Jeffrey Bergier RCL Concept Brunel University

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Contents

Remote Controlled Lighting

Screen Capture from RCL Corporate Web Site

A Problem, Solved

Remote controlled lighting set out to solve a problem in the commercial industry. Luxurious dining rooms in spectacular hotels have high ceilings. On those ceiling are lights that illuminate the tables and objects below them. However, if the tables are ever rearranged or changed the lights on the ceiling no longer properly illuminate the tables or the room. The only solution to this problem is to get employees or contracters onto tall ladders to readjust each light one by one until the tables are lit appropriately. Remote Controlled Lighting solved this problem by installing motors into the ceiling mounted spot lights and a control that was accessible to people without hopping onto ladders. This fantastic innnovation frees up the layout of rooms so that a dining situation can be made into a flexible and ever-changing experience.

Of course RCL now has many more products and they appear in many more spaces than just dining rooms. The technology is extremely flexible and powerful. RCL clearly has a bright future. As the technologies they employ become cheaper to design, build and implement, more and more locations will use this technology to enhance the buildings that have already had so much money invested into them. On top of that, RCL continues to stay innovative with a research and development core that not only involves in house designers but also reaching out and developing ideas with young designers

Quoted from LightingAcademy.org - Lighting Designer: Rosenius, Tapio

Tapio Rosenius

“

Tapio Rosenius is the founder and design director of the Lighting Design Collective, an independent design studio with no commercial relationship with any manufacturer or supplier offering impartial service to all clients.

Tapio grew up in Northern Finland exposed to the extremes of 24 hour daylight at summers and 24h darkness at winters. This might have influenced his choice to start exploring lighting, first through photography and then later through theatre, film and show lighting. In 1998 he graduated as a lighting designer from Tampere Polytechnic University specialising in architectural lighting.

Tapio worked in Great Britain from 1998 until 2009. First as a designer for Kevan Shaw Lighting Design in Edinburgh and then as a Director for Maurice Brill Lighting Design in London. He has contributed as a lead lighting consultant to over hundred projects in the UK, Europe and the Middle East ranging from Public Squares to Museums and Exhibitions and from Hotels, Theatres, and Commercial Interiors to Landscapes. In 2009 he moved to Madrid, Spain.

His background in film and show lighting regularly influences his lighting design work. He formed Lighting Design Collective to act as a collaborative platform between professionals from the worlds of architecture, lighting design, visual arts, interaction, film production, and motion graphics.

He has gained a Master of Science in Light & Lighting degree from UCL Bartlett University, London and a Medianomi in Lighting Design degree from Tampere School of Arts and Communication, Finland. He regularly lectures at universities, trade fairs and professional conferences about lighting design for the built environment.

Tapio is a Director of Membership for the Professional Lighting Designers Association (PLDA), representing over 600 members in 52 countries.

Lighting Design Collective studies and experiments with light in response to architecture, its function, ambience and context. The office provides creative lighting design and consulting services incorporating latest lighting technologies and knowledge. The projects are undertaken for architects, designers and end clients such as hospitality groups, developers, museums and public bodies.

Lighting Design Collective offers an eclectic mix of talent and experience with the ability to deliver demanding and unique solutions. Its designers operate internationally with experience covering twenty countries from Europe to Middle East and Central Asia to the Americas.”

Inspiration

Tapio came to Brunel as a guest lecturer. His presentation was extremely inspiring. Tapio put together a smashing presentation to show some of his past work and show his massive knowledge of lighting. Before Tapio began to speak he took the overhead projector, which he had no intention of using, off the desk, put it on the floor, adjusted it and turned it on so that he would be lit perfectly throughout the entire show. But beside that, his past and current work was simply stunning. From the Burj Al Arab to the hippest bars and restaurants in London, everything in his portfolio was stunning. The main inspiration I took from his work was his experience with interactive lighting. From lights that changed colour based on the time of day or lights that looked like water flowing down the stairs, Tapio had experimented with everything. Tapio’s interactive light concepts were the main inspiration for my first concept involving the London City Hall building and a little politics.

02 Project Two

Design Concept for an LED Architectural Light Fitting

Remote Controlled Lighting Ltd.
In the five years since its launch, RCL has established itself as the world's primary manufacturer of architectural spotlights which can be aimed and dimmed from ground level by a hand held remote control. The Director DR2 (the very first product in the RCL range after the DR1 prototype) won the Interior Luminaire Design award at the Light Design awards in 2003. Since then, RCL has expanded its product range to encompass different scenarios where the flexibility of RCL spots is required, and has developed its technology to support various computer control protocols in addition to the basic handheld. *www.rclighting.com*

Project background
The lighting industry is currently in a time of transition. Tungsten based bulbs, commercialised for over 80 years, are in the process of being phased out, which will eventually lead to a global ban. To accommodate this, the lighting industry is already moving over to other sources. One of the most prominent options is LED, due to its high lamp life and efficiency. To keep abreast of the market, companies must investigate new design opportunities that the new source creates.

Brief
You should design and develop an LED architectural light fitting. The design should be innovative either in the lighting effect it produces, its operation, its mounting arrangement, or in the way it fits into its surroundings.
You will have to focus on one of the following sectors of the architectural lighting market:

1. Retail
A very big sector, consider the vast range of different retail environments encompassed by this category. While retail displays are very decorative, the bare bones of most shops are functional and flexibility is key. Therefore fittings should be designed for mounting on a track system for a window or display area, or recessed if designed for a common area. The fittings should blend cleanly into the building and not distract from the merchandise on display.

2. Hospitality and Entertainment
Hotels, restaurants, and bars or clubs.
Atmosphere and interior design are very important in these places so architectural fittings must be minimal or preferably recessed, but not necessarily into the ceiling. Remember, there are interior and exterior elements here, including parks and gardens, or outdoor smoking areas in pubs and clubs.

3. Gallery and Museum
Includes exhibition lighting and illumination of architectural features.
This is a very technical lighting area, colour temperature and IR/UV emissions are considered carefully. This makes LED a very good option in this environment. Exhibit lighting is generally track mounted for flexibility but common areas are often lit by recessed fittings.

4. Office and Commercial
Another huge area, but current solutions can be very constrained – select this option with caution. These areas are generally lit by fluorescent fittings. It is hard to sell LED in this market

The brief is to come up with new and fascinating ways to take advantage of, the still evolving, LED technology. Originally LED's were only bright enough to be used as indicator lights on electronics and, soon after, automotobile dashboards. But as technology progresses LED's are getting brighter. Now they are easy to find in small, power sipping, torches and soon they'll be lighting up our office spaces.

The nerd in me likes LED technology simply because it is so small. A subsidiary of Philips called Lumileds that is based in Silicon Valley, or as I call it, home created the Luxeon Star LED that we are using in our lamp. Well its not exactly a Luxeon Star. Its an asian copy but its functionally the same as the Lumileds original.

It is clear that before any designs can be made, the basics of LED's and how they compare to current lighting technology must be understood.

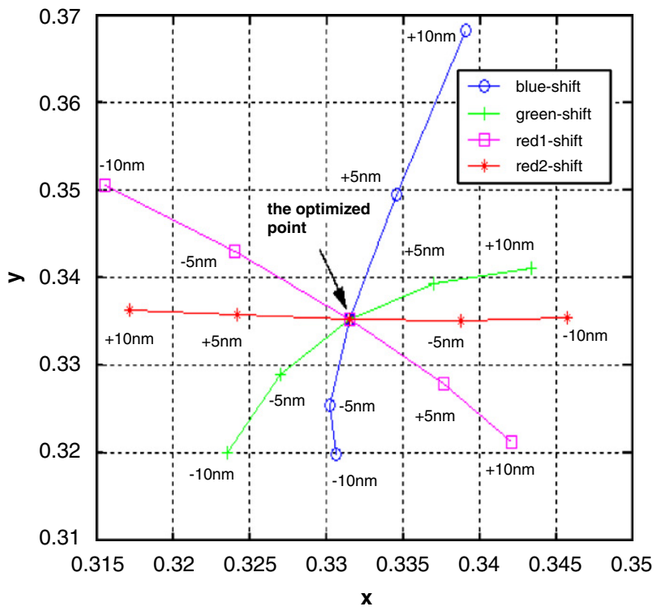

Fig. 8. The chromaticity coordinate changes of the tetrachromatic white LEDs.

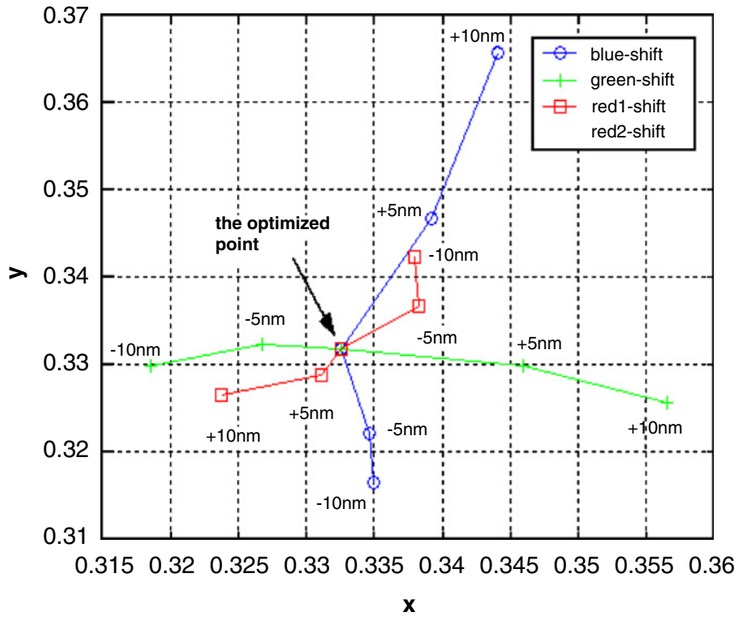

Fig. 5. The chromaticity coordinate changes of the trichromatic white LEDs.

1. Introduction

Since, the incandescent lamp was invented by Edison in 1882, artificial lighting has passed through three phases—incandescent lamp, neon light, and discharge lamp, and has been advancing towards the fourth phase—semiconductor lighting, especially white LEDs, which are already being used in numerous applications such as traffic signals and full-color video displays, due to advantages such as high efficiency, long life, excellent durability, and absence of mercury content. White LEDs are believed to be the attractive ''green lighting source of the 21st century'' and show wide applications and considerable prospective market [1–3].

Luminous efficacy and color rendering are two important characteristics of light sources for general lighting [4,5]. Color rendering is a property of a light source that shows how natural the colors of objects look under the given illumination. If color rendering is poor, the light source will not be useful for general lighting [4]. The main driving force for solid-state lighting is the potential of huge energy savings on the national or global scale. Thus, when considering spectra of light sources for general illumination, another important aspect to consider is luminous efficiency. The luminous efficiency of a source is determined by two factors: the conversion efficiency from electrical power to optical power and the conversion factor from optical power to luminous flux. The latter is called luminous efficacy. As is well known, luminous efficacy and color rendering are determined solely by the spectrum of the source. But there is a fundamental trade-off

There is no such thing as a "white" LED. Light emitting diodes can only be made in blue, green and red. To make an LED that is white, these three colours must be combined and balanced in such a way to achieve a white light. Having truly white colour is extremely important to LED lighting becomging a commercial success. Current incandescent bulbs produce a warm, yellowish to white colour and are very pleasing to our eyes and skin tones. However, they use a lot of power. In office spaces, most facilities use flourescent lighting. Flourescent lighting is relatively low power and of a pleasant white colour. Its not the best light for our skin tones but its not as bad as blue or red light. LED's on the other hand have a lot of trouble getting a white light and maintaining brightness.

The article cited on the left goes through and explains, in a very technical way, how to balance the different colours of LED's and their power output to achieve a bright white light from an LED source. This article explains that there are two types of white LED's. There are trichromatic and tetrachromatic LED's. Trichromatic LED lights have red, blue and green LED's that are mixed to create white. Tetrachromatic have the same blue and green but they have two shades of red that are added to the mix.

The graphs at the left show the optimised point for balancing the different colours to produce the whitest LED possible with either of these two systems. The text below that just gives a basic overview of what the article explains. The copy Luxeon Star that we have is a trichromatic LED and so it has been balanced to meet the graph on the left.

This balance is not adjustable by the end user but it is still important to know how the colour has been balanced and to understand that if this balance is wrong the effectiveness of the light in terms of brightness and colour correctness will be wrong and the LED needs to be replaced with a better balanced model.

Zhang Lei, Guo Xia, Liang Ting, Gu Xiaoling, Lin Qiao Ming, Shen Guangdi, Color rendering and luminous efficacy of trichromatic and tetrachromatic LED-based white LEDs, Microelectronics Journal, Volume 38, Issue 1, January 2007, Pages 1-6, ISSN 0026-2692, DOI: 10.1016/j.mejo.2006.09.004. (http://www.sciencedirect.com/science/article/B6V44-4MBT4RW-1/2/d50ddb815a3e4758eb10bb99b4033f31)

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System dynamics model of high-power LED luminaire

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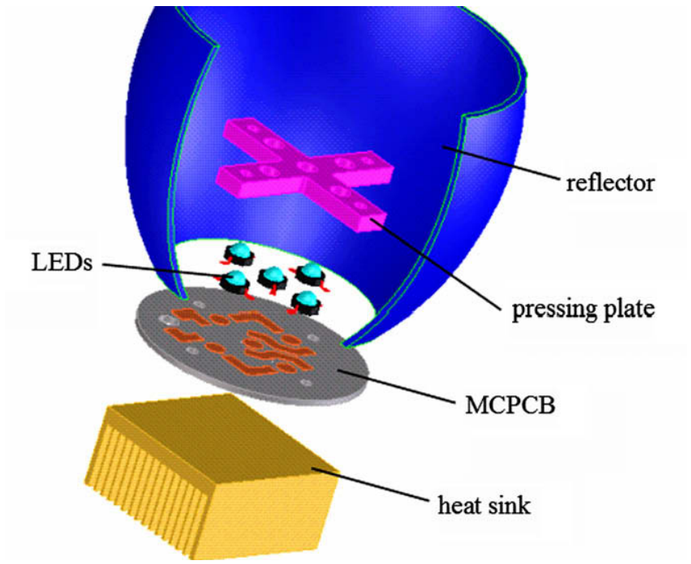
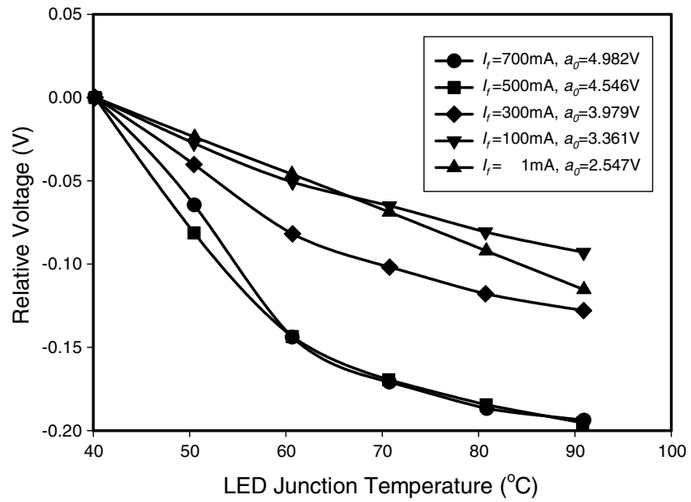
ABSTRACT

Optical properties of LEDs are sensitive to junction temperature. From the principle of solid-state lighting, the luminance of LED is induced from two physical mechanisms: energy effect and optoelectronic effect. Both effects are related to junction temperature. The understanding of system dynamic behavior in junction temperature is quite important for lighting control design.

