

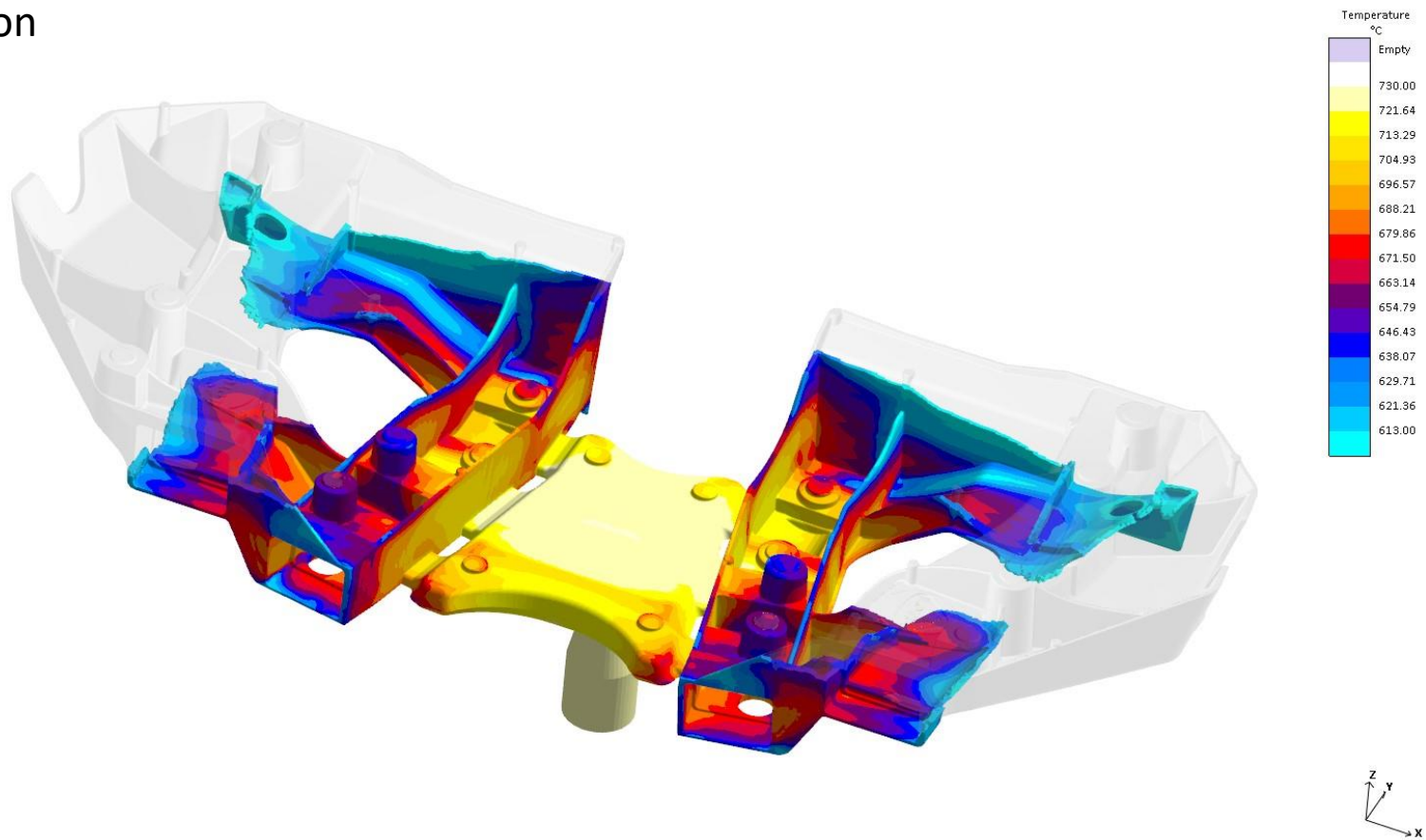
DFM+ A New Approach to Casting Development

13th Jan 2022



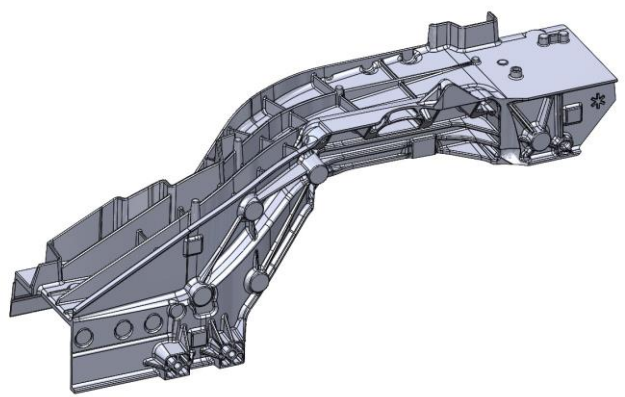
[sarginsons.com](https://www.sarginsons.com)

