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**Masters Degree**

**Programme**

**Product design**

## Abstract

This thesis sort to

- To study the existing operation lamps used in the field of crisis to reveal the strengths and weaknesses.
- To redesign and existing Operation Theatre lamp and improve it, based on the strengths and weaknesses of the existing Operation Theatre lamp

## Methods used

The Participatory Design approach was used

## Results

The humanitarian organization didn't have an operation lamp suited for their environment

LEG gives a maximum output of light if focused in area.

# **Chapter One**

## **1.0 Introduction**

This chapter seeks to address the following:

- Background to the study
- Research question
- Research Objectives
- Delimitation (Scope)
- Definition of terms
- Importance of the study
- Arrangement of the rest of the text
- References

### **1.1 Background to the study**

The idea behind this project is to redesign an operation lamp for the medical sector that help save lives in time of crisis (natural disaster).

Natural disaster has been occurring every now and then, causing lots of damage to the environment and endangering both human and animal lives.

Some examples of recent Crisis that has caused unprecedented devastation and great loss of life which have been etched in our minds due to the magnitude of the devastation are

- The earthquake that occurred recently in Haiti on January 12, 2010. 1

- The earthquake which occurred in Chile on February 28, 2010. 2
- The land slide in Uganda which happened on March 3, 2010. 3
- The tsunami which occurred in Asia on December 26, 2004. 4

Good lighting is very essential to the humanitarian organization to work with, in times of crisis.

Examples of such humanitarian organizations are the Red Cross, Norwegian Peoples Aid, Norwegian Church Aid, Care, Redd Barna, Noreps (Norwegian Emergency Preparedness System) these are but a few of some humanitarian organizations.

In crisis situations there is usually chaos everywhere within the disaster zone, and getting electricity to power electrical equipment becomes a bit of a challenge, and since everything is not in order the need for a lamp that could be carried around with ease and function in the environment in which they find themselves is also very important for the humanitarian organizations.

There is the need for the medical crew to have lights for long hours to enable them to save as many lives as they can.

## 1.2 Research question

How can an Operation Theatre lamp be redesigned for crisis area.

### 1.3 Research Objectives

- To study the existing operation lamps used in the field of crisis to reveal the strengths and weaknesses.
- To redesign and existing Operation Theatre lamp and improve it, based on the strengths and weaknesses of the existing Operation Theatre lamp

### 1.4 Delimitation (Scope)

The project seeks to focus on humanitarian organization (medical people), on their equipments used on the field of crisis.

There are different types of equipment used by the humanitarian organization to help save lives during crisis situation. This project addresses or target the lights used by the medical people. Specifically the operation theater lamp (O.T) used on the field of crisis.

The sun is the source of life. Its influence, however, extends far beyond instilling life. Its light affects well-being, moods and health. It makes us happy and gives us unforgettable moments. Its influence on people is immeasurable. These positive effects of natural light serve as a benchmark for us in everything we do.

And thanks to the latest technology and intelligent lighting solutions, we are now able to create artificial light that does more than just illuminate an area.

Therefore, there is the need for the humanitarian organization to have good lighting to work with for efficiency and accuracy.

#### 1.4 Definition of terms

The definitions provided are strictly used in the context of this study.

**Crisis:** Crisis in this project, refers to unfortunate events caused by natural disasters where majority of people needs medical attention. Such as, flood, tornado, volcano eruption, earthquake, or landslide, epidemic, outbreak, war, and major accident.

**Natural disaster:** are extreme, sudden events caused by environmental factors that injure people and damage property. Examples of natural disasters are earthquakes, windstorms, floods, tornado, volcano eruption, landslide, global warming, epidemic outbreak, war, and major accidents. Natural disaster can strike anywhere on earth, often without warning.

**Operation Theater lamps (O.T):** An operation theater lamp is a special type of lamp used by the medical people in times of crisis.

**Humanitarian organization:** they are nonprofit organizations that provide aids to people who have been hit with natural disaster.

## 1.6 Importance of the study

- The humanitarian organizations will have the benefit from, having lights that will help them save lives in times of crisis.
- The society will benefit from this, in the sense that, more hands will be available to rebuild the tragedy that has befallen them.
- The idea could be adopted by developing countries who don't have stable electricity not to rely too much of on the country's main source of electricity for power

## 1.7 Arrangement of the rest of the text

The rest of the text is arranged with chapter two focusing on review of related literature, chapter three, design methodology; chapter four, results and discussion and chapter five the summary, conclusions and recommendations for the study. The bibliography has been arranged according to books and documents and Internet sources.

## References

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4. <http://www.globalissues.org/article/523/asian-earthquake-and-tsunami-disaster>



## **Chapter Two**

### **2.0 Review of related literature**

This chapter discusses:

Operation lamps

Crisis

Redesign

#### **2.1 Operation lamps**

Research was made on OT lamps to get adequate information about the lamp and also to be well equipped for this task. Research was made on the types of lights and bulbs used in OT lamps, the types of OT lamps and also so functions of the OT lamps.

Types of medical lights

There are two main types of lights used in the hospitals or clinics and majority of the medical sectors like the Red Cross.

- Observation light
- Operation lights

Observation lights: the observation lights mostly come in the form of hand held equipments, like the Otoscope or Auriscope (An Otoscope is a medical device which is used to look into the ears), optical lamp (an optical light is a medical device used to look at the eyes), X ray light, to mention a few of observation lights used.

The operation lights: the light used for conduction surgeries in the hospitals, known as the OT lamp. 1

## Types of OT lamps

A general research was made on medical OT lamps. From the information acquired from various sources the lamps were grouped into three

- Ceiling operation lamp
- Standing operation lamps / Trolley operation lamp
- Head lights operation lamps 2

### Ceiling operation lamps:

Ceiling operation lamps are designed to be mounted on the ceiling just as the name implies. They come in different shape and sizes. Some of which are designed for a specialized type of surgery. These are mostly used in the hospitals, especially in rooms designed for surgery.

They are mounded on the ceiling and the advantage with the ceiling lamp is that it does not get in the way of the medical people when working.





Figure 001. Operation theatre ceiling lamps

Some functions of the stand operation lamps / Trolley operation lamp

- Control switch for the light(s)
- Adjustability of the height of the lamp,
- Some come with infrared filter and steady illuminations to cast very little shadow or no shadow
- The lamp is designed to be rotated in all directions that is, both 'X' and 'Y' axis
- Quick focus
- Removable handles for sterilization
- Key pad on the lamp housing
- Some are designed with laser light to pin point a particular place during surgery

### Standing operation lamps/ Trolley operation lamp:

These lamps are designed to stand and move around some of them are designed to have all the capabilities of the ceiling operation lamps, the only difference is that these type of lamps are designed to be moved around.



Figure 002. Operation theatre standing lamps

### Some functions of the stand operation lamps / Trolley operation lamp

- Control switch for the light(s)
- Adjustability of the height of the lamp,
- Some come with infrared filter and steady illuminations to cast very little shadow or no shadow
- The lamp is designed to be rotated in all directions that is, both 'X' and 'Y' axis
- Quick focus
- Removable handles for sterilization
- Key pad on the lamp housing
- Some are designed with laser light to pin point a particular place during surgery

4

### Head lights operation lamps

Head lamps are mostly used by physician and dentist. These are special lamps worn on the head for special surgery. They mostly run of battery.

Dentist occasionally used them for observation purposes.



Figure 003. Operation head lamps

Some features and functions that come with the head lamps are;

- Joystick for accurate and easy positioning, removable for sterilization
- Adjustable spot light
- Adjustable crown support
- Detachable/Replaceable perspiration cushions (foam or leather)
- Battery Charger 5

#### OT lamp bulbs

It was discovered that there are two main types of bulbs used in OT lamps.

- Halogen bulbs
- LED bulbs (light-emitting diode)

Halogen bulbs: Before this type of bulb was introduced the conventional bulbs were been used. Halogen bulbs are type of incandescent light bulb, introduced in 1958. The halogen bulb is capable of burning much more brightly than conventional light bulbs, and it is a popular choice for headlights and other applications for which very bright light is needed. In addition to burning more brightly, halogen bulbs are also more efficient and have a longer life expectancy than conventional light bulbs. 6



Figure 004.Variation of halogen bulbs

#### Advantages of Halogen bulbs

The design of the halogen bulb has one very interesting property: halogen gas can combine with tungsten vapour and redeposit it on the filament of the bulb, thereby recycling energy and making the bulb last longer. The heat that halogen bulbs emit is used in the chemical reaction between the tungsten and the halogen gases, and this increases the efficiency of the bulb immensely. The halogen bulb can be heated more than a conventional light bulb, which will result in brighter light as well as more recycling ability.

#### Disadvantages of Halogen bulbs

Halogen bulbs get much hotter than conventional bulbs and can cause burns if handled. Handling a halogen bulb with bare hands exposes the quartz to salts and oils in the hands and may cause a weak point. This will decrease the life of the bulb, and it is recommended that halogen bulbs be handled with gloves or cloth to prevent unnecessary contact. Halogen bulbs have a shorter life span of about 4 to 5 months.

During transportation care must be taken since the bulbs are not that strong.

