A Proposed Lighting Design Strategy for Retail Stores

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Abstract:
Lighting design plays a key role in retail stores. It can add a remarkable retail atmosphere, affecting buying behaviour and stimulating buying decisions. With new lighting technologies, it is obvious that lighting design can help businesses to achieve their goals by highlighting brand elements and products. In this paper, the process of lighting design for retail stores was explored to reveal its element and factors that affect it. The paper investigated how lighting can maximize benefits for retail stores through research and case studies. Statement of the Problem: The lack of an appropriate design procedure or methodology that responds to the requirements of lighting design for specific purposes and with the extremely wide-ranging environments in retail houses. Objective: introducing a lighting system that is compatible in every aspect with the varying constituents and functional requirements of retail stores. Results: A design procedure that constitutes a design strategy and a few design techniques have been introduced and discussed. The strategy describes certain phases and milestones for designers to follow. The strategy also leaves a space for the designer's creativity to take place and encourages mutual cooperative design thinking.

Keywords:
Lighting Design,
Retail Stores,
Buying Behaviour

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Introduction
The age where interior design and lighting were separate components of a design is a matter of the past. Business competition has intensified, with brands competing for consumer attention by targeting all the senses of the consumer. Of all our senses, lighting has a direct influence on moods, with 80% of sensory information coming from our eyes. From a retail perspective, lighting highlights architectural elements, and product qualities and creates virtual spaces. This affects how we feel in a space, our opinion of a product, and ultimately, our decision to purchase or not.

While lighting may be an afterthought for many retailers who are just starting, retail lighting goes much further than just providing a simple ambience. The function of lighting in a retail format can potentially have an extremely rich impact on your customer experience. Studies conducted have gone so far as to suggest that retail lighting design can influence a window shopper into becoming a loyal customer. Research has shown that well-thought-out lighting can affect cognitive purchase behaviour. As such, it makes sense for retailers to understand the kind of lighting best suited to showcase their product lines. New technologies, such as LEDs, now allow lighting to be fully incorporated into any architectural elements thereby opening up lighting opportunities exponentially. Retailers should roll out a lighting environment that is conducive to customers spending time and money in their store. To do that, retailers must think about how they want customers to feel when they walk into the store. Research indicates that cool white lights can make a space feel more spacious and would lend themselves to a modern, clean look. In contrast, warmer lights can make a customer feel safer and extend their shopping time in a comfortable environment.

In this paper, the researcher explores how a successful lighting design process for retailers can be achieved. Firstly, the product design process was introduced and then connected with lighting design. Then, lighting design for retails was explored and the relationship between lighting and buying behaviour was revealed. Case studies were analyzed to show clearly the role of lighting in retail stores.

Product Design Process
The product design process has various definitions. Many researchers attempted to define the product design process according to its aim, some work out to explore its steps, and others work through both sides of the design. The product design process describes the process of ideation, creating, and developing products that solve users' problems or address specific needs in a given market (Baxter, 2018). The key to successful product design is understanding the end-user customer, the person for whom the product is being created. Product designers attempt to solve real problems for real people by using empathy and knowledge of their prospective customers' habits, behaviours, frustrations, needs, and wants (Matzler & Hinterhuber, 1998).

Product design can be divided into three fundamental components:

- Appearance;
- Functionality;
- Quality.

Creating a successful, competitive product needs to carefully work out all these three points: an attractive, modern appearance; a convenient function that allows users to cope with their pain points (or achieve certain goals); maximum availability, high performance, and security (Ulrich, K., & Eppinger, 2011).

As for the requirements for product design, it all depends on the chosen target audience. There are two options: the first is when the product is designed for the widest possible audience, and it is almost impossible to determine who exactly will use it.

The second option implies the existence of clear customer requirements for product design (as a rule, they are presented in the form of requirements specification). Usually, the development company needs to submit several wireframes of the possible design that would correspond to all requirements, for the customer to choose the option they like most.

The product design process is divided into 5 main phases:

- Discussing plans for launching a new product within the team, brainstorming;
- Defining pain points (desires) of the consumer and solutions for their elimination (achievement);
- Developing strict product requirements (documenting technical specifications);
- Splitting the product implementation process into iterations;
- Testing and modifying the created solution based on real usage and target user experience.

