MODELLING OF CASTING STRUCTURES: A COMPREHENSIVE INVESTIGATION.

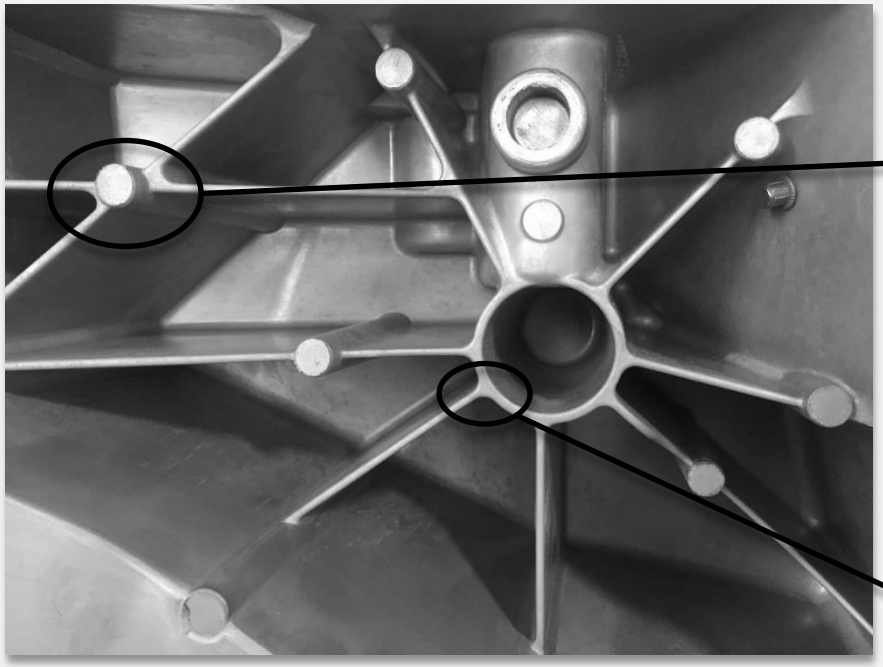
8TH BEFORE REALITY CONFERENCE, MUNICH, 2019.

Dr. Octavian Knoll (BMW Group)
Michael Tryfonidis (BETA CAE Systems SA)

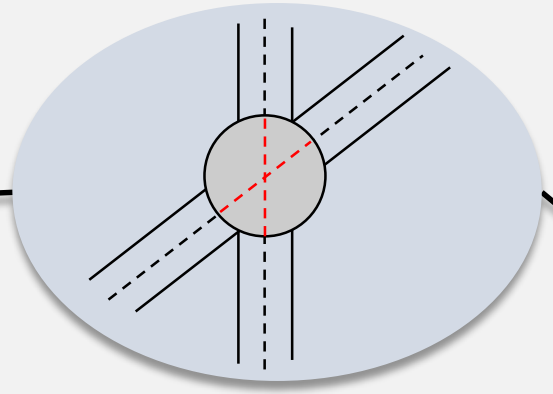
BMW GROUP THE NEXT 100 YEARS

Rolls-Royce Motor Cars Limited

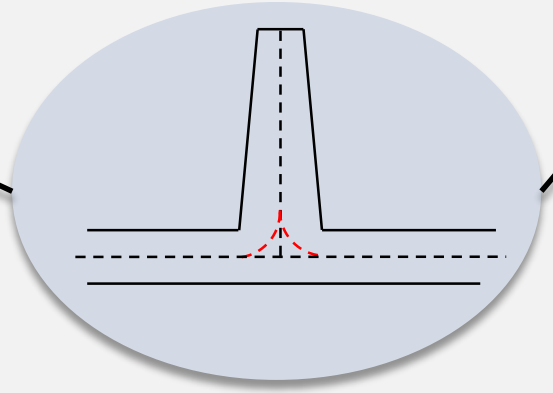
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: CROSSING RIBS AND VARYING THICKNESSES.



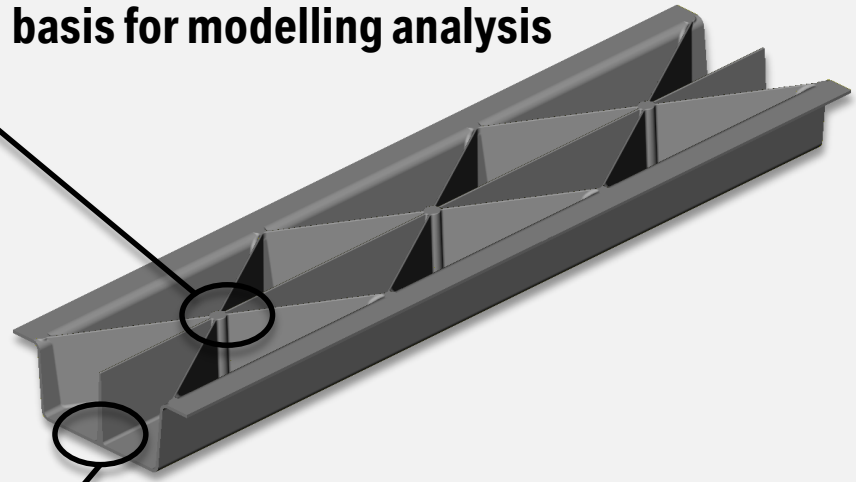
Extreme changes in thickness?



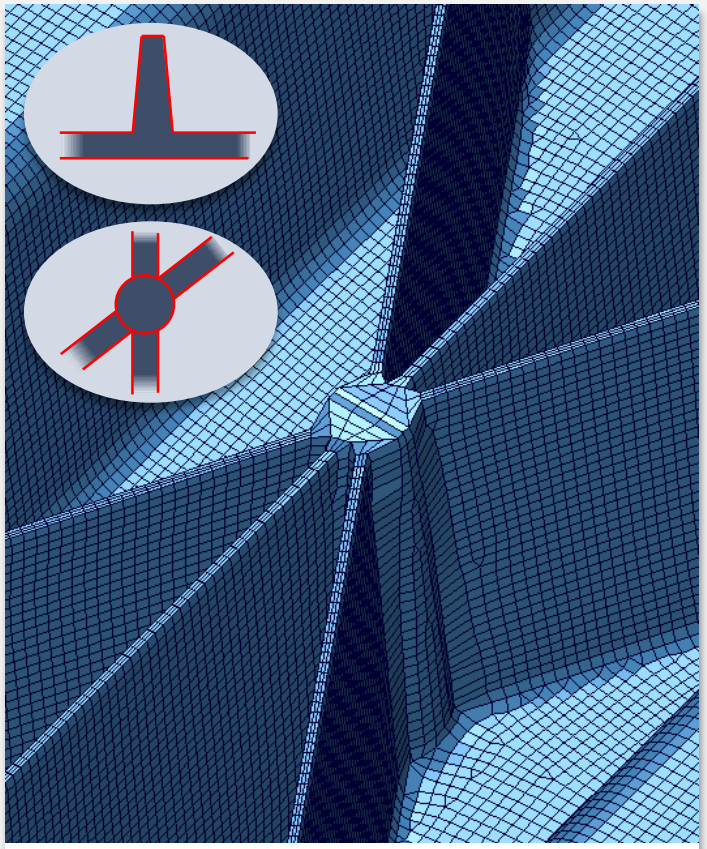
Definition of middle surface?



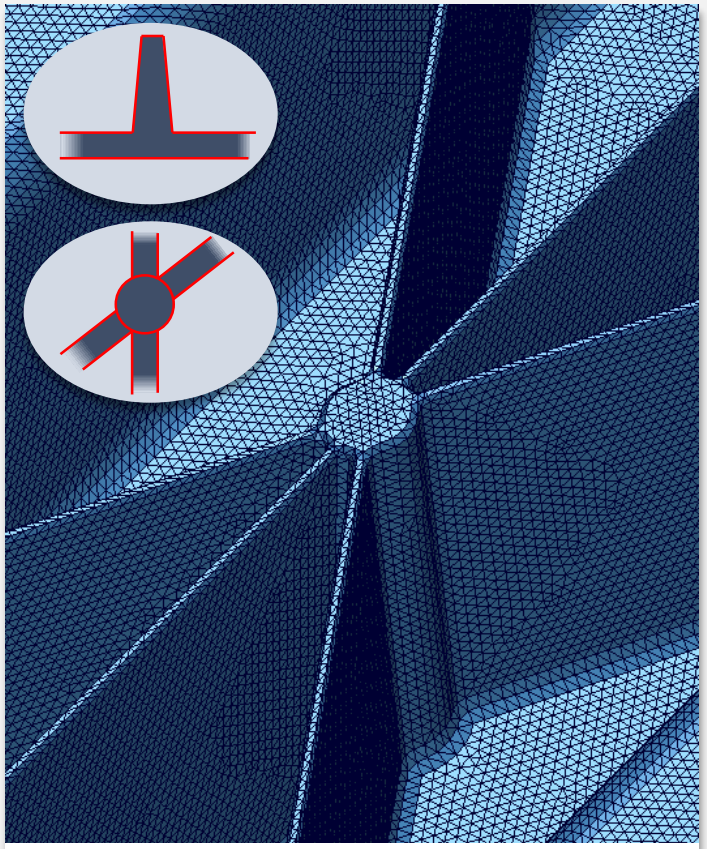
Generic casting component as basis for modelling analysis



MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: DISCRETIZATION USING SOLIDS, SHELLS AND BOTH.

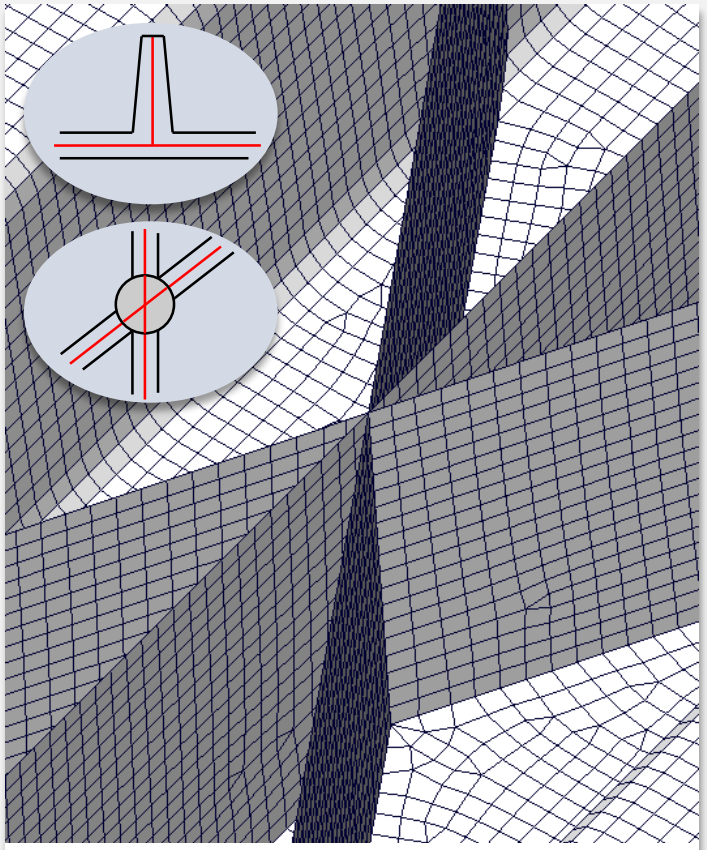


Solid modelling (Hexa):
Hexahedral elements (1L, **3L**, 5L)

