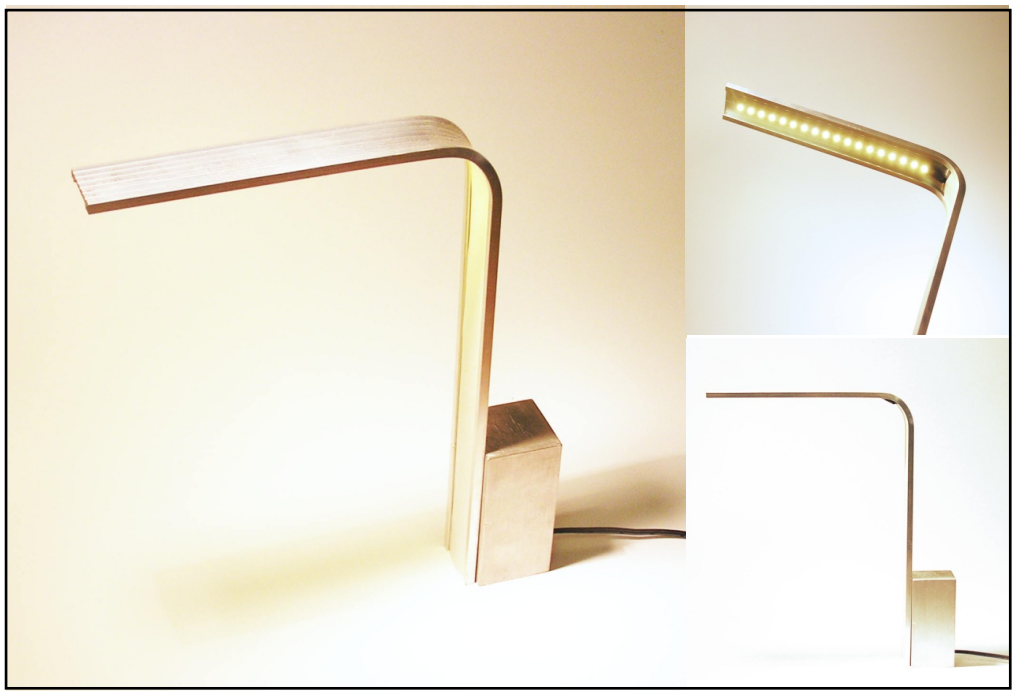
ecolamp

Written by M J Russell



Name:

Class: Teacher:

Contents

Introduction

Students learn about:

- The impact of energy use on global climate change
- Energy efficiency of different kinds of lighting technologies
- A brief history of lighting and what the future may hold
- The benefits of light emitting diodes (LEDs)
- The nature of light
- Why light is important to us
- How light has been used as a symbol
- Different kinds of lighting
- Principles of good lighting
- Stability of small free standing structures
- The work of lighting designers

Students learn to:

- Design and make a functioning task lamp
- Draw ideas using concept sketch techniques
- Do simple soldering
- Bend aluminium
- Draw an accurate perspective of their chosen design
- Use hand tools: drill, screwdriver, hot air gun, soldering iron, knife.

Portfolio tasks:

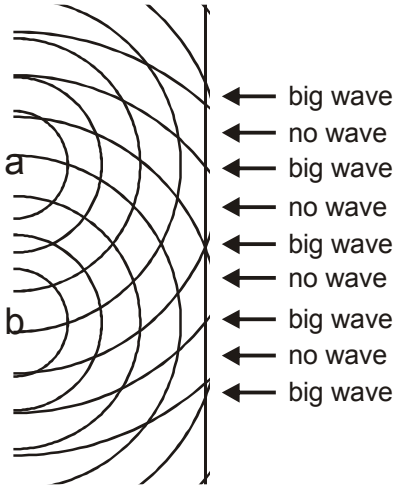
	Description	Mark
1	Complete the 8 questions at the end of the information sections.	
2	Video notes	
3	Class test on information covered and safety	
4	Take photos of two different environments that use good lighting principles and take photos of two different environments that don't.	
5	Find pictures of five different task lamps that you particularly like. Explain what it is that you like about each one.	
6	Present information on one of the following lighting designers. • Motoko Ishii • Claude Engle • Shiu-Kay Kan • Richard Kelly • Kaoru Mende • George Sexton • Rogier van der Heide a) A picture of the designer b) A picture of some of their work c) Describe what makes their work interesting d) A quote of theirs that has something to say about lighting design.	
7	Complete a page of concept sketches in response to the design brief.	
8	Complete an accurate perspective drawing of your chosen design using a 3D drawing board. Label the different parts.	
9	Make your lamp.	
10	Complete the evaluation questions.	
11	Staple all work together and submit folio.	

Information sheets

What is light?

Before designing with light, it's a good idea to know a bit about it. First of all light is weird stuff, actually *really* weird. It's only in the last 100 years that we have got a reasonable understanding of it, but there are still some mysteries. The problem is you can't just look at it down a microscope. You can only ever see the effect it has on something else, and this is where it starts to play some tricks.

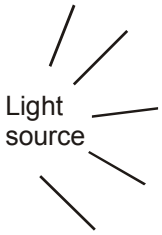
Ancient Greeks thought light shone out of our eyes and Romans thought light was made up of small particles which flew around in straight lines, but by the 1660's the idea that light was waves was put forward. Two hundred years later someone decided to do an experiment to test this idea.

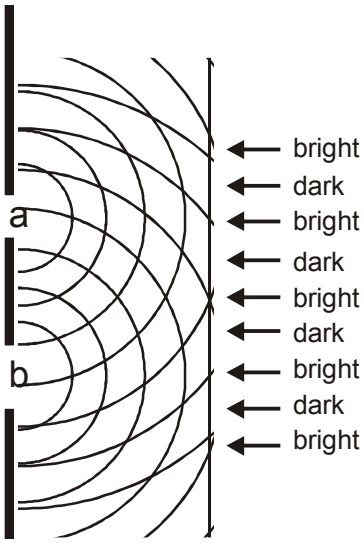


Two waves have this handy property of being able to cancel each other out or to amplify each other. This is called interference. In the picture (left) two rocks have been dropped into a pond and the height of the wave has been recorded at the line shown left.

