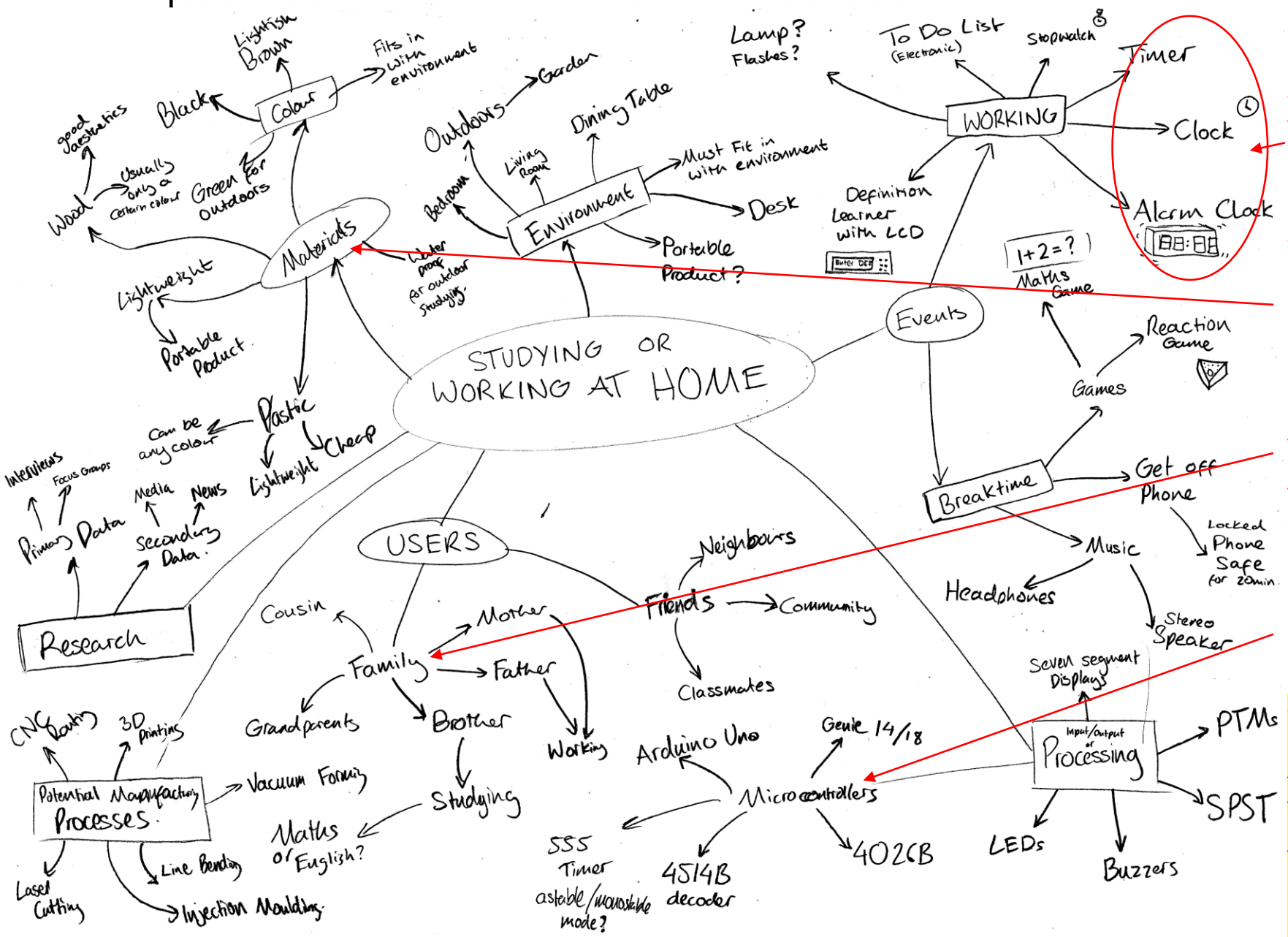
Design and Technology

GCSE NEA Project

Charlie Roberts

Mind Map

Introduction: On this slide, I have chosen the context "Studying or Working at Home" and I explore ideas via a Mind Map.



Client Feedback

I have a desk where I work, therefore these would be very helpful on a desk.

A smooth surface should be added as I do not want to damage my desk.

The product should be versatile and should be able to be easily used by many people.

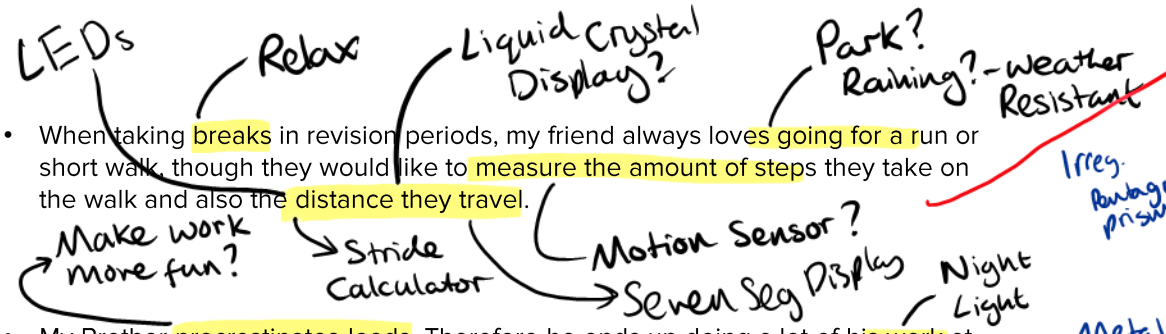
The product should have good electrical efficiency.

Summary

In conclusion, the product should be versatile enough to accommodate multiple users, feature a smooth surface and have good electrical efficiency.

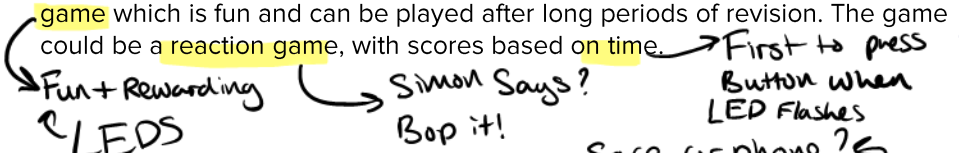
Possible Product Scenarios

- When taking breaks in revision periods, my friend always loves going for a run or short walk, though they would like to measure the amount of steps they take on the walk and also the distance they travel.

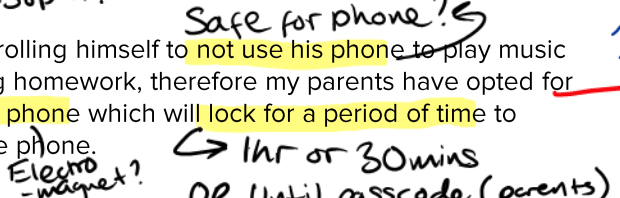


- My Brother procrastinates loads. Therefore he ends up doing a lot of his work at night and therefore completes work mostly in the dark. A lamp would provide a better working environment for him and allow him to complete more work effectively.

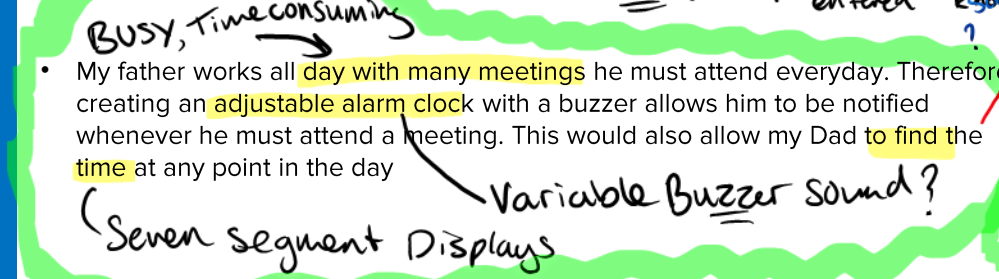
- When taking a break, one of my friends like to play games to reward themselves for studying after long periods of time. Therefore they have asked I construct a game which is fun and can be played after long periods of revision. The game could be a reaction game, with scores based on time.

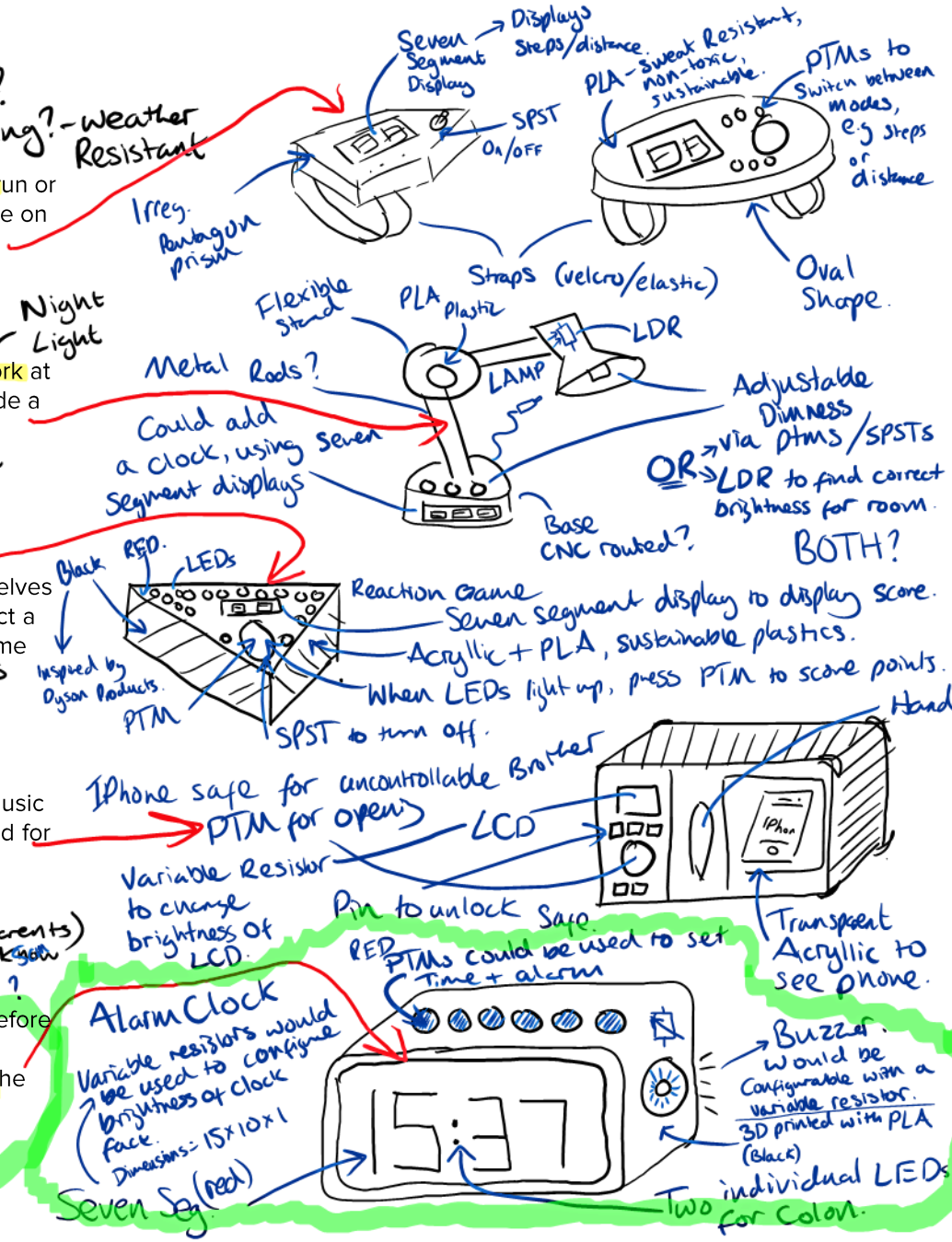


- My Brother struggles with controlling himself to not use his phone to play music and use when revising or doing homework, therefore my parents have opted for me to make a container for the phone which will lock for a period of time to keep my brother from using the phone.



- My father works all day with many meetings he must attend everyday. Therefore creating an adjustable alarm clock with a buzzer allows him to be notified whenever he must attend a meeting. This would also allow my Dad to find the time at any point in the day





Client Profile

Introduction: On this page, I will conduct research on my client.

Name	Lee Roberts
Age	54
Gender	Male
Occupation	Marketing Consultant
Residence	London, UK
Relation	Father
Interests	History, Travelling
Hobbies	Television, Reading
Style	Modern, clean, vibrant
Preferred Brand	Dyson
Favourite Designer	James Dyson, Norman Foster

Needs: My client needs an adjustable alarm clock **costing no more than £30**, fits on his desk, be able to set the alarm time, weighing no more than **3kg** and be able to last **2-3 years**. The product should also be powered by **battery (24hr battery) and mains** with the user being able to switch between them.
Wants: The product should be made of **sustainable plastic**, should be comprised of a **two tone colour scheme** and should have a cuboid shape with fillets on edges

Problem/Solution:
My father works all day with many meetings in his study he must attend everyday. Therefore creating one Adjustable Alarm Clock with a buzzer allows him to be notified whenever he must attend a meeting. This would also allow him to know the time whenever.

Client Taste:
My client enjoys smooth and sleek materials with vibrant colours. The client's study area (where the product will be placed) is decorated with modern and varnished wood. The client's desk has a largely brown colour tone, and therefore my client needs an item of vibrant colour to rejuvenate the environment. My Client favours the designs of these designers:

Potential Spec Points:
- The price should be limited to £30
- The product should be able to last 2-3 years.
- The product weigh no more than 3kg
- Should be both battery and mains operated (Togglable).

Research Plan	
Find out...	**How?**
Max size of product	Conduct a site study
Correct size batteries to last a whole day.	Conduct a component analysis
Component prices	Conduct a component analysis
The correct colour and design	Create a mood board and collect anthropometric data of client

Client Questionnaire

(Red: Needs, Blue: Wants)

Q: What would you like the product to do?
A: I need the product to tell me the time and be able to set alarms.
Q: How often do you have meetings?
A: One or two times a day – setting the alarm must be quick and easy.
Q: What should the maximum dimensions of the product be?
A: 30cmx15cmx30cm (It must fit on my desk).
Q: What is your ideal budget?
A: I would think around £30.
Q: How long would you like the product to last?
A: As long as possible, though probably around 2-3 years.
Q: How should the device be powered?
A: As the clock is on a desk, it should be powered from mains.
Q: How much should the product weigh?
A: The product should weigh no more than 3kg.
Q: Should the product be portable?
A: I would not mind, though a portable power source may be useful as I often read newspapers in the garden.
Q: Who else might use the product?
A: My youngest son may use it and so the product must be made of non-toxic materials. My eldest son may also use it.
Q: What material should the product be made of?
A: I would like the product to be made of sustainable plastic.
Q: What colour would you want the device to be?
A: A two tone colour scheme combining a darker colour with a vibrant colour, similar to Dyson Products on the market.
Q: What shape should the product be?
A: A simple cuboid could work well.

Summary
In summary, my client needs an alarm clock which can tell the time accurately and able to alert him when he has a meeting. The clock should be no heavier than 3kg and be able to fit on the desk. The product will additionally not cost more than £30. The product should also be able to be used by the client's children and wife.

Mood Board

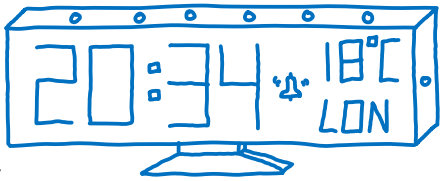
Introduction: On this page, I have created a mood board for my client. (With Client Feedback)

Client likes the modernist buildings with glass used substantially on the exterior, yet would not like this product placed on the right – no working parts should be exposed

I personally like the simplicity of the Nest Thermostat and Xbox controller the use of darker colours. It is important to add a striking colour to the product.

Client enjoys the sleek and modern design of Dyson, Apple and the clock products. The Client appeals to the curved surfaces of the products.

Client dislikes the single bold colours. He suggests having two primary colours – one vibrant and bold, the other dull, much like Dyson's product palette.



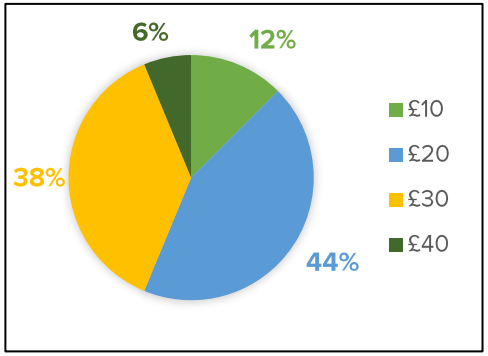
Summary

In summary, my client favours the modernist, sleek and clean designs with smooth edges and curves. The client additionally asks for a specific colour tone: a vibrant and bold colour combined with a duller one. However, the client hates exposed working parts. All these points will help me to create the best product for my client.

Group Questionnaire

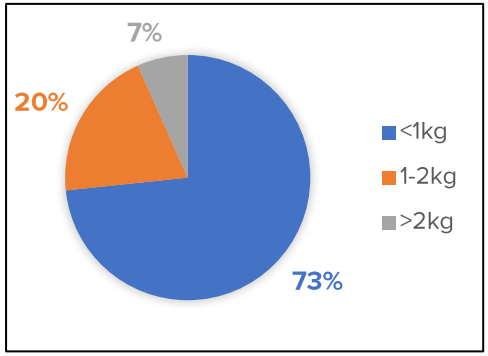
Introduction: On this page, I have conducted a questionnaire using fifteen people. (With Client Comments in Red)

How much should the device cost?



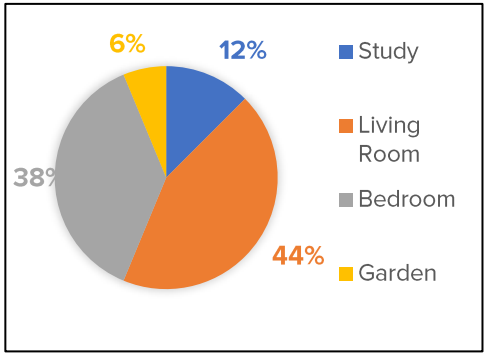
Of the fifteen people questioned, the majority decided that £20 was the correct price for a single product. This is followed by £30. Therefore the device should cost between £20 and £30 to account for this. Client agrees, though he thinks that £30 is more likely.

How much should the device weigh?



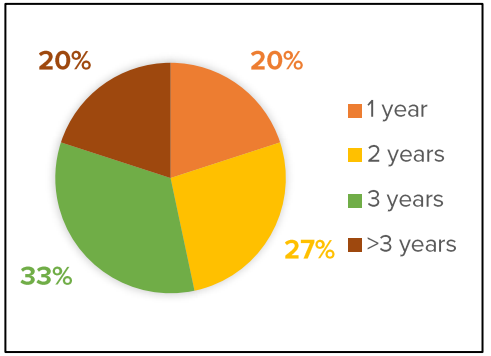
An overwhelming majority decided that the product should weigh under a kilogram. This is likely due to the want for the device to be portable and ease of use. Few people desired a product which was above these weights. Client agrees in Client Questionnaire.

Where would the device be used?



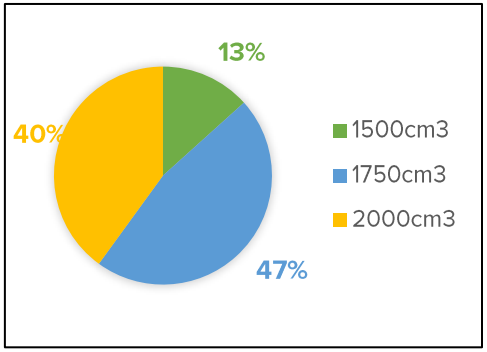
Despite these results, the device should be able to be used everywhere (If outside then UV resistant paint). However, the majority would use the product in the living room or bedroom. Client says that they want to use it in the garden.

How long should the device last?



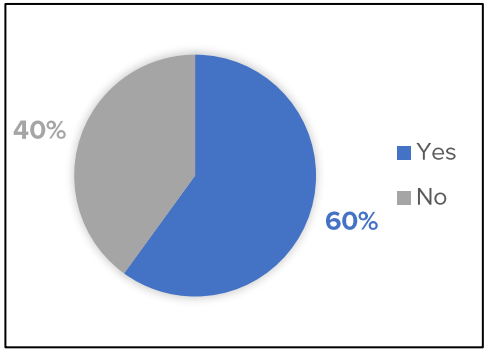
With this question the user group was more or less equally divided. However the majority was 3 years, therefore the product should be able to last at least three years. The client agrees, as said in the client questionnaire.

How big should the device be?



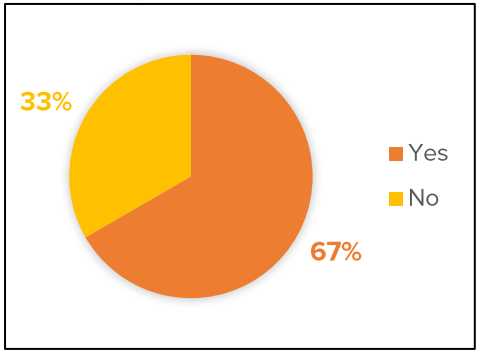
Although it is difficult to tell with the volume, the group have decided that the product should have a medium size. Client says to refer back to Client Questionnaire.

Should the device be portable?



The majority here would like the product to be portable. The Client agrees and as stated in the client questionnaire, he would like to use it outside in the garden.

Should the device be made from recyclable materials?



The majority of the people said that the product should be made of recyclable materials. The Client agrees, but notes that sustainable materials are not necessary.

Potential Spec Points:

- The device should be portable.
- The product should have UV resistant paint.
- Should be made of sustainable materials.
- The device should be easy to transport, should have small dimensions and be lightweight.

Summary

After conducting a group questionnaire, a few potential specification points have been made. The client as well as seen the range of questions and made appropriate feedback where necessary.

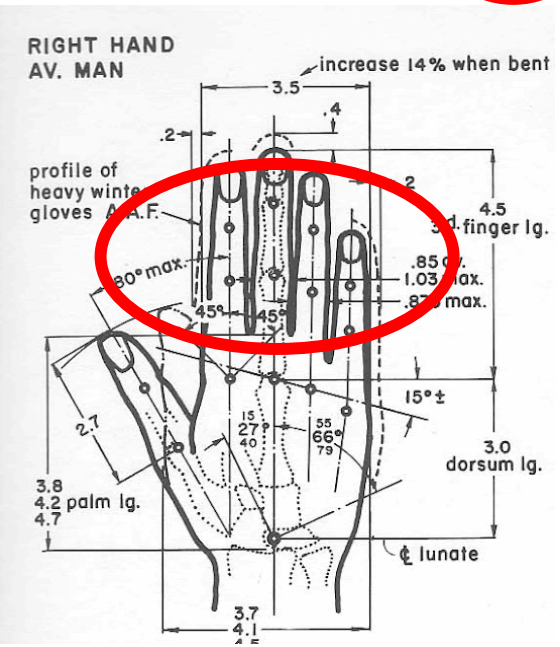
Size Data and Ergonomics

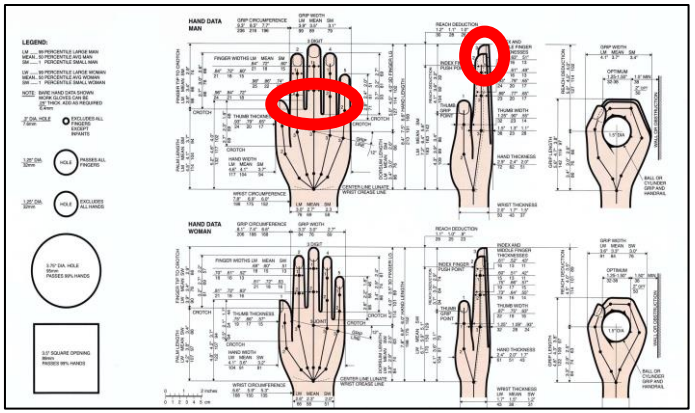
Introduction:
On this page, I aim to seek the required anthropometric and ergonomic data for my project and what main factors I must take into account for a successful product for my client.

Anthropometrics:
My Client has near average finger length and palm size. The chosen product is a digital alarm clock which will require my client to interact with the clock (set time and alarms). Therefore, the button sizes and body of the clock should be adjusted to fit my client's hand. However, my client's family may use this product, therefore the average human hand sizes must be accounted for.

Parameter	Maximum	Minimum	Mean
Age (years)	35	22	27.54
Height (cm)	181	169	174.81
Body weight (kg)	79	60	70.27
Hand length (mm)	205	180	188.73
Palm circumference (mm)	220	185	197.67
Hand size	**10**	**8**	**8.93**
Thumb length (mm)	70	59	63.79
Index-finger length (mm)	81	69	74.19
Middle-finger length (mm)	90	74	83.06

Ergonomics:
Touch and sight will be considered as my Client will carry and see the device often. He desires a clean, sleek shape and design which incorporates a smoothened blocky shape with curved edges, making it easy to interact with, aesthetically pleasing with increased portability. Components like the buttons and switches, are designed specially to ensure maximum comfort whilst using them and they fit well to the client's human hand. The product would have a buzzer and the frequency must be in the range of human hearing (20-20,000Hz) and have a configurable amplitude, allowing for a range of hearing. How the product smells/taste will not be taken into consideration as it is not relevant. This information is crucial to tailor the product specifically for the client.



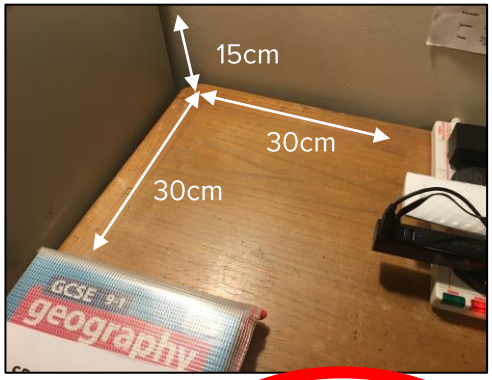


Potential Spec Points:
- The Width of the product must be 90mm
- The length of the product must be 190mm
- The height of the product must be 90mm
- The frequency of the buzzer must be within the range of human hearing.
- The product shape should be sleek, aiming for the best interaction with it.