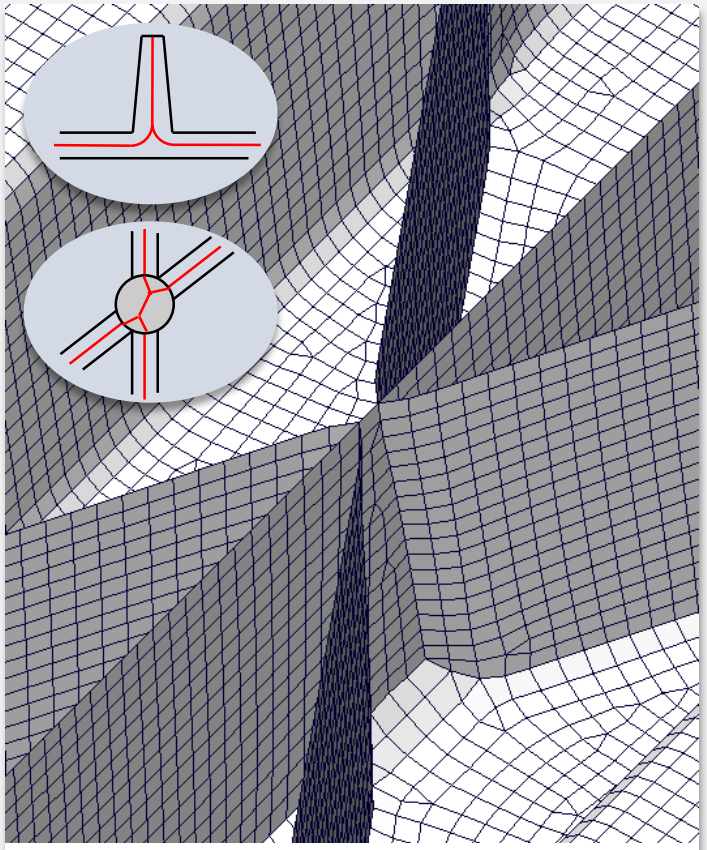


Solid modelling (Tetra):
Tetrahedral elements (1L, 2L, **3L**)

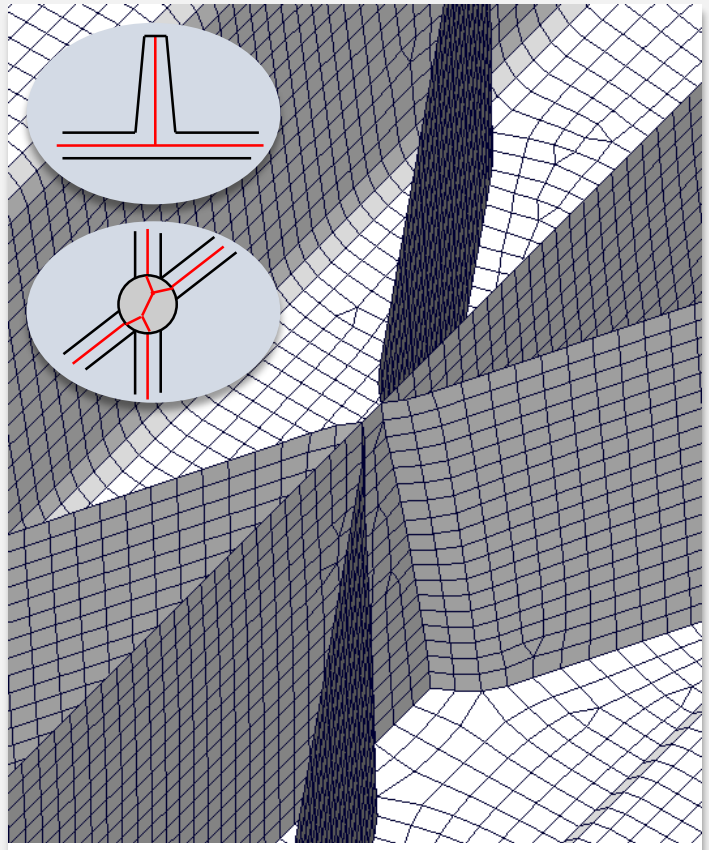
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: DISCRETIZATION USING SOLIDS, SHELLS AND BOTH.



Shell modelling (Exact):
T-junctions (8mm, **4mm**, 2mm)

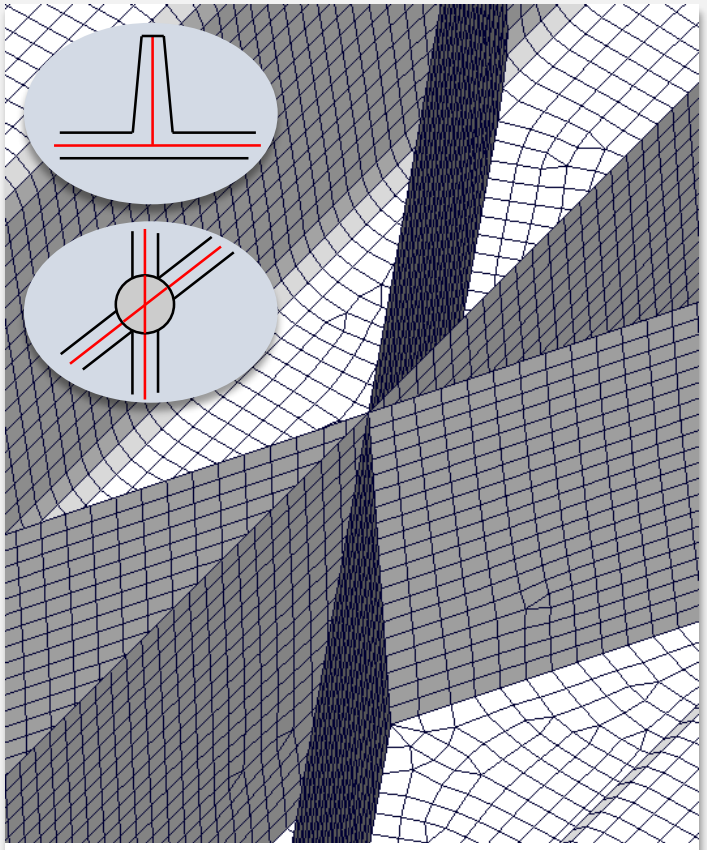


Shell modelling (Real):
Y-junctions (8mm, **4mm**, 2mm)

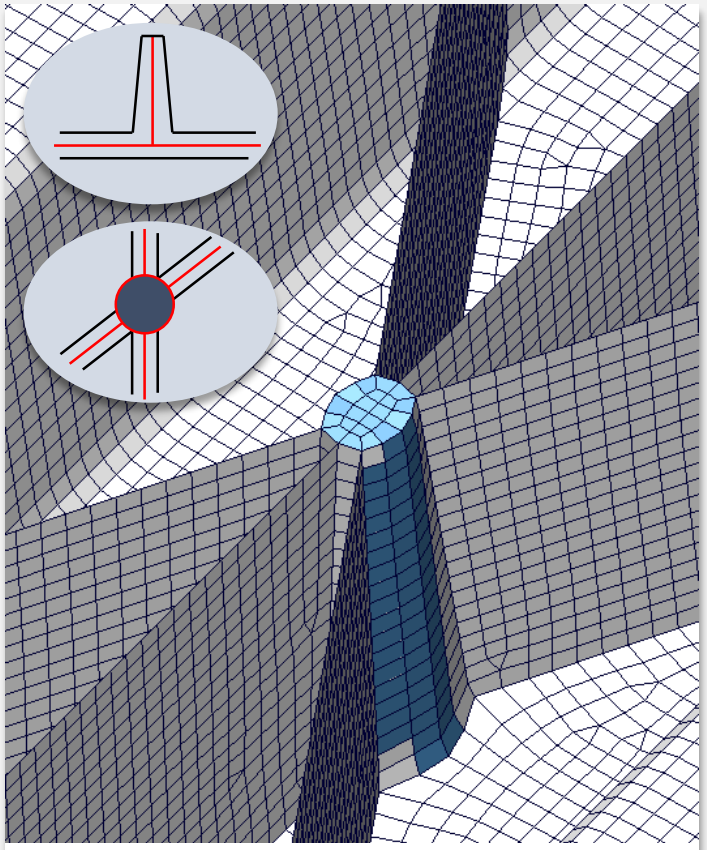


Shell modelling (Hybrid):
TY-junctions (8mm, **4mm**, 2mm)

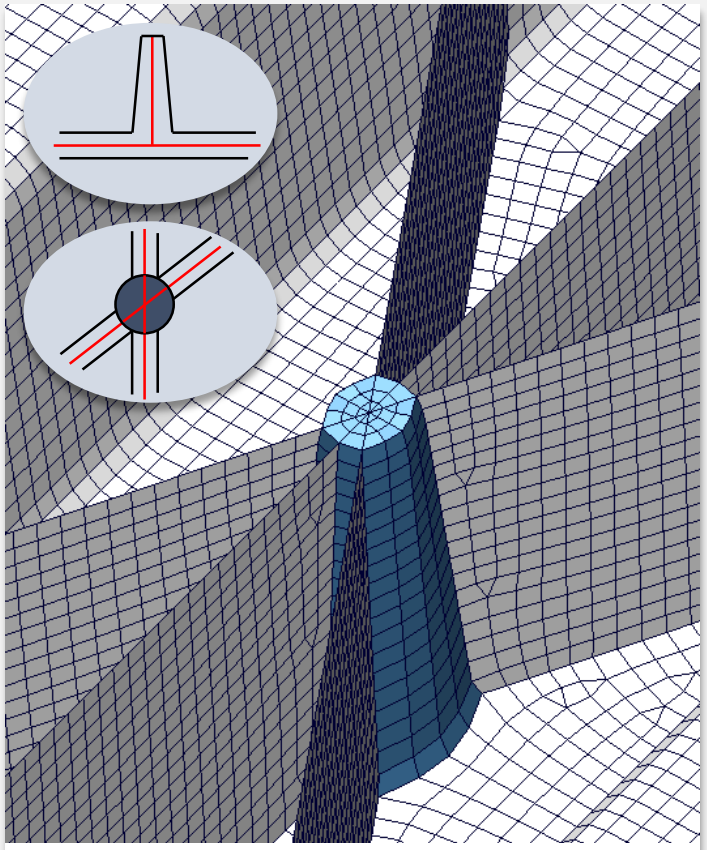
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: DISCRETIZATION USING SOLIDS, SHELLS AND BOTH.