Introduction

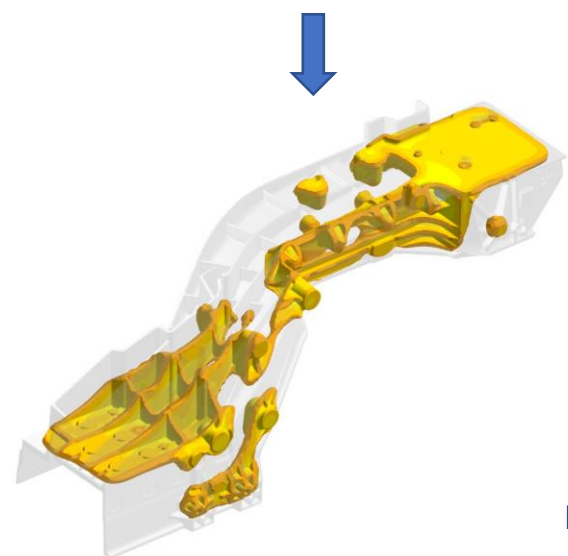


Sarginsons have recognised for some time, through casting testing and calibration, that the simulated CAE homogenous figures inputted in vehicle CAE development do not replicate the reality. We have therefore developed digital twin solutions that can – at the concept and design development phase – simulate the mechanical property variability from the casting and heat treatment stages, map this to FE meshes and export for intelligent further CAE work. This allows the customer to make informed decisions on design suitability, offers opportunity for significant light-weighting by removing geometrical pessimism and allowing for integrated optimised topology, identifies areas of reduced strength before manufacture, and critically compresses the development timescales.

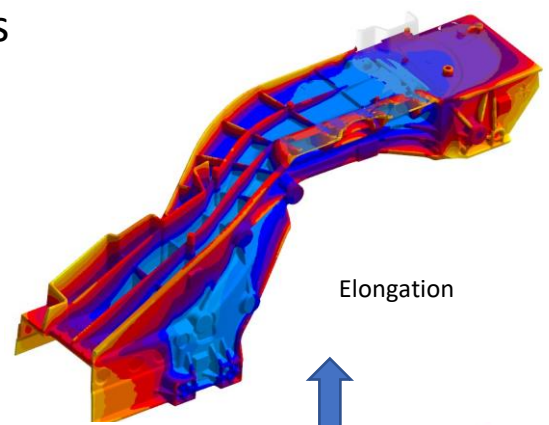
Material Property Mapping Process



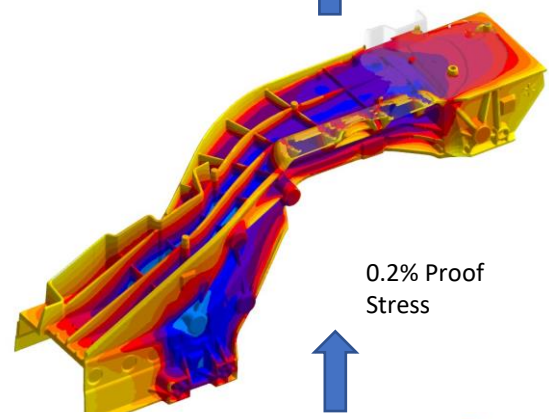
Casting is analysed and developed for manufacturing suitability



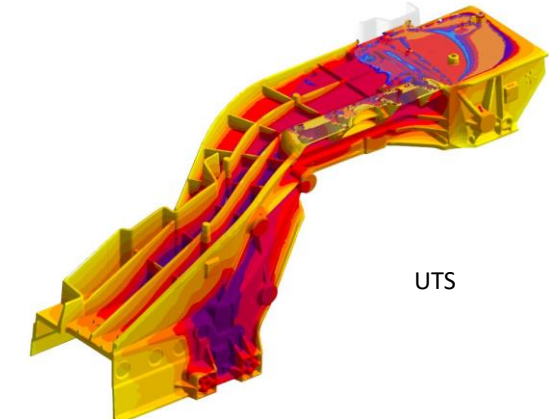
Magma software used for casting and heat treatment simulation



