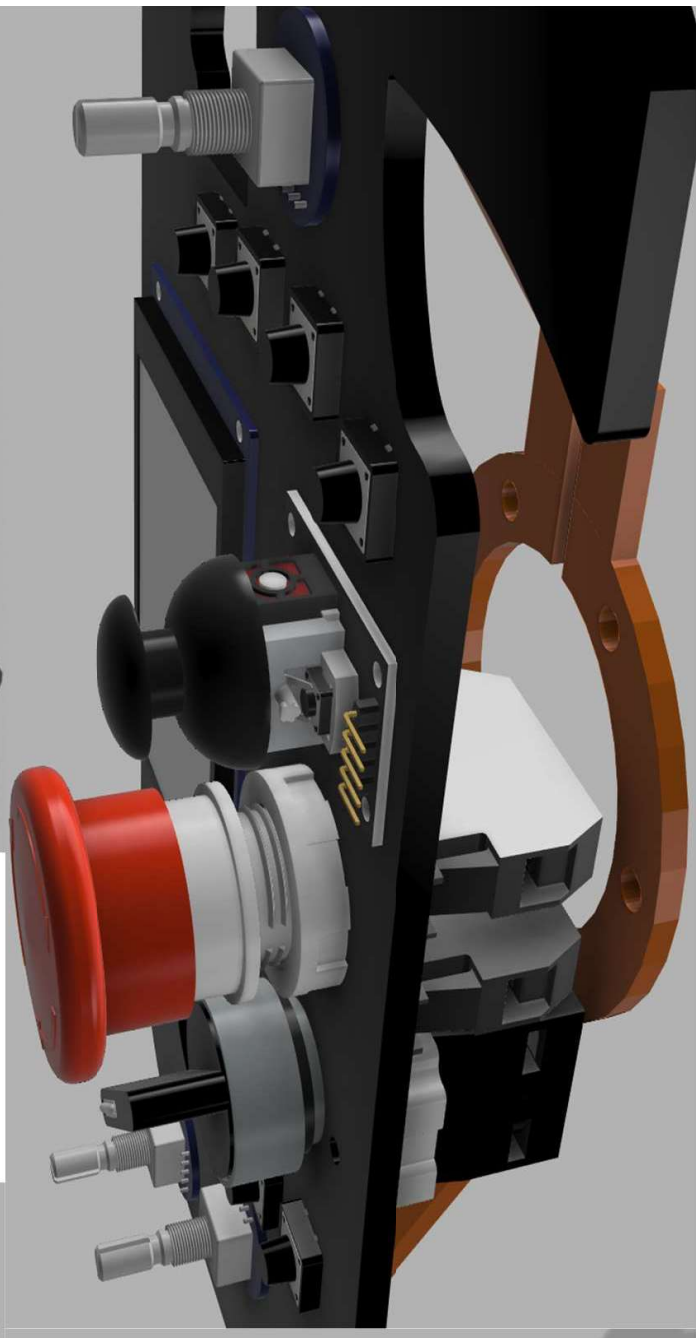
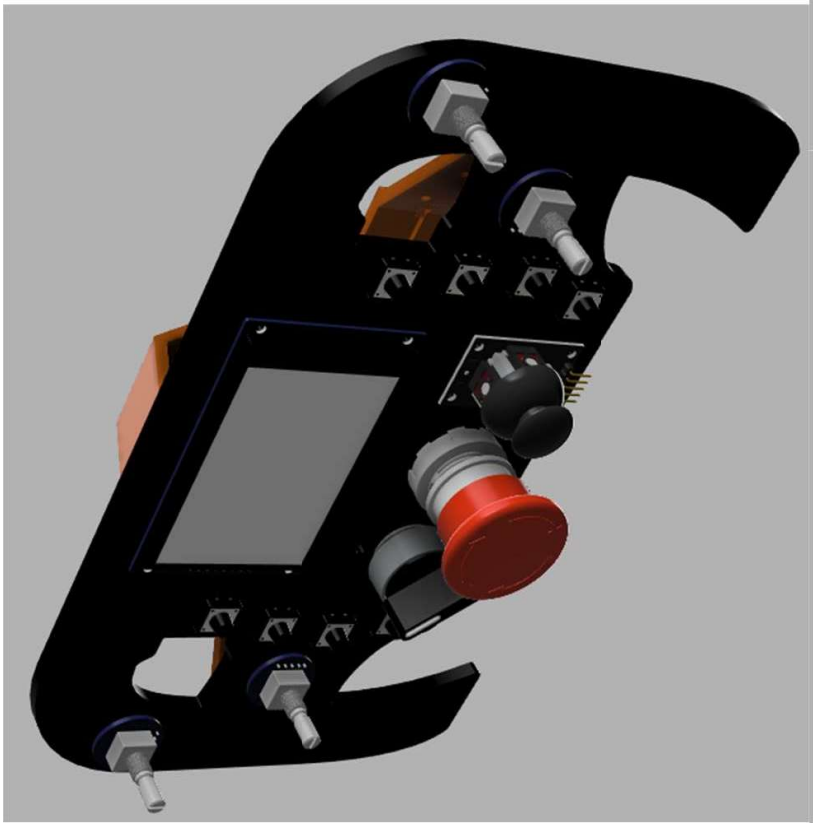
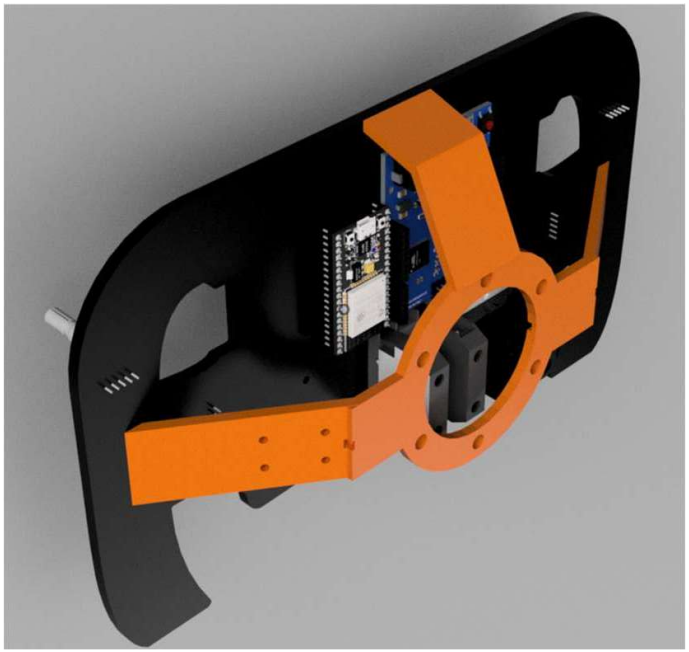
