Rotating Promotional Display

AQA Centre Number 46443

Lytham St Annes Technology and Performing Arts College,

Albany Rd, Lytham St Annes, Lancashire, FY8 4DG.

- GCSE Design and Technology 2016-2018
- Electronic Products AQA Specification
- Promotional display
- Joe Butterworth 4033
- Expected Grade: A*

AO1 - Research & Analysis	1	Project title; Task & Design Brief
	2	Mood Board. 30+ relevant images; Similar products, components , materials, users , CAD CAM machines, tools,
	3	Target Market & the Profile of typical buyers / users of the product
	4	Detailed Product Analysis / Existing products + images {ACCESSFM x 4} and how theses meet customer needs.
	5	Research and Analysis of; Materials, Batteries and Power Supplies. Which can be used in school, which in Industry
	6	Research and Analysis of; Input, Process and Output components, System Diagram. School & Industry, Which can be used in school, which in Industry
	7	Research and Analysis of Processes ; SMDs, Vacuum forming, Injection Moulding, Laser cutting, 3D printing. Which can be used in school, which in Industry
	8	Initial Design Specification
AO2 - Designing & Planning	9	5 different initial ideas, hand drawn, 3D, with ACCESS FM, based from research section.
	10	Developed idea (designs drawn on paper) showing improvements and increased detail explaining materials, size and construction methods.
	11	SolidWorks development of parts and whole project showing evidence of CAD, with full analysis
	12	Power on LED circuits , calculations , astable and bread boarding , with circuits, pcbs and photos
	13	4 Yenka files, screenshot and fully explained for your chosen project and final Yenka circuit, costing
	14	Photos of Modelling of case in card / Styrofoam {Photos} . Social, moral, cultural and environmental
	15	PIC program versions. Development of PCB, Screenshots. Analysis of how theses meet customer needs.
	16	Final view of outside of box and sketches of how PCB and parts on flying leads will be fitted to the box
	17	Manufacturing Specification (include a Cutting List—Identify parts, sizes and tools/machines to be used)
	18	Step by step plan of how you are to make it. (do this in a cartoon style layout. Written information and sketch to explain each stage)
AO3 - Making	19	Flow Chart – Showing main steps for PCB manufacture test, case manufacture and assemble and quality control procedures. School V Industry manufacturing
	20	Photographic Record – All photos labelled and described Including any modifications that were made during manufacture
	21	CAM explanation – showing settings and details of the parts that have been completed. Include photos of the machines used.
AO4 - Evaluation	22	Evaluation against Specification and how theses meet customer needs.
	23	Testing, QA, QC, fault-finding, 3rd party evaluation , user manual, self evaluation
	24	Future Modifications & Commercial Manufacture

Design Brief

- For my GCSE electronic products Controlled Assessment. I intend to design and make a turntable display this products is aimed to display small products, this will be good for small businesses. However, these will not be my only audience. This is intended to promote a wide range of products and so can be used by any person looking to promote such an item.
- I may make my promotional display PIC controlled , these would use 5V ICs. This makes it possible for a remote controlled display. Alternatively I could use this to make speed pre-sets which would be alternated between.
- The promotional display could have manual controls. These can be operated by the person to adjust the settings of the display. This product would be best used in promotional videos as it will have many control functions that will make it versatile in promoting many different products. This may also be used in window displays as it will be out of the customers way but also within eye line.
- The display could be powered by 6 AA BATTERIES, this will be equivalent to one 9V PP3 battery. It will have a wooden or plastic case with a generic but visually pleasing design for the base and a turntable on top. It will also have LEDs on the top or turntable, they will be facing towards the product to illuminate it.
- If the display uses a PIC or Microcontroller it will have to use a 5V power supply as they are ICs. This could be powered by a phone charger or use a 5V regulator. To make 5V out of battery you would need to use 4 AA batteries.
- A commercial one may be powered the same way, but it may also be powered from the mains. This would require an AC/DC adaptor. It would also require a large potential divider, this would change the 230V AC to 12V DC.
- I may use a forward and reverse switch, this would utilise a DPDT switch. I would also have the option of speed control this would use a variable resistor or Infra RED remote.

Links to similar products

- https://www.youtube.com/watch?v=KusJ7KuX374
- https://www.youtube.com/watch?v=jczYz-dSLxs
- https://www.youtube.com/watch?v=0nCUcHd_xnQ
- https://www.youtube.com/watch?v=FM8OSVJQw6A
- https://www.youtube.com/watch?v=DQPvUpOaRtI
- https://www.youtube.com/watch?v=CH7pY1MsIpE
- https://www.youtube.com/watch?v=9UlAfDetako
- https://www.youtube.com/watch?v=FCfp3Fe3kEE
- https://www.youtube.com/watch?v=AnYgK3XkHIY
- https://www.youtube.com/watch?v=rh13vRQ4GRU


ECG
UNIVERSAL
NE555N
7828
CLOCK IN
RESET
ENABLE
4017B
F B A C G H D -ve
PINS 'A' to 'J' ARE THE OUTPUTS
DURACELL
PLUS
Epoxy lens/c
Wire bond
Reflective cavity
Semiconductor die
Anvil
Post
Leadframe
Flat spot
Anode
Cathode
LM386
ZN6411

Task 4:AO1

Customer Profiles & Target Market

- Name: Sam Deacon
- Gender: Male
- Age: 14
- Location: Lytham St Annes
- Interests: Gaming
- Occupation: Student
- Reason for buying my product: I like to show off my things.
- Comment on the price: Too expensive.

- Name: Larry Tang
- Gender: Male
- Age: 15
- Location: Lytham St Annes
- Interests: Music, tall buildings
- Occupation: Student
- Reason for buying my product: I want to display my instrument.
- Comment on the price: Good price, I think.

- My target market for this product is anyone who wishes to show a product. This is primarily aimed at individuals than at businesses as the display will not have an abundance of intricate settings and will lack pre-sets. These functions would be desired by a business as they could easily fine tune there display and set it as a pre-set.
- However, it may be used by smaller businesses as it would be cheaper and easier to work than a more intricate counter-part. This should be factored in to the final product with a high build quality to ensure that it looks nice and for consumers and won't break under heavier loads.
- Individuals would use this for novelty or occasional purpose. If it used for novelty then expenses should be kept to a minimum so that the overall price is low. This is because if someone is buying something for novelty they are not willing to spend much on it.

ACCESS FM for a Promotional Display

- Appearance: Six panels of blue felt, each rimmed with silver metal, arranged in a two by three format. It is freestanding and can have things attached to it.
- Cost: Between £95 - £120 Inc. VAT. This makes it affordable to low end consumers.
- Customer: Anybody, likely to be an adult looking to display paper in an organised way. More likely to be used for business displays with analytics.
- Environment: For indoor use only, as rain would damage the felt. It would also be liable to be blown over by the wind if it were to be used outside. It is optimal for rooms and corridors as its size means it must be put on the floor.
- Size: This promotional display is six foot by six foot. With each panel being three foot by 2 foot.
- Shape: This display consists of 6 attached boards that can be folded away. It is two boards high and three boards wide.
- Function: The function of this is to attach sheets and other thin objects to a vertical display to present information or a persuasive argument in a clear and ordered way.
- Material: This display is made of panels of man made wood with blue felt attached. This gives it a more aesthetically feeling look and allows Velcro to be applied. These boards are held together and in place by metal boarders, probably a light non ferrous metal like aluminium.

ACCESS FM for an Electronic Promotional Display

- Appearance: A curved two segment panel with a screen in the upper segment. Both sides are supported by curving tubes.
- Cost: Between £300 - £400Inc. VAT. This makes it affordable to middle end customers.
- Customer: This product would best benefit medium to high end businesses looking to promote a new product. It could also help public establishments looking to put forward new proposals.
- Environment: For indoor use only, as rain would damage the electronics. It would also require an indoor plug to work and would be best suited to large rooms and conference areas.
- Size: This promotional display is five foot by two foot.
- Shape: A curving surface flanked by cylindrical tubes, with a flat square base.
- Function: The function of this is to upload videos or presentations that will play and show information. These can be continuous or alter through a cycle.
- Material: This display has a casing of plastic, with the electronic components inside. The metal tubing flanking the two sides is made from metal, presumably aluminium or some other cheap light material.

ACCESS FM for a Rotating Promotional Display

- Appearance: A black base with chamfered sides that supports a thin clear rotating display.
- Cost: Between £10 - £30 Inc. VAT. This makes it affordable for home and business uses.
- Customer: This product is accessible to anyone who wants to show a physical product. It allows all angles to be seen which is good for letting the customer now what they are buying.
- Environment: For indoor use only, as rain would damage the electronics. It doesn't require an indoor plug to work but wold be best on a table so the product is closer to peoples eye lines
- Size: This product is approximately 20x20x15 cm.
- Shape: This display has a chamfered box as the base which is attached to a disk of transparent plastic. This uses simple shapes for easy manufacturing.
- Function: The function of this is to rotate a specific item 360° to show the product entirely to the consumer.
- Material: This display is made out of plastic, both black opaque and transparent. It will also include electrical components made from a verity of metals and plastics.

ACCESS FM for a Promotional Display

- Appearance: Flat cuboid with fillet edge. LED display inside allows for many different images to be presented. Currently there is the Doritos logo being displayed
- Cost: Between £40 - £65 Inc. VAT. This makes it affordable for middle range businesses.
- Customer: The customer is most likely going to be a shop owner or franchise that has a medium range outlet. This would most likely be used for a convenience store as food products are best suited to be displayed in such a way.
- Environment: This would not be used outdoors and would be most visible suspended in a shop window of some kind.
- Size: This display would be 35x20 cm with a minimal thickness.
- Shape: This display is a filleted rectangle with minimal depth.
- Function: This display is designed to hang in a shop window and to display a programmed image using LEDs it may also rotate through some pre-sets depending on the memory in the display.
- Material: This display is made from a series of LEDs this will be controlled from a processor in the display. There will be plastic to case these components and the plug will be made from formaldehyde.

Research and Analysis: Materials

- Softwood: Softwoods come from coniferous trees, like Pine, Cedar and Yew. There are several types of pine but they're all generally pale with brown streaks. Scots pine is fairly strong but knotty, Paraná pine is more expensive, it's hard and is most used for interior joinery. Softwoods grow in colder climates and are fast growing, as they are evergreen, this makes them fairly cheap. Pine may be used in my display as it is cheap and can bring some good results. If my display was made commercially it would most likely be made out of pine as it strikes the best balance between cost and appearance.
- Hardwood: Hardwoods come from deciduous trees, like Oak, Mahogany, Beech and Elm. They usually grow in warm climates and are slow growing, as they loose there leaves in autumn, so they are generally more expensive than softwoods. These can make really nice products but are too expensive to be viable in either my display or a commercial display. If a commercial display wanted a good wood like finish they would probably use veneer as it is light and can be used on many shapes.
- Plywood: Plywood consist of layers of hardwoods and softwoods glued together with their grains at right angles. This is expensive but very strong, it s best used in construction for this reason. This would not be used in neither my display nor a commercial display
- Blockboard: Blockboard consists of strips of softwood sandwiched between layers of veneer. This is cheaper than plywood and better looking. This may be used in a commercial display if it did not want exposed pine. However, this is best suited for interior décor.
- Chipboard: Chipboard is made by compressing wood chips together with glue. It's cheap but not very strong, so it's usually used with a stronger veneer surface. It's often used in cheap self-assembly furniture and would be ill suited for either the commercial or my personal display.

Research and Analysis: Materials

- MDF: Medium Density Fibreboard (MDF) is made from tiny wood particles, glued and compressed together. It's pretty cheap and has smooth faces that are easy to paint. It can easily be laser cut and is so a likely material for me to use. This would not be used in a commercial setting as it looks unprofessional. However, they may use MDF and paint it.
- Ferrous Metal: These are the metals that contain iron because of this almost all of them are magnetic. These are metals like mild steel, high-carbon steel and stainless steel. These would not likely be used in my promotional display as metal often requires complex ways of manufacturing. It would not likely be used in a commercial display as they are often heavy and will rust over time.
- Non-ferrous Metal: If a metal doesn't contain iron, it's non-ferrous. These are metals like, aluminium, brass, copper, zinc, gold and bronze. These all have different properties and different purposes, they are most often corrosion resistant. These would not likely be used in my promotional display as metal often requires complex ways of manufacturing. It would not likely be used in a commercial display as there are plastics and woods that would work better for the display.
- Aluminium: Aluminium is a non-ferrous metal. It is lightweight and corrosion resistant, but it is expensive and not as strong as other materials. This would not likely be used in my promotional display as it requires complex processes. It may be used in a commercial display as it is light and corrosion resistant, but plastics also do this and are cheaper.

Research and Analysis: Materials

- Acrylic: Acrylic is a thermoplastic meaning it can easily be melted and reshaped using heat. Acrylic usually comes in thin sheets, these can be cut using a laser cutter into any two dimensional shape. These shapes can then be bent and contorted using heat, for this we would usually use a line bender to heat a certain section of the material. It would then be kept in a jig until cooled to form it to its new angle. This is a material we are likely to use in school as it is easily manipulated. It would probably not be used in a commercial setting as it requires gluing and is not an easily automated system, for this they would probably use injection moulding.
- HIPs: HIPs or High Impact Polystyrene is a thermosetting plastic. It is moulded to make products using a vacuum former. In industry this is often used to prototype designs, the results are not the most visually pleasing and the plastic is often weak as the stretching has made it thin. However, in school it may be used as it is one of the easiest and cheapest materials to make a hollow box out of.
- Thermosetting Plastics: Thermosetting plastics, like melamine-formaldehyde, polyester resin, epoxy resin and urea-formaldehyde, do resist heat. Making them not melt or mould, once they have been made into a product they are rigid and can't be reshaped, this makes them unrecyclable. The resist heat and fire so are used for electrical and cooking equipment. These materials are too hard to use in school, but may be used in a commercial setting to create a plug for my display.

Not all of these materials will be usable, due to school limitations. In school I may use MDF, HIPs or acrylic. An MDF or acrylic case would be glued together, a HIPs case would be vacuum formed into a simple shape. For my case I will most likely be using MDF as it is strong, durable and easy for use.

Research and Analysis: Batteries

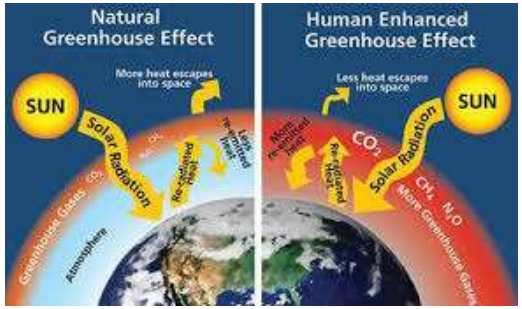
All electronics require power to work. Most power is stored as chemical power and can then be converted to electrical energy. For my promotional display I may use a 9V PP3 battery, I could use six 1.5V AA batteries. However, this would be bulky, heavy and expensive. To combat this we could use six AAA batteries, but this would face the same problems as the AA batteries and wouldn't last as long.

Disposable batteries are bad for the environment. This is because when they are thrown away the chemicals can leak. This is bad as they may have heavy metals. If the heavy metals sink to the water table it can bond to the water. If drank it can be damaging to the body and it's cells.

Rechargeable batteries for the environment as they are not thrown away as often. Once they have run out of charge they can be plugged into the mains again and recharged. However, unless the mains electricity is generated from renewable energy sources, these make up 15% of the electricity generated in the UK, then there are still environmental issues.

For my project it is likely I will use a battery pack. In this battery pack I will probably just be using whatever batteries I have. If so it is likely I will be using a combination of renewable and non renewable batteries in my display. This is less considerate to the environment. However, as my product is only a one off product it is not as harmful as shipping many units of the product with disposable batteries.

Research and Analysis: Batteries



This is because non-renewable resources primarily come from burning thing. This creates electricity by heating water, this water then evaporates and the steam turns a turbine. This turbine is connected to a magnet in a coil of wire (or a coil of wire in a magnet). When the wire rotates it cuts through the magnetic field. This frees electrons from there shells and are then used in electricity.

The burning is the problem as the emissions created. These mainly comprise of greenhouse gasses, like carbon dioxide, carbon monoxide, and methane. These create something called the greenhouse effect when put into the atmosphere. This is where the gases trap in heat from the sun making the world heat up. This is Global Warming.

Our other source of non-renewable power is nuclear power. This is generated through nuclear fission (the splitting of the unstable element into two more stable elements). The fission releases heat which is used to heat up water in a similar way as burning does.

Nuclear Power is a dangerous power to harness as the potential risks are high. If something goes wrong in the reactor this can cause a nuclear meltdown. These are highly dangerous as the resulting hydrogen explosion (from super-heated water vapour) can damage/break containment. If containment is breached then the radioactive particles can leach into the surroundings.

If particles leach into the surroundings then plants, animals, and humans can suffer radiation poisoning. This is nuclear fallout. Nuclear fallout is devastating physically and economically as it renders a region completely unusable.

An example of this is Chernobyl. A nuclear power plant that melted down in 1986 Ukraine. This has caused the surrounding are unsafe for human habitation for the next 20,000 years.

Research and Analysis: Batteries

Another problem with nuclear power is there is no place to safely store the bi-products of the reaction as the resulting radioactive parts would leach into the surroundings making the area unsafe. To counter this we can make dedicated storage places or eject them into space. However, both are very expensive and are resource heavy.

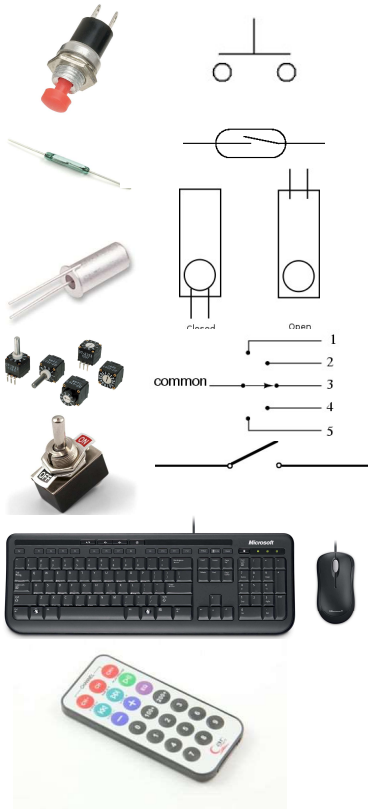
Laptops, mobile phones, and digital cameras have rechargeable battery as the shape and capacity is specific with the product. This would make disposable versions really expensive as they are so specific. Another reason is they are often attached to a product and are complicated to remove. This is prevalent in something like a tablet. A third problem can be accessibility as it can be hard to get to the battery needing a screwdriver or exacto-blade. It is better to run it from the mains (charging the battery) as it doesn't create much waste and you are less likely to damage yourself or the device.

Renewable Energy can be generated in many ways like wind farms, wave power, tidal barrages, hydro-electric dams, wind farms, and large scale solar cells in hot parts of the world. These all use a magnet and coil of wire (with the exception of solar power) like non-renewable resources. However, they use nature to turn the turbines. It uses wind or moving turbines. This is renewable because we are not going to run out of them.

Solar panels have to be south facing because if they faced east or west they would only have coverage for half the day. They south facing opposed to north facing as this points them towards the equator, where the most sun is. Renewable will become more and more important in the decades to come, as we use up our reserves of coal, oil, and natural gases. As they dwindle we will need to at alternate power sources. This will make prices skyrocket as there is not enough for demand.

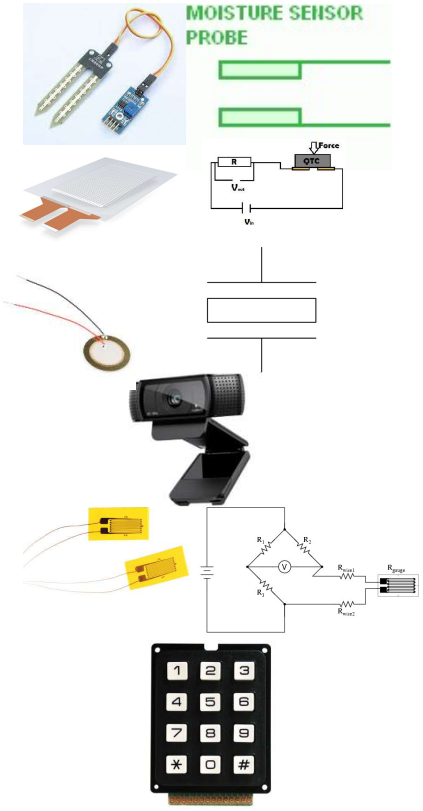
In my project I will be using batteries as they shall easily fit in to my case. I will probably use a 9V battery as they are space efficient and have a longer use life.

