UNIVERSITY OF LIVERPOOL

School of Engineering

MNFG601

Product Design Specification

Group 1

Authors:

Jose Martin Salvador Medina, 201590959, 07426900191

Surendra Kumar Bandaru, 201596256, 07825039776

Swaraj Patra, 201596665, 07883130769

Karan Kumar Mahalingam, 201601989, 07577744170

15th of October 2021

Academic Guide: Dr Dan Hibbert

Table of Contents

1. General Product Description

The proposed product is a small LED light that will be attached to the user's wrist with the aid of a movable arm fixed to a wearable bracelet. The product is designed to be used in situations where light is limited and precise lighting is essential, these scenarios include writing, typing, fishing, watch repairing, electrical servicing, mechanical work, etc. Furthermore, the flexible arm will have an internal structure made from a wiring matrix which will allow a steady movement in 3 dimensions, this will provide an effective adjustment to the light beam. Additionally, The LED will be powered through USB connection and is intended to be connected to an external power bank, however in can also be used connected to any 5 volts USB input.

2. Commercial Considerations

2.1. The Customer

This product is targeted to consumers that carry out precise manual activities when light is restricted. Firstly, this device is aimed be for individuals who work in an industry where these scenarios happen commonly. These include mechanics, electricians, horologists, etc. Secondly, this device aims to attract interest from people whose hobbies may include precision and low lighting, some of these hobbies are fishing, reading, gardening, writing, knitting, etc. As precision work is essential for our targeted costumers, the device must allow full mobility of the wrist. Additionally, the product must be small, firm, and lightweight to not interfere with the user's arm centre of gravity. Furthermore, the bracelet must be comfortable as it may be used for extended periods of time. In addition, the USB cable should be strategically placed to not interfere with the users' movements.

A significant strength of the proposed product is that there is no direct competition in the market. Most devices available now provide illumination from LED'S positioned in places such as the forehead and the fingers, this does not provide precision lighting. For this reason, the position of the LED light is considered the products UPS.

Regarding the lifespan of the device, it is expected to be around 5000 hours. This is considered a conservative approximation because LED lights have a lifespan of 50000 hours (Greenlighting, 2019). This high reduction in the device's working life is due to the rest of the circuitry and other components.

This product will be very efficient in terms of production cost as it will be manufactured from low-cost components. For this reason, the sales price should be between 6-7 £, this would leave a profit margin of around 80%. The pricing of this product lands in the lower section of the price range which costumers are willing to pay for a product with the same applications, it was found that costumers pay between 6-15 £ for a comparable product. By being the lower-cost option in the market, it is expected to generate more cashflow, allowing the company to reinvested money into the business (Hayes, 2021).

2.2. The Market

The potential market size is estimated to be of 1734500 £. This is a conservative value as it is only considering the UK population which profession falls into our biggest targeted industries, and it is not considering smaller industries or hobbyist that might also be interested in the product. This data can be found bellow.

Profession	**Population**	**Source**
Electricians	259000	(Statista, 2020)
Mechanics	759000	(Institude of the Motor Industry, 2019)
Fishermen	12000	(Uk Parliament, 2020)
Total	346900	

The achievable market share for this product is expected to be relatively wide, this is because there is no product in the market which provides the same adjustable precision lighting capabilities. Additionally, because it is price will be lower than the competition, a future target market expansion is expected. This growth could be to smaller communities such as model airplanes afficionados, wax sculptures designers, etc.

The market for this product has been found to be very wide as it is aimed to a variety of different industries. However, because the objective of this device is to improve productivity and it is not crucial, marketing strategies demonstrating its usefulness are fundamental. This marketing campaigns will be done through online advertising; this is because this method was found to be the fastest way to reach the greatest number of potential customers from different industries (Kiang, 2015).

It is crucial that the brand name expresses the functionality of the product in development. Instance “Luminara” effortlessly expresses the market space in which the brand will be operating. Additionally, the name demonstrates the rugged but slick ambiance of the company. This is important because our targeted market includes

costumers in fields in which ruggedness is of importance, and hobbyist that value lightness and portability.

