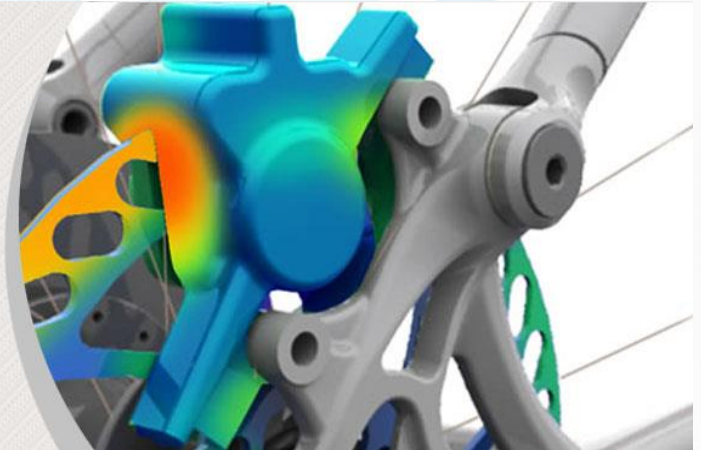


Stress Simulation of a Basketball Rim



Perform Structural Testing of Parts and Assemblies for Product Innovation.



Aim

The objective will be to modify the pre-defined steel alloy basketball hoop in a bid to improve its performance. I will also be observing and analysing the hoop's strength and deformation characteristics when subjected to the sort of stresses caused when Michael Jordan (MJ), performs a slam-dunk.

When analysing my results, I will be referencing the Yield strength data for the majority of the time rather than Tensile strength data.

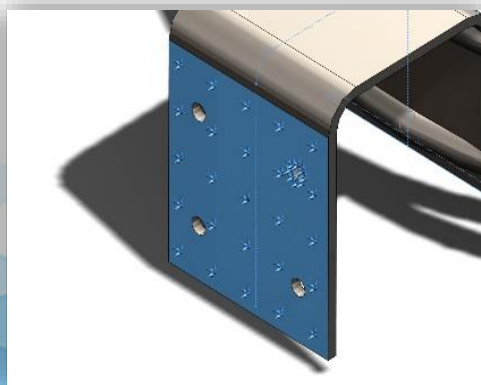
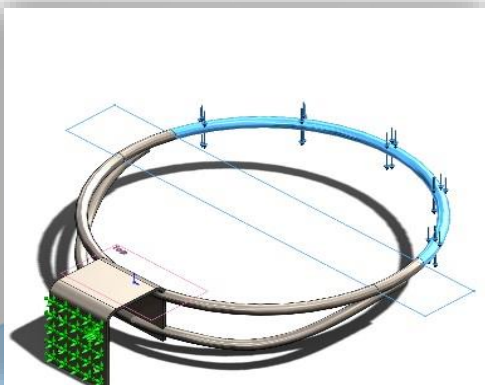
The reason for this is because despite Tensile strength representing the breaking point of the material, it is the Yield strength that represents the point at which permanent deformation begins.

The Yield strength also has a lower value than the Tensile strength.

This means that the material's Yield strength will be reached before its Tensile strength: therefore, when the stress on the hoop is lower than its Yield strength, it is inevitably lower than its Tensile strength.

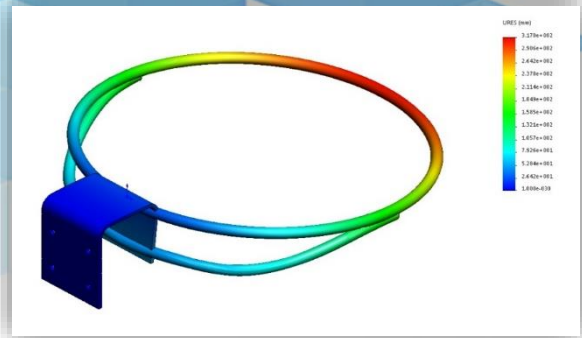
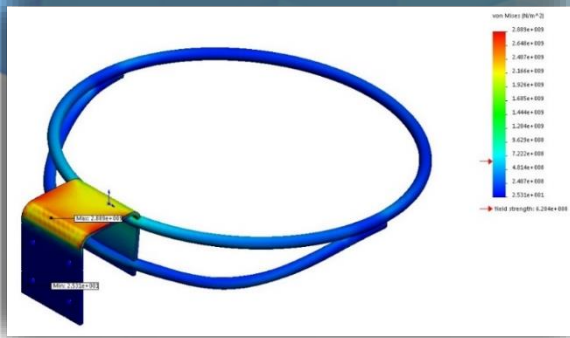
The amount of force I will be applying is 2500N. The reason for this is to ensure there is a suitable allowance considering that MJ, and other athletes, will be dunking, slam-dunking, and potentially hanging on the hoop with a lot of force. With MJ weighing 98kg, applying 2500N will also compensate for the impact force as well.

For the benefit of the objective, I attached the hoop using a bracket on the back. I then went on to apply the 2500N force vertically on the front of the hoop for each iteration.



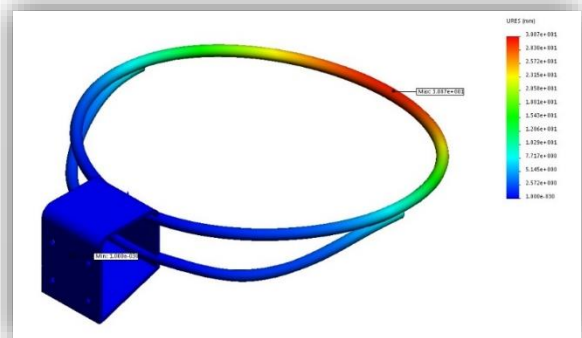
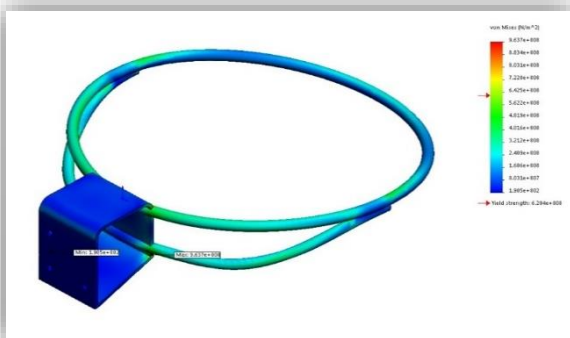
Sebastien Stone

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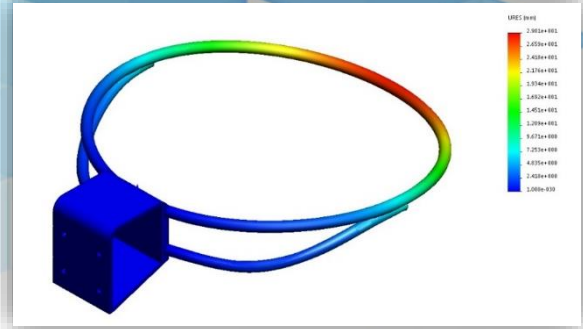
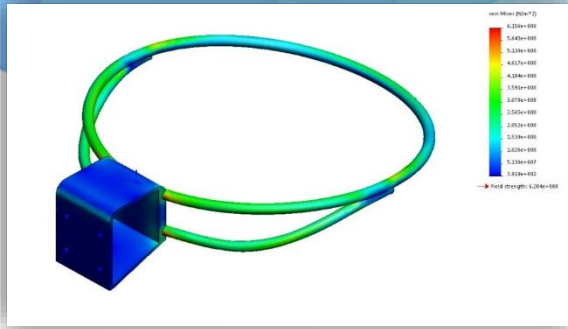
Benchmark

I carried out a standard benchmarking test on the unmodified hoop as a performance measure for all subsequent tests. It indicated that the top part of the hoop's bracket is unable to sustain the force of 2500N. Application of such a force causes the upper full-hoop section to bend in on itself despite its lower semi-circular reinforcement, as stress is applied to the area where the hoop and bracket come in to contact. This outcome is indicated on the accompanying stress key: where any colour above the top arrow on the scale indicates that the material's Yield strength has been surpassed. It also indicates that the maximum stress point is $2.88864 \times 10^9 \text{ N/m}^2$, which is a great deal beyond the material's Tensile strength, and would mean that the hoop would in fact break away from the bracket. The accompanying displacement key shows that the hoop has a maximum displacement of 317.046 mm, which occurs on the front of the rim. This is not an indication that the rim alone is bending 317mm, it means that the entire hoop and bracket are bending down 317mm when 2500N of force is applied resulting in it breaking, which is an unacceptable outcome.



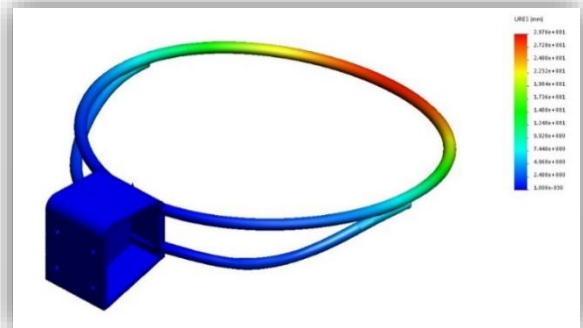
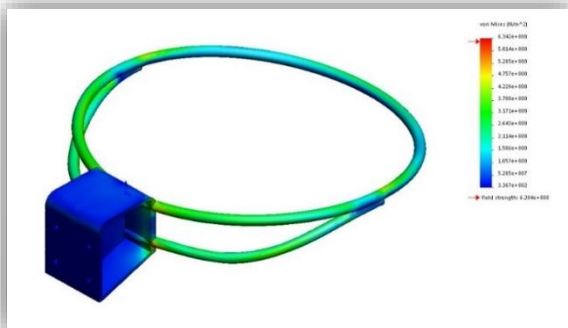
Modification 1

In an effort to strengthen the design and prevent the hoop from bending too much, I added a reinforcing connection to the bottom of the bracket. As the illustrations indicate, the reinforcement runs from rear to the front of the bracket along its base, enclosing the bracket itself and running underneath the hoop's semi-circular reinforcement. This alteration was made to prevent the hoop folding in on itself and was found to work very well. The addition means its maximum displacement drops to 30.9mm. This single adjustment, therefore, has improved the maximum displacement ten-fold with a small change of 3.1cm in total. As the stress graph and diagram indicate, however, some of the stress has now been transferred over to the joint where the hoop and bracket meet, creating a new weak area in the process. The diagram shows that the maximum stress point is $9.6372 \times 10^8 \text{ N/m}^2$ in this area, whereas the Tensile strength of this steel alloy is $7.23826 \times 10^8 \text{ N/m}^2$. This means that the hoop would actually break in the corners if 2500N of force was applied.



Modification 2

To try to address the new weakness created by the modification set out above I made a further modification of the model within the virtual environment. In the first instance, I made the connecting parts between the bracket and hoop slightly thicker. This is the flat side of the bracket opposite the four fixings. The change resulted in a very similar outcome to the previous design where the structural weakness remains in the same location. However, this small “tweak” does act to improve slightly the displacement and stress levels. As the illustrative measures show the maximum stress lowers to $6.15647e+008 \text{ N/m}^2$, and has a slightly improved displacement of 29mm which is a 0.2cm improvement on where it had previously been. Despite the tiny enhancement of the overall design, the outcome is that the hoop becomes technically strong enough to withstand 2500N of force. The holes used to fix the hoop in place, on the rear of the bracket, are also still easily accessible to allow the hoop to be fixed to a wall. This represents, potentially, an acceptable “real world” working solution to the hoop’s design weakness as the materials Yield strength is not exceeded. Moreover, the rim only flexes 29mm when a “maximum load” scenario is simulated. However, the hoop’s overall manufacturability is another aspect which has to be considered. This alteration of the design could potentially have an adverse or complicating impact on the manufacturing process which would need to be explored and, if problematic, addressed.