Research and Analysis: Input Components



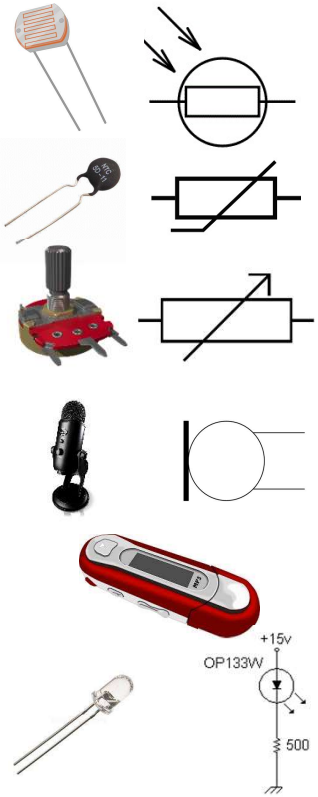
- Push to make switch: This switch completes the circuit when pressed. This is a common component so it is possible that it may be used in my display. However, I don't think I will as my display should function with minimal input
- Reed switch: This switch completes a circuit when a magnetic field is present. This closes the switch as one of the wires are magnetic. It is unlikely I will use this as it has a specific purpose, remote switching, that is not needed in my display
- Tilt switch: This switch completes the circuit when a metal ball bearing slides into position on the electrodes. This uses gravity to determine the orientation on the devise. This can be used to trigger an alarm or as an emergency switch off. I think my devise will be simple enough that I don't need this.
- Rotary Switch: This switch uses human input to change between four or more output options. This directs the circuit to one output at a time. This could be used to operate set speeds instead of a variable resistor. This may be used in my design for this reason
- Toggle Switch: This is a simple SPST switch. It is exceedingly likely I will use this.
- Keyboard and Mouse: This sends several inputs from one devise which are each operated by a human. These are too complicated to be used in my device and would need a computer or Arduino to organise the data.
- Infra-red Remote Control: This allows the product to be controlled without wires by emitting a code of infra red light which is accepted by a receiver in order to use it like a TV remote. This could be used to control my product from a distance.

Research and Analysis: Input Components



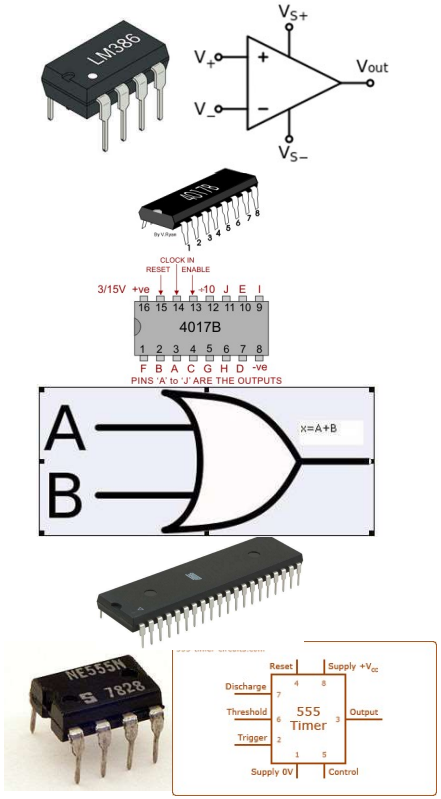
- Moisture Sensor: Moisture sensors test the water concentration in soil. This is requires a devise to read the data. This would not be good for my display as it has no relevance to my display.
- QTC Sensor: QTC sensors use multiple pressure dependant resistors to a change in state. This is often used to make sure complicated equipment is still functioning correctly. Tis would be fairly redundant in my design as it will be simple as so to easily be produced.
- Piezo sensor: This uses piezo crystals to measure subtle changes in air pressure. This is a cheap but not very reliable way to test if sound is over a certain intensity. This would not be used in my design as it would make it unnecessarily complicated. However, for a commercial display it would be well used as it could switch the display on when there is sound, indicating people.
- Webcam: This inputs video. These are too complicated to be used in my device and would need a computer or Arduino to organise the data and so won't be used in my display.
- Strain Gauge: The strain gauge measures change in pressure. Unlike the QTC and Piezo sounder it is much less sensitive. This means it is more adjusted for heavier loads. This could be used to trigger the display when a customer comes nearby.
- Key pad: This input is similar to a keyboard but much similar. This is 12 push to make switches that can be programmed only to work in combination or can be used as buttons for control. This would not be useful for my display as my display will not need some form of lock.

Research and Analysis: Input Components



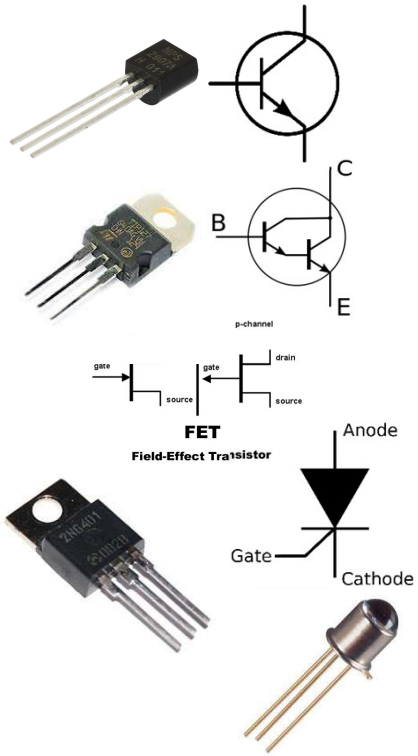
- Light Dependant Resistor: An LDR changes resistance dependant on the light intensity. This can be used to switch something on or off dependant on how light it is, for example a street light. This would be good for a commercial display as it would switch on when the shop switches on the light or when it is light enough for the window display. This would not best be used in my display as I want my display to have manual controls.
- Thermistor: This resistor changes resistance dependant on how hot or cold it is. This is good for heat sensors. This would not be good to be used in neither my display nor a commercial display.
- Variable Resistor: This resistor changes resistance dependant on human input. This allows you to change the resistance allowing for a change in frequency for astable circuits. It is likely I will use one of these to control the speed of my turntable.
- Microphone: This input takes sound input and turns it into electrical information. This can then be sent to a speaker, computer or Arduino. It is unlikely that I will use this in my controlled assessment as it would serve little purpose.
- Mp3 player: This sends pre-installed audio files to the circuit. It works in a similar way to the microphone. It is possible that I will use this in my Controlled Assessment as it would allow a little jingle to play. This could also be used in a commercial product as it would help draw attention to the display.
- Infra Red LED: This receives infra red wavelengths. When this is present it sends an output. This is useful for remotes. This would not be good to use in my display as all the controls will be on the box. However, it would be good for a commercial display as you could control it remotely.

Research and Analysis: Process Components



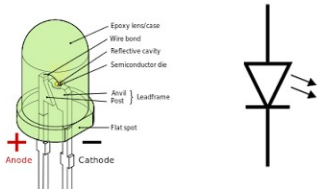
- Amplifier: This component increases an input signal's intensity as by supplementing it with power from the battery. This is well used in a speaker to make it louder or it could increase the power to a specific component. It is unlikely I would use this in my display. It is possible it would be used in a commercial display but may not be.
- Decade Counters: Decade counters send different outputs, using different pins, when a new pulse is sent to the component. It can count up to ten but if one pin is connected to the reset pin then it loops back to the start. This can be used to restrict which number it counts up to. This probably wont be used in my display nor a commercial display, but it could be used for a time out circuit.
- Logic Gates: Logic gates or Boolean gates are different combinations of transistors to fulfil different functions. These are the building blocks of all electrical computation. These are used in computers and calculators to compute functions. These would have little use in a display as they use analogue electronics opposed to digital electronics.
- Microcontrollers: A Microcontroller is a chip used to input and output data according to a program. This is useful in digital electronics. It is likely that I will use one or more of these in my final controlled assessment. In industry this would be used as it is the most cost effective way to make a product.
- 555 timers: 555 timers count up to 255 on a set tick. At 255 they reset and start counting again. They send out a pulse. These are commonly used to output secondly signals. This is more reliable than an astable circuit as it removes all the tolerances. I may use this in mine as an auto switch off for if it is left on too long.

Research and Analysis: Process Components



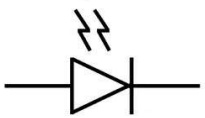
- Transistor: Transistors are semiconductor devices with three connections, which rectify and amplify a signal. They act in a similar fashion to an amplifier circuit, however can route signals by having three terminals rather than having a single IN-OUT. I am not likely to need these in my product but they may be used in a more complicated industrial design.
- Darlington Transistors: A Darlington transistor is a mix of 2 bipolar transistors which are connected in a way which allows the signal from the first amplifier to be amplified by the second one. They are essentially a wide loop. I am not likely to need these in my product but they may be used in a more complicated industrial design.
- FETs: Field Effect Transistors are transistors that use electrical fields to control the way the device behaves. They are also known as Unipolar Transistors, since they involve a single type of carrier operation.
- Thyristors: A thyristor is a component with 3 ports; an anode, a cathode, and a control. These act as is suggested, with the anode and cathode being the ports for a constant signal, and a control gate which is manipulated by a signal. This means you can manipulate current in many more ways. I am not likely to need these in my product but they may be used in a more complicated industrial design.
- Phototransistor: A Phototransistor is a light dependent transistor meaning it controls the output dependent on whether there is light or not. This can be used as an on and off switch for a circuit that detects light. I am not likely to need these in my product but they may be used in a more complicated industrial design.
- A worm drive and worm wheel change the direction of rotation through 90 degrees. The worm drive only has one tooth and will turn much faster than the worm wheel, which has many teeth so will turn very slowly. This is good for my project as it will slow down the motor.

Research and Analysis: Output Components



- LED: Light Emitting Diodes turn electrical energy to light energy. This can be as bright as incandescent bulbs, but is much more efficient. This will probably be used in both my display and a promotional display as it is good for an indicator light.

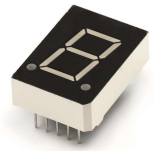
- Light Bulb: This is an inefficient way to change electrical energy to light energy. It does this by sending current through a resistive wire in a vacuum, this heats the wire and emits light. It is unlikely to be used in a promotional display, as it is bulky and inefficient. It is better used to light a room as one bulb lights a large area.

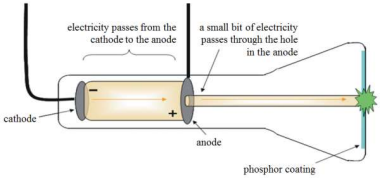


- Flashing LED: This is the same as a normal LED but it flashes on and off at a consistent rate. This is even better for an indicator light as it conserves more energy. The rate of flash can sometimes be controlled by a third input.

- Rainbow LED: This is also similar to a LED. However, this LED rotates through different colours. This can look nice but is also much more expensive. This would be good for my display as it can be used to give the product different hues. This would be feasible in a commercial display but would possibly be too expensive to use in school.

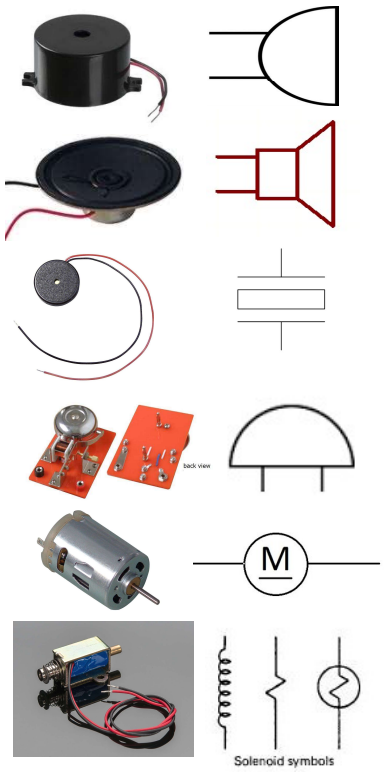
Research and Analysis: Output Components





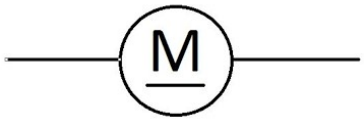
- LED Cluster: This is a cluster of LEDs running off of the same anode and cathode. This is good for bright lights, like in torches or house lights. This would be too bright and big to be used in a display. If it were an outdoor display it may be commercially viable but it wouldn't be for my display.
- LED/LCD 7 segment display: 7 segment displays can be LED or LCD, the use of LCD can be more expensive for small components but it requires less energy to run and would be better used in larger displays. The 7 segment display can show any number and would be well used in a dice or counting system. This would not be used in my display as I would have no reason to display numbers. In a commercial display it may be used to show the speed of the turntable, this is too complicated for what we need to do in school.
- Cathode Ray tube: Ray tubes bend beams of light to different parts of a monitor or display. This was used on old TV and computer monitors. Large magnets are a problem for ray tubes as they can permanently damage the display. This should not be used unless needed as they are large and bulky, can be damaged and rarely display anything but 4:3 displays. It won't be used in either commercial display or my display as it is unnecessary.
- LED/LCD/Plasma Screen: These are the types of screen commonly used today. They can be very slim and are now fairly efficient. However, they need some form of OS and computing components like an Arduino to display anything. This is to complicated for what I want to do. This could be used in a commercial display as they would have the budget and the ability to utilise a screen like this.

Research and Analysis: Output Components



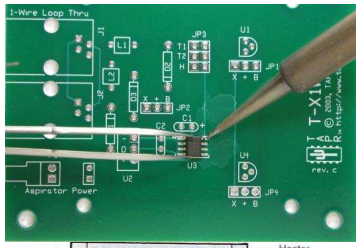
- Buzzer: Creates a buzzing noise when powered. This is good for alerts and alarms. This may be used in a commercial device to signify low battery, but they would probably use an LED. This won't be used in my display as it is unnecessary.
- Speaker: Speakers use an electromagnet to move a diaphragm material up and down this creates sound. This could be used in a commercial or my personal display to play music or sound as part of the display.
- Piezo Sounders: Piezo sounders oscillate piezo crystals to emit sound. This is cheaper and more space efficient than speakers. They could be used in instances of speakers to cut down size and prize, this makes them a more likely candidate to be used in the display.
- Bell: This uses an On and Off switch, witch comprises of an electromagnet, to make a hammer hit a bell. This is useful for making a ringing sound. This is similar to a buzzer but works in a much simpler way. It is unlikely that it would be used in either my display or a commercial one.
- Motor: This uses an electromagnet and a coil of wire to rotate a pulley or gear. This rotation is made when a current is passed through the motor. This will be used in both a commercial and personal displays as it is the most effective way to turn the turntable.
- Solenoid: This is similar to a motor but instead of rotating it intersects through the solenoid. The motion is created when a current is passed through the circuit. This would serve no purpose in my display nor a commercial one.

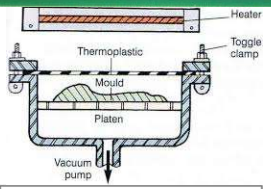
Research and Analysis: Motors

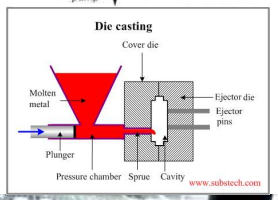


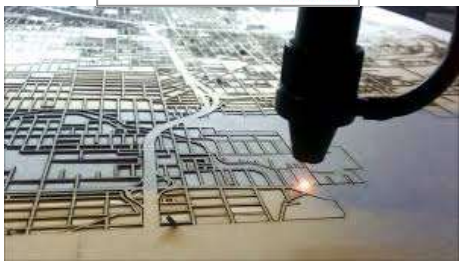
- A motor uses an electromagnet and a coil of wire to rotate a pulley or gear. This rotation is made when a current is passed through the motor. If the rod was spun by hand it would start to generate electrical charge. This is an electrical generator.
- In my project I'm going to use a DC motor. DC motors spin very fast, the only limiter is the resistance of air and the bearings. A simple, and inefficient way of controlling a motors speed is to put it in line with a variable resistor, even with a low power motor the resistor would get hot.
- To control the speed of a DC motor we use a mark space ratio circuit. This uses a PIC and a variable potential divider (using a variable resistor). This outputs different lengths of highs and lows which changes the speed proportional to the length of highs and lows.
- This will still be going very fast, to reduce this I may use a compound gear but this would not give me enough speed reduction with many bulky gears. So instead, I'll use a worm gear to reduce the speed to about one fortieth. A worm drive changes direction of rotation through 90^{o}. The worm drive only has one tooth and will turn the much slower worm wheel, which has many teeth so will turn very slowly.
- To control an AC circuit we use a chopper circuit. This only allows part of the AC wave through. This controls the speed in a similar way to how a mark space ratio works for a dc circuit. AC circuits are more powerful than DC this allows for much more powerful motors. If the turntable was up sized so that it could turn a 2 tonne car it would need a high power AC turntable.

Research and Analysis: Manufacturing methods



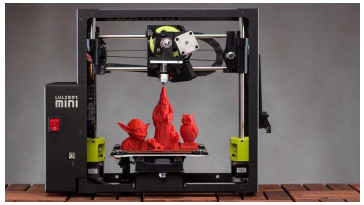


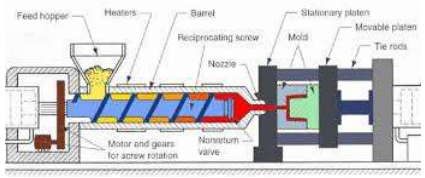


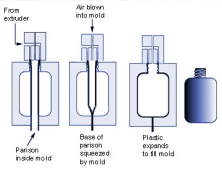


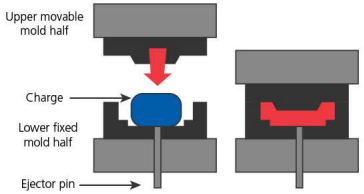
- SMDs: Surface mount devices use solder powder and legless components. This is easy for automated manufacture, as the components can be placed onto the circuit board with the powder. The board can then be heated melting it and attaching the component. This process is good for industry as it is cheaper and can be automated. However, it is not good for my project as we will be making our own PCB and it is easier to conventionally solder our components.
- Vacuum Forming: Vacuum forming heats a sheet of thermoplastic, like HIPs until it goes soft. A mould is put onto the vacuum bed and is lifted up to the plastic. Then all the air is sucked out of the system, creating a vacuum the pressure difference moulds the plastic to shape, were it cools. This is commonly used for prototyping in industry. This would likely be used for the casing on school projects as it is cheap and easy.
- Die Casting: Die casting is used to mould metals and thermoplastics. The material is melted and poured into a mould, the die, which is in the shape of the product. Some plastic resins can be cold-poured, then can be chemically hardened. This could be used, in industry, to produce high quality prototypes and job lots. This is probably too complicated to make a case for electronics but may be used in Resistant Materials, and so won't be used in my exam.
- Laser Cutting: Laser cutting uses a laser router (Laser cutter) to cut out a 2d design made in CAD programs, like 2D design and Ethos. The CAM uses a precision laser to cut out the design. This can make simple shapes but is limited to the 2D nature. This is likely to be used in my project as it is simple to use. Similarly it may be used in simple industrial products

Research and Analysis: Manufacturing methods









- 3D Printing: 3D printing is an additive CAM (computer aided manufacture) process. It uses a computer to move a printing nozzle across the printing bed. This nozzle excretes a semi solid plastic which cools quickly. This is used in industry for rapid prototyping, although recently it has been used in third party products for children brands, like Lego and Nerf. This will probably not be used in my product, as it is a complex process.
- Injection Moulding: Injection Moulding forces molten material into a closed mould under pressure. These moulds are made from tool steel so they're quite expensive. The plastic is often heated using built in heaters but low melting point materials will melt under pressure anyway. This is an industrial process and so often automated and continuous. This makes it an unlikely process for my school project.
- Blow Moulding: Blow moulding uses a tube of softened plastic. This is inserted in a mould where air is injected which forces the plastic to expand to the shape of the mould. This is used in industry often for disposable items like bottles. This would not likely be used in my controlled assessment as it is a complicated process and expensive for just one item.
- Press Moulding: Press Moulding is used to form thermosetting plastics, like melamine formaldehyde. A slug of this powder is put into a female mould, were the male mould presses the plastic into the mould. Very high temperatures and pressures liquefy the powder, were it sets in a permanent shape. This would not be used for my product, but may be used for a plug in an industrial product.
- In my project I shall be laser cutting my case out of MDF, this will be cheap as the materials don't cost much and there is no manufacture cost in school.

Initial Design Specification

- Based on my Research and Analysis and the needs of my potential customers, my Initial speciation is shown below. As my project progresses I will justify any changes to my specification. I will write a final specification , once my project is finished in late 2017/early 2018, and I will then evaluate the two specifications.
- In school my case may be: a thin flimsily vacuum formed polystyrene case, a band sawed MDF moulds with manually drilled holes or a laser cut MDF case. These may all utilise a paper labels on the box and a bought in battery holder, especially for the vacuum formed box. A Mass Produced case would be: Injection moulded ABS case, CNC machined made, aluminium die casted with pre made holes for PCB and battery pack, holes on lid, feet, air vents for cooling and a screen printed label.
- In school, made a single sided PCB designed by CAD, bare copper pads, no lacquer, etched manually, holes drilled manually, paper overlay fitted, wires fitted by hand, comps spaced well apart, leaded through hole comps, DIL ICs, assemble by hand, no antistatic precautions. Mass Produced PCBs: designed by CAD etched by CAM, drill by CAN, doubled sided PCB, lacquered, tin plated, SMD QIL, high component density. Solder pasted, populated and flow soldered by machine, inspection and text by machine, high levels of QA CA, antistatic. PCB and battery very tight fit into box.
- If my display was mass produced it would be more complicated as the components would be much smaller and more tightly packed. Commercial will probably use Programmable circuits, will have packaging, will meet EU/ UK / USA standards for safety and environment.
- All PIC/Microcontroller projects need a 5V supply, this could be a 5V USB supply like a phone charger, a 9V PP3 battery or 6 x AA 1.5 V cells and a 5V voltage regulator. Batteries and a 5 V regulator, or a USB supply is the best option .