The proposed product will be sold under the name of “Light able” this name is expected to subconsciously explain to the consumer very efficiently what the product capabilities are. Additionally, as this product is design for a wide variety of different industries, this simple name was chosen as it does not specify the applications for any in particular, this will increase the chances to reach a larger market.

This device is expected to have a larger chance of expanding by being sold in large retail shops, such as Tesco, Sainsbury, Marks and Spencer’s and Asda. However, it is important to consider online platforms due to the drastic changes that our society is experiencing due to the ongoing pandemic. For this reason, it is believed that Amazon is a very good way to reach our targeted consumers and create brand exposure. Furthermore, after the first 8 to 10 months on the market and depending on successfulness of the product, a private website must be considered.

2.3. Competitor Information

This product will potentially acquire a high percentage share in the market, this is expected because it does not have any direct competitor. As stated in the previous section, there are comparable products which provide lighting, however these devices do not provide precision illumination. For this same reason, the product's UPS is considered to be its capability to deliver a more focused light beam to the workpiece.

The indirect competitors include big companies such as Led Lenser, Makita and DeWalt. These brands offer more high-ended products at a higher price that ranges from 30 to 100£. On the other hand, there are other smaller companies who offer comparable products but at a lower cost, with prices ranging from 6 to 15 £, most of these retailers make their sales through third parties e-commerce websites such as Amazon, eBay, and On Buy. Because nowadays is so simple for individuals to create a product and sell it through business schemes such as Amazon FBA (D, 2021), is anticipated that more competition will arise in the upcoming years.

As this is a product which could be simply replicated, it is expected that after launching the product existing brands start to develop a similar product resulting in a drop in sales (Investopedia, 2021). For this reason, it would be beneficial to protect this project through a patent. This patent could be for the locking system connecting the bracelet to the arm or the casing for the LED light.

3. Performance Specification

The Performance specification creates guidelines that helps to compare the device that is being designed with expected criteria. The designed model is to be assessed with multiple devices so that we can compare its utility, portability, and comfort in different scenarios alongside other devices that serve the same purpose.

- **Function**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Mass • The overall weight needs to be low. Device must be easy to carry and store. Doesn't strain the user while using	4	Intent- Keeping the total weight < 0.3kg
2.	Illumination: • Able to focus light to increase visibility of a specific area for clear visibility	5	Single LED on the board can produce between 40-50 lumens.
3.	Capacity- • Provide multifunctionality with simplest design while occupying less space and being user friendly.	5	Can be powered by a power bank or laptop for both indoor and outdoor applications. The size is easy to fit in a pocket.

4.	Lifespan: • Similar devices do not come with a warranty rather a return or replacement guarantee in case of a damaged product is delivered • The product is a utility wear so the lifespan depends on the how the product is used so no warranty can be issued.	3	Under good conditions the light should last for 5000hrs, which can be covered in warranty, but a lot of other factors can contribute to damaging the light.
5.	Scope and range: • Device is a wearable product, so it needs to fit a wide range of sizes • Brightness of the light needs to be able to pride user with good visibility.	3	Available in multiple sizes so it fits well to a wider range of customers. The designs have different holding mechanisms with some range of flexibility.
6.	Utilisation: • The light pointer and the holder need to be sturdy so that the light can be pointed to a required place with ease	4	The design is made with an intent to provide user with stable grip and ability to direct the light at different angles.
7.	Effectiveness & Efficiency: • Should be easy to set up and remove from the wrist.	4	The device is a wearable product for hand and can be used without being worn as well.

	• Should not take more than 5 minutes to wear and operate.		In both applications time to setup <5 min
8.	Storage: • Needs to be foldable so it does not take much space. • Must be light so it is easy to store.	3	Like most portable lights it should be easy to carry and access it with ease. Easy to fit in pocket, backpack, etc. without being damaged.
9.	Personalization: • Available in range of colours • Surface is suitable for digital printing	1	The product will have minimal branding so it's possible to personalize it.