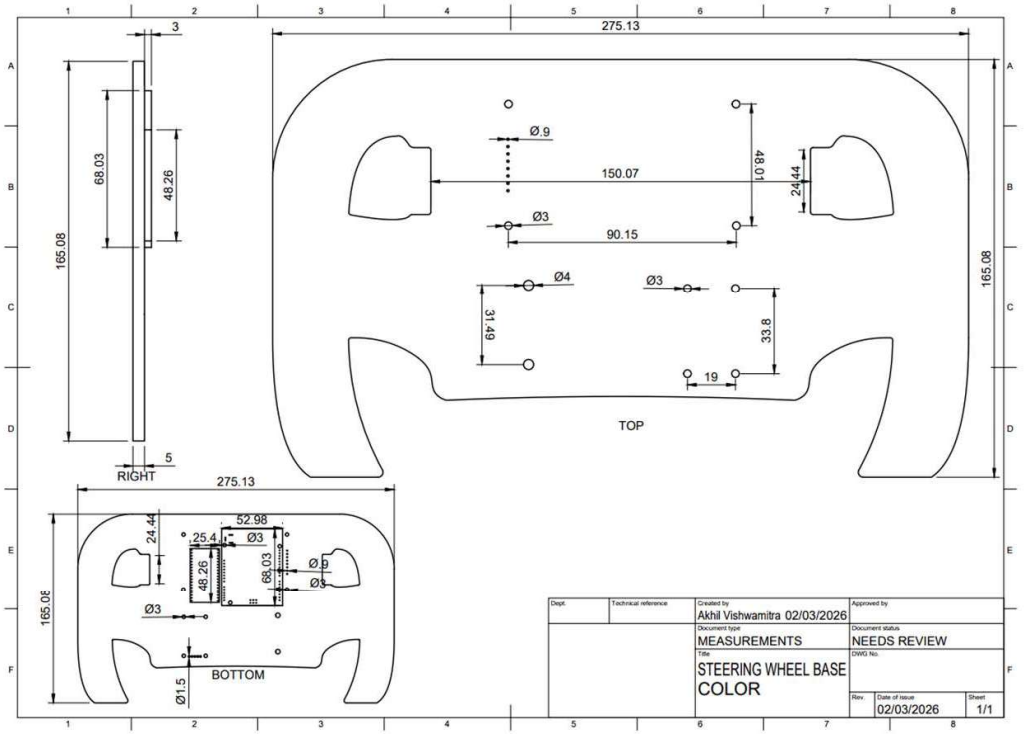
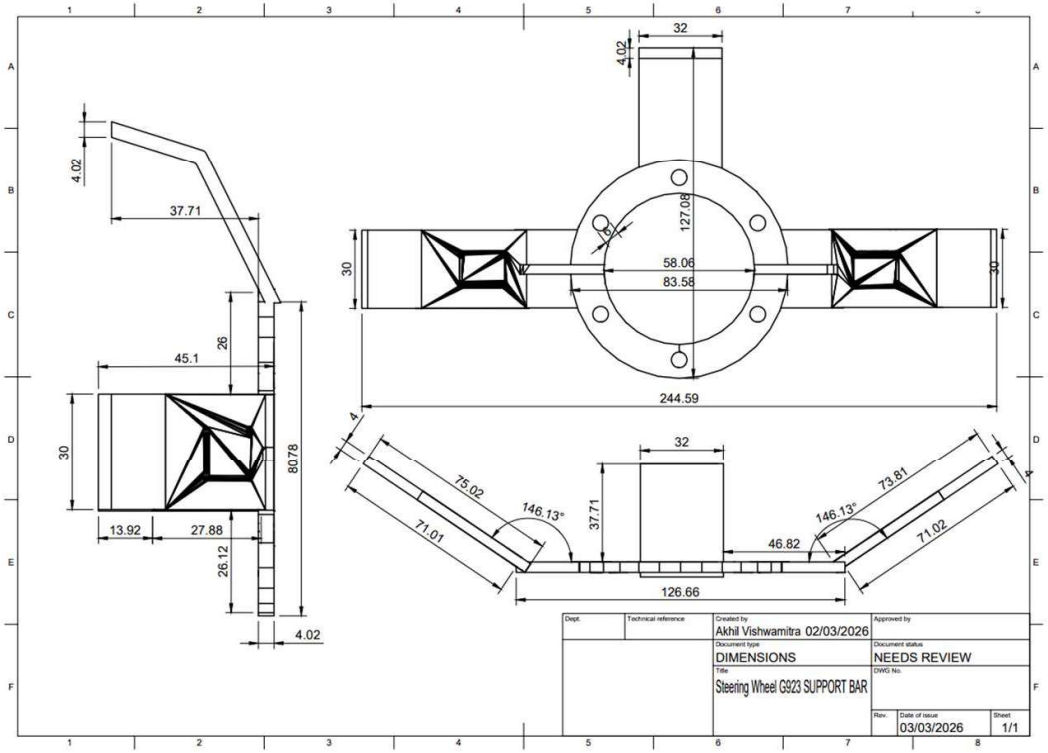