Summary
Whilst conducting this research, I have discovered the need to acknowledge and incorporate anthropometric data into casing ideas and how I should approach designing cases for different people with different anthropometrics, e.g., larger hand = larger button. Therefore, based on this research, I know my case should be around 90mm by 190mm by 90mm.

Site Study

Introduction: On this slide, I have conducted a site study for the product. Here, I find the area in which the product will be used the most.



This is the site of my client's working desk. He frequently works here and keeps a neat and tidy desk and environment; this is main place where my client will need the product.

Site Description

The site contains a large desk with books, a computer, electrical plugs and folders. The wall contains posters and meeting information for my client. The Desk is made of hardwood, finished with varnish to give a brown colour. Since the electrical plug is fitted near the working area of the product, a short wire for power is needed. The product will be located near the corner of the desk, meaning the clock will be easily readable and configurable.

Client's statement

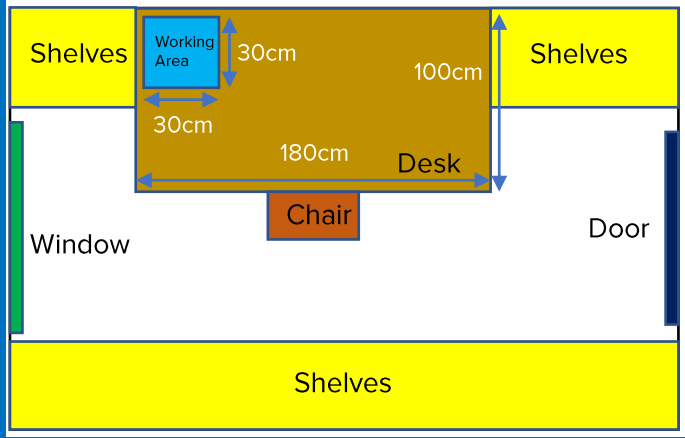
This is where I work, I complete work on the computer here and spend most of my day here.

Terrain

The area of the desk is flat and open as my client adores a clean and tidy desk. The product could therefore lay on the desk at an angle for better vision of the digital clock.

Location in House

The location of the room in the house is widely accessible and therefore my client should want the product to be accessible and robust to all that use it. The product is also placed in a way so that anyone in the house may find the time by opening the door and viewing the desk. The product must be able to be seen from the door and the buzzer must be heard from this distance (3m).



Materials and Finish

The product will use sustainable plastic as a primary material. The product should be portable and therefore be able to carry outdoors, therefore the product should be equipped with a water-resistant material.

Measurements

The site contains a desk which is around 1.8m by 1m, though the upper left corner of the desk will be used to store the product. This space is adequate for storing the product and therefore The product will be no more than 30cmx15cmx30cm.

Safety

The area that the product will spend the most time is on the desk. There is little to say about safety here, but the product could be fitted with a fuse or safety device with the switching power between battery and mains, ensuring safe and efficient transitions without consequences.

Aesthetics

The site in which the product will sit, contains quite dull and brown colours, much like a common work desk. This allows for the product to have colour scheme similar to Dyson products (dulled colour combined with a vibrant one). A dullish grey and blue or red could look striking with red Seven Segment Display LEDs. The product could be made of metal and wood via CNC routing to better fit the wooden desk environment

Potential Spec Points:

- It should be no larger than 30cmx15cmx30cm
- The display should be seen from at least 3m away.
- The Buzzer should be able to be heard from 3m away.

Summary:

In conclusion, I must design a product which can both be used indoors (desk environment) and outside (garden environment, though not often), with adequate protection – robust materials and UV resistant paint. It must be within the dimensions of 30cmx15cmx30cm and be easy and comfortable to use whilst being aesthetically pleasing.

Product Analysis One – Dyson Handheld Vacuum (Dyson Animal DC34)

Introduction: On this page, I hope to learn about a commercialised product by Dyson and hope to incorporate these features into the product.

Function

This device was built in order to clean spaces and collect dust. Using cyclonic separation, the device sucks in dirt and dust and breaks down the dirt into smaller parts via centrifugal forces when the dirt is spun around a cylindrical container. The device also sports a mechanism which allows the dust and dirt to be put in a larger bin with ease.

Processes

The Hoover is primarily made of PC/ABS Plastic, meaning the most likely process it went through was injection moulding to account for the complex shapes of the plastic, however, this requires very high setup costs.

Cost

At launch the product costed £145. Since then, the price has deflated. The product was released and bought in 2016 and is still functional now (2022-2023). Therefore, the product's cost is completely justified as the build quality of Dyson products is of the up-most standard.

Ergonomics

Firstly, the product lacks sharp edges and vertices and therefore is ergonomically pleasing. The product makes use of a curved handle/grip, allowing the user to transport the product comfortably and securely around a house. The pull-down bin latch also sports a bevel, allowing the finger to perfectly lie there.

Customer

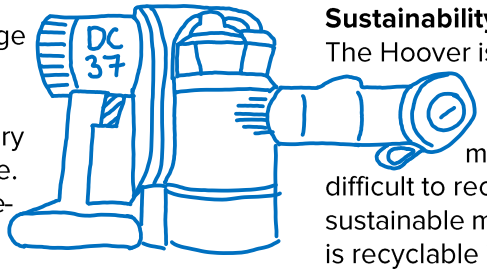
This product was most likely designed for family use. The product has been simplified for both child and adult use, supported by coloured red buttons for functions (such as: start the vacuum and empty dust container).

Form and Materials

The Dyson Animal DC34 is primarily made of PC/ABS plastic, with the battery, filter and motors being some exceptions. The device has a clear colour palette, as with most Dyson products. A bold more vibrant colour is combined with a dulled one, emphasising the purple colour in this case.

Components

The Portable vacuum uses a large lithium battery powering all the components. The notable ones are the motor powering a rotatory motion, driving the vacuum force. The product utilises interchange-able components, supporting a vast array of different functions.



Sustainability

The Hoover is mostly made of PC/ABS type plastic. This plastic is a thermosetting plastic, meaning it is extremely difficult to recycle and is likely to not be a sustainable material. The Lithium battery is recyclable is some circumstances.

Client Feedback

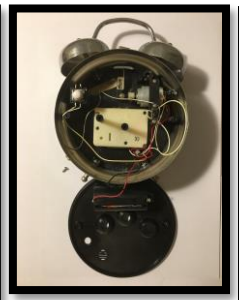
I particularly like the bold two primary colours of the device. However, being made of PC/ABS plastic, the device is not very sustainable or recyclable. The Clock body should be made of sustainable material. I am also impressed with the lifetime of this product: over 6 years!

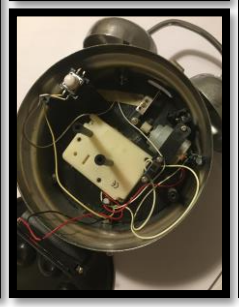
Summary

The product should utilise the benefits of this device. Therefore, in conclusion, the device should be made of a sustainable material, incorporate a Dyson colour scheme, be easy and secure to hold, have minimal sharp edges and the product should finally be able to last for a long time – 3 years preferably.

Product Analysis Two – Analogue Clock

Introduction: On this page, I hope to learn more about how clocks are made.



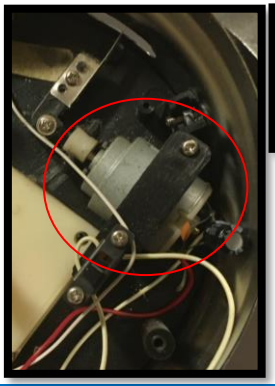


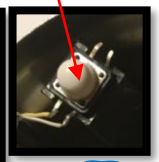
Ergonomics
This product utilises a curved thin handle, making it extremely easy to transport around a house or area. However, The handle could be a little thicker to account for more comfort and security with more contact with the hand. In addition, the product lacks sharp edges and vertices and therefore is ergonomically pleasing.

Components
The product uses many electrical components. The clock uses a motor and several gear ratios, allowing for the clock hands to move at different paces and another motor creating a reciprocating motion which guides a metal prong to bash against a bell, creating a loud noise. The product also uses a button on the rear of the device which is used to power the night light.

Customer
This product was most likely designed for a middle-income family with general interests and or occupations. This allows for the product to be attractive to many people due to a simple yet enticing design and therefore pitches itself to a wide audience and demographic.

Cost
This product has no printed brand; no price can be determined. However, the product was bought in the late 2000s to early 2010s and therefore would have costed around £30. This is justified with the many features: clock, alarm clock and a nightlight and its slick yet simple design





Function
This device's function is to clearly display the time in an analogue manner. It contains a single motor with several different gear ratios to clearly illustrate the time in seconds, minutes and hours. The device also uses a light which can be toggled from the back white button, allowing the device to be viewed in the dark. In addition, there are fluorescent strips located on the hour and second hand, allowing for the time to be seen in the dark

Form and Materials
The clock combines both a thermosetting plastic with a thin layer of stainless steel. The product contains clear digits on the face of the clock with an attractive and simple design, making it perfect for the intended audience.

Processes
To make the shapes in the product, the steel is casted (a molten metal is poured into a mould and left to set). The plastic is then injection moulded to account for the complex morphs and areas of the product.

Sustainability
The clock is mainly made of two materials, steel and plastic. Steel is non-renewable and therefore cannot be replaced. The mining of iron is highly energy intensive and harmful to the environment. The creation of plastic additionally sources from non-renewable stores of crude oil. The creation involves polluting the air with toxic chemicals causing air, land and water pollution.

Client Feedback
I particularly like the simplicity of the design; the device only uses three main colours (chrome, black and white) and two main materials (steel and a thermosetting plastic)

Summary
In summary, I have learnt that my product should contain a simple yet sleek design, with little materials with sustainable origins allowing for many people in the household to enjoy using the device. The product should cost around the same as this clock: £30.

Designer Analysis One – James Dyson

Introduction: On this page, I hope to learn more about a designer: Dyson.

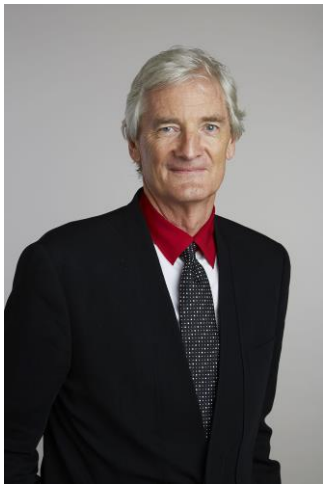
Sir James Dyson is a British inventor credited with founding the successful technology Company, **Dyson**. James was born on 2 May 1947 in Norfolk, United Kingdom, with three siblings. Originally studying Furniture and Interior Design, Dyson soon found a passion in **Industrial Design** and later pursued this. **The Dyson Company thrives** on **experimentation**, **thinking differently** and **embracing mistakes** – which has led them to be extremely **prosperous**.

Dual Cyclone bagless vacuum cleaner

Back in 1978, Vacuum Cleaners utilised bags to collect dust and dirt, however, James had become very frustrated with this design. He instead had the innovative idea of creating one without a bag – iterating his design over five thousand times. Using cyclonic separation, it proved to be more efficient, cost-effective, compact and additionally minimised the inconvenience of replacing bags.

Lightcycle Morph

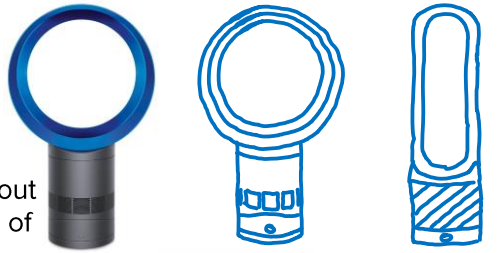
This light is a competitor to all desk and floor lights and outclasses them with its vast number of features. The Lightcycle automatically adjusts light depending on the consumer's natural light at a location, time of day, age and whether you are studying.

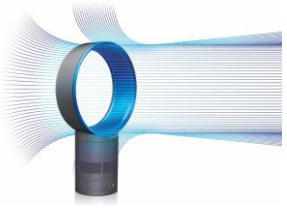


The client dislikes the exposed working parts on the Vacuum cleaner.

Bladeless Air Multiplier

This advanced product is in a league of its own. James set out to design a fan which instead of using traditional bladed fans – utilised by all other fans on the market – he used an annular aperture which accelerates air evenly out, amplifying the flow by a factor of 15, capable of producing 400 litres of air a second. The sleek innovative design also makes it safe for children (no blades) and much easier to clean. The product also consists of a variable controller of airflow, differing it again from the market.





My client adores the bladeless air multiplier because of the vibrant colours with a sleek, simple and modern design. The client also appreciates the Dyson's ethos of function over form.

Airblade Tap

The Dyson Airblade Tap is a faucet providing the function of cleaning your hands and fully drying them in twelve seconds, outcompeting the whole market. The sleek design of the tap saves space as it is a 2-in-1 product (clean and dry), saving the inconvenience of buying two devices and in some cases, be less expensive.

Ballbarrow

One of Dyson's first ever inventions was a variation of the Wheelbarrow. Here, the product has a 'ball' allowing for more maneuverability and control over softer soil. It also makes the barrow more laterally stable whilst carrying heavy weight, proving at the time (1970s), better than its competitors.

Conclusion

James Dyson is successful because of the determination he possesses. James will iterate the design repeatedly to ensure perfection in efficiency and practicality. Dyson additionally uses quite bold, yet vibrant colours in combination with a darker tint, which helps elevate design and would be an excellent addition into the Alarm clock project as the client adores this colour scheme. Dyson values practicality more than design ensuring the best product is created first, despite this, the client dislikes the exposed working parts of the vacuum cleaner.

Summary

In resolution, the client likes the colour schemes of the designer and values the ethos of function over form when designing, yet the client dislikes the exposed working parts.

Designer Analysis Two - fitbit

Introduction: On this page, I hope to learn about the smartwatch company Fitbit.

Fitbit, an American consumer electronics company, are best known for making wearable fitness products or devices that are able to monitor the health of the user - heart rate, stairs climbed, steps taken, quality of sleep and even able to tell the time. My client is a fan of modern and sleek products and therefore this company is perfect to research. Fitbit was founded in March 2007 and released its first product in 2009 named the Fitbit Flex. Since then, Fitbit has gone onto sell 120 million devices and acquired 29 million users in over 100 countries.

Fitbit 'Alta' Range

The Alta range combines all the functionality of a basic tracker, with a slim and attractive design. It tracks time, steps, distanced travelled and even calories burnt. The device has additional functionality like being able to set alarms and alerting the user if an alarm is set.

Although the Fitbit Alta is in the low-range of the line-up, the device is still superb at tracking fitness and the time.

Fitbit 'Charge' Range

The Charge range combines all of the Alta range's functionality and adds to it. The charge range can measure heart-rate and additionally has a full touchscreen, allowing the user to better navigate the data that Fitbit collects about your health. The device comes with a buzzing system to alert the user when an alarm is set and when a goal has been reached. Yet, the Fitbit charge allows you to better control when this happens due to the touchscreen display.

Fitbit 'Sense' and 'Versa' Range

The Fitbit Sense and Versa range have the higher quality and price range of the line-up. The main difference between these and the lower tier watches, are the larger screens, built-in GPS for tracking, microphones for calling and a battery lasting for almost a week. Due to the larger screen, it makes using the device very easy to use. One can make calls, log data and even set alarms and the time. This device connects to your phone, allowing for notifications and reminders to be displayed on the watch. This means the time never needs to be updated as the smartphone send the relevant data to the watch. This device has all the functionality anyone could ever need, but lies in the price range of £150-250, depending on customisations.

My client loves the simplistic nature of these fitness trackers and smartwatches. The client supports the idea of different products suiting the needs of clients with different budgets. All products have excellent aesthetics and functionality. My client particularly likes the customisation of the watches; he loves the different GUIs and wristbands

Other Products

This is the Fitbit Aria Air, a smart scale which links to a smartwatch to help the user to keep track of their weight. It comes in two colours (white and black) and costs £50.

Summary

In conclusion, the client very much desires the sleek and modern nature of all the devices at Fitbit. The client envies those with these well-designed products and hopes the Alarm clock can include high functionality with excellent aesthetics.

Designer Styles and Movements

Introduction: On this slide, I analyse a range of designer movements and styles.

Bauhaus Movement

The Bauhaus was a German design movement founded by Walter Gropius that aimed to create functional and visually appealing objects for everyday use. It stressed simplicity, functionality, and geometric forms in design, whilst having a large impact on architecture and graphic design. Despite its brief existence, the Bauhaus remains highly influential among contemporary designers, and its legacy can be seen in modern design.

Memphis Movement

The Memphis movement was an Italian design and architecture movement in the 1980s, it led by Ettore Sottsass. It was characterized by its bold colours, unconventional shapes, and postmodernism. It rejected minimalism and traditional design conventions and used unconventional materials to create playful and whimsical furniture. The Memphis movement had a lasting impact on design, despite being prevalent for a short period.

Cubism Movement

Cubist architecture is known for its use of bold geometric shapes, fragmented planes and rejection of traditional ornamentation. It sought to break down traditional forms and create innovative designs in line with the modern world. Notable examples include the Villa Savoye in France and the Schroeder House in the Netherlands. The movement was short-lived but heavily influenced future developments in modernist and postmodernist architecture.

Client Feedback

I really like the abstract architecture of the cubist buildings, It combines both modern and erratic shapes, creating a cartoon-like environment.

Ethics, Morals and Impact on Society

Introduction: Here I evaluate the Environmental and Social impacts that the product might have if it were to be commercially made.

Affordable

- The product should be reasonably priced to ensure that the product is accessible to all demographics.
- The components should be cheap themselves to ensure a very little repair cost.

Safe to Use

- The product should not promote substance abuse or any addictive behaviour.
- The product must not goad harm to humans or animals.
- The product should not cause damage to the environment.
- The product should not cause harm to manufacturers.

Respectful to Cultures and Beliefs

- The product should not offend cultures and beliefs.
- The product should not promote any cultural/political beliefs, it must be impartial.
- The product must not insight violence.

Ethically Made

- The working place should be a safe environment.
- Workers should be entitled to a fair wage and paternity/maternity leave.
- A Transparent business model should be constructed that is publicly available to anyone.

Extended Obsolescence

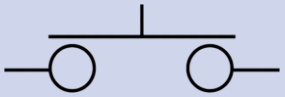
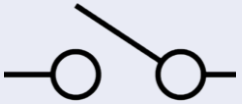
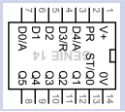
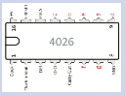
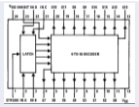
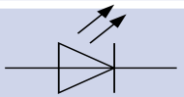
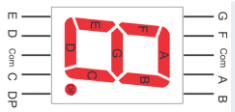
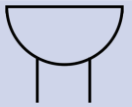
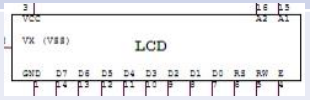
- The product should be created out of durable and reliable materials, that are built to last a very long time.
- Use durable components to reduce waste by ensuring the device does not break
- If the product does break, it should be made from replaceable and repairable components.

Summary

In conclusion, to design a successful product, it should prioritize simplicity, sustainability, ethics, and social impact. Bauhaus, Memphis, and the Cubism movements suggest simple geometry and neutral, yet bold colours. The client likes the abstract nature of the cubism movement and this should be added.

Component Analysis

Introduction: On this page, I hope to find and learn about potential electrical components for the Clocks Project.

	Component	Picture	Circuit Symbol/Diagram	Function	Use in Project	£	Source
INPUT	Push To Make Switch			A PTM allows current to pass through a point when pressed. The switch must be pressed constantly for current to flow.	This could be used with a Genie 14 or other microcontroller (processor) to trigger an output for my project. It would also need a pull-down resistor.	£0.36 per 10	https://www.rapidonline.com/r-tech-780520-miniature-push-to-make-switch-red-78-0520
	Single Pulse Single Throw			SPSTs allow for current to flow through a point when switched. It will flip between two states (on or off).	This could be used with the battery, allowing for the circuit to be switched off, conserving battery. Also, could be used with a Genie.	£0.76 5 per 5	https://www.rapidonline.com/sci-r13-270a-black-mini-rocker-switch-2p-spst-on-off-panel-mount-round-12a-250v-75-0057
PROCESSING	Genie 14 Microcontroller			The Genie 14 is a programmable microcontroller which has multiple functions. Has 14 Pins, 5 Inputs, 6 Outputs.	Depending on the size of my project and the complexity of the program, I will decide which one is more suitable for the project. The Genie microcontroller will be the processor for my project, it will most likely be used to check if a button is on and then providing an output in the form of an LED, Buzzer or LCD.	£2.68 per 1	https://www.rapidonline.com/Catalogue/Product?Id=13-6042
	Genie 18 Microcontroller			The Genie 18 is a programmable microcontroller which has multiple functions. Has 18 Pins, 6 Inputs, 8 Outputs.		£2.78 per 1	
	4026			This microcontroller allows for feasible connections with the Seven Segment Display. It can increment and reset the value.	The 4026 will be used to display and increment figures for the user to interpret. This could output a score or even a time.	£0.90 per 1	https://www.bowood-electronics.co.uk/buy/4026b/
	4514 Decoder			The 4514 Decoder has four inputs which combine to make a binary value. Therefore, this IC has 16 individual outputs.	This microcontroller could be used as having 16 different outputs, means long LED chasers can be made, along with other outputs. This IC is a very versatile processor.	£4.89 per 1	https://www.ebay.co.uk/itm/201613608412
OUTPUT	LED			LEDs will allow for a microcontroller/switch to display if there is current and voltage present, by lighting up.	In the project, LEDs could be used to display values, show whether the electronics are on or even displaying a harder difficulty in a game.	£8.88 per 100	https://www.rapidonline.com/truopto-osnr5164a-5mm-2-2v-red-led-pack-of-100-55-1790
	Seven Segment Display			Seven Segment Displays, are comprised of 8 LEDs, allowing for a digit from 0-9 to be displayed. A 4026 must also be used with it.	Having a Seven Segment Display allows my project to be able to display a time or even the number of points in a game. This can be done with a 4026.	£0.90 per 5	https://www.rapidonline.com/kingbright-sc52-11hwa-red-led-display-cathode-57-0115
	Buzzer			A buzzer is an output component which produces a sound, when given a current by either a switch or a microcontroller.	In my project, a buzzer could be used to display whether a player has completed a game or even a warning to alert the user of an event.	£1.55 per 1	https://www.rapidonline.com/rvfm-6v-buzzer-low-profile-35-0040
	LCD			An LCD is a programmable display, which can be programmed by a Genie to displays words/numbers.	An LCD in the project could be used to give the player/user an important message in words, in which a seven segment or LEDs could not.	£16.76 per 1	https://www.rapidonline.com/genie-13-6026-serial-lcd-kit-13-6026

Specification & Design Brief

Introduction: On this page, I am outlining the specifications of the product.

Design Brief:
My client/father works in the study for most of the day and must attend many meetings every day. My client does not currently have an efficient way to remind him to go to his meetings. Therefore my client has asked for an adjustable alarm clock with buzzer to be notified whenever my client needs to attend a meeting. This adjustable alarm clock should have multiple functions: to display the time, set the time, set an alarm, turn off the alarm and change the volume/amplitude of the buzzer in the alarm. This has been found in the research section.

The budget for this project will be £30 as this is a reasonable price for a digital clock with this functionality. The project will be in construction from Summer 2022, with a finished product at the end of the Easter 2023.

No.	Specification Point	Justification and Explanation	Page	Measurement
1	The product must work and function as a clock.	The client has asked for an adjustable clock, meaning it will tell the current time, 24 hours a day. This allows the user to get to his meetings on time (specified in the client profile).	4	When finished, I will test the product to make sure it functions like a clock: it is able to tell the time.
2	The product should be no larger than 300mm by 150mm by 300mm.	Whilst conducting a site study, the client specified where the product should be and in order for the product to fit in, it must confine to 300mm by 150mm by 300mm.	7 and 8	When finished, the product will be measured and will confine to these dimensions, otherwise will be reworked.
3	The product should weigh less than 1 kilogram.	In the client questionnaire, they specified that the product must be portable and therefore must be lightweight.	4	When finished, I will weigh the product and make sure it confines to the weight of under 1 kilogram.
4	The device should be both battery and mains powered.	In the client questionnaire, they specified the product must be portable. This means the product should be both mains (when using on the desk) and Battery powered (outside).	4	When finished, the product will be able to switch between mains and Battery powered.
5	The product must cost under £30.	My client has asked for a well-priced product and asks for the price to be affordable to many people, which was conducted in the client questionnaire.	4	When complete, I will sum the cost to be below £30.
6	The product must be constructed out of sustainable materials or plastics.	In my client questionnaire, they specified that they would prefer if the materials that the product is made of is recyclable plastic. Therefore I should aim to use recyclable plastic e.g. PLA	4	When construction the case/exterior of the product, I will ensure I use a sustainable plastic like PLA to make the casing.
7	The product must use non-toxic materials.	In the client questionnaire, my client specified that he has a young infant who may try to bite or lick the plastic, therefore to avoid the child becoming ill, the product must be made of non-toxic materials.	4	When deciding on the materials of the product, I will conduct secondary research to guarantee the material is made of non-toxic materials.