These 5 phases can be implemented through ten steps which make the product design process. These ten steps are shown in figure (2) as follows:

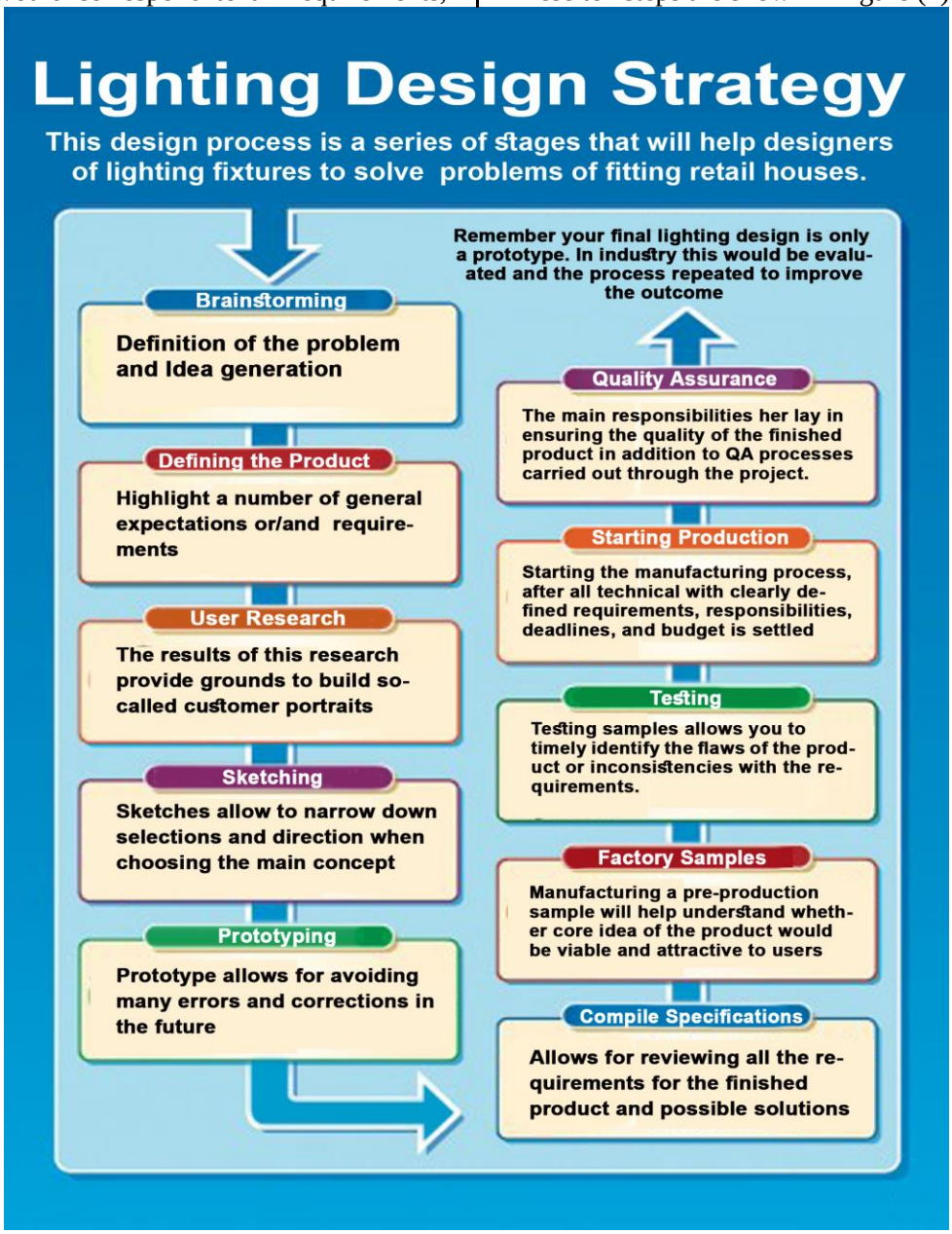

Figure (1) a scheme of the proposed design strategy

1. Brainstorming

The first step to designing a product is brainstorming, which appeared in 1953 in the United States. As a rule, two groups are created for its implementation. The first group includes people who generate ideas to solve the problem. The second group consists of a "commission" that deals with the processing of the proposed ideas. Brainstorming consists of three phases:

- In particular, you must announce the problem (in this case, the need to create the "right" product design) and select participants for both teams (Petersen & Joo, 2015).
- **Definition of the problem and Idea generation.** This stage involves the most creative approach. Participants of the brainstorming voice every idea they can imagine, however crazy it may sound. Here, quantity is important, not quality. (Von Hippel, 1978). Therefore, it is necessary to be guided by the following rules:
  - generate as many ideas as possible,
  - without any limitations;
  - even the most absurd and non-standard ideas should be considered;
  - ideas can and should be combined and improved;
  - no criticism is allowed – at this stage, ideas should not be evaluated in any way.
- **Selection of the most viable ideas among the proposed ones.** In this step, appreciation and criticism are welcome. This stage is usually conducted by the second team

2. Defining the Product

After brainstorming, when all the viable ideas for the future product are chosen, you need to highlight a certain number of general expectations (requirements) for its implementation. As a rule, the output is a fairly abstract list, the task of which is not to form an exact guideline on the development, but rather to determine the directions for further team activities.

3. Conducting the User Research

Research implies several aspects: market research to define the presence of competitors, the definition of trends, the assessment of the product's prospective longevity, etc. As a rule, this task is solved by marketers and business analysts. The results of this research provide grounds to build so-called customer portraits. In turn, these portraits would give your team a better understanding of what the final product should be. A properly-composed portrait includes such parameters as gender, age, marital status, income level, place of residence (geography), employment, job position, typical problems, needs, fears, desires, and so on (Miaskiewicz & Kozar, 2011).

In no case should you neglect this step in the hope of creating a universal product "for everyone"? With a high probability, you simply will not please anyone and drain your entire budget "into the pipe".

4. Sketching

Any large project with a significant budget will only benefit from the creation of sketches. Before time is invested in finding solutions, the direction of the search must be coordinated with the client. Sketches allow us to somewhat narrow down this very direction when choosing the main concept, and only then work with composition, layouts, edits, refinement of the concept, etc., would follow (Bao et al., 2018).

5. Prototyping

Creating a prototype is a no less crucial task than developing a design itself. Note that the obtained result is not a beautiful final appearance, but rather a "skeleton" of the future product's look. Nevertheless, it allows for demonstrating the functionality, ways of user interaction with the product and its basic appearance. The creation of the prototype allows for avoiding many errors and corrections in the future. This will help save time, money and nerves, for both the customer and the retailer (Hallgrimsson, 2012).

6. Compiling Specifications

The creation of a list of specifications is, in fact, the process of the above-mentioned requirement specification's elaboration. It allows for reviewing all the requirements for the finished product and possible solutions in maximum detail. Also, these specifications should contain the final delimitation of responsibilities, deadlines, and costs. These documents would be essential at the product development stage.

7. Producing the Factory Samples

Manufacturing the pre-production samples will help you understand whether the core idea of the product would be viable and attractive to real users or if, perhaps, it's worth shifting the activity vector to other key points (Ulrich & Eppinger, 2011). In the case of a physical product, it also allows an understanding of how much the varying manufacturing departments/manufacturing contractors are ready to produce the developed goods with the required speed and quality.

8. Testing

Testing samples allows you to timely identify the flaws of the product or inconsistencies with the requirements. That is before you even begin an expensive (as a rule) procedure of its implementation. Manufacturing and testing the samples can be iterated as much as needed until

they correspond to all the requirements and gain enough positive feedback from customers (Thomke, & Bell, 2001).

9. Starting the Production/Development

At the time of starting the manufacturing/development of the product, you will already have a full set of technical specifications with clearly defined requirements, tasks, responsibilities, deadlines, and budget settled. Your goal is to break the major tasks into smaller subtasks (so that the deadline for their implementation does not exceed several weeks) and assign priorities. In the software industry today, Agile methodologies are employed for this, such as Scrum or Kanban.

10. Providing

Quality assurance activities cover all stages of product development, including release and further maintenance. Nevertheless, their main responsibilities lay in ensuring the quality of the finished product (Elassy, 2015). In the case of app development, the QA team is responsible for pre-release testing conducted to ensure the quality of the released solution, its accordance with the requirements specification, and the expectations of the target audience (they are determined at the stage of forming the customer portraits).