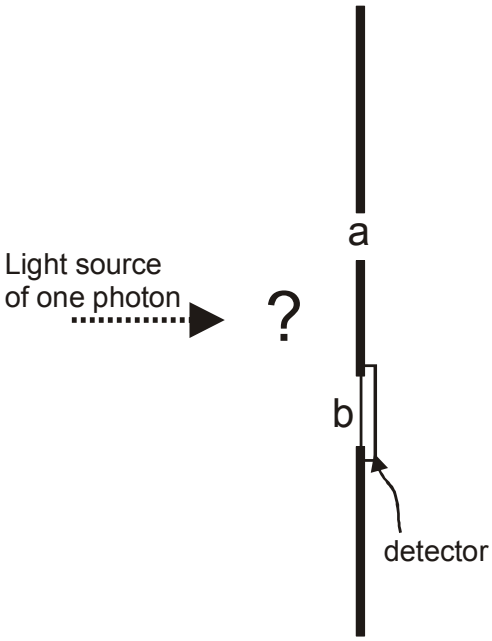
This pattern of no wave-big wave is called an interference pattern and it only happens with waves. In 1880 Thomas Young used light going through slits at 'a' and 'b' shown below.

He recorded an interference pattern and so proved that light was waves. But that wasn't the end of it, some real problems remained that could only be solved if light was a particle, a massless particle what's more. Einstein proved that there was a limit to how small an amount of light you could get and it behaved like a particle which we call a photon. A photon can be detected individually and when you detect it individually it doesn't provide any interference pattern.





It seemed that light behaved as both particles and waves. No one was really happy with this so Young's experiment was re-done, but this time using just one photon from the light source but still using two slits. The amazing thing is that it gives an interference pattern, which means that the one photon must have gone have through *both* slits. This can't be right, but it is.



Let's put a detector on one of the slits so we can find out which one the photon goes through.

Sure enough, the detector is able to show which slit the photon goes through, but when you do this there is no longer any interference pattern. Take the detector away again and the interference pattern comes back. The act of observation has changed the behaviour of the photon! (Einstein hated this).

What if we send one photon on its way and then *while* it is travelling toward the slits decide if we were going to put a detector at one of the slits (you need to slow light down to do this, which can be done). Once again our act of observation determines the behaviour of the photon. But to do this the properties of the light must have changed mid flight. It is as though the photon knows whether or not we were going to put the detector there before we did. There's the mystery.

As tricky as all this is, there have been some very definite things light has been able to tell us about our universe. Light comes in different colours that are usually mixed together. When you burn something the mix of colours in the flame can tell us exactly what materials are being burnt. Each element has its own colour signature and this is how we can know what stars are made up of even though they can be millions of light years away. This can be a handy thing to know if you are interested in understanding what the universe is made of.

It turns out that the further away a star is the redder it becomes. This is because it is moving away from us and this effect is called 'red shift'. The light from stars can tell us how big the universe is and even how old it is.

Questions (research required)

1. What is the actual difference between light of different colours?

_____

2. How slow can we make light go?

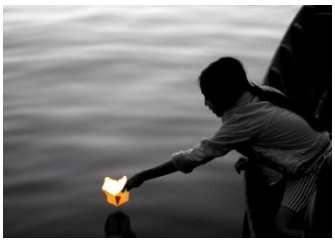
_____

Light as a symbol

Given our strong dependence on and general fascination with light, it is not surprising that it has become a potent metaphor for all kinds of virtues. So many religions refer to light as a source of life and truth. Hindus celebrate Divali by lighting lamps on the darkest night of the lunar month which represents the triumph of good over evil. The bible is also full of references to light overcoming darkness. The Torah refers to itself as a light that guides the way.

Light to portray power and glory

The 'lamp of knowledge' is commonly used on university crests and medals. As with most symbolism with light it is so ancient that no one really knows the origin of the 'lamp of knowledge'. It is a very good symbol as knowledge does show the way through ignorance.



Perhaps the strongest idea connected to light is life itself. Here a Vietnamese woman sends a floating lantern along a river. The light represents the life of her ancestors. It joins the crowd of other lanterns, floats away, and becomes dimmer.

In literature light is often used symbolically. There are so many examples. In A *Streetcar Named Desire* Blanche lives in a cocoon of unreality to protect herself against her weaknesses and shortcomings. When she greets Stella the first time in the apartment, she says, "And turn that over-light off! Turn that off! I won't be looked at in this merciless glare!" Blanche avoids bright lights throughout the play. Bright light is the penetrating gaze of truth that sees the real Blanche with all of her imperfections.

Painting has traditionally been all about portraying the effects of light and has provided fertile ground for the symbolic capacity of light. What does light symbolise in the following painting of the Greek god Prometheus wielding the flame of a torch? (research)

3. _____

_____

It seems that light has been used as a metaphor for just about every kind of virtue there is - Knowledge, freedom, hope, awareness, consciousness, reason, energy, progress, life. It would be hard to find anything else that has been used so widely as a symbol.

Our response to light

Without light we cannot see world we live in. It's a very basic thing. We are completely dependent on light and we always respond to it. It's a kind of survival instinct. Light has always been coupled with safety and security. Think of our ancestral tribes around the campfire. The light of the fire provided a focal point for the community and safety from the unseen beasts. We seem to be hardwired to be attracted to light, it always gets our attention. This has not been missed by advertisers using bright billboards and neon signs, or car designers with illuminated dashboards or event organisers using fireworks for entertainment.

Light for advertising

Light for safety

Light for entertainment

Light has the capacity to change the way we see our world. Sometimes we might talk about 'seeing things in a different light'. The kind of light that shines on an object may give us very particular ideas or feelings about it. Light is very powerful in this way. The warm glow of a candle makes us feel cosy, relaxed and even romantic. This is very different to the harsh, even light of a fluorescent tube, which can be jarring and uncomfortable.

Some commercial spaces are overlit to attract attention. Once inside the space can feel very unnatural.

Why do we respond so differently to different kinds of light? It's all about 'naturalness'. The kinds of light we are used to seeing in nature are the ones that we feel most at ease with. These are the sun and the flame. A man-made light source which is similar to these will give the same effect. A light source that does not emulate anything natural will be discomforting. This can happen when a space is too bright, too evenly lit, or the light used is not quite the right colour. We prefer a slightly yellow (warm white) light rather than a slightly blue (cool white) light.

These are all subtle differences and would go unnoticed except for the fact that we would 'feel' different. Changing subtle things about a space so that we feel good about it is what design is all about.

