

LIGHTING FOR RURAL INDIA

INDUSTRIAL DESIGN PROJECT III

BY

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GUIDE:

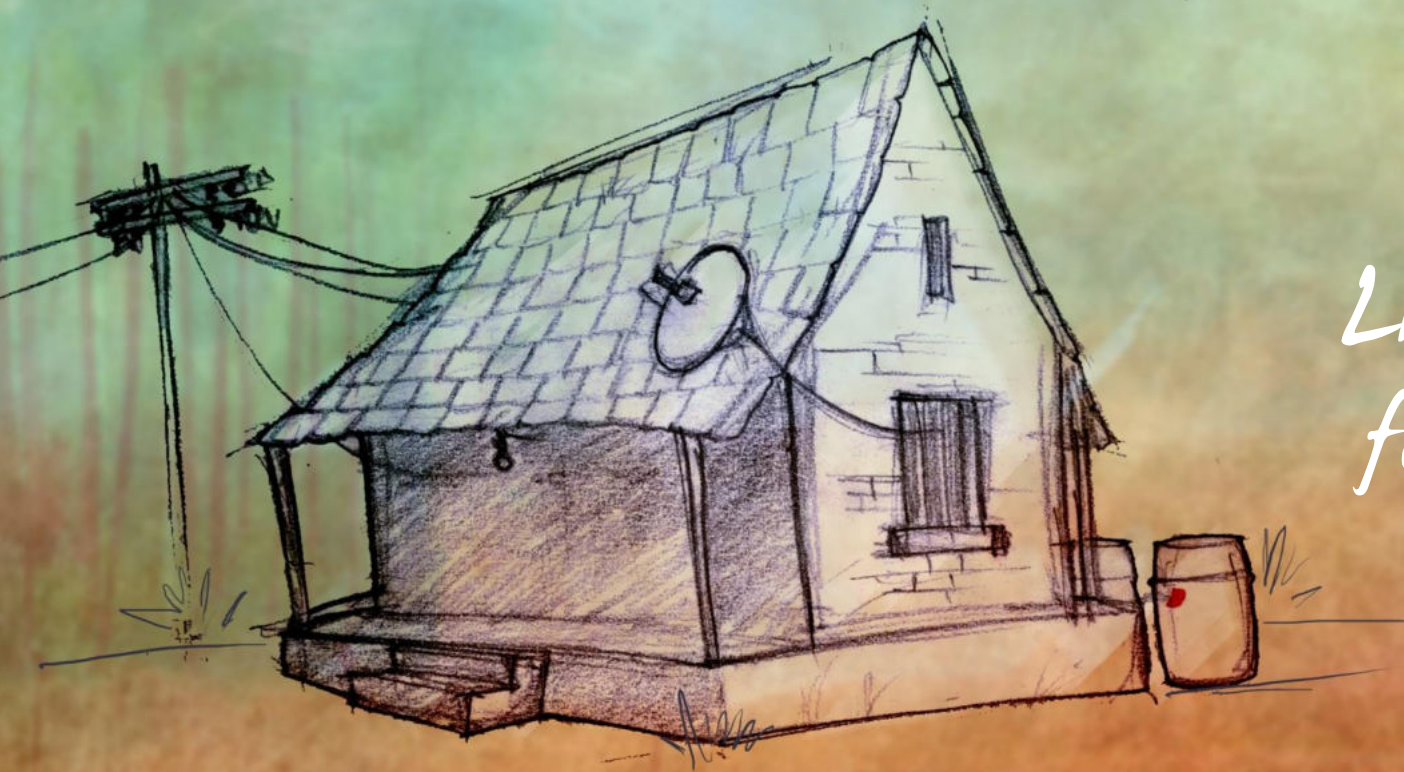
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Lighting for Rural India

P-III

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Approval

Industrial Design Project III

'Lighting for Rural India'

by Shashank N. Sawant

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is approved as partial fulfilment of requirement of post-graduate degree in Industrial Design.



Prof. R. Sandesh
[Project Guide]



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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all the principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/ data/ fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

According to the 2011 census, 68% of our population still lives in rural areas. Despite all the development schemes and incentives that the government provides, a large chunk of our population is still oppressed, socially and economically. Absence of light, or darkness, is a very powerful metaphor of this divide. The project set out to remedy this hardship. Over the course of the project, more emphasis was laid on user and usability issues of the product.

To observe the daily tasks and identify the needs and of people in rural India, field studies were carried out. The initial field study was to understand the people, the social structure, the activities, tasks and hardships in rural India. This helped gain an idea of rural psychographics, the attitudes, interests and opinions of rural people. A second field study was carried out in which rural folks were given a solar lamp to handle and usage patterns were observed. Important insights were gained from both the excursions, which helped shaped the functionalities and usability of the product.

Based on these insights, opportunity areas were looked into which had scope for lighting. They included possible interventions in night schools, community gatherings, medical emergencies, dedicated task lighting for rural occupations, etc. Simultaneously, ideations were carried out to give a form to possible solutions. Initial explorations included ideas like flexible neck lamps, disc lights, simple cubical clustered lamps, light cylinders, value lights, triangular lights and others. Amongst these, the concept of value lights was found to be more beneficial than others. The idea was a product that could be split into three light components that could be used for three disparate tasks. The lights come together to form a single product whose combined value is more than the sum of its individual.

The lights provided include:

- A focussed light for outdoor excursions in dark, wayfinding
- A diffused light for general indoor purposes
- A secondary low power light for auxiliary activities

The selection of these tasks was done on basis of needs identified in the user studies. The components are stacked vertically providing a sense of hierarchy and separation of purpose. The uppermost component is a torch, with high power beam of cold light with illumination of around 150 lumens and a beam angle of up to maximum 30 degrees. The central component provides warm ambient light for general activities with an illumination between 250-300 lumens. The lower light is a secondary light of 150 lumens meant for auxiliary tasks like short trips to the washroom, the cattle shed or to be hung outside in the verandah.

Further, by incorporating solar technology, we free them from dependence on unreliable power grids and take them back to the purest source of energy: the sun. The solar panel doubles up as docking panel on which the lights are docked. The lights can be detached from the panel and hung on the wall, while the panel can be placed outdoors for charging. The primary battery pack in the solar panel gets charged thus and then discharges into each of the lights' individual batteries when the lights are again docked onto it indoors. The central light is the main hub to stack the components and to connect electrically with the docking panel. The focus was to formally integrate the three distinct lights with emphasis on stacking the components. Efforts have been directed to make the product maintenance free and keep the assembly as easy as possible.

The proposed strategy for marketing could either be a Government scheme, with participation from NGOs or a corporate venture as a part of social responsibility. Else, it could be manufactured under a social entrepreneurship venture with nominal profits. The product is designed to fit seamlessly in a rural household. It aims to assist more than one rural activity in night time. The result is not a mere artefact that is just one more addition to the market, it is a product that is sensitive to the needs of rural India and addressing the disparate needs of this diverse rural sector.

1. Introduction

"India lives in her seven and half lakhs of villages...
If villages perish, India will perish too..."
-M.K.Gandhi

68% of Indian population still lives in villages[1]. Villages, that are spread across the length and breadth of this country. Some developing, some who have heard of development and some still stuck in the medieval ages. Some villages near roads and highways, some tucked deep in forests, valleys and in mountains. Some big with all sorts of people, artisans, farmers, some consisting of just two houses with a handful of people. And yet they all are a part of Indian tapestry as much as me and you are.

Gandhi was correct in his assessment that India lives in her villages. The rustic rural side is an allure as much as a challenge. Much of our rural folks live as per traditions and rituals defined eons ago. Even as the world moves forward, rural India is trying hard to catch up, to taste the fruits of development. It is a dichotomous setting in many ways. Whilst still being governed by cultures and a time-tested way of life, people of rural India now want to break way and explore the wide world.

Along all my travels across India, I have observed how alienated urban people are from the lives of rural folk. And a mild bit insensitive too. After a lot of brainstorming on the topic for this major project, we narrowed down upon lighting up the house of the poorest person who resides in this country. Light is a symbol of enlightenment, empowerment. Those living in fear of darkness are still caught up in the medieval times. By providing them lights, we hold their hands and guide them into this bright new world.

When I say medieval times, I am not exaggerating. Facts are truly strange. On a remote stretch between two forts of Raigad and Torna where the Sahyadri steeply falls into the Konkan, lives a man name Baban Kadu. His is the only house in the village of Lingana Machi. His wiry frame might mislead someone, but Baban's perseverance is amazing. His urge to stay on the land of his forefathers, help the occasional passerby is commendable. But he too realises, that people like him are becoming extinct. He wants his kids to go to high school, maybe help him in free time and later help him fetch a better price for whatever crop he grows on his small land. his subsistence is bare minimum. It is such neediest of needy people whose needs i have tried to address through this project.

There are many more Babans dispersed through India, waiting for development, for simple needs like lights in their homes and water in their farms. Our founding fathers had envisioned a country where every individual lives with independence and self-respect. Only after empowering every single individual will our tryst with destiny be fulfilled.

2. India Energy Scenario



Courtesy: Author

India is a nation in transition. Considered an "emerging economy," increasing GDP is driving the demand for additional electrical energy, as well as transportation fuels. The democratic structure, our economic policies, and the mounting aspirations of our people has made the energy sector a diverse one. The problems we face can be looked upon as opportunities for all stakeholders, ensuring accessibility and availability to all at affordable prices. Though Indian economy and GDP is increasing steadily even in middle of global slowdown, we still face energy deprivation. To maintain social equality and an all-inclusive progress, it is unavoidable that we increase our energy intensity.[2]

The following data from Central Statistics Office reports the energy scenario in the country:

- India is 9th largest economy in the world, with a GDP growth of 8.7%
- India's totalled installed capacity: 236.8GW (+36.5GW in captive power plants)
- Of this, 66% is thermal energy, 19% is hydel energy
- Coal contributes to around 54% of total installed electricity generation
- 55.3% households in India have access to electricity
- 62% households still use kerosene lamps
- Traditional biomass viz. firewood, dung, etc. contribute to 800million households for cooking
- Our overall energy deficit is 8.7% with a peak shortage of 9.0%

Thus it is clear that as a nation we are still heavily dependent on non-renewable energy resources for our energy needs.

India relies heavily on coal energy to produce electricity. . Our import dependence on oil is currently about 75%, which is projected to increase to 80% by 2016-17.

Due to dependence on such fossil fuels and non-renewable energy sources, India faces a threat to its energy security.

The consumption of all renewable energies represents fully one third of the total consumption, mainly due to hydel power.

Special focus is being laid upon renewable energy sources to meet this power deficit.

India has one of the highest potentials for hydro-power generation in the world. The present installed capacity as on September 30, 2013 is approximately 39,788.40 MW which is 17.39% of total electricity generation in India[2].

India being a tropical country, it has huge solar potential. Photovoltaic (PV) cells have a low efficiency factor, yet power generation systems using photovoltaic materials have the advantage of having no moving parts. PV cells find applications in individual home rooftop systems, community street lights, community water pumping, and areas where the terrain makes it difficult to access the power grid.

Harnessing energy from wind through windmills is one of the most environment friendly, clean and safe energy resources. Wind energy has a lot of advantages. It has the lowest gestation period as compared to conventional energy. The equipment erection and commissioning involve only a few months. There is no fuel consumption, hence low operating costs. Maintenance costs are low. [3]

To meet the demands of our economy and overcome our energy deficit, we need to consider three key factors: Cooperation between Companies and Industry & other sections of the society; Innovation to exploit new frontiers & non-conventional sources of energy and Investment needed to meet the growing demand for energy across the society.

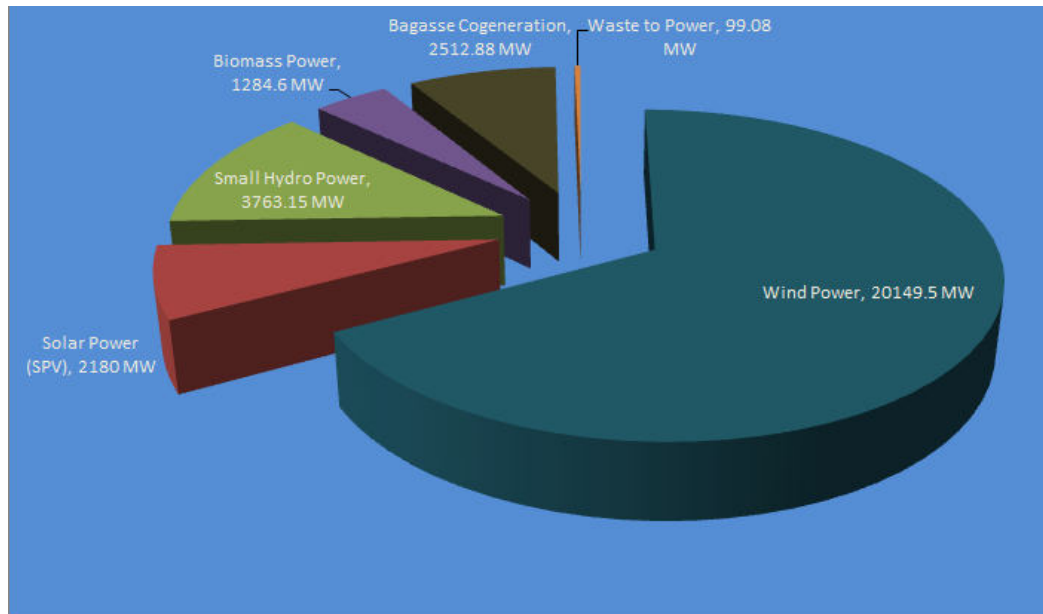


Fig.1 Renewable Energy by Installed Capacity in India

3. Rural India

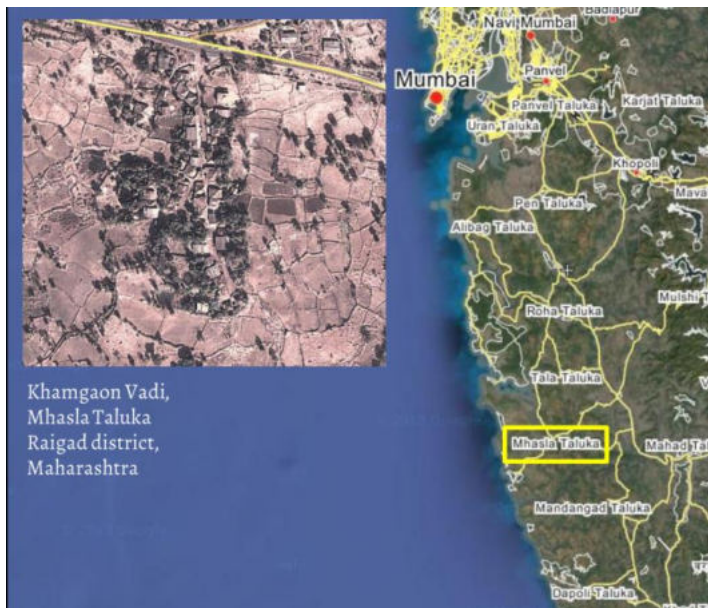


Fig 2. Khamgaon Location



Courtesy: Author

Fig 3. Solar Lamp in Khamgaon



Courtesy: Suhas Sawant

Fig.4 Amitabh Bacchan in Khamgaon on behest of Swades Foundation

3.1 Field Study:

Place: Khamgaon, Taluka Mhasla, District Raigad

Khamgaon is a quaint little village tucked away in the rugged terrain of Konkan, some 200kms south of Mumbai, 30kms off NH-17. Like every other village in Konkan region, Khamgaon has two distinct zones. The 'Kond' area is the main zone, perhaps the older settlement. It houses the govt. offices, school, banks, shops and around 75-100 families. It is the hub of all developmental activities in a radius of 10kms or so. The other settlement called the 'Wadi' is about a kilometre away from the Kond area. It houses around 25 families and is primarily an agrarian settlement, closer to the farmland. Khamgaon suffers from frequent power cuts, thought they have reduced in past few years. Traditional fuels as firewood and kerosene are still widely used, but all houses have electricity (barring one exception). The village was studied with respect to the following aspects:

- location, geography
- people, communities
- livelihood
- aspirations, dreams, plans for the village of the people
- developmental activities

Like almost all of India, even Khamgaon is highly divided village. There are groups of people primarily divided along lines of communities. Yet there is hardly any noticeable tension. From the talks of the villagers, everybody seems to be in unison regarding developmental issues. Khamgaon is located on a small flat expanse above a hill. Despite this there are problems with groundwater reserves of late and that is a major cause of concern faced by the villagers.

Luckily, Khamgaon is one of the villages under an NGO called the Swades foundation which funds various activities of rural relevance. Even so, the solar street lamps installed by them have failed because the batteries were not replaced by the villagers and the organisation apparently refused to intervene. The failure of such a solar-based endeavour has put off many a people. Yet the wise men have acknowledged the drawbacks of the parties involved and not the technology itself. Just recently a solar-powered pump was installed on a boring in the fields and water is now carried all the way up to the farthest areas of Wadi. This has been a successful demonstration of potential of solar power, so much so that even now, 6 months since the last rains, water has been flowing freely in the connected taps! A number of people were spoken to. These included farmers, migrants, housewives, old women, school-going students, etc.

In all their conversations, Swades foundation emerged as a major factor when it came to developmental issues. No mention was made of govt. policies. For a person who uses 'solar', 'photovoltaic' even in such a setting, the former sarpanch seemed unaware of govt.'s Jawaharlal Nehru National Solar Mission JNNSM. The organisation is referred to as 'share-sanstha' since they ask for nominal investments from the villagers' side. It outsources technologies from far-off contractors.

3.2 Rural India Psychographics:

For every product to be successful, it has to be in the right place, at the right time and in the proper hands. A product that is designed and marketed out of context is seldom successful. When the product is designed intelligently keeping the right context in mind, it in turn markets itself. It is said that India is made up of a million Indias. Each India with a different story, peopled with billion different dreams, and each plagued with unique issues and problems! How the do you design a product that makes itself fit seamlessly into this tapestry. Simple demographic studies give you numbers, statistics that very well give you a scale of the work to be done. But to understand this unique landscape, its needs and provide solutions, one has to go beyond simple numbers. This is where psychographics step in. Psychographics focus on AIO-attitudes, interests and opinions[4]. It's been said that demographics help you understand *who* buys your product or service, while psychographics helps you understand *why* they buy.

Rural India is a huge sector comprising of a distinct and clearly visible hierarchy. This social system has been prevalent for ages and influences life wholly in these areas. The hierarchy also limits dreams, aspirations of the people and also limits their opportunities to some extent. People are aware of this and operate in communities, but this does not prevent them from having feuds within themselves too! Rural India heavily believes in collectivism and hierarchy. If we are to classify rural India on socio-economic grounds, it can happen in the following way[4]:

Socio-Economic Classification	Characteristics	Lifestyle attributes
R1	Landlord farmers, traditionally rich, exposed to urban environment, children studying in schools and colleges in nearby towns, having a number of urban comforts and goods in households viz TV, sofa, music systems, cupboards, refrigerators etc., owns durables like tractors, other vehicles	Aspire to meet urban standards, politically and socially well connected, technology adaptors, eager to experiment new farming methods and add new sources of income, big spenders on social occasions
R2	Rich farmers with upto 5 acres of land, may not be educated, children studying in schools and colleges in nearby towns, friends and relatives in urban areas. Owns durables like tractors, two wheelers.	Want to get educated, consult friends and relatives while adapting new technologies, conscious of status, aspire to be well-known within political and social circles
R3	Avg. landholding 2-5acres, manage savings, send children to village schools, own durables (self and rental basis).	Opts for time-tested technologies, low risk taker, desires knowledge, followers, seekers
R4	Have little or no land, agricultural labour living below poverty line, major purchaser from public distribution system and govt. schemes.	Averse to new technologies, laggards, averse to risks, uninformed(at times ill-informed)

Over the course of field visit, following people came across who typically belong to these categories:

Balkrishna Sawant (72) [Category: R4]

- retired mill worker
- shuttles between Virar and village
- returns to village for every festival (once every two months or so) and spends one entire day cleaning the house
- electricity meter was uninstalled by local office after months of no usage
- borrows electricity from neighbour
- uses tubelights, incandescent bulbs and kerosene lamps, CFLs are absent
- skeptical of almost all activities in the village

Baliram Sawant (75) [Category: R1]

- former sarpanch
- owns acres of land and has a huge, affluent joint family back in the city
- open to experimenting, new and alternative technologies
- has successfully run a biogas plant for 25 years (shut it down last year due to excessive smell), also has a small pisciculture setup in his backyard
- rebuilt house in modern bungalow style
- uses incandescent bulbs, CFLs and kerosene
- ardent supporter of solar technologies and knows basics of these technologies

Akshay Shirke (16) [Category: R2]

- scion of the Shirke family, the Khots (former chiefs) of Khamgaon, giving his board exams
- though heir to acres of land, wants to become an engineer
- house was rebuilt, but remains unplastered even after 3 years
- well aware of alternative technologies and fuel crisis, power shortages, etc
- skeptical of villagers but curious on newer technologies

Savita Shirke (37) [Category: R2]

- manages the Shirke household
- housewife and volunteer at an NGO Swades Foundation
- insists on self-reliance and independence, champions for the women cause, literacy

Thus, Khamgaon is home to all typical categories of rural folks. They represent the potential customers in the rural market along with needy groups at the bottom of the pyramid. However, the indifference in the bottom strata is the main hurdle and to provide them with conveniences is the main challenge.

3.3 Nokia 1100: A case study

Nokia's success is a very interesting case-study here. The Nokia 1100 was not the first phone in India, but it was the first one to unlock the potential of the nation as a cellular market. A volume of 904.51 million (March 2014) users owe a lot to this small, remarkable product.

'Made for India'

Customising a phone for a country as diverse and raw as India was a challenge and Nokia did it. It was designed to survive in the rough, rugged Indian hinterland. The physical dimensions and features served the purpose well. But the Nokia guys went ahead and provided personalised back covers, body panels, replace-able num-pads as a part of services. Further, they provided a loop which could be used for a variety of purposes viz. handling, hanging, attaching keys, accessories, etc. this gave the phone a possibility of personalisation. Nokia provided a LED light on the head, thus single-handedly killing off bulky torches. Nokia added FM and other multimedia thus making radios and transistors obsolete. the sort of personalisation that Nokia brought to the mobile phone was phenomenal, and that too in an era long before iPhones and Galaxys! All this success stemmed up from extensive user research and designing for a focussed segment. The Nokia 1100 was marketed as 'Made for India' and it lived up to its word.



Fig. 5 Nokia 1100 body details



Fig. 6 Nokia 1100 with torch



Fig. 7 Nokia 1100 customised body covers

If one were to gauge the success of this phone, it could be attributed to the various needs of the typical Indian user it satisfied[5].

- Rational need through proper pricing
- Emotional need through connectivity to near and dear ones
- Aspirational need through placing a desirable product of a desirable brand at the bottom of the pyramid
- Physical need through apt sizing and comfort, materials with proper grip
- Spiritual need through sms-es and other media for devotional/religious purposes

Nokia thus played a major role in ushering the digital era in India. Nokia wasn't the first company to bring cellphones in India, but they were the first ones to do it right. They addressed the needs of the people, going well beyond technical specs and addressing the aspirations and dreams of people. They realised the need for personalisation, for connectivity all neatly packaged in a product that well suited the conditions across the country.

4. Rural Lighting



Fig. 8 Godawari Green Energy Concentrated Solar Power Plant, Rajasthan



Courtesy: Author

Fig. 9 Wire mesh from power grids

4.1 Rural Electrification:

It is estimated that 55.3% of households in India have access to electricity. The other have to rely on other energy sources to meet their illumination and other needs. Around 62% households still use kerosene lamps. Traditional biomass viz. firewood, dung, etc contribute to 800 million households for cooking. But this does not mean that all is well in the areas which have access to electricity. India faces an energy deficit of 8.7% with a peak shortage of 9.0%^[6].

4.2 Looking up to the sun:

4.2.1 Govt. Initiatives:

To meet these demands of our energy hungry nation, the government launched the ambitious Jawaharlal Nehru National Solar Mission. The mission looks at solar powered feeder power plants that support national electric grids and rural hinterlands as well. Its objectives read, “The Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010 by the Prime Minister. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 is aimed at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022. Mission will create an enabling policy framework to achieve this objective and make India a global leader in solar energy.”

On paper, the mission seems capable enough to provide a feasible answer to our energy problems. In accordance, India's first concentrated solar power (CSP) plant has been commissioned by Godawari Green Energy Limited (GGEL). GGEL has deployed parabolic trough CSP technology with state of the art SKAL-ET 150 trough structure in constructing this 50-MW power plant located near the Nokh Village in Jaisalmer district of Rajasthan.