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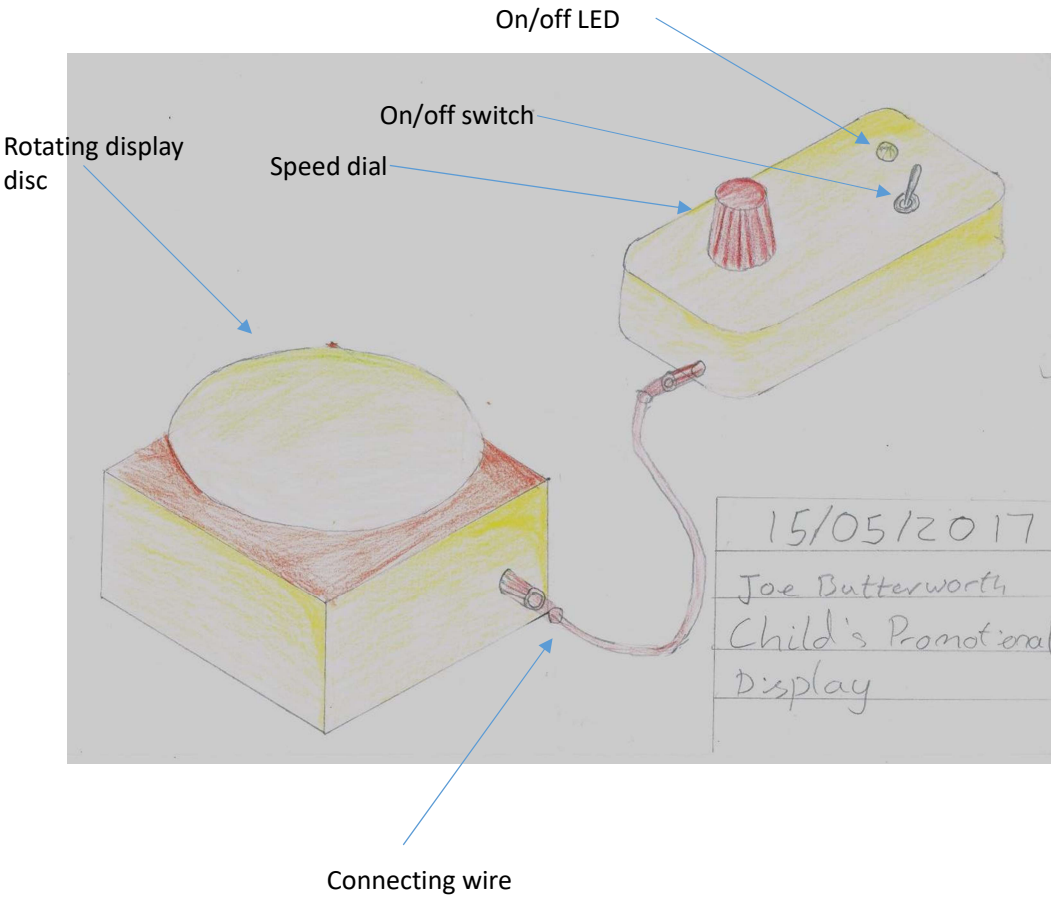
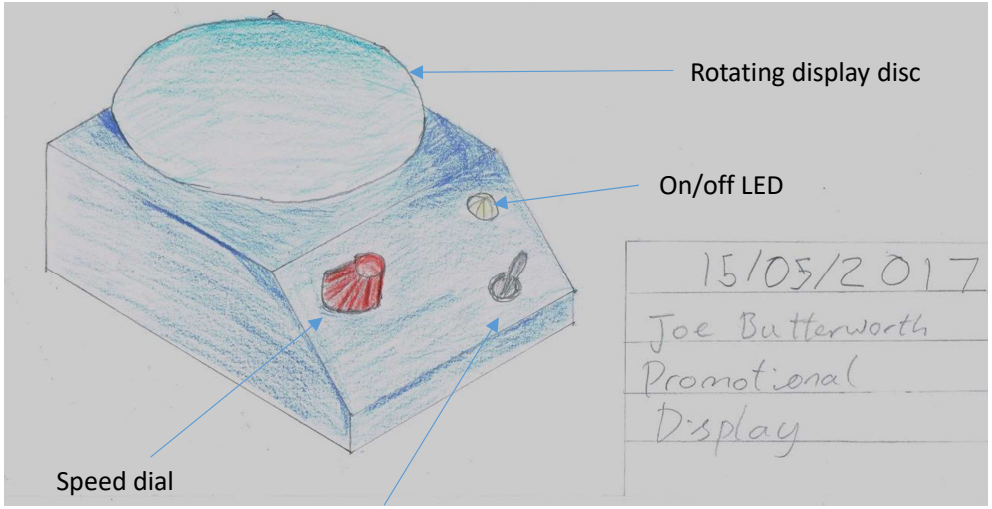
Initial Designs: One – Isometric



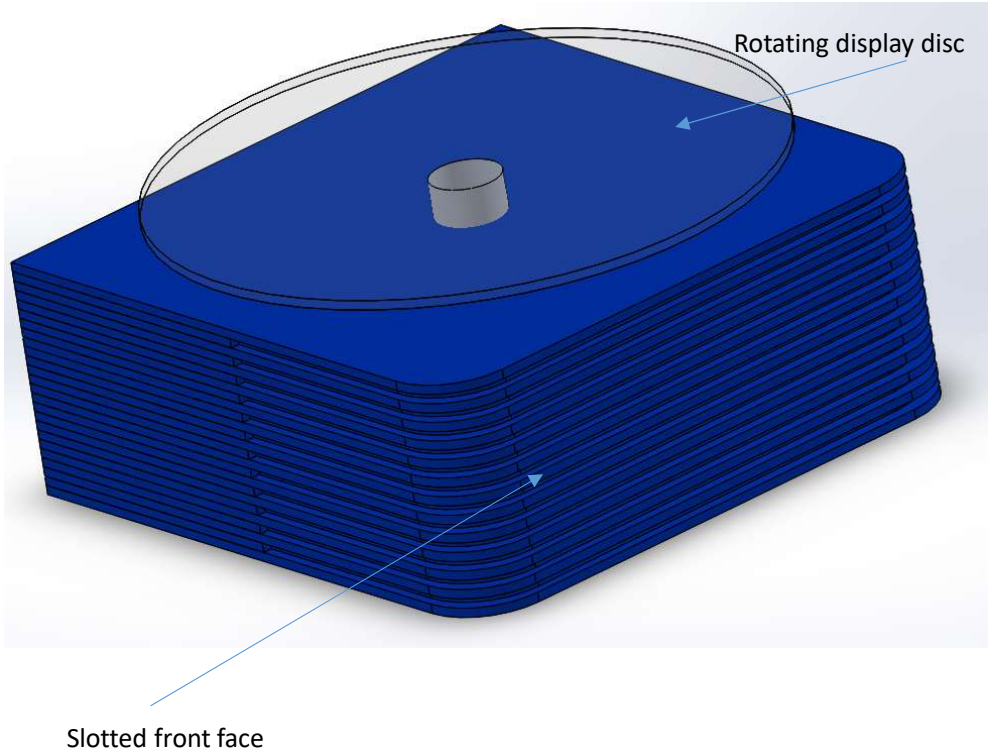
- Appearance: Two yellow and orange boxes one smaller than the other. The larger of the two boxes is connected to a rotating display stand. This is large enough to fit larger items like toys on the display.
- Cost: Approximately £8. This is cheap for parents.
- Customer: This would be bought by parents for children. It has a separating box so that the parent can take control away when necessary. It has bright colours to appeal to children.
- Environment: For indoor use only, as rain would damage the electronics. This doesn't have sharp edges so it is safe for younger users who aren't as precautious.
- Size: This promotional display is 13x13x6 cm, and the control box is 20x6x3 cm.
- Shape: Two smallish boxes each rectangular with rounded edges.
- Function: The function of this is to rotate a specific item 360° to amuse a child through novelty.
- Material: This display has been moulded with a thermoplastic like abs. This is common in children's products as they are safe for the user.

Initial Designs: Two – Isometric



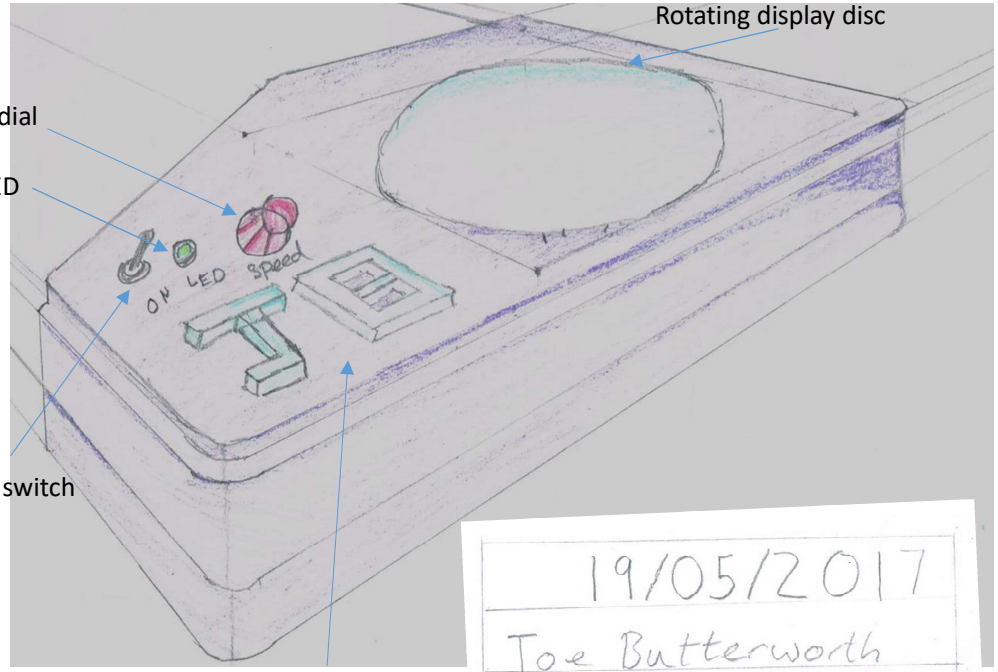
- Appearance: This box Is rectangular with a chamfered top edge. On this chamfer is a power on LED, Speed dial and on/off switch. This is case is blue with a lighter blue rotation disc.
- Cost: this will cost approximately £10. This slightly more than the first design as it is for more serious consumers.
- Customer: This is aimed for people who wish to display an item in a collection, probably to be put in a display cabinet.
- Environment: This will be put in a display cabinet and so will be isolated in environment and unlikely to cause any safety concern for anyone.
- Size: This promotional display is 13x18x6 cm.
- Shape: This is a simple box with a chamfered edge.
- Function: This is to display a collectable item in a collection from all angles, at a consistent speed.
- Material: This will be made of a higher quality of plastic. It will be made of acrylic or abs.

Initial Designs: Three – CAD



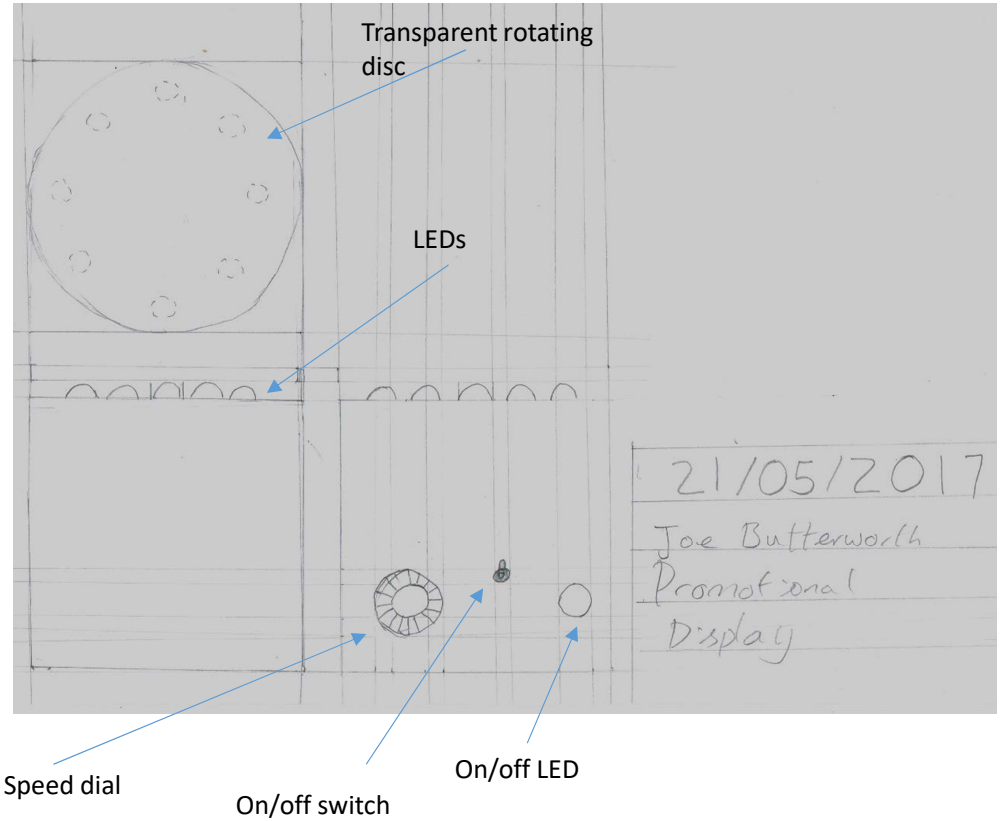
- Appearance: A blue box with a slotted front for aesthetics. On top of this is a clear circular disk that rotates.
- Cost: Approximately £10. This is good for all consumers.
- Customer: The low price point makes it good for anybody. This is even within some peoples range for novelty.
- Environment: For indoor use only, as rain would damage the electronics. This also has sharp edges this can be dangerous for some.
- Size: This promotional display is 13x13x6 cm.
- Shape: A blue box with a slotted with a clear circular disk that rotates.
- Function: The function of this is to rotate a specific item 360° to show the product entirely to the consumer.
- Material: This display has been mostly laser cut from acrylic and glued together. This is expensive but makes it hard.

Initial Designs: Four – Two Point Perspective



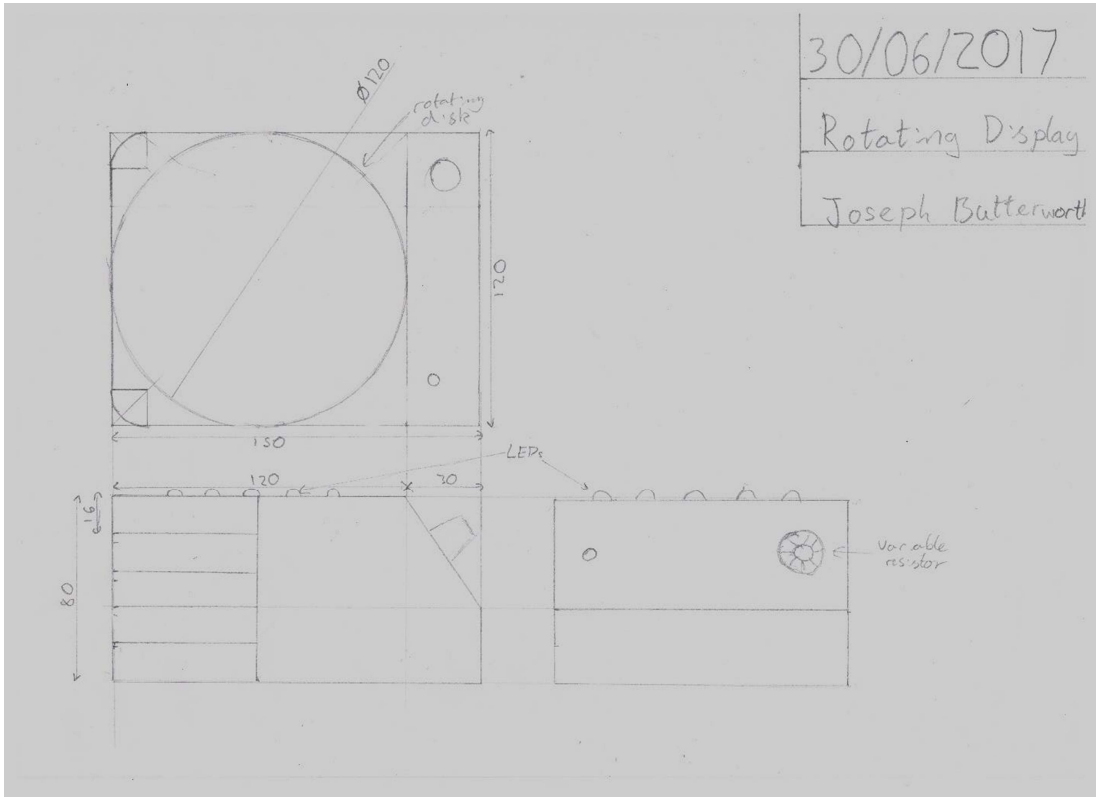
- Appearance: This is like a rectangle with one of its vertical edges chamfered. It has a rotating disc at the larger end of the box. At the shorter end there is controls for the box. It is coloured purple and blue.
- Cost: Approximately £15. This is more of an enthusiast grade item.
- Customer: This will be used by someone who would use it for content creation like YouTube videos.
- Environment: For indoor use only, as rain would damage the electronics.
- Size: This promotional display is 8x15x5 cm.
- Shape: This is like a rectangle with one of its vertical edges chamfered. It has a rotating disc at the larger end of the box.
- Function: The function of this is to rotate a specific item 360° for content creation purposes.
- Material: This display has been vacuum formed with a harder material like acrylic.

