Design Thinking, Analysis and Specification

CCEA Theme

Fit For Life

Problem

In many different motorsports around the world, a driver's reaction time must be very quick to avoid very serious or even fatal crashes , also costing their team upwards of a few million pounds in damage. This is why my product is going to be a reaction timer, this will allow drivers from many motorsports like Formula One, Moto GP, right down to lower levels like Karting, to improve their reaction time, which may indirectly save their life one day and the life of their fellow drivers.

Overview

What? - This product is a reaction timer, this will allow drivers to train and improve their reaction time.

Who? - This product will be for athletes and motorsport drivers and possibly gym enthusiasts, to stay focused.

When? - This product will be used in a gym environment and possibly outside when the user is doing their workout, this can be as a cool down or a warm up exercise.

Where? - This reaction timer will be used in training or before drivers get into the car, it can also be used everyday in and around the home, gym and outside.

How? - This product will have 5 lights, when they go out, the user has to press a button, this will activate the LCD screen, outputting their reaction time.

Aesthetics

This product will have a blue base. The reaction timer will be in the shape of a gaming controller, to allow for comfort when in use.

Size and Weight

My product will not be too big, it will be hand held. It will be quite lightweight.

Materials

My reaction timer will be made from a type of plastic, probably PLA plastic.

Problem Analysis

Safety

My product will contain some small parts, like the push to make switch. There will be no parts that will easily break off to harm anyone, however care should be taken when putting it away in case the PTM switch would catch on something and break.

Circuit Specification

Function -

- The circuit for my reaction timer should be able to light up the 5 LEDs, they must also be able to go out at random times, so for example, once all 5 have been lit they go out after 5 seconds once, then the next time they go out after 3 seconds, because they go out at random times this will force the user to be very alert to get the best time possible.

Power -

- My reaction timer needs to be portable so I will use one 9 Volt battery.

Performance -

- Once the user has turned the reaction timer on, they will press the button to start, this then sets off 5 LEDs all getting lit up one after another. Then they will all go out randomly each turn, the user then has to press the button as fast as they can and their reaction time will be outputted onto the LCD screen.

Safety -

- In my reaction timer there should be no exposed wires as they will be tucked into the casing. There will be no high voltages as it runs via a 9 volt battery. My product will also be waterproof incase it is used outside, and this will also make it sweat resistant incase used in the gym.

Size -

- My circuit for my reaction timer will be about 80mm by 50mm in size depending what I choose to add, like buttons and buzzers ect.

Casing Specification

Function -

- The casing for my reaction timer should be able to hold all of the components needed for my reaction timer safely and securely.

Environment -

- The environment in which my reaction timer will use is in the gym, it can also be used outside, this is the casing from my reaction timer must be waterproof, this will also make it resistant to sweat when being used in the gym environment.

Aesthetics and Ergonomics -

- My reaction timer will have 2 switches, one rocker switch and one push to make switch, these must be easily accessed and be able to be easily pressed by the user.
- The casing for my reaction timer must be able to be used by 95 percentile of the population, so therefore, they must be able to easily hold it and not have it slip out of their hand easily.

Safety -

- My reaction timer must have no sharp edges, and there will be no small pieces that children can easily access.

Materials and Manufacturing -

- The reaction timer will probably be made via 3D printing, using PLA plastic. This would mean the casing for my reaction timer would be waterproof, however i could use ABS instead as this would give better water resistance.

Sustainability -

- My reaction timer will be powered by a battery, which will be easily changeable if it dies, as well as this when it has reached its end of life it could be taken to a specialist, and because it is a user friendly shape, the user can swap the circuit out for something different if they want, for example to do different things around the house like turn on lights, or use an automated system.

Maintenance

The reaction timer will have a battery cover in order to replace the battery when it dies. It will be made from a type of plastic, probably PLA so it will be easy to wipe clean it if a liquid was to spill on it.

Ergonomics

Once the user turns the product on they will be able to press a button , then 5 LED lights will light up, and at a random time go out and the user will have to press the button as quickly as they can, this will then trigger the LCD screen to output a time onto the screen, this will be how long it took for the user to press the button, it will be measured to three decimal places(thousandths).

Target Market

If I was selling this product, I would sell it to anyone above the age of three as there are small parts involved, I would also sell it to both boys and girls alike, as well as athletes, and motorsport drivers.

Design Brief

I plan to design and manufacture a working prototype of a reaction timer. This will measure the reaction time of the user.

Ease of Use

My product will be in the shape of a gaming controller, so that it is easy and comfortably held, so that muscle fatigue doesn't occur during use, allowing the user to get the most time out of the product. It also contains a buzzer that, when the lights go out it will beep, making it more user friendly for those with impaired vision.

Product Research
This will give me ideas about what components and materials I need to use for my product.

Component Research
Looking at components will allow me to find the best ways to create my product, a reaction timer.

Product 1 - Rain Light
Purpose/Function - This is to warn other drivers of cars in front of them.
Appearance - There are 15 LEDs that flash with a black frame.
Materials - One piece resin moulded PVC
Size - 90x58x50mm
Systems - LEDs, Rocker switch
Advantages - It is lightweight, waterproof and durable
Disadvantages - could be flimsy because it is resin moulded
Target Market - Racing Teams
Source - Link

Product 2 - RGB Lights
Purpose/Function - This is to light up your room.
Appearance - There is a strip, with changeable LED lights, there in an included controller to change the colour of the lights.
Materials - PVC
Size - 5 meters
Systems - LEDs, Infrared(remote control)
Advantages - Multi-colour, dimmable LED lights
Disadvantages - Only come in large sizes
Target Market - Anyone
Source - Link

Product 3 - Light up Controller
Purpose/Function - This product adds colour to your gaming setup.
Appearance - LEDs behind each joystick, ergonomic, user friendly design.
Materials - Melamine Formaldehyde
Size - 199x197x283mm
Systems - LEDs.
Advantages - Has a user friendly grip, and ergonomic design.
Disadvantages - Some people may not have big enough hands to properly grip it.
Target Market - Gamers
Source - Link

Product 4 - Whack a Mole
Purpose/Function -A children's play game to keep them entertained.
Appearance - Plastic with large hole where the heads pop up out from.
Materials - Melamine Formaldehyde
Size - 254x304.8x76.2mm
Systems - No Systems
Advantages - Can keep children entertained.
Disadvantages - Made from plastic, so might be flimsy.
Target Market - Children and their parents.
Source -Link

Name: Push to make switch
Advantages - Will allow a time to be outputted onto the displays.
Disadvantages - Can sometimes tough to push down so may require some force.
Reason - This is what the user will press when the 5 LEDs go out, which will then output a time on the seven segment displays.