It is more difficult to direct the beam of the light in one direction as illustrated below. 7

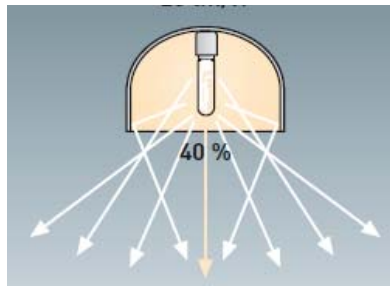


Figure 005. Direct reflector of a halogen bulb

LED bulbs (light-emitting diode): The LED is based on the semiconductor diode. When a diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the colour of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor.



Figure 006.Variation of LED bulbs



## Advantages of LED

LED bulbs can emit light of an intended colour without the use of the colour filters that traditional lighting methods require, this make LED bulbs less costly. LED bulbs are very easy to dim either by pulse-width modulation (is a very efficient way of providing intermediate amounts of electrical power between fully on and fully off. A simple power switch with a typical power source provides full power only when switched on) or lowering the forward current.

LED bulbs consumption lower energy and have a longer lifetime of approximately 7 to 8 years. It mechanically robust, making LED produces easy to transport. LED bulbs have faster switching capability when switched on or off. LED bulbs are also smaller size (smaller than 2 mm<sup>2</sup>) and are easily populated onto printed circuit boards. With LED bulbs it is easy for the beams or the light to be directed in one direction as illustrated below.

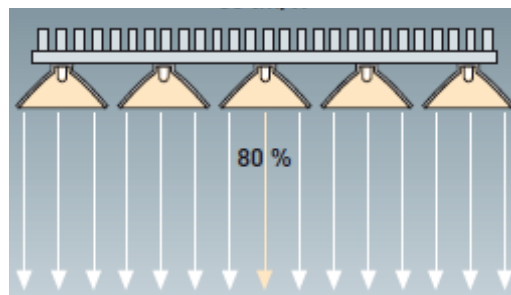


Figure 007. Direct light beam with high success on LED

## Disadvantages of LED bulbs

LEDs must be supplied with the voltage above the threshold and a current below the rating. This can involve series resistors or current-regulated power supplies. 8

## Findings found on both the LED and halogen bulbs

It was discovered that, the way LED bulbs give off heat and the way halogen bulbs give off heat are completely opposite. Halogen bulbs give off heat from the light they output, warming up the rooms they light. LEDs give off heat from behind the light source, and if this is not dispersed correctly the LED will lose its brightness and eventually stop working.

The way LEDs disperse their heat is by use of a heat sink. The heat sink is a surface of metal, usually aluminium, attached to the LED. The heat is transferred into this heat sink and then into the air. The amount of surface area you need to disperse heat from an LED is largely debated, but the generally agreed rule is that you need 30cm<sup>2</sup> per Watt of energy consumed by the bulb. For example, a 5 Watt bulb needs 150cm<sup>2</sup> of surface area to disperse the heat. 9

Research on LED bulb best suited for this project was made. The High Powered LEDs are best bulbs to be used for this project in terms of good lighting for surgical purposes.

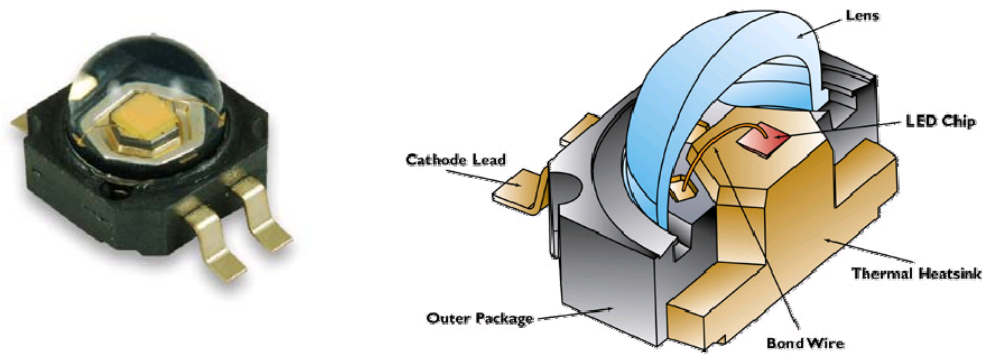


Figure 008. Direct reflector of an LED

The High Powered Led has a Lens coving it, the lens focuses the beam of the light in one directions. Having more diodes focusing in one direction greatly increases the luminance of the light.

## 2.2 Crisis and crises areas

Crisis is defined as “a situation that has reached an extremely difficult or dangerous point”. 10

Crisis' refers to an event that affects many people and large sections of society, and threatens basic values and functions. A crisis is a state of affairs that cannot be handled using the regular resources and systems. A crisis is unexpected, beyond the range of regular or commonplace events, and resolving a crisis requires coordinated measures by several actors. A crisis can occur as a result of, for example, a natural disaster, a major accident, an epidemic, fire or a computer system crash. 11

Some books and other sources argue that these crisis that befall us, is as a result of some activates of mankind that results in the natural disaster.

A natural disaster is the result of when a natural hazard affects humans. The amount of human vulnerability is the factor that leads to financial, environmental, or human impact. The amount of damage and the death toll from a natural disaster usually depends on the ability of the population to resist, prepare, or lessen the affects of a natural disaster. The general notion is that “natural disasters happen when hazards collide with vulnerability. This means that natural disasters do not occur in an area that is not populated by humans. 12

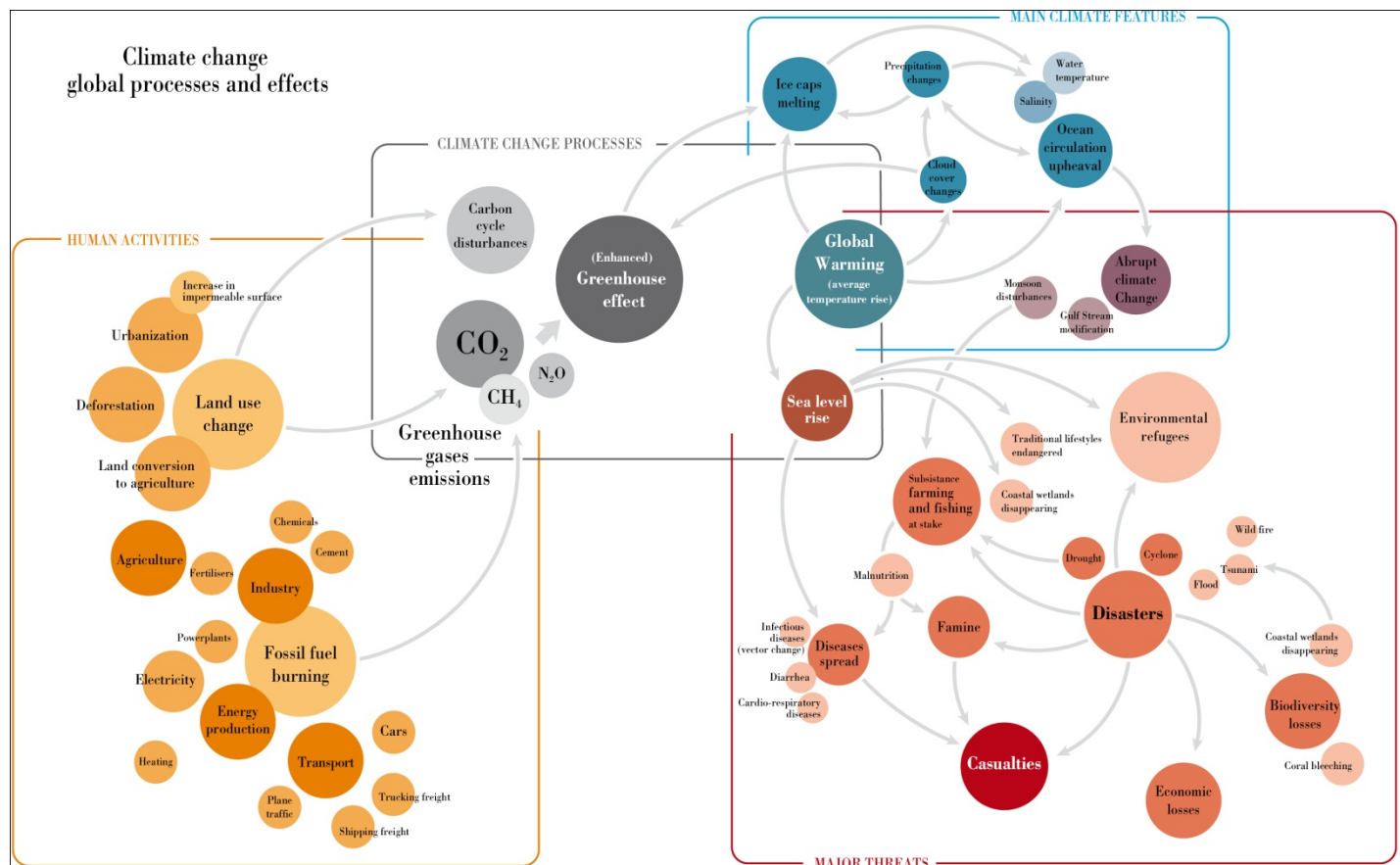


Figure 008. A cart of some human activities which leads natural disasters

The cart illustrates some human involvement that leads to natural disaster. The trend in the illustration goes in the other of human activities that leads to climate change processed, which also leads to the main climate features then finally to the major threats that befall us as crisis.

Awareness of these arguments has been made by most developed countries and have taken some drastic measures to reduce the activities that contributors to these threats.