Initial Designs: Five - Orthographic



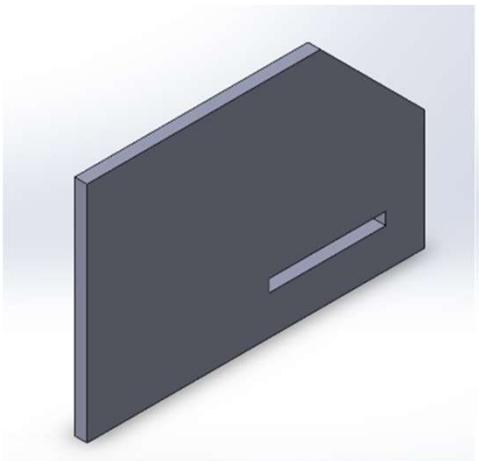
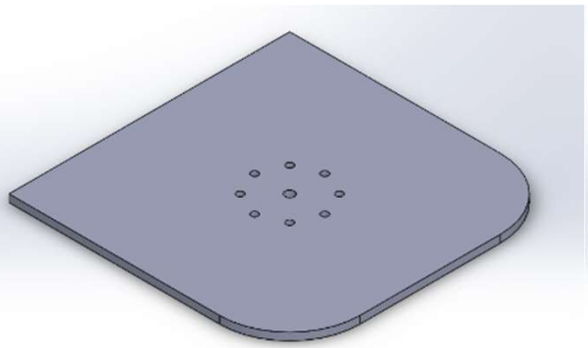
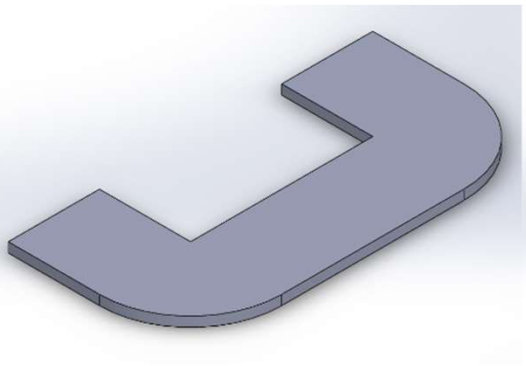
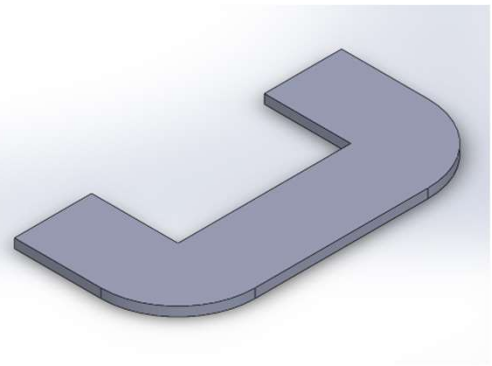
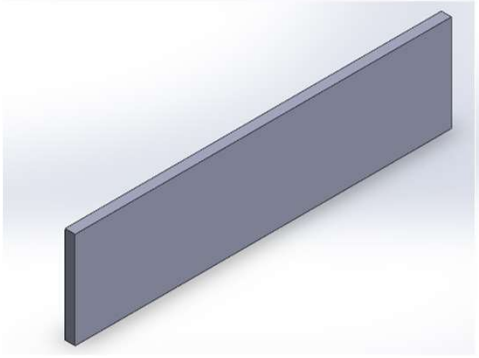
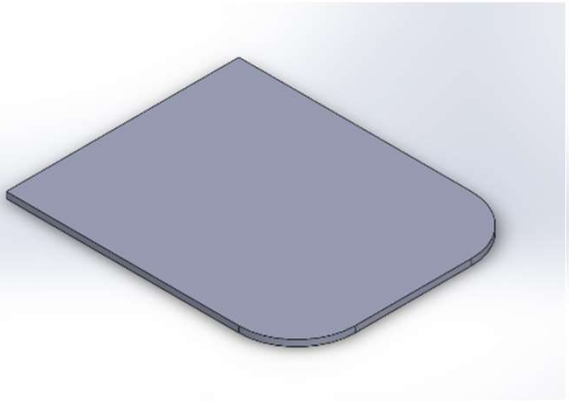
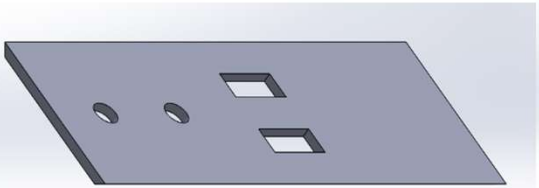
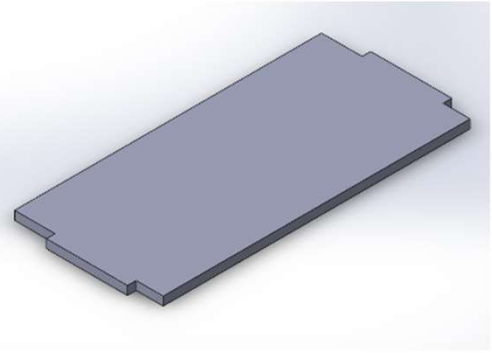
- Appearance: This is a square with eight LEDs at the compass points on the top. Above these is a transparent rotating disc.
- Cost: Approximately £8. It is cheap as it has a low construction value.
- Customer: The low price point makes it good for one of use and this compliments the
- Environment: For indoor use only, as rain would damage the electronics. This also has sharp edges this can be dangerous for some.
- Size: This promotional display is 13x13x6 cm.
- Shape: A blue box with a slotted with a clear circular disk that rotates.
- Function: The function of this is to rotate a specific item 360° to show the product entirely to the consumer.
- Material: This display has been vacuum formed out of hips which makes it cheap and replicable.

Developed Idea

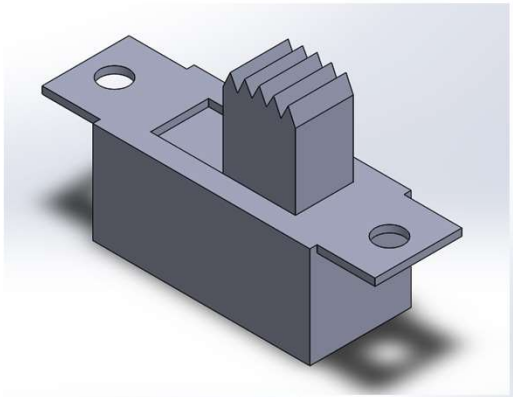


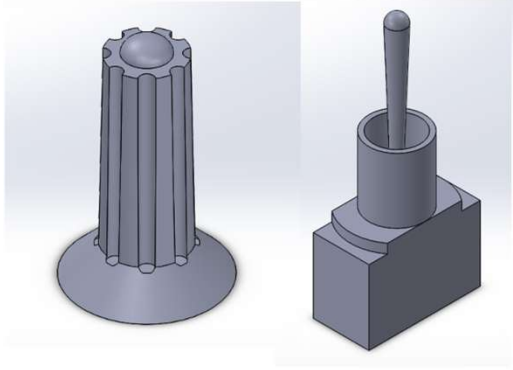
- Appearance: This is similar to design 3 with a slotted appearance at the front of the case. It also takes features from design 2 with a slotted
- Cost: Due to the limitations of the school my case will be made out of less expensive materials. It will probably not exceed £4.
- Customer: This product, although only being made for this project, would be aimed at small shop owners.
- Environment: For indoor use only, as rain would damage the electronics. This had sharp edges which can be dangerous, these have mostly been removed.
- Size: This promotional display is 12x15x8cm.
- Safety: This has a chance of entanglement for this reason it shouldn't rotate too fast.
- Function: The function of this is to rotate a specific item 360° to show the product entirely to the consumer.
- Material: This display will be laser cut out of MDF and glued together.

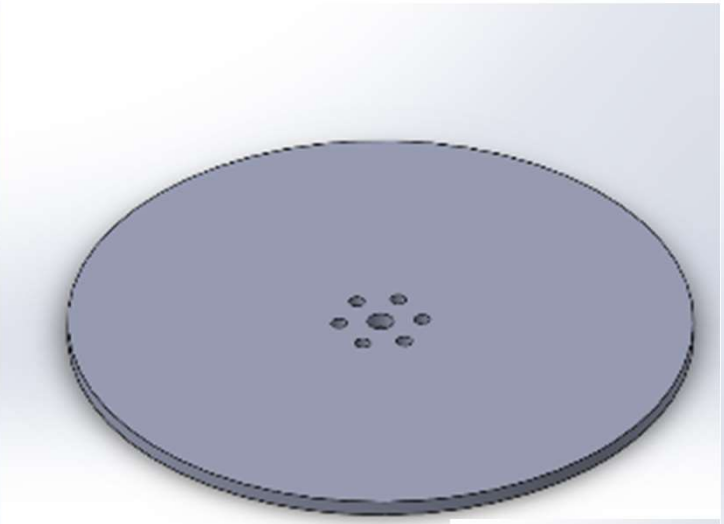
Solidworks Development: Parts

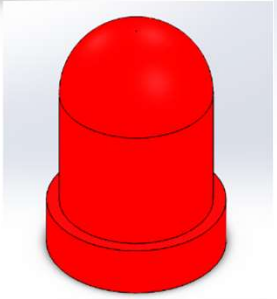









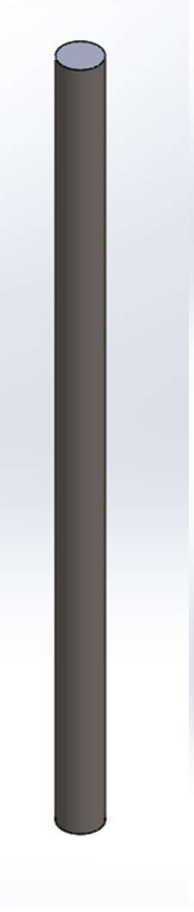
Solidworks Development: Parts

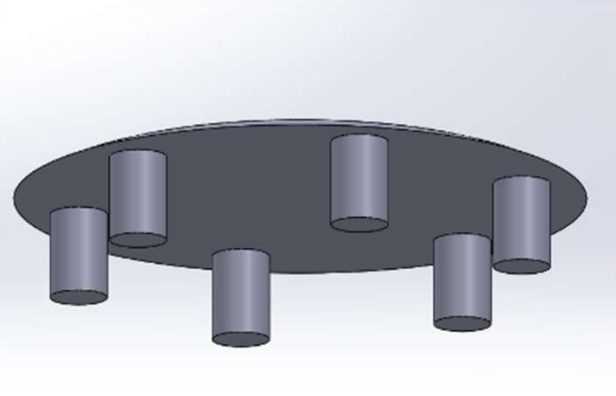


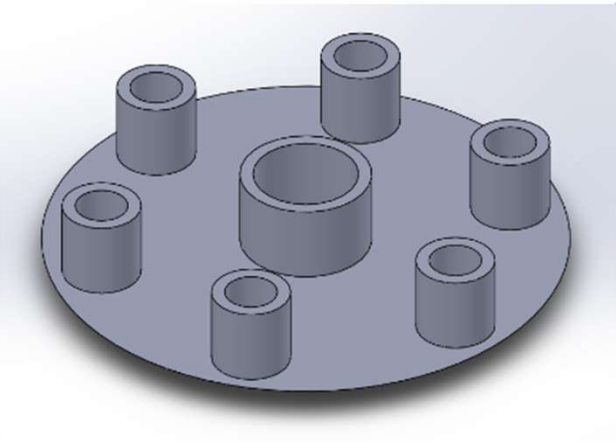




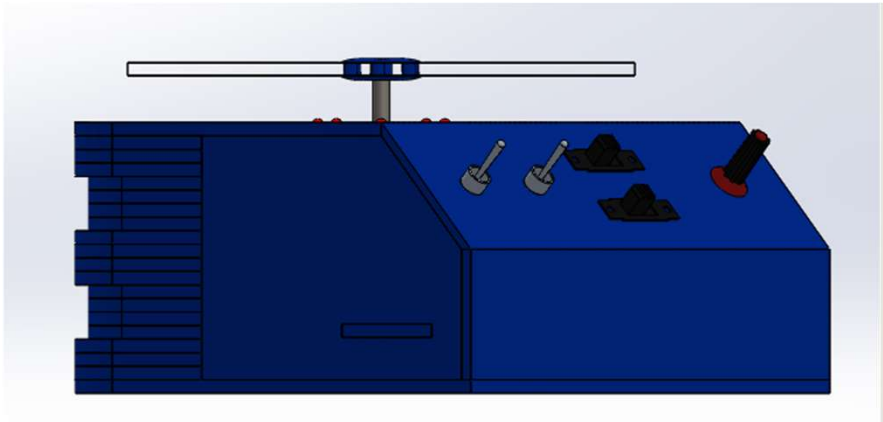


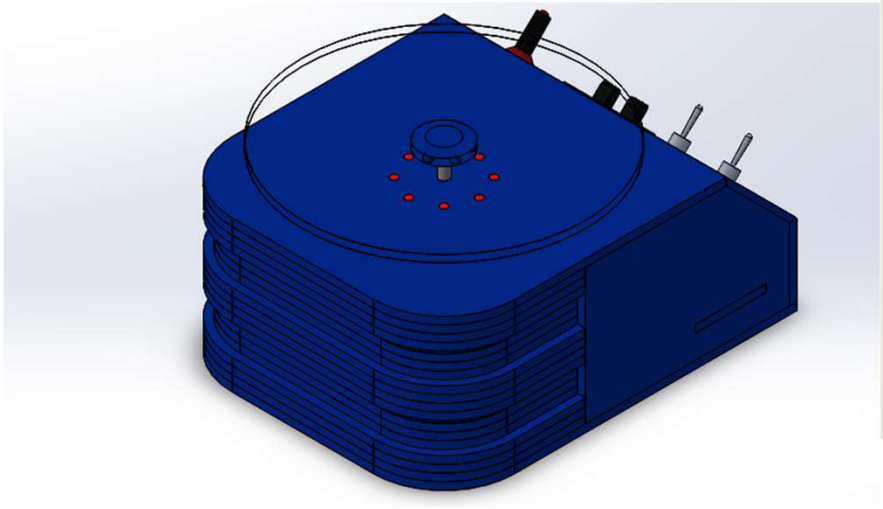


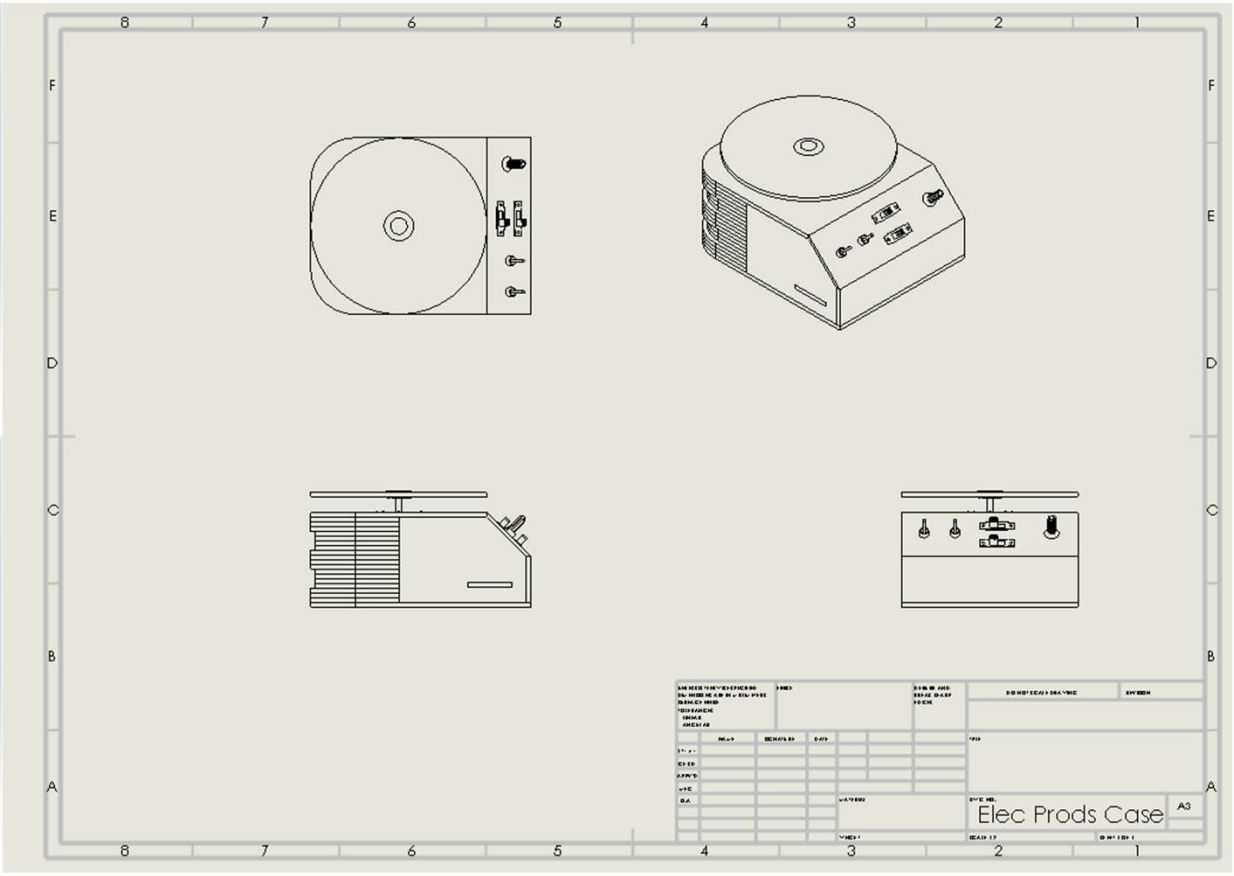




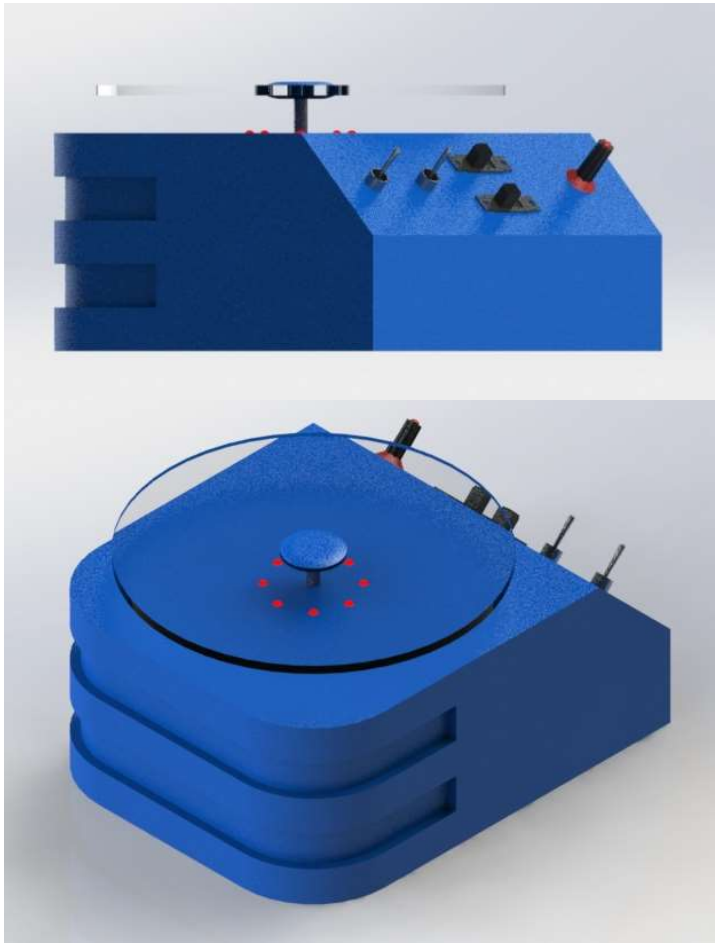
Solidworks Development: Final Case





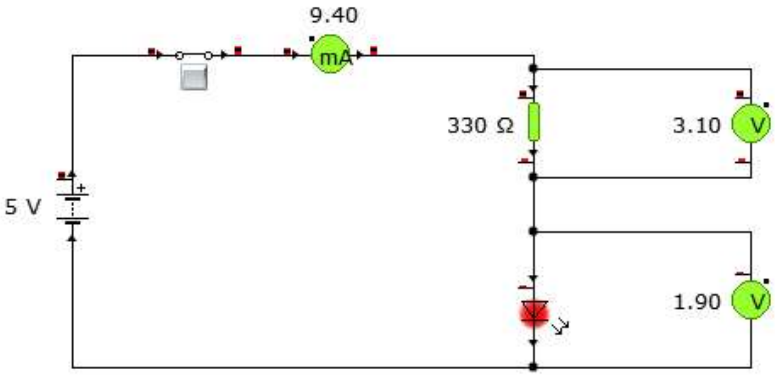


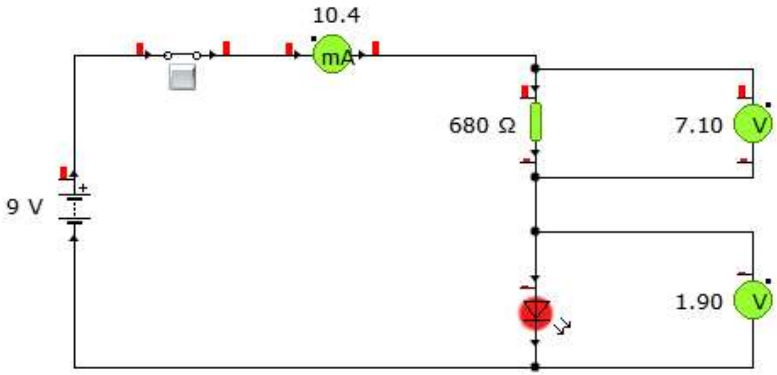
Solidworks Development: Final Case

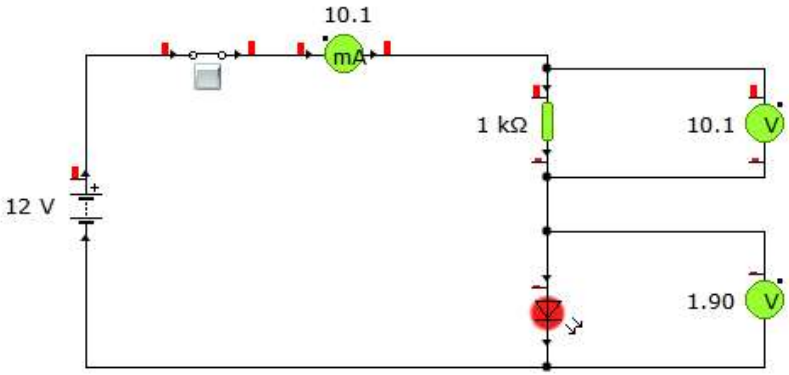


- This is a realisation of my developed Idea. It will be made out of segments of 3.2mm MDF.
- I have decided against using HIPS, like the rest of my class, as I feel that it isn't aesthetically pleasing. However, to keep the cost down and as their are no marks for my case, I have decided to use another cheap material, MDF.
- To make my case I will use the schools laser cutter to cut various 2D shapes I have designed. These will then be glued together with PVA glue. Once securely made it will be primed and sprayed Blue.
- The components, mechanical and electrical, shall have to fit into my case. It will be a tight fit as my case as relatively small and I must fit all of them inside.
- The input components shall have holes laser cut on the case for them. The components shall be fitted to these holes, making them easily accessible for the user.
- I chose a sharp blue colour for my product's case which I thought lends itself to a wider range of customers as it is a widely used and well liked colour.