Name: LCD Screen
Advantages -Takes up less room on the PIC to allow for more outputs.
Disadvantages - Can be small in size.
Reason - It takes up less room on the PIC than the 7 Segment Displays.

Name: Genie 20
Advantages - Allows there to be sufficient of input and outputs.
Disadvantages - Requires a lot of room on the circuit.
Reason - This will allow there to be sufficient input and outputs, without maxing it out.

Name: Astable 555 Timer
Advantages - Allows LEDs to light up randomly.
Disadvantages - Takes up space on the circuit.
Reason -Will allow the LEDs to light up randomly.

Name: LED
Advantages - Gives out a bright, clear light.
Disadvantages - I need 5 so will take up 5 slots on my Genie Pic.
Reason - This will light up and go out at random times making 5 start lights.

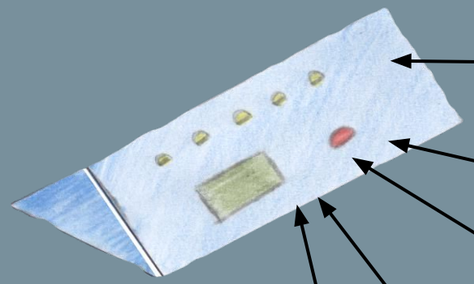
Name: Rocker Switch
Advantages - Gives to timer power.
Disadvantages -Takes up a slot on the Genie pic as an input.
Reason - This will be used to turn the reaction timer on and off.

Name: Buzzer
Advantages - Makes the project more user friendly.
Disadvantages - Needs holes in the project to hear it.
Reason - This will have a short buzz after the lights go out, this will help make the reaction timer more user friendly.

Name: Battery Pack
Advantages - Provides power to the circuit.
Disadvantages - Takes up space in the product.
Reason - This provides power to the product allowing it to function.

Concept Ideas

Here are some initial concepts for my reaction timer casing. I have included black box system diagrams to illustrate the inputs and outputs of each case.



This casing idea provides an angles surface in which you can test your reaction speed.

This is a prism design that has an angled side that allows the user to see the device and LED's clearly.

This concept contains one rocker switch, a PTM switch, 5 LED's and an LCD screen as an output. This is because the PIC might run out of output slots if i was to use 7 segment displays.

This casing concept would be 3D printed.

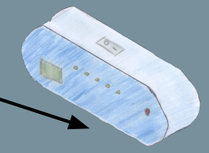
However this concept has got a major disadvantage; the angled side may be too steep for some users and may become uncomfortable after prolonged use.

1 Rocker Switch
1 PTM

?

5 LED's
LCD Display

This concept has a casing like a modern alarm clock.



This casing idea would also be 3D printed, like the prism concept.

This casing idea is like a modern day alarm clock and so has a vertical face and so therefore will be easier to see outside as it won't reflect the sun.

One major disadvantage with this casing design is that it sits vertically and will be very difficult to use.

This product is contains the same components at the prism, but the only difference is the 7 segment displays, this is because you can be more accurate with a 7 segment display, than with an LCD screen.

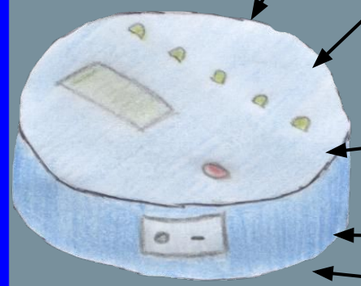
1 Rocker Switch
1 PTM

?

5 LED's
7 Segment Displays

This casing concept is a flat cylindrical shape, I would probably have a design on the top of the case.

This design contains the exact same components as the prism above, this is idea as the components are compact to fit inside the compact space.



This case would be 3D printed.

This reaction timer case is a lot more compact as the others, and it can be stored conveniently.

However this case will have a high edge and may hurt the user with very little use.

1 Rocker Switch
1 PTM

?

5 LED's
7 Segment Displays

This idea is good as it has a clear display of the LED's

One major disadvantage is the fact that it cannot be easily stored or transported.

This case contains the same components as the alarm clock style case, in this case there is no need to have compact components

This case would also be 3D printed like the other cases.

This case is convenient will clearly display the LED's even if outside.

1 Rocker Switch
1 PTM

?

5 LED's
LCD Display

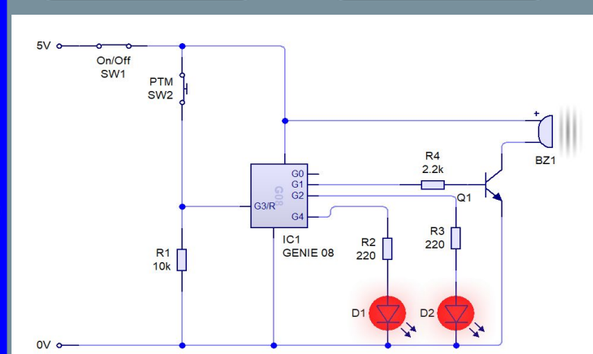
How the circuit works:

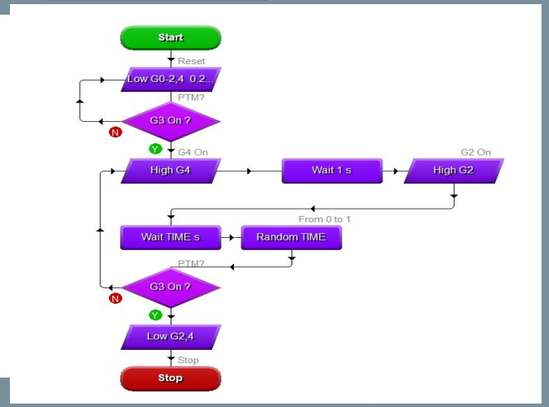
- The user will power the circuit on via the rocker switch at the back side of the product, then they will hold the PTM switch to activate the LED sequence.
- Once this sequence has begin the user should hold down the PTM, once the LEDs go out they will then release the PTM, at this point they will hear a buzz, reminding them that the LED's have one out.
- Finally if the user wants to restart the reaction timer, they should just press and hold the PTM until the LED sequence begins again.

