

Optimisation in the Design Process



- FEA/Optimisation in the Product life cycle
- Concept Example
- Comparison of costs and timing of CAE v CAD led concept
- Concept to production example
- Summary

Optimisation in the Product Lifecycle

■ Historical Approach

Design in CAD > Build Tools > Test parts
> Redesign in CAD > ... etc etc ...

■ CAD led design

Design in CAD > Assess in CAE >
Redesign in CAD > Assess in CAE > ... etc
etc...

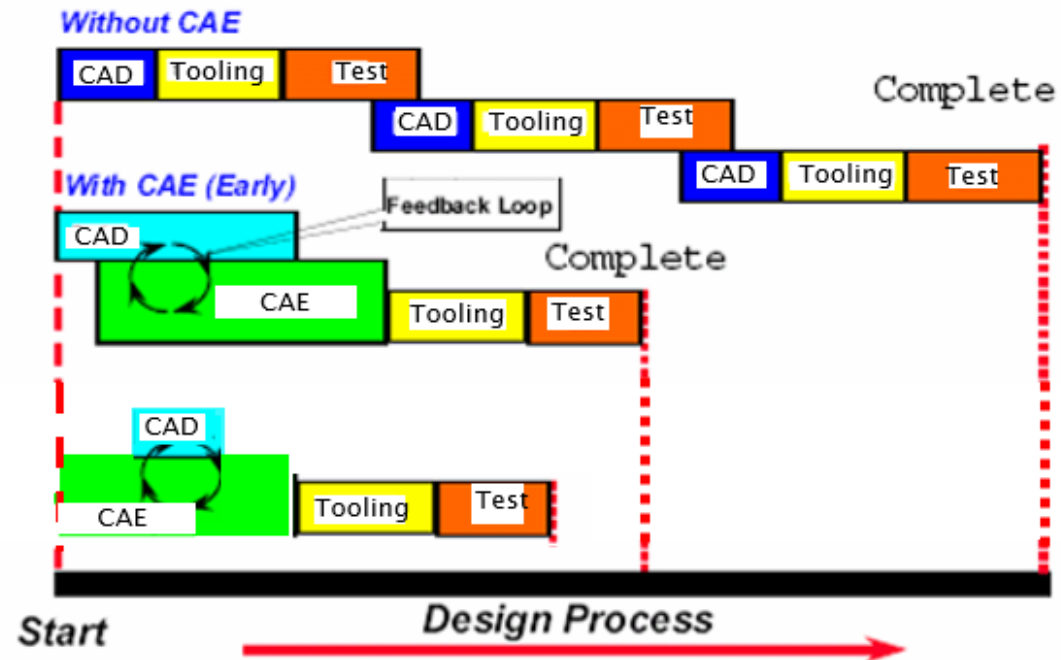
Build Tools > Test parts

■ Optimisation led design

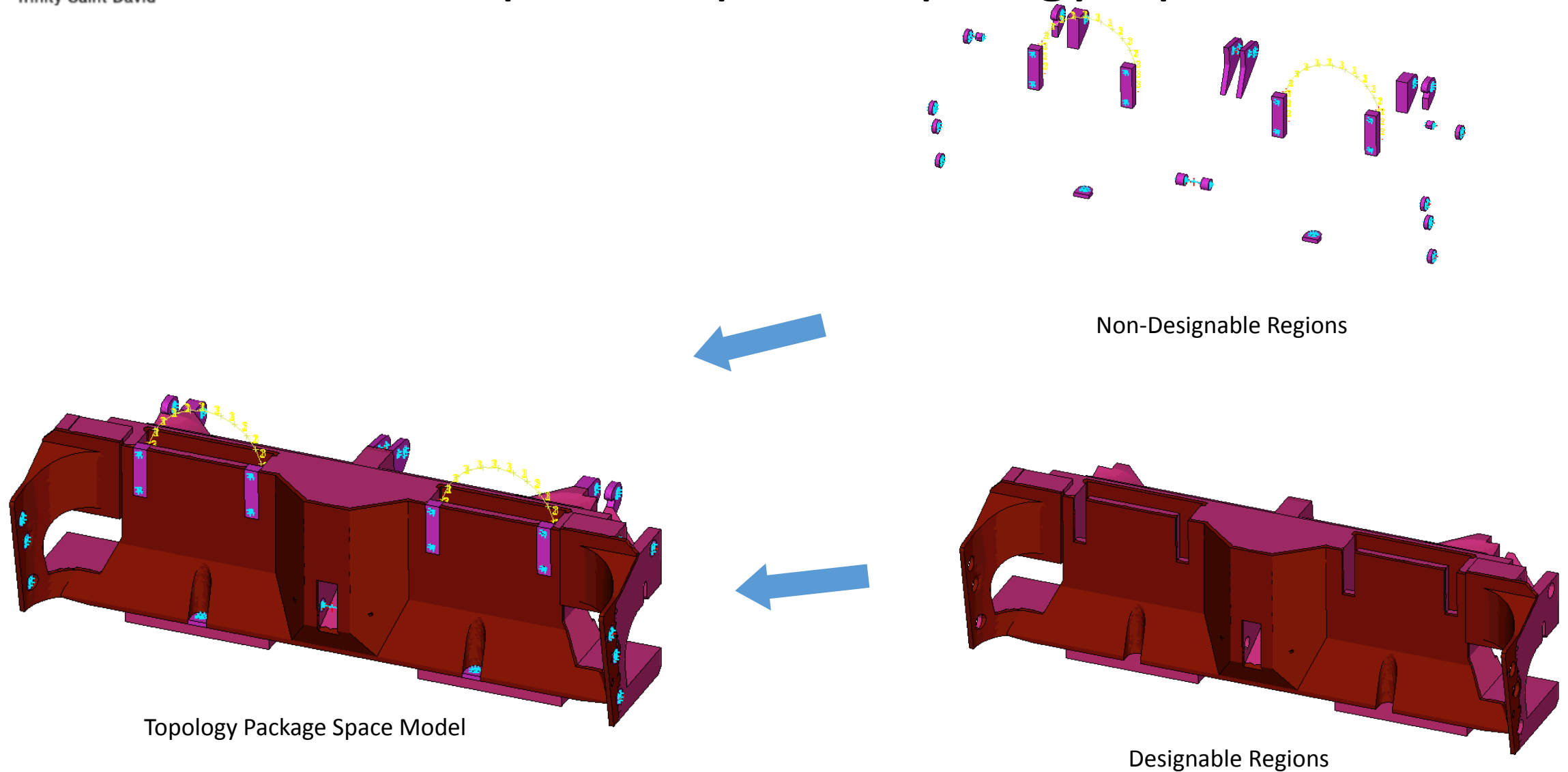
Design in CAE > Assess in CAE >
... etc etc...

Produce CAD > Assess in CAE >
Build Tools > Test parts

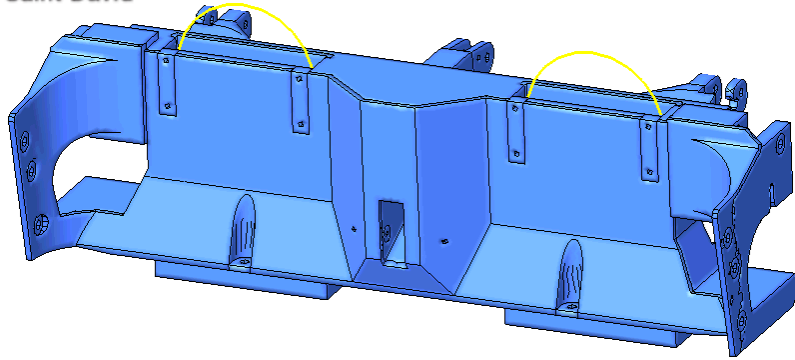
Feedback Look Identifies Problems Early



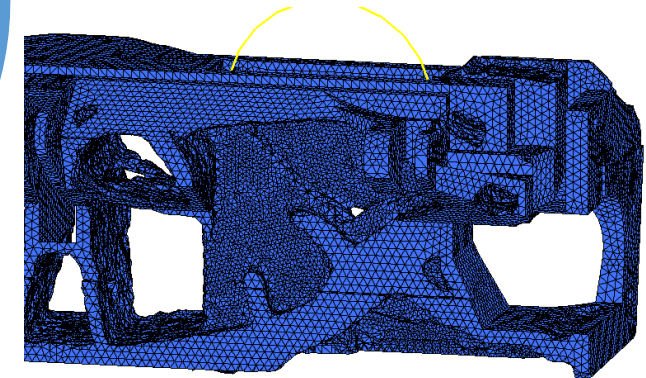
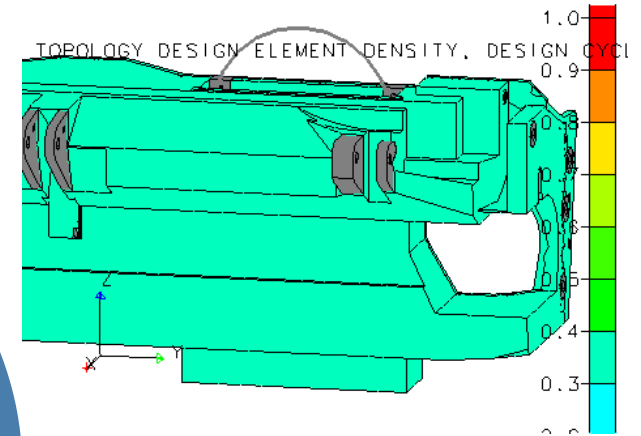
Concept Example – Topology Optimisation