4.2.2 Challenges:

But not all is well. March 2014 was the deadline for the extended period to start commercial operation of all the Concentrated Solar Power plants awarded under the National Solar Mission (JNNSM) program in 2010. So far, only one plant has come online i.e. GGEL. This has been due to government's loss of interest and no follow-up of project implement with initial levels of enthusiasm with which the projects were kicked off. Adding to it is our country's tendering processes. The first tender for CSP projects resulted in a race to offer the lower prices per kWh and the higher local content, something that left many of the international recognized players out of the top positions. And yet the reasons why solar energy field continues to attract more players is obvious from the decreasing costs of installation and tariffs.

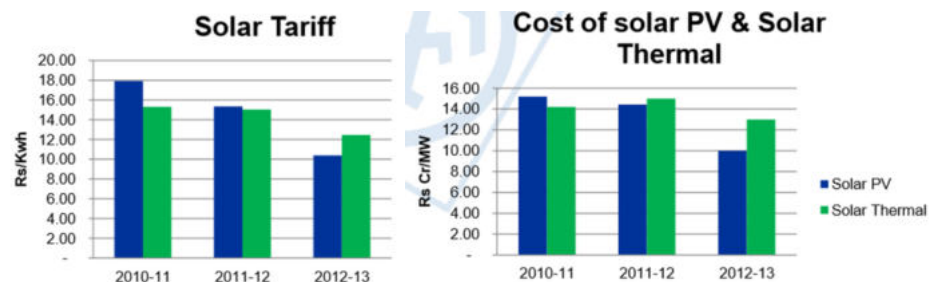


Fig.10 Charts for Solar Tariff and Costs pf PV and Solar Thermal

Recognising all these hurdles in lighting up rural India's a number of NGOs and social organisers have come forth and working earnestly to ensure that light reaches the proper people at the proper time. They operate on donations majorly, sourcing lights from a technology vendor and distributing it across villages in a district (Swades Foundation). Some players opt for govt. partnerships, subsidising the products and thus reducing costs on the distributors' part (OCOL). Some operate as social entrepreneurs thus ensuring profits while marketing cost-effective solutions (SELCO)

4.3 SELCO: A case study

Solar Electric Light Company is the brainchild of Dr. Harish Hande, an IIT-KGP alumnus. It positions itself as a 'for-profit' enterprise and operates on a unique model. SELCO firmly believes in social commitment. SELCO also looks to dispel the following myths:

Poor people cannot afford sustainable technologies;

Poor people cannot maintain sustainable technologies;

Social ventures cannot be run as commercial entities[]



Fig.11 Dr. Harish Hande (inset) and one of SELCO's installations

SELCO systems utilize solar photovoltaic (PV) modules to provide electricity for lighting, water pumping, communications, computing, entertainment, and small business appliances. These products can be purchased by individual homes and businesses and do not require connection to a larger network.

SELCO started with a financial model in which each customer would pay 25% of the cost upfront as down payment and will further pay a monthly instalment which is affordable and within the average monthly budget of a family in the region. Along with this, the SELCO INDIA also provided a year's guarantee to the warranty of the manufacturer along with free service for a year and a 90-day money back guarantee.

Further, upon the purchase of every system, each SELCO customer receives the following services: Custom system design, Installation, Training on proper system use and after-sales maintenance and support. Since its founding in 1995, SELCO has grown leaps and bounds. They have lighted upto 1,35,000 + solar home lighting systems in 18 years.

SELCO's founder, Dr. Harish Hande wanted to make an impact on the society. Somewhere along the way he realised that activism is not the way to go about it. If real change needed to be brought, grassroot-level innovation was needed. A system was needed in place that would make technology accessible and affordable to the poorest of the poor. These insights were drawn from his PhD days at MIT and his numerous studies in villages across India and Sri Lanka. He was a wing mate of Arvind Kejriwal at IIT-KGP and it is notable how these two IIT-ians are trying to bring about change in their own ways. Through SELCO, Dr. Hande has tried to tackle the fundamental question of balancing social, economic and environmental stability at the same level.

4.4 Scenarios around the world:

Some 1.6 billion people worldwide have no access to electricity. For people living near the equator, darkness falls around 7pm all year round, slowing down or completely stopping many vital tasks. In different parts of the world, various efforts are taking place to remedy this.

4.4.1 Latin America:

Latin America is the world's birthplace for small rural solar electric systems used for residential power, refrigeration, distance education and hybrid systems. The use of PV systems has increased dramatically from an initial concept pioneered by a few visionaries to many thriving businesses throughout the rural regions today. As early as 1980s, solar energy pioneers began to disseminate PV technologies in rural Latin America as a solution for providing basic electricity services for non-electrified populations. Some of the first pilot projects in Latin America were undertaken by NGOs, such as Enersol Associates in the Dominican Republic, beginning in 1984. 50 Wp PV lighting system installed in Talayotes, Moris County, Chihuahua. Shown besides is one of the first PV lighting systems to come up in Chihuahua, Mexico.

Another interesting project is lighting up football fields across South America to promote sports. Royal Philips Electronics and the Royal Netherlands Football Association (KNVB) are carrying out this project. The partnership will cover in total some 90 light centres across Africa and South America, the first of which are scheduled for installation in early 2013, will be focused on schools which are closely linked to villages and towns in off-grid or semi-grid areas (this can also include parts of cities). This is an innovative approach for illumination through a sports-centred cause.[7]

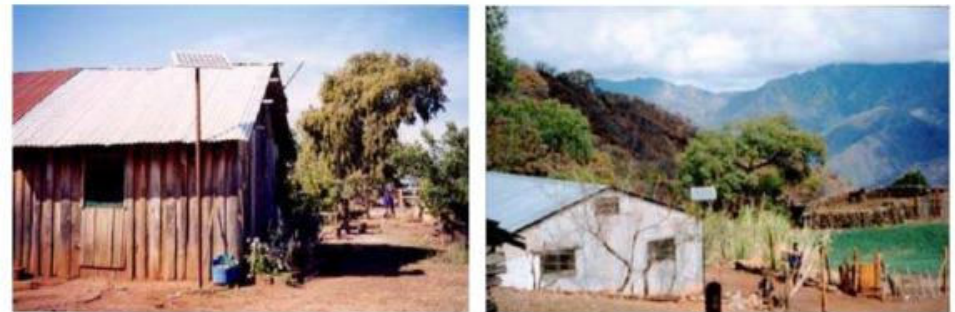


Fig. 12 50 Wp PV lighting system installed in Talayotes, Moris County, Chihuahua

4.4.2 Europe:

Countries in the European Union are considered world leaders and pioneers in large scale implementation of photovoltaic systems. In Europe, 21.9 GW of photovoltaic systems were connected to the grid in 2011, compared to 13.4 GW in 2010. Solar power usage in Germany itself has increased by 50% since last year, the country's solar resources have pulled in a phenomenal 14.7 terawatt-hours in the first six months of 2012 alone, which amounts to 4.5 % of Germany's power needs. The Germans have installed an additional 73,756 solar power systems across the German countryside, with more sprouting up each week. Combined, the new systems have an output of 2,328 megawatts. In 2012, Germany will have reached a total of 28 GW of solar power capacity, which far exceeds other countries of its size. This growth is often triggered by technological advances and willingness of folks to accept these technologies. They are more willing to implement such systems as a community on a large scale without much hassles.

As opposed to this situation, Latin and South American countries are driven by a desperate need for progress and development. They have ensured that civil wars, dictators and corrupt governments do not come in way of development. Their's is a story of perseverance. Their solutions might not be technologically advanced but are much more rooted in their simple way of life.[9]



Fig. 13 Solar panels on rooftop in Bavaria, Germany

4.4.3 Africa:

Africa is a different ball game. Problems here are compounded by extreme weathers, dense forests, arid deserts, civil unrests and the fact that it has been a largely neglected continent despite being the cradle of human race. Almost every country from the rest of the world with surplus resources reaches out to African countries and contributes to these weaker economies. NGOs from India too are actively participating in supporting the African cause. Most of the help is in form of light bulbs for education. This help is on the belief that education is the only hope for a brighter future. African children line up in hundreds outside distribution centres for such products.



Fig. 14. African Children studying in traditional lights



Fig. 15. African Children studying in LED lights

4.5 Solar products in India:

The market study was an exercise in finding gaps. The Indian market for solar-powered lighting solutions is crowded. New players enter the market everyday. The typical product they offer is a lamp having LED light sources, a plastic casing shaped much like a typical kerosene lamp. The products offer portability and some additional function as phone charging, etc. However it has been noted that the user feedback to these products has been lower than expected.

The numbers suggest that a large number of people are purchasing these products, but their satisfaction index would be quite lower than expected.

These products often seem faceless in a crowd. One does not know what company designed them nor does it seem that they have been designed for a rural context despite that being its main aim. The bulk of the electronics required to drive the LEDs are housed at the bottom. The plastic housing at times feels crude, to an extent cheap. Online forums have reported to low qualities of manufacturing. This can be attributed to sudden opening of market for solar powered devices and many players jumping in without much thought. Such markets often tend to suffocate innovation. Innovation, not just in terms of technologies but the approach in designing products for such a critical market.



Fig. 16. Indian market for solar lamps



Courtesy: Author

Fig. 17. Solar lamp on field in Pachwad, Maharashtra

4.6 Re-visiting Rural India with a solar light:

This visit was a more focussed visit with samples of solar lamps and conversations directed to usability patterns.

Place: Pachwad, Taluka Khatav, District Satara

Pachwad is a fairly remote village located on the Deccan plateau, some 60kms southeast of Satara. It is connected to the rest of the world through a small road that one has to travel on after a series of confusing interior roads off Satara. It is bounded by low hills on one side and the flat expanse of the plateau on the rest three. The lack of terrain would make one uneasy, were it not for the numerous windmills dotting the horizon. These windmills stand as sentinels on the perimeter of this village. Despite this, Pachwad faces severe power shortage. Power cuts are the norm. In my stay there, the power went off for 5-10 minutes atleast once every hour at an average.

The village is many crowded with Ghadges. There might be close to 30-40 Ghadge families staying in the village. However most of the houses seem abandoned owing to a drought 5 years back. Being on the borders of Khatav and Maan taluka, Pachwad has been visibly neglected. The Mayani dam lies nearby but that does not help solve its water issues, just like the windmills who do not solve its power issues.

4.6.1 Context:

For the pilot study of solar systems, the house of a certain Digvijay Phadatare was selected. It was a pretty old house-complex, with one main house, one smaller, old house and a newer small one. Being on the plateau, these houses lacked sloping roofs, but the smaller had one that was accessible. The solar panel and the lamp were kept side by side on a broken wall some 1.5m in height. However the place had to be changed as the shadow from the neighbouring house started falling on it. The setup was shifted to the smaller house. The solar panel was kept on the roof while the lamp was hung on one of the many wires passing from beneath the roof in the front. That the panel wouldn't slip off had to be checked again and again. The lamp hung comfortably on the wire. It helped that the height of the house was relatively low. It would be difficult to achieve the same on the bigger house. Even in the setting sun (4-7pm), the lamp charged efficiently to provide us light that would last through the night. The toilets were detached and on a completely different plot, some five minutes from the house. Normally, the family members would just walk through the night, saying that the eyes adjust to the night light. But on the way, we saw a family trying to kill a scorpion. Even though they are aware of such dangers, the villagers abhor from using lights. There are no streetlights also. The light from the houses that spills on the road seems enough for them. When the lamp was provided to the villagers, they found it convenient to use, especially for the trip to toilets.

4.6.2 Using the lamp:

In the house, the lamp was detached from the solar panel and tried at various locations. The solar panel was kept in a plastic bag by the villager himself. This is an important activity; he did not let it lie on the roof. One reason maybe that he feared it slipping off and

getting damaged, the dangling wire getting caught up in something else or maybe even theft. The bag with the solar panel was kept neatly near the table in the living room. The lamp was hung on metal hooks on the old wooden door frames, from ropes wound across the wooden knobs in the walls, and wires used for drying clothes, etc. .

The lamp provided enough light in the balcony/upper verandah for moving around. However for indoor use, the light was insufficient for even moving around, it cast shadows and gave an overall dull feeling. Any activity in such low light would be a little bit precarious. However, the position and switching action was found to be very comfortable. When the lamp fell once or twice during the experiments, the upper cap gave way and separated, as is the design. But the fact that it can be assembled again gives it tremendous forgiveness value.

4.6.3 Look and feel:

Finally, the lamp is visibly foreign in nature. There is a distinct Japanese feel to it. The pink hues are dominant but they are compensated for by a strong base and an overall bulky form. The hook-like appendage is convenient to hang but a bit uncomfortable to hold in two fingers. The user then tends to grasp it but the girth is larger than the palm and the frosted texture makes it slippery.

The field study was helpful in looking at rural scenario, considering positioning or solar products there. Being more focussed than the earlier visit, it gave a lot of insights on user perceptions and usage patterns.



Courtesy: Author

Fig. 18. Lamp in washroom



Courtesy: Author

Fig. 19. Lamp being hung on door



Courtesy: Author

Fig. 20. Typical rural house façade with lamp being hung outside

5. Light

The chapter is composed mainly from Basics of light and lighting, Philips lighting academy.

Lighting plays a vital role in our lives. It opens up a walkway for us to lead our lives and spend our time in the way we want. Lights define our homes, make it the place we yearn to return. In commercial establishments, lighting helps in setting the mood of the potential customers and creates an ambience. In workspaces, proper lighting ensures employee satisfaction and consecutive better work output.

Basic requirements like lighting level, contrast, light distribution and colour rendering have to be taken into consideration for each situation in general and the activities that are taking place there in particular. But good lighting goes beyond mere efficiency and functionality. Lighting helps define the settings of our immediate environs: cool or warm, business like or casual, happy or solemn, or any combination in between.

Scientifically speaking, light is nothing but electromagnetic radiation, but in the visible spectrum (within 380-780nm). Whenever light strikes a surface, it is either reflected, absorbed or transmitted. Often a combination of two or even all three effects occurs. The amount of reflected light depends on the type of surface, angle of incidence. If the material's surface is not entirely reflecting or the material is not a perfect transmitter, part of the light will be absorbed often being converted into heat. The colour of a light source depends on the wavelength of the light emitted by it. The apparent colour of a light reflecting surface, on the other hand, is determined by two characteristics: the wavelength of the light by which it is illuminated, and the spectral reflectance characteristics of the surface.

5.1 Light sources

Ever since their invention in 19th century, electrically powered lights have come a long way. Their efficiency has increased from 3lm/W to 14lm/W.

5.1.1 Incandescent Lamps

Here, electrical current is passed through a high resistance metal wire (usually tungsten) placed in an evacuated chamber filled with an inert gas. These have the predominant light sources for almost a century.

5.1.2 Gas discharge lamps

Here an electric current is passed between two electrodes in a gas filled chamber. The ionisation of gas molecules leads to emission of light.

5.1.3 Fluorescent lamps

The (compact) fluorescent lamp is basically a low pressure mercury gas discharge lamp with the inner surface of the discharge tube coated with a mixture of fluorescent compounds — called phosphors — that convert the invisible ultraviolet radiation emitted by the mercury discharge into visible radiation. They are used for general lighting.

5.1.4 Solid state lighting

These are light emitting diodes based technologies. Their key features are: long life, robust, small size and low maintenance.



Fig. 21. General Lighting

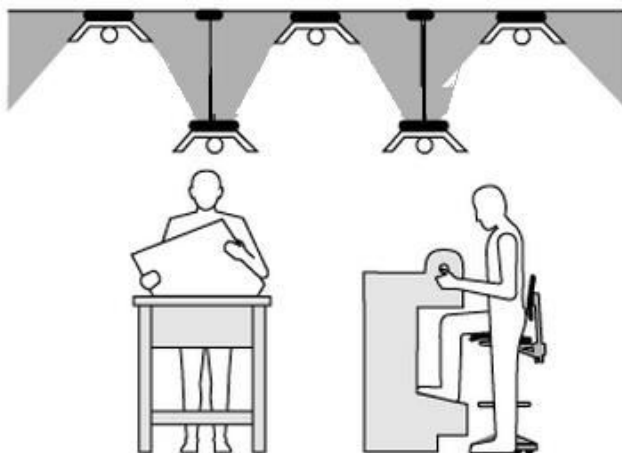


Fig. 22. Task Lighting

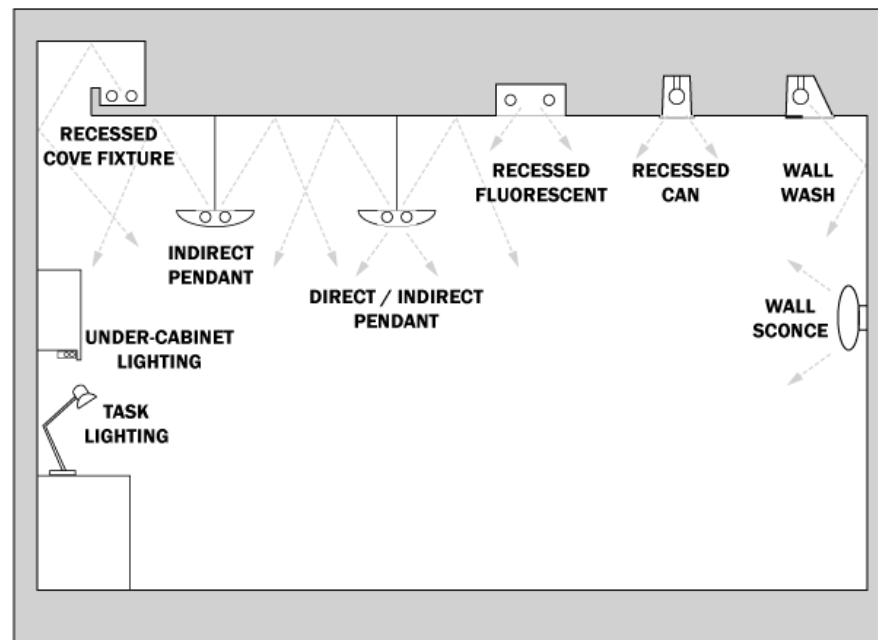


Fig. 23. Types of Luminaires

5.2 Lighting quality

The quality of light is a crucial factor in carrying out the tasks in any specific environment. It is a combination of accurate lumen selection, taking into account glare and spatial distribution and the colour and temperature of light. Proper selection of these factors can make lighting cost-effective and economical.

Lighting does more than just revealing our surroundings to us. Lighting was often an afterthought in interior planning, but it has now assumed equal importance as other elements. Lighting helps to accentuate the functional and aesthetic qualities of a space.

5.2.1 General lighting

It provides uniform illumination throughout a room. When combined with other lighting styles in proper manner, general lighting helps in generating an ambience in the room.

5.2.2 Task lighting

Task lighting helps reduce dependence on ambient lighting by illuminating a specific workspace for any defined task. Most task lights are directional and local.

5.2.3 Accent lighting

This type of light is used to highlight certain features within a room. It operates on play of light and shadow to attract our attention towards the desired feature.

5.3 Luminaires:

Luminaires include the reflectors, lamellae and other elements that hold the light source and help to distribute and direct light where it's needed. Luminaires help in distributing, filtering and transforming the light emitted by a lamp and includes all items necessary for fixing and protecting the lamp(s) and for connecting it (them) to the power supply.

Types of luminaires:

- Recessed-mounted luminaires
- Spots/projectors
- Surface-mounted luminaires
- Decorative luminaires
- Pendant luminaires
- Free-floor-standing luminaires
- Up lights
- Down lights

5.4 Safety and Sustainability:

The design of lighting systems should be to optimise energy usage and yet deliver effective lighting across the desired space. With increasing problems of energy deficit across the globe, such planning assumes greater importance. The selection of materials is also very important to avoid additional matter on the planet. Lighting systems have to be developed keeping in mind its social role, environmental role and its economic value.

6. Possible project directions

6.1 Possible scope 1:

The system is built around a simple handheld light source powered by solar energy. The components include a solar panel and a light source (typically LED based). The solar panel could be a simple flat plate collector separate from the device or alternately mounted on/part of the device. The product builds upon the semantics and the psychographics of the typical Indian rural scenario. Since it is handheld and can be carried around, it can act as an auxiliary tool for numerous activities. The system could be taken a step further and designed as a household lighting system, wherein the product could be attached/detached from wall fixtures wired to a common energy storage fuelled by a solar power source.

The ownership is still individual based. Hence the purchase and maintenance costs of such a product/system would have to be borne by the individual only. Hence, the product has to be widely approved and used which ensures a reliable supply chain in place. Else (or compulsorily) the product has to be fool proof even in adverse conditions as the Indian hinterland.

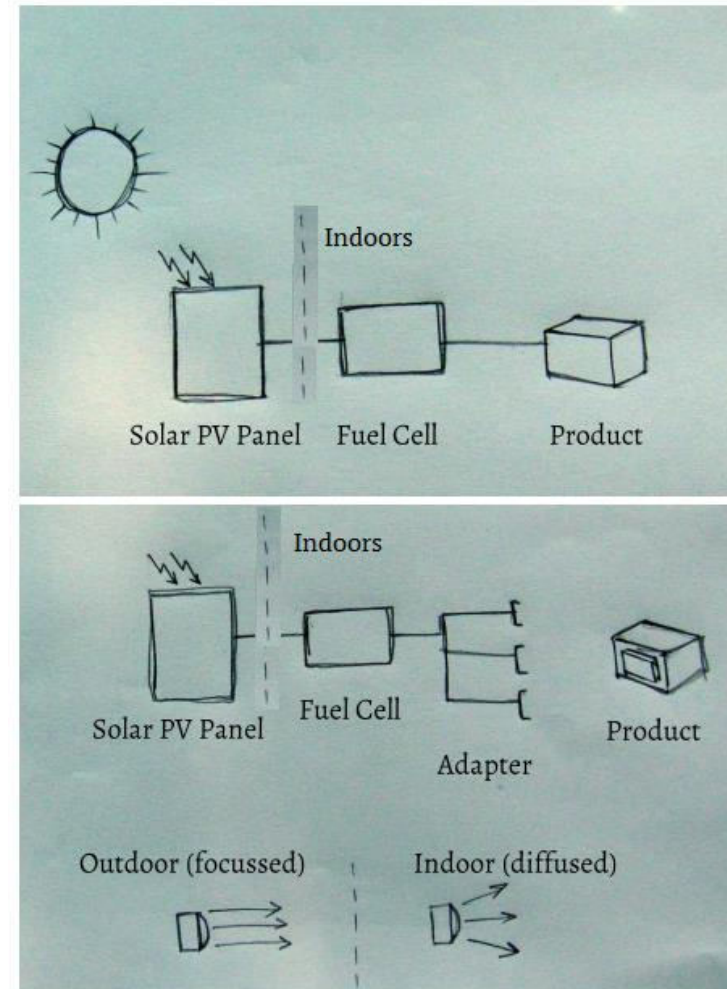


Fig. 24. Design Direction 1

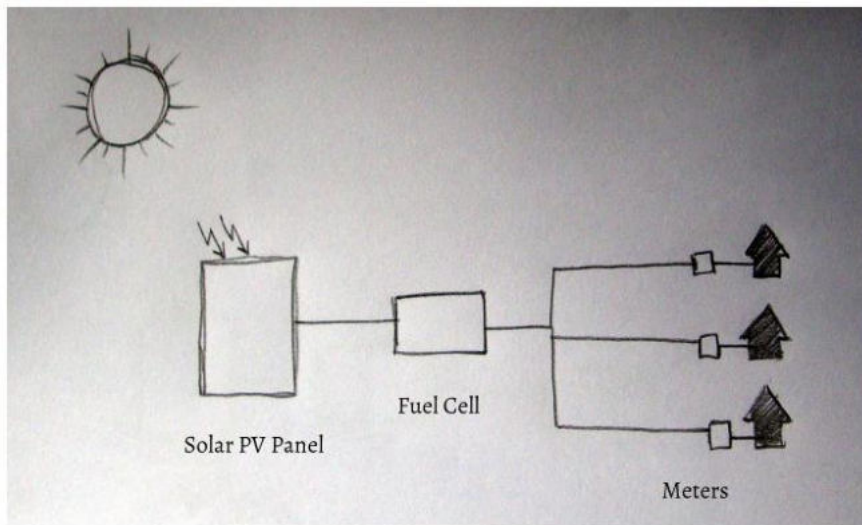


Fig. 25. Design Direction 2

6.2 Possible scope 2:

This is typically a system level design for a community based lighting system. Small, independent, self-sufficient solar banks fuel a common energy storage. From here, energy is transferred to households who are a part of this system. Now, since the consumption of different households may vary, the share-holding depends on the number of consumption points in the respective households. Alternately, a simple meter could calibrate consumption patterns. In other words, a community based lighting system on the principle of sharing.

