

Weight Saving of a Sports2000 MCR Upright

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Sports2000 MCR
(Photo courtesy of UWTSD).

Introduction

This project arose as the MCR currently weighs 527.5kg, 6.5kgs over the championship minimum weight of 521kg.

The aim was to make the new upright 0.5kg lighter, whilst being strong enough to ensure it wouldn't fail on track. This would equate to 1kg across the axle and potentially lead to a 0.03 second lap time benefit. (McLaren, 2013)

This was done through the use of topology optimisation and finite element analysis (FEA).

Research

When designing a new upright 2 key points must be considered (Staniforth, 1994) :

- The upright must not come into contact with the wheel rim
- The further outboard an upright can be placed, the less the wheel levers against the suspension links
- The upright will be exposed to 'shock' loads, such as hitting a kerb (Wong, 2007)
- Along with 'shock' loads, a 'worst case' scenario must be considered, this would be when the car brakes during cornering (Dhakar & Ranjan, 2016)

Compliance in the upright must be kept to a minimum as works from Smith, 1978 and Gillespie, 1992 show. As the upright ties the suspension together it will have a big influence on the path the wheel takes when disturbed. Therefore, if the wheel is not in predictable contact with the track then the driver will not be able to perform to their maximum.

Methodology

The upright was workshop tested with 15kgs applied at each attachment point. In the X,Y and Z directions according to ISO standard 8855. (International Organization for Standardization, 2011)

Three DTI gauges were used to measure deflection, one at the attachment point and one on each side of the rig to measure the deflection in the rig.



Workshop Test of Top Attachment Point in Y Direction.

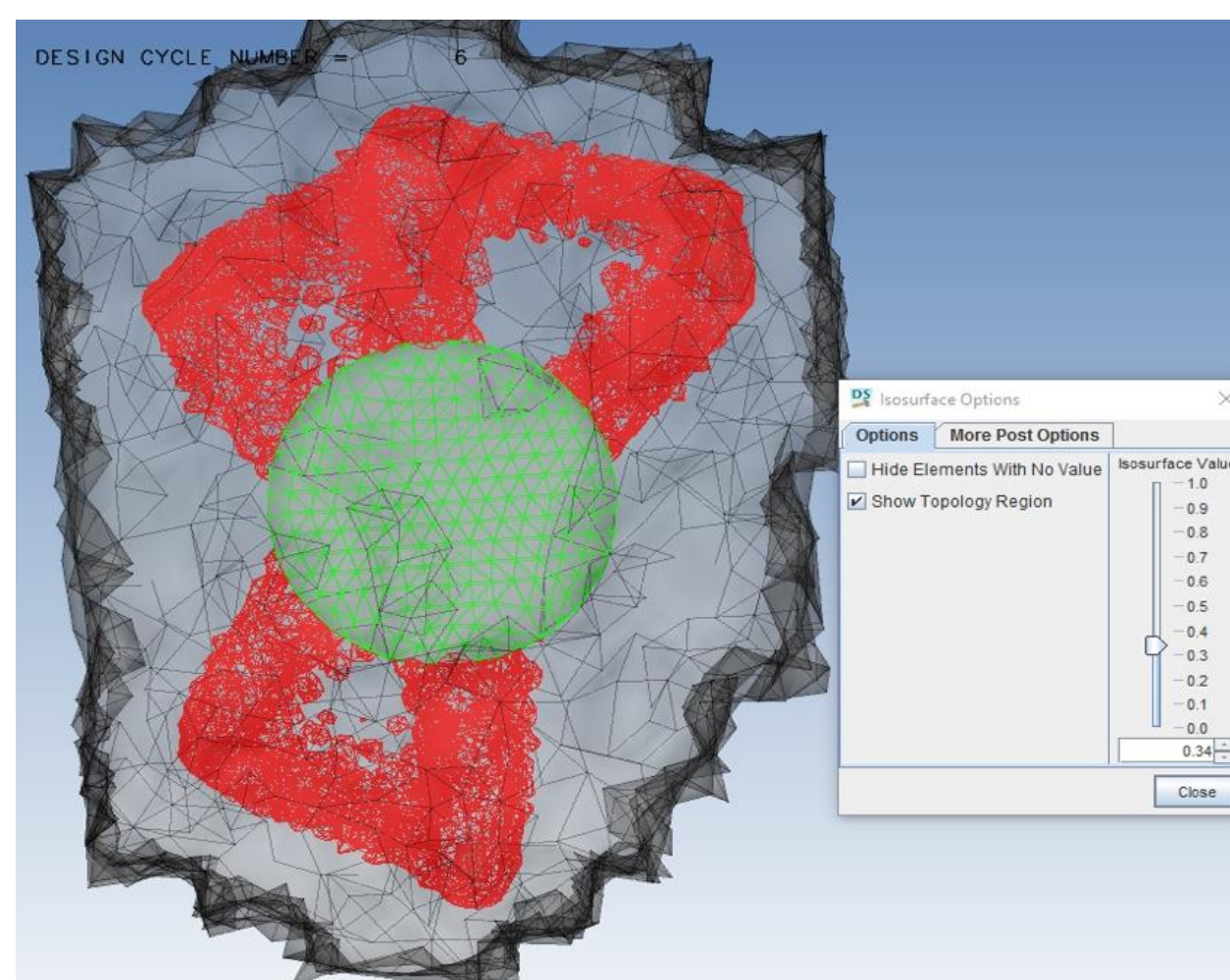
The workshop testing setup and applied loads were used to form the basis of the topology optimisation. The result of the optimisation influenced the new uprights design.

