G E O L I G H T S

New Dimension of Applied Photovoltaics

By **Kiran G,** M.Des

Under supervision of **Prof. Avinash Shende**

Department of Design

Indian Institute of Technology Guwahati

Guwahati, Assam -781039

Abstract

Although the crisis of renewable energy is rising every minute and the whole world especially developed countries are focusing this issue. However Asian countries are going to be the most contributing countries to this problem. The project deals with the use of sunlight as a design tool that was followed up from research into 'Geo Lights'. The sunlight could inspire and produce design by playing with geometrical patterns. Here you are at the mercy of nature, as you have to wait for the sun to shine and the angle and strength of the light constantly changes, creating unusual and unexpected results.

This Project deals with the playful and creative action with photovoltaic technologies and introduced to the concept of patterning with electrical energy by using sunlight as the primary energy source. Moreover pattern is embedded everywhere around us physically, it is a word used in many contexts, from aesthetic patterns to relationship patterns, sociological patterns, mathematics, computers, processing, and science...

This project ends with the number of exciting approaches towards capturing energy.

1. Introduction

1.1. Theme

The Changing Face of Design

As the first decade of the new millennium reaches its end, nobody can anymore disagree with the view that green design is one of the most important, if not the most important, design issues. Policy makers and scientists, governments and NGOs, media and ordinary people; they all seem to remind us every day that what used to be just a problem a few years ago has now become a major crisis. And what is even more worrying, those with a certain degree of expertise warn us that the future looks even less bright than the present.

Design has unfortunately played a significant part in creating and sustaining this crisis. Almost three quarters of the environmental impact of the objects consumed everyday is determined at the design stage, and the ways in which designers have treated the world so far, still force people to waste stupendous qualities of energy and matter. Yet, at the same time, a section of design has also been trying to become a part of the solution of this crisis, for numerous strategies are now being used in the design and development of products in order to improve their existence. One material can think of the use of recycled, recyclable, renewable, biodegradable and low embodied energy materials; of modularization, weight reduction, efficient processes, minimization of composite parts, maximum efficiency, simplification, durability, remanufacture, ease of disassembly, and reduction of consumables and so on.

This unavoidable plethora of design methods, however, while being highly valid and increasingly important is evidence of the existence of a new scenario where design, in order to be really *GREEN,* tends to rely heavily on technical or technological standards, rules and principles. And this situation actually represents a second crisis that design might have to face in the near future, because what will be asked for it will no longer be just a matter of becoming sustainable but also, and may be even more importantly, a matter of simultaneously finding an alternative course to follow; one that will eventually permit designers to avoid the path of strict technological innovation, where their role will be reduced to that of producing visually interesting, or simply pleasing forms.

It is through a better understanding of these two crises, and their interaction, that this specific matter will start form, leading to a new proposal about the relationship between green energy and the design of objects. In order to do that however, it will need to accept that there is still an unchartered territory that needs to be explored, and a group of issues that designers have yet to fully address, the most crucial of which is the possible existence of ways in which objects can create highly rewarding experiences for the individuals who use them, while at the same time achieving a high degree of sustainability.

“Thought By Mr. Avinash Shinde
Assistant Professor
Department of Design
IIT Guwahati, Assam

1.2. Design for People

Design is not serving the needs and dreams of everyday people today. But new design spaces are emerging that provide them the means with which to balance consumptive and creative experience. In the near future, designers will learn to use their own creativity to amplify the creativity of everyday people

It has become increasingly evident that they are no longer satisfied with simply being “consumers.” Everyday people want to be “creators” as well.

Ivan Illich, a radical theorist of the 1970’s said, “People need not only to obtain things, they need above all the freedom to make things among which they can live, to give shape to them according to their own tastes, and to put them to use in caring for and about others”

1.5. Changing Roles of Design

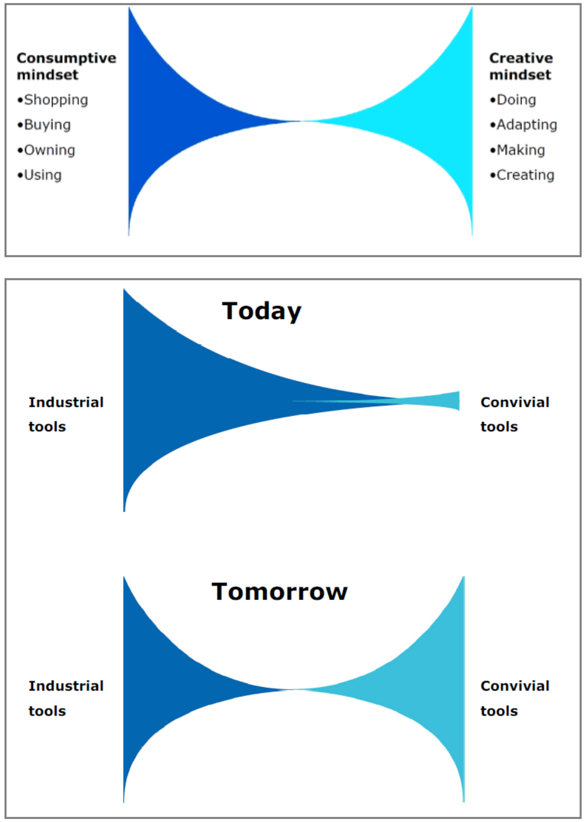

Fig: 1.5.1 Industrial tools/Convival tools

"Convivial tools allow users to invest the world with their meaning, to enrich the environment with the fruits of their visions and to use them for the accomplishment of a purpose they have chosen. Industrial tools deny this possibility to those who use them and they allow their designers to determine the meaning and expectations of others"

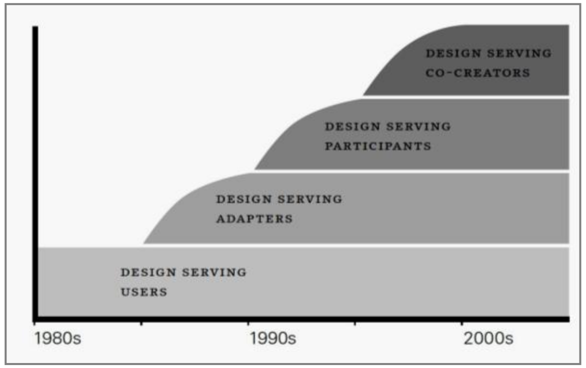

Fig: 1.5.2 Graphical representation on design serving

Are we losing control of the design process?

Yes, we are losing control of the traditional design process, but we are at the same time opening it up to others. We are entering new design spaces where we let go of our control in order to amplify the creativity of other people.

Making

To make something with my own hands.
Genuine interest.
Domain experience.

Fig: 1.4.5 Making Pastries

Fig: 1.4.6 Kids making Eiffel tower

Creating

Most advanced level of creativity is **creating.**

Passion, Domain expertise.

Fig: 1.4.7 Making Cakes

1.4. Everyday creativity

At least four levels of creativity that everyday people seek.
We need to help them balance consumptive with creative experience.We need Co-designing.

People are Creative
Some innovate while exercising.
Making Scrapbooks

Fig: 1.4.1 innovating while exercising

Fig: 1.4.2 Making Scrap books

Doing

The most basic level of creativity is **Doing!**
The roles people play are changing

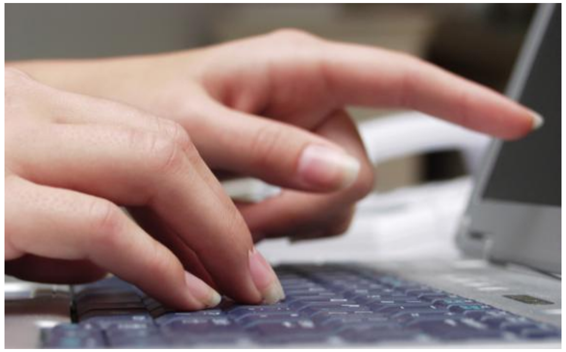

Fig: 1.4.3 Computer Gaming

Adapting

To make something on your own.
Some interest.
Some domain expertise.
Adding an extra Ingredient.

Fig: 1.4.4 Adding extra ingredient

2. Literature Review

2.1. Solar Energy

Solar Energy: The Ultimate Renewable Resource

Energy reaching the earth is incredible. By one calculation, 30 days of sunshine striking the Earth have the energy equivalent of the total of all the planet's fossil fuels, both used and unused.

The surface receives about 47% of the total solar energy that reaches the Earth. Only this amount is usable.

The earth receives more energy from the sun in just one hour than the world uses in a whole year.

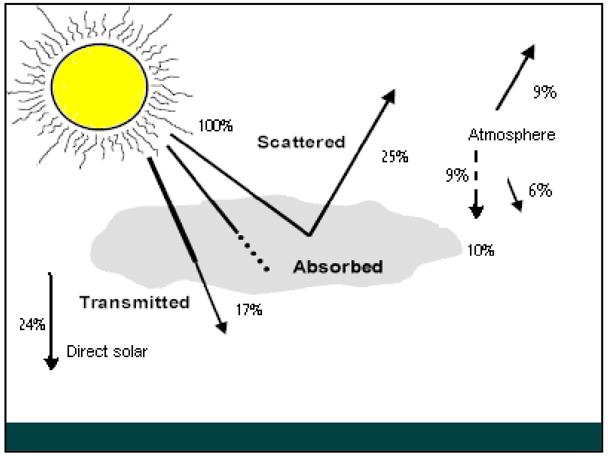

Fig: 2.1.2 solar energy observation

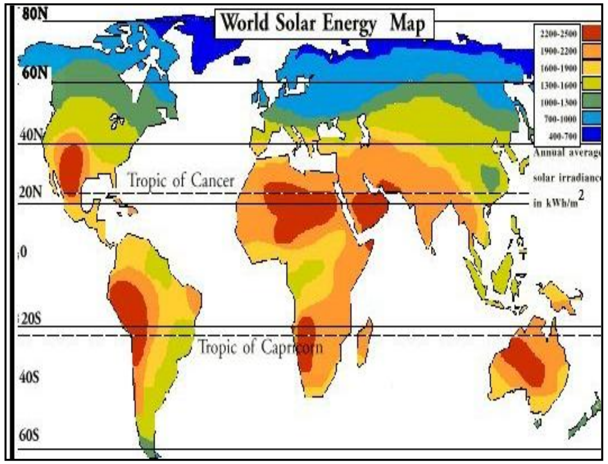

Fig: 2.1.1 World solar energy map

2.2. Photovoltaics

Photovoltaic's (PV) is the direct conversion of light into electricity at the atomic level. The word refers both to the science and the technology, which are based on **the photovoltaic effect**: *the generation of a voltage and/or a current, by absorption of light in some material or a combination of materials.*

Electricity that can be used for immediate power -Direct PV Systems- or delayed, with the help of storage technologies. In PV these elements are interconnected by various sciences: (quantum) physics, optics, (bio-) chemistry, engineering, materials science and micro-electronics.

The photovoltaic effect is first observed in 1839 by A.E. Becquerel, a French physicist. The first functional, intentionally made PV device is from American inventor Charles Fritts in 1883 with an efficiency of 0,1 percent. The modern era of PV starts in 1954 when **Bell Labs** in the USA produces a 6 percent efficient solar cell using silicon as a semiconductor. Five years later the Sputnik 3 is the first satellite using solar arrays, followed by Vanguard I for powering a small radio transistor. A major visual proof for the world that the Sun's energy can be harvested to generate electrical energy.

"Light - a mysterious element that enables people to command nature." *Sir Francis Bacon*, *New Atlantis (1627)* Radiant energy, in the form of photons. In the 21st century, supportive government policies in many European countries and Japan, -partly driven by the Kyoto Protocol,

Climate change and especially the steep rise of oil prices in 2007/08- result in a substantial increase in production. Radiant energy, in the form of photons. In the 21st century, supportive government policies in many European countries and Japan, -partly driven by the Kyoto Protocol, Climate change and especially the steep rise of oil prices in 2007/08- result in a substantial increase in production. Most of the big manufacturers are either divisions or subsidiaries of large companies with diverse manufacturing interests (Sharp/BP/Shell/Kyocera). Most of the research for advanced future technologies takes place in academic and privately owned research centers.

The role of PV-power in the world's overall energy system is still negligible -less than 0.5 percent- with predictions by the industries and environmental organizations that it could raise to 26% by 2040.

The environmental impact of PV is probably lower than that of any other renewable or non-renewable electricity generating system." - IEMC Research Center – Leuven [BE]

Is photovoltaic different than other solar energy conversion technologies?

There are a variety of ways to convert sunlight into useful energy. One method used for many centuries is to convert sunlight into heat, which can then be used for building heating or water heating. Two common examples of solar energy into heat are solar pool heating and solar water heaters. There are also two ways to convert sunlight into electricity. One is solar thermal electricity generation, which uses much of the technology from conventional utility electricity generation. In most utility electricity generation, heat is generated by burning a fuel such as coal or by a nuclear reaction, and this heat is turned into electricity. In solar thermal generating systems, the heat is created by focusing sunlight onto a spot rather than burning fuels, but the remainder of the electricity generation process is the same as conventional utility generation.

Photovoltaic's is another mechanism for converting sunlight into electricity. Photovoltaic's, (also called solar electricity, solar batteries or solar cells) are fundamentally different in that they convert sunlight directly into electricity without intermediate steps.

Advantages and Disadvantages of Photovoltaic's

Photovoltaic systems have many advantages. In many types of applications, PV systems have several important ***technical*** advantages that make them the best choice for electricity generation. PV panels are extremely reliable and require low maintenance, they can operate for long periods unattended, they are suitable for both large and small loads and additional generating capacity can be readily added. These characteristics make photovoltaic's an ideal technical choice for both remote power and remote residential electricity applications. For such remote applications, a PV-based System is also usually the lowest cost system. There are a number of additional technical advantages, such as the distributed nature of PV power production and the low lead times to installation, which may be beneficial in grid connected installations. In addition to its technical advantages, photovoltaic's electricity generation is also environmentally benign, with arguably the lowest environmental impact of any of the electricity generating technologies.

The key disadvantage of photovoltaic's is its relatively high cost compared to many other large-scale electricity generating sources. This disadvantage applies mainly to the use of PV for applications that are already tied to the electricity grid. Another disadvantage is that the power density of sunlight is relatively low. This means PV tends to be less suited to applications that are physically small compared to the amount of power they require. This affects primarily transport applications. Although solar cars, solar trains, solar planes and solar boats have all been made and used, in general these applications are difficult for PV or other solar-based systems.

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2.2.1 Working of Solar cells

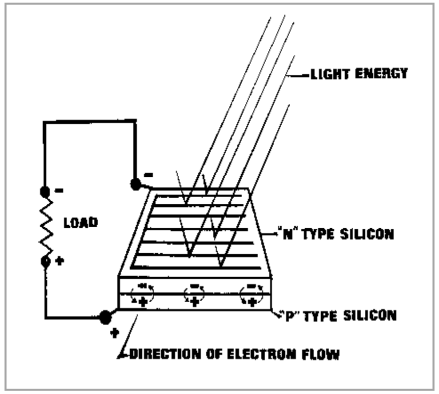

Fig: 2.2.1 working of solar cells

Solar cells (or photovoltaic devices) directly convert light into electricity, and usually use similar physics and technology as that used by the microelectronics industry to make computer chips. The first step in the conversion of sunlight into electricity is that light must be absorbed in the solar cell. The absorbed light causes electrons in the material to increase in energy, at the same time making them free to move around in the material. However, the electrons remain at this higher energy for only a short time before returning to their original lower energy position. To collect the carriers before they lose the energy gained from the light, a *pn* junction is typically used.

A pn junction consists of two different regions of a semiconductor material (usually silicon), with one side called the p type region and the other the n-type region. In p-type material, electrons can grain energy when exposed to light but also readily return to their original low energy position. However, if they move into the n-type region, then they can no longer go back to their original low energy position and remain at a higher energy.

The process of moving a light generated carrier from where it was originally generated to the other side of the pn junction where it retains its higher energy is called collection.

Once a light generated carrier is collected, it can be either extracted from the device to give a current, or it can remain in the device and gives rise to a voltage. The generation of a voltage due to the light generated carriers is called the Photovoltaic effect. Typically, some of the light generated carries are used to give a current, while others are used to create a voltage. Electron absorbs light and gains energy, the electron is collected by the pn junction, it leaves the device to dissipate its energy in a load, and then re-enters the solar cell.