There are several types of natural disasters that may occur and the type of disaster usually depends on the geographic location in which a population of humans resides. For instance, an avalanche occurs in areas of mountainous terrain and a cold environment. The following natural disasters are common to happen throughout the world:

- Avalanche
- Earthquake
- Flood
- Tornadoes
- Landslide

The cart below show the trends in number of natural disaster from the 1900 – 2000.

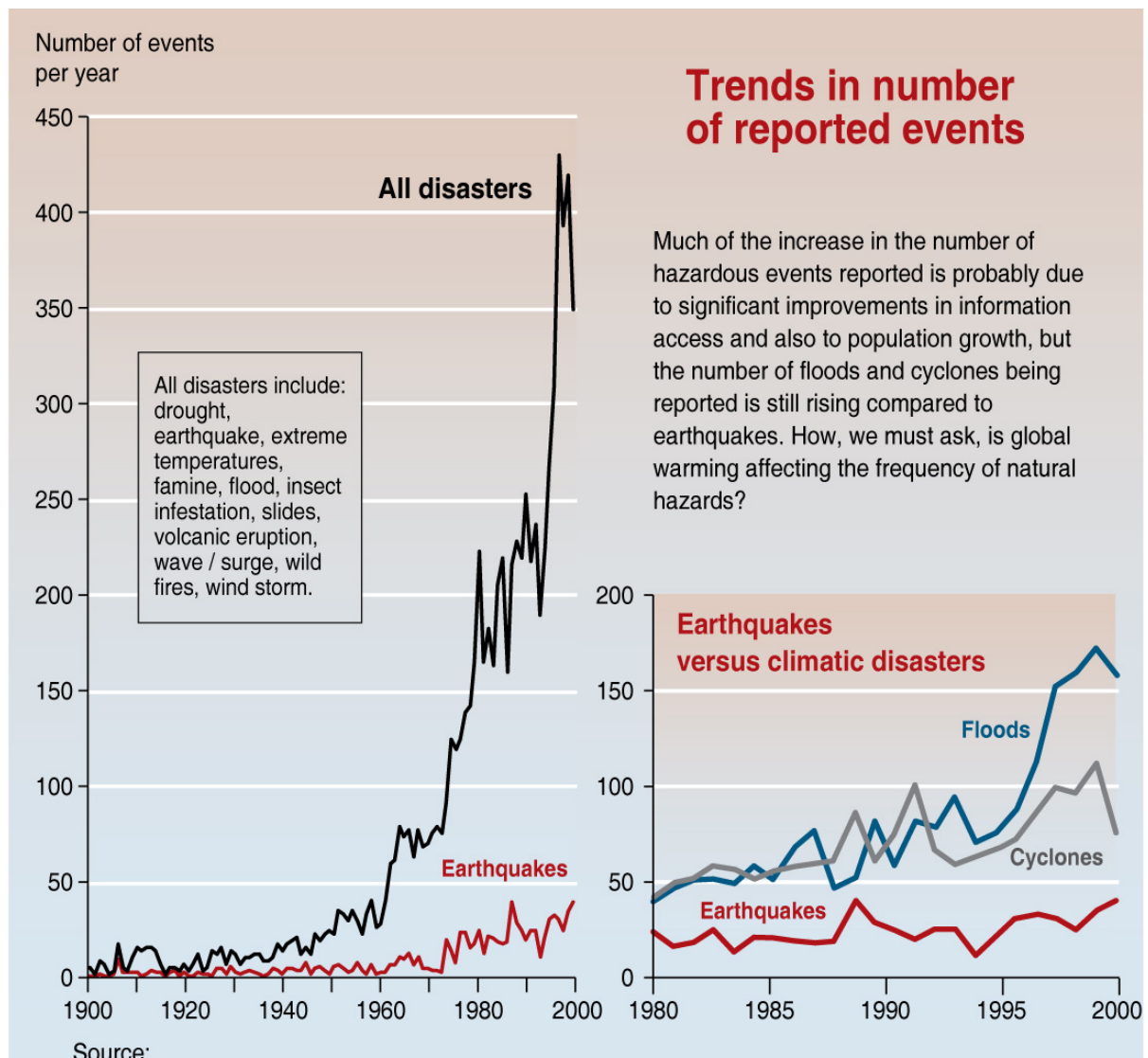


Figure 009. A cart of trends in number of reported events of natural disaster

Number of natural disasters by type: regional distribution  
1991-2005

	Hydrometeorological disasters							Geological disasters			Biological disasters			
	Drought	Extreme Temperature	Flood	Slide	Wild Fire	Wind Storm	Total	Earthquake & Tsunami	Volcano	Total	Epidemic	Insect Infestation	Total	Total
Africa														
Eastern Africa	87		132	7	2	46	274	11	3	14	146	3	149	437
Middle Africa	8		37	2	2	1	50	1	1	2	50	2	52	104
Northern Africa	9	6	56	2	2	9	84	12		12	19	2	21	117
Southern Africa	23	1	24	1	7	17	73	2		2	12		12	87
Western Africa	18	2	87	2	2	15	126		1	1	151	8	159	286
Sub-total	145	9	336	14	15	88	607	26	5	31	378	15	393	1031
Americas														
Caribbean	6		44	2	2	95	149	5	4	9	6		6	164
Central America	20	13	82	12	7	76	210	31	19	50	30		30	290
North America	8	11	90	1	56	236	402	10	1	11	9		9	422
South America	23	21	165	46	20	36	311	34	10	44	28	3	31	386
Sub-total	57	45	381	61	85	443	1072	80	34	114	73	3	76	1262
Asia														
Eastern Asia	31	8	132	34	8	219	432	81	5	86	17	1	18	536
South Central Asia	22	47	285	63	7	137	561	95		95	103	4	107	763
South East Asia	25		198	47	13	140	423	56	23	79	61	1	62	564
Western Asia	13	11	57	7	5	23	116	38		38	12		12	166
Sub-total	91	66	672	151	33	519	1532	270	28	298	193	6	199	2029
Europe														
Eastern Europe	7	46	108	10	23	47	241	12		12	19	1	20	273
Northern Europe	2	12	22	2		27	65	2	1	3	6		6	74
Southern Europe	9	19	70	5	25	20	148	22	2	24	10		10	182
Western Europe	1	19	60	6	3	38	127	5		5	6		6	138
Sub-total	19	96	260	23	51	132	581	41	3	44	41	1	42	667
Oceania														
Australia	6	5	36	2	11	49	109	1	1	2	2	2	4	115
Melanesia	5		9	5	1	24	44	11	9	20	5		5	69
Micronesia	2					10	12	1		1	2		2	15
Polynesia	1			2		16	19	1		1	2		2	22
Sub-total	14	5	45	9	12	99	184	14	10	24	11	2	13	221
Total	326	221	1694	258	196	1281	3976	431	80	511	696	27	723	5210

Figure 010. Number of natural disasters worldwide from 1991-2005 by type

## Trends in natural disasters

With growing population and infrastructures the world's exposure to natural hazards is inevitably increasing. This is particularly true as the strongest population growth is located in coastal areas (with greater exposure to floods, cyclones and tidal waves). To make matters worse any land remaining available for urban growth is generally risk-

prone, for instance flood plains or steep slopes subject to landslides. The statistics in this graphic reveal an exponential increase in disasters. 13

## 2.3 Redesign

Researches on what it entails when redesigning a product was conducted. The Merriam-Webster dictionary defines redesign as, to revise in appearance, function, or content of a product.

Based on the definition further research was done on the terms 'functionality' and 'ergonomics' to get a clearer picture on what to consider when redesigning the lamp.

### Functionality

The term functionality is defined as designing something to be practical and useful rather than attractive. Other sources had different definition about the word functionality, Merriam-Webster had the definition of functionality as, the particular set of functions or capabilities associated with computer software or hardware or an electronic device. 14

### Ergonomics

Ergonomics is defined as the study of people while they use equipment in specific environments to perform certain tasks. 15

Ergonomics seeks to minimize adverse effects of the environment upon people and thus to enable each person to maximize his or her contribution to a given job.





Figure 012. Exploration into the term 'ergonomics'

Figure 012, shows a worker behind her desk in a correct posture, putting less strain on her body to maximize her working output.



Figure 013. Exploration into 'ergonomics products'

## Product communication

Research was made on the role of signs on products, what role they play on products and what it communicates to users. This research seeks to find if there is a necessity for an OT lamp to have signs on them.

A researcher Monö's, states that a user interprets a product and its corresponding properties through semiotic signs. These signs are embodied within the visual form. In addition, Monö claims that there are three types of product signs. These signs are as follows:

### Icon:

Icon is a sign which shares a direct visual resemblance to what it signifies.

### Symbol:

A sign that has no direct visual correlation to what it signifies. The interpretations of symbolic signs are completely dependent on the socio-cultural background of the user.

### Index:

A sign which has a causal relation or physical connection to what it signifies.

Monö also states that products communicate their practical qualities using the following four semantic functions:

To Identify: Communicate origin, location, category or brand

To Describe: Communicate purpose or mode of operation

To Express: Communicate properties

To Exhort: Communicate desired reactions 1

#### 2.4 Conclusion on relevant literature for work

Some of the literature relevant pertaining to the project seems very relevant for the project. This information will help in the designing of the lamp and what to consider when designing.

