

Solar Car Challenge: Pushing the boundaries using Composite Optimisation

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JEC World 2019 - Paris



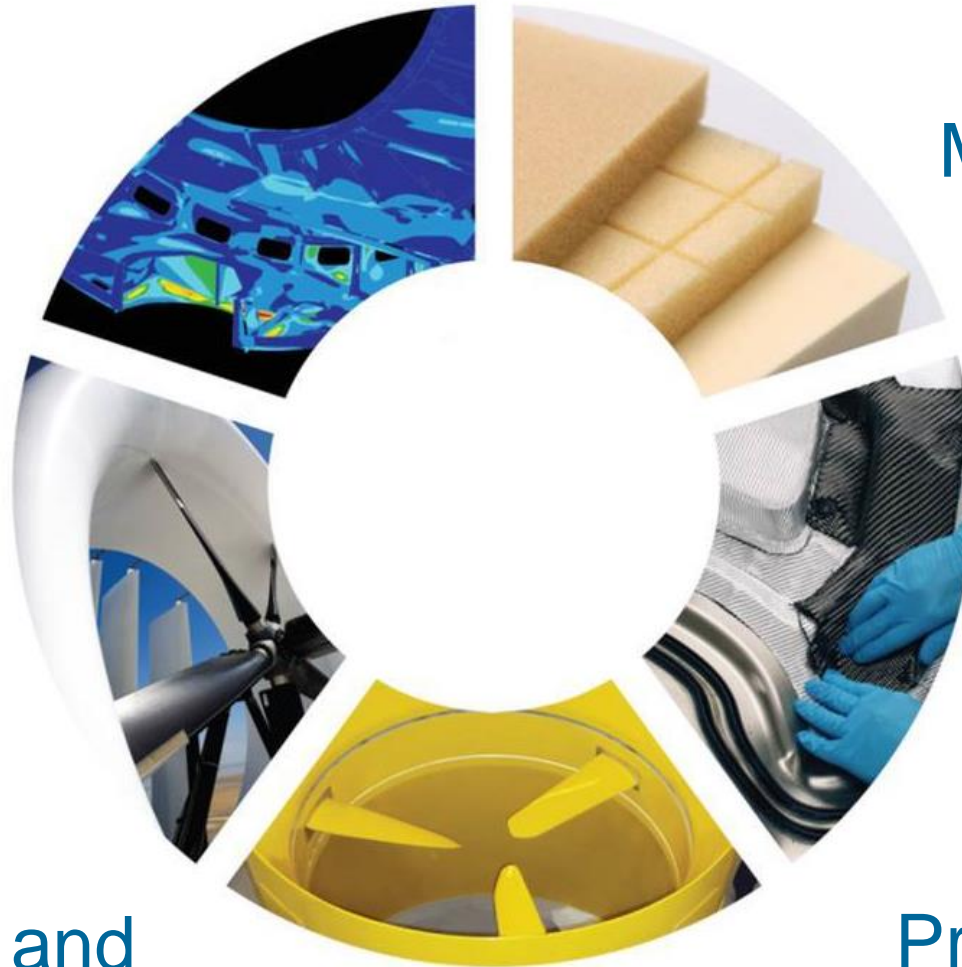
Raphael Gerard
Gurit Composite Engineering