The combination of a current and voltage give rise to a power output from the solar cell. The electrons that leave the solar cell as current give up their energy to whatever is connected to the solar cell and then re-enter the solar (in the n-type region) at their original low energy level. Once back in the solar cell, the process begins again: an electron absorbs light and gains energy, the electron is collected by the pn junction, it leaves the device to dissipate its energy in a load, and then re-enters the solar cell.

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2.2.2 Different Solar Technologies

Solar cell technologies differ from one another based firstly on the material used to make the solar cell and secondly based on the processing technology used to fabricate the solar cells. The material used to make the solar cell determines the basic properties of the solar cell, including the typical range of efficiencies.

Most commercial solar cells for use in terrestrial applications (i.e., for use on earth) are made from **wafers of silicon**. Silicon wafer solar cells account for about 85% of the photovoltaic market. Silicon is a semiconductor used extensively to make computer chips. The silicon wafers can either consist of one large singe crystal, in which case they called single crystalline wafers, or can consist of multiple crystals in a singe wafer, in which case they are called **multicrystalline silicon wafers**. **Single crystalline wafers** will in general have a higher efficiency than multicrystalline wafers.

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Silicon wafers used in commercial production allow power conversion efficiencies of close to 20%, although the fabrication technologies at present limit them to about 17 to 18%. Multicrystalline silicon wafers allow power conversion efficiencies of up to 17%, with present fabrication achieving between 13 to 15%.The efficiency achieved by a solar cell depends on the processing technology used to make the solar cell. The most commonly used technology to make wafer-based silicon solar cells is screen-printed technology, which achieves efficiencies of 11-15%. Higher efficiency technologies are the buried contact or buried grid technology, which achieves efficiencies op up to 18% and has been in production for about a decade.

Although silicon solar cells are the dominant material, some applications – particularly space applications – require higher efficiency than is possible from silicon or other solar cell technologies. Solar cells made from GaAs or related materials (called III-V materials since they are in general made from groups III and V of the periodic table) have a higher efficiency than silicon solar cells, particularly for the spectrum of light that exists in space. GaAs solar cells have efficiencies of up to 25% measured under terrestrial conditions. To further increase these efficiencies, solar cells made from different kinds of materials are stacked on top of one another. Such devices are called tandem or multijunction solar cells (the term multijunction applies to other types of structures as well). Such solar cells have efficiencies of up to 33%.

A final class of solar cell materials is called thin film solar cells. These solar cells can be made from a variety of materials, with the key characteristic being that the thickness of the devices is a fraction of other types of solar cells. Thin film solar cells may be made either from amorphous silicon, cadmium telluride, copper indium diselenide or thin layers of silicon. The efficiencies of thin film solar cells tend to be lower than those of other devices, but to compensate for this the production cost can also be significantly lower. Of these technologies, amorphous silicon is the best developed, and laboratory efficiencies are between 10 to 12%, with commercial efficiencies just over half these efficiencies. The other thin film technologies are still the subject of development, although commercial products exist. The efficiency of these devices is about 6% to 10% efficient. Most solar

Most solar cells will theoretically operate with a higher efficiency under intense sunlight than under the conditions encountered on earth. Concentrator solar systems exploit this effect, by focusing sunlight into a concentrated spot or line. Concentrator systems exist for both silicon and III-V solar cells. Silicon concentrator systems have reached efficiencies of 28% while III-V based systems have reached about 33%.

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2.2.3. Contribution of Art and Design using Photovoltaic's.

The cases that are shown in this section provide an overview of art works that have used photovoltaic systems in a functional and/or aesthetic way. All the works presented here have been made after 2000 and -although the aim was to illustrate the use of various technologies- most of them use the predominant Si-based technologies. As the focus of the research is on the off-grid use of PV, all the works presented are not connected to the main power supply. Where possible it is indicated if battery storage was foreseen.

Within this context the aim was to provide also a mix in terms of type of (art) work, the ideas behind it and the setting (indoor or outdoor).

Sweet Responsive PV Water Pump

Liujia Solar
A Confucian Stand ('Installation')
Intersolar 2006, Freiburg, GE
PV-Set up: Off-grid; No storage
PV-Tech: m-Si

Fig: 2.2.2 Liujia Solar

London Oasis

Laura Chetwood (Archs.)
Installation – London, UK
June 16-25, 2006
PV-Set up: Off-Grid, Hybrid PV/Wind; Storage: Hydrogen fuel cell
PV-Tech: not specified

Fig: 2.2.3 London Oasis

SOH19 States of Nature

Alex Vermeulen – *Syndicaat*
Landscape Sculpture
Campus Technical University
Eindhoven, Holland – 2006
PV-Set up: Off-grid;
No storage
PV-Tech: 88 Si-panels

Fig: 2.2.4 SOH19 States of Nature

Earthspeaker

Jeff Feddersen

Acoustic Sculpture
Accra (NY), US, 2006-2008
PV-Set up: Off-Grid; Storage:
bank of ultra capacitor modules
(Maxwell Technologies; ***-*** *5 55F 15V modules and one 110F module)*.
PV-Tech: 4V 100mA glass
Polycrystalline cells (<40W)

Fig: 2.2.5 Earth speaker

Drone #2

Autonomous observing system –
Köln, Germany, 2002
PV-Set up: Off-Grid; No storage
PV-Tech: Solar panels; type notspecified

Fig: 2.2.6 Drone#2

Walk

Laurie Anderson

Series of installations – Aichi Expo 2005, Japan
PV-Set up: Off-grid; no storage (Aimulet LA) & Grid-connected (other system components).
PV-Tech: Spherical Si

Fig: 2.2.7 Walk

Bamiyan Afghanistan Laser Project

Hiro Yamagata

Laser Installation - Bamiyan City, Bamiyan, Afghanistan - opening in June 2012
PV-Setup: Hybrid wind/PV; Off-grid; Storage batteries: not specified
PV-Tech: not specified

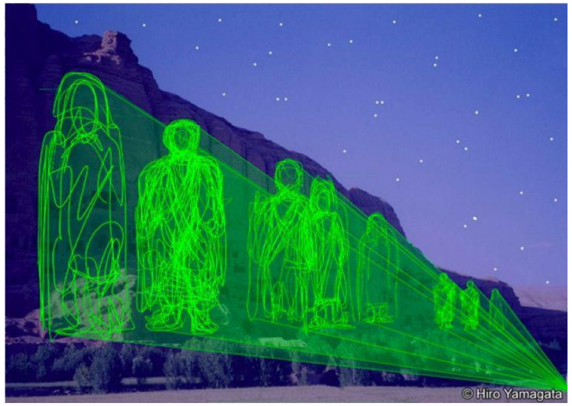

Fig: 2.2.8 Bamiyan Afghanistan Laser Project

I also went through some of the latest design innovations in the field of photovoltaic technologies.

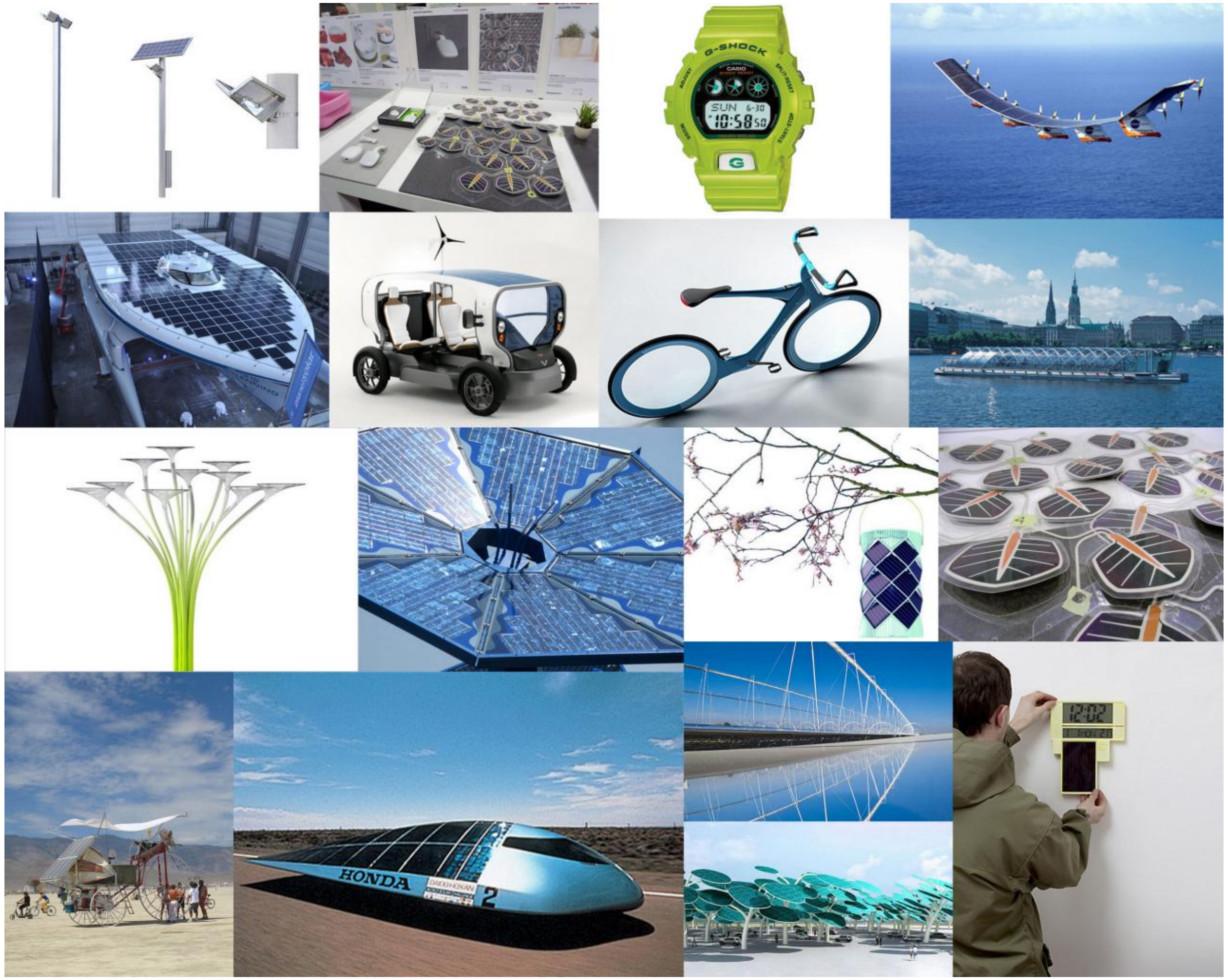

Fig: 2.2.9 Collage on the application of latest photovoltaic technologies

2.3. Light

Light since Antiquity

Light has been fascinating mankind since antiquity through their various shades and colors. All of us see light every moment and everywhere but physicists peeped “into” these valuable gifts of nature to fathom what they are. The curious insights into these enigmas led to the development of most important branch viz., optics.

The Greeks believed that light sources emit tiny particles that stimulate vision upon entering the eye. In the 18th century several physicists, including Newton, studied light. Newton proposed the corpuscular (particle) theory of light. However, these models failed as they lacked agreement with the experiment.

Later Huygens proposed the wave theory of light that was highly successful due to its close agreement with experiments. Maxwell found the speed of light using the theory of electromagnetism that was in nice agreement with the experimental value measured by Fizeau. Coincidence of these two numbers is considered a major milestone in the history of physics. we can see only a very narrow range of the electromagnetic spectrum from 4000 A to 7000 A (A means angstrom, the unit of wavelength equivalent to 100 millionth part of a centimeter)

2.3.1. Light Emitting Diode

History

For the past 150 years, lighting technology was mainly limited to incandescence and fluorescence. While derivative technologies such as high-intensity discharge lamps (HID) have emerged, none has achieved energy efficacies exceeding 200 lm/W (for monochromatic low pressure sodium lamps), with of less than 28 lm/W. With the advent of commercial LEDs in the 1960s, however, a new kind of lighting became available.

LEDs can consume less electricity than conventional lighting and can produce less of the parasitic by-product heat. However, at present, commercial LED systems are not as efficient as fluorescent lighting. Initial LEDs were red in color, with yellow and orange variants following soon thereafter. To produce a white SSL device, however, a blue LED was needed, which was later discovered through materials science and extensive research and development.

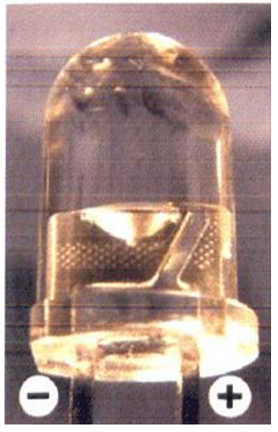

Fig: 2.3.1 Light emitting Diode

In 1993, Shuji Nakamura of Nichia Chemical Industries came up with a blue LED using gallium nitride (GaN). With this invention, it was now possible to create white light by combining the light of separate LEDs (red, green, and blue), or by placing a blue LED within a special package with an internal light conversion phosphor – some of the blue output becomes red and green with the result that the LED light emission appears white to the human eye..

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2.3.2. Working of Light Emitting Diode

LEDs differ from traditional light sources in the way they produce light An LED, is a semiconductor diode. It consists of a chip of semiconducting material treated to create a structure called a p-n (positive-negative) junction. When connected to a power source, current flows from the p-side or anode to the n-side, or cathode, but not in the reverse direction. Charge-carriers (electrons and electron holes) flow into the junction from electrodes. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon (light). The specific wavelength or color emitted by the LED depends on the materials used to make the diode.

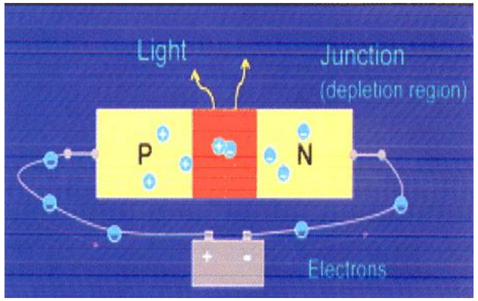


Fig: 2.3.2 Working of LED

Future of LEDs

OLED

OLED or organic light emitting diode is another technology creating ripples in the industries. Its making revolutions in revolution in laptop screens, mobiles and PDA. Its main advantages are that it draws less power, thinner and lighter than LCD, better contrast than LCD and it does not need backlight to function.

2.3.3. Contribution of Art and Design using LED technologies

I also went through some of the latest design innovations in the field of Light Emitting Diode technologies.