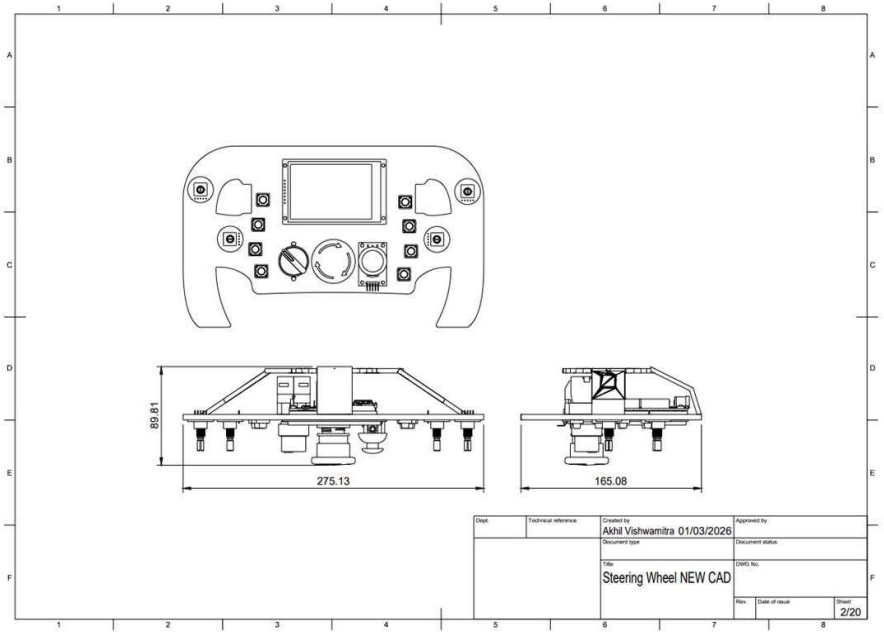


Manufacturing Specification









Production Plan

Step Number	Method	Tools	Health and Safety	Quality Control	Tips
1	Acquire a 5mm thick sheet of plywood and mar out a rectangle shape of 300x200mm using a pencil, try square and a steel rule. Using a scroll saw, cut out the marked shape	• Pencil • Try square • Steel rule • Scroll saw	Wear safety goggles and gloves when operating the scroll saw	Imperfections are accepted as they will not affect the next step but make sure the lines are straight and lengths are tolerated to maximum of 2.5mm	You don't have to cut it to the exact mm but just close enough. Use the steel rule, to mark out the lengths, then use the try square to make a straight line in line with the mark
2	After cutting out, you should be left with a 300x200x5mm sheet of plywood. Next, open a new file in CorelDRAW with the same 300x200 sheet size to account for the same size as the plywood sheet cutout. Then, draw out the exact shape outline of the Mclaren Mercedes Formula 1 Team car steering wheel. Then, save the file and save an additional backup of the file in a cloud storage to avoid losing the file. Next, open the printing dialog and make sure the laser cutter is connected and select that printer. Then, place the sheet of plywood inside the laser cutter at the top left corner and click "print" and let the laser cutter cut out the shape of the steering wheel. Once it is cut, take out the shape	• Laser cutter • CorelDRAW	Do not look directly at the laser of the laser cutter when it is cutting and make sure the lid is shut to avoid inhaling the dangerous fumes of the laser cutter cutting the plywood. Also, once the laser cutter has finished cutting, let the wood cool for a minute from the intense heat of the laser on the wood	Confirm the shape of the steering wheel fits inside the 300x200mm sheet in CorelDRAW. Further confirm the shape and size of the cutout shape of the steering wheel to make sure it fits with the client's hands	Place an image of the F1 steering wheel in CorelDRAW and manually draw the outline around it to reduce imperfections
3	Next, acquire a large sheet of 5mm thick aluminum. Next, place the cutout wooden steering wheel on the aluminum sheet and place it at the corner of the sheet. Use a G-Clamp to clamp down both sheets together to the workbench. Next, use an engineer's blue or permanent marker to mark out the shape of the wooden steering wheel onto the aluminum sheet. Next, use an engineer's try square to mark out a rectangular shape around the marked out steering wheel shape (ideally a 200x300mm shape). Use a steel rule to complete the shape. Make sure to also mark out the holes for the finger grips	• G-Clamp • Engineer's blue/permanent marker • Engineer's try square • Steel rule • *Scribe*	Wear gloves and an apron when working with metals	Keep a tolerance of at least 5mm to account all around the marked-out shape	You can also use a scribe if a permanent marker is unavailable or not working

Step Number	Method	Tools	Health and Safety	Quality Control	Tips
4	Next, ask a suitable or qualified adult to cut out the shape using a bandsaw with a metal blade. Once they have cutout the shape, use a pillar drill and a 5mm metal drill and drill holes around the finger grip outlines. After, clamp a metal vice to the worktop using a bench vice and put protection clips on the mouth of the metal vice. Then. Take out the blade of a junior hacksaw and send it through one of the holes and reassemble the junior hacksaw. Then, use the junior hacksaw to cut out the excess metal of the finger grip	• Bandsaw • Cutting fluid • Pillar drill • Metal drill bit • Junior hacksaw • Metal vice • Bench vice • Protection clips	Always wear gloves and an apron when working with metals and wear googles when cutting metals	Make sure to cut on the waste side to account for tolerance	Frequently spray cutting fluid on the blade of the bandsaw to make sure it easy cuts through metal. When drilling into aluminum, drill slowly so the metal does not stick to the drill bit and frequently stop and remove excess metal
5	Next, use a curved file to smoothen the curves and edges. Then, use emery cloth metal to soften and smoothen the 5mm thick edges. Next use a brass wire brush attachment and attach it to a power tool and brush every surface of the steering wheel baseplate	• Curved file • Emery cloth metal • Brass wire brush • Power tool	Always wear gloves and an apron when working with metals and wear googles when filing brushing metals	Soften the edges with the emery cloth metal until it is nice and shiny surface. Continue using the copper wire brush until it reveals a bright silver shiny surface.	Keep the file straight when filing to avoid uneven bumps
6	Next, place the stock Logitech G923 steering wheel on the massive aluminum sheet and mark out the outline of its exact shape using engineer's blue to create small T shape. Then, using the manufacturing specification, mark out an additional 75x30mm extending from the both arms of the T shape. Next, mark out a box shape around the drawn shape to cutout using a steel rule and an engineer's try square. Then, clamp the aluminum sheet to the workbench with the section to cutout hanging in the air. Next, attach an aluminum cutting disk to an angle grinder and cut out the box shape using the angle grinder. Additionally, cut out parts of excess metal to reduce amount of filing later. Next, hold the cutout aluminum piece in a metal vice attached to a bench vice attached to the workbench. Then, using a file, file down all excess metal until it is the correct shape as marked out	• Engineer's blue • *Scribe* • Angle grinder • Engineer's try square • Steel rule • Metal vice • Bench vice	Always wear gloves and an apron when working with metals and wear googles when cutting metals. Cutting aluminum with an angle grinder will cause the aluminum to heat up very quickly. Make sure to wear gloves, face mask, ear protection and an apron to protect yourself from flying debris and the loud sound of the angle grinder	When using the angle grinder to cut off excess metal, cut from the waste side to allow for tolerances	You can also use a scribe if a permanent marker is unavailable or not working