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## **Chapter Three**

### **3.0 Design Methodology**

#### **3.1 Approach and method used:**

The Participatory Design approach was used in acquiring information.

Participatory Design:

Participatory design (known before as 'Cooperative Design') is an approach to design that attempts to actively involve all stakeholders (e.g. employees, partners, customers, citizens, end users) in the design process to help ensure that the product designed meets their needs and is usable. The term is used in a variety of fields e.g. software design, urban design, architecture, landscape architecture, product design, sustainability, planning or even medicine as a way of creating environments that are more responsive and appropriate to their inhabitants' and users' cultural, emotional, spiritual and practical needs.<sup>1</sup>

In order to come up with a design to suit the intended environment, the participatory approach was used to get the relevant information for the lamp.

The involved users were nurses from Asker og Barum Sykehus, the participation with the nurses in Asker og Barum Sykehus was to find out how the lamp is used outside the field of crisis. This was to have a brief idea on how well the OT lamps works at the hospital.

The Red Cross was also included using the Participatory Design, this was done by interviewing them on how they use the OT lamps on the field of crisis.

This was done to make the uses of the OT lamps participate in the design data collection stage. The participation of the Red Cross will have an influence of the design of the lamp, which will suit them better than without their participation.

The Participatory Design approach was used also when acquiring information from Luxo. With their experience and knowledge in OT lamps, during discussions their view on what to consider when designing an OT lamp were talked about and also what to look out for when designing for crisis situation.

### 3.2 Data collecting instruments

This study made use of the interview and questionnaire tools to collect data

#### Interviews

The interview can be described as a verbal questionnaire used to seek the views of people concerning given issues or events. This is done usually on a face-to-face verbal approach rather than asking interviewees to write. First, a rapport is established, and then the interview conducted.

Questions asked are of two forms: the open-form and the closed-form. The open-form calls for a free response in the respondent's own words, while the closed-form call for short check responses.

Information was collected by interviewing nurses, a field worker from Red Cross, an OT lamp designer from Luxo. The open – form type of questions were used in acquiring data.

### Questionnaires

The questionnaire is a data collecting instrument used to gather factual information, opposed to opinions. Questions are well designed and put on paper (usually), then, given to prospective respondents.

As with interviews, the open-form and or closed-form of questions are asked. For effective response from respondents, rapport is established and the purpose of the study explained. In a face-to-face encounter, clarification is given to respondents on items that are not clear or easy to understand. Where it is impossible to establish physical, face-to-face contact with respondents, the mailed form of questionnaire is used.

### 3.3 Collaboration with stakeholders

Stakeholders collaborated with were the

- Red Cross organization,
- Luxo
- Asker og Barum Sykehus

Red Cross: This organization delivers significant contributions in the event of a crisis. Their primary focus is on the disaster relief and recovery aspect of emergency management. Their goal is to “improve the lives of vulnerable people by mobilizing the power of humanity” by promoting humanitarian principals and values, educating the public for better preparedness, and to supplementing the societies with youth activities. The Red Cross was part of my stakeholders, because they are the part of the target users of the product. They have the experience in the field and know what goes on there. Without involving the Red Cross it will be just like producing a product that will not suit their use. 2

Their involvement was the back bone of the design.

Luxo: (An organization that deals with lights and lamps of various types including medical equipment such as OT lamps, observation lamps) 3



Figure 013. Images of some medical lamps produced my Luxo



Luxo became a part of the stakeholders because of their broad knowledge with medical equipments. They have vital information on what to look out for when designing a product for the medical sector. They also have information on what is new on the market in terms of new technology, materials, rules and regulations updates on the medical field, to mention a few of them.

Asker og Barum Sykehus: It is a general hospital. The main stakeholders involved where nurses from the delivery department. This stakeholder was involved to acquire information on the OT lamp outside the crisis field.

### 3.4 Data collecting procedures

Data was collected mainly from the stakeholders, at Asker og Barum Sykehus, two nurses at the labor ward section were interviewed on how they use the OT lamps.

Feedback from them was that, the lamps was used only after delivery to check if the womb(the uterus of the human female) of the now nursing mother is ok and examine her to make sure there were no complications.

Their opinion on the OT lamp used in the labor ward was discussed and feedback got was

- It take a longer time to repair when it broken down.
- Patients do complain of the hash light that emits from the lamp
- The focusing of the light at times gets a bit tricky to get it right. 4



Figure 014. Images taken at Asker og Barum Sykehus

The Red Cross was also interviewed, since they are part of the targeted group or users of this product. A practitioner on the medical sector was interviewed on how they get their OT lamps and how they were used on the field in times of crisis.

The responds was, the Red Cross buy parts of medical equipments and make a mini like surgeon room in a container delivered to places were crisis occur. This type of aid is done by a few countries and Norway is one them.

The OT lamps used currently on the field of crisis are the same OT lamps used in the hospitals. There are normally two OT lamps in one container, usually of the same type of lamp and the same light output. The difference is that one is a ceiling mounted lamp and other a standing lamp or a trolley lamp. Both lamps used that is, when there are lots of patients to attend to, and one lamp gets heated up due to the heat from the bulbs. The lamps are changed during or after the surgery. Depending on the decision of the surgeon, this is done in order to prevent the patient's tissue from drying out and provides favorable working condition for the surgeon and his or her crew.

The practitioner added that there were cases where by the container couldn't get to due to the nature of the landscape caused by the crisis. A camp is then set to get closer to the local people in need of aid. The medical equipments are then moved from the container into the camp. In cases like this the standing lamp or trolley OT lamps are used. The lamps are frequently cleaned with chemicals to keep them hygienic all the time since there is lots of blood in crisis situation.

The question on how the lamps are powered was asked. The reply was the Red Cross department uses a generator to power the container equipped with the necessary tools. Norway has the environment in mind when undertaking any project, as not to harm its surroundings. Solar generators are used on the field. Each container has a generator that powers all the electrical equipments in it. 5



Figure 015. A picture of a solar based generator

A designer who works with OT lamps was also interviewed on the OT lamps used on the field of crisis. The reply was that, Luxo design lamps to be used on surgical rooms but it does not suit the environment this project is trying to address.

Ideas were shared on the topic, information on some medical requirements or rules had to be present before the OT lamp passed to be used for surgery.

Some of these rules are

- The lamp should be easy to clean since there are bound to be blood stains on them especially during crisis.
- The handle for adjusting the focus or height of the lamp should be removable to be sterilized.
- The base of the lamp should have enough weight, so when the lamp is tilted at an angle of 10% the lamp should be able to stand and not topple over.
- The lamp should have the possibility of focusing the light.

- The head of the lamp should be able to be rotated on both the X and Y axis, meaning the head of the lamp should be able to move in the upward and downward direction and should be able to move from right to left direction.
- There is also the rule of surface temperature and radio emissions

Further discussions were made as to how important it is to get maximum or good high luminous efficiency. Information on how good lighting eliminates shadows making it easier for the surgeon or the practitioner work well. In other words good lighting helps the surgeon to distinguish between pathological and healthy tissue in relation to his/her own memory index. 6

During the discussion on the choice of bulb for the project, High Power LED. He said LED was a good choice, because the performance of LED is been increased about 30% every year and will reach a point that will be approximately 6X efficient as the halogen bulb.

Friends were used as part of the data collecting process. When the functionality of the lamp was essential for the project. For additional information, questionnaires were handed to friends to find out about what they consider to be functional in a product. No restrictions were given it could be a product they use in their daily activates, at work place, school or occasionally and why they consider the selected product to be functional.

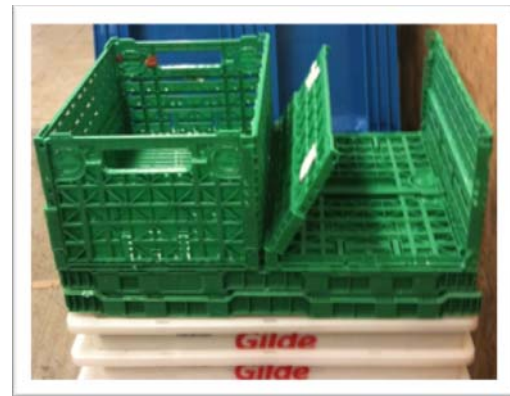


Figure 016. Exploration into the term 'functionality

The responds for figure 011., is as follows

Watch

From a student, who said his time is the most functional product he uses because all his activities are scheduled by it.

Laptop

She works with it anywhere she goes and can use it for a while before the power runs out.

### Phone

He uses his phone to make call, check his mails, as GPS, for surfing the internet, as his reminder, keeps his songs on and uses it to check the time.

### Elastic key holder

He finds this key holder to be the most functional product in his daily activities because it is easy to use, he does not have to keep the keys in his pockets and feel the weight of it and it is difficult to misplace the keys since he has it on him all the time.

### Foldable basket

She finds this basket to be functional because it takes less space and you can combine two or more baskets make her work faster.

From the questionnaire a deduction was made on some qualities people look out for in a product and term these products as functional products these qualities are:

Ease to use

Comfort

High-quality materials

Expensive

Meaningful familiarity

### 3.5 Primary and secondary sources of data.

Information very close to the solution of the problem of the research was treated as primary data. These include information gathered from the Red Cross, Luxo and information gathered through interviews

Information that was relevant but did not directly lead to the solution of the problem was treated as secondary data. Some examples are information collected from the internet and books.