This system would work well in remote areas, remote, inaccessible hamlets totally disconnected from the national power grids. They could also power utilities as streetlights, boring wells, common areas as temples etc.

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6.3 Possible scope 3:

This is a grid connected system. The solar power feeds into the grid in normal conditions, when the power supply from the grid fails, the solar power steps in and ensures smooth uninterrupted power. This decreases the dependence on the grids and ensures the best of both worlds.

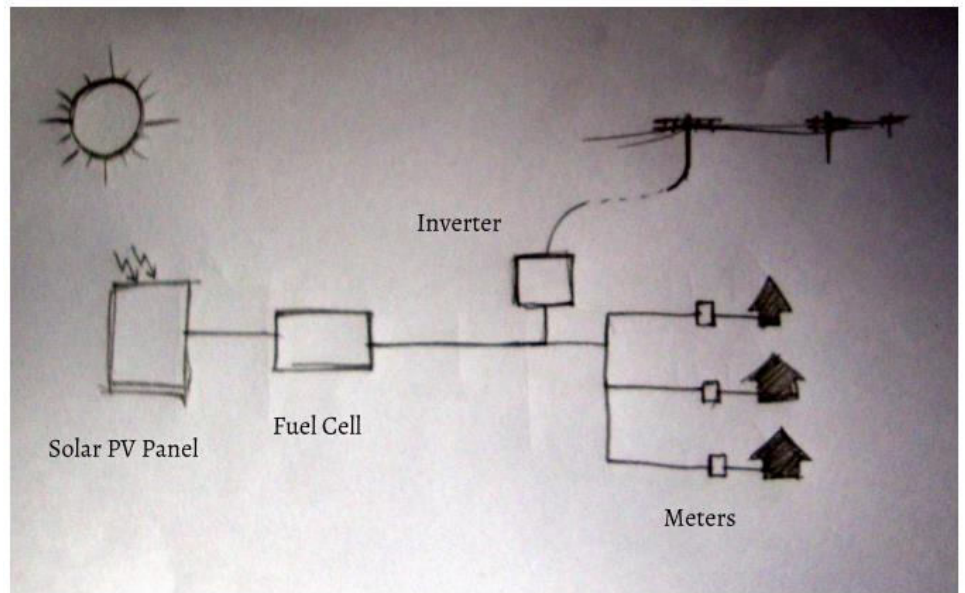


Fig. 26. Design Direction 3

6.4 Design interventions:

Rural India is subject to adverse conditions and harsh climate. Even today there is severe lack of infrastructure facilities and very little functioning systems in place. Hence the product/system proposed has to be almost absolutely maintenance free, hassle free, something that can be operated without even reading an instruction manual after the installation/purchase. If there is any backup, servicing needed the product/system should allow for it to happen locally. Most importantly, it should not be foreign and look out of place in the rural scenario. A common thread of simplicity and Indian-ness should be present in all the components of the system. This approach goes beyond just form but extends into the technology that powers it too. The product should become an expression of self-reliance and empowerment for rural India, much like the Mahatma would have wanted.

In terms of technology, efforts could be directed to achieve greater efficiency of solar panels, re-looking batteries/fuel cells. All these can be designed at the far-advanced edge of the technology spectrum, but since we are reaching out to a fairly remote sector care has to be taken to ensure hassle-free operation and ease of maintenance. The vulnerable parts will have to be identified and taken care of, right down to the last screw.

Not to be ignored is the environmental impact of crowding the rural scene with products adding to rural trash and having a possibly heavy carbon footprint. Each material of each component has to be carefully selected.

“...sovereignty of the people based on moral authority”
-M.K. Gandhi

Based on the the inputs from Stage I presentations, many possibilities were seen as out of the scope of the a design project, hence direction 1 seemed feasible to work upon. The scope was narrowed to a (possibly) standalone product that was solar-powered and had more than one applications, including indoor and outdoor functionality.

7. Design Brief

8. Opportunity Finding

8.1 Opportunity Area 1:

The light source here is an individual cell itself which can be packed in clusters. Additionally they can be inserted in special slots on appendages that are attached to powerlooms, sewing machines or devices for medium and small scale industries, handicrafts, etc. studies show that artisans indulging in such crafts such as Bidri silverware, Paithani sarees, etc. suffer from eyesight problems.



Fig. 26 Lights installed on a powerloom

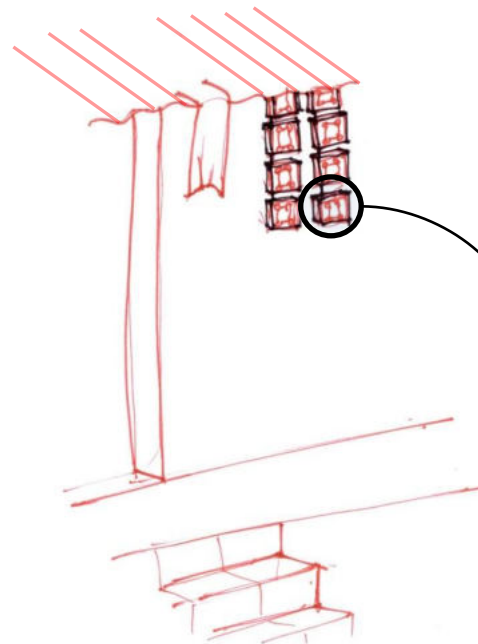


Fig. 27 Lights being charged

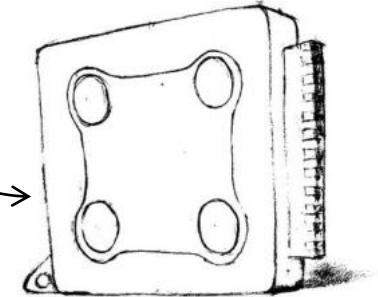


Fig. 28 Details of the cell with connector pins with LEDs on front side (shown here) and a solar panel on the backside

8.2 Opportunity Area 2:

These are simple form cluster lights that can be used for general lighting and can be clustered to illuminate social gatherings, meetings, etc. the scenario typically illustrates use of cluster lights for night schools. The user brings the lights from his house, gives it to a person responsible for collecting and stacking them. Possible problems might arise while returning the product back to the respective owners. These may include shuffling of products and other issues like position of the product (below someone, besides someone).



Fig. 29 Carrying the lights



Fig.30 Stacking the lights

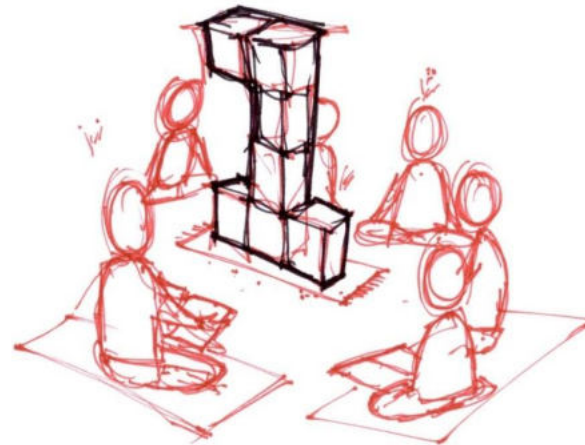


Fig.31 Seating around the arranged lights

8.3 Opportunity Area 3:

These are thick circular disks with possible silicon/rubber casing with electronics mounted on a central chip. A central aperture provides light from one side and has solar panel on the opposite side. A carabineer like attachment helps to make it portable and versatile in terms of hanging, carrying around and other activities.



Fig.32 Wayfinding

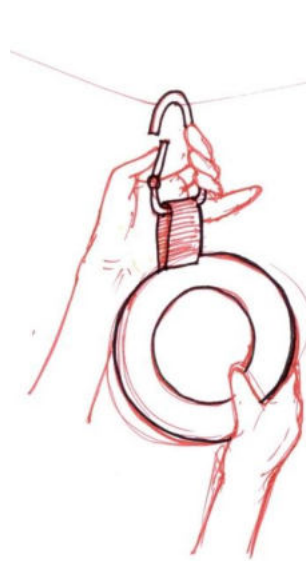


Fig.33 Hanging on a rope with a simple accessory



Fig.34 Lighting up a 'Kirtan'

8.4 Opportunity Area 4:

These are clustered lights mounted upon a central collapsible stand. They are typically community owned, where the stand is stored at the village head's house or the Panchayat office. For community gatherings, responsible people assemble stands collect lamps from attendees and light up the place. The lamps thus create a sense of harmony and unity among the rural folk.



Fig.35 Assembling the lamp
 (i) Extending the rod
 (ii) Attaching the base plate
 (iii) Clustering the lamps on it

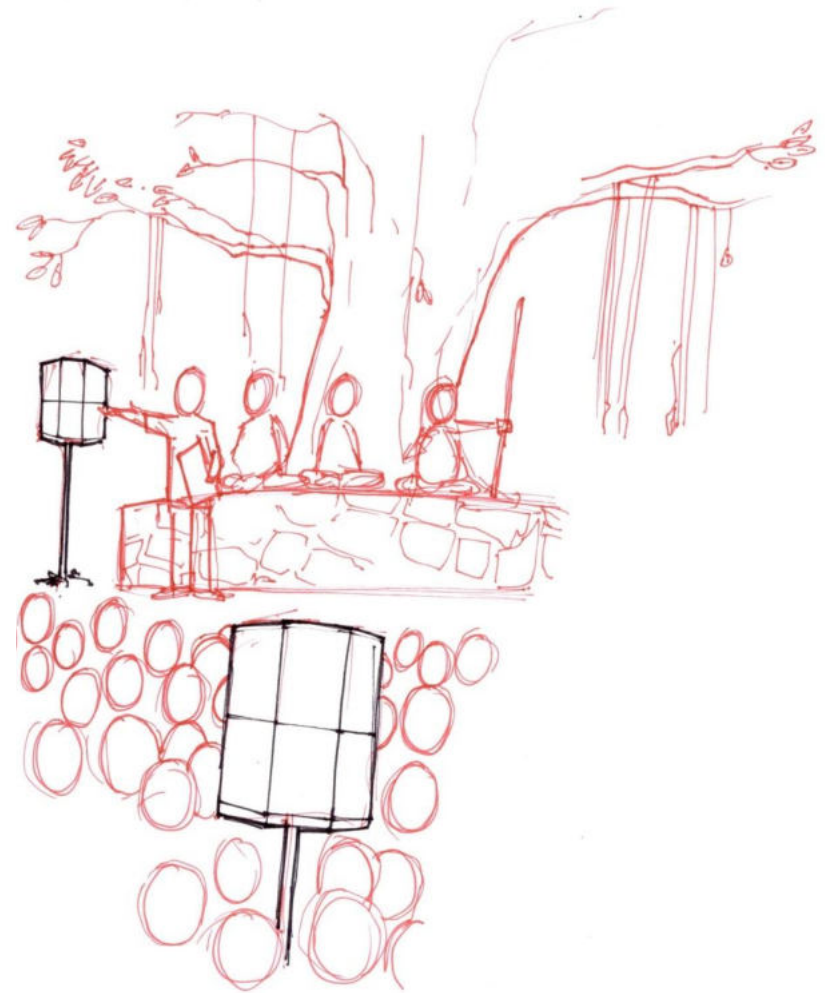


Fig.36 Illuminating a community gathering

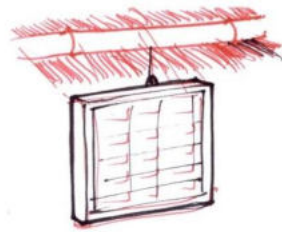


Fig.36 Docking panel being hung outdoors for charging

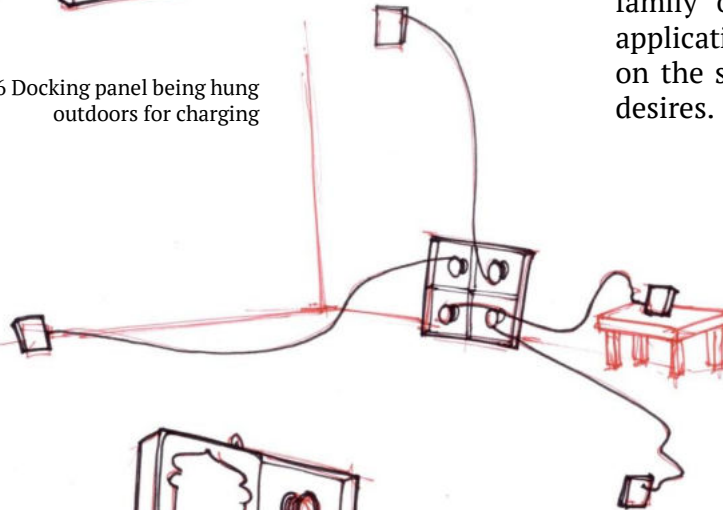


Fig.37 Lights across the room

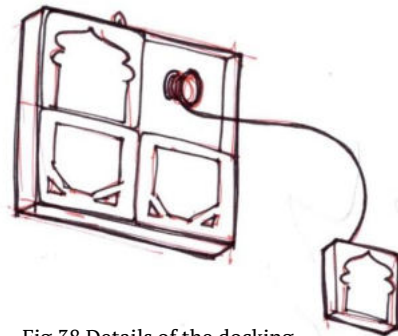


Fig.38 Details of the docking panel and wound cable

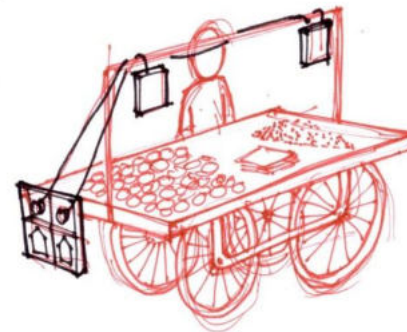


Fig.39 A hawker using the lights

8.5 Opportunity Area 5:

These are elaborately docked lamps that are held in place with a wire string that can be unwound to the desired length and locked. The docking plate acts as a solar panel. Each plate-like lamp can have details of its own and go back to be part of a family of similar lamps on the docking plate. A typical application could be for roadside hawkers who could hang it on the side of their carts and use just as many lamps as he desires.

8.6 Opportunity Area 6:

Another scenario for a night school, where a simple hand held lamp fits into a dock. The dock is a negative of the form to accommodate the product. Since it is suspended from the top, it ensures proper distribution of light across the verandah of the school, where such night classes usually take place.

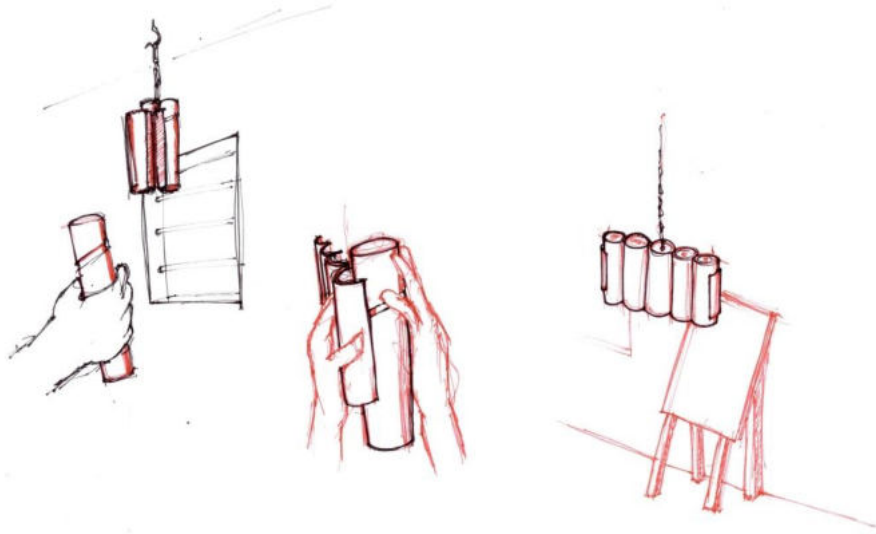


Fig.40 Docking the lamps in the holder

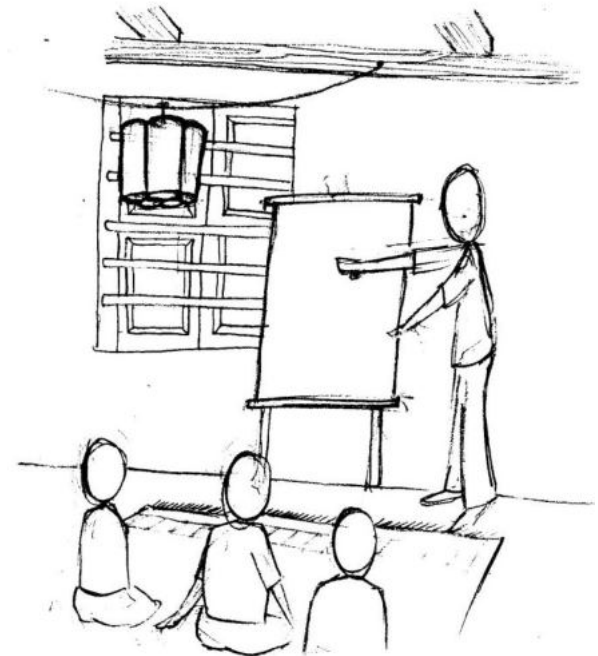


Fig.41 A typical night school scenario

8.7 Opportunity Area 7:

These are formally clustered lamps with each lamp for a dedicated purpose. Even if one lamp goes outside the house, there are still more options left to illuminate the house.



Fig 42 Detaching the light



Fig 43 Wayfinding

8.8 Opportunity Area 8:

The idea behind such lamps is to lift the source to a certain height above the ground. A typical application would be a medical emergency for a rural doctor who himself owns the lamp and the patient who might also own the lamp.

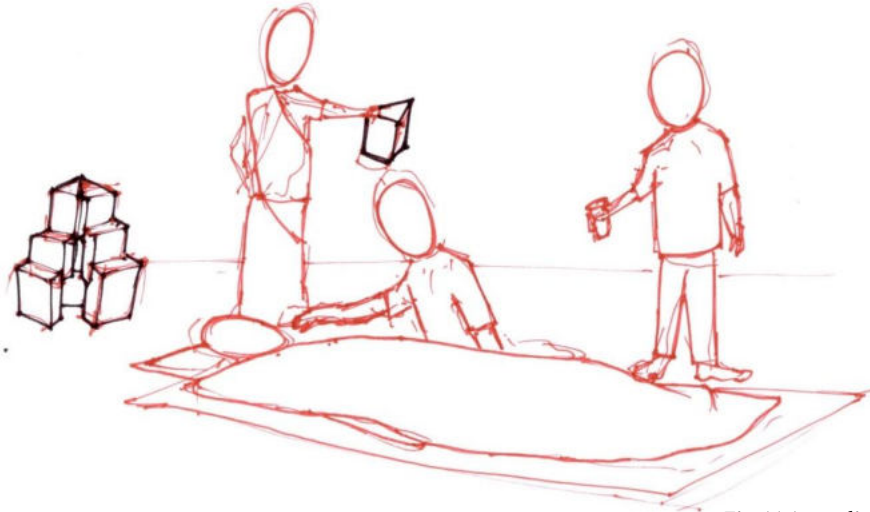


Fig.44 Attending a patient

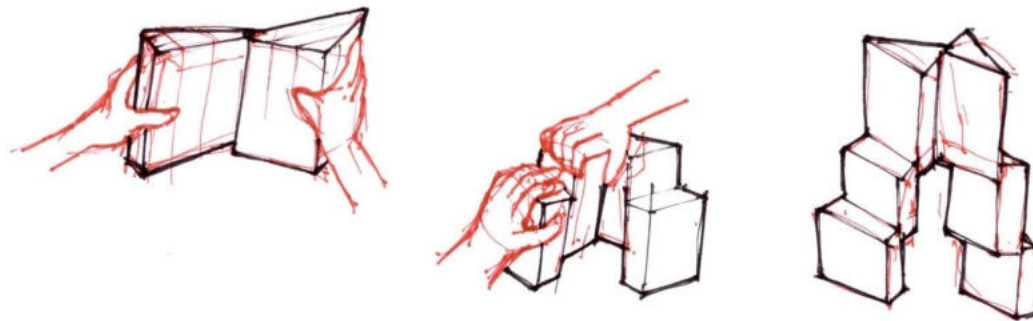


Fig.45 Assembling the lamps and splitting them vertically

8.9 Opportunity Area 9:

This is a typical table lamp with a flexible goose-neck. The lamp can be detached from the base and the neck can be wound around the user's hand or a stick to be carried around.



Fig.46 Wayfinding



Fig.47 Lamp

8.10 Opportunity Area 10:

This is a simple soft cubical form with four out of six faces diffusing light. The top face has a solar panel embedded in it. The lamp can be mounted on the wall, placed on the ground thus making it apt for simple rural indoor tasks. An additional strap can be attached to help in carrying it around



Fig.48 Lamp views

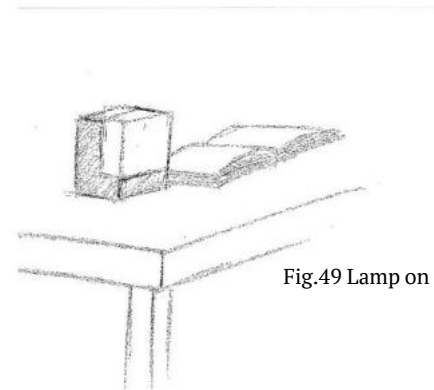


Fig.49 Lamp on table

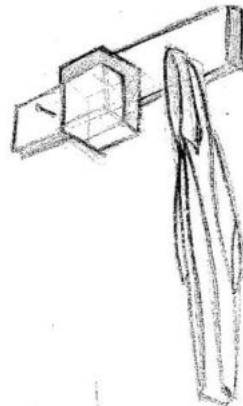


Fig.51 Lamp hung on wall

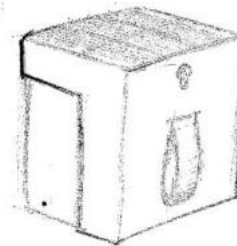


Fig.52 Lamp on ground with strap visible



Fig.50 Family eating around lamp

9. Ideations and Mockups

Courtesy: Author



Fig.53 Lamp



Fig.54 Detaching the lamp



Fig.55 Holding the lamp



Fig.56 Wrapping around the wrist

9.1 Detachable goose-neck lamp:

The lamp is mounted on a self-balancing base. The solar panel is fitted in the head of the lamp itself. The lamp is detachable from the base. The flexible goose-neck can be wound around the hand of the user, thus keeping his hands free in case the user has to go outside with his tools, stick, etc.

Advantages:

- Dual functionality for both indoors and outdoor
- Customisable handle, shape of which can be decided by the user

Disadvantages:

- Just an added functionality to simple table lamp
- Form looks weak and alien
- Low power

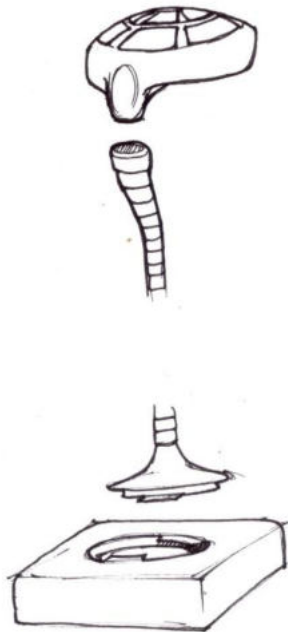


Fig.57 Lamp Assembly

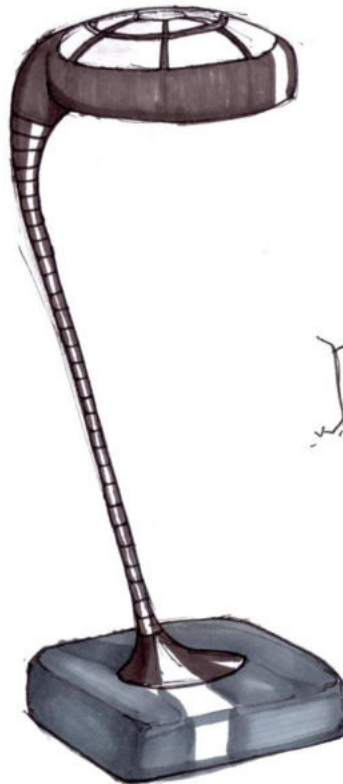


Fig.58 Lamp

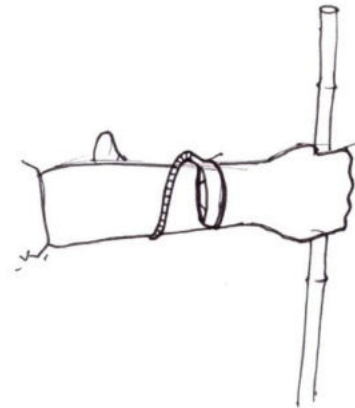


Fig.59 Wrapping around wrist

Courtesy: Author



Fig.60 Detaching the upper light



Fig.61 Assembled lights

8.2 Value lights:

Here the lamp is split into three sections, with one section that can be detached and carried around. The central portion is meant for indoor purposes, the bottom portion typically as an auxiliary light for miscellaneous purposes.