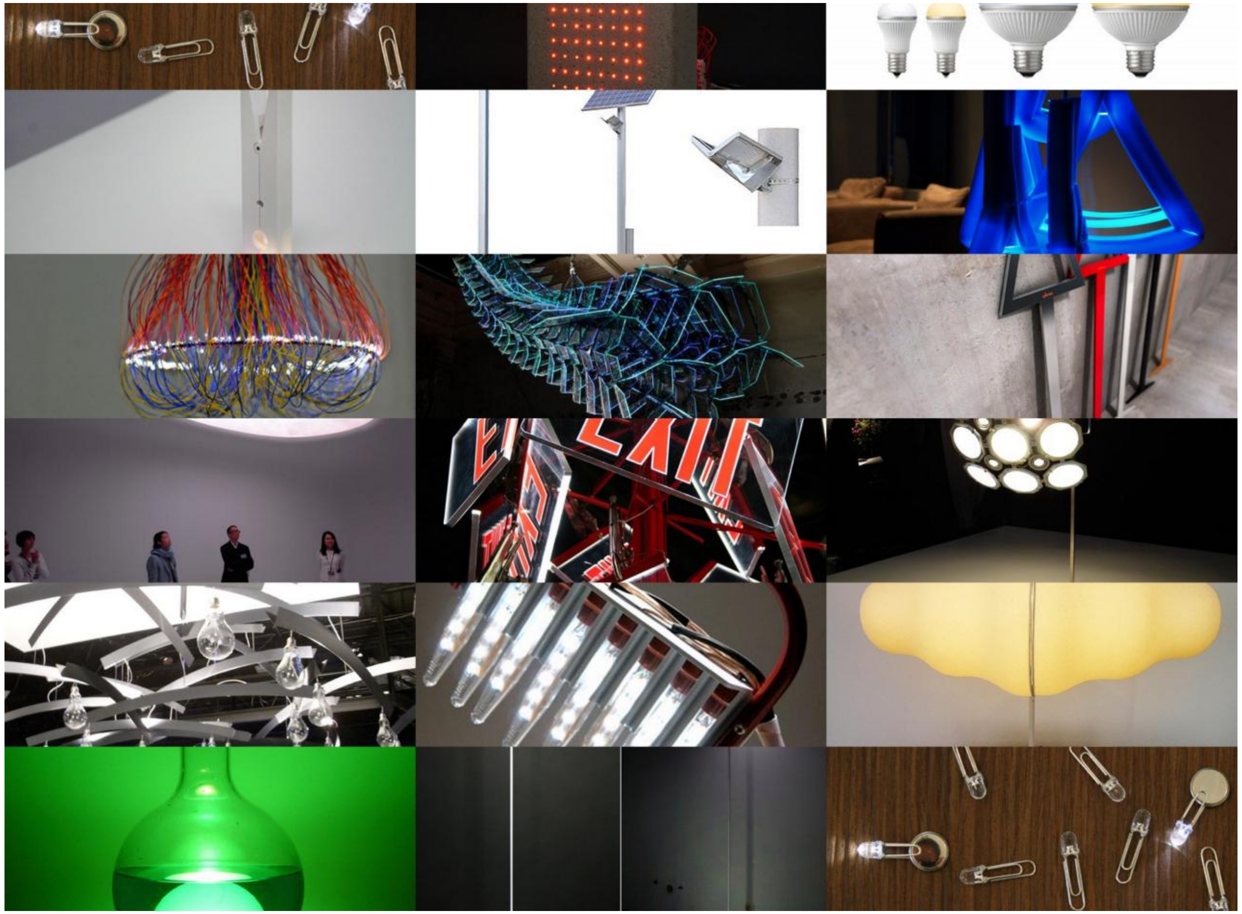


Fig: 2.3.3 Contribution of art and design in LED technologies

3. Design Process

3.1. Phase 1

Started with aim and objective and finding an area to narrow down where the process should start was the initial stage**.**

Aim

Looking how sunlight could inspire and produce design for capturing energy.

Objective

Allowing people to create themselves with sunlight as a design tool which would help them to capture energy as well as produce light.

Initial Brief

Lighting for Bridges (Creating a new experience in the cross over's) .

3.1.1. Scenario Building

Scenario 1

After lots of Iterations I have reached to this two scenarios

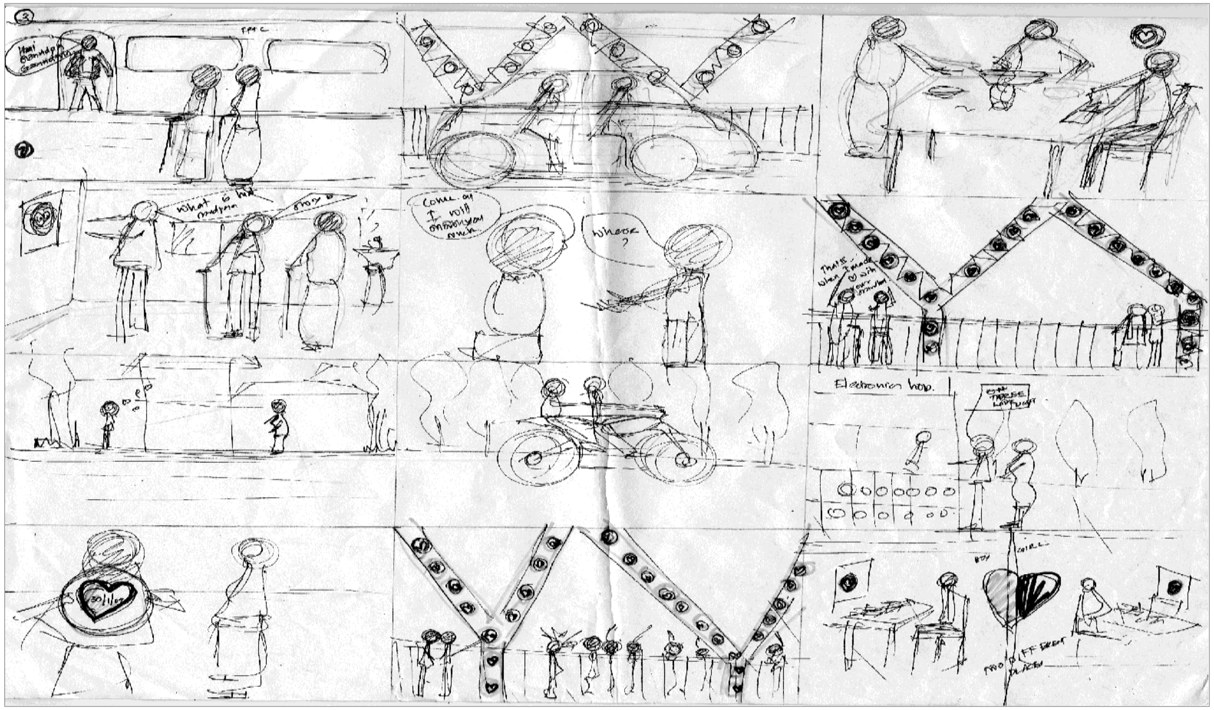


Fig: 3.1.1 Scenario 1

This is a scenario of a boy who comes to see his grandparents and takes the experience from the bridge to his native place

Scenario 2

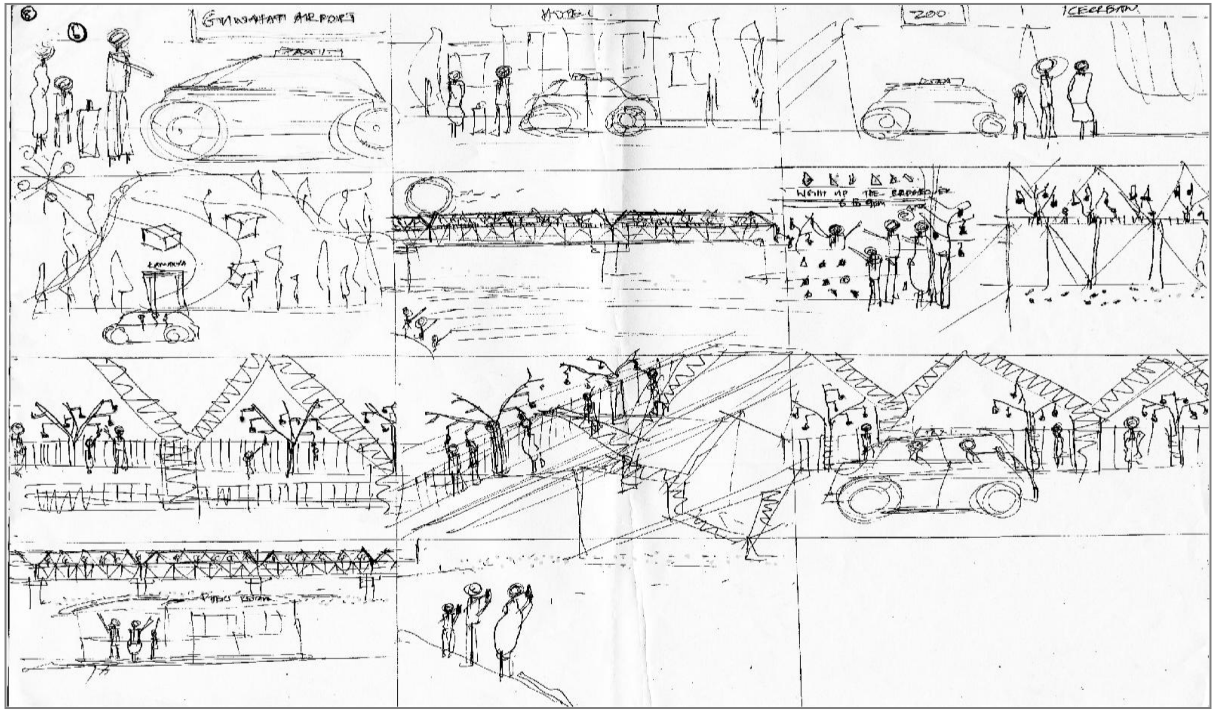


Fig: 3.1.1 Scenario 1

This is a scenario of a family who comes for a holiday trip to Guwahati and takes the ritual of the Saraighat Bridge to their native place

These scenarios led me to reach the concept Tree.

Taking Tree as a concept for lighting and finding keywords for tree was the next step.

3.1.2. Concept Generation

Keywords for Tree

A collaborative effort was done with the M.Des First Years

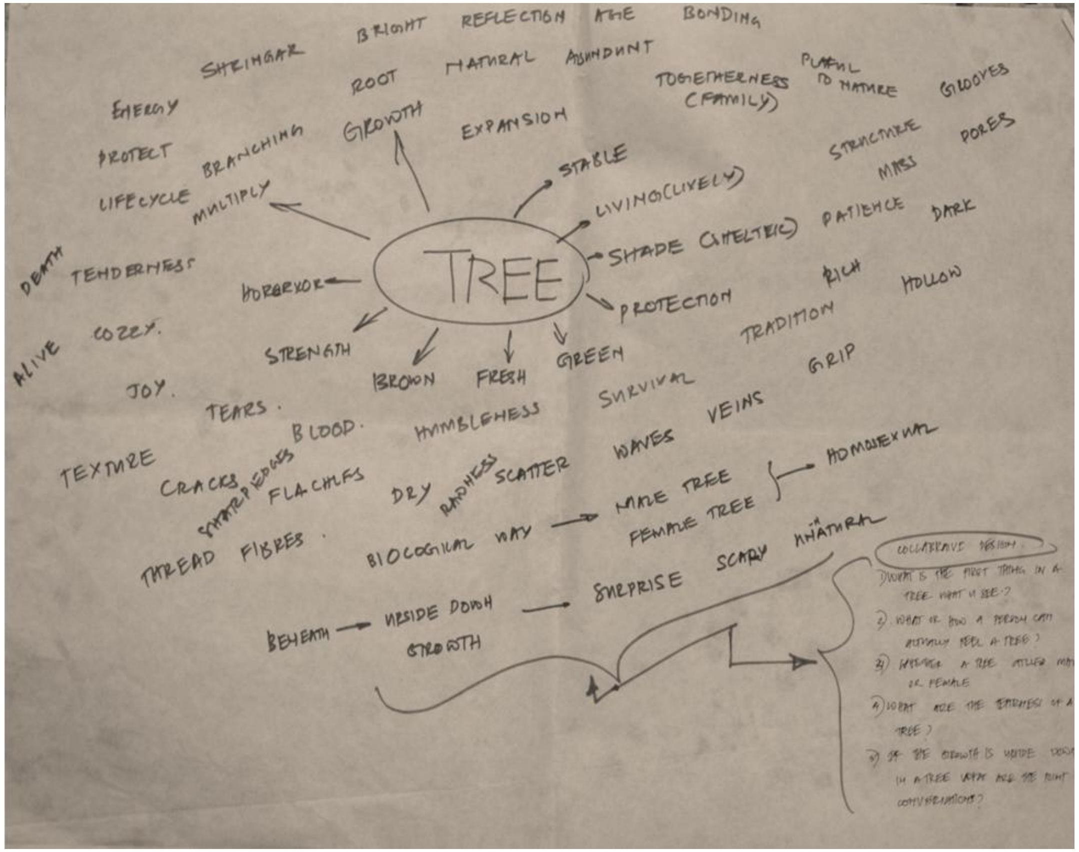


Fig: 3.1.2 Concept Generation for Tree

As a result I founded out very interesting keywords like sharp edges, symmetric, pattern

Keeping the keywords in mind and started to sketch concepts

Initial Concepts

Taking origami as constraint and started working on various concepts.

