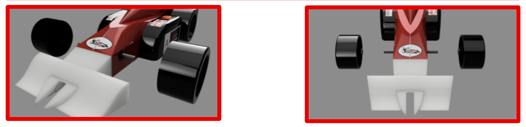
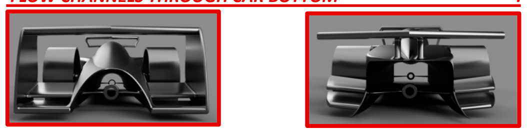
WHEEL DESIGN

One of the main differences stepping up from designing our Development Class Car, was having to create our own wheels and wheel support systems, as we had previously used the standard, development class system, which consisted of a rotating axel running through the car with fixed wheels on either end. There were numerous reasons why we could not use this same system, including the following:

DEVELOPMENT CLASS SYSTEM



FLOW CHANNELS THROUGH CAR BOTTOM

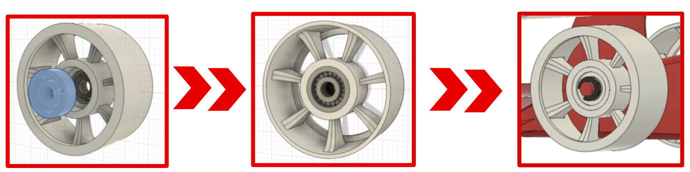


- The steel axel rotating in the plastic axel bush inevitably resulted in large amounts of friction between the two components, which slowed the car down
- Article *P7.8* of the technical regulations stated that 'each wheel had to rotate freely about its own centre axis', which meant that the previous system (fixing both wheels to the axel and having the entire axel rotate) would not comply with the new technical regulations
- To reduce the frontal area of our car, both prototype designs had a flow channel running through the bottom of the car, which meant that having one continuous axel running across the entire width would no longer be an option

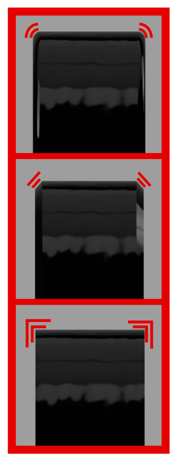
WHEELS

After considering various wheel profiles, we chose to keep the edges straight, as this would allow us to make the wheels as narrow as possible (given that the minimum width would only be 'measured along the surface of the wheel that makes constant contact with the track surface' – *P7.4)*, in order to reduce frontal area and the effects of wheel wake.

The wheel design itself consisted of a central ring connected to an outer ring by seven spokes, with in-built casings for the bearings, which had to perfectly match the diameter of the outer race of the bearing, to ensure a snug fit .



WHEEL PROFILES



- Fillet tool applied to edges in attempt to minimise flow separation and thus, wheel wake
- Chamfer tool applied to edges to give a lower frontal area
- Edges kept straight

The more spokes we put on the wheel, the more spread out the load would be, meaning less stress on the rim and a lower risk of the wheel deforming. For this reason, we chose to use seven spokes: a reasonably high number, which was also odd, meaning that any load on the wheel would always be shared across at least two different spokes, increasing its strength.

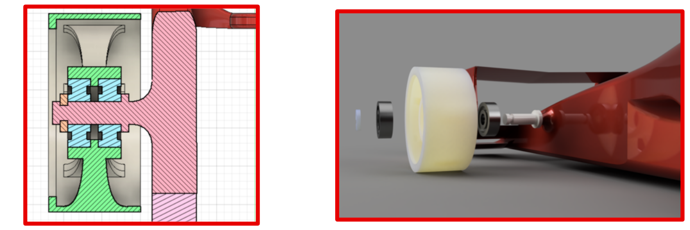
AXELS

Due to the restrictions outlined above, we would have to manufacture an individual 'axel' on either side of the car body. This, however, meant that the chances of having misaligned wheels could increase if we weren't careful, as the axels on either side would need to line up perfectly. We constantly kept this in mind throughout the design process: the need to reduce the scope for human error when manufacturing, by ensuring that our system could be easily assembled to the high degree of precision required.

We used two different ideas on our prototypes so that we could physically test both (for performance and manufacturability), to see which one was better. We knew that the axels would be too small and intricate to be machined directly onto the F1 in Schools model block and that polyurethane would be too fragile a material to use. We therefore decided that we would 3D-Print these parts and our wheel support structure would have to perfectly fit onto the car body.

WHEEL HUB

In order to achieve a faster lap-time, we would have to minimise the friction between the wheels and axels, so we decided to use miniature ball bearings (which would reduce the area of contact between moving parts, meaning less friction). To better spread the weight of the car across the full width of the wheels and to ensure good alignment, we chose to put two bearings in each rim, which also reduced the load, and therefore the wear, on each bearing. Although this would mean extra weight, we calculated that our main body design would be light enough for the weight of eight bearings to be added on, whilst still remaining under 50g.

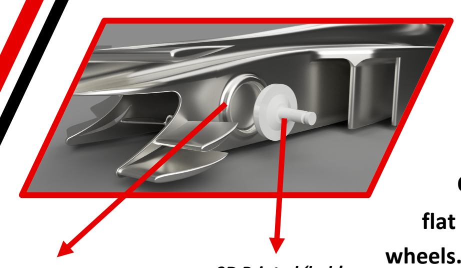


Having spoken to previous world finalists: 'Aflex Hose Centurion Racing' and taken inspiration form their design, we developed our own wheel system, which consisted of mounting a bearing on either side of the wheel rim, securing them with a clip designed to fit onto a groove in the axel, and covering the end of the wheel with a sticker.

This also allowed for easy assembly and disassembly, should any component need to be replaced.

Bearing Type	*Advantages/Disadvantages*
Steel	*Heavier* *Lower max RPM* *Relatively durable, but likely to deform after multiple races* *£0.94 per unit*
Hybrid Ceramic	*Lighter* *Higher max RPM – balls are smoother, rounder and more uniform* *More durable as ceramic balls are harder* *$23.37 per unit*

SUPPORT STRUCTURE 1



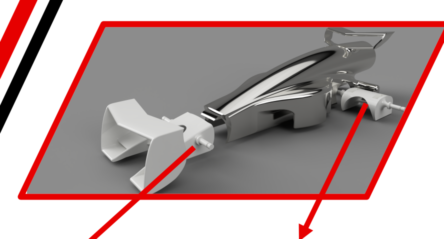
Ridge machined onto F1 model block

3D Printed 'hub'

Our first structure consisted of four individual wheel 'hubs', designed to fit perfectly into specially made slots on the machined model block. Ridges would act as a guide so that we would be able to perfectly position the wheel hubs when manufacturing.

Our only concern with this design, however, was that if the wheel 'hubs' were not placed perfectly flat on the body (perhaps due to extra volume from glue), there would still be a risk of misaligning the wheels. Furthermore, these wheel 'hubs' would have to carry the weight of the whole car and we weren't sure whether the very thin ridge we had designed would provide sufficient support to stop the wheel hub slipping/detaching from the main body.

SUPPORT STRUCTURE 2



Nose, front wing and front wheel support structure

Rear wheel support structure

The second structure had the wheel supports manufactured as single 3D-Printed units, which would slot perfectly onto the model block (at the front, this was manufactured together with the nose and front wing). We had to ensure that these components did not exceed the boundaries of the "cylindrical volume generated through the diameter of the two opposing wheels" as per article *P7.12.1* of the Pro Class Technical Regulations.

If we adopted this system, it would help with durability and would also mean that wheel alignment would be less of a concern, as the precision of the axel positioning would be down to the CNC machines and as a result, there would be less scope for human error due to there being fewer parts to assemble.