Modification 3

The third modification was an attempt to improve on the previous alteration to eradicate potential manufacturing difficulties. To this end, I reduced the thickness of the same flat side of the bracket opposite the fixings, which was previously changed in Modification 2. This acted to make cooling times similar to the rest of the bracket when being manufactured. I also added a centre section within the bracket, which bisected the interior of the bracket, front to back, and acted as a reinforcement. This was done to compensate for making the previous reinforcement thinner, although still thicker than it had originally been. These alterations still allow sufficient room for the fixings to be accessed to mount the hoop on a wall. Although aesthetically this iteration looks to be strong enough with only a minor difference, the point of maximum stress is $6.34218e+008 \text{ N/m}^2$ which is $0.13818e+008 \text{ N/m}^2$ over the Yield strength. Once the Yield strength has been surpassed, permanent non-reversible deformation begins. Despite the hoop only moving 29.8 mm with the force of 2500N on the rim, the steel alloy will not return to its original shape as the material would have reached its limit of elastic behaviour, and will start behaving like a plastic. In a “real life” situation, the hoop would only permanently displace a few millimetres and would probably not be noticeable. However, if this were repeated multiple times, as would be likely, it would gradually displace more and more until it was no longer suitable to use, or would over time break as it is weakened.



Conclusion

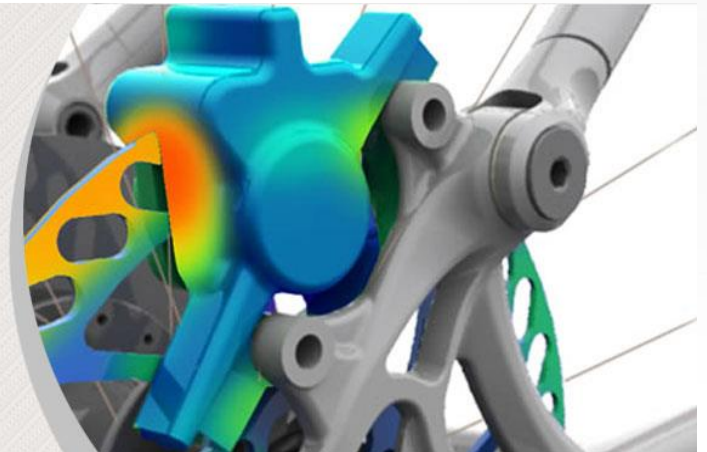
In conclusion, the series of alterations carried out on the virtual hoop and bracket demonstrate that the changes made in modification 2 were the most successful. The weakness between the hoop and bracket, which was identified in the benchmarking test, was addressed and solved with a minimal “tweak” to the overall design. The thickening of the bracket’s outer connecting flat side meant that it was reinforced enough to be able to withstand 2500N of force without it exceeding the material’s Yield strength. It has a maximum displacement of 29mm when the maximum load of 2500N was simulated. This actually allows for a slightly higher “ceiling” above the tested maximum and represents a vast improvement considering the benchmark had a displacement of 317mm. The other modifications made, while representing improvements on the original design, did not strengthen the overall design enough to address fully the fundamental weakness identified at the outset, as the analysis of each modification showed.



Simulation of Bolmen Stool



Perform Structural Testing of Parts and Assemblies for Product Innovation.



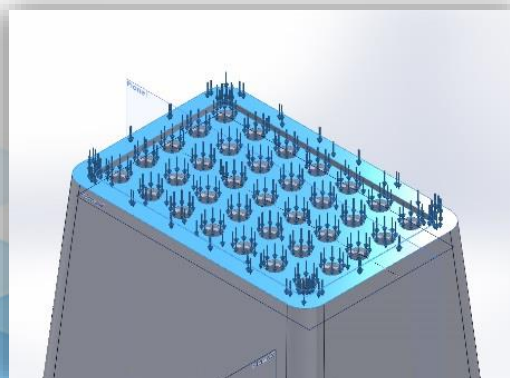
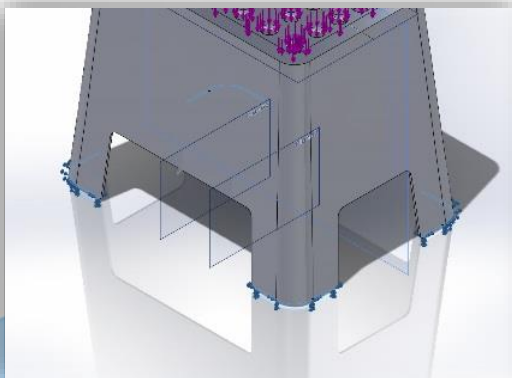
Aim

I will be analysing this Bolmen stool which is made of Polypropylene using SimulationXpress to ensure a Factor of Safety of 3 (FoS3) is achieved when a load of 100kg is applied to the top. I will achieve this aim by adding ribs to the underside to optimise its strength.

I will be ensuring that the minimum factor of safety for each modification is 3. This means that the entire stool will have at least a FoS3 in its weakest parts, while other parts will be stronger.

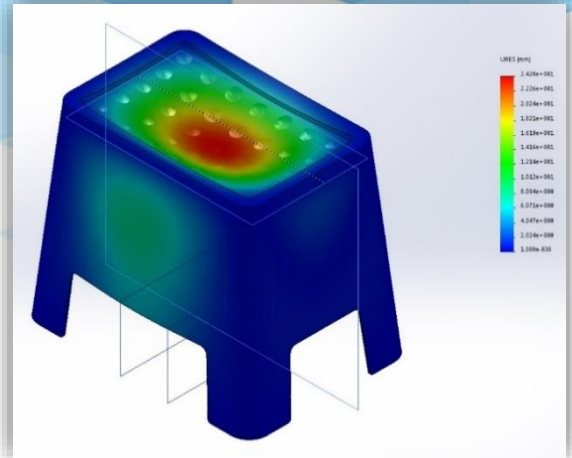
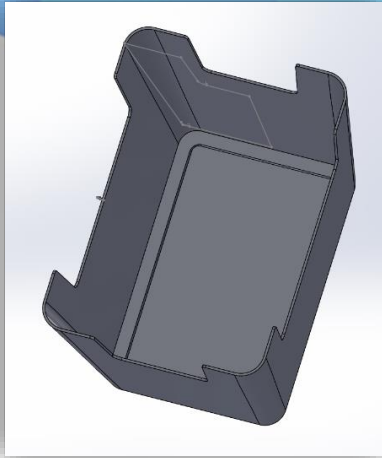
The reinforcing ribs will be designed to ensure that they have a FoS of more than 3 so that the stool will have a built-in strength which makes it more robust than would be needed for normal daily usage. This is to factor in a comfortable safety buffer which allows for unexpected loads, misuse or emergency situations.

Using g as 9.8m/s^2 , I will consistently use 980N as the load throughout.



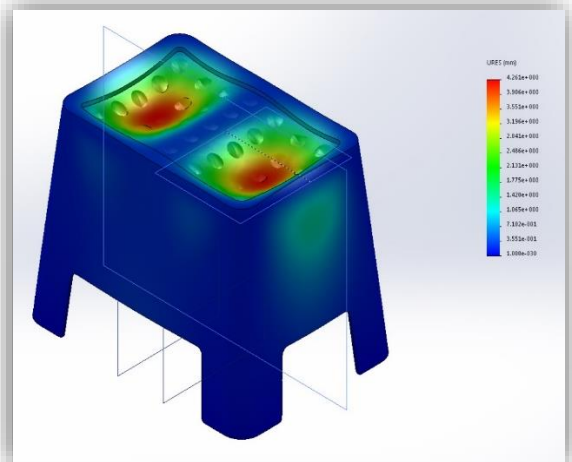
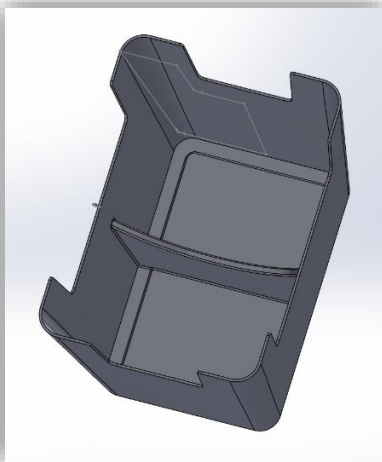
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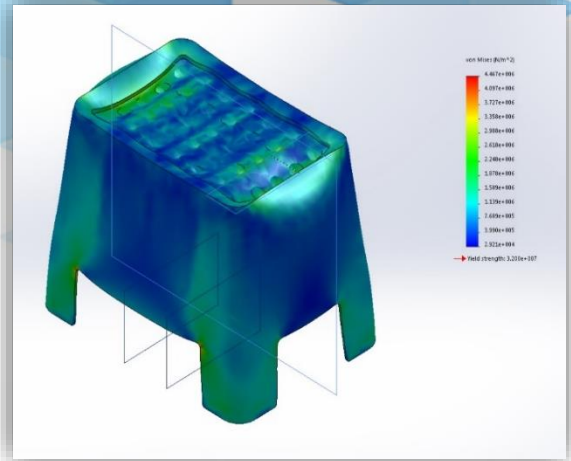
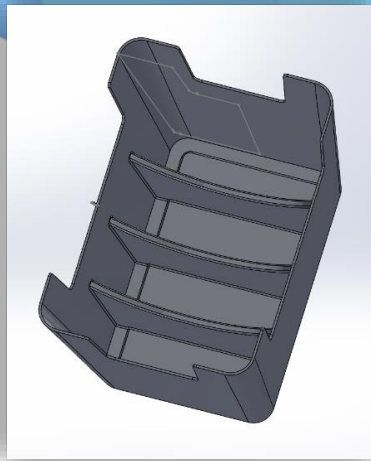
Benchmark

I began by carrying out a standard benchmarking test which analysed the stool's weak points and highlighted areas where improvements could be made. The test clearly showed that the top centre area of the stool is the weakest part as it displaces 24mm when subjected to a force of 980N. However, it does not surpass its Yield strength of 3.2×10^7 N/m² with a maximum stress of 2.74801×10^7 N/m². The point on the stool with the lowest factor of safety has a FoS of 1.16448. The additional ribbing reinforcement will have to almost triple that FoS figure to ensure that the weakest parts of the stool are brought up to the minimum required safety level.