4. Why is a bright, evenly lit environment jarring?

A short history of lighting design

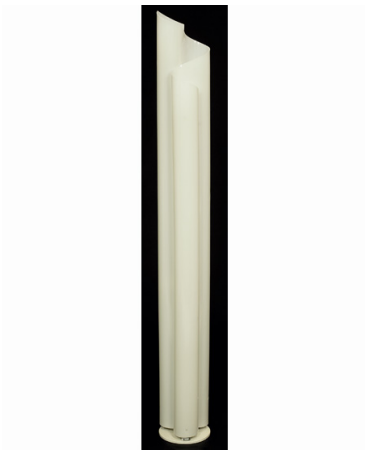
There are two main kinds of lighting – natural and artificial. Our ancestors were quite dependent on the natural light of the sun when it came to doing work. It imposed an inescapable routine. The pattern of light was very much the pattern of life. This can account for our very strong sense of connectedness and dependence on light.

Until the twentieth century the dark world was mostly lit by fire of one kind or another. The light of the flame was used in the Stone Age during ceremonies in caves where animal paintings would come to life in the flickering light. This imbued them with magical, mystical qualities. The power of light was not lost on just about every religion since. The design of religious spaces often pays careful attention to the use of light. Natural light and the flame was all they could work with until the invention of electricity.

The electric light was shown to be possible in the early 1800's but only became commercially available in 1879. The incandescent globe has a fine filament of the metal tungsten which was found to be the best material to glow when electricity was passed through it. With the advent of the electricity supply network the twentieth century was set to be the century of electric lighting.

Electric lighting opened up a whole new range of possibilities for designers no longer constrained by candles, wax and wicks. Their main challenge was to keep direct light out of the viewer's eyes because it is just so bright. The two possible solutions are to shade the light so that it becomes diffuse or to direct it all one way using a reflector.

Early designers were quick to find ways to make diffusers a feature rather than a problem. (this design is from the early 1900's)



This freestanding floor lamp is entirely diffuser. (Vico Magistretti, 1969)

The angelpoise was designed by George Carwardine in 1932. There is no diffuser. Light is directed away from the eyes.

Le Corbusier's Notre Dame du haut, Ronchamp, France

It is worth noting that not everyone was excited about artificial lighting. Le Corbusier and Frank Lloyd Wright (famous architects) were suspicious of artificial light believing that it could only ever be a poor imitation of what we really want – natural light. Consider the different ways they used natural light.

Guggenheim Museum, Frank Lloyd Wright

Fluorescent tubes came onto the market in the 1940's and were used widely for industrial applications and public spaces. They never got that many designers excited for a few reasons. They are large which means that the range of applications is limited and the shapes open to designers are few; the light they give off is often not quite the right colour white; they flicker just a bit faster than you can notice, but can still be annoying; and they can never be directional. Gerrit Rietveld had a good shot at designing a pendant lamp using fluoros.

Halogen bulbs were the next big thing to happen in lighting and became popular by 1980. They are smaller, tougher and more energy efficient than incandescent globes. For designers they represented a new opportunity. Because halogen globes are small there are few limitations on the shape of the lamp.

'Ara' table lamp by Phillip Starke

'Tizio' lamp by Richard Sapper

'Dove' lamp by Marco Columbo

The Tizio is a classic because it was a real departure from standard lamp shapes. It seemed to be a perfect expression of the halogen globe technology. Designers are always excited by new technologies, because it gives them the opportunity to invent the next classic. The new technology for lighting is LEDs. No one has designed the classic LED table lamp – yet.

Designing with light

Lighting designers have a kind of power. They decide how people will look at their environment and how they will respond emotionally to a space. If you have been in a stage production you will know how important lighting is to set a mood, draw attention or to create excitement. It's the same for the home, but the effects are more subtle. In terms of design it is more important to get the lighting right than anything else. Furniture, wall finishes, curtains are all secondary. Above anything else the lighting used will determine what you feel when you enter a room.

At the heart of lighting design is providing light that is both functional and decorative. For purely functional spaces the rule is: the more light the better. This is an easy formula that works well for factories, but for a home we want to make people feel something, like being welcomed, a sense of security and well-being. We want to punctuate the space with interest and drama. Uniformly bright light doesn't do this. Lighting expert Claude Engel said: "anyone can fill an entire room with light; the secret lies in the ability to make proper use of darkness". A bright and evenly lit space feels unnatural and we won't feel at ease in it. (think 7/11 store) A room with 'pools of light' will feel more natural because it is evocative of the forest. A room with 'wall washers' will be evocative of the cave and we will feel secure and cosy.

Halogen lighting took off in the 80's because it provided a very bright crisp light and for a good while we couldn't get enough of them. Somehow the answer to every lighting situation became 'more halogens'. The beauty of the halogen light tricked us into thinking that more light would always be better. However maximum, even brightness is not the goal of good lighting. Another problem with halogens is that they cast sharp edged shadows. Some downlights should be directed on the wall so that a mixture of direct light and ambient light is achieved.

Another principle of good lighting is energy efficiency. Too much lighting is expensive and has a large carbon footprint. Approximately 30% of household electricity use is in lighting. This means significant energy reductions can be made.

Good lighting design for homes:

- Not too much light
- Non even light (pools of light)
- Highlight points of interest
- Use both ambient light and direct light
- Use energy efficient lighting

5. Fill in definitions for the following lighting concepts (research required):

Ambient light	
Direct light	
Warm white	
Diffuser	
Watts	
Luminosity	
Efficiency	

6. Fill in the table below describing the different kinds of lighting available:

Picture	Name	Feature	Use
	Ambient light	Light source is covered by diffuser	
	Spot light	Bright, direct light, narrow beam, no diffusion.	
	Pendant light	Light can be diffused or directed down; hangs from ceiling; usually a design feature.	
	Task light	Light points downward; often articulated; no direct light to eyes.	

Global warming

Just before the United Nations Climate Change conference in Copenhagen in 2009 the national science academies of the G13 nations issued a joint statement declaring, "Climate change and sustainable energy supply are crucial challenges for the future of humanity. It is essential that world leaders agree on emission reductions".

The broad scientific community is in agreement that that human activity is very likely the cause for the rapid increase in global average temperatures over the past several decades. Global warming is upon us and the urgency of Copenhagen 2009 shows that it has caught the attention of world leaders. It may take a miracle for a unified global response, but it seems clear that the costs of inaction outweigh the costs of tackling climate change.