INPUT
PTM

PROCESS
Genie 08

OUTPUT
LED's
Buzzer





How does the circuit solve the problem?

- This circuit has 2 LED's, when the user holds down the PTM, the first LED will light up then, after 1 second the second LED will get lit up, then the LED's will stay on for a few seconds, and after a random amount of time the LED's will go out, this will keep the user alert and ready to let go of the button at any moment.
- The buzzer adds to the user friendliness of the design, so when the LEDs go out, the buzzer will buzz allowing blind people to also use the device.
- Once you let go of the PTM at any point in the sequence it will automatically restart the process.

Problems with the circuit.

This circuit has a number of problems, including:

- The wait time of the circuit can be very long so although this is good, the user may have to wait a while once the both LEDs get lit up.
- The user may release the PTM, restarting the process.

Summary of the proposed circuit idea

- The LED's work well and go out when they are supposed to .
- The buzzer works when the LEDs go out, like it is supposed to .
- The product works as i suggested it would in my design brief, it will test your reaction time.

Proposed Casing Idea

I have chosen this casing idea because it is more user friendly than previous designs and it also allows for more portability when the user is taking the device to and from its stored place.

The components I have used in this idea include;

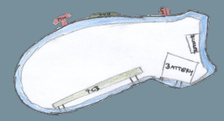
- **A PTM** - this is used to begin the LED sequence.
- **2 LED's** - These will light up and go out at random times to tell the user that the lights have gone out.
- **A Buzzer** - This makes the idea more user friendly and allows a wider range of people to use it.

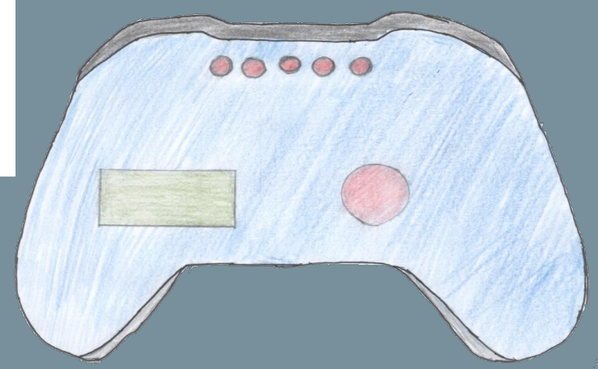
This sketch solves my problem by having all the key components included, however there is room for improvement with the shape and some of the components to improve ease of use.

As you use the product it will wear down many things like the battery and the LED's more due to prolonged use so changing these components can be key part in the design of the case, for example the batteries as mentioned are easily changeable be just a clip on the back of the case. However the same cannot be said for the other components like the LEDs or the buzzer, this is because when these components wear out they will be irreplaceable due to the nature of the case.

This case would get 3D printed, from PLA plastic. Or this idea could be vacuum formed around a mould.

This casing concept features an easy to hold design , with the user not having any hand strain after prolonged use. As well as this the case is easily transported to and from places due to its compact design.





The strength of the case is a key aspect of the case and of the life of the case and how the case proforms under loads like if it falls or if there is something is stored on top of the product, this is why some parts of this case would be screwed together, for example, this case idea is going to get designed in two parts and they would then get screwed together to make sure they will not fall apart.

Some disadvantages of this casing idea include:

- **The casing will be difficult for the user to store** - this is due to its complex design and curved edges.
- **The casing can easily get damaged -** This casing concept contains a fragile design and if dropped may not withstand the force of the impact.
- **If the case gets damaged it will be unable to get fixed -** This is not good as it will increase the users environmental impact and it would not look good for the product either. The reason it cannot get repaired is due to its complex shape and its method of fabrication.

This casing idea includes many advantages including

- **The Reaction timer's batteries can easily be changed -** The reaction timer's casing design allows the batteries to be changed when needed by just pulling on a part of the case and it will slide off, however a bit of force will be required.
- **Its convenient and comfortable grip** - This reaction timer includes a very user friendly grip design, and allows for prolonged use of the product without wrist strain or getting tired of holding the product.

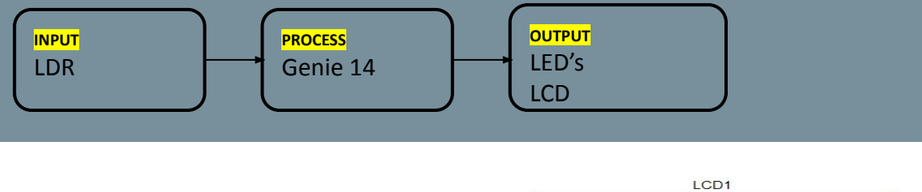
The section view of this case concept allows you to see how the PCB, LED's and other components like together, this provides a detailed view and a breakdown of the case, this also allows for some very basic repairs to be carried out, for example the LEDs replaced. The user can do this by seeing what pport the LEDs go into and replacing them, this can also be carried out for a number of other of different components.