Elongation

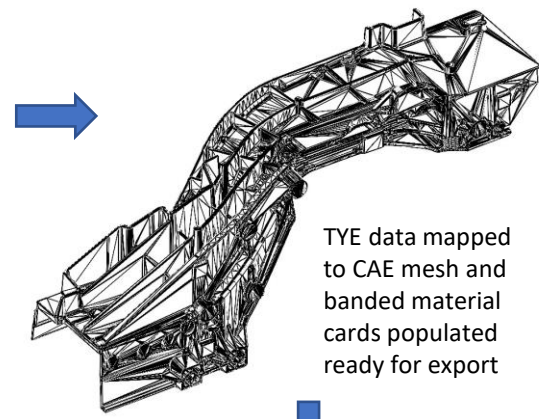
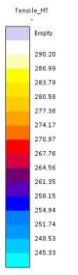
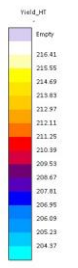
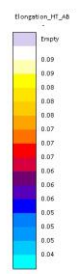


0.2% Proof Stress



UTS

Mechanical property variability due to geometric and manufacturing processes specified



TYE data mapped to CAE mesh and banded material cards populated ready for export

MODIFY MATERIAL M1MAT3922

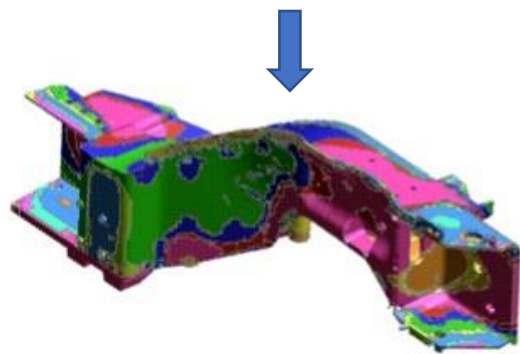
Label: 3922 | Elem Type: Solid, Shell, TShell, SPH

Type: MODIFIED_PIECEWISE_LINEAR_PLASTICITY | PL16

Suffix: none

Title: get_Nominal_strny_hist_3% true used (eng: 165/205/8.03)

Row/Col	1	2	3	4	5	6	7	8
1	ELMOD	RD_F	E_F	PR_F	SIGY_F	ETAN_F	FAIL_F	TDEL_F
2	3922	2.75E+9	69000.0	0.3	165.0	0.0	1.0	0.0
2	C_F	P_F	LCB3_I	LCB3_V	NP_F	EPSTPRY	EPISMA	TAABITY
3	EP31_F	EP32_F	EP33_F	EP34_F	EP35_F	EP36_F	EP37_F	EP38_F
4	0.0	0.027	0.1	0.0	0.0	0.0	0.0	0.0
4	ES1_F	ES2_F	ES3_F	ES4_F	ES5_F	ES6_F	ES7_F	ES8_F
4	165.0	211.2	211.3	0.0	0.0	0.0	0.0	0.0



