REDESIGN OF THE MILLION SOUL SOLAR LAMP

PRODUCT DESIGN PROJECT - II

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Introduction

THE NEED FOR A SOLAR LAMP :

The problems that under developed regions around the world encounter are more or less similar. They include some of the of the basics such as unavailability of clean water, unavailability of electricity, unavailability of proper healthcare and education etc. It is unfortunate that after almost 70 years of independence, India still faces these problems at a considerable scale.

A staggering 40% of our country's population still use the kerosene lantern as their main source of lighting. In the age of efficient and affordable lighting solutions, it is the bitter truth that we as a nation must accept and act to.

Kerosene lamps are harmful in many ways

1. **TRAP FAMILIES IN POVERTY**: Kerosene as a consumable fuel takes a toll on the economic conditions of the family. As the lamp needs to be refilled regularly, it becomes very expensive for the users (who are mostly below the poverty line) to keep their homes lit.
2. **PREVENT CHILDREN FROM LEARNING :** Kerosene lamps are also one of the causes of illiteracy. Children find it difficult to read under the kerosene lamps. Moreover, since kerosene lamps are expensive to maintain, the children do not enjoy the liberty of studying for long hours after sunset.
3. **TOXIC FUMES CAUSE RESPIRATORY DISEASES :** Being a combustible fuel, kerosene fumes are toxic. Since these lamps are generally used indoors and the users have to sit close to them, (for reading, studying etc.) they are bound to experience long term health issues.
4. **CONSIDERABLE IMPACT ON CLIMATE CHANGE :** Fumes consist of black carbon and carbon dioxide gas. In fact studies have shown that the carbon dioxide released in the atmosphere by the kerosene lamps in Africa alone is greater than the carbon dioxide emissions of Europe.

FIG 1.0
40% OF OUR COUNTRY'S POPULATION STILL USE KEROSENE LAMPS AS THEIR MAIN SOURCE OF LIGHTING.
IMAGE SOURCE : GOOGLE IMAGES
HTTP://I1.EBAYIMG.COM/IMAGES/M/MDP4JBKI_KZRHVFRVFNAOIA/S-L225.JPG ON 3RD AUG 2016

There is an immediate need for a better lighting solution.

The need of the hour is to make a better lighting solution because today, in the world of global connectivity and advanced technology, it is possible to do so.

1. **SOLAR TECHNOLOGY IS FINALLY COMING OF AGE :** The advances made in solar technology are commendable. Not only have the parts become more efficient but they have also become substantially cheaper. It is not the panels that have become better, even the light sources have improved in terms of their efficiency and operational life.
2. **A HEALTHY MARKET FOR UNPARALLELED GROWTH :** From the business point of view, the solar market is very profitable and growing quickly. Moreover, with the government offering subsidies to promote solar based products manufacturers are enjoying healthy profits. The customer base for these people is enormous as a major chunk of people are still of the grid.
3. **HEALTHY AND SUSTAINABLE :** Solar lamps are not harmful to the users as their kerosene counterparts. There are no toxic fumes and heat generate is almost negligible. Apart from being healthy it is also sustainable with zero dependence on fossil fuels.
4. **MORE THAN JUST A LAMP :** The solar lamp is more than just a lighting source for their users. It is a matter of status and a symbol of their upliftment. For them it is more than just a lamp.

About Million SoUL

Million SoUL is an IIT Bombay initiative where people work to localise solar energy through local assembly, sale and usage of 1 million Solar Urja Lamps (SoUL) in India.

The team is rigorously working to enable children in the rural parts of India to study without the dependence on primitive forms of lighting such as kerosene lamps.

The total cost of the lamp is Rs.500 which includes Rs.200 paid by the philanthropic partners, Rs.180 bore by the NCEF and finally the student who pays Rs.120.

Fig 2.0 : Cost Breakdown

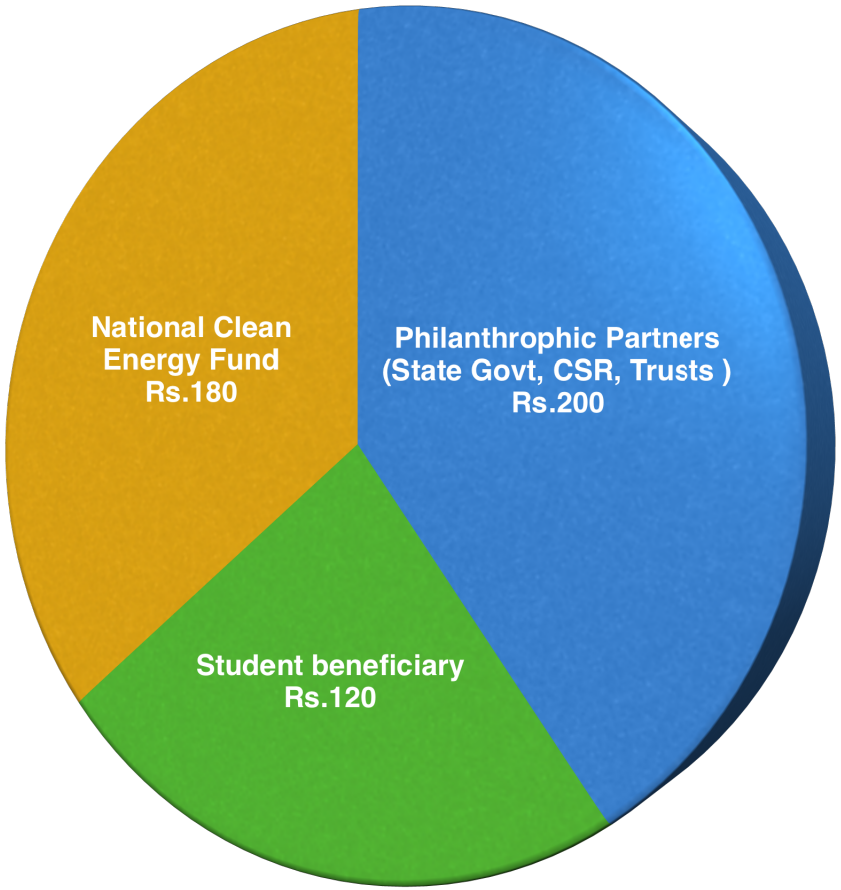
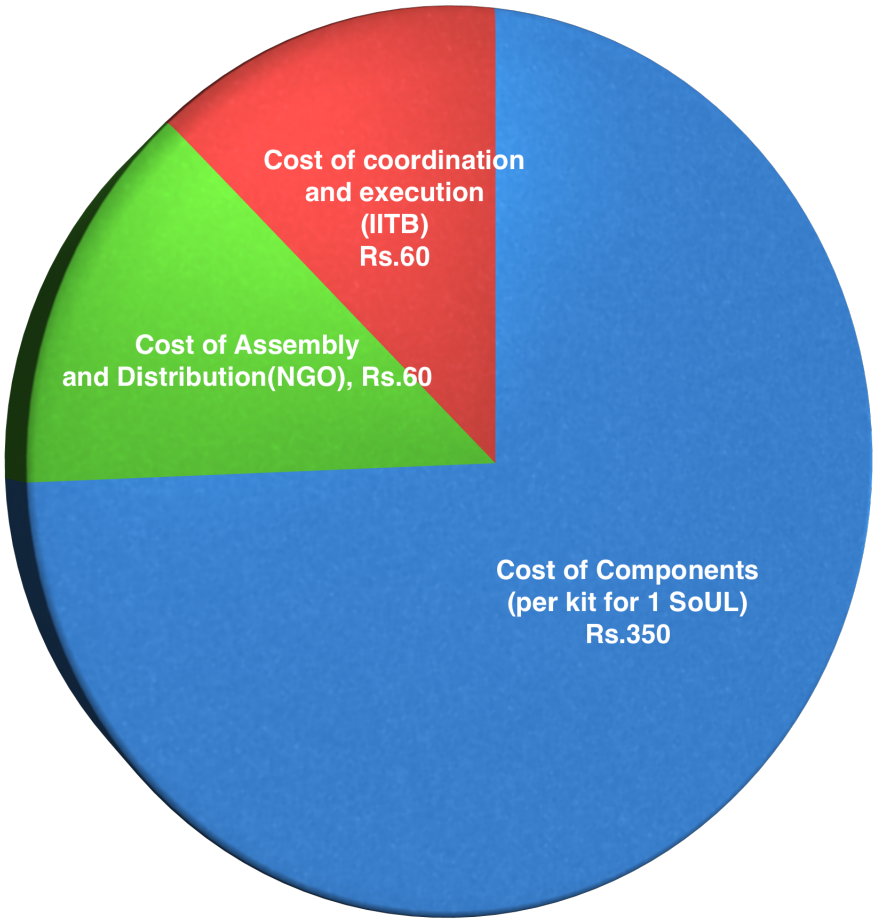


Fig 2.1 : Cost Breakdown



Impact of distribution of the subsidised solar lamps :

Their relentless hard work has brought in some very noticeable changes in a very short span of time. These changes are not only in the lives of the students and their families but also in the lives of other people involved such as the manufacturers, engineers etc.

1. **IMPROVEMENT IN ATTENDANCE AND PERFORMANCE OF STUDENTS IN SCHOOL :** One of the most significant effects was that the children could now finally study post sunset. This directly reflects with their performance in school. They could now enjoy the luxury of studying at night and thereby ably compete with other students who had similar facilities before hand.
2. **REDUCTION OF SCHOOL DROPOUT RATE AND ILLITERACY :** With the solar lamp helping children to study in a friendly environment, the numbers of children dropping out of school saw a significant decline. The reduction in school drop out thereby helped in the reduction of illiteracy among the rural population.
3. **REDUCTION OF KEROSENE CONSUMPTION :** With an increase in the use of the solar lamp, the consumption of kerosene subsequently decreased. This, in the long run will ensure that the children grow up in a healthy environment and a considerable impact on the carbon dioxide emissions will also be observed.
4. **EMPLOYMENT GENERATION AND ENTREPRENEURSHIP DEVELOPMENT :** The business model of the manufacture and distribution ensured that there were jobs for people to assemble, distribute and maintain the solar lamps.
5. **AWARENESS ABOUT THE USE AND CAPABILITY OF SOLAR PHOTOVOLTAIC TECHNOLOGY AND PRODUCTS :** The deep reach of these solar lamps has ensured that there is widespread awareness of the uses and capabilities solar technology and products have to offer.

Studying the existing design

The existing design has three main parts

1. Base
2. Gooseneck
3. LED Housing

The base functions as the housing for the PCB, the battery and the ON/OFF button. It also adds stability to the lamp. The base also has the charging port for the internal battery. It is an assembly of two injection moulded plastic parts. One part acts as the base and the other acts as the top.

The gooseneck adds adjustability to the lamp. It enables the lamp to be adjusted in multiple positions. It also houses the cable that connects the LED to the PCB.

The assembly houses the LED. The LED housing consists of a backplate, an LED mount and a transparent plastic LED protector.

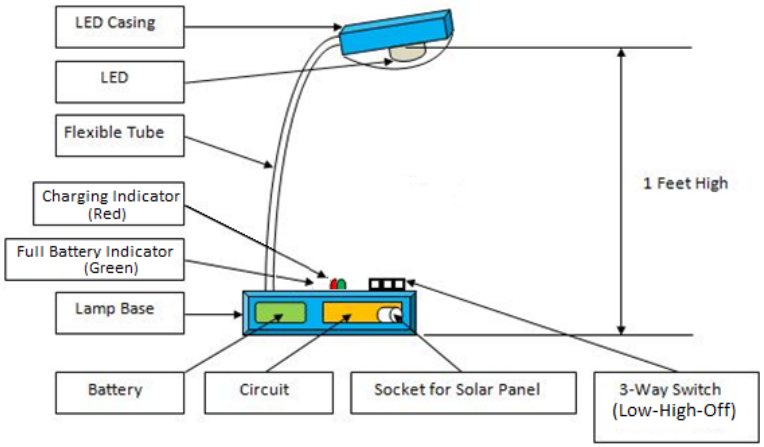


FIG 3.0 EXISTING DESIGN

Image Source :http://www.millionsoul.iitb.ac.in/images/DesignLamp.png as on 5th Aug 2016

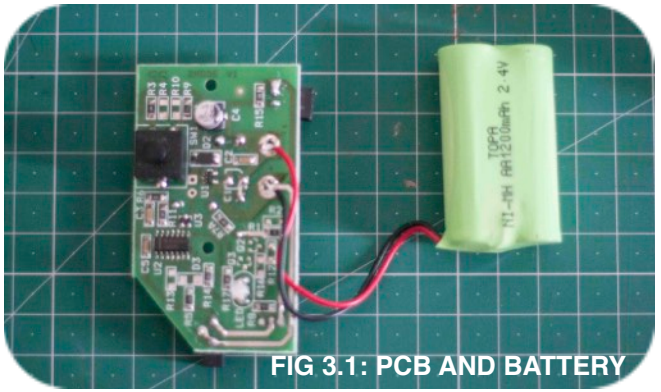


FIG 3.1: PCB AND BATTERY

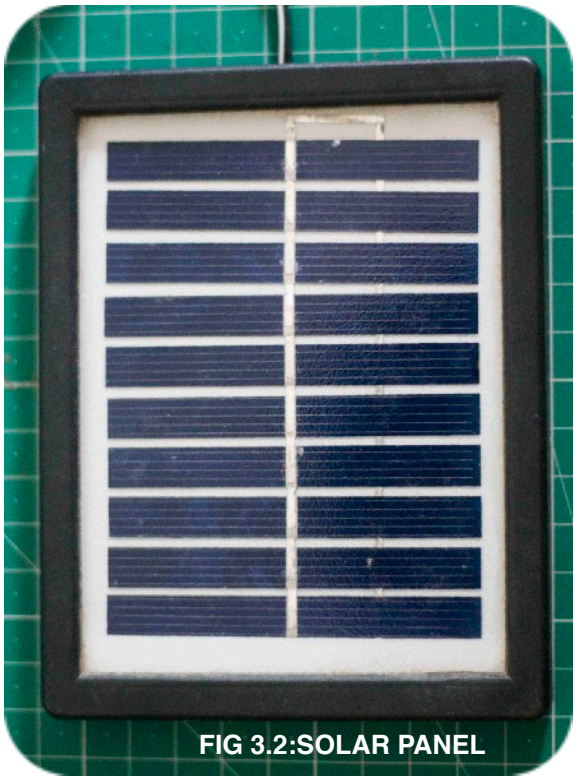


FIG 3.2:SOLAR PANEL

Use case scenarios

Initial studies revealed that though this lamp was designed and developed to be a study lamp for children, it was also used in a lot of other cases. These cases included people from different walks of life and for different purposes. Shown below are some of the uses cases that one would typically encounter in a rural scenario.

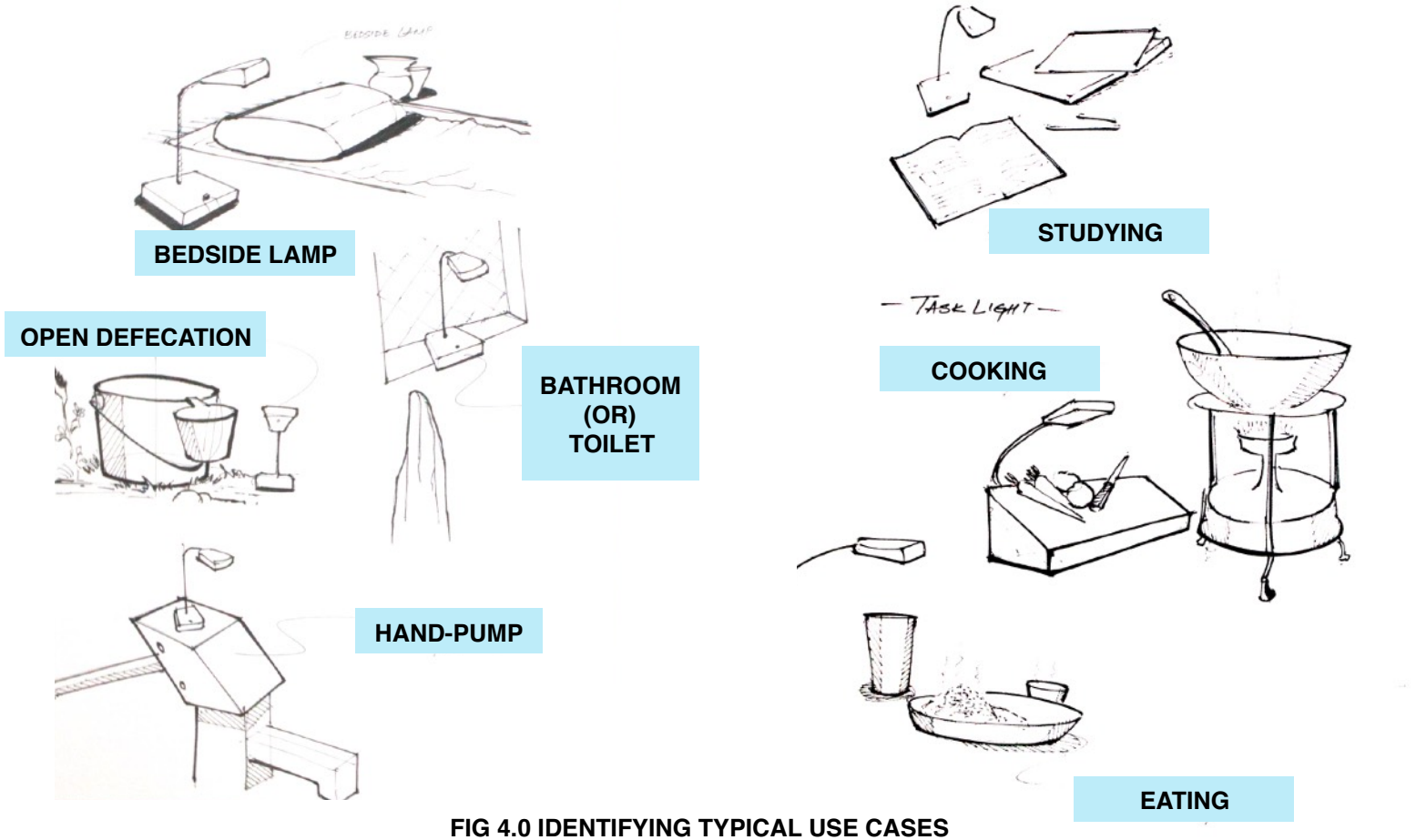


FIG 4.0 IDENTIFYING TYPICAL USE CASES

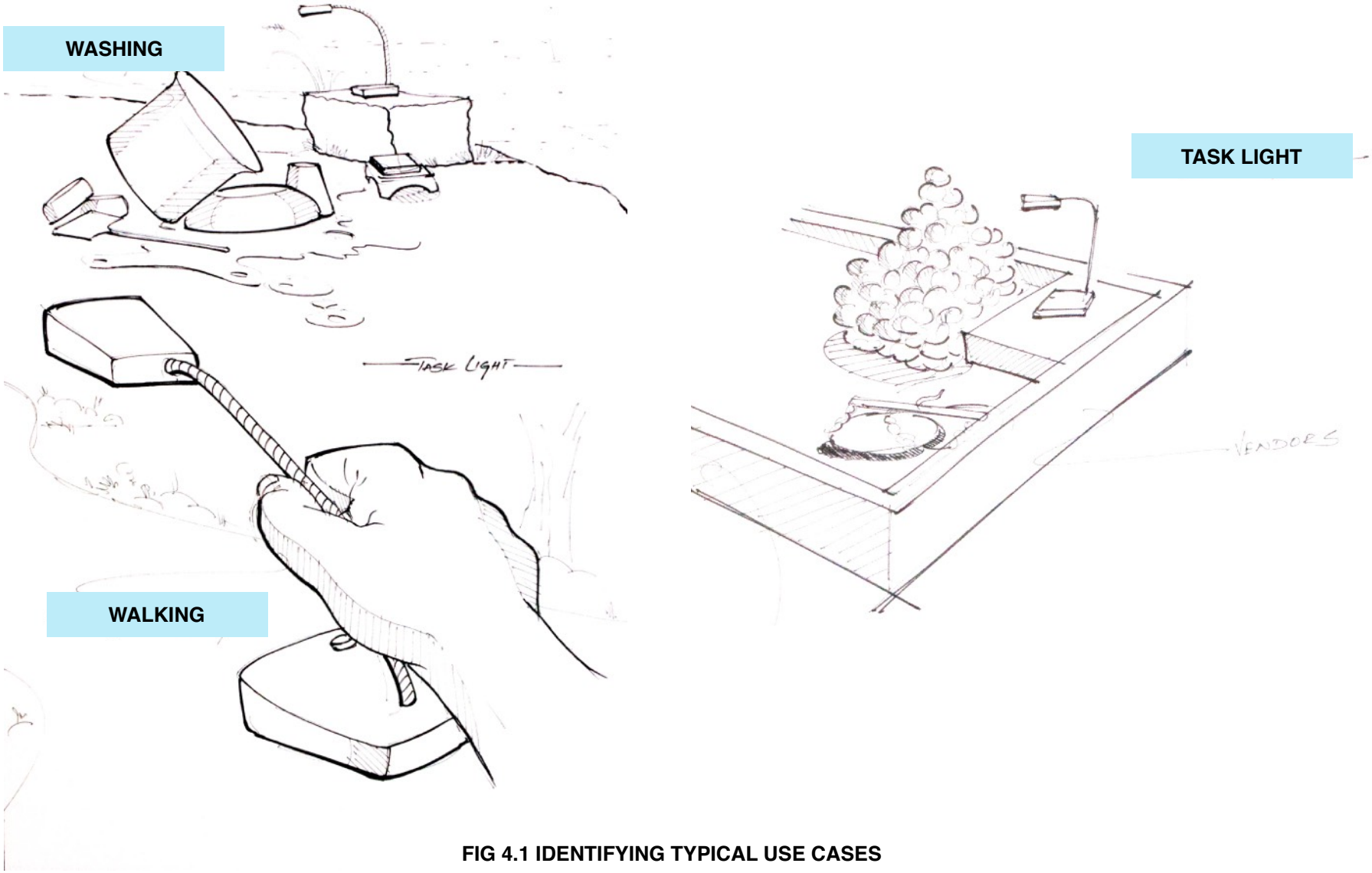


FIG 4.1 IDENTIFYING TYPICAL USE CASES

Documented use cases

FIG 4.2 DOCUMENTED USE CASES
Image courtesy : Million Soul

Identifying the limitations based on the use case scenarios

Since this was a redesign process it was quintessential to ensure that the existing design was studied thoroughly so as to appropriately identify and address the limitations of the same. Interviews with the people involved with the Million SoUL project and personally using the lamp for an extensive period helped in the identification of the problems in the existing design. The primary shortfalls of the lamp were as follows :

1. **NOT DESIGNED FOR MULTIPLE ROLES :** The lamp was primarily designed as a study lamp. However, interviews with the Million SoUL distribution team suggested that this lamp was actually used in multiple use cases as mentioned before. These included some daily tasks like bathing, washing and cleaning, using the toilet, cooking etc. In some cases, these lamps were also used by street vendors and hawkers. It was essential that the redesigned lamp could adapt and be more than just a study lamp.
2. **GOOSENECK LIMITATIONS :** In the current design, adjusting the position of the light source is done by the gooseneck. However it was observed that over time the gooseneck became very flexible and thus handling the lamp became increasingly difficult. Furthermore, when the lamp was used by pedestrians, the gooseneck failed to maintain the light source in the desired direction.
3. **BULKY IN RELATION TO ELECTRONICS :** The lamp has a lot of empty spaces in the enclosure. Furthermore the solar panel is also not built within the main body and is a separate unit. This not only makes the lamp more bulky but also makes the packaging larger increasing the overall footprint of the product while shipping. For a product that has to be offered at the cheapest price point, it becomes essential that costs are cut wherever possible.