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## **Chapter Four**

### **4.0 Results and discussion**

This chapter deals with the Conceptualisation

#### **4.1 Conceptualisation:**

Before coming up with concepts of the lamp, based on the findings and the knowledge acquired during the research period, a list of functions or qualities the lamp should have was made.

The lamp should be:

- Have a high tech and low tech feature
- Fixed focus
- Flexible arm or joints
- Handles should be removable and
- Dimmable

#### **High tech and low tech feature**

The OT lamp the need for an OT lamp to have all the advance technology it has to make work easier for the uses. But then there with high technology mean high cost. High technology means the involvement of only specialist to repair or fix when the lamp is broken. Majority of the world's population are countries that are third class country. Basic necessity of life such as food clothing and shelter is a challenge to the average worker. Regardless how rich or poor a country is there are medical organization as well as humanitarian organization. Designing an OT lamp with high technology built, it becomes a big problem when it cannot repair them locally.

This is the reason why this project seeks to use the combination of high tech and low tech to make it easy for local people to fix when it is broken

#### Fixed focus

Fixed focus because it takes more technology to the beam of the light with other bulbs, it is a lot easier to focus the beam of LED lights especially with High Powered LED. Hence tuning of the beam is not that necessary. From the research conducted it at certain times gets tricky when focusing the light probably due to malfunction or pressure due to the nature of the surgery. Also with good focused light the chances of getting shadows in the focused area is less than a percent.

LED lights are easily controlled in a circular arrangement, It does not necessary have to be arranged in a doom shape for the beams to be controlled, especially with the High Powered LED. Since it has lens on it directing the beams of the light.

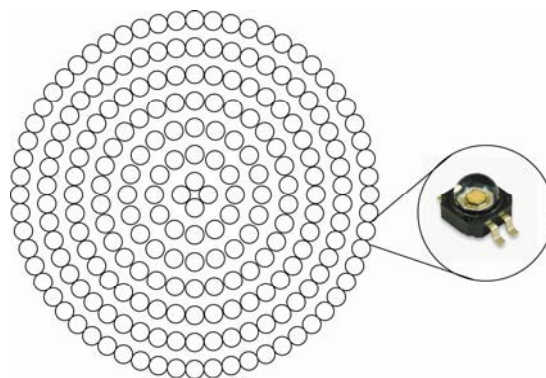


Figure 017. Arrangement of the LED bulbs for the OT lamp

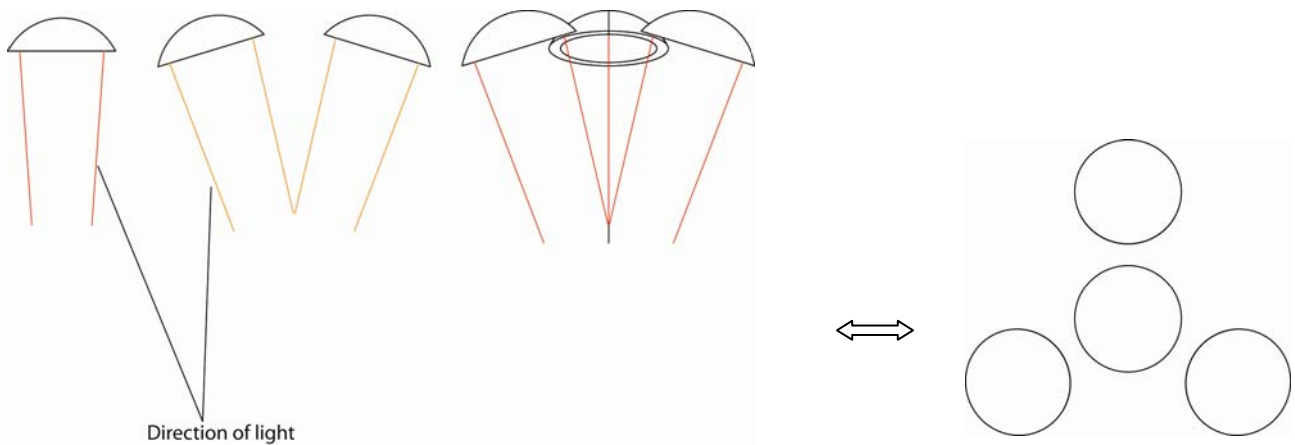


Figure 018. LED light focus direction

LED beam arrangement. The triangular like four set arrangement was settled on. This arrangement gives more lights space and does not take too much space due to the way they have been arranged.

Upon coming up with a the light beam concept, sketches on how the casing of the light was made and with the knowledge on how LED emits heat the casing has to be designed

in a way to help the heat emission. Since the chance of the OT lamp being used for longer hours, it is a necessity to keep the heat from the diodes to prevent heat accumulation in the surgical room. Aluminium is the material going to be used in the casing of the diodes. This is because aluminium is a very good conductor of heat and electricity. Other materials can serve as very good conducts of heat such copper, silver, gold, iron, silver, lead, tin, platinum, nickel to mention a few . Aluminium has other properties the helps in making this OT lamp suit it area of use.

Aluminium is light in weigh. This means that the whole set up of the lamp will not be that heavy. From the research it was found out that the base of the lamp should be heavy enough. So if the lamp is tilled to an angel of 10 degrees it does not topple over.

If the head of the lamp is light weighted, not much weight is needed for the base of the lamp.

Apart from aluminium being a good conductor of heat, it also cools down very fast, meaning that aluminium conducts and emits heat at a faster pace.

Aluminium can easily be gloss polished, making the surface very easy to clean for hygienic purposes. Another important aspect of aluminium is that it can easily be recycled and also easy to obtain. Aluminium is also very easy to mould cast for mass production.

Sketches of the housing of the LED bulbs were made various shapes we made house the four directional arrangements of the LED bulbs.

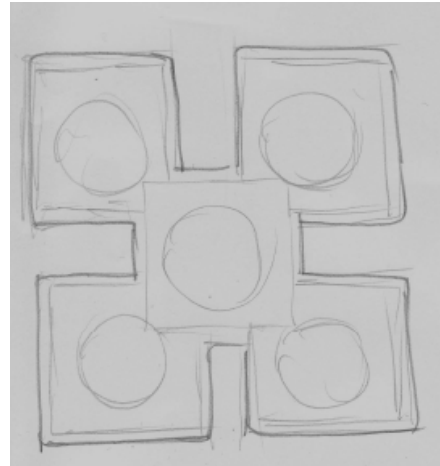
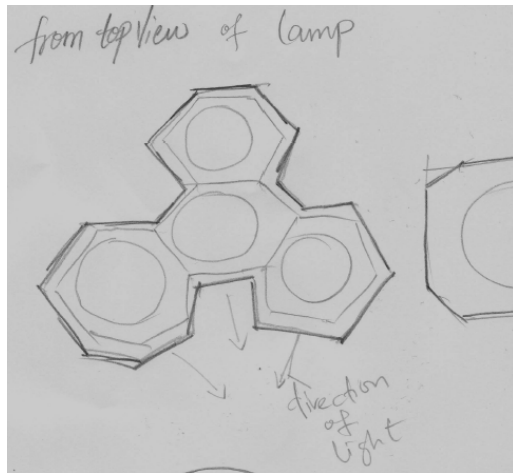
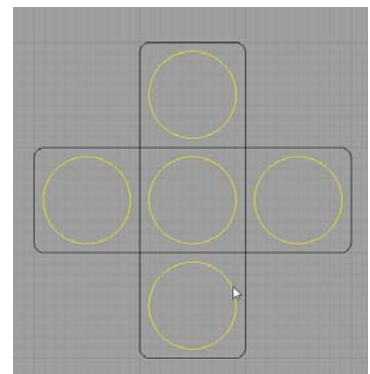
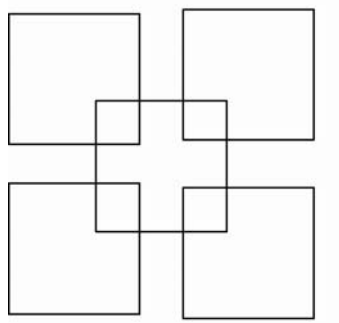
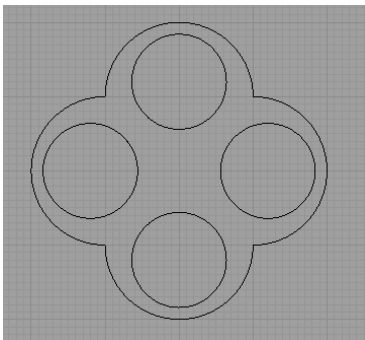


Figure 019: Sketches of the LED light casing



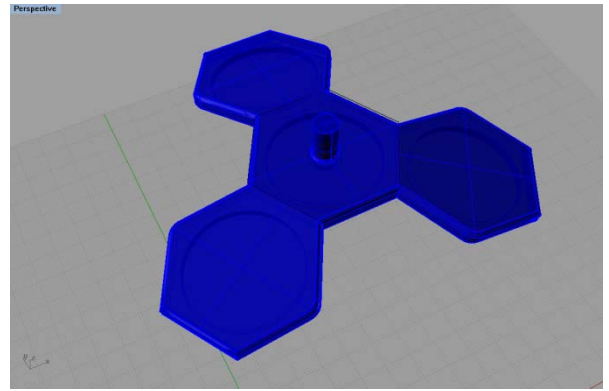
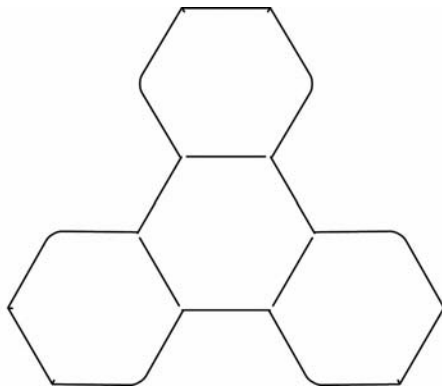


Figure 020: Computer drawings of the LED light casing

The polygonal shape was selected was selected out of the lot. The arrangement gives room for air flow, this will help cool down the aluminium.