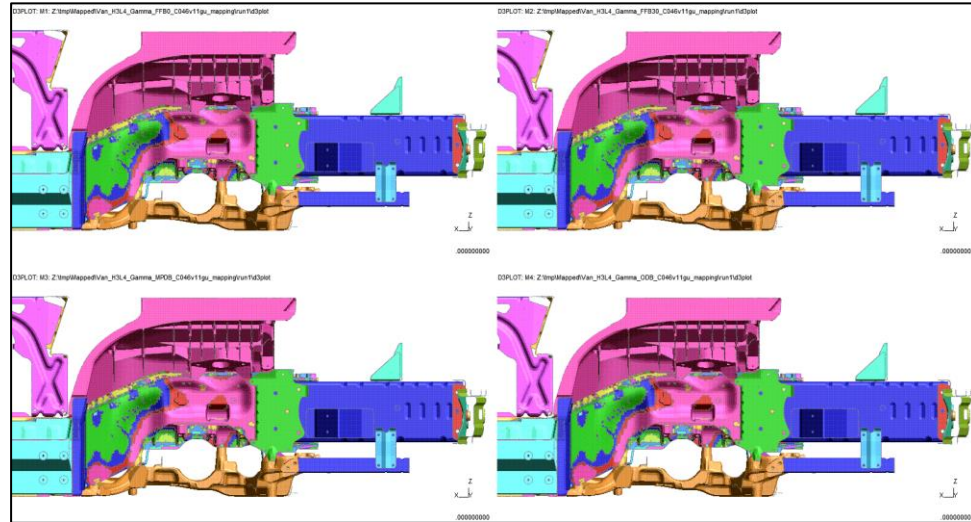
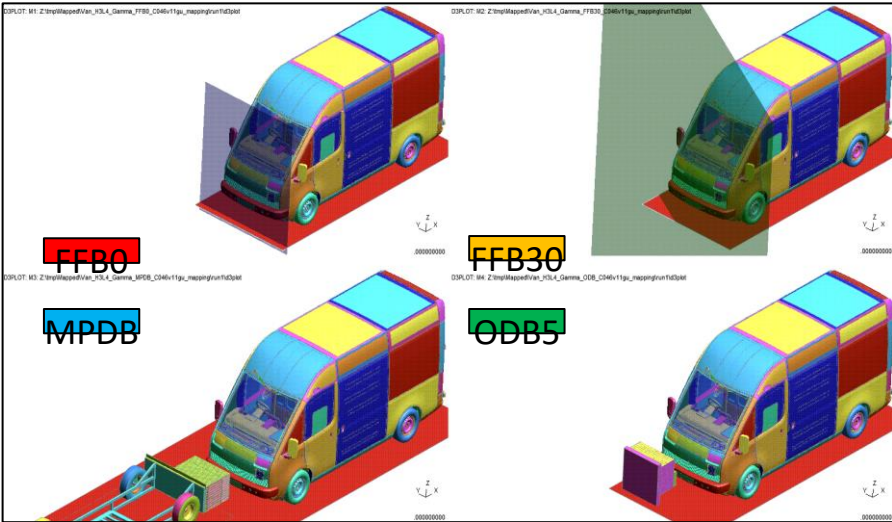
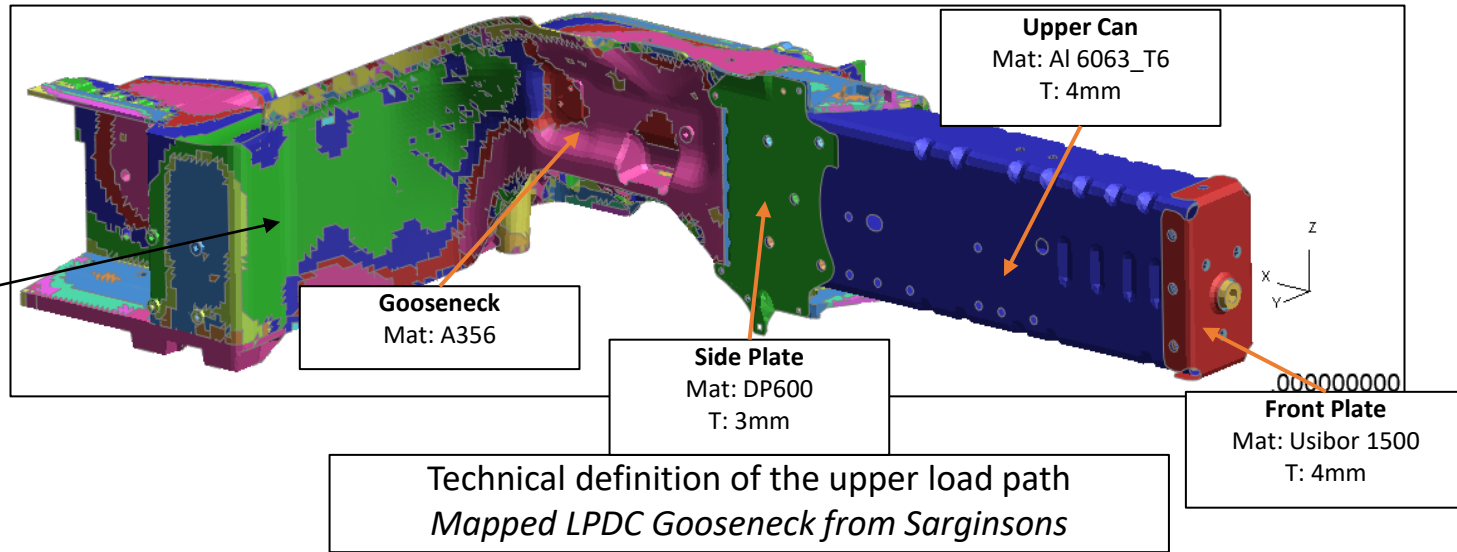
Fully mapped mesh as seen in CAE software (in this case LS DYNA)