Circuits: Power On LED





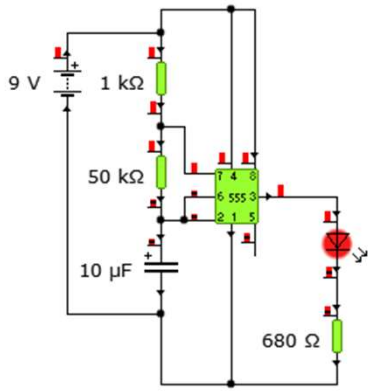


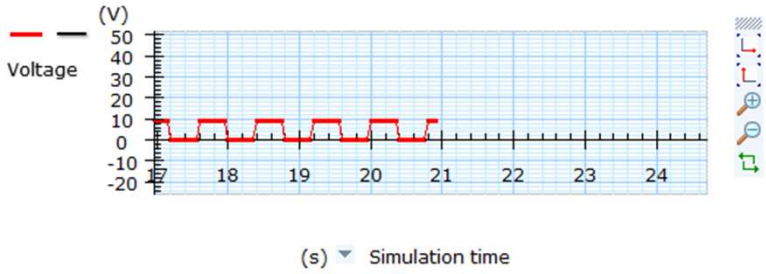
I will use an LED and resistor as my power on indicator, that lights up when I switch my promotional display on.

In school I could use a battery pack or power supply of 5, 9 or 12 volts. The LED current needs to be a limited to about 10mA. For each voltage I have selected resistors that limits the current to about 10mA.

The colour codes are as follows:
330 Ω = Orange Orange Brown (tolerance)
680 Ω = Blue Grey Brown (tolerance)
1000 Ω or 1k Ω = Brown Black Red (tolerance)

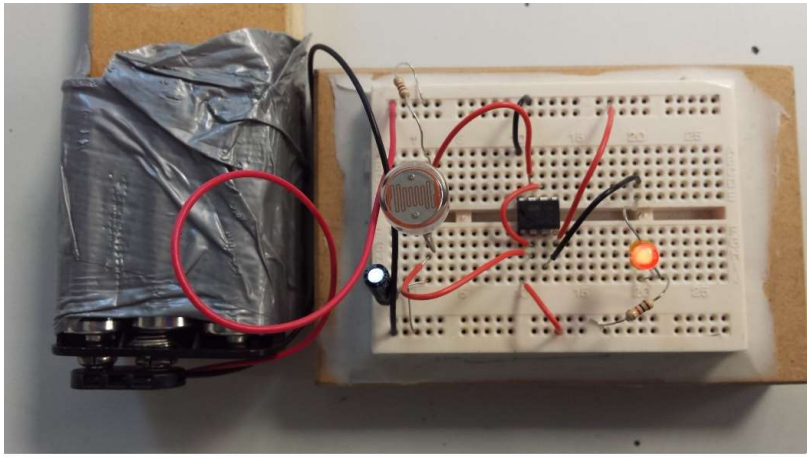
Circuits: Power Astable Circuit

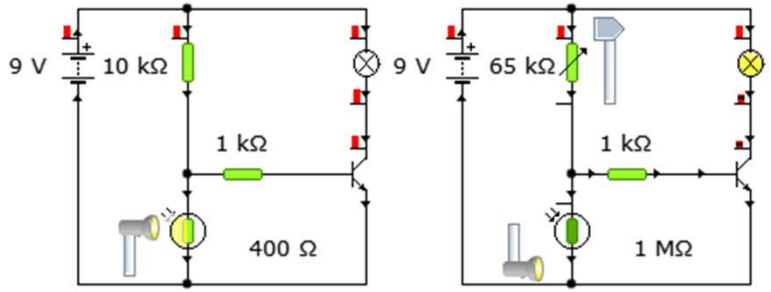




- An astable circuit generates a chain of continuous pulses this sends an on off chain to a component. This makes an LED flash if it is connected to it.
- This can be used to send information to another IC like a decade counter. A decade counter counts up from 0 to 9, for more than 10 counts you must use two decade counters one to count the tens the other to count units.
- The interval of the pulses change dependant on the values of the resistors and capacitor. Swapping out one of the resistors for a thermistor or LDR means that the pulse duration becomes dependant on temperature or light.
- An astable circuit is what is inside a flashing LED. However it is a very small version of it.
- I could develop this into a variable Mark Space circuit, with a transistor, to control the speed of my motor. This would be more complicated but safer and more accurate than just a variable resistor.

Circuits: Power Astable Circuit & LDRs

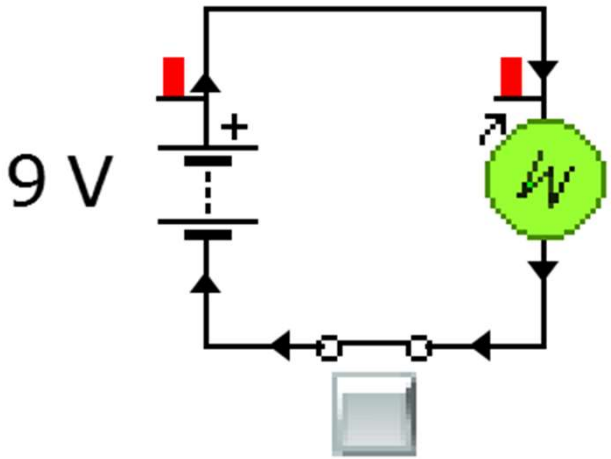




- This astable circuit uses an LDR as R_2 of the potential divider, this changes the input voltage. The change in input voltage changes the speed of the flashing for the LED.
- A similar circuit may be used with a range of sensory components to create different speeds of motor or a flashing LED. These may be used in displays intended for larger companies who want automation.

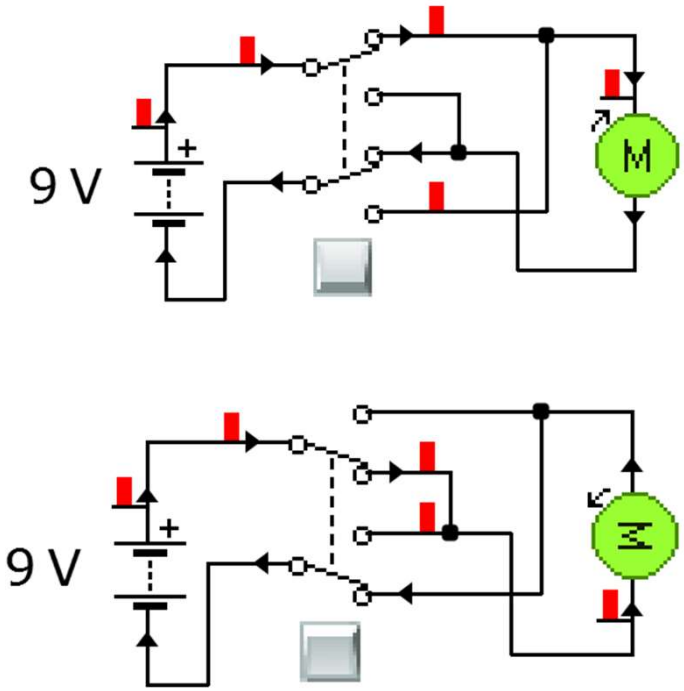
- In the image opposite the Light Dependant Resistor acts as a switch for the circuit, as if the light source is taken away, the circuit completes to give a total of zero volts to the lamp.
- This circuit may be useful for a night alarm that requires a threshold frequency to switch on. It is not very useful for my promotional display as I am looking for manual tuning of the components instead of automatic. Although this may be used in a more commercial display.

Circuits: On/Off Switch



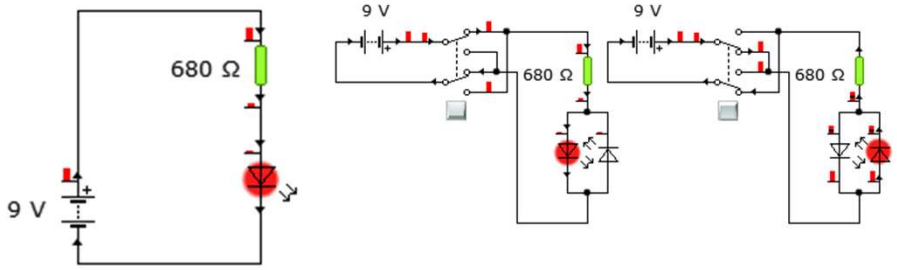
- This circuit comprises of a power supply, a SPST switch and a motor. This circuit uses an SPST (single pole single throw) switch; this creates a very simple on/off switch, that works very effectively.
- This is a very cheap solution as it only uses one component. A power switch in much more complicated circuit this may not be used if a proper shut down sequence is needed. In such devices the switch sends information to a shut down command opposed to just breaking the circuit.
- When the switch is open the circuit is not powered as it is incomplete. When it is closed there is power throughout the circuit, making it function. This means when switched off the circuit does not use any power, this is more efficient for the batteries as it does not use up any power between uses.
- I would use this to switch off and switch on my entire circuit. A similar mechanism would be employed in a commercial display as it would be the cheapest and most effective way to switch off the circuit.

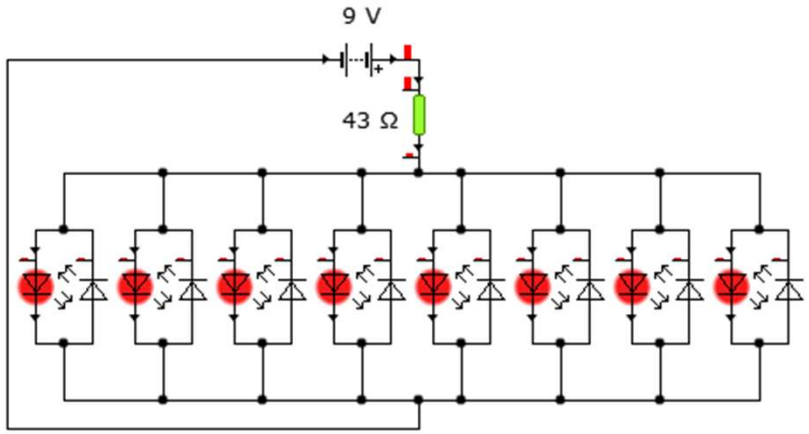
Circuits: Motor Direction



- This circuit comprises of a power supply, motor and a DPDT switch. Unlike with the last switch, the switch changes the direction of the motor. It does this by reversing the current to the motor.
- When the motor is supplied by a reversed current it spins in the opposite direction. This is utilised by the DPDT to change the direction of current from the battery.
- This may be done by two SPDT switches, but they would have to be switched simultaneously. This is difficult to do and inconvenient for the user. If they are not switched at the same time then it will short circuit the design.
- It may also use a microcontrolled DPDT this would allow other factors in the circuit switch the direction. However, I do not need this in my circuit. This may be used by a commercial display, with a more complicated design.
- If it were to use a microcontroller the direction may be a push to make switch opposed to a flick switch. This would streamline the design but ma not be best for all users.

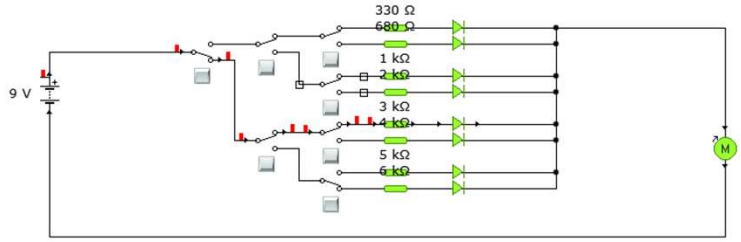
Circuits: LEDs

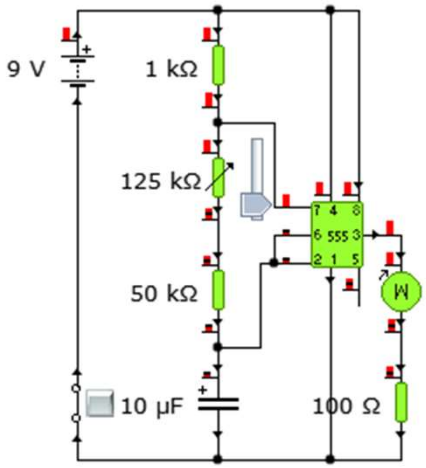


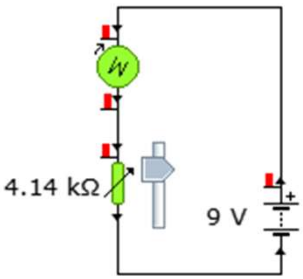


- An LED uses 2 volts, when using a 9 volt battery a resistor must be put in series with the LED. This divides the voltage between the components. The division of voltage is proportional to the resistances of the components.
- Like with the motor direction circuit, the colour of a bi-colour LED can be controlled using an DPDT switch. When the switch is switched in one direction one colour lights. When switched in the other the other colour lights. This will allow me to light the rotating display in two different colours.
- My promotional display utilise many LEDs to light the display from many angles. This will give the product a more even coverage. This will run off the same 9V power supply as the motor system.
- This will use eight bi-colour LEDs in parallel with each other. This will supply each bi-colour LED with equal voltages. The current is still high enough to break the LEDs so there is a resistor in series with the LEDs, this resistor is

Circuits: Motor Speed

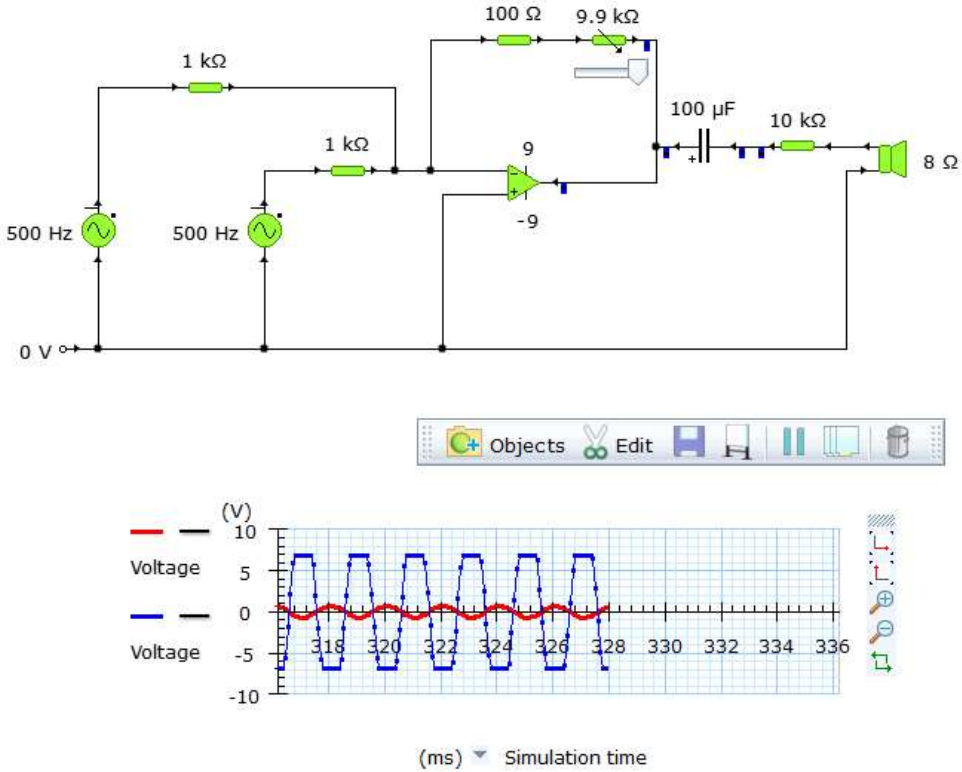






- To control the speed of my motor I can use a few different circuits. The simplest of these is a variable resistor in line with the motor. The different resistances of the variable resistor changes the voltage sent to the motor as it forms a potential divider. The different voltages change the speed of the motor. This could damage the motor as it would allow the user to unknowingly send too much current to the component.
- If I wanted fixed speeds for the motor I could use a rotary switch. As Yenka does not have a component for the rotary switch, I have modelled this with a series of SPDT switches. I t would not uses as many switches in the actual design. From each of these outputs there are different values of resistor. These, like the variable resistor, will form different potential dividers. In series with each resistor I have put a diode as to stop the current flowing back.
- The final, and most likely for me to use, uses a 555 timer to create a mark space ratio. As the length of the highs and lows can be altered with a variable resistor, different speeds can be achieved with this. The motor will move at a proportional speed to the mark space ratio. This method protects the components from damage better than just the resistor but allows better fine control than the rotary switch

Circuits: Speaker System



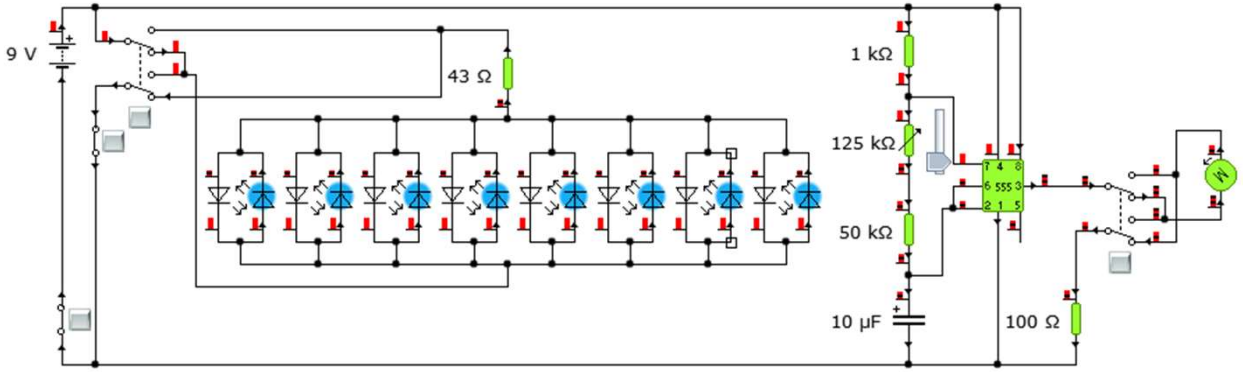
- I could use speakers and an amplifier to go with my display – this shows how an amplifier turns a small amplitude, voltage, signal into a more powerful output.
- The 500 Hz inputs are left and right channels from an Ipod or CD that would normally go to earphones. This amplifier has a gain of up to 10, to drive a loud speaker.
- The larger, blue trace is the output and the red trace is the input, the smaller:

Gain= $\frac{-Rf}{Rin}$ = $\frac{-10k}{1k}$ = -10Hz

- This means it's an inverting amplifier, which make no difference to our ears, which can hear up to 20kHz
- I have decided that this will make my project a little too complex, so I will stick to the motor control circuit

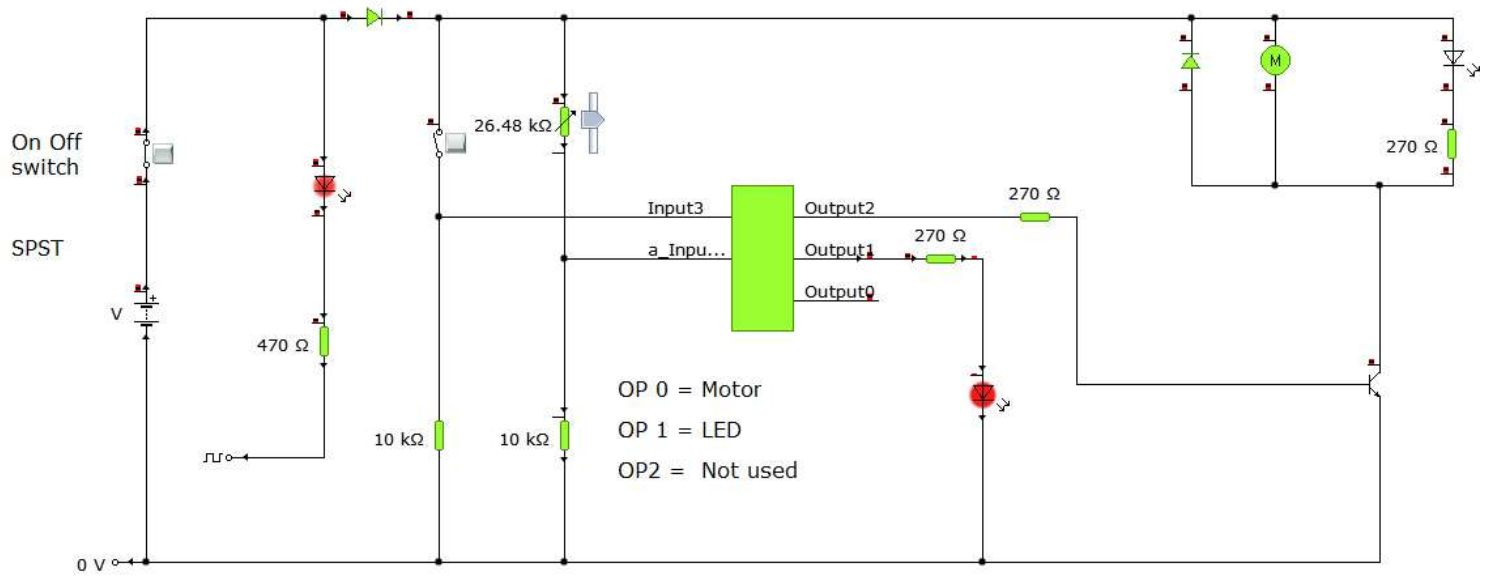
Task 13:AO2

Circuits: Final Design



- This is the final design for my circuit. It combines the On/Off Switch, Motor Direction Switch, Bi-colour LED Series, and the Motor Speed Control. This has combined it all in to one circuit that can now be exported to RealPCB.
- When exporting I will have to remove one LED from each bi-colour LED, as these have been made in Yenka with two LEDs as it does not have that component.
- This design can be split into two visible sections, the LED series and the 555 timer. These could be two separate circuits in the same case. However, by having them on the same board they can run of the same batteries with one point of connection to the board
- I have opted not to use a PIC, so that there is a smaller chance of breaking. With an analogue circuit the only chance of breaking is caused by physical damage with the circuit. However, with a PIC the program can cause problems and can be edited by the consumer.