Lighting Design

"Lighting" is the application of light to spaces. Where the light is placed, at what relative intensities, and in what direction, can have a major impact not only on vision and visual comfort but perception. Not just light, but the lighting equipment itself can also affect impressions of the space and its owner (Karlen et al., 2017).

Lighting, therefore, can impact satisfaction, visibility, task performance, safety, security, sales, mood and atmosphere, aesthetic judgment and social interaction. It also tells a story about the space, whether a given store is likely to be focused on discounts or high-end products, or whether a restaurant is selling fast food or a fine dining experience.

According to the previous, lighting design is a question of seeking maximum comfort in space, taking into account how light will influence this. Therefore, it is important to be sure that lighting design provides the following factors:

- To have the appropriate lighting levels for each space.
- That each of the areas is practical and pleasant.
- That people feel comfortable with each activity they do in a certain place.
- That as a result, the specific atmosphere that was sought in each place is obtained.

At the time of planning the lighting design, some factors should be taken into account aspects such as:

- The fulfilment of the lighting levels.
- The control of the lighting.
- The points of light.
- The uniformity of the light.
- Energy efficiency.

Retail Lighting Design

Shoppers may sense this, even if they don't understand why. A well-lit store provides a warm and inviting atmosphere for customers, and well-lit products attract a customer's attention. %80 of all sensory impressions come through our eyes. Thus, making your products inviting in today's retail environment means making the most of light (Schielke & Leudesdorff, 2015).

Retail lighting design should focus on the customer experience. Effective retail lighting should create an inviting atmosphere that encourages people to browse and explore your shop. Retail lighting that is too bright or uses too many contrasting colour temperatures can overwhelm the shopper's senses. Instead, strike the proper balance between ambient and accent lighting.

Selecting the correct colour temperature, which is measured by its K (kelvin) rating, of LED bulbs is integral to a retail space. Colour temperature can create either a warm or cold environment and affect how products are displayed.

For example, to produce a pure and more natural lighting effect which is ideal for dressing rooms and grocery stores, may consider installing 4000-4500K bulbs. Jewellery stores can use bright bulbs up to 5000K resulting in a bluish-white colour. Generally, the higher the CRI, the truer the product's colour appears under that light (Hinks & Shamey, 2011).

Strategically placed accent lighting can help draw attention to specific items or displays, while ambient lighting can provide an overall mood that makes shoppers feel comfortable in the space. It's important to find the right balance between highlighting product displays and not overwhelming shoppers with too much light.

Retail lighting design steps:

Based on the previous, the researcher developed 6 steps process to design lighting for retails. These steps are as the following:

1. Identifying the requirements

This involves gaining a full understanding of **what the lighting installation is intended to achieve**. This includes the following:

- Task Requirements:
  - Illuminance
  - Glare

- Mood of the space
- Relation to the shape of space
- Things to be emphasised
- Things to hide
- Direction of light
- Interaction of daylight

2. Determine the method of lighting

At this stage, consideration is given to **how the light is to be delivered**, e.g. will it be recessed, surface mounted, direct or indirect, or will up-lighting be used, and its primary characteristics, e.g. will it be prismatic, low brightness or mellow light (Russell et al, 2005).

Consideration should be given at this stage to the **use of daylight** to minimize the need for artificial light.

3. Select the lighting equipment

Once the method of lighting has been selected, the most appropriate light source can then be chosen followed by the luminaire. The following attributes should be studied when choosing the light source:

- Light output (lumens)
- Total input wattage
- Efficacy (lumens per Watt)
- Lifetime
- Physical size
- Subrightness/glare glare
- Colour characteristics
- Electrical characteristics
- Requirement for control gear
- Compatibility with existing electrical system
- Suitability for the operating environment

Several factors also affect luminaire choice:

- Characteristics of the light source and control gear
- Luminaire efficiency (% lamp light output transmitted out of the fixture)
- Light distribution
- Glare control
- Finish and appearance
- Size
- Accessibility of components for maintenance
- Ability to handle adverse operating conditions
- Aesthetics
- Thermal management

4. Calculate the lighting parameters

Lighting calculation methods fall into three broad categories:

1. Manual calculation methods
2. Three-dimensional modelling

4.1. Manual calculation methods

There is a wide range of manual computation methods for the calculation of different lighting aspects. These include complex methods for calculating the illuminance from a wide variety of shapes of luminous objects (Tian & Su, 2014). The majority of these have now been superseded by computer programs. One of the most used methods is the Lumen Method. This method was the mainstay for interior lighting and has remained in use as a quick and relatively accurate method of calculating interior illuminance.