Advantages:

- 3 possible value applications, each considering rural activities
- Comes together as a single form
- Getting more out of a single product

Disadvantages:

- Increased chances of component getting lost or stolen



Fig.62 Lamp assembled



Fig.63 Lamp being detached

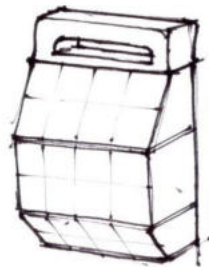


Fig.64 Solar panels on backside

Courtesy: Author



Fig.65 Triangular Lights



Fig.66 Holding the light



Fig.67 Lamp with handle in the form

8.3 Triangular lights:

This light is typically an extruded triangle with one face for diffusing light. The other faces hold the solar panels. The slope could be at an angle that is conducive to maximum reception of light from the sun (20-30 degrees at our latitudes). The handle is incorporated into the form itself.

Advantages:

- Ease of handling

Disadvantages:

- Neutral form
- Limited usage

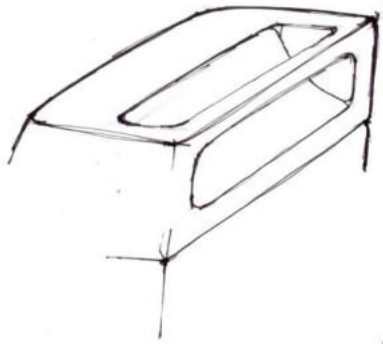


Fig.68 Handle details

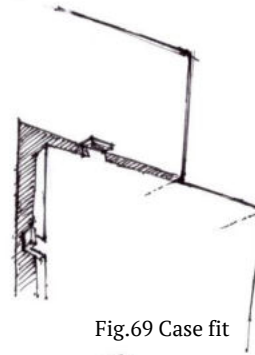


Fig.69 Case fit

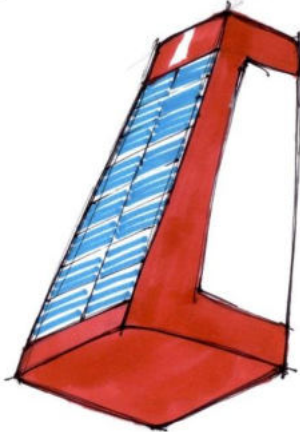


Fig.70 Strong form

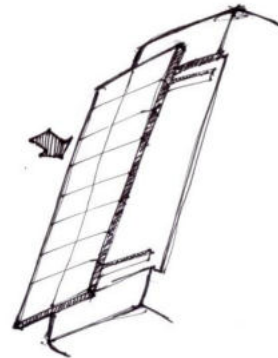


Fig.71 Solar cell cassette

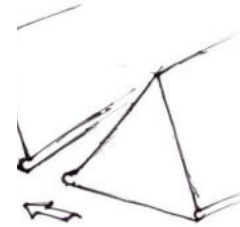


Fig.71 Stacking details

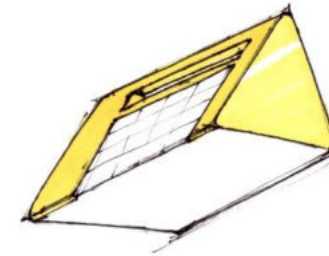


Fig.72 Triangular light



Fig.73 Clustering

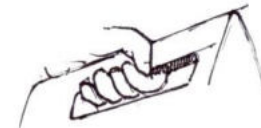


Fig.74 Holding the lamp

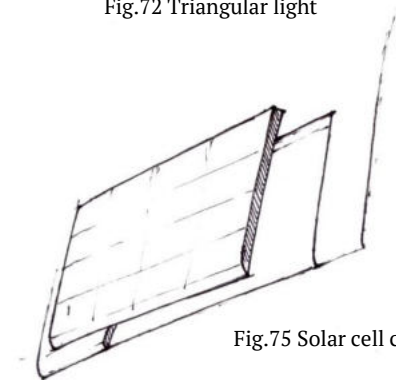


Fig.75 Solar cell cassette

Courtesy: Author



Fig.76 Disc light variations



Fig.77 Ornamental disc



Fig.78 Rim details

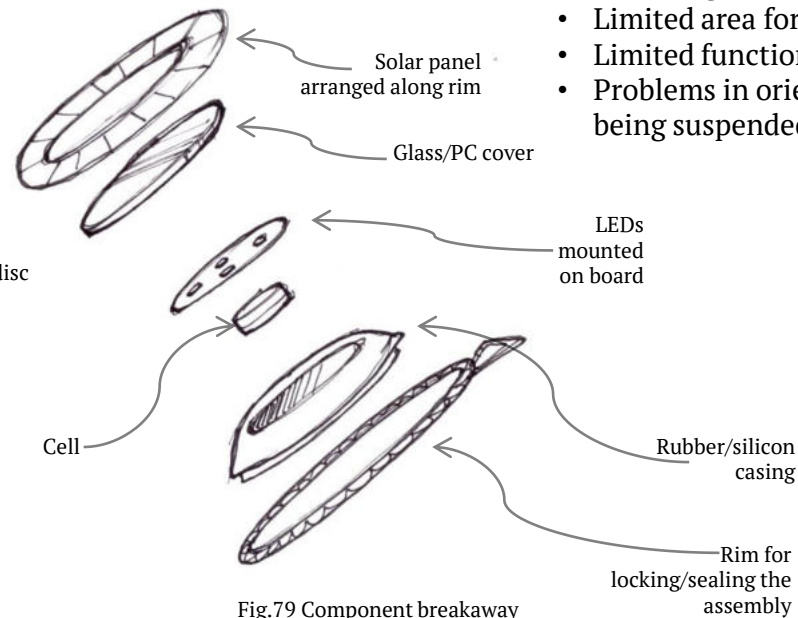


Fig.79 Component breakaway

8.4 Disc lights:

The lamp is a tick disc with a rubber/silicon casing. The material allows for selection of vibrant colors, patterns, etc. it also protects from mechanical shock and considerable weather-proofing. The central part diffuses light from one side and receives sunlight for the solar panel on the other side. The inclusion of a strap enables attachment of various accessories that can multiply the functionality.

Advantages:

- Protection from elements of nature
- Form and material gives scope for ornamentation
- Ease of use

Disadvantages:

- Limited area for light diffusion
- Limited functionality
- Problems in orientation, cannot be kept standing without being suspended or supported

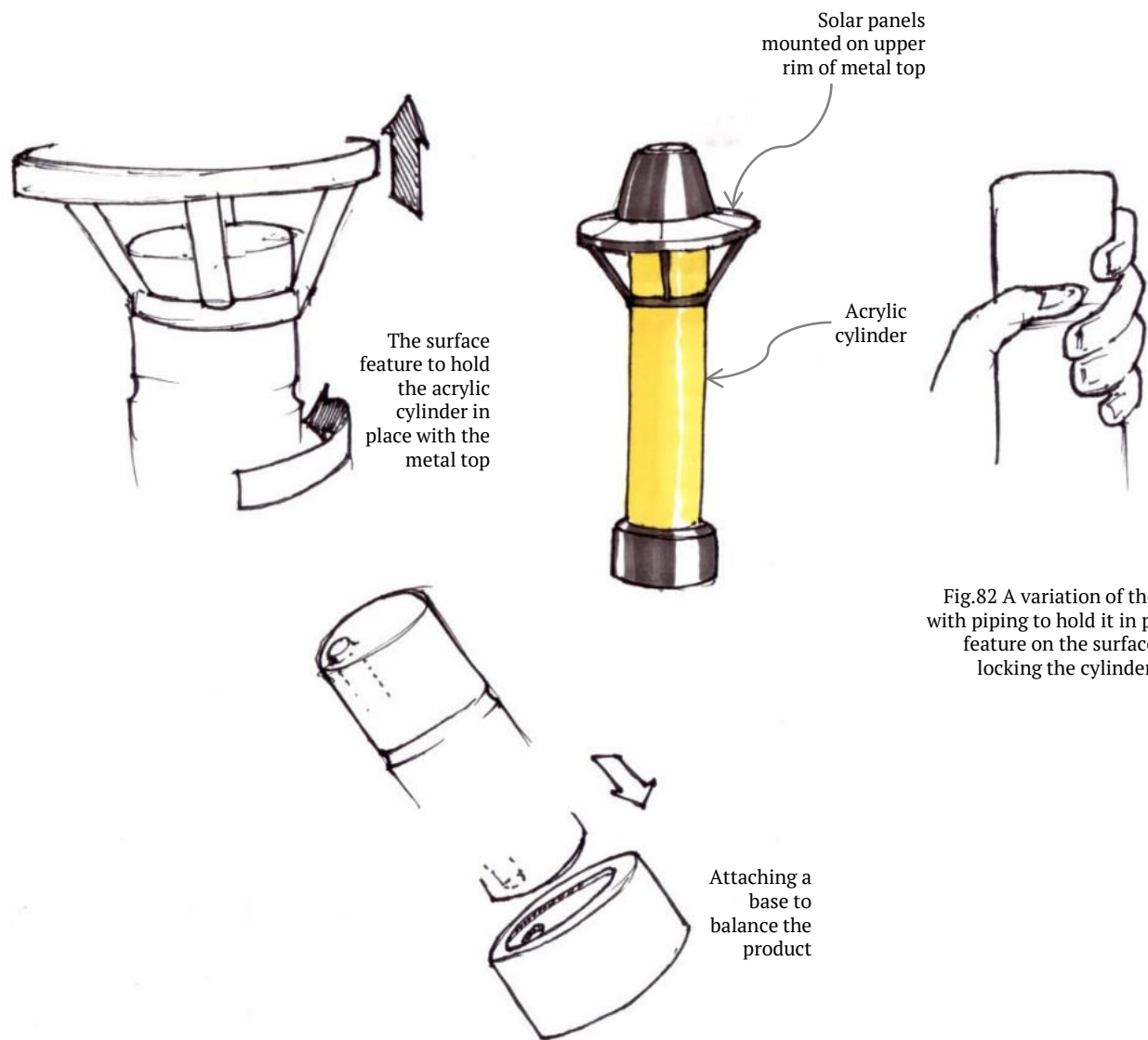


Fig.82 A variation of the concept with piping to hold it in place. The feature on the surface helps in locking the cylinder in place.

8.5 Light cylinders

These are frosted acrylic cylinders that diffuse light throughout the body. They can be stacked on to holders that may come in groups of two or more. The locking and fitting happens mainly because of the form. A feature can also be provided for further fitting assurance.

Advantages:

- Varieties of clustering possible

Disadvantages:

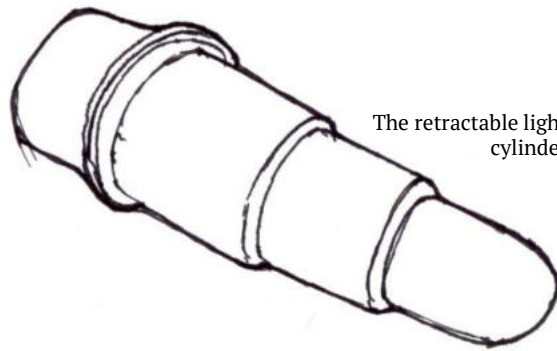
- Either too minimalistic or elaborate



The chandelier inspired solar panel cum holder



The holder for cum charger for lights

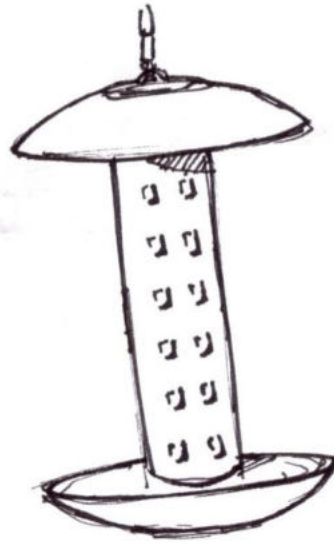
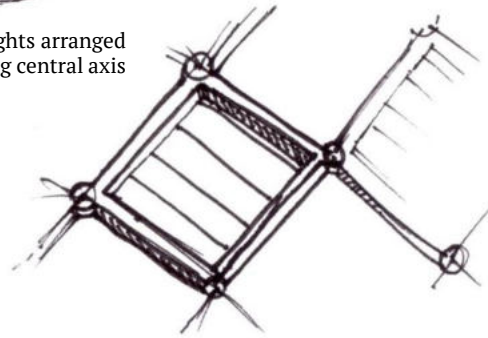


The retractable light cylinder

Fig.83 An inspiration from a traditional chandelier, where lights fit into holders that double up as contact chargers. The upper face acts as a solar panel. The lights are retractable for easy portability.



Fig.84 Lamp

Fig.85 Lights arranged
along central axisFig.86 Details of framed
solar panel

8.6 Globular lamp:

Here the solar cells come together on a spherical frame to power a lights arranged on a central axis. Inspired by a Mughal lamp, these lights diffuse through spaces between the solar cells, possibly creating a pattern through play of light and shadow.

Advantages:

- Resembles a traditional lamp
- Beautiful accent lighting possible

Disadvantages:

- Complex assembly, with too many
- Does not satisfy need for general lighting
- Difficult to move around with

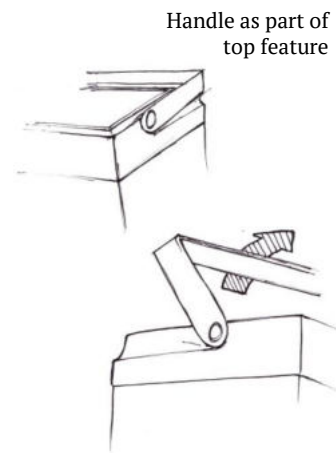
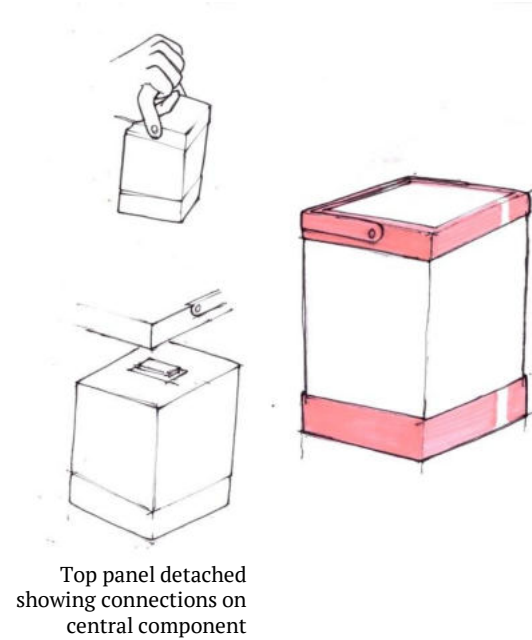


Fig.87 Simple lights with handle incorporated into the form

8.7 Simple Lamps:

These are cubical forms, with light diffusing from four faces and a solar panel on one face. The form has been softened.

Advantages:

- Easy assembly
- Fits in simple rural households

Disadvantages:

- No affordance for portability
- No affordance for knowledge of orientations

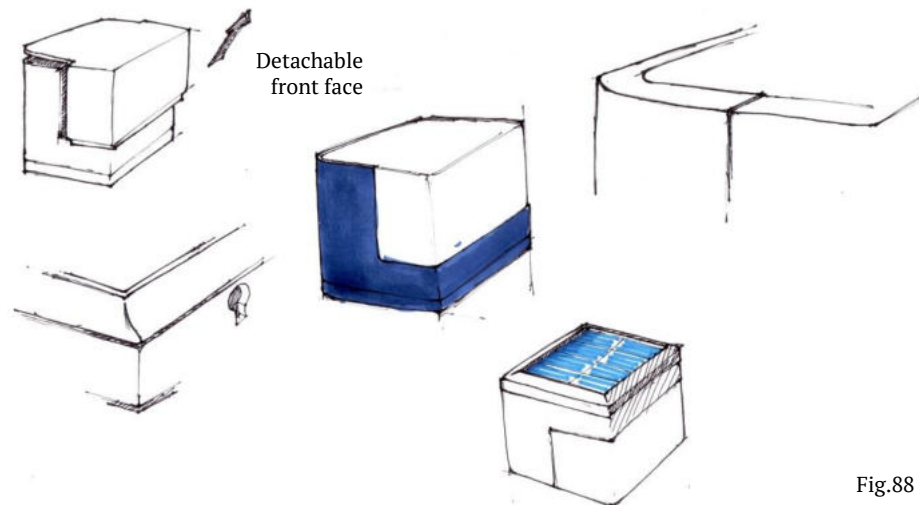


Fig.88 Simple lights a softer form

10. 'Value lights' as a design direction

The thought is to provide the user with more than one light for dedicated tasks. The lights come together to form a single product whose combined value is more than the sum of its individual.

The inspiration for this concept rises from the dire need of the various activities of a rural household. In a typical rural setting, a life is not bound by walls and activities are spread across the village and even beyond it. Every member of the household works in different settings, carrying out assigned tasks with amazing dedication. When a single light source, independent of the power grid is given, the singularity of the unit is a major hurdle in carrying out more than one tasks simultaneously. Add to it the all-pervading darkness when the source fails or is taken elsewhere. There is always one person who has to compromise and carry out the task in darkness. Compromise in terms of quality of work or endangering one's life. While working on these lights, emphasis was laid on clustering, stacking, form, manufacturing, technology and usability.

10.1 Need:

Consider a typical scenario of a remote rural household, bereft of power supply, sinking in darkness during dusk. This is the house of a typical user we are targeting. The kitchen or the stove area becomes the hub of all activities if a lamp is kept there. All the family members huddle around the lamp. If we are to stereotype, the man to relax and talk, the woman to cook food and the kid to study. The elder members usually sit in a dark corner. If the man gets a call to go outside for an emergency situation in the fields, in the nearby village or to attend the meeting, he carries the lamp with him. Or else he has to leave the lamp inside the house and tread alone in the darkness.

Rural areas are infested with all sorts of insects, reptiles, scorpions, and smaller beasts. Even a simple stone can prove fatal if not seen. If he carries the light along with him, the house is plunged into darkness, all activities come to a standstill and the house becomes vulnerable if the man is away for a long time. Since we are considering the remotest of the houses and the most deprived people, the chances of them having more than one light source are slim.

To remedy this problem, we give them three lights, each having value of its own, each dedicated to specific tasks. The assigning of these tasks was done based on observations of rural activities and usage patterns of what users do when given lights. For example, in Pachwad, people normally go to the washroom in darkness, but when lights were given for use, Digvijay Phadatare asked if he could carry it to the washroom. In Khamgaon, the head of the village, Baliram Sawant, has a habit of going to the cattle-shed again and again in the middle of night to check on his cattle. Akshay Shirke goes to the Kond (man village) for group studies in the evening, leaving his mother and sister alone (his father is a bus conductor and is away for a better part of the week). Balkrushna Sawant has a habit of switching off all the lights in other rooms, before sitting down to eat dinner in the kitchen. These habits and quirks give insights to what the users want, sometimes even they themselves don't realise it but as in the case of washroom, when given an option, they'd like to exercise it. Value lights build upon this need of providing simultaneous illumination at different locations for different activities by a product that is intimate and yet omnipresent.

10.2 Typical tasks:

The tasks for each component were finalised after sets of discussions based on user insights.

The product when not in use is wall mounted, with the solar panel frame as a back-frame. The three lights are docked in place, with the product fitting seamlessly in the rural household. When a member wants to go outside, he detaches the torch and goes outside. The torch is handy and fits easily into the palm of his hand and he can move around with ease. Meanwhile inside the house, the other members switch on the middle light and go about their activities. The middle light is a powerful light source that can light up an entire room. It can be kept in the kitchen, wall mounted separately on any common nail or placed on the ground. The lower light can be used for a number of secondary tasks. When the man of the house goes outside, it can be hung in the verandah of the house. It can be used to welcome guests who arrive late at night. It can be hung in the cowshed, or near the outdoor toilet. It can be used when the handful people of this remote village meet together. Clamps hold the three components in place.

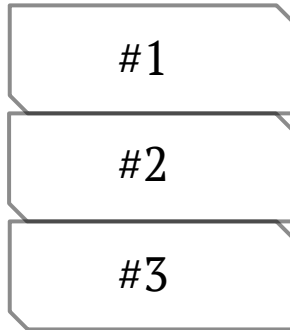


Fig.93 Detaching the central fixture

Fig.94 Using the central light



Fig.95 Taking the upper light outdoors and hanging the lower light in the verandah



10.3 Approach:

To integrate the three components, simple stacking was considered. The initial ideations included a sketch of a man sitting in the kitchen and detaching the upper part of a product to take away with him. Similarly the product was developed in a vertical combination. Semantically, it fits in with norms of a wall mounted product, offering distinct hierarchy and separation of purpose. Within this other combinations were tried, but in quest for simplicity, the broad outline was kept as a line-up of vertically stacked components.

10.4 Revised Design Brief:

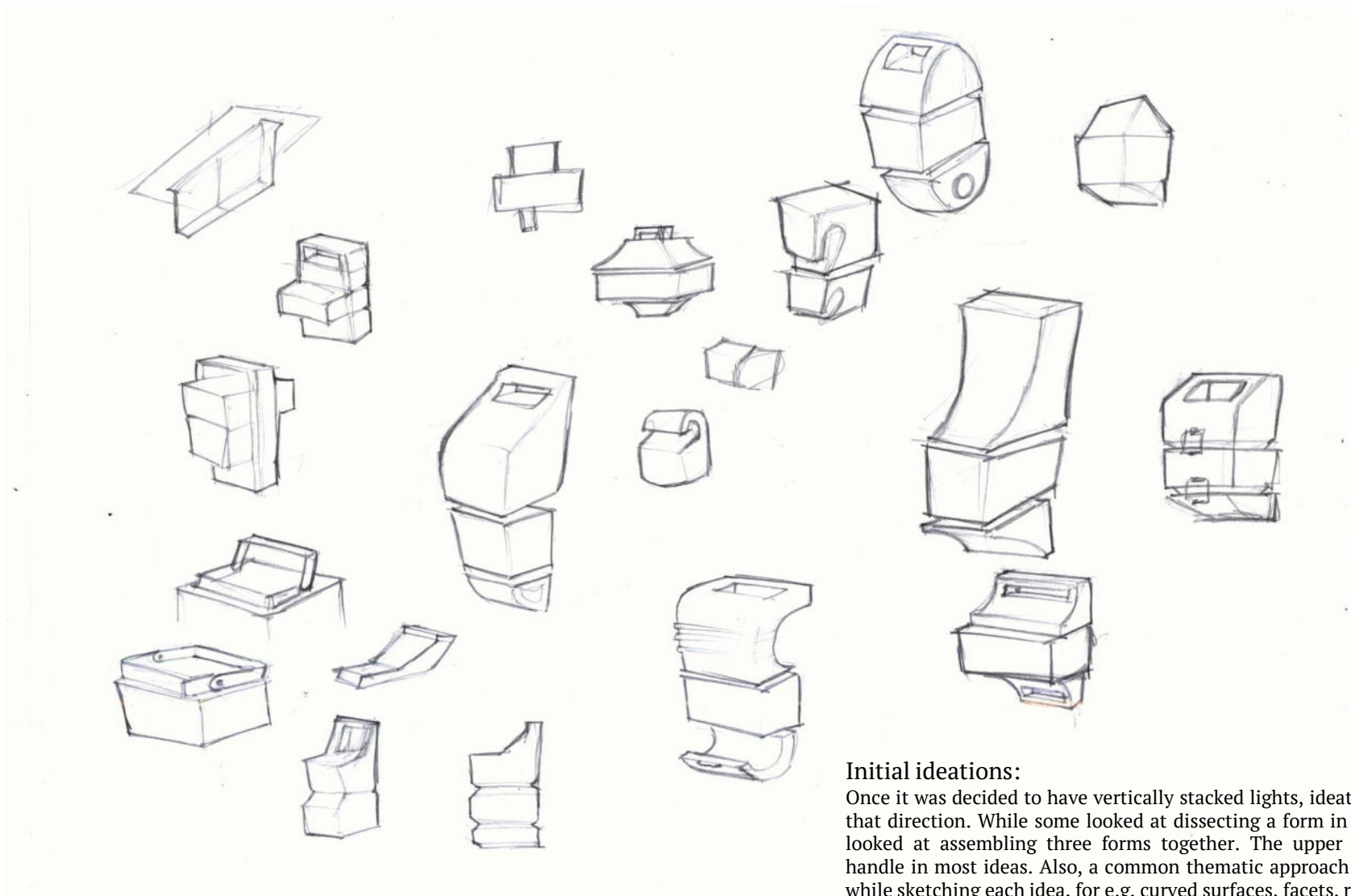
Keeping in mind the needs that were realised and the ideas that came up in course of the discussions, the design brief needed to be revised. This was an effort to provide a clearer direction to proceed in and set constraints to work within.