- **Material**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Appearance: • Must fit in well with other tools and have utility tool vibe. • Simple looking design without any sharp edges.	3	This is a crucial factor as bad design can make it look more like a childish toy than a tool. Intent- The holding area needs to look simple and rugged; the light casing needs to compliment the lamp design and when folded all parts need to fit neatly.
2.	Colour: • It is important to choose the colour of the body carefully, so it does not look out of the place when using. • Using colours that are commonly found on tools and utility wear.	2	The product will consist of dark body and the casing for light should not reduce the intensity of light Intent- Preferably dark colours for the body like Black or Dark Green or Dark Blue.
3.	Conductivity:	4	It is essential that exterior is made of good, insulated casing to protect the wires and

	• Must have insulated body to not conduct heat. • Must have insulated body to protect the inner components. . • Must have properly working and conductive components on the inside		board which are conductive in nature. Intent- Body to be made of insulating materials like ABS and HDPE
4.	Density: • Must use low density material in the body to keep the overall product light. • Must be durable so different materials are used in various places	3	The light and strong body will make it more durable and comfortable to wear. Intent- A right balance needs to be found between amount of different material being used to retain the overall balance in the product
5.	Elasticity: • Must have a slightly elastic body to be able to fit to different wrist sizes	3	The body needs to be light and have a bit of elasticity to withstand damages. The flexible neck can be approached in many ways, but all need some elastic material.

	• Must be flexible contributing to its durability. • Must have a flexible neck to give it good coverage and reach		Intent- using TPU and aluminium wire for flexible neck or using segments and Aluminium wire to get the same effect.
6.	Hardness: • Should be hard enough to withstand small drops and impacts. • Excess hardness can make the body less flexible, so the right amount of hardness is necessary.	2	Material used are mostly plastic, so they have right amount of harness small scratches are less visible.
7.	Phases: • The product is made for operation in room temperature and withstand little heat so it should be solid in all the time.	4	The operational temp of body ranges from -20 to 80 C and 150 C for the PCB.
8.	Purity: • The purity of material affects the hardness but since higher hardness is	1	Materials that have good strength even after recycling should be used like HDPE.

	not needed it is suitable to made of recycled plastic		
9.	Recycling and potential: • The materials from the product should be highly recyclable. • The product could be made from other eco-friendly materials.	3	Proper disposal is needed so the PCB is recycled properly along with the wires and body.
10.	Strength: • The body needs to have high strength, so it doesn't break or damages while being used. • It should also be able to handle small impacts after it is stored	3	High strength material and appropriate material thickness will make it durable.
11.	Texture: • The body needs to be comfortable when used as it is a handheld device, • The product should not damage any other surfaces due to its texture	3	Smooth surface on the portions that will come in contact with skin. Surfaces that will have less skin contact can be made a bit rough to avoid scratches and provide grip.
12.	Viscosity: • The product should not exhibit any viscous	1	No viscous material is used.

	properties since all parts are rigid or flexible.		

- **Dependability**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Availability: • Availability as shelf product at tools store or hobbyist store. • Can also be sold for general use. • Available at most used online platforms.	2	Available for customers in both general stores as well as online platforms.
2.	Reliability: • It's not possible to give warranty but field testing can be done and advertised	3	Field testing on all possible scenarios.
3.	Modification: • It is hard to modify by a user. • Advised not to make any modifications	1	Although no modifications can be made the pro duct can be used for a variety of purposes.
4.	Maintainability: • Product doesn't need any maintenance.	1	No maintenance.
5.	Lifecycle cost:	1	LED PCB can be replaced if found defected.

	• No additional cost involved in its lifecycle.		
6.	Logistical support: • Product will also be available on various online platforms.	2	Delivery, Return/Replacement <1 week.
7.	Disposal: • Needs proper disposal as it contains parts that need to undergo different recycling processes	2	While disposing dispose under electronic waste.
8.	Level of service: • No service for maintenance or repair. • Only services regarding the purchase and delivery	1	Online services- Delivery, return, refund.
9.	Refurbishment: • Not enough value to refurbish	1	No refurbishment.
10.	Redundancy: • Portability and flexibility are key features.	2	No redundancy in range of movement.