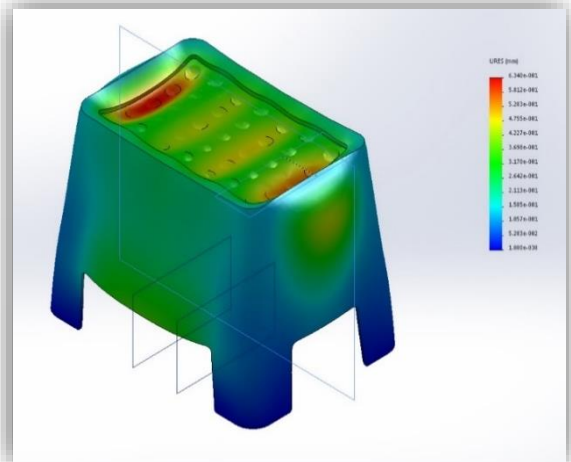
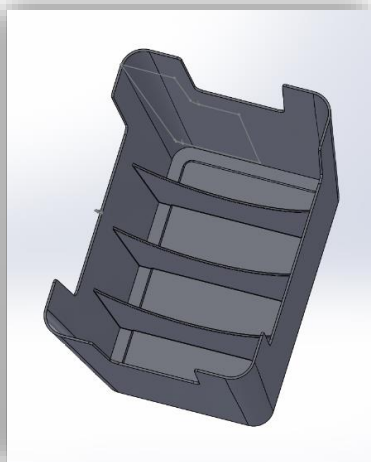
Modification 1

The addition of a single 6mm rib reduces the maximum stress to 1.21647×10^7 N/m², while the maximum displacement is reduced to 4.3mm, giving a minimum FoS reading of 2.6. This one minor modification, therefore, has significantly improved the strength of the stool, and raised its FoS reading to just below the target threshold of 3. This represents a major improvement even though the safety integrity of the stool remains below the minimum FoS3 target. However, the deformation diagram clearly indicates where the majority of the displacement occurs. This, in turn, highlights where improvement can be made to raise the necessary safety level to the required "3."



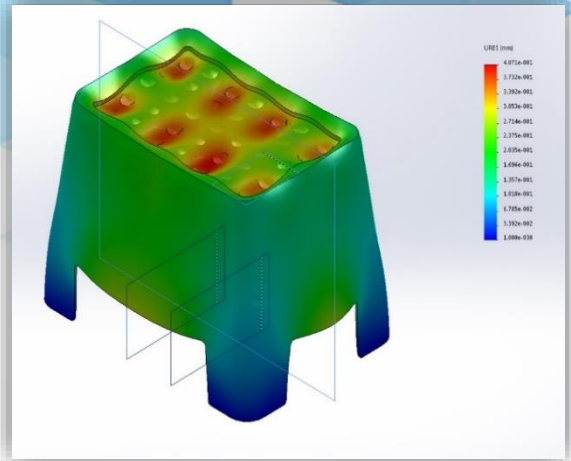
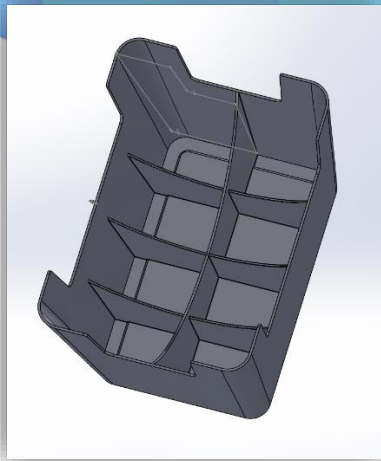
Modification 2

For this modification I added two other ribs to the underside of the stool, taking the total number of strengthening ribs to three. Each was placed so that the 6mm ribs were equally spaced on the underside of the stool and none would bare a disproportionate amount of any weight when the top side was used. This configuration produced a remarkable improvement of 7.2 FoS – substantially more than double the required amount. The diagram on the right, below, shows how the stress is evenly distributed throughout the stool's upper side. The maximum amount of stress for the weight is recorded as being 4.46712e+006 N/m². This resulted in a very low maximum displacement of 0.5mm. Although this simulation shows very promising results, the one drawback of the test is that the thickness of the ribs I have added would complicate the manufacture of the stool, making its production more difficult than before.



Modification 3

To make my previous modification more realistic in terms of manufacturability, I have reduced the thickness of the ribs by half, to 3mm. Despite this the maximum displacement rising by a negligible amount of 0.1mm, to 0.6mm, while the maximum stress level has dropped to 4.27824e+006 N/m². Neither is a very substantial change from before considering the ribs have been reduced in size by 50%. This outcome is as welcome as it is unexpected. The result sees the FoS actually going up to 7.5. It means that the stool is now far more manufacturable, sturdy and safe. It has a very large FoS allowance which provides a generous safeguard for unexpected loads, misuse or emergency situations. In fact, boasting as it does such a high FoS it could be considered over engineered. I would not consider this to be the case, however, because I think it must be acknowledged that customers wanting to purchase an item like this may think it does not appear very strong, even though it's more than strong enough. It's extra strength, therefore, could be used as a selling point. Human perception plays a big part in how products are purchased. With that in mind, I'll be making one more modification.



Modification 4

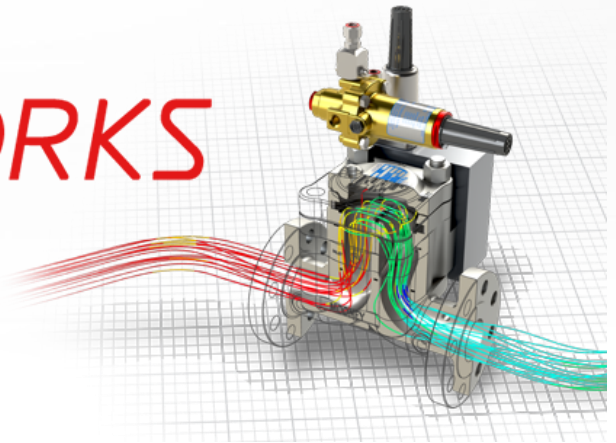
By adding this 4th rib perpendicular to the other three ribs, and through the middle of all three, the strength perception of the stool naturally increases. The reason is because the ribs on the X and Y planes are intersecting each other, making a stronger looking formation. The deformation diagram shows that the displacement is more evenly distributed than the previous modification, for a more reliable surface top. The stool now has a FoS of 8 which in most cases would be considered as over engineered, but as mentioned before, human perception plays a big part in how we purchase products. If the product does not look strong enough, people can be hesitant when buying because they want to be able to put their trust in the product

Conclusion

In conclusion, modification 3 is well optimised and analysed to have high performance characteristics. It has a target of FoS of 3 which is attained, and surpassed, through the addition of strengthening ribs. These ribs are an evolutionary development which retain the strength of an earlier modification while improving the products manufacturability. As the analysis demonstrates it can easily hold a force of 100kg while its maximum stress remains well under its yield strength. Modification 3 has thin enough ribs to be manufacturable, and allows the stool to be suitable for everyday use with an allowance for unexpected loads, misuse or emergency situations. With modification 4 having an extra rib perpendicular to the other 3, this massively improves the strength and FoS. This is a modification based on improving the strength perception of the product so that its salability is also improved. Modification 3 showed itself to be more than strong and safe enough for the practical need of its everyday use. However, if the perception of the product does not match the reality customers might switch to buying another product that appears stronger. This is a topic, however, where more research into customer perception would be beneficial. It may well be that a majority of potential buyers would perceive modification 3 to be not strong enough, or might see modification 4 as too clunky and over engineered.

Flow Simulation of a Lamborghini and MCR

SOLIDWORKS **FLOW SIMULATION**



Aim

I will be simulating each of the predefined vehicles travelling at 30mph and 100mph, analysing the velocity and flow trajectories for each vehicle with regard to their design characteristics using FlowXpress.

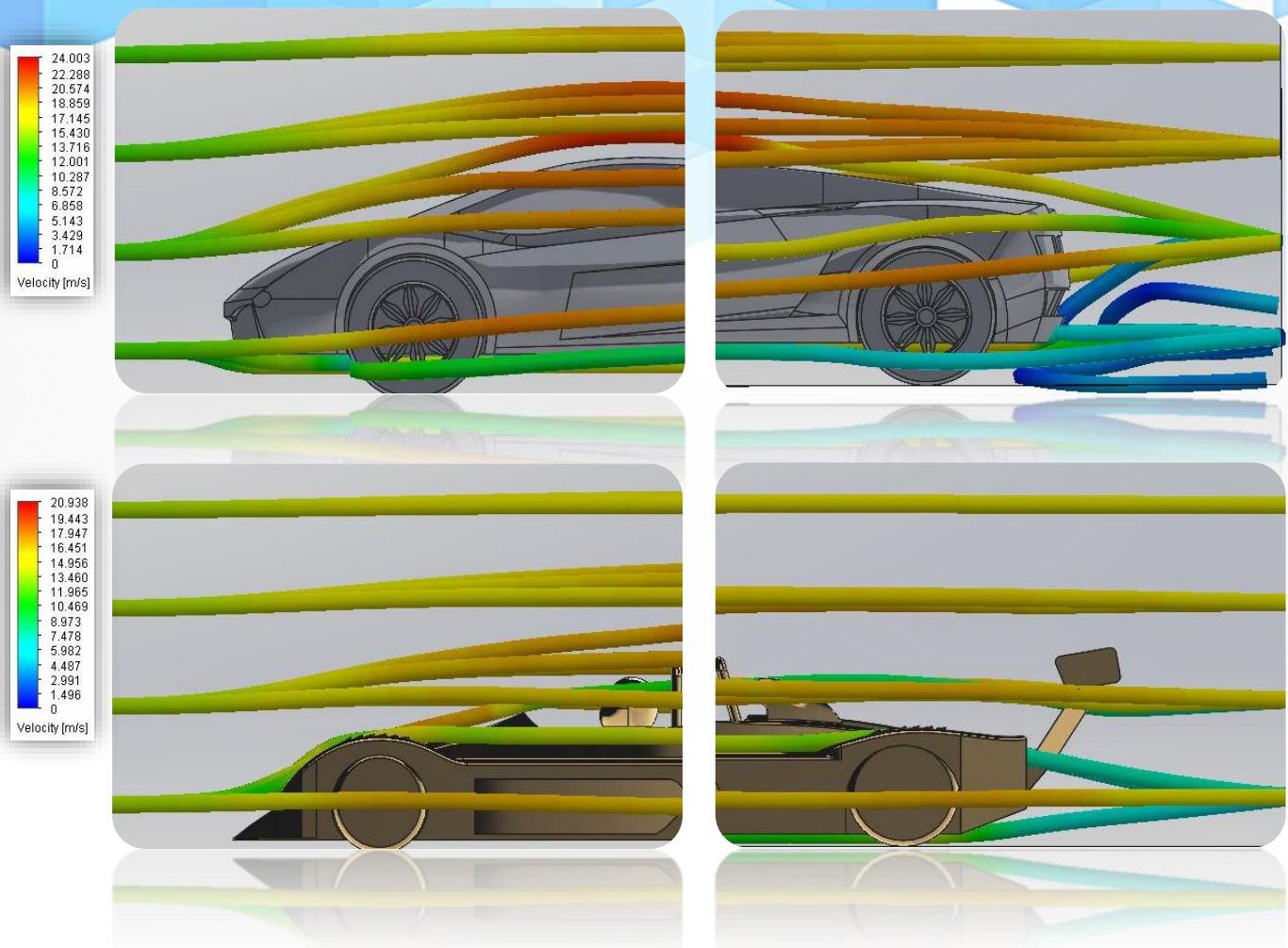
Using 1m/s as 2.24 mph to calculate the Volume Flow Rate in m³/s.