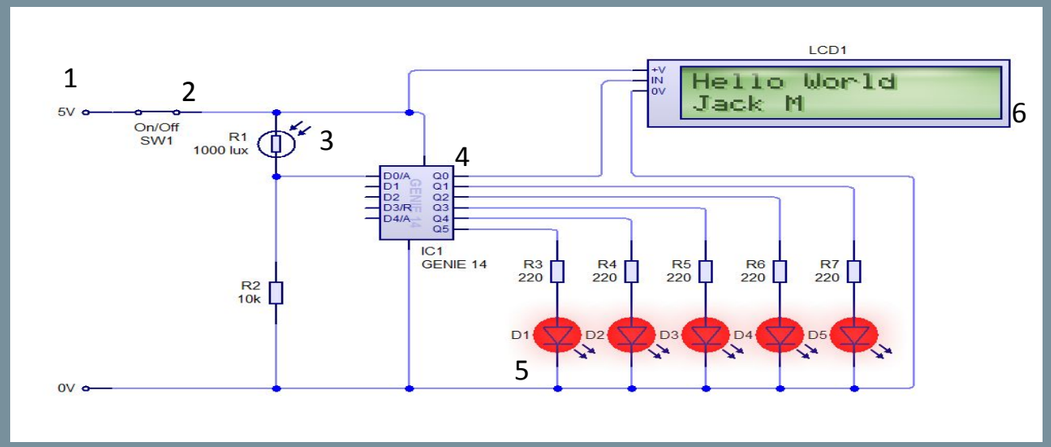
Development of Proposed Concepts

Development of Circuit

After choosing what casing design I would like to take forward and manufacture, I am now designing a circuit that needs to meet all of the my requirements and solves my problem. I have also came up with a circuit that allows a wide variety of people to use it.

- One of its main features and it's only input, is a light dependant resistor, this means people can use the product whenever and wherever, without the worry of their finger slipping off of the button.
- The process is will be the genie 14 with a sufficient amount of inputs and outputs to handle my circuit design.
- The outputs of my reaction timer include 5 LEDs and an LCD screen. The LEDs will light up in sequence, one after another, and then go out randomly each go.



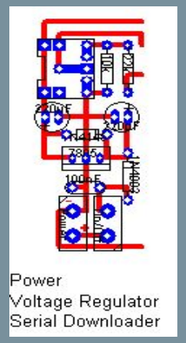


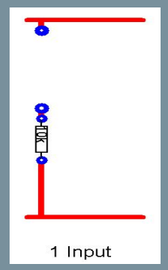
1. I have used a 5V power input, this is the positive rail going into the genie and is required in order for the genie to turn on.
2. I added an SPST switch, I have added it in the form of a rocker switch, This will be used to power on and power off the reaction timer.
3. This component is a light dependant resistor, this will measure changes in the light levels surrounding the sensor and will change accordingly. It has a 10K resistor paired with it, and this allows the correct number of volts to transferred to the component.
4. This is a genie 14, the core component of my reaction timer and will be essential for its functioning. I chose the genie 14 because of its perfect number of outputs, it has 6 Outputs, this is perfect as the number of outputs I have is 6, 5 LEDs and an LCD screen. The genie is connected to both positive and negative power rails of the circuit.
5. In this reaction timer I have chosen 5 LEDs, when the LDR is triggered it will activate the LEDs in sequence, one after another. The LEDs are protected, each with its own 220Ω resistor, all of the LEDs are red.
6. In my reaction timer I have included an LCD screen, this is a key part to the reaction timer as it will display the time taken for the user to press the button. The LCD screen only needs to be connected to the genie and the positive and negative power rails.

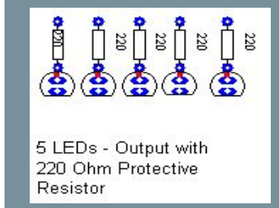
Development of PCB

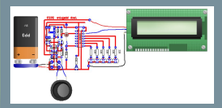
1

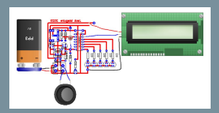
2











In the development of this PCB for the reaction timer, I took the circuit I made and used Circuit Wizard 3's auto-route feature. I have attached two pictures, the first one was my first attempt at the auto-route and it gave a message saying that only 74% of connections were successful. Then my second time using the auto-route it said 100% of connections were successful. However, upon using the auto-route feature, the board is very large with the components all spaced out too much, this is where manual routing is better suited.

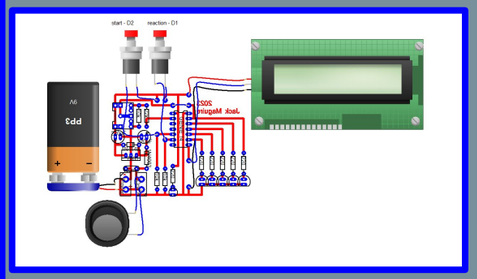
The next stage in developing the PCB is to use the manual routing of the circuit, fortunately my school provides a breakdown of parts I would need. On the left is a break down of my PCB with onboard components, including; Inputs, Outputs and the power components. I will join these together to create a working PCB to be manufactured for my reaction timer.

Following on from previously, I have joined all of my components together as well as added off board components. The 5 LEDs all have their own 220Ω resistor. The power to the genie is handled by a 9V battery, this will then go down to 5V in order for the genie to work properly. This process is done via the 7805 Voltage Regulator. I only have one input: an LDR, this got connected up to the genie via the pin called A0, the A stands for analogue. My LCD has a wire going to the 9V power rail and is connected to the genie via D1.

This is my final circuit proposal, I have made it a lot more compact from the previous version, but is just as good. It is ready to be manufactured in the bubble etch tank and then will have the flowchart diagram, downloaded onto it via the download socket. After this, the circuit will be fully functionable and ready to use in my reaction timer project.

Programming the Circuit

Input	Process	Output
2X PTM	Genie 14	LCD 5X LED



On the left is my final circuit design, it includes off board components. These are one LCD, two PTM switches, and five LED's.

Pin	Component	Purpose
Q0-4	LED	These will light up and go out at a random time between one and five seconds.
Q5	LCD	This will give instructions to the user as well as give the reaction time of the user.
D1/2	PTM	These will be received inputs from the user and will give the user control over the reaction timer when in use.