- **Environment**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Access: • All joints and parts should be relatively accessible • It should be easy for an expert or trained professional to access it for maintenance or disposal purpose.	2	Easy to open for trained professional.
2.	Corrosion: • PCB and USB connector susceptible to corrosion. • Rest of body is made of plastic so corrosion can occur.	5	Should try avoiding using in places with high moisture.
3.	Erosion: • There is little to no chance for erosion. • In case erosion occurs, product will fail.	5	High erosion resistance.
4.	Force: • The product should function well even after being subjected to force and impact.	3	Should withstand drops and impacts.

5.	Mass: • The mass should be minimised to make use and storage effective.	4	Recommended weight on wrist for healthy function is 0.5 – 1% of body weight
6.	Noise, Vibration and Shock: • The product is shock proof. so, it can with stand shock throughout its life period.	3	Withstand heavy noise and impact.
7.	Pollution: • Must produce least amount of pollution as possible	3	Less pollution in packaging and transport. Most product should be recyclable.
8.	Radiation: • Product is not made for use in radioactive environment.	1	Not designed to resist radiation.
9.	Relative Humidity. • Product can withstand regular humid climate • But extreme humidity can cause corrosion	4	Can withstand a range of 30-50% humidity.
10.	Temperature: • Suitable to function in room temperature. • Places with high temp must be avoided as it may cause the casing to deform.	4	Working temp without deformation 50-80 C.

- **Ergonomics and Aesthetics**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Illumination: • Able to focus light to increase visibility of a specific spot.	5	Single LED on the board can produce between 40-50 lumens. Casing should be transparent, or the LED should be left open, so brightness does not reduce.
2.	Colour: • It is important to choose the colour of the body carefully, so it does not look out of the place when using. • Using colours that are commonly found on tools and utility wear.	2	Intent- Preferably dark colours for the body like Black or Dark Green or Dark Blue.
3.	Controls and display: • The device does not contain any display parts. • Only one switch to turn light ON and OFF	3	Controls and other features to be displayed in the packaging.
4.	Culture:	2	The product is simple and not offensive in any way.

	• Nothing culturally inappropriate in the product. • No advertisement of any offensive nature.		
5.	Signs and Indicators: • No additional sign or indicator present in device light turns on when switch is turned on.	1	Light turns on if switch is at ON position.
6.	Size and Shape: • The size and shape vary for different concepts. But all of them are made to fit size of a human fist.	3	The shape varies depending on how movement is achieved for the light to move flexibly.
7.	Transportability: • The size of product is small enough to fit in pocket or backpack with ease	4	Easy to carry anywhere.
8.	Visual Impact: • Easy to understand and simple design. • Should look like a tool.	3	Simple design and a rugged look

- **Interface**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Configuration: • Ability to be used in different configuration or positions. • Customer should be able to easily operate all functions.	4	All configurations to be displayed on the packaging and user manual.
2.	Compatibility: • The product can only be powered using a USB-A port. • The product can easily fit to most people. Different sizes available.	3	Can mostly be used with a power bank or laptop.
3.	Emissions: • All emissions during manufacturing, packaging, delivery, and disposal should be reduced.	2	Eco friendly or easily recyclable materials should be selected for manufacturing and packaging. Occupy less space so reduces emissions while being transported.
4.	Heat input and output:	3	Highly Insulative material is selected during material selection process.

	• Heat generated from the PCB is insulated by plastic • Can function in heat up to 80C		
5.	Local utilities: • Product is powered by electricity	2	Can only be powered by electricity from a USB port.
6.	Interchangeability: • The PCB can be changed in case of damage or wiring issue.	1	Not preferred but PCB can be replaced with ease by an expert.
7.	Use and abuse tolerance: • Not made for abusive use can withstand drops and small impacts.	2	Made to endure day to day use.
8.	Visibility: • All features and parts must be easily visible. • The range of visibility using light should be maximized.	5	Should be able to provide proper visibility wherever light is pointed.