For 30mph, $\left(\frac{30}{2.24}\right) \times (3 \times 2) = 80.4 \text{ m}^3/\text{s}$

For 100mph, $\left(\frac{100}{2.24}\right) \times (3 \times 2) = 267.9 \text{ m}^3/\text{s}$

Sebastien Stone

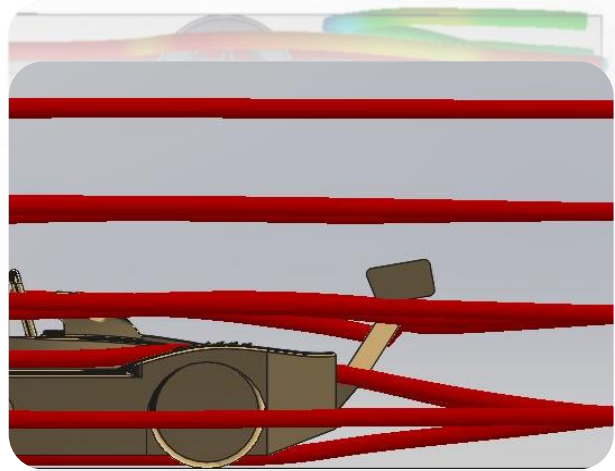
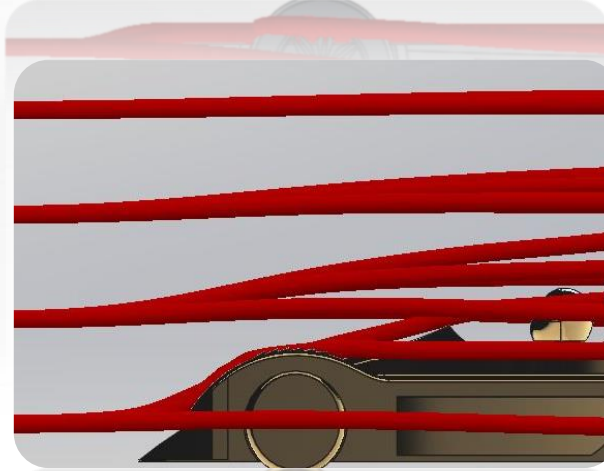
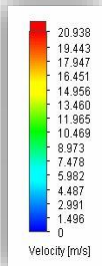
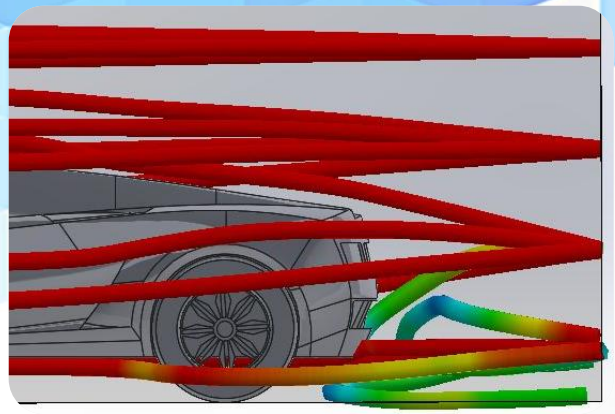
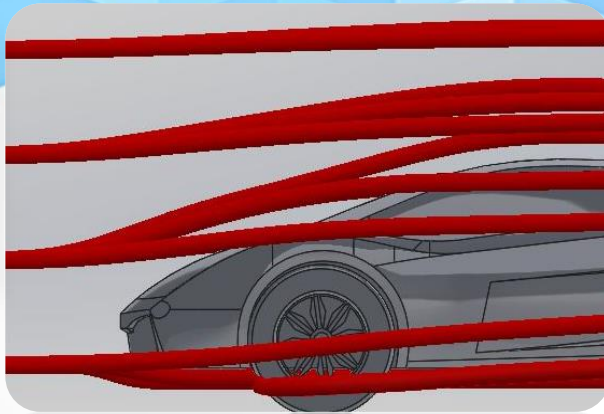
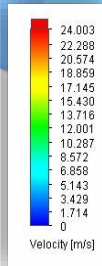
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The Lamborghini and MCR vehicles were both tested under identical 30mph speed conditions and an analytical comparison carried out. The data produced by the FlowXpress Report clearly demonstrated the differing aerodynamics of each car.

The diagrams above offer a quick and very useful visual illustration of the way air circumvents the vehicles and the effects that the vehicles' design produce at a given velocity. By looking at the key you can see that 0, at the bottom of the measure, is blue, and 20+ is red. These are the maximum and minimum points of the velocity m/s at which the air is travelling. Air flow of 30mph (13.4 m/s) is represented in green. Anything above that can be described as friction (due to the first law of thermodynamics), and anything below is some sort of negative space, and often turbulent. As you can see, the Lamborghini has a larger angled front to it. This means that the air with which it comes into contact is projected at a slightly greater angle, increasing the speed at which it is projected. This is why the "pipes" are orange/red. The greater the angle the more friction there is. Although a Lamborghini is very aerodynamic, it is not purely built for speed. They are luxury cars which are nevertheless intended to be driven every day as a form of transportation. The MCR, however, is a car made purely for racing. It has a very low frontal surface area, and causes very little disruption to the laminar flow compared to the Lamborghini. The diagram shows that the frontal air flow is projected at a much lower angle, creating less friction. This is due to the MCR's design characteristics being more aerodynamic. That's why the colour of the "pipes" making contact with the car are lower down the key. The point where there is the greatest displacement and friction of air, projects it at 24.1 m/s on the Lamborghini, while on the MCR it is 21.0 m/s.

When comparing the outlets of the cars from the report, the chaotic airflow, known as turbulence, is far greater on the Lamborghini. The diagram shows there are a lot of turquoise and blue "pipes" behind it. This means that the air is moving slower than the original inlet speed. The spoiler on the MCR disrupts the airflow patterns to prevent it from forming a chaotic turbulence such as is with the Lamborghini.



When comparing the data on both cars as set out in the visual illustrations after undergoing testing in air velocity of 100 mph (44.7 m/s), the turbulence behind the Lamborghini is still very noticeable. The test data shows that at 100mph the maximum velocity of the air (m/s) for the Lamborghini is 81.6, whereas it is 70.2 for the MCR. The speed increase from 30mph to 100 mph is 3.3' times more. When looking at the maximum velocity increase of the air from both cars traveling at 30mph and 100mph, the MCR should have a lower amount due to its aerodynamic attributes.

$$\text{Lamborghini} - \left(@ \frac{100 \text{ mph}}{30 \text{ mph}} \right) - \frac{81.6}{24.1} = 3.386.$$

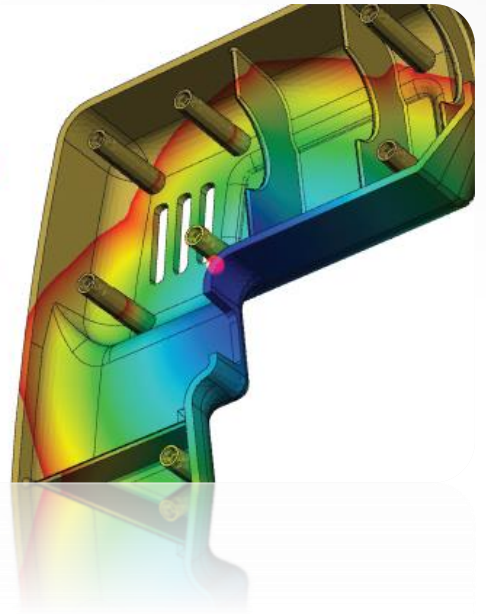
$$\text{MCR} - \left(@ \frac{100 \text{ mph}}{30 \text{ mph}} \right) - \frac{70.2}{21.0} = 3.343.$$

The reason these figures are larger than the increase from 30mph to 100mph (3.3') is because friction does not increase linearly when the speed is increased. The MCR has a 0.043 lower maximum air velocity increase than the Lamborghini because its design characteristics are more aerodynamic. The diagram clearly shows the Lamborghini has a large amount of air turbulence behind it still. This turbulence is very inefficient when travelling at higher speeds. If there was more information about the amount of torque each car had to output in relation to weight, the reading would be considerably more for the Lamborghini considering the extra friction it has to overcome.

Injection Moulding Simulation

(Drill Body & Funnel)

DS SOLIDWORKS
PLASTICS
Professional

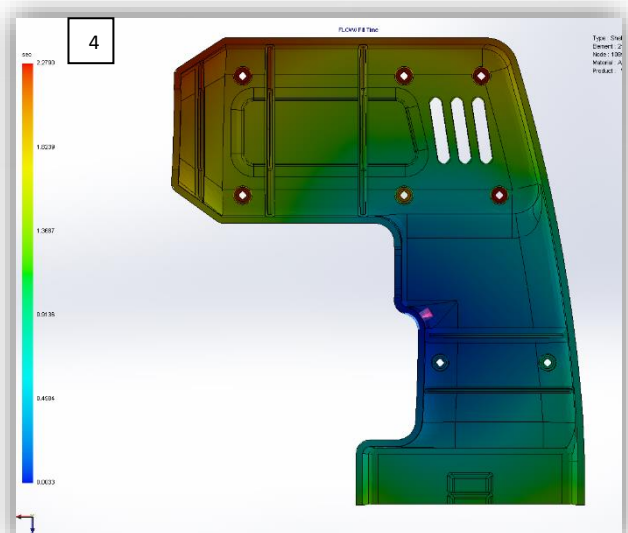
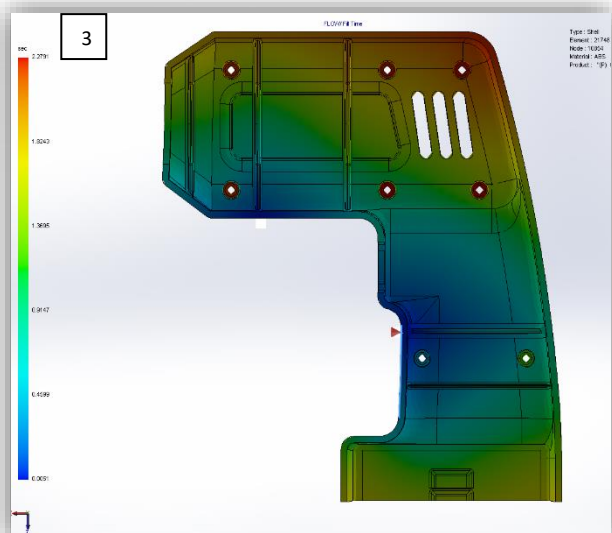
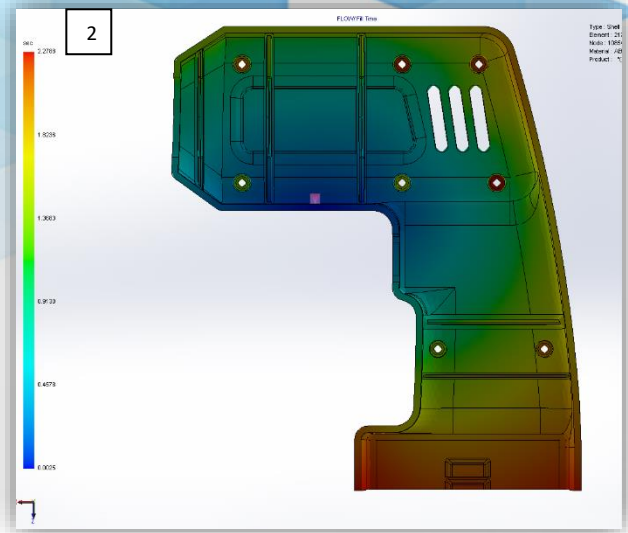
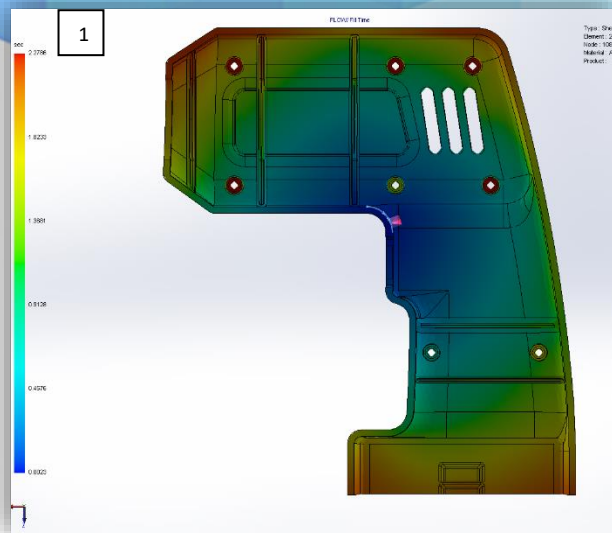


Aim

I will be simulating the injection moulding of the pre-defined drill handle/funnel by adding the appropriate gate location(s) that would theoretically ensure that they could be successfully moulded. I will investigate and analyse the output results with regard to the following criteria: Fill Time, Ease of Fill, Gate Filling Contribution, Cooling Time, Sink Marks, Weld Lines, and Air Entrapment in relation to the gate position(s).