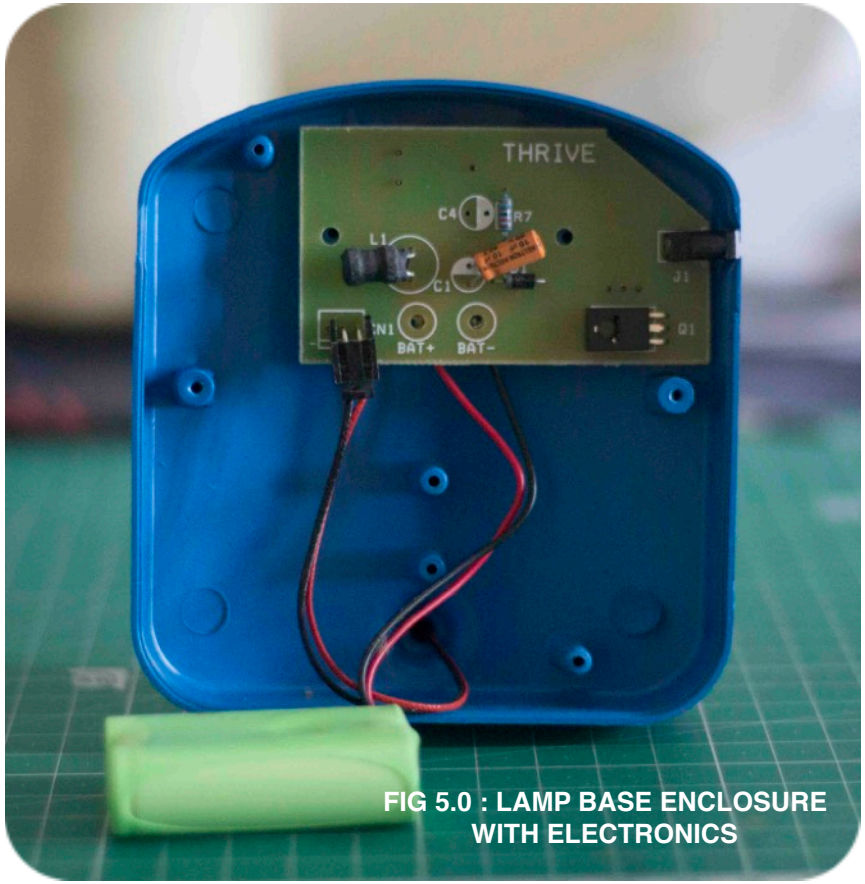


FIG 5.0 : LAMP BASE ENCLOSURE WITH ELECTRONICS

4. **SUSCEPTIBLE TO DAMAGE DUE TO THE ENVIRONMENT :** The distribution team further pointed out that the enclosure and especially the area around the button was prone to facilitate the entry of dust and moisture into the enclosure. This would often lead to malfunctioning of the lamp and thus require servicing.

Identifying the sitting postures

FIG 6.0 : WIGHAWALI
Image Source : Google Maps

It was found that the conventional sitting posture at school is generally different from the postures at home. Occasionally in schools it is found that there is minimum furniture like a bench or a table and stool to study. However at home, it was observed that most of the children studied on the floor. In some cases however it was also observed that students enjoyed the privilege of studying on a table and chair.

The reason for identifying the sitting postures was important because it was the sitting postures which determined the position of the light source. This meant that the source of light had to change with a change in the sitting posture. I had the chance of visiting the village of **Wighawali** in **Satara District of Maharashtra** to observe how children in rural India studied. Wighawali being a small village of about fifty houses offered the perfect scenario to study my users. It was here that I observed students studying not only at school but also at their homes.

FIG 6.1 : STUDENTS STUDYING AT SCHOOL IN WIGHAWALI

NOTING VARIOUS STUDY POSTURES

1. **STUDYING WITH A BOOK OR SLATE ON THE LAP :** In this case the light source has to be over the shoulder so that it falls directly on the book / slate.

FIG 6.2

2. **SITTING WITH BOOK / SLATE ON THE FLOOR :** In this case the light source has to be in front of the student.

FIG 6.3

3. **STUDYING IN A GROUP :** Often we find that children don't study alone. They may either study with their siblings or friends. In that case the light should be adequate enough to enable all of them to study comfortably.

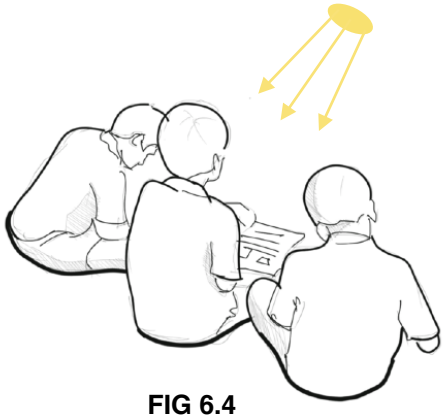


FIG 6.4

4. **STUDYING WHILE LYING DOWN :** It was observed that some students were lying on their bellies or on their backs while studying. In this case the light source should be in front of the student so that there is no shadow cast on the book / slate.

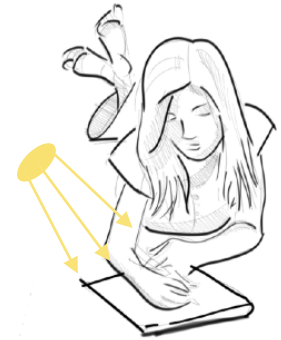


FIG 6.5

5. **SITTING WITH BOOK ON THE KNEE :** This is one of the many common common positions children sit in while studying. The light source in this case needs to be behind the child such that it beams light from over the students shoulder.

FIG 6.6

After studying the various postures, it was essential to understand the different anthropometric dimensions of students across various ages. This was done because the lamp would cater to students of different age groups. To arrive at an effective range, body measurements of of a 5 year female and a 17 year old male were considered to be minimum and maximum respectively. This would ensure that the demand of light for most children across all age groups would be fulfilled.

1. SITTING WITH LEGS CROSSED :

FIG 6.6(A) ANTHROPOMETRIC

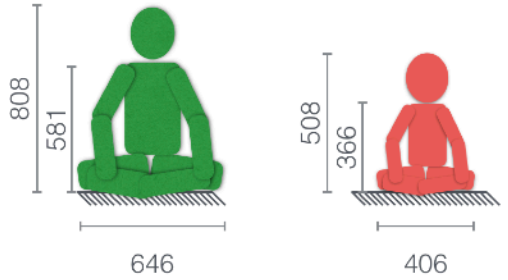
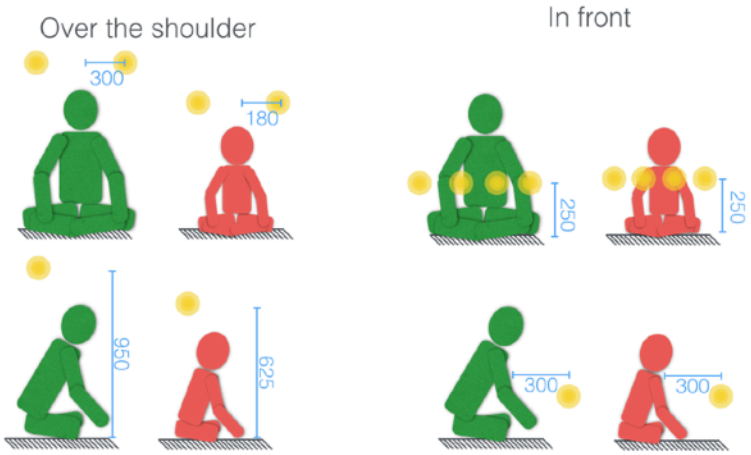


FIG 6.6(B)POSITION OF LIGHT



2. SITTING WITH FOLDED LEGS :

FIG 6.6(C)ANTHROPOMETRIC

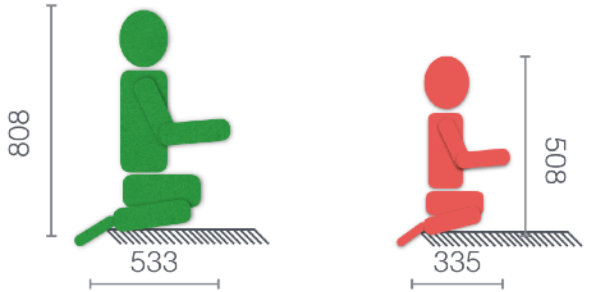
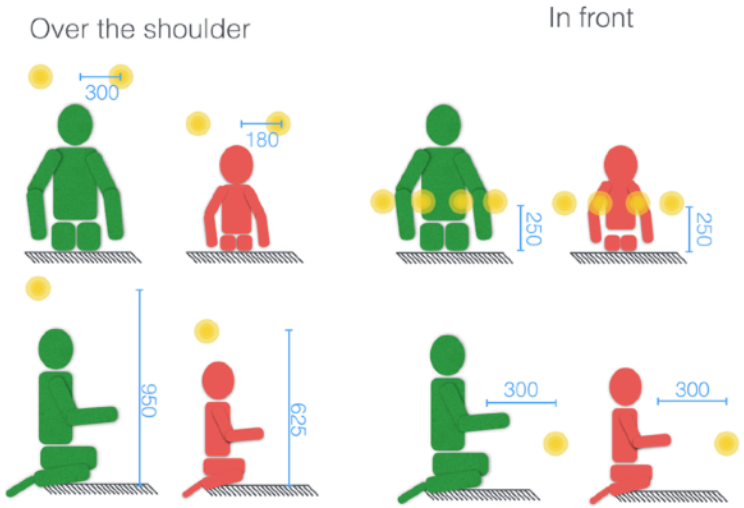


FIG 6.6(D) POSITION OF LIGHT



3. SITTING ON A CHAIR AND USING A STUDY TABLE :

FIG 6.6(E)ANTHROPOMETRIC

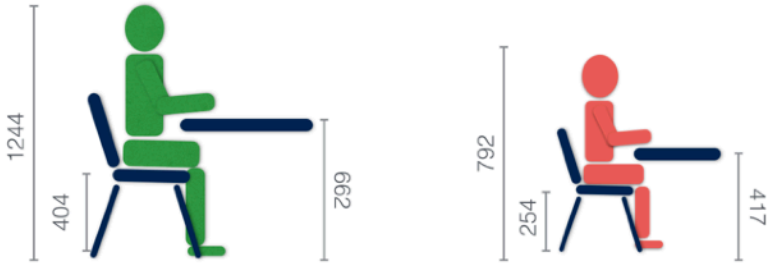
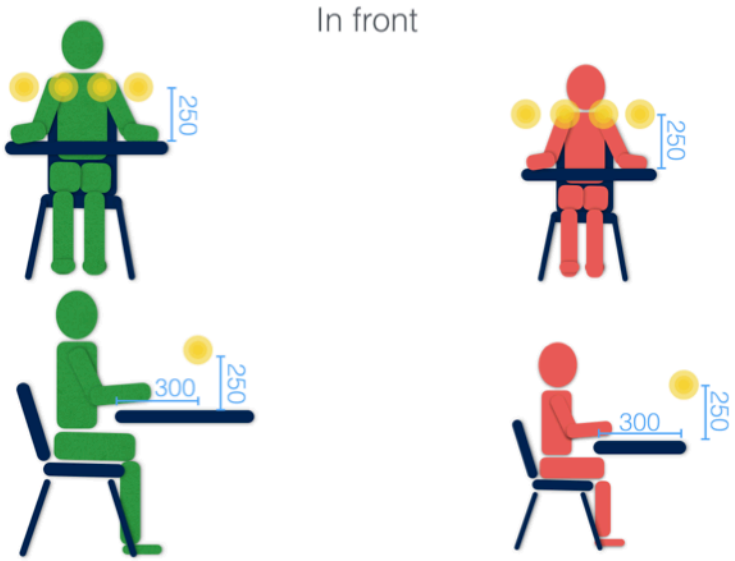


FIG 6.6(F)POSITION OF LIGHT SOURCE



4. LYING ON THE BELLY AND STUDYING :

FIG 6.6(G)ANTHROPOMETRIC

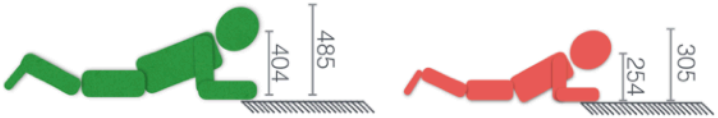
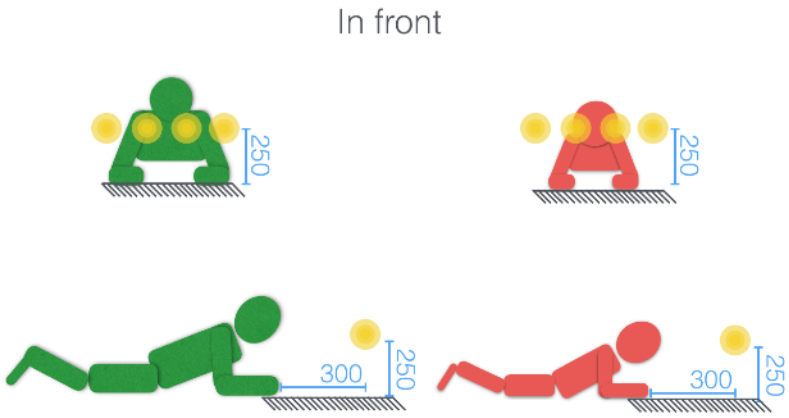


FIG 6.6(H)POSITION OF LIGHT



After studying the positions and the dimensions, they were then compared to some other tasks apart from studying. It was found that though the task had changed from studying some of the positions were common. For example, studying on the floor with folded legs was a similar position to eating on the floor with folded legs. Like this there were a lot of other tasks such as cooking, cleaning, eating, washing etc that were performed in positions similar to studying. Some of the examples of such tasks are as follows :

- Cutting vegetables
- Stitching
- Playing indoor games
- Washing clothes
- Combing child's hair
- Cleaning utensils

The design brief

It was studying the various postures and also the other common tasks where these postures were adopted, that the brief of the project was arrived at.

"To redesign and develop a solar lamp that can quickly, easily and efficiently adapt to multiple use conditions."

This had to be done by also keeping the following points at the back of my mind.

1. **DESIGN FOR MANUFACTURE :** The design has to be such that it was easy and economical to manufacture. Use of mass manufacturing process such as injection moulding would ensure optimum manufacturing costs.
2. **EASY TO SERVICE & REPAIR :** The design has to be such that apart from being easy to manufacture it should also be easy to service and repair. These lamps should be designed in such a way that servicing and repairing can be done on site.
3. **FRIENDLY AND APPEALING :** The design has to be such that it looks friendly to the user. It should not look alien to the user and also be easy and self explanatory to use.
4. **DURABLE :** The lamp has to be durable and should withstand the trying conditions of the rural environment. It should be structurally sound and work as expected.

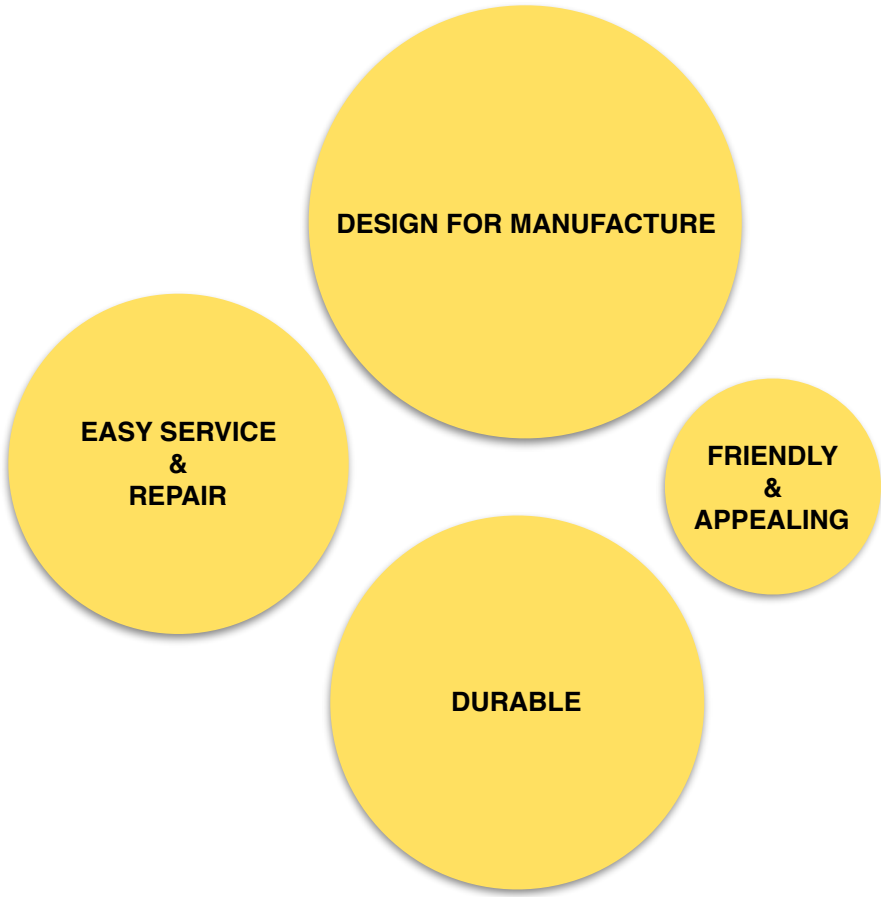


FIG 7.0 CLOUD REPRESENTATION

Market study - studying the existing products

To better understand the preferences of the user it was essential to know and understand the products that were already in existence. The fact that these products were already being used was testimony to the fact that users liked these products. The products that were referred to have been in exhaustive use in rural parts of the world. All aspects of these products like features, price, availability, materials used, distribution process etc haven been studied. Some of the more successful products are shown and described in more detail below.

1. **THE SUN KING SOLAR LAMP:** The product is one of the most successful solar lamps. It consists of a single circular plastic enclosure which houses all the electronics like the PCB, battery and the LED. A circular dome shaped covering protects the LED's while also acting as the diffuser. For the stand, a single metal wire is bent in the form as shown in the representative image, The lamp swivels about the axis of the stand so as to adjust as per the users preferences. There is also a Velcro strap that enables the user to attach the lamp on the head. They have two different models, one with the solar panel built into the enclosure and the other with a separate one. These lamps are extensively distributed in the rural regions of Africa and quite successful in India as well.

Source : https://www.greenlightplanet.com/wp-content/uploads/2015/10/SK-Pro-AN-w-panel-600.jpg

FIG 8.0(A)

2. **THE EURODIYA SOLAR LAMP:** The eurodiya solar lamp is a lamp without a stand. The idea here is that the lamp can be suspended for use. It consists of a plastic enclosure that houses all the electronics. It also has a diffuser in the shape of a dome which also protects the LEDs. The lamp is designed in such a way that it can be fixed to a bulb holder. The three parts of the lamp are the plastic enclosure, the metal wire frame and the bulb mount.1Thus, this lamps makes use of existing hardware found in homes to suspend and fix itself.

FIG 8.0(B)

Source :http://ecx.images-amazon.com/images/I/31Gu8AINiXL.jpg

3. **THE PANASONIC LAMP :** As seen in the picture the lamp made by Panasonic is highly adaptive. It is a simple design that includes a plastic enclosure that houses all the electronics and a bent wire. The wire is attached to the enclosure in such a way that it can be rotated about the axis it is fixed to. IT can be used as a torch, a lantern, at different angles and also be hung by using a string.

FIG 8.0(C)

Source :http://news.panasonic.com/global/stories/images/03_lantern6way.jpg

4. HAPPY CAMPER 2-WAY LED LANTERN : The happy camper 2-way primarily consists of three parts : the electronic enclosure, the diffuser and the lampshade. The lamp shade also has an integrated hook as shown so. The lampshade / hook is such that it can also be attached to the base of the lamp. So, when the it is attached to the diffuser it acts as a table lamp as the lamp shade reflects all the light downwards. And when it attached to the base, it can be hung in a hook or string at a height so that it acts as an ambient light.

Source : https://i5.walmartimages.com/asr/

FIG 8.0(D)

Apart from the ones mentioned above, there were other products that were studied. Furthermore, it was not only solar lamps that were studied. Apart from them, other lights and lamps were made note of. In fact extensive exploration was done by studying other categories of portable products. Some forms of Bluetooth speakers were also studied to get inspirations for form designs. Since the role of a Bluetooth speaker was vaguely similar to the one of a portable light source, it became easy for me to relate their forms to those of a solar lamp.