- **Cost and Timing**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Unit cost: • Cost per unit online should be <£15 • Wholesale cost for order of 100 +pcs be <£10	4	Retail Cost per piece <£.15
2.	Transportation and storage: • Transportation and storage cost can be reduced by decreasing the volume and weight of product.	3	Compact packing and good material selection can reduce volume and weight, hence reducing the cost.
3.	Marketing and Sales factors: • The product needs to be marked showing its unique features. • Should market it on multiple platforms.	5	Refer marketing section.
4.	Installation and commissioning: • Easy to use, can be self-installed. • No need additional installation service available.	1	No installation services or commissioning.
5.	Customer support:	3	Delivery, return, refund, user manual and videos.

	• Online support on delivery and refund available. • User manual and videos available to make user familiar with the product.		

- **Training & safety**

Performance Specification			
No.	Description	Importance (1 - 5)	Notes
1.	Education: • No form of Training needed to use the product. • Only need to keep general health and safety in mind while using it.	3	General health and safety Guidelines.
2.	Documentation: • Much documentation not needed. • Proper copy of buying receipt, H&S guidelines and user manual needed.	2	Proper bill, user guide, caution, and safety instructions.
3.	Language: • Documentation supplied in few selected languages.	1	Following the UK market European countries shall be targeted therefore such languages as Czech, Slovakian, French, German, Lithuanian, Swedish and Norwegian must be accounted for
4.	Skills and experience: • No set of skills or experience is required only basic understating of	2	Easy to use, no prior experience required.

	what it can be useful for is enough.		
5.	Tools and equipment: • No additional tools required for operation. • To power it a USB-a port is needed	1	No additional tools required for use. Can be used by powering through power bank or Laptop.
6.	Accessibility: • No sharp edges or corners that may be safety concern while using it or storing it.	3	Safe to access and store without the need for extra cation.
7.	Cultural: • No offensive material used in the product. • No inappropriate branding related to the product.	4	No offensive use of material or branding.

2. Regulatory Requirements

Some possible hazardous situations regarding the design of this product involve, low voltage electrocution due to circuitry being in touch with water, possibility of burns due to overheating electrical components, the material use should be bio compactable in order to avoid skin allergies and probability of cuts due to sharp edges. Furthermore, the design of the proposed product must be in accordance with the safety standards and code of practice developed by the HSE (Health and Safety Executive) and The General Product Safety Regulations 2005.

The list below illustrates some of the General Safety Requirements stated in The General Product Safety Regulations 2005, the following must be taken into consideration:

- No producer shall place a product on the market unless the product is a safe product.
- No producer shall offer or agree to place a product on the market or expose or possess a product for placing on the market unless the product is a safe product.
- No producer shall offer or agree to supply a product or expose or possess a product for supply unless the product is a safe product.
- No producer shall supply a product unless the product is a safe product.

(Legislation.gov.uk, 2005)

To determine if a product is considered a “safe product,” the following is taken into consideration.

- The characteristics of the product, including its composition, packaging, instructions for assembly and, where applicable, instructions for installation and maintenance
- The effect of the product on other products, where it is foreseeable that it will be used with other products
- The presentation of the product, the labelling, any warnings and instructions for its use and disposal and any other indication or information regarding the product

- The categories of consumers at risk when using the product, in particular children and the elderly.

(Legislation.gov.uk, 2005)

The proposed product will not need CE marking, this is because it is not covered by the any of the scopes described in the New Approach Directives. (Department for Business, Energy & Industrial Strategy, 2020) (European Commision , 2021).

The product must go through various tests to be market ready. It must be checked for electrical safety and photobiological safety in different conditions and meet standards as per 2014/35/EU and DIN EN 60598, DIN EN 62471 and IEC/TR 62778. Then it must go through to tests to check the effect on functionality when exposed to various environmental factors. The device is then tested to determine its service life and effectiveness in different situations. The devise must be compatible with various power sources so it must be tested to check for thermal and electrical safety. As concern to environment the sustainability of the product is also tested.