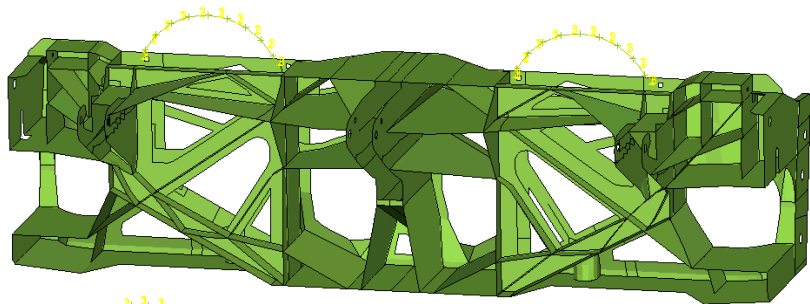
Concept Example – Topology Optimisation



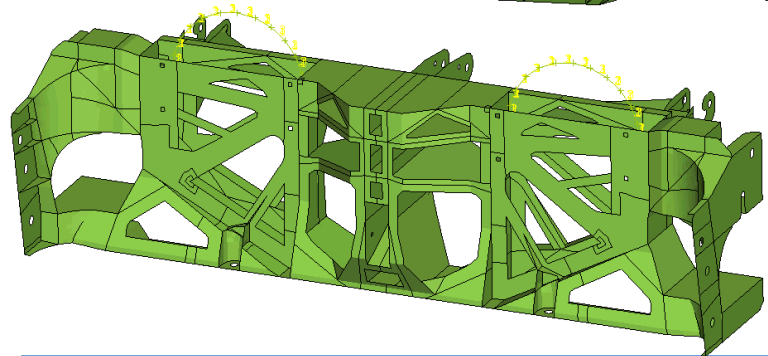
Topology Package Space Model



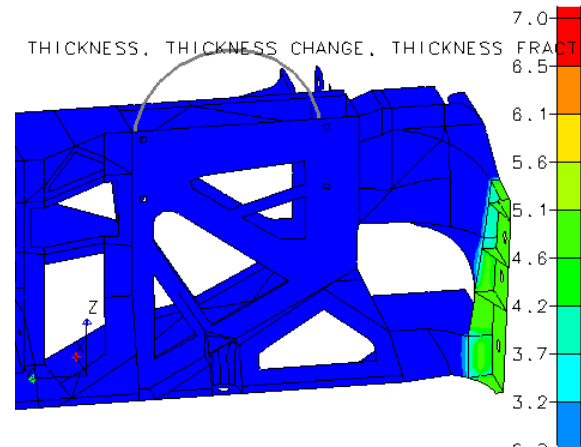
Topology Optimisation Results



Casting Concept Design