OTHER LAMPS

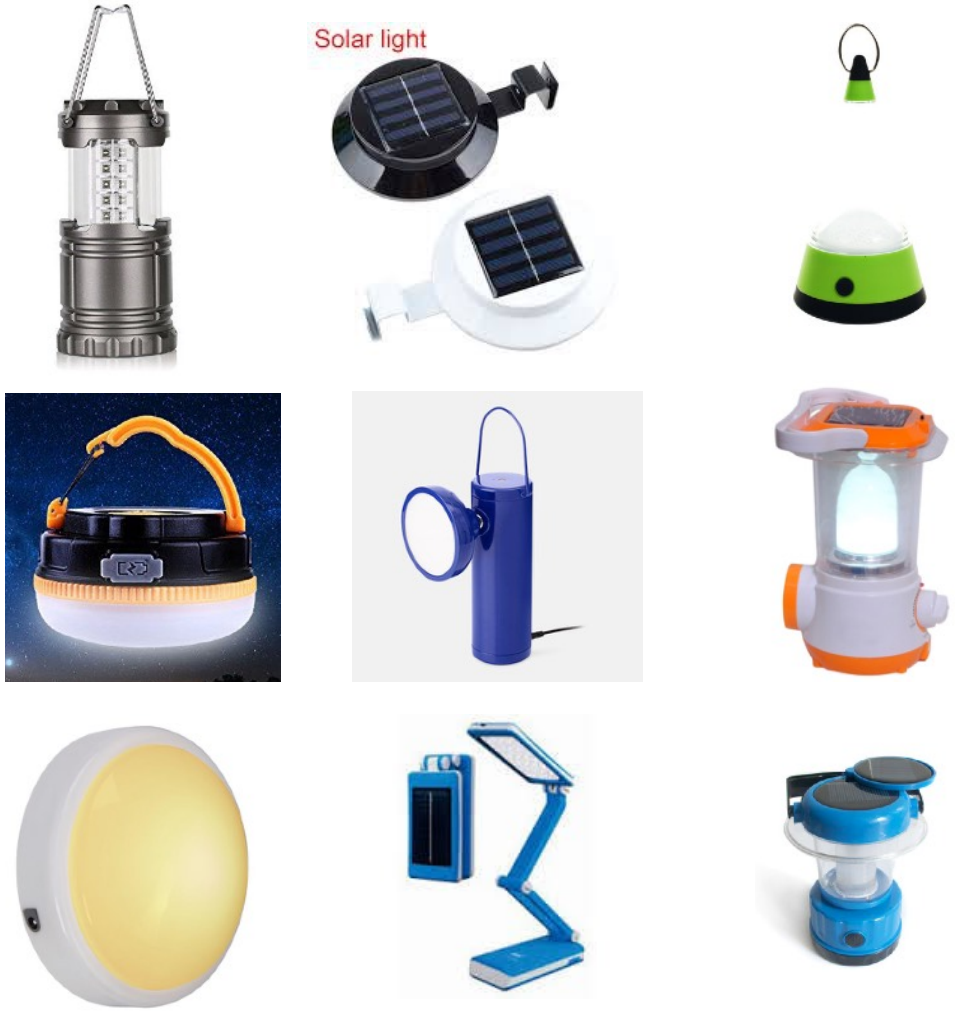
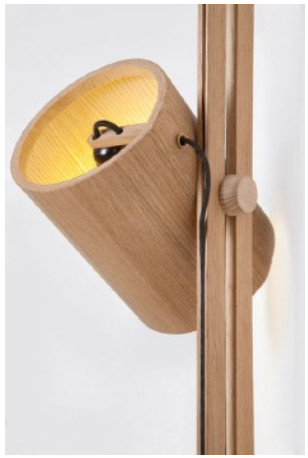


FIG 8.1(A)

Source : Google Images

OTHER CONTEMPORARY DESIGNS



Source : Pinterest (As seen on 21st Aug 2016)

PORTABLE FORMS (BLUETOOTH SPEAKERS)

Source : Pinterest (As seen on 25th Aug 2016)

SOME NOT SO USUAL LAMPS

Image Courtesy : Self

Brainstorming : In how many ways?

Brainstorming is a process in which we note down the number of possible options in any criteria of the product. The ideas that come to mind may be logical or totally absurd. It is important to note down each of this idea so as to arrive at a wide variety of alternative solutions. Once all the possibilities are listed out, we choose about 5-6 of them that seem to be feasible, innovative, different or interesting. These ideas are then taken forward by working on them and making them possible.

For the lamp there were a lot of aspects that required brainstorming. These included right from the structure of the lamp to the packaging. Each aspect was approached with the same question : *"In how many ways?"* Brainstorming sessions were done both individually as well as in a group and about 35-40 ideas were generated for each aspect. The following are some of the aspects for which these sessions were conducted.

- Location of the solar panel
- Method of assembly
- Structure of the lamp
- Control / button type and placement
- Type of light source
- Portability
- Disposability
- Packaging
- Value addition
- Method of charging
- Servicing structure
- Storage when not in use
- Lighting modes
- Adjustability

Example 1 :
Location of the solar panel :

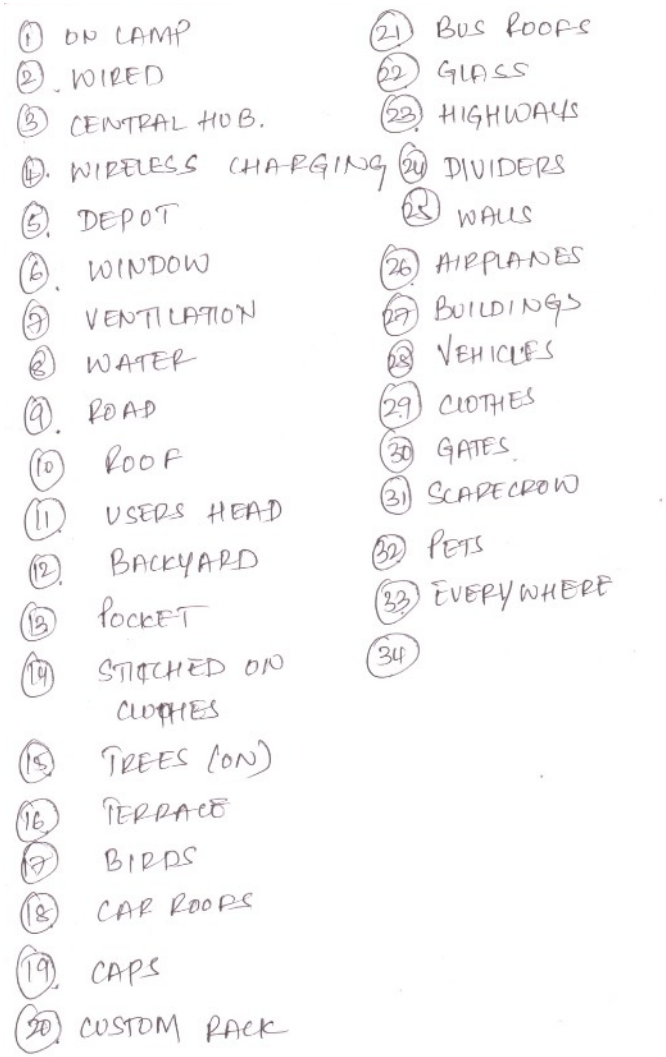


FIG 9.0

Example 2 :
Adjustability:

1. CONCENTRIC PIPES
2. PIPES
3. GOOSENECK
4. STRAW
5. PULLEYS
6. CANTILEVER~~S~~ WEIGHTS
7. DRONES
8. AIR PROPULSION.
9. LADDER
10. USE OF BODY
11. HOOKS AT DIFFERENT PTS.
12. COUNTERWEIGHTS
13. SCISSOR MECHANISM
14. MAGNET
15. CLAY SHAPING
16. LIFTING IT PERSONALLY
17. SEPERATEING BASE
18. MAKING SHELVES AT DIFF HTS.
19. CAM ARRANGEMENT
20. STRAPPING ON DIFF PARTS OF BODY
21. FIXING ON ~~SOME~~ OBJECT TO BE LIT
22. USING ZIPPERS
23. FLOATING IN WATER

FIG 9.1

Example 3 :
Packaging:

1. CARDSHEET
2. INSTRUCTIONAL
3. VALUE ADDITION
4. DEGRADABLE
5. CORRUGATED
6. PRIMARY |SECONDARY
7. HEIGHT ADJUSTMENT
8. PRODUCT INFO
9. BRANDING
10. AFTER USE
11. STORAGE
12. WATER RESISTANT
13. VISUAL INFORMATION
14. LIGHT
15. GEOMETRIC
16. STACKABLE
17. INTERACTIVE
18. VISIBLE PRODUCT
19. STRUCTURE
20. PENCIL BOX
21. PEN STAND
22. BOOKMARK
23. PLANK
24. TOY
25. STOOL
26. VALUE
27. REPACKED
28. STORING CAMP
29. EASY TO CARRY
30. ERGONOMIC
31. HANDLE
32. NO ADDNAL. SUPPORT
33. MULTIPLE DISPLAY
34. IDENTITY
35. CONNECT TO USER
36. CHEAP
37. EDUCATIVE
38. USER MANUAL
39. COLLAPSABLE
40. SNUG FIT.

FIG 9.2

Example 3 :
Modes: What all it can transform into

1. Study lamp
2. Night lamp
3. Ambient lamp
4. Torch
5. Warning lsos
6. ~~Bet~~ Tube light
7. Laser
8. Flash light
9. Spotlight
10. Headlight
11. Kitchenlight
12. Vendorlight
13. Rescue light
14. Navigation light
15. Insect killer
16. Light to attract insects
17. Light for search
18. Lighting your house
19. diwali.
20. door lamp
21. operation theatre
22. lighting cupboards
23. drooelight
24. lighting temple
25. emergency lamp
26. photography
27. reading lamp
28. cooking lamp
29. land aeroplanes
30. navigate ships
31. ship bouy
32. candle light dinner
33. surgery
34. tooth checkup lamp
35. doctors torch
36.

FIG 9.3

Since the lamp has to be extremely affordable, every option in the existing design has to be looked to be made more efficient and economical. It becomes quintessential that parts are designed in a way that they play multiple roles.

While thinking about the solar panel, which is one of the most expensive components of the lamp an idea was put forth that the lamp would not be shipped with a solar panel. Instead, it was suggested that a single large solar panel be installed in the neighbourhood or a few of them in schools. This way, the students can take their lamps to the school and charge them during their stay at school. There was also an entrepreneurship model that suggested that these large solar panels be put in someones house and they can charge a very nominal amount for recharging these lamps. It was essential to develop thoughts like these to try and bring the costs down.

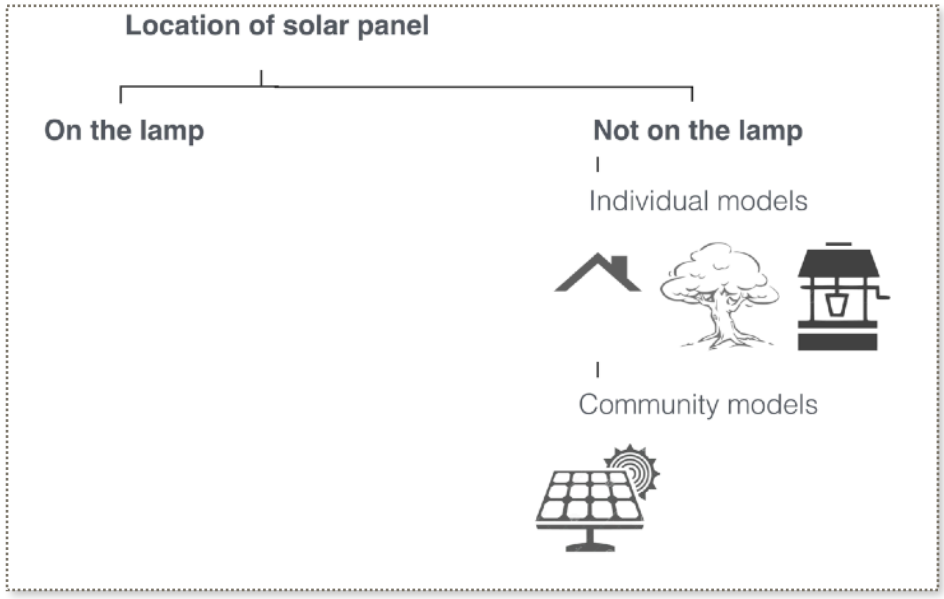


FIG 9.4 PROPOSED COMMUNITY MODEL

Another idea was to reduce the plastic in the lamp. While the lamp was making use of renewable energy, it was primarily made of plastic. Since it is one of the cheapest materials around doing away with plastic was not and option. However there are considerable efforts made so that the amount of plastic that is used per lamp is reduced.

Studying the electronics of the existing lamp

The electric components of the lamp are :

1. Main printed circuit board
2. Battery
3. LED
4. Solar panel

The Million SoUL team wanted to use the electronics designed by them. The dimensions of the same were provided.

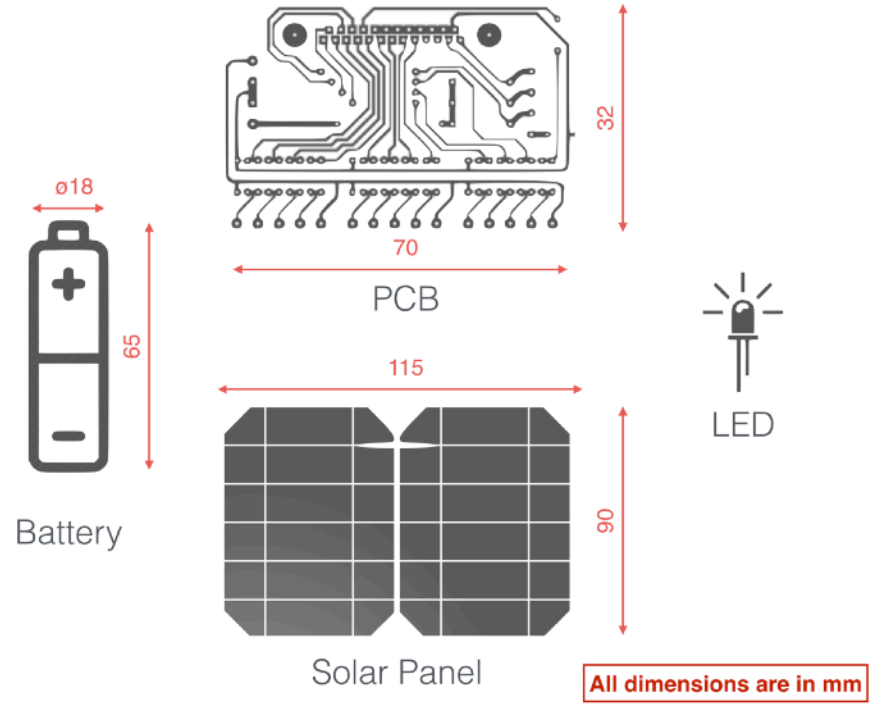


FIG 10.0 LAMP ELECTRONICS DIMENSIONS

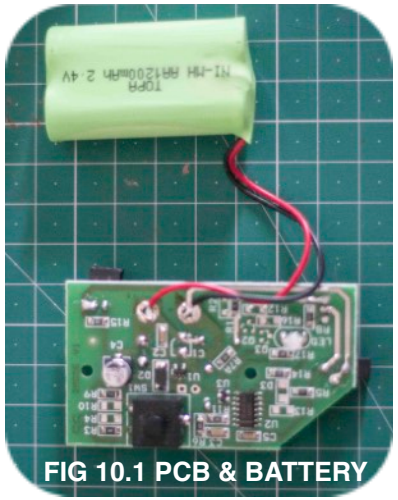


FIG 10.1 PCB & BATTERY

FIG 10.2 SOLAR PANEL

FIG 10.3 PCB BACKSIDE

Note : A single battery will be used in the new design.

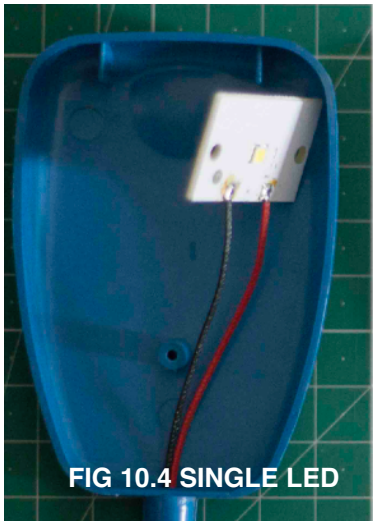


FIG 10.4 SINGLE LED

Concept generation

This concept is a simple horse shoe shaped design that has a hinge to allow rotation upto 150º. It has a provision to be fixed on the wall, held by hand and rest on the ground. Moreover a clip could also be provided so that it can be fixed on to a shirt pocket, a notebook or a wooden plank.

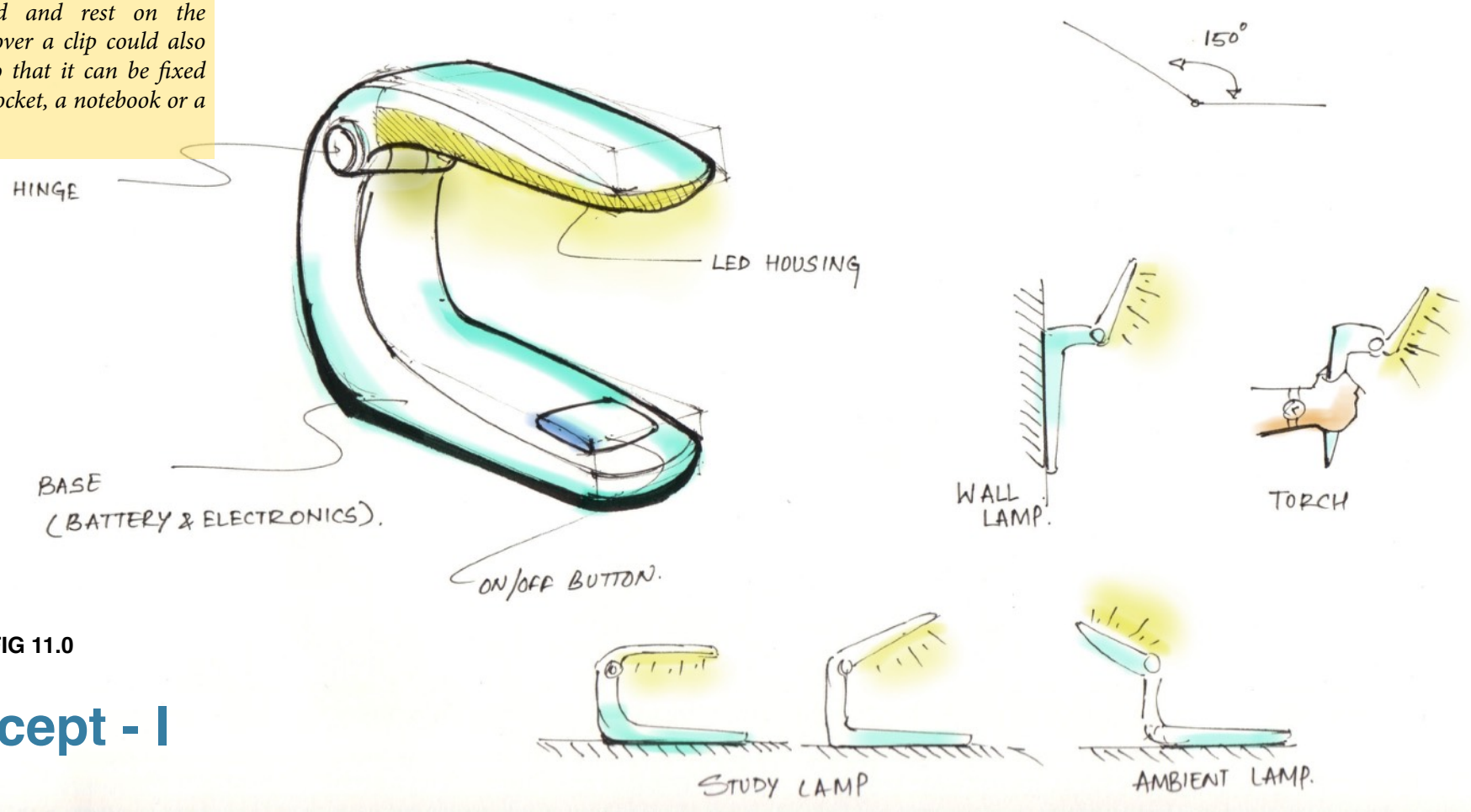


FIG 11.0

Concept - I

This concept consists of a diffuser and a light source. The light source, i.e the LED housing can slide and rotate about a hinge as shown. The diffuser adds height to the lamp and also can be used when an ambient light is needed. There is a provision in the rear to hang the lamp on a nail fixed to a wall.

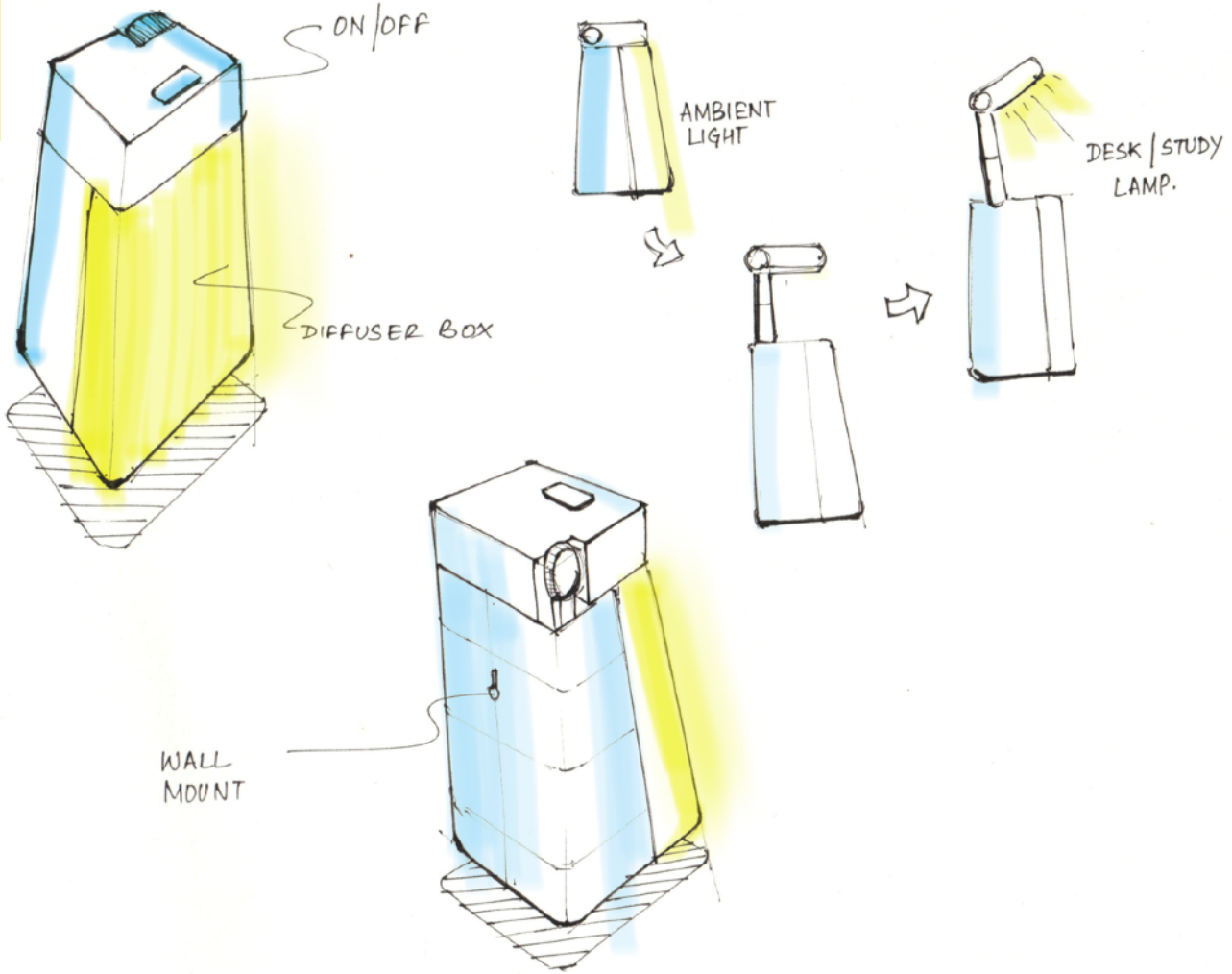


FIG 11.1

Concept - II

This concept has a cylindrical strutted attached to a hinged stand. The cylinder has a spherical diffuser at one end and a truncated cone at the other. The cylindrical design makes the lamp easy to hold when using it as a torch. The truncated end helps to hang the lamp on a wall at an an angle as shown. A hook is also provided to hang it by a string.