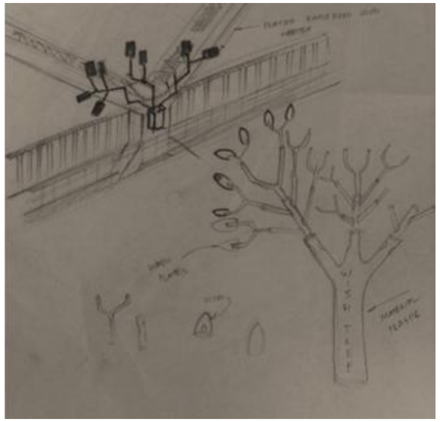


Fig: 3.1.1 Concept 1

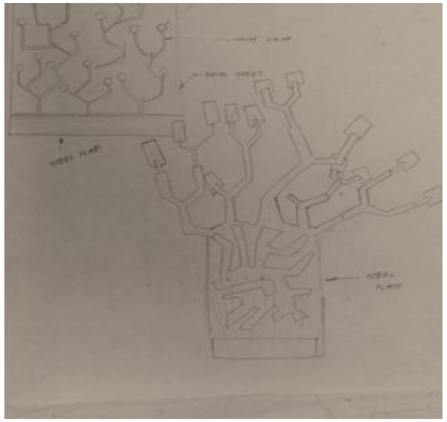


Fig: 3.1.2 Concept 2

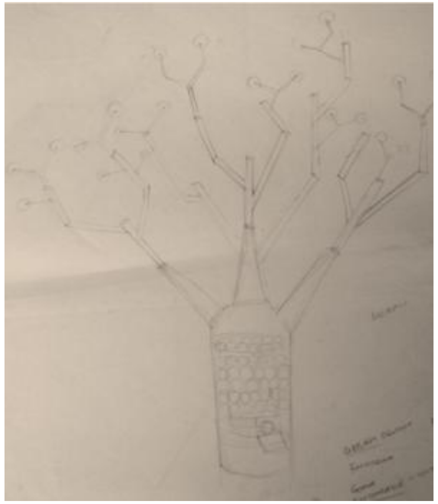


Fig: 3.1.3 Concept 3

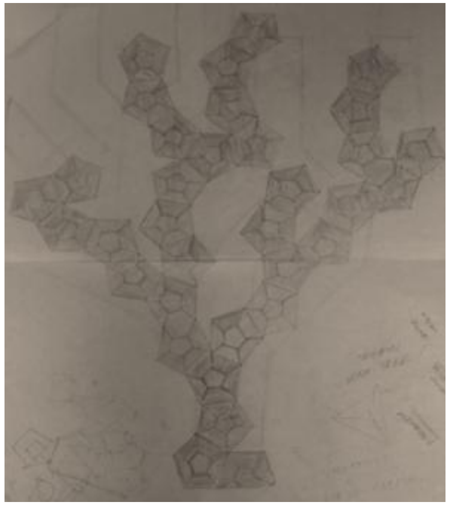


Fig: 3.1.4 Concept 4

Taking concept four for the iteration in common geometric shapes

Initial Geometry Iterations
Common Geometrical Shapes

1) Triangle
2) Square
3) Pentagon
4) Hexagon
5) Heptagon

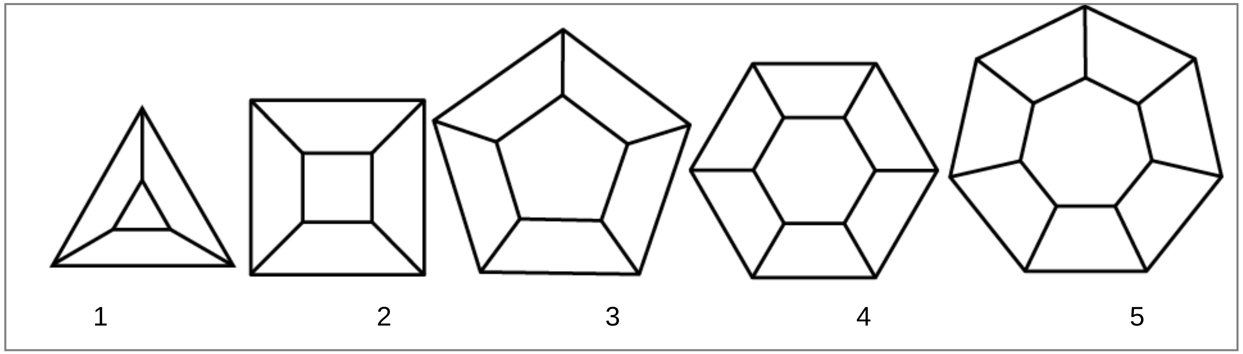


Fig: 3.1.5 Geometric iterations

Each of the shapes was put into patterning and many tree explorations where done

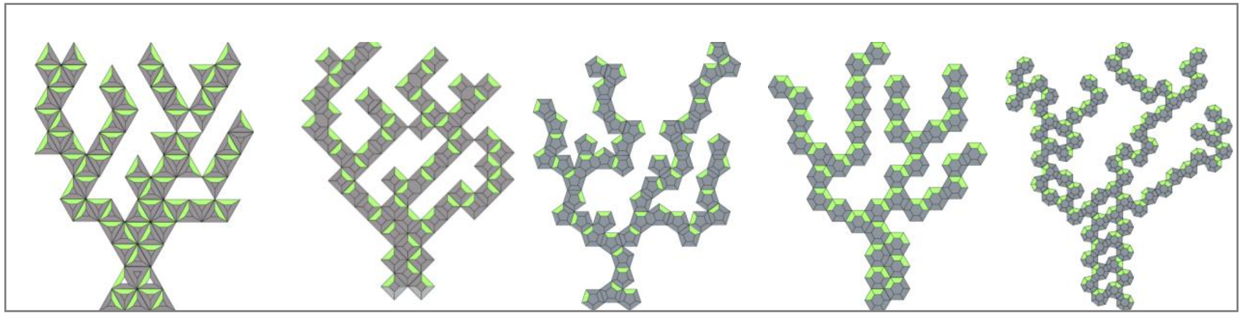


Fig: 3.1.5 Geometric Patterning

Finalizing Hexagon and Pentagon Tree

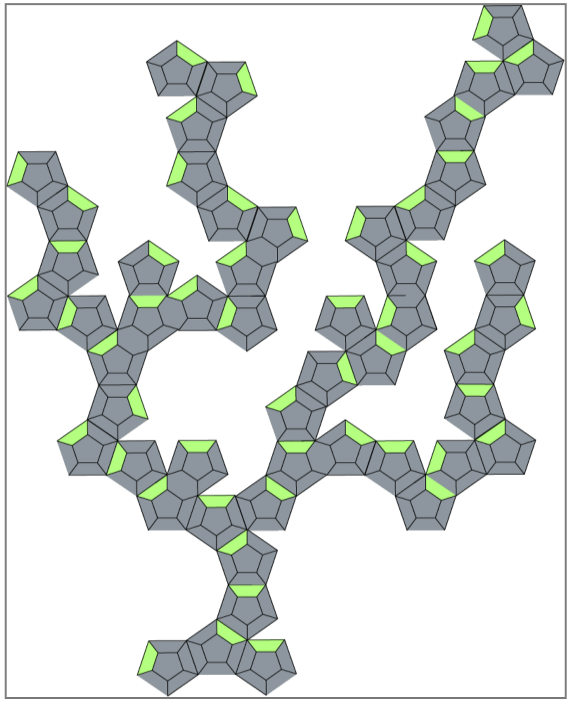


Fig: 3.1.6 Pentagon Tree

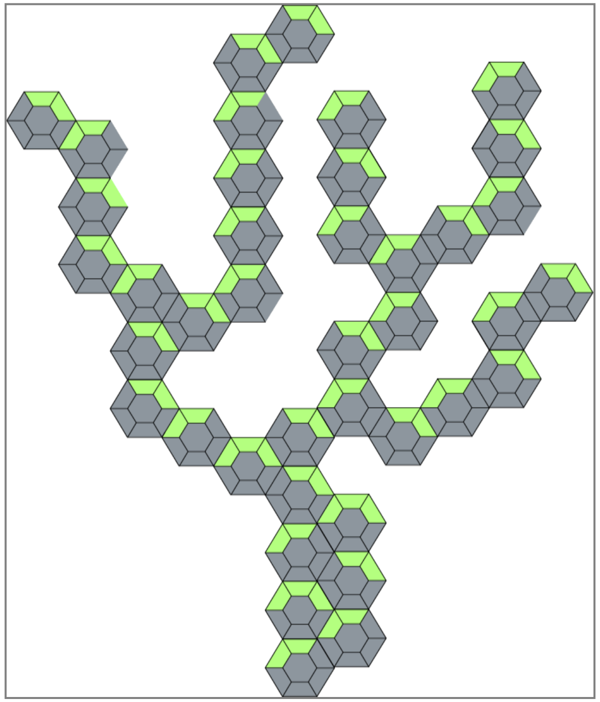


Fig: 3.1.7 Hexagon Tree

Two Dimensional to third dimension.

Bringing tree from two dimensional to three dimensional space

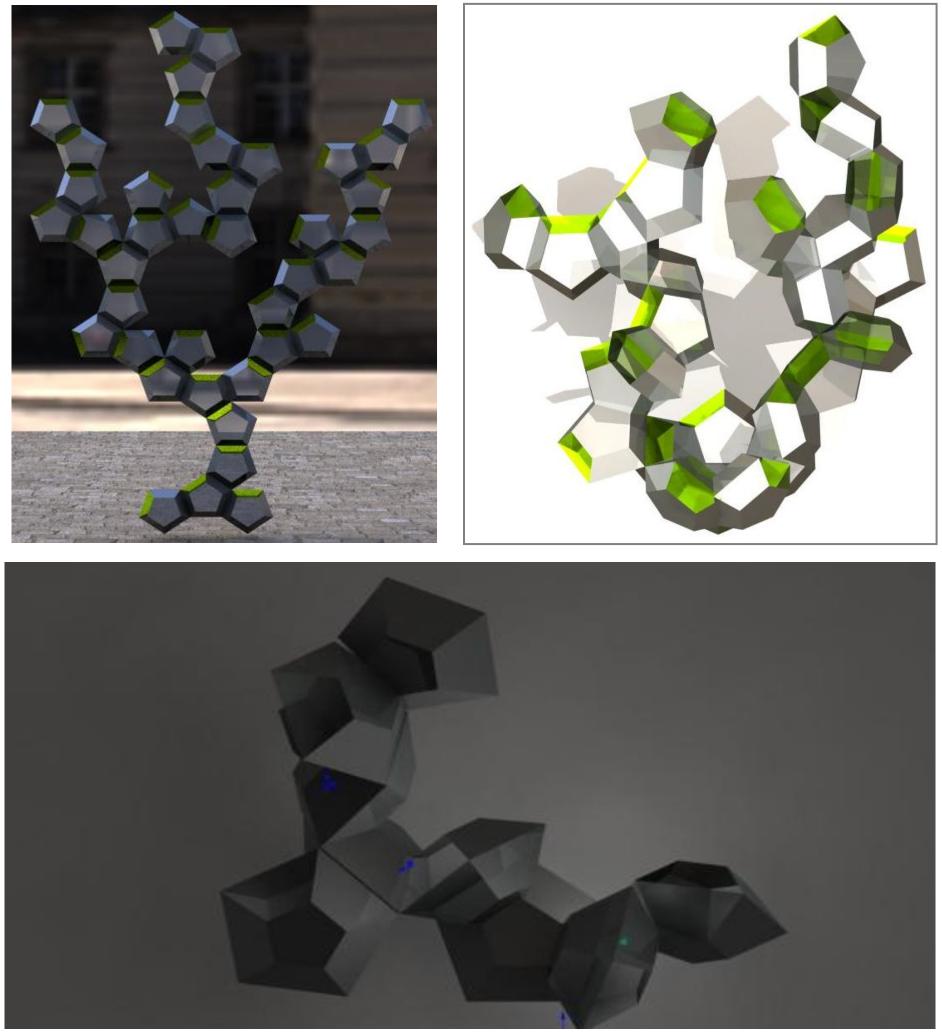
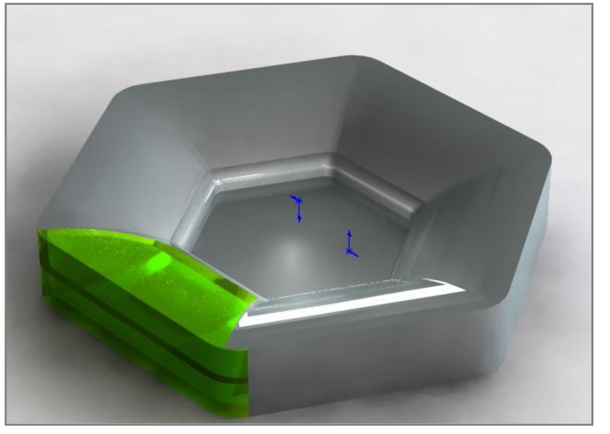
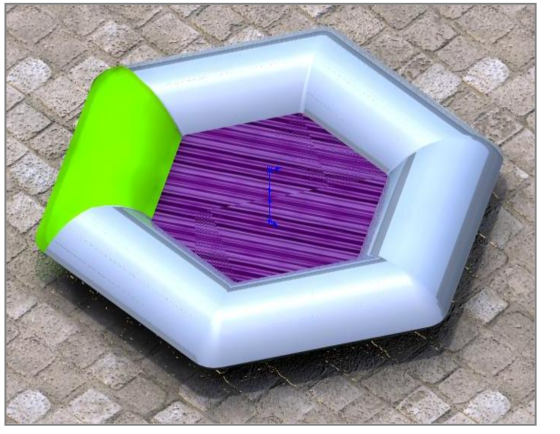


Fig: 3.1.8 Three Dimensional Tree Explorations

Detailing of the geometrical shape

From straight edges to fillets. In each stage there were different types of fillet explorations in order to bring the right curve.





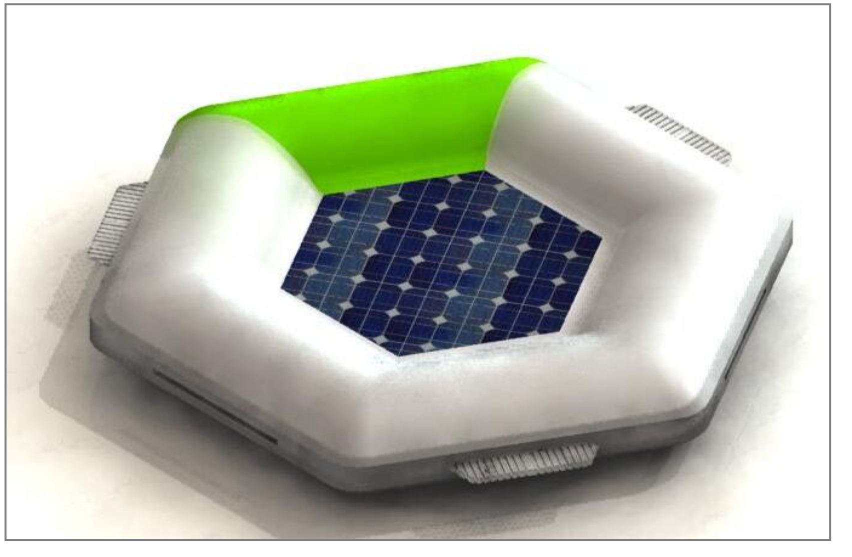


Fig: 3.1.9 Detailing the Individual Geometries

In order to visualize the three dimensional possibilities, started working with paper to feel the geometry on hand.

Geometry into new space

With the resource of a book named order in space by Keith Critchlow the level of two shapes went into another space. Icosahedron, Dodecahedron, Snub Dodecahedron, Truncated Dodecahedron, Truncated Icosahedron. As the truncated icosahedrons led me new dimension of dome creation with pentagon and hexagon came into picture. The relation of Leonardo da Vinci for truncated icosahedrons was also visited.