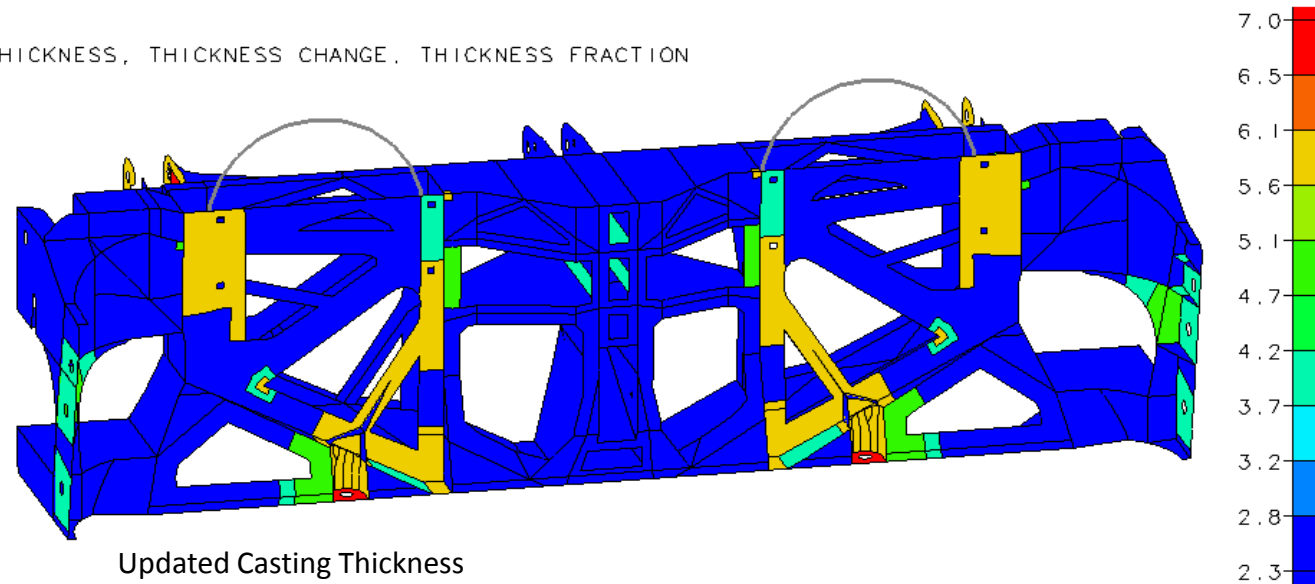


Concept Example – Topometry Optimisation

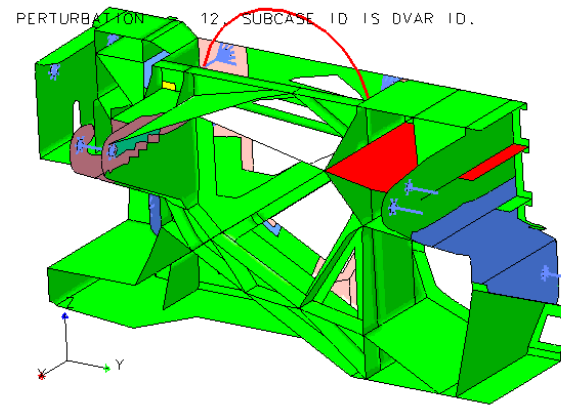


Topometry Optimisation Results

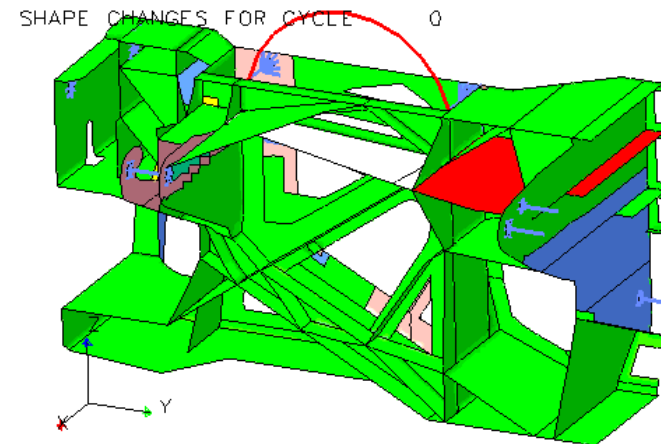
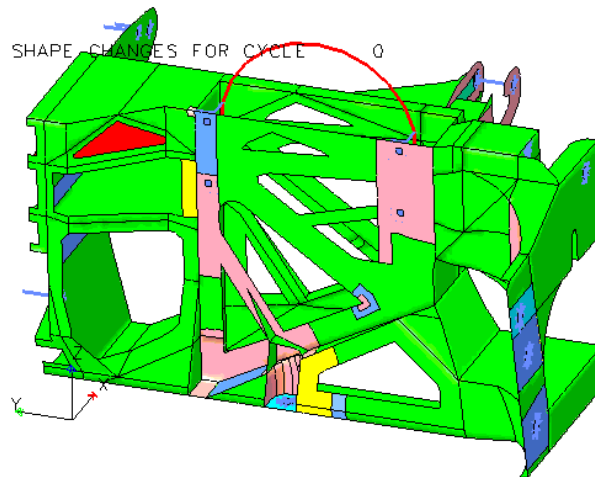
THICKNESS, THICKNESS CHANGE, THICKNESS FRACTION