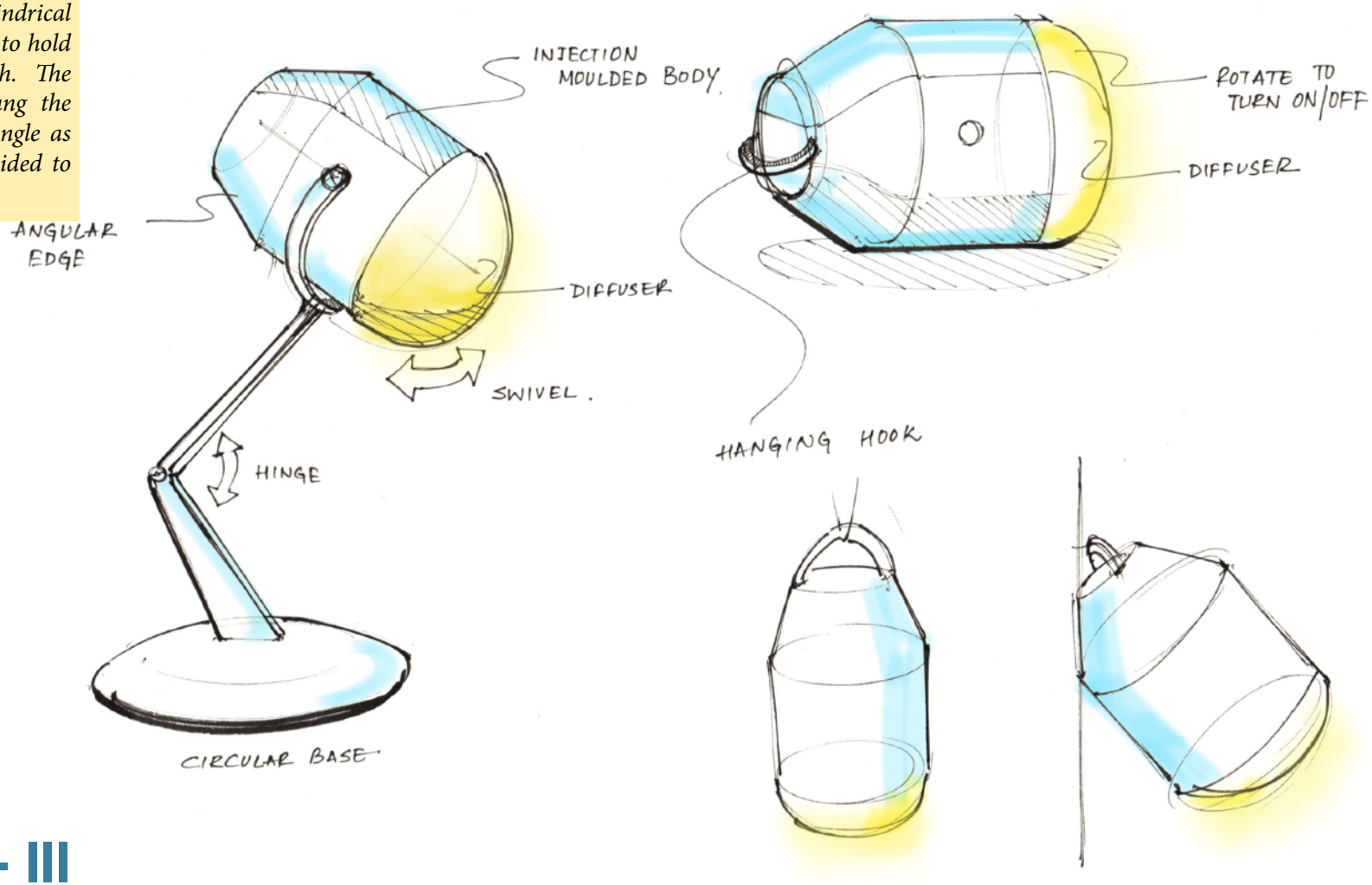


FIG 11.2

Concept - III

This concept comprises of a circular enclosure with a spherical diffuser. A wire bent as shown acts as the stand. A magnet is fit inside the enclosure which helps it to attach to the stand. The magnet facilitates easy adjustment of the lamp. At the back of the lamp is a hinged loop that enables it to be hung by a string. There is also a provision to attach it to a wall by a nail.

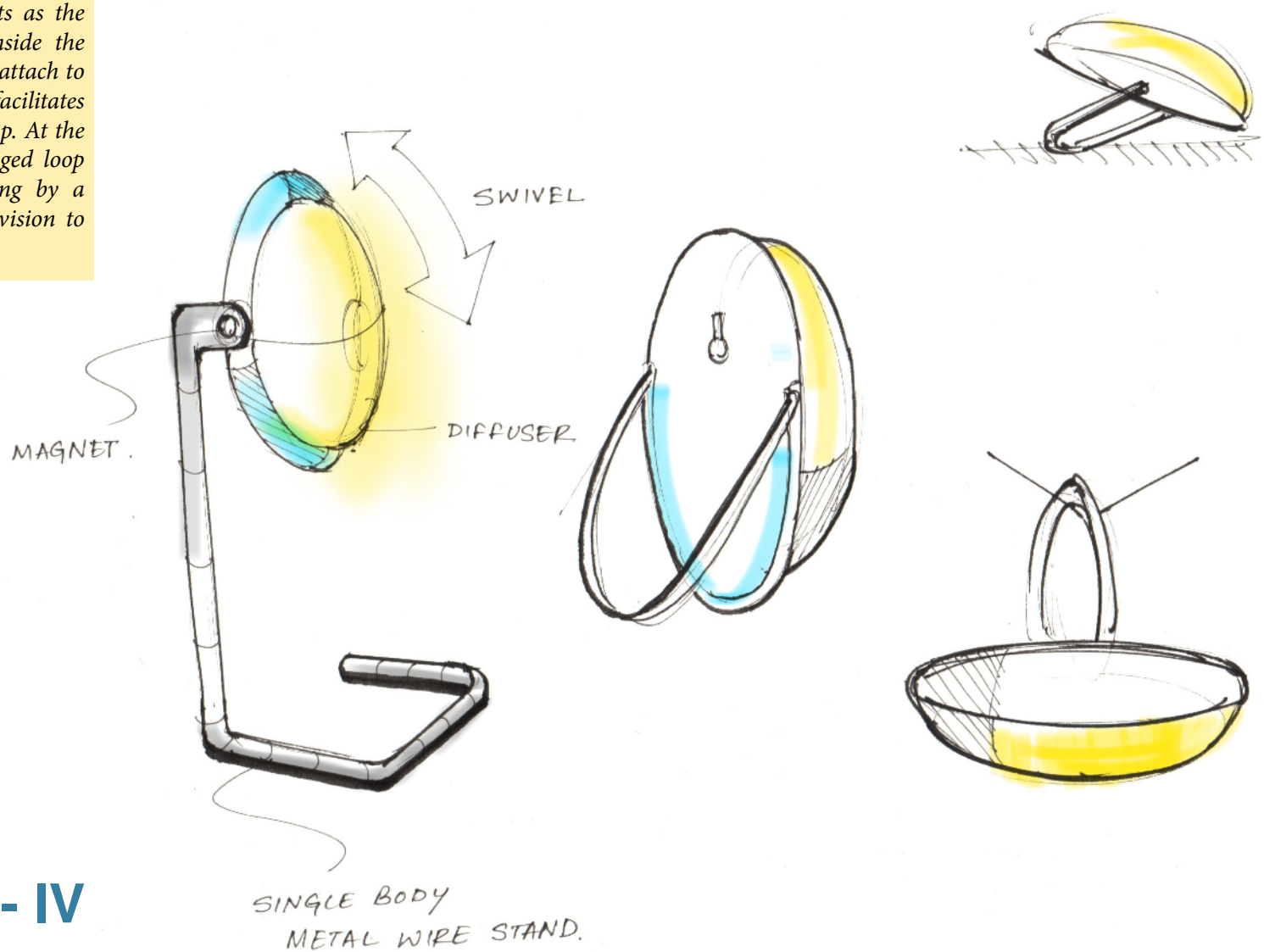


FIG 11.3

Concept - IV

This concept comprises of a simple square enclosure and a stand. The enclosure can slide as well swivel about the base as shown. The base can have the a kickstand or some other way to increase the surface area and to make it more stable. It can be hung on the wall, held like a torch apart from being used as a lamp.

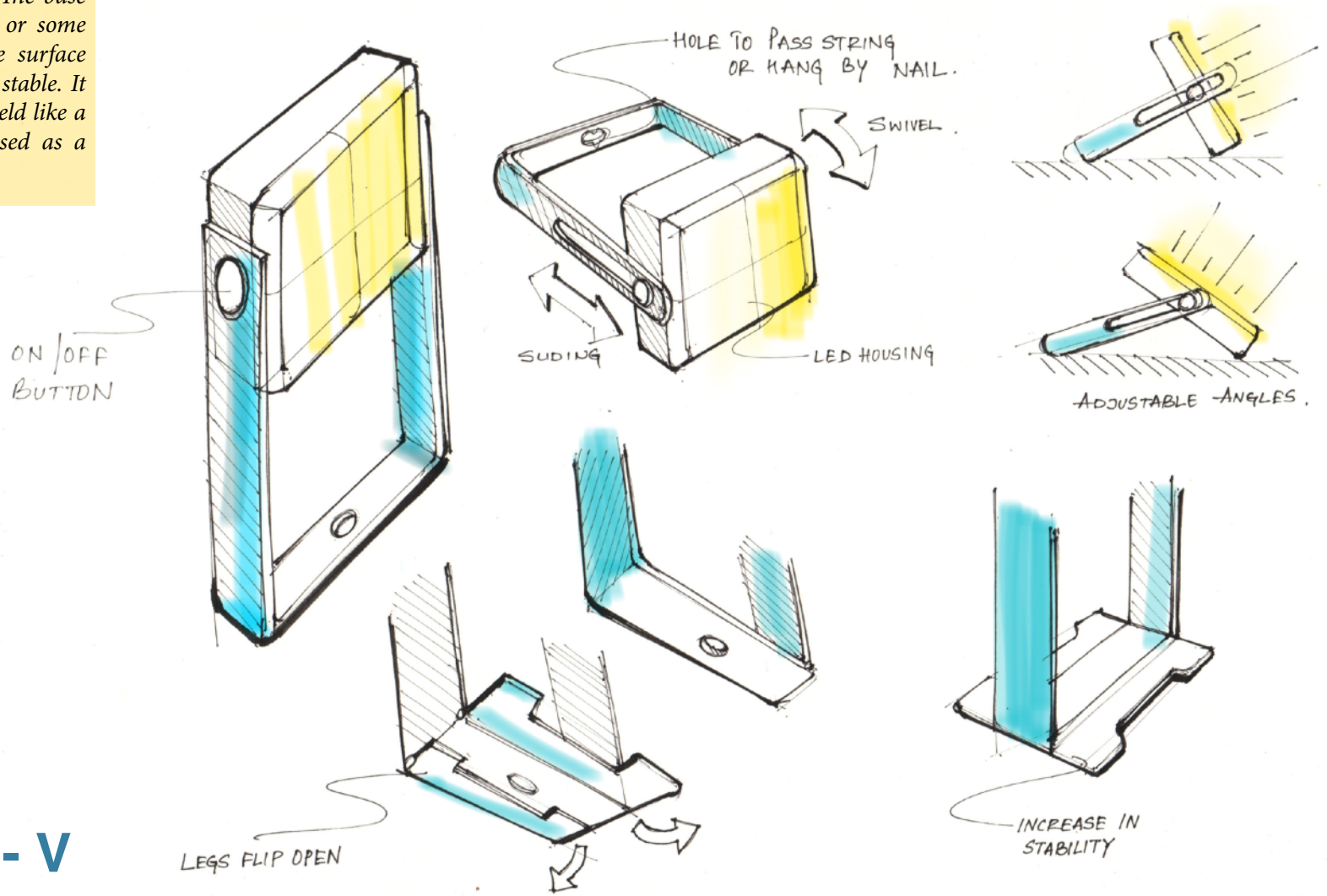


FIG 11.4

Concept - V

This concept consists of three parts : enclosure, stand and diffuser. The enclosure attaches itself to the stand through a screw mechanism as shown. The slotted stand facilitates sliding as well as rotatory motion of the enclosure. The diffuser can be attached to the enclosure and that makes it and ambient light. The stand can be attached to the wall and since the light source swivels freely, the direction of the light can be controlled.

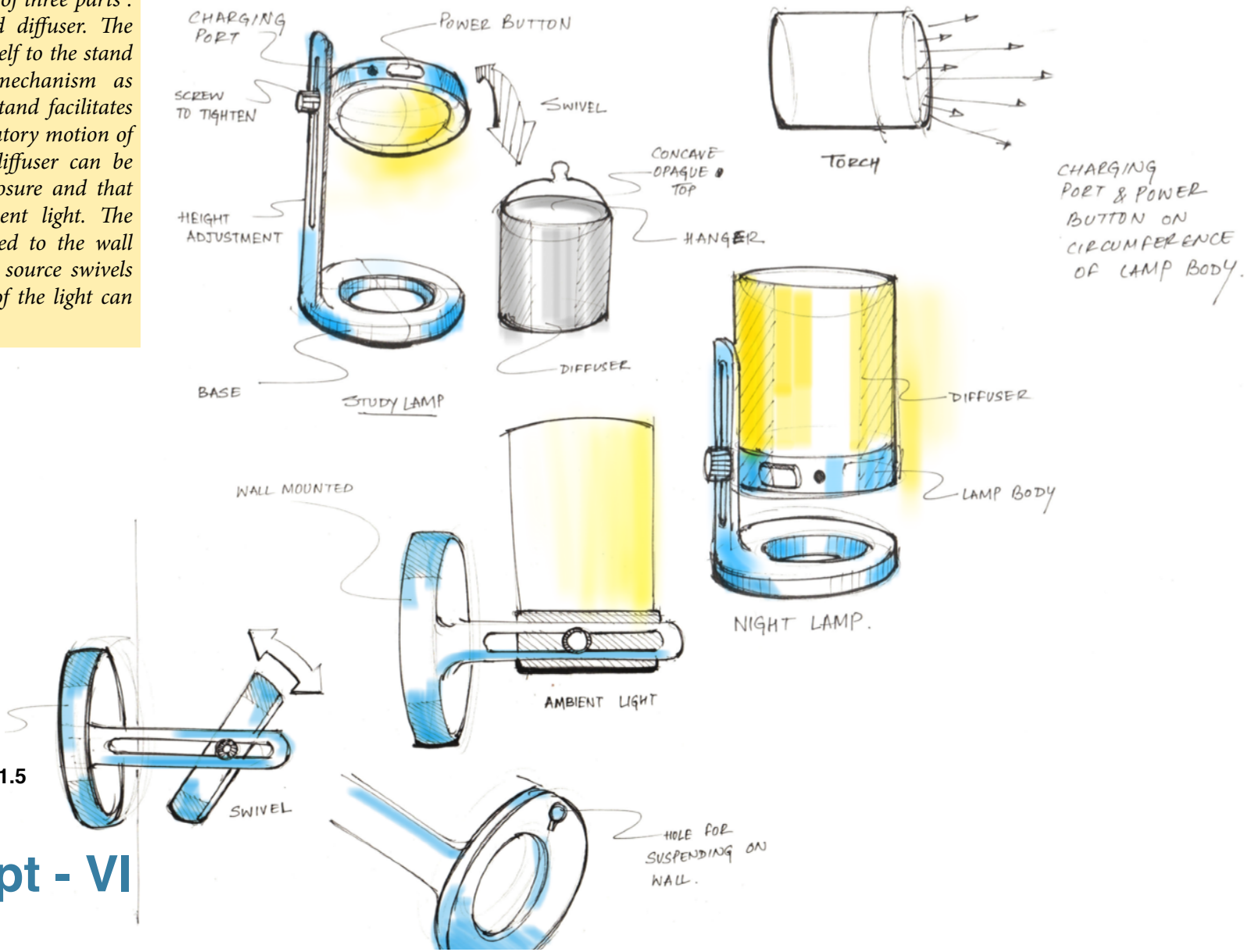


FIG 11.5

Concept - VI

This concept has two parts, the enclosure and the diffuser. The diffuser also adds height to the stand. The enclosure has a provision to swivel as shown. When the light source is facing upwards it acts a torch. When it rotates such that the light source faces the diffuser it acts as an ambient light source. When the lamp is at an angle as shown in figure 3 it it acts as a lamp. This design can also accommodate the solar panel within the lamp body.

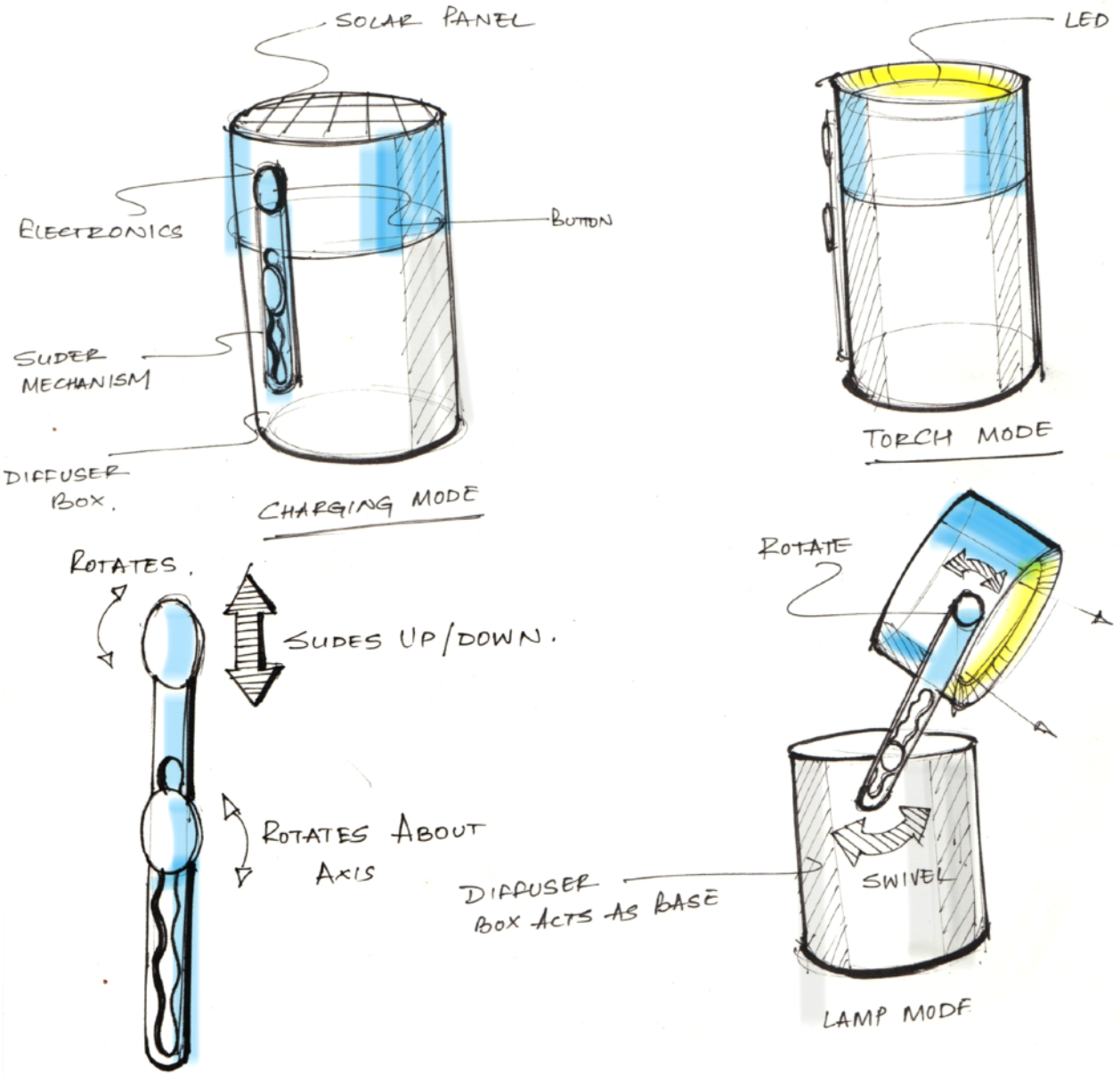


FIG 11.6

Concept - VII

Mockups

Some quick mockups were made in order to get a better understanding of the dimensions, size and proportions. The mock-ups were made of thermocol and styrene. They were tested at a basic level in different use conditions. The mockups were made keeping in mind the size of electronics, ergonomics, usability etc.

FIG 12.0 MOCK UP LAMP

FIG 12.1 MOCK UP WALL LIGHT

FIG 12.2 TORCH / LANTERN

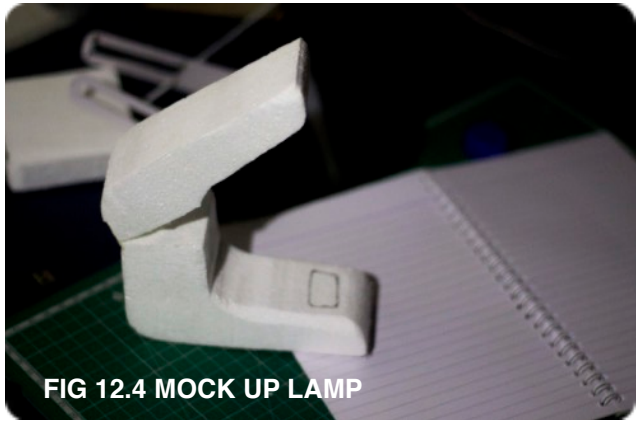


FIG 12.4 MOCK UP LAMP

FIG 12.5 MOCK UP WALL LIGHT

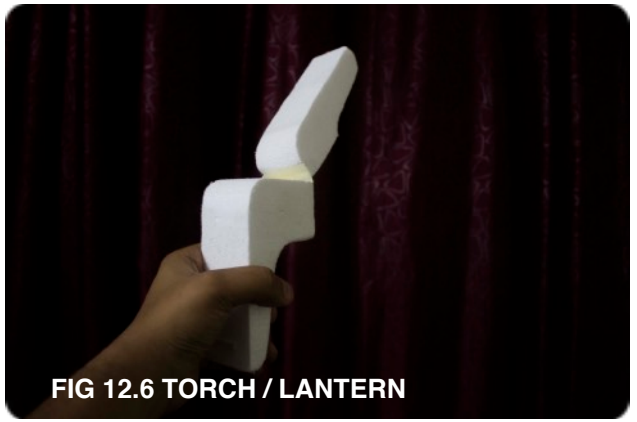


FIG 12.6 TORCH / LANTERN

Manufacturing Details

Looking at the concepts and mockups, it became clear that the design moved towards a single electronic enclosure. This meant that all the electronics (battery, PCB, LED etc) were fitted in the same enclosure. This was one of the stark differences compared to the existing design where the base and houses the PCB, battery, button and indicator lights and the LED is in a separate housing. To familiarise myself with the the way the electronics are arranged in the existing design, studying of individual enclosure parts was necessary. It would also help me gain some insights and understand the way the electronics are mounted on the plastic enclosure parts.