Continued Specification

No.	Specification Point	Justification and Explanation	Page	Measurement
8	The product must be durable and be able to last for 3 years at least.	In the client questionnaire and group questionnaire, the client suggested the product should be able to last around 3 years and is fairly durable. The client does not want to have to purchase a new clock often and therefore the device should be reliable.	4 and 6	When deciding on the materials of the product, I will conduct more secondary research to guarantee materials are durable and will last for years to come.
9	The product must have a vibrant colour/finish.	From my client's tastes and the client questionnaire, the client desires vibrant colours that resemble a two tone colour scheme combining both a vibrant colour and more dull colour.	4	When choosing the colour for the device, I will present a sketched version of the product for the client to choose the colour.
10	The product will be manufactured only once.	Given that I only have one client and a relatively short manufacturing time, it is sensible to construct this product only once for my one client. This is also said in the client profile.	4	When designing, I will ensure that I only make one clock for my client.
11	The device must have curved edges allowing for an ergonomic feel.	Whilst gathering size and ergonomic data, my client specified there must be smooth edges for maximum comfort, indicated on the Size Data and Ergonomics page and on the Client profile.	7	When designing the product, I will add fillets to edges and minimise sharp edges to be put on the product.
12	The clock must be within one minute of accuracy over a week.	In the client questionnaire, my client indicated he wanted an 'accurate' clock and therefore the clock should be within one minute of accuracy over a week.	4	After one week, I will measure the clock time and will make sure that the clock is within one minute.
13	The clock must be clearly visible from up-to three meters away.	According to the Client's Site Study, the door to the room is a few meters away from the proposed resting place of the clock. Therefore, when someone opens the door, they should be able to see the clock and time clearly.	8	After making the product, I will measure the furthest distance that the clock can be from the client ensuring that the client can read the clock from over three meters away.
14	The clock should have no more than ten buttons.	In the client questionnaire, the client specified that the clock should be easy to use and quick to set alarms for my client's many meetings.	4	When designing the circuit, I will make sure the circuit has no more than ten buttons/switches.
15	The buzzer in the alarm should be able to be heard from at least three meters away and preferably through a door.	If the client is outside the door, the buzzer should ring at the correct volume that is distinguishable. The design could also incorporate a variable resistor controlling the volume of the buzzer. This was suggested by the client in the Site Study.	8	After making the product, I will measure the furthest distance that the clock can be heard from the client ensuring that the client can hear the clock from over three meters away.

Continued Specification

No.	Specification Point	Justification and Explanation	Page	Measurement
16	The device should function as an Alarm (make sounds and flicker at a time).	In the client questionnaire, the client outlined the main uses for the product. My client has many meetings and needs a way to notify him when they start. When the time is reached, a sound can be heard and the lights start flashing.	4	When finished, I will build a focus group to test the functionality of the clock, meaning they will give a conclusion to whether it meets the objective.
17	The clock should have a test buzzer button, letting the user to set the right volume.	On the size and ergonomics page, I outlined that everyone has slightly different hearing, therefore there should be a specific button for the user to press and hear the buzzer (at a set volume).	7	At the end of the project, I will test the button and ensure that the buzzer rings as intended.
18	The product should have an adjustable volume.	On the size and ergonomics page, I outlined that everyone has slightly different hearing, but the pitch of the buzzer should be within 20-20,000Hz and with an adjustable volume (amplitude).	7	After the buzzer has been implemented, I will use a decibel meter to ensure that it is loud enough.
19	The product should be resistant to UV radiation (when product is used outdoors).	When the client uses the device in the garden in the summer, product may be subject to large amounts of UV radiation. Therefore the product should use UV resistant paint to stop the product from degradation.	6	After the product is constructed I will leave the product in the sun for 8hrs, I will then check for damage to electronic components and the base.
20	The battery must be easily replaceable (under 2mins to replace batteries).	In the client questionnaire, the client suggested that the product should be easy and quick to use. Therefore the time to change the batteries should be very short – 2mins.	4	After the construction of the product I will gather a focus group and check to see if they can change the battery in under 2mins.
21	The battery should be able to last 24hrs.	In the client questionnaire, the client mentioned his ‘needs’ in which he mentioned that the battery should last at least 24hr. This allows him to read his newspapers in the garden.	4	After completion of the product, I will measure how long the battery lasts. confirming it is over 24hrs.
22	The program should be easy and quick to set times and alarms.	As the client has several meetings a day, he does not want to waste time setting alarms, therefore the program should be extremely quick to set alarms. This is mentioned on the client questionnaire.	4	After the construction of the product I will gather a focus group and measure their own opinions (subjective) on how easy the product is to use.
23	The program must indicate when setting the time differently to when setting an alarm.	In the client questionnaire, the client mentioned that the device should be easy to use. Therefore a way of identifying which mode that the user is setting would be invaluable.	4	After the construction of the product I will gather a focus group and measure their own opinions (subjective) on initiative the GUI is.

Manufacturing Specification

Introduction: On this page, I plan the itinerary for manufacture, starting with the design of the circuits.

No.	Task	Materials/ Components	Equipment/ Tools	Health and Safety	Quality Assurance	Est. Time
CIRCUIT DESIGN	Research of Circuits (Work of others)	N/A	Computer, Internet, Circuit Wizard Software	N/A	Ensure that the sources are accurate and from confirmed and reliable resources.	45mins
	Circuit Iteration 1	N/A	Computer, Internet, Circuit Wizard Software	N/A	Ensure that for each iteration the client provides valid feedback. Make sure that the circuit functions as intended.	30mins
	Circuit Iteration 2	N/A	Computer, Internet, Circuit Wizard Software	N/A	Ensure that for each iteration the client provides valid feedback. Make sure that the circuit functions as intended.	45mins
	Final Circuit Design	N/A	Computer, Internet, Circuit Wizard Software	N/A	Ensure that the client is completely happy with the design and guarantee the client is informed about each section of the design.	50mins
	Final Program Design	N/A	Computer, Internet, Circuit Wizard Software	N/A	Ensure that the program has no bugs. Ensure that the client understands the flowchart for the program and provides relevant feedback.	50mins
TESTING	Breadboarding	Breadboard, Wires, Genie, 4026, Oscillator, Resistors, PTMs	Wire cutters, Wire strippers, Voltmeter, Ammeter	Be cautious when using live wires, turn them off when not in use. If soldering, use googles and an extractor fan to prevent fume inhalation.	Ensure that the basic functions of the breadboard work whilst using few but colour-coded wires to better track the wire.	60mins
	Breadboard Debugging	Breadboard, Wires, Genie, 4026, Oscillator, Resistors, PTMs	Wire cutters, Wire strippers, Voltmeter, Ammeter	Be cautious when using live wires, turn them off when not in use. If soldering, use googles and an extractor fan to prevent fume inhalation.	Ensure that the circuit and program are able to work in the real-world environment.	30mins
PCB DESIGN	PCB Design	N/A	Computer, Internet, Circuit Wizard Software	N/A	Ensure the PCB is small, allowing for the most efficient case and minimising copper waste later on. The PCB should be well-designed so that the tracks and pads are large enough and few components are labelled. Create different shape pads for Drilling and soldering to minimise confusion and improve speed when drilling.	60mins
	PCB Virtual Testing	N/A	Computer, Internet, Circuit Wizard Software	N/A	Ensure that the PCB works in a virtual environment and if not repair the program/PCB as intended.	10mins

Manufacturing Specification (Continued)

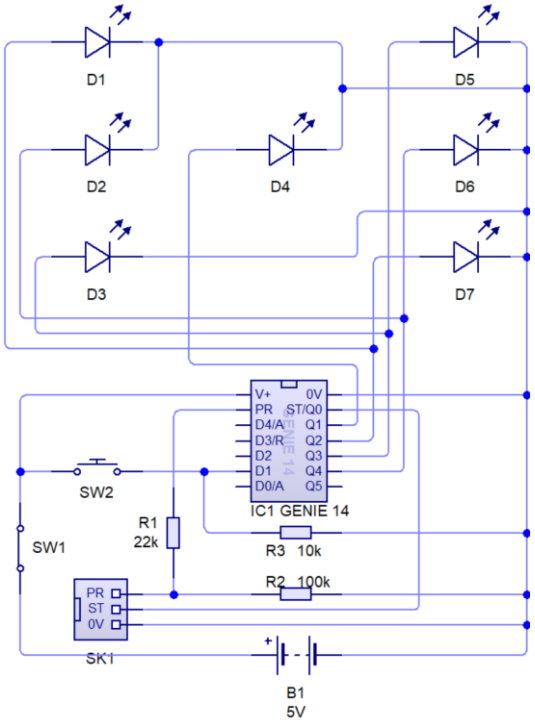
No.	Task	Materials/ Components	Equipment/ Tools	Health and Safety	Quality Assurance	Est. Time
PCB MANUFACTURE	Print Transparency	Acetate	Printer	N/A	Ensure that the printer has printed the PCB on the acetate with no malfunction. The PCB should be printed in black to reduce the amount of UV light hitting the copper board.	3mins
	Expose Copper to UV Light	Copper Plate, Printed PCB on Acetate	Guillotine, UV lightbox	Make sure not to expose oneself to UV radiation	Ensure that the copper plate and acetate are the only objects in the box. Expose the copper plate to UV for 2mins. When finished, transport the copper to the solution, hold the exposed side to your chest so that external UV does not interfere with the copper side.	4mins
	Develop PCB	Developer Solution, Exposed Copper Plate	Developer Solution, Water, Brush, Container, Gloves, Apron	Ensure that you wear gloves and an apron to protect from corrosive chemicals	Place the PCB in the dilute Developer's Solution (ensure correct concentrations), then brush the PCB to remove residue. Make sure to not over develop the PCB	5mins
	Etch	Developed PCB	Etching Tank	Ensure that you wear gloves and an apron to protect from corrosive chemicals	Place the PCB in the etching tank for 2mins at 45°C, wash the PCB and then repeat until the PCB is fully etched. Now it is ready to be soldered.	10mins
	PCB Sanding	Etched PCB	Wire wool, gloves	When sanding, wear gloves and goggles to prevent irritation and redness in eyes and skin. Wash hands thoroughly afterwards.	Make sure to sand the PCB thoroughly to remove the thin plastic coating on the PCB. The copper should appear shiny when this is complete.	2mins
	PCB Drilling	Sanded PCB	Drill, 'Second hand' (Clamp)	Keep fingers away from the drill bit. Wear goggles.	Ensure that all holes are drilled before soldering. Ensure that the correct drill bit is used for each type of hole.	15mins
	PCB Test (Soldering Genie)	Genie 20, Resistors, Wires, Download Socket.	Soldering Iron, Goggles, Extractor Fan	Wear goggles, gloves and use an extraction fan to avoid toxic fumes.	Ensure that all components are placed correctly using the final PCB design as a reference. Make sure to heat the copper pad as well as the solder to ensure a tight bond.	15mins
PCB POPULATION	Soldering of Oscillator and 4066	Crystal Oscillator, 4066 microcontroller, resistors, solder.	Soldering Iron, Goggles, Extractor Fan	Wear goggles, gloves and use an extraction fan to avoid toxic fumes.	Ensure that all components are placed correctly using the final PCB design as a reference. Make sure to heat the copper pad as well as the solder to ensure a tight bond.	20mins
	Soldering of 4026 Microcontrollers	4026 microcontroller, wires, resistors	Soldering Iron, Goggles, Extractor Fan	Wear goggles, gloves and use an extraction fan to avoid toxic fumes.	Ensure that all components are placed correctly using the final PCB design as a reference. Make sure to heat the copper pad as well as the solder to ensure a tight bond.	60mins

Manufacturing Specification (Continued)

No.	Task	Materials/ Components	Equipment /Tools	Health and Safety	Quality Assurance	Est. Time
PCB POPULATION	Soldering of Seven Segment Displays	Seven segment displays, wire, resistors	Soldering Iron, Goggles, Extractor Fan	Wear goggles, gloves and use an extraction fan to avoid toxic fumes	Ensure that all components are placed correctly using the final PCB design as a reference. Make sure to heat the copper pad as well as the solder to ensure a tight bond.	90mins
	Soldering of Input Components	PTMs, variable resistors, SPDT, Power plug, wires	Soldering Iron, Goggles, Extractor Fan	Wear goggles, gloves and use an extraction fan to avoid toxic fumes	Ensure that all components are placed correctly using the final PCB design as a reference. Make sure to heat the copper pad as well as the solder to ensure a tight bond.	70mins
	Soldering of Output Components	Buzzer, wires, LEDs	Soldering Iron, Goggles, Extractor Fan	Wear goggles, gloves and use an extraction fan to avoid toxic fumes	Ensure that all components are placed correctly using the final PCB design as a reference. Make sure to heat the copper pad as well as the solder to ensure a tight bond.	30mins
	Testing and Debugging components	N/A	Soldering Iron, Goggles, Extractor Fan	Wear goggles, gloves and use an extraction fan to avoid toxic fumes	Ensure that all components are placed correctly using the final PCB design as a reference. Make sure to heat the copper pad as well as the solder to ensure a tight bond.	120mins
CASING DESIGN	Sketches	Paper	Pencil, Rubber, Ruler, Pen	N/A	Ensure that with every iteration of sketch, the client should provide relevant feedback.	60mins
	Casing Design	N/A	Computer, Internet, Inventor (CAD)	N/A	Ensure that the corrected dimensions are found and used in the CAD. Ensure that the components can fit inside the product.	30mins
	Casing Prototyping	Card, tape, pencil	Pencil, Rubber, Ruler	N/A	Create a prototype base before 3D printing, certifies size. Create a face with testable dimensions to ensure accuracy.	20mins
	Casing Manufacture (Base)	PLA	3D Printer	Do not touch the nozzle of the 3D printer as it can become very hot.	When using the 3D printer, apply a layer of glue to the base to ensure that the print can be removed without issue afterwards. Give the 3D printer more than enough PLA, reducing the chance of failure if there is not enough filament.	Est. 10hrs (for 3D printer)
	Casing Manufacture (Faces)	3mm Acrylic	Laser Cutter	Close the lid of the laser cutter when using. Do not stare at the laser.	Ensure that the laser cutter is auto focused to the correct height. Place the acrylic in the cutter, upload the relevant data and wait for the laser cutter to finish. Peel the plastic layer off after.	30mins
	Joining of Casing and PCB	Screws	Glue Gun, Screwdriver	N/A	Ensure that a glue gun is used to guarantee that the Seven Segment Displays are securely fitted and flush with the face. Ensure that the faces are secured to the base with screws.	30mins
	Final Testing	N/A	N/A	N/A	Ensure that the product meets all of the specification points.	180mins

Circuit Analysis

Introduction: On this page, I am analysing the designs of others' circuits for inspiration or implementation into the circuit designs.



Genie 14

To the left, there is a circuit using a Genie 14. This circuit diagram is for an electronic dice (Press a button and a random number is output in a dice format). A Genie 14 has five inputs with a further two analogue inputs (voltage-measuring inputs). The Genie 14 also has six outputs, but with Q0 as an output pin and a status pin for maintenance. Any Genie microcontroller has the ability to hold a program and based on inputs, can output signals based on anything. This makes the Genie 14 a versatile microcontroller and a must have in a circuit. A Genie would allow the project to manage various functions and variables.

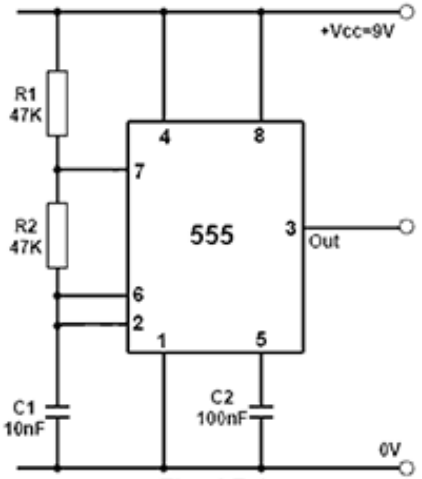


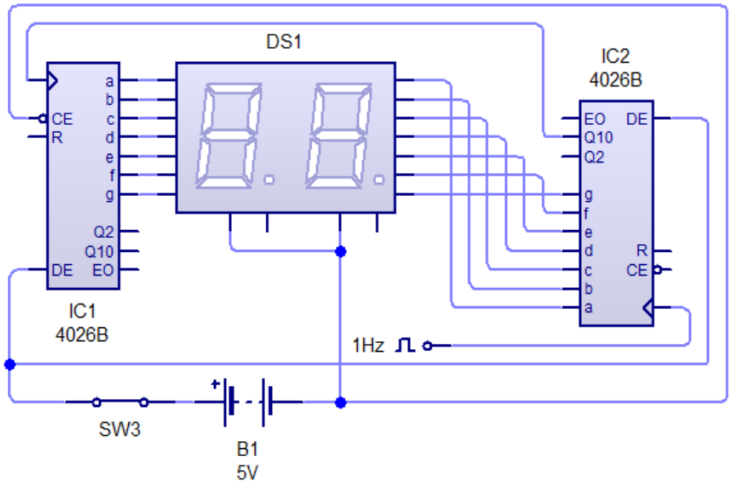
Fig. 4.7.4

555 Timer

In this circuit, a 555 timer is wired up in astable mode. This mode is a consistent oscillator which oscillates on time periods set by the capacitance of *C1* and *C2* and the resistance of *R1* and *R2*. This could be greatly useful for the project as although the Genie 14 microcontroller can produce pulses, background pulses are inaccurate for a 24hr Clock. Therefore, a separate 555 timer will be used.

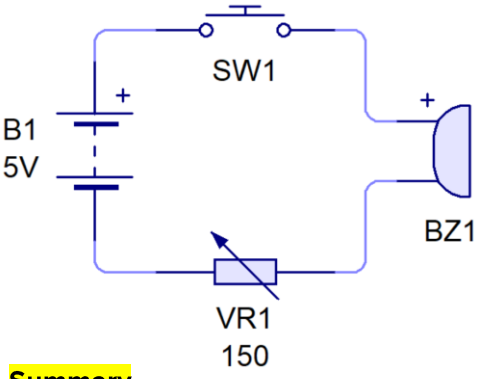
Client Comments

My client likes the idea of a configurable volume for the alarm, meaning the alarm can be muted at any time. He also likes the Seven Segment displays which are easily able to display the time, however, the colon in the 24hr time is not here and therefore could be added with separate LEDs.



Seven-Segment Display

This circuit diagram contains a seven-segment display with two 4026B microcontrollers. These allow pulses to be turned into numerical figures. A Dual Seven-Segment Display uses two 4026B microcontrollers which work together to produce a two digit number. This will be useful in the project as it will be used to display the numerical format of a clock.



Buzzer

In this circuit, the diagram shows a buzzer. This buzzer's amplitude can be configured using a variable resistor. This circuit can be easily implemented into my final design as my client desires an alarm for the digital clock.

Summary

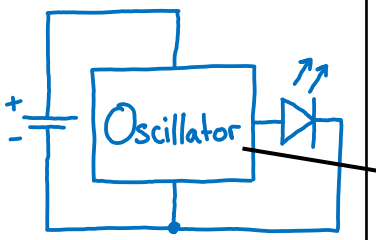
In summary, my final circuit design should incorporate an oscillator for the counting the clock, a microcontroller for managing the alarms and display, a Seven-Segment display for displaying the clock and a buzzer for the alarm.

Circuit Design One – Basic Clock

Aim: For the first Circuit Design, this oscillator will flash an LED, allowing the user to count the amount of seconds that pass.

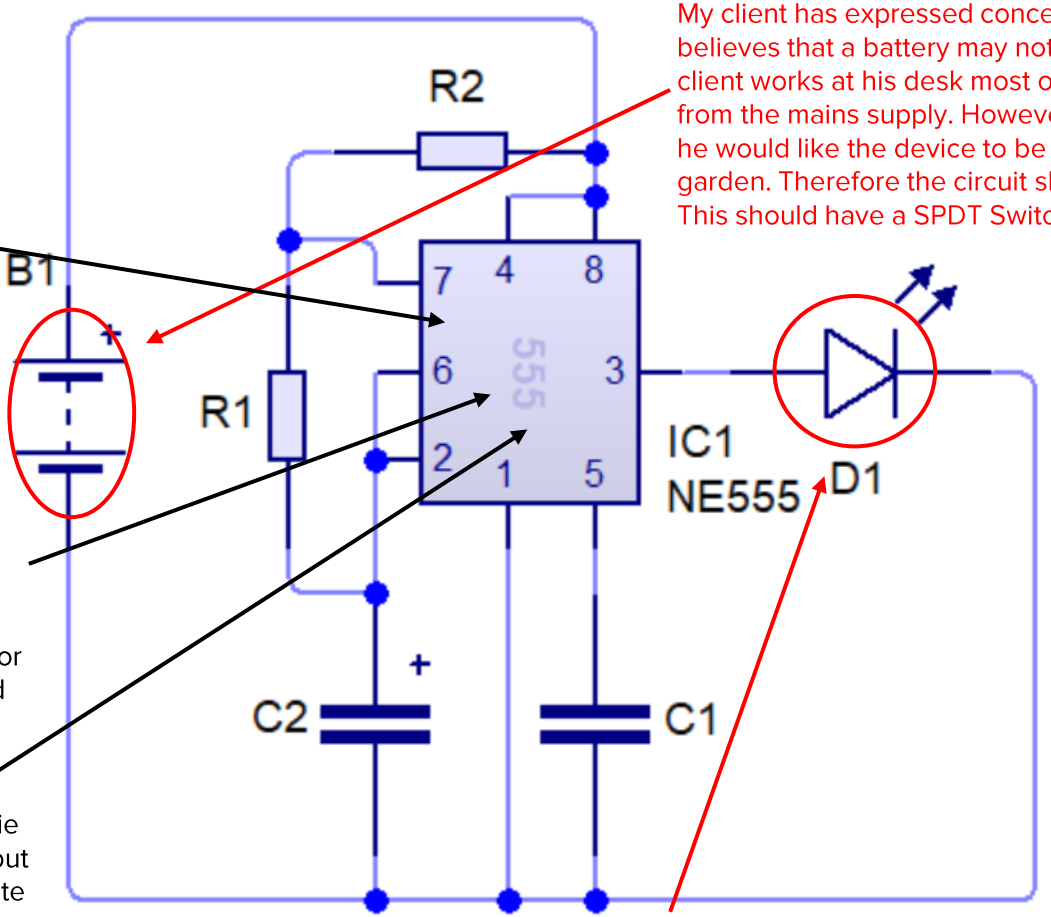
Input	Process	Output
A constant 5V input, powering the 555 timer in astable mode	555 Timer with 1Hz clock – one pulse every second	LED flashes every minute, counting the minutes that pass.

Sketched Diagram: (First Iteration of Idea)

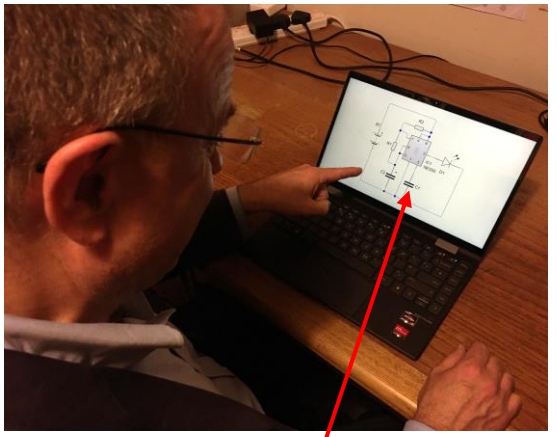


This circuit utilises a 555 timer set in astable mode. With the correct capacitance and resistance on the capacitors and resistors, the oscillator will correctly output 1Hz pulse, counting every second passing.

In the first diagram, an oscillator is used, this can be completed in different ways, yet I have chosen to use a 555 timer in astable mode due to more configurability. Utilising a Genie for timings is another option, but genies cannot keep an accurate oscillator running and therefore will not be used.



My client has expressed concern for the power source of the circuit. He believes that a battery may not be the best source of power. Since the client works at his desk most of the time, a better power source would be from the mains supply. However, in the client questionnaire, he specified he would like the device to be portable and be able to take it to the garden. Therefore the circuit should have **an adjustable power source**. This should have a SPDT Switch.



My client has also explained that the alarm clock should have an alert, for example **an alarm**. Therefore the Circuit diagram should include a microcontroller controlling a **buzzer** with an added variable resistor.

Client dislikes the output section of the clock. The client believes that the LED should be swapped out for a few **Seven Segment Displays** which can display the current 24 hour clock time instead of manually counting the seconds going by.

Considering the client feedback, I will make these amendments in the next few iterations of the circuit design.

Conclusion

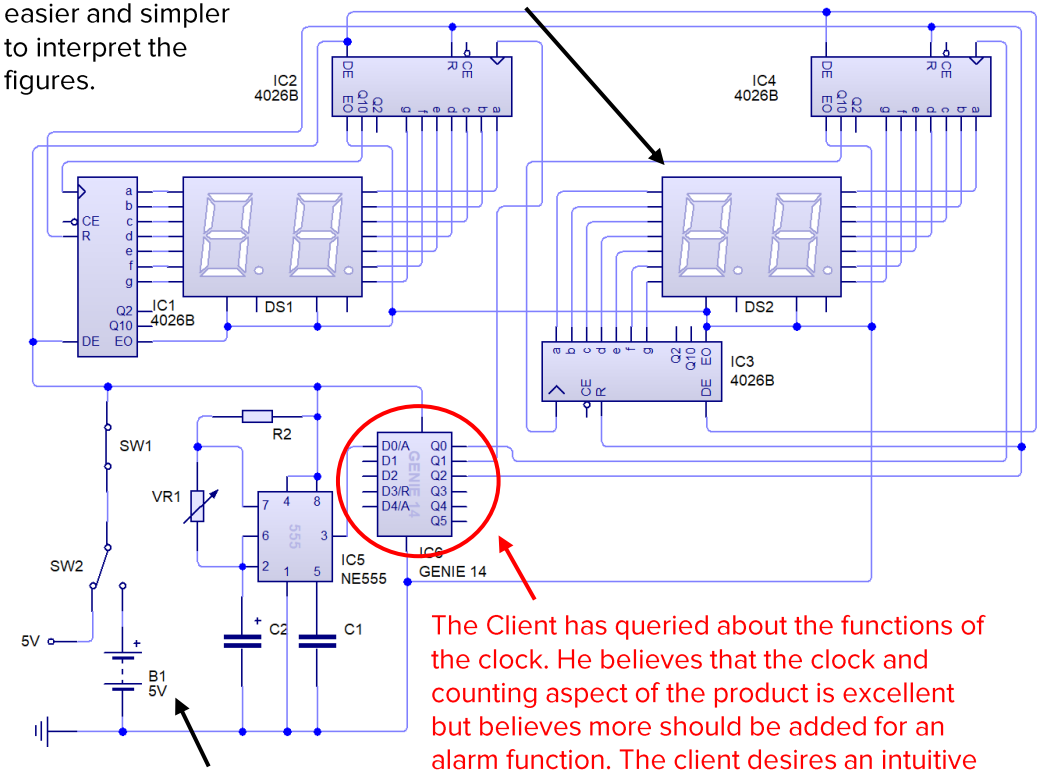
The Circuit has basic functionality, consisting of a single 555 timer in astable mode. This design can be iterated and as my client asks, a seven-segment display can be added. The power source of the basic clock should also be altered to include both a battery and a port for mains electricity. Additionally, due to the simplicity and nature of the 555 timer, there is no need for any program unlike with a Genie microcontroller.