D1 and D2 is the inputs for the two PTM switches

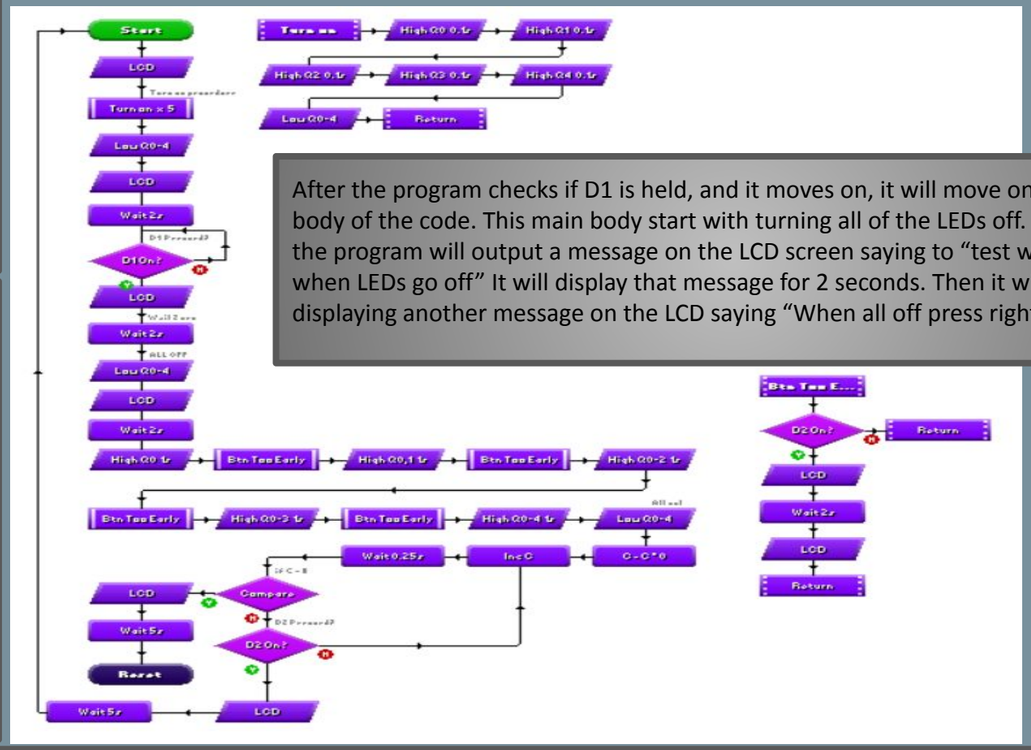
These are the pins for the five LEDs in my circuit.

This is the input for the LCD.

Initially I wanted to output the users time onto the LCD screen, however this would require a lot of programming, o even come close to being able to do, as the time system is incapable of registering decimal places, and a reaction timer normally rounds to three decimal places.

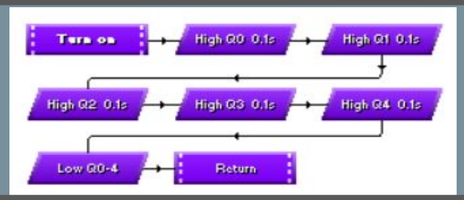
Once the start procedure has ran, the LCD screen will clear itself, Then it will tell the user to "Hold the left button to start." When the user holds the button, the program will check if button if held, if so, it will move onto the next stage of the program. If the button is not held then the program will loop until the button is pressed.

When my program first starts, it will run through a subprocess, that is looped 5 times. This lets the user know that it is powering on and that everything works like it is supposed to. Please see bottom box for an explanation of the start subroutine.

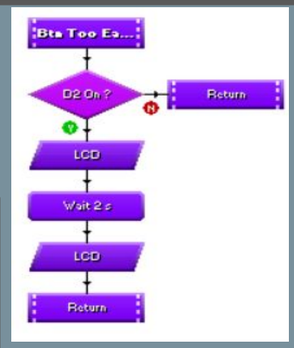


After the program checks if D1 is held, and it moves on, it will move onto the main body of the code. This main body start with turning all of the LEDs off. After this the program will output a message on the LCD screen saying to "test will start when LEDs go off" It will display that message for 2 seconds. Then it will move onto displaying another message on the LCD saying "When all off press right PTM."

Once the above code has ran, the program will first light up Q0 (1st LED). Once it is lit, it will call the subroutine Btn Too Early. This will check is the right PTM has been pressed too early (before all LEDs are out). If this is the case it will display a message on the screen saying "Button pressed too early." It displays this message for 2 seconds before wiping the LCD, to then return to turning on the LEDs. This check will run immediately after each LED is turned on. This keeps the user right, and prevents them from cheating. Once all LEDs are lit, the program will define a variable, "C" and will set it equal to 0. Then it will increase "C" every 0.25 seconds, 8 times, comparing it to 2. If it is below 2 then the program will check is D2 pressed, if it is and "C" is below 2 it will output "Target met. Well done!" on the LCD screen. If "C" is above 2 it will output "Target missed try again." on the LCD screen. Both messages will lead to a reset/restart of the program.



Above is the turn on routine, this will loop 5 times. It lights up all 5 LEDs individually, then turning them all off at the same time. It return to the program and is repeated another 4 times

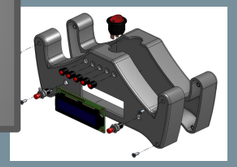


On the left is the Btn Too Early subroutine. It is called after each LED is turned on. It starts by checking is D2 is pressed. If it is then it will output a message saying "Button pressed too early." onto the LCD screen. This message will display of 2 seconds, then the LCD will get cleared of any message on the display. Before returning to the program to continue lighting up the LEDs.

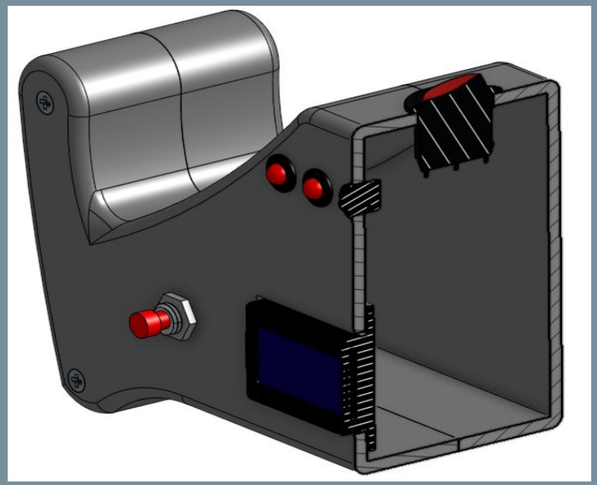
Development of Housing

This design incorporates the best bit of some of the other suggested cases. For example the LEDs are in the centre of the case, I decided this was a good position for them because the middle of the case is the most likely place that the user will look at when in use. I also decided very early on to use red LEDs. This is because in formula one, they use red LEDs as the start lights and thought it was a good idea to use them. The red colour for the LEDs also means that they will stand out from the case as it is a darker colour, a grey colour.