Dome Explorations

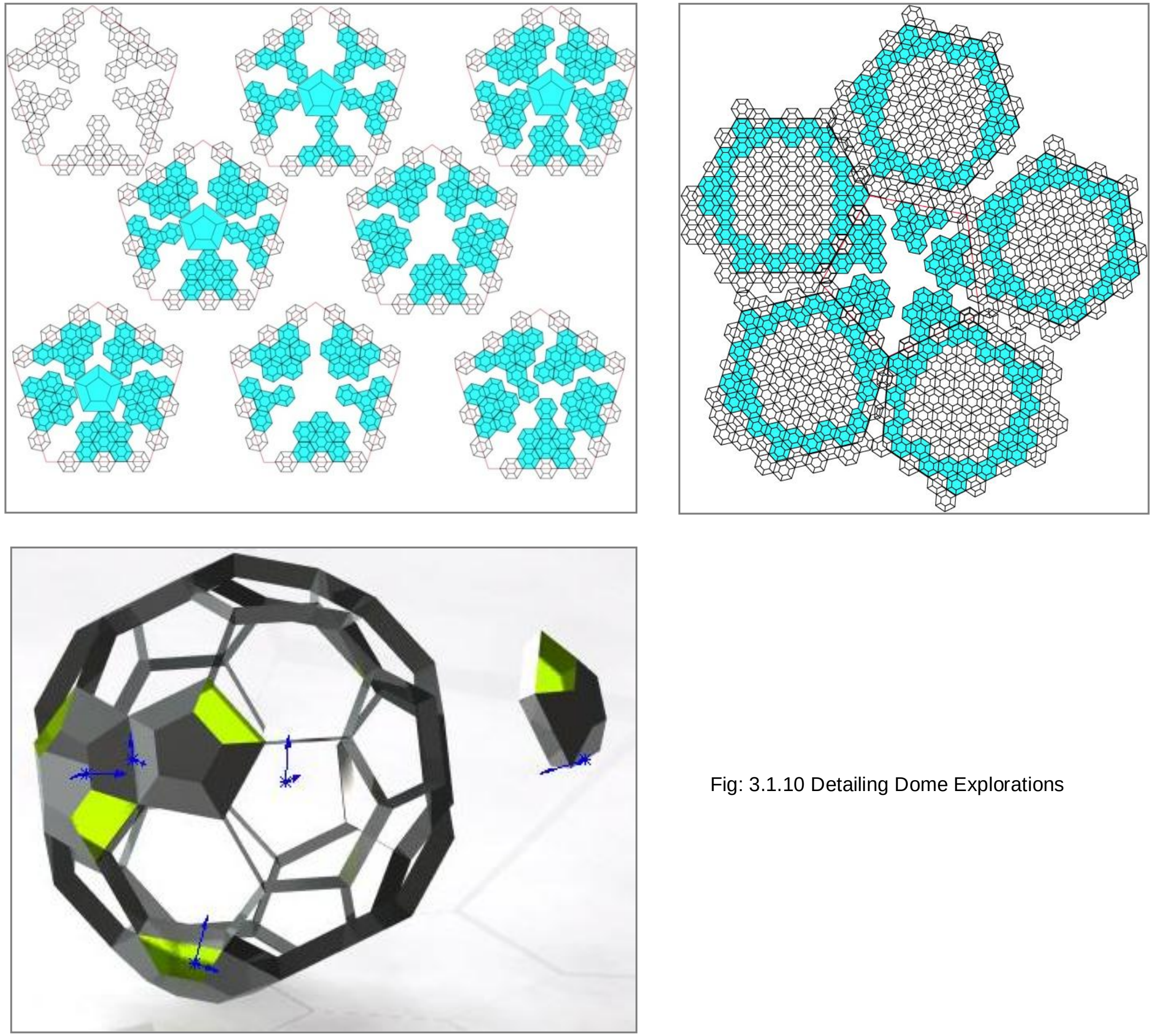


Fig: 3.1.10 Detailing Dome Explorations

3.1.3. Logo Explorations

Logo and identity exploration

Keywords

Geometry
Geodesic
Green
Energy
Origami
Geography
Hexagon
Pentagon

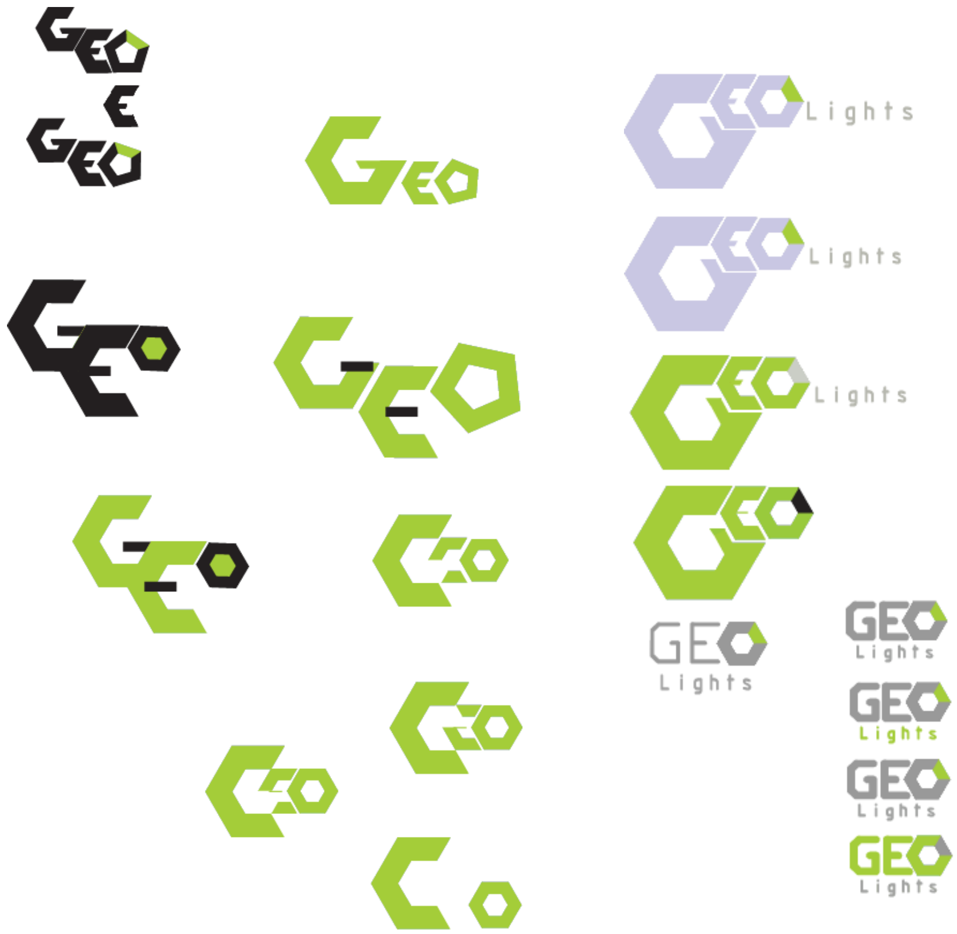
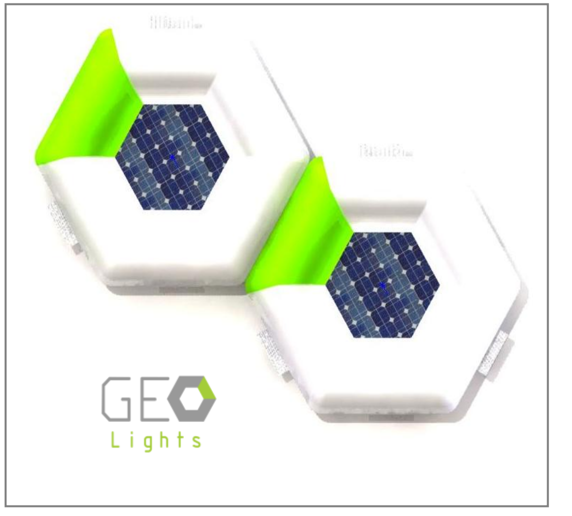


Fig: 3.1.11 Logo Explorations

Phase I Scenarios

Taking two shapes into account one Hexagon and another Pentagon by patterning them in two and three dimensional space lead me to these scenarios.



1) Blinds for Interior and Exterior Lighting

Fig: 3.1.12 Blinds interior and exterior

2) Garden Lamps

Fig: 3.1.13 Garden lamps for parks

3) Light installations in bridges

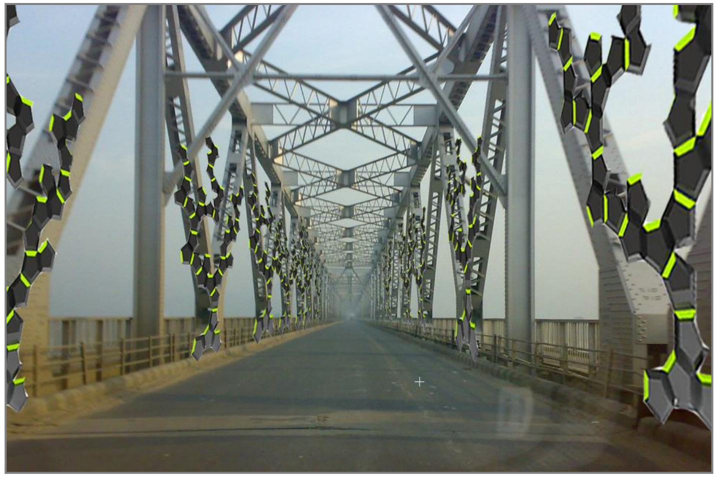


Fig: 3.1.14 Light installations in Bridges

Light installations in Parks

Fig: 3.1.15 Light installations in Parks

The Whole journey in PHASE 1 took me into new dimensions of order in space but still with the constraint on the detail and also in the three dimensional led me more to explore into differ rent ways of modularity .The feedback was more on the weight factor, joineries, material wastage.

3.2. Phase 2

The New Year started with a bright sun and geo started to move into new levels of capturing energy. From the feedbacks of PHASE 1 the geometry started to move from static to more dynamic.

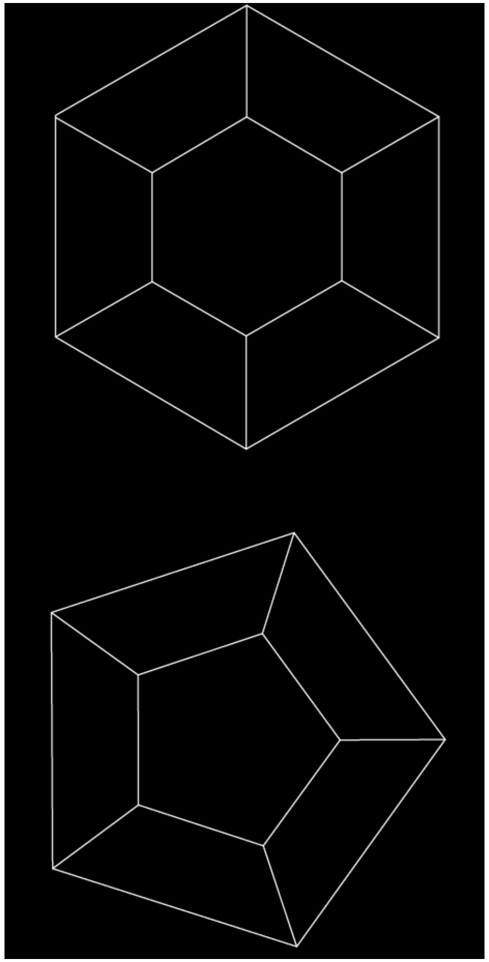


Fig: 3.2.1 Static Geometry

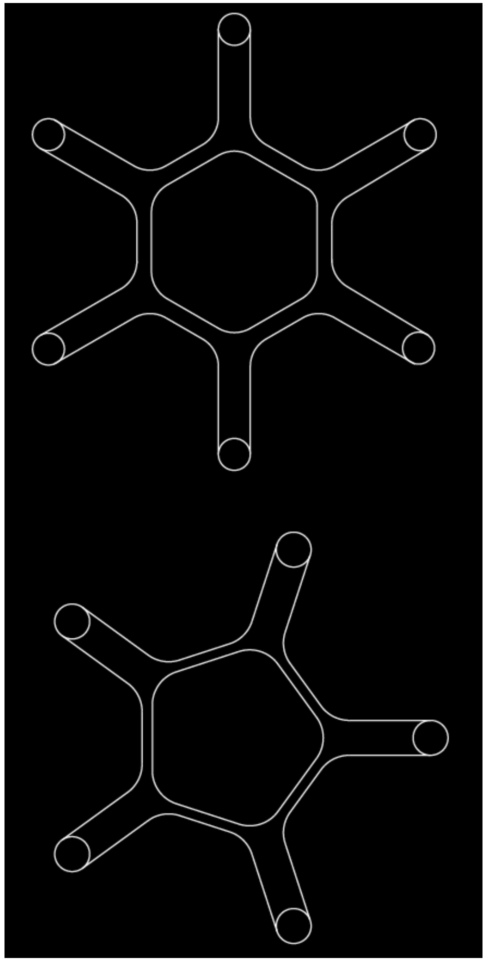


Fig: 3.2.2 Dynamic Geometry

In order with the flexibility as mode exploring more dynamic forms started to play with forms

3.2.1. Concept Refinement

Hexagon Exploration

By connecting those in two by two joineries and three by three joineries the forms were generated.

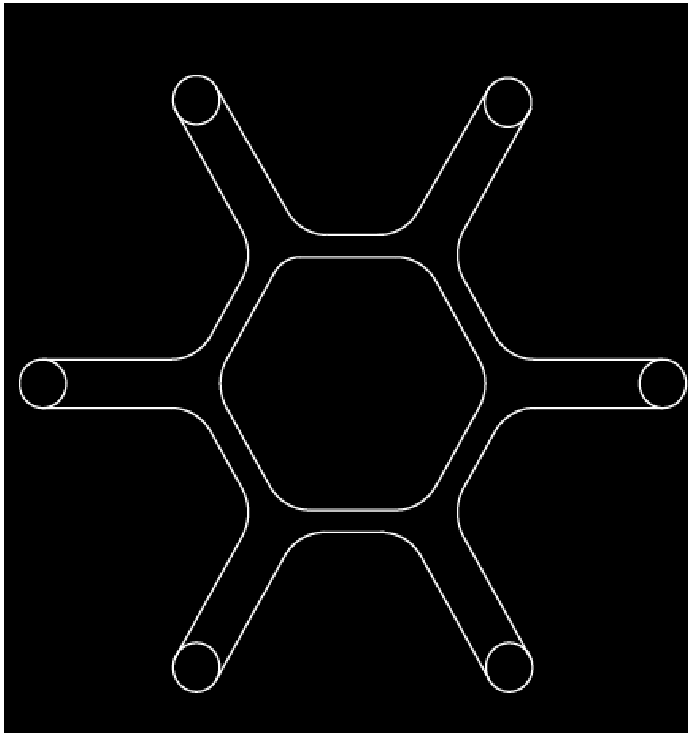
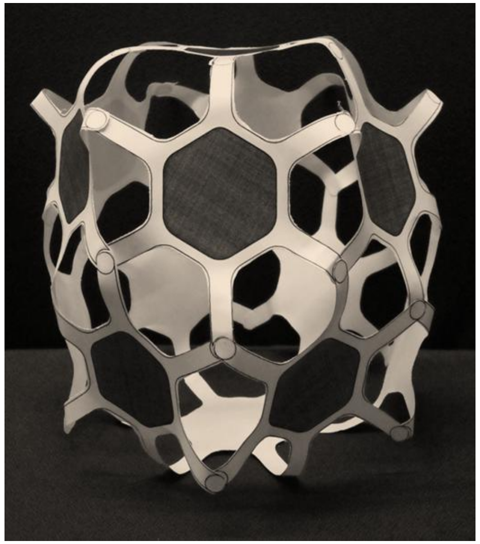


Fig: 3.2.3 Hexagon module exploration



Pentagon Exploration

By connecting those in two by two joineries and three by three joineries the forms were generated.

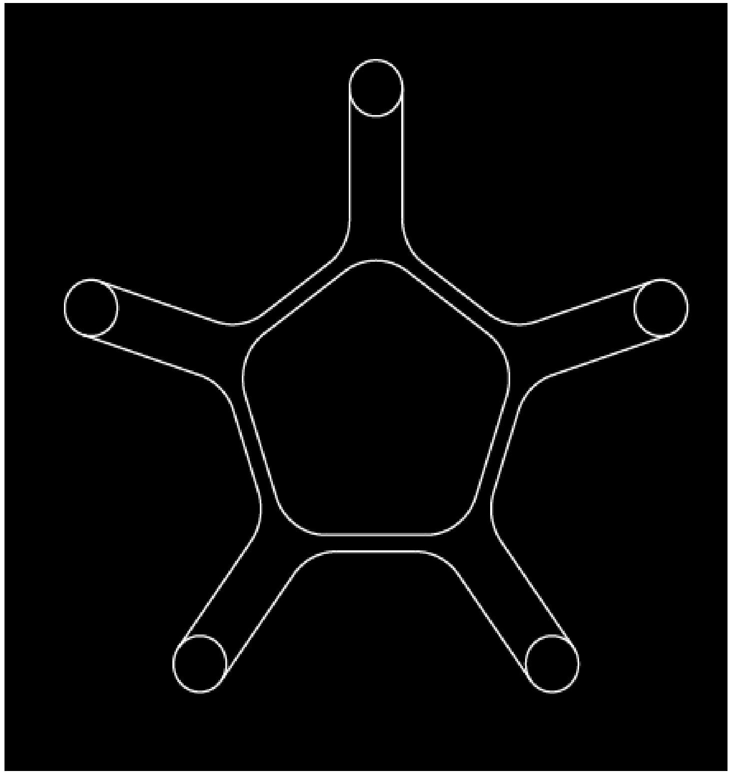
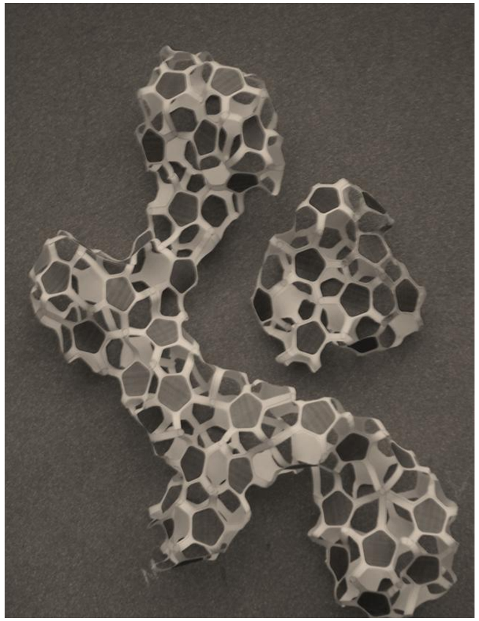
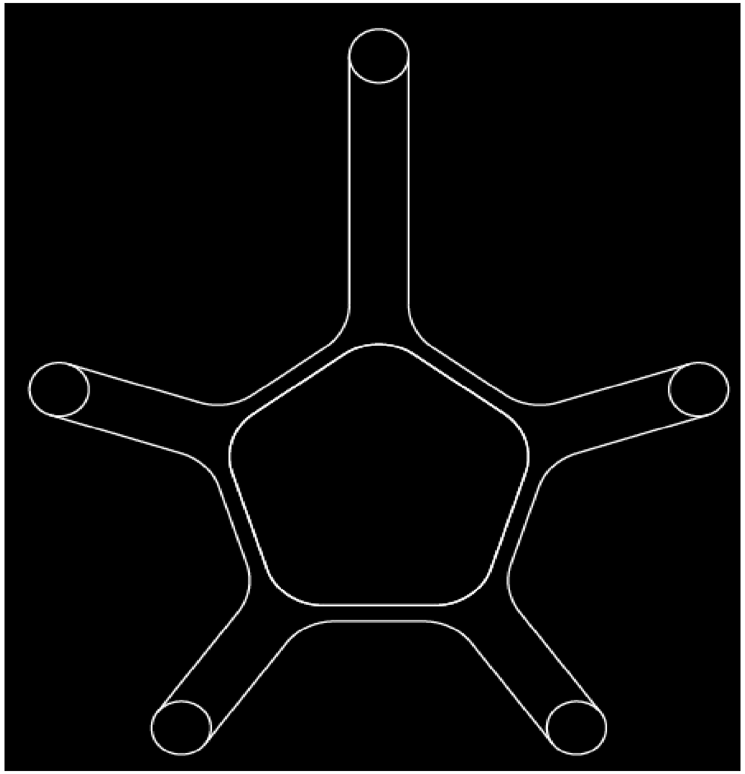


Fig: 3.2.4 Pentagon module exploration



Pentagon with one hand extended

By connecting those in two by two joineries and three by three joineries the forms were generated.