At centre stage is carbon. During periods of prehistory carbon was captured naturally as plant and animal matter decomposed, was covered over and eventually became coal and oil. This took carbon out of the atmosphere to the levels we see today. Now we are digging up the oil and coal and burning it, releasing the carbon back into the atmosphere. Pollution may be the wrong word for it, but the effect is climate change (although some scientists do put the case that the cycles of the sun have more to do with climate change than carbon levels).

Reducing carbon output is on the agenda and for countries like Australia that burn coal to produce electricity there is a real challenge ahead. We live in the era of climate change. Not so long ago being ‘green’ was to take a weird political stand and could even lose you some friends, but today concern for our environment is mainstream. We talk about ways to reduce our ‘carbon footprint’ and are often prepared to pay more for the green option.

Burning coal and gas to produce energy will always produce carbon emissions and it will be up to government and industry to find solutions and alternatives. What about individuals? The key is energy efficiency. Reducing the amount of energy you use around the house will reduce the amount of coal that needs to be burnt to support your lifestyle. Individual consumers actually have a lot of power. Consumers are the main drivers of the economy and when they show their concern through their buying patterns, industry takes note.

Building standards

Using energy efficient systems is no longer just a good idea, it’s something all new buildings must do to get approval. In the state of New South Wales the Basix standard was introduced to ensure homes are designed for maximum energy efficiency. The designer enters data on an online program regarding the energy efficient features of the proposed building and a Basix certificate is issued. Using energy efficient lighting such as LEDs is one way to help new buildings comply.

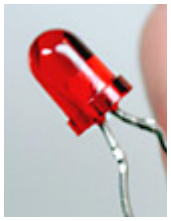
Energy and lighting

7-12% of household energy use goes into lighting. It may not be the best place to find big reductions, but it is an easy place to make a start. Many governments have decided that standard incandescent globes are not efficient enough. That is, the amount of light they put out takes too much energy to produce. In 2010 it became impossible to buy new tungsten filament globes in Australia. Minimum energy performance standards (MEPS) are now applied to all kinds of household appliances and it will get harder to buy an electrical product that is inefficient.

The main kinds of lighting technologies available for domestic use today are:
Fluoroescent lighting. These come as tubes and CFLs (compact fluorescent light). These are much more efficient than the old incandescent globes, but they do have their problems. They contain mercury which is a disposal problem, they take a while to reach full brightness, and the light is not as 'warm' as an incandescent.

Halogens are desperately inefficient. 90% of the energy they use goes into producing heat not light. People tend to use 50W halogens which is really too bright especially when more than 4 are used in one room.

LEDs (light emitting diodes) are the small standby lights on so many appliances. Until recently they were the sole domain of electronics enthusiasts. Now they have been developed to be bright enough to use as replacements for globes of all kinds. They are super efficient – much more efficient even than CFLs and last for an incredible 50, 000 hours. If you turned it on for 5 hours a day for 5 days a week, you wouldn't need to replace it for _____ years.



LEDs

LEDs are the simplest kind of semiconductor. There are two parts to an LED , one area with an excess of electrons and another with a deficit. A charge is passed through the material and as electrons drop to a lower orbit energy is released in the form of a photon. This happens in any diode, but you can only see the photons when the diode is composed of aluminum-gallium-arsenide. This allows for a large drop producing a visible photon.

Go to www.electronics.howstuffworks.com/led3.htm and explain the difference between incandescent globes and LEDs.

_____

_____

7. What is the efficiency of LEDs, ie: what percentage of the energy used goes into making light? _____

8. LEDs come in several shapes. List three kinds of lighting they can replace.
i) _____ ii) _____ iii) _____

Video notes. Watch the video “Designing with Light” (Designability 2013)