LEADERS IN LIGHTWEIGHTING

Mapped Data Application

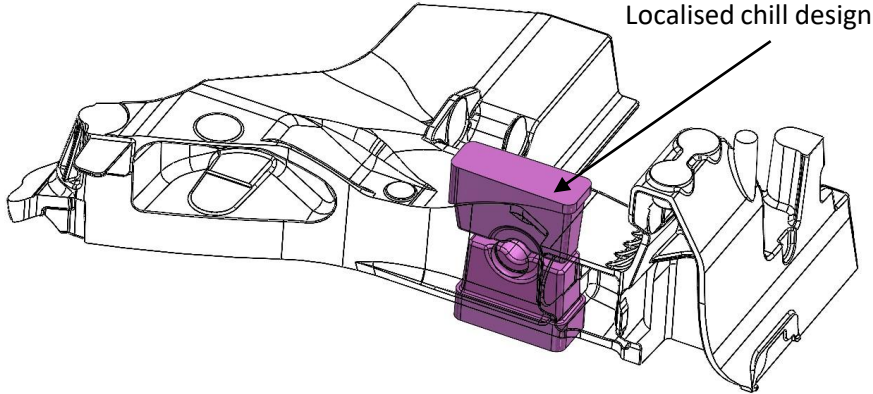
Cast form with variable mechanical property data banded and mapped



Once re-imported into CAE software, the mapped casting data (the number of data bands can be specified as required) can be used to give a realistic replication of the casting performance. This allows the engineer to make intelligent and informed decisions at the development stage that are simply not achievable with fixed homogenous material data that is currently used in most CAE. Opportunities for light-weighting, redesign, and process adaptation are enormous. Development loops can be shortened, errors avoided, and substantial cost savings made.

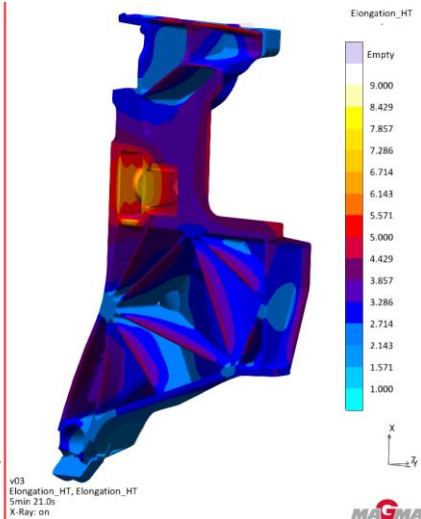
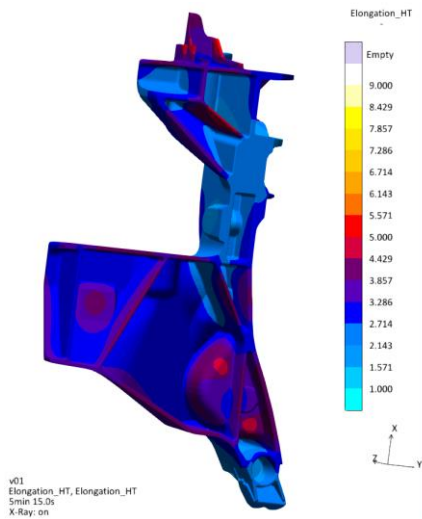
Manufacturing Considerations

Targeted Chilling



Pre chill elongation

Post chill elongation

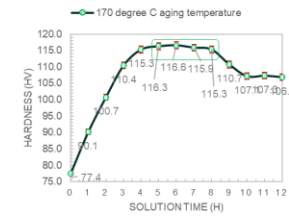
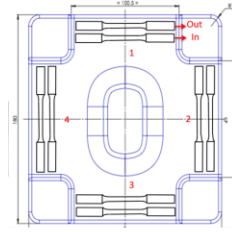


Localised use of chills in sand casting can address areas of high stress/strain and elevate mechanical properties to allow successful deployment. This approach can be fully simulated and mapped for CAE analysis. For permanent mould there is the opportunity to explore 3D printed cooling channels to work in the same way with key areas of high stress.