Concept Example – Shape Optimisation



Allowable Shape Changes



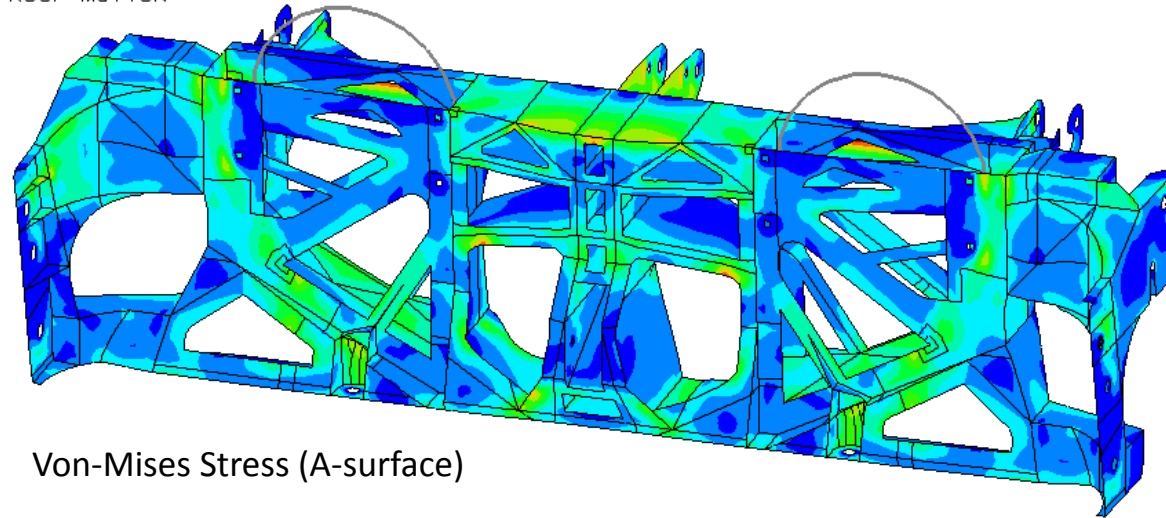
Shape Iteration History

Concept Example – Performance Assessment

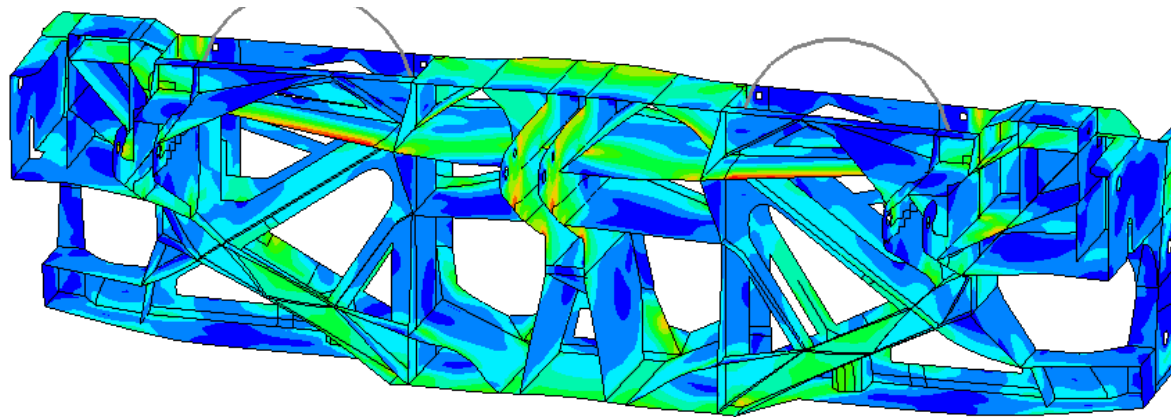
Roof Opening Load Case

Maximum Stress = 70.0MPa (Target $\leq 70\text{MPa}$)

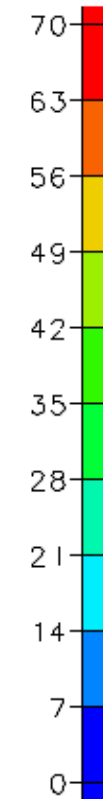
ROOF MOTION



Von-Mises Stress (A-surface)



Von-Mises Stress (Rear View)