- Gurit: Who we are
- Solar Car – Composite Optimisation



Structural
Engineering

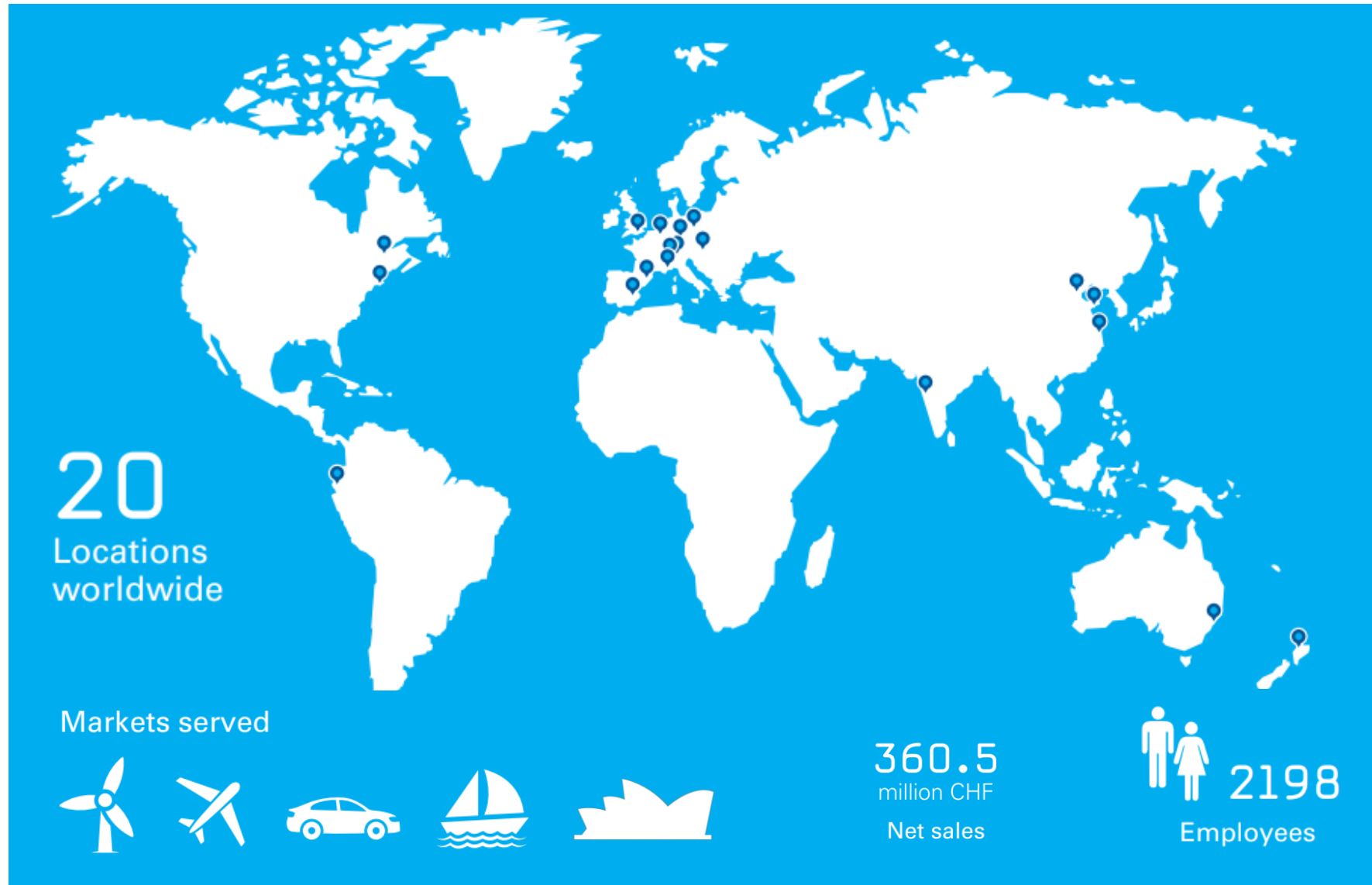
Materials

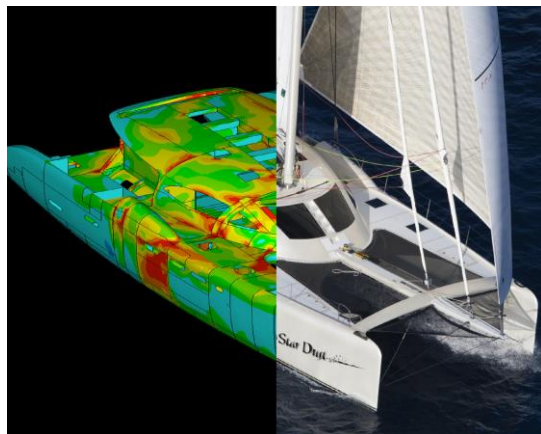
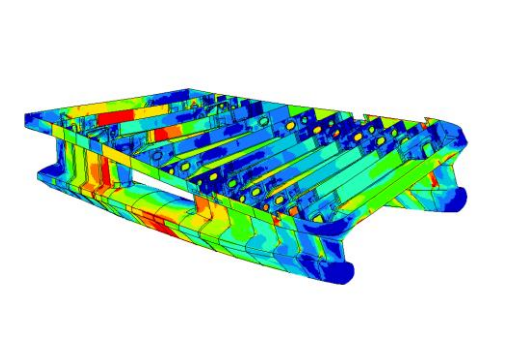


Prototyping and
manufacturing

Processes and
Testing

Gurit – Global Footprint



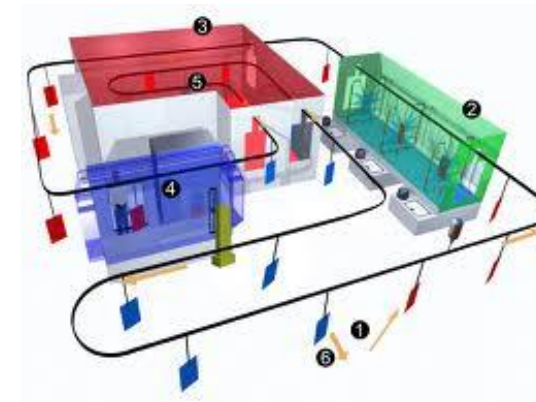