Shell modelling (Exact → Basis):
T-junctions (8mm, **4mm**, 2mm)



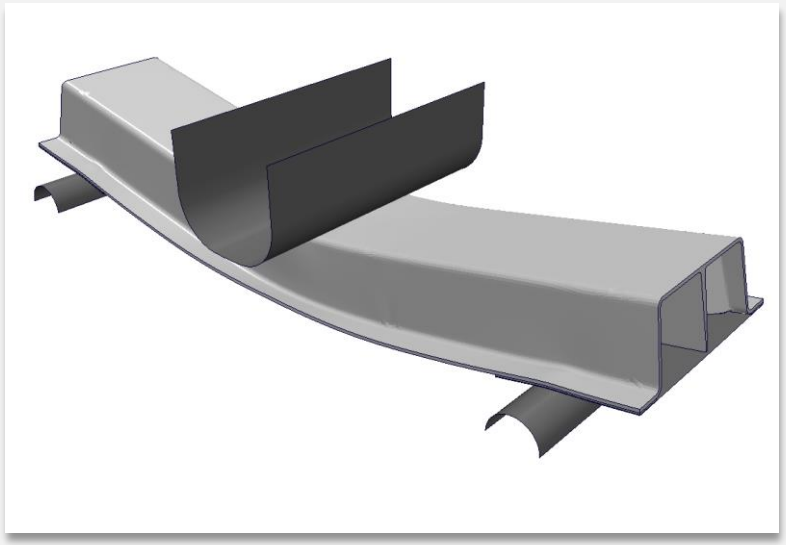
Hybrid modelling (V1):
Variant 1 (8mm, **4mm**, 2mm)



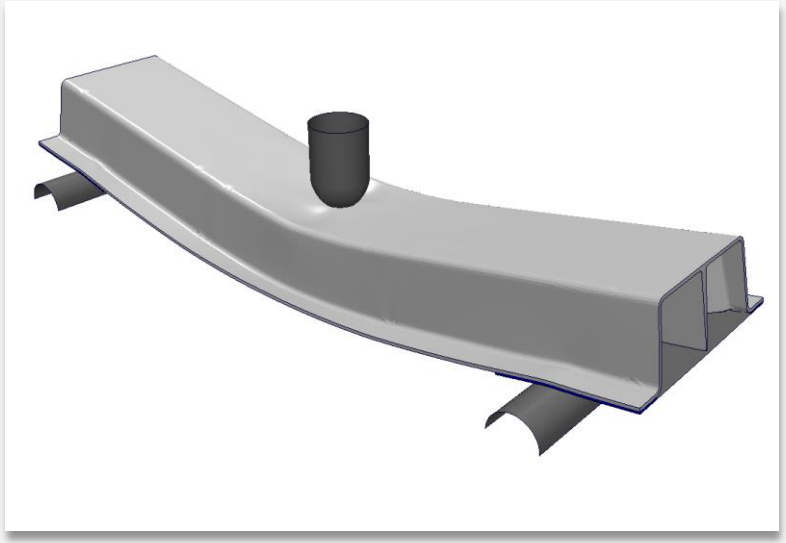
Hybrid modelling (V2)*:
Variant 2 (8mm, **4mm**, 2mm)

*O. Knoll: A Probabilistic Approach in Failure Modelling of Aluminium High Pressure Die-Castings (2015)

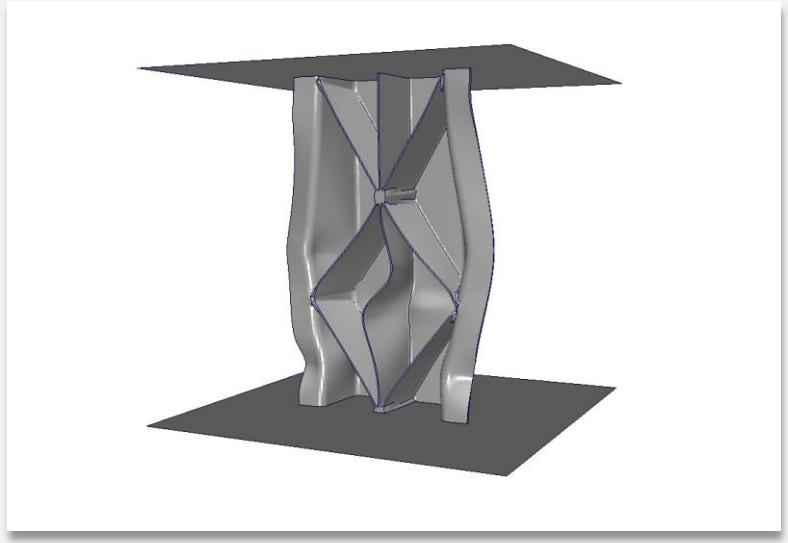
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: BENCHMARK BASED ON BENDING AND CRUSHING.



Global bending
(3-point-bending with cylindrical impactor)



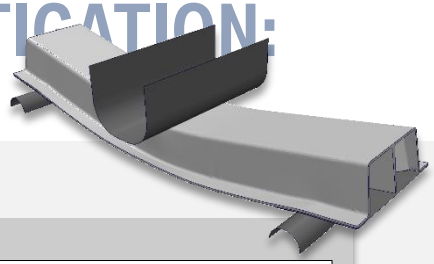
Local bending
(3-point-bending with spherical impactor)

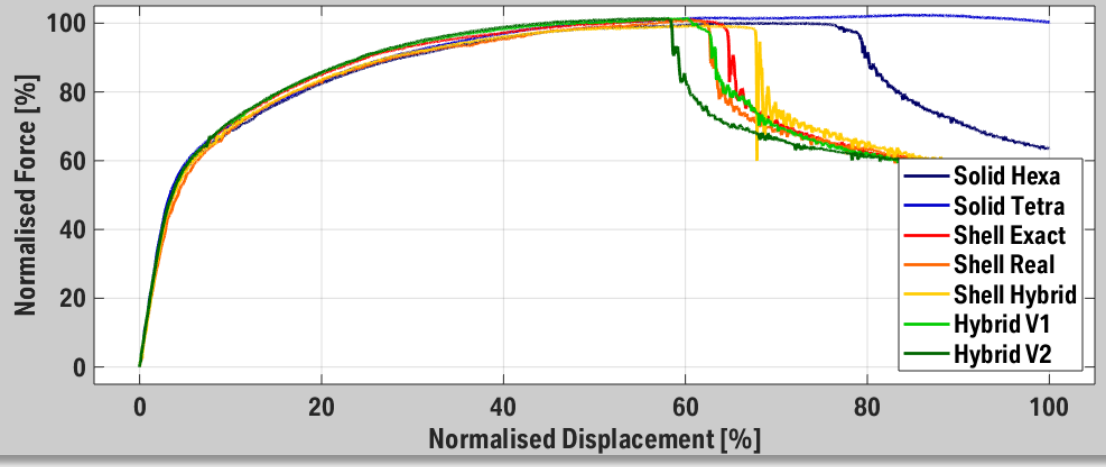


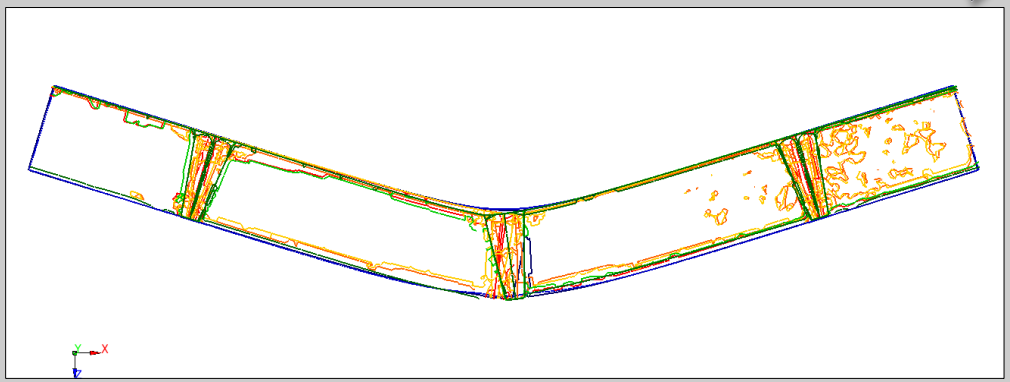
Crushing
(Axial crushing between two plates)

Solver:	ABAQUS/Explicit
Elements:	Under-integrated linear elements with stiffness based hourglass control
Material model:	v. Mises plasticity combined with IDS failure criterion (material ALSI10MNMG-T7)
Impactor:	Displacement controlled rigid bodies
Settings:	General contact, no mass scaling

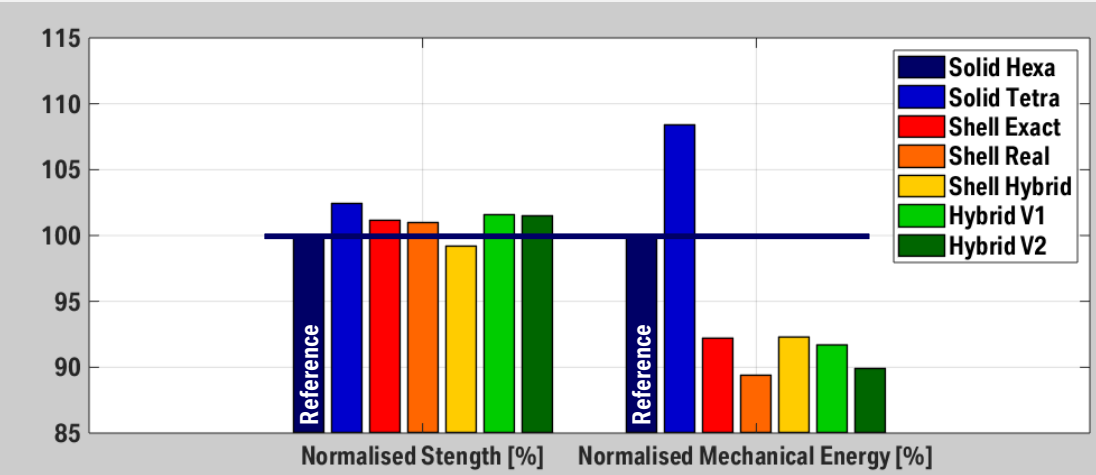
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: RESULTS OBTAINED FROM BENDING TEST SET-UP (CYLINDER).