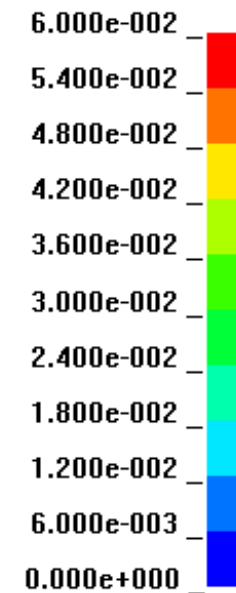
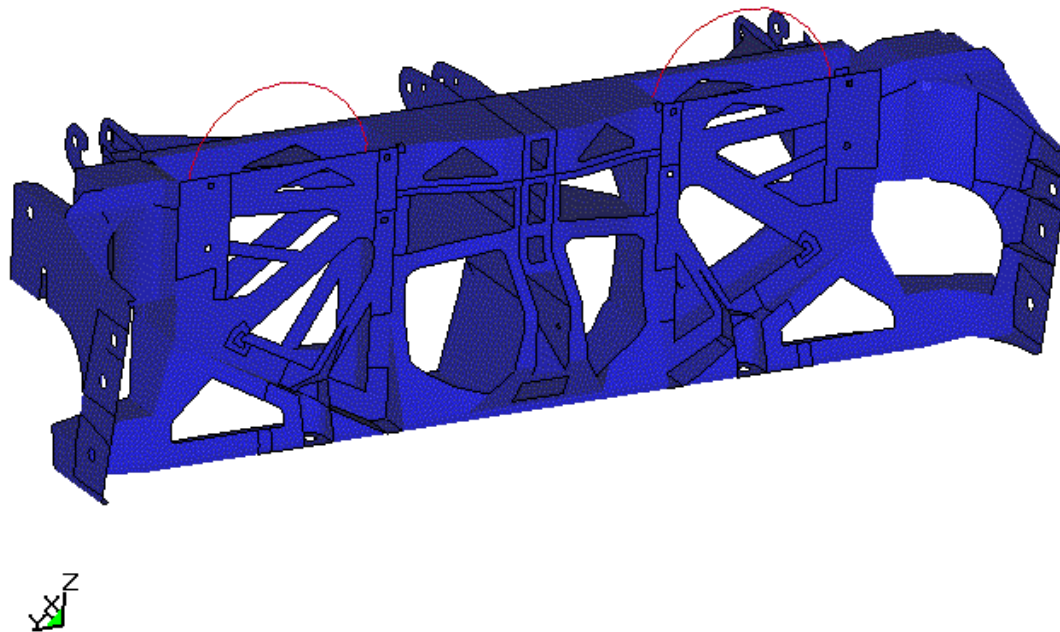


Concept Example – Performance Assessment

ROPS Opening Load Case

Maximum Plastic Strain = 5.7% (Target $\leq 6\%$)

Time = 0



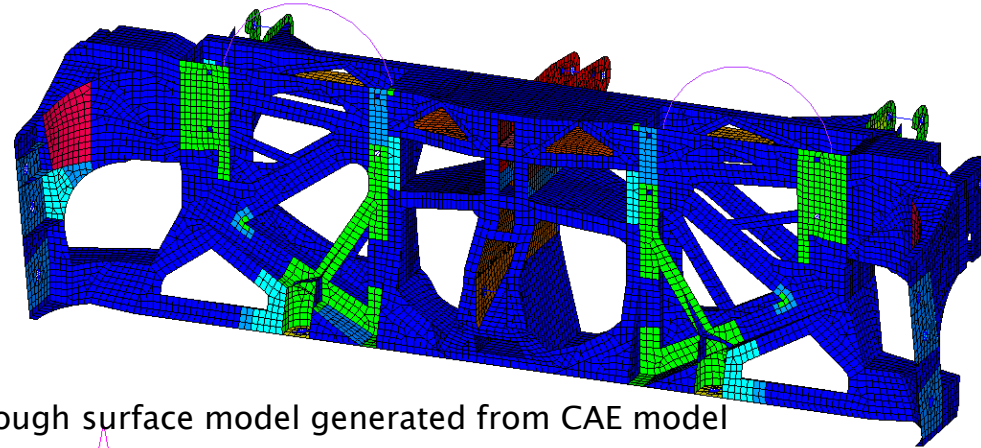
Effective Plastic Strain

Concept Example – Optimisation led design

CAE_model

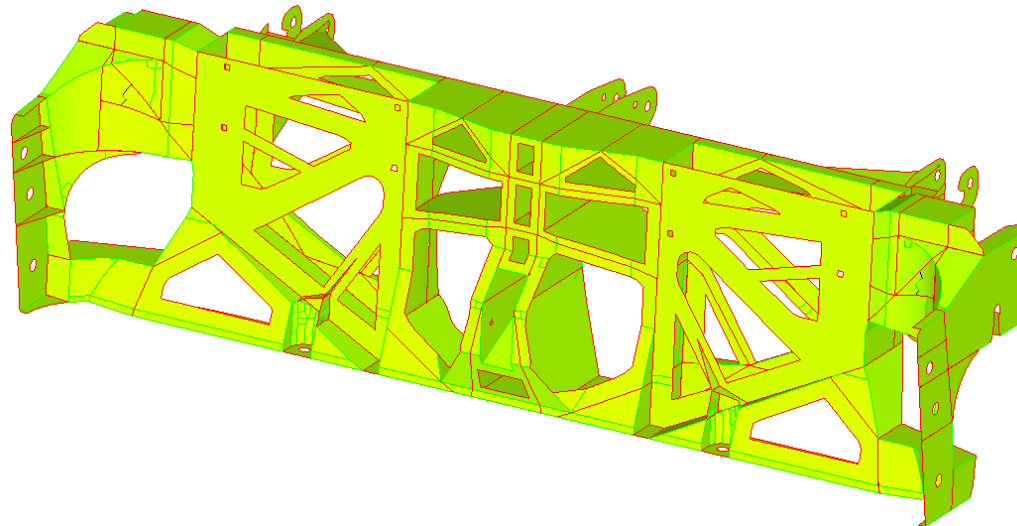
This has been developed and verified to meet customer requirements