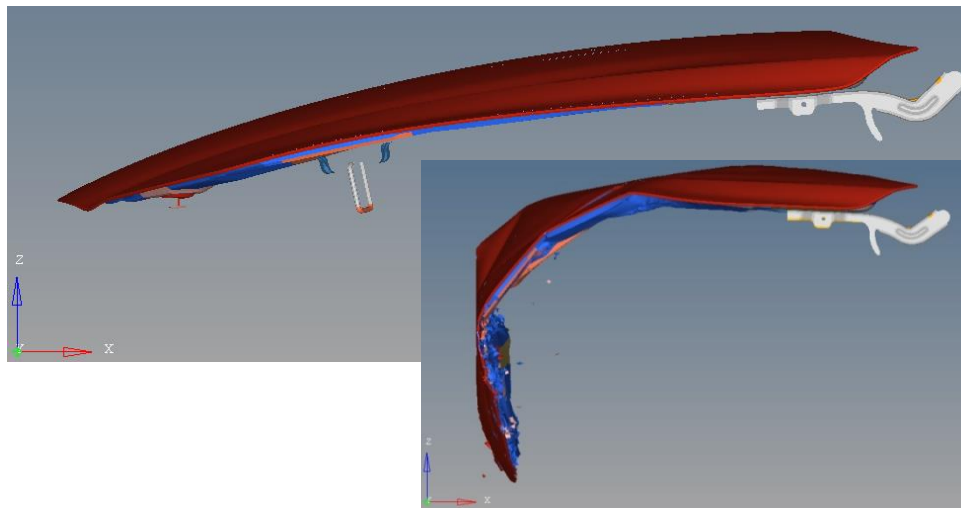
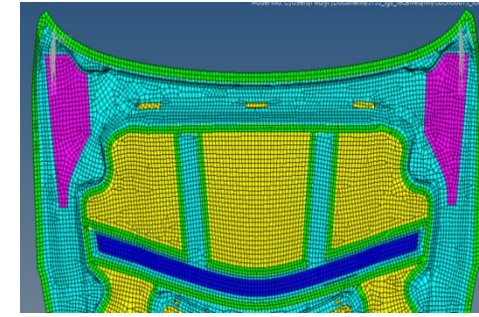


40+ years of
experience



Photo: World Architecture

Markets – Automotive and Transportation



Markets – Automotive and Transportation



Photo: Mix telematics

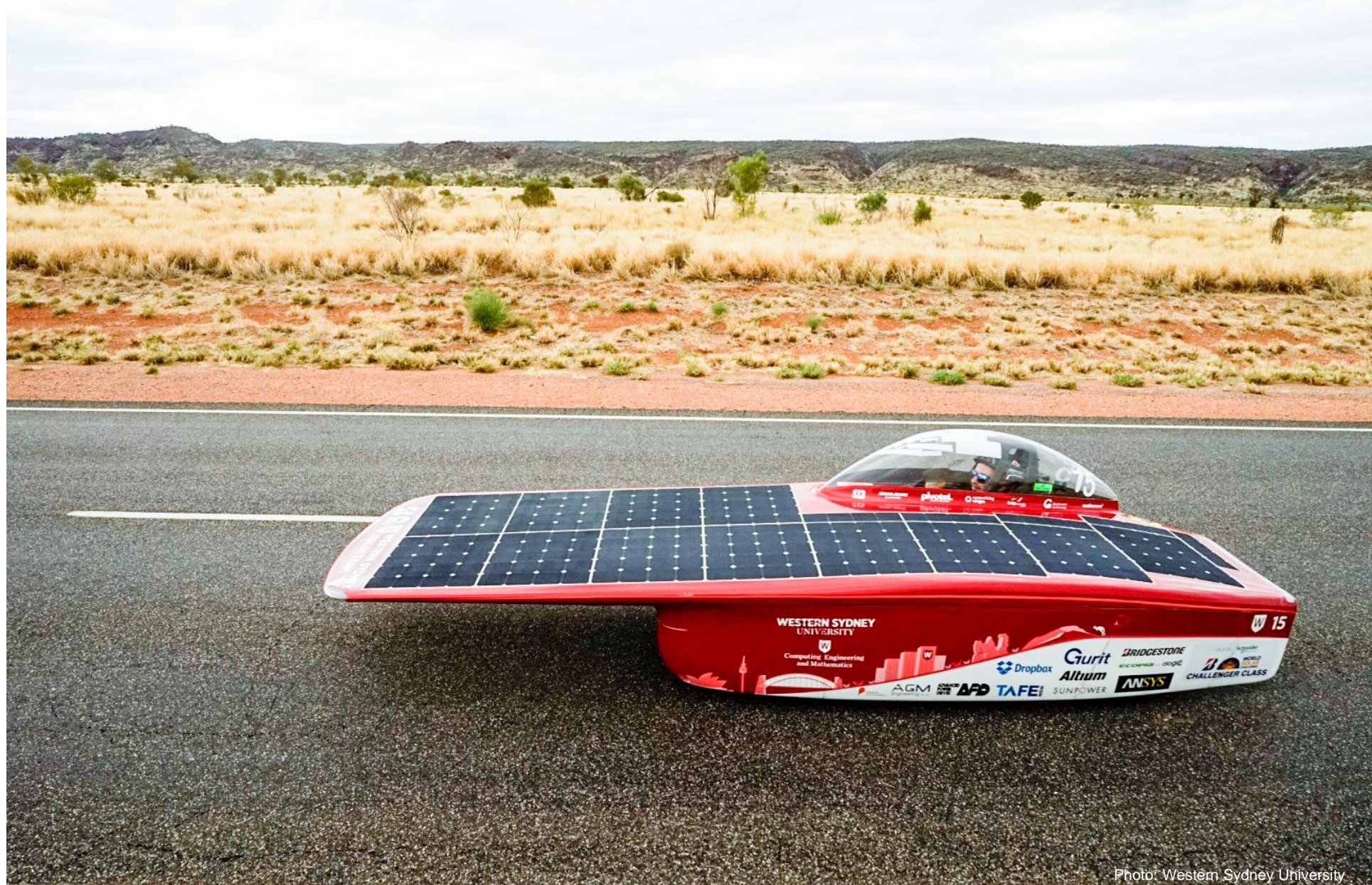
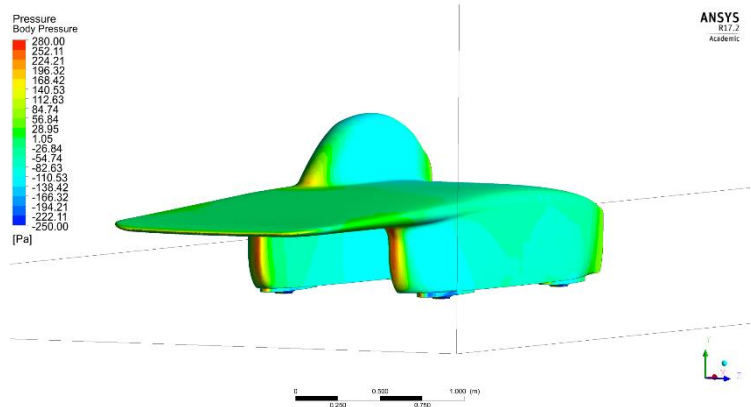