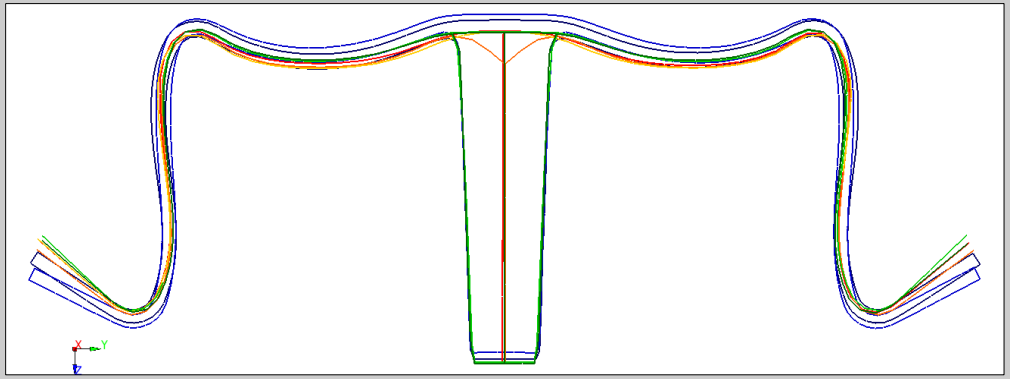






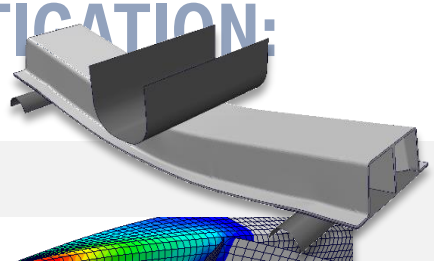
Final Bending Line Component

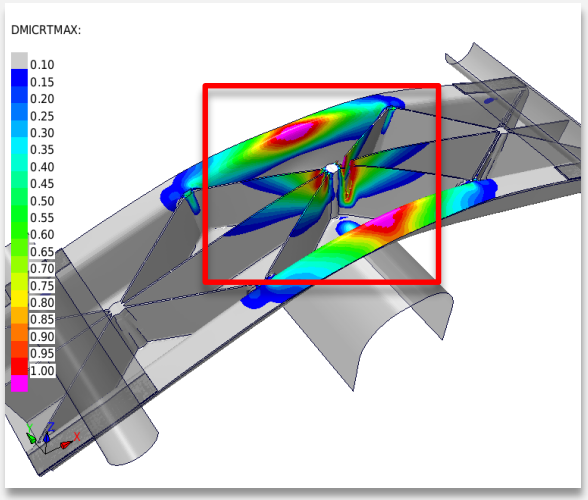


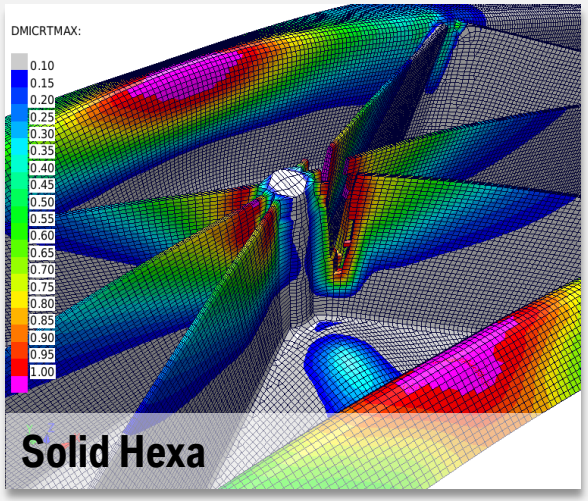


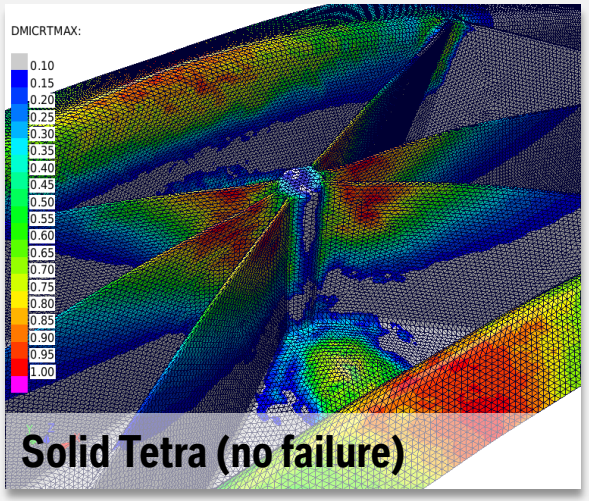
Final Middle Cross Section Deformation

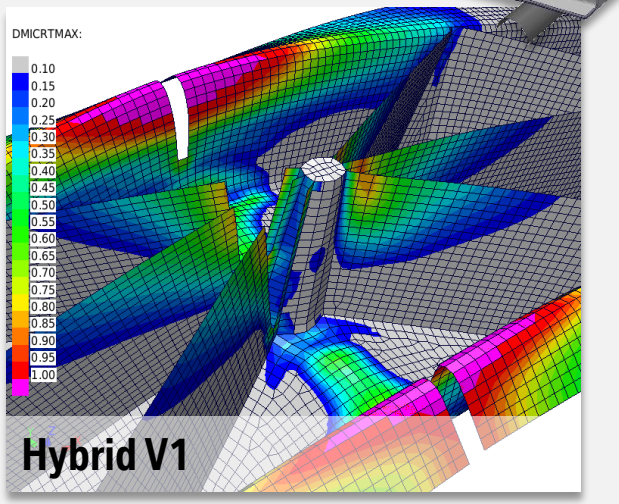
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: RESULTS OBTAINED FROM BENDING TEST SET-UP (CYLINDER).