The system dynamics model of a high-power LED fixture for energy effect was derived and identified in the present study using step response method. Both theoretical and experimental analyses have shown that the thermal system dynamics model of the LED fixture is 4th-order with three zeros and can be reduced to a first-order biproper system. The instantaneous jump of junction temperature dominates the thermal behavior of LED at the beginning of the step input. The optoelectronic effect was induced mainly from the current input and the junction temperature. Combining the two physical effects, an electric-heat-optical system dynamics model of LED luminaire was finally proposed which is the basic system dynamics model for LED luminance control.





Bin-Juine Huang, Chun-Wen Tang, Min-Sheng Wu, System dynamics model of high-power LED luminaire, Applied Thermal Engineering, Volume 29, Issue 4, March 2009, Pages 609-616, ISSN 1359-4311, DOI: 10.1016/j.applthermaleng.2008.03.038.
(http://www.sciencedirect.com/science/article/B6V1Y-4S5FJK4-1/2/265defd93d1b67b937d50510184657b2)

Despite myths to the contrary, LED lights do create heat. If they are powerful LED's they can make quite a bit of heat. Also, because they are built out of integrated circuits, heat can be an even bigger issue than the completely analogue circuits of incadescent bulbs. The article cited to the left explains how to construct and evaluate an LED design for its heat output. Its quite an advanced article but some of the basics are shown to the left.

The most basic is a simple construction of an LED lamp. The key to this element is the big heat sink. This is necessary to vent excess heat away from the printed circuit board and LED elements. The graph to the right of that is a little more interesting. It shows how the voltage available to the LED changes when the amperage and temperature change on the LED. As the LED warms up voltage goes down which means a dimmer LED. This is not good.

The LED lamp in provided to us for this project gets hot but the small piece of aluminium its attached to is sufficient to cool it. Even still there are advantages to giving it a bigger heat sink to keep it even cooler. This will result in a more efficient and brighter LED lamp.

Targeted Market

How Are You Today Stockholm?

EMOTIONAL CITIES
BLOG

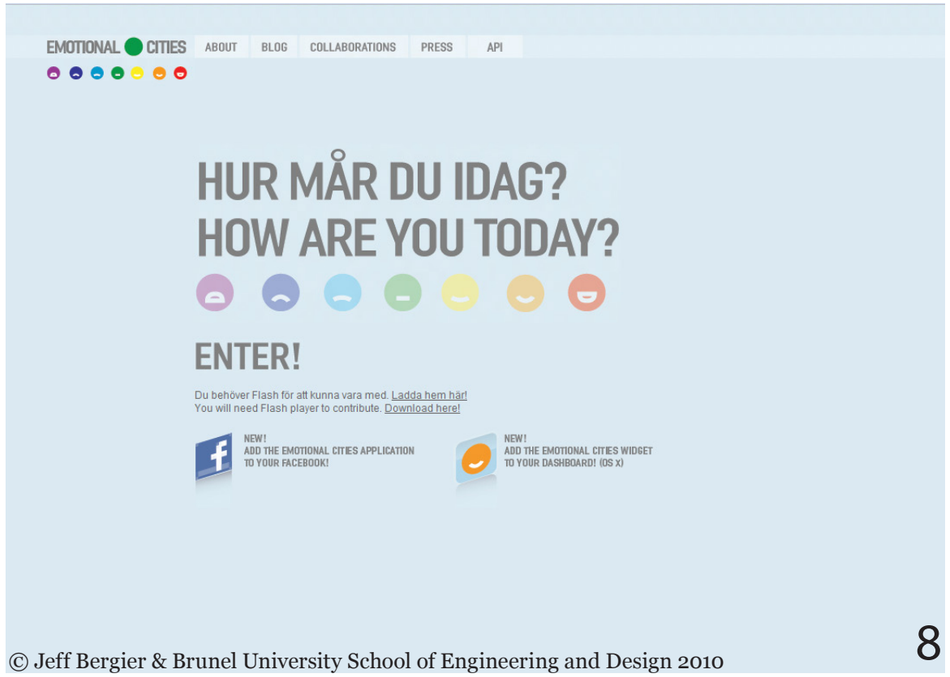
Archive for the ‘Pressrelease’ Category

Stockholm tonight!
Saturday, November 1st, 2008

The market I am targeting with this lighting project is small but it is growing. This is very exciting. To the left is an image of some of the largest buildings in Stockholm showing how the people of that city feel. Sadly the best picture I could find is Stockholm while purple which indicates deep depression. Nonetheless this idea really excites me. Buildings should let people know what is going on around them at a glance.

A company called Emotional Cities appears to be working on a system to allow simple web integration with an emotional city lighting system. This kind of system is beyond the scope of this project, so to know that it already exists and could be licensed makes the rest of the development a little easier.

What will the proposed design do differently from what already exists in Sweden? These buildings are already showing emotion with colour. The new addition that I intend to bring to the mix is showing emotion with shape as well as colour.

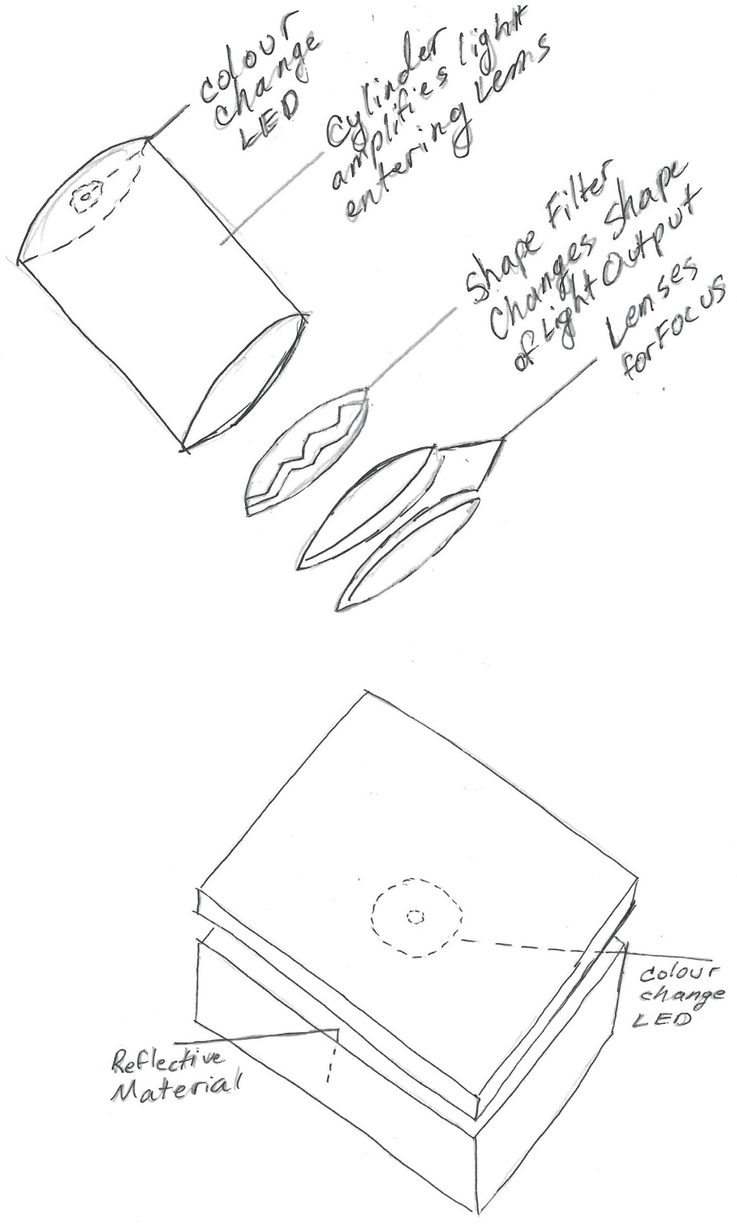


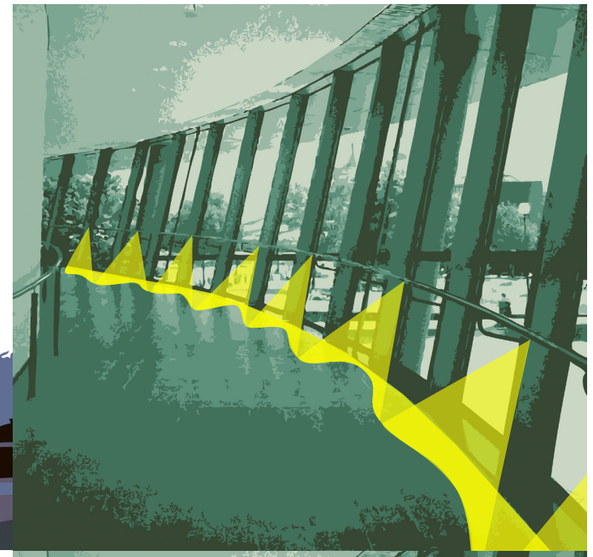

The First Idea
Let's Get Political

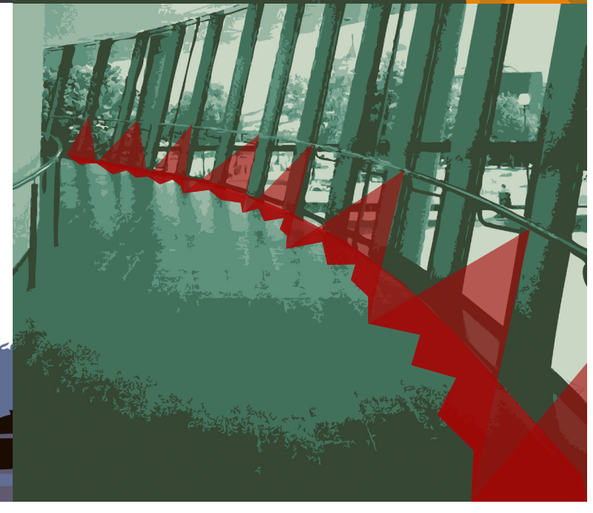
A Concept for Remote Controlled Lighting

A visual realisation of Boris Johnson's Popularity

A system for building identity in commercial spaces







Colour Shape Focus

Feedback

Because of how powerful Tapio's past work and presentation was I gravitated towards his perspective on how to make really cool architectural lighting effects. Tapio's perspective involved mostly digitally controlled lights. Tapio used projectors, lights, filters and other technologies combined with digital computing circuitry to make truly dynamic lighting for the interiors and extoriors of famous buildings around the world.

After presenting my initial idea to RCL it became clear that they were not interested in how a computer would interact with a light. They want an actual analogue effect that was interesting and dynamic. Listed below I have a summary of what the folks from RCL said about my initial concept.

The Good,

The guys from Remote controlled lighting absolutely loved the idea of the people of London voting for what colour the GLA would be lit up in. They thought there was no better way to give Boris Johnson a hint.

The Bad and

Lighting up buildings with LED's is boring and its been done. The idea I gave them was completely based on the software controlling the colour change and had nothing to do with a new and interesting way to illuminate a building.

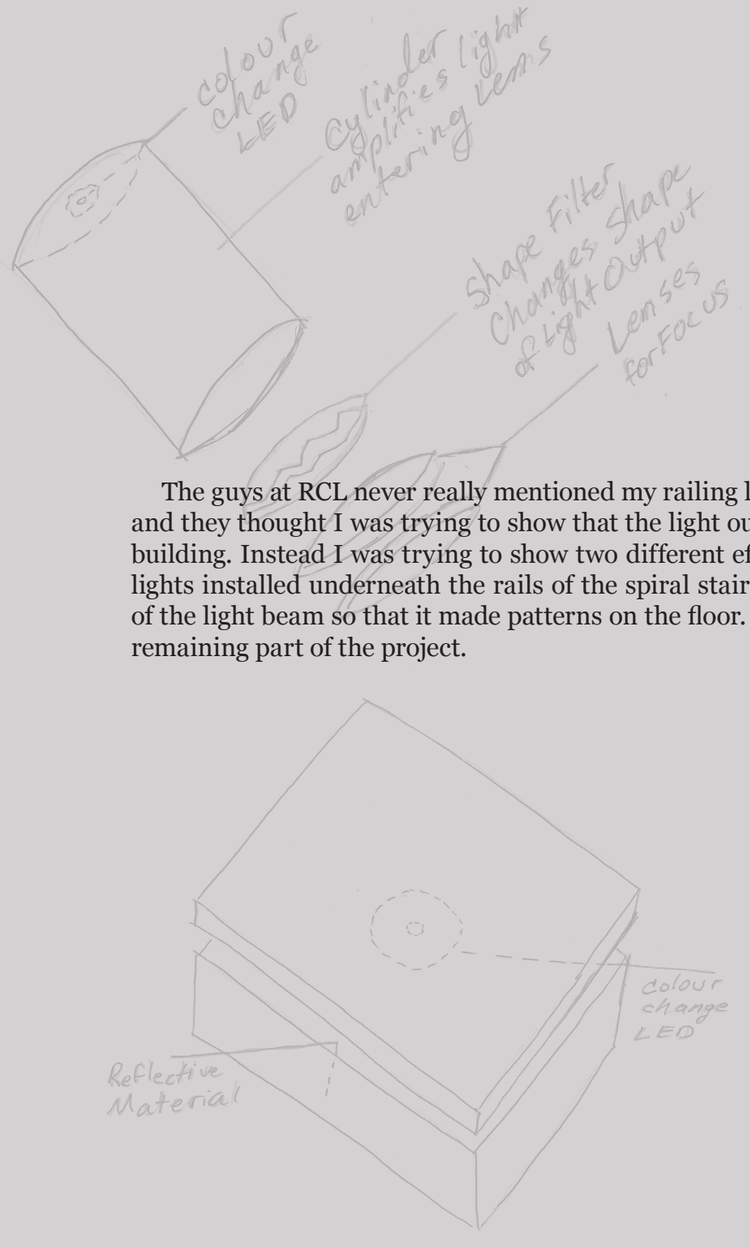
The Ugly

"Back to the Drawing Board." Thats literally what I was told. Clearly Tapio had influenced me too much. I was trying to build a neat and interactive system with which to control lighting. The RCL guys simply want an effect that can be used in an architectural setting.