Step Number	Method	Tools	Health and Safety	Quality Control	Tips
7	Next, using the manufacturing specification, the support bracket will be 46mm long before bending at a 140 degrees angle for another 71mm. Furthermore, we must add an additional 10mm length to account for the screws to hold both the base plate and the support bracket together. Therefore, holding the support bracket with the metal vice and protection clips, each measurement must be marked out as according to the manufacturing specification on where to bend the metal. Thus, after holding the metal support bracket in place, use any hammer and hit the metal in the direction of the bend several times before until I use a protractor to check the angle of the bend. Repeat the same step for the other hand until both hands are bent perfectly to attach onto the base plate steering wheel	• Metal vice • Protection clips • Protractor	Always wear gloves and an apron when working with metals	Make sure the angles are matching the same as to the manufacturing specification	Constantly check every 5 hits to see how close the angle is to the specification
8	Next, using a very thin permanent marker, find the small 10mm bit of the bent arm of the support bracket and mark out 2 spots for the screws to screw to the base plate. Next, using a centerpunch and a hammer to dent the marked out spot for drilling. Then, using a power tool and a 5mm metal drill bit, drill holes at the spots marked out. Repeat for the other arm.	• Permanent marker • Power tool • 5mm metal drill bit • Centerpunch • Hammer	Always wear gloves and an apron when working with metals	Make sure the holes are clear of any excess metal by fitting an M5 bolt though	When drilling into aluminum, drill slowly so the metal does not stick to the drill bit and frequently stop and remove excess metal. When drilling into metals, clamp it to a wooden piece underneath
9	Next, place the support bracket on top of the base plate steering wheel and align it at the center while also making sure that the arms are not sticking outside the body. Then, clamp the entire structure together and using a very thin permanent marker, mark out a spot through the holes of the support bracket for it to be screwed onto the base plate steering wheel. After, remove the clamps and using a centerpunch and hammer, dent the spot	• Clamps • Permanent marker • Center punch • Hammer • Power tool • 5mm metal drill bit	Always wear gloves and an apron when working with metals	Make sure the holes are perfectly lined up by fitting an M5 bolt through all 4 holes at the same time	When drilling into aluminum, drill slowly so the metal does not stick to the drill bit and frequently stop and remove excess metal. When drilling into metals, clamp it to a wooden piece underneath

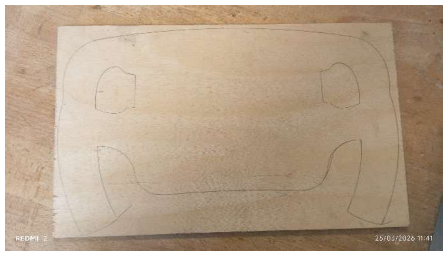
Step Number	Method	Tools	Health and Safety	Quality Control	Tips
9	marked out for the power drill. Then using a power tool and 5mm metal drill bit, drill through the marked out dented spots.				
10	Next, using a tap and M6 tap set, ensure the tap set has 3 different threading options clearly marked out. In our case, we had number of stripes (no stripes, 1 stripe and 2 stripes). Attach the 2 striped tap to the tap wrench and tighten the tap wrench to secure the tap in the tap wrench. Then, apply some metal cutting compound to both the tap and the hole in the baseplate steering wheel. Next, carefully position the tap tool on top of the hole and continuously twist the tap wrench clockwise slowly until the tap has gone fully through the hole. Then, continuously twist the tap wrench anti-clockwise to take out the tap tool. The swap the 2 striped tap with the 1 striped tap and repeat the same process again and the same with the no stripes tap. Repeat for all holes on the baseplate steering wheel.	• Tap wrench • M6 tap set • Metal cutting compound	Wear latex gloves when applying metal cutting compound	Ensure a thread is visible inside the hole and an M6 bolt can easily be screwed through the hole	If the tap wrench is not twisting, twist in the opposite direction 180 degrees before twisting back in the initial direction
11	Increase the size of the screw holes in the support bracket by using a 6mm metal drill bit and a power tool and drill through the holes to expand their diameter. Next, using a soft metals countersink drill bit set, use the 12.4 countersink and attach it to the power tool and drill 4mm into the metal for M6 countersink bolts. File off any excess metal	• 6mm drill bit • Power tool • Soft metals countersink drill bits set • 12.4 countersink drill bit	Always wear gloves and an apron when working with metals	Ensure an M6 countersink bolt easy fits though and sits flush in the surface	When drilling into aluminum, drill slowly so the metal does not stick to the drill bit and frequently stop and remove excess metal. When drilling into metals, clamp it to a wooden piece underneath
12	In our case, the only M6 countersink bolts we had were 40mm long. So firstly, we screw the both structures together using the M6 bolts. Then mark out the excess screw using a permanent marker and repeat for all other screws. Then, hold the screws in a metal vice and cut out the excess screw using a hacksaw	• Permanent marker • Metal vice • Hacksaw	Always wear gloves and an apron when working with metals. Wear goggles when cutting metals	Ensure the screws sit flush or slightly elevated from the baseplate steering wheel when screwed in	Cut the screws from the waste side