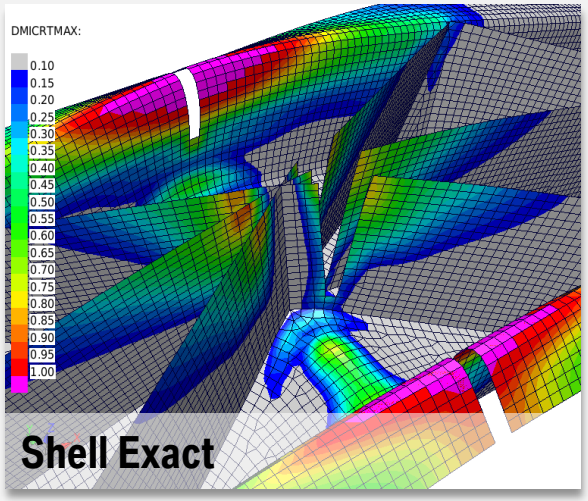


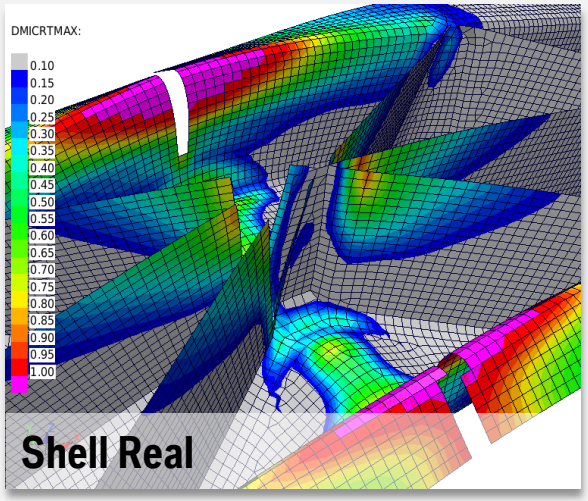


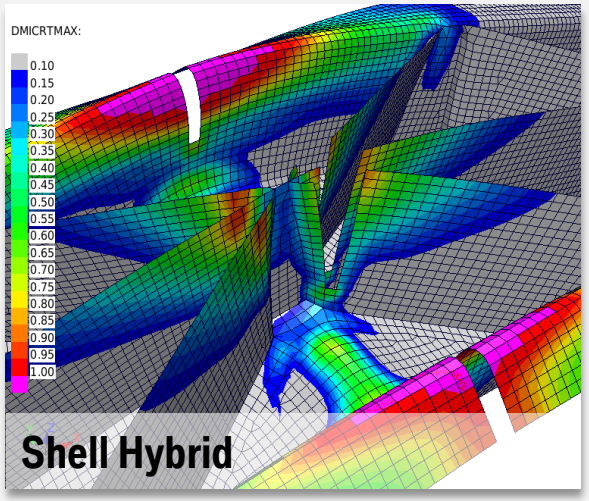


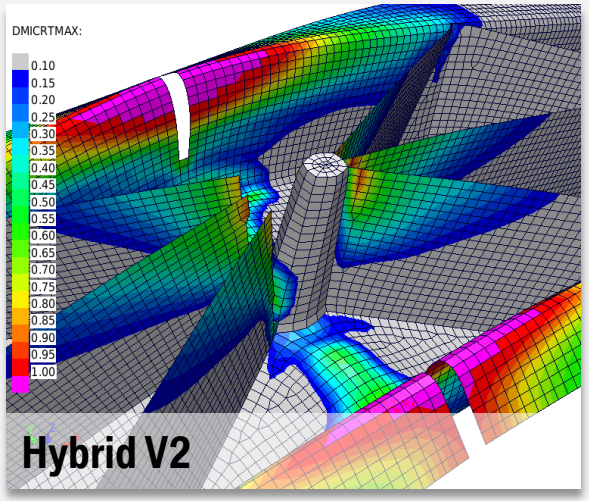




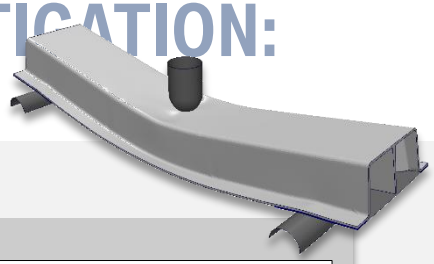


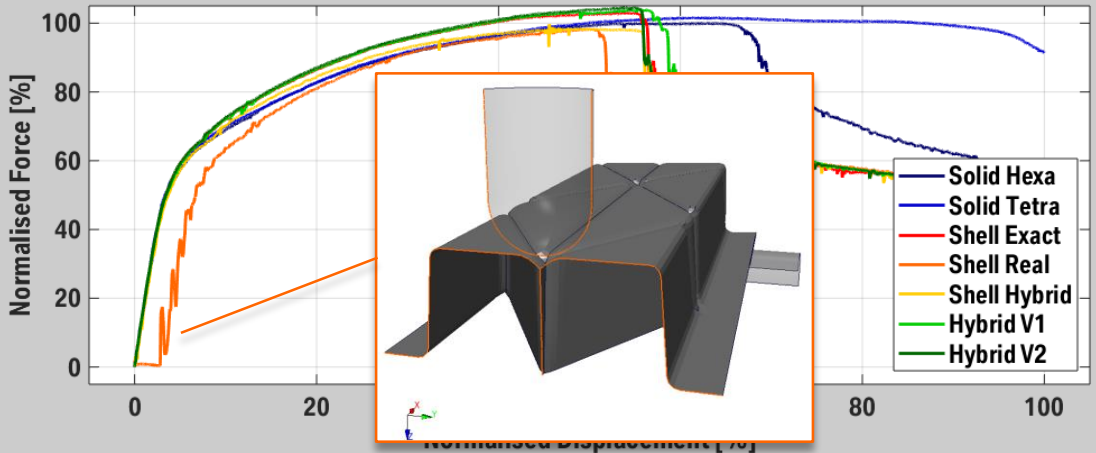


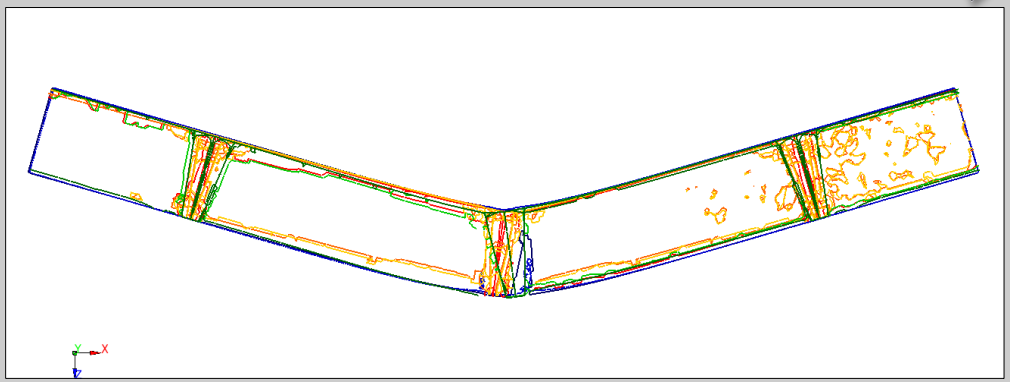




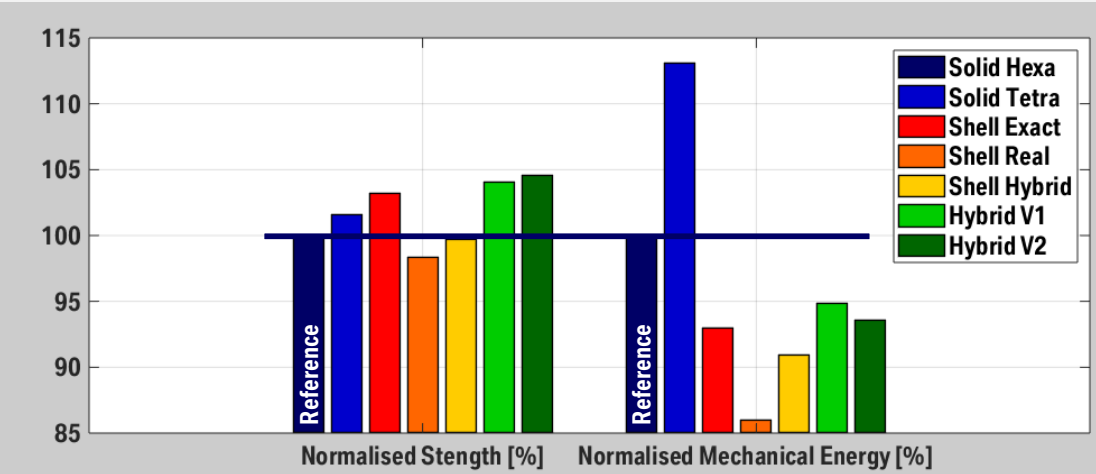
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: RESULTS OBTAINED FROM BENDING TEST SET-UP (SPHERE).

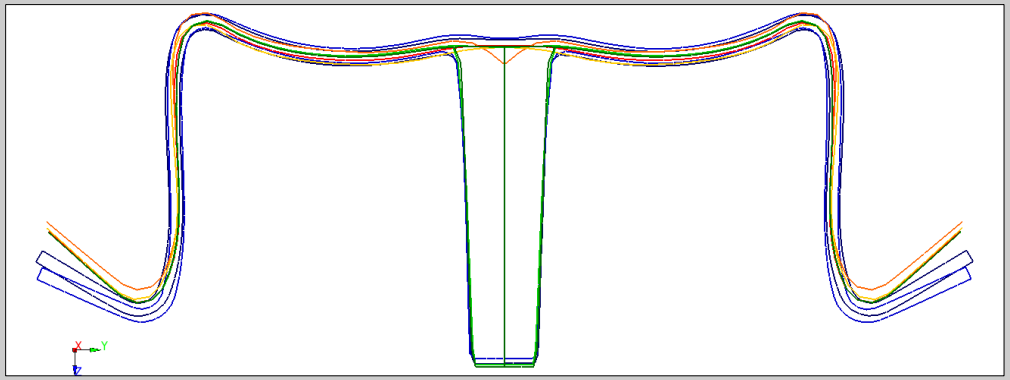






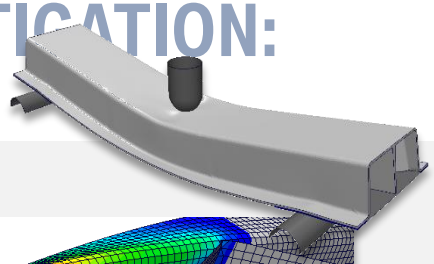
Final Bending Line Component

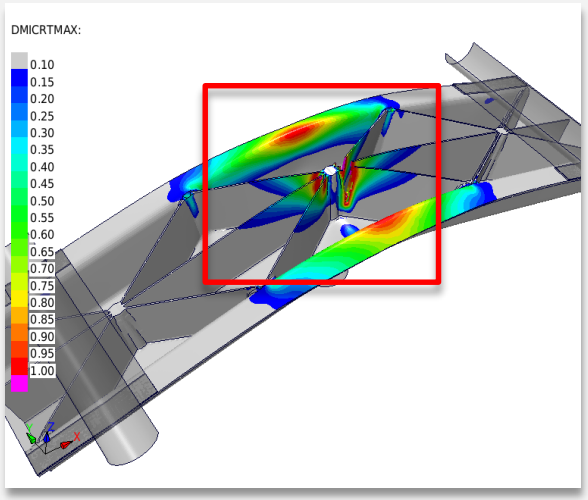


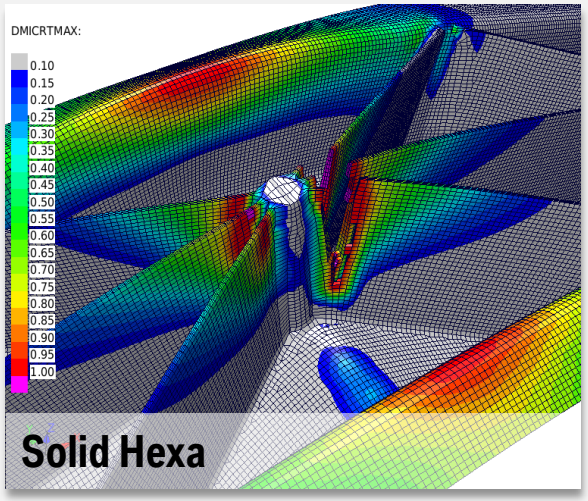


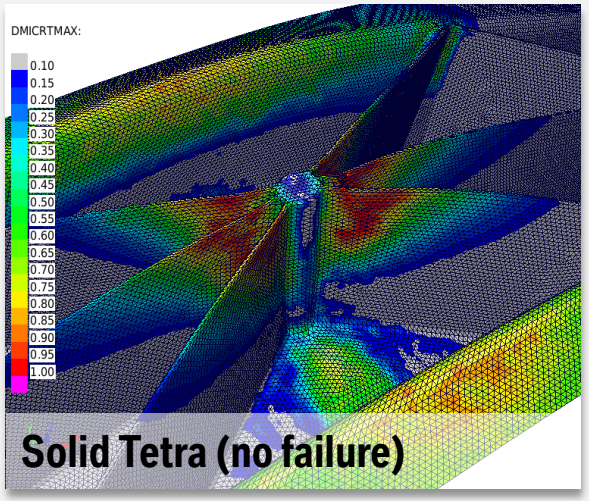
Final Middle Cross Section Deformation

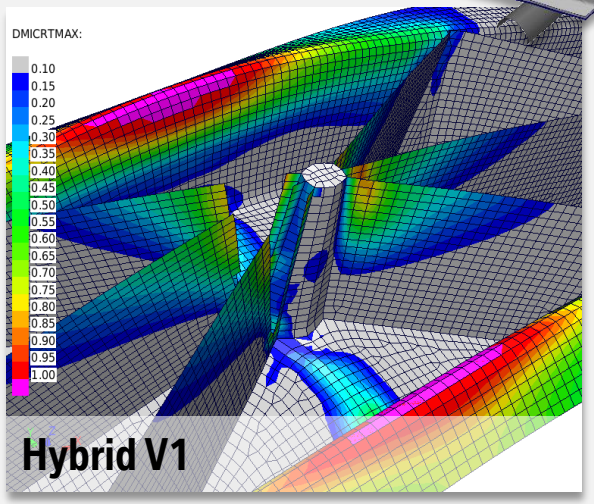
MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: RESULTS OBTAINED FROM BENDING TEST SET-UP (SPHERE).