A Concept for Remote Controlled Lighting

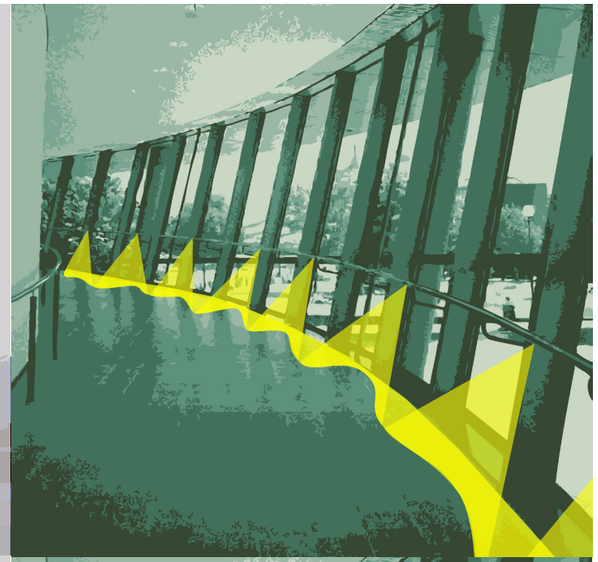
A visual realisation of Boris Johnson's Popularity

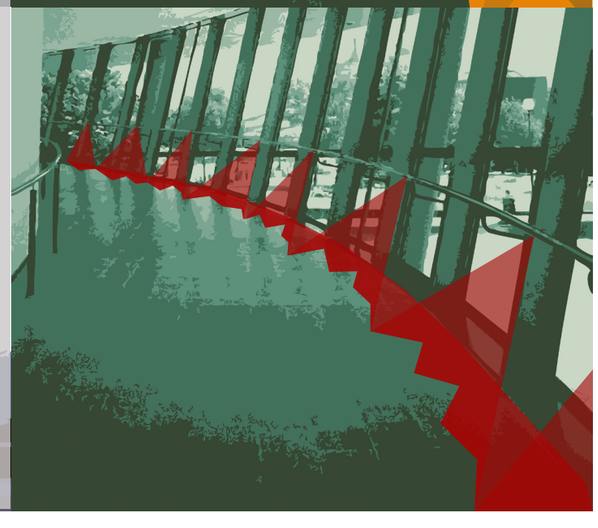
A system for building identity in commercial spaces



Focus

The guys at RCL never really mentioned my railing lighting. The presentation was not clear and they thought I was trying to show that the light outside the building was shining into the building. Instead I was trying to show two different effects. The indoor effect was a series of lights installed underneath the rails of the spiral staircase. The light could change the shape of the light beam so that it made patterns on the floor. This is the effect I will focus on for the remaining part of the project.

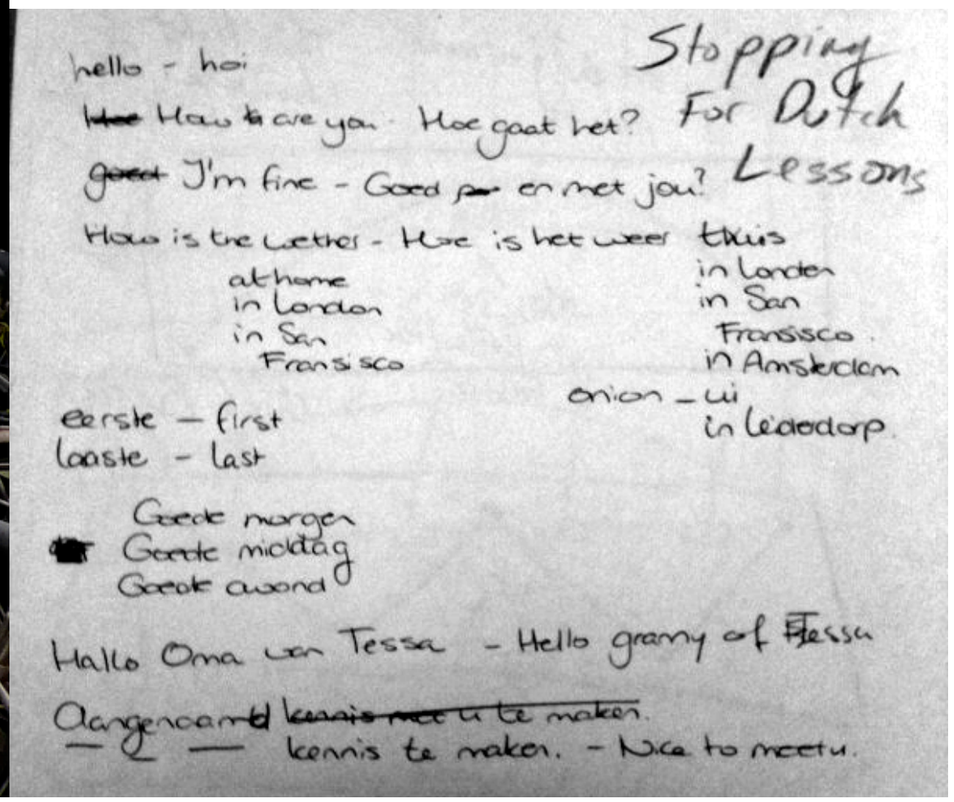




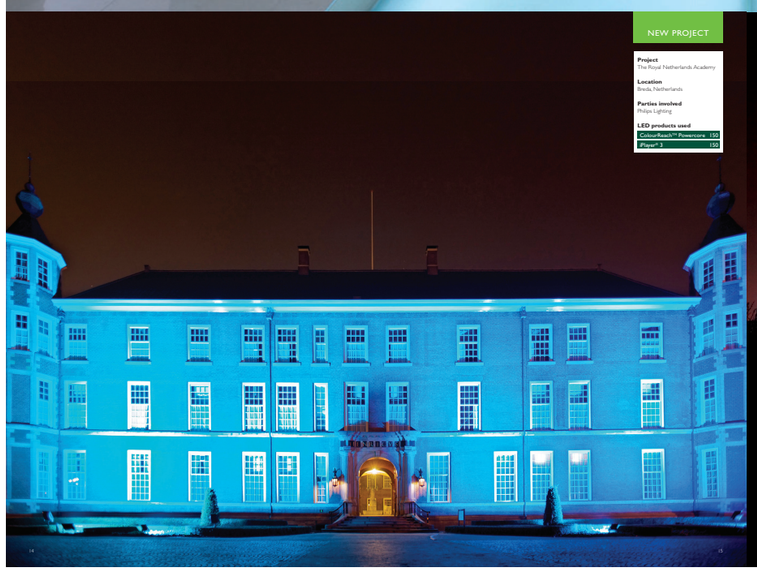
Colour Shape Focus

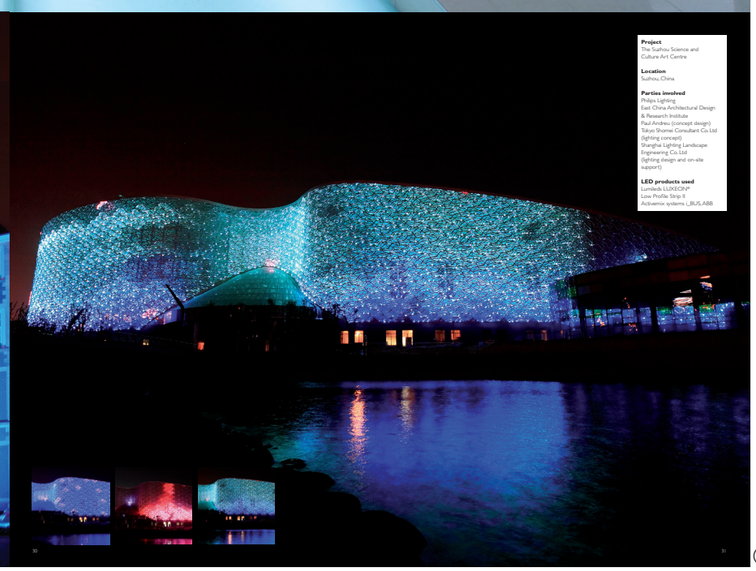
A Trip to the Netherlands

Seeing as the Luxeon Star was developed by a Philips subsidiary, it seemed only reasonable to visit. A one-day lesson in Dutch and a 45 minute flight brought me to the city of Delft. While I was initially surprised by the number of bikes, it is clear that the Philips is the brand when it comes to Dutch lighting. Every houseware, electronics, entertainment and any other type of store carry all kinds of Philips lighting products. Some are cheap and consumable and simple. Other products are absurdly expensive and decorative. One thing became clear from this trip; the Dutch certainly stand by their lighting brand



“Solid State of the Art”





These people love lighting

Philips is one of the biggest pioneers in all forms of lighting. They are particularly famous for their architectural lighting. Well maybe famous is the wrong word. Its hard to associate architectural lighting with a specific brand because, to most people, its just “there.” But Philips is a company with an extremely vast portfolio of advanced architectural lighting.

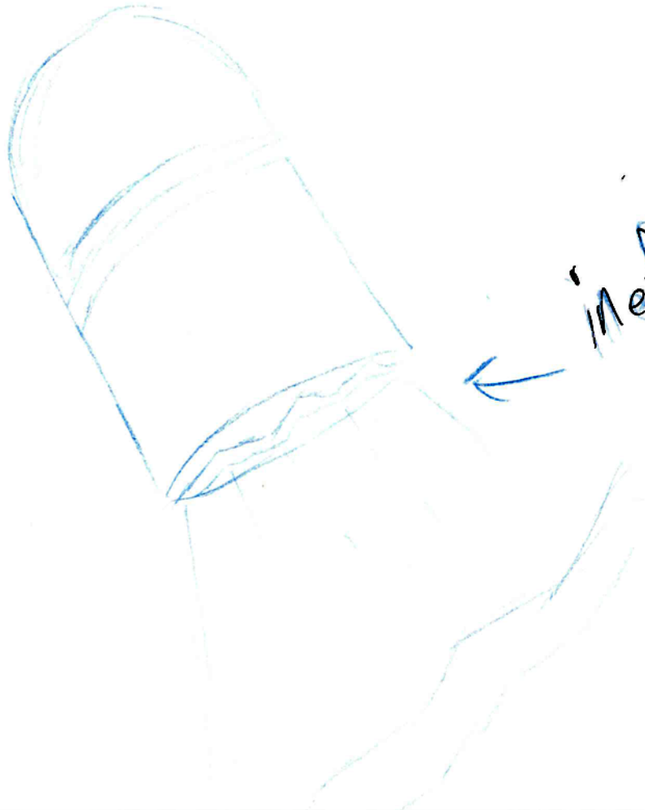
Philips Lighting Catalogue for 2009

This catalogue has no pricing of course. It does, however, have beautiful images of beautifully lit buildings and rooms. No seriously, they’re beautiful. Along side these buildings are images of the lights that do the actual work. What struck me about them is that the architectural lights are usually a tad boring. It makes sense. Most of these lights will never be seen. This is what I’m going to bring into my design. Its all about the effect, not about the looks of the light fixture. So what look do I want?

Leading to the Centre

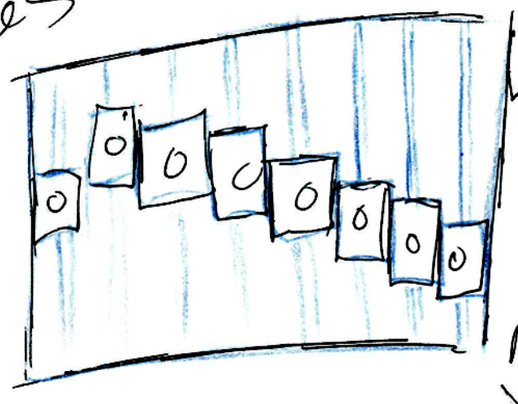
These LED's are showing a path. They lead to the centre of everything. They light the way. They are elegant, skinny and to the point. While the purple glow around them may be a little ostentacious, they do their job and they do it well. This is in the inspiration for my LED architectural lighting. I am quite struck by the honesty and effectiveness of these LED's

More Lamps



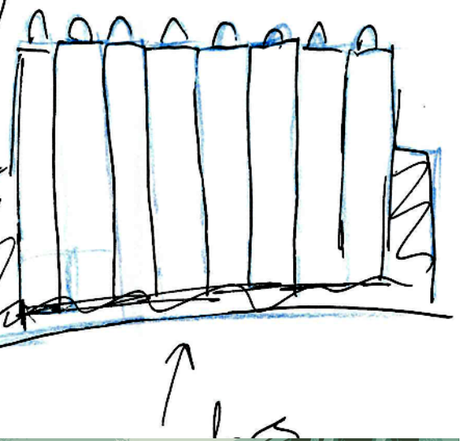
Floor Tiles

inefficient

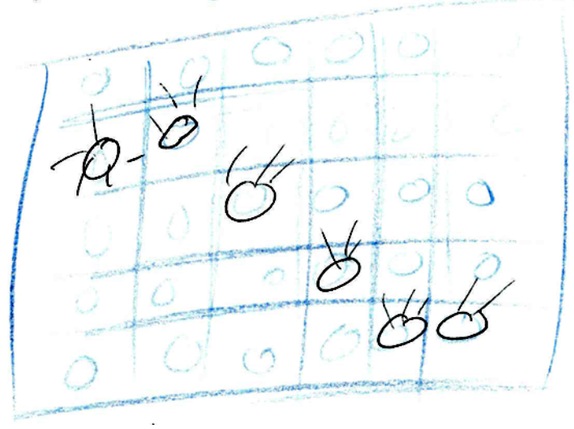


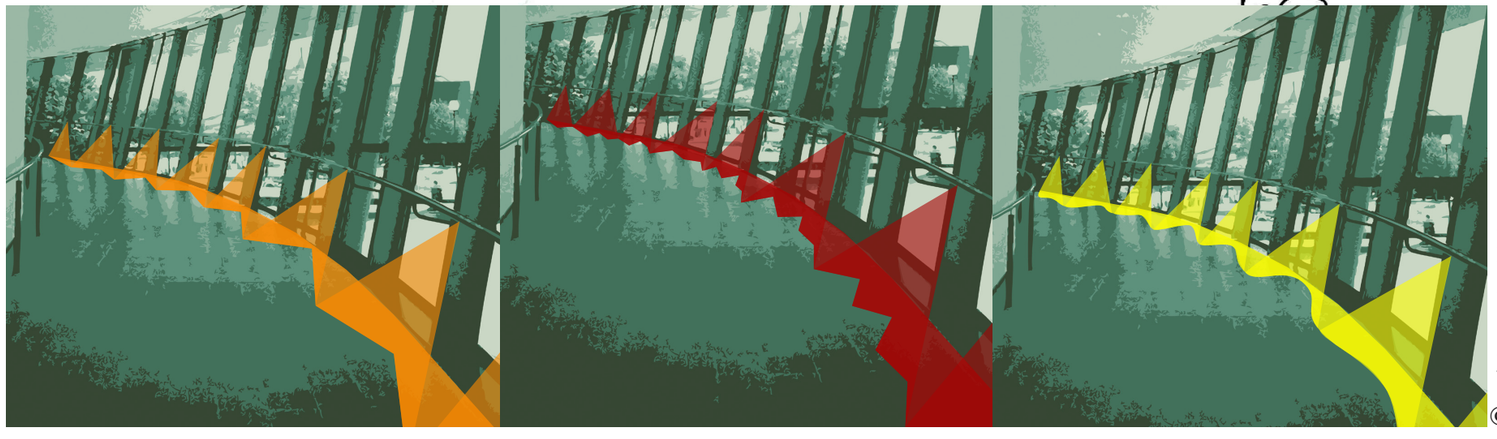
slides

moving parts = bad
creates more = good
natural movement



Illuminate Something other than itself





An initial projection idea on the left showed the effect I wanted to achieve. Its very faint but the line is jagged across the floor and that shows the “shaped” light pattern. But it seemed like a better idea to have a tile on the floor with LED’s. The first tile concept is in the middle and shows LED’s on rails and motors that move to different shapes based on how they are programmed. Then the obvious next step was to get rid the moving parts and just use a basic LED matrix. The matrix just sites in the floor tiles and can be programmed to take any shape.

due to high diode cost and quantities required to produce sufficient ambient light, but for smaller offices the source could be beneficial. Light fittings are generally suspended or surface mounted. Aesthetics are often a marginal consideration to the buyer, and therefore also to the designer.