This can be provided to the customer



Time to develop concept
~2 Weeks

- Rough surface model generated from CAE model
 - This can be provided for package checks



Time to generate rough CAD
~10 mins

Time to 3D CAD
~ 6 weeks

Concept Example – Cost and time

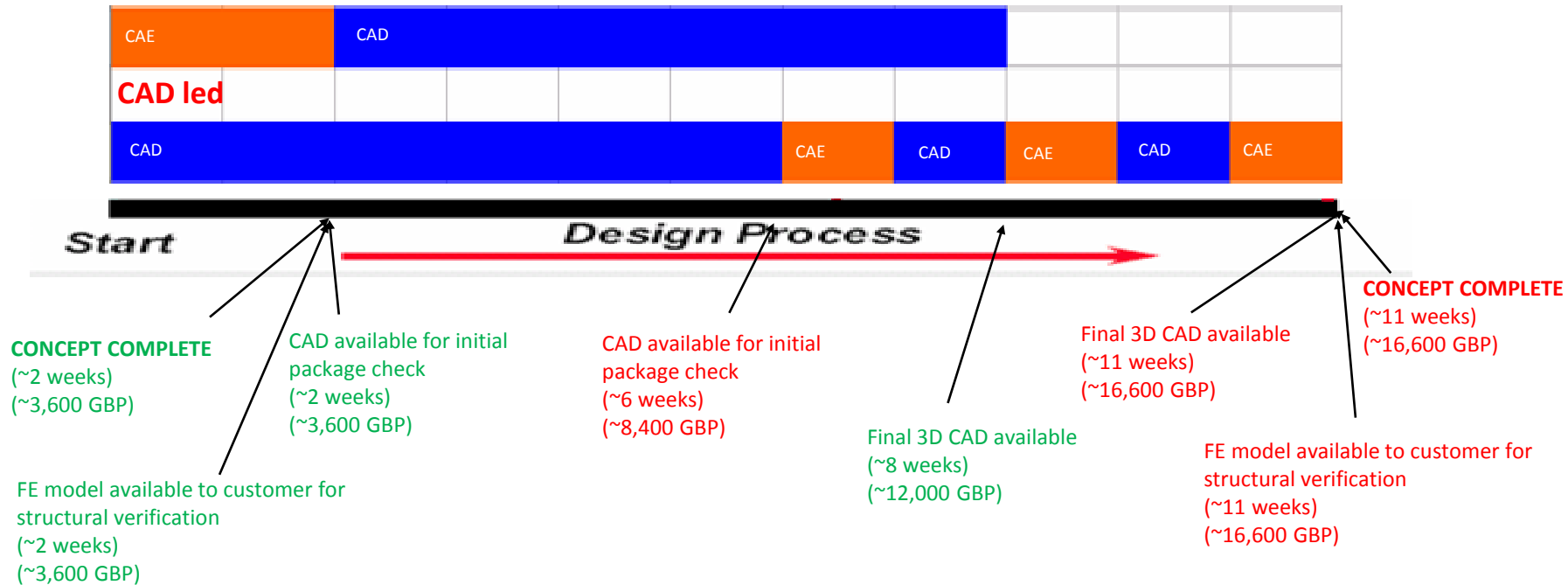
Timing Assumptions

- Initial CAD = 6 weeks
- FEA assessment/Optimisation structural development = 2 weeks
- FEA assessment = 1 week
- CAD led approach requires 3 iterations to get structural performance working