Circuit Design Two – Digital Clock

Aim: For the Second Circuit Design, the circuit will count the number of minutes that pass and display it in a 24hr time format.

Input	Process	Output
The oscillating 555 IC will input a 1Hz frequency to the Genie 14.	Genie converts pulses from 555 timer to numerical figures.	Numerical figures are displayed on seven segment displays.

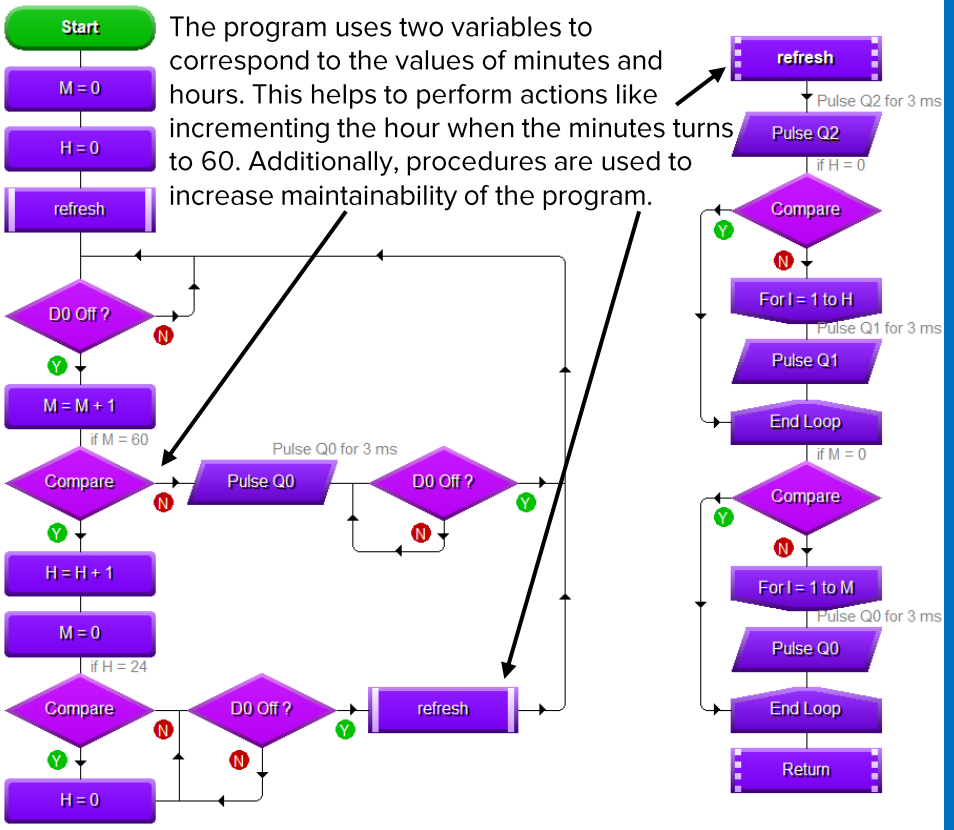
The client's comment about the format in which the time is displayed has been reiterated. Now the device displays the time in a numerical format, making it easier and simpler to interpret the figures.



Here the client's concern about the power supply has been resolved. Now the user is able to toggle between a power source from mains or battery.

The Client has queried about the functions of the clock. He believes that the clock and counting aspect of the product is excellent but believes more should be added for an alarm function. The client desires an intuitive **way of setting the clock** without the need for an external device. This should also include **a way of setting an alarm** quickly and use a **buzzer or flashing LEDs** to alert my client when the time is reached. This would result in more inputs being added.

The program uses two variables to correspond to the values of minutes and hours. This helps to perform actions like incrementing the hour when the minutes turns to 60. Additionally, procedures are used to increase maintainability of the program.



A problem that I have noticed is the variables are stored in the main memory, therefore when power is cut to the IC, the clock's values are lost (volatile memory). This could prove troubling when an alarm feature is implemented – the user would want the alarm to be saved when power is cut. Fortunately, the Genie contains a few EEPROM locations where clock and alarm values can be stored. This will be fixed in the next iteration of the program design.

Conclusion

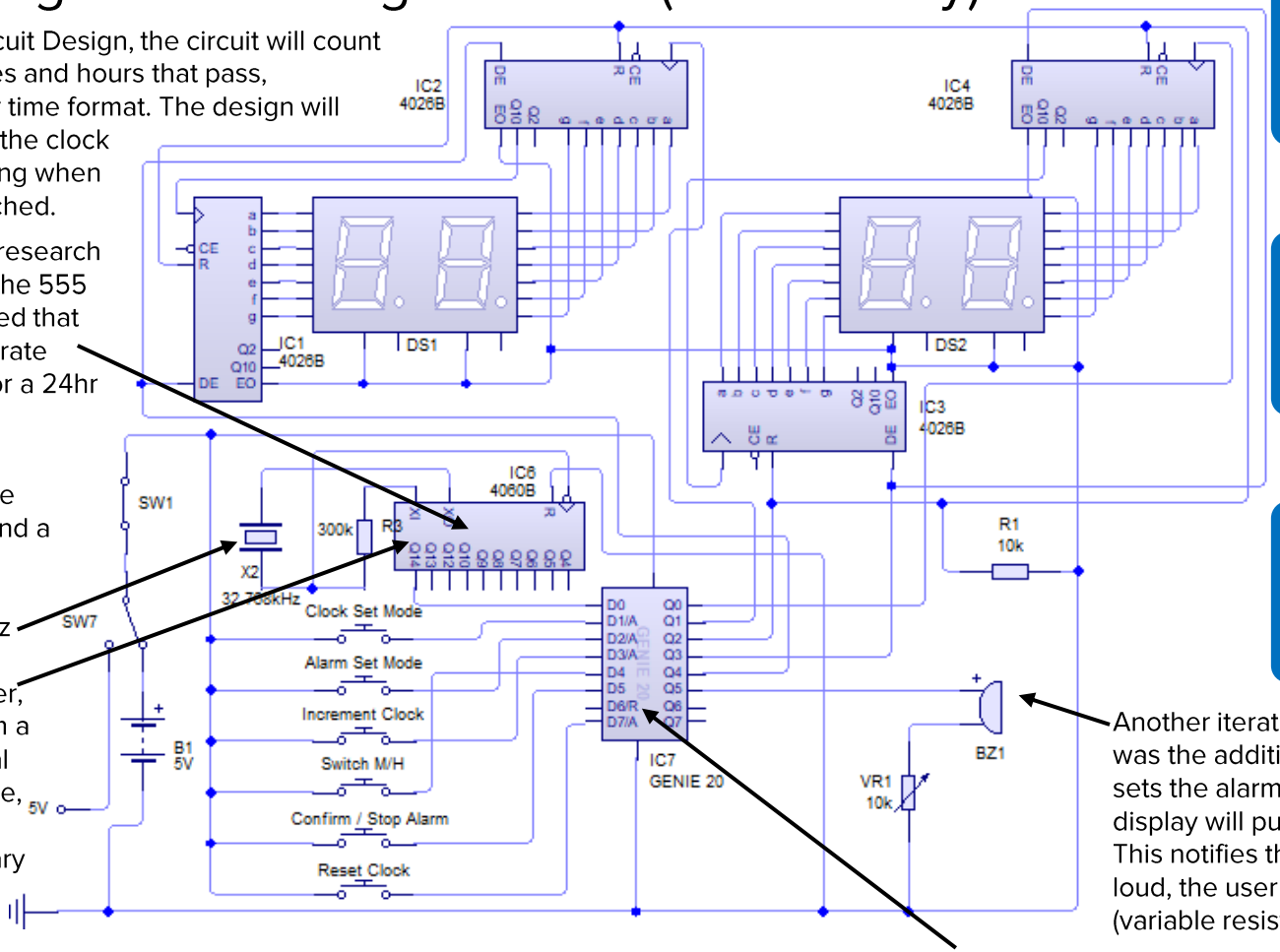
The Circuit is now beginning to take shape as a digital clock. Some areas of improvement have been addressed from subsequent feedback like the power supply and the display. The client has now asked for better functionality in the design, asking for the clock to consist of a programmable alarm and time. The program should also be improved by utilising the non-volatile memory in the IC, allowing the alarm and clock times to be kept when power is not supplied.

Circuit Design Three – Digital Clock (Circuit Only)

Aim: For the final Circuit Design, the circuit will count the number of minutes and hours that pass, displaying it in a 24hr time format. The design will also allow for setting the clock and alarm and notifying when the alarm time is reached.

After further primary research was conducted with the 555 timer, I have concluded that 555 timer is not accurate enough to be used for a 24hr clock.

After more primary research into accurate oscillators, I have found a reliable and accurate oscillator. These components, a 32KHz Quartz Crystal and a 4060B Microcontroller, work together to form a 1Hz pulse. The Crystal creates a 32KHz pulse, which is fed into the 4060B (14 Stage binary ripple counter) converting a 2^{15}Hz pulse into a 2^{1}Hz pulse (2Hz). This 2Hz pulse is then fed into the Genie, converting it to a 1Hz Pulse. (One pulse per sec)



Input
The oscillating crystal with 4060 will input a 1Hz frequency to the Genie 20. Genie will also read PTMs, for customisation of the clock

Process
Genie will convert the pulses from the crystal to a HH:MM time format. Additionally, the Genie will process the inputs to be able to set the time.

Output
The Genie will output the time as in HH:MM format. The genie will also use a buzzer to tell the user when the current time reaches the alarm time.

Another iteration made, guided by the client, was the addition of an alarm. When the client sets the alarm, the buzzer and the LEDs on the display will pulsate when that time is reached. This notifies the user and if the buzzer is too loud, the user may either turn the volume down (variable resistor) or press the alarm stop button.

After considering the client's feedback to add more functionality to the Genie, that task has been fulfilled. Now the genie is able to process inputs from the user that allow the correct clock to be set. It has an intuitive GUI: the clock face flashes slowly every few seconds (parallel processing) which tells the user that they are setting the time. Another mode is the Alarm setting mode, which flashes much quicker – telling the user they are setting the alarm – whilst the user enters the time at which to buzz. The Genie additionally has inputs for incrementing either the minute or the hour, reset button and a confirm button for the user to exit and stop setting either the clock or alarm.

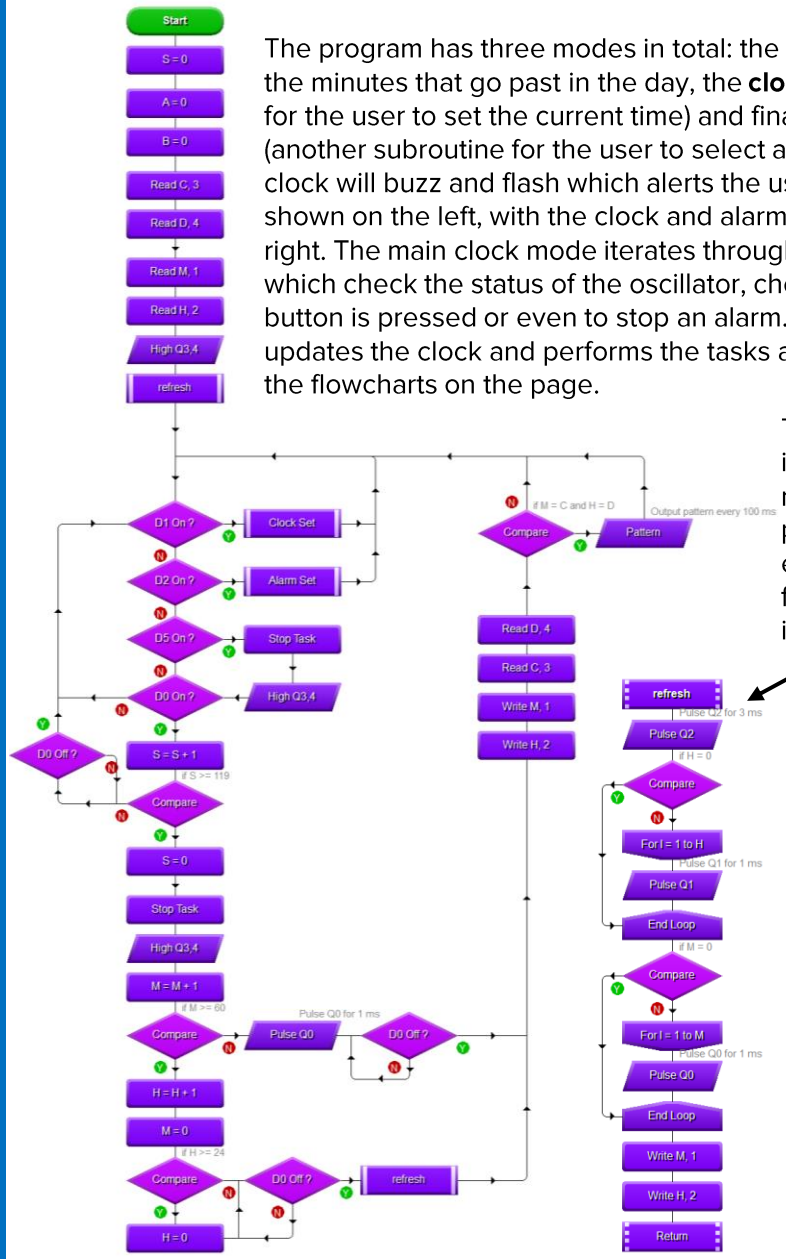
Conclusion

The circuit is now complete, and the client is pleased over the functionality of the clock. The circuit design allows for the user to both set the time and one alarm for every 24 hours, whilst processing different inputs (a constant oscillator) and outputs (flashing seven segment displays or pulsating buzzers). The program/flowchart for this circuit diagram is on the next page.

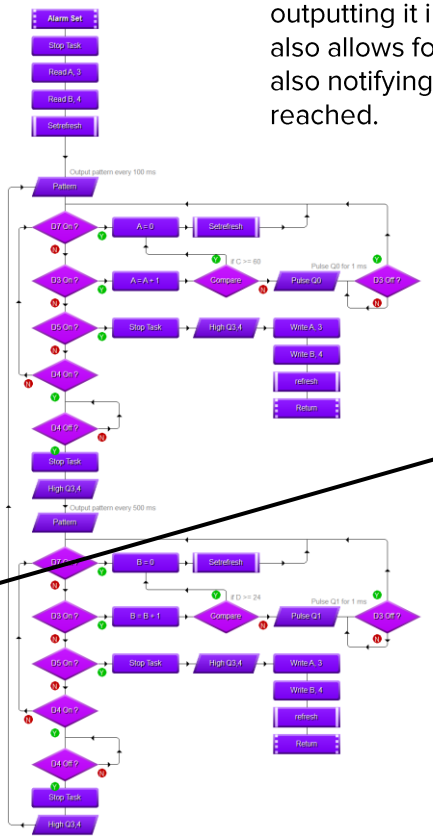
Circuit Design Three – Digital Clock (Program Only)

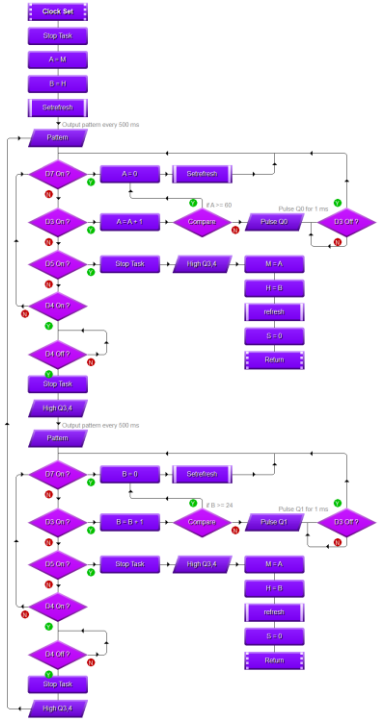
Aim: For the final Circuit Program, the program will count the number of minutes and hours that pass, outputting it in a 24hr time format. The program also allows for the clock and alarm to be set, whilst also notifying the user when the alarm time is reached.

The program has three modes in total: the **clock mode** (counting the minutes that go past in the day, the **clock setting mode** (a GUI for the user to set the current time) and finally an **alarm set mode** (another subroutine for the user to select a time for which the clock will buzz and flash which alerts the user). The clock mode is shown on the left, with the clock and alarm set mode are on the right. The main clock mode iterates through a series of commands which check the status of the oscillator, check if any mode switch button is pressed or even to stop an alarm. The program then updates the clock and performs the tasks accordingly as shown on the flowcharts on the page.



The use of subroutines increases the maintainability of the program, helping to catch errors and making the flowchart smaller, improving Quality Control.





On the previous program (program two), I outlined a problem of the variables being stored in primary memory and therefore when the power is cut, the variables of the current time and the alarm time is lost completely. Now the program stores these variables in EEPROM Locations, which are non-volatile memory – stores values even when power is cut.

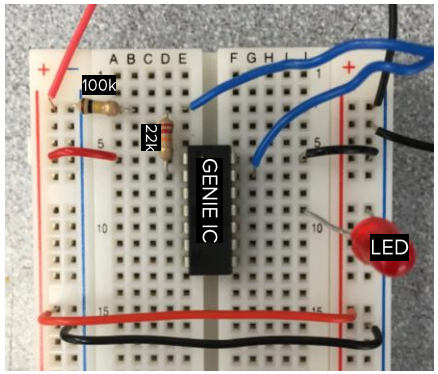
Conclusion

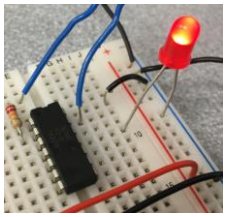
The circuit is now complete, and the client is pleased over the functionality of the clock. The circuit design allows for the user to both set the time and one alarm for every 24 hours, whilst processing different inputs (a constant oscillator) and outputs (flashing seven segment displays or pulsating buzzers). The circuit diagram for this program/flowchart is on the previous page.

Breadboarding

Introduction: On this page, I have prototyped the final circuit design onto a Breadboard.

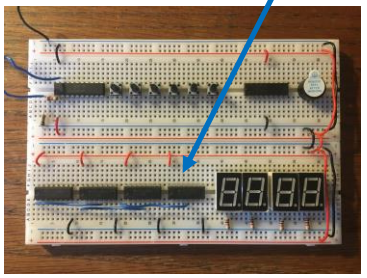
Before staring Breadboarding, I have made sure the Genie Microcontroller works and connects to the software, Circuit Wizard.



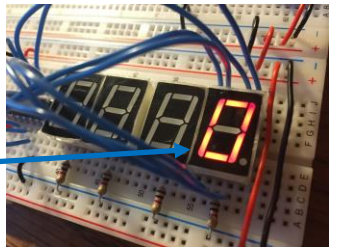


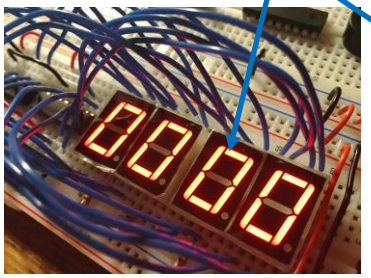
The Genie Microcontroller is working, shown by the bright LED, powered by the Genie. Therefore, I can start Breadboarding.

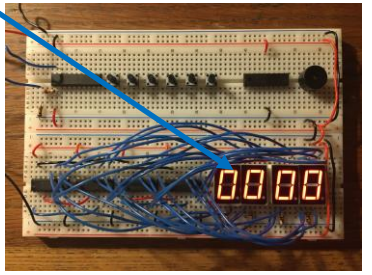
To begin with I have placed all the components on the Breadboard that I will use. I have also given power to all the microcontrollers, shown in this picture.



Since seven segment displays are complex and require lots of wiring, I wired up each display and checked they worked individually before going further.



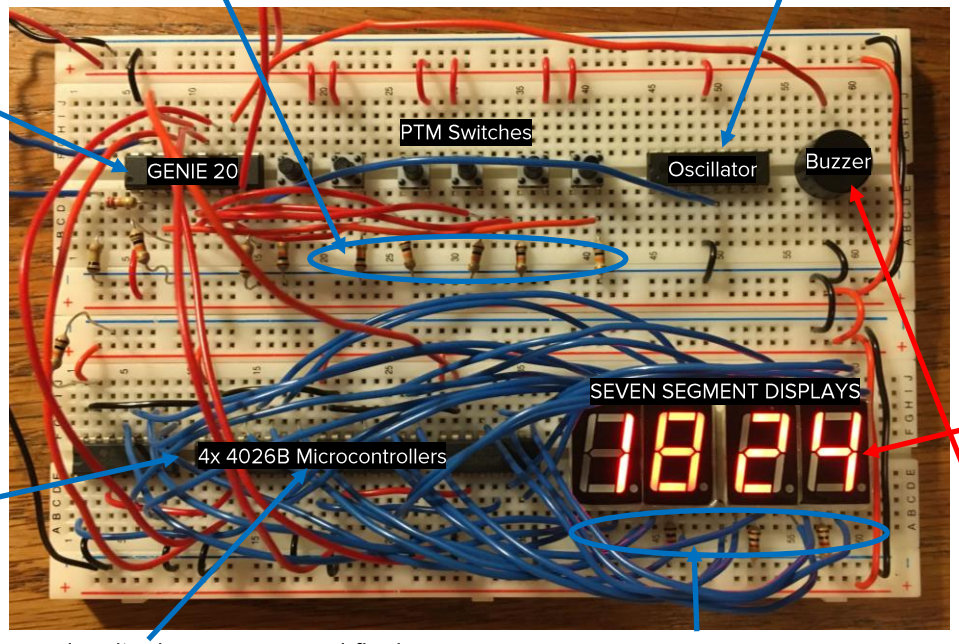




Controls clock setting and alarm settings. Orchestrates the whole device. Allows the display to increment, flash and reset.

(Pull-down Resistors preventing floating voltage)

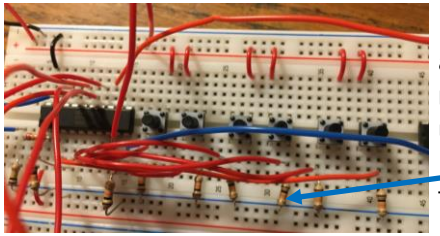
Oscillator, oscillates at frequency of 1Hz (one pulse every second)



These 4026B controllers allow pulses to be transferred to numerical digits.

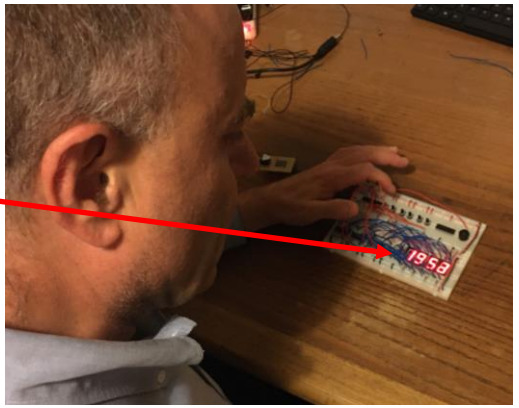
Also allows the display to reset and flash, controlled by the Genie 20.

(Current Limiting Resistors preventing current overflow)



Next I hooked up all the buttons and input devices to the microcontroller. These allow the user to set the time and alarm. Pull down resistors are also used to minimise floating voltage.

The Client loves the intuitive program and acknowledges that it is a prototype, but he is excited for the final product. The Client would however desire **larger seven segment displays**, and a **quieter buzzer** for the alarm.

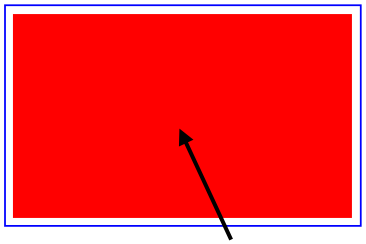


Summary

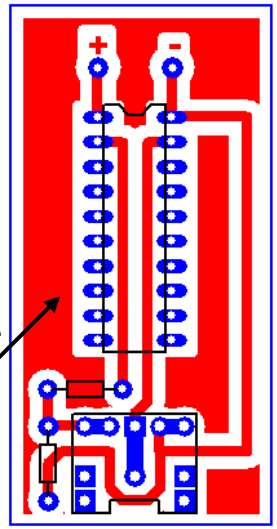
In summary, the client likes the program of the clock. However, the client desires a larger display and quieter buzzer. These amendments can be made when constructing the PCB.

PCB Design

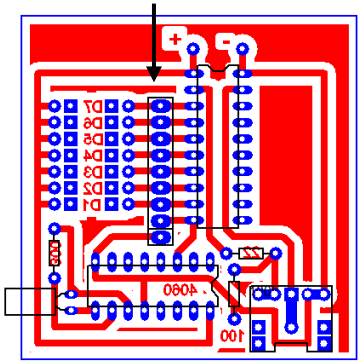
Introduction: On this page, I have created permanent circuit boards which will be used in the final project.



