td>
<td>2 (40%)</td>
</tr>
<tr>
<td>5</td>
<td>1 (20%)</td>
</tr>
</tbody>
</table>

T4 with computer screen

1. How was the lighting?
   (Was the lighting very sharp (very defined boundaries with shadows)? or very Diffused (blurred boundaries with shadows)?)

Diffused

Sharp
2. Did you find it easy to read through the paragraph given under the lighting?

Did you find it easy to read the paragraph under the lighting.

<table>
<thead>
<tr>
<th>Maybe</th>
<th>No</th>
<th>Yes</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>0.5</td>
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<td>4</td>
<td>4.5</td>
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<tr>
<td>Number of Responses</td>
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</tbody>
</table>

3. How do you rate the vertical lighting to read on the computer screens?

How do you rate the vertical lighting to read on the computer screens?

<table>
<thead>
<tr>
<th>1 (20%)</th>
<th>1 (20%)</th>
<th>1 (20%)</th>
<th>3 (60%)</th>
<th>0 (0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (0%)</td>
<td>1 (20%)</td>
<td>1 (20%)</td>
<td>3 (60%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
4. Did you experience glare from the luminaire with respect to the screen?

5. During the period did you experience visual discomfort?

6. How would you rate the lighting here?