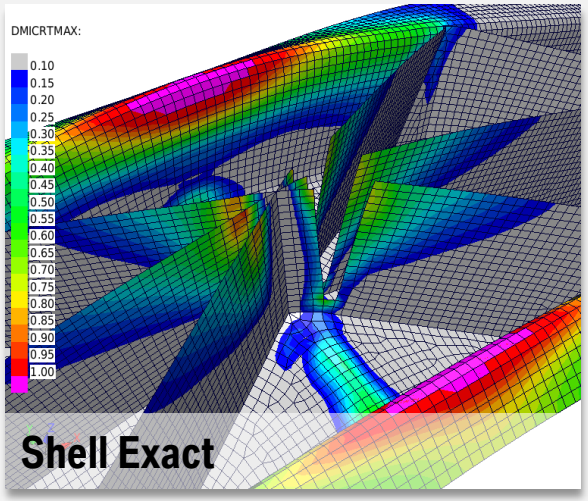


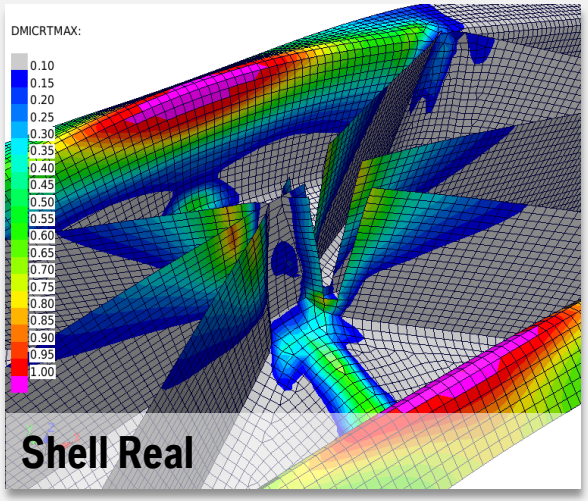


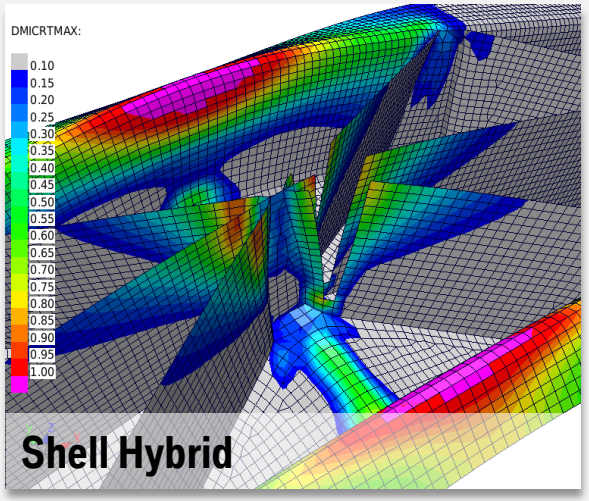


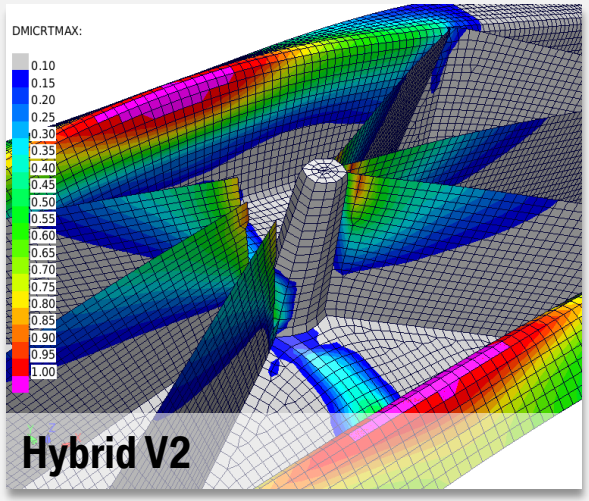




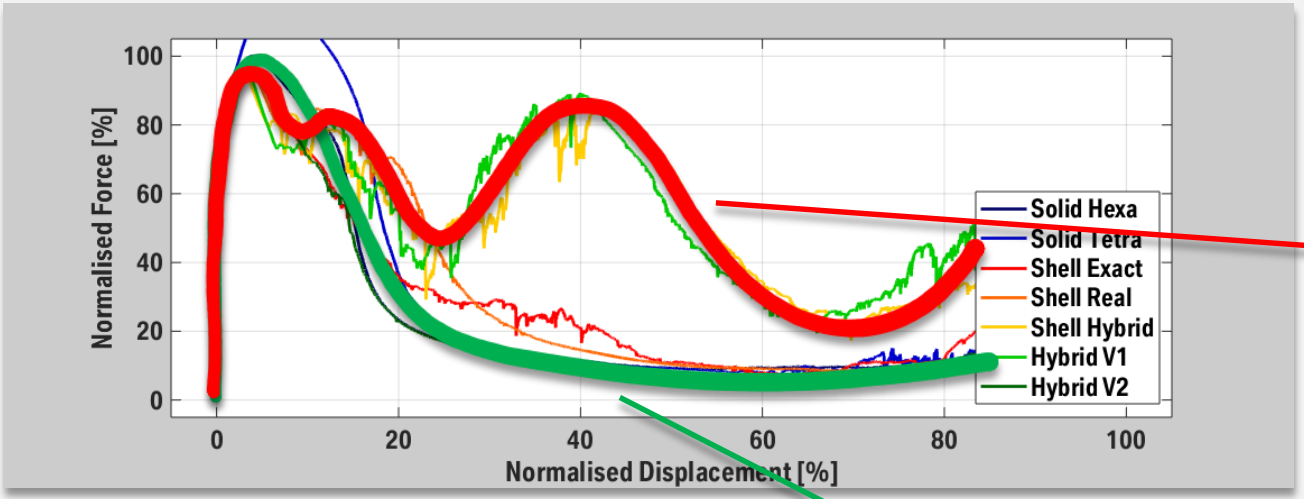


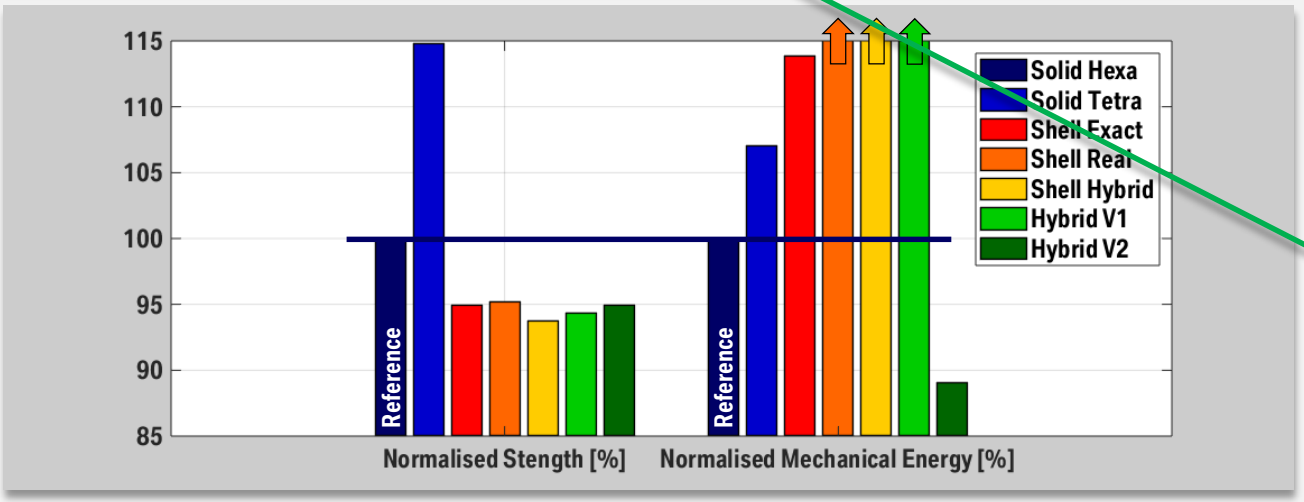


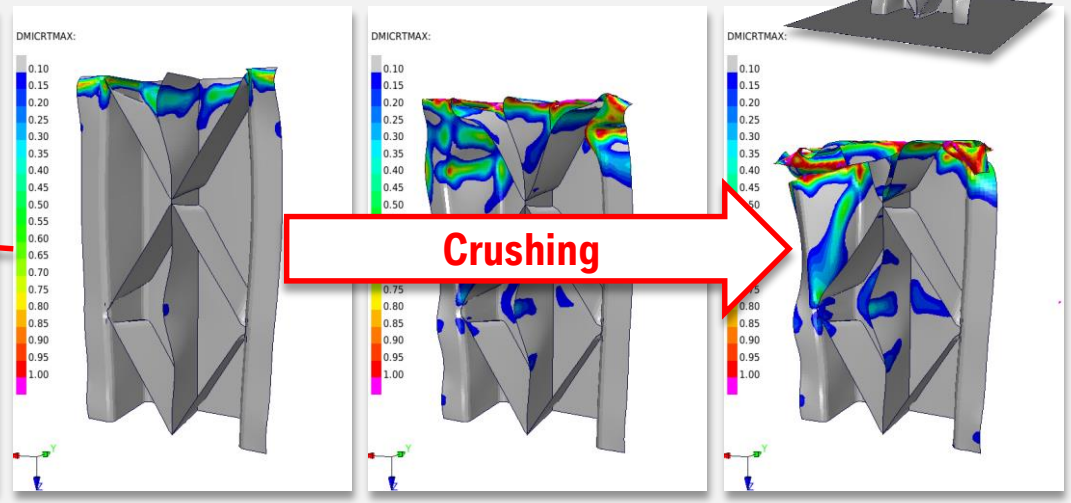


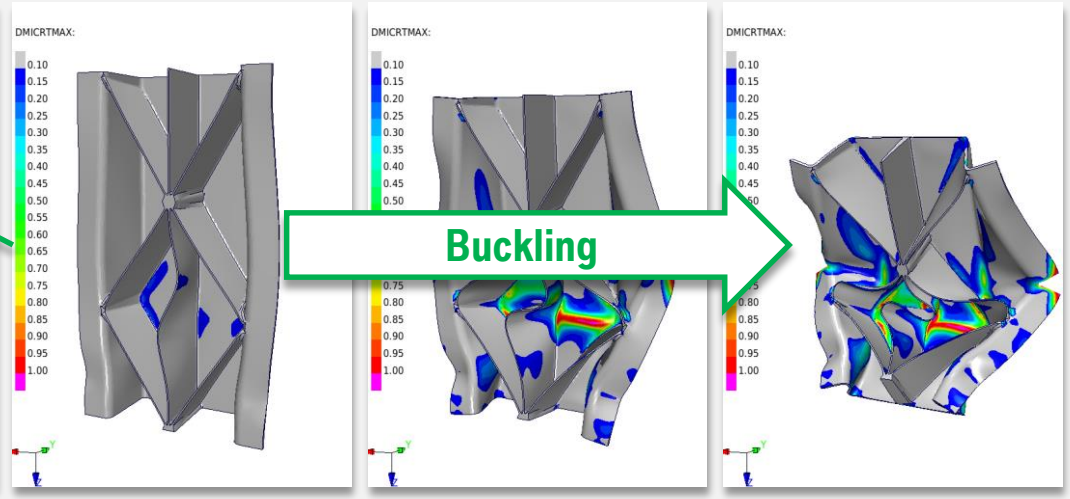


MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION. RESULTS OBTAINED FROM CRUSHING TEST SET-UP.









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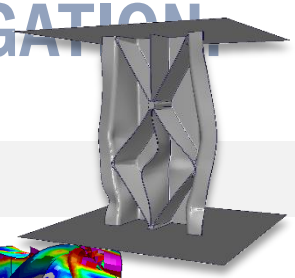
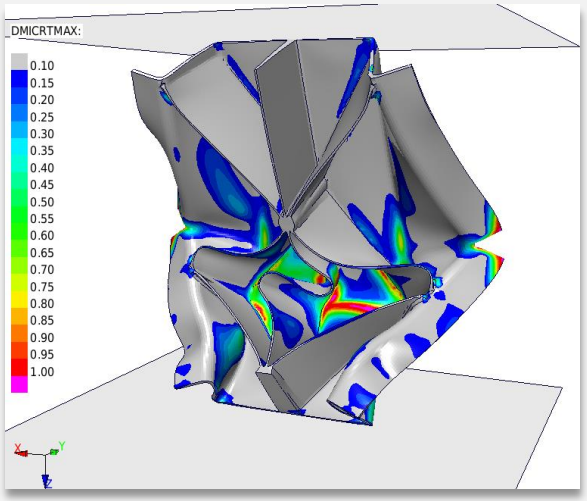
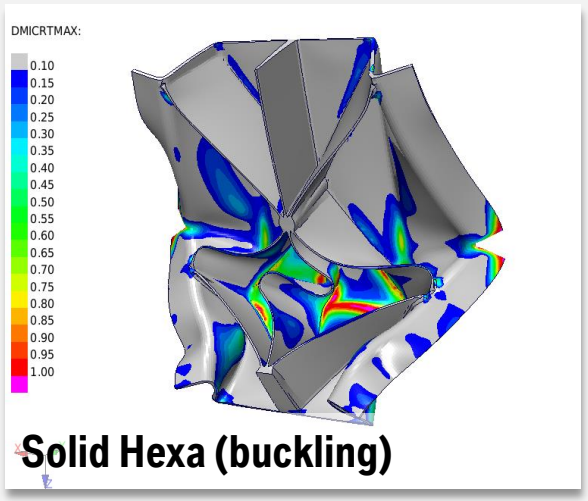
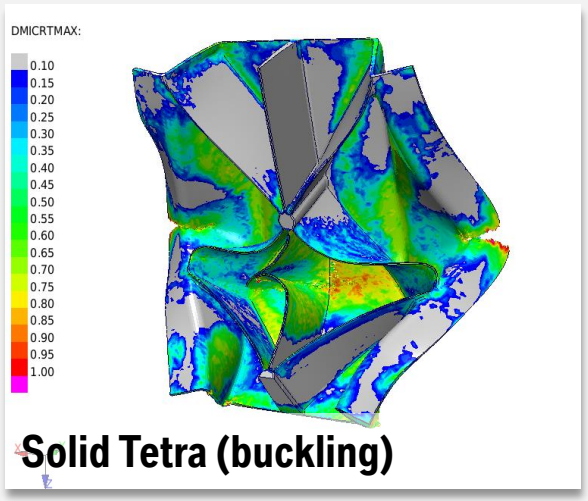