Cost Assumptions

- CAE = 45 GBP/hour
- CAD = 35 GBP/hour
- 40 hours/week

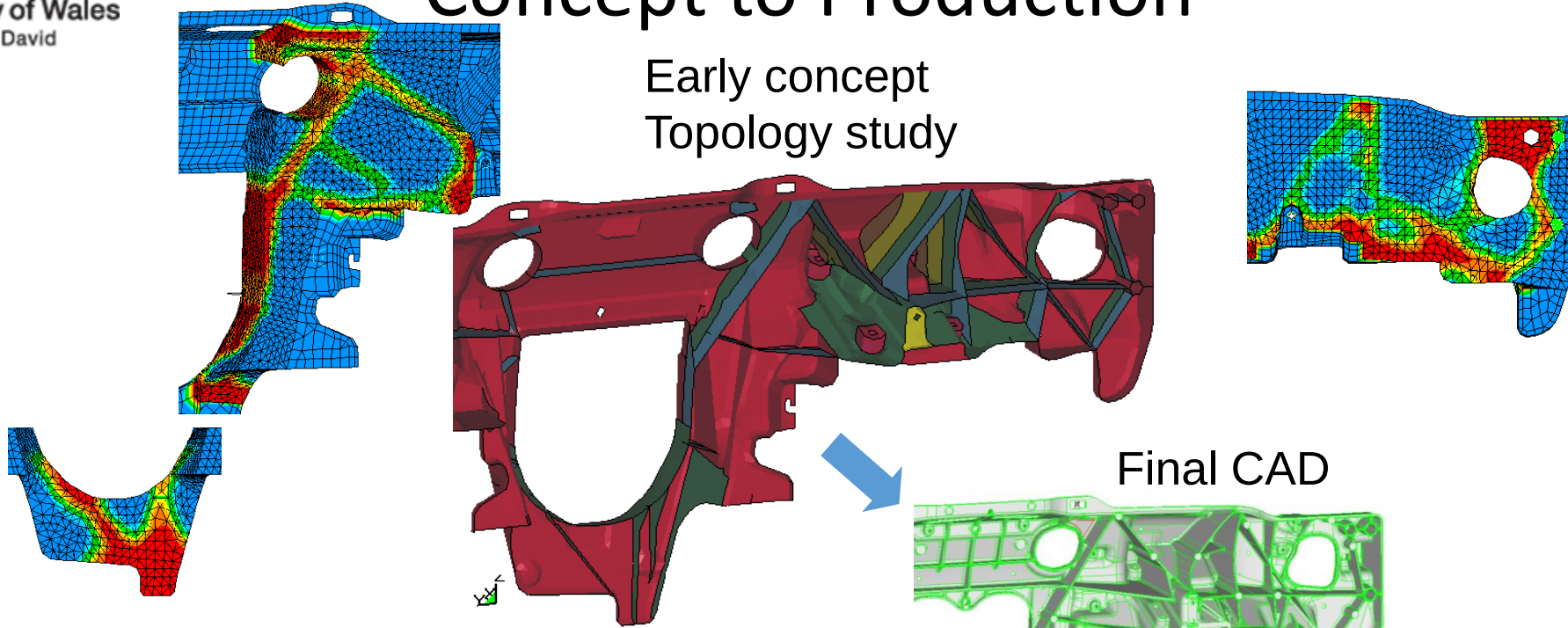
Optimisation led



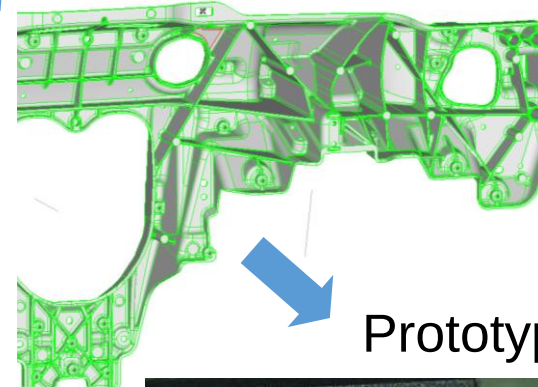
- CAE approach is likely to be lighter
- Timings/Costs are approximate

Concept to Production

Early concept
Topology study



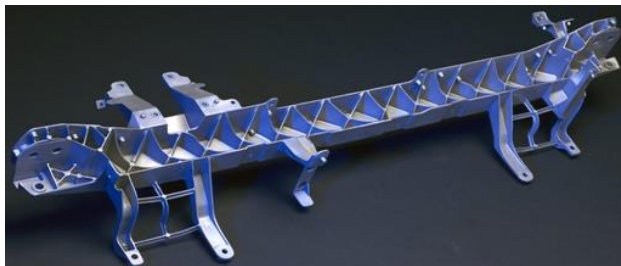
Final CAD



Prototype Part



Example of CAD led design



Summary

CAE led design in these examples has achieved the following...

Conceptual designs

Reduced cost and timing by approximately

80% when solid CAD is not required

30% when solid CAD is required

Production designs

Lighter

Cheaper

Quicker

More robust

More Efficient

Improved customer confidence in Business Development quotes.

Less cost to the business when quotes done at suppliers expense.

Further reading

- Practical Aspects of Structural Optimisation, Altair University, 2014