1. **BOTTOM CASE :** As seen, the bottom case has the bosses which houses screws that fastens itself to the top case of the lower enclosure. For strength it has ribs running in perpendicular directions. Also, tit has a more or less rectangular extrusion which snugly houses the battery.

FIG 13.0(A) ENCLOSURE BASE

2. **TOP CASE :** The top case, has bosses which help to fasten itself securely with the bottom case. Moreover, it also has bosses that attach the PCB. It has cutouts for exposing the charging sockets, ON/OFF button and indicator light. It also attaches itself to the gooseneck and it is through that joint that the cable connecting the LED to the PCB is passed.

FIG 13.0(B) ENCLOSURE TOP

3. **LED ENCLOSURE :** The LED enclosure consists of three parts. The transparent plastic protects the LED while letting the light pass through. The white LED mount that has bosses to attach it with the LED and the blue plastic back that completes the enclosure. All these parts are held together in place by a single screw.

FIG 13.0(C)LED ENCLOSURE

4. **SOLAR PANEL :** The solar panel is sandwiched in-between a 2-part plastic enclosure. To add resistance to dust and water, further gluing is done to firmly secure the solar panel to the enclosure.

FIG 13.0(D) PANEL ENCLOSURE

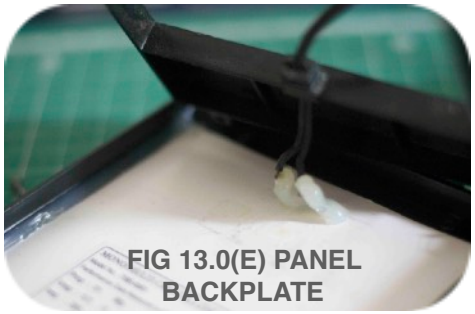


FIG 13.0(E) PANEL BACKPLATE

Internal arrangement of parts

After measuring the dimensions of the electronics, the challenge was to arrange them in such a way that there is optimum use of space. As an extreme reference, a schematic diagram was made to determine the maximum thickness if the parts were stacked on top of each other. This maximum thickness would be a base point in trying to make the product as compact as possible.

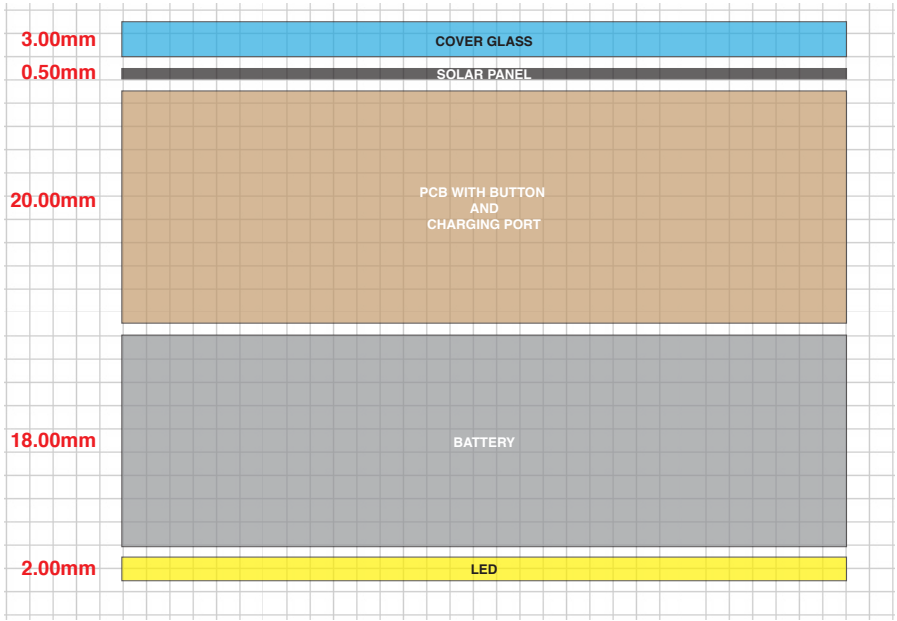


FIG 13.1 STACKING OF ELECTRONIC PARTS

As shown, the total thickness of the enclosure keeping in mind of the clearances and tolerances as well is close to 50mm. It should be noted that this thickness is without considering the thickness of the enclosure itself. Coming to the length and width it was concluded that the size of the solar panel would

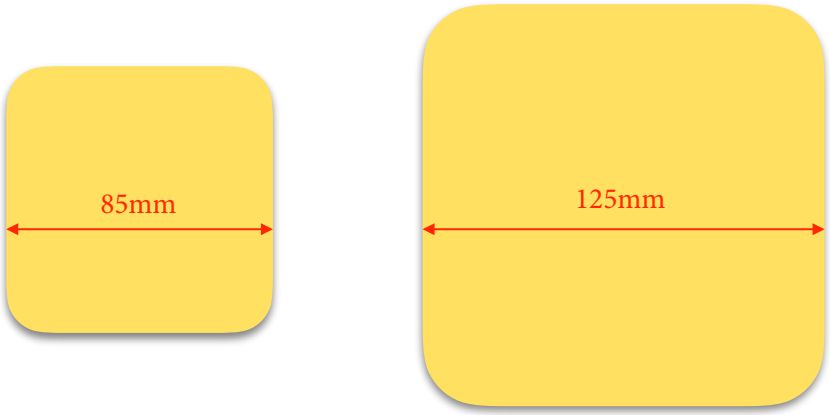


FIG 13.2 ENCLOSURE DIMENSIONS

dictate those dimensions. as the solar panel was the largest of all parts. If the solar panel was built into the main electronic enclosure then the length of the side would have to be at least 125mm. However, if the solar panel was not integrated into the main electronic housing, the dimensions would be considerably reduced to around 85mm.

Once the length and width were determined, arrangement of the internal components was done in various combinations so as to optimise the thickness. Once the arrangement was finalised, a styrene mockup was made. The mockup included parts cut in dimensions resembling the dimensions of the electronics. The enclosure was made such that it securely housed all the internal electronics while it was securely closed. Adjacent is the exploded view of a render showing the internal parts and their arrangement.

Styrene models of both the 85mm as well as the 125mm boxes were made. The 85mm mockup did not need a backplate to securely fix the solar panel as the solar panel was not supposed to be built in it.

Consideration was given to the injection moulding process as well. Undercuts were avoided to facilitate economical injection moulding. Detailed study about the dimensions and placement of bosses was done so as to make the enclosure of the desired strength.

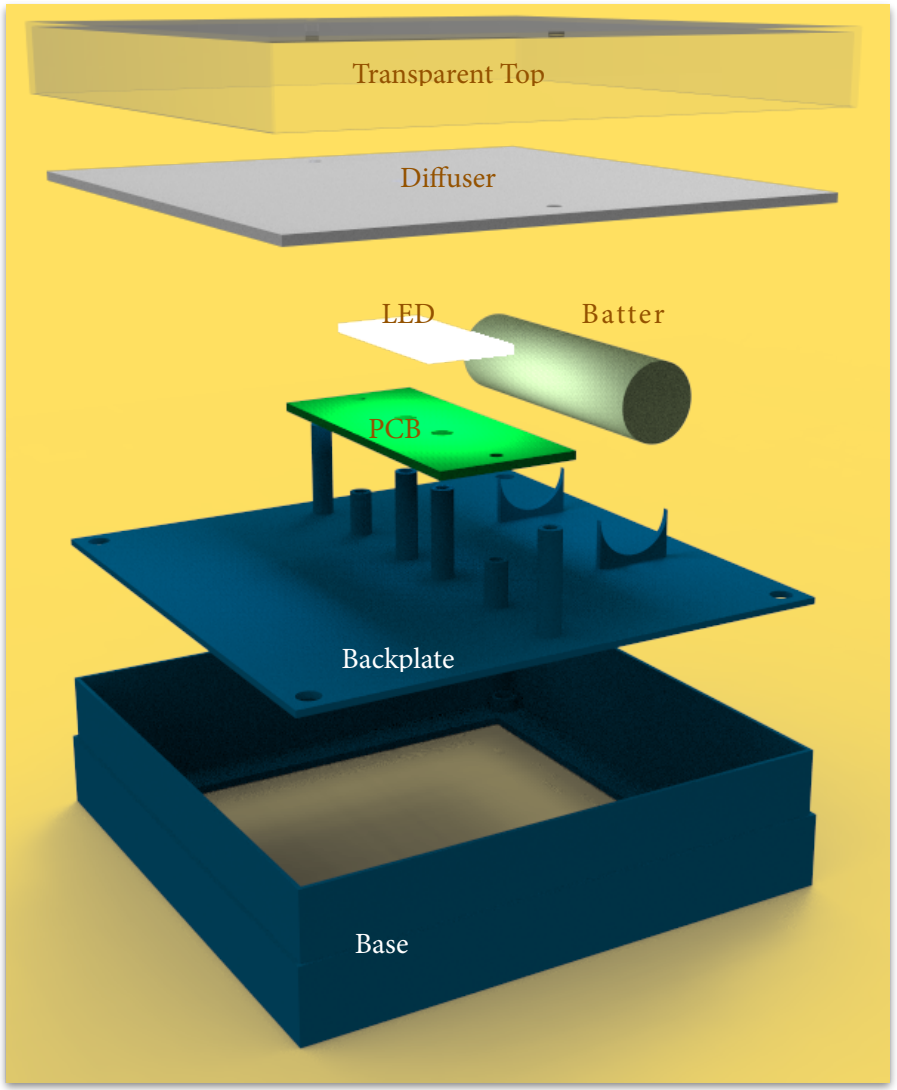


FIG 13.3 EXPLODED VIEW

Arriving at Concepts

With the internals finalised, the concepts based on the preliminary sketches were digitally modelled and rendered. These concepts were made keeping in mind the initial study about the multiple use cases and postural studies. The concepts were also designed to be used in both cases, the integrated solar panel and the separate solar panel. The concepts were designed such that they have the simplest of mechanism ensuring that they were easy to use and durable.

CONCEPT - I

Features :

- Single electronic enclosure which houses all the electronics namely the LED, PCB, battery, button etc. The square profile of the enclosure provides ample surface area to mount the solar panel into the design as well.
- The enclosure rotates about the stand as shown. This enables the lamp to easily adapt to multiple use conditions. A simple hinge mechanism ensures that the enclosure positions itself at any angle that the user may require.
- The presence of a kickstand adds stability to the lamp especially when it is being used as a table lamp The kickstand appears to be a neat addition that springs in use whenever required.
- As shown in the images, the lamp can easily transform from a study lamp into a torch, lantern or a light that can be hung over a hook etc.

FIG 14.0(A) LAMP MODE

FIG 14.0(B) KICKSTAND TUCKED IN

FIG 14.0(C) TORCH MODE

FIG 14.0(D) BULB / AMBIENT LIGHT

CONCEPT - II

Features :

- Single electronic enclosure which houses all the electronics namely the LED, PCB, battery, button etc. The circular profile of the enclosure provides ample surface area to mount the solar panel into the design as well.

- The enclosure rotates about the stand as shown. This enables the lamp to easily adapt to multiple use conditions. A simple hinge mechanism ensures that the enclosure positions itself at any angle that the user may require.

- Circular base adds stability.

- The enclosure is attached to the base with a screw mechanism which has a threaded metal insert in a plastic cap. This means that the light enclosure is detachable from the stand and can thus easily be used on its own without the stand.

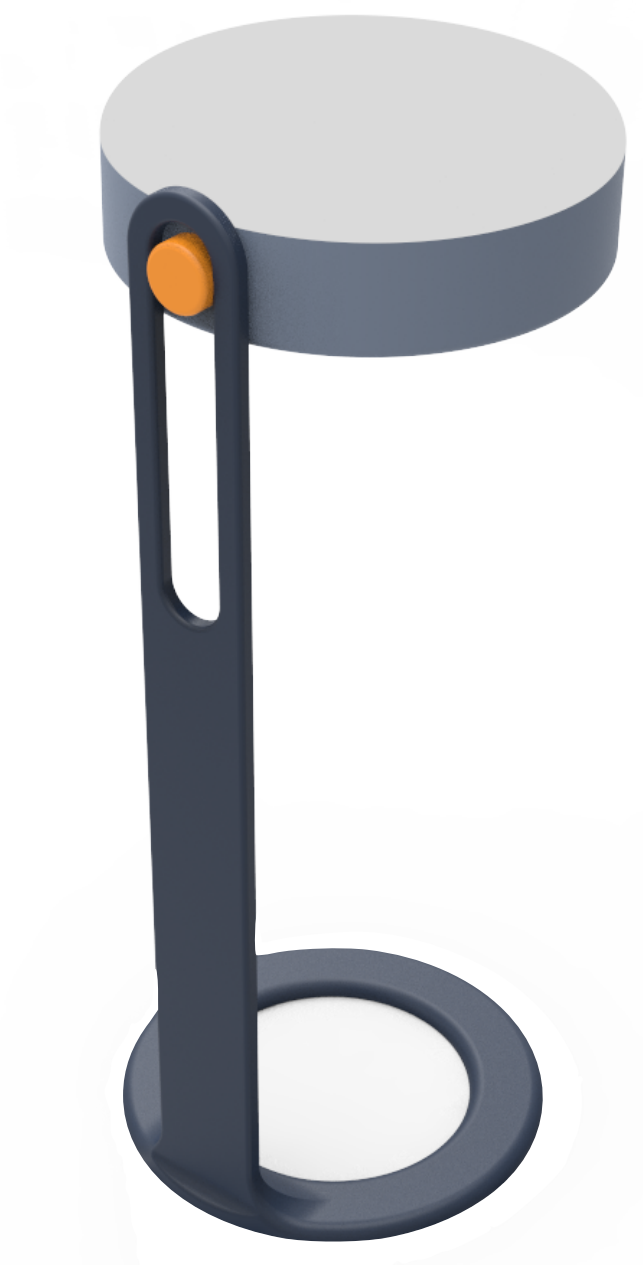


FIG 14.1(A) CONCEPT - II

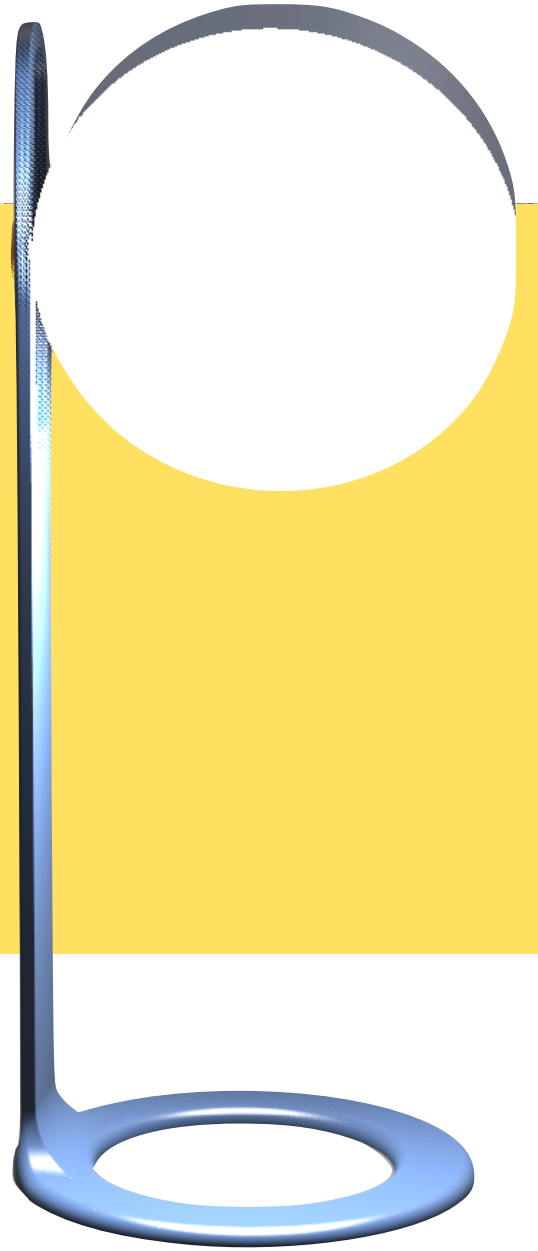


FIG 14.1(B) LAMP MODE

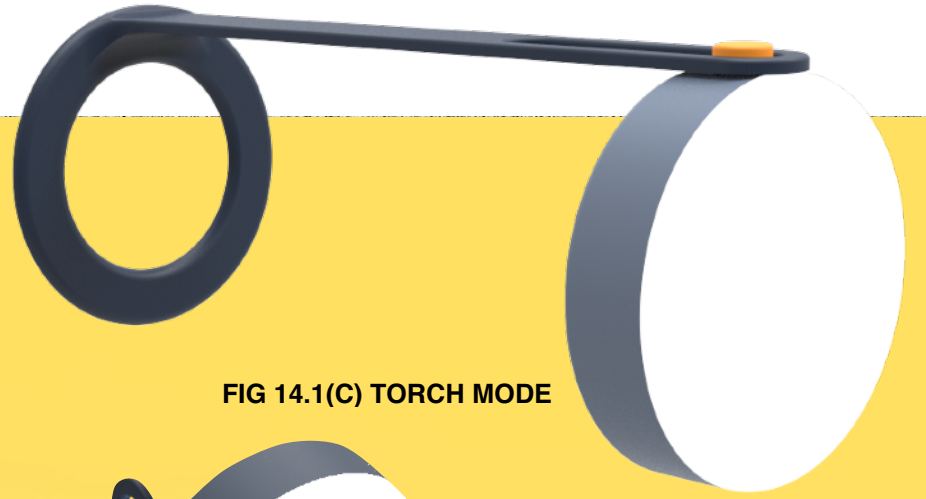


FIG 14.1(C) TORCH MODE

FIG 14.1(C) SLIDABLE ATTACHMENT

CONCEPT - III

FIG 14.2(A) CONCEPT - III

Similar to the first concept this also has a single electronic enclosure. It also has a similar attachment to the stand. With the hinge the enclosure can also rotate about the stand.
Even thought the design looks very similar to the first concept, there are some clear differences between the two designs.

Features :

- This design has a wider base for added stably. Since the height of the stand is also less, there is no need for an additional kickstand. The lamp is quite stable on its own.

- As the stand is considerable small, the overall volume of the lamp increases drastically. This means that the size of packaging of the lamp is much smaller than the existing packaging. This would directly result in reduced shipping and storage costs.

- In order to make up for its low height, the lamp can attach itself to any pet bottle. The circular hole in the base is wide enough to let lamp be attached to almost all PET (Cold drink) bottles.

- This ensures that the lamp doesn't need a long stand which would result in a larger package and increased shipping / storage costs.

Why pet bottle?

- **PET BOTTLES ARE EVERYWHERE :** Pet bottles are one of the most widely used plastic bottles. The reach of soft drinks and packaged juice is tremendous and these bottles are found littered everywhere around us. Since it is one of the cheapest and readily available object, the choice of using a PET bottle as a stand seems obvious.

- **UP-CYCLING OF PLASTIC :** While some of the PET bottles are used as water bottles after the drink in them is consumed, most of them are simply thrown away. Using these bottles would ensure that fewer bottles go as waste. Since we are talking about these lamps being made in millions, it would also imply that millions of PET bottles will be up-cycled.

- **EASY TO ATTACH :** The stand attaches itself like a washer placed between a nut and a bolt. The cap needs to be opened, the mouth of the bottle is slid into the stand and the cap is then securely tightened. The way the stand is fir to the bottle ensures that a wide variety of PET bottles of different sizes can be attached to the lamp.

- **CREATIVITY AND A SENSE OF OWNERSHIP :** As the target user of this lamp is a child, the use of bottle can promote creativity. These bottles can be painted, decorated and thus be given a personal touch. This would also create an identity to the lamp and thus a sense of belonging and ownership to something as common as a PET bottle.

- **MAY BRING OUT CREATIVE USES :** The PET bottle can act as a canvas and can result in a lot of creative uses. This may not be limited to just painting but can also be used as creative storage products like pencil boxes, marble holders, piggy banks etc.

- **ERGONOMIC TO HOLD :** Since all PET bottles are designed to be held comfortably, it becomes perfect to be held and used as a torch, lantern etc.

FIG 14.2(B) PET BOTTLE ATTACHED

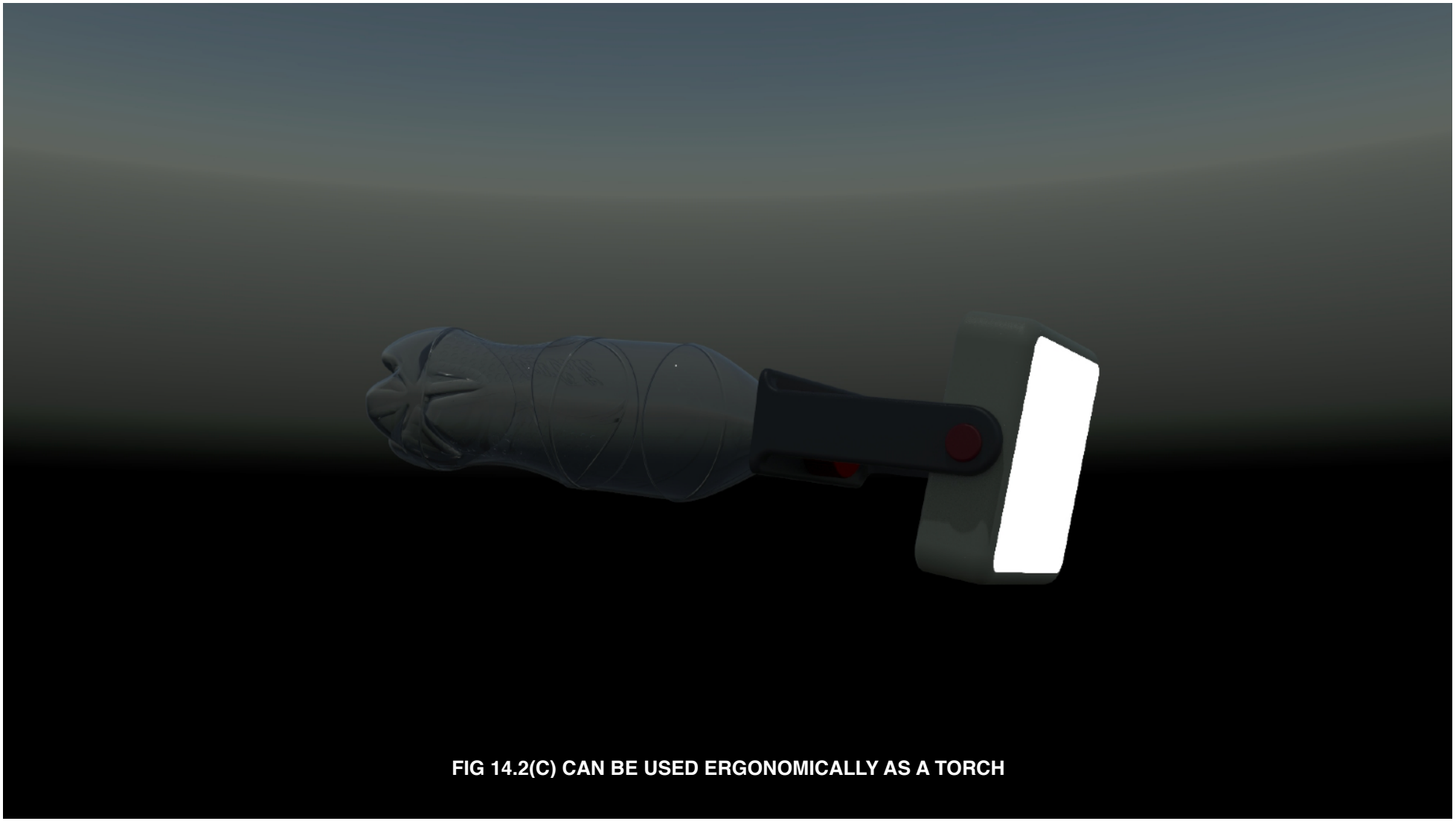


FIG 14.2(C) CAN BE USED ERGONOMICALLY AS A TORCH

Validation

The validation happened in two parts :

1. **Million SoUL Team**
2. **Prospective Users**

VALIDATION WITH MILLION SOUL

The million soul team, obviously, have extensive knowledge about not only the product but also the mentality and behaviour of the rural user. Thereby it was of utmost importance that I get their feedback before testing the concepts in the field.