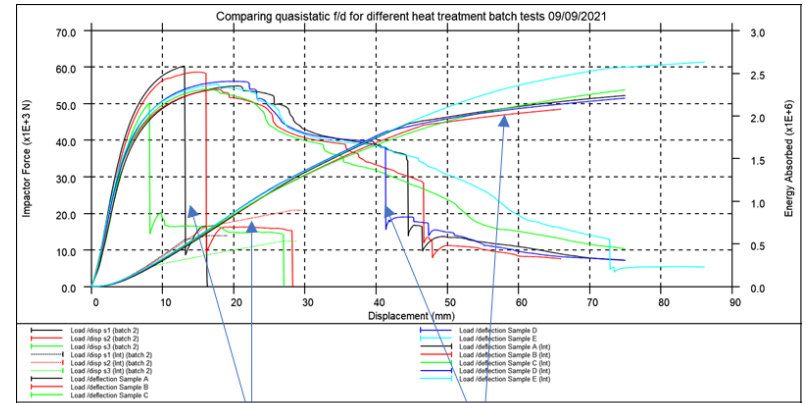
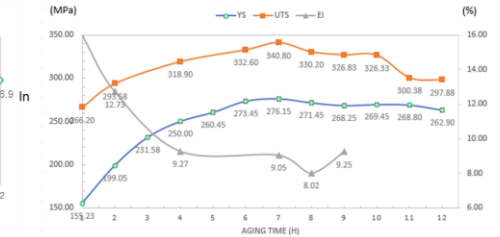
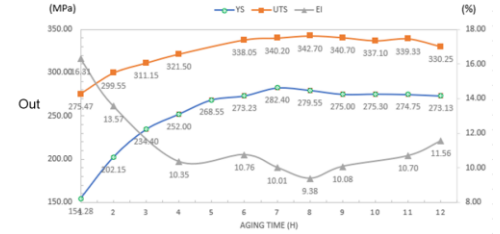


Heat Treatment Variables

Aging heat treatment – TYE (A356)



540C 6h solution + 170 C aging heat treatment



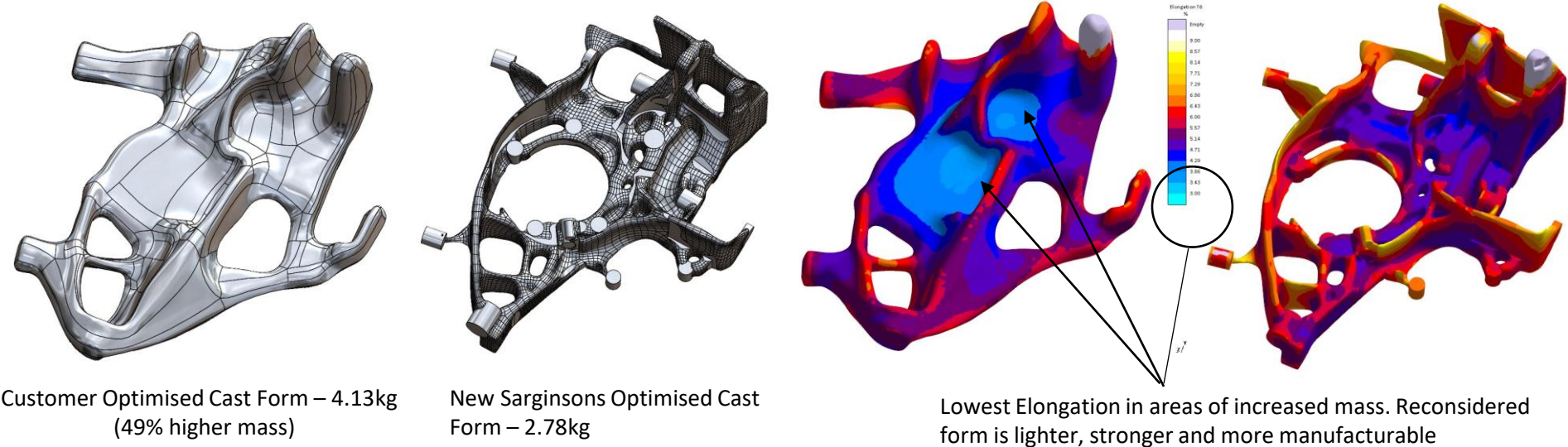
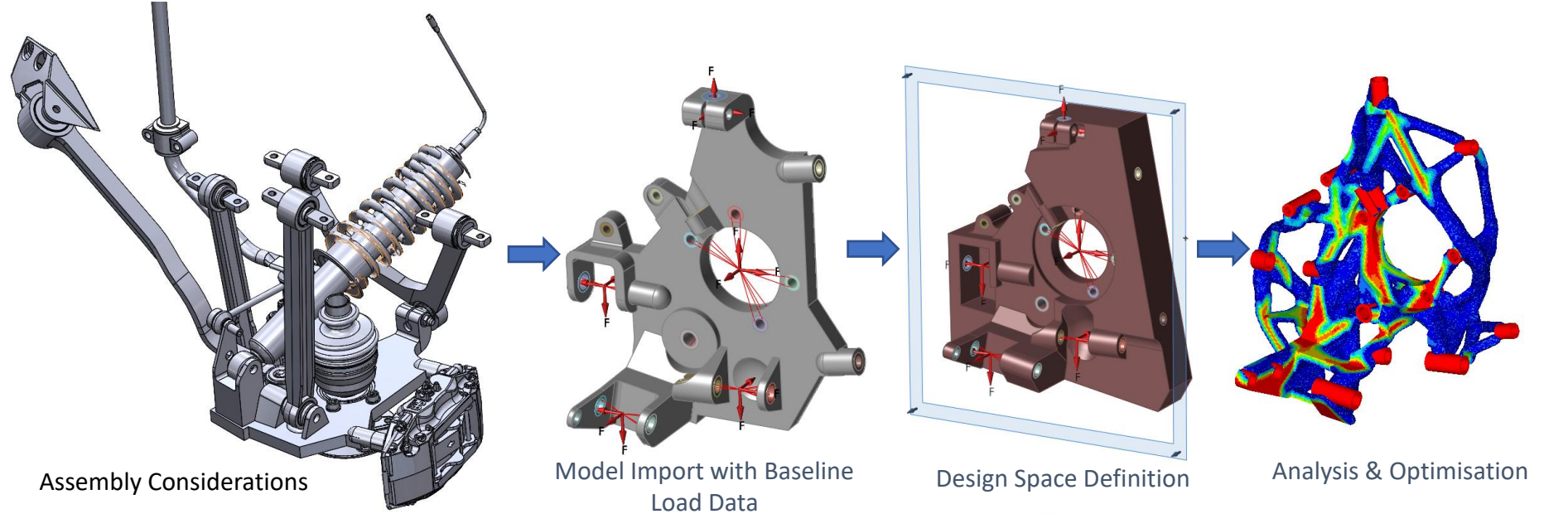
Results for lower elongation/higher yield (test run 2)