Sebastien Stone

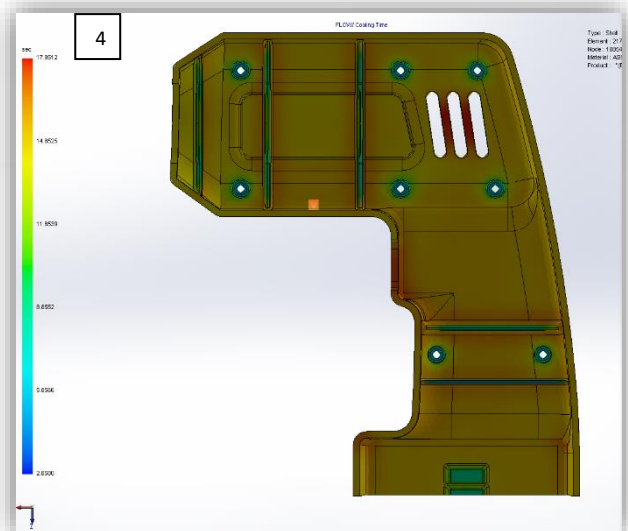
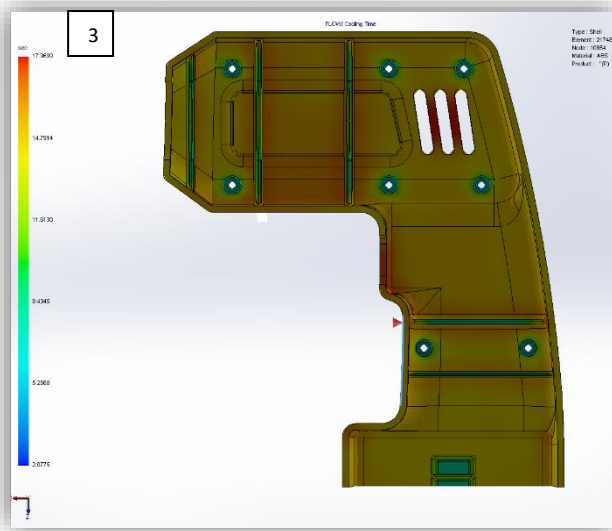
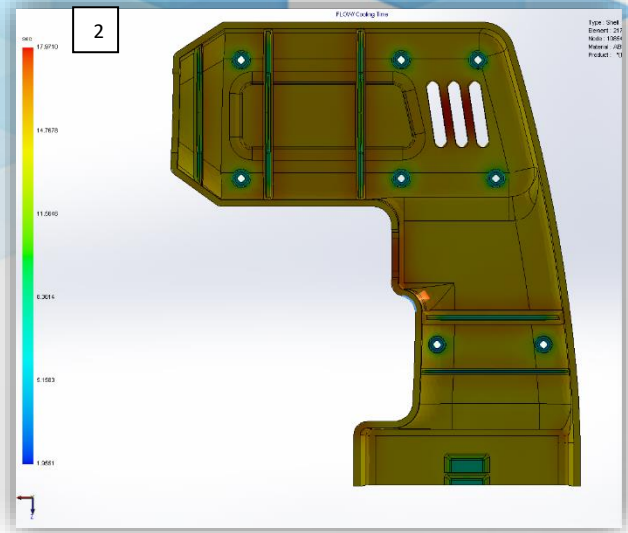
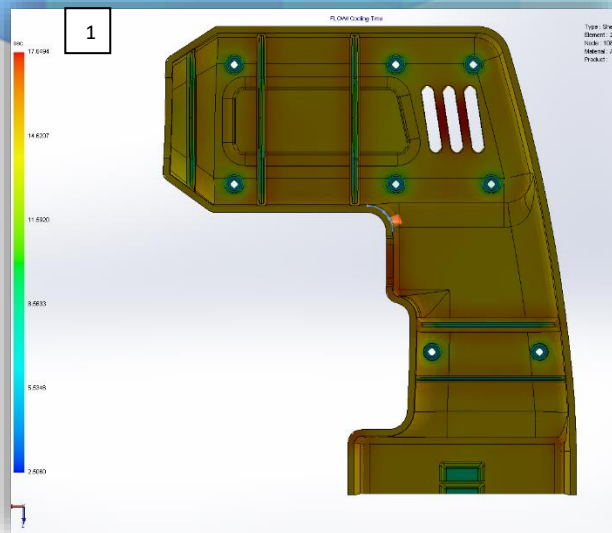
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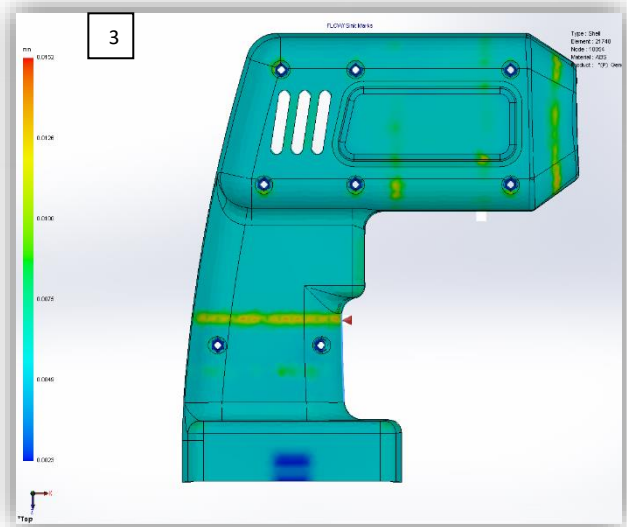
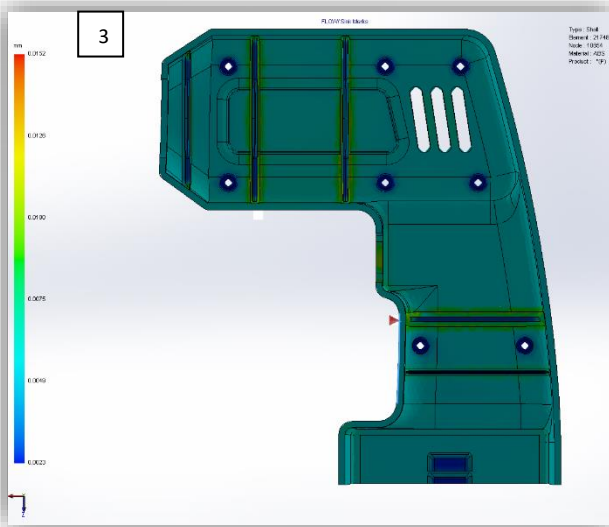
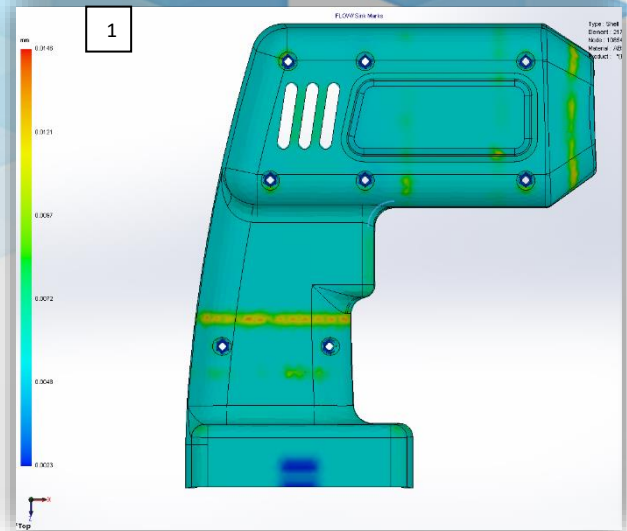
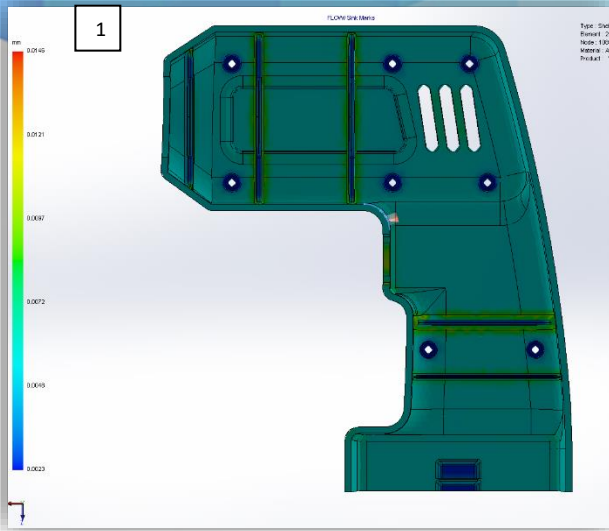
To decrease the fill time of this drill shell, I have placed the gates of these four iterations around the centre. This is to reduce the time for the plastic to fill the mould, and to fill it evenly. On the single gate iterations, I have placed the gates on the inside of the mould. This is because if the gate is located on a visible surface, the designer would want to consider its cosmetic impact in designing the part. Having it on the interior eliminates any negative cosmetic impact.

All four Iterations have very similar fill times. There is a negligible 0.001 seconds between them, no specific iteration is better than the other in terms of fill time. If the difference was more substantial, and the product was being produced in its millions, for example, then being able to shave off a few seconds in fill time could be very beneficial. However, since the cooling time has such a large time bracket, shaving off time there would be more logical.