Photo: Western Sydney University

Solar Car – the Project



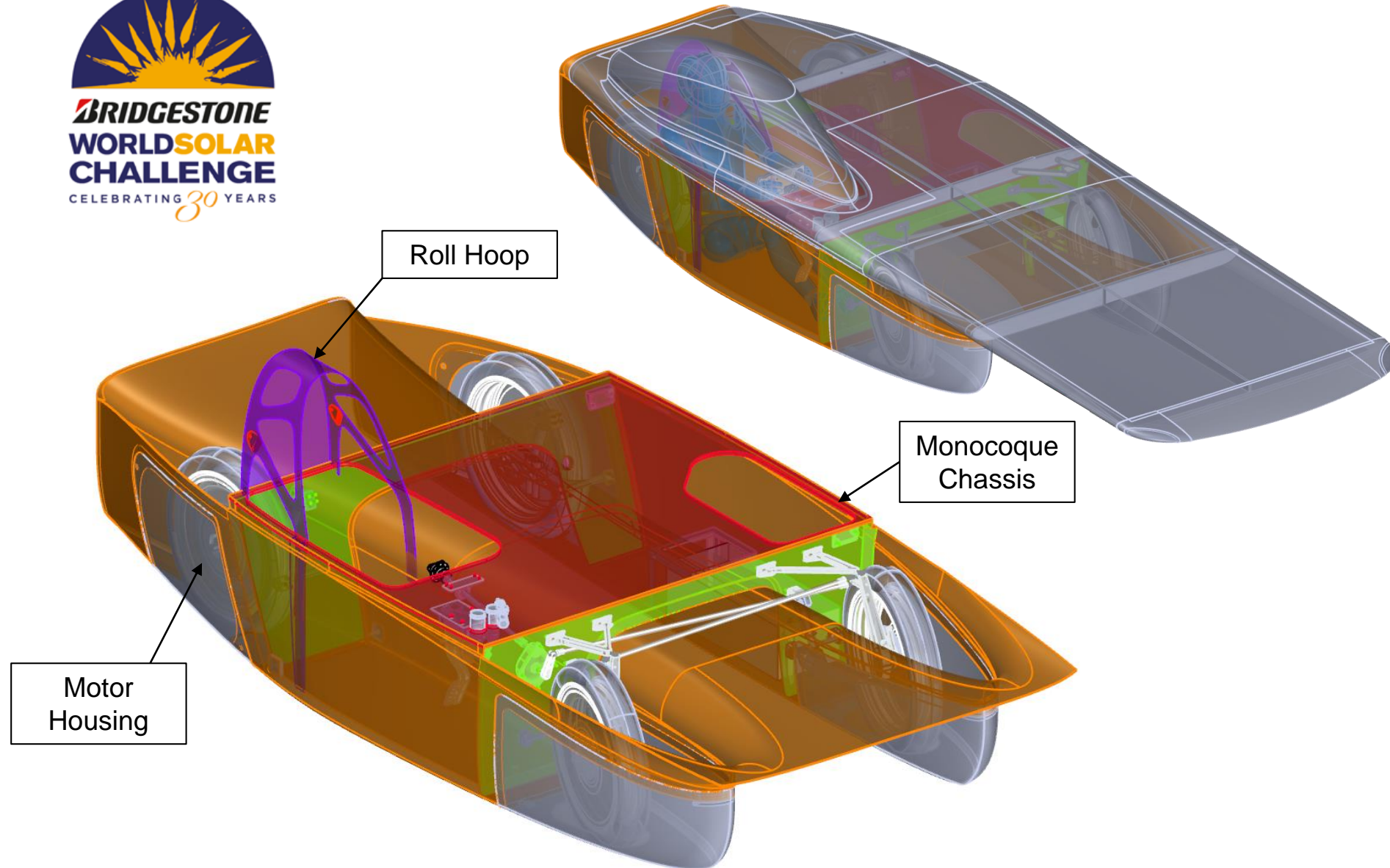
Priority = aero drag rather than weight



model	composite weight (kg)
2015	80
2017	42

item	weight (kg)	
Systems	100	45%
Driver	80	36%
Structure	42	19%

Solar Car – the Structure



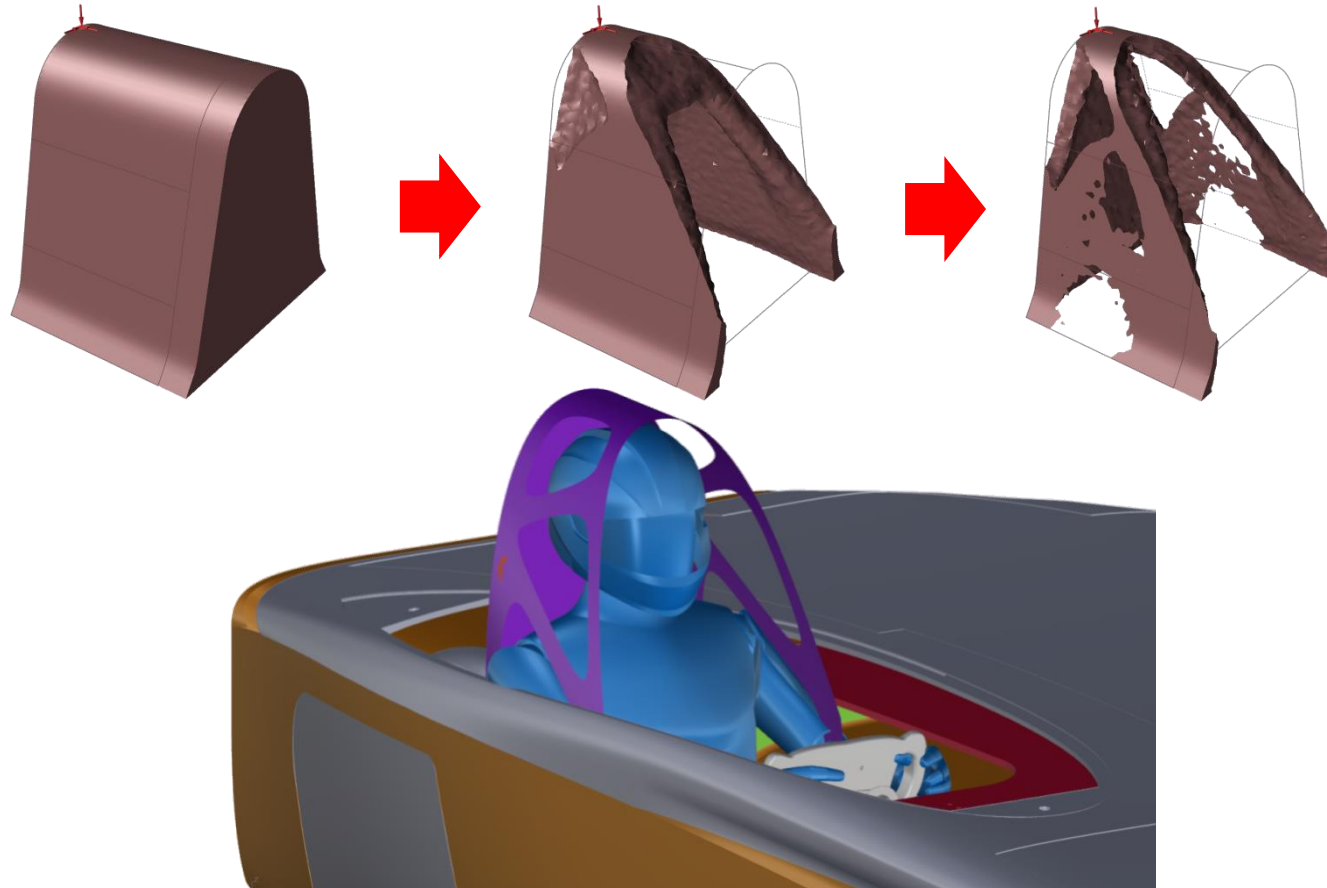
Solar Car – Load Cases

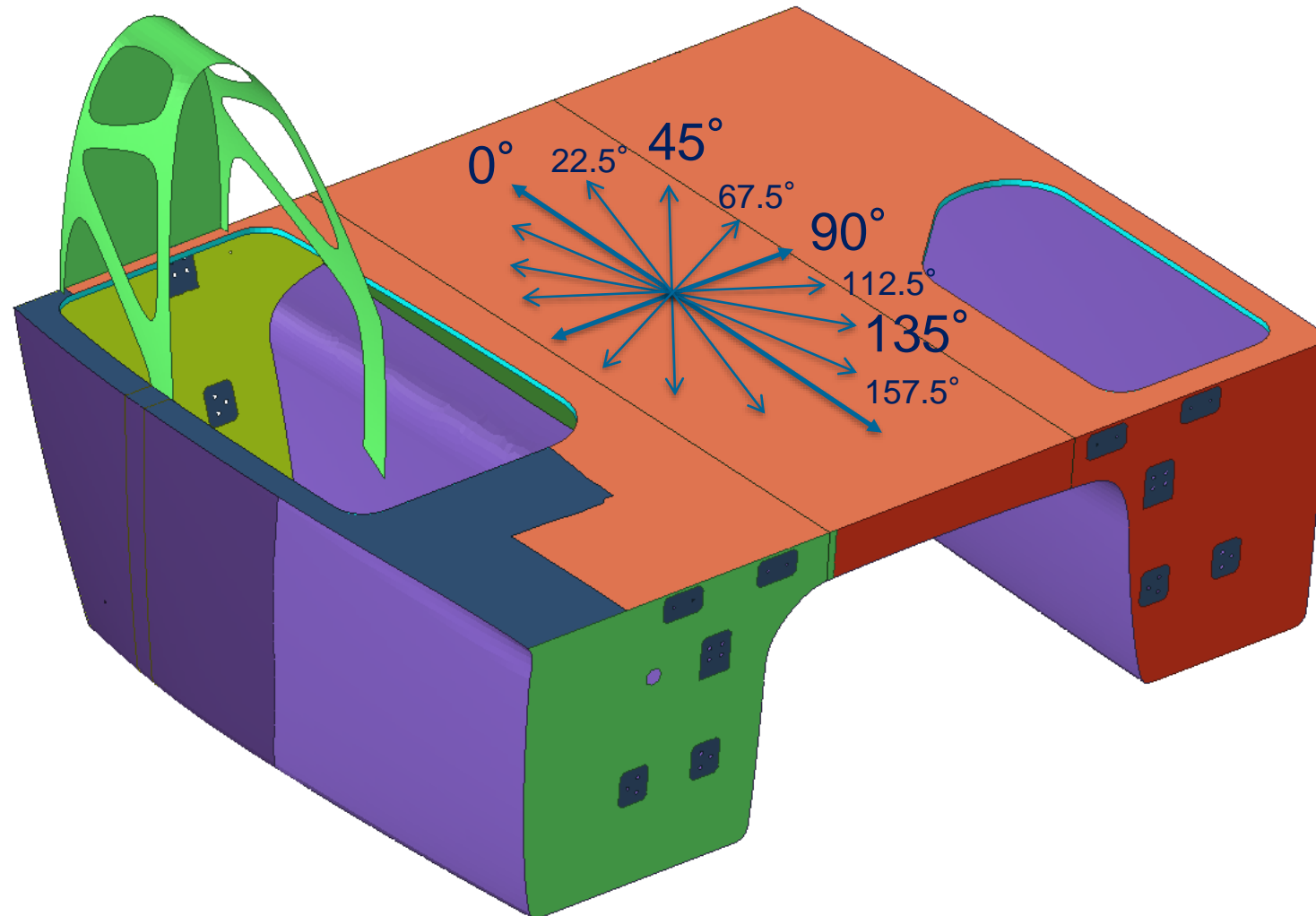
- ▢ Design Load Cases
 - ▢ Driving Load Cases
 - ▢ Jounce (3g)
 - ▢ Front Braking (1.5g)
 - ▢ Rear Braking (1.5g)
 - ▢ Right & Left cornering (1.5g)
 - ▢ Combinations of the above
 - ▢ Accidental Load Cases
 - ▢ Front Impact (5g)
 - ▢ Side Impact (5g)
 - ▢ Roll Over (1.5 / 4 / 5g)
 - ▢ Seat Belts (17g)