Results for higher elongation/lower yield (test run 1)

Mechanical properties in aluminium cast forms can vary significantly during the heat treatment process, due to the impact of precipitation through the ageing process. Sarginsons have built a comprehensive library of this data that allows a specific heat treatment to be simulated and specified for parts with certain requirements. For example, elevated ductility.

Optimised Topology +

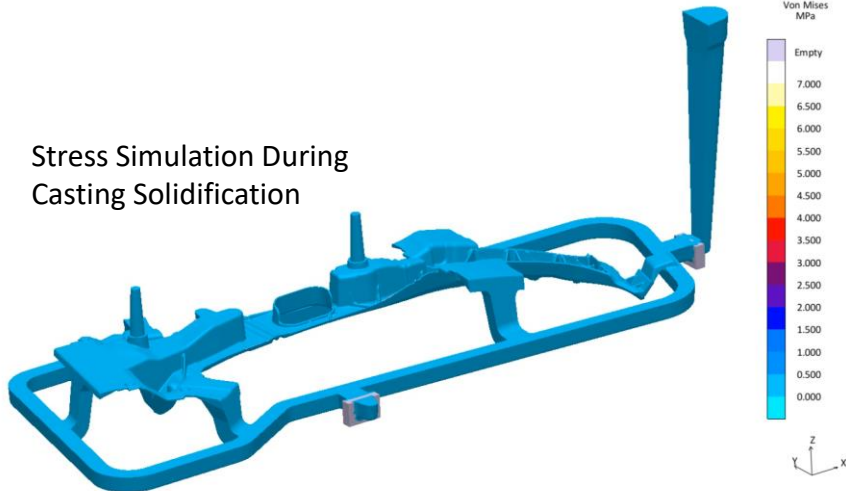
The integrated use of advanced casting simulation with optimised topology is key to maximising light-weighting opportunities in future vehicle design. By fully understanding the impact of organic geometry on cooling rates, manufacturability, and mechanical strength castings can be lighter, stronger and lower cost.