Step Number	Method	Tools	Health and Safety	Quality Control	Tips
13	In our case, our screws were slightly elevated by 3mm. To fix this, screw the entire steering wheel together and hold it with a metal vice. Next, use an angle grinder with an abrading disc attachment. Then, use the angle grinder to abrade the surface and make the screw sit flush within the surface. Repeat for all other screws	• Metal vice • Angle grinder • Abrading disk	Always wear gloves and an apron when working with metals. When using an angle grinder, wear a face mask and ear protection. Keep distance from the angle grinder and make sure the debris does not fly towards your body	Make sure the surface of the base plate steering wheel is perfectly flat and smooth with the screws in	After abrading, use the brass wire brush and brush the surface again
14	Next, using the mount for both the emergency stop and 3 position selector switch, mark out the screws to make holes for their mounts to screw onto the baseplate steering wheel. Then, hold the entire steering wheel structure on a metal vice and using a power tool and a 3mm metal drill bit, drill through the marked-out screw holes. Then, using a screwdriver, tighten the screws to secure the mounts to the steering wheel. Then attach the emergency stop to its mount and the selector switch to its mount	• Metal vice • Power tool • 3mm drill bit • Screwdriver	Always wear gloves and an apron when working with metals	Make sure both the estop and selector switch work seamlessly when fitted in the steering wheel	Use a hand screwdriver to avoid damaging the screws
15	Unscrew everything including the selector switch, estop and the support bracket. Then use pliers to cut a piece of steel wire and tie the steel wire to the baseplate steering wheel. Then, using a blow torch, heat up the entire baseplate for a couple minutes to ensure that the dipcoat will stick to the baseplate. Next, using a dip coating machine and black dipcoat, dip the baseplate steering wheel into the machine for 1 second before taking it out and inspecting for imperfections. If there are any parts not dip coating properly, dip it in again. Once finalized, hang the baseplate using the steel wire to let it cool for at least 5 minutes. After, screw back everything except the support bracket	• Pliers • Steel wire • Blow torch • Dip coating machine • Black dip coat	Always wear gloves and an apron when working with metals. Keep a safe distance from the blow torch when using it	Make sure there are no imperfections and now dry spots with no dip coat	If some imperfections are visible, reheat that part and spray some dipcoat dust on it

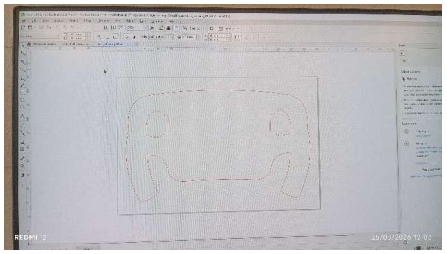
Step Number	Method	Tools	Health and Safety	Quality Control	Tips
16	Next, load up the initial design of the steering wheel used to mark out the shape of the baseplate steering wheel on the aluminum sheet on CorelDRAW. Next, Using 3-point curves, mark out layers like contour lines of the handles with approximately 5mm gaps in between. Next, separate all the layers and arrange them for a 300x210 sheet of 5mm thick plywood. Then, print the design twice on a laser cutter for 2 sheets of plywood. After printing, use PVA glue to stick all the layers together. Then clamp it together and let it sit for 4 hours to fully settle. Next, use an instant adhesive called “Loctite 401” to stick the plywood handles to the dip coated baseplate steering wheel handles and clamp together for another hour	• CorelDRAW • Laser cutter • PVA Glue • Loctite 401 • Clamps	Wear gloves when working with Loctite 401. ensure a qualified professional or trusted adult is present when the laser cutting print is started	Ensure There is clearance for the rotary encoders to fit on the steering wheel too	Mark out the spots for the encoders on CorelDRAW itself to reduce workload and adjust the wood pieces online
17	Next, cut some steel wire using pliers and tie it around one of the holes of the support bracket. Next, using some orange spray paint, spray the entire bracket from all sides. After, hang it using the steel wire to let it dry. After 12 hours, apply a second coat and repeat the same process and dry for another 12 hours	• Steel wire • Pliers • Orange spray paint	Wear gloves and wear a mouth mask the protect from the dangerous invisible fumes oof the spray paint	Ensure there are no dry spots or spots where the shiny silver aluminum is visible. Additionally, ensure that each hole is also painted orange	When using the spray paint, spray from at least 15-20cm away from the support bracket to evenly spread the paint
18	Purchase some dupont wires, an Arduino Leonardo, ESP32 Dev module, 8 tactile push buttons, 4 rotary encoders, a TFT display and one joystick. Then using the Arduino IDE, program the Leonardo to press keys on the pc when a tactile button is pressed, joystick is moved or rotary encoder is twisted. Program the ESP32 to flash on screen when a button is pressed and display live telemetry data from the game. Then, hot glue all the wires and components together and hot glue the components and wires to the baseplate steering wheel. Use heat shrink tubes and insulating tape to bundle large collection of wires together and use a hot air gun to shrink	• Hot glue • Arduino IDE • Hot air gun			