1. What is the name for a particle of light?

2. Can anything travel at the speed of light (apart from light)

3. What are the two ways in which light behaves?

4. When it comes to photography do people like the ‘warm look’ or the ‘cool look’?

5. Why do photographers care about light?

6. Why do photographers like diffused light?

7. Why is light important to farmers?

8. What is the connection between light and life?

9. Why do religions use light so much?

10. Why is light important in theatre?

11. What is the job of the lighting designer in the production of plays?

12. What do lighting designers try to do?

13. What are the four different kinds of lighting used by lighting designers?

14. What do we like about camp-fires?

15. Why is sunlight important when it comes to designing spaces for people?

16. What sort of light is used in fast food outlets? Why?

17. What gas produced when fossil fuels are burnt?

18. The peak demands for energy is increasing. What sort of days does this usually happen?

19. By 2050 there will be a mix of energy sources. What are they likely to be?

20. What output of CO_2 per person per year do we need to get down to?

21. Name four different kinds of light fitting.

22. What is the average life of an LED light?

23. List two drawbacks of LED lighting.

24. It is good to use lighting in ways that remind us of _____

25. Who designed the Tizio lamp? What makes it special?

Ecolamp design

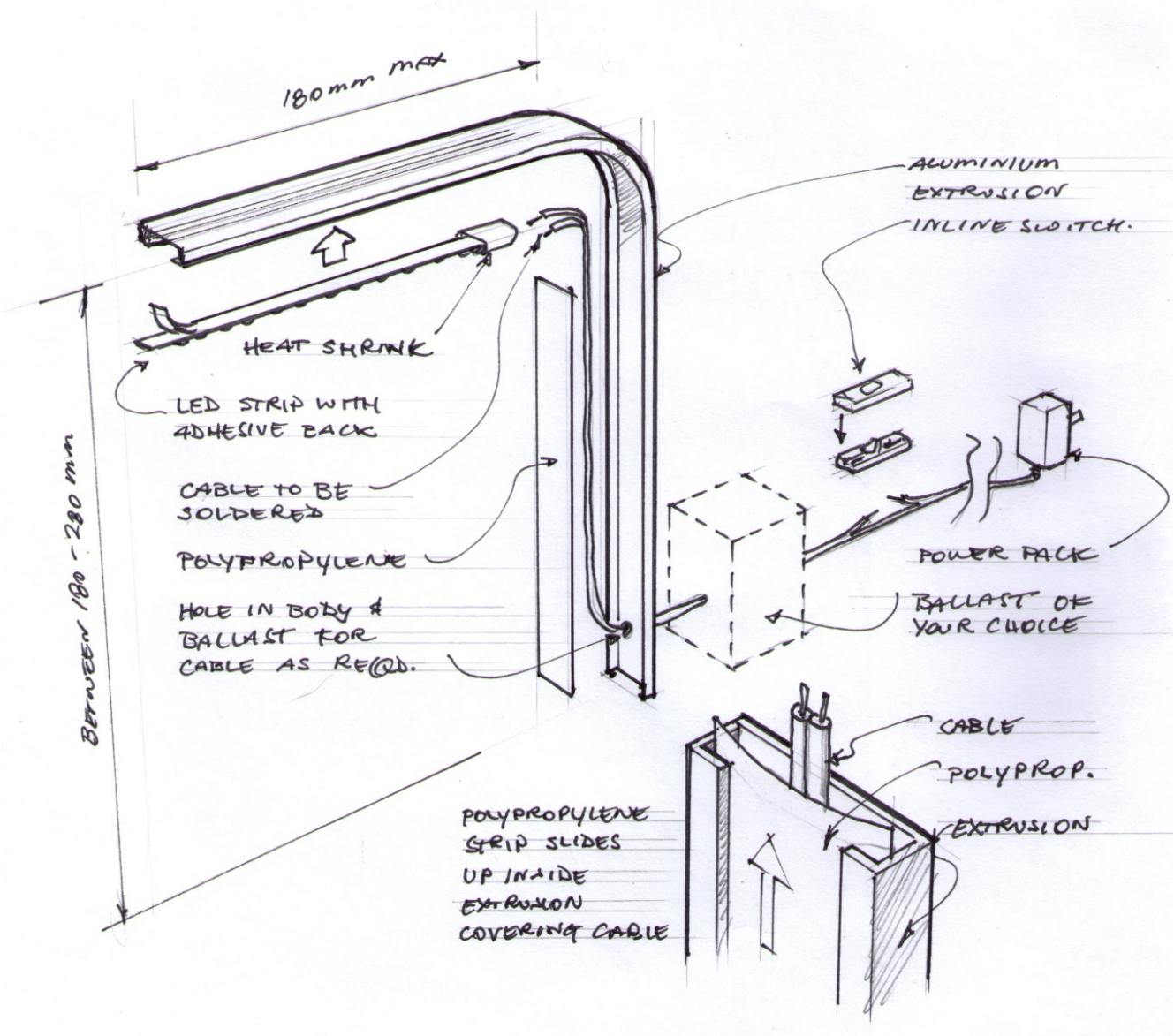
Brief

LEDs offer designers a range of new opportunities when it comes to designing lamps. Not only do LEDs give superior energy efficiency, they are also extremely versatile. Flexible LED strip has an adhesive backing and only requires 12V making it extremely easy to work with.

Design and make a small working task lamp using LED technology. It is to be freestanding and stable.

You will be need:

- 12V power adapter with cable,
- 180mm LED flexible strip,
- inline switch
- 600mm of aluminium extrusion (cut it down to the size you want to use)
- strip of polypropylene 30mm wide
- a small piece of heatshrink



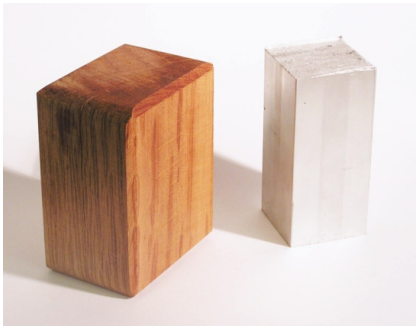
Parameters:

1. The aluminium extrusion can be bent around a radius, but not folded. No more than three bends are really possible.

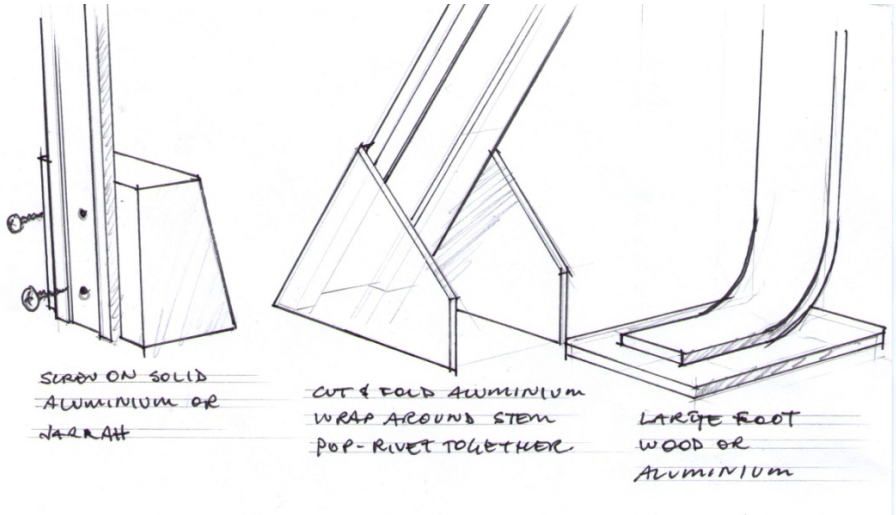
2. The LEDs must be directed downwards and between 180mm and 280mm off the table.

3. It is to be a task light without any diffuser or shade.

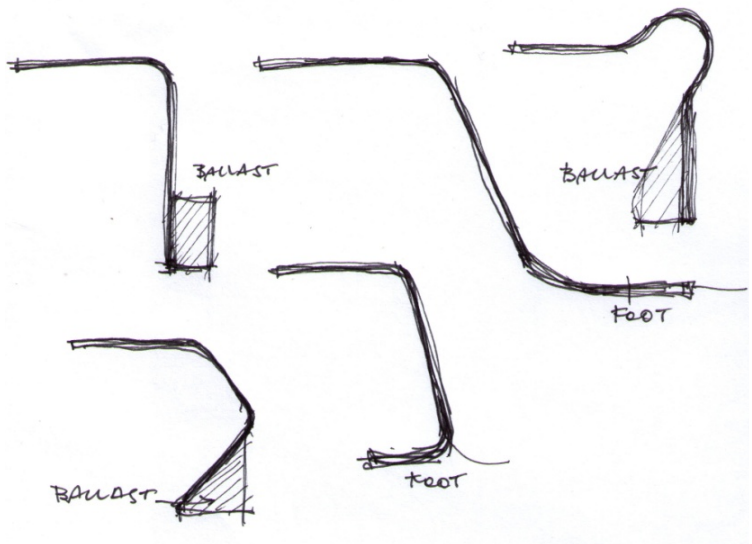
4. Stability will be the biggest issue you need to resolve. You may need to use some kind of ballast such as aluminium or hardwood connected to the base of the lamp. It should not be easily tipped over. You could also increase the footprint of the lamp to provide stability. Screws are the best way to join a foot or ballast to your design. Be sure not to screw through your cable and cover the screw with the polypropylene strip if possible. Here are some ideas you can consider:



Jarrah and aluminium make good ballast.



