MANUFACTURING

SAFETY CONSIDERATIONS

Risk:	Mitigation:
Getting cut/burnt/caught in the sharp and exposed, fast moving parts of much of the large and powerful equipment we would be working with and around (eg: injury from a rotating dill bit)	*Only operate machines once we have understood how to work them properly and even so, under adult supervision. Wear appropriate clothing, that isn't likely to get caught and tie back hair, and wear gloves where necessary. Always be alert and aware of our surroundings.*
Small parts flaking off materials could fly into eyes, causing irritation (eg: whilst drilling/sanding/sawing)	*Wearing goggles when using equipment*
Slippery workshop floor (due to spillages/sawdust/etc.) increases risk of falling over, around potentially dangerous machinery	*Check for potential slipping hazards before starting work. Clean any mess made as we go*
Fumes from the spray paint can irritate eyes, nose and lungs. Prolonged exposure can result in more serious, long-term health issues	*Paint in well-ventilated area with a face mask, goggles and appropriate workwear*

MATERIALS

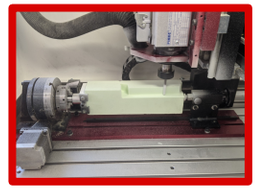
Manufacturing Material:	Justification:
SUPERGLUE We made sure to position the materials being glued very carefully and wore gloves to reduce the risk of the glue bonding to exposed skin.	⚡ An instant adhesive, which is also quick drying, meaning that there is no need to clamp materials together for a long time. ⚡ Thin layers required, so it will not alter the dimensions of the car ⚡ It snaps off cleanly in the case that the materials need to be readjusted ⚡ It is an extremely strong adhesive
PRIMER Used to provide a uniform base coat, for the coloured paint to go on. It would be sanded down between coats for a smooth finish.	⚡ Fills and seals any pores in the polyurethane body ⚡ Sanded between coats to remove any imperfections/machine marks left from the CNC router ⚡ Provided an optimum surface for the paint to grip to
SPRAY PAINT Before spraying, the surface would be primed, to ensure that the paint would grip effectively.	⚡ Can be applied in thin coats - therefore will not alter the dimensions of the car ⚡ Even surface coverage which does not upset the balance of the car ⚡ Fast and efficient ⚡ Produces minimal waste, as little paint can cover large areas, giving a smooth finish due to even paint particle distribution
CLEAR LACQUER Applied evenly in thin coats to the fully assembled car	⚡ Hardens and reinforces the structure of the car ⚡ Keeps decals flat on the bodywork, so they do not lift up and create unwanted drag ⚡ Provides a smooth surface finish, which minimises skin friction drag and aids clean airflow ⚡ Make the car more visually appealing
WATERSLIDE DECALS: Manually transferred to car body before the clear coat was added	⚡ Extremely thin so they easily conform to the shapes of the body and do not impact the dimensions ⚡ Gives a more professional look as they can be put underneath the coat of resin

We outsourced our CNC manufacturing to UTC Scarborough as due to COVID-19 lockdown restrictions, we did not have access to the necessary equipment. However, we had previously manufactured other cars, in person, at UCL, which meant we had first-hand experience with the technologies that would be used.

CNC ROUTING

We exported our CAD files as .stl files, which were then imported onto QuickCam Pro: a software that would map the tool paths, cutting from four different sides, with the Y and Z datums calibrated with the centre of the CO_2 cartridge chamber.

A CNC router with a 3mm drill bit was used to cut our main body out of the F1 model block. We had designed our CAD beforehand, with rounded edges and fillets, in order to accommodate the rounded tip of the ball nose cutter, ensuring a high quality finish.



3D PRINTING

	Fused Deposition Modelling (FDM)	Stereolithography (SLA)	Selective Laser Sintering (SLS)
PRINTING PROCESS	Thermoplastic filament melted and applied layer by layer	Photopolymerisation- UV laser cures liquid resin into hardened plastic	Laser fuses thermoplastic powder
COST	£0.50/cm^3 (Possibly free from school)	£0.50/cm^3	£1.00/cm^3
TIME	150-340 minutes ⚡ Easy physical set up ⚡ Time-consuming CAD file set up	75-350 minutes ⚡ Easy physical and file set up	120-200 minutes ⚡ Time consuming physical set up ⚡ Easy file set up
ADVANTAGES	⚡ Range of thermoplastics and colours available	⚡ Wide range of resin can be used ⚡ Easier to break support structures	⚡ No need for support structures and sanding ⚡ High quality complex designs ⚡ Rigid structure
DISADVANTAGES	⚡ Parts are brittle ⚡ Clearly visible layers – rough finish ⚡ Unable to replicate intricate designs ⚡ Support structures need to be removed by sanding	⚡ Parts are brittle ⚡ Parts need to be rinsed in isopropyl alcohol ⚡ Support structures need to be removed ⚡ Sanding may be required	⚡ Rough finish but no visible layers ⚡ Porous and brittle ⚡ Possible shrinkage and warping ⚡ Not environmentally friendly- only 50% of waste powder can be reused
ACCESSIBILITY	Available at school	Requires outsourcing	Requires outsourcing

Having track tested all the different 3D printing methods, we chose SLS as it produced stronger components with the highest quality finish. Through research we concluded that Nylon-12 would be the best fit as it is commonly used for SLS printing, and is also low density and resistant to abrasion and chemicals. Its low coefficient of friction also makes it ideal for the wheels.