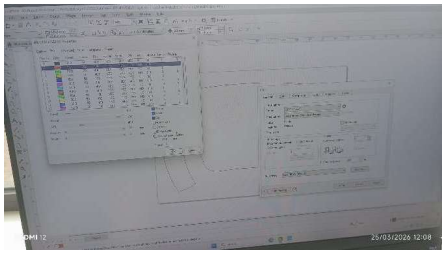
Step Number	Method	Tools	Health and Safety	Quality Control	Tips
19	Next, on CorelDRAW insert a picture of the Mclaren logo from google and format it to only show the outline of the Mclaren logo. Then, measure the dimensions of the logo and make sure it is small enough to fit on the circular shape of the support bracket. Then, upload it to a vinyl cutter and print it on a white vinyl sheet. After, take out the cut out logo and stick it on the support bracket	• CorelDRAW • Vinyl cutter	N/A	Make sure it fits within the circular shape of the support bracket	None
20	Then, purchase some tennis racket grip tape and apply it all around the handles. Use some insulator tape to tighten and secure the grip tape and use it to cover some of the wiring	• Tennis racket grip tape • Insulator tape	N/A	Make sure it covers and hides all the wood handles to make ergonomic for the client	Use some of the insulator tape to hide the PCB and wiring to keep it aesthetically pleasing for the client
21	Next, attach the support bracket to the Logitech G923 wheelbase first using the 6 screws and a screwdriver, then attach the baseplate steering wheel to the support bracket and secure it using the 4 screws	• Screwdriver	N/A	Ensure the steering wheel setup is secured and rigid with the wheelbase and there is enough clearance for the steering wheel to easily turn 900 degrees	Using the screwdriver, tighten the screws slowly so the thread does not wear out
22	Then, connect 2 MicroUSB cables from both ESP32 and the Arduino Leonardo and connect them to the PC. Then, install SimHub and select the ESP32 in the “Custom Serial Devices” and click connect. Finally, install Assetto Corsa, start and run the game and the steering wheel is complete with active in-game telemetry feeding to the ESP32 which is then displayed on the screen.	• MicroUSB cables • SimHub • Assetto Corsa	N/A	Make sure the 2 MicroUSB cables are secured and hidden so they do not interfere or distract the client when driving	Use cable ties to secure the cables together

Production plan photos



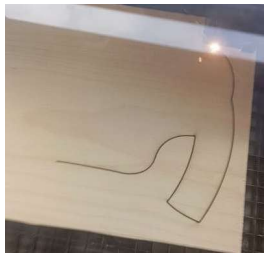
Step 1

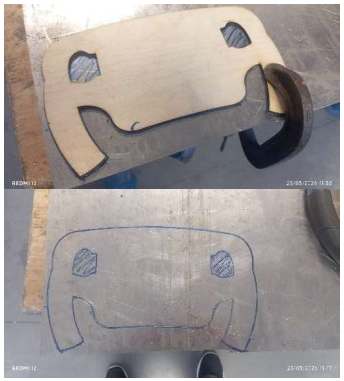




----------Step 2----------→

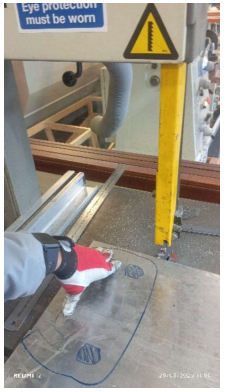
Laser cutter





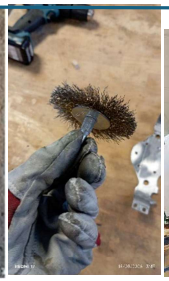
Step 3

Metal bandsaw



----------Step 4 ----------→

File



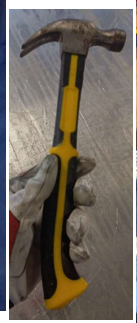
Brass wire brush----------

----------Step 5----------→ ----------Step 5----------→

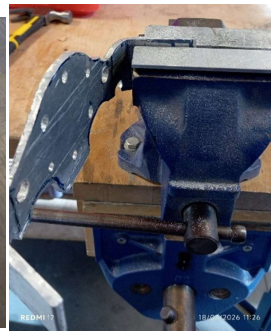
----------Step 6----------→

Angle grinder

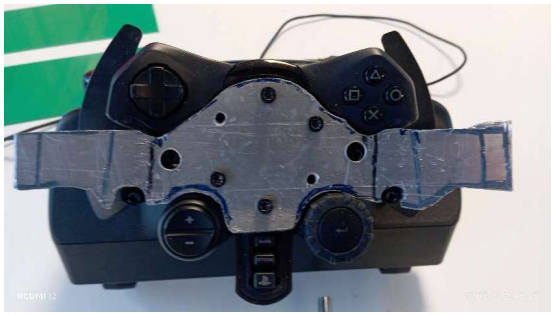
---------Step 6------→



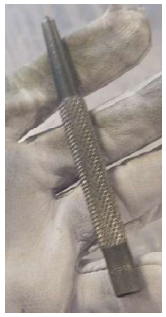
Claw Hammer



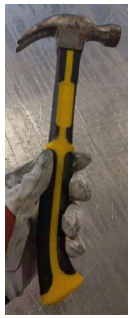
Step 7



Test fit cutout support bracket

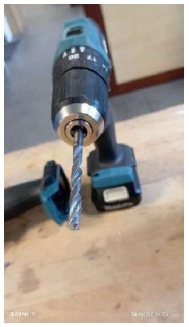


Center punch



Claw Hammer

Step 8



Power tool

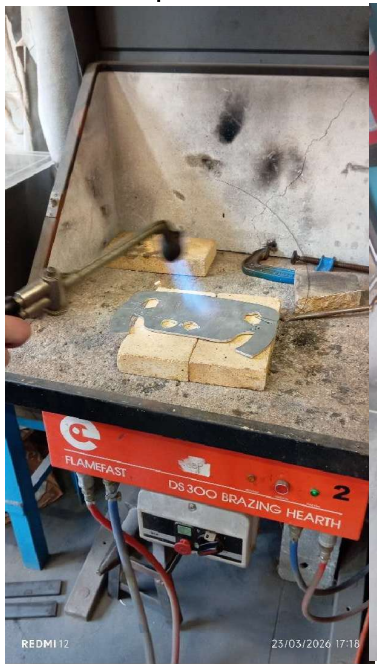
Step 10

----------Step 11----------→

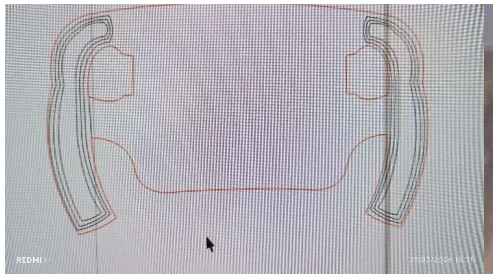
-------Step 12--------→ ----------Step 13----------→