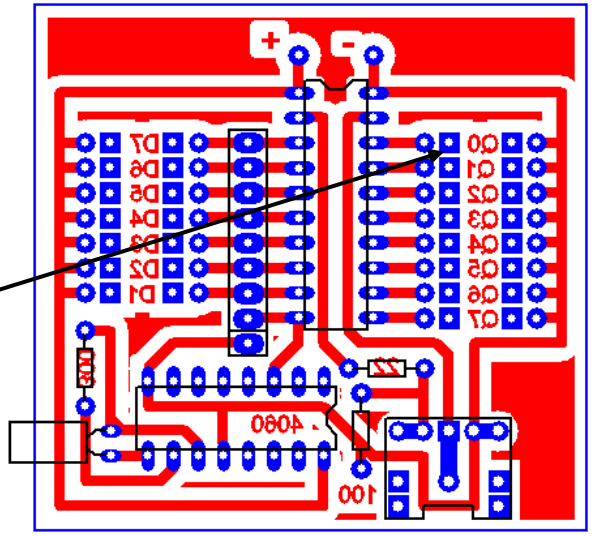
When designing PCBs, it is beneficial to start with a blank copper area to visualise where components should go. On the next iteration, I have placed the Genie 20, resistors and the download socket for communication with the IC.

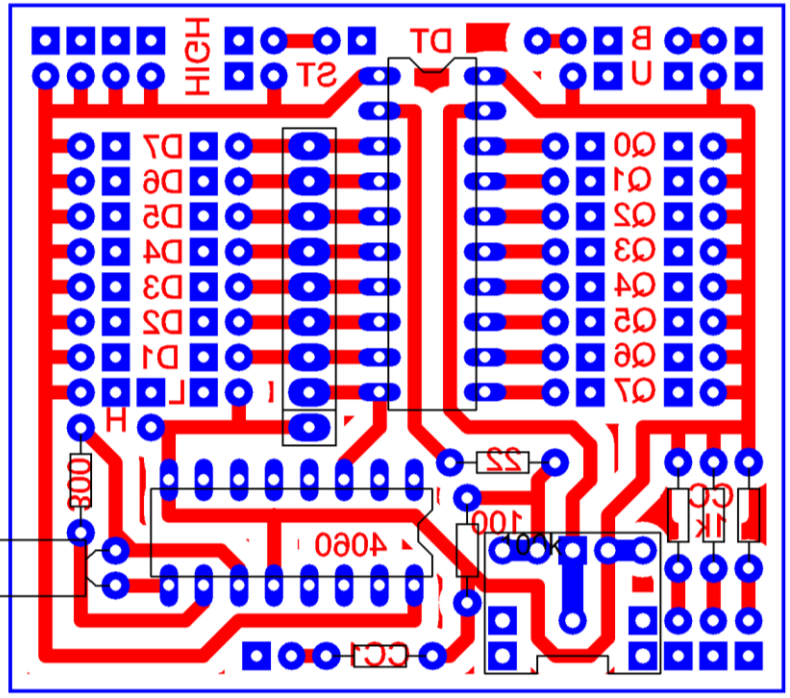


On the iteration below, I have added all the inputs to the device, which includes the 4060B IC with a crystal oscillator and several buttons which will be used to control the Genie microcontroller. A 9 pin resistor SIL is also used to prevent floating voltage.

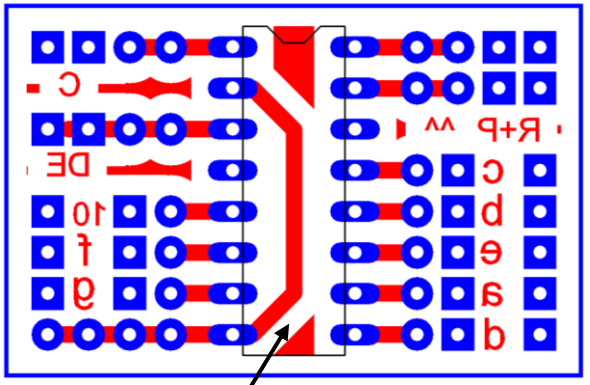


On this iteration, I have added the outputs. With this I have made sure to include suitable strain holes (square) which allow for the wire to be tightly secured after soldering. This has also be completed on the previous iteration of the design.





On this final iteration, I have added the capabilities of switching power to be drawn from the mains or a portable battery, shown at the top of the device. These will both have a voltage of 5V. Additionally, current-limiting resistors have been included for the seven segment displays, preventing them from breaking. The PCB has been manufactured to be small, minimising the amount of copper and chemicals used, with the added benefit of the inner electronics being easier to fit into the device when the casing for the product is created. In addition to this, extra high and low pins have been added in case of unforeseen malfunctions when etching or soldering.



Another PCB design has been made for the seven segment displays. The 4026 microcontroller will sit on this PCB and allows for a permanent place for the IC to be as the Genie gives it inputs. Four of these PCBs will be made for the project.

Summary

In summary, the PCB design has been completed and additionally checked via virtual simulation (see next page), therefor the manufacturing can now start.

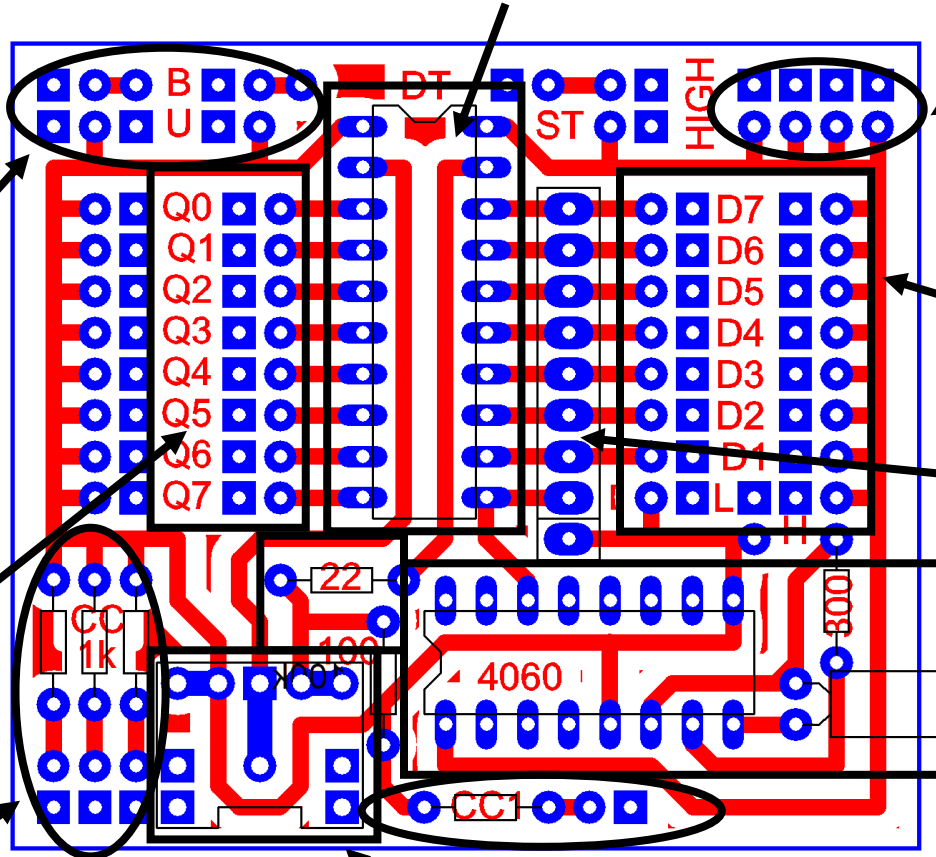
Further Annotation of Final PCB Design

Introduction: On this page, I complete further annotation on the PCB Design.

As outlined on the previous page, the PCB has been designed to be the smallest possible to minimise total copper usage and prevent waste. This is also done to allow the outer casing to be small as well.

The Genie is located here. This is the powerful microcontroller which can store programs and variables, whilst also containing EEPROM locations (non-volatile storage). This needs inputs and outputs and they can be found either side of the microcontroller.

Over the whole PCB, in areas which have not been used, I have added some high and low inputs. This means that if a new component can be added or something goes wrong, a new PCB does not need to be created.



Here, there is the blueprint for the SPDT where the power supply will be diverted from either mains or battery power. This will permit a 5V power either way to the whole of this PCB.

On the right, the inputs are located. This will be a collection of PTMs, which are given a specific function as they are connected to one input pin on the Genie.

Inputs can create floating voltage and to prevent it, a series of pull-down resistors have been added with this SIL.

Here, the outputs to the Genie 20 are located. These mostly are connected to the 4026s which manipulate the seven segment displays. Other outputs are used for things like the buzzer.

The oscillator is located here on the board. This outputs a 1Hz pulse which is fed into the genie, giving an extremely accurate pulse, perfect for clock timings. This consists of a Crystal Oscillator of 32kHz, and a divider (4060) which shortens it down to 1Hz.

A number of resistors have been added to the PCB. These are for the Common Cathodes of the seven segment displays. These current-limiting resistors will reduce the voltage in the seven segment displays so that the displays will last longer (if necessary).

This is the download socket which permits the computer to be able to communicate with the Genie in order to bug fix, upload programs and also run live.

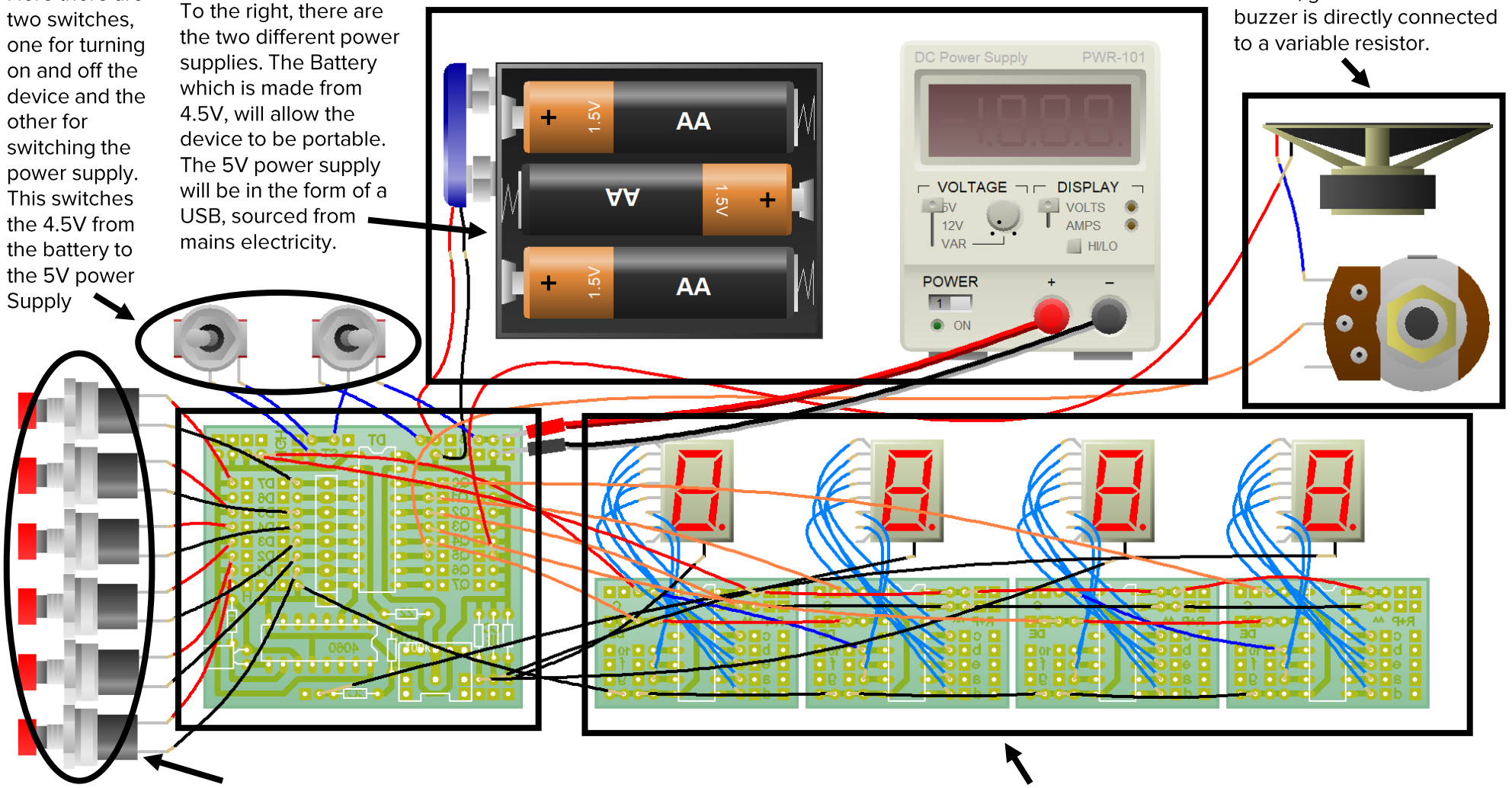
PCB Design (Virtual Modelling)

Introduction: On this page, I explain the virtual model before constructing a real model.

Here there are two switches, one for turning on and off the device and the other for switching the power supply. This switches the 4.5V from the battery to the 5V power Supply

To the right, there are the two different power supplies. The Battery which is made from 4.5V, will allow the device to be portable. The 5V power supply will be in the form of a USB, sourced from mains electricity.

Below is the tweakable buzzer, given that the buzzer is directly connected to a variable resistor.

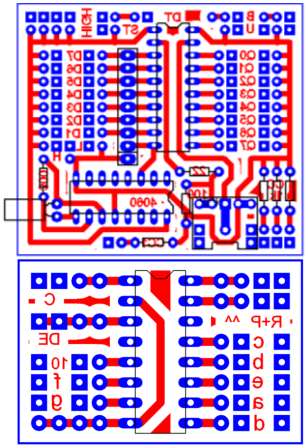


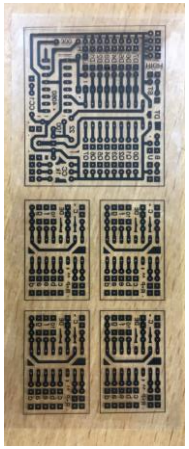
Here the inputs are located which allows for the Genie to perform various functions to control the Seven Segment displays and the Buzzer.

The 4026 microcontrollers are located here. These are controlled by the Genie 20 and allow for the seven segment displays to be incremented, reset and flash. This means that any number can be displayed on these seven segment displays using the Genie 20.

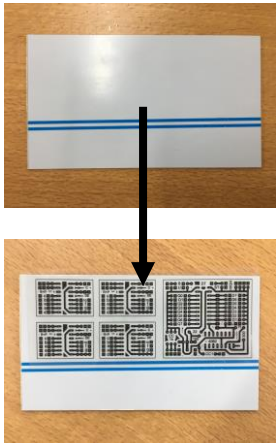
PCB Diary of Manufacture (Construction of PCB)

Introduction: On this page, I construct the physical PCB.



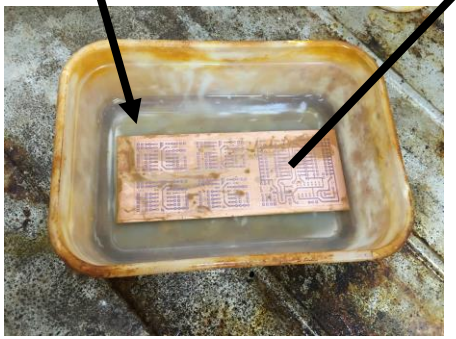


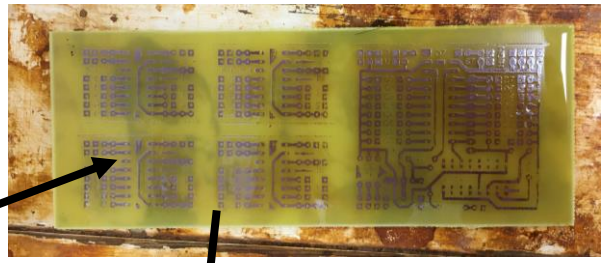
To construct a single-sided PCB, I must print the PCB design onto a acetate sheet. Afterwards, a copper board's protective layer is peeled off and the design on acetate is placed underneath the copper and placed into the UV light box.

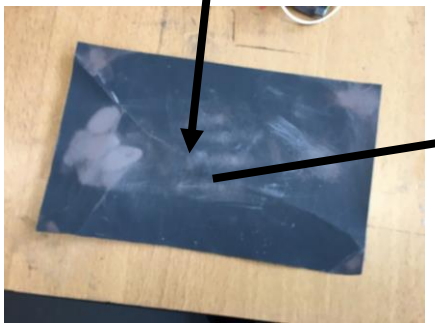


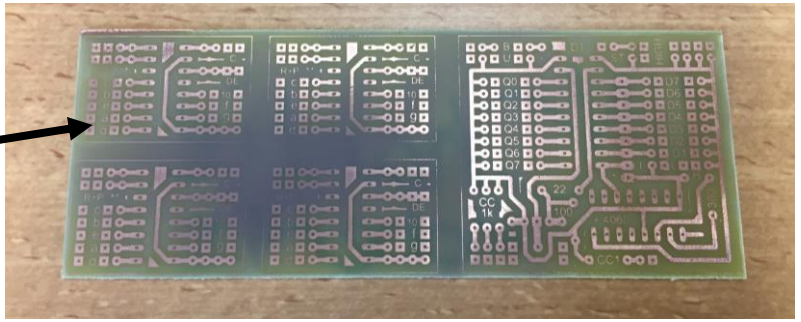
After the peeling the protective layer of the copper board and placing it in the UV light box, the acetate will block certain areas of the copper from exposure of UV light. This allows for a custom design to be imprinted onto one side of the copper board. The copper should stay in the box for 60-120 seconds. I have done 120 here.

After exposing the copper to UV light, The copper is put into a solution of 5cm3 of developer solution and 100cm3 of water. I must wear protective equipment when handling the developer solution as it is corrosive.









After the PCB has been fully etched, it is washed and dried. Next, sandpaper and wire wool is used to remove the thin top layer on plastic on the copper board, allowing for soldering to be easier later on in the project. This leaves a final working PCB in the picture below, ready for the holes to be drilled and the components to be soldered on.

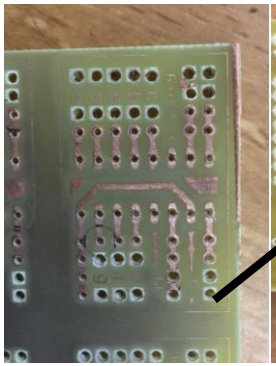
The photoresist solution dissolves the areas exposed to UV light so that the when the PCB is placed in the etching tank, the unwanted copper can be completely removed and etched. I had to complete the etch twice at 45℃, set to 40 seconds each etch. This allows enough time for the unwanted copper to dissolve away, leaving the desired copper for the components in the project.

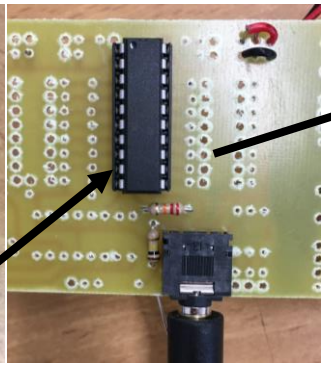
Summary

In summary, the PCB manufacture has been completed and now I have a fully functional PCB. This PCB is now ready to be drilled and then the components can be soldered onto the board.

PCB Diary of Manufacture (Drilling and Soldering Components)

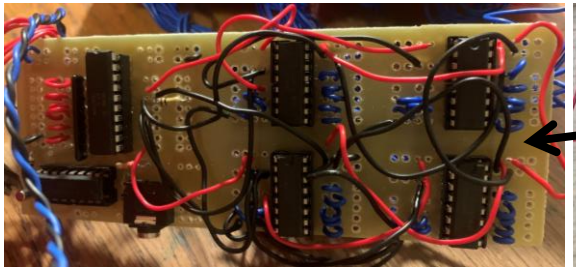
Introduction: On this page, I add components to the PCB.

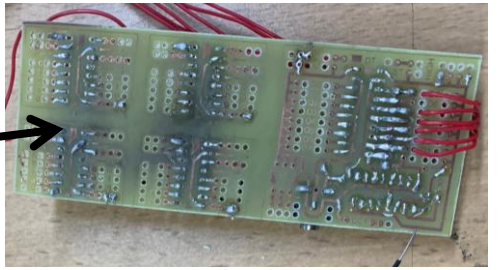




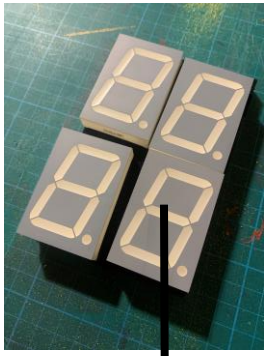
After constructing the PCB, I drilled the related holes for the components (strain holes which are larger for wires to permeate and solder holes for components to be soldered through.

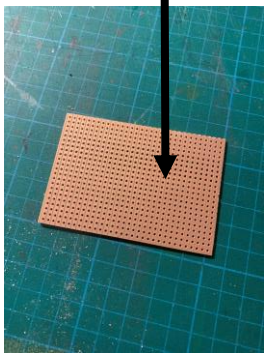
After all the holes were drilled, the first objective was to ensure the main microprocessor functions. Therefore these relevant components were soldered and the Genie successfully connected





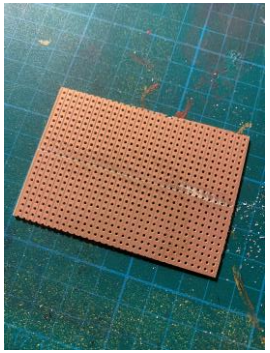
Next was to add all the subsequent microcontrollers and components whilst simultaneously debugging the multiple issues that I encountered. These mainly included sloppy soldering. However, another issue I encountered was with the seven segment displays that were ordered, they required a different amount of voltage to that of the main components of the PCB. This meant that a different voltage was required for the processing circuit board. Therefore a voltage regulator needed to be added to this circuit board. This problem is further explained in the next slide.

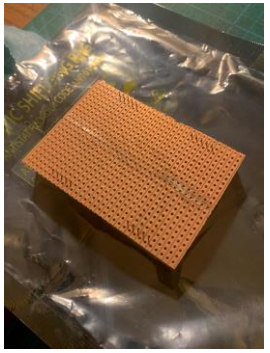


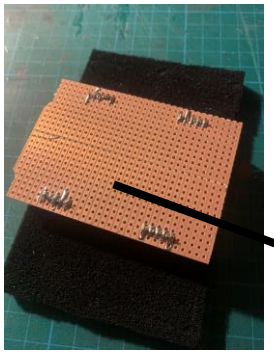


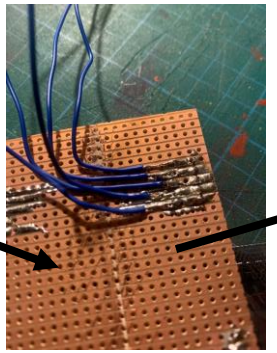
The first objective was to collect the seven segment displays and calculate where they will stand on the stripboard provided. Seven segment displays contain ten pins, yet some connect to decimal points which are not needed in the project and also multiple common cathodes pins. The stripboard also allows the displays to have a constant distance between them.

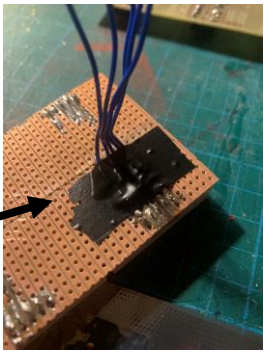
The next step was to cut a horizontal line in the strip board to separate the vertical strips into two, facilitating the addition of the ten pins of the seven segment displays. After doing this, the seven segment displays are placed into the relevant holes in the strip board and the soldering can commence. Notice two seven segment displays are placed onto one small rectangle of strip board which is the correct size, therefore saving valuable space inside the project.











After the seven segment displays were fitted, they were soldered into place, giving the object rigidity. Furthermore, this allowed for wires to be soldered onto the strips, extending the connection of the different segments, facilitating the connection to the 4026 microcontrollers. After these wires were soldered, a single piece of black electrical tape was fitted across the strips, securing the wires and further ensuring the wires do not collide and break the connection.

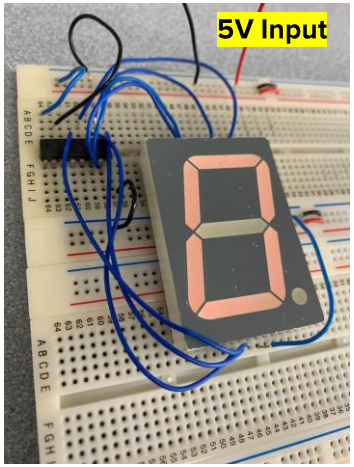
Summary

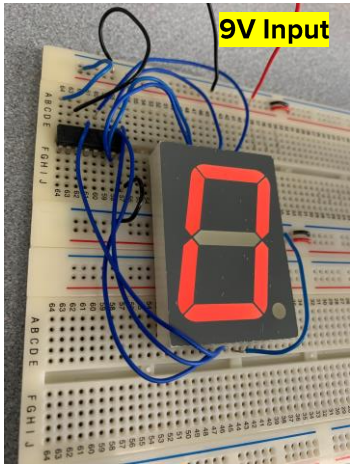
The Genie and all the relevant components have now been attached to the PCB, meaning they are now functional. This leaves the main display of Seven Segment Displays in which a problem occurred.

Resolving Seven Segment Displays (Diary of Manufacture)

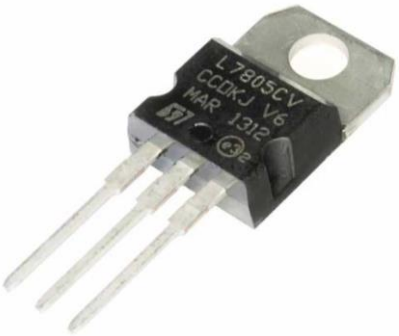
Introduction: On this page, I diagnose a power problem and debug it.

Before utilising every component, I conducted tests to ensure it functioned properly with a breadboard.