Design Brief:

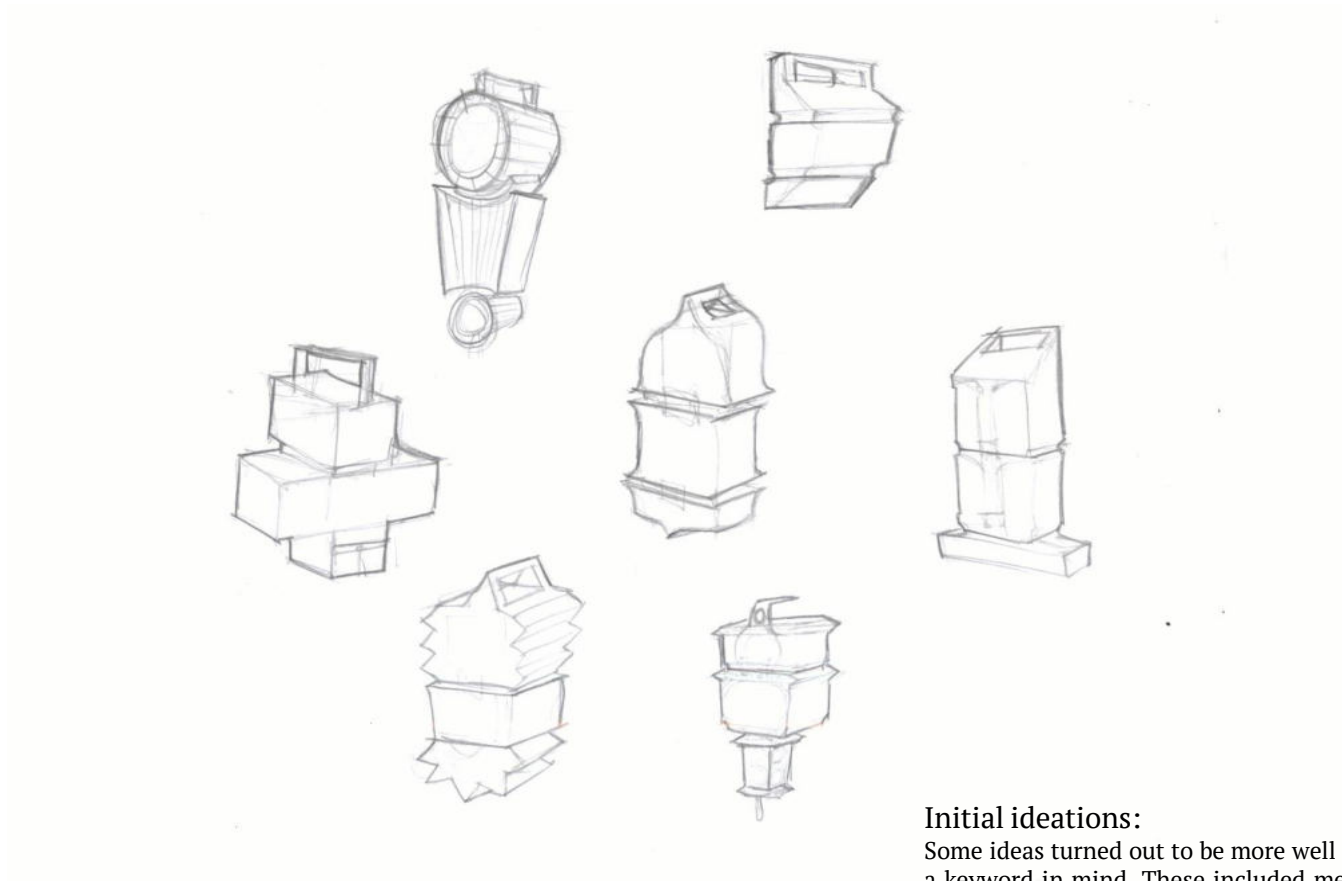
To design a lamp within the context of an Indian rural house-hold. It consists of three separate lights for three value-based purposes. These include:

- Outdoors
- General lighting for indoors
- Secondary multi-purpose lighting

The product focuses on stacking and integration of form despite the three separate components. The form arises from the distinct functions that these components are meant to perform. The lights are powered by a separate solar panel which doubles up as a docking panel.

**Initial ideations:**

Once it was decided to have vertically stacked lights, ideations proceeded in that direction. While some looked at dissecting a form in three parts, some looked at assembling three forms together. The upper part was given a handle in most ideas. Also, a common thematic approach was kept in mind while sketching each idea, for e.g. curved surfaces, facets, radii, ribs, etc.



Initial ideations:

Some ideas turned out to be more well attended to. They were sketched with a keyword in mind. These included medieval, ornate, basic shapes, lantern, human face, traditional pattern. The central light became a prominent hub with the handling happening clearly in the upper light. The lower lights were formally similar to the upper lights.

Initial ideas and exploration



Fig.89 Lantern form:
Like a typical wind lantern, except with LEDs inside



Fig.90 Traditional form: an effort to break away from flat surfaces with traditional lamps in mind



Fig.91 Pottery inspired form:
Like earthen pots stacked on top of each other with apertures for light to filter through



Fig.92 Wall-hanging inspired form:
Like typical wall-organisers and stacked along edges

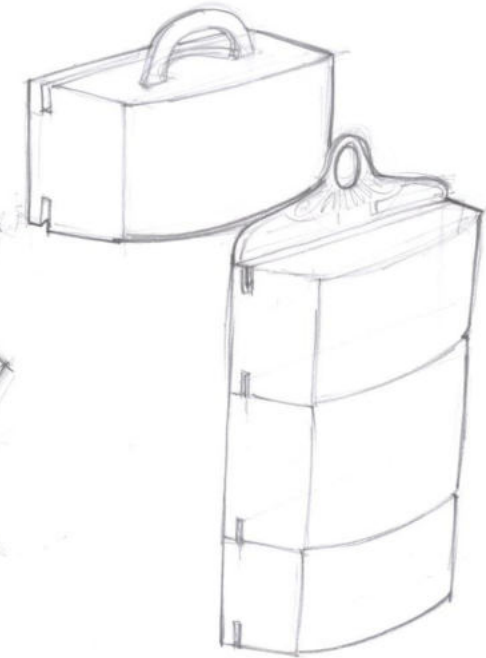


Fig.93 Typical wall mounted form: minimalistic, urbane form

Initial ideas and exploration

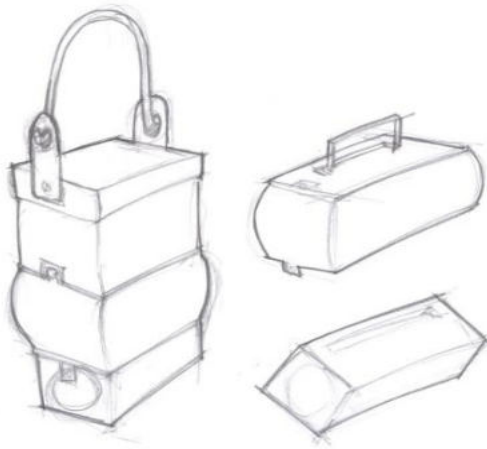


Fig.99 Lantern form:
An idea inspired by traditional lanterns looking at
metal-plastic interfaces for the product

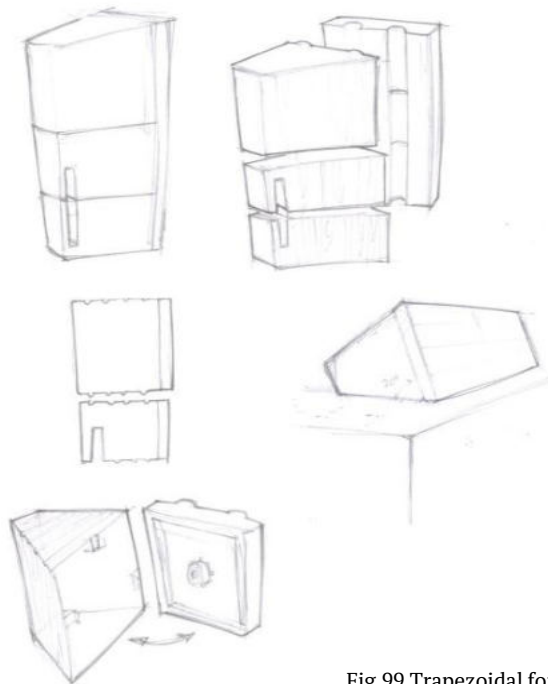


Fig.99 Trapezoidal form:
A different form, much stronger than a simple
triangular form. The handle is incorporated into the
front face.

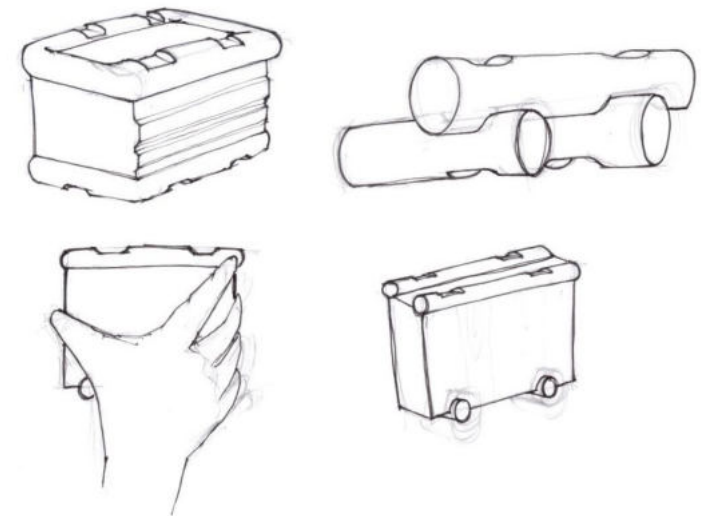


Fig.99 Log-like locking:
Just like wooden log houses, where wooden logs are
stacked on to each other through simple notching,
here the upper and lower border have notches that
latch onto their partner in the other component.

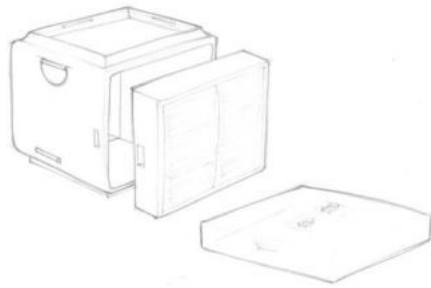


Fig. 107 Possible details of back panel

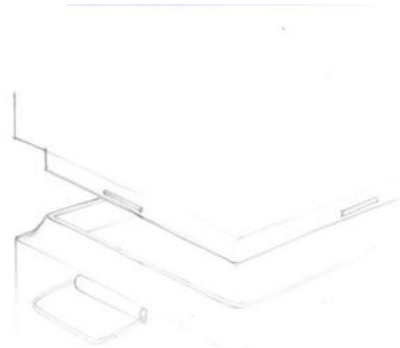


Fig. 108 Top stacking

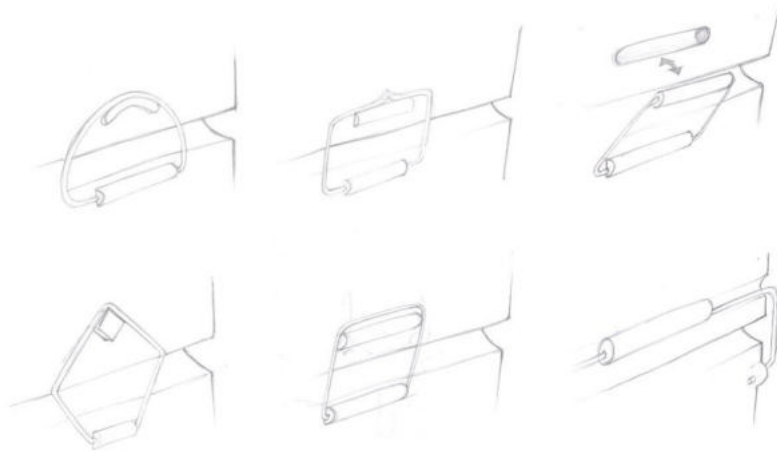


Fig. 109 various holders/clamps

10.4 Clustering and stacking:

Clustering and stacking helps hold the three components together formally and functionally. The main inspiration behind this concept was the unity that the villagers demonstrate. How they come together for various gatherings, community meets, do their tasks and then return to their place. All this happens within a strict hierarchy that has been laid out. They all form part of the unit called the village.

For stacking, we are looking at simple press fits or interference fits. Any elaborate spring mechanisms or retractable components have not been considered because that would lead to more number of moving parts and chances of failure are increased. Options like positive-negative spaces, male-female joints were looked at. Further, parallel products in the rural context were observed. The one that came forth strikingly was the three-tier metal tiffin box. The three boxes fit into each other and are further secured by metal clamps. Thus the product is an excellent example of guiding and fastening/locking. The metal clamps were seen as a viable locking solution owing to their simplicity and replace-ability. Further they could double up as hanging loops for the individual components.

Care had to be taken, that though the stacking had to secure the components in place, it would be possible for the user to easily detach the components without any extra physical effort from his side. The action of detaching and using the product had to be designed to be as intuitive as possible.

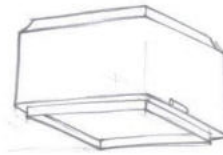


Fig. 110
Details of
stacking

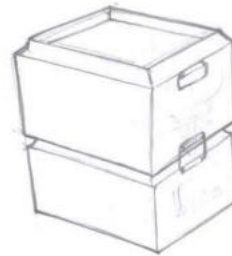


Fig. 111 Strap
allowing free
hands



Fig. 112 Holding
the lower light in
fingers via the
clamp

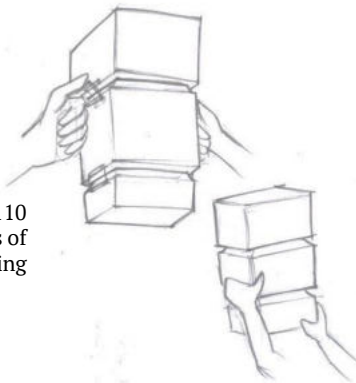


Fig. 113
Activities in
unclamping and
detaching

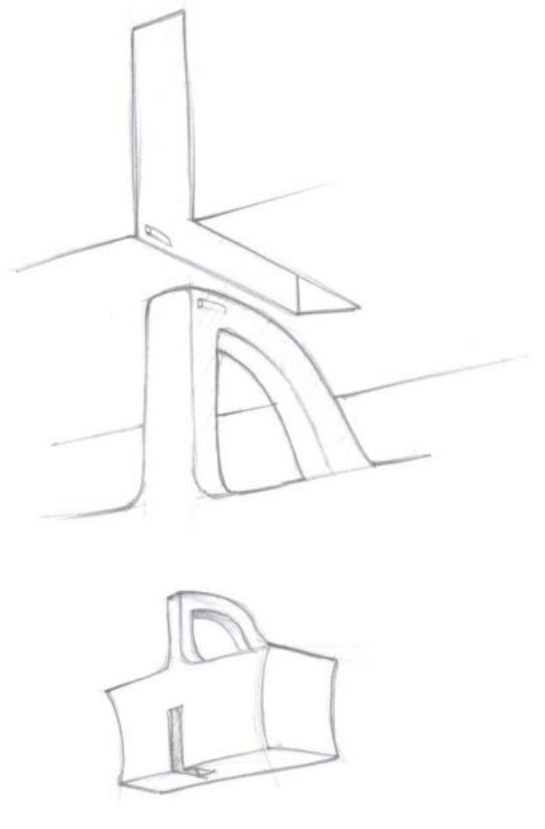


Fig.114 Fin -like locking and stacking: The protruding fin fits into negative space on other component through a press fit. It doubles up as a handle too.

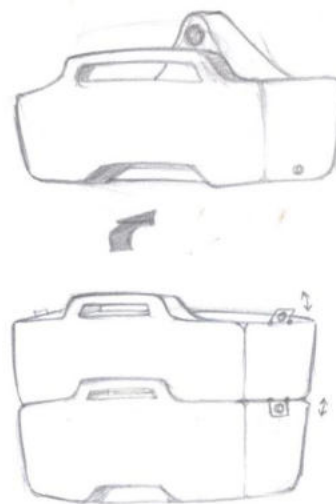


Fig.115 Bucket Form: The handle again doubles up as stacking component fitting into the negative space. The idea is to have a voluminous form which is complete in itself.

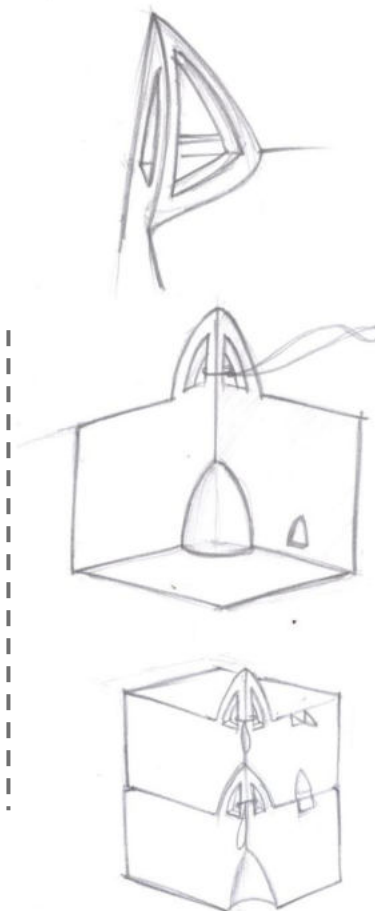


Fig. 116 Diya-like notch for locking and stacking: here, the notch doubles up as a stacking component along with a space to pass holding straps and other accessories

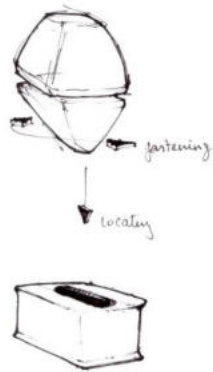


Fig. 117 Locking details of freight container:

This is a world standard for container locking where the male part is guided into its female counterpart and then twisted for locking

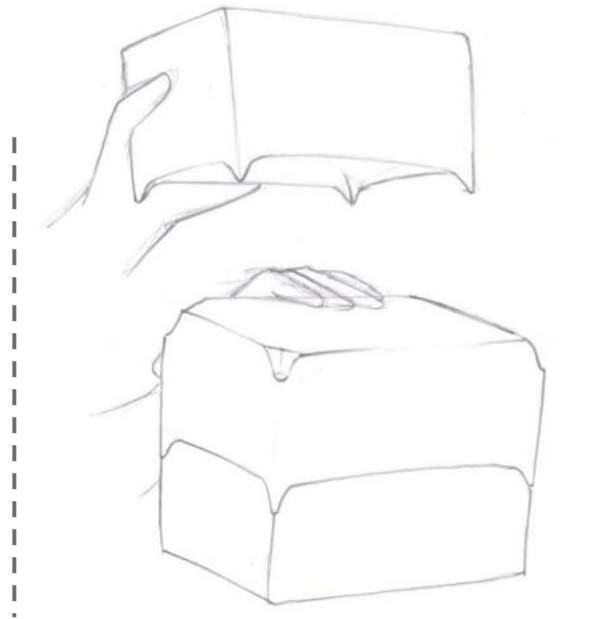


Fig. 118 Container like stacking: here the form is blockish, much like a container where the protruding legs acting as press fits with possible lego block -like locking in the fit cavity

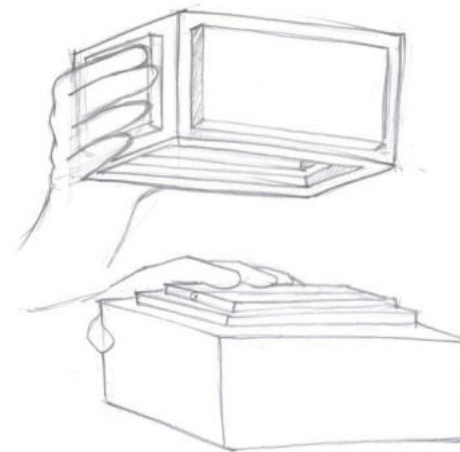


Fig.119 Pyramidal stacking: The stepped features act as fits, with handle incorporated into the handle

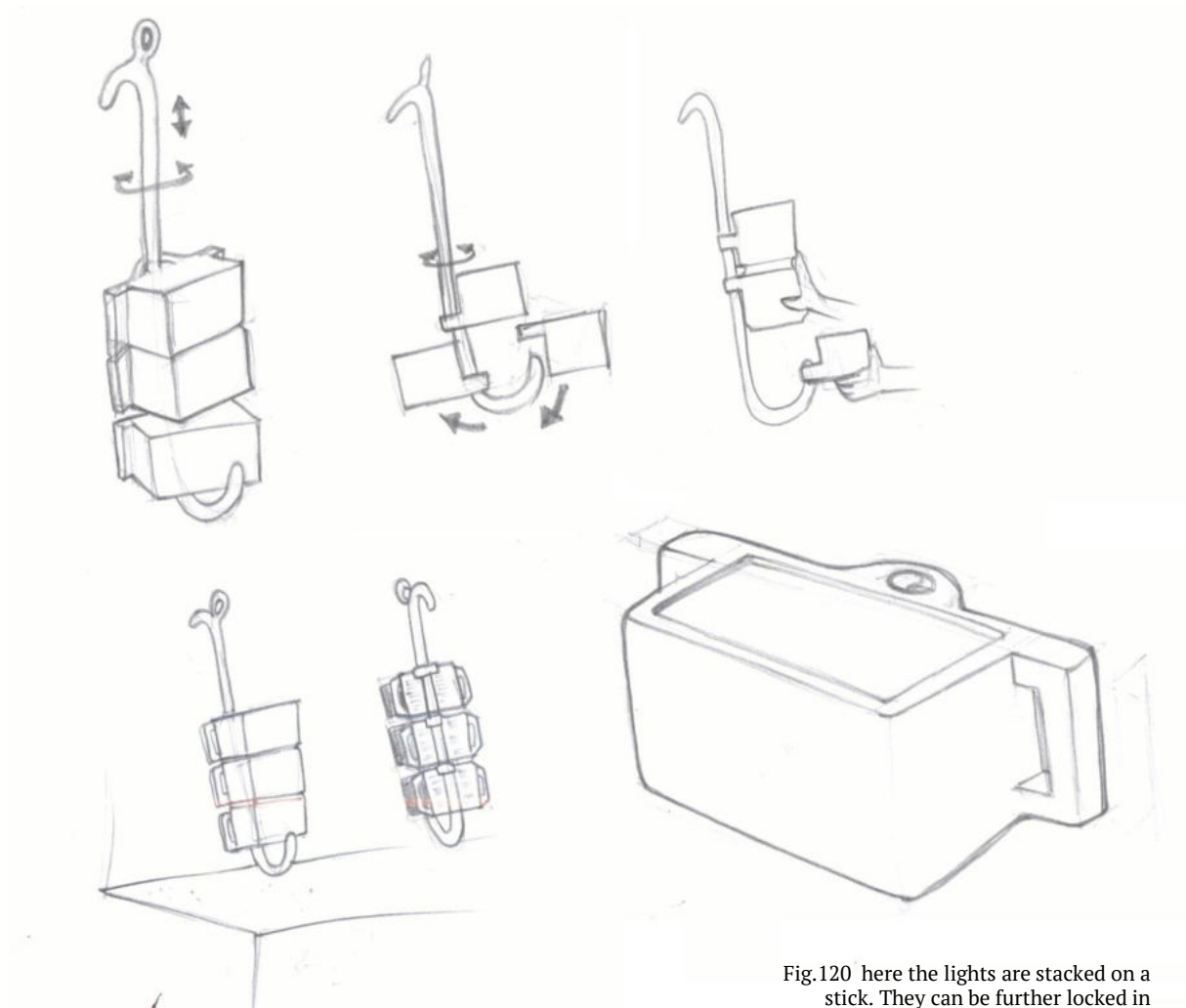


Fig.120 here the lights are stacked on a stick. They can be further locked in position. The handles on both side help interact with each module.