On the left you can see a side view of the case, this gives an insight into the depth of the case, when I made the model, I immediately knew that the depth was far too big, so this would need decreased when I would do the final model in CAD.



In this section view (right), you can see the inside of the casing and how much space all of the components will have, to fit as well as this the battery pack will have lots of room to fit in along with my LCD screen and there is no wires overlapping or getting tangled with each other. I made this by using the fastened mate feature in Onshape.

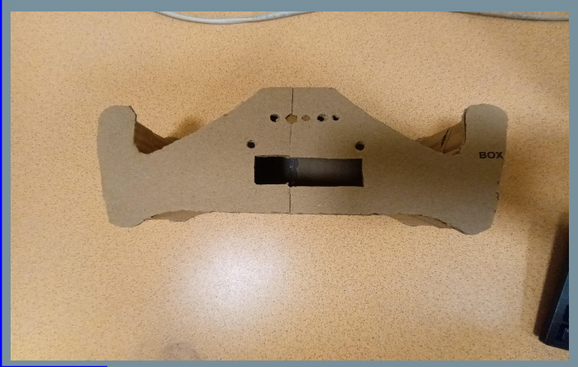


This is the back part of my product, the back and the front will now only be 2 pieces instead of four, as this is something i learnt from doing the cardboard model in four pieces

On the right you can see the top view, with a slight view of the front. This gives an insight into the placement of the rocker switch, this will turn the reaction timer on and off. It is placed at the top because it prevents the user from accidentally flicking the switch. Whereas if the switch was on the back, and the user put the reaction timer down onto a table for example, the switch could get flicked and mights get turned on, draining the battery.

This is the front part that will connect to the case with four 3mm screws in the corners. This makes it easy to take the two sides apart when you need to replace the battery.

This is my exploded view of my product, this allows me to easily see the two parts and multiple off board components contained my product.

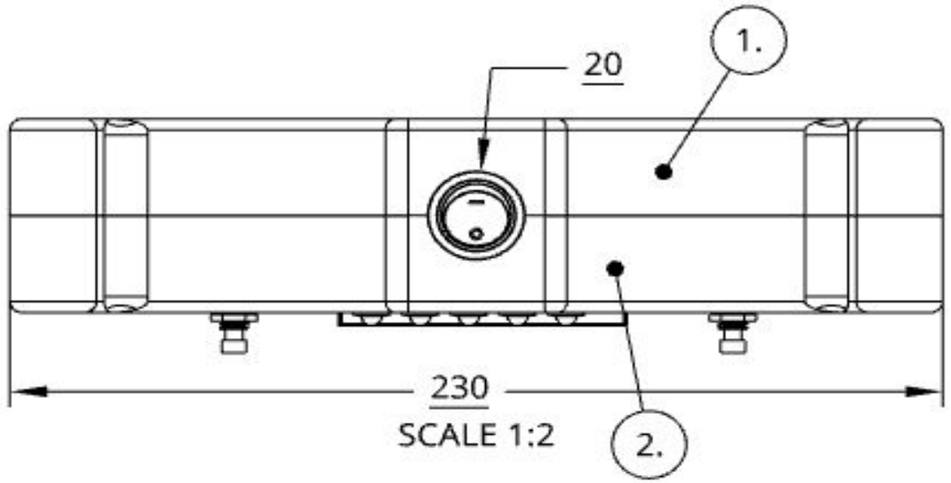


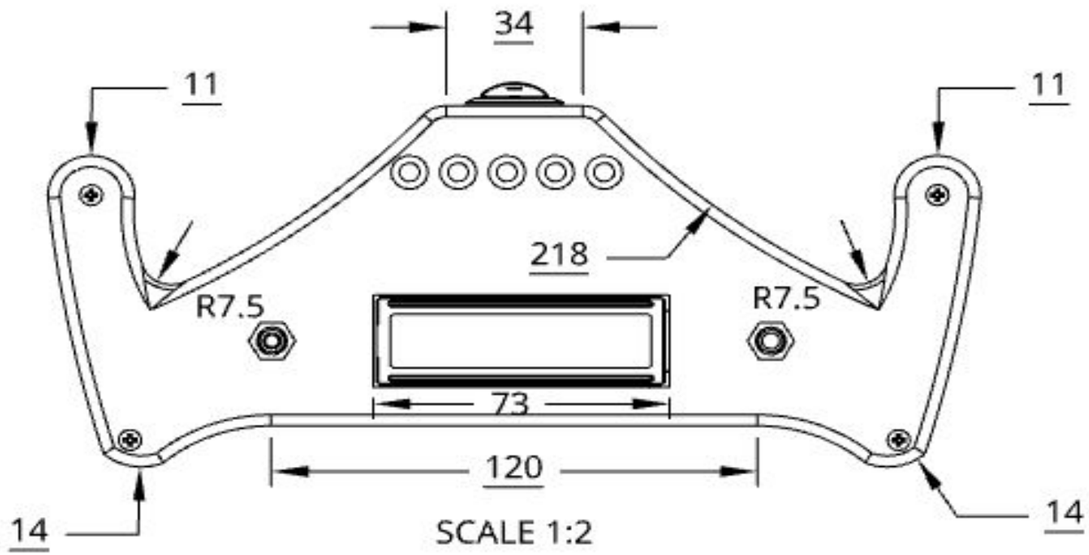
On the left is a top view of the case, giving us an insight into the placement of the LEDs and the LCD screen. As mentioned above the LEDs are in the centre of the case. I also lined up the LCD screen with the LEDs. For the two PTM switches I have put them above the LCD screen however when I done the model in CAD I realised that the PTMs will hit the board of the LCD screen so therefore, for the final model in CAD I had to move the PTMs to the sides of the LCD to avoid a clash.