Important Notes
Carry out your own initial research before selecting a market sector. You should state when submitting the concept which market sector you selected.

The fitting should connect to a low voltage or mains power source and be mounted in keeping with the options currently used in your chosen market sector, unless your system relies on a unique mounting element.

The design proposal must produce a functional light output – LED mood lights that only 'glow' will not be accepted.

The light output level of the supplied source is low but it is acceptable to assume that the design can be scaled up in production (a lot of commercial LED lights use a cluster of individual diodes in a single fitting) or installed in multiples and the student should state whether their concept will use a single diode or a cluster.

Beware, although a cluster is more powerful, some effects produced with a single diode source will not work with a cluster. If you state the fitting would use an LED cluster but have a concept and prototype that would not work with that arrangement, it will count against a good design during assessment.

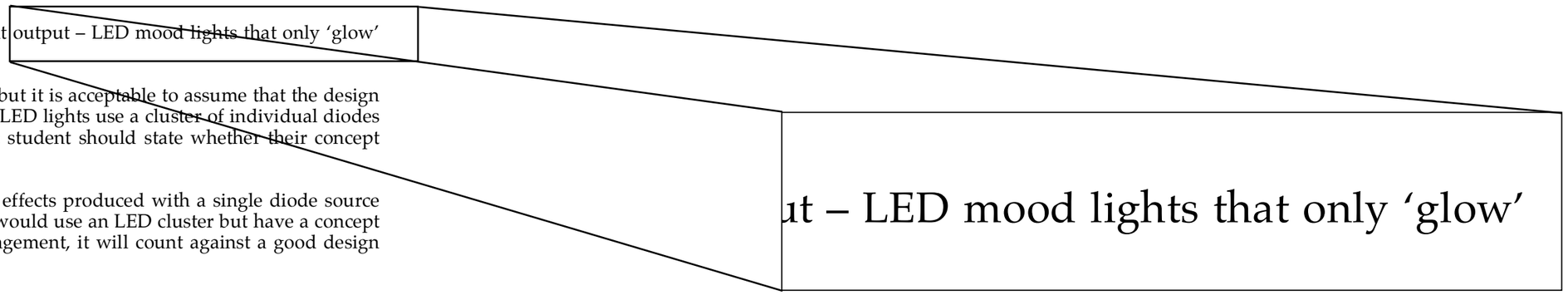
In addition, an understanding of how the fitting(s) will be manufactured is essential. It will be enough to state two or three main processes used to produce the fitting, but it will also count against a good design if your suggestions for manufacture are not realistic.

Summary RCL assessment criteria
Innovation eg one or a combination of; lighting effect, operation, mounting details, fit to surroundings
Efficiency/effectiveness of lighting effect
Aesthetic and detail quality
Sound manufacturing considerations
(note that the Brunel assessment includes additional considerations)

Deliverables and Time Scale

8th October 2009 -	Briefing Lecture from Remote Controlled Lighting, PT, Stephen Green and Peter Evans - 'let there be light'.
15th October 2009 -	RCL/ Guest lighting designer presentation.
7th November 2009 -	Concept presentations submitted to U-Link by midnight. A3 PDFs should include:
	* Clear Indication of the chosen market sector
	* General overview of the concept – Graphical depiction of the concepts effect or operation. Innovative or unique elements should be highlighted.
	* Photographs of any PPPs are a great benefit at this stage.
12th November 2009	Remote Controlled Lighting feedback meetings from submitted concepts.
17th December 2009	Final 2D and 3D submission (for RCL review – Brunel requirements covered separately)

But the Brief!

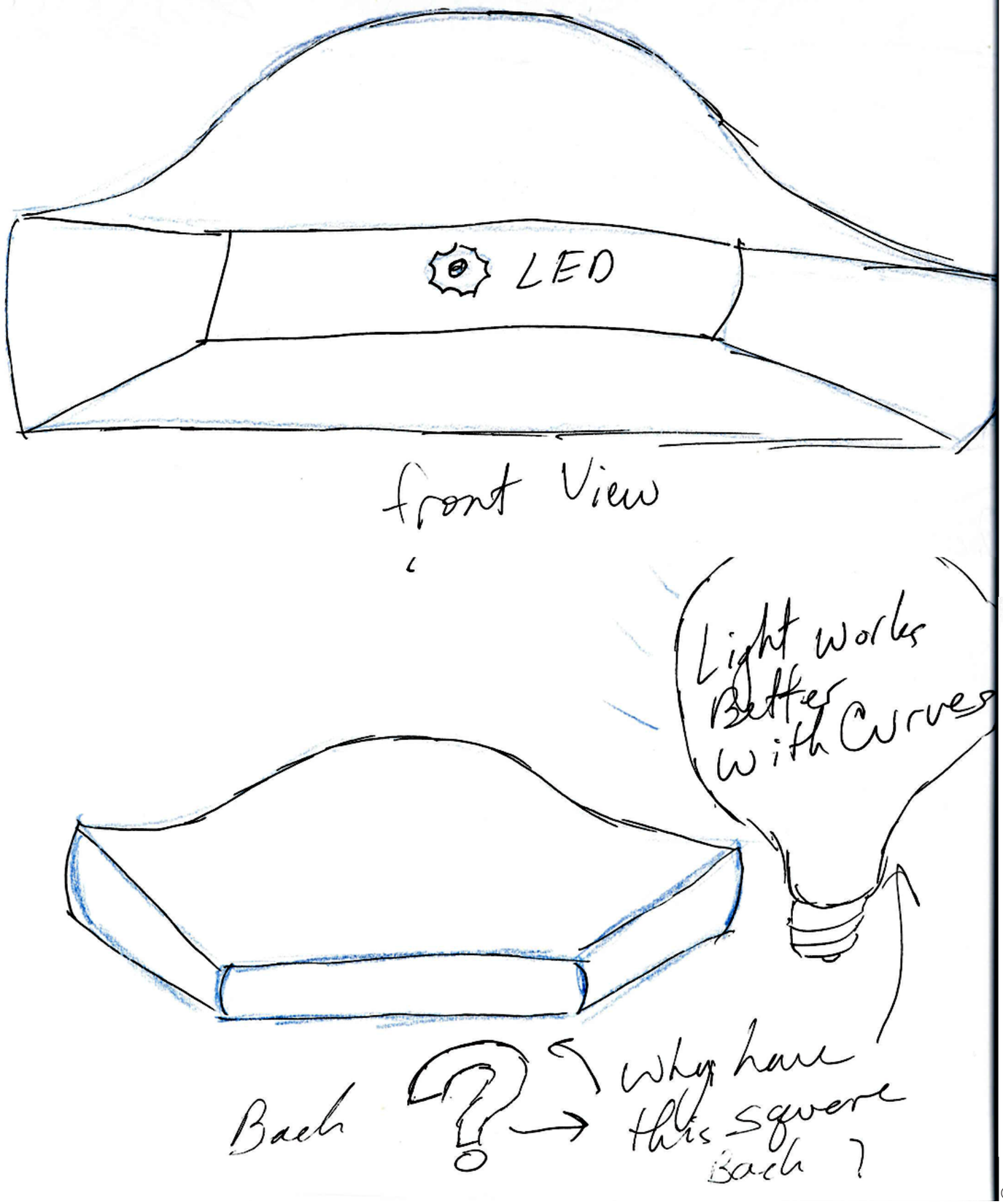


LED lights that ONLY glow! What condescending phrasing. All lights just glow. Then we focus that glow into a certain direction to project. But if RCL wants projection, I'll give them projection.

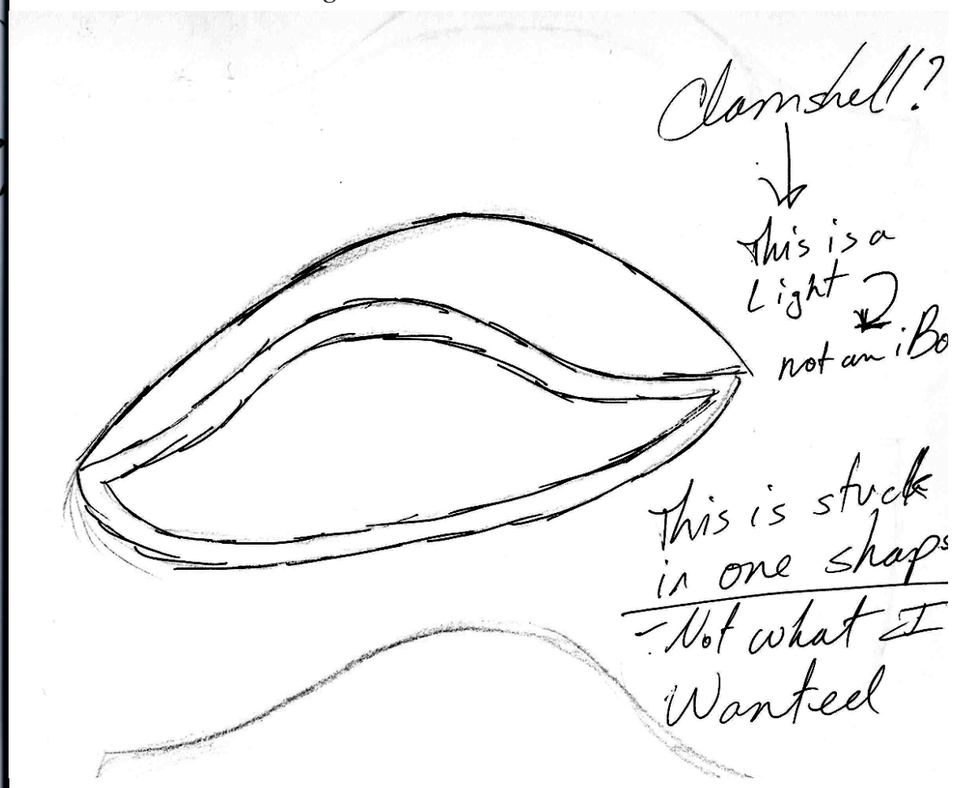
Projecting

Masking tape and Aluminium foil. Its not pretty but it projects a focused and shaped light. I simply covered some heavy card stock with some aluminium foil and bent it into a curved shape. Once I turned off the lights and held the fake luxeon star up to it, a perfect projection of the shape hit the ground. Its not extremely bright because a lot of light is lost towards the bottom as its not covered. This is a replication of an LED matrix tile with projected light. This may even be an improvement because it doesn't look digital, it looks analogue. It looks natural.