To allow for valid FEA to be carried out on the new upright design, the results of the workshop test were replicated in FEA.

The new upright was put through the same FEA workshop testing to allow comparison with the current upright design. Both uprights underwent FEA using track data to calculate the forces the upright would see. A 'worst case' scenario was also tested.

Results

The result of the optimisation is shown below, the key areas where material needs to be are clear to see.

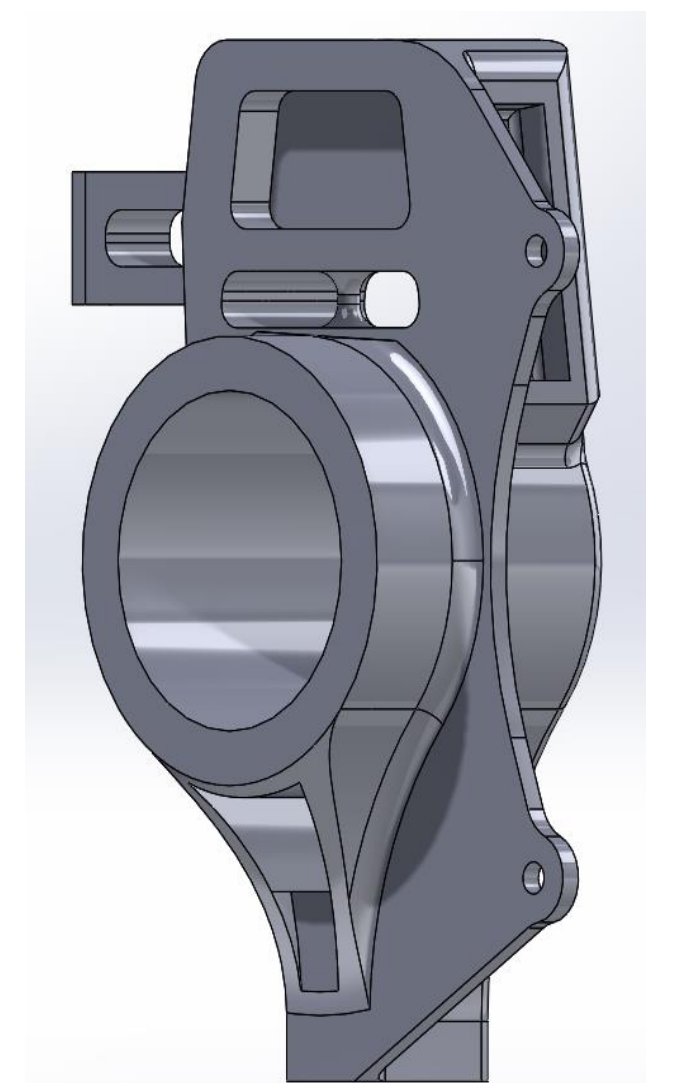


Optimisation Results

The results of the 'worst case' FEA testing of both upright designs can be seen below:

Results of 'Worst Case' FEA

Attachment Point	Force	Upright			
		Old	New	Difference	Deflection Δ
Top	N	mm	mm	%	mm
Vertical	8154	0.00167	0.01317	688.00%	0.01150
Horizontal	1335	0.00168	0.01400	733.00%	0.01232
Bottom					
Vertical	8154	0.00114	0.01862	1533.00%	0.01748
Horizontal	7820	0.01072	0.06897	543.00%	0.05825
Brake Top					
Vertical	8154	0.09950	0.08439	16.00%	-0.01511
Horizontal	2024.58	0.66710	0.45220	33.00%	-0.21490
Brake Bottom					
Vertical	8154	0.10950	0.10677	3.00%	-0.00273
Horizontal	8239.58	0.00653	0.00645	2.00%	-0.00008



New Optimised Upright Design

Conclusion

The weight saving goal of this project (0.5kg) would equate to roughly 0.03 seconds per lap. However, with the proposed upright design being 26% lighter than the current upright, the weight saving that could be achieved was 0.95kg. This would lead to a potential lap time benefit of almost 0.06 seconds per lap. Therefore, the increased deformation is acceptable.

Acknowledgements

I would like to thank Paul Davies for assistance in designing and welding the twist rig.

I am also grateful to Team MCR for lending me the upright to test and for providing me the initial CAD model of the Upright.

References

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