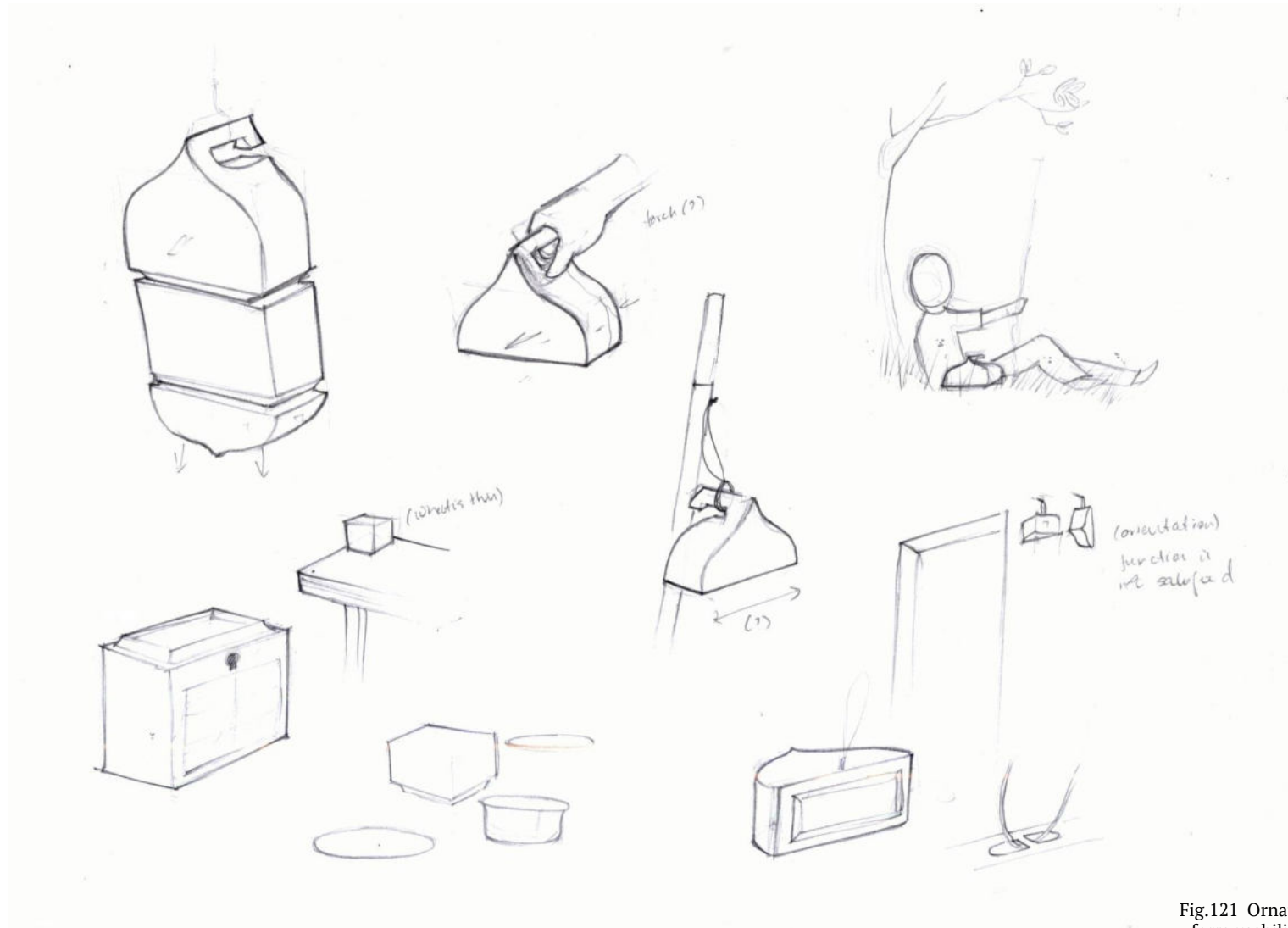


Fig.121 Ornate
form usability
scenario

Courtesy: Author

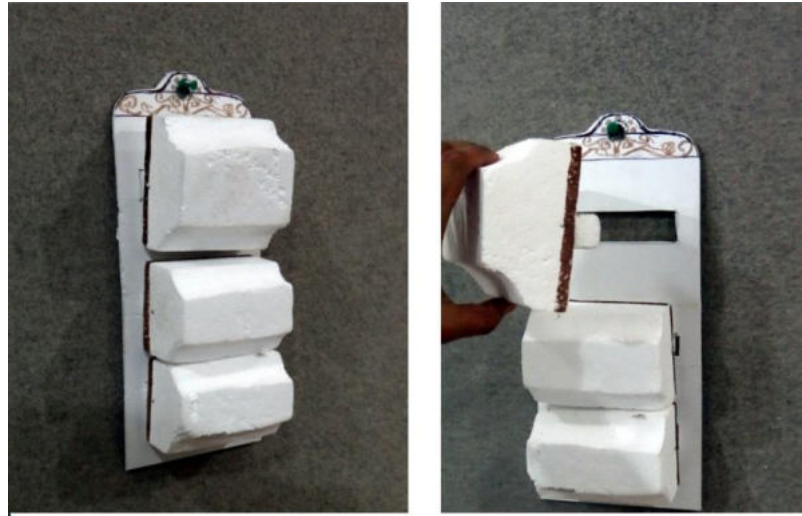


Fig.122 Docked lights and detaching them

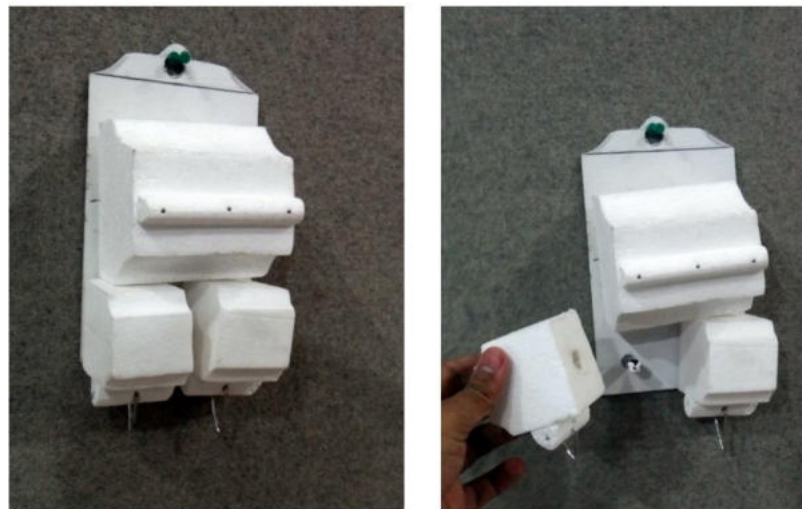


Fig.123 Docked lights with two smaller lights and detaching the smaller light

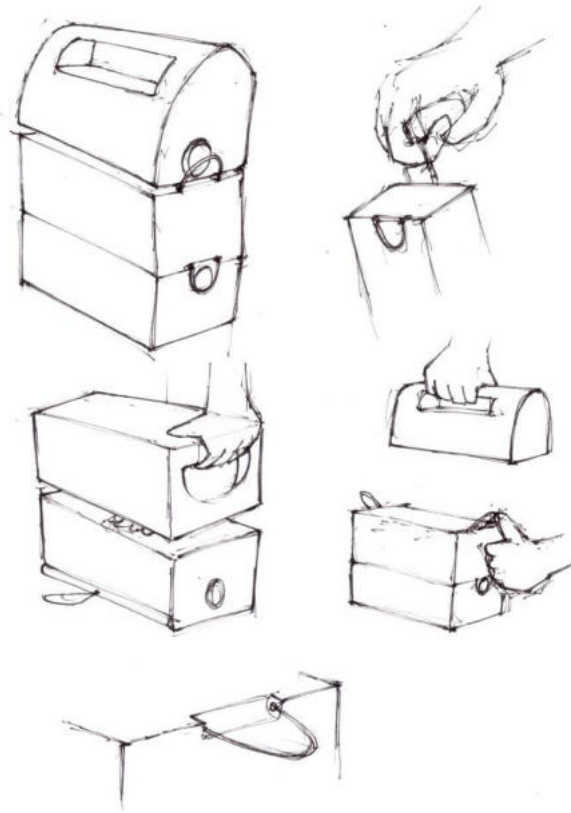


Fig.124 Details of activities in detaching, and holding

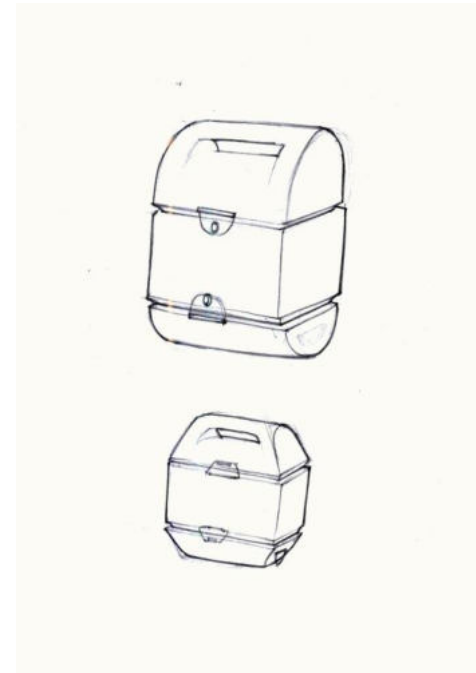


Fig.125 Curved facades

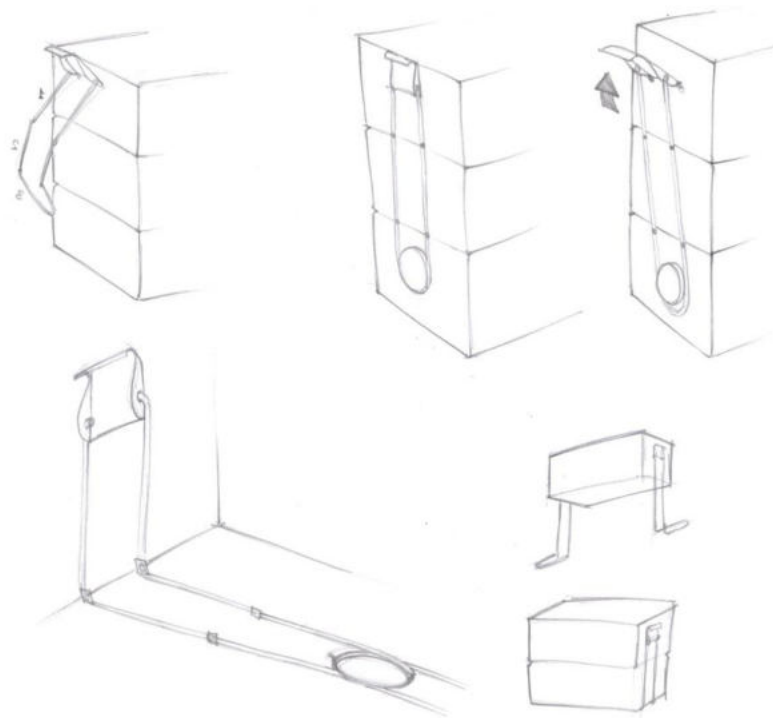


Fig.127 Details of
folding and locking
for metal
clamps

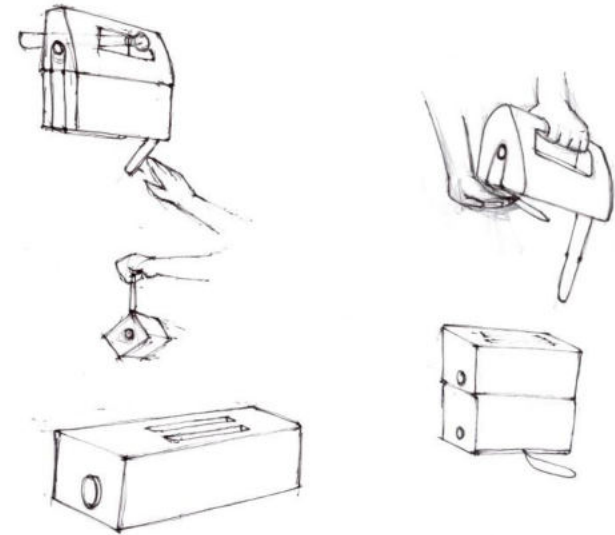


Fig.126 .Activities
to unclamp and fold
metal clamps

Hand Grip length:

	5 th percentile	50 th percentile	95 th percentile
Male	39	50	65
Female	41	50	63
Combined	40	50	64

Hand breadth (with thumb):

	5 th percentile	50 th percentile	95 th percentile
Male	86	99	111
Female	77	86	95
Combined	81	95	109

Hand breadth (without thumb):

	5 th percentile	50 th percentile	95 th percentile
Male	72	81	90
Female	66	71	79
Combined	68	79	90

Fingertip breadth:

	5 th percentile	50 th percentile	95 th percentile
Male	11	13	15
Female	8	10	13
Combined	10	13	15

Data sourced from Indian
anthropometric dimensions for
ergonomic design practice.
Debkumar Chakrabati

10.6 Ergonomics and handling the product:

10.6.1 Ergonomics

Various ergonomic factors too were considered. These dimensions were important to determine the dimensions of parts like handles, width of the frame and the widest light and so on. The dimensions of handle girth, the width of the central light were roughly calculated from this data. The crucial actions considered here were:

- Detaching the torch
- Holding/gripping the torch
- Detaching the central fixture
- Holding the frame against the wall
- Holding the central fixture
- Holding the lower light

These are just some of the actions from a host of other actions that could be performed.

10.6.2 Light

For lighting purposes,

Torch light: 200-400lumens (focussed)

General light: 1500-200 lumens (diffused)

Lower Light: 500-1000 lumens (diffused)

The recommended lighting levels were sourced from IESNA documents.

10.6.3 Handling

The product aims to have visible efforts for affordance. Ideations for the upper torch are aimed to achieve proper grip and ease of carrying around. The light can be carried around while on a cycle or along a stick. This can be made possible by attaching a strap or providing a groove that could hold a ring or a thread. The middle light can be placed on the ground or just switched on while still docked. To be placed on ground, it has to be detached from the dock, hence the dimensions are well within the 95th percentile range. The secondary actions that can be performed by lower light are left open to the user. The clamps at the side can either be used by the user to carry it around for short distances else to hang it. Rural houses have typical wooden knobs called khuntis on which the lower light can be hung. The entire usability has been devised keeping all possible rural scenarios in mind.

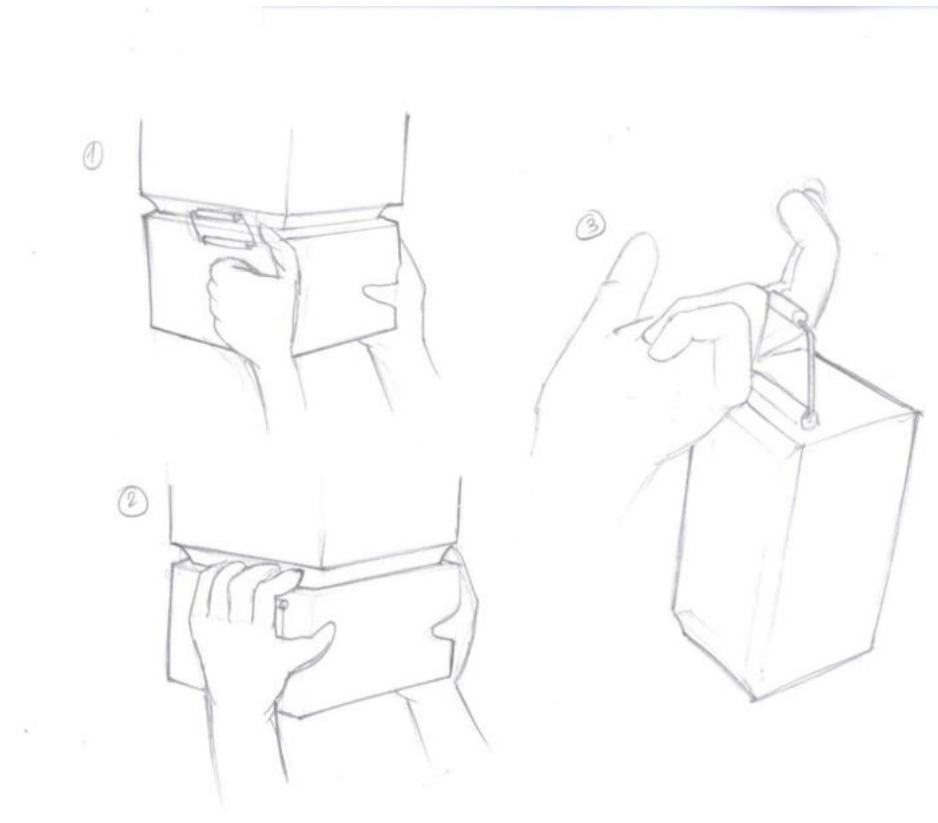


Fig. 128 Typical usage for detaching and holding

10.7 Materials:

Keeping in mind the rugged exteriors and the need for dispersion of maximum light in the desired way, the light diffusers can be of frosted PMMA. The lights cases can be made from polypropylene. An ABS casing could hold the lights in place behind the solar panel.

10.8 Technology:

The solar panel doubles up as a frame and docking panel that holds the components together. Within the solar panel, circuitry is included to charge the battery pack whose capacity is enough to discharge into the three modules. The upper light is a powerful torch. The middle portion is the most powerful one. The lower light is the least powerful light. The electrical charging happens mainly through the central fixture. The mechanical stacking can have points for electrical connections as well. Each of the lights have batteries of their own into which the solar battery pack discharges.

The dimensions of the solar panel and consecutively the frame are dependent on the lights docked in the front. The area in turn decides the charging potential of the battery pack and hence the power emission for the lights. The frame can have possible micro-USB ports or Nokia pins for charging other devices. A low power indicator can show the charge on the solar battery pack. Alternately, these batteries can also be charged via the main power grid.

Smart circuitry within the central fixture can help track which light is in place and which is not. Accordingly it can divert charge to the modules which are docked.

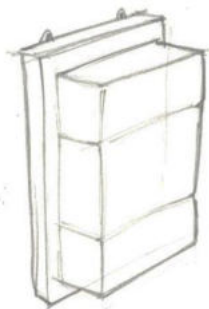
Further, to allow fail-safe operations, the charging of three lights can be routed through three separate wires from inside the central light. Thus even if one light malfunctions, the remaining two can still function. Since the lights cannot be charged unless docked on the possibly proprietary contact charging points, it discourages theft of any light.

10.8.1 Charging:

The solar panel has to be placed outdoors for charging. They typical usage would be as follows:

- Detach the product from the wall
- Un-dock the central light from the panel, all the lights get un-docked.
- Hang the lights on the wall using the holes provided at the back of the central light
- Place the solar panel outdoors for charging
- After charging for sufficient time, bring the panel indoors, un-dock the lights from the wall, attach the lights onto the panel and hang the frame on the wall again.

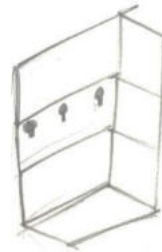
While charging outdoors, the solar panel's primary battery pack gets charged. Then it is brought inside and hung, with solar panel facing the wall. When the lights are docked onto it indoors, it continuously discharges into the respective cells of the batteries. This eliminates any sort of external wiring and removes any extra component.



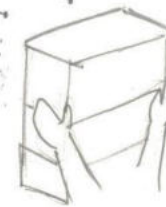
(i) The lights docked on the panel



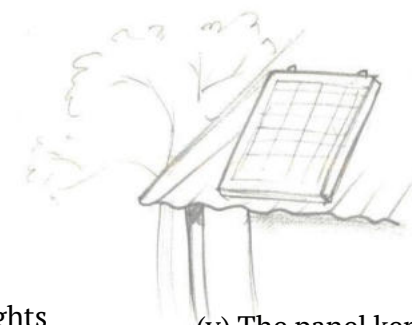
(ii) The lights being un-docked from the panel



(iii) The details on the backside with holes for the nails to be hung on the wall



(iv) The lights being hung on the wall



(v) The panel kept outdoors for hanging

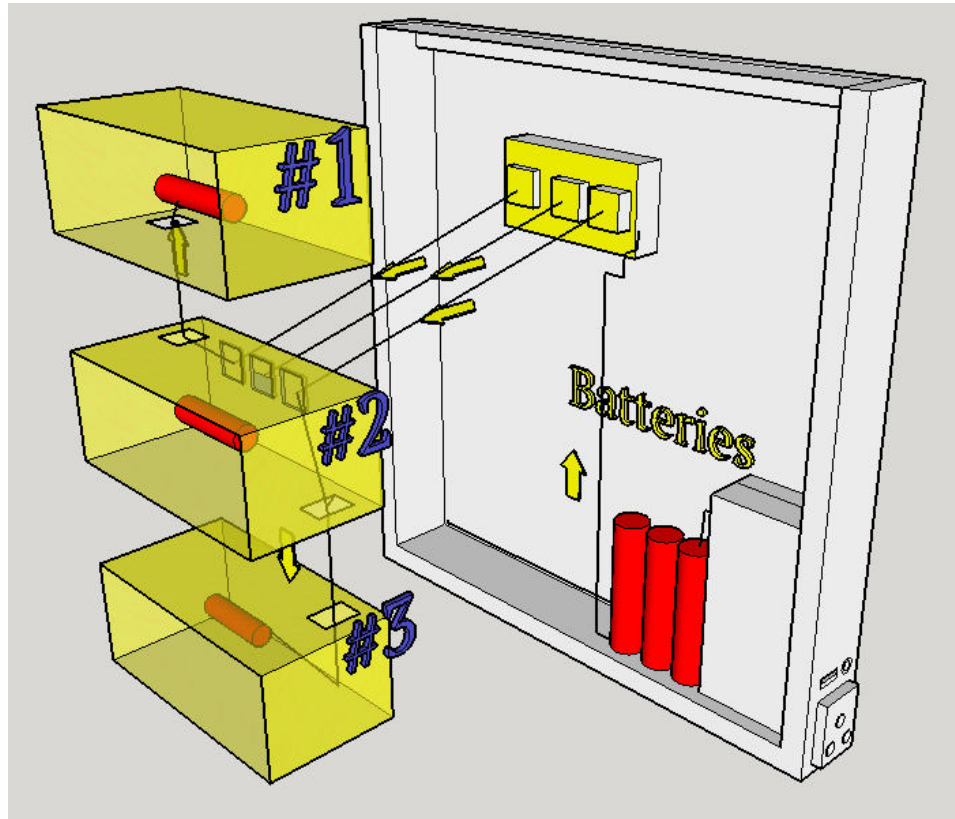


Fig.129 Schematics 1

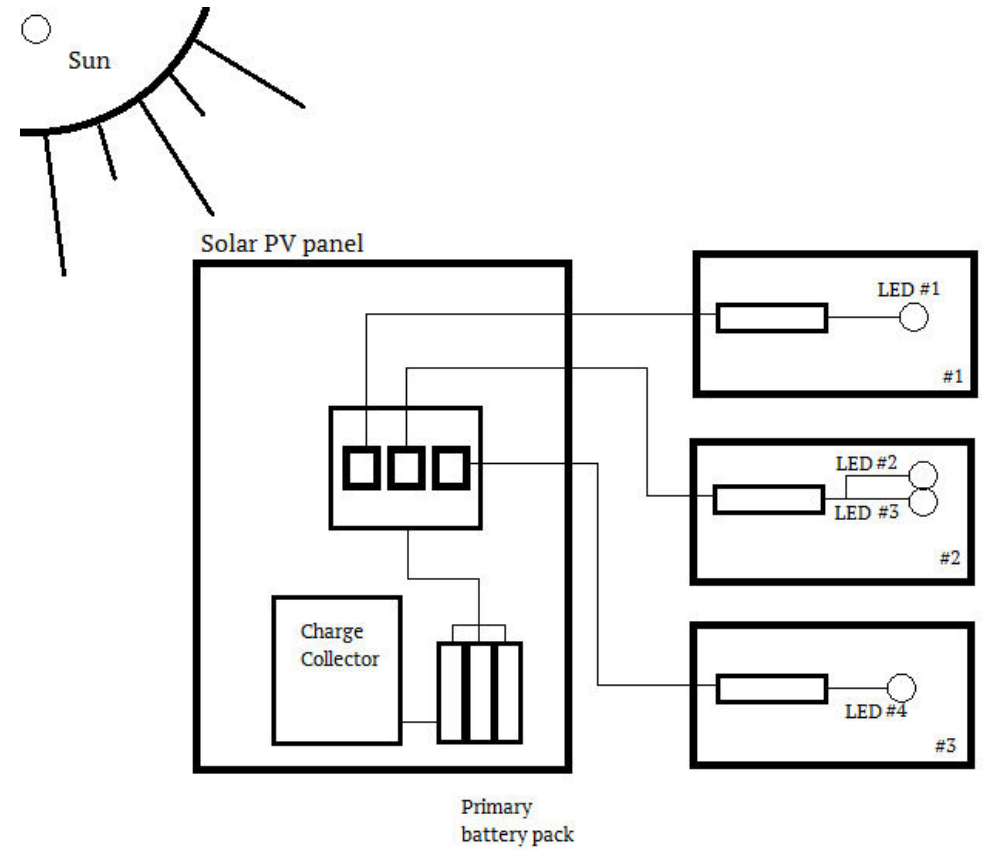


Fig.130 Schematics 2

10.9 Look and feel:

Since the setting was rural India, the product had to go beyond being just durable and rugged. The rural-ness had to be visible in all elements. Now, rural-ness is not about medieval elements. Again, though the components serve three distinct functions in rural scenario, they have to be unified in terms of their visuals, so be it proportions, the patterns, etc. There has to be a sense of continuity to form and overlaid elements that visually integrate the components. One cannot make just the central part rich in terms of formal elements, features and keep the others neutral, or purely functional (unless properly justified). One cannot make the upper part strong and others weak. This would make the product look clumsy when brought together. Uneven addition of formal and functional elements would also make the product appear gimmicky, a 'me-too' product in an already saturated market.