Circuits: Alternate PIC Design



- This is an alternative idea to my chosen 555 timer, mark space ratio circuit.
- This circuit would use 4 AA batteries, I would use a flashing led used for my power on.
- Input 3 could be a PIR sensor, that runs the motor for 3 minutes once triggered.
- Input 4 is a variable resistor to control the speed of the motor, the motor has a back EMF diode and an LED, mounted on the box lid.

Costing: Final Design

Component	Cost (from Rapid Electronics)	Quantity	Total Cost
PP3 Battery	£0.552	1	£0.552
Battery Snap	£0.255	1	£0.255
SPST Switch	£0.700	2	£1.4
DPDT Switch	£0.226	2	£0.46
Resistors (100 pack)	£0.670	1	£0.67
Bi-colour LED (RED/White)	£0.169	8	£1.352
Variable Resistor	£0.817	1	£0.817
PIC Socket	£0.321	1	£0.321
555 timer	£0.204	1	£0.204
10 microfarad capacitor	£0.062	1	£0.062
Motor	£0.470	1	£0.470
Total			£6.56

Modelling of the Case

- This is my model of my case. This was made to visualise how my design would look once made. It helps me find any possible problems with designs before making the case itself.
- To make our models I used polystyrene. Polystyrene was used in modelling as it is a cheap material, this reduces the costs of prototyping in industry. Polystyrene is a quick and relatively easy material to use when making, I used it for these reasons.
- To make my model I first used a ruler and pencil to draw the sides onto a sheet of polystyrene. This was then cut out with a craft knife. I then glued the design into the shape, with a hot glue gun.
- From this design I learnt that having the curve on the side panel would be hard to implement. This means I won't be using it in my actual case. I have also decided that I want thicker and fewer slats. This is an aesthetic choice over a practical choice.
- My final design will be made out of MDF not polystyrene. This is still a relatively cheap material but is much sturdier. The rotating disc shall be made from clear acrylic, but the same size (the diameter of a dvd)

Social, Moral, Cultural, Sustainability, and Environmental Issues

I am making a 'one off' product, a prototype for my controlled assessment and this will have no real impact on these issues. However, I will still consider the social, moral, cultural, safety, sustainability and environmental issues of a mass produced product like my promotional display.

Social Issues

Promotional displays are generally inoffensive and do not have much societal impact. However, some have been viewed as obnoxious and generally ugly. To prevent this my design will have to be more subdued but still noticeable as so to not defeat it's purpose.

Moral Issues

Promotional displays generally do not go against anyone's ethical code. However, the type of product displayed on it can. The type of product cannot be controlled by the manufacturer, but the display can be designed to dissuade this kind of customer.

Cultural Issues

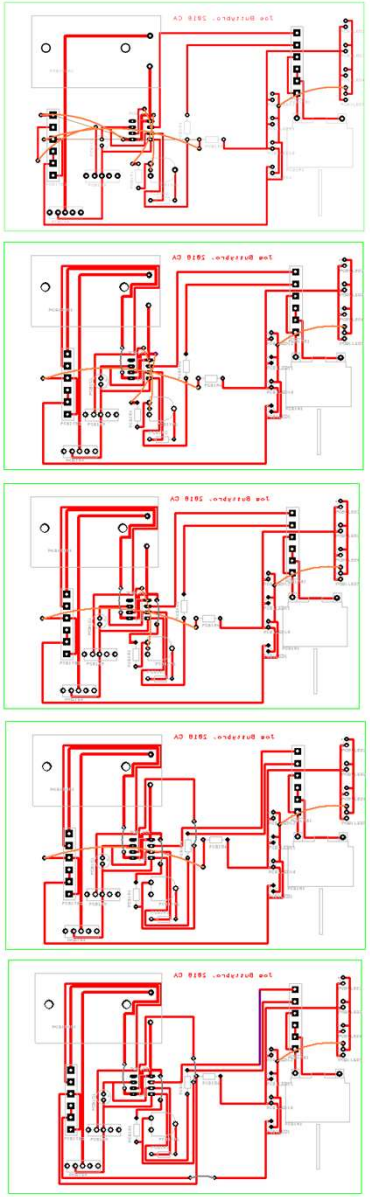
Cultural issues are issues that are concerned about people from different cultures such as Buddhists, Muslims and Jews. As people in different culture believe different things and have different tradition, so your product might offend other people in other culture. This means that I must make sure my design does not incorporate any religious symbols.

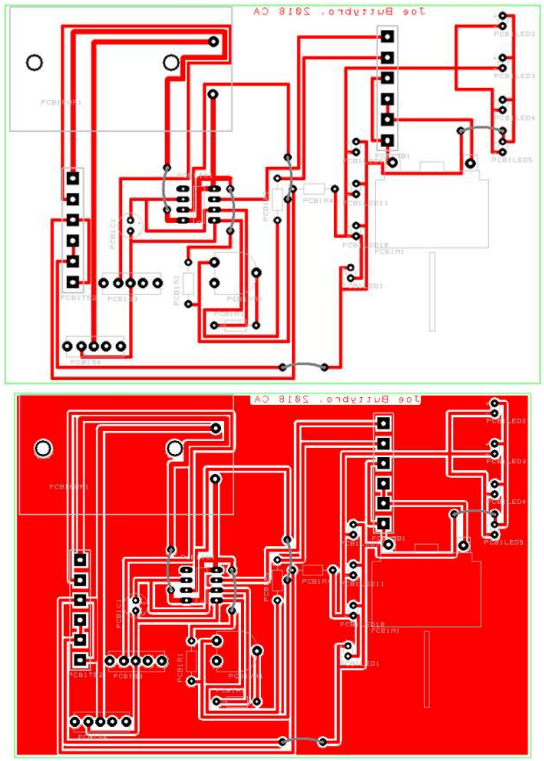
Sustainability Issues

The components in this product can be recycled. This is done by reclaiming components and them being reused in new products. Electronics use metals primarily, these are non-renewable materials. This means that once all the metal is mined then there will be no more to be used, this can be avoided by reusing metal.

Environmental Issues

The pine wood it is made of will be recyclable where as the electronic circuit can be difficult to recycle, as the cost of removing the components can more expensive than the cost to replace them. Also care needs to be taken when disposing of battery chemicals because if they were placed in a landfill with other non-biodegradable materials it would cause pollution.

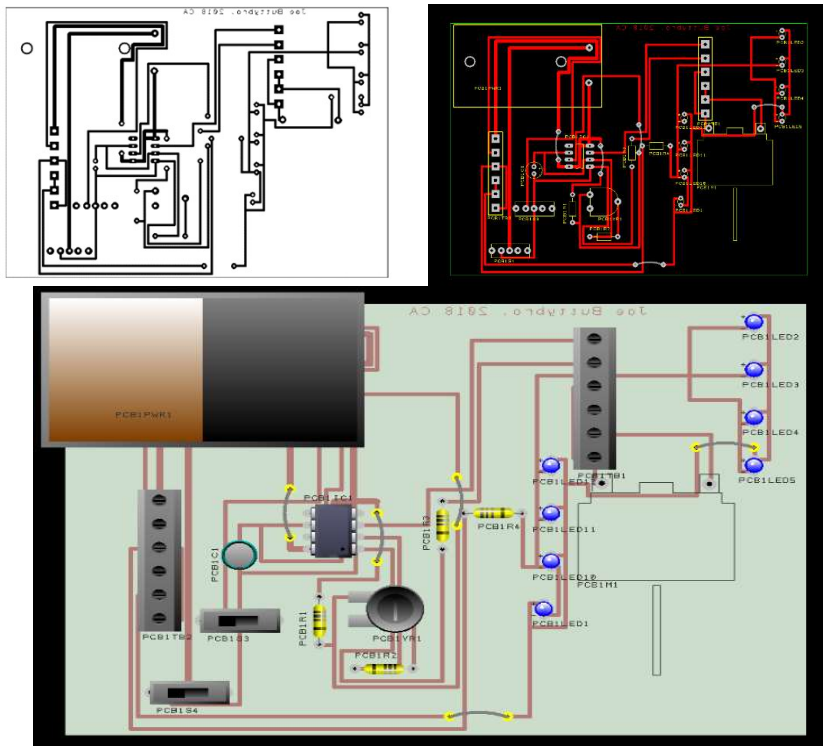




PCB: Final Design

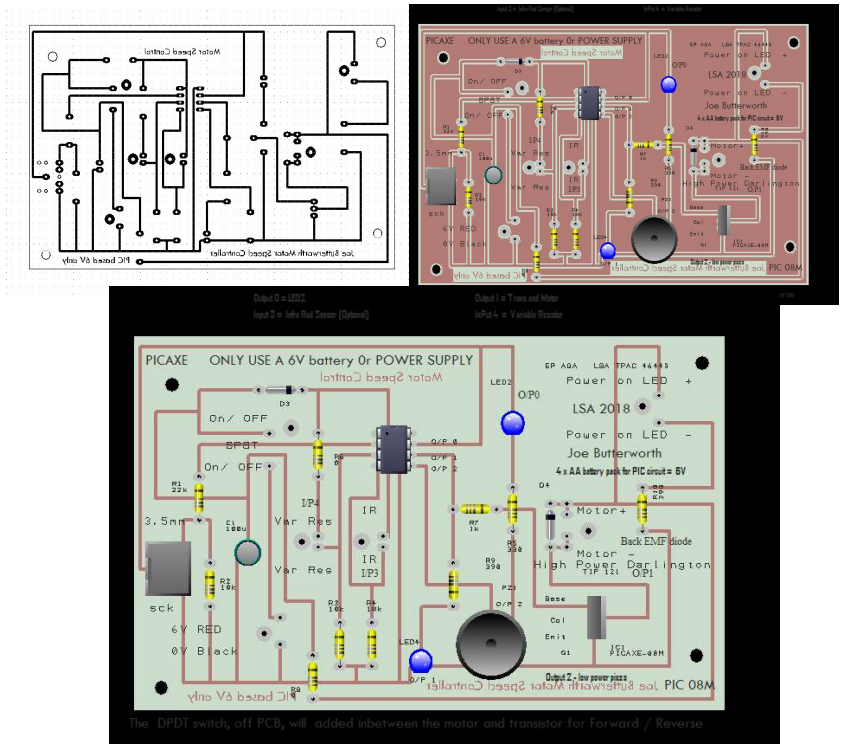
- To make my PCB design I exported my Yenka design and used auto-route to make my tracks. This, due to the complexity of my design, required six wires as it could not properly route it on just one level.
- To condense the design, I manually rerouted several parts whilst adding jumps to remove the need for the wires. This took it from six wires to three jumps and a wire which is much easier to populate.
- I used standard view to design the PCB. This shows the component outlines and values. On top of this the copper tracks and text are displayed in red.
- Copper fill view show how the board would look if it were copper filled. Copper filling is used to mass produce PCBs. It is faster to use and kinder to the environment as it produces less CFCs and waste effluents. It make soldering difficult as it is much easier make solder bridges due to the level of accuracy needed.

PCB: Alternative Views



- The artwork view is used when etching. It is the same as the standard view but all the red is replaced with black. This is then be printed on acetate sheeting and then used to expose a piece of photo etch PCB.
- Retro view is no longer in PCB, CAD but in early computer designing computers had a very small memory space so it was used to reduce the amount of information sent to the screen.
- Real Life view shows all the components on the board. I will glue a copy of this onto my board once it is etched as it will show me the polarity of electrolytic capacitors, LEDs and the orientation of my 555 timer.
- This will later be used to show how the board will be held in the case. This is important step in the general manufacture of my promotional display.

PCB: PICAXE Design



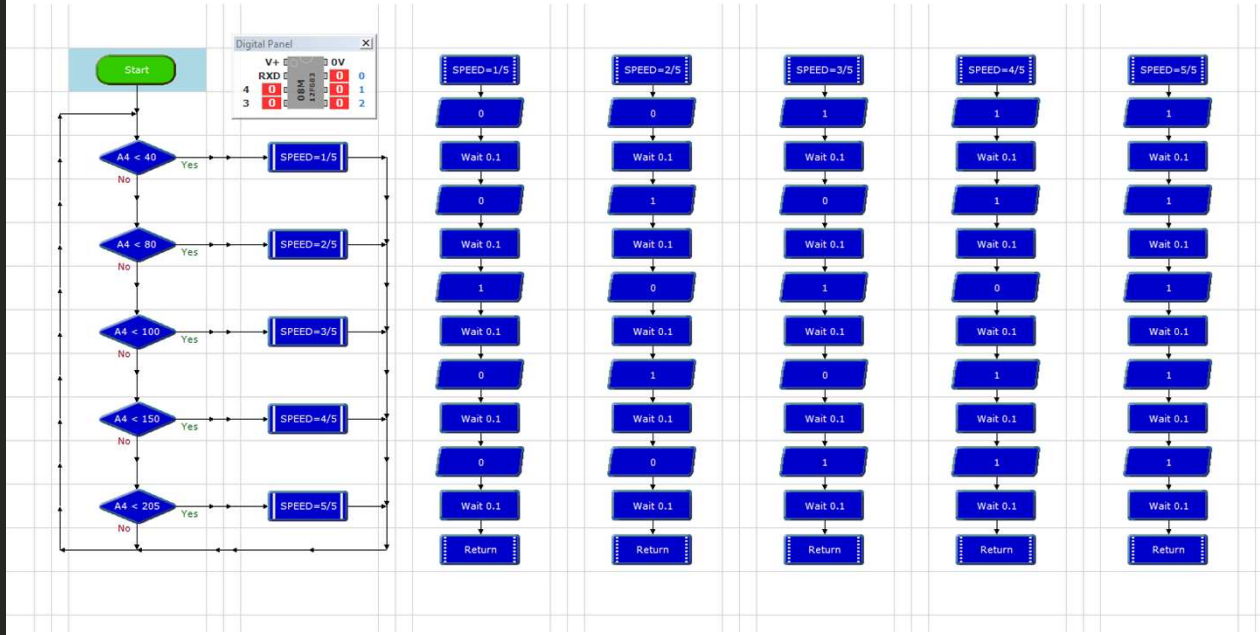
- This is an alternative design for my circuit. Instead of using analogue processing, a 555 timer, it uses a PIC to control the speed of the motor.
- A PIC is a programmable integrated circuit, it functions like a low power computer within the circuit. A PIC microcontroller includes a CPU, RAM, ROM, a clock, and input & output ports, like an actual computer does.
- My alternative design takes a voltage input from a variable resistor and converts it to an output voltage, used by the motor. This means a change in the variable resistor results in a change in the speed of the motor.
- For a PIC to work it runs off of a program loaded onto the PIC, hence the programmable. This is loaded onto the PIC in BASIC, a programming language, which instructs the IC on what to output based on the input information.

alarm.dat

```
Summary of Logicator for PIC® and PICAXE® flowsheet
Author: Joseph Butterworth
Filename: F:\Technology\Controlled Assessment EP\Yenka\2018 Joe Butterworth motor control speed.plf

Print Date: 19/3/2018


OUTPUTS: [1=ON 0=OFF -=IGNORE]

10,3  0
   - - - - - - 0 -
10,5  0
   - - - - - - 0 -
10,7  1
   - - - - - - 1 -
10,9  0
   - - - - - - 0 -
10,11  0
   - - - - - - 0 -
13,3  0
   - - - - - - 0 -
13,5  1
   - - - - - - 1 -
13,7  0
   - - - - - - 1 -
13,9  1
   - - - - - - 1 -
13,11  0
   - - - - - - 0 -
16,3  1
   - - - - - - 1 -
16,5  0
   - - - - - - 0 -
16,7  1
   - - - - - - 1 -
16,9  0
   - - - - - - 0 -
16,11  1
   - - - - - - 1 -
19,3  1
   - - - - - - 1 -
19,5  1
   - - - - - - 1 -
19,7  0
   - - - - - - 0 -
19,9  1
   - - - - - - 1 -
19,11  1
   - - - - - - 1 -
22,3  1
   - - - - - - 1 -
22,5  1
   - - - - - - 1 -
22,7  1
   - - - - - - 1 -
22,9  1
   - - - - - - 1 -
22,11  1
   - - - - - - - 1 -

COMPARE: [Variable Evaluator Variable]

4,4  A4 < 40
   A4 < 40
4,6  A4 < 80
   A4 < 80
4,8  A4 < 100
   A4 < 100
4,10  A4 < 150
   A4 < 150
4,12  A4 < 205
   A4 < 205

PROCEDURE: [Name]

10,2  SPEED=1/5
   SPEED=1/5
13,2  SPEED=2/5
   SPEED=2/5
16,2  SPEED=3/5
   SPEED=3/5
19,2  SPEED=4/5
   SPEED=4/5
22,2  SPEED=5/5
   SPEED=5/5

DO PROCEDURE: [Name, Number of times]

7,4  SPEED=1/5
   SPEED=1/5, 1
7,6  SPEED=2/5
   SPEED=2/5, 1
7,8  SPEED=3/5
   SPEED=3/5, 1
7,10  SPEED=4/5
   SPEED=4/5, 1
7,12  SPEED=5/5
   SPEED=5/5, 1


** End of report **
```

PIC: Program Versions

- This is my final flowsheet, made using Logicator (for PIC and PICAXE), it is a flowsheet program. It allows for the simple making and testing of PIC programs.
- As my final design isn't using a PIC, I have created a simple flowsheet that reads the input voltage and outputs a different mark space ratio based on the original voltage.
- I also have the print summary of the PIC code, this allows for people to look over the code and find any problems in the program.



alarm.dat

```
;Symbols
{
symbol varA = b0
symbol varB = b1
symbol varC = b2
symbol varD = b3
symbol varE = b4
symbol varF = b5
symbol varG = b6
symbol varH = b7
}


let dirs = %00000111


main:
label_21:
        readadc 4,b11       'read A4 into b11
        if b11 < 40 then label_20   'Compare command
        readadc 4,b11       'read A4 into b11
        if b11 < 80 then label_26   'Compare command
        readadc 4,b11       'read A4 into b11
        if b11 < 100 then label_27  'Compare command
        readadc 4,b11       'read A4 into b11
        if b11 < 150 then label_28  'Compare command
        readadc 4,b11       'read A4 into b11
        if b11 < 205 then label_29  'Compare command
        goto label_21

label_29:   gosub prc_SPEED=5/5 'Do Procedure
        goto label_21

prc_SPEED=5/5:
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        return      'Return

label_28:   gosub prc_SPEED=4/5 'Do Procedure
        goto label_21

prc_SPEED=4/5:
```

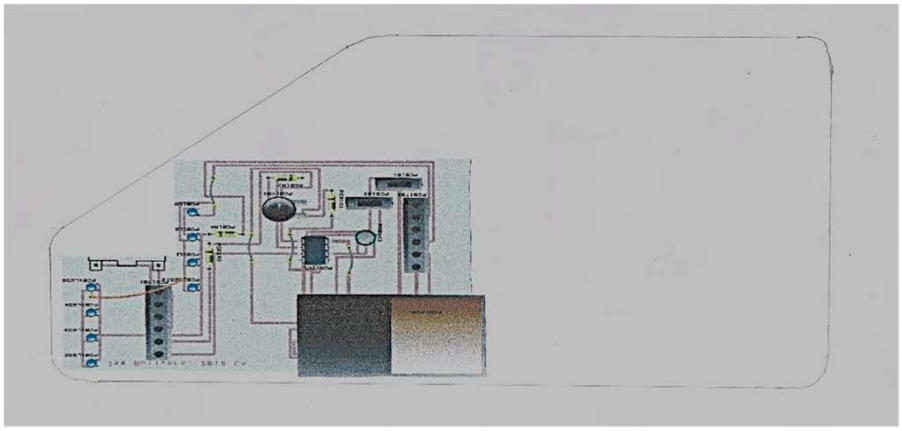
```
prc_SPEED=4/5:
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        low 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        return      'Return

label_27:   gosub prc_SPEED=3/5 'Do Procedure
        goto label_21

prc_SPEED=3/5:
        high 1
        pause 100   'Wait command
        low 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        low 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        return      'Return

label_26:   gosub prc_SPEED=2/5 'Do Procedure
        goto label_21

prc_SPEED=2/5:
        low 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        low 1
        pause 100   'Wait command
        return      'Return

label_20:   gosub prc_SPEED=1/5 'Do Procedure
        goto label_21

prc_SPEED=1/5:
```

```
        low 1
        pause 100   'Wait command
        return      'Return

label_20:   gosub prc_SPEED=1/5 'Do Procedure
        goto label_21

prc_SPEED=1/5:
        low 1
        pause 100   'Wait command
        low 1
        pause 100   'Wait command
        high 1
        pause 100   'Wait command
        low 1
        pause 100   'Wait command
        low 1
        pause 100   'Wait command
        return      'Return
```

PIC: Program Versions

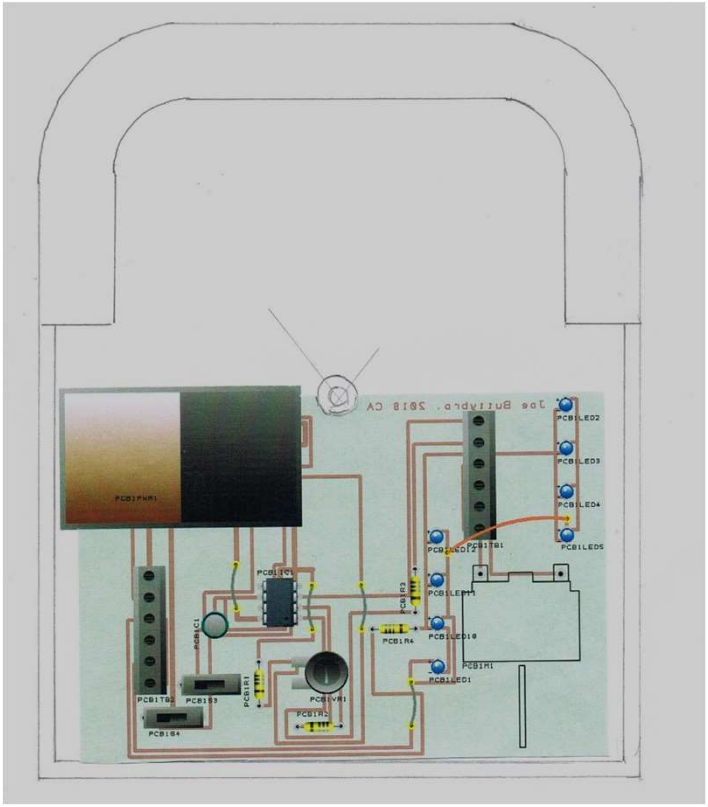
This is the PIC code in BASIC. Basic is a low level processing language, meaning it is close to how processors function (ie. Boolean logic gates) and is using in the PICs.