Explore a range of possible shapes and configurations. Here are some ideas:



Making your lamp

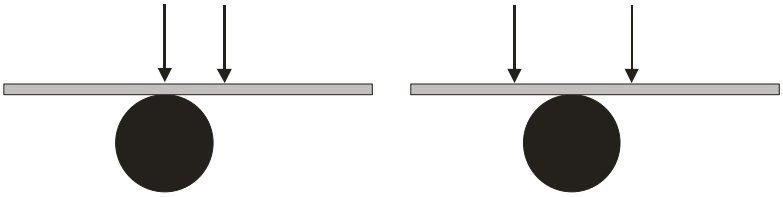
Most lamp designs will follow a similar making process even though the shapes may be different. Below is a list of the steps in the making process, but there are some blanks. Fill in the missing steps using the information below the table (which are in no particular order). Fill in the equipment used and safety for each step.

	Description	Equipment used	Safety considerations
1	Measure the location of your first bend in the aluminium. Remember about 20mm either side of the centre of the bend will not be straight. Allow the correct length of straight aluminium to house the LEDs		None
2			None
3		Junior hacksaw Vise	
4	Join the ballast or foot with screws (clamp the pieces together and drill pilot holes first)		
5	Drill the 4mm hole for the cable through the body and if necessary also the ballast.		
6			None
7			
8			
9	Slide the heat shrink over the soldered joint and apply heat gun.		
10	Stick the LED strip to lamp and pull cable tight.		None
11	Slide polyproplylene through extrusion covering the cable		

- Continue measuring and bending to complete the overall shape.
- Solder the LED strip to the correct wires.
- Connect the switch.
- Thread the cable through the hole.
- Cut off the extra extrusion

Bending the extrusion:

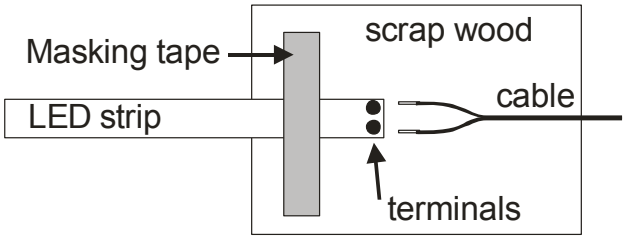
The extrusion we are using is best bent by pressing it over some pipe or bar with a diameter no smaller than 90mm. Be careful where to press (see below).



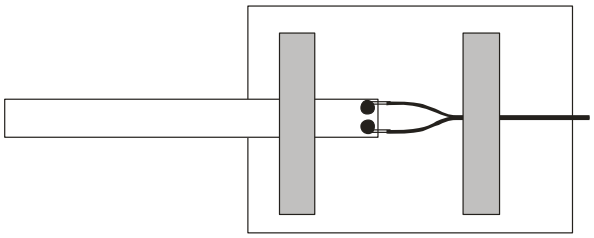
Connecting the cable to the LED strip:

Soldering is a good way to make a permanent and conductive join between wires and electrical components. The LED strip and the two electrical wires from the power adapter need to be soldered together. Here's how to do it:

1. Tape one end of the LED strip to a scrap piece of wood (not the tale as it will get marked). Plug the power pack into a power point and slide the heatshrink over the wire. Touch the ends of the wire to the two terminals at the end o the LED strip. If the LEDs don't light up switch the wires over.

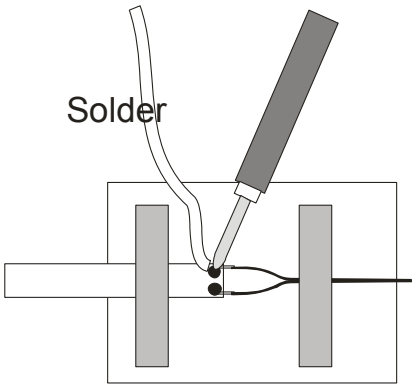


2. When you have found out which wires connect to which terminal tape the cable down to the scrap wood so that the exposed metal tips of the wires are resting on top of the correct terminals. Disconnect the power



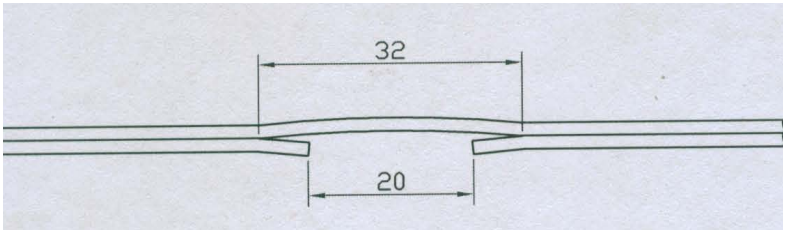
3. Press the wire on to the terminals with a hot soldering iron and wait for about 10 seconds.

4. Without removing the soldering iron push a small amount of solder onto the tip of the iron and then take both the iron and the solder away.

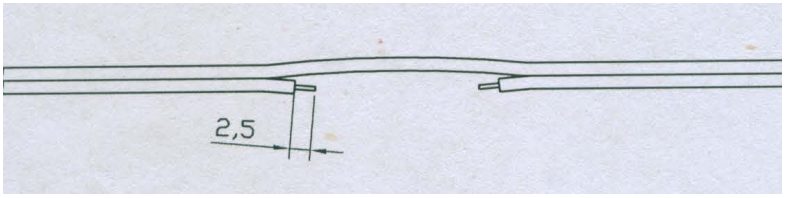


5. Slide the heatshrink over the soldered join and heat it up with a heat gun.

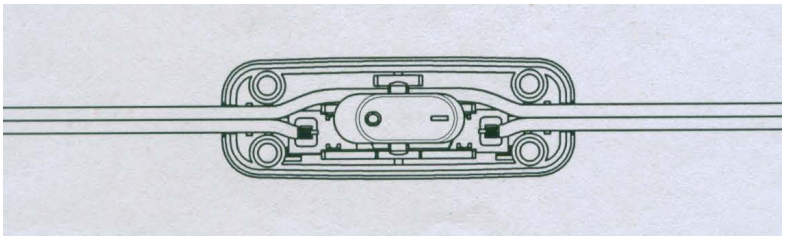
Connecting the switch:



Separate the two wires and cut one as shown.