#### Flexible arm or joints

For fast and efficient work, the flexibility of the joints of the lamp is very important in crisis situation. The surgeon or the user of the lamp can move angel of the light to a desired angle.

Some sketches were made on different concepts of the arm of the lamp, all attempting to make the arms as flexible and efficient as possible

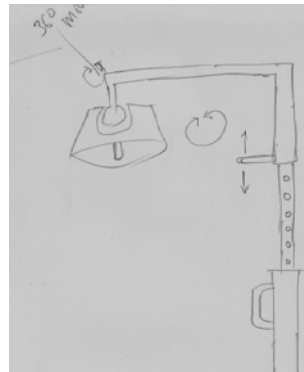
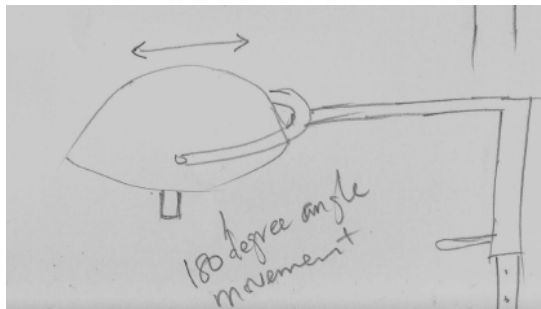


Figure 021: Sketches of the flexible arms of the OT lamp

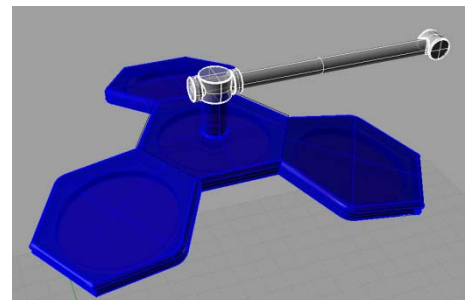
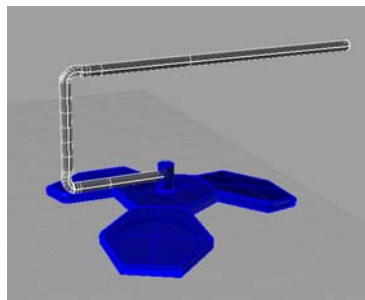
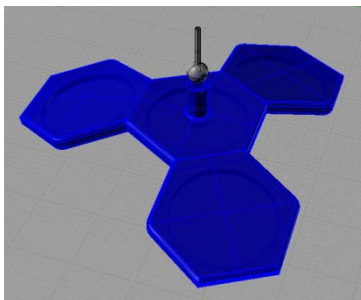


Figure 022: Sketches of the LED light casing

The arm connecting to the head was the first joint considered when designing the lamp. The thought of making it easy and at the same time function well. The spring gear going technique was used. This type of joining is mostly seen in the joints of OT lamps.



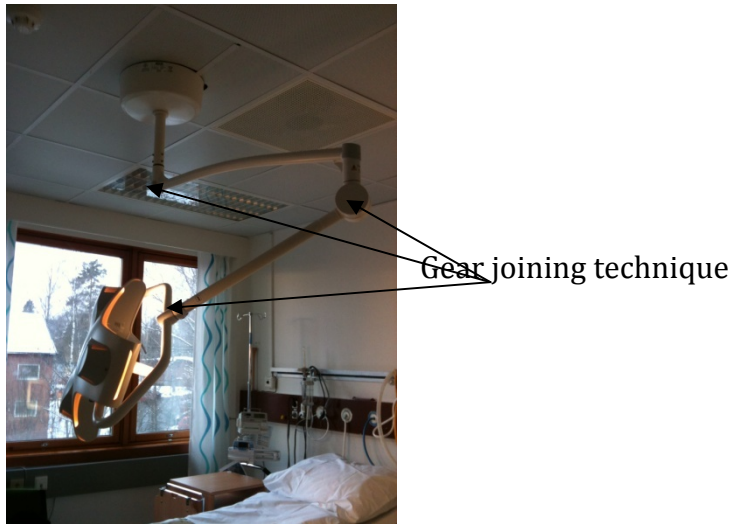


Figure 023: OT lamp with Gear joining

This type of joining used levers like gears to rotate. The rotation takes place on only one axis either the Y axis or X axis. This type of joint was the idea of assembling the lamp for easy transportation and save space as well.

The body of the lamp was then designed using the same principle of the gear joint.

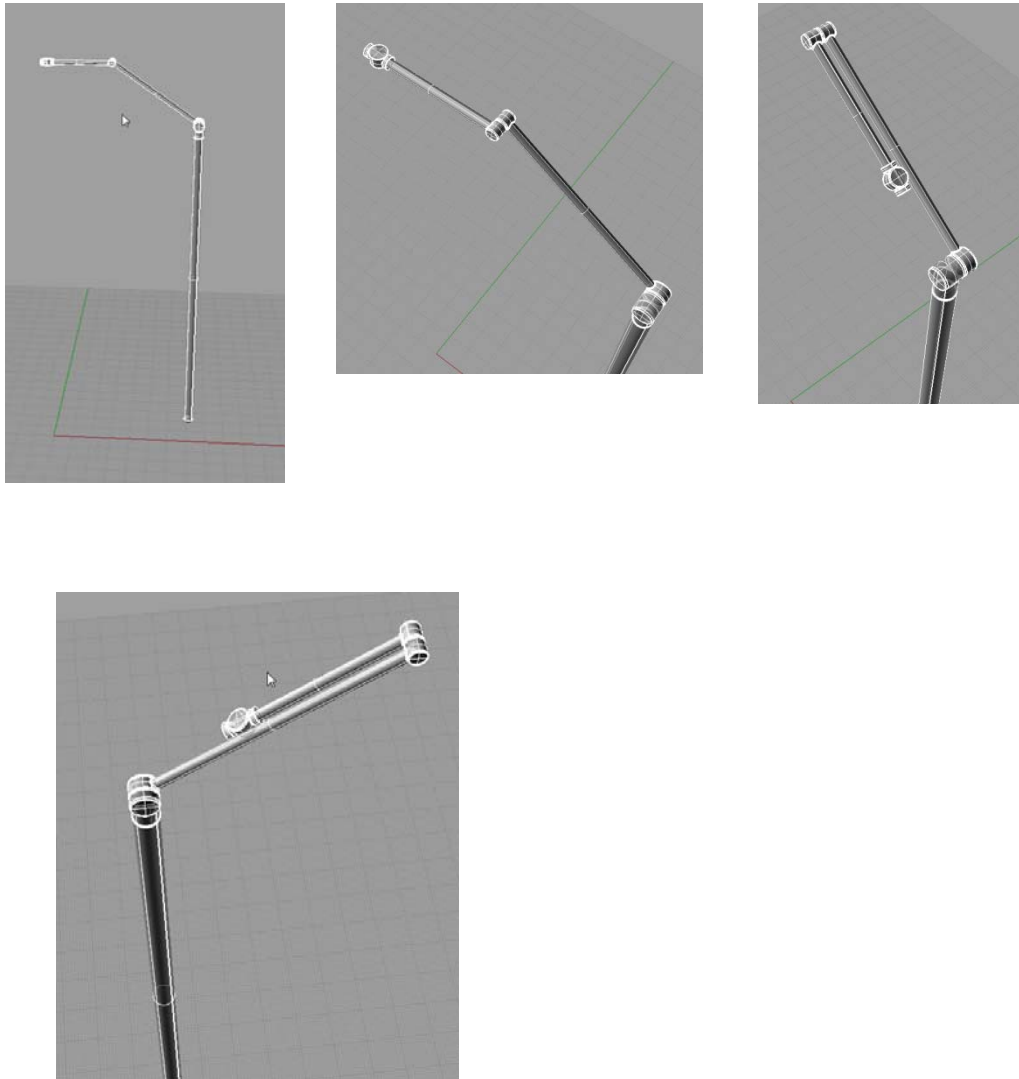


Figure 024: Flexible parts of the OT lamp.

With this type of joint the lamp could be folded easily to save space. The material for the body of the lamp is in aluminium as well. With this type of movement, surgeons and

users of the OT lamp can increase the depth of the light or reduce it by pulling the lamp upward for a bigger light radius or narrow it by pulling it down

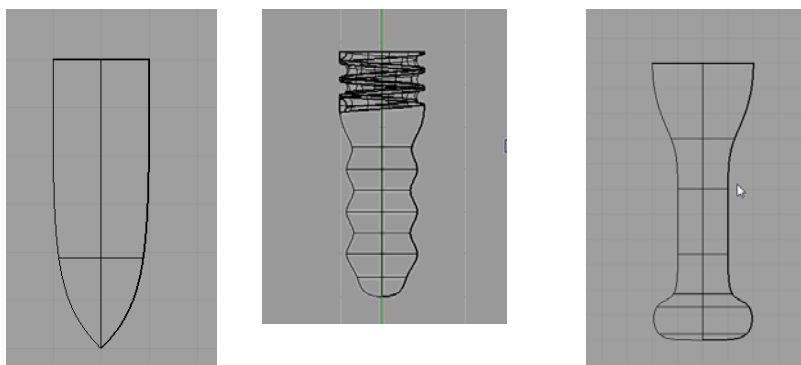
### Removable handles

For hygienic purposes almost all the current OT lamps have removable handles for either focusing the light or when rotating it.