Solar Car – Roll Hoop

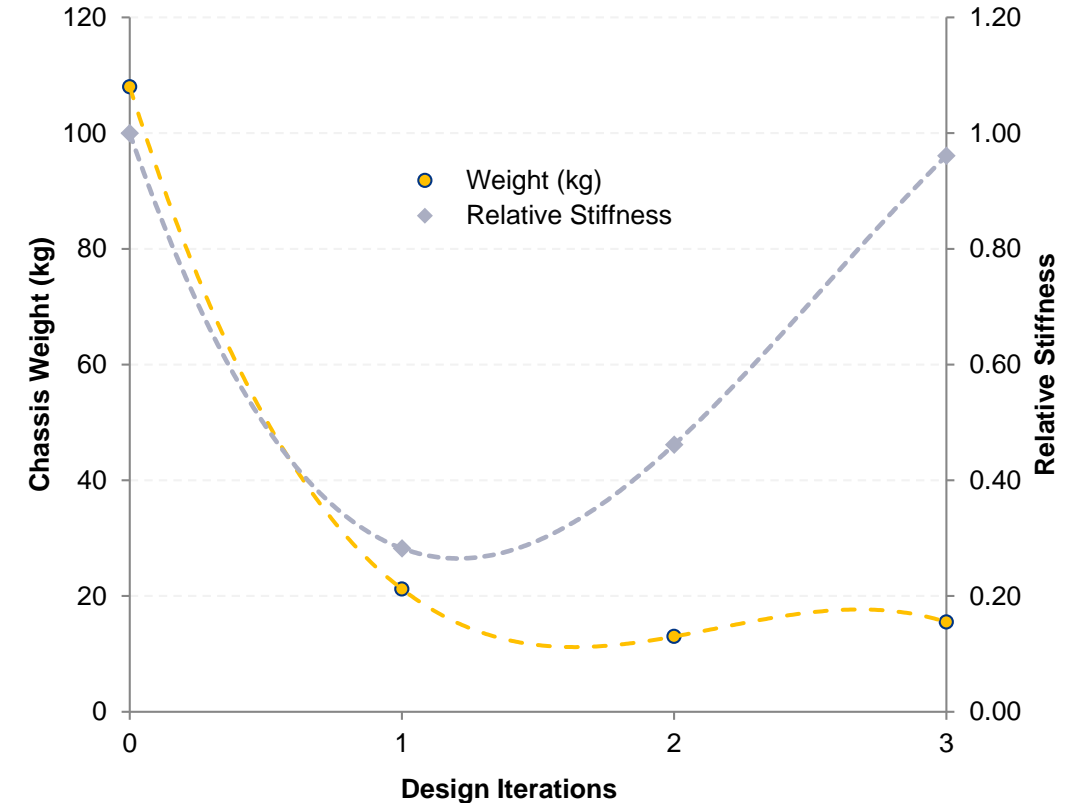
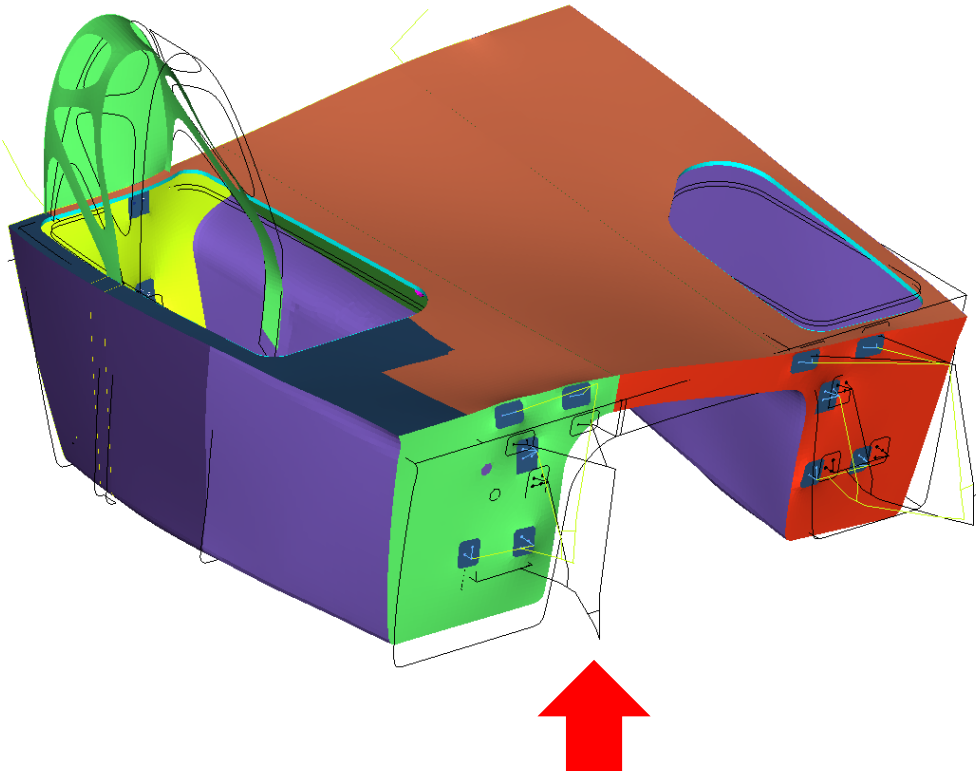
- ▢ Roles
 - ▢ Protect Driver in Roll-over
 - ▢ Seatbelt Attachments
- ▢ Topology optimisation using Inspire





Composite Optimisation – Objectives

- ▢ Objectives
 - ▢ Minimise Mass (Primary focus)
 - ▢ Maximise Stiffness (Secondary focus)
- ▢ Constraint: No Failure