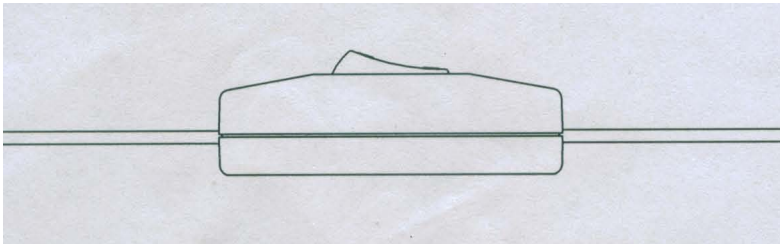
Strip the ends of the cut wire.



Feed both wires through the tunnel under the rocker until only the continuous wire is under the rocker.

Solder the wires to the terminals. Be sure not to melt any plastic. Or you can use conductive paint for this

Test to see if it still clicks. Test to see if it lights up the LEDs.

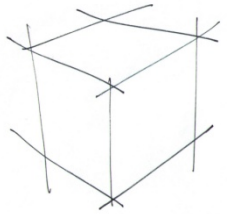
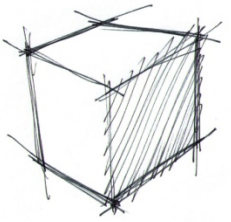
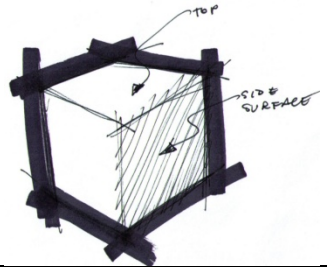


Press lid of switch securely onto assembly

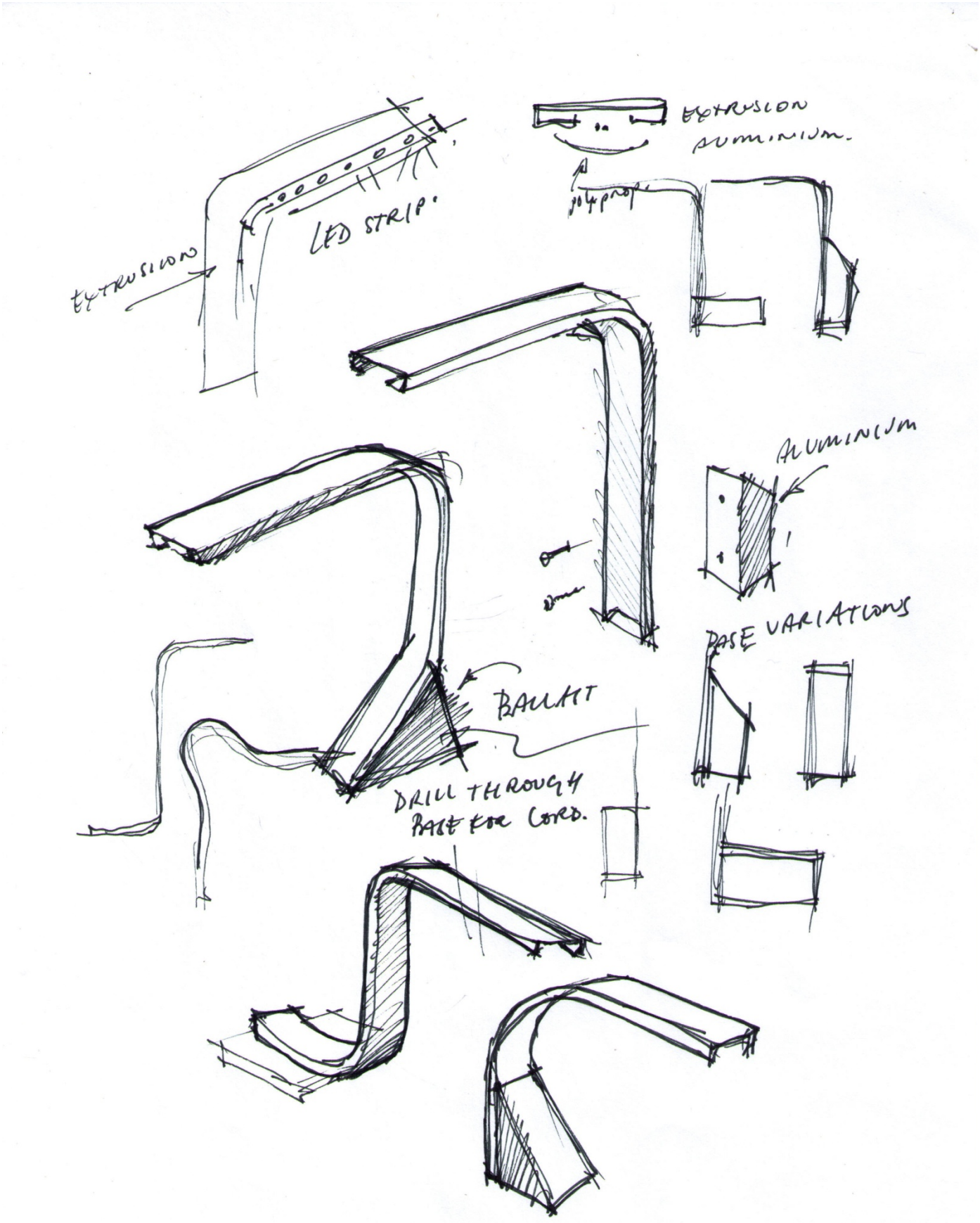
Concept sketching technique

Early in the design process the name of the game is generating ideas. Your drawing will need to be quick, and a bit of mess is fine – it shows that you are thinking creatively. You will also have more ideas to choose from. A 'what if...?' kind of mind set is what you want to use. Be curious about variations of ideas and draw them. If you are drawing slowly then you'll get stuck.