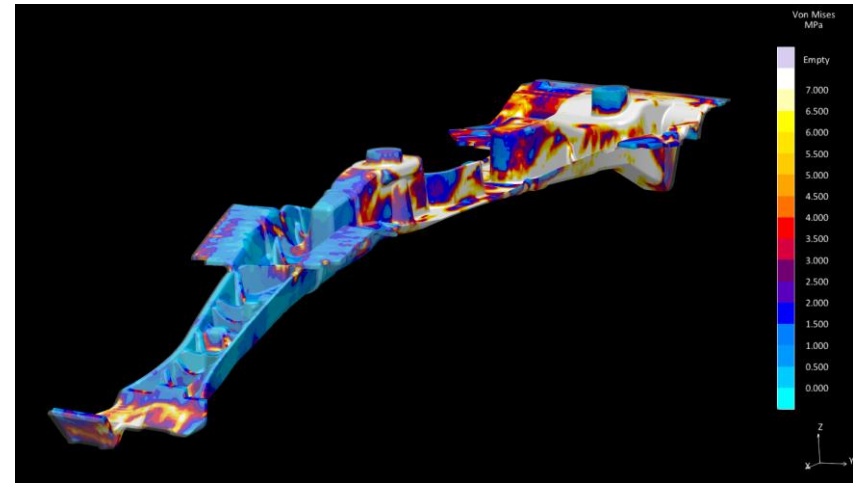
Stress Mapping + Predictive Deformation

The impact of casting deformation during cooling and particularly heat treatment can also be simulated, and results files created to align with nominal geometry allowing distortion risk to be considered at the design stage. Additionally, residual stresses inherent in the casting forms following these processes can also be predicted and mapped, much in the same way as TYE properties. This data can then be used for informed CAE fatigue and other engineering analysis

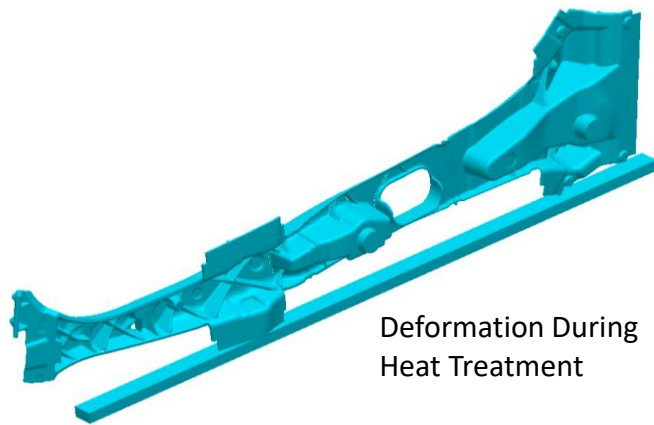
Stress Simulation During Casting Solidification



AML_B_PILLAR_RFMY83_279K02_FEB_2019/v15
Cycle 9, Solidification & Cooling until Eject, Von Mises
9.011s, 2.00%

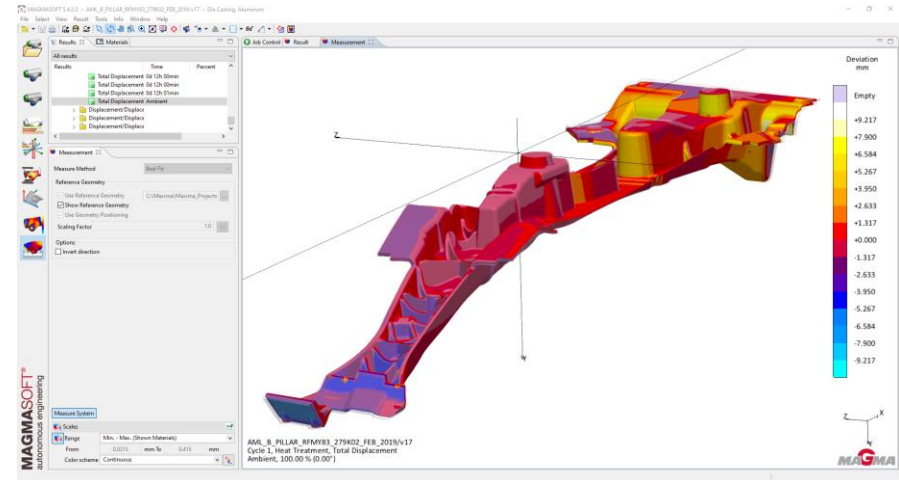


Stress Mapping – can be exported for CAE fatigue analysis



Deformation During Heat Treatment

C:/Maxima/MAGMA54/Support_Projects/Sarginsons/AML_B_PILLAR_RFMY83_279K02_FEB_2019/v17
Cycle 1, Heat Treatment, Temperature
0.0ms, 0.00% (0.00")



Final Model with predicted levels of deformation (from nominal)



Thank you

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