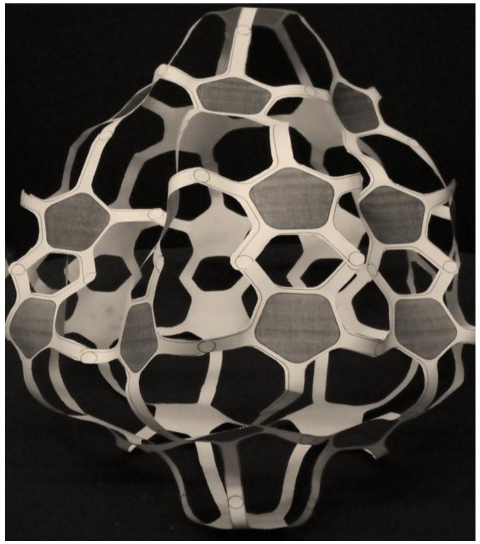


Fig: 3.2.5 Pentagon module exploration

Iteration in the Dynamic Geometry

This is how from initial geometry to final it kept on changing.

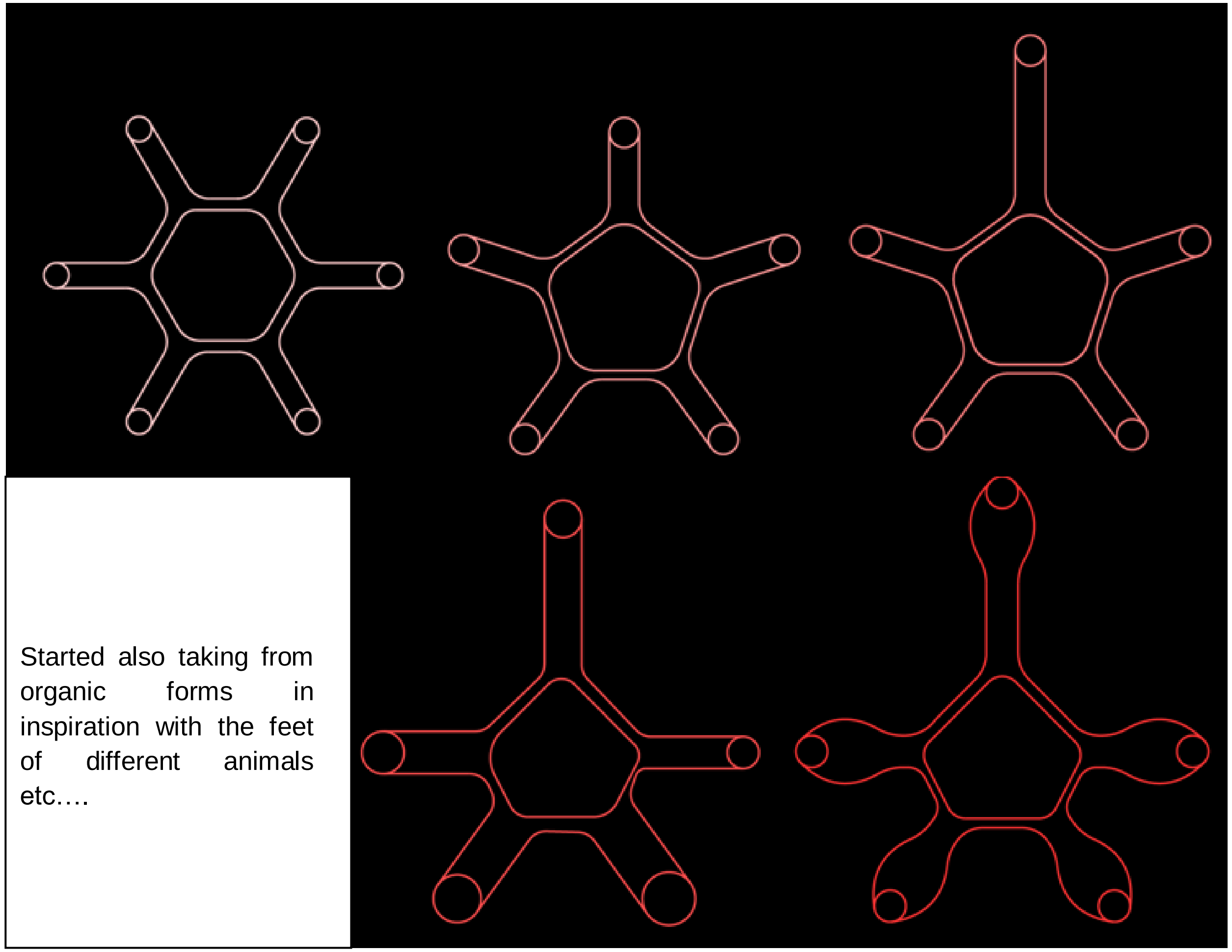


Fig: 3.2.6 Pentagon module exploration

As one of the leg lengths and two of the legs angle is made straight the geometry took to new dimension which gave explorations to more symmetric and asymmetric forms.

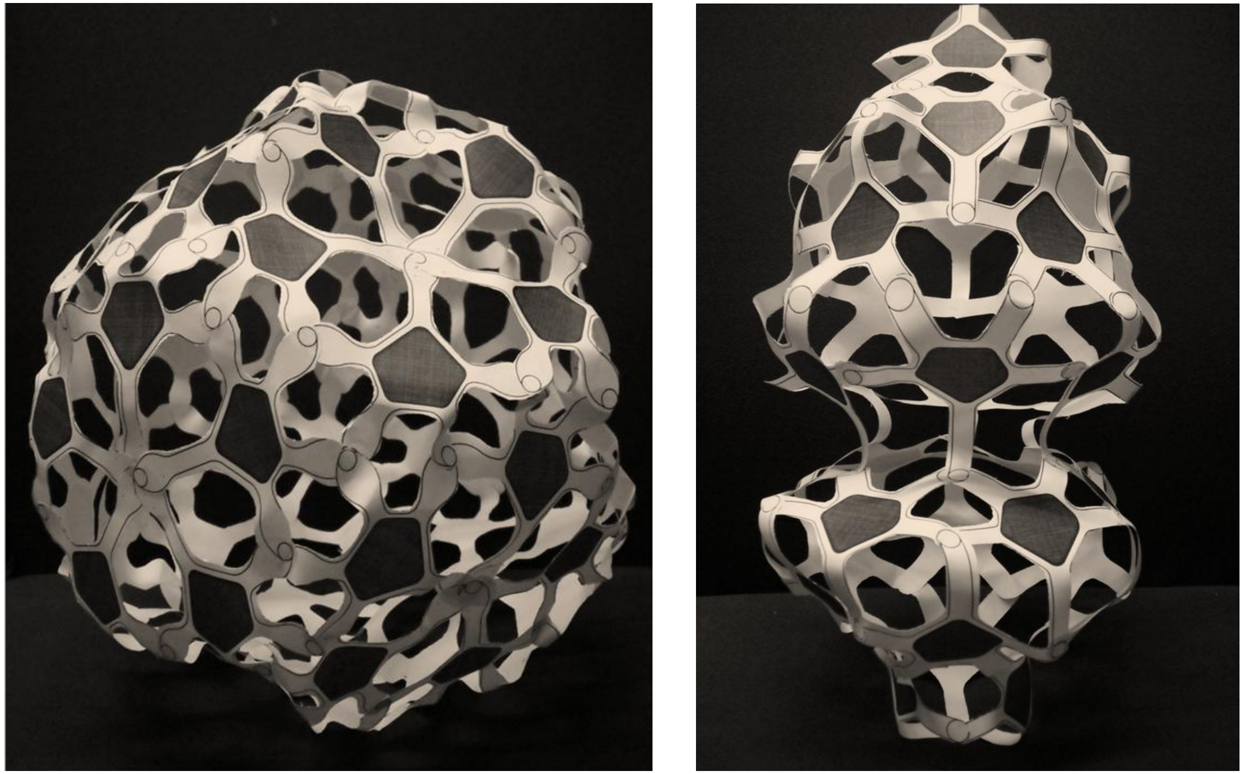


Fig: 3.2.7 Revised Pentagon module exploration

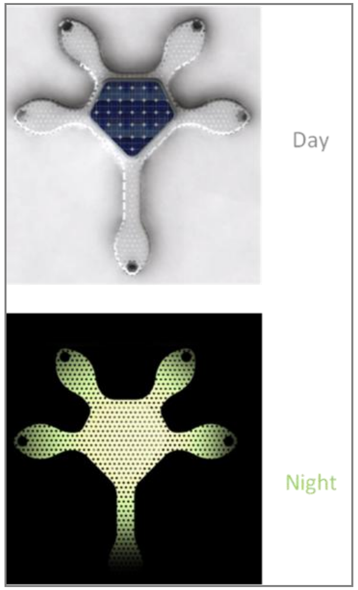
3.2.2. Logo Refinement

PHASE 2 Logo Iterations

Fig: 3.2.8 new logo exploration

PHASE 2 Scenarios

Modular Lights for Indoor and Outdoor Architecture for Charging Electronic Equipments

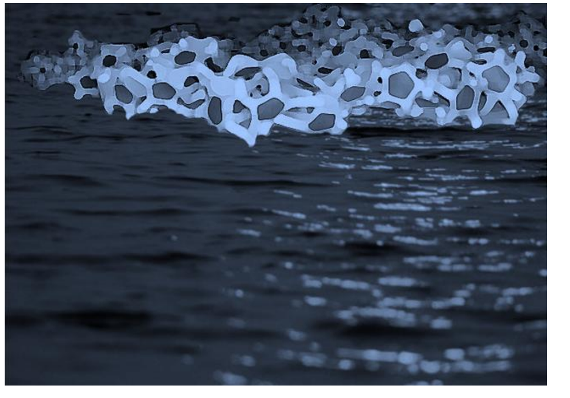


Installations

By joining geo lights with more of them can lead to huge installations in land, air and water.

Land

Air



Water

Feasibility Study of Solar cells, circuitry and Light Emitting Diodes

3.3. Phase 3

Phase 4 is called as detail phase, all the things get into the real world. A design lie on the details is the right metaphor I can use for this particular modular light.

After 10 to 15 iterations, the model is brought into live with the constraint of solar cell and the LED and battery package.

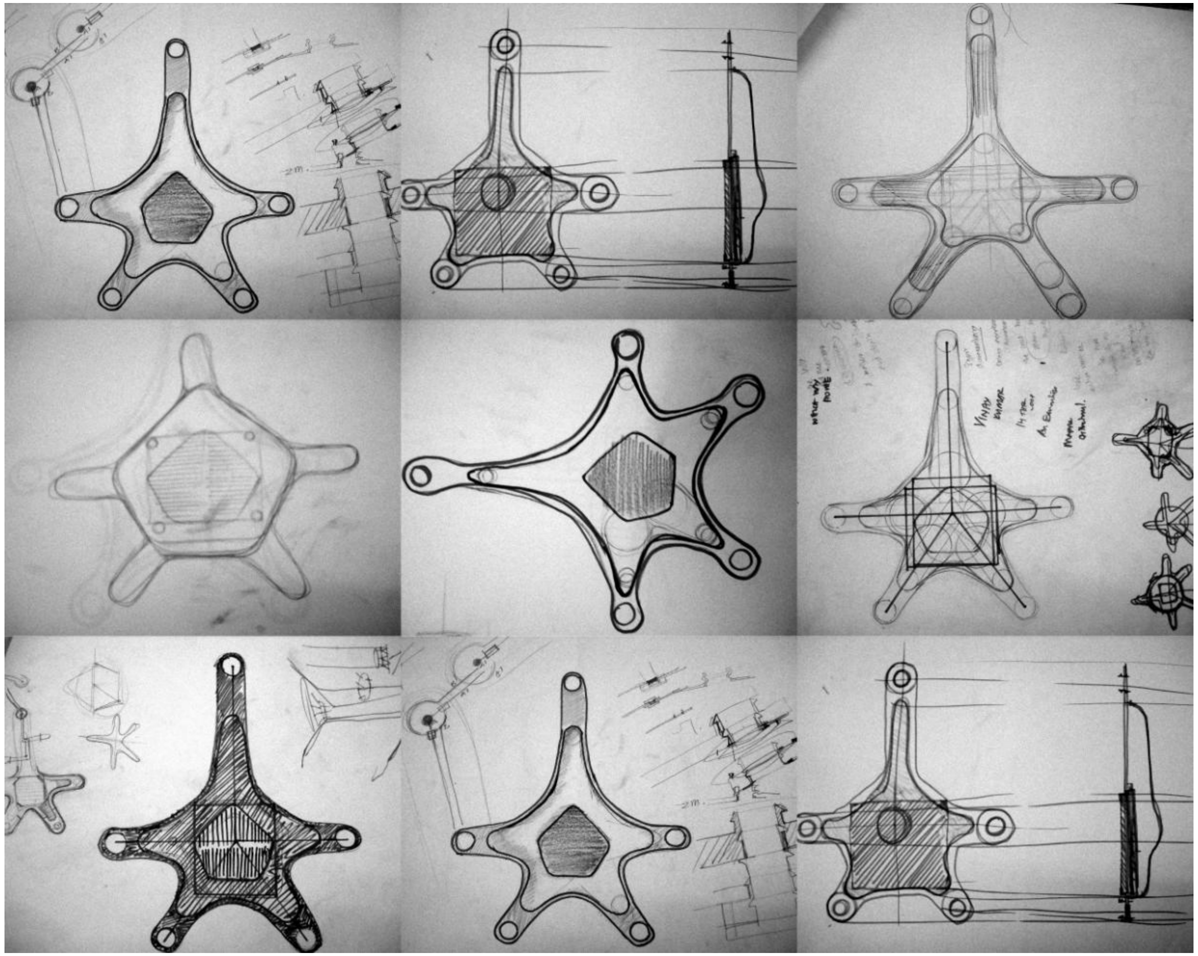


Fig: 3.3.1 Final Pentagon detail exploration

3.3.1. Fine Detailing

The details where then brought to computer generated form for the perfection in the geometricity.

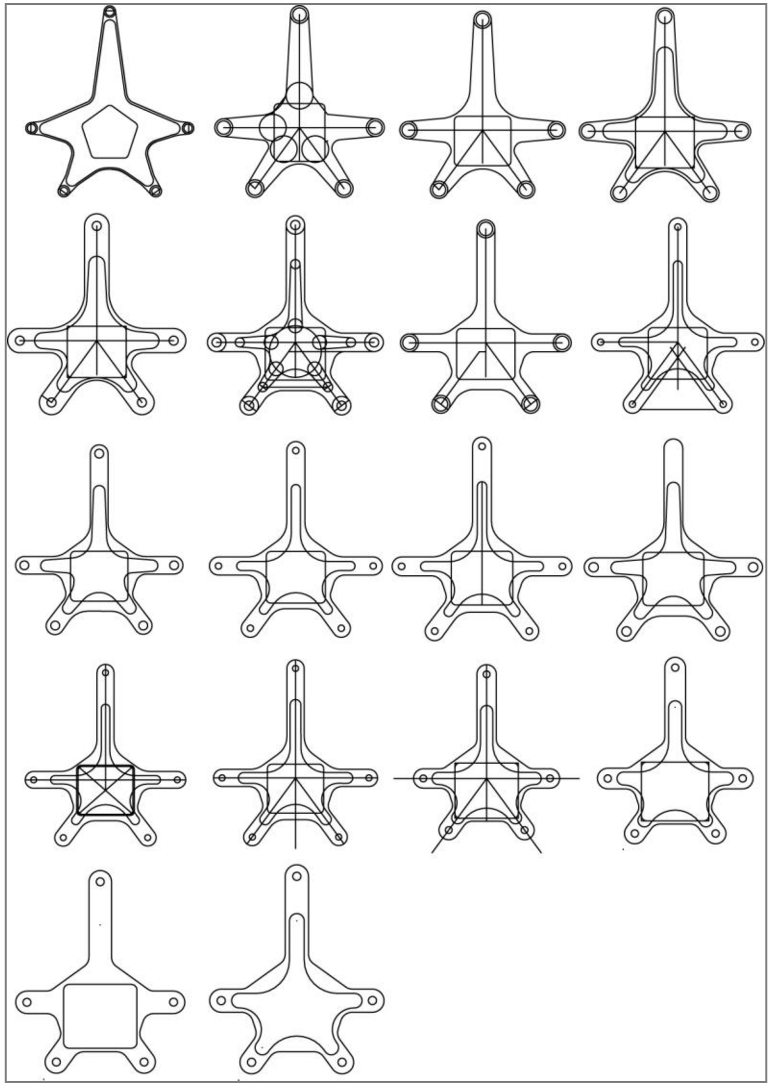


Fig: 3.3.2 Final detailing keeping geometric constraints

Detailing

Packaging Detail - the LED, battery and the solar cell should be packed in order it should not remove and come out.