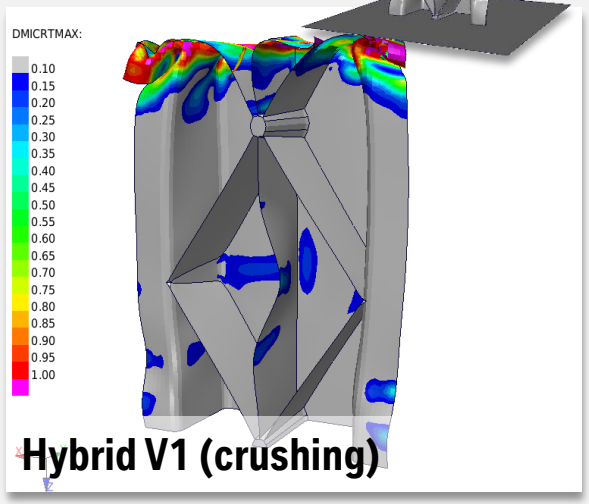




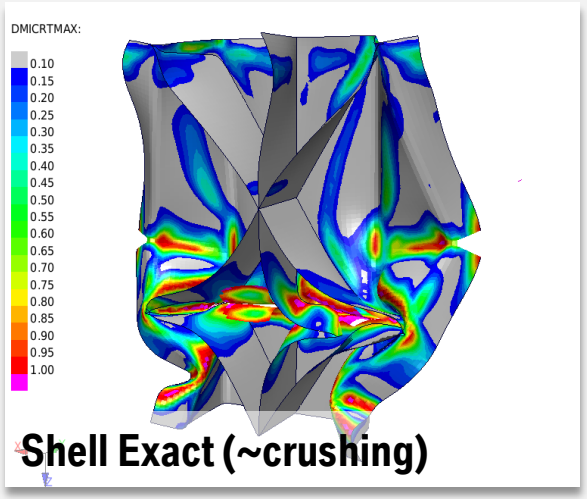
Solid Hexa (buckling)



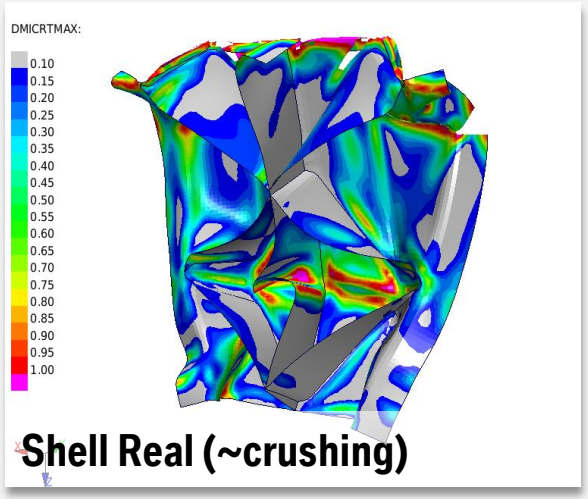
Solid Tetra (buckling)



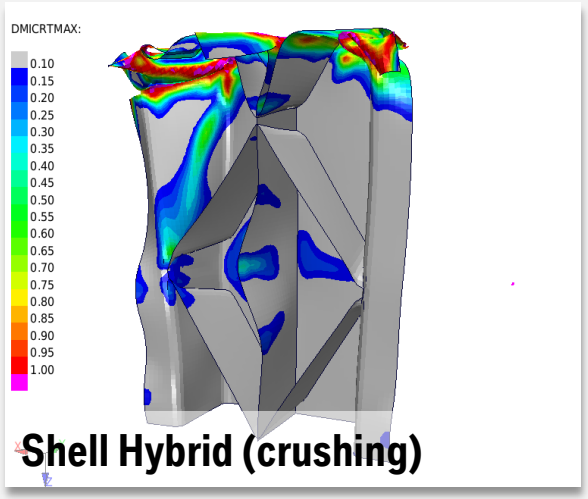
Hybrid V1 (crushing)



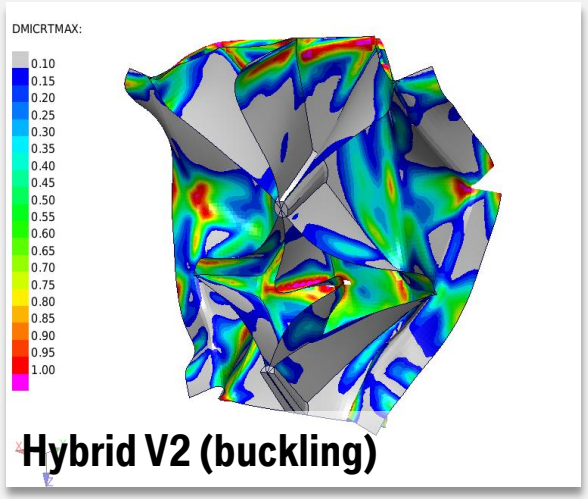
Shell Exact (~crushing)



Shell Real (~crushing)

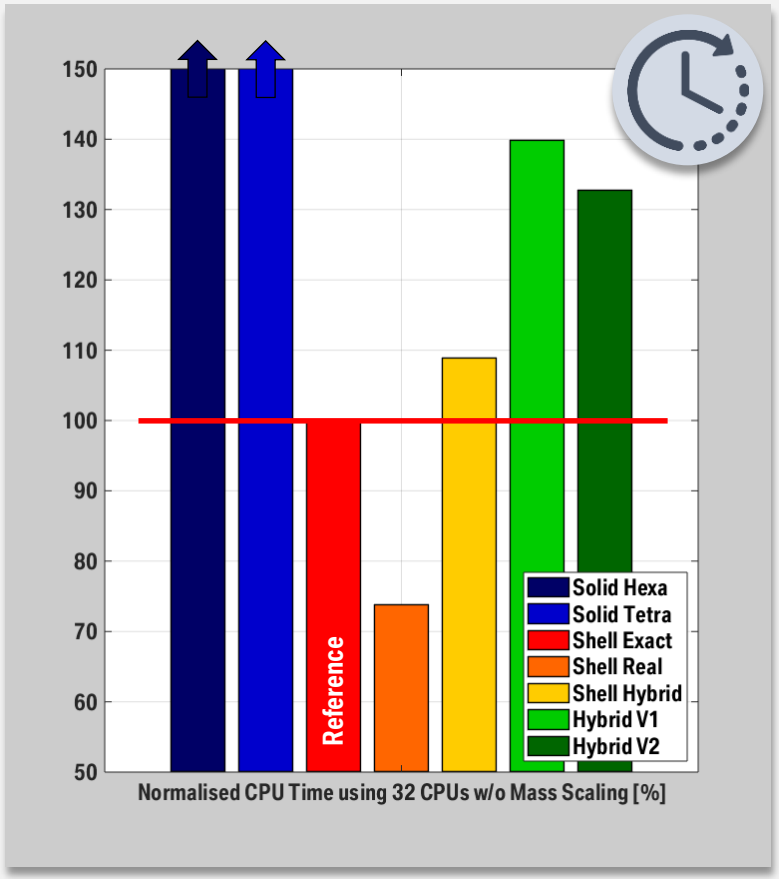


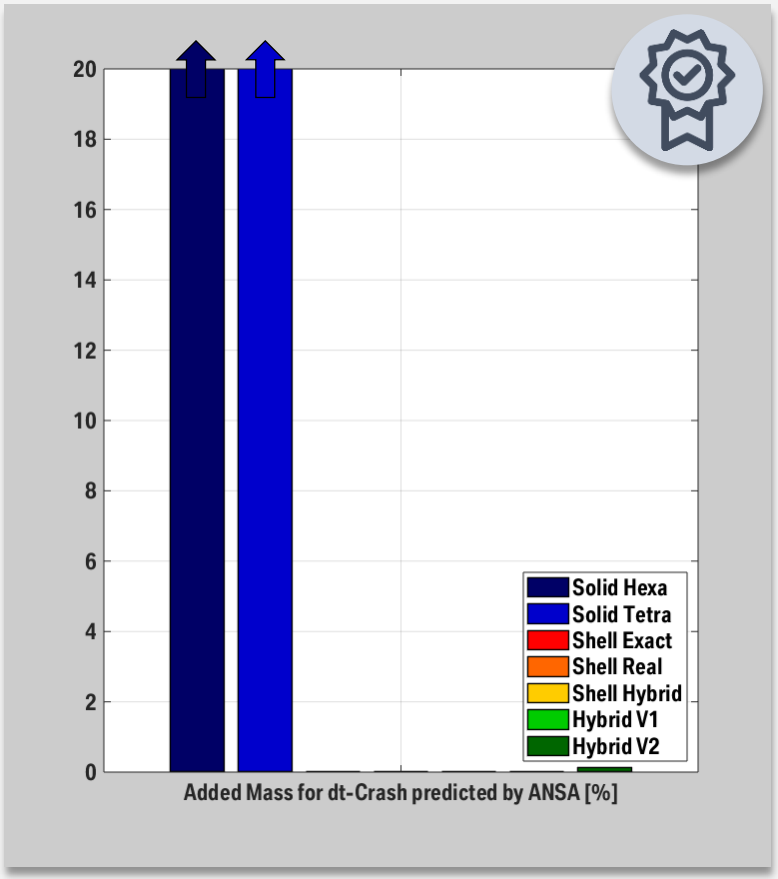
Shell Hybrid (crushing)

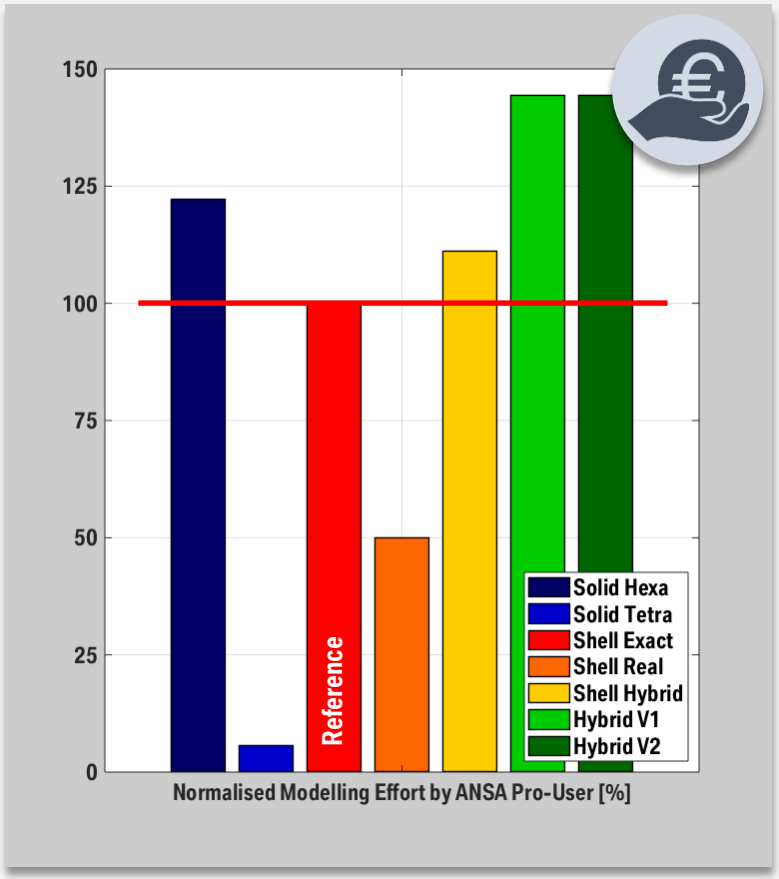


Hybrid V2 (buckling)

MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: KPI'S COMPUTATIONAL TIME, MASS SCALING AND MODELLING EFFORT.