During designing of the lamp the idea of having additional handles to the head of the OT lamp and at the same time make it removable. These additional handles is to help the users work faster and efficiently but redirecting the light even faster.

From the research conducted and from most observing various OT lamps. The main handles for trolley lamps are not removable. This is also mostly held by users and the need to also sterilize it seemed important. Since the idea of making them all removable, the material choice is polyporeline. This is to help reduce the weight of the OT lamp and also give the handles more grip.

Various shapes of the handle for rotating and adjusting the height of the lamp was made



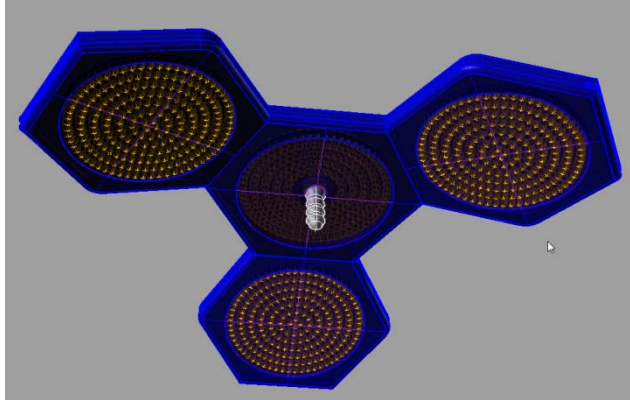


Figure 024: Computer drawings of the handle responsible for rotating or directing the lights of the OT lamp

The concept of using the screwing style of fastening it and giving it uneven surface for good griping

For the extra handles on the casing of the LED the side lock was used. This lock makes used of a groove as a path of which the slides and at the same time locks it.

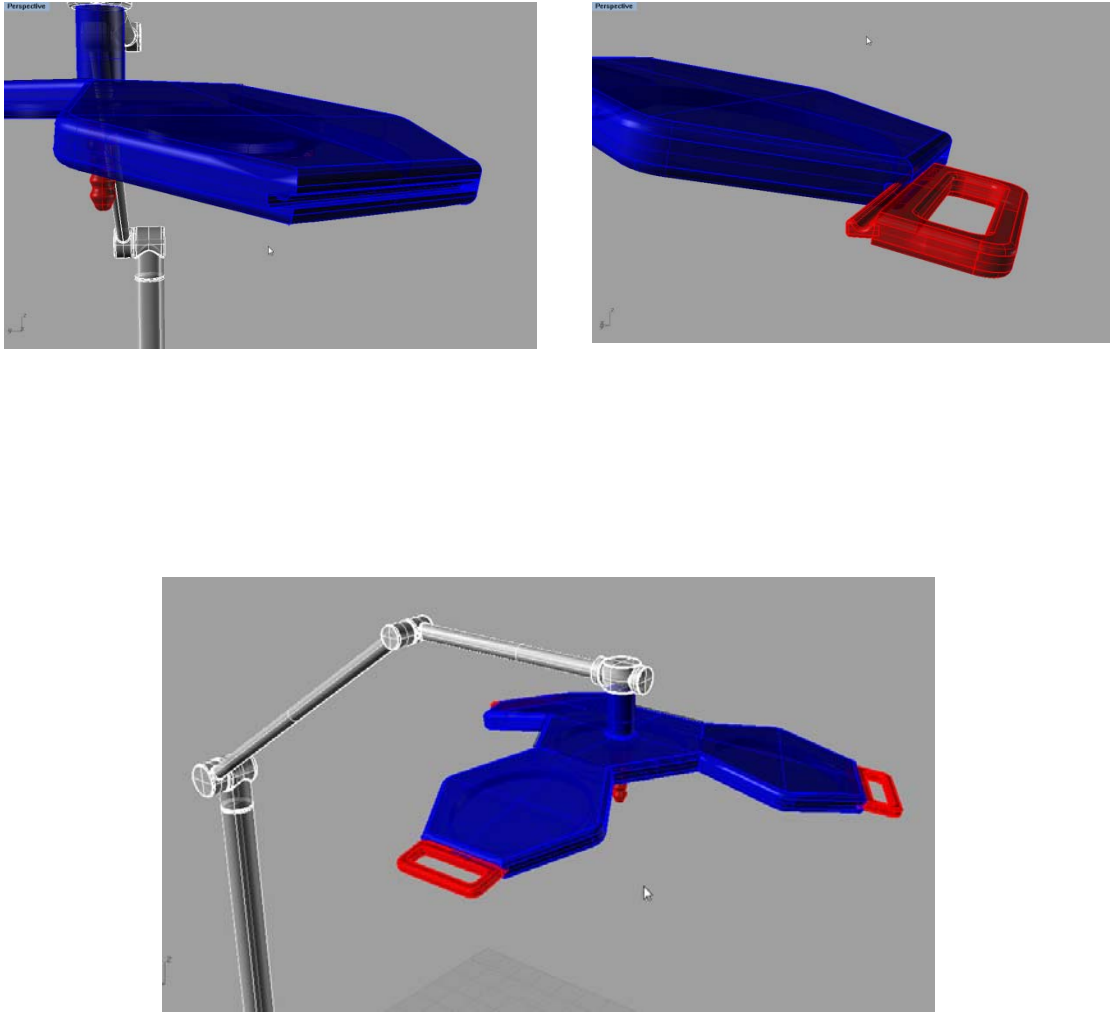


Figure 025: Additional removable handles located on the casing of the OT lamp

With the main handle , the expansion property of plastic was used. Since there is no name of this type of fastening. I was termed force and lock.

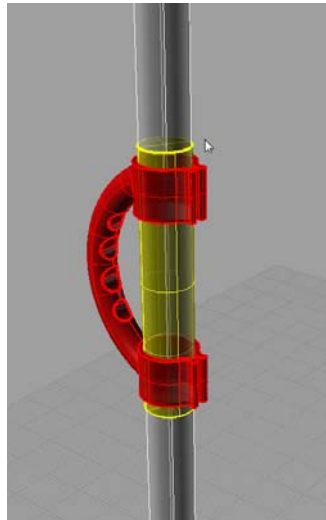
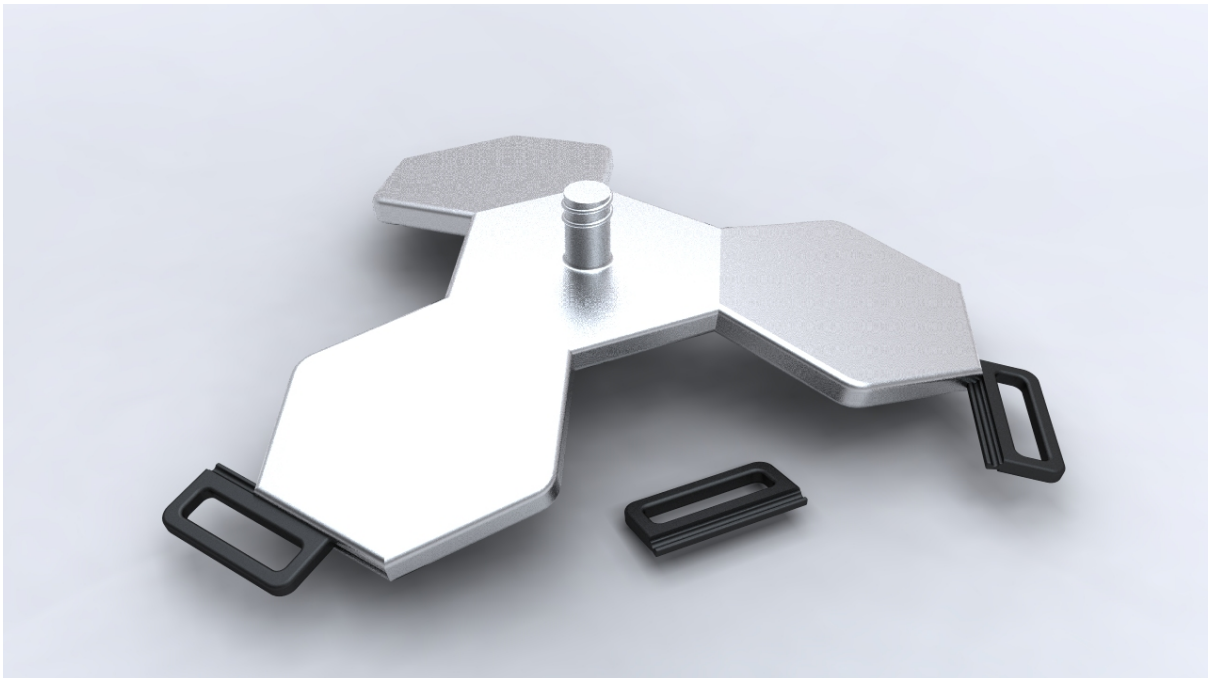


Figure 026: Computer modelling of the main handle for moving the trolley

The base of the lamp was designed to have wheels or easy movement. The material of the base is also aluminium. But this is thicker and heavier. This is to enable the base of the lamp to be firm and also not to topple over then it is slanted to an angle of 10 degrees.