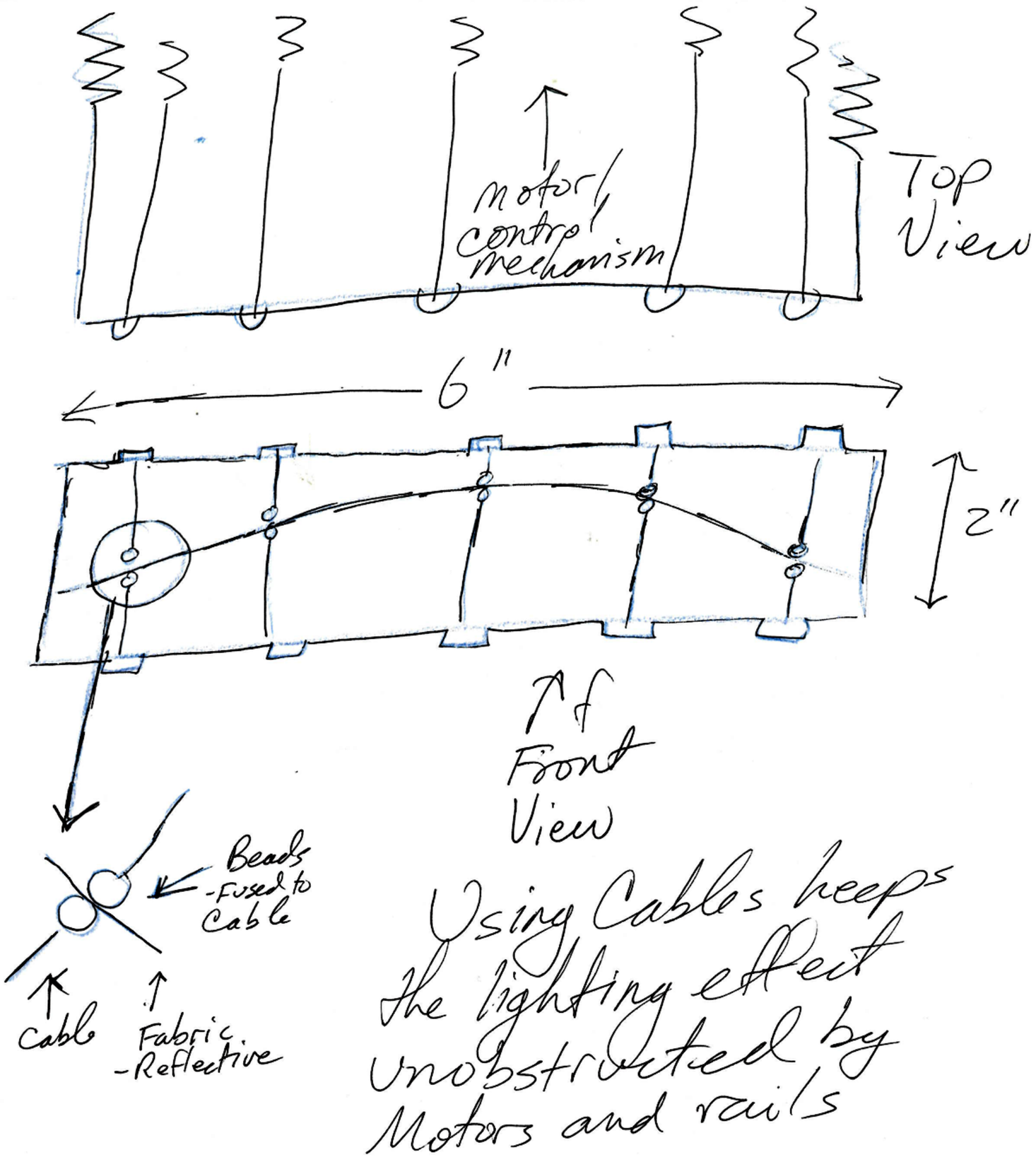
Designing the Fixture



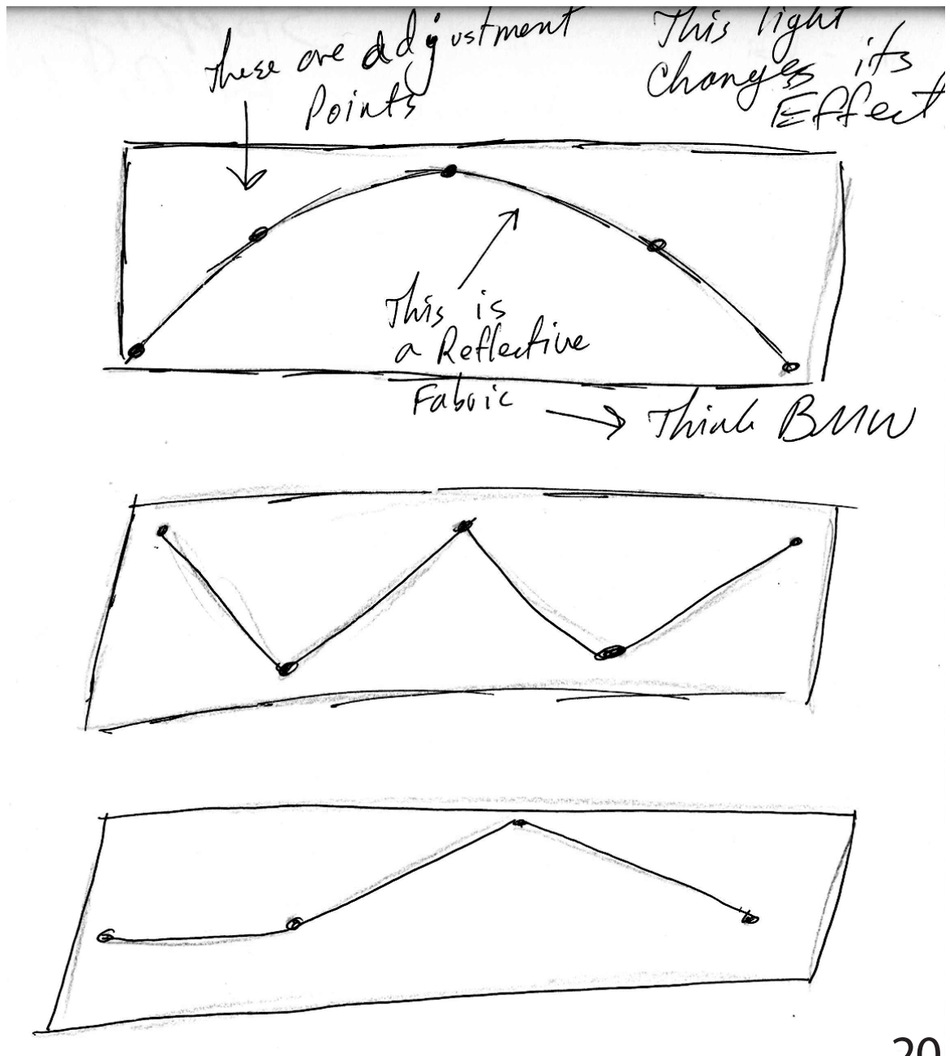
Initial sketches showed a a light fixture that had a curved top. The idea was that this top would shape the light as it hit the ground. But the problem with these ideas is that they are fixed. The shape cannot change like I had originally wanted. This was not a flexible system at all. It would just display one shape and on the floor and it can never change.



Making it Flexible

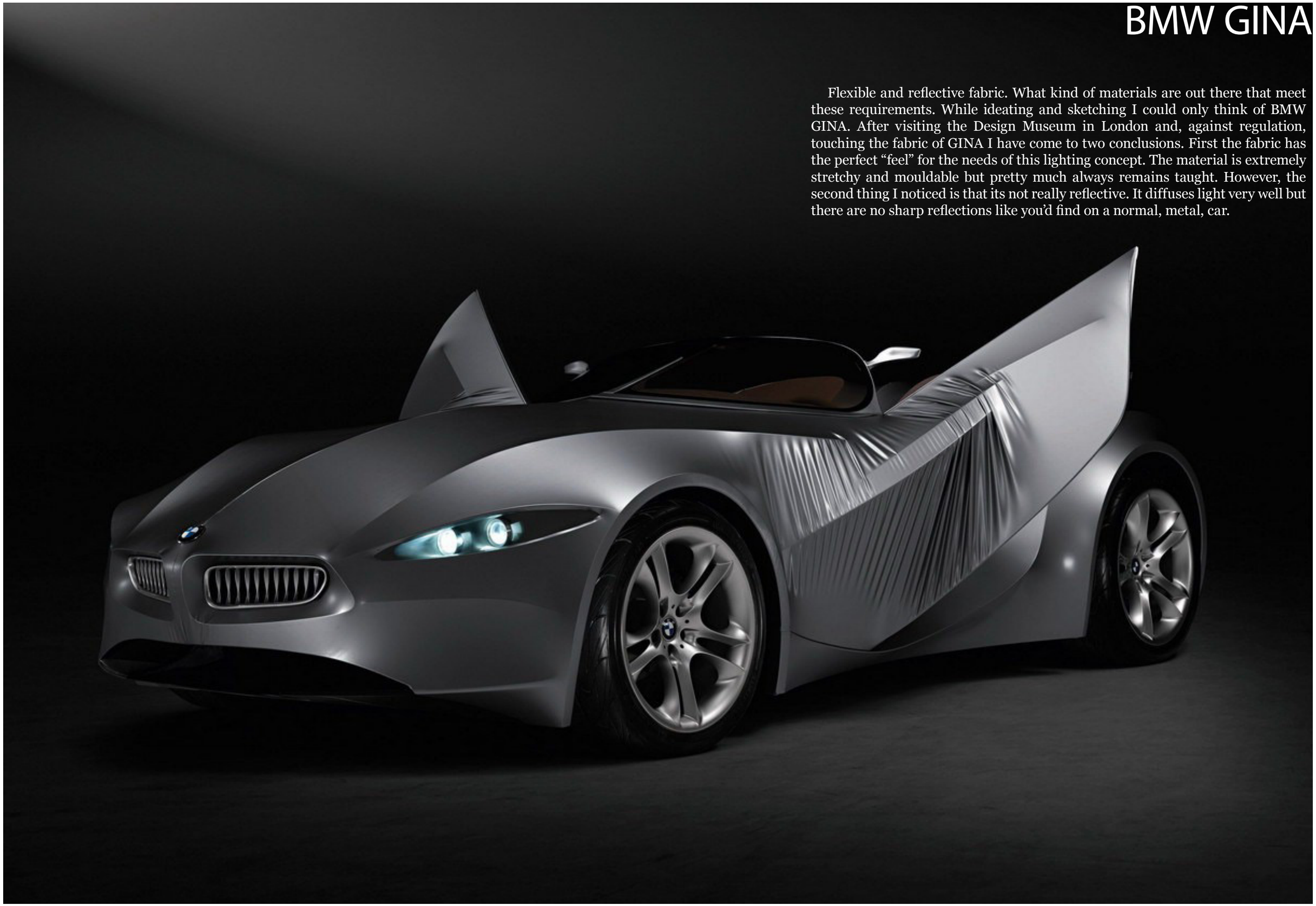


Some more sketching revealed a design that uses some sort of reflective fabric attached to control cables. These cables can pull the fabric up and down to create one of many possible shapes. Below are some examples of the shapes possible with a 5 point control system. On the left is an idea of how to hold the fabric onto the cables in a reliable way.



BMW GINA

Flexible and reflective fabric. What kind of materials are out there that meet these requirements. While ideating and sketching I could only think of BMW GINA. After visiting the Design Museum in London and, against regulation, touching the fabric of GINA I have come to two conclusions. First the fabric has the perfect “feel” for the needs of this lighting concept. The material is extremely stretchy and mouldable but pretty much always remains taught. However, the second thing I noticed is that its not really reflective. It diffuses light very well but there are no sharp reflections like you’d find on a normal, metal, car.



High Visibility

I think the best example of a reflective fabric is what the police officers in London have to wear, high visibility jackets. The silver stripes on these babies reflect light like a mirror. Maybe brighter. If this light were to move to prototyping stage varying fabrics would need to be tested. The most extreme in reflectivity would be this type of fabric. The most mundane would be a softer, stretchier fabric similar to what GINA uses.

High Visibility

BS 471:2003

To play a pun on a popular mobile phone marketing campaign, “There’s a British Standard for That.” British Standard 471:2003 covers the “Test methods and requirements” of “High-visibility warning clothing.” While it is not particularly helpful in explaining the science behind how this reflective material works, it does categorise and provide some insight as to how this material is used in the real world with real people.

First there are different names and definitions based on different standards. The name of the material that I’m interested in for this project is the “Retroflective Material.” This is the material that you see as bright stripes when you drive past a wearer with your headlights on.

Second, there are different classes of these articles of clothing. The different classes have to do with the ratio between the different kinds of materials on the clothing and the different reflectivity rates properties of the retroflective material.

Lastly, there are standards for optimising the spacing between stripes of retroflective material on clothing to create maxiumum visibility.

This British Standards document provides an insight into how robust this material is. There is further information on weatherproofing and other such requirements that these garments are required to pass. However it does not provide an insight into the science behind how this material reflects light with such efficiency.

4 Design

4.1 Types and classes

The warning clothing is grouped into three classes. Each class shall have minimum areas of visible materials incorporated in the garment in accordance with Table 1. Garments shall comprise the required areas of background material and retroreflective material or alternatively shall comprise the required area of combined performance material. Examples are illustrated in Annex A. The area shall be measured on the smallest garment size available and fastened to the smallest configuration possible.

Table 1 — Minimum required areas of visible material in m²

	Class 3 garments	Class 2 garments	Class 1 garments
Background material	0,80	0,50	0,14
Retroreflective material	0,20	0,13	0,10
Combined performance material	-	-	0,20

The proportion of the required background material shall be 50 % ± 10 % on the front and backside of the garment. The garment is to be measured flat on the table including torso, arms and legs.

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
high-visibility warning clothing
warning clothing intended to provide conspicuity at all times

3.1.1
fluorescent material
material that emits optical radiation at wavelengths longer than absorbed

3.1.2
background material
coloured fluorescent material intended to be highly conspicuous, but not intended to comply with the requirements of this standard for retroreflective material

3.1.3
retroreflective material
material which is a retroreflector but which is not intended to comply with the requirements of this standard for background material

3.1.4
separate-performance material
material intended to exhibit either background or retroreflective properties but not both

Annex A
(informative)

Examples for positioning of bands of retroreflective material

The following examples may be used for the design as indicated in 4.1.

Note Other models may also comply.

Dimensions in millimetres

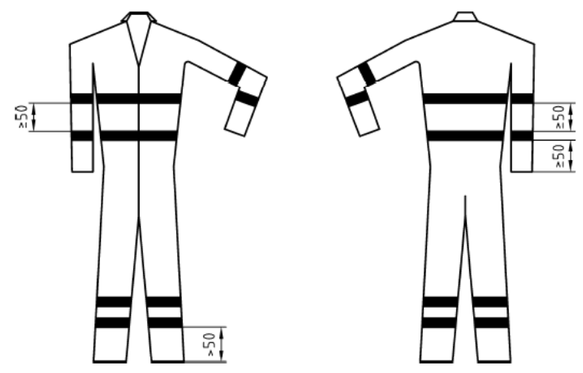


Fig. 4. Measuring condition for retroreflective lights.

When a ray enters into a medium of lower refractive index, it is reflected without refraction, which is called 'total reflection', within a RIA θ_1 defined as in Eq. (2):

$$\theta_1 \leq \sin^{-1}\left(\frac{n_2}{n_1}\right), \quad n_1 > n_2 \tag{2}$$

Reflectance is represented as reflected light intensity defined as in Eq. (3):

$$\text{reflectance} = \begin{cases} \dfrac{(n_2 - n_1)^2}{(n_2 + n_1)^2} & \text{if } \theta_1 = 0^\circ \\ 1.0 & \text{if } \theta_1 = 90^\circ \\ \dfrac{\sin^2(\theta_1 - \theta_2)}{\sin^2(\theta_1 + \theta_2)} & \text{otherwise} \end{cases}$$

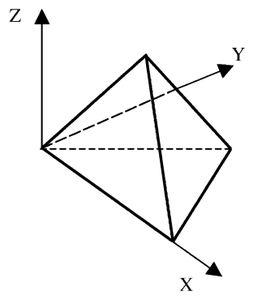
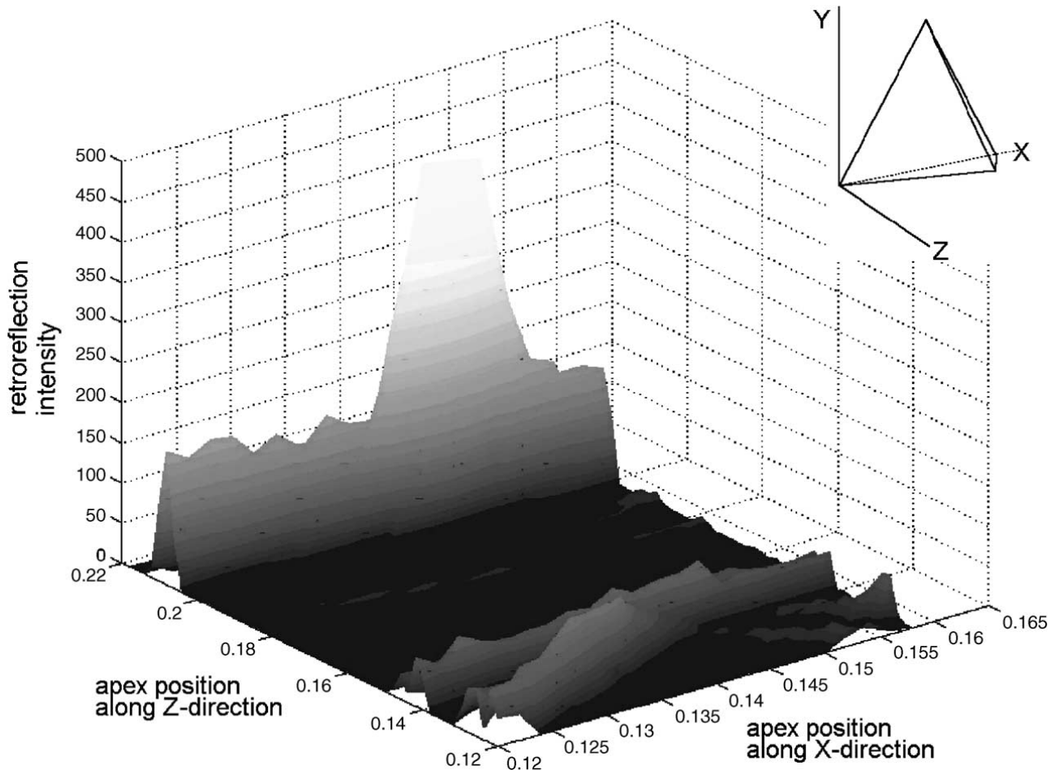
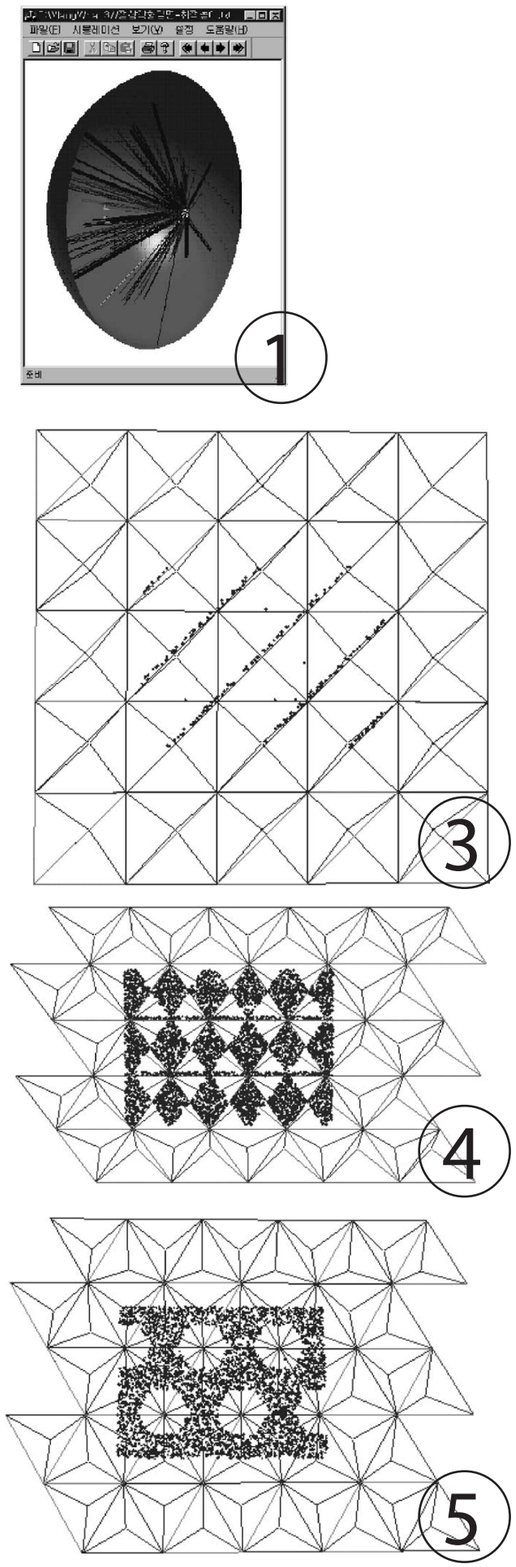