By drawing quickly and not being too concerned about mistakes, we are helping our brain think in a certain way. The act of drawing and seeing these ideas can actually stimulate us to have more ideas. It is very likely that the idea we choose to develop further would not have sprung from our mind without the activity of sketching and continual evaluation. Using fineliner (not pencil) follow the steps:

1. Construction lines Light-weight lines that are drawn too long (and are not made up of multiple short lines). Keep them light by drawing faster (this will also help them to be straight). Most construction lines are in fact not the line you will end up with. If you draw a construction line that is not what you want then repeat that line until you get the one you want.	
2. Firming lines Now that you have constructed the shape go over all the correct lines a second time with fineliner, but drawing slowly to achieve a darker line. All the incorrect lines will be less noticeable. Firming lines are also drawn long and straight where possible.	
3. Shading Light-wieght crosshatching. These lines are diagonal, but should not be parallel to any other line on the object. One of the vertical surfaces is chosen for shading (as well as any other vertical surface facing the same way). Shading lines start and finish just outside the shape you are shading.	
4. Outline With an Artline 90 draw a dark line around the perimeter of the object. Once again make these lines straight and too long. The dark outline cleans up any mess from construction, firming and shading.	
5. Annotation Show that you have solved important problems or are at least thinking about them by writing notes about materials and joins. These notes should not appear to be a part of the object and so they should be outside the object, be small, and if they refer to a particular part of the object then a wavy arrow is helpful.	

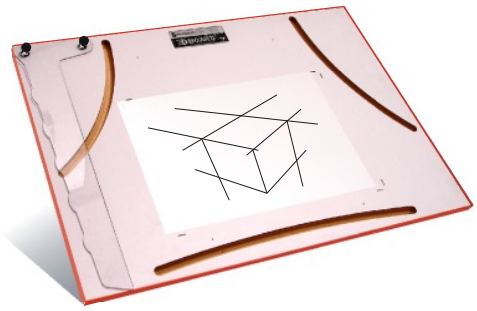
Concept sketching example

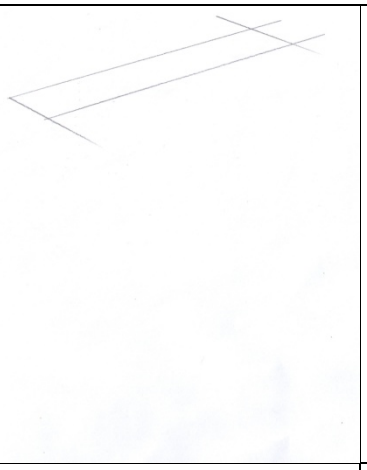
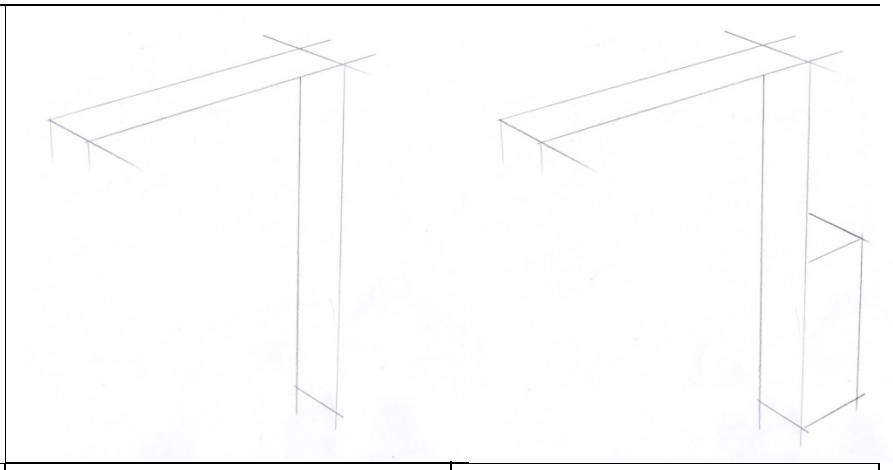
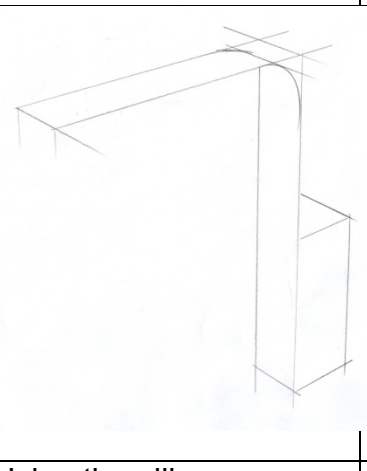
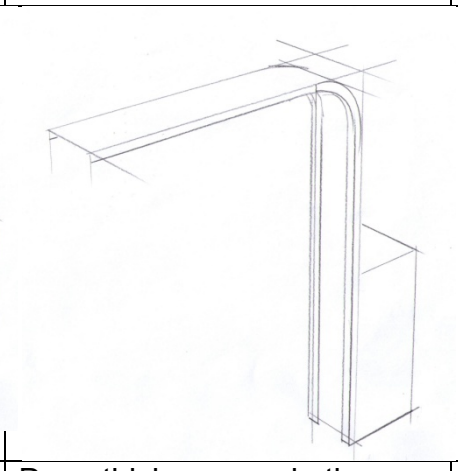
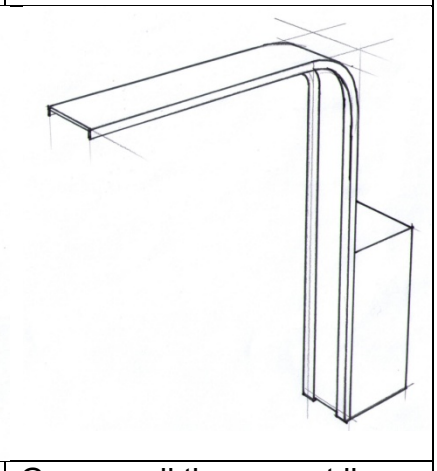


Concept sketches

Accurate perspective drawing

The 3D board will help you develop your favourite idea from concept sketch stage. Work in pencil first and then go over the lines you want to keep in fineliner. Here are the steps used to draw the basic model in perspective:



		
In pencil draw the top part of the arm.	Draw the stem	Draw the base.
		
Using the ellipse template, radius the corner.	Draw thickness and other details.	Go over all the correct lines in fineliner.

Evaluation questions

1. What is the height of your LED strip off the table?

2. What do you like most about your lamp?

3. What do you like least about your lamp?

4. How could you increase the stability of your lamp?

5. List three things that you would do differently if you were to make your lamp again.

6. If you could change the design brief what would you change?

7. If you had the opportunity to design another LED strip lamp what would it look like. Do a quick sketch.