The basic assumptions are:

- All the luminaires in the room are the same and have the same orientation
- The luminaires do not have a directional distribution and are aimed directly at the floor
- The luminaires are arranged in a uniform array on the ceiling and have the same mounting height
- The luminaires are spaced less than the maximum spacing to mounting height ratio nominated in the coefficient of utilization tables

The average illuminance produced by a lighting installation, or the number of luminaires required to achieve a specific average illuminance, can be calculated using utilization factors (UF), a UF being the ratio of the total flux received by a particular surface to the total lamp flux of the installation (Selim et al, 2020).

4.1.1. Lumen method formula

The **average illuminance E(h)** over **a reference surface s** can be calculated from the "lumen method" formula (Shikder et al, 2009).

$$E(h) = \frac{F \times n \times N \times LLF \times UF(s)}{\text{area of surface s}}$$

where:

- **F** – the initial bare lamp flux (lumens)
- **n** – the number of lamps per luminaire
- **N** – the number of luminaires
- **LLF** – the total light loss factor
- **UF(s)** – the utilization factor for the reference surface s of the chosen luminaire

Utilization factors can be determined for any surface or layout of luminaires. The **"UF" symbol** is normally shown followed by an extra letter in brackets, to denote the surface, for example, **UF(F) is the utilization factor for the floor cavity** and **UF(W) is the utilization factor for the walls.**

Although the lighting designer can calculate utilization factors, lighting companies publish utilization factors for standard conditions for their luminaires. The standard method of presentation is shown below. To use this table, it is only necessary

to know the Room Index and the effective reflectance of the three standard surfaces (floor cavity, walls and ceiling cavity) (Nazaruddin & Radzi, 2021).

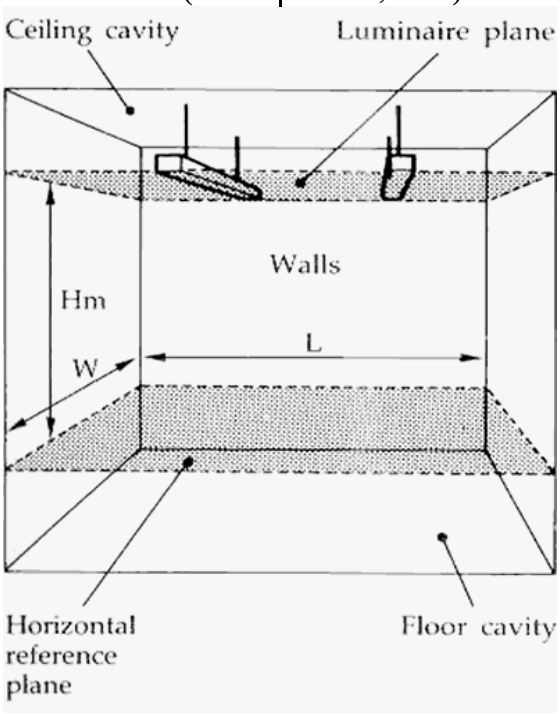

Figure 2 shows the Room Index Calculation

4.1.2. Room Index

The Room Index is a **measure of the angular size of the room** and is the ratio of the sum of the plan areas of the F and C surfaces to the area of the W surface. For rectangular rooms, the room index is given by:

$$RI = \frac{L \times W}{(L+W)H_m}$$

Where:

- **L** – the length of the room
- **W** – the width of the room
- $\mathbf{H_m}$ – the height of the luminaire plane above the horizontal reference plane.

If the room is re-entrant in shape, **for example, L-shaped**, then it must be divided into two or more non-re- entrant sections, which can be treated separately.