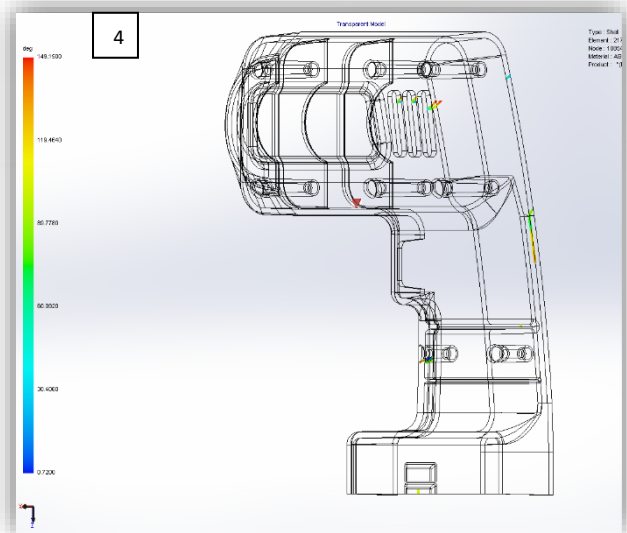
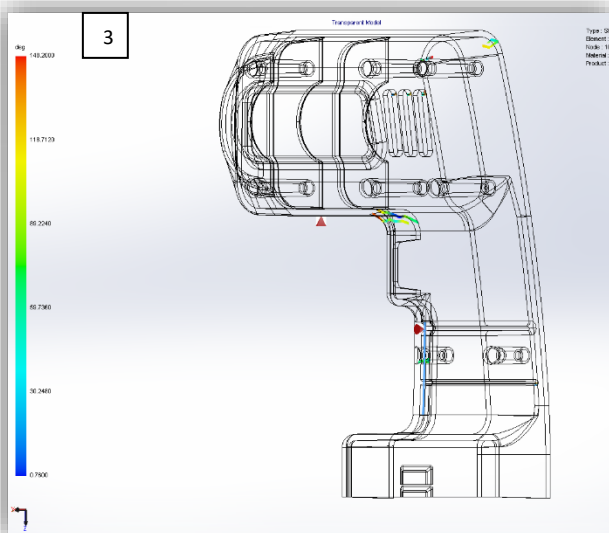
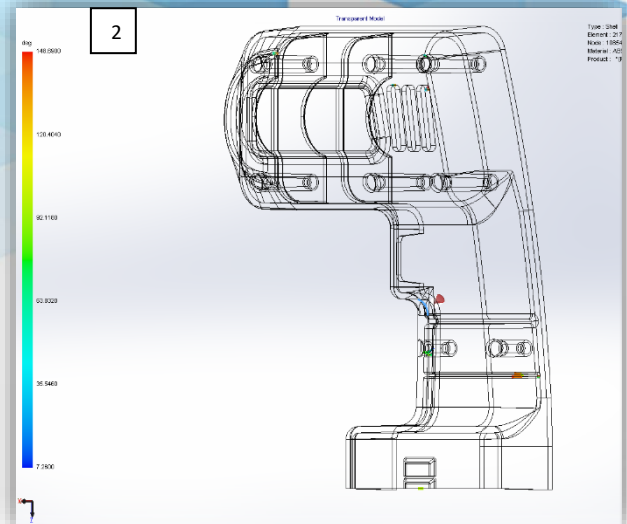
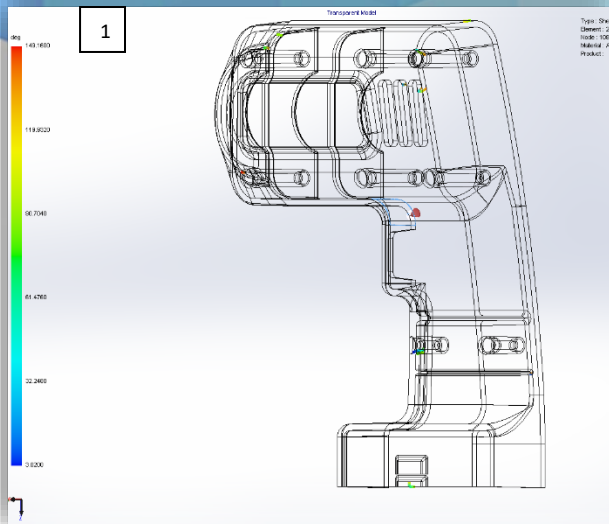
To test to see if multiple gates would be beneficial, I placed two on iteration three. I located them on the exterior so that the gates are not directly facing a mould wall. This, in theory, allows the plastic to flow freely through the ribs without a mould wall causing any instant impact friction. The results show that this wasn't beneficial in any way with the fill times all being virtually the same.



With four different placements of the gates, there is no real difference in cooling times between each iteration. The reason for this is because they each have the same mould volume, the same material, and extremely similar fill times. The diagrams show that they all cool at a very similar rate. However, iteration three takes a little longer on the left between the two ribs, as shown on the diagram. This is probably due to it having two fill gates, and one of them being in that section. The slowest place to cool is usually the thickest section in the mould, and the section closest to the gate. This is because the gate is the last place to receive the hot plastic, while the rest of the mould would have already started to cool - roughly 2 seconds earlier. Iteration one had a faster fill time by 0.0002 seconds, and now has a faster cooling time by 0.2018 seconds. While 0.2 seconds might seem a negligible amount, if the product was mass produced, it would save a significant amount of time. If 100 were being made at a time, for example, it would produce a saving of 20 seconds.

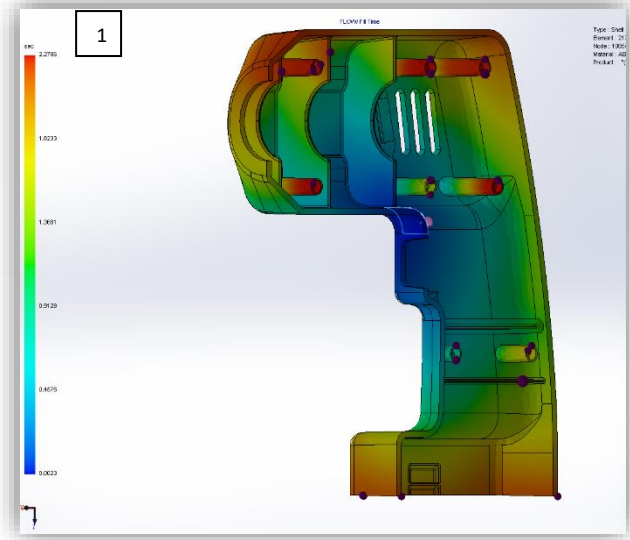
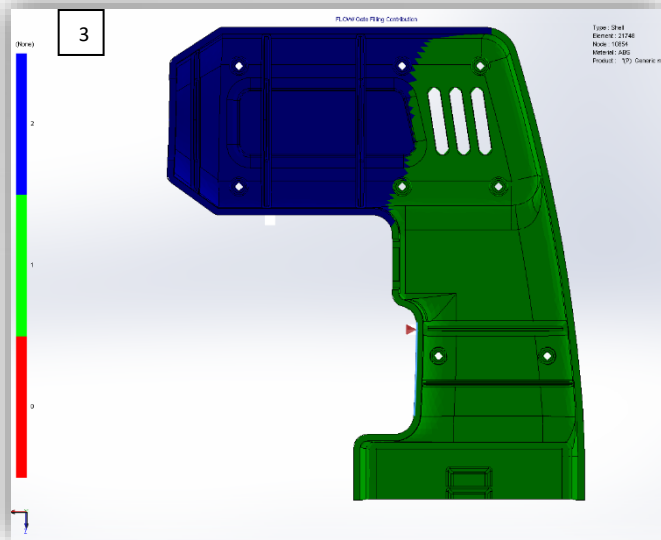


With all the previous results being so similar, it is no surprise that the sink marks for each gate iteration are again almost identical. As each diagram for the separate iterations show, there is nothing of real importance between them. This is due to the similarities. The images above show two angles of the drill handle, to better analyse the results. One with the lowest amount of sink marks, and the one with the highest. From this you can tell that the cooling times correlate to the sink marks. Depressions typically occur in thick areas of a design and are caused by uneven cooling of the injection material. The images on the right show that there is localised shrinkage at the thick sections of the handle, such as the ribs. The rib with the largest amount of depression has a larger fillet to it, as shown in the images on the left. To reduce the amount of depression in this one localised area, the designer could reduce the fillet size of this specific rib. Doing this would have negative repercussions to the structural integrity however, and would need to be discussed with the designer. In this area, the iteration with the highest amount of depression has a maximum depression of 0.0152 mm. There will always be a small amount of shrinkage no matter what, and this is something you will have to discuss with the designer. With a depression so minimal, depending on the products attributes, is nothing to be concerned about. For other products that need to be extremely accurate to $\pm 0.01\text{mm}$, making certain parts of the geometry thinner to have less of a depression might be needed.

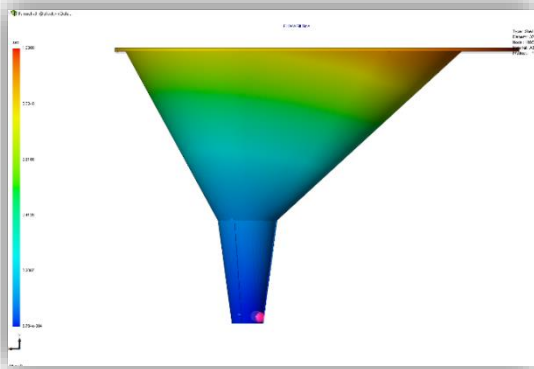
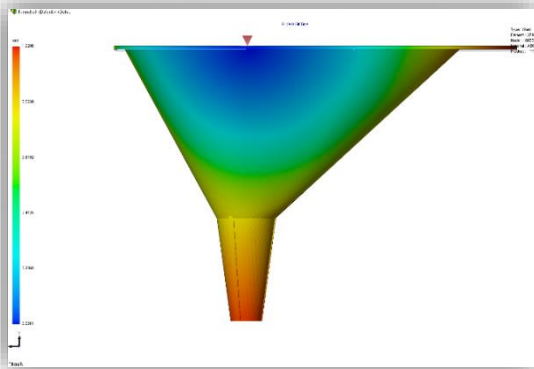
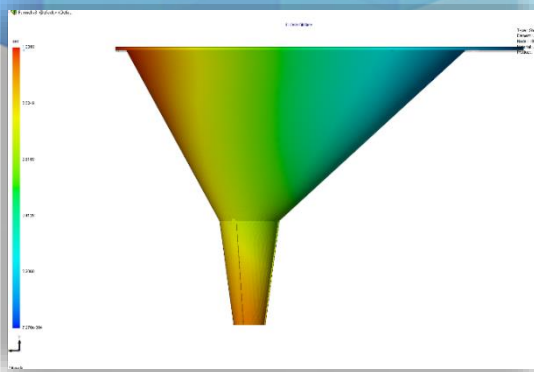


It is no surprise that the version with two gates has the most weld lines. Weld lines occur when two or more flow fronts merge. With it having two gates, it is inevitable that the two flow fronts meet. This gives it a higher chance of weld lines being produced. Weld lines significantly weaken the strength of the moulded part, and can leave visible blemishes that can affect the cosmetic value of the part. The other three handles have weld lines that are so minor it would not affect the strength of the handle, but may show some visible marks or blemishes.

I would be concerned with iteration three, where the two largest weld lines are on the points where the materials meet from the two separate gates. This is better shown on the gate filling contribution diagram (below), exposing the weakest part. This is concerning because there would be a lot of stress along this line if the product was used. With these weld lines reducing the structural integrity of the handle, it could cause the handle to be unsafe to use.