The selection of visual elements has also to be done sensitively. Much like the walls of houses in Bhuj, the surfaces have to be adorned with formal elements that enhance the products appeal and ups its aspirational value. A product that would grace the houses of the poorest and yet not compromise on the Indian-ness. The inherent essence of Indian-ness comes from folk-art, tribal art. Rural-ness especially doesn't arise out of simply medieval inspired features.

However there are some forms, patterns that endure. Islamic patterns are one such example. They endure because they develop not from classical styles of certain periods but out of mathematical perfections and geometrical abstractions[10]. They are fractal in nature, a concept perfected by nature over millions of years and yet recognised and defined by man by as late as 20th century. The jali patterns that adorn Mughal architecture across India form a strong influence. This is obvious because in a land like India, a confluence of philosophies and pluralistic cultures, motifs, symbols, patterns get amalgamated over time. They become a part of the very essence of the country.

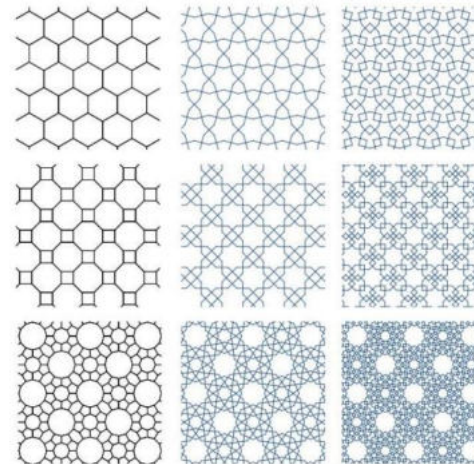


Fig.131 Islamic patterns



Fig.132
Floral
patterns



Fig.133
Architectural
patterns

While we have ornate and intricate Mughal art on one side, we have very articulate and expressive folk arts on the other side. Arts like Gond art, Warli art, Madhubani, etc. They express themselves on vessels, ornaments, walls, clothes, etc. Though these may seem very basic in approach, they have evolved in their own ways over the years. They are formed by beading, paint drops, ground rice paste on mud and other techniques. They use vibrant colors, mirrors, etc. to make it eye catching. But all of this done from locally available materials and tools. Further, since they have been devised in communities closed from rest of the world for the better part of time, they are indigenous in nature.

The challenge is to select appropriate patterns from this wide spectrum and incorporate it within the form. There has to be consistency in selection and imprinting of patterns on the three components. If these elements contribute to the stacking feature physically or visually, it would be an achievement in itself. Further, they help in unifying the three components and integrating the product as a whole. It helps define usage patterns.



Fig. 134 Madhubani patterns

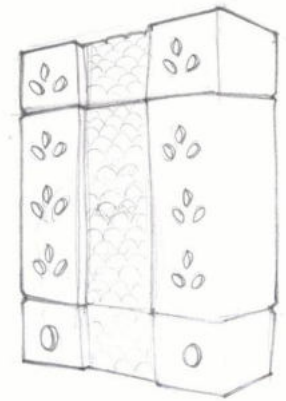


Fig. 135 Floral patterns

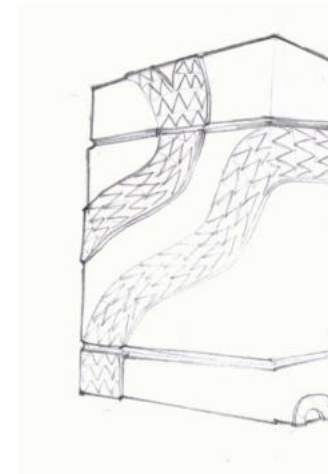


Fig. 136 Serpentine patterns

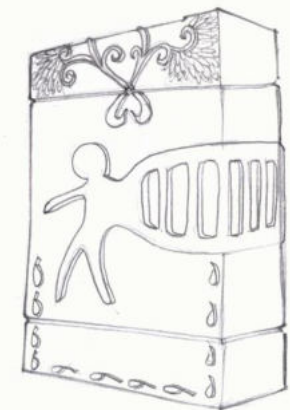


Fig. 137 Bhil art

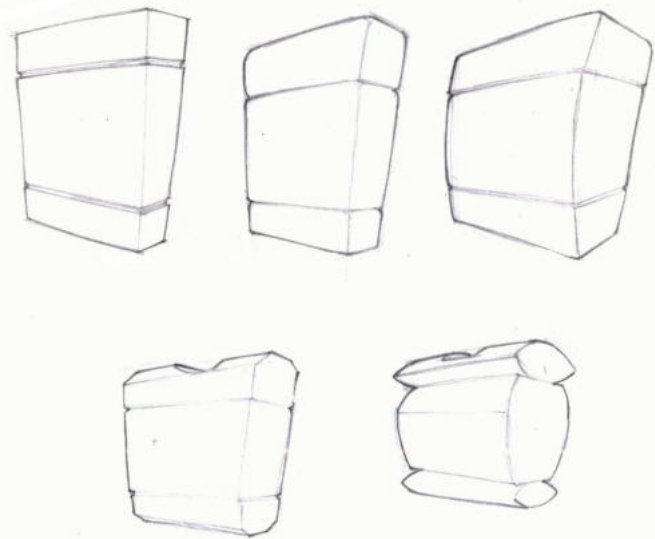


Fig. 138 Form exploration in grids

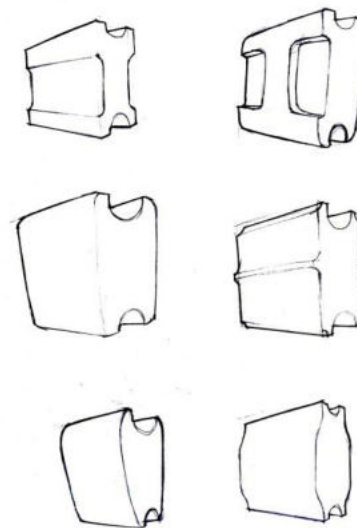


Fig. 139 Form exploration for torch-on-top idea

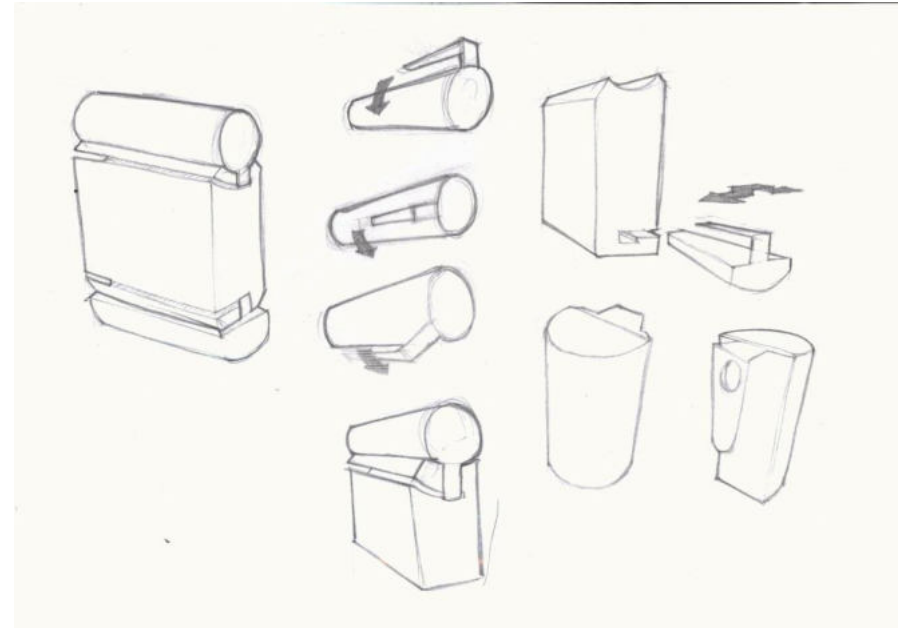
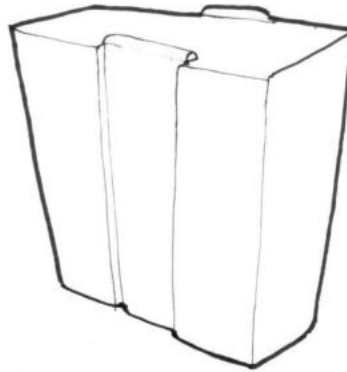
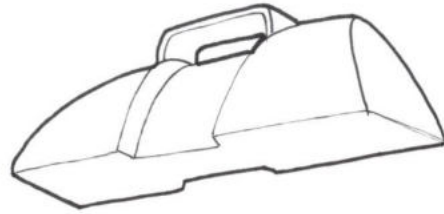
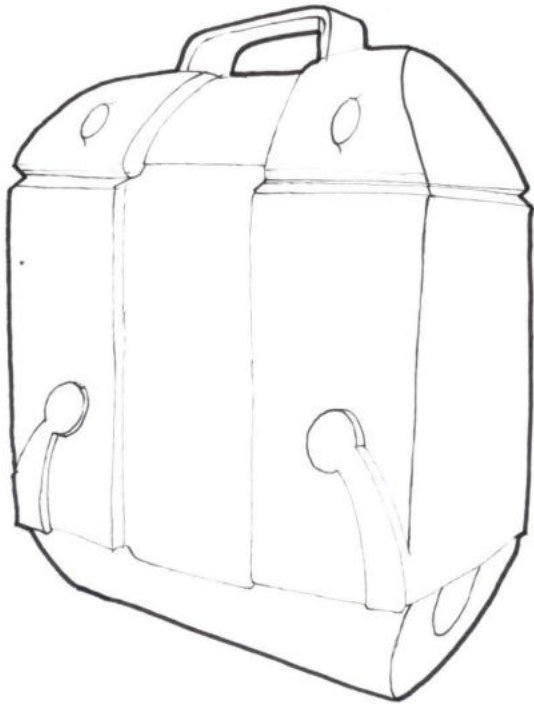


Fig. 140 Ideation with groove to attach torch and lower light

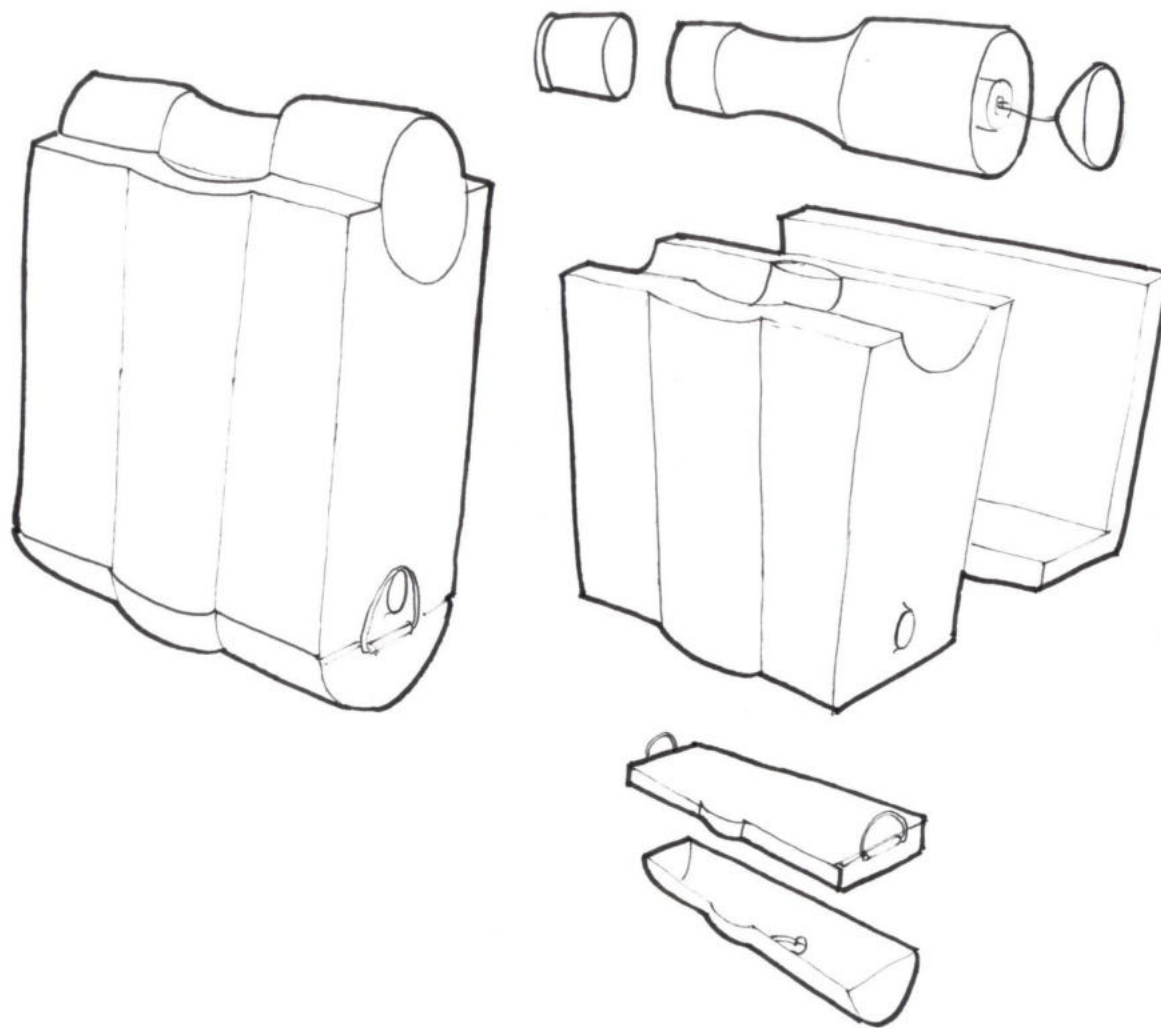
10.10 Final Concepts:



Concept 1:

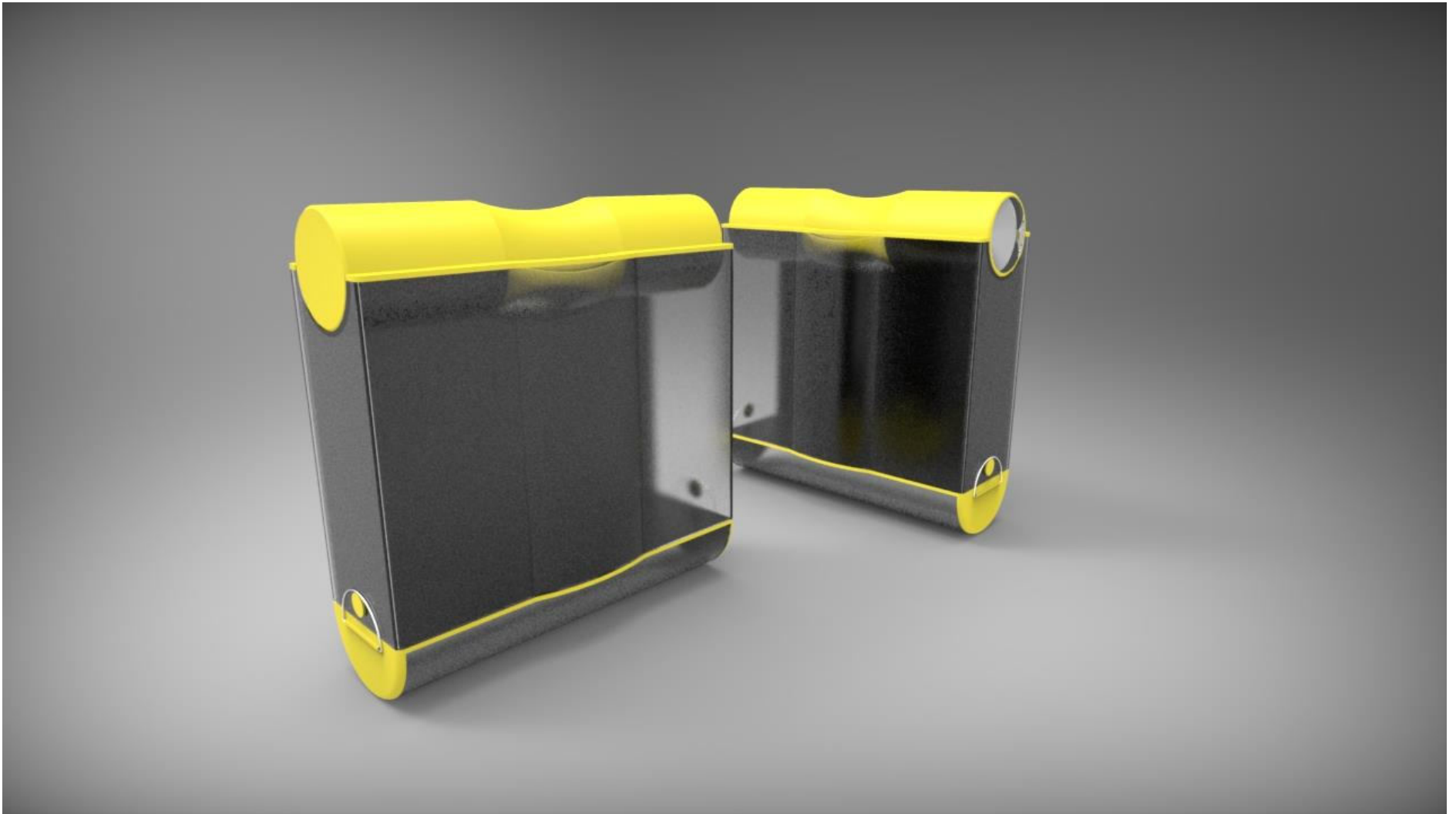
The form gives a dynamic feel, owing to the facets on the sides. The handle offers affordance to the upper torch. Strong edges and distinct surfaces give it a stylish, complete look. The middle light has press fits to accommodate the upper torch. The surfaces can afford to have features from abstract tribal art.

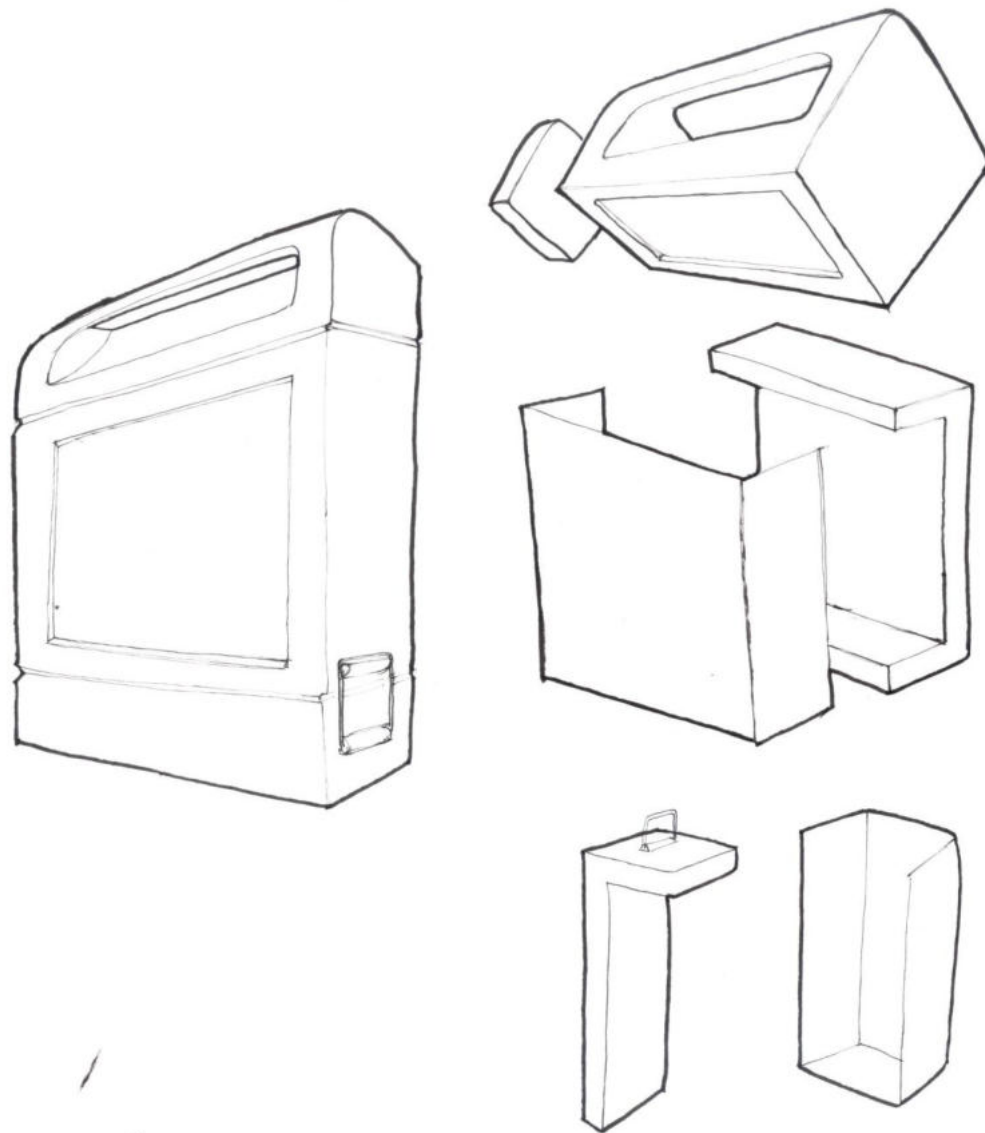




Concept 2:

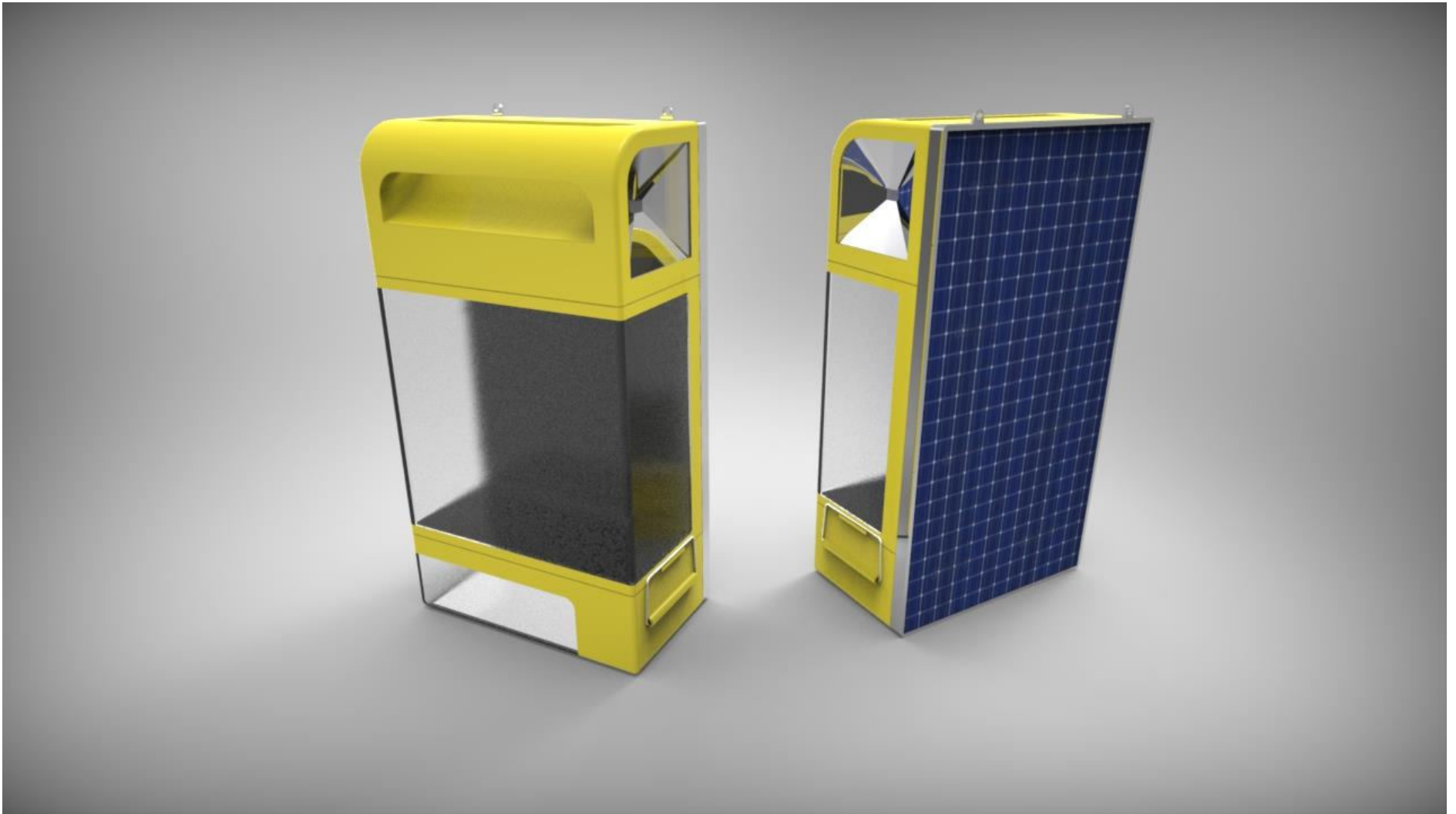
The idea is to have a form that accommodates the lights. The central light has a groove and a bed for the torch to fit into. The theme of curved surfaces is followed throughout the modules. The form gives it a fairly futuristic look.