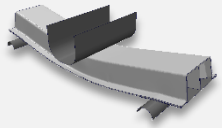
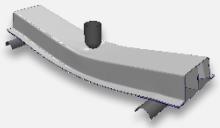
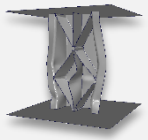






KPI's calculated from simulations of axial crushing

MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: CONCLUSIONS AND RECOMMENDATIONS.



								?
Solid Hexa	👍	👍	👍	👎	👎	👎	👎	Not realisable in real castings
Solid Tetra	👎	👎	👍	👎	👎	👍	👍	2nd order tetras required and computational expensive
Shell Exact	👍	👍	✊	👍	👍	✊	👍	Still the best compromise
Shell Real	👍	👎	👎	👍	👍	👍	👍	Not recommended due to contact problems
Shell Hybrid	👍	👍	👎	👍	👍	✊	✊	No benefits identified
Hybrid V1	👍	👍	👎	✊	👍	👎	👍	No benefits identified
Hybrid V2	👍	👍	👍	✊	👍	👎	👍	Great benefit identified

MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: CONCLUSIONS AND RECOMMENDATIONS.

Solid modelling:

- Hexa: Best results were obtained from hexa modelling. However, hexa modelling is nearly impossible for a real casting component. It should be noted that 3 elements about the thickness are already sufficient.
- Tetra: Tetra modelling is the best way to capture the geometry with almost no modelling effort. However, tetra modelling is numerical expensive. Moreover, quadratic tetra elements are necessary to describe well the structural behaviour.

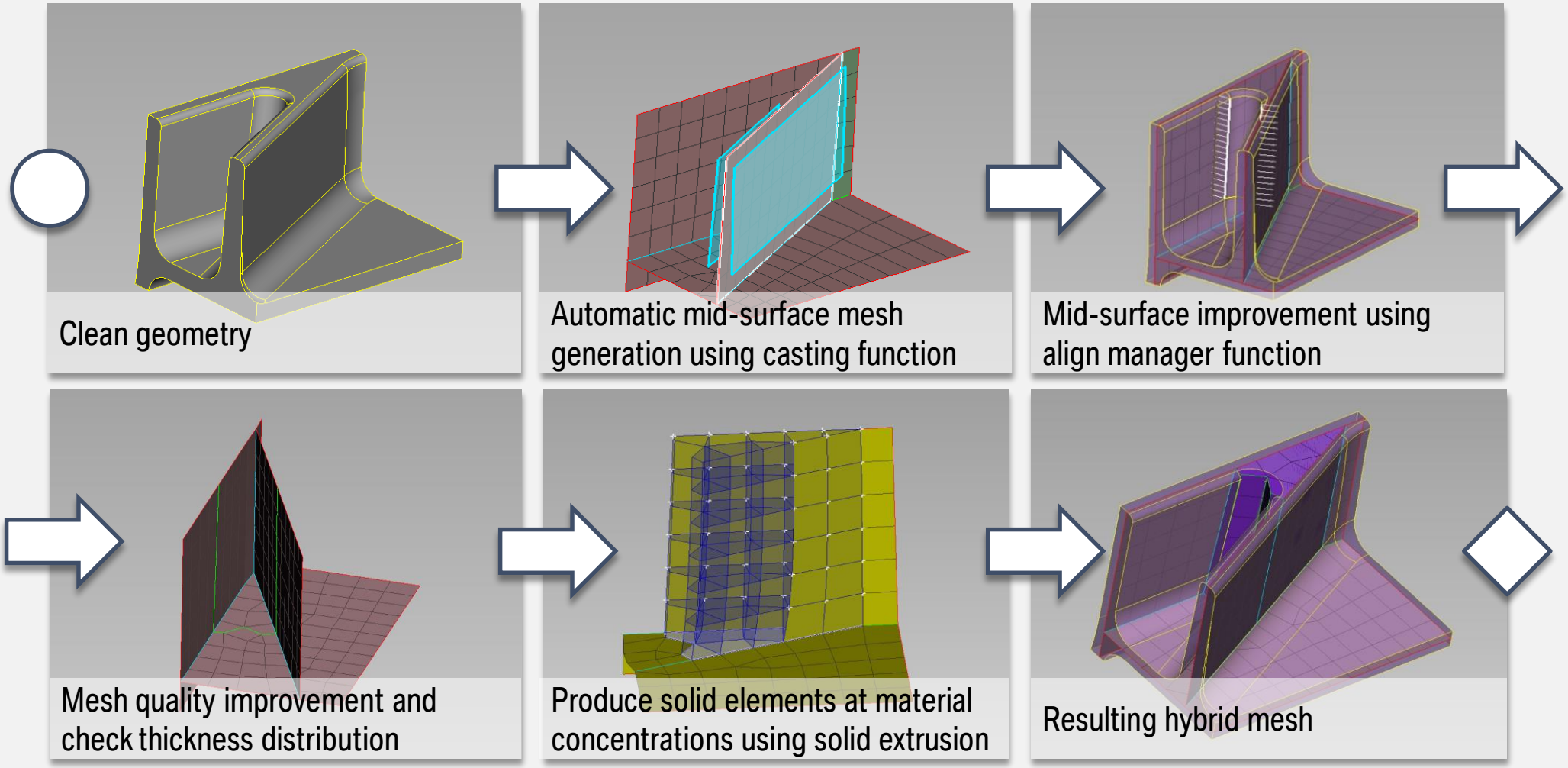
Shell modelling:

- Exact: Exact modelling with T-junctions is still the best compromise! Hence, it is still standard. However, some modelling effort is necessary. Here, ANSA provides and will provide functions to keep the effort to a minimum.
- Real: Real modelling with Y-junctions results in problems regarding contact. Therefore, it is not recommend for any analysis.
- Hybrid: Hybrid with TY-junctions modelling is acceptable. However, it does not show any benefit compared to exact modelling.

Hybrid modelling:

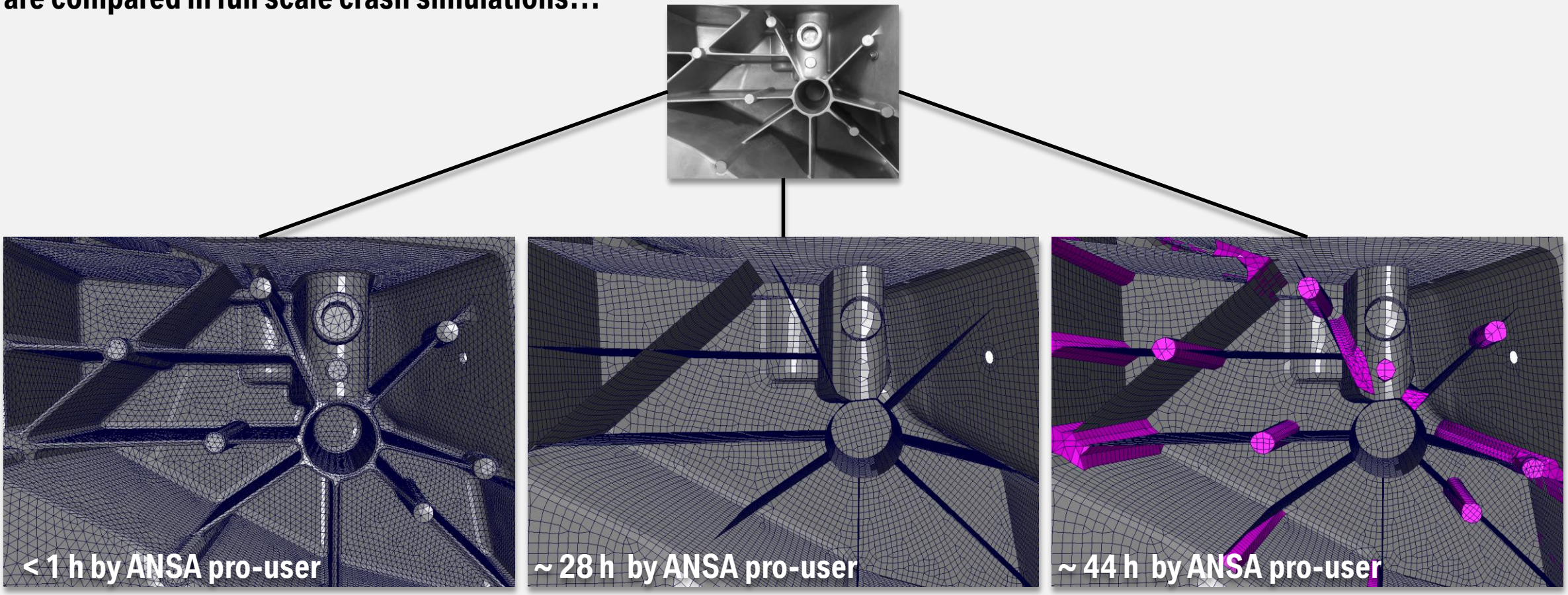
- V1: The first variant of hybrid modelling shows no distinct benefit.
- V2: In contrast, the second variant of hybrid modelling shows a great benefit – especially in axial crushing. Moreover, it offers the possibility to use exact modelling as basis and to add hexa elements as needed. Currently, the hexa elements are added by hand. Here, ANSA will provide functions.

MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: HYBRID V2 MODELLING APPROACH – HOW TO DO IT.



MODELLING OF CASTING STRUCTURES – A COMPREHENSIVE INVESTIGATION: … AND WHAT'S NEXT.

Tetra, Exact and Hybrid V2 modelling approaches were applied on a real casting component (done by BETA). Now, there are compared in full scale crash simulations…



THANK YOU.