A detailed presentation was made to Prof. Chetan Solanki, the head of the Million SoUL project in the presence of my project guide, Prof. Vijay Bapat. The presentation included demonstration of different concepts, mockups, other portable product forms etc. The idea was to present concepts with reason so as to make it easy to relate for the audience. It would also help me get some constructive feedback and thereby get a direction in which I could take the project forward.

The following is the feedback that I received :

1. **SEPARATE SOLAR PANEL :** Prof. Solanki suggested that it is better to keep the solar panel separate and not integrate it with the main electronic enclosure. This was suggested because if the solar panel is integrated, the entire lamp would have to be kept outdoors to charge. Since India is typically a hot country, where temperatures reach close to 50°C in the summer it was observed that the temperatures inside the electronic enclosure reach around 60°C. This can cause failure of electronics since their maximum operation temperature is also around 60°C. Keeping in mind the limitations of these electronics it was decided that the solar panel was separate from the main enclosure.
2. **CELL PHONE CHARGING :** The Government of India has directed the million SoUL team to include a cell phone charger in the lamp. This would mean that the lamp needed to have a separate USB female socket to charge the phone. The PCB will be programmed to allow half of the battery capacity to be used to charge the cell phone while the other half will be used to power the LED. This distribution of power was done so that the lamp is not just used as a cell phone charger.
3. **FUTURE UPGRADATION :** The team is also working on a project called Solar Energy for Local by Local(SELL). The aim of the project is to provide houses that are not electrified a solar kit which would include basics like a solar panel, lights. fans, mobile charger and a radio. It was suggested that the size of the lamp be finalised keeping the thought of future upgradation at the back of the head.
4. **ADDING REDUNDANCY :** It was suggested that there could be efforts made in adding some redundancy to the product. However I felt that if the lamp ceased to work, then it could be better if the amp was eligible for exchange and the user could buy a new lamp at a slightly lower cost. This would also help the supplier / manufacturer use the working parts of the exchanged lamp.
5. **LOCAL MANUFACTURING :** The million SoUL team wanted the lamp to be manufactured locally. However it was suggested by Prof. Bapat that in order to get the cost down, it is essential that modern manufacturing processes are implemented. It was also suggested that manufacturing of parts can take place in factories with modern machinery whereas the assembly could be done locally. This would ensure a good quality product and also help in generation jobs in the rural scenario.
6. **ACCESSORY MARKET :** Prof. Solanki liked the idea of using a PET bottle and suggested that an accessory market can be made for the lamp. These can include some useful products like carrying pouches, cell phone stands etc. that can be sold separately to interested people. This would also encourage users to be creative and come up with their own ways of using the lamp better. I suggested to conduct a “PET Bottle Decorating Competition” among rural children. This would help me bring out the creativity and also demonstrate the thinking of children. Prof. Solanki and Prof. Bapat liked the idea and asked me to go ahead.

The feedback was both helpful and encouraging as the team really liked the third concept, i.e the one with the PET bottle attachment. The concept was to be taken forward.

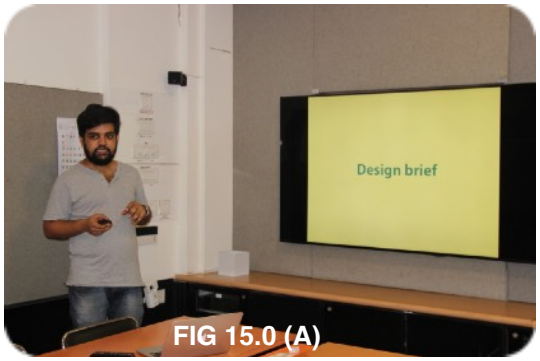


FIG 15.0 (A)


FIG 15.0 (B)

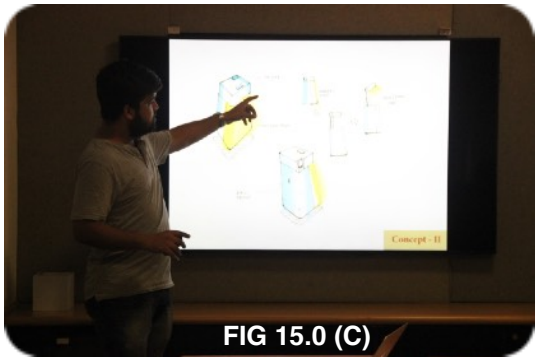


FIG 15.0 (C)

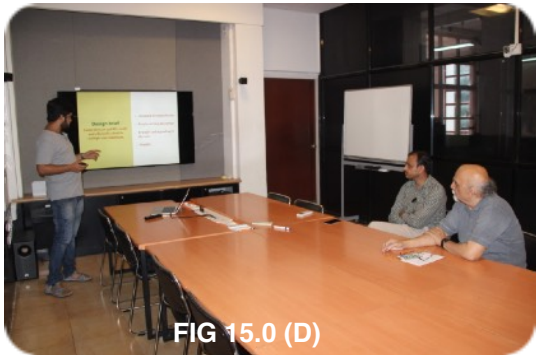


FIG 15.0 (D)


FIG 15.0 (E)


FIG 15.0 (F)

Presentation to Prof. Chetan Solanki and Prof. Vijay Bapat

Working Prototypes

After the validation, working prototypes were developed. These were made of styrene. The enclosure was vacuum formed whereas the stand was bent into shape after heating. The prototypes were of the exact size of the final model and were taken to the rural environment for further testing and validation.
There were two types of prototypes that were made : One was similar to the finalised concept and the other was designed in such a way that the LED housing would screw fit onto a PET bottle. Both these prototypes were very similar yet offered a stark difference in the way they were attached to the bottle.


FIG 15.1 (A) PROTOTYPE - 1


FIG 15.1 (B) PROTOTYPE - 2

VALIDATION WITH PROSPECTIVE USERS

After acting on the feedback received from the Million SoUL team, it was not time to test these lamps with their prospective users. The validation had to include critical undertakings like task analysis, determining the perceived value, comparing it to the existing design, recording user feedback etc. The village chosen was Kevaregaon, Maharashtra. Although the village had a power supply it frequent power cuts. Participants for the analysis not included children but also people of different age groups.

Task Analysis

Test Method : **Think Aloud Test**
The user was handed over the prototypes and the current design and asked to speak up whatever thoughts came into his/her mind about the product, its usefulness, shortcomings and usability.
The testing team kept a close eye on how users held the lamp, turned the switches on / off, whether they reached the button intuitively, whether users could relate to the form of the lamp.

The following were the conclusions of the think aloud test :

1. **New design better in different use cases :** The audience felt that the Prototype - 1 was better in different use cases. They quickly connected to the different adaptations that the lamp had to offer. The value that they identified in it was of the multiple use cases it could be used in. Prototype - 2 was perceived to be uncomfortable to hold as the radius of the handle was too small for the hands of adults. The children however felt that Prototype-2 was better looking due to the circular enclosure.
2. **Looks like a TV :** Prototype-1 looked like a TV according to the users. This observation was made by a almost 10 people.
3. **Light is inadequate :** Users felt that the light that was emitted from the lamp was inadequate. They felt that in outdoor use conditions, they would need more light. This observation was especially made by women. They felt that more light was required when doing tasks like cutting vegetables and cooking. Note : The prototypes had a 0.5-Watt LED whereas the final

design would have a 1-Watt LED so the lack of brightness is understandable

4. **Would like to buy for all houses in the village :** The village Sarpanch was also among the audience. He was impressed with the adaptations the lamp could carry out. He offered to buy a lamp for each house in the village. This offer was made after we declared that the lamp would be sold for a price of Rupees 250.
5. **A metal stand would be better :** A few users thought that the plastic stand supporting the lamp was weak and would break. They thought that a metal stand would make the stand stronger and ensure a long product life.
6. **We can fill the bottle with marbles :** The children gave creative suggestions to make the bottle heavy. While many of them suggested water or sand to make the bottle heavy, some gave interesting ideas like marbles, coins, pebbles. This shows that the true potential of creativity can only be seen after students are given these lamps.

Some other observations:

1. **Mobile phone charger will boost sales :** The perceived value of the product went from Rs.350 to Rs.450 once it was mentioned that the lamp would also be able to charge phones by using solar energy.
2. **Users suggested creative uses :** Like I mentioned before, the true potential of the lamps usability will only be visible once the lamps are distributed. A child suggested that Prototype - 1 can be fixed to an umbrella using the hold in the stand. He felt that the lamp could be attached to an umbrella and the user will have to only hold the umbrella and not the lamp.
3. **Existing design perceived to be weak :** Users, especially adult males felt that the existing design is weak. It appears that they found this to be true as the existing design has two large volumes connected by a slender gooseneck. They felt that this lamp should not be put anywhere near children as they are bound to break it.
4. **Wires and electronic components are alien to users :** Users said that they would not like to use a product with exposed or visible wiring and electronic fitting. This trend was seen especially among women and children.
5. **Increasing usability increases the perceived value of the product :** It was observed that users were ready to pay more for the new designs as they offered more usability / adaptability compared to the existing design.
6. **Users like to bring in their own creative solutions :** It was observed that users loved to bring in their own creative solutions to solve problems. This further strengthens the idea of developing an accessory market like pouches, cell phone holders, covers etc.


FIG 15.2 (A)


FIG 15.2 (B)


FIG 15.2 (C)


FIG 15.2 (D)


FIG 15.2 (E)


FIG 15.2 (F)


FIG 15.2 (G)


FIG 15.2 (H)

Validation and user feedback
at Kevaregaon, Maharashtra.

An attempt to promote creativity in children

On our second day at Kevaregaon, we held a bottle decorating completion among children aged 5-15 years. They were given basic material like paints, brushes and coloured paper and were then asked to decorate used PET bottles. The idea here was to exhibit the creative capabilities of children.


FIG 15.3 (A)


FIG 15.3 (B)


FIG 15.3 (E)


FIG 15.3 (H)


FIG 15.3 (C)


FIG 15.3 (F)


FIG 15.3 (G)


FIG 15.3 (D)

PET Bottle decorating competition

FIG 15.3 (I)

FIG 15.3 (J)

FIG 15.3 (K)

FIG 15.3 (N)

FIG 15.3 (L)

FIG 15.3 (O) COMPETITION PARTICIPANTS

FIG 15.3 (P) COMPETITION WINNER

FIG 15.3 (M)

PET Bottle decorating competition

Photographs of working prototypes

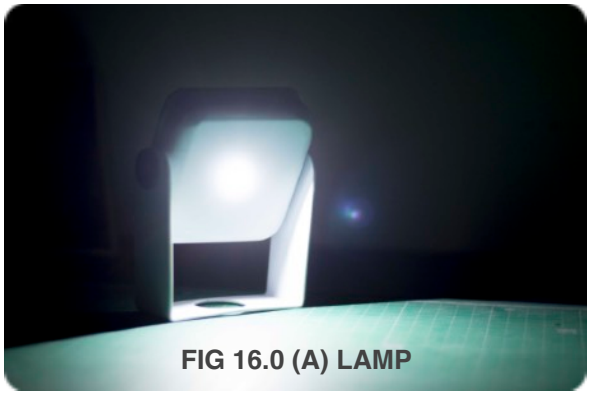


FIG 16.0 (A) LAMP

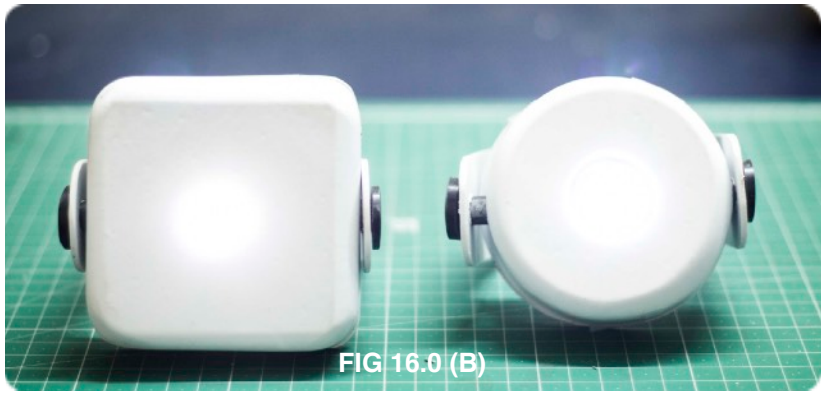


FIG 16.0 (B)


FIG 16.0 (C) HANGING LIGHT


FIG 16.0 (D) STUDY LAMP


FIG 16.0 (E)


FIG 16.0 (F) TORCH

Images of prototypes being used in typical use case scenarios

Variations in form

Once the dimensions were finalised the product was then given some variations in form. We had a workshop where Mr.Ashok Panwalkar exposed us to the creation of a Visual Perception Matrix. It is a graph were products are places solely on the basis of their form. Products are placed appropriately on the matrix as shown.

Innovative product forms tend to appear on the upper right area of the graph whereas the more traditional and known product forms appear on the bottom left. The challenge here is to design a from that appears in the DISTINCT x INNOVATIVE matrix.

The products whose forms I chose were not just solar lamps but other portable forms such as speakers etc. Also, since the product was designed for the rural population, it was essential to generously include product forms from the rural context as well.