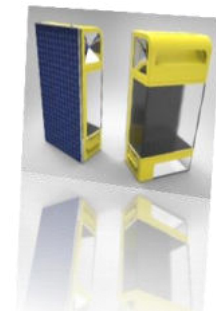
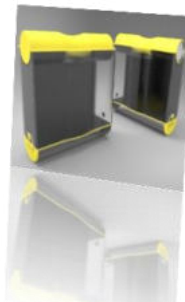
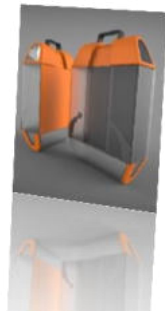
Concept 3:

The form is simple and yet very true to its purpose. It offers great affordance to hold along the handle as well as to simply grasp in the hand. The plain surfaces offer scope for ornamentation and other features.



Concept Evaluation:

Criteria	Concept 1	Concept 2	Concept 3
Size	Moderate	Compact	Big
Manufacturability	Considerably complex	Complex	Simple
Portability	Easy portability	Not easy	Easy portability
Stackability	Good	Very good	Good
Form	Contemporary	Futuristic	Contemporary
Scope for solar power	Moderate	Low	High
Fitting in rural scenario	Yes	Somewhat	yes





Selection of concept:

The concepts were evaluated on various grounds as in their true-ness to the design brief, functionality, usability, etc. Based on these, concept 3 was selected.

Though the product may seem simple, it is an outcome of a long thought process. The entire exercise was to come up with a product that fits into a rural household. Of all the three concepts, I can see this one perfectly going in a rural household.

The scope for designs and ornamentation is good. One can have a range of these products, based on the patterns, which the user can select, thus aiming to satisfy his aspirational needs at no extra costs.

The upper torch offers great affordance to hold in hand as well as to grasp in the hand. The lower light being fairly neutral, can be used in a variety of contexts.

From point of view of manufacturing, this form beats the other concepts downright. Focus can then be laid on simplifying the assembly through press fits and snap fits.

Most importantly, the product gives a feeling of being grounded, a sense of truthfulness to its purpose and its context by eliminating unnecessary features.

11. Detailed Technical Specifications

Power:

Type of solar panel:

Monocrystalline silicon solar panel

Total area available for solar panel:

504sq.cm

Power output for given area:

6W approx.

On average (as a general "rule of thumb") modern photovoltaics (PV) solar panels will produce 8 - 10 watts per square foot of solar panel area

(<http://www.solar-estimate.org/?page=solar-calculations>)

Optional connections:

Charging through main grid

Micro-USB charging

Smart Circuits:

Control charging-discharging

Prevent over-charging

Monitor usage

Lights :

Upper light: 1x 1W

Middle light: 2x 2W

Lower light: 1x 1W

Suggested LEDs:

Cree LEDs (300Lumens/Watt)

Philips LEDs (200Lumens/Watt)

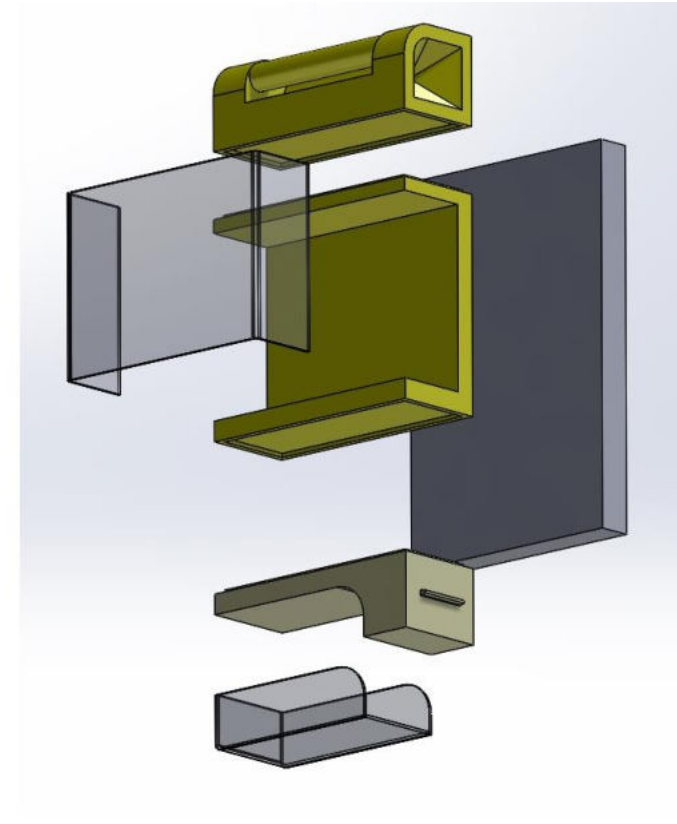
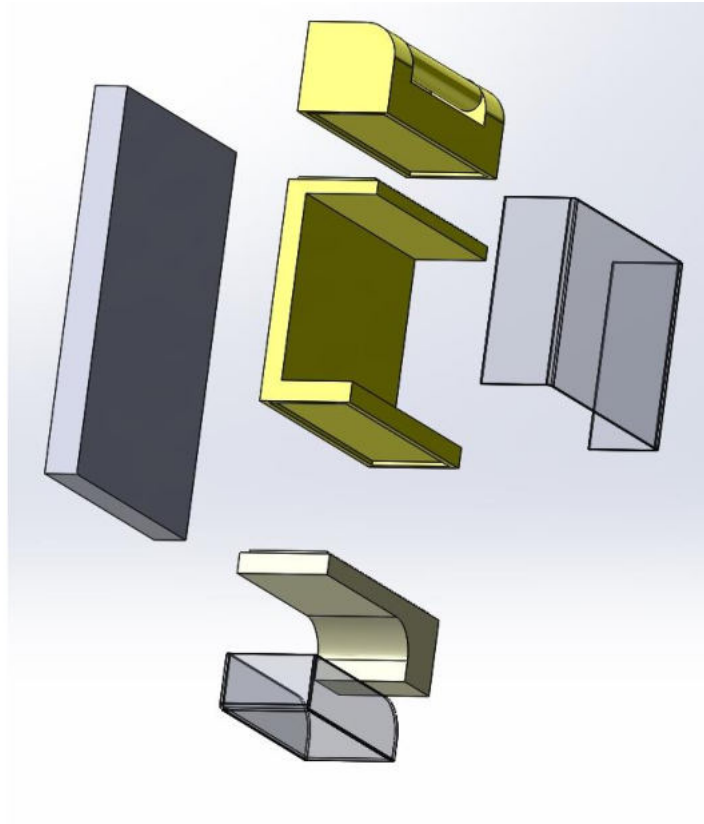
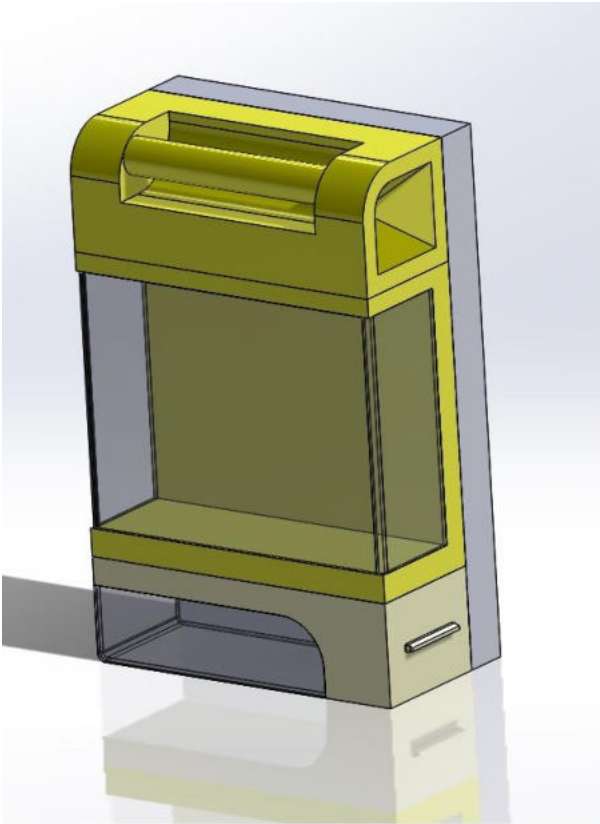
Batteries:

8x 3.6V Lithium ion batteries
 (4 for primary battery pack,
 2 for middle light, 1 each for
 upper torch and lower light)

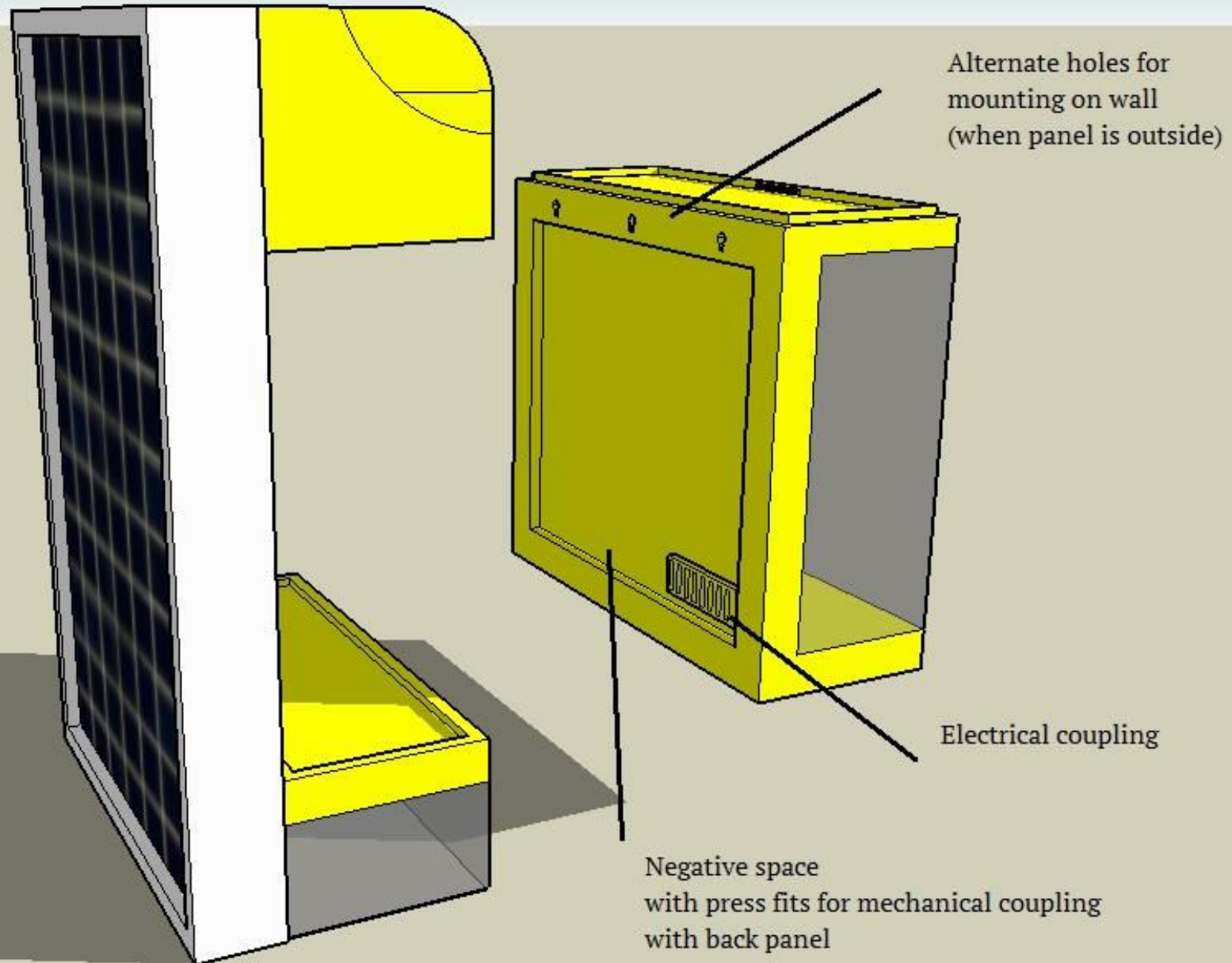
Light	Suggested lumens	Light Temperature
Upper light (torch)	150 (focused light with beam angle upto 30 degrees max.)	4000-5000K
Middle light (general ambient light)	250-300 (diffused light through PMMA sheet with 2mm max. thickness)	1500-2000K
Lower light (secondary ambient light)	150 (diffused light through PMMA sheet with 2mm max. thickness)	1000-2000K

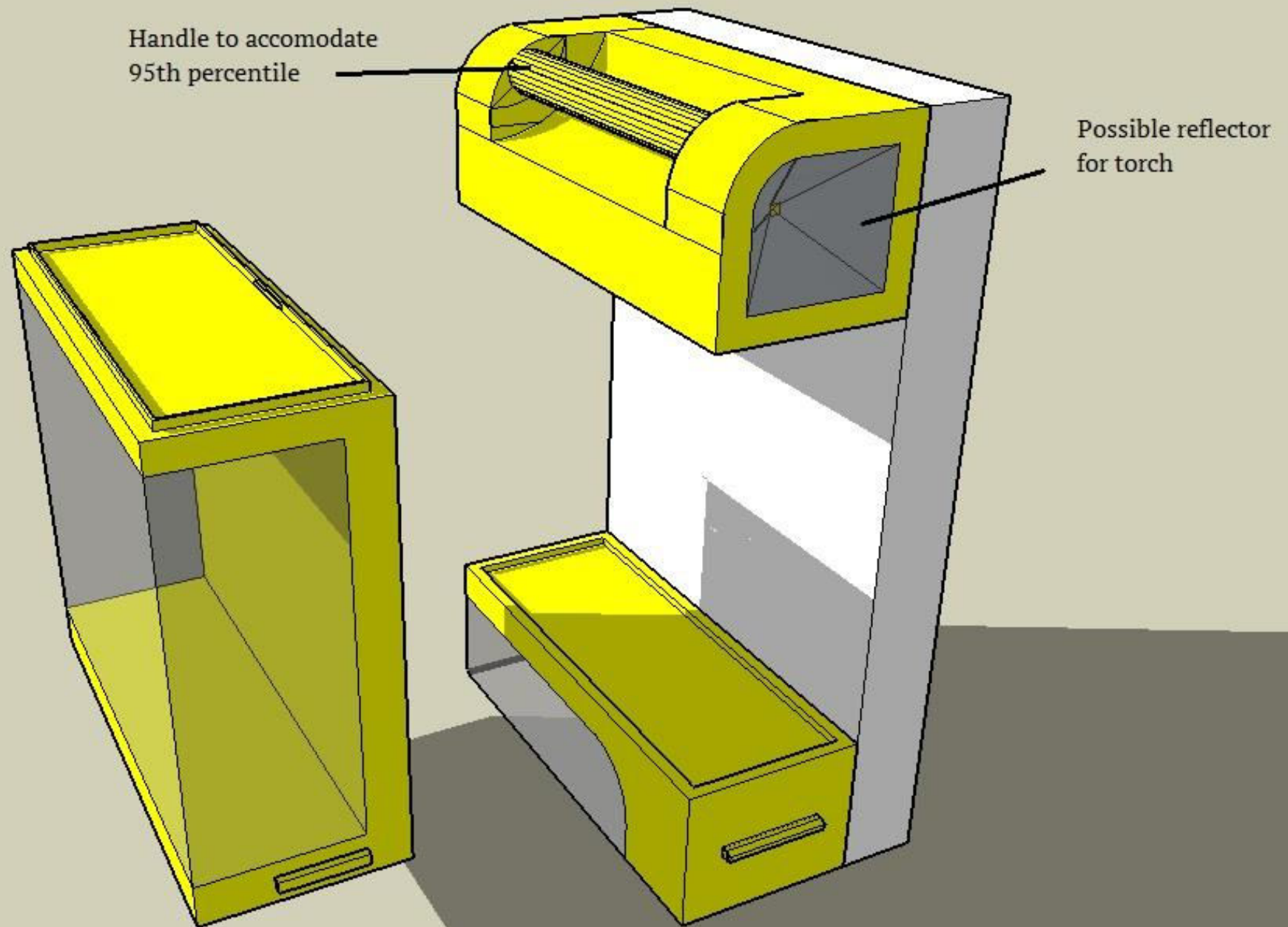
(Further optimisation to reduce costs is possible by reducing wattage of LEDs in middle light by bringing it down to 1W each. This will also help in reducing number of batteries)

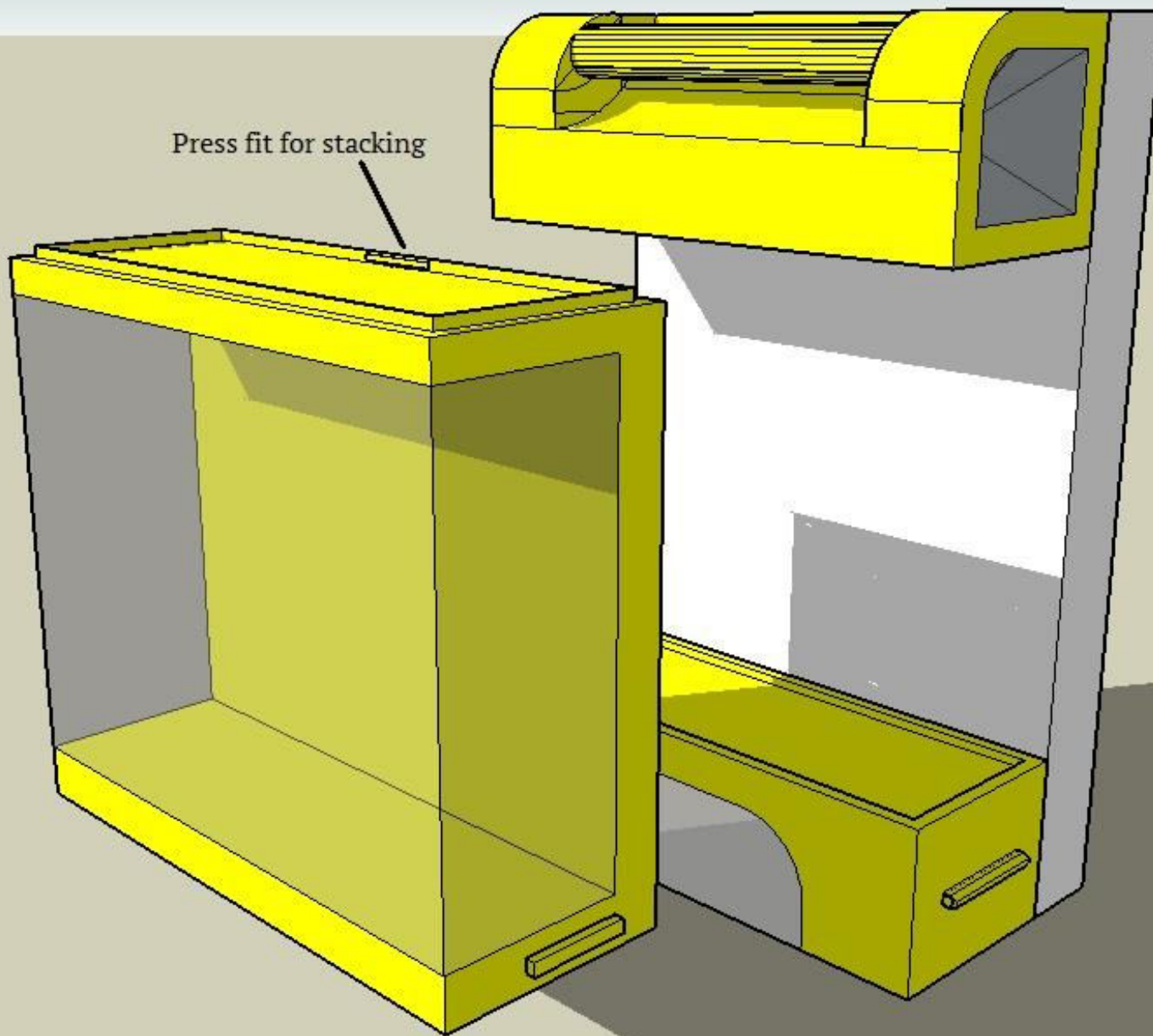
12. Final Models

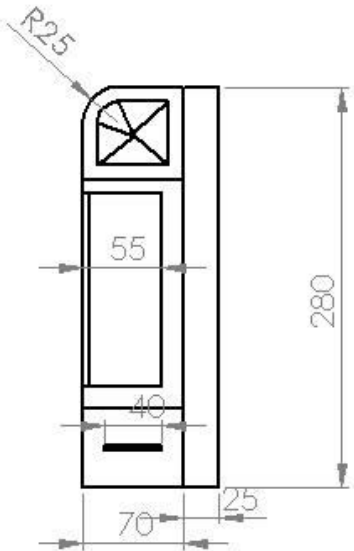
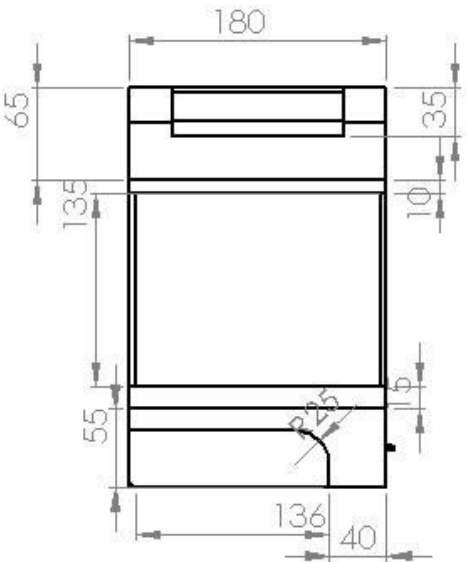


Solidworks models and exploded views









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		ANGULAR: MACH $\pm$ BEND $\pm$		IMFG APPR.			
		TWO PLACE DECIMAL $\pm$		Q.A.		SIZE DWG. NO. REV	
		THREE PLACE DECIMAL $\pm$		COMMENTS:			
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		FINISH					
		DO NOT SCALE DRAWING				SCALE: 1:5 WEIGHT: SHEET 1 OF 1	
NEXT ASSY		USED ON					
APPLICATION							



Final Model

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