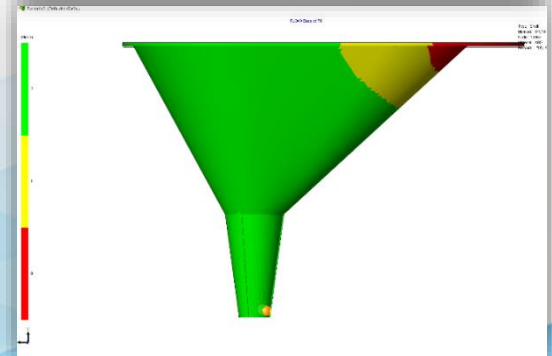
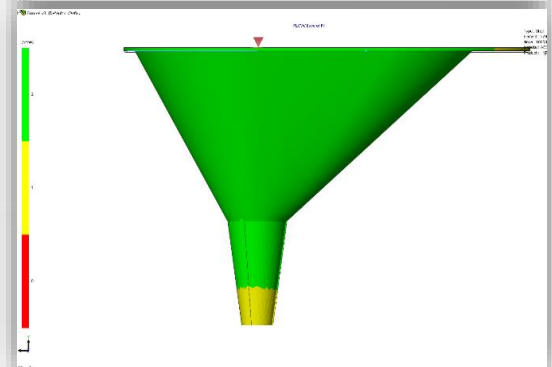
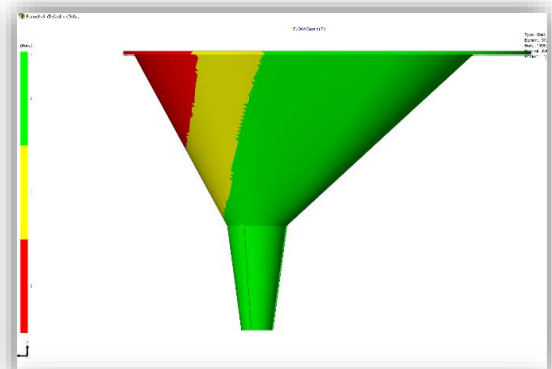


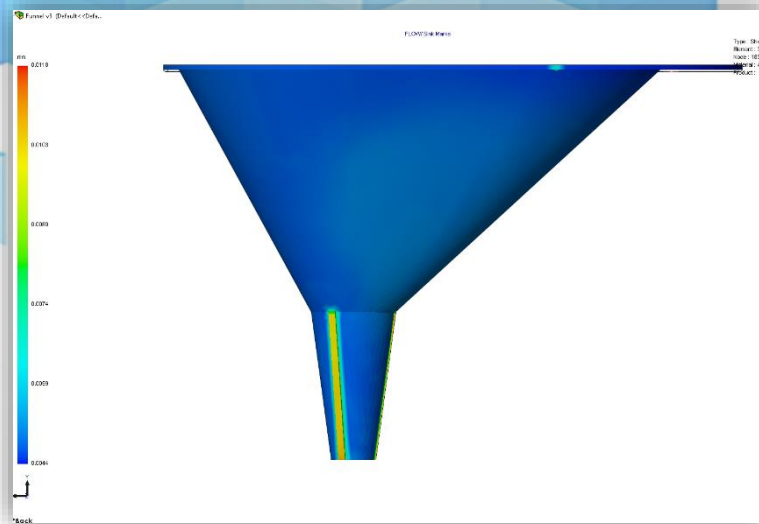
In conclusion, all four simulations offer the same successful ease of fill, and show similar fill and cooling time. The iterations do not have any concerning air entrapment in areas such as the exterior, as shown on the image to the right. Despite this, however, it is clear to see that single gate injection moulding for this particular design is more beneficial than having two gates. Iteration 3 which has the duel gate configuration inevitably has more weld lines due to its two flow fronts merging. The gate fill contribution image to the left illustrates this well. It was iteration one which had the most successful gate placement overall, as it is better in every aspect, even if only by a small fraction.



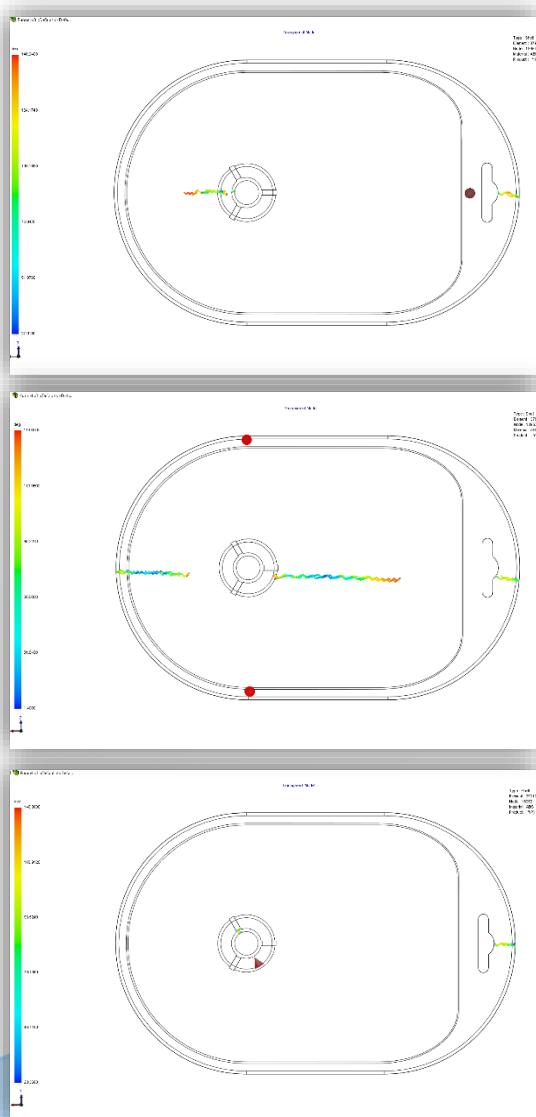
I placed gates in various locations on the mould to test which would be the most efficient. One was on the top, another was on the bottom, and I also tested a design in which two gates were placed at the top. Despite these variations of gate placement and amounts, fill times only differed by 0.01 seconds. All take one second to fill because almost all factors, including mould volume, material temperature and gate size, are the same. Each variation fills the same volume from different angles. I placed gates in these specific locations to minimise the number of weld lines that could form. However, despite a one second fill time, I believe the distance the material travels will affect the ease of fill in proportion to the fill time colour diagrams, on the left. To reduce the fill time, I could have placed a gate around the centre of the mould, or have two gates opposite each other, one on top and the other on the bottom. The reason this is not logical is because weld lines would definitely form where the two flow fronts meet, causing cosmetic faults and weakening the mould's structure.

Ease of fill is a key factor to analyse. Colour diagrams represent a quick visual reference to the ease of fill in multiple aspects of the moulding process. For example, if the maximum pressure requirement is starting to peak, the ease of fill to go down. At this point the product is unlikely to be manufactured properly without a design change, or even a material change. As shown on the diagrams to the right, the ease of fill has a correlation to the fill time diagram. The further the material has to travel the harder it is to fill. The funnel with the best ease of fill is the one with two gates. This is because it requires less pressure and material from each separate gate to fill the mould. The other two diagrams show the beginnings of small red sections at the furthest point of the gate. This is something to monitor and, if critical to the product's manufacture, can undergo slight changes to the gate size, pressure and placement, along with type of material and perhaps some slight alterations to the design if necessary.



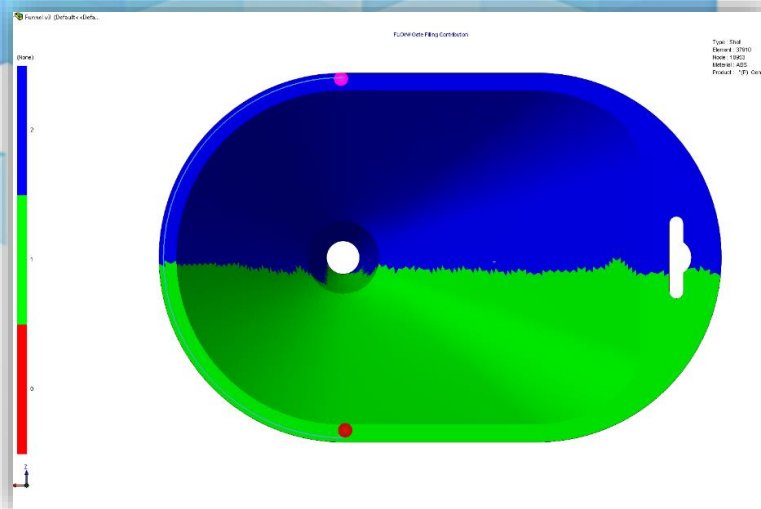


The difference in sink marks between each gate iteration placement is a negligible amount of 0.007mm. They have a maximum depression of 0.01mm on the three strips of the funnel as shown above. This indicates that the gate placement for this funnel will not affect the sink mark depressions in any major way. This is because the uniform thickness of the funnel wall is the majority of the mould's structure, with only the small lower strips being thicker.

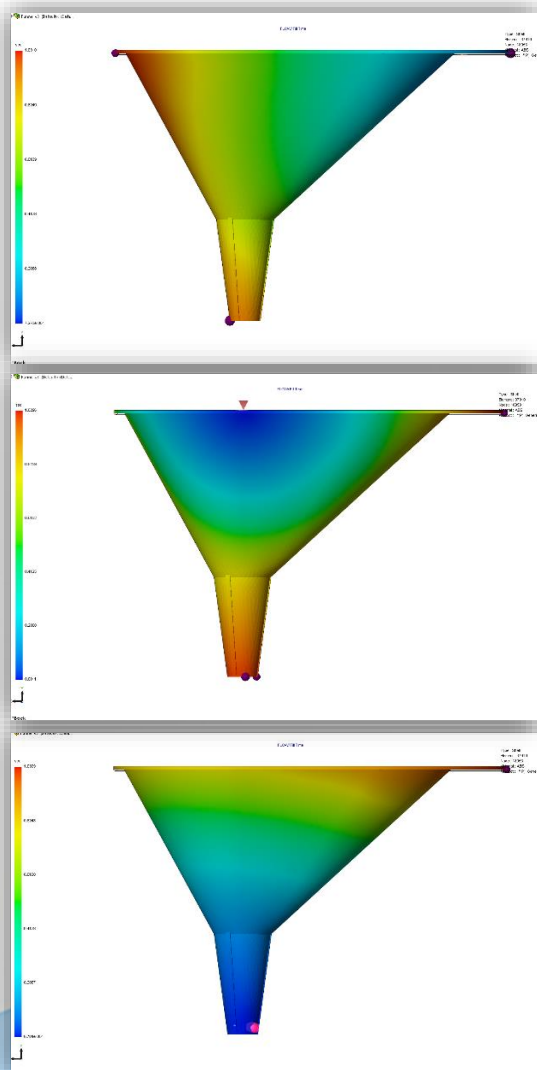


With the funnel being so rounded, the gate placement is crucial to prevent getting too many weld lines. The version that has two gates had a better ease of fill. However, it did produce an unacceptable number of weld lines. Weld lines of this size would produce significant cosmetic defects. They could break under stress, making it unsafe and unusable. These weld lines are caused because there are two large flow fronts being merged through the middle of the funnel, almost separating the funnel in to halves. The top version also has a large weld line from the base, escalating half way up the funnel. This again would produce significant cosmetic defects which could break under stress, rendering it unsafe and unusable.