Rendered images of the OT Lamp concept







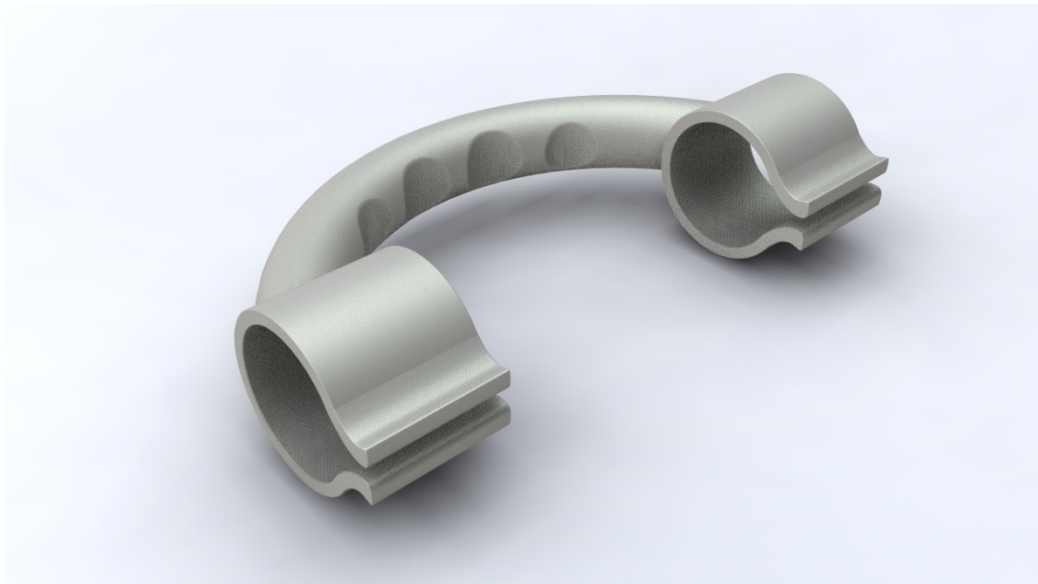
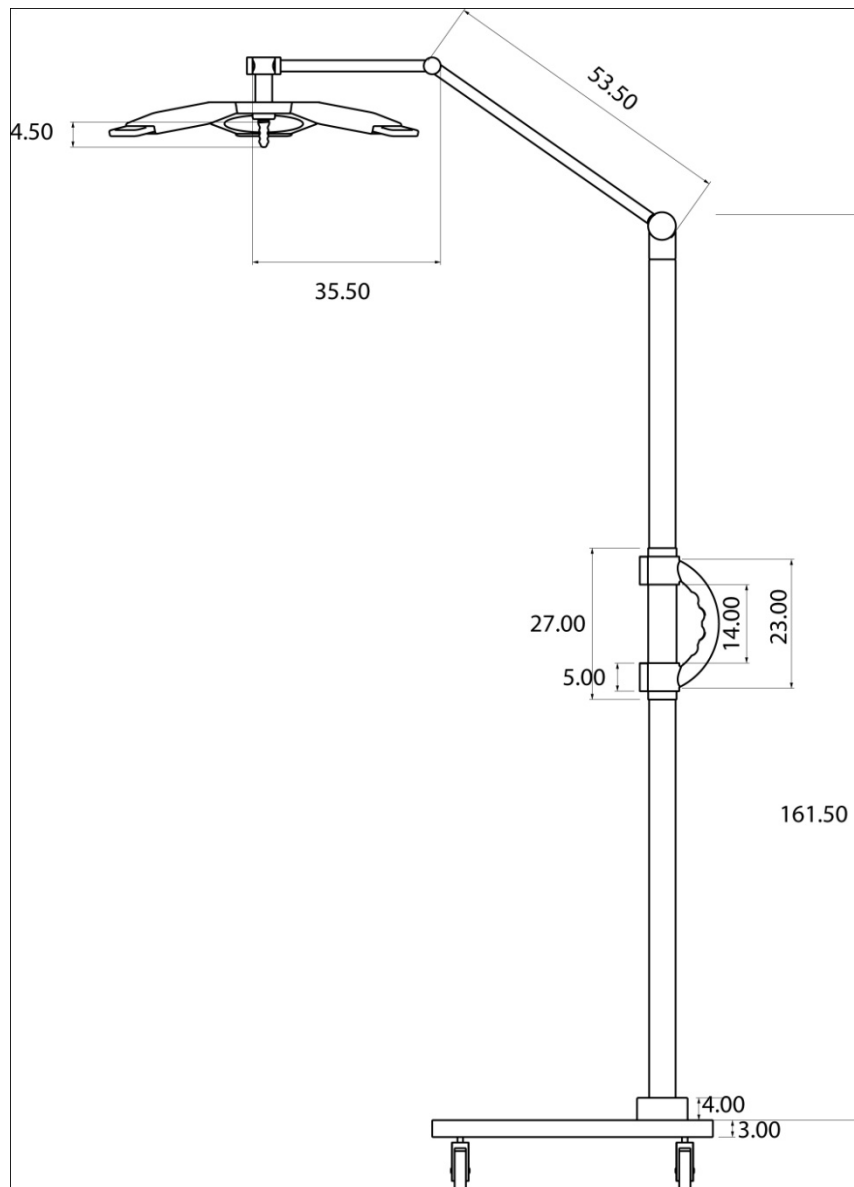


Figure 027: Computer rendered images of the OT lamp

## Technical drawing of the OT lamp



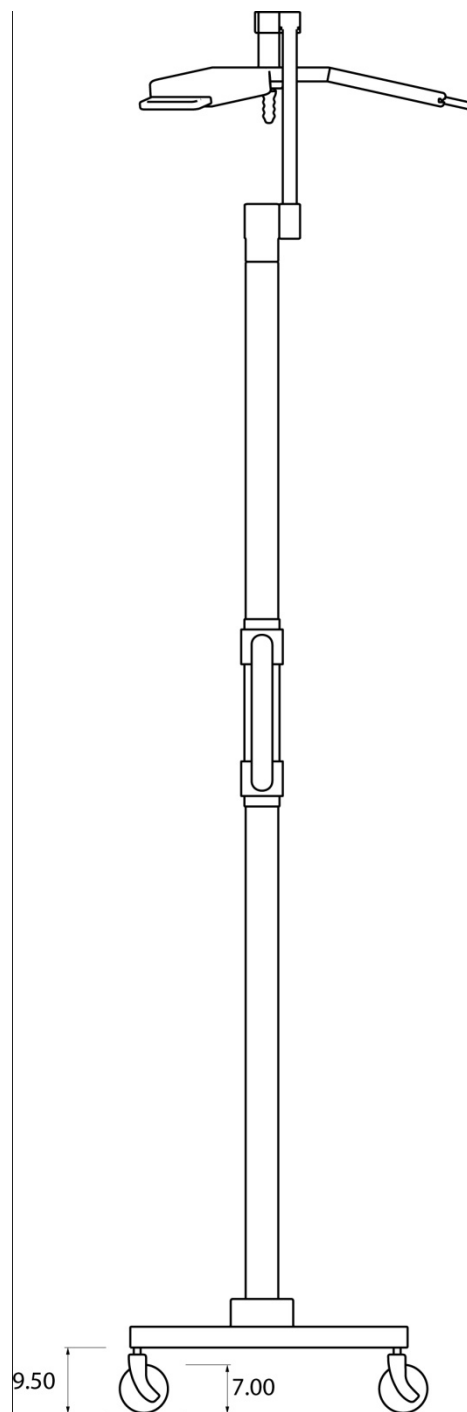


Figure 028: Dimensions of the OT lamp.

The OT lamp is designed to consume 50 watts of energy. The OT lamp is dimmable. LED lights do not stay on like the halogen bulbs. LED flickers about 4000 a sec which is not visible to our eye, and when it flicking is reduced, the human eyes is to be dimmed and when this is done, a lot of energy is saved. When LED is made to flicker about 4000 per second close to about 90% of energy is saved.



## **Chapter Five**

### **5.0 Conclusion to the study**

This thesis sought to

- To study the existing operation lamps used in the field of crisis to reveal the strengths and weaknesses.
- To redesign and existing Operation Theatre lamp and improve it, based on the strengths and weaknesses of the existing Operation Theatre lamp

Summary of the study

### **5.1 Findings**

The following findings were made

- There isn't an OT lamp designed to be used for crisis area
- LED light has high potentials
- There are rules or equipments for medical products
- LED can save up to 90% of energy by dimming it and still get the amount of light needed
- LED are mechanically robust making is suitable for other products.
- Some actives that contributes in natural disaster

## 5.2 Conclusions

- There is the need for the humanitarian organization to have an OT lamp designed for them.
- LED is the future the good lights and energy bulbs
- Designers should adopt the use of renewable materials dismountable products for easy transportation and recycling

## 5.3 Recommended areas for further research

Research is recommended to be made on made on LED and developing countries.

More research should be done on the medical field to help them make their works easier.

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