Sketches of how PCB will be fitted to the box: Vacuum Formed Box



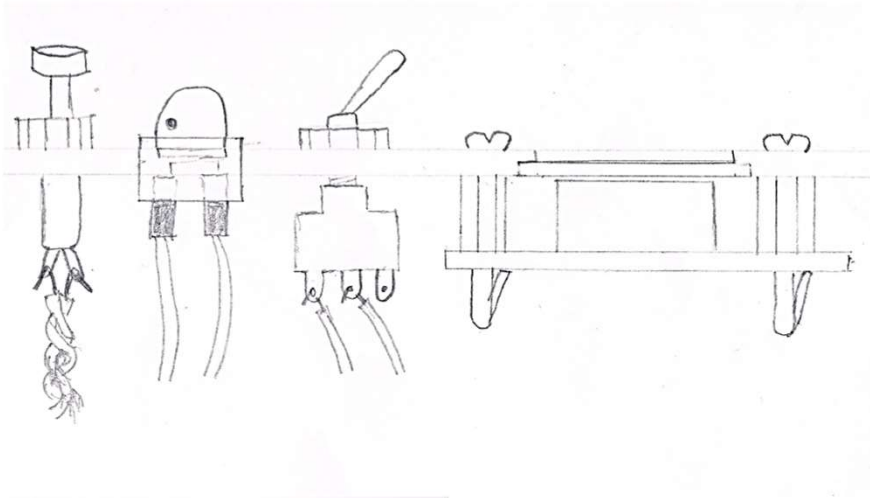
- If I made a vacuum Formed box I would have made a full shell, from two parts of a polystyrene box, as this meets my customers' needs and the specification of my project. This is not ideal, but it is how we prototype plastic boxes in school.
- HIPS stands for High Impact Polystyrene and is used when Vacuum Forming. To make a mass produced plastic box I would injection mould an ABS box, as this is sturdier than a HIPS box and cheaper at large scales. HIPs is a thermoplastic, meaning it melts when it comes into contact with heat. MDF stands for Medium Density Fibreboard and is a manufactured wood, I would use MDF and not a solid wood to make my case as they it's a cheaper material.
- The technician would spit my mould into two with the band saw. I would drill 3.5 mm holes in the base mould and screw in four 4mm pan head screws, to make the feet of my box. I then fit a 25 x 1 mm gaffer tape lip to top mould. The same pair of moulds can be used many times in mass production but mine will only be used once as I am making a 'one off' product.
- I would put the mould on the vacuum former bay and attach a sheet of HIPS over it, and cover with the heater for 40 seconds. Then I would push the heater back, raise the moulds and switch on the vacuum pump. The polystyrene takes on 3D shape of moulds. After 10 Seconds, I would switch off the pump and remove the moulds from the moulded plastic
- To finish I would remove excess HIPS with a rotary cutter. For safety I would wear goggles and keep my fingers away from the cutter as it is moving at high speed. This method of making a case creates lots of waste, this is bad for the environment and should be avoided.

Sketches of how PCB will be fitted to the box: Wooden Box



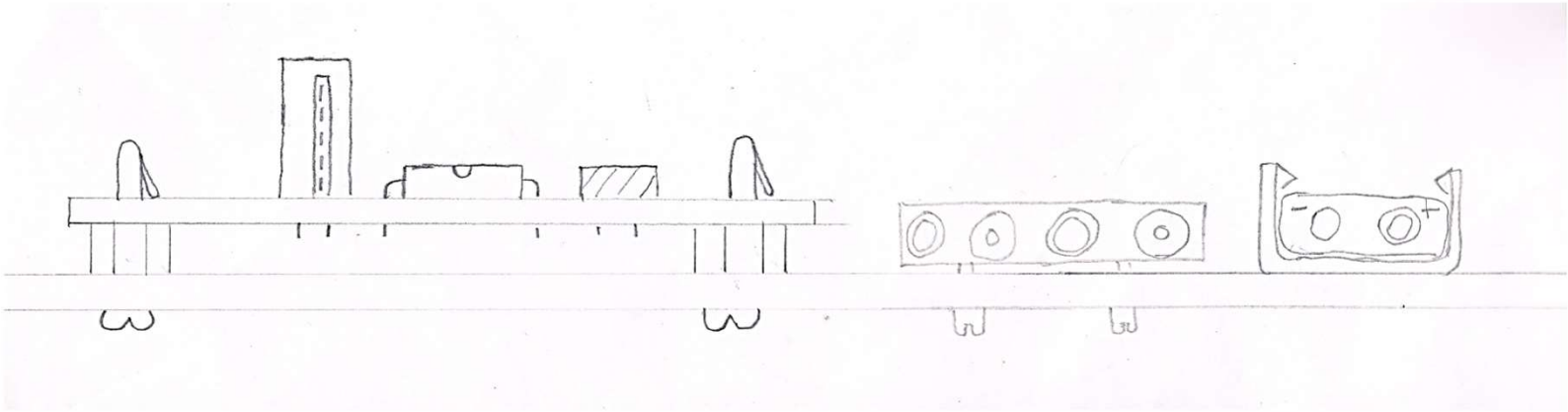
- This will be the box that I use to house my electronics. It will be made from several parts of laser cut MDF. This will make the case more expensive than the HIPS box, but it shall still be within an acceptable price range.
- Unfortunately, my design PCB will occupy a large area of the case. This does mean that the axle for my rotating disc doesn't fit within the case whilst the PCB is in. To compensate for this I will have to drill through my PCB so there is an area around the axle free. I have worked out that there is space without tracks running through it, this will be were the axle goes.
- To make the box each piece will be design in 2D Design and exported as a DXF file, this will be used in Ethos and exported to the laser cutter. This creates perfectly accurate, to what you designed, pieces out of whichever material you put in. For my project I will mostly be laser cutting 3.2mm MDF. I will also be laser cutting the clear spinning top for my display out of clear acrylic.
- Once all laser cut I will have to glue together all the parts to make the case. This will be done with PVA glue as the pieces are made of wood. I will not glue together the top and side until the end as this allows me access to the inside of my box to put the mechanical and electrical components.
- After I had glued together the pieces of wood I sanded the result down until all the glued parts were flush. I will use both the linisher machine and hand sanding with glass paper, each time I will move down in grit making it finer and finer.
- Finally, before priming and spraying it blue, I will seal it with sand seal. This must be done in a well ventilated area as sand seal is very harmful to inhale, and to get on the skin. To prevent this I will wear an apron, goggles and wash my hands very carefully.

Sketches of how parts on flying leads will be fitted to the box



These are sketches of how components are commonly attached to the inside of their case.

- PTM Switch – held through a hole with a lock nut
- LED – held through a hole with an LED mount
- SPST Switch – held through a hole with a lock nut
- Seven Segment Display – suspended from the top with PCB mounts
- PCB – suspended from the box with PCB mounts
- Phono Sockets – suspended by socket mounts
- Battery – held by a battery mount



Manufacturing Specification

Materials

Part	Material	Size	Quantity
Case	MDF	3.2mm	1
Rotating Disc	Clear acrylic	12x12x3mm	1
Drive Rod	Steel	4mmø	1
Worm Drive	Plastic	N/A	1
Worm Gear	Plastic	N/A	1
Disc attachment	ABS	N/A	1

Components

Component	Quantity
PP3 Battery & Battery Snap	1
SPST switch	2
DPDT switch	2
Resistors	8
Bi colour LED	8
Variable resistor	1
PIC socket & 555 timer	1
Motor	1

Machines & Tools Used

Soldering Iron	Laser Cutter	Pillar Drill	Linisher & Glass Paper

Manufacture: PCB Etching

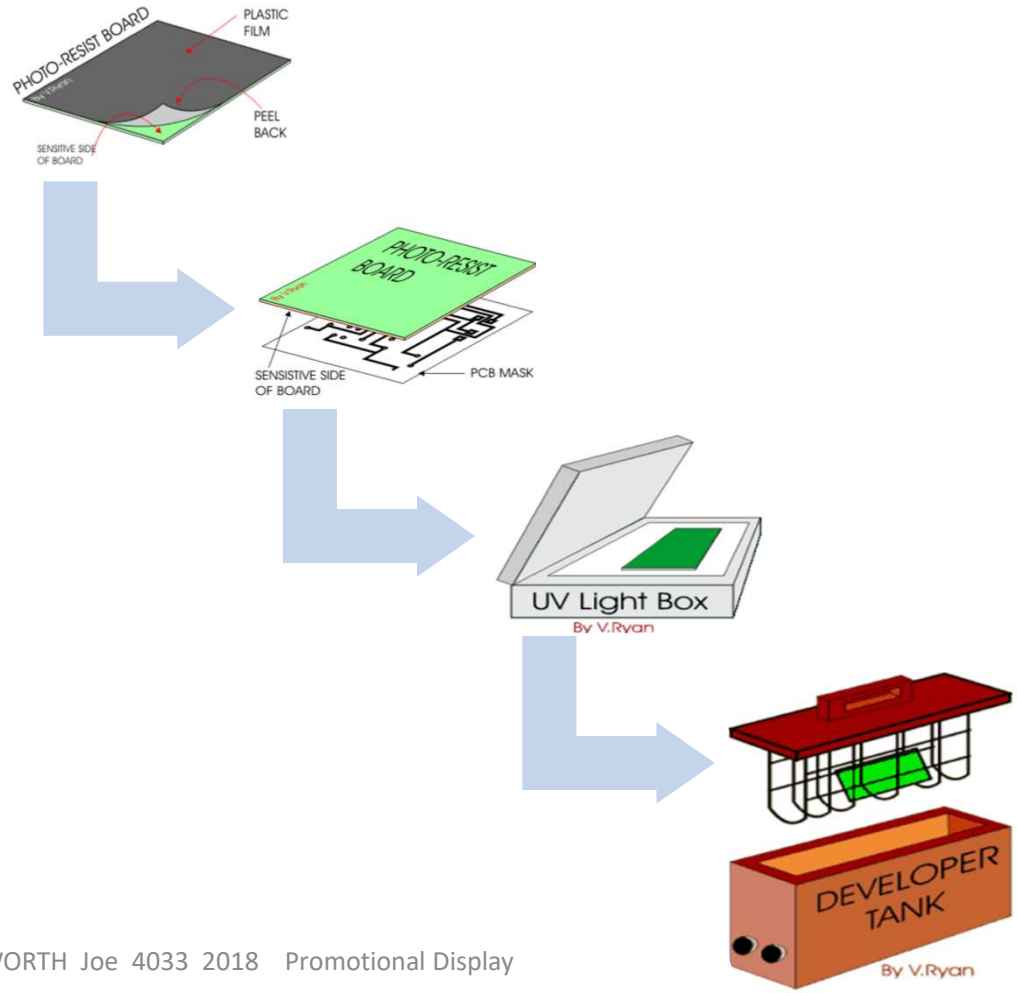


Photo-resist board is a piece of glass reinforced plastic. One of the sides is copper clad and this copper is photosensitive. When the plastic film is peeled back this sensitive coating is revealed, this will become the PCB.

The PCB mask is placed underneath the photo-resist board. PCB mask, made from printing on acetate sheets and board are then transferred to the UV light box.

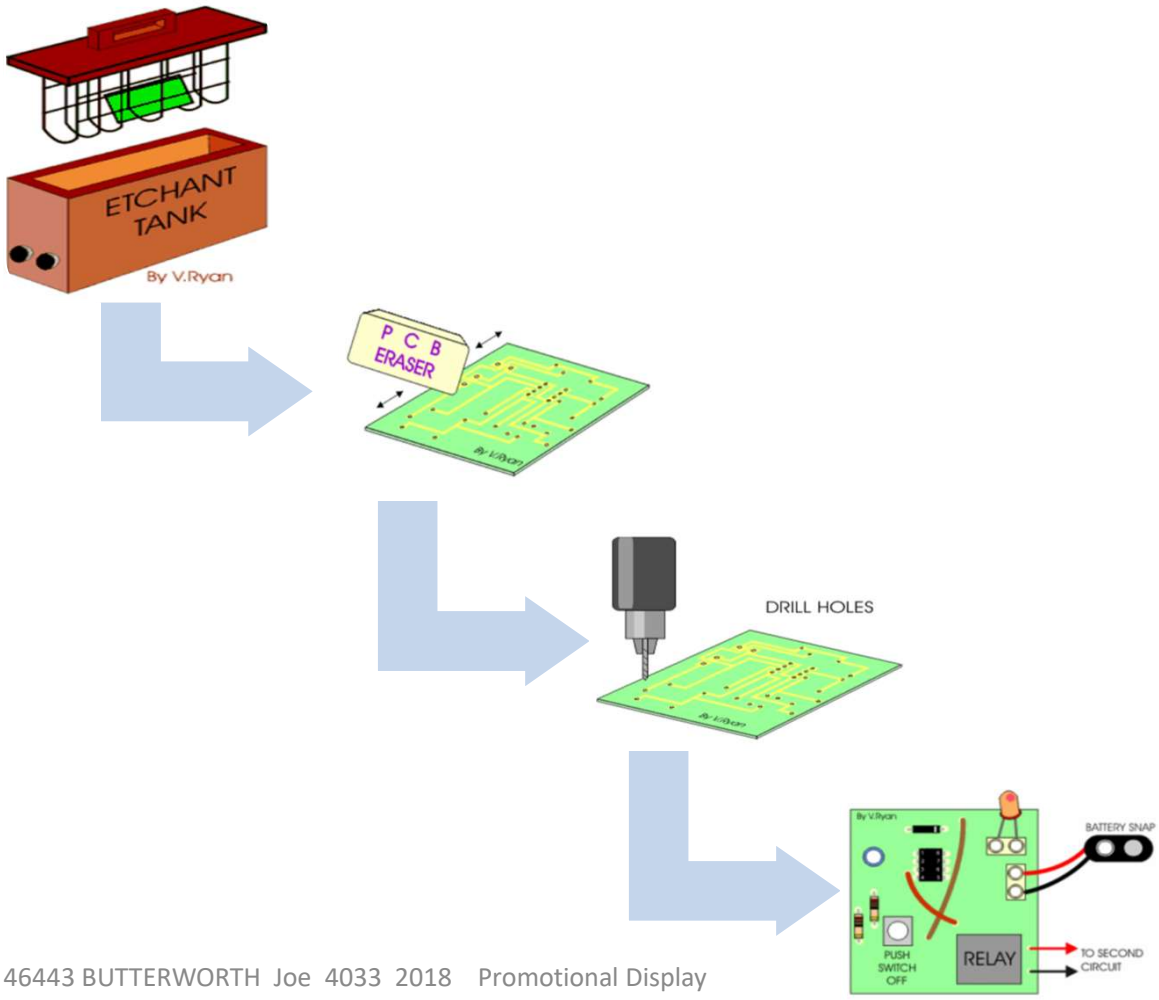
You must be careful to ensure that the PCB mask is the right way up, otherwise when the circuit will be etched backwards and won't be usable as the tracks will be the wrong way round.

The lid is shut and the box switched on. The photo-resist board, with PCB mask are left underneath the lid for 2.5 minutes. The photo-resist board is then placed in a tank filled with developer (using plastic tongs).

It is important that the board is only left in the developer for ten seconds.

When the board is taken out of the developer it must be washed in clean water before transferring to the etching tank using plastic tongs.

Manufacture PCB Etching



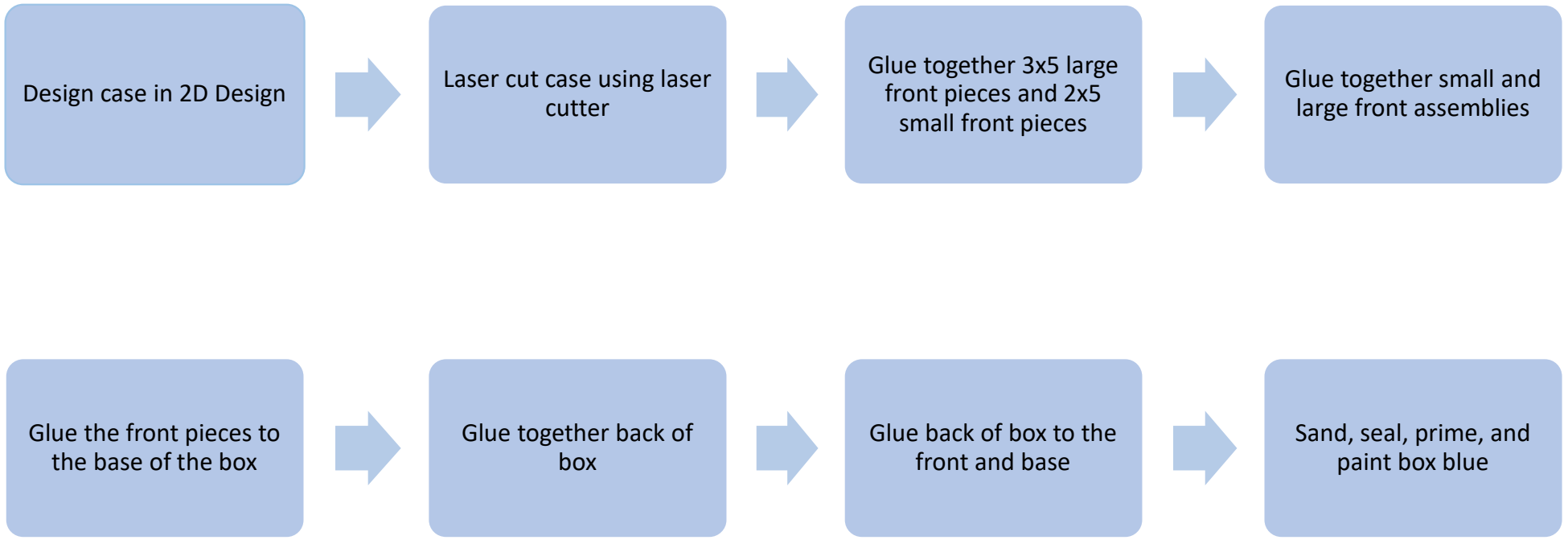
The etchant is held in an etch tank and is heated. This solution slowly etches away the unwanted copper, leaving the tracks only. It is important to keep checking that the PCB is completed, if it is left in the tank too long the copper tracks will also be removed or damaged.