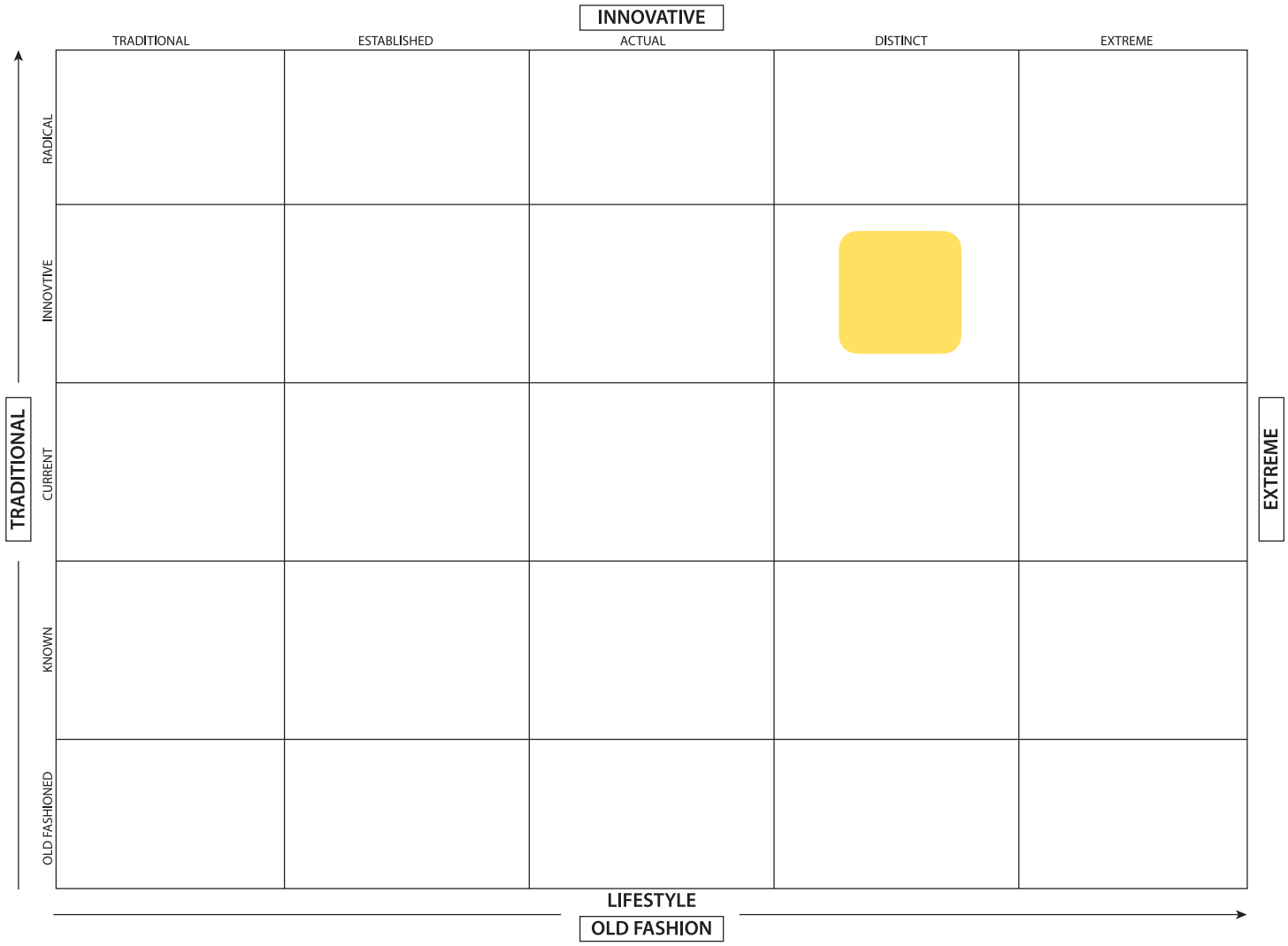


FIG 17.0 VISUAL PERCEPTION MATRIX GRID

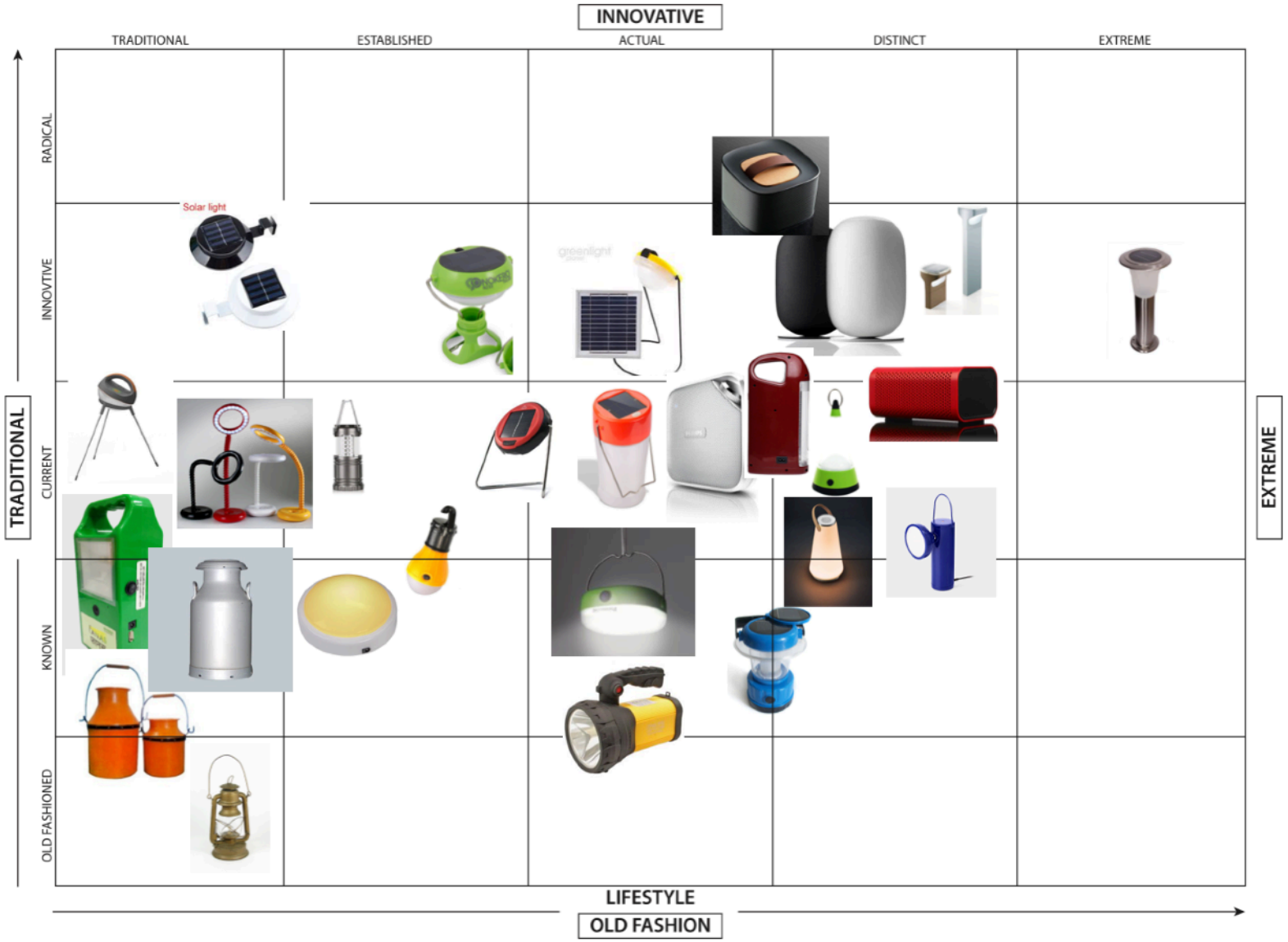


FIG 17.1 PRODUCT PLACEMENT

Generating Options

ENCLOSURE VARIATIONS

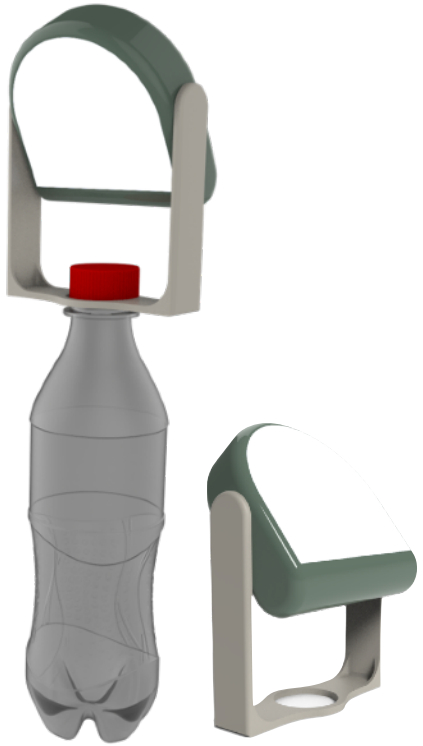


FIG 18.1(A) OPTION - I

FIG 18.1(B) OPTION - II

FIG 18.1(C) OPTION - III

STAND VARIATIONS

FIG 18.1(D) STAND VARIATION OPTION - I

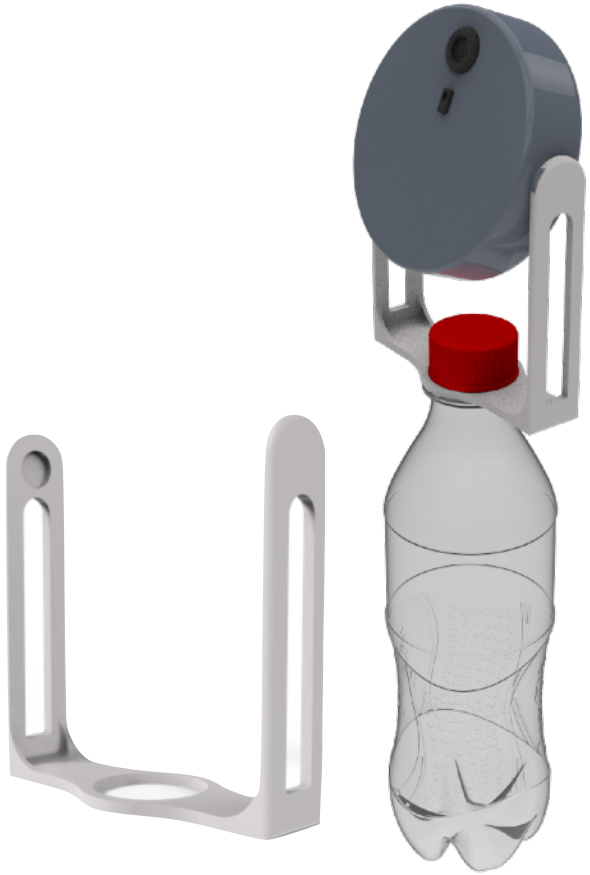


FIG 18.1(E) STAND VARIATION OPTION - II

Mechanical Drawings

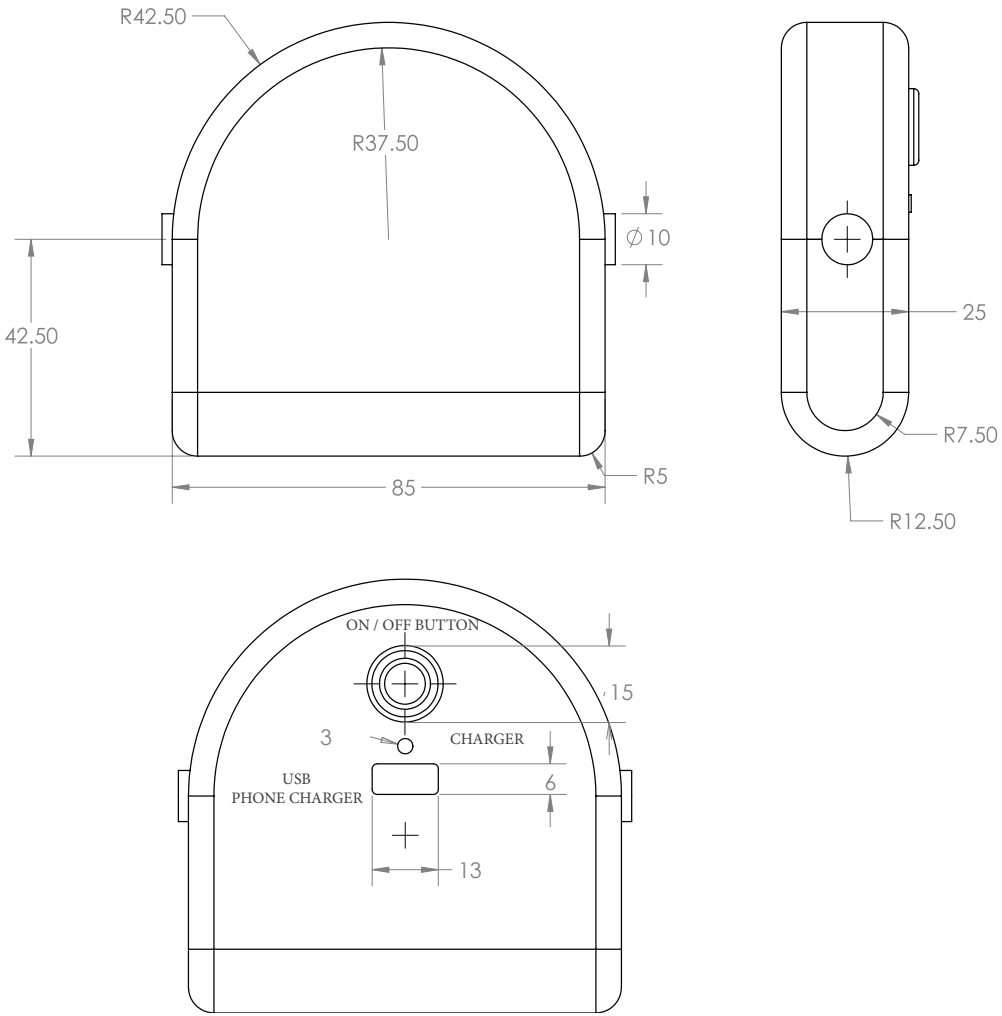


FIG 18.2(A) OPTION - 1 MECHANICAL DRAWING

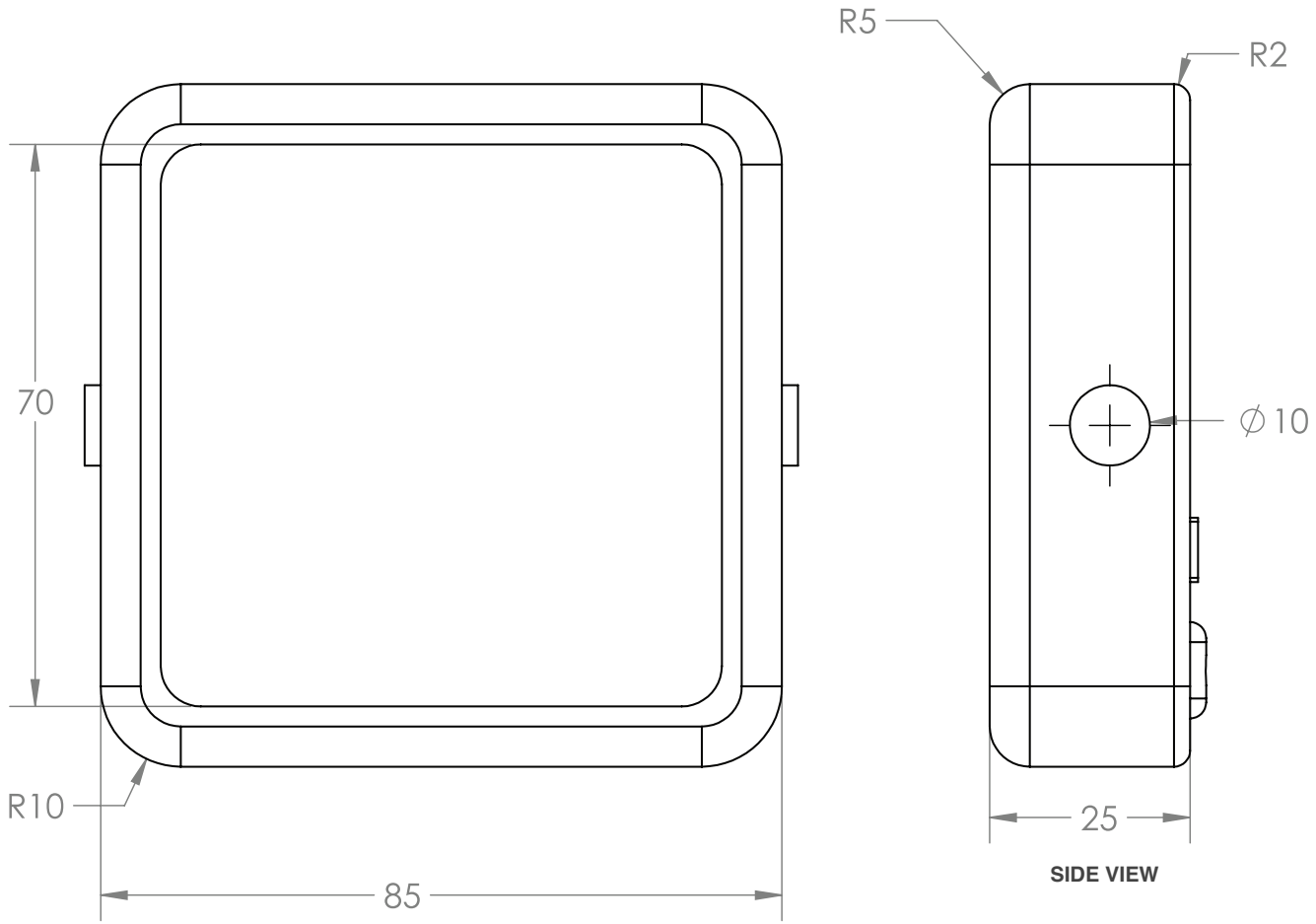
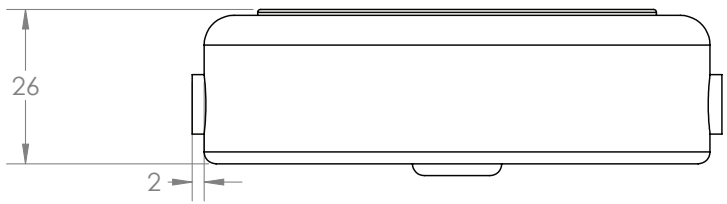
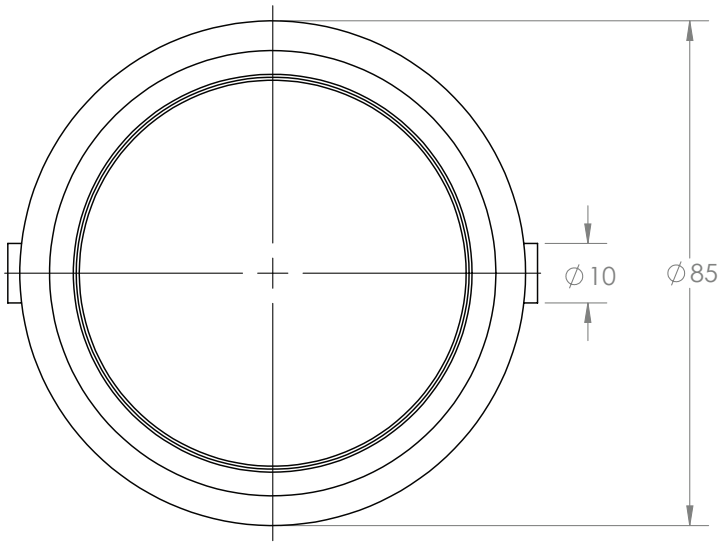


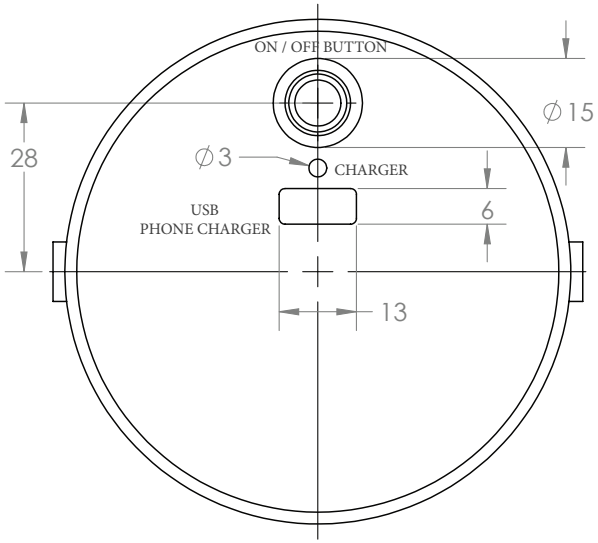
FIG 18.2(B) OPTION - 2 MECHANICAL DRAWING



TOP VIEW



FRONT VIEW



REAR VIEW

FIG 18.2(C) OPTION - 3 MECHANICAL DRAWING

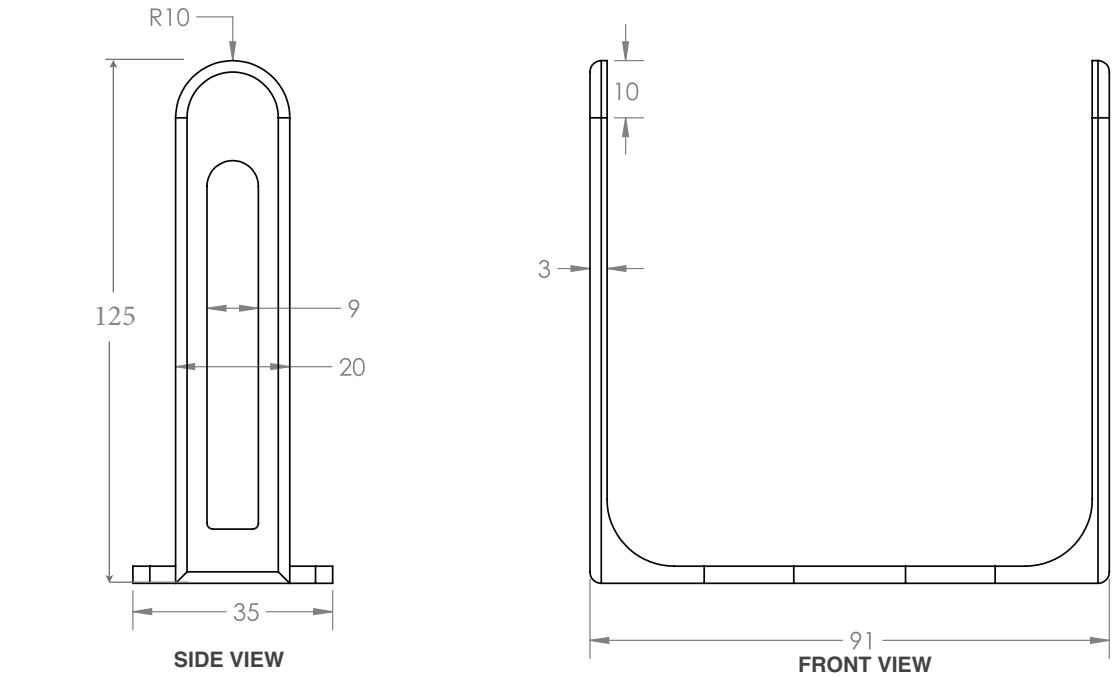


FIG 18.2(D) STAND / BASE

Final Concept

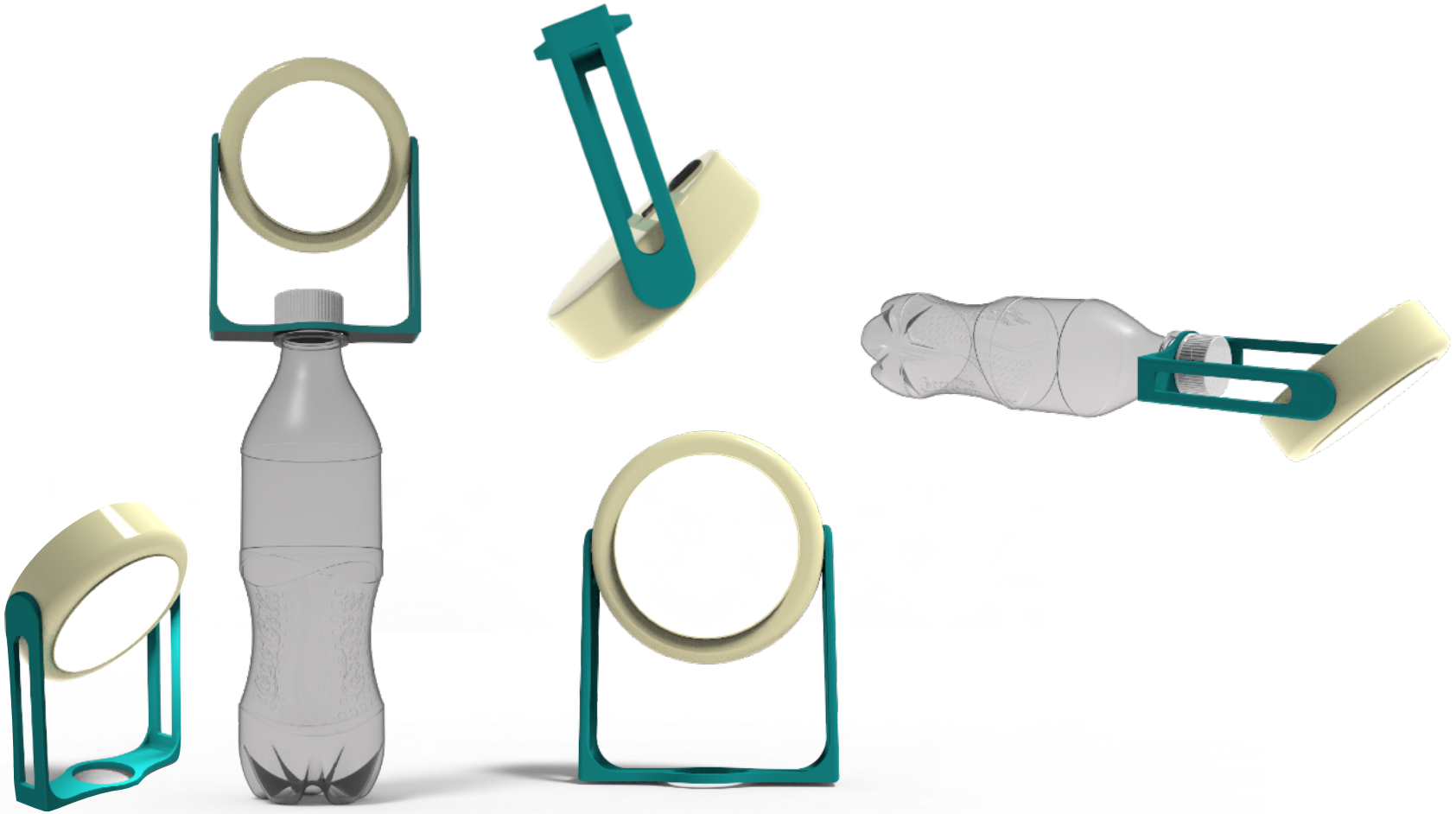


FIG 19.0 FINAL CONCEPT

Final Design

The final design is such that it offers a clean and modern look to the product while being easy and economical to manufacture. It consists of four parts namely, the diffuser, back enclosure, the reflector and the stand. They are designed to lock into each other and the entire lamp is secured by just two screws.

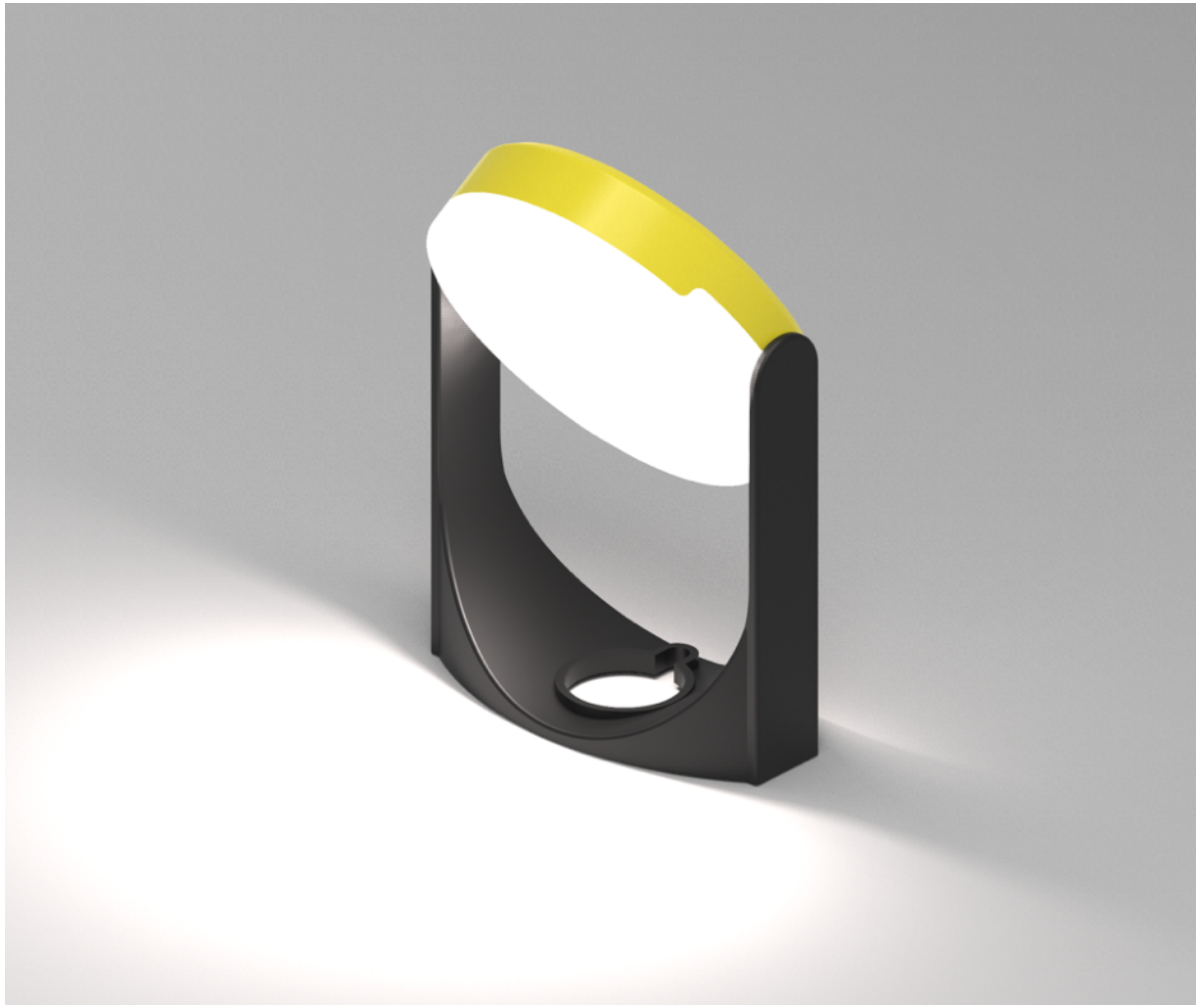


FIG 20.0 FINAL DESIGN

The stand has a hole such that it can be attached to generic pet bottles, umbrellas or can be hung on the wall.