On the left is my final product designed in CAD (Onshape). This is the final design that will be getting manufactured via 3D printing, I had to take into consideration the overhand while printing these two parts as the printer may be unable to print the overhang, as the two pieces would get printed face down as there would be no supports needed.

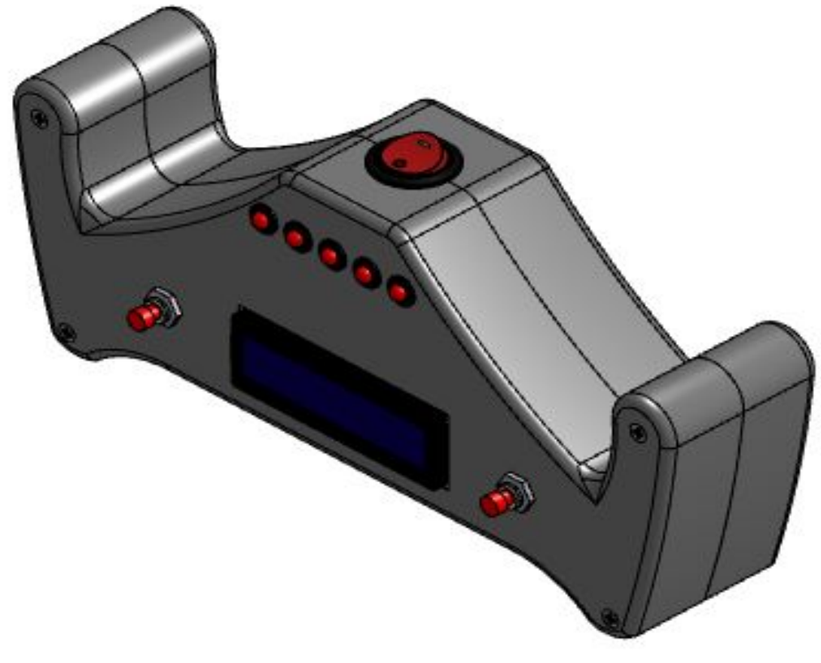
Working Drawing

2

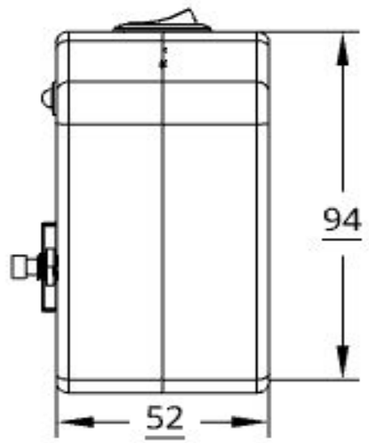




1



SCALE 1:2



SCALE 1:2

Title: Reaction Timer	Scale: 1:2	Part 1: Top panel	Part 2: Bottom panel	
		Part 1 Material: PLA Plastic	Part 2 Material: PLA Plastic	

2 1

This is the testing page of my reaction timer. This is the page where my problems will be discovered in my circuit and how I will deal with those problems that do arise.

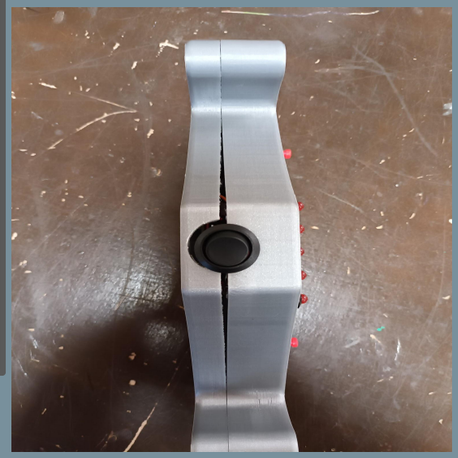
These pictures showed my overall testing experience, there was only two major issues with my final product, one of which is not shown here. On my PCB my transistor which steps the power down from 9V to 5V, there was two pins soldered together. This was a very simple fix, just take the excess solder off. The other issue I encountered was when I had finished assembling the reaction timer, I realized there was a gap between the back and the front of the case. This is only an aesthetic issue however this is something I would like to have fixed, however due to the time constraints I couldn't get it fixed in time.

The picture above is showing the product when you first switch it on. It shows the first message on the screen saying "Press left PTM to start"

This picture below is half of the case assembled. It shows the scale of the PCB and the LCD screen in the case. This is the first stage of the testing process. In this stage I will make sure that all of the soldering is allowing the circuit to work properly and that all of the wires fit inside the case. A few of them needed extended in order to fit into the LED holes, however it was easier to do these now rather than being ready to assemble the final product and then the wires are too short.

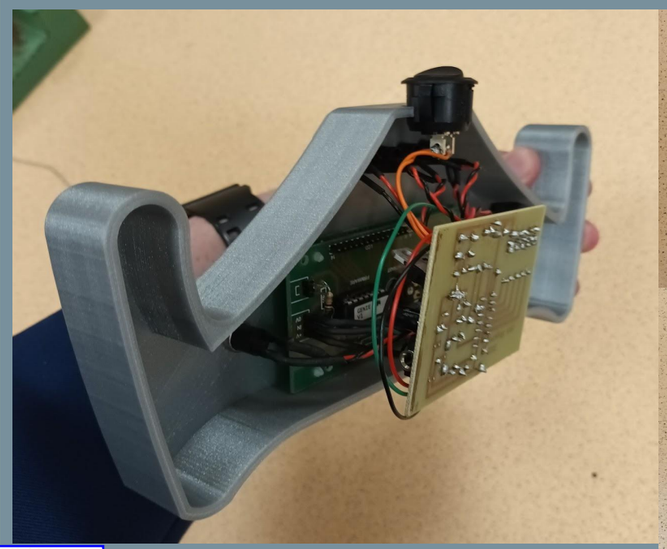
(Right) This is the issue I had stated above about the screws not being able to hold the middle of the case together. This was caused by the 3D printer failing at 54%, while printing the bottom part of the case, This could be fixed with more time, however within the time frame this was unable to be completed. As stated above this is only an aesthetic issue, however the dangers are it may lead to over time wires coming out of the case, and leading to a dangerous situation when the product is then switched on. This is made worse by having the power switch leads quite close to the top of the case, so this may, over time be a health and safety hazard, or the circuit may short out if the leads are power leads.