Step 14

Pliers and steel wire



----------Step 15----------→

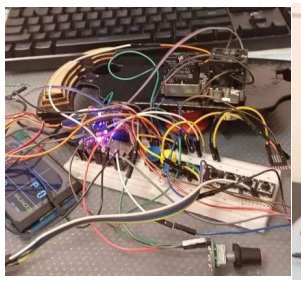
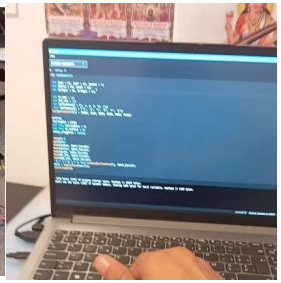




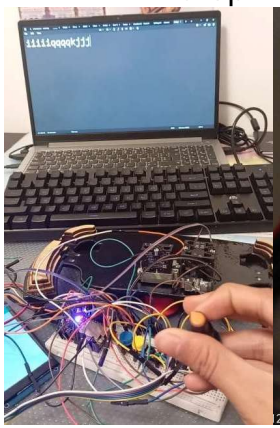
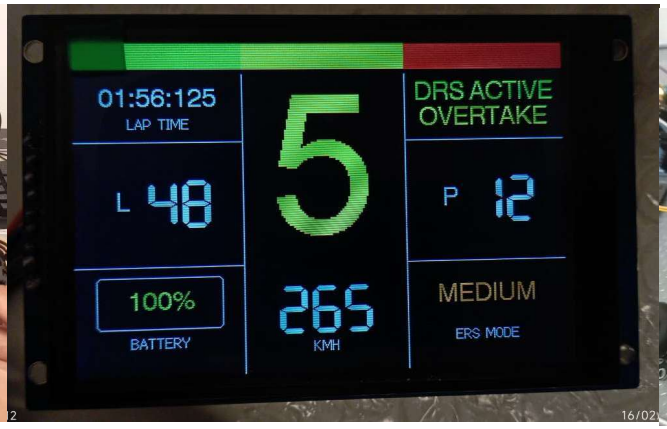

----------Step 16----------→

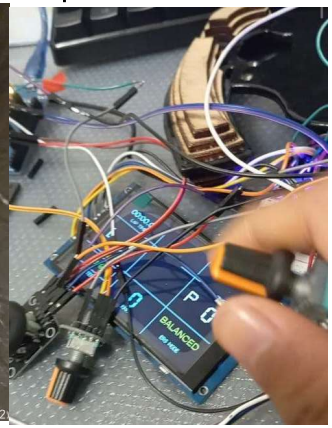
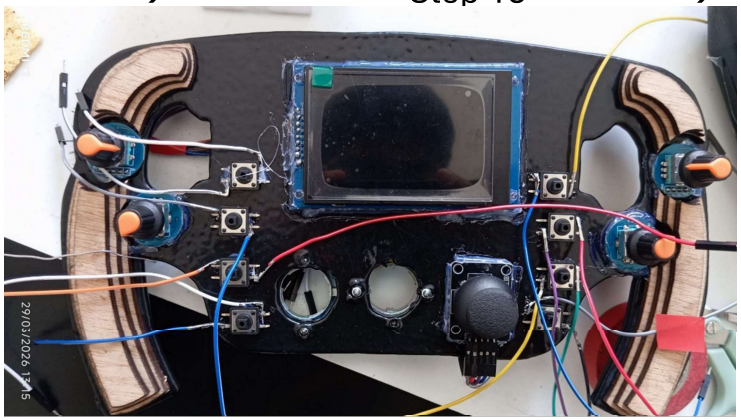




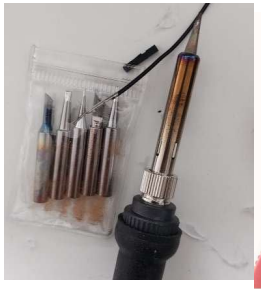
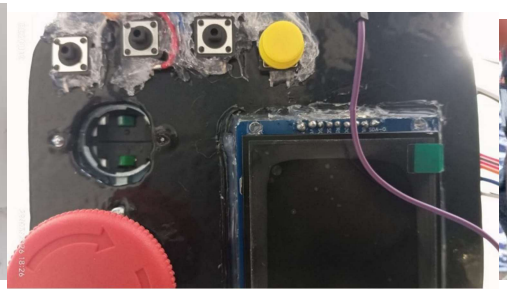
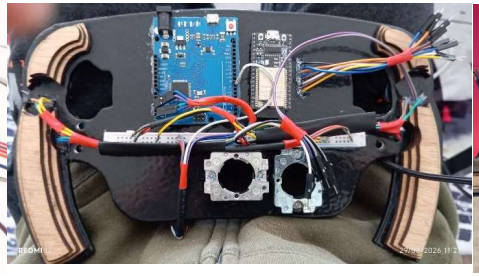




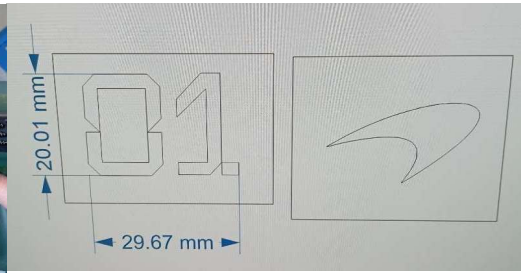
Step 16 ----------Step 17----------→ ----------Step 18----------→