Through working closely with British standards, BS 16365-1:2014- Specifications for Thermoplastic polyurethanes for moulding and extrusion –Designation system and basis, it ensures relative information for material selection.

4. Patents

It is essential to recognize the patents which might interfere with the design of the proposed product. The design and development phase ensures that patents are not infringed upon and, that all designs can be developed without any legal difficulties. Please find bellow the patents that apply for the development of this product.

Patent claims that may enable closer examination as the project expands

Sl. No	Patent Number	Title	Author
1	D369,429	Multiple flexible neck lamp	Huang, Thomas M

5. References

Department for Business, Energy & Industrial Strategy, 2020. *www.gov.uk.* [Online]
Available at: https://www.gov.uk/guidance/ce-marking
[Accessed 17 10 2021].

D, S., 2021. Elsevier. *Business Horizon, Winning the new channel war on Amazon and third-party platforms,* 13 09.pp. 2-4.

European Commision , 2021. *ec.europa.eu.* [Online]
Available at: https://ec.europa.eu/growth/single-market/goods/
[Accessed 17 10 2021].

Greenlighting, 2019. *Greenlighting.co.uk.* [Online]
Available at: https://greenlighting.co.uk/the-lifespan-of-an-led-bulb/#:~:text=LED%20bulbs%20afford%20in%20the,still%20make%20an%20attractive%20investment.
[Accessed 13 10 2021].

Hayes, A., 2021. *Investopedia.* [Online]
Available at: https://www.investopedia.com/terms/c/cashflow.asp
[Accessed 03 10 2021].

Health and Safety Executive, 2021. *Health and Safety Executive.* [Online]
Available at: https://www.hse.gov.uk/work-equipment-machinery/uk-law-design-supply-products.htm
[Accessed 16 10 2021].

Institude of the Motor Industry, 2019. *sthelens.* [Online]
Available at: https://www.sthelens.ac.uk/images/departments/school-leavers/documents/Motor-Vehicle/IMI_Automotive_Industry_Fact_Sheet.pdf
[Accessed 13 10 2021].

Investopedia, 2021. *Investopedia.* [Online]
Available at: https://www.investopedia.com/ask/answers/033115/what-strategies-do-companies-use-regain-market-share-they-have-lost.asp
[Accessed 14 10 2021].

Kiang, M. Y., 2015. *Elsevier.* [Online]
Available at: https://reader.elsevier.com/reader/sd/pii/S0167923699000627?token=FDE5E601B76D736A2D0778152979A0484B7FB2096C410451B460053F67377933FF02C6072D86907586CDB673EA4B0C1B&originRegion=eu-west-1&originCreation=20211014154416
[Accessed 14 10 2021].

Legislation.gov.uk, 2005. *Legislation.gov.uk.* [Online]
Available at: https://www.legislation.gov.uk/uksi/2005/1803/regulation/2/made
[Accessed 16 10 2021].
Statista, 2020. *Statista.* [Online]
Available at: https://www.statista.com/statistics/318824/numbers-of-electrical-and-electronic-trades-professionals-in-the-uk/
[Accessed 13 10 2021].

Uk Parliament, 2020. *commonslibrary.parliament.uk.* [Online]
Available at: https://commonslibrary.parliament.uk/research-briefings/sn02788/
[Accessed 13 10 2021].

Patents.justia.com, 2021. US Patent for Multiple flexible neck lamp Patent (Patent # D 369,429 issued April 30, 1996) - Justia Patents Search. [online] Available at: <https://patents.justia.com/patent/D369429> [Accessed 14 October 2021].

6. Bibliography

British Standards Institution, 2001. BS 16365-1:2014. Product Specifications– Part 1: Guide to preparation.

British Standards Institution, 1969. BS 4300-10:1969. Specifications for Thermoplastic polyurethanes for moulding and extrusion – For Designation system and basis.