When removed from the etching solution, the PCB is washed and a PCB eraser is used to remove any film from the tracks. The film will prevent good soldering of the components to the PCB, this must be done carefully. If etched poorly, sometimes they can be repaired using wire but usually a new PCB has to be etched.

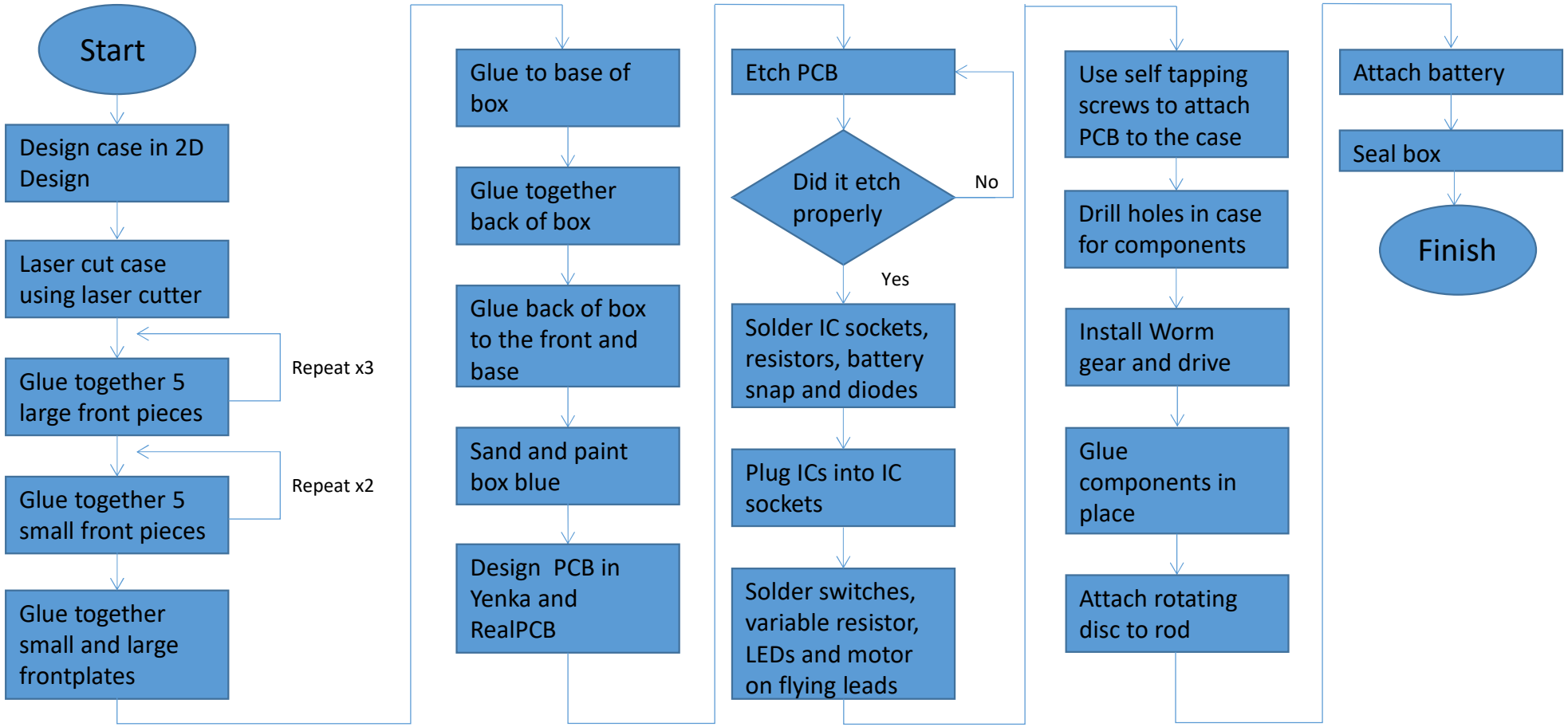
The last stage is drilling the holes for the components. A small PCB drill is used for this purpose. This must be done carefully as drilling can remove the track.

This completed Printed Circuit Board (PCB) has all its components soldered in position. PCBs manufactured in industry are designed on a computer and then manufactured on a production line controlled by computers. Usually there is very little human contact.

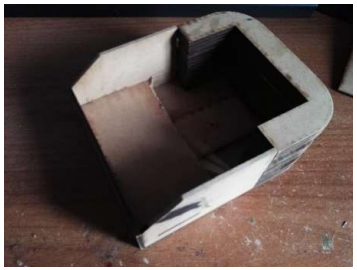
Manufacture: Case



Flowchart


Start
Design case in 2D Design
Laser cut case using laser cutter
Glue together 5 large front pieces
Repeat x3
Glue together 5 small front pieces
Repeat x2
Glue together small and large frontplates
Glue to base of box
Glue together back of box
Glue back of box to the front and base
Sand and paint box blue
Design PCB in Yenka and RealPCB
Etch PCB
Did it etch properly
No
Yes
Solder IC sockets, resistors, battery snap and diodes
Plug ICs into IC sockets
Solder switches, variable resistor, LEDs and motor on flying leads
Use self tapping screws to attach PCB to the case
Drill holes in case for components
Install Worm gear and drive
Glue components in place
Attach rotating disc to rod
Attach battery
Seal box
Finish

Photographic Record







Photographic Record

These are the labels for my promotional display box. I have worked out the sizes and the colours contrast with my blue coloured box. I will laser print these on A4 white paper and glue them to the cover of my vacuum formed box. I could also put a label on the underside of my box. A mass produced version of my promotional display would have screen printed labels, like the letters on a QWERTY keyboard or as on this plastic storage box .

Joseph Butterworth
Promotional Display
LSA (46443)

AQA GCSE
Electronic
Products

ON/OFF

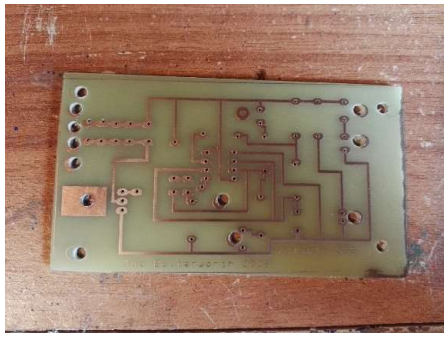
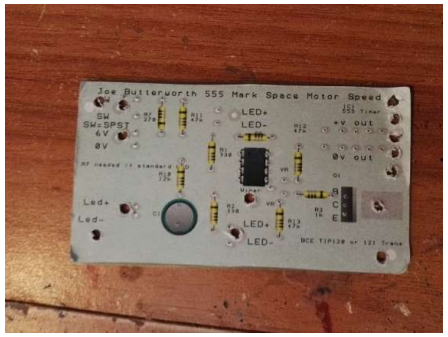
Display Direction

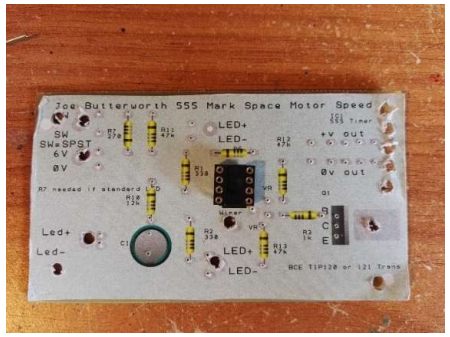
Speed Control

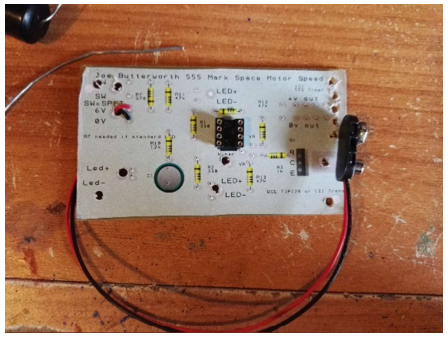
LED Colour

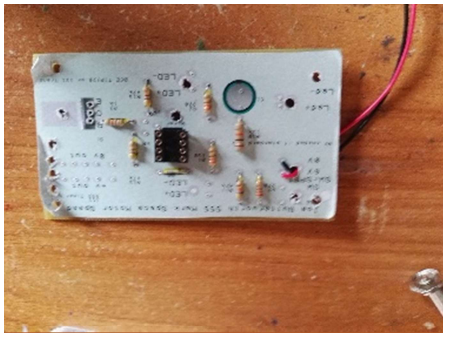
LED ON/OFF

Photographic Record

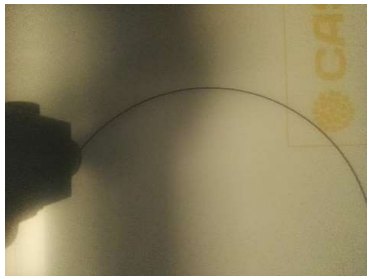







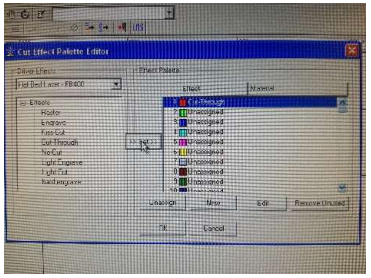


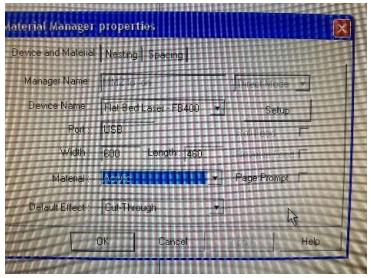

This was the laser cutter in school that I used to cut out my case and the rotating disc of the display. In the images it has clear acrylic (with protective covering) in it, this will be cut out into the rotating disc.

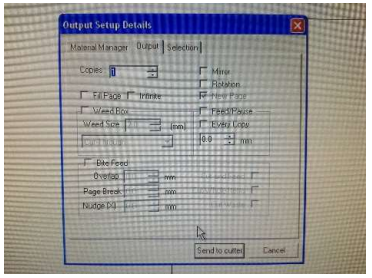


In these images the laser cutter is part of the way through cutting the clear disc.

CAM Explanation







- To Laser cut the individual pieces I first designed them in Techsoft's 2D Design suite. This allowed be to make the unique components to my promotional display. This was then exported from 2D Design as a DXF file.
- The DXF was then loaded in another program called Ethos, the PC this was on is connected to the laser cutter. I then changed the outline of my shapes to red, this is so the laser cutter can distinguish between functions.
- I then had to set my output settings. First I changed red to cut through material. Then I changed the material to 3mm MDF (and then again to acrylic when doing the rotating disc), so that it cuts with the right intensity for the material.
- Before cutting I had to set the media on the cutter. To do this I had to load a new sheet and set the origin and the media, these are two coordinates that tell the program where they can laser cut.
- Finally I exported the design to the laser cutter by using the "send to cutter" function. This had to be done a few times as it must be repeated for a change in material and was repeated for broken or incorrectly cut parts.

Evaluation

- My project fulfils my initial design brief as my final product is a rotating promotional display. However, it does not fulfil the initial design specification as in the design brief it was said that I would be making a “flimsily vacuum formed polystyrene case”, although the MDF case was suggested as an idea for the case of my project.
- When I initially designed my case on 2D Design I left holes for components to be placed through. However, when it came to putting the components in the holes were too small to fit the components through. To remedy this I used files to increase the size of the holes.
- I didn’t use PCB stands, instead attaching the PCB to a raised board in my case by self tapping screws. This is not necessarily the best way of attaching the board as it courses the board to flex and can damage the leaded connections.
- CAD is more accurate than hand drawing, this can be good when using the designs for reference or as a template. CAD files can be shared directly, making the cooperation on a project easier - they can also be outputted to machines for CAM. This does make the files less secure as they are susceptible to leaks and industrial espionage.
- CAD can help with QA and QC testing as the process can be ran through the computer system to find any possible faults in the design this can be quicker and is less costly as you do not need to pay a trained professional.
- I did not make any changes to my design in either my box or my electronics, from the initial ideas. However, due to a broken etching tank I had to use a different board that had already been etched. Breadboards were used occasionally in testing circuits but it could have been more frequent. Stripboard PCB was used in my design to extend the LED to incorporate eight LEDs in parallel as the compromise circuit board only had one output LED port. These types of circuits would not be used in industry. In industry SMD PCBs would be used.
- Due to a lack of experience the technician was unable to etch my PCB. Then we had to wait for a new order of photo-resist board to come in before my teacher was able to etch my board. However, this board was etched backwords meaning it wasn’t usable. By this point the etching tank had broken, so I had to modify a spare board the school already had, this made me several weeks late to doing my practical work

Evaluation

- The case design is aesthetically pleasing, an important feature for a promotional display. The display isn't particularly ergonomic because it is not supposed to be handled that often. However, the controls are ergonomic and are comfortably spaced so that it is comfortable for a consumer to use it.
- If I could restart the project I would I would try to be better disciplined in sticking to my time management plan, that I would probably make a little less ambitious on what I could complete. I would also have liked to have etched my PCB myself instead of going through the hassle with the technician, but I am aware I would be unable to do this as it would not be covered by the school's insurance.
- My Product does not compare to a commercially made promotional display. This is due to limited access to materials and machines, I have in school. In industry many people will work on the same project often over much longer periods of time.
- It would be a sleeker design if the components were recessed but this would not be practical in a school made project. It would require a lot of support, this would be hard to achieve at school but in a commercial product it could be supported if the case was injection moulded, as the more complex design can be achieved by this process.
- I used leaded components and drilled the PCB manually. A commercial PCB would use SMDs (surface mount devices). The PCB would be drilled and or populated and soldered by machine, this would be CAM (computer aided design).
- I didn't fasten my PCBs down with nylon PCB pillars, I instead used self tapping screws. However, it would have been better to use PCB pillars to hold all of the components in place. In a commercial product the case would have injection moulded posts, like the recessed components' supports, for the PCB moulded into the case.
- It did work first time but the lights were quite temperamental due to loose connections to the switches. I fixed this by cutting of the switch connections, desoldering it and reattaching the leads to it.
- The motor is always running and is quite loud, If I were to do this project again I would have the motor on a separate circuit to the LEDs (but use the same power supply. To fix the loudness, I would use an anti-vibration mount as that would stop the majority of the noise and bring it down to a reasonable amount.

Testing, QA, QC, and Fault-finding

Quality Assurance, QA:

The steps that I put in place in the design and development stages was the QA stage:

- I tested each of my circuit ideas in Yenka, this software not only draws the circuits but also tests the circuits for faults. If they work in Yenka they will work in real as a produced board. However, Yenka does not allow PIC programming, this makes it hard to test for faults in PIC controlled boards, this was not a problem for me as I only used analogue processing in the design of my circuit board.
- I also used Yenka to produce my PCB, by exporting my design to RealPCB. This is only educational software and does not design PCBs very efficiently. To create a PCB without lots of missing connections, I had to do a lot of the PCB design work 'manually'. Once complete this was tested against the circuit to make sure it still worked properly.
- I tested the 555 astable part of my circuit, on a breadboard before assembling my finished design. If the astable circuit is working properly then it will flash the power on LED on breadboard.
- Most commercial circuits are tested in software and then go straight to the PCB stage, this cheaper than hiring a someone to do the fault-finding, by doing it this way companies guarantee there is no fault in the design of the circuit.
- Many modern electronic circuits, especially ones using microprocessor, like phone, PCs and tablet would not work on breadboards, as these circuits are far to complicated. They use SMDs and have thousands of components, there would not be enough space on the breadboard for it.
- I measured the dimensions of my populated PCB, battery pack, switches, variable resistor and worm gear & drive, to work out the final dimensions for my case. This makes sure that all the necessary parts fit within the case of my product.

Testing, QA, QC, and Fault-finding

Quality Control, QC:

The steps I took during and after manufacture were the QC stage:

- I used the resistor colour code sheet to work out all of the values of the resistors I needed to make my product. As the values I used were fairly common I had access to all of them. If the values weren't in stock, I would use the nearest values, eg 270 ohms for 330 ohms, 18K ohms for 22 K ohms etc.
- I ensured that I used the correct values of capacitors and that they were the correct polarity. This is important in the design as it effects the mark space ratio it outputs.
- When soldering I looked at the PCB tracks and pads, to make sure there were no copper bridges, if these were present they would cause a short circuit when the circuit was switched on.
- I used the strain holes in the pcb when attaching a flying lead. These reduce the amount of force on the connection point between the soldering and the pad. This helps reduces the risk of wires falling off ands breaking the circuit.
- If I were using a PIC to control my PCB then, while programming my PIC I would undergo several tests in program and with my actual PCB to make sure the code delivers the intended result.

Testing the circuit.

- I made a final check of my PCBs and checked all component values were correct; the polarity was the correct way around for all my components; and the flying leads were all still intact.
- To test my promotional display I tested that each of my inputs were working correctly: Switch on, LED lights, motor turns, and varies speed with the variable resistor.

3rd Party Evaluation , User Manual, and Self Evaluation

3rd Party Evaluation

- “It has a cool looking box and looks very good when rotating” – Larry Tang
- My box is not a shop bought, mass produced product, it is a school project and so would not be sustainable for industry manufacture.
- In a real company, the product would be shown to the target demographic. The company would then write down what they said about your product.

Owners’ User Manual

- Insert 4 AA batteries, close the box, and switch on.
- The display should start to spin, to change the direction - slide the direction slider, and to change the speed – turn the speed control dial.
- The LEDs are not automatically on, these need to be turned on with the on/off switch. The colour can be changed from red to white (or Visa Versa) with the colour slider.
- Switch off when not in use, to save battery power and to reduce the impact on the environment.

Self Evaluation

- I was very efficient in using my time, using all the time within class to do my work to the best of my abilities. I used catch-up sessions every Monday, to further extend the work I have done, mostly on my written work but also the practical work I have done.
- I did have delays caused by problems in manufacturing my board, this was out of my control as it was down to the technician to etch the PCB. I took full advantage in using the technician to make my final product, using him to etch my PCB and using him to laser cut the case for my product.
- I have not been able to stick to my time management plan as I underestimated the time needed to complete some of the later tasks. I was also held back by factors outside of my control, having to wait till my board was etched.
- If I were to do things better if I did it all again, I would be more realistic in my expectation of how much work I could accomplish. Through the design and manufacture process, I have learnt better planning for the time I have, and how to use RealPCB to create PCBs.

Scales of Production

Job Production

Job production is the making of a single item at a time. Every item will be different, to meet the customers needs. This type of production is very labour intensive. The workforce needs to be highly skilled, this makes it an expensive way to make things In industry this is often used for the prototyping of a product.

Batch Production

Batch production is making a set number of products. A specific quantity of a product is made - called a batch - repeated as many times as necessary. Processes are carried out on the entire batch instead of one product, this is quicker than making each product individually. Batch production requires flexible machinery and labour, so that they can change from one product to another. It is the most adaptable scale of production, but machines can cause backlogs of products meaning it isn't the most efficient.

Mass Production

Mass production is making loads of the same product. This is the method to use to make thousands of an identical product. It is only used for mass-market products. The different stages of production and manufacture are broken down into simple repetitive tasks for unskilled labour. Mass production often uses computer-aided manufacture and expensive specialised equipment.

Continuous Production

Continuous production is highly automated. It uses expensive machines that run all the time. The equipment is built to make huge amounts of only one thing, this makes the process very efficient.

Just In Time Production

Just in time production is a form of mass production. When lots of one product are being made over an extended period of time than it can be too costly to store all the parts. With just in time the parts arrive on the day they are going to be used.

Modifications for Mass Production

- In school my case, was made from layers of laser cut MDF. Although this created a sturdy case, it would not be a sustainable way of manufacturing them in industry as it was highly labour intensive.
- For a mass produced case it would be an injection moulded ABS case. To make an injection moulded product a mould must be made. To make an injection moulding mould a CNC machined aluminium die is made. It has pre-made holes for PCB mounts, area for a battery pack, holes on lid, feet, air vents for cooling, and screen printed labels.
- In a commercial product it would have a smaller compartment for the batteries to go in, this would be an accessible way to change the batteries if they were to run out in use.
- In school, we made a single sided PCB designed by CAD. These were bare copper pads with no lacquer and were developed manually. In this the components were spaced well apart, with many being attached by flying lead. DIL ICs were assembled by hand, with no antistatic precautions.
- Mass Produced PCBs are designed by CAD and etched by CAM. The boards are doubled sided, lacquered, and tin plated, this provides the best result for the cost of manufacture.
- SMD, surface mount devices, are used on these boards as it more easily automated and is cheaper to produce in large quantities than a leaded component. The board will have a high component density, with both sides having tightly spaced components.
- Commercially made products will probably use Programmable circuits, these can be programmed to control all the functions a mass produced display may have: speed control, direction, lights, and sound.
- The promotional display will have to be packaged before it is sold to an end customer. As it is a commercial product it will have to meet EU and UK regulations on the safety and environment impact of the product.
- When making the product the company will need to work with many suppliers and customer to meet there needs. This will be part of an extensive market research, before the designer even starts to make the product.