FIG 20.1 ATTACHED BOTTLE

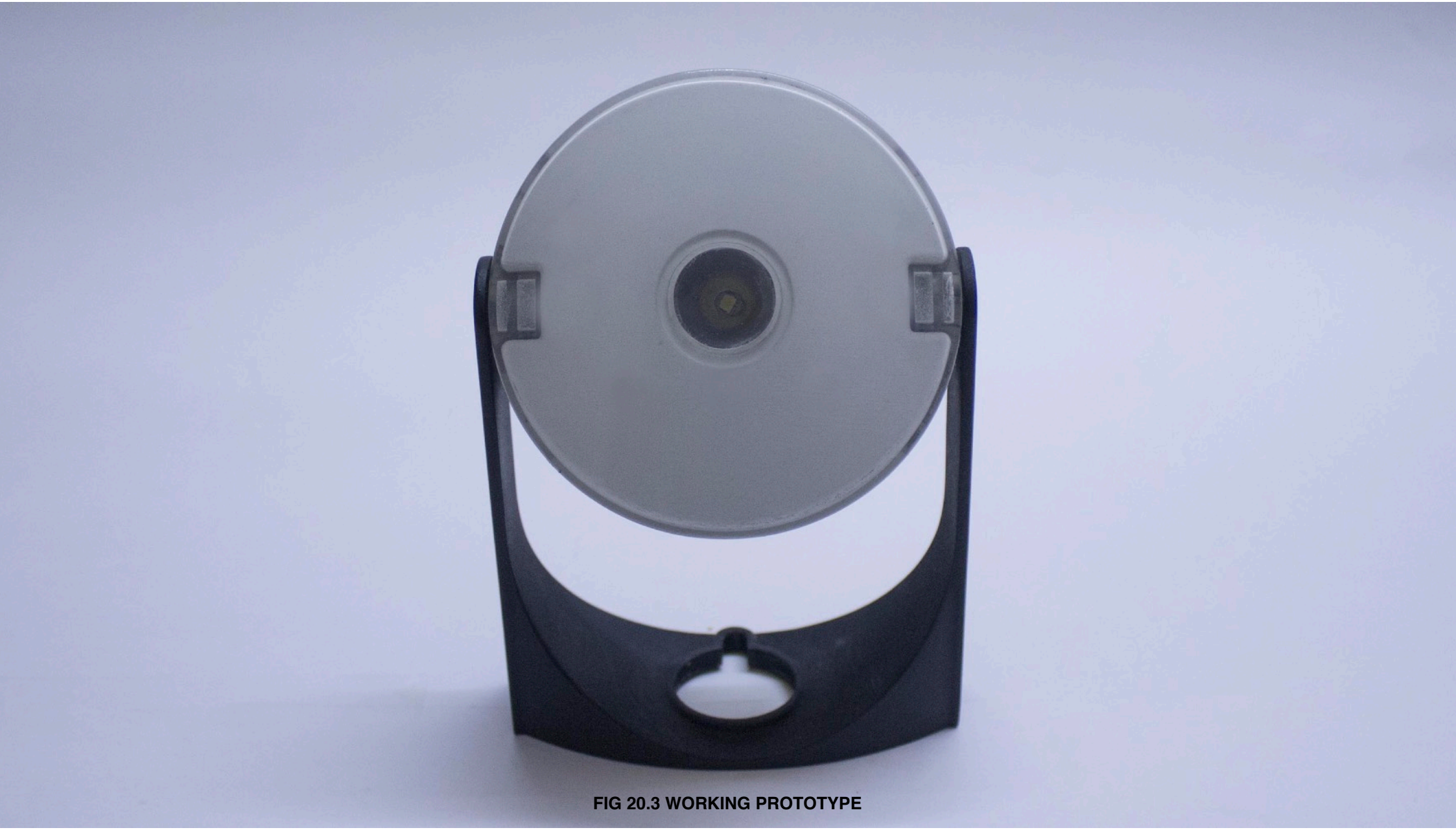


FIG 20.3 WORKING PROTOTYPE

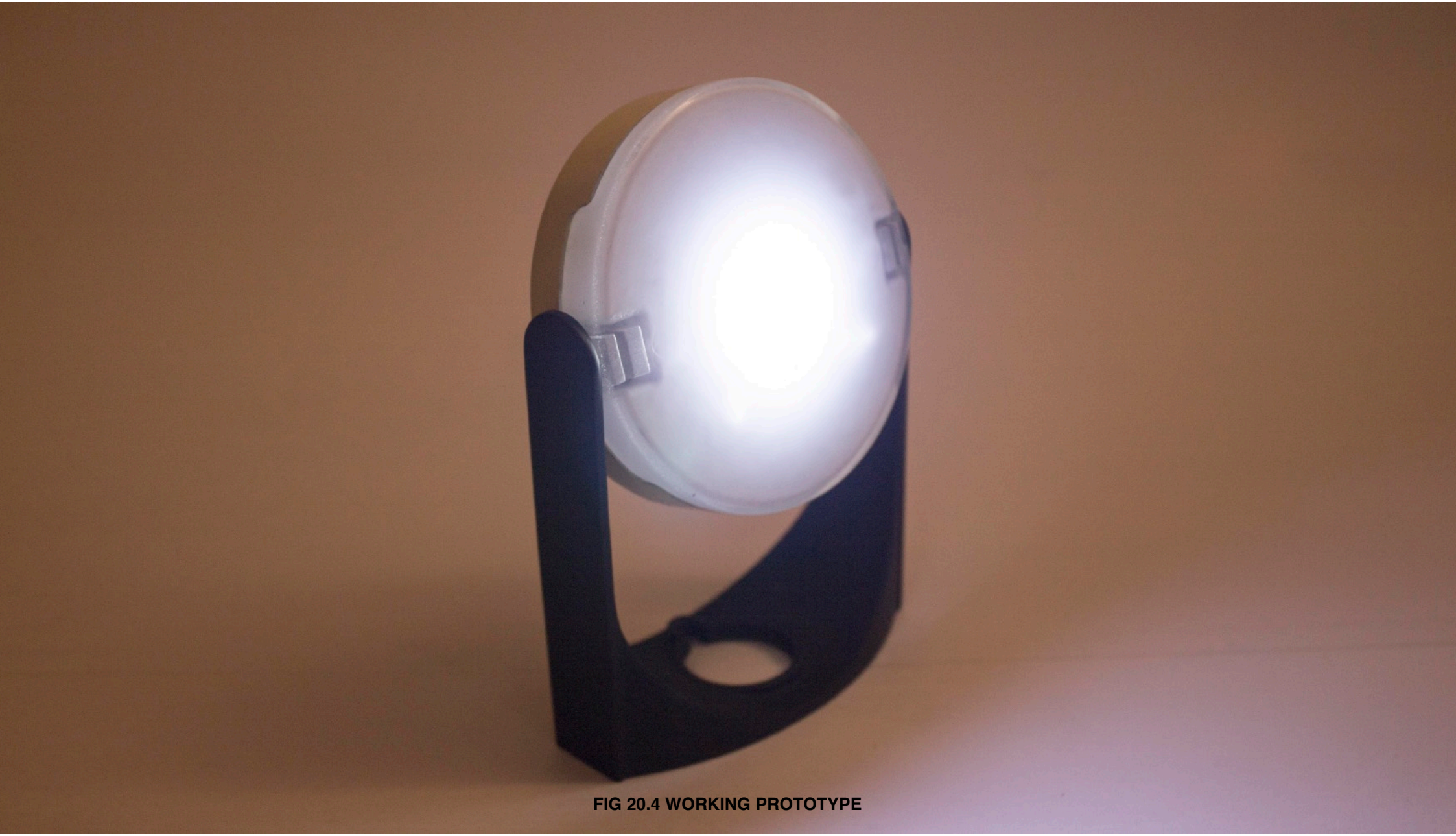


FIG 20.4 WORKING PROTOTYPE

FIG 20.5 WORKING PROTOTYPE

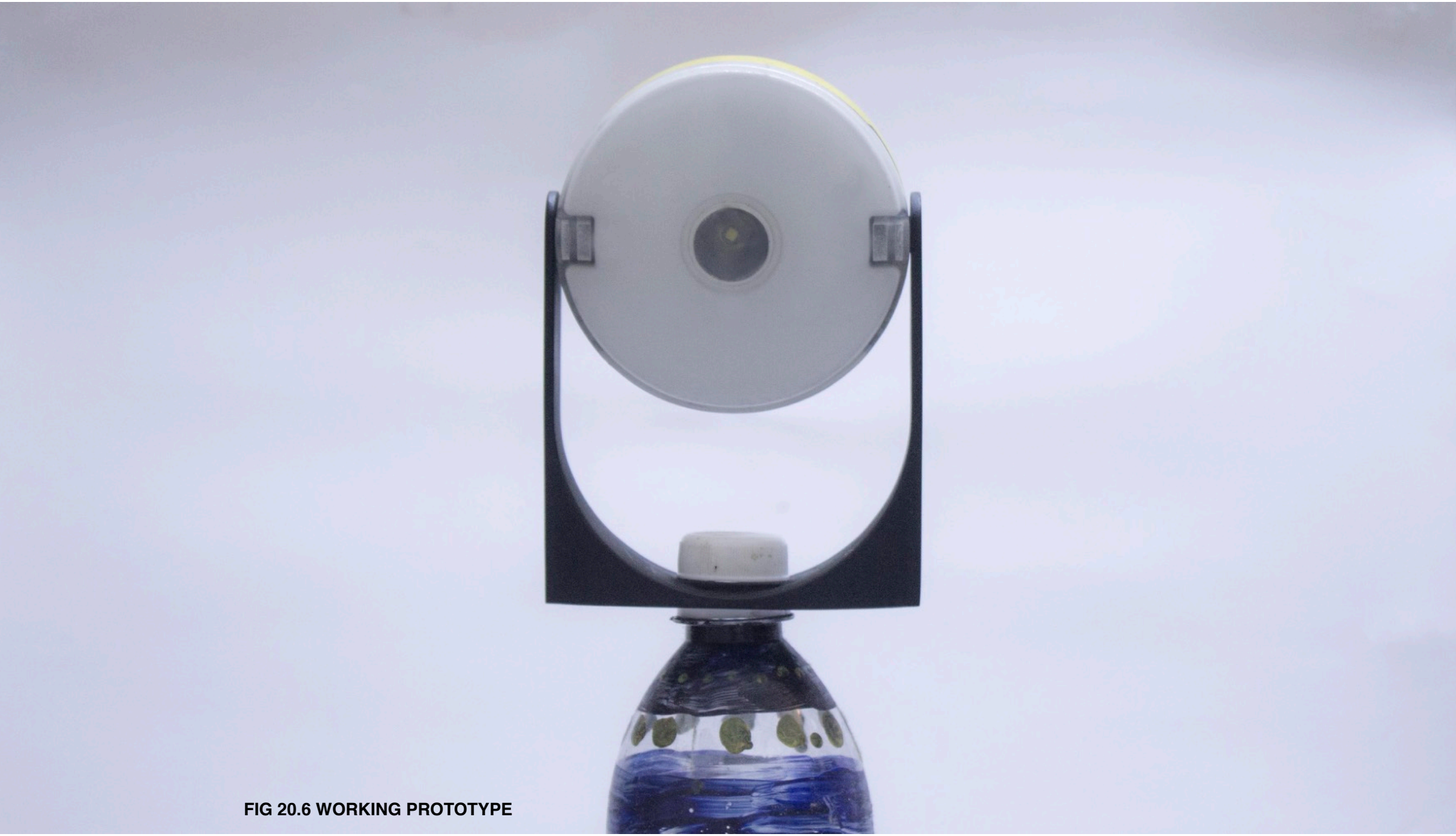


FIG 20.6 WORKING PROTOTYPE

FIG 20.7 USE AS TORCH

FIG 20.8 PROJECTING LIGHT FOR DIFFERENT READING POSTURES

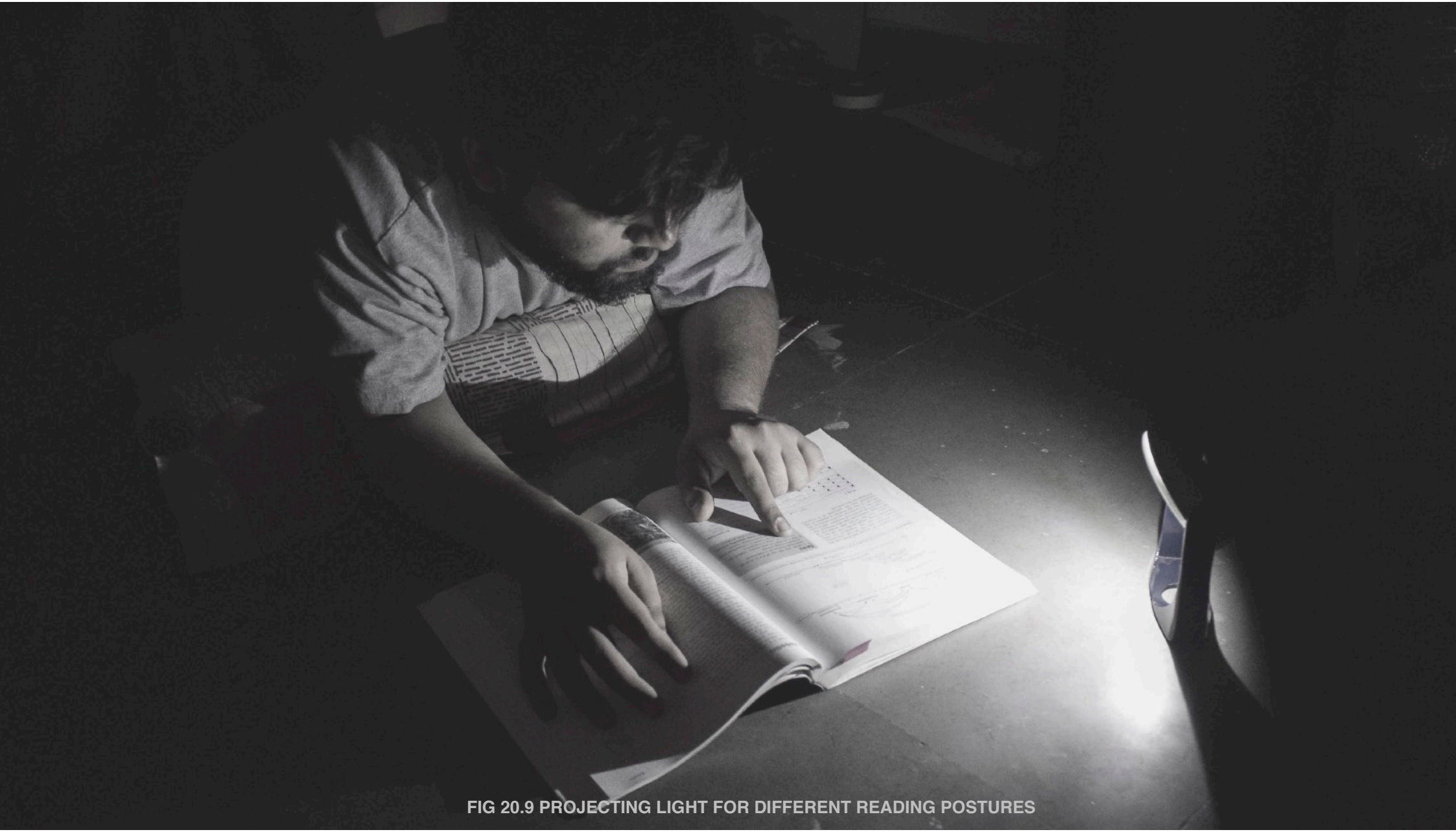


FIG 20.9 PROJECTING LIGHT FOR DIFFERENT READING POSTURES

FIG 30.1 INTERNAL DETAILING

FIG 30.2 INTERNAL DETAILING

FIG 30.3 INTERNAL DETAILING

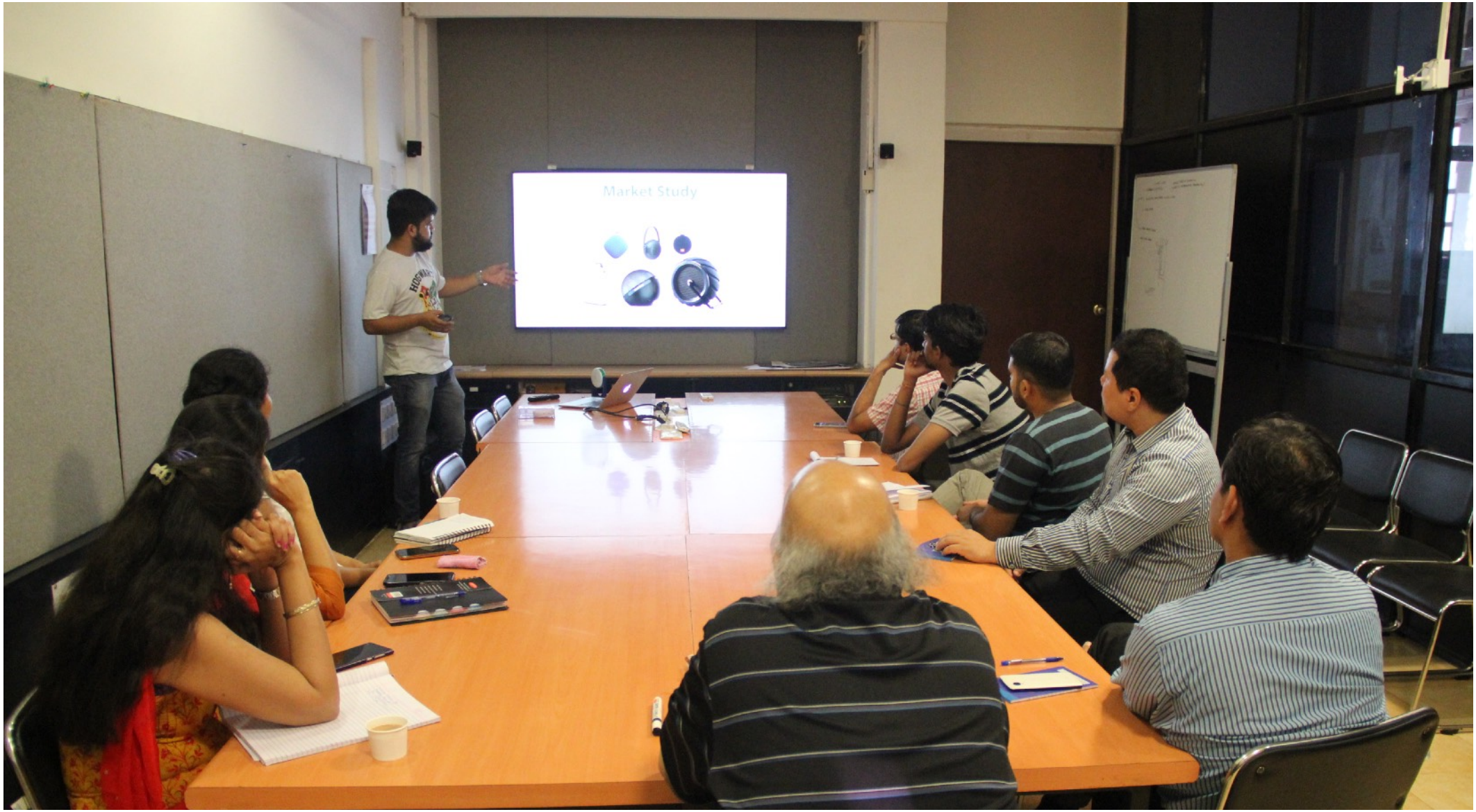
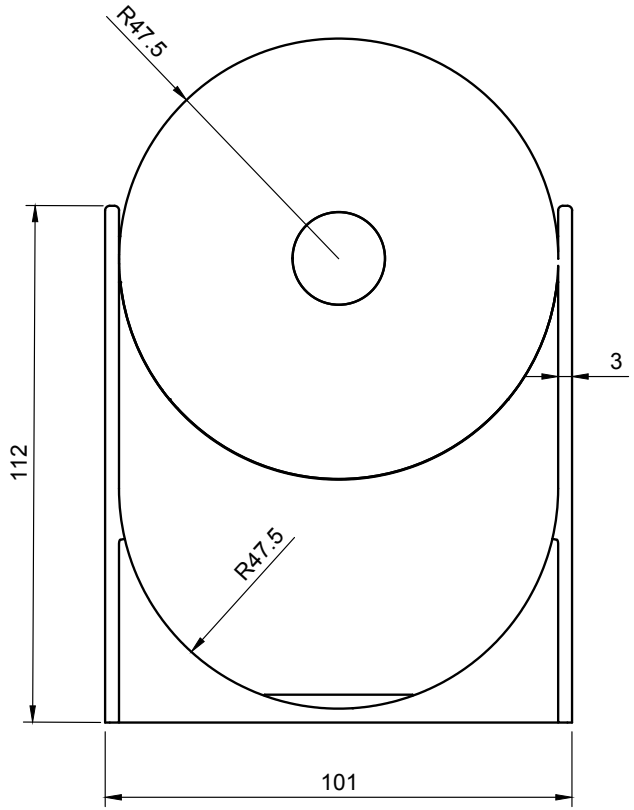
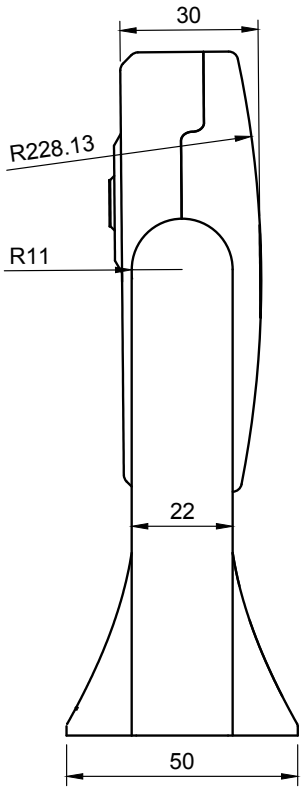


FIG 31.1 PRESENTING THE DESIGN TO MILLION SOUL TEAM AT IIT BOMBAY

FIG 31.1 PRESENTING TO BIDDERS AND REPRESENTATIVES OF MNRE (MINISTRY OF NEW AND RENEWABLE ENERGY) AT E.E.S.L, NEW DELHI

FIG 31.2 PRESENTING TO BIDDERS AND REPRESENTATIVES OF MNRE (MINISTRY OF NEW AND RENEWABLE ENERGY) AT E.E.S.L, NEW DELHI





Dept.	Technical reference	Created by	Approved by
Dimensional Drawing	Lamp Full Body	Nishith Parikh 12/12/2016	
		Document type	Document status
		Title: Final Design	DWG No.: 1
			Rev. / Date of issue / Sheet: 1/1

Future Scope

Reduction in the size of electronics can facilitate better, more environmentally friendly designs.

With progress in technology components, especially electronic components are bound to get smaller. This would ensure that the enclosures required to house them will also reduce in size. As the number of lamps in this project is really high, smaller enclosures will have an very positive impact on the environment.

Smaller modules can be developed that attaches itself to commonly found objects like PET bottles. We can imagine some product like a bottle cap that is shipped to users and it is this bottle cap that can be attached to any PET bottle. This would mean that the cost of manufacturing, transportation, packaging, storage etc will all come down substantially thus deepening the penetration of the lamp. There are organisation like Lite of Light which have been involved in similar initiatives. However, their products seem to lack design intervention and if an organisation like Million SoUL teams up with these smaller organisations then the potential to do something game changing in renewables is tremendous.

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