(Left) It is clear in this picture that the LEDs are not centered with the case, this was a mistake during the CAD process which if I was going back to do it again I would fix.



The case will have no loose wires, when complete. This is to ensure the safety of the user. This can be seen below where although it is not properly secured, there will be no loose wires coming from the case. At the minute the rocker switch is currently out dueto there not being long enough screws to hold the case together.

Below is a picture of the front view of the case. This once again shows the LCD for scale in the case. This helps to understand the size of the case in the users hand when the LCD is 75mm wide.



(Left) The sides case is not very easy to be cleaned as it is 3D printed. However due to the way the two front pieces of the case being printed on a glass bed it gives the reaction timer a smooth surface which is easier to clean. The pictures show a comparison before and after having marker put onto the front of the case. There is a red circle to make the mark more obvious.

Evaluation

Final Product Evaluation

Circuit Function
The message will say hold the left button to start, when held it will advance to the next section. The next section is lighting up each of the five LEDs individually, then they all go off at once, press the right button to activate the reaction. If the time to press the button from all of the LEDs go out is under two seconds the LCD will display “Target met, well done.” Otherwise it will output “Target missed, try again.”

Circuit Power
The circuit is powered by one 9V battery, this then gets split down to 5V by the voltage regulator soldered onto the circuit.

Circuit Performance
The circuit performs well with all tests, doesn’t crash and has no failures when testing it multiple times.

Circuit Safety
The circuit is not secured in the case, just take the back cover off and it reveals the battery and the back of the circuit.

Circuit Size
I have a 79mm x 49mm PCB size, I had to make this PCB more compact so that it would fit inside a small, portable and handheld case

Casing Function
The function of the case for my reaction timer is to be able to fit a quite small PCB into a portable case, that is handheld andsutable for most ages.

Casing Environment
The environment for my reaction timer is in a gym or at home, it can also be for on the go due to its small size and it also running off of a 9V battery.

Casing Aesthetics and Ergonomics
My case for my reaction timer is very easy to grip for prolonged use and even after a workout whereby your hands may be tired from holding weights. This design also makes it friendly for users with small and big hands alike.

Casing Safety
My case’s safety took priority in the design phase of it. I had to think about having no loose wires and even when the battery needs replacing, to do that and maintain the safety of the user is key. So therefore when changing the battery, the rocker switch at the top of the case will be glued onto the front to stop it from coming loose during the changing of the battery.

Casing Materials and Manufacturing
The case for my reaction timer is 3D printed out of PLA plastic, it is melted and then formed to make my case.

Casing Sustainability
3D printing is an additive manufacturing process, this means it is better for the environment than vacuum forming or cutting, shaping and filing sheets of acrylic or other types of plastic due to not wasting material.

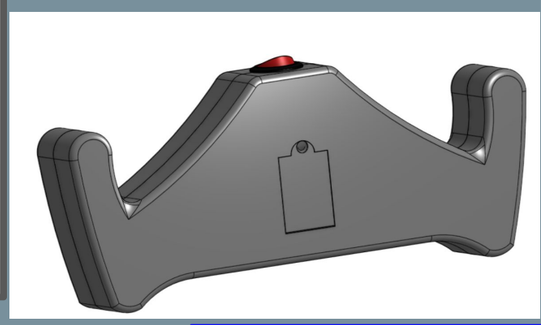
Suggested Modifications

One major modification I would make is to reduce the overall depth of the product. This would make it more user friendly as it would be able to fit into smaller hands.

A final modification I would make is to add a battery cover onto the back of the case. This would make the battery far easier to change instead of having to open up the whole case, and be careful of wires, just to change the battery.

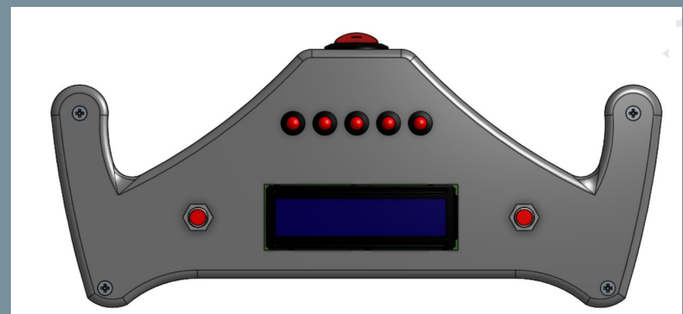
One final modification I would make to the case is to add screw holes in the centre of the case just above the LEDs to pull the whole case together

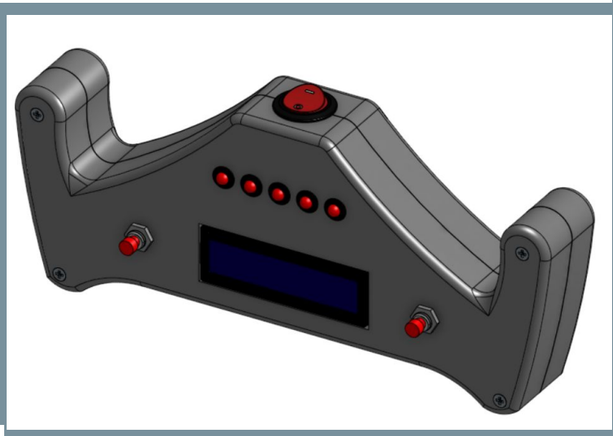
One modification I would make to the program is to have the LCD display the users time however this would not have been possible to do within the timeframe given to complete this project.



Another modification I would make is to put the screws onto the back of the case. This is more for aesthetics as the screws are an eyesore when they are at the front of the case.

I would also like to lower the LEDs, a this would make them easier to see when you are focused on both the LCD screen and the LEDs.





Above are a few pictures of what some of the modifications would look like applied to the case.