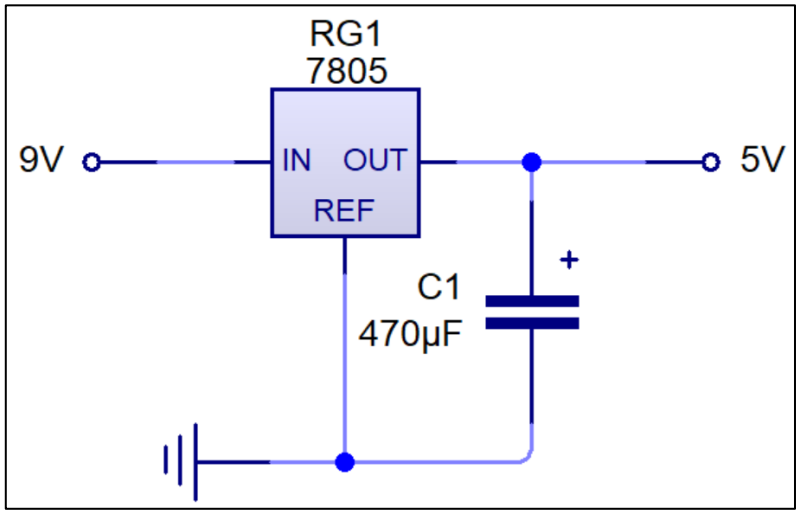




Whilst testing the newly ordered seven segment displays, the component ordered had a considerably higher power requirement than the rest. The two images above illustrate the problem: the 5V input is insufficient for both the 4026BE microcontroller and the seven segment displays. Therefore, an increased voltage was used and the brightness increased substantially. This meant that an increased voltage was needed to be used for the seven segments, yet the PCB board, containing a Genie 20 will fry under a voltage of over 5.5.

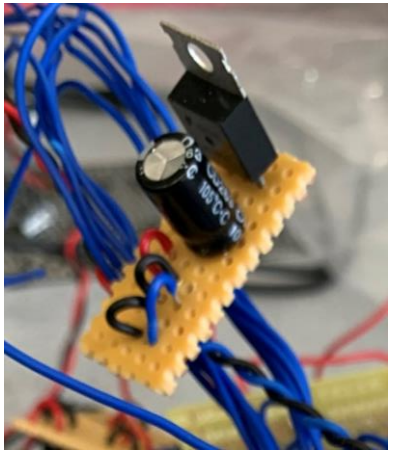


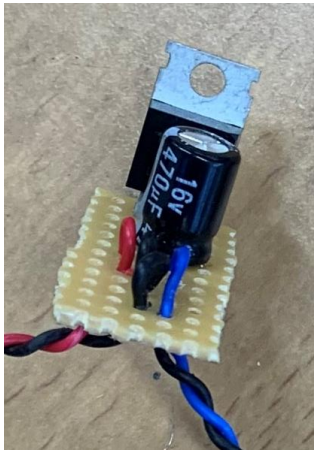
The solution was create two localised circuits with differing voltages using a voltage regulator. This circuit allows for one higher voltage to be input and reduces and smoothens the voltage to 5V. The specific component name is the LM7805.



Before making the new circuit, it has been simulated on circuitry software. Shown on the picture to the left, the circuit successfully converts a high voltage of 9V to 5V. The circuit also contains a capacitor which smoothens out the output of 5V, meaning one must be ordered in of 470 microfarads. As the simulation and research has been carried out on the circuit, it is now ready to be implemented to the project itself.

After ordering the relevant components, one small piece of strip board was utilised to ensure smallest possible size to facilitate it fitting in the final product. The red, blue and black wires shown in the image below show the input voltage of 9V which is carried by the red wire, and the out voltage which is carried in the blue wire (5V). Using a voltage regulator ensures only one power input is needed for the whole project, meaning one battery can power the whole circuit, this is the reason for not implementing a relay – which uses two circuits independent from each other (independent power supplies). This reduces complexity for the client when changing batteries in the final product, ensuring the product meets the rigorous specification points.





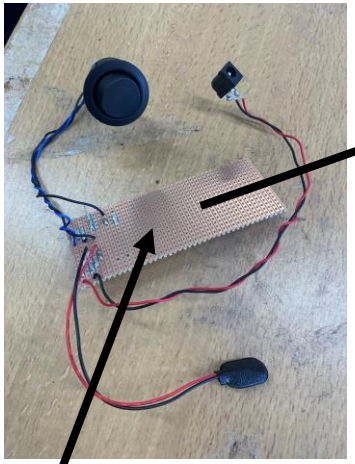
The voltage regulator has been completed and now will be attached to the final PCB where 5V is needed for all the components.

Summary

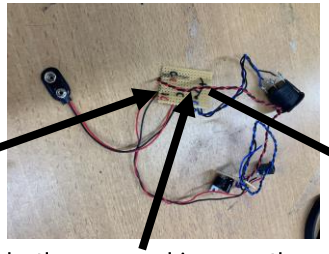
Overall, the problem of the seven segments needing more voltage was a difficult problem to solve, but I have found a viable solution which was feasible to implement. The voltage regulator circuit will now be concatenated to the rest of the circuit.

PCB Diary of Manufacture (Soldering + Completion)

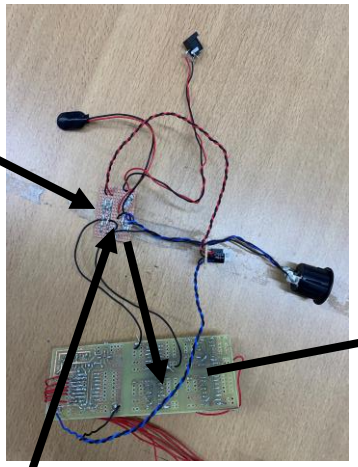
Introduction: On this page, I continue to construct the electrical element of the product.



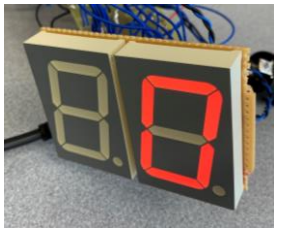
Here I am making amendments to the SPDT to work with the voltage regulator. This has meant I have had to construct this on a piece of strip board. This SPDT has been soldered in place so that it can switch between two different power supplies: battery and mains. Therefore you can see the battery snap, mains adapter and the switch in the first image.



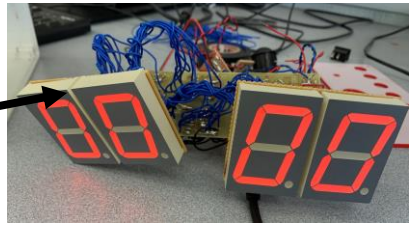
In the second image, the strip board has been shortened and the voltage regulator has been implemented into the circuit without issue.



On the third image, I introduce power to the processing area of the PCB (Genie) with 5 volts. This is connected from the voltage regulator in the blue wire – this is explained on the previous slide in which the brightness problem is addressed. To ensure that all of this worked, I connected the genie back to power and it was able to communicate, meaning five volts is successfully being transferred to the Genie.



After the success of the genie, the next thing to do was implementing the seven segment displays without error. This section of soldering was extremely finicky and therefore I approached with caution, only soldering one seven segment display at a time, ensuring they functioned correctly straight after soldering.

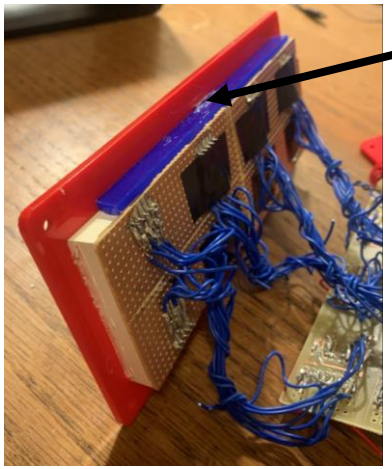


This process allowed me to complete the soldering relatively quickly with this quality control and ensured there were no problems with wires colliding and breaking the circuit.

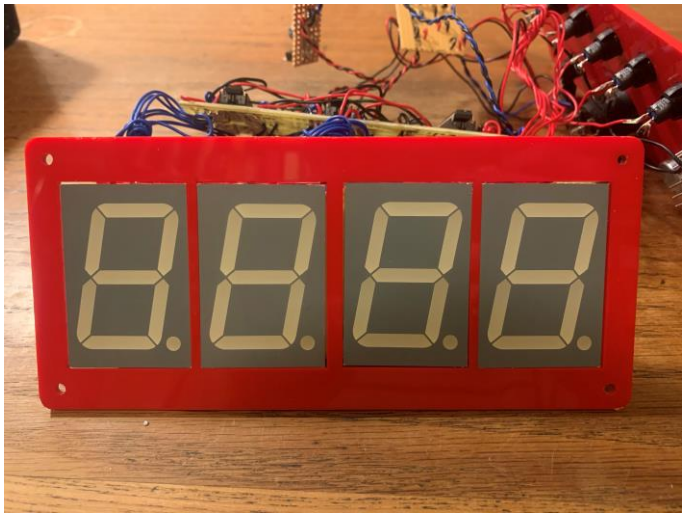
Summary

On this page I have successfully completed the final circuit. It resembles a scaled version of the breadboarding in which the client liked, the design has adapted on the feedback, i.e., a larger display. This means the completed circuit can now be implemented onto the final design.

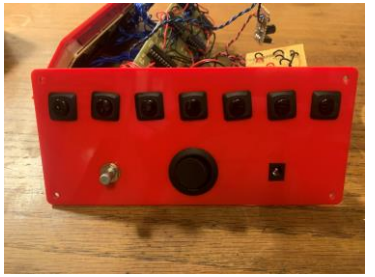
Joining Circuit and Design (AFTER CONSTRUCTION OF FINAL DESIGN):



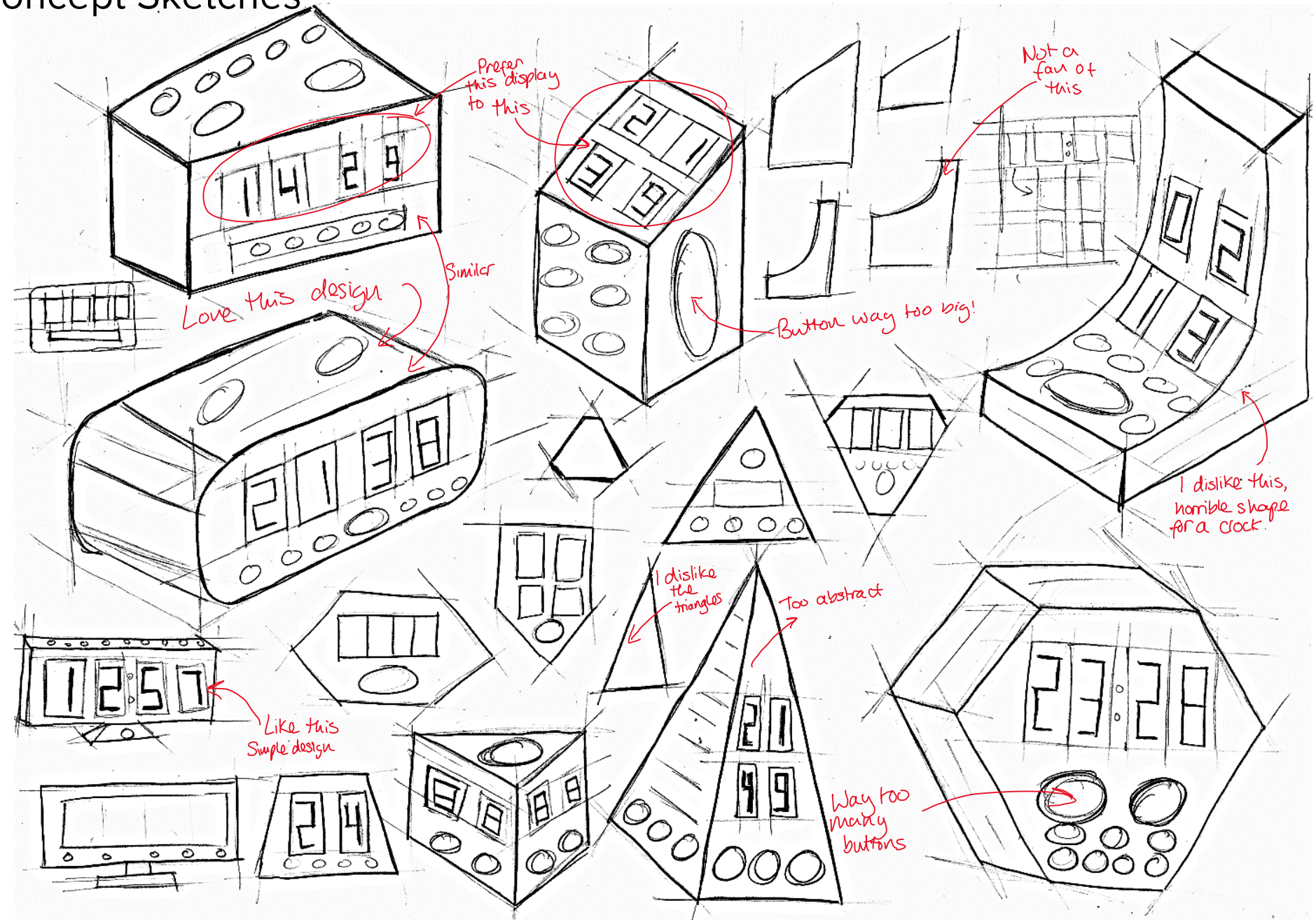
After the completion of the final exterior design, the PCB had to be permanently attached to the base of the front face and additionally the input components such as the buttons, which had to be attached to the back of the final product. To allow for the front face to have a flush face with the seven segment displays, a piece of acrylic was used to guide and secure the seven segments permanently in place, shown in the image to the left. The plastic was fused together using a hot glue gun. The image to the right is the result of the fusion: it looks excellent.



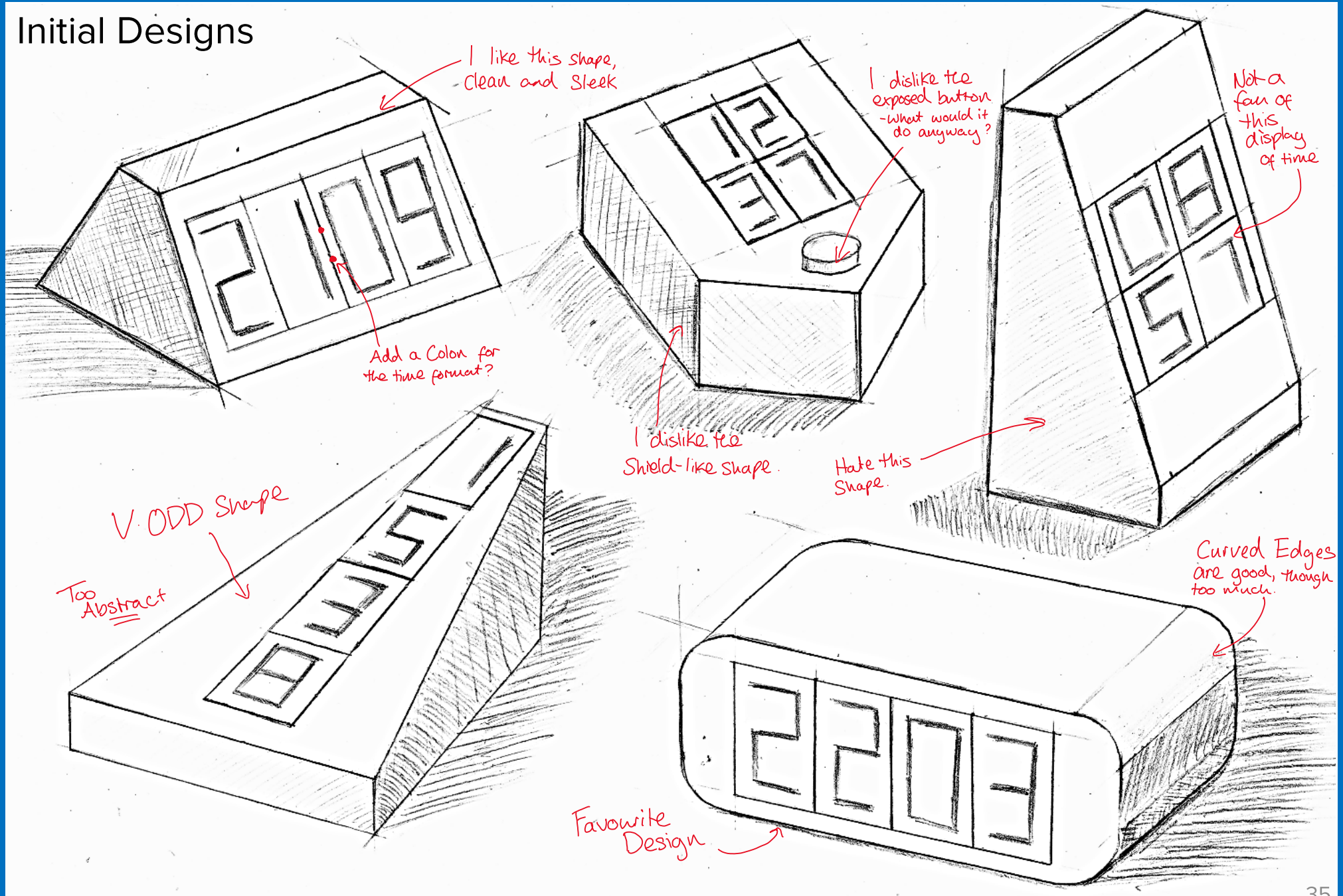
Below shows an image of the final back face in which the buttons, variable resistor and the power input have all been secured in place. It now looks very good.