5. Determine the control system

The effectiveness and efficiency of any lighting installation are affected as much by the control system as by the light sources and fixtures were chosen chosen (Pandharipande & Caicedo, 2015). Consider to:

- Providing multiple switches to control the number of lights that come on at any one time. Using one switch to turn on all the lights in a large room is very inefficient.
- Placing switches at the exits from rooms and using two-way switching to encourage lights to be turned off when leaving the room.
- Using 'smart' light switches and fittings which use motion sensors to turn lights on and off automatically. These are useful in rooms used infrequently where lights may be left on by mistake, or for the elderly and disabled. Make sure they have a built-in daylight sensor so that the light doesn't turn on unnecessarily. Models which must be turned on manually and turned off automatically, but with a manual override, are preferable in most situations. Be aware that the sensors use some power continuously, up to 5W or even 10W in some cases.
- Using timers, daylight controls and motion sensors to switch outdoor security lights on and off automatically. controls are particularly useful for common areas, such as hallways, corridors and stairwells, in multi-unit housing.
- Using solar-powered lighting for garden and security lights.
- Using dimmer controls for incandescent lights (including halogens). This can save energy and also increase bulb life. Most standard fluorescent lamps cannot be dimmed, but special dimmers and lamps are available. If lamps are to be dimmed it is important to ensure that the correct equipment is used, especially when retrofitting more energy-efficient lamps.

6. Choice of Luminaire

The performance of a luminaire should be considered just as carefully as its cost (Cengiz, 2020). In the long term a well-designed, well-

constructed luminaire will be cheaper than a poor-quality unit; and the salient features of a good-quality luminaire are:

- Sound mechanical and electrical construction and a durable finish
- Adequate screening of high-luminance lamps to minimize discomfort and glare
- Adequate heat dissipation to prevent over-heating of the lamp, wiring and ancillary equipment
- High light output ratio with the appropriate light distribution
- Ease of installation, cleaning and maintenance

Case studies

In this section, the researcher selected some types of lighting that add value to retail stores through their use in lighting design. These types were used in famous brands such as LOUIS VUITTON Vuitton and SEPHORA.

Figure 3 shows famous brands' lighting design

1. Creating spatial depth with light

Bright zones in the shop visible from the outside signal to customers that it is open. Illumination of the rear and side walls with wall washers attracts customers into the shop and creates a bright, appealing overall impression, even in small shops. After the shop closes, individually illuminated zones are sufficient to display the merchandise in the evening and during the night., even in small shops. After the shop closes, individually illuminated zones are sufficient to display the merchandise in the evening and during the night (GmbH, 2021).