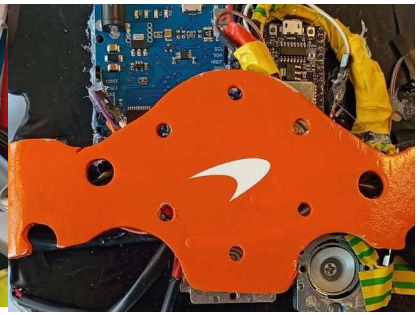



----------Step 18----------→

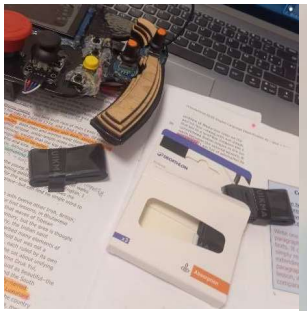




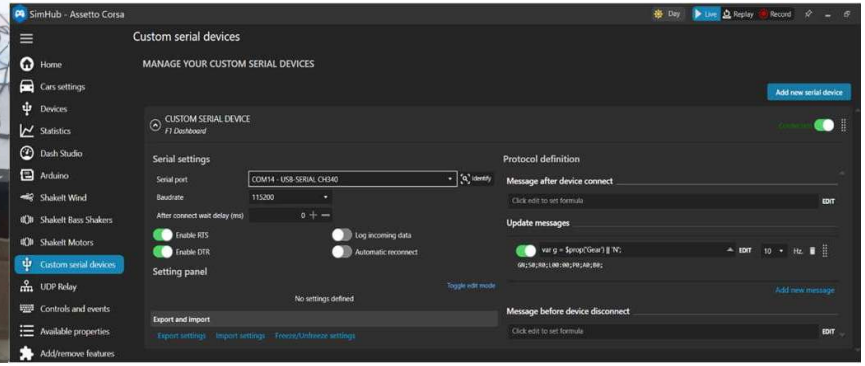
Soldering Iron ----------Step 18----------→ Step 19



----------Step 19----------→



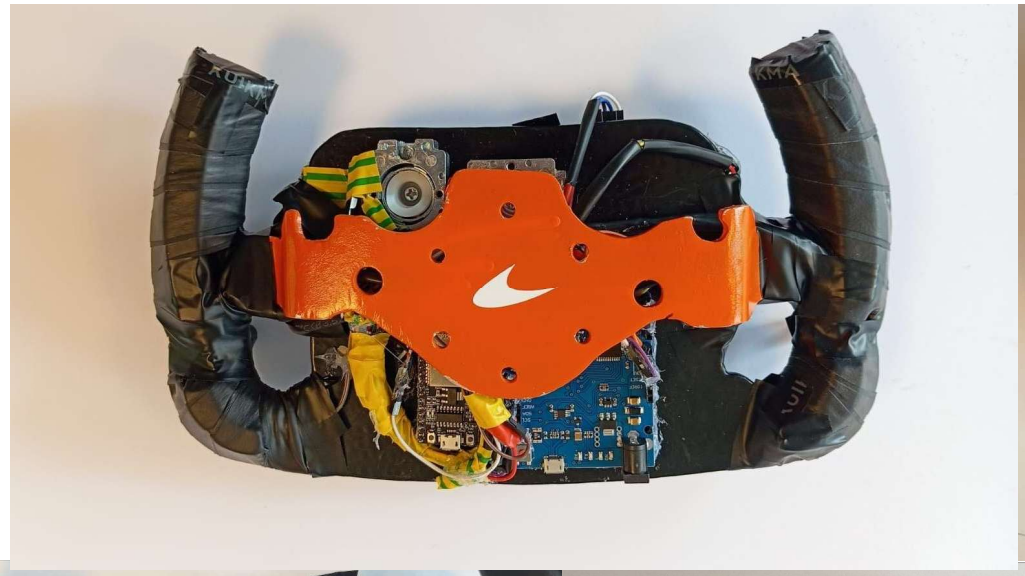
---------- Step 20----------→

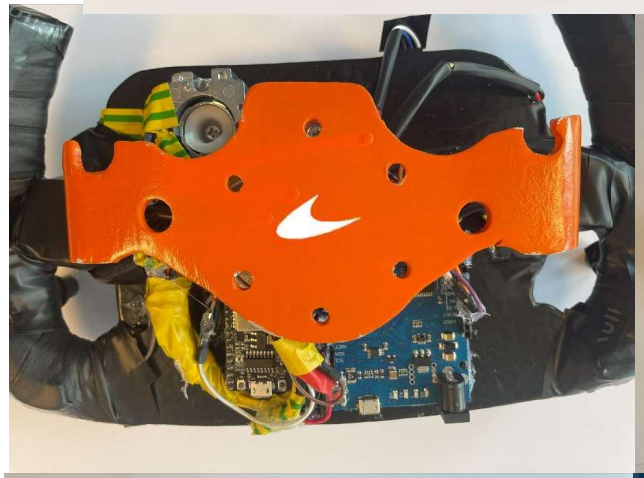


----------Step 21----------→

Step 22

Watch the steering wheel in action here







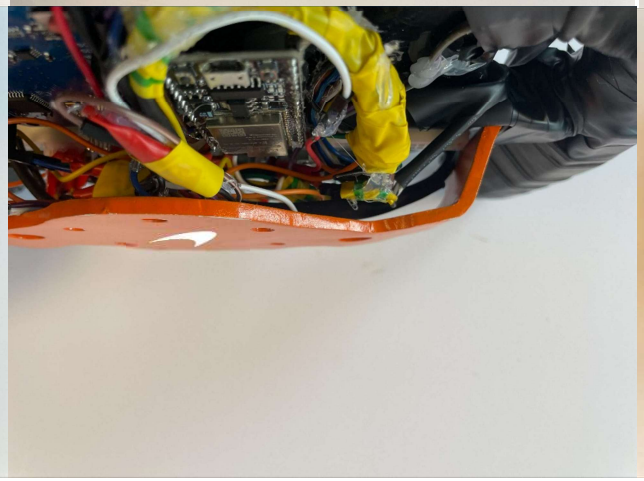



Photo of me holding the product

Photo of the client holding the product