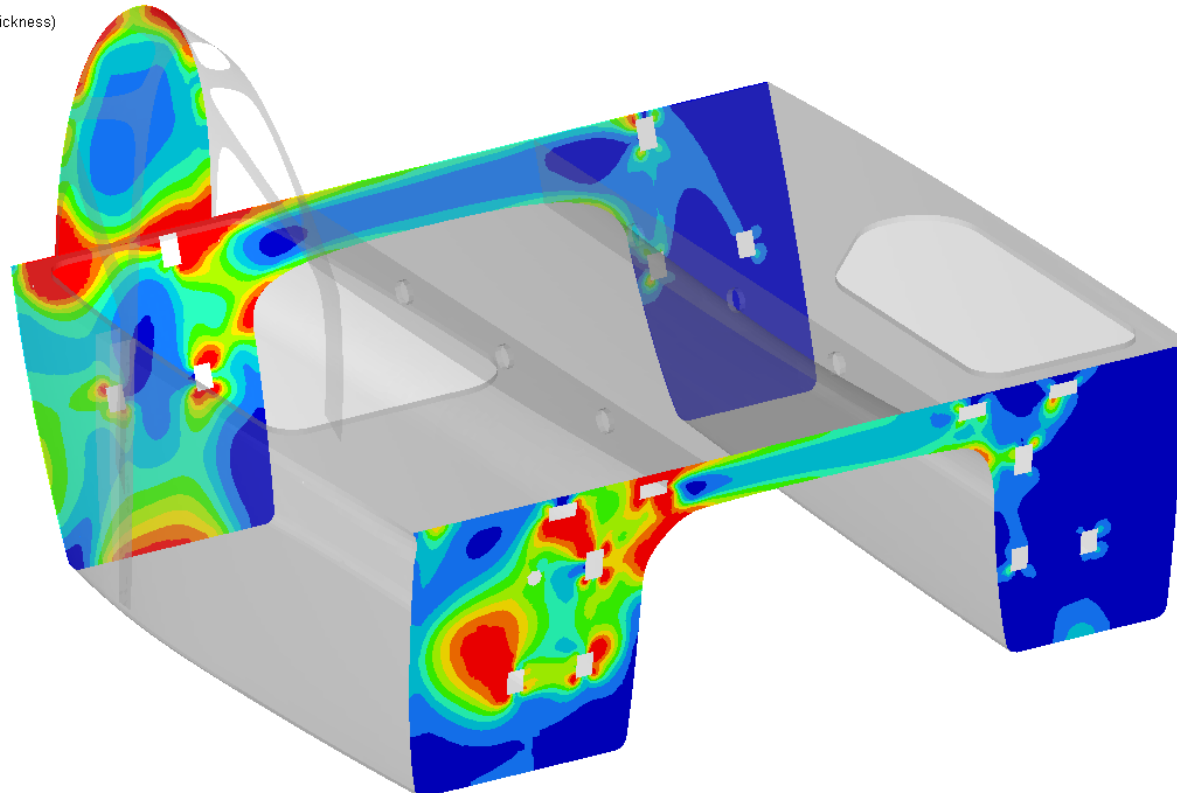
Composite Optimisation – 1st Phase

- 1st Phase
 - Free Size Optimisation
 - Objective: Maximise Stiffness
 - Constraint: 10% volume Fraction
 - Leitmotiv: “I give you only that much, tell me where it is most efficient to put it”

Contour Plot
Element Thicknesses(Thickness)
Simple Average

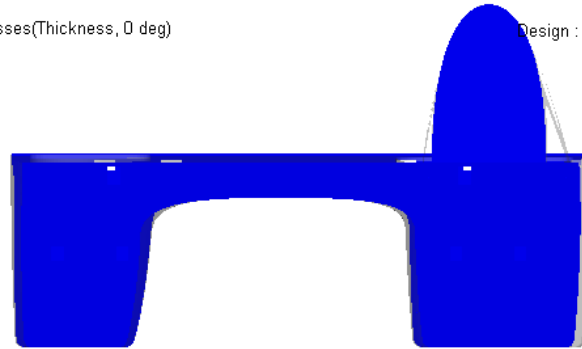
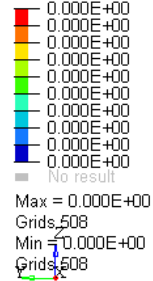
3.200E+01
2.500E+01
2.439E+01
2.378E+01
2.317E+01
2.256E+01
2.195E+01
2.134E+01
2.073E+01
2.012E+01
No result

Max = 3.200E+01
Grids 587397
Min = 2.012E+01
Grids 593935

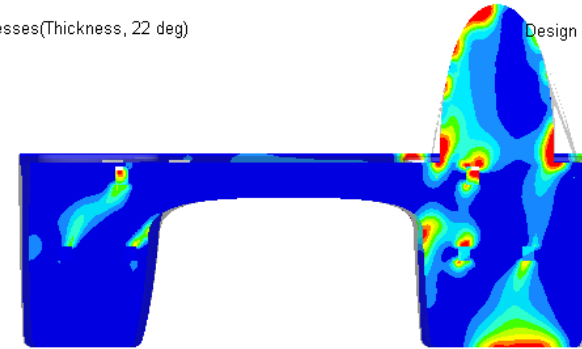
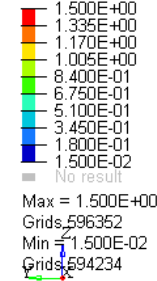


Composite Optimisation – 1st Phase

Contour Plot
Orientation Thicknesses(Thickness, 0 deg)
Simple Average

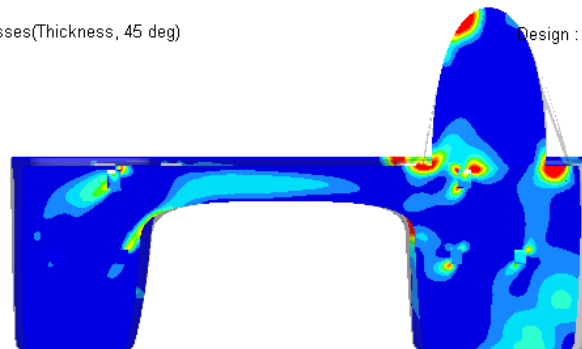
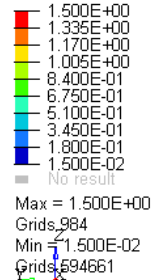


1: 1
Contour Plot
Orientation Thicknesses(Thickness, 22 deg)
Simple Average

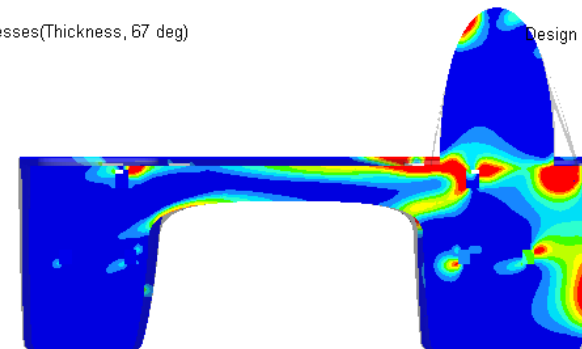
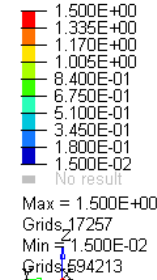


1: 1

Contour Plot
Orientation Thicknesses(Thickness, 45 deg)
Simple Average

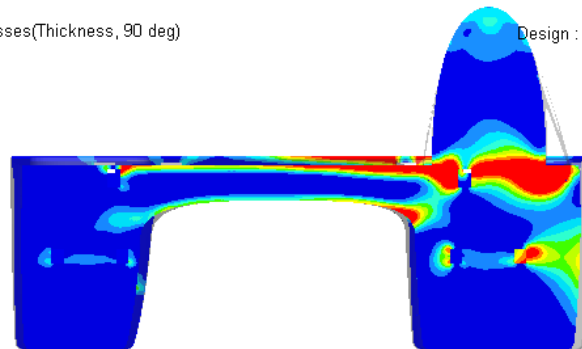
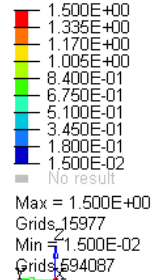


1: 1
Contour Plot
Orientation Thicknesses(Thickness, 67 deg)
Simple Average

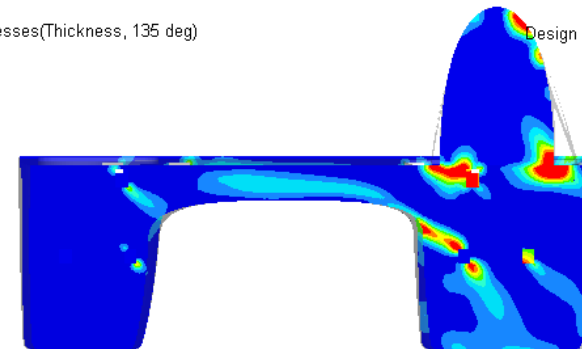
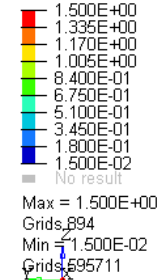