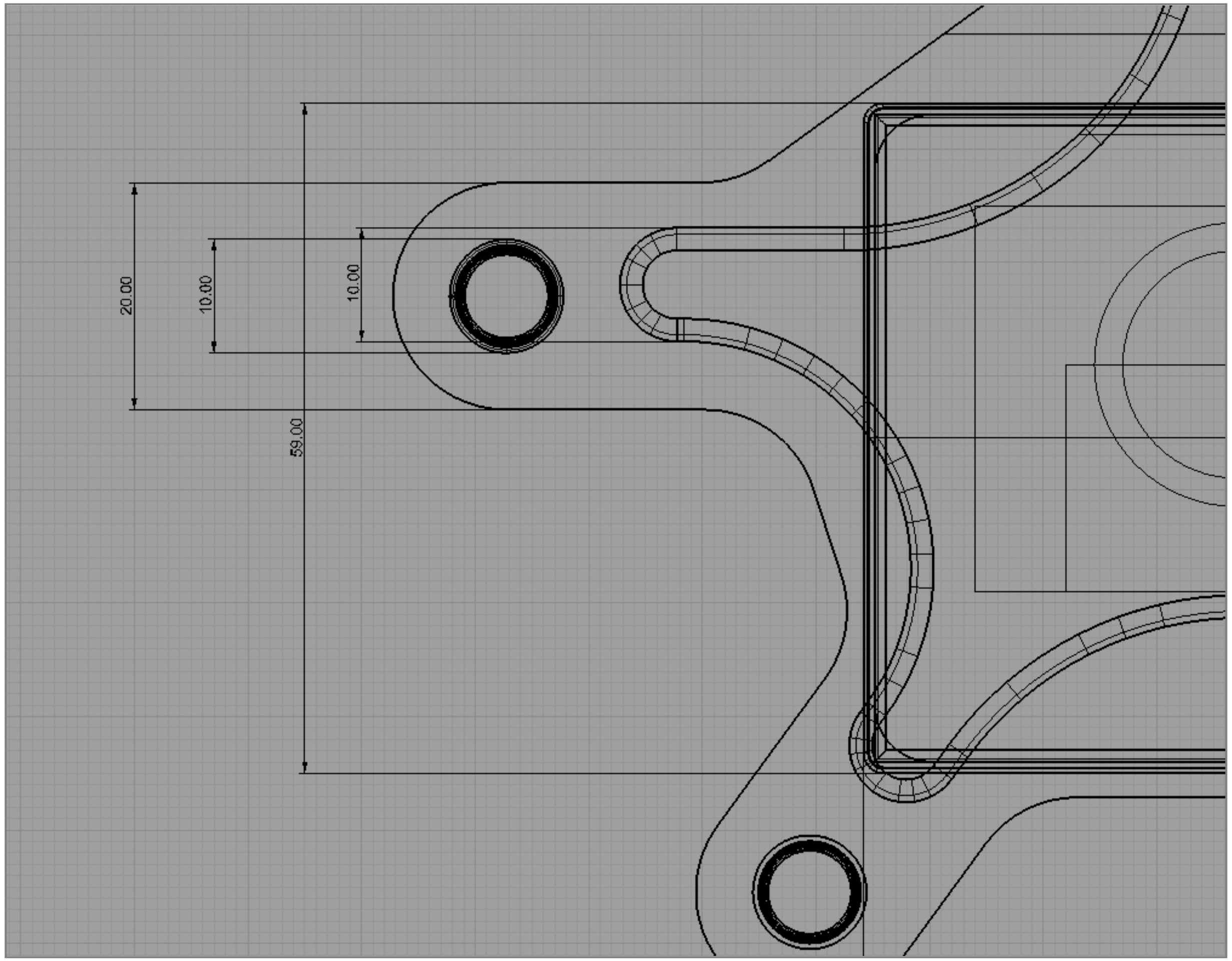
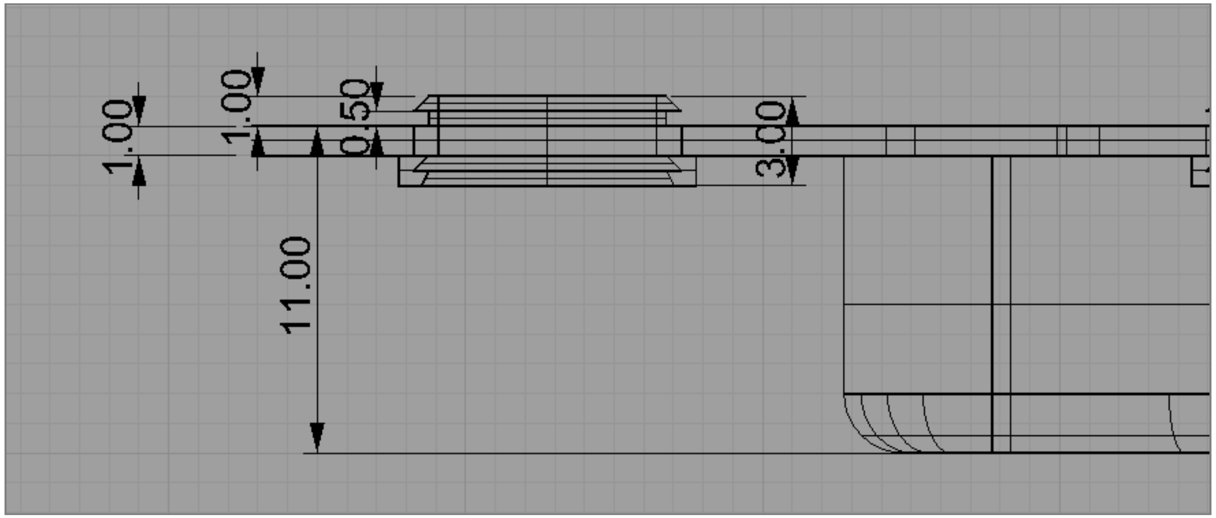
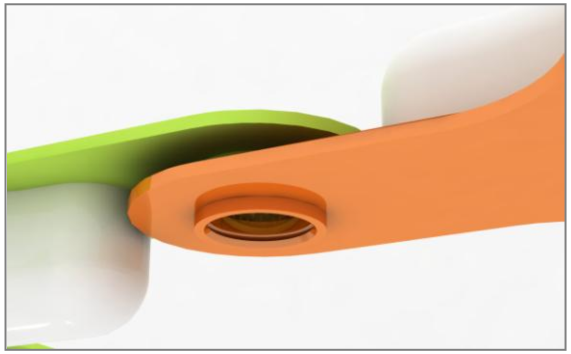


Fig: 3.3.3 Final packaging detail keeping geometric constraints

Joinery Details

The joins of the modular light was brought to microscopically leveled so the details are hidden.





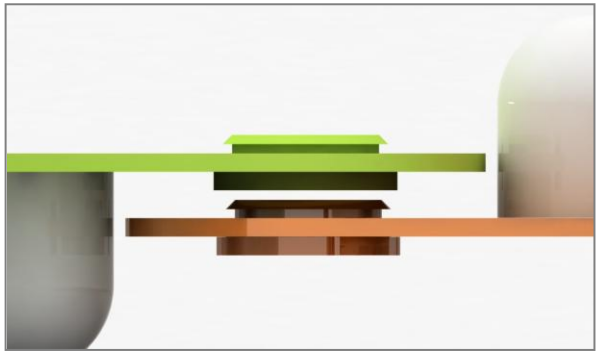


Fig: 3.3.3 Final joinery detail keeping geometric constraints

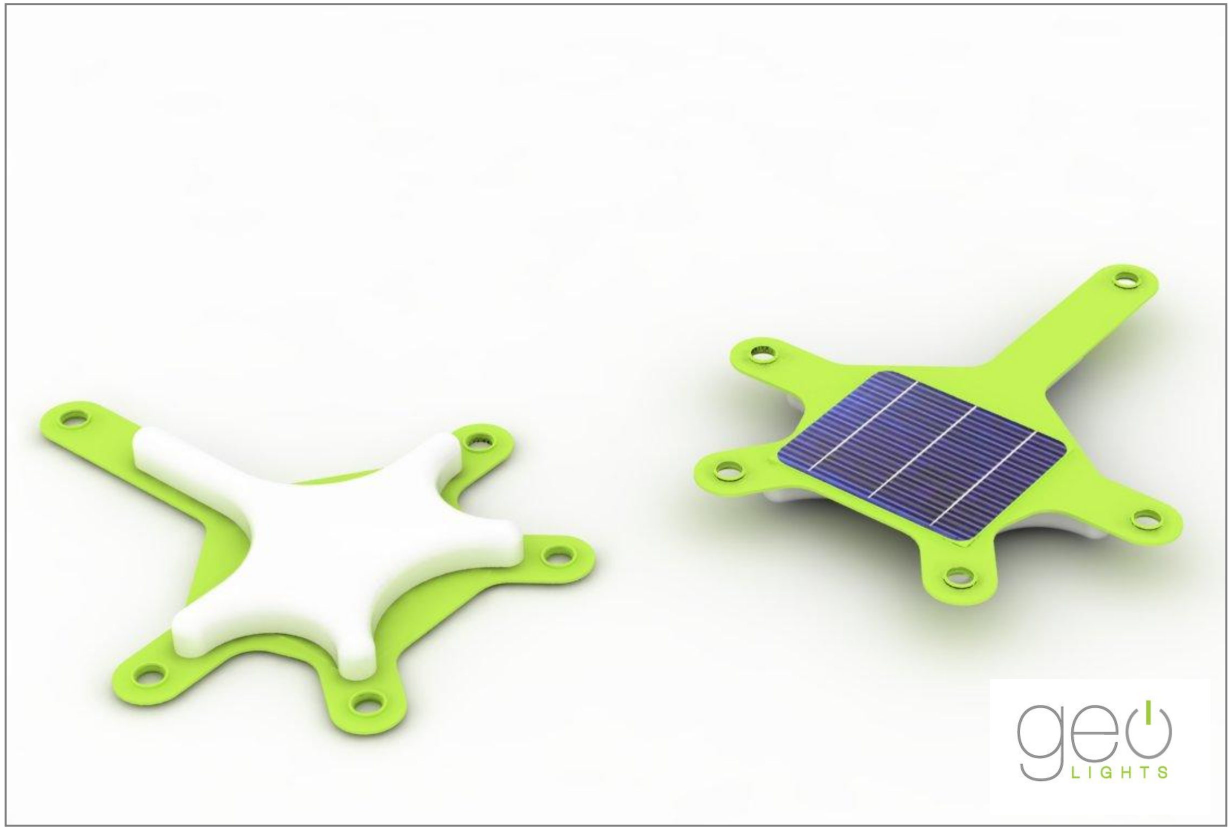
3.4. Phase 4

Design Scenarios and Renderings

3.4.1. Final Scenarios and Renderings

GEO Family

The mother is said to be the source. The energy is captured by the mother and distributed to the children.

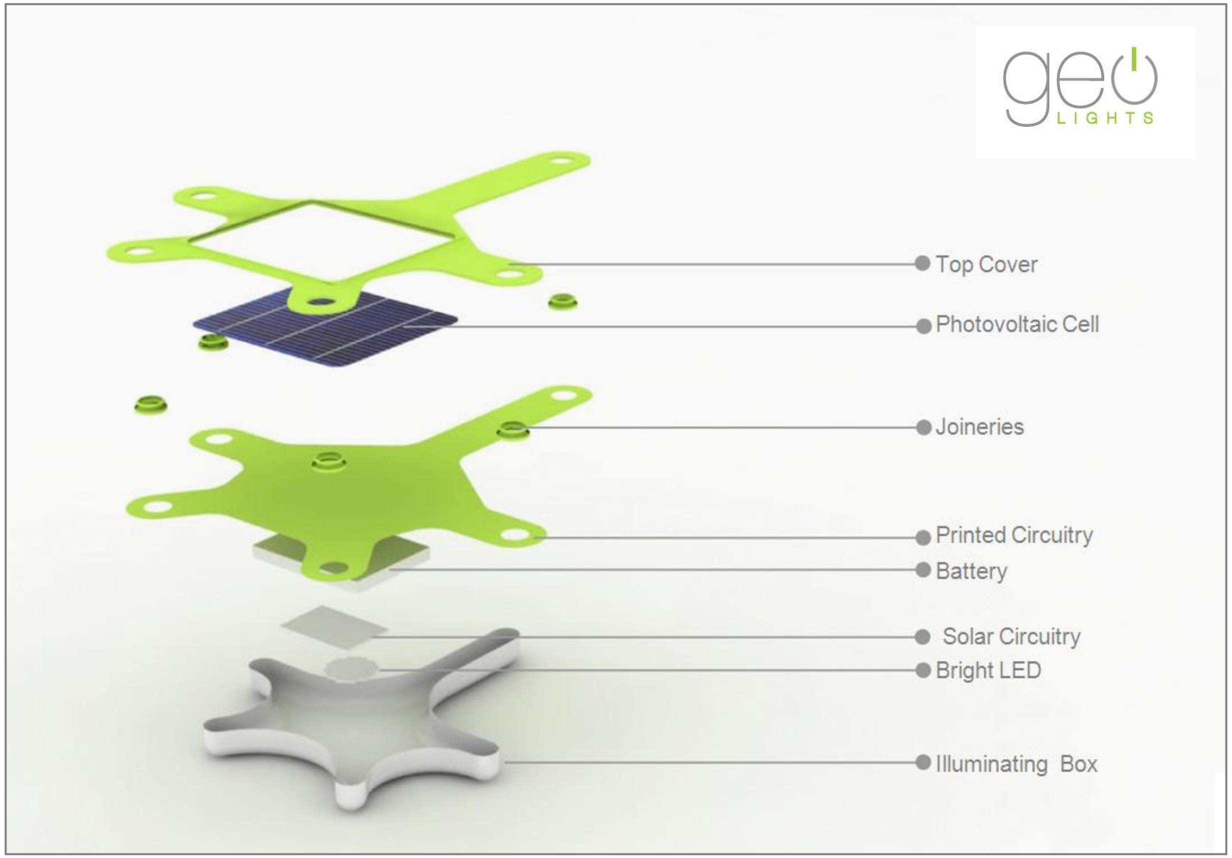


Working of the mother and children

Mother light will have only the solar cell/LED/Battery all others will have LED or LED/Battery Options.

Detail of Mother Geo

Mother Geo will give power to the geo children's.