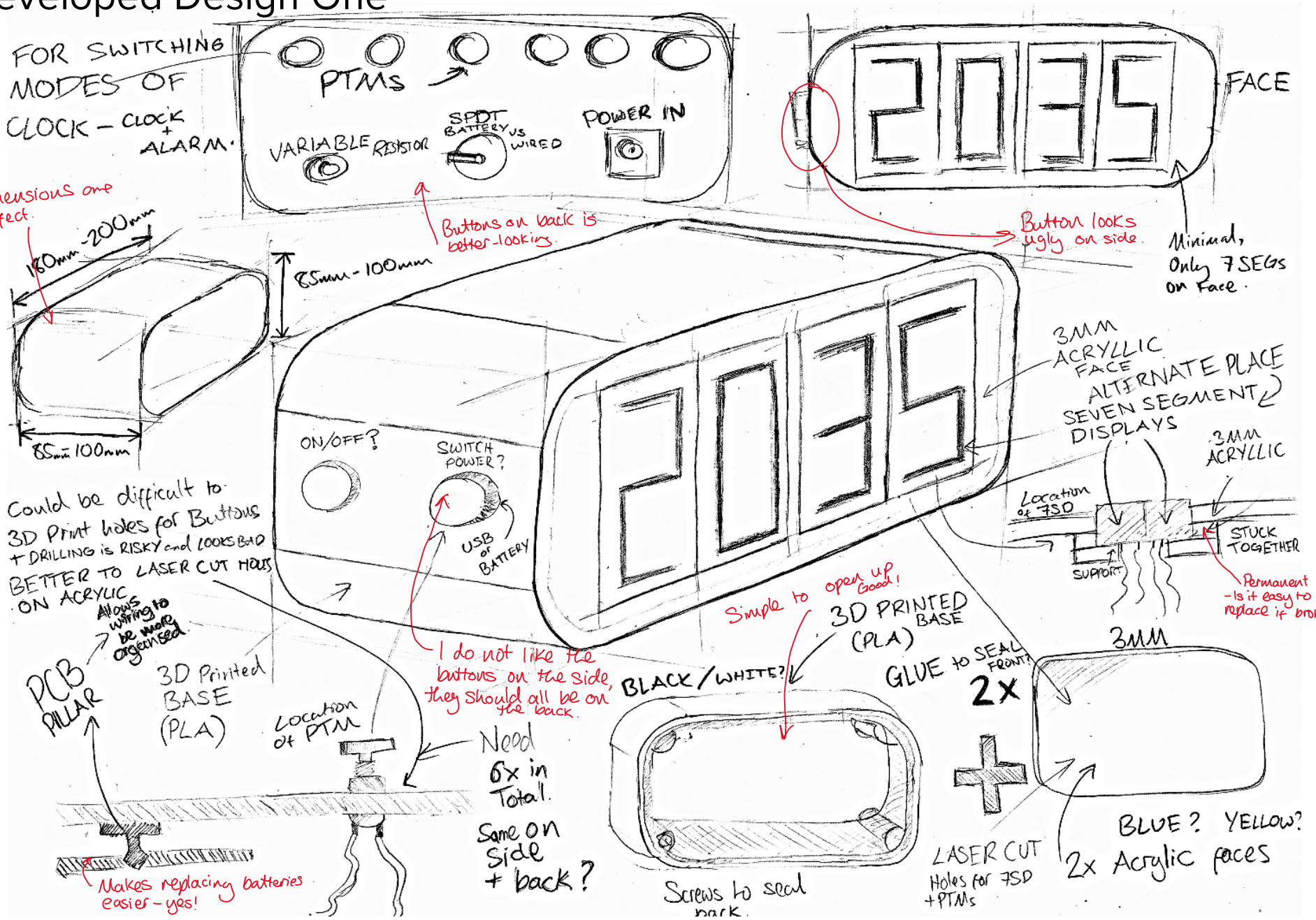
Concept Sketches



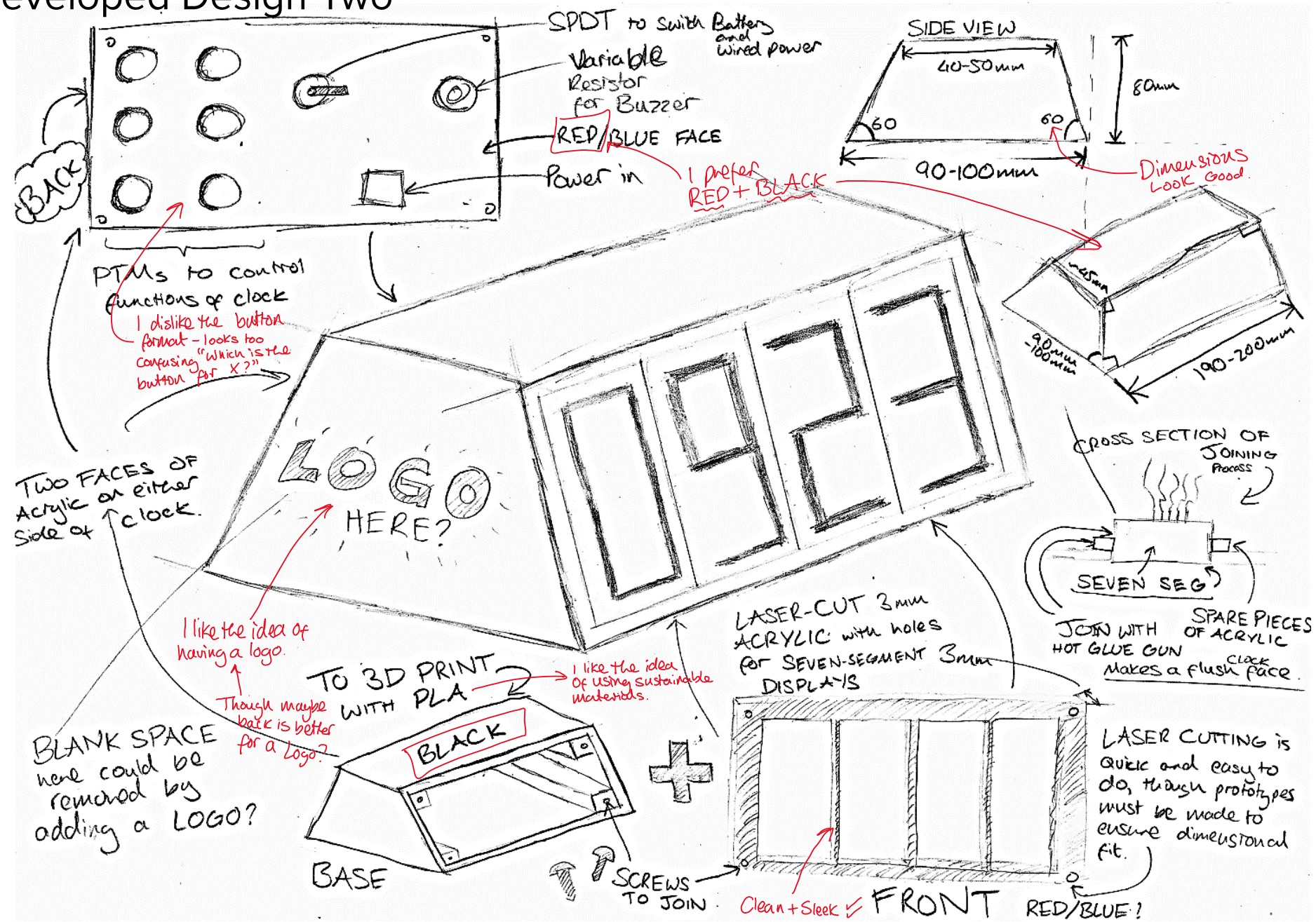
Initial Designs



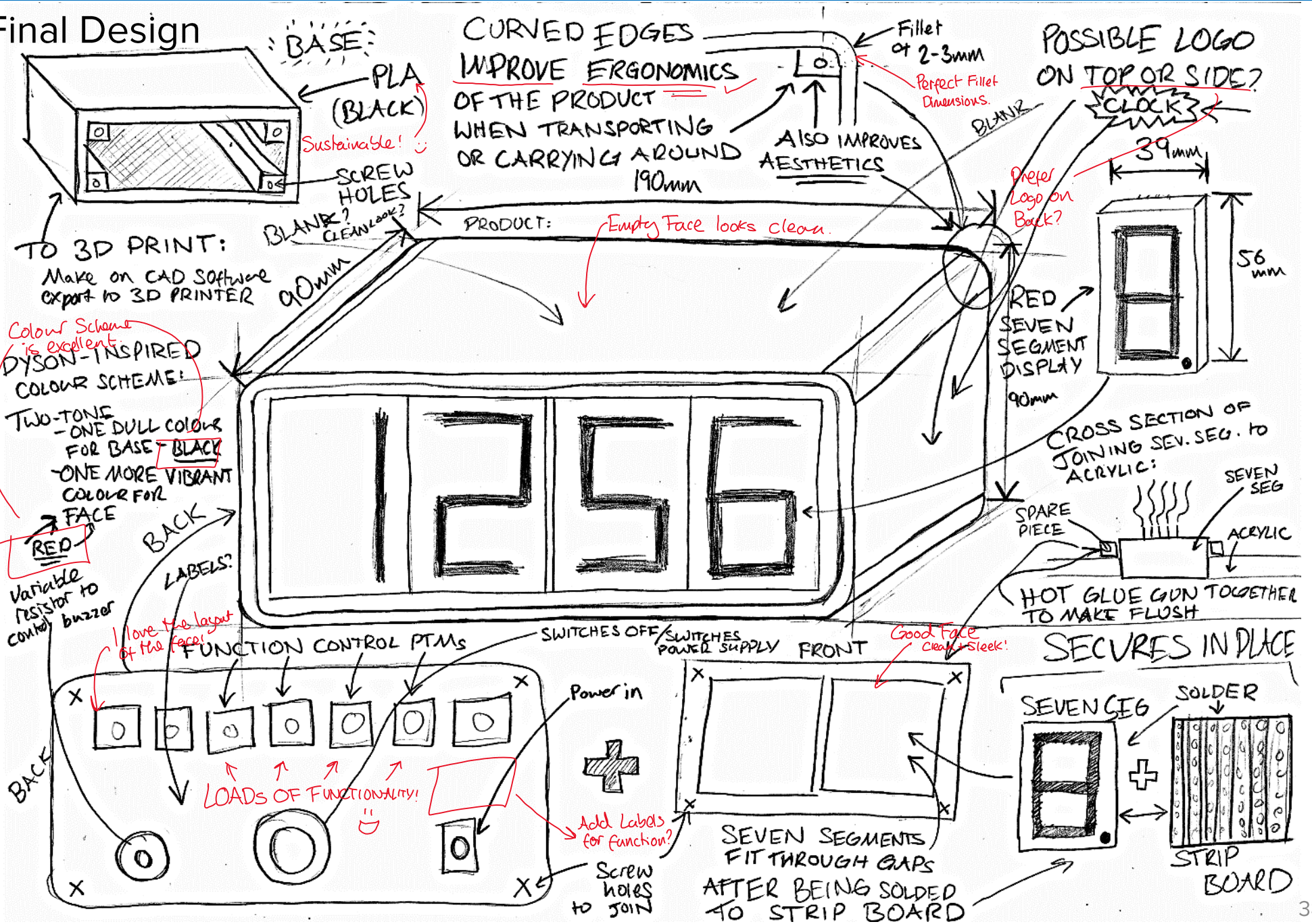
Developed Design One



Developed Design Two

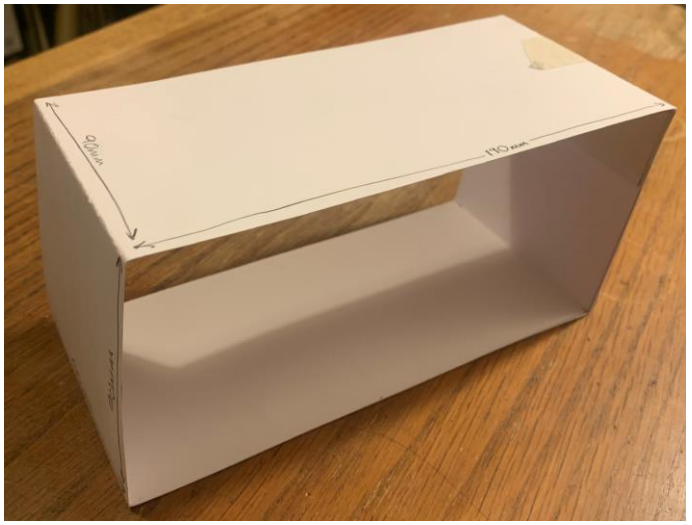


Final Design

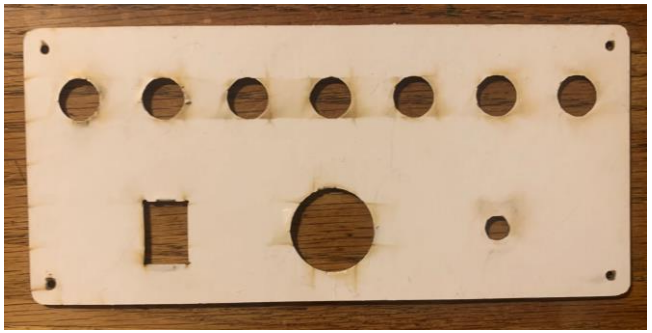


Prototyping (Base and Acrylic)

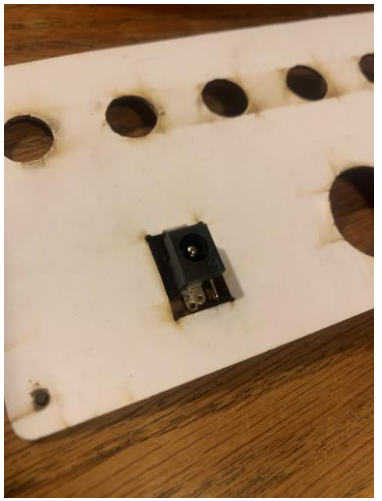
Introduction: On this page, I prototype the final exterior design and make draft models of them.



Before constructing a final design for the exterior of the product, a quick and feeble prototype was made from card and tape. Drawing from my client's feedback and questionnaire, I was able to conclude that the correct dimensions were that of 90mmx190mmx90mm, therefore these dimensions were used to make the prototype. A correctly scaled version of the final product was extremely useful as the PCB constructed previously was able to be used to consider if the dimensions had to be larger if the PCB and components would not fit. Despite this, the PCB and components were able to fit into the model and therefore were very likely to be able to fit in the final product.



After prototyping the base, the two faces (front and back) had to be constructed. This was arguably more difficult as the component's dimensions had to be measured very accurately. The datasheets were also used to ensure dimensional accuracy. The front face prototype, shown in the picture to the left, shows that all the seven segment displays fit smoothly on the front of the face. This face was made of card and not acrylic which would have saved money if the dimensions were not accurate. A similar process was used with the back face. The component holes were cut out with a laser cutter from a CAD file. This time, some components like the power plug was not the correct dimensions, despite some components like the variable resistor fitting in nicely. Therefore these corrections were made to the final printing of the acrylic faces.

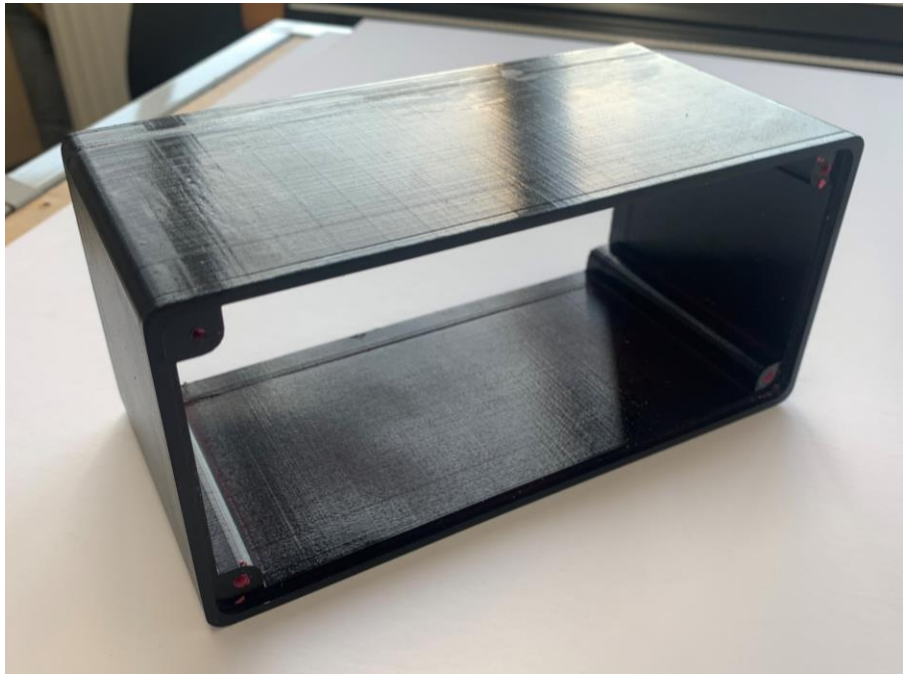


Summary

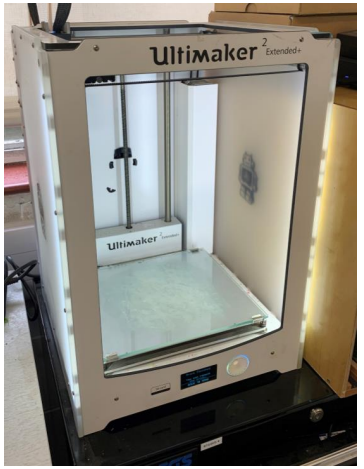
The base of the product was built, and dimensions were tested to ensure enough space for interior components. The CAD files of the faces were tested and later corrected with the correct sizes of the components.

Production Diary – CAD + 3D Printing

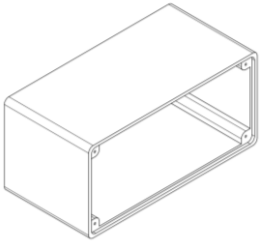
Introduction: On this page, I construct the exterior of the product.



After constructing a prototype, the rough dimensions can be used to create more precise dimensions for the actual final product. After client feedback, the final dimensions came to be 90x190x90mm after strenuous client feedback. The base of the product was constructed with CAD software (Inventor 2023) and was used to add the ergonomic fillets and tiny 3mm lips in which the acrylic faces would lie.

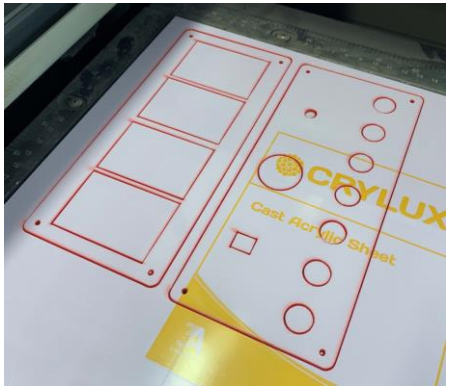


After the competition of the CAD, (orthographic drawing of CAD shown on the next page) The CAD file was sliced using CURA Ultimaker Software (for use with the Ultimaker 3D Printer). The CAD file was sliced and then converted into a GCODE format.



The GCODE was uploaded to an SD card and put in the printer. A layer of glue was applied to the base, ensuring easy removal when complete. The 3D print took a total of 14hrs. After finished, the product was sanded and sprayed with a UV resistant black paint.

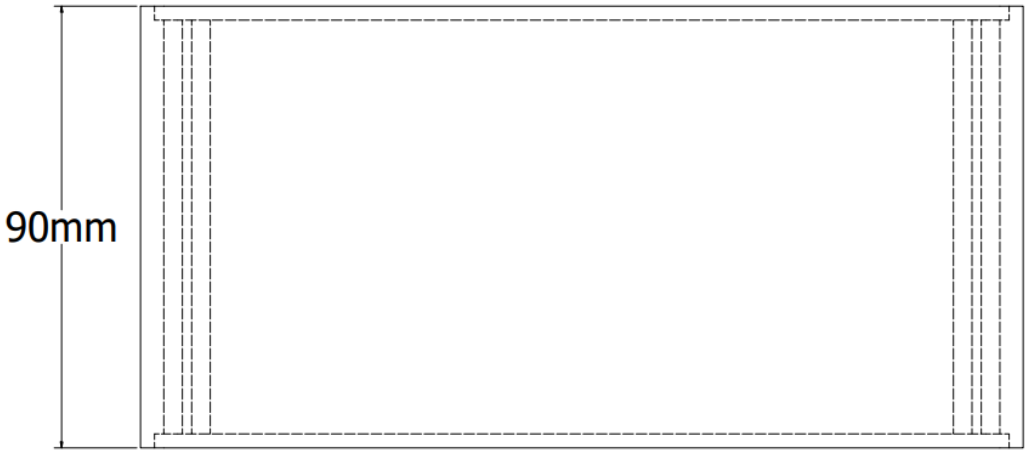
Whilst the 3D printer was printing, the laser cutting was being carried out. The CAD file from the previous page in which I completed prototyping, was used to create a new final design in which was laser cut onto acrylic. The dimensions of the component holes were tweaked to ensure total dimensional accuracy with the faces of the product. The CAD file was uploaded to the laser cutter and was set to Acrylic Cutting Mode. 2mins later, the final faces have been completed and ready to attach to the base.

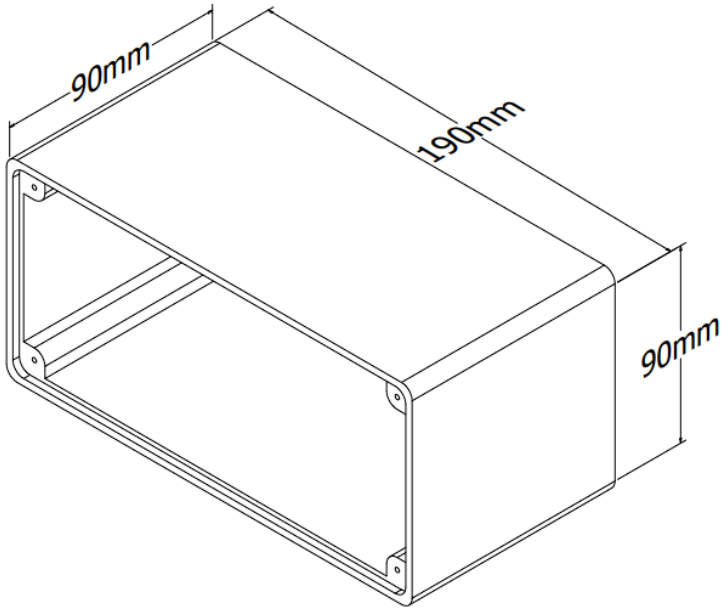


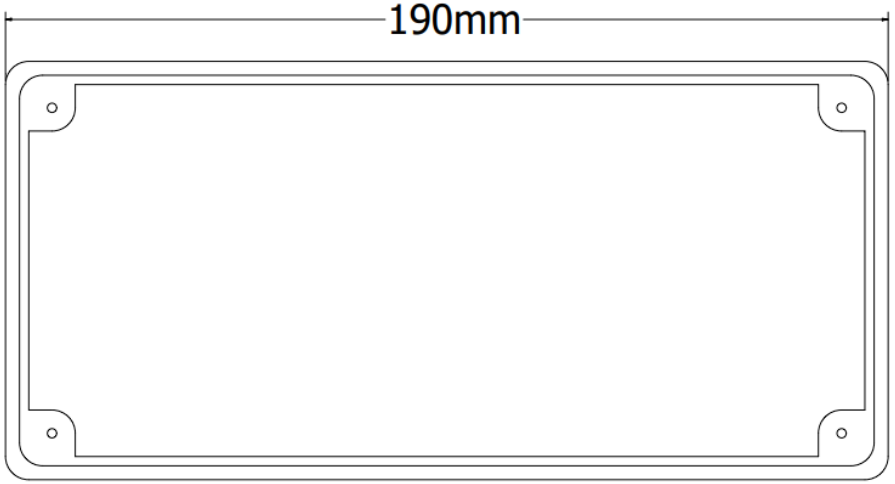
Summary

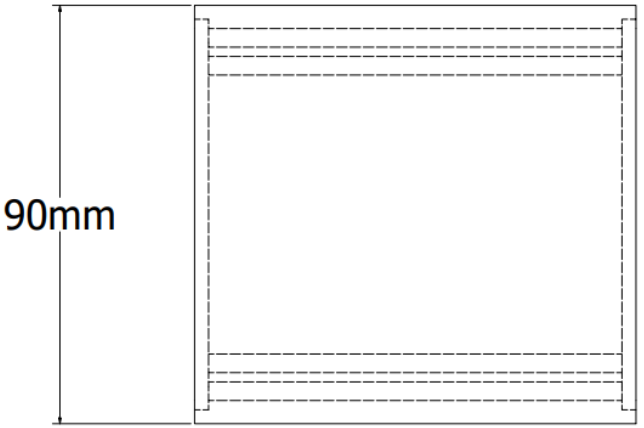
The faces and the base of the product have been created and are ready to be fused together. Now the various electrical components are ready to be attached to the faces of the product and the soldering can commence.

Orthographic Drawing of Base









List of Components

Introduction: On this page, I outline the list of components that were ordered and used in the final project..

Component	Quantity	Dimensions	Justification and Explanation	Hyperlink	Cost/ Component	Total Cost
3D Printed Base	1	90x190x90mm	The base is needed to hold the product together.	N/A	N/A	N/A
Acrylic Face	2	180x3x83mm	The faces are red and add aesthetics	N/A	N/A	N/A
Screws	8	Ø2mm	Secures the face to the base	https://www.amazon.co.uk/3-5x30mm-Multi-Purpose-Roundhead-Screws-Woodscrews/dp/B09XZ1MGZ2/	£0.08	£0.64
Seven Segment Display	4	39mmX56mm	Allows for the client to see the time.	https://www.rapidonline.com/kingbright-sc18-11ewa-45mm-high-efficiency-red-led-display-cathode-57-0525	£3.08	£12.32
PTMs	7	Ø13mm	Allows for client to interact with product	https://www.rapidonline.com/sci-r13-510a-black-push-button-switch-push-to-make-78-1522	£0.65	£4.55
Variable Resistor	1	Ø5mm	Controls buzzer amplitude	https://www.rapidonline.com/alps-402152-10k-lin-with-detent-dual-unit-horizontal-stereo-potentiometer-55-0301	£1.56	£1.56
DC Power Socket	1	10mmX11mm	Mains electricity can power the device	https://www.rapidonline.com/switchcraft-rapc722x-dc-power-socket-pcb-mount-2-1mm-20-0960	£0.940	£0.94
SPDT	1	Ø30mm	Switches from mains to battery power	https://www.rapidonline.com/sci-r13-223d-black-rocker-switch-3p-spdt-on-off-on-panel-mount-round-10a-250v-75-0056	£1.50	£1.50
Buzzer	1	Ø10mm	Alarm for Alarm clock	https://www.rapidonline.com/r-tech-350905-5v-miniature-electronic-buzzer-35-0905	£0.760	£0.76
Wire	≈5m	--	Used to connect components	https://www.rapidonline.com/rapid-gw011535-10-0-1mm-equipment-wire-red-100m-01-1535	£0.10/m	£0.50
Genie 20 IC	1	20 pin DIL	Orchestrates components (process)	https://www.rapidonline.com/genie-20-microcontroller-version-2-13-6043	£2.50	£2.50
IC4026BE	4	16 pin DIL	Increments Seven Segments	https://www.rapidonline.com/texas-instruments-cd4026be-decade-counter-7seg-out-83-0359	£0.379	£1.52
IC4060BE	1	16 pin DIL	Divides oscillation down to 1Hz	https://www.rapidonline.com/texas-instruments-cd4060be-14stage-ripple-carrybin-ctr-dil-83-0390	£0.310	£0.31
Crystal Oscillator	1	Ø1-2mm	Oscillates 32KHz for clock	https://tinkersphere.com/components/2806-32khz-crystal.html	£0.80	£0.80
Genie Download Socket	1	12x11x5mm	Allows for communication to computer	https://www.rapidonline.com/truconnect-pcb-jack-socket-stereo-3-5mm-20-0137	£0.256	£0.26
8 SIL 10k Resistor	1	8 Pin SIL	Prevents floating voltage	https://www.rapidonline.com/Catalogue/Search?Query=8%20Sil%2010k%20resistor&Size=20	£0.275	£0.28
Resistors (10k, 22k, 100k)	5	7mmxØ2mm	Prevents floating voltage and ensures communication with a computer.	https://www.rapidonline.com/royal-ohm-cfr01sj0102a10-1k-5-1w-axial-carbon-film-resistor-73-0069	£0.024	£0.12
Voltage Regulator	1	Same as 3pin SIL	Converts 9V to 5V	https://www.rapidonline.com/st-l7805cv-5v-1a-voltage-regulator-47-3290	£0.368	£0.37
Capacitor (470µF)	1	Ø3-5mm	Smoothens out Voltage from regulator	https://www.rapidonline.com/suntan-ts13dj1v471msb0b0r-470uf-35v-low-imp-electrolytic-capacitor-11-2927	£0.528	£0.53
TOTAL						**£29.44**

Final Product

Intro: On this page, I have completed the final product and now showcase the various aesthetics and functions of the product.

Front Face
The Front of the product consists of few details. The sleek and clean design draws the user's eyes to the current time displayed by the seven segment displays.

Dimensions and Materials
The device is a medium size for a clock, coming in at a size of 190mmX90mmX90mm. Each seven-segment display is 39mmX56mm. The Product is made of PLA (Base) and Acrylic (faces). These are non-toxic and sustainable materials.

Detachable Base
The exterior of the product is made of three parts, the base and two faces which are attached via screws. The two faces are detachable which allows for the battery inside to be changed. (Also allows for additional debugging if necessary)

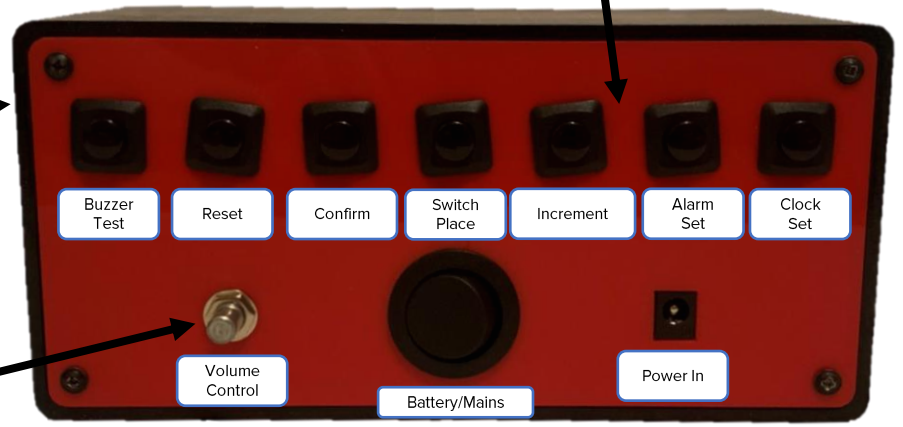
ADJUSTABLE ALARM CLOCK

Accuracy
The Device consists of four seven segment displays which work together to form an accurate time. The product uses a 32kHz crystal oscillator which accurately allows the device to constantly tell the correct time.

Weight
Despite other clocks on the market weighing over a kilogram, this product only weighs 500g. This makes it perfect for transporting and moving around.

Power
This device features a toggleable power supply. For when you are at a desk, there is a convenient input for a mains connection. For when you want to relax in the garden, battery power can be switched to using the central switch. This central switch can additionally turn the device off.

Clock and Alarm Set Modes
Not only does the device contain a mode for setting the clock, but it also includes a separate mode for setting an alarm so that when the set time is reached, it will notify the client to get to his meeting.



Back Face
The back face consists of many inputs. The top few PTMs, control the basic functions of the clock, like clock set mode, increment, reset and test alarm. The Variable resistor controls the volume of the buzzer. The bottom central switch, toggles the power supply – battery or mains.

QR CODE FOR VIDEO

Buzzer
The alarm in this product uses a loud buzzer. The amplitude of the buzzer can be changed using the variable resistor. One button allows for the user to test the buzzer for the correct volume.

Summary
The product has now been completed and fulfils many of the specification points. The product function fully as intended and planned.

Client Feedback

Introduction: On this page, I ask the client their thoughts and feedback on the final product.

On first impressions, the product is fantastic. It performs the functions of providing a source of time 24hr a day as well as implementing a sleek and intuitive interface in which allows myself to create alarms and keep UpToDate on all my very important meetings. The product aesthetically looks very good. It has a desirable colour scheme, similar to that of many Dyson products where a combination of a dull colour and a vibrant colour is used, which is very effective and eye-catching.

In my opinion i think that the screws are not needed on the front if only the back is needed to be detachable.

I think that the seven segment displays are a fantastic size and look very striking.

This edge of the product is sharp, consider adding a smaller fillet to ensure excellent ergonomics.

It was quite confusing noting which button did what on the back face, it would be better if the buttons were labelled.

There is a lot of blank space on the side and the top, although I really enjoy sleek and clean products, I think it would be beneficial to add a graphic or a logo on one of these faces.

Summary

In summary, the product can be improved by adding a logo, removing unnecessary screws and filleting more edges.

Client Questionnaire

Q: Has the product successfully performed the function of telling the time?

A: Yes, definitely! The product is able to tell the time for the entire day for weeks!

Q: The product has the ability of switching the power source from mains to battery, do you believe that the switch is easy to use and the correct way of toggling them?

A: The way of switching between battery and mains power is definitely extremely easy. The SPDT here is the best way of going about this.

Q: With your first impressions of the product, do you believe that the product could last for three years?

A: Although it might be difficult to tell now, the build is very rigid and secure. It does seem it would be resilient enough to survive for three years at least.

Q: When holding the product, does the device have an ergonomic feel on the edges?

A: On the edges of the product, there are fillets, which ensure comfort when holding the product. However, these smooth edges are not present on the front face of the product. This would be a potential improvement.

Q: Would you say that the product has a vibrant colour/finish?

A: The product is definitely very striking with the two-tone colour scheme. This is reminiscent of the palette of Dyson products, where a dull colour is combined with a more vibrant colour.