1: 1

Contour Plot
Orientation Thicknesses(Thickness, 90 deg)
Simple Average

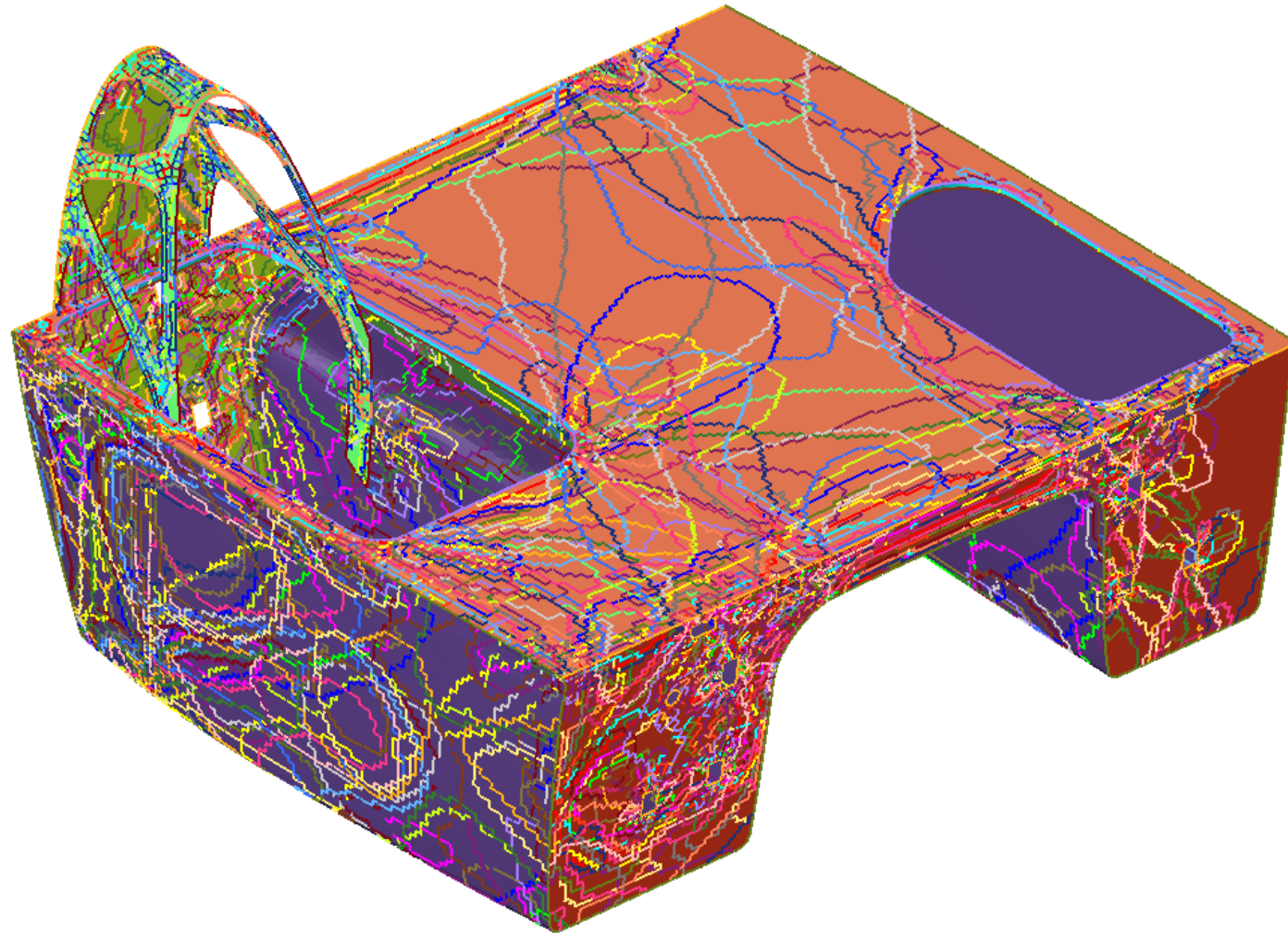


1: 1
Contour Plot
Orientation Thicknesses(Thickness, 135 deg)
Simple Average



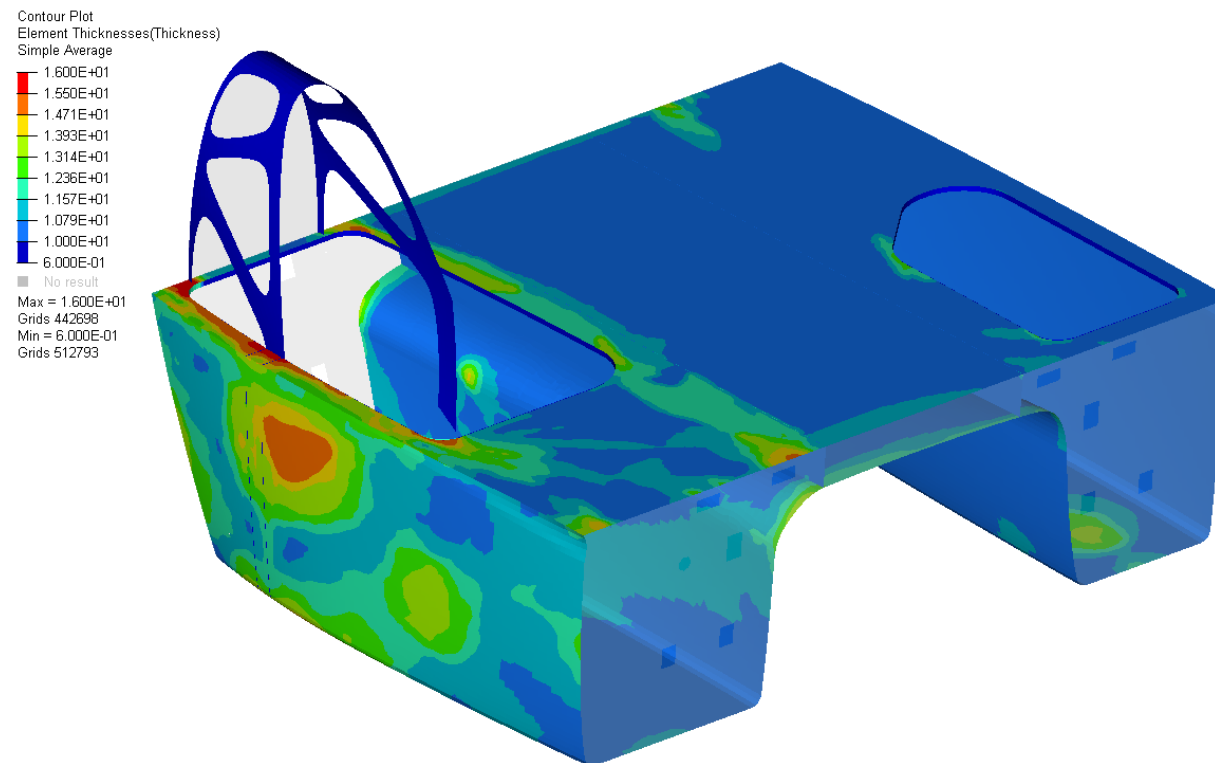
1: 1

Composite Optimisation – 1st Phase