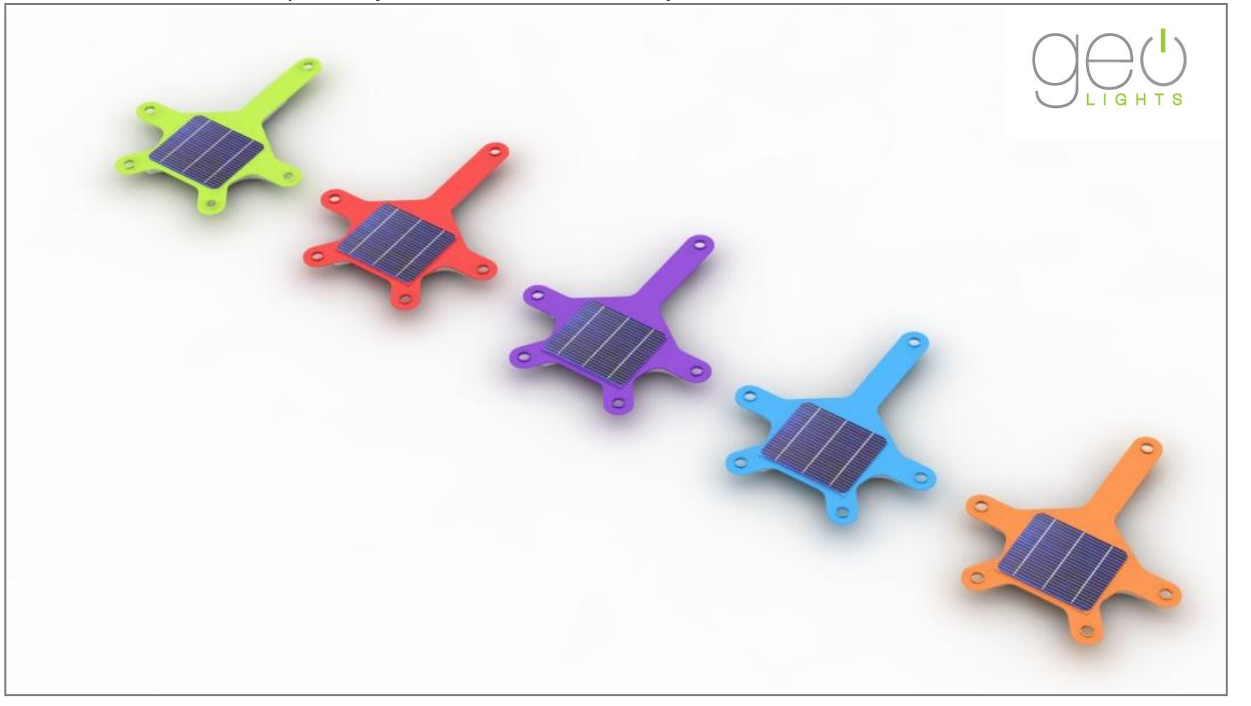


Detail of Geo Children's

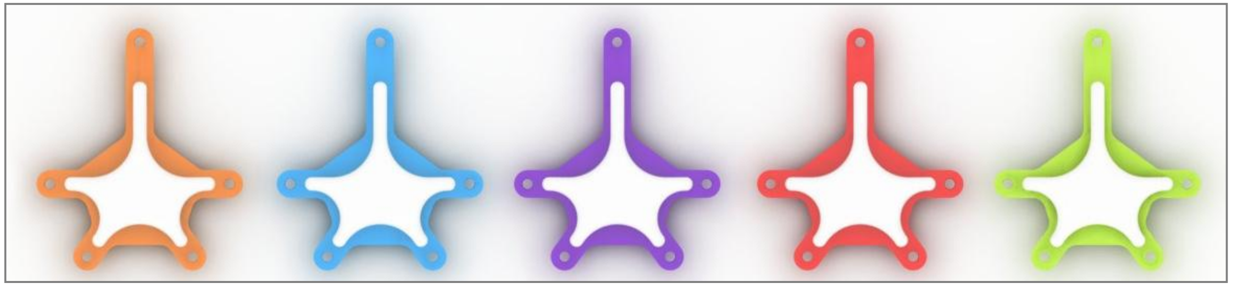
Geo Children's gain power from the mother geo.

Colors available

Each color was chosen perfectly to meet the same family.



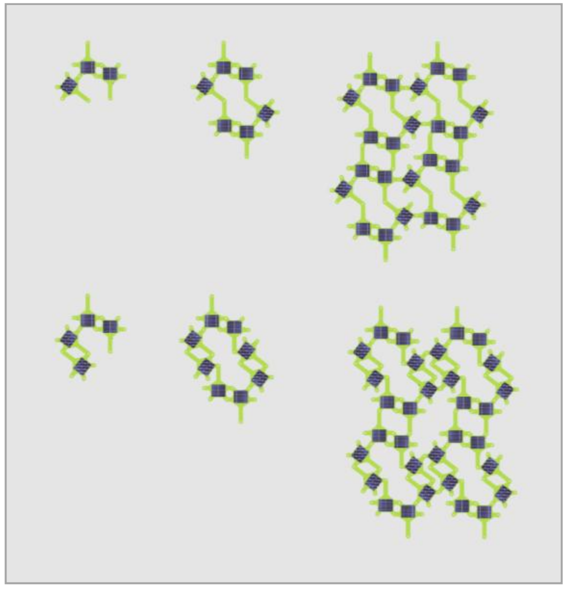
The family has 5 colors orange, sky blue, violet, red and green.



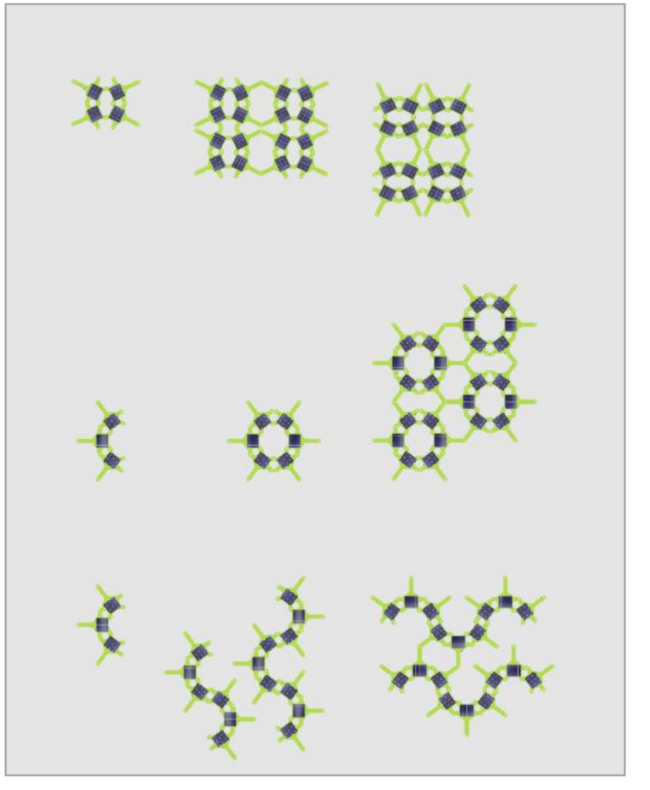
Permutation and combination of Geo lights

Patterning with solar cells as well as with lights.

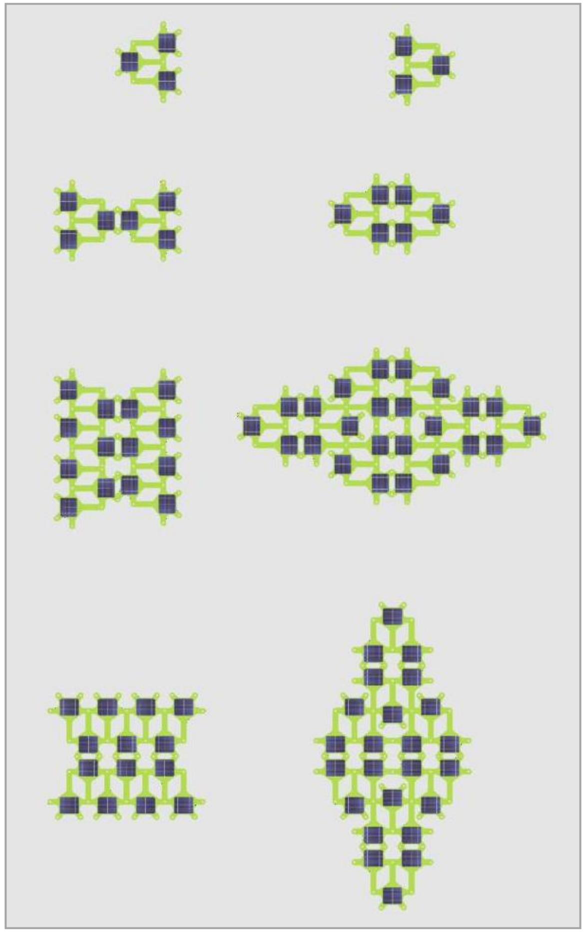
Formula 1



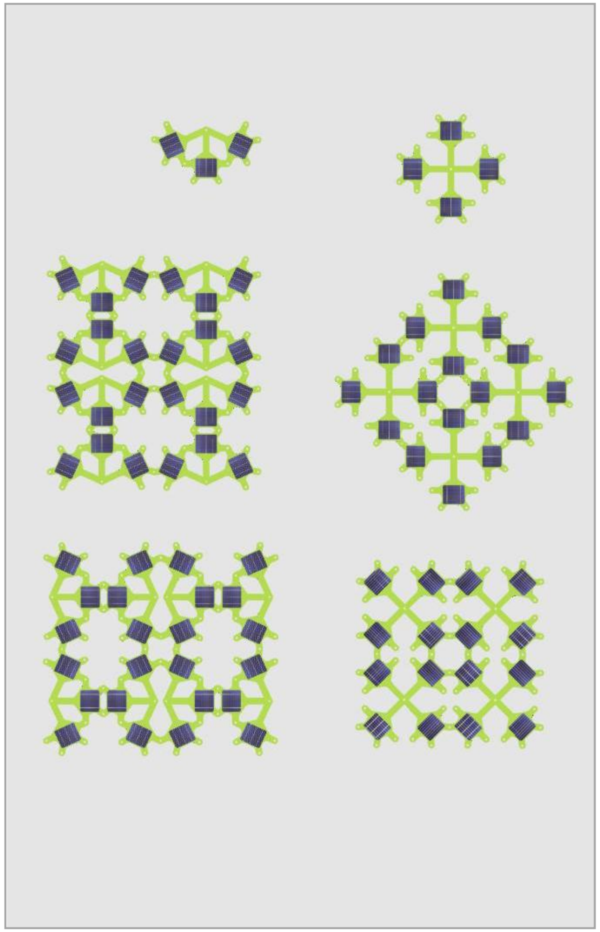
Formula 2



Formula 3



Formula 4



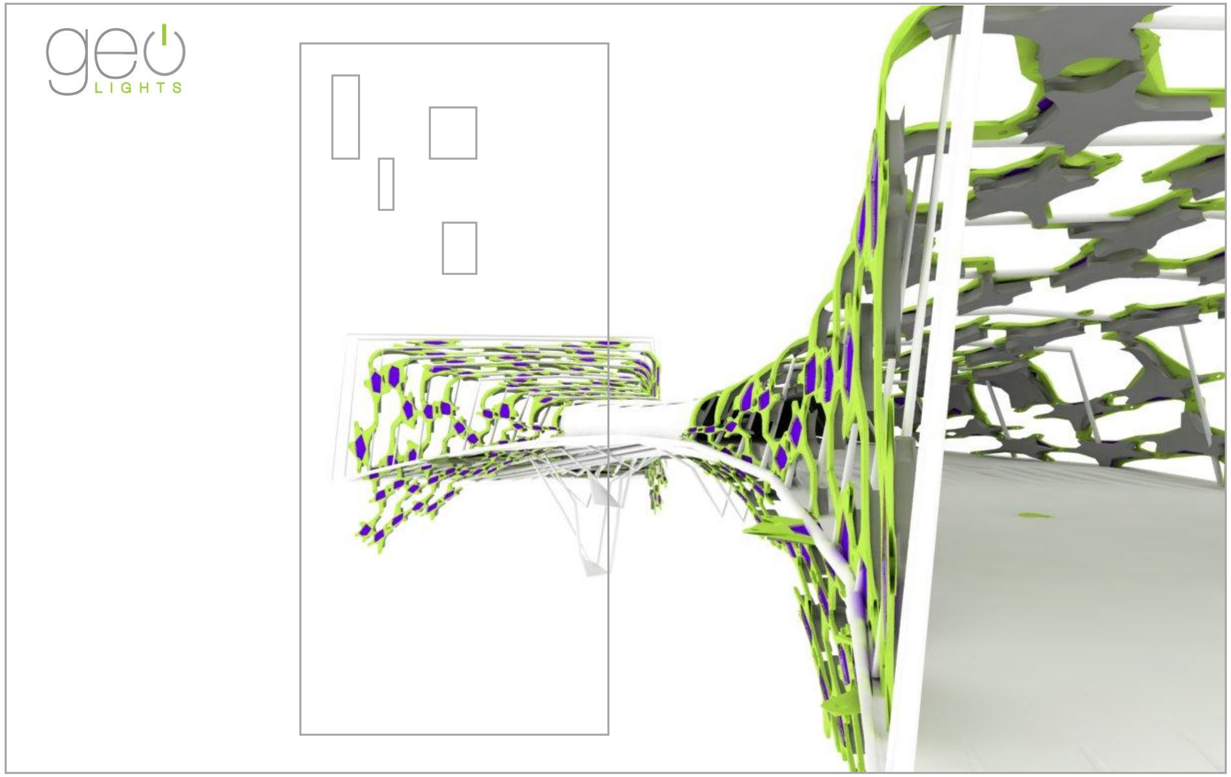
GEO lights in different Spaces

Park installations

Where people can come together and have an experience of light.

In-between Buildings

In future there will be pavilions where people move across the buildings to have a new experience of light.



Cafetaria

Since the permutation and combination of geo light is more you can create any type of form whether it is symmetric or asymmetric the extention of this is shown as installations

Inspired from the form of wine glass

Future Street Lamps

The extension of this various installation lead to the concept of beehive Street lamp.

3.5. Phase 5

Making Prototype

First of all the geometry is checked with the paper mock up

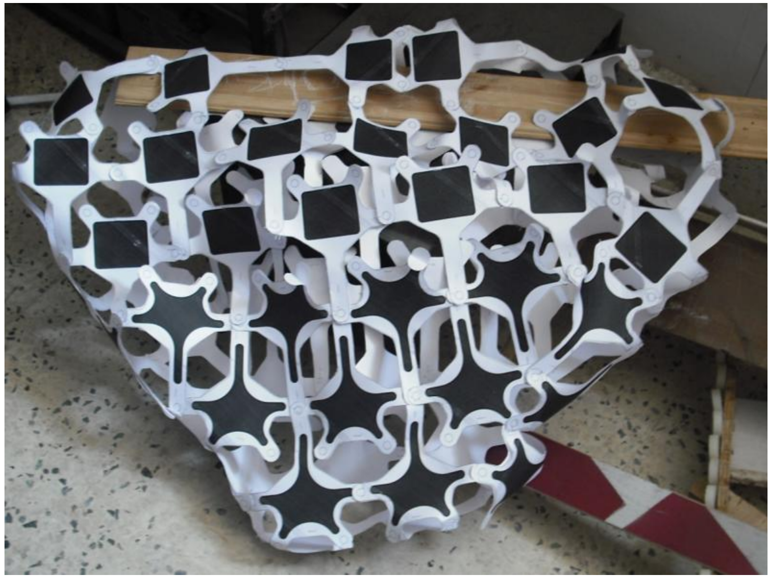


Fig: 3.5.1 Final mock-up for the beehive lamp

System Design

Circuitary mainly consists of a LED Driver circuit,solar charger circuit,12 volt battery, LDR switch for ON/OFF purpose, mono crystalline phovoltaic cells and LEDs.

Materials Used to make the modular boxes

Styrene Sheets - 1 mm thickness and 0.5 mm thickness
Acrylic sheets - 1 mm thickness

Two moulds where made to detail out the styrene at the top surface.
Two moulds where made to make the Acrylic Boxes.

Machines Used to make the prototype

Vacuum Forming machine
Drilling Machine

Material used for joineries
Aluminum rivets

Fig: 3.5.2 Final prototype making

4. Conclusion and Future Scope

4.1. Conclusion

The thesis started with looking how sunlight could inspire and produce design for capturing energy. Later it was discovered that by arranging them in geometrical patterns in space can lead to create enormous number of forms. In the study phase a lot of details of geometrical patterns have been perceived and other things were also explored about the origami, energy, organic forms, new experience, creativity and detailing. In this project an approach of modularity was also explored. It was quite interesting to learn different elements in two geometric shapes and more interesting was the way it has been perceived and interpreted. Different explorations have also been tried and while exploring these, constraints were also clarified.

4.2. Future Scope

Geo lights can be a new dimension of creating forms for architectural fields where light and energy is said to be one of the constraints. It can also be seen as street lamps in future.Geo also can take modularity into another world of creativity in people.

5. References

5.1. References

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5.2. List of Figures

6. Bio-data

6. Bio-data

Kiran.G

Education:

Bachelor of Mechanical Engineering
Panimalar Engineering College
Chennai
Tamilnadu

Master of design (pursuing)
IIT Guwahati
Assam

Contact:

'Rohini'
Near T.K.M Arts College
Karicode
Kollam-691005
Kerala

Email: kiranmech2007@gmail.com
kiran_mech2003@yahoo.com