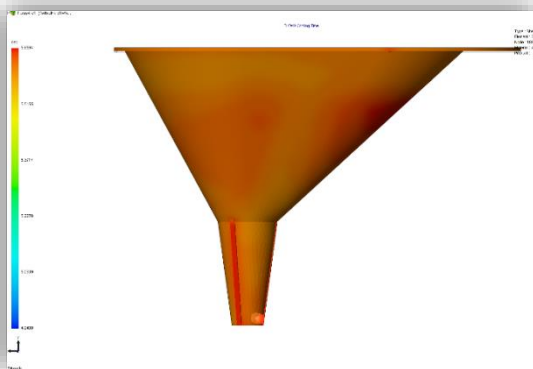
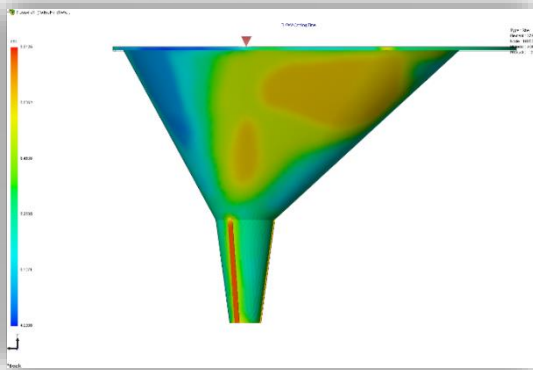
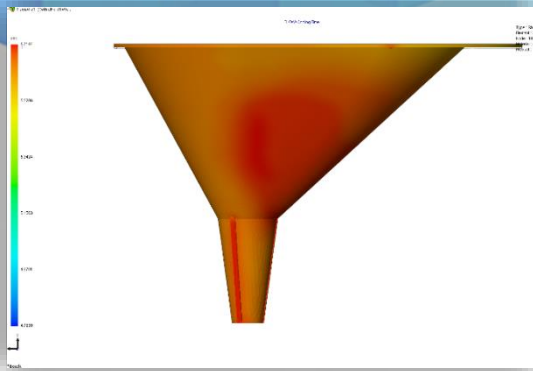
Having the gate at the bottom of the funnel has proven to be the most successful choice when it comes to weld lines. Their production, however, seems inevitable to some extent. The version with two gates at the top showed the largest weld lines, because the two fronts have to meet. Each version has a weld line but the one at the bottom would show only a minor cosmetic defect that would not damage the product's appearance significantly.



In terms of the gate filling contribution, the version with two gates is the only one we can look at. As shown above, the two gates fill the funnel to an almost identical 50/50 extent. This has created a bond straight down the middle of the funnel, and is the reason this iteration had so many large weld lines. It would be very hard to prevent the production of weld lines when having two gates because the funnel is so rounded. There will always be areas where the two fronts would merge and likely create weld lines. After analysing the results, having a single gate would be a better option for this funnel. Using two only seems to benefit the ease of fill, so far. But not the final outcome.



Air entrapment will almost always happen if a mould doesn't have any vents or inserts which also act as vents. Air usually gets trapped in areas that are filled last. To better illustrate this, I have placed the fill time and air gaps diagram on the same picture. This better shows that the places filled last (red) also have air entrapped. Air entrapment is a problem because it causes bubbles in the mould. The final mould will not only have terrible cosmetic defects, but it can affect the strength of the overall product too. The first two iterations have three bubbles each. They are in the corners so may not be detrimental to the funnel's appearance or use, but must be considered. The last iteration, however, only has one bubble in the less functional part of the funnel. This is by far the better outcome because the bubble is actually located where the two mould halves would meet. This means that the bubble would be pushed out between the gap of the joining mould halves, and there would not be a single bubble in the funnel.



The cooling times are very similar with 5.7 seconds for this single gate, and 5.8 seconds for the dual gate version. Looking at the diagrams I'm surprised by how unevenly the dual gate funnel cools. I would have thought this outcome might perhaps cause some deformation. When looking at the sink mark diagram for this iteration it doesn't seem to have made any affect.

The version that has cooled more uniformly is iteration 3. This is probably because the gate location allows the plastic to flow evenly throughout the mould, giving an even cooling duration.

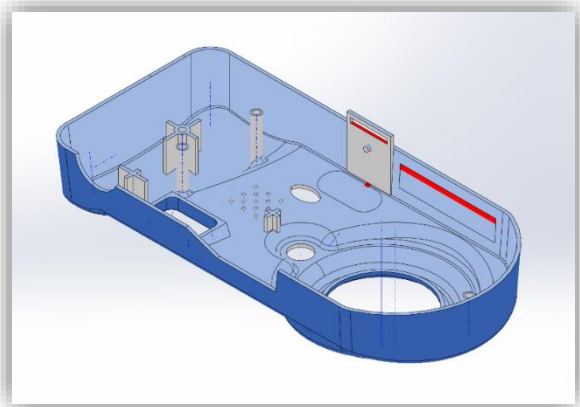
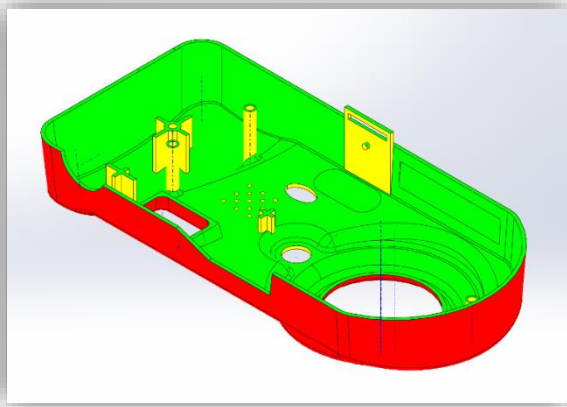
The parts which take longest to cool are inevitably the thickest parts of any given mould. Those particular strips must have some function when the funnel is locked in position. To reduce the cooling time, the designer could refashion these strips to have the same use, but require less thickness. This would reduce the cooling time by a relatively small 0.2 seconds. But while this seems insignificant if the funnel is being mass produced it can add up to a considerable amount of time.

In conclusion, having a single gate is far more beneficial not only for the financial side of production, but for the product's manufacturability too. Iteration 3 has a gate location that allows for a slightly quicker fill and cooling time, less depression in sink marks, acceptable weld line formations and realistically no air entrapment. The only area it falls behind on in is the ease of fill. Having multiple gates is beneficial when it comes to smaller gate sizes and lower pressures. The area where the ease of fill goes red is on the less functional part of the funnel. It seems to be designed in a way where the small cut-out is for hanging in a shop. This could be redesigned to be smaller as that whole section seems to be unnecessarily big. With that modification, and the gate being displaced a small amount higher up the funnel, the funnel will have a far more acceptable ease of fill, and would be suitable for manufacture.

Draft & Undercut Analysis of a camera body

Aim

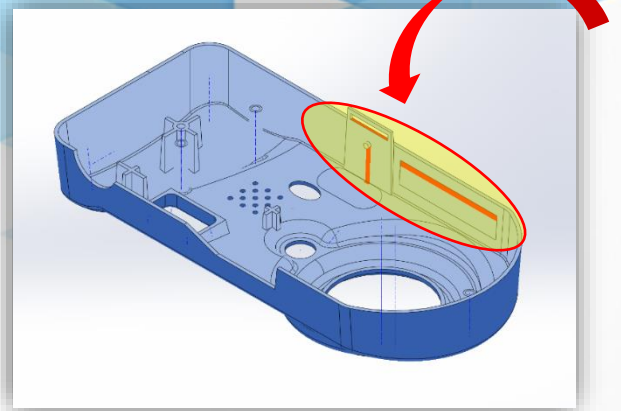
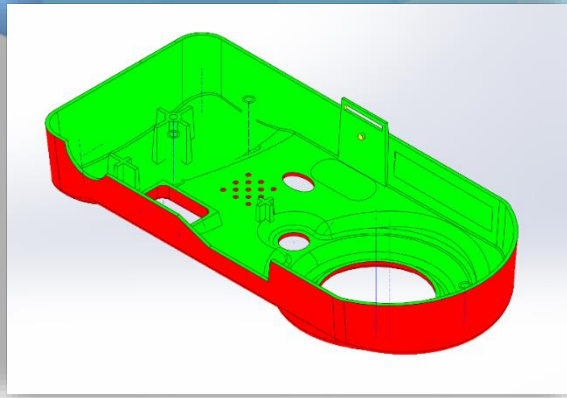
I will examine and analyse the pre-defined camera part with regard to undercut and draft criteria. I will then describe the modifications necessary to be made to the part to make it manufacturable.



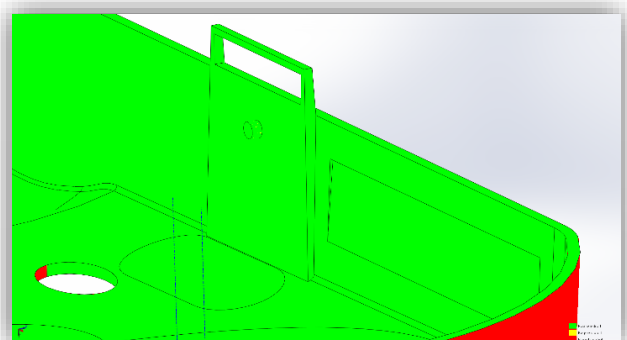
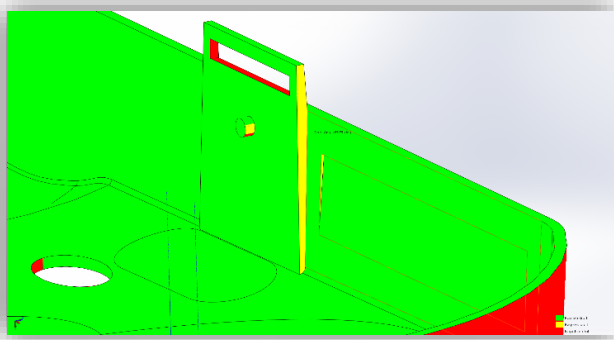
When first examining the camera body mould, it is clear that there are a number of sections to which a draft would need to be added. This is indicated in yellow on the left image. The right image (blue) indicates the undercuts of the mould in red. To redesign this section to make it manufacturable, it would be necessary to add a draft to everything marked in yellow, as illustrated on the left image above. Applying a draft to the required faces is a key step in improving the ability of the part to be successfully moulded. Without such a step, it is likely the product would have negatively affected cosmetic finishes. Sections could also warp due to moulding stresses caused by the plastic cooling. Not having a draft may prevent parts from ejecting from the mould, possibly damaging the mould itself which can be extremely costly. A 2-degree draft works very well in most situations. An undercut means the part cannot be moulded using only a single pull mould. Having multiple sliding parts in a mould is extremely expensive and needs to be avoided if possible. After examining the part, it is obvious from the locations of the undercuts, that without any major editing to the geometry of the camera body, multiple sliding parts will be needed.

Sebastien Stone

P148091



The draft analysis image on the left illustrates where I have added the 2-degree draft to all the possible faces. I decided to give all of the holes in the camera body a negative draft for consistency. Although that is not essential. The camera body would be manufacturable if not for the highlighted sections on the undercut image above. To make this manufacturable without editing the geometry, a sliding part will be needed. The part in question would cover the entire extruded face. It would house the hole for the cylinder, and have parts which slot into the stretched rectangle above it and the angled rectangular slit to its right. All sections to the left are 1mm in depth so the sliding part would be able to mould the entire section in one movement. The right hand angled slit is a maximum of 0.25mm. For it to be moulded in the same movement of this described slider it would have to be 1mm closer, to compensate for the extra distance. To better visualise this, it would be useful to imagine the highlighted section as a mirror image of the slider.



When visualising this slider, the highlighted section (above) will need to undergo a draft analysis on a perpendicular plane. The image on the left show those faces which need to have a 2-degree draft. A positive draft would be needed for this, as the slider would be on the inside of the mould. The image on the right shows how every face can now be successfully mouldable with a slider on this plane due to the 2-degree drafts added. This means that from the face of the cylinder to the depth of the angled slit, the slider's total depth is 2.25mm.

Despite the success of these changes, it must be acknowledged that having a slider for a cheap disposable camera, is an extremely expensive option. One way of avoiding such a cost might be to contact the designer to discuss the expense concerns. It might prove possible to edit the geometry of the part without critically affecting its performance. If the cost, however, is not an issue for the client, then having a slider would be a successful option.