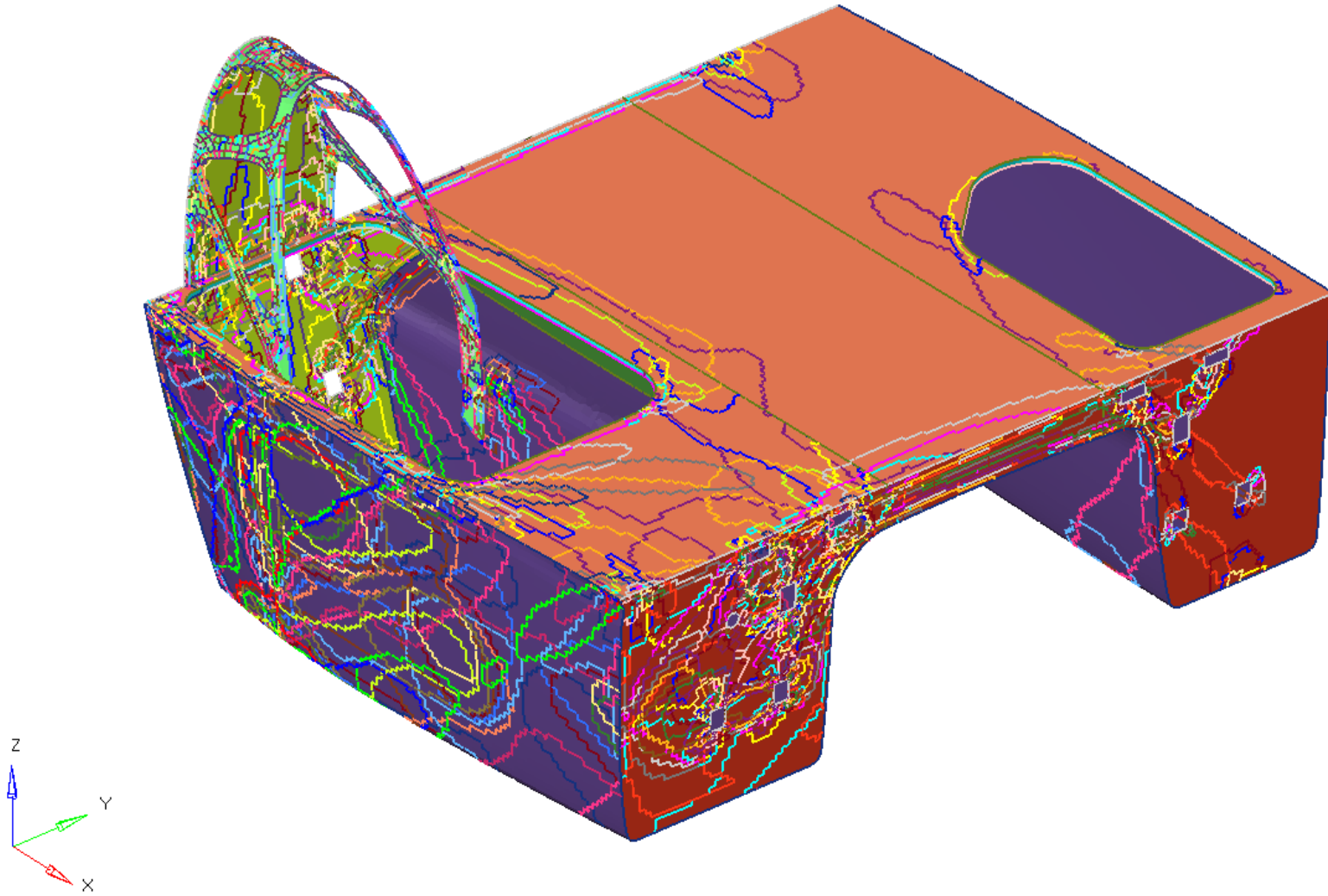


→ 2nd Phase

- Size Optimisation
- Objective: Minimise Mass
- Constraint: No Failure
- Leitmotiv: “We’ve chosen the most efficient places to put material, now tell me how much I need to be strong enough”

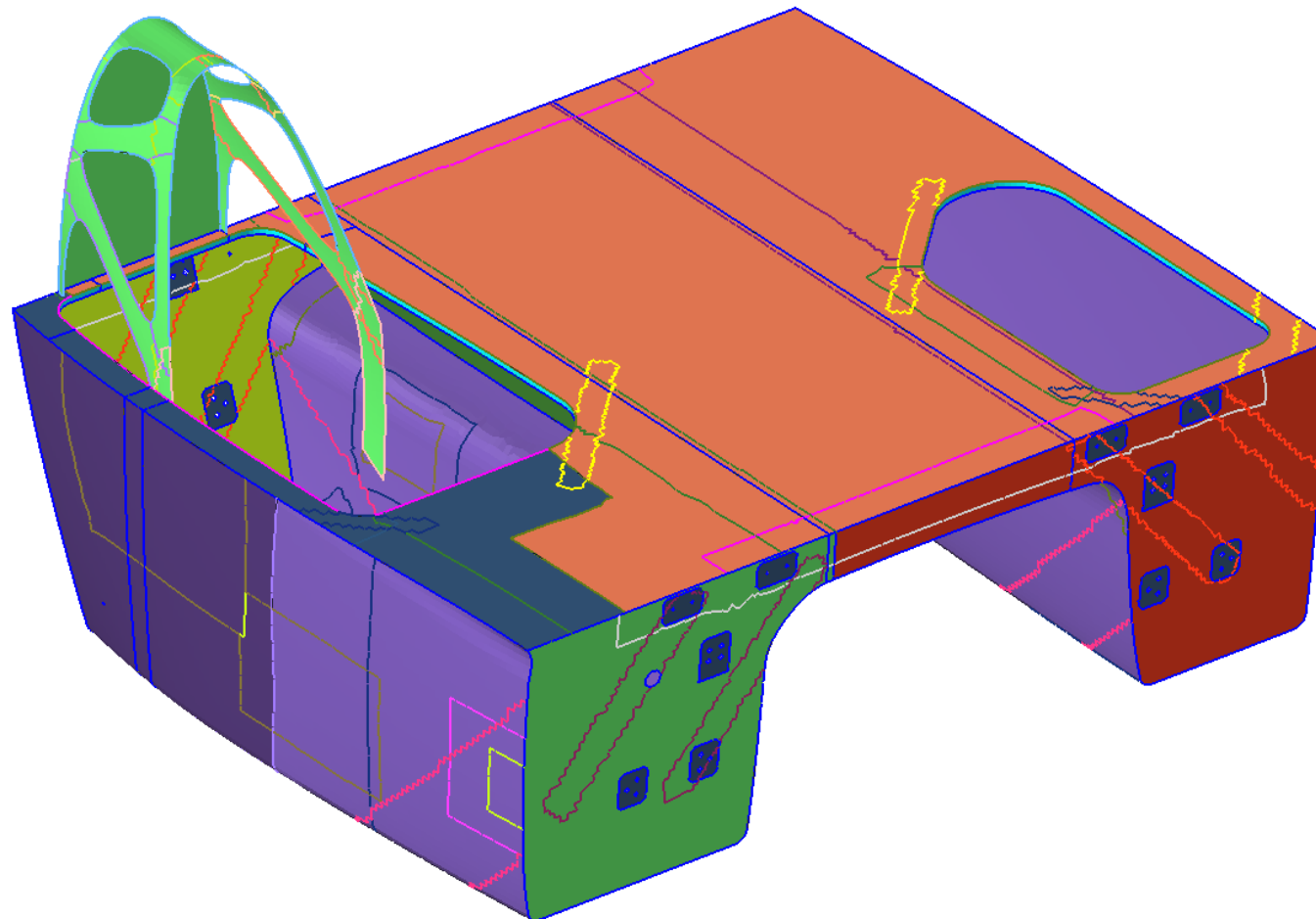


Composite Optimisation – 