Q: Are you happy with the way in which the buzzer functions, e.g. Test buzzer button and variable resistor and do they work as you intended?

A: The Alarm function as a whole works very well. When the time reaches the alarm, the buzzer rings and the lights flicker. The variable resistor helps myself to configure the correct amplitude for the buzzer and the test buzzer button allows for more frequent testing of the buzzer.

Q: Do you think that the device has too many buttons?

A: The product definitely is not short of buttons, but considering the vast functionality of the product, the amount of buttons is justified and therefore there is the correct number.

Focus Group/Survey

Introduction: On this page, I ask a focus group subjective questions in order to meet a specification point.

Here I have gathered a Focus group to test the more subjective specification points for the product. The focus group of three have been selected on the basis that they are of a similar demographic to my client. This means they will be able to give more compelling feedback towards the final product.

Matt Fletcher	Freddie West	Barry Smith
Matt is 44 and currently has an occupation in finance and business, similar to my client's occupation. However, Matt has slightly differing interests, being Geography.	Freddie is 31 and has an occupation in a tech conglomerate as a software engineer. He has a similar taste to my client, where he like modern and sleek designs.	Barry is 53 and works in construction. He is a similar age to my client. Barry additionally has similar interests to the client, which is History and Television.

On the first impressions from the focus group, the feedback has been overwhelmingly positive. As with the client feedback, It performs the functions of providing the time for the whole day, whilst giving the user a intuitive GUI for setting alarms and the time. The group says the product aesthetically looks very good. The two-tone colour scheme, strikes the group with interest and intrigue. Barry Smith has noted that the product may look better with a different colour to red. He suggests another colour like blue, yellow or green. Matt and Freddie have also brought up the colour mismatch between the base of the product (black) and the seven segment displays (grey outline). This should be fixed for the future commercialised product.

Summary

In summary, the product can be improved by adding a Logo, changing the background colour of the displays and labelling the product's buttons,

Group Questionnaire (General Summary)

Q: Do you believe the product has successfully performed the function of telling the time?

A: Every single person said that the product successfully fulfils this function.

Q: Do you think the product should have a logo?

A: Freddie believed that the product did not need a logo, given his modern and sleek taste. However, Matt and Barry did not agree and believed a logo or graphic would definitely improve aesthetics.

Q: Do you like the colour of the product?

A: Matt and Freddie liked the colour red combined with the darker base. Barry contrastingly claimed that either blue or green would look better than the red.

Q: Are the dimensions correct for your needs?

A: The group unanimously agreed that the size of this product was medium and the product was a good size.

Q: Is the device Comfortable to Hold?

A: Freddie and Barry claimed that the device was very comfortable to hold, yet Matt said that the device should have fillets on the front, to account for greater comfort when wielding the device.

Q: Can you change the batteries of the device in under 2mins?

A: The group were given batteries and a screwdriver to complete this task. Matt managed a time of 80seconds, Freddie did it in 68seconds and Barry completed it in 93seconds. These are all under 120seconds.

Q: Do you believe that the Buzzer is loud enough to be noticed in a room?

A: The group used the test buzzer button and they were all pleasantly surprised with the amplitude of the buzzer. The buzzer is loud enough

Q: How can this product be improved?

A: Overall, the general consensus was that a logo should be added to the side of the product, the colour mismatch between the seven segment displays should be fixed and finally, possibly the most frustrating part of the product was the need for labels on the back of the face.

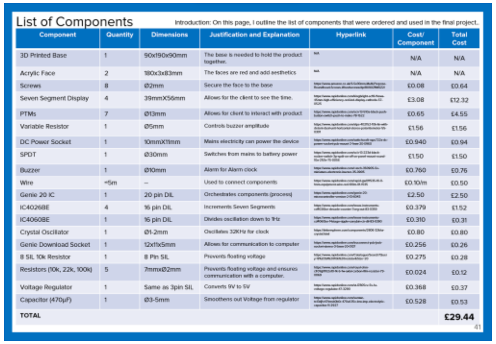
Objective Tests

Introduction: On this page, I test the final product, noting if it has met the measurable specification points.

Here I test the dimensions of the product with a ruler so that it fits within 300x150x300mm. The dimensions of the product are 90x190x90mm. Therefore it meets specification point 2.

Here I test the weight of the product using a weighing scale so that it weighs less than 1 kilogram. The product weights around 500g, meaning it meets specification point 3.

Here I ensure the product is able to draw power from mains as well as the battery. Specification point 4 has been met as the power can be switched easily with the large switch on the back of the product.



List of Components

Introduction: On this page, I outline the list of components that were ordered and used in the final project.

Component	Quantity	Dimensions	Justification and Explanation	Hyperlink	Cost/ Component	Total Cost
3D Printed Base	1	90x190x90mm	The base is needed to hold the product together.	N/A	N/A	N/A
Acrylic Face	2	180x3x83mm	The faces are red and add aesthetics	N/A	N/A	N/A
Screws	8	Ø2mm	Secure the face to the base	[illegible]	£0.08	£0.64
Seven Segment Display	4	39mmX56mm	Allows for the client to see the time.	[illegible]	£3.08	£12.32
PTMs	7	Ø13mm	Allows for client to interact with product	[illegible]	£0.65	£4.55
Variable Resistor	1	Ø5mm	Controls buzzer amplitude	[illegible]	£1.56	£1.56
DC Power Socket	1	10mmX11mm	Mains electricity can power the device	[illegible]	£0.940	£0.94
SPDT	1	Ø30mm	Switches from mains to battery power	[illegible]	£1.50	£1.50
Buzzer	1	Ø10mm	Alarm for Alarm clock	[illegible]	£0.760	£0.76
Wire	~5m	--	Used to connect components	[illegible]	£0.10/m	£0.50
Genie 20 IC	1	20 pin DIL	Orchestrates components (process)	[illegible]	£2.50	£2.50
IC4026BE	4	16 pin DIL	Increments Seven Segments	[illegible]	£0.379	£1.52
IC4060BE	1	16 pin DIL	Divides oscillation down to 1Hz	[illegible]	£0.310	£0.31
Crystal Oscillator	1	Ø1-2mm	Oscillates 32KHz for clock	[illegible]	£0.80	£0.80
Genie Download Socket	1	12x11x5mm	Allows for communication to computer	[illegible]	£0.256	£0.26
8 SIL 10k Resistor	1	8 Pin SIL	Prevents floating voltage	[illegible]	£0.275	£0.28
Resistors (10k, 22k, 100k)	5	7mmxØ2mm	Prevents floating voltage and ensures communication with a computer.	[illegible]	£0.024	£0.12
Voltage Regulator	1	Same as 3pin SIL	Converts 9V to 5V	[illegible]	£0.368	£0.37
Capacitor (470μF)	1	Ø3-5mm	Smoothens out Voltage from regulator	[illegible]	£0.528	£0.53
TOTAL						£29.44

41

Specification point 5 states that the product should cost under £30. With the List of components page, I have ensured that the product has costed under £30.

With specification point 6 and 7, the product should be made with sustainable and non-toxic materials. These specification points have been met as the base is made of PLA and the faces are made of acrylic. These are sustainable and non-toxic plastics.

Specification point 12 states that the product should have an accuracy so that the time is within a minute over one week. This has been met as over a seven day period of no interaction, the clock was accurate to the exact minute. It has met specification point 12.

For specification point 13 and 15, the product's display should be able to be seen from at least three meters away and buzzer should be heard from this distance. The picture shown above has been taken around 3.5 meters away and the display and sound is heard.

In Specification point 19, it states that the product should be resistant to UV light as the product will be used outside. The base of the product was spray painted with UV-resistant paint, meeting the specification point.

Summary
This page has showcased the objective specification, which are measurable specification points. Due to them being objective, they are easy to test for. They have all now been confirmed and met.

Evaluation against Specification

Introduction: On this page, I evaluate the product against the specification.

No.	Specification Point	Measurement	Evidence and Conclusion	Objective/ Subjective
1	The product must work and function as a clock.	When finished, I will test the product to make sure it functions like a clock: it is able to tell the time.	On the final product page and the client feedback page, it states that the product has achieved the function of the clock. The Client additionally enjoys the presentation of the GUI and other processes of the clock.	Subjective
2	The product should be no larger than 300mm by 150mm by 300mm.	When finished, the product will be measured and will confine to these dimensions, otherwise will be reworked.	On the final product page, the dimensions of the product was noted to be 190mmX90mmX90mm. This is well below the maximum dimensions said in the site study.	Objective
3	The product should weigh less than 1 kilogram.	When finished, I will weigh the product and make sure it confines to the weight of under 1 kilogram.	On the objective testing page, the weight of the product was measured. This was measured to be significantly less than 1kg, it was 500g.	Objective
4	The device should be both battery and mains powered.	When finished, the product will be able to switch between mains and Battery powered.	On the objective testing page and the final product page, the device is shown to successfully be able to switch from mains power to battery power.	Subjective
5	The product must cost under £30.	When complete, I will sum the cost to be below £30.	On the list of components page, the total cost sums to be £29.44, which is less than £30.	Objective
6	The product must be constructed out of sustainable materials or plastics.	When construction the case/exterior of the product, I will ensure I use a sustainable plastic like PLA to make the casing.	On the final product page, the materials list the use of PLA for the base of the product and Acrylic for the faces of the product. These materials are sustainable plastics, providing little harm to the environment.	Objective
7	The product must use non-toxic materials.	When deciding on the materials of the product, I will conduct secondary research to guarantee the material is made of non-toxic materials.	On the final product page, the materials list the use of PLA for the base of the product and Acrylic for the faces of the product. These materials are non-toxic materials so that minimal harm is done to those who use the product.	Objective
8	The product must be durable and be able to last for 3 years at least.	When deciding on the materials of the product, I will conduct more secondary research to guarantee materials are durable and will last for years to come.	On the client feedback page, the user outlined how it can be difficult to calculate the lifespan of a product with little time. Therefore this specification point has been classed as subjective as the client expressed confidence in the build of the product as it was strong and secure when he tested the product.	Subjective

Evaluation against Specification

No.	Specification Point	Measurement	Evidence and Conclusion	Objective/ Subjective
9	The product must have a vibrant colour/finish.	When choosing the colour for the device, I will present a sketched version of the product for the client to choose the colour.	On the group questionnaire, the users outlined that they liked the colour of the product. On the client questionnaire, the client expressed his love for the aesthetics of the product (colour/finish).	Subjective
10	The product will be manufactured only once.	When designing, I will ensure that I only make one clock for my client.	On the final product page, the product has only been manufactured once, meaning the specification point has been met.	Objective
11	The device must have curved edges allowing for an ergonomic feel.	When designing the product, I will add fillets to edges and minimise sharp edges to be put on the product.	When asking the group on the focus group page, they expressed their interest in the ergonomics of the product. This was done by using fillets on the edges of the product.	Subjective
12	The clock must be within one minute of accuracy over a week.	After one week, I will measure the clock time and will make sure that the clock is within one minute.	On the objective testing page, the product was tested to ensure the clock's accuracy is totally accurate over a seven day period.	Objective
13	The clock must be clearly visible from up-to three meters away.	After making the product, I will measure the furthest distance that the clock can be from the client ensuring that the client can read the clock from over three meters away.	On the objective testing page, the product was photographed from over three meters away and the product's display was legible. This means the specification point has been met.	Objective
14	The clock should have no more than ten buttons.	When designing the circuit, I will make sure the circuit has no more than ten buttons/switches.	On the final product page, the final product has a total of 10 buttons. This is the maximum said for the specification point, meaning the specification point has been met.	Objective
15	The buzzer in the alarm should be able to be heard from at least three meters away and preferably through a door.	After making the product, I will measure the furthest distance that the clock can be heard from the client ensuring that the client can hear the clock from over three meters away.	On the objective testing page, the product placed a distance of 3.5m away and the product's buzzer was audible. This means the specification point has been met.	Objective
16	The device should function as an Alarm (make sounds and flicker at a time).	When finished, I will build a focus group to test the functionality of the clock, meaning they will give a conclusion to whether it meets the objective.	After the construction of the device, the client and focus group said that the product had successfully met the specification point as the product is able to set and display alarms very well.	Subjective

Evaluation against Specification

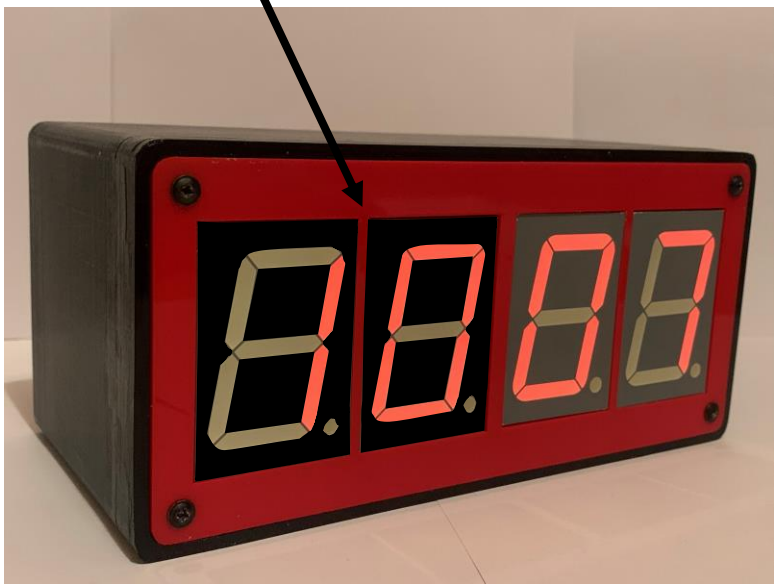
No.	Specification Point	Measurement	Evidence and Conclusion	Objective/ Subjective
17	The clock should have a test buzzer button, letting the user to set the right volume.	At the end of the project, I will test the button and ensure that the buzzer rings as intended.	On the final product page, I outline the functions of the buttons. One of the buttons outlined is to test the loudness of the buzzer, therefore meeting the specification point.	Objective
18	The product should have an adjustable volume.	After the buzzer has been implemented, I will use a decibel meter to ensure that it is loud enough.	On the final product page, I outline the functions of the input devices on the rear of the device. One of the input components is the variable resistor which changes the amplitude of the buzzer's soundwave, therefore meeting the specification point.	Objective
19	The product should be resistant to UV radiation (when product is used outdoors).	After the product is constructed I will leave the product in the sun for 8hrs, I will then check for damage to electronic components and the base.	On the objective testing page, I explain that the specification point has been met as the product was sprayed with a UV resistant paint after the base was 3D printed. This is also explained in the Diary of Manufacture on the Base page.	Objective
20	The battery must be easily replaceable (under 2mins to replace batteries).	After the construction of the product I will gather a focus group and check to see if they can change the battery in under 2mins.	On the focus group page, the group was asked to change the batteries of the product. Their times were recorded and all of them came out to be under 120seconds.	Subjective
21	The battery should be able to last 24hrs.	After completion of the product, I will measure how long the battery lasts. confirming it is over 24hrs.	On the objective testing page, a new battery was inserted into the product and the device was tested to make sure that it lasted over 24hrs. It met the specification point.	Objective
22	The program should be easy and quick to set times and alarms.	After the construction of the product I will gather a focus group and measure their own opinions (subjective) on how easy the product is to use.	On the client feedback page, the client outlined his love for the clock and alarm setting system. He said that the system was very quick, therefore meeting this specification point.	Subjective
23	The program must indicate when setting the time differently to when setting an alarm.	After the construction of the product I will gather a focus group and measure their own opinions (subjective) on initiative the GUI is.	On the final product page, the page outlines that the alarm set mode is different to the clock setting mode. This results in the GUI of the device to be more user-friendly. This results in the specification point being met.	Objective

Modifications

Introduction: On this page, I outline the possible modifications to the final design to improve aesthetics or functionality.

When considering the potential modifications, a key area of improvement which was outlined by both the client and focus group was to add labels for each button and switch. On the client feedback page, the client found it difficult remembering the various functions of the buttons and found himself repeatedly pressing the incorrect button. The client found this frustrating as it wasted valuable time for him (in which he will need to get to his meetings online). A similar picture was conveyed in the focus group, in which the three reviewers unanimously agreed that labels should be added to the product as they frequently asked “Which button is the reset button?” or “How do I turn the device off?”. This modification will be added in the 2nd Generation Design.

The next key area of improvement was to fix the colour mismatching. As you can see, the background of the seven segment displays is grey, which is different to the colour scheme of the whole product. On the Focus group, they outlined this issue and the fix would be constructing the product with a different stock component of a seven segment display. Another idea is to add a large vinyl sticker over the display, but for a future commercialised product, this would be costly.

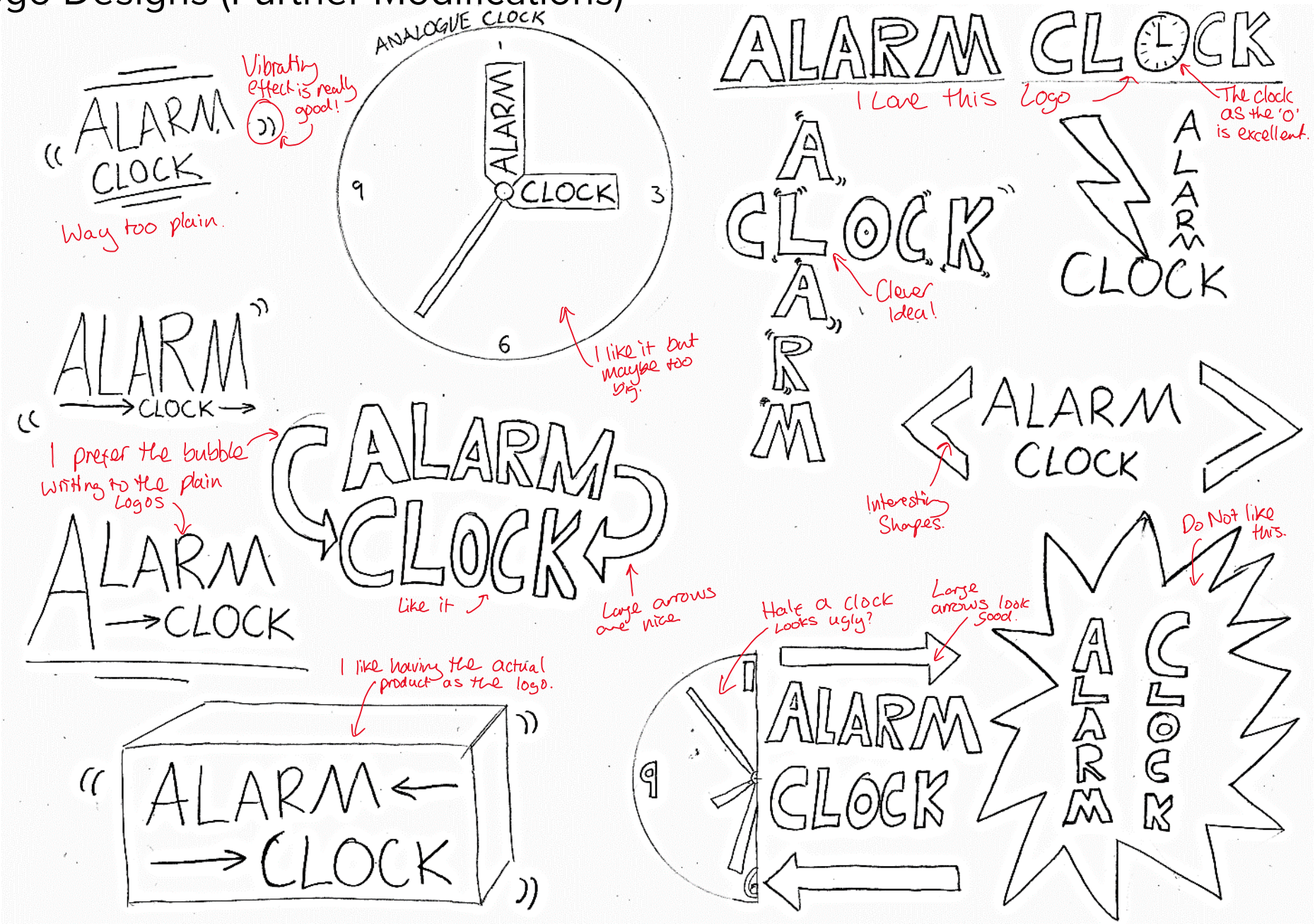


On the client feedback page and the focus group, the idea of a graphic or logo being added surfaced. The group discussed that the logo could be placed on either the top of the device or on the side as both of the faces lacked pattern or function. However, the client suggested that a logo should be added on the side. The picture above showcases where the product should be placed. On the next page, a list of logo designs have been explored and the client has picked his favourite.

Summary

In summary, the client and focus group have suggested a plethora of changes of which some include: add labels, fix the colouring mismatch on the displays and add a logo or graphic.

Logo Designs (Further Modifications)

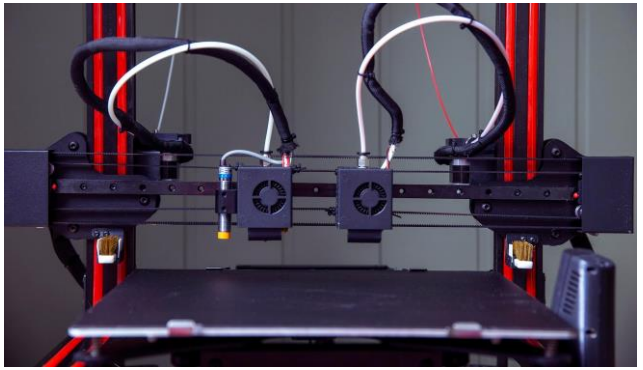


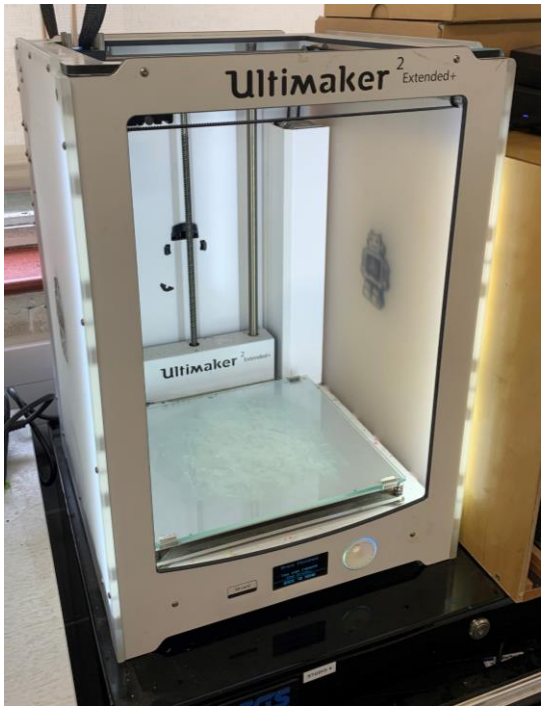
2nd Generation Design Research

Introduction: On this page, I research different manufacturing methods that could be utilized in a future, commercialised product.

3D Printing

In this method, called 3D printing, a 3D object is created by adding successive layers of material, typically plastics. This process is beneficial because it offers flexible design options, creates less waste, produces standardized parts that are both strong and lightweight. The process is swift and cheap. It is particularly suitable for the large-scale production of the product's casing as it can create these intricate shapes, but does take a very long time.



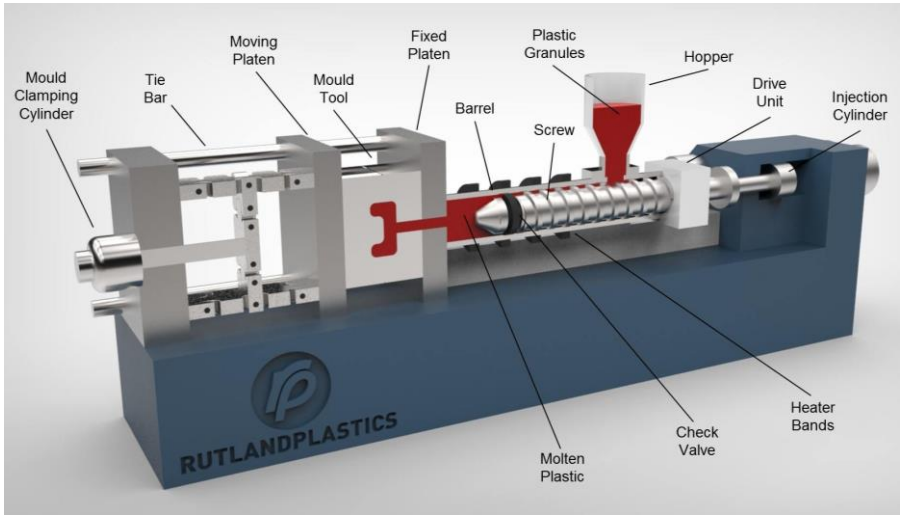


Laser Cutting

Laser cutting is a technique that utilizes a high-powered laser to vaporize materials, resulting in a precise cut. This is accomplished by directing the laser output through optics using CNC (computer numerical control) technology. The laser beam is focused on the material, which can then melt, burn, vaporize, or be blown away by gas, leaving a clean, high-quality edge finish.

Plastic Injection Moulding

The injection moulding process is widely used in industry to create the majority of mass-produced plastic parts. The process involves feeding plastic granules into a hopper, which is then moved along a heated tube called the heating chamber using an Archimedean screw. Once the plastic has melted, it is injected into a steel mould using a hydraulic ram, which ensures the appropriate amount of material is injected each time. The mould is then cooled so that the moulded plastic part can be extracted. This could be used as the process is extremely quick and the base of the product would fit into a mould.



CNC Routing

A CNC (Computer Numerical Control) router is a device that can intricately carve complex shapes out of soft materials such as wood, plastic, and metal. However, due to the limited movement of the cutting tool along a single axis, CNC routers are restricted to relatively thin materials, such as wooden boards or metal plates, suggesting that CNC routers could be useful for this product.

Summary

Overall, I believe that Injection Moulding and Laser cutting are the best processes for the final product.

2nd Generation Design