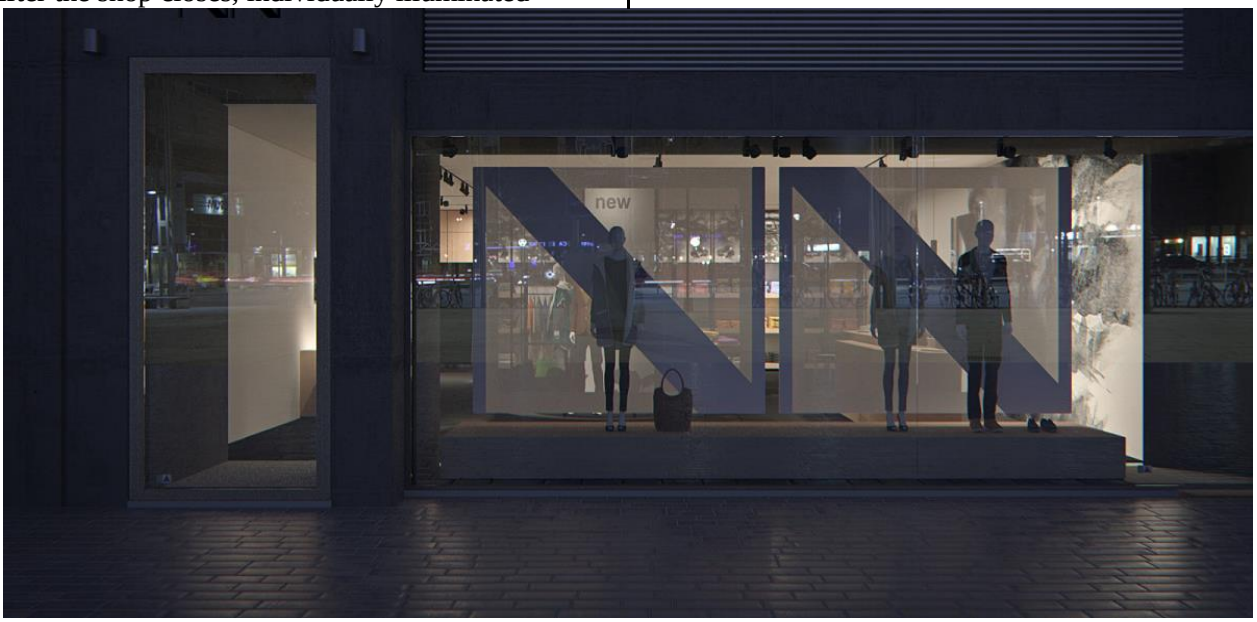

Figure 4

2. Highlighting points of interest with light

Bright-dark contrasts also create a lively impression. Focused brightness areas on vertical surfaces are indispensable for guiding the view of customers onto important seasonal merchandise. Narrow distribution accent lighting also creates intensive modelling and brilliance. Track luminaires with interchangeable light distributions provide a flexible infrastructure in such cases that individually coordinate accents to the specific merchandise groups (GmbH, 2021).

Figure 5

3. Creating room depth with light

Focused brightness areas along the most important axes of view also create an impression of distance in narrow rooms. The various accents send the eye on a trip of discovery. The room is given further depth with wall washing in the background, for example on largescale graphics (GmbH, 2021).

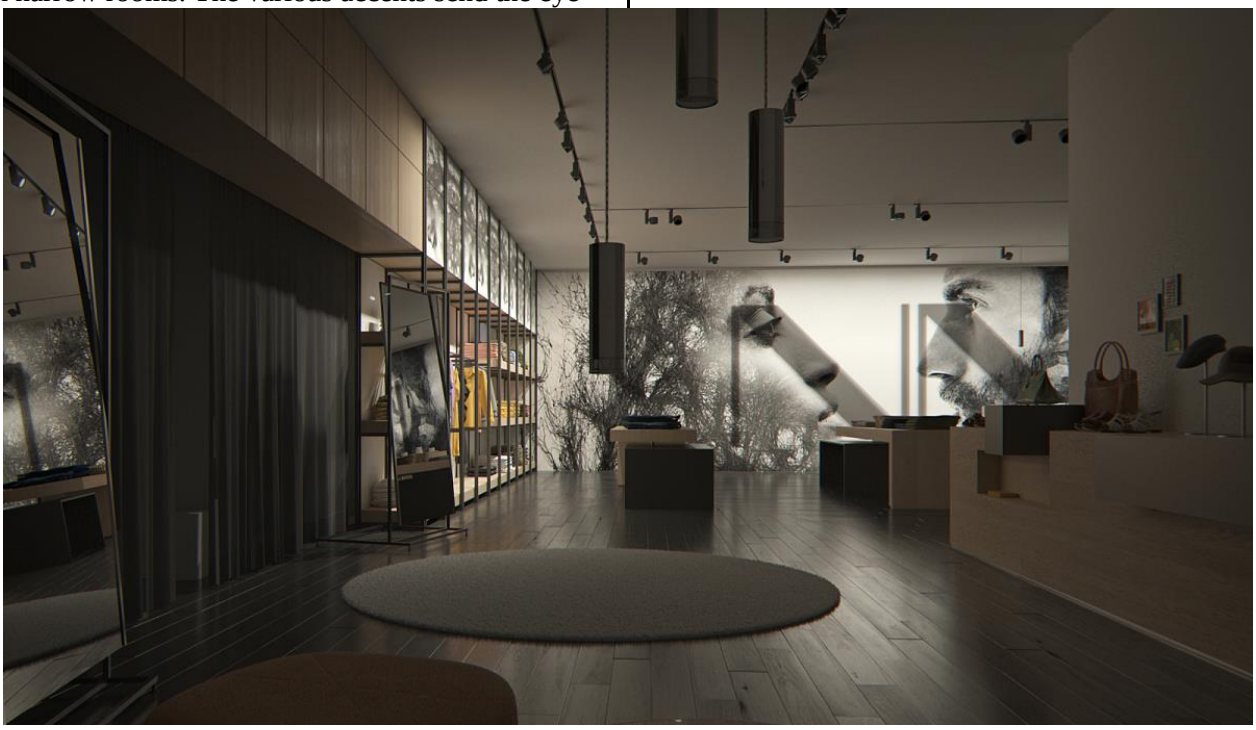

Figure 6

4. Avoiding glare

Visual comfort is a decisive aspect of shop lighting. Direct glare caused by poorly aligned luminaires or from excessively wide light distribution adversely affects the shopping experience (GmbH, 2021). The following measures minimize glare and optimize visual comfort:

- Align luminaires on display areas and not on circulation areas
- Observe the 30° rule
- Match the width of the light distribution to the display surface, e.g. by using

interchangeable lenses
- Try to achieve precise light control without spilling light

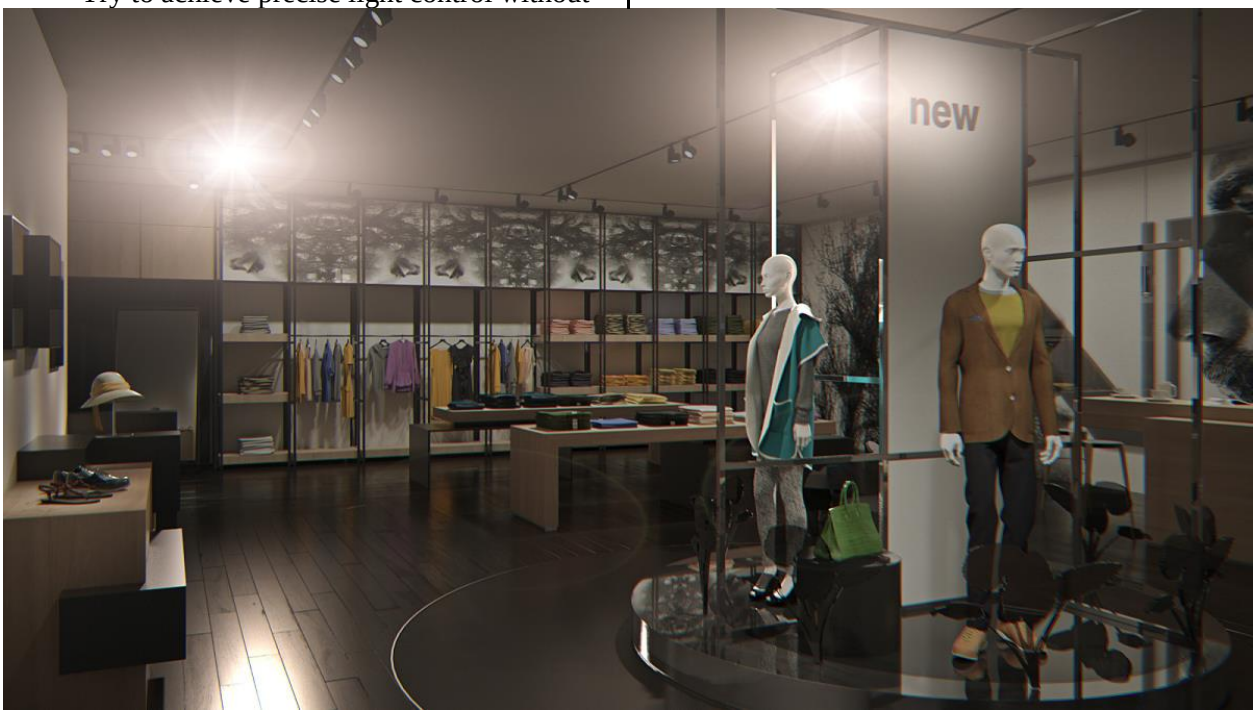

Figure 7

Discussion

Modern lighting options can help augment and amplify a brand strategy, providing an additional communication medium. For example, in retail cosmetic companies, most higher-end products are placed on illuminating shelves to highlight and contour the packaged product. By highlighting certain products, it allows the customer to pick out certain merchandise from background noise (other products). Further, architectural elements like accent lighting on lower shelves work to catch the eye of casual shoppers.

It was noticeable from case studies that dramatic lighting can make particular products look attractive which draws consumers one step closer to buying your product. Retailers are successfully deploying lighting as a part of the brand strategy because the lighting systems, are offered through manufacturers.

Lighting also plays a key role in buying behaviour of customers. brighter lights affect the buying decision of consumers in specific contexts. From an ecological perspective, using the lowest amount of energy for maximum impact is critical areas throughout the store. Contrasting light not only highlights certain dimensions of a product but also helps move customers along the buyer journey.

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