Fig. 5. Coordinates for retroreflective element.

With the previous basic principles of optics, a ray of light from its source can be traced whenever it hits each face of retroreflective elements.



Arthur R. McGurn, Enhanced retroreflectance effects in the reflection of light from randomly rough surfaces, Surface Science Reports, Volume 10, Issue 8, 1990, Pages 357-410, ISSN 0167-5729, DOI: 10.1016/0167-5729(90)90006-Y. (http://www.sciencedirect.com/science/article/B6TVY-46J0PS0-M/2/6d5768bf270dd21f82463ba47112c0a8)



High Visibility

The Science

The reason this material reflects so well is because its designed with reflected surfaces that combine to bounce a light ray back to the source of that light ray. This construction cannot be seen with the naked eye as the construction is performed on a microlevel. The images on the left illustrate different aspects of how this works.

Image 1 shows a visual model of light rays entering the reflective area and bouncing back at the same source. Retroreflective shapes can be parabolic domes like in image 1. This is how satellite dishes work. But they can also be more geometric in shape which is shown in Image 3.

Image 3, 4 and 5 show the retroreflective construction of high visibility jackets. These shapes reflect light back in the same direction that it came from. The different images show how slightly different shapes can drastically increase or decrease reflectivity. Image 5 has the highest reflectivity, shown by the black areas, and image 3 has the lowest reflectivity.

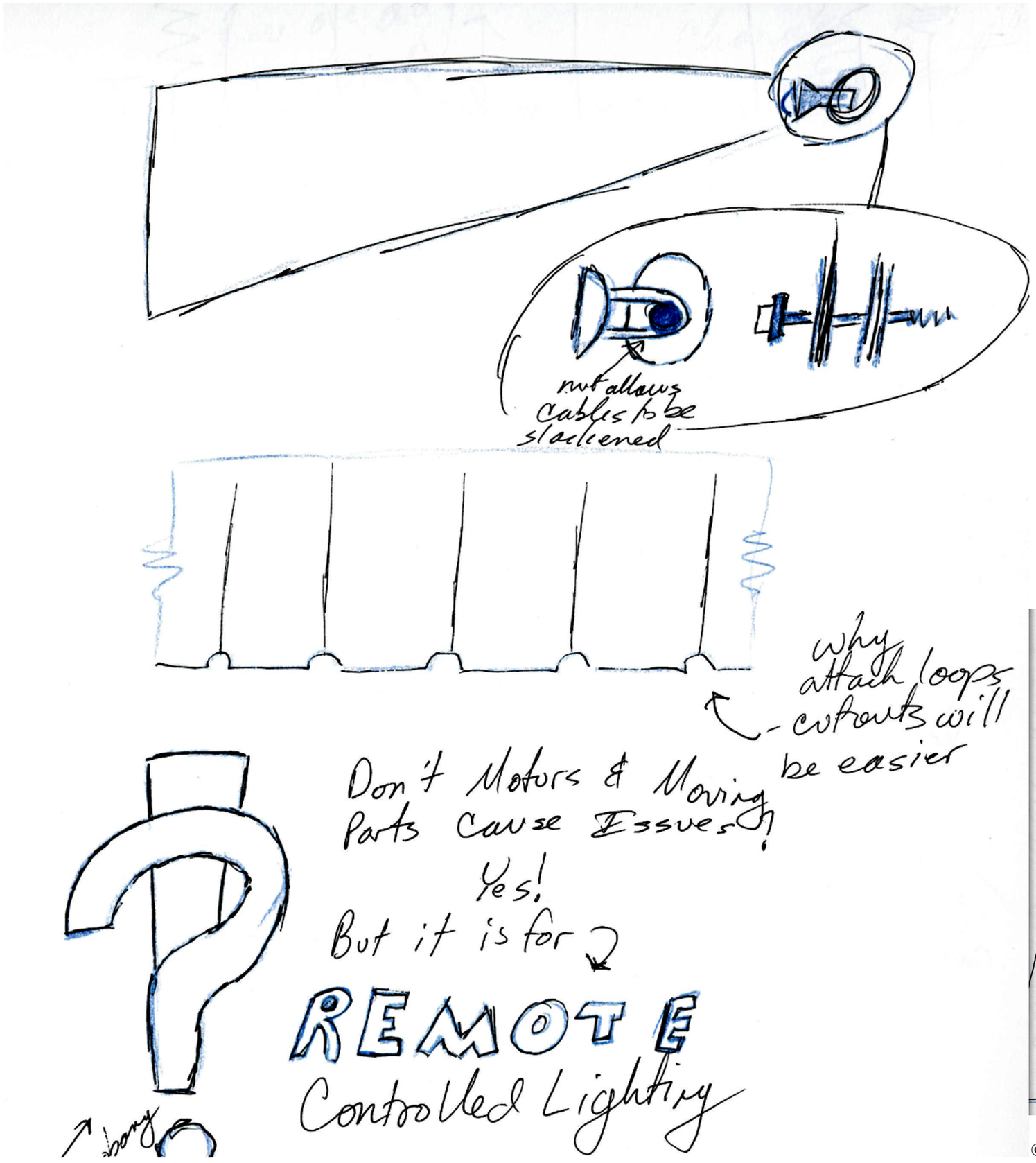
Image 2 shows the mathematics that connect the shape of the material and how much light it reflects.

Retroreflectivity seems like a dead end for a projective lamp. All they do is reflect light back at the source. Thats OK in this case. the luxeon star LED projects light in all directions. A combination of the reflective internal lamp casing and the retroreflective shape means that the light will be bouncing off of every surface of the shaped fabric and will eventually bounce out of the lamp and onto the ground.

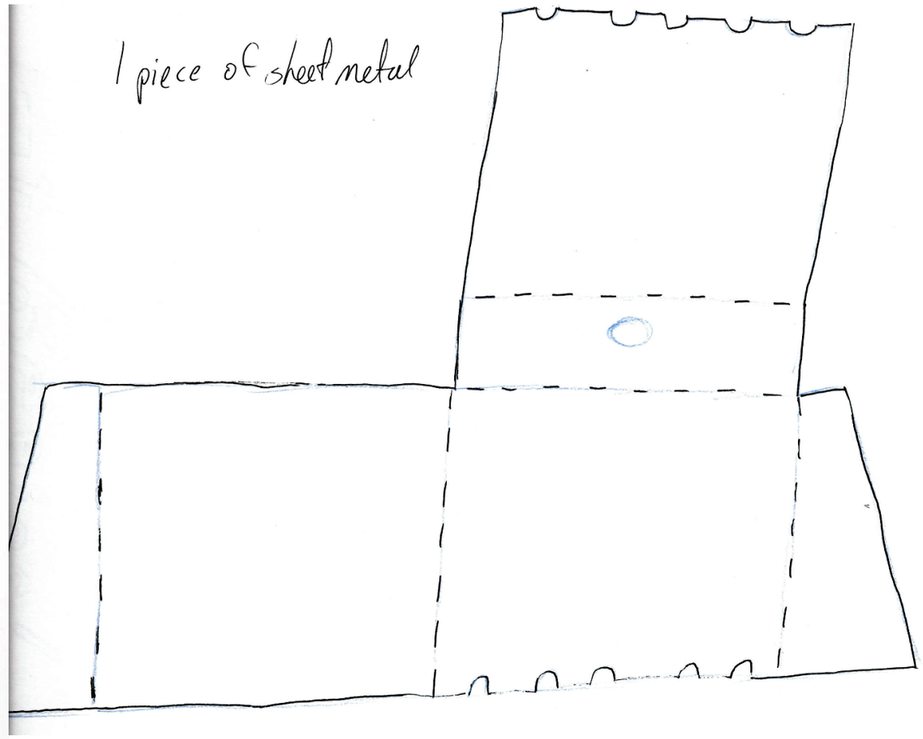
Unfortunately, the resources to test this could not be easily acquired. But while researching this it has become clear that if materials can be made to an exact shape to reflect light directly at the source, the shapes can be altered to reflect light away from the source as well. With some material experimentation this reflective fabric could be extremely effective at getting a sharp, bright and crisp projection onto the floor below the lamp.

PPP Number 1

Conceptual

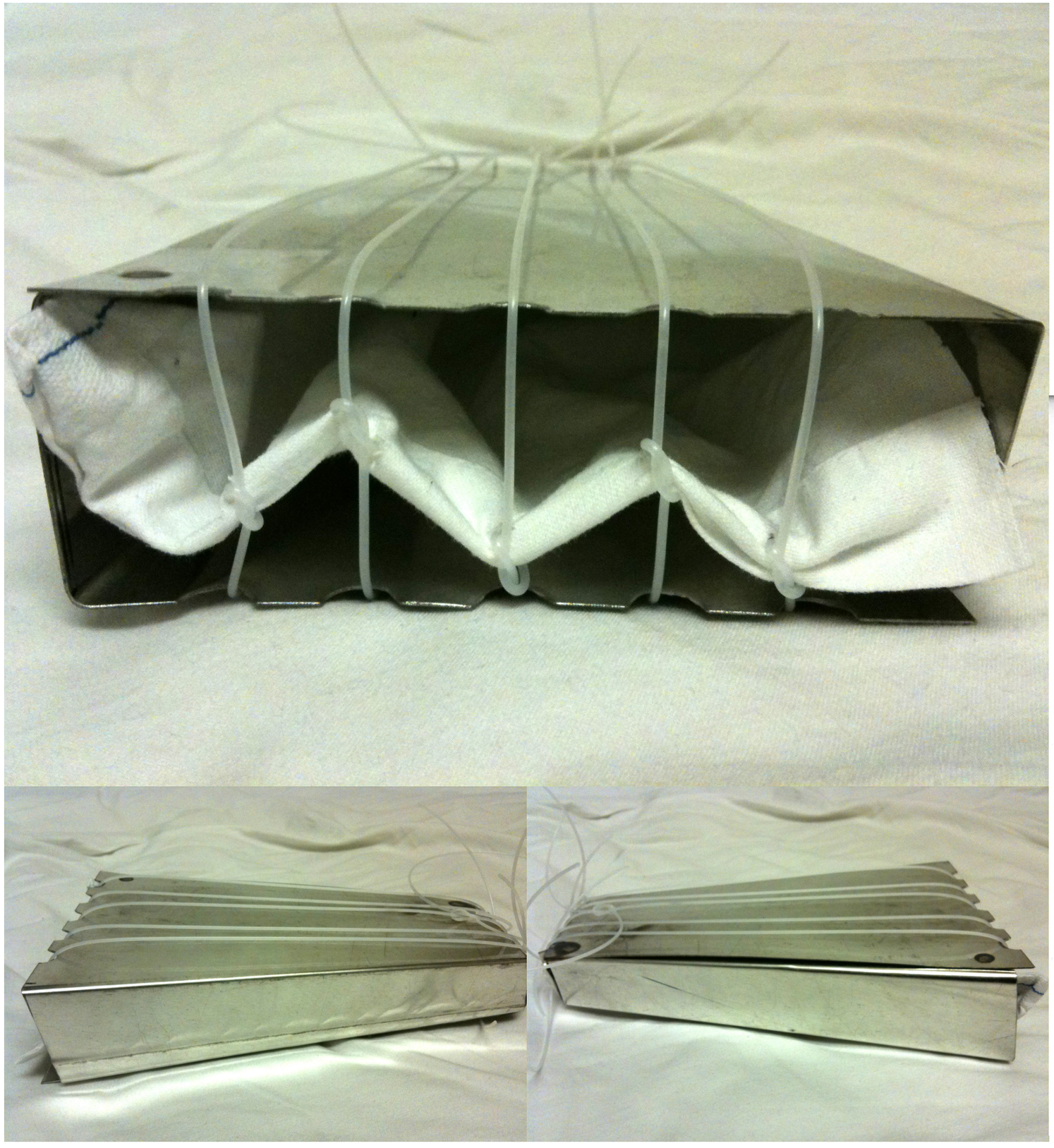


After some more sketching and ideating I was ready to start the first PPP. This PPP would show how the fabric motion system works. I designed a one piece cutout that could be bent into the shape of this light fixture. I dropped the complicated "loop" system of previous sketches and instead opted to just cutout places for the cables to rest while they move the fabric. I went to Guy's workshop and showed him my idea. He showed me the best metal to use, I cut it out and he gave it two small welds and the body was done.

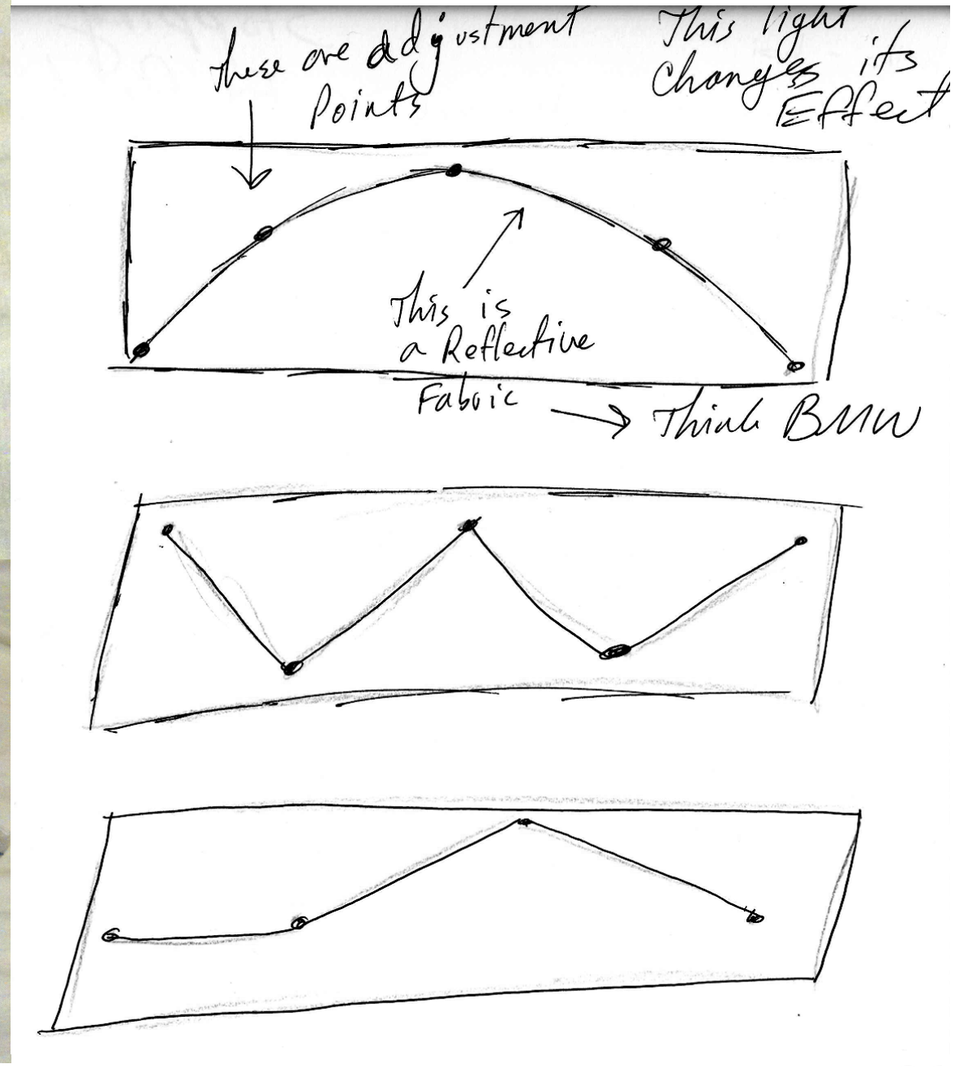


PPP Number 1

Physical

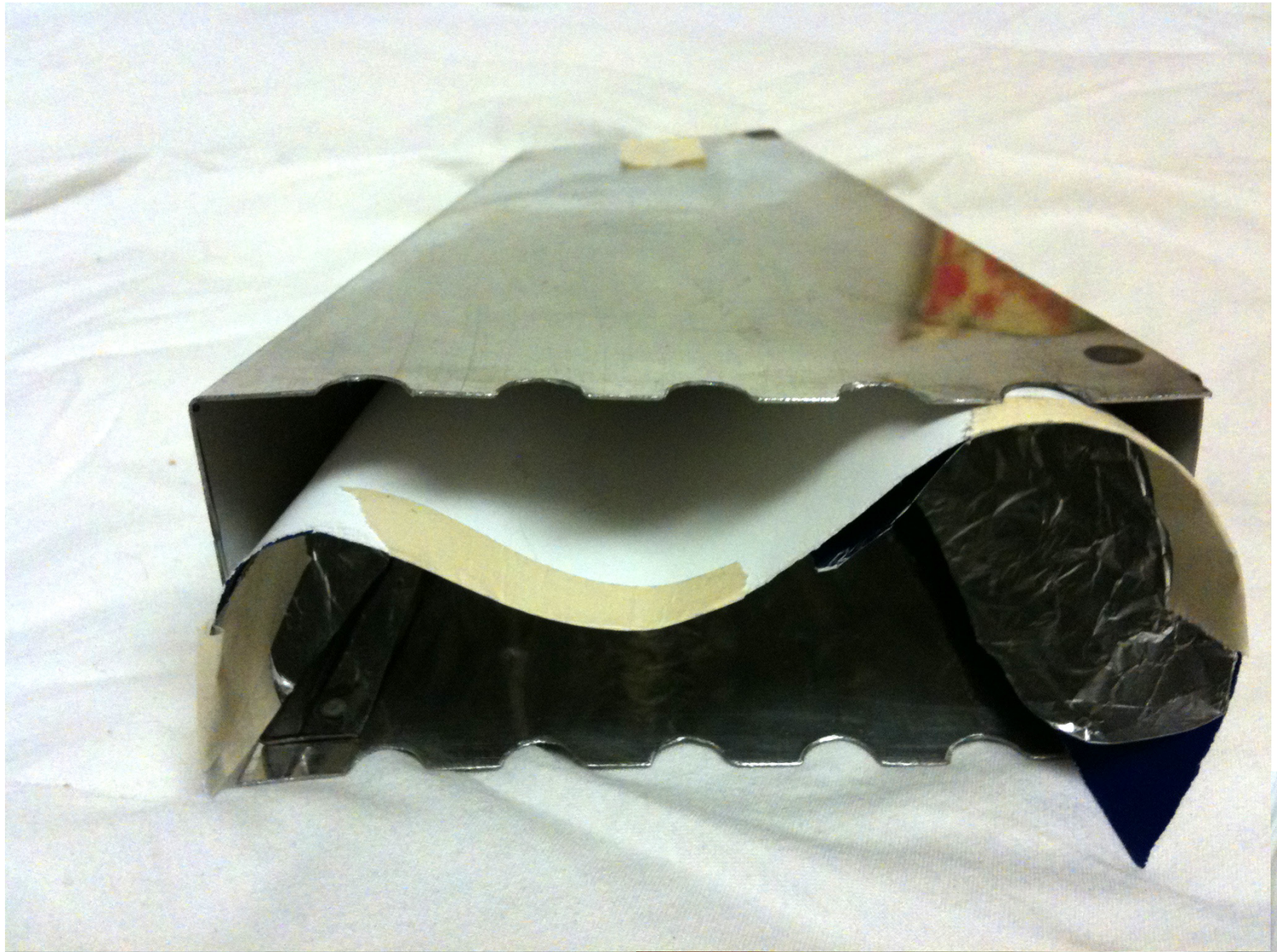


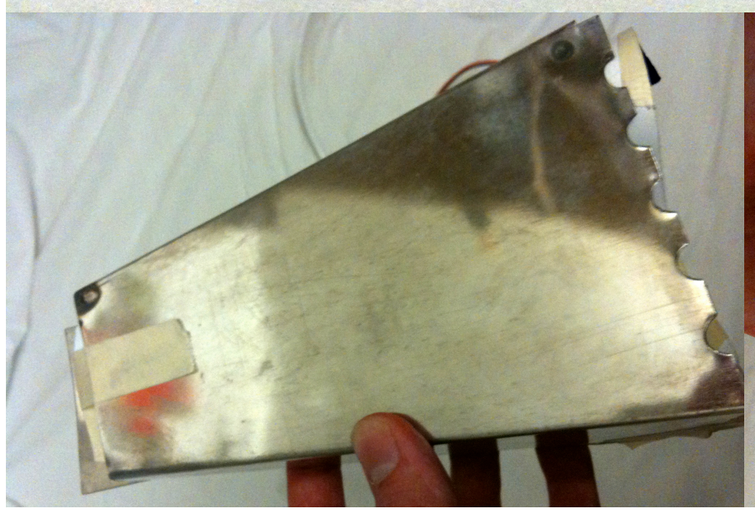
PPP number one intends to prove that a basic lamp shape combined with a simple pulley system can shape a piece of fabric at will into a number of different shapes. The shape shown here is the most radical. This shape has every contact point as far away as possible from the next contact point over. This shape would be used to display a jagged line on the floor which should convey a negative emotion. The sketches below show some other shapes that could be formed to convey different feelings. The shapes range from smoth curves to shapes that aren't even symmetric.



PPP Number 2

Construction





PPP number 2 is based on a duplicate tin frame that is almost identical to the one used for PPP number 1. I then simply took the the aluminium foil covered cardstock that I used to generate the original light effect and trimmed it to fit. Once I fit it inside the frame I put it into a nonsymmetrical curved shape to see how it looked once the LED was turned on.

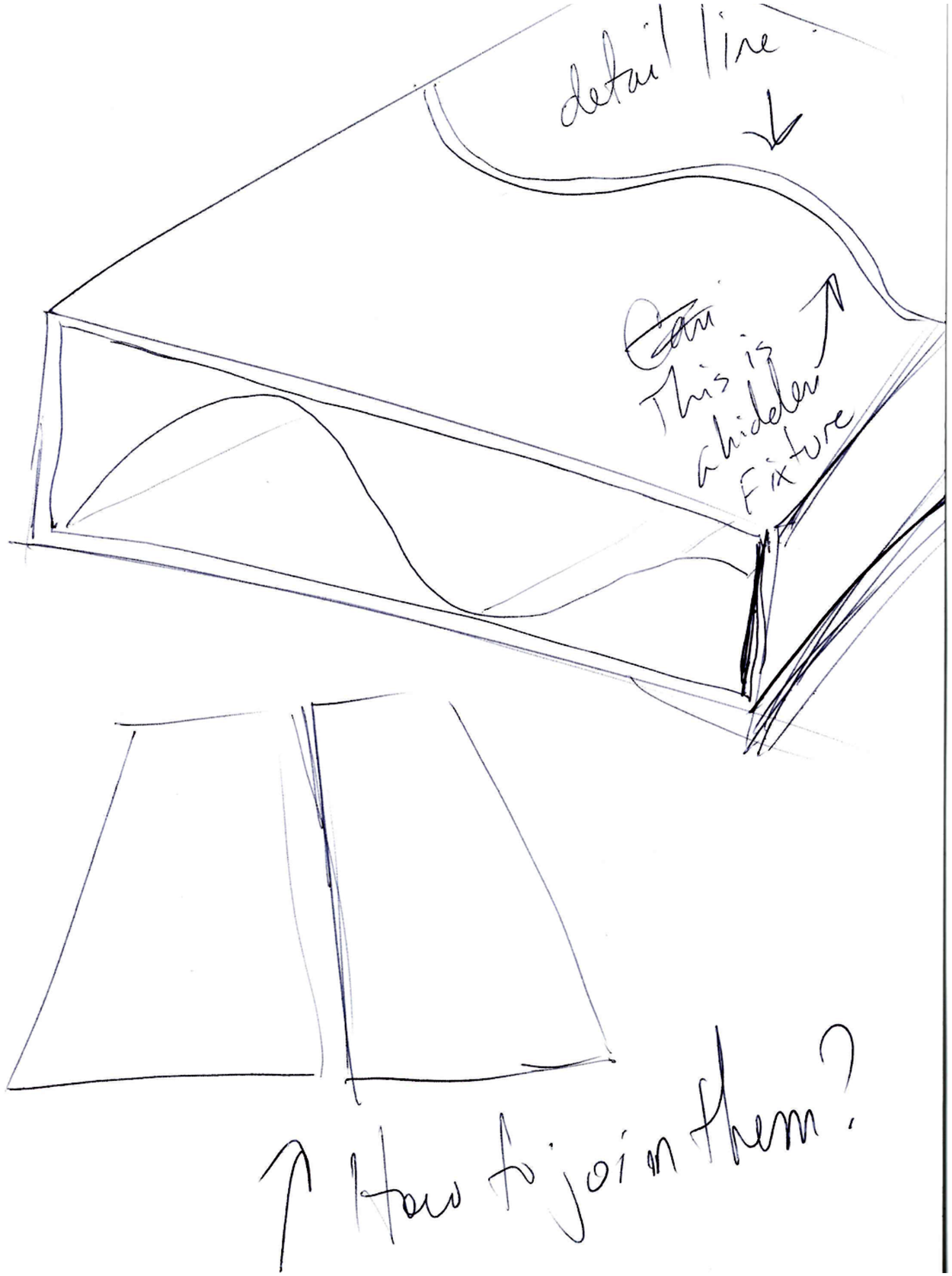
PPP Number 2

Effect

PPP number 2's lighting effect, shown to the left, has both good and bad qualities when compared to the original desired lighting effect achieved with just the aluminium foil cardstock which is shown below.

The negative aspect of this PPP is that the light is not clear and focused like the original. This is caused by the non-optimised internal reflections of the tin frame. If shaped properly after lots of testing and fine-tuning this effect could be optimised to provide a super sharp and super crisp projection on the floor.

The positive aspect of PPP number 2 is that it is much much brighter than the original. The original shows up from about a foot away from the projected area but gets much lighter as the lamp is moved away. This new PPP is so bright that from more than 8 feet away it still illuminates other parts of the room. This PPP is bright enough to work, and be visible, in an already lit environment. That is a requirement for this concept to work well.

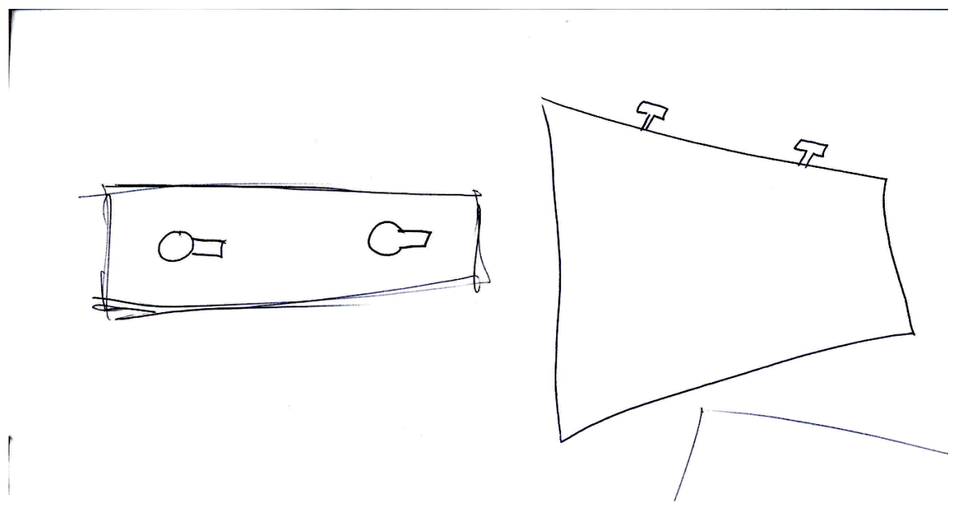


PPP Number 3

Concept

These three sketches illustrate my thought process when ideating the visual looks of this light fixture. At the top left is my initial visual model. At the front of it the flexible fabric can be seen. Near the rear I put in a little detail accent line. My initial thinking was that this might add just enough “flair” to the fixture to make it interesting. After I drew in that detail I decided that this light fixture will be hidden underneath railing and so adding a little detail like that will add to manufacturing cost and add absolutely no gain for the target customer.

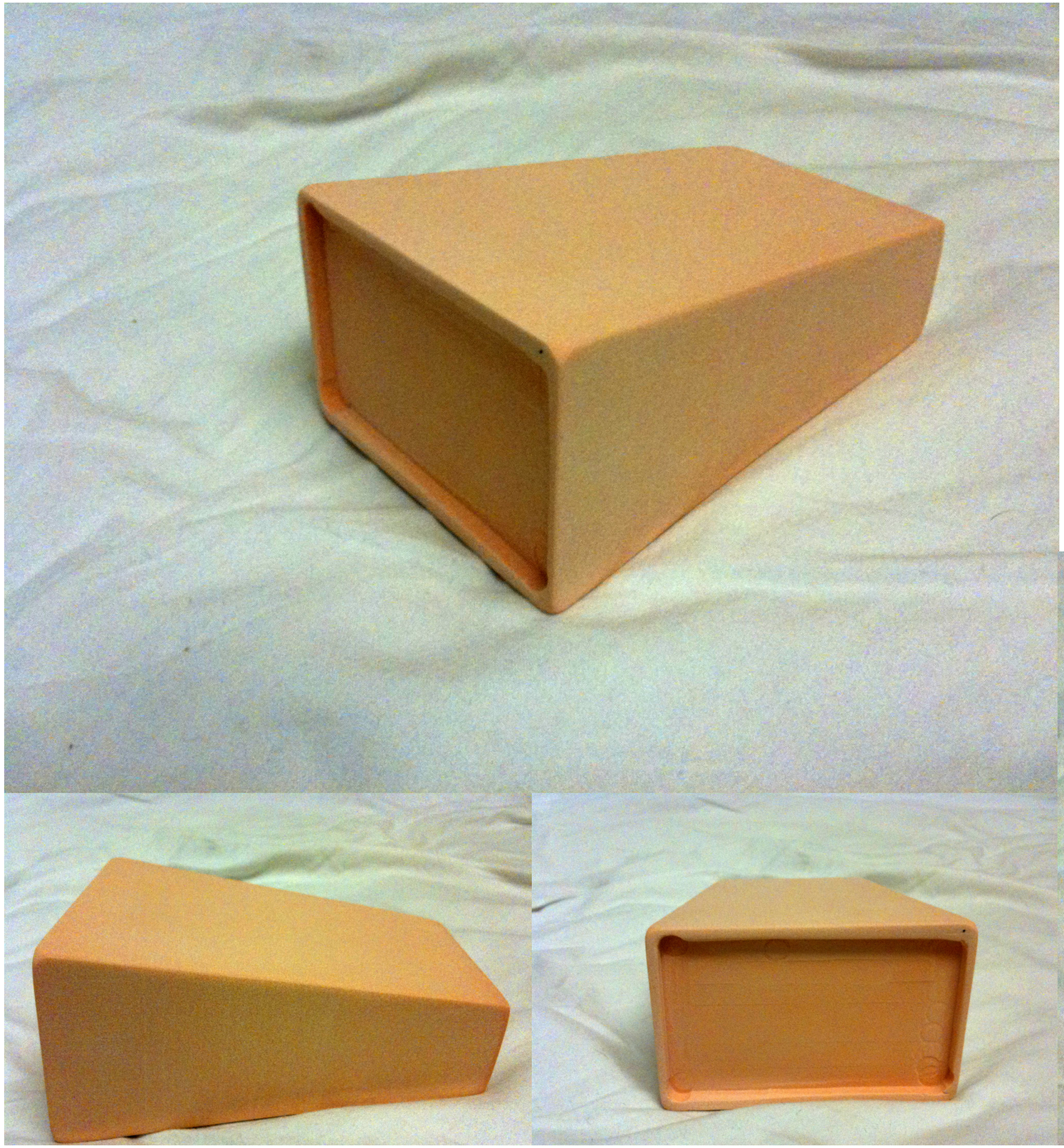
Because I intend these lights to be connected in a system, there should be some way that they attach to eachother. I devised a simple system of snap fits. These will just be holes in the product. If the customer wishes to actually insert the cylindrical connectors they can. Then the lights will join together. To make it so that the lights can be connected at varying angles for different curves, spaces of different sizes and shapes can be placed inbetween the fixtures. These will come in different widths to allow for different angles to be achieved so that the lights can wrap appropriately around any curved railing.

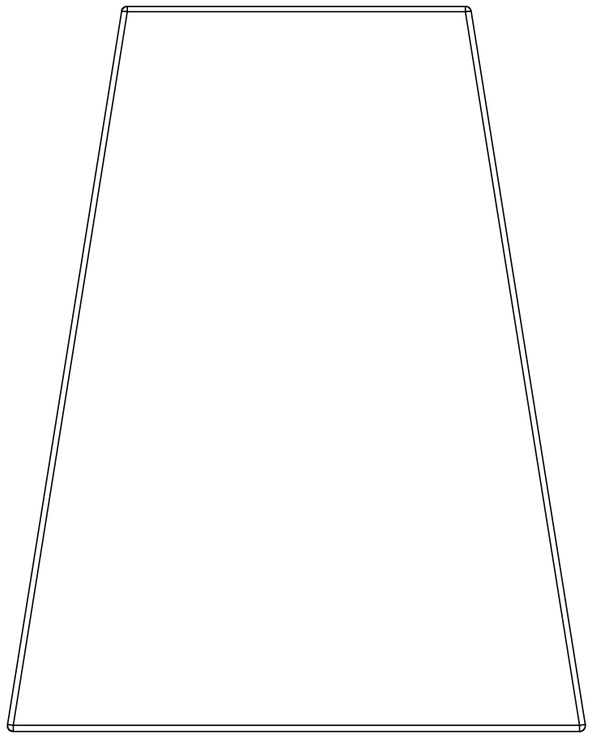


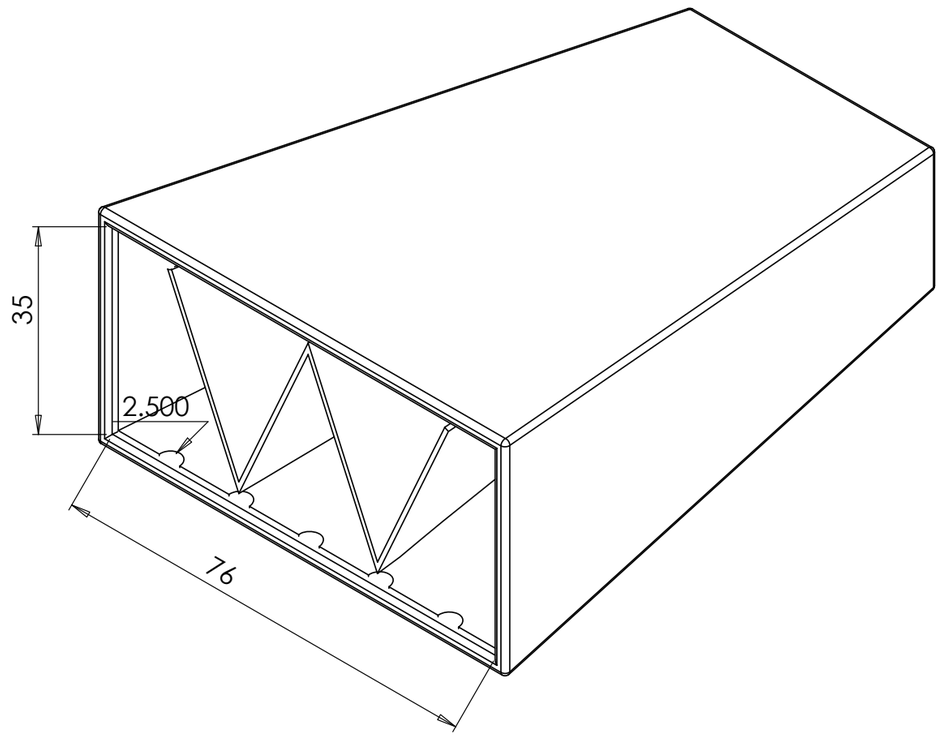
PPP Number 3

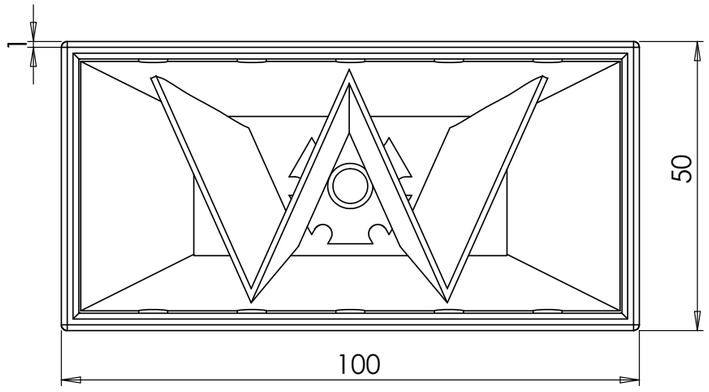
More Cowbell

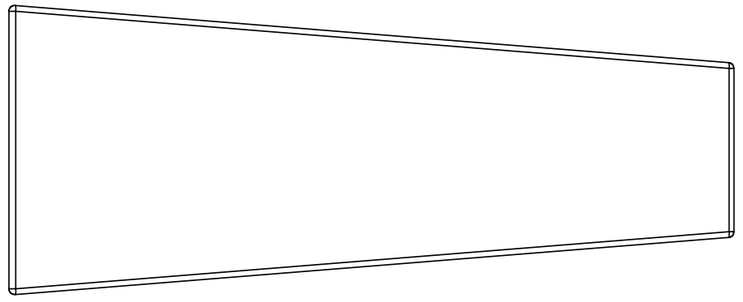
The visual model is fantastically simple. As with the Philips architectural light fixtures, this fixture is not meant to be seen. The model is purely built to hold the internal components. The actual design calls for a hollow fram but simply milled out a half centimeter or so to illustrate, visually, that its hollow.

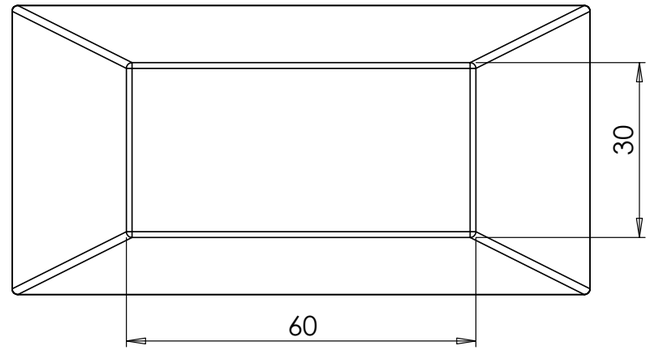












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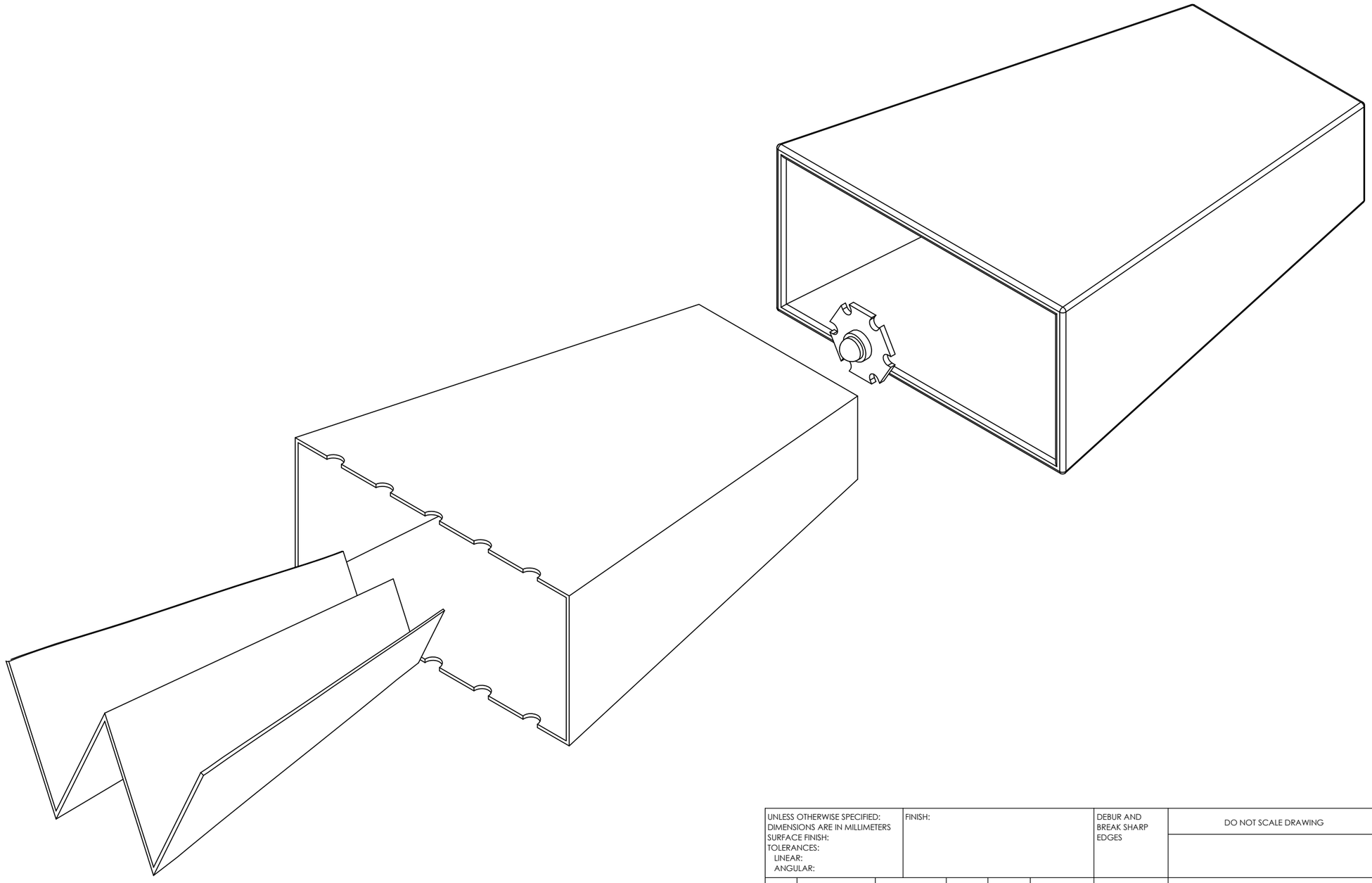

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A Concept for Remote Controlled Lighting

A system for building identity in commercial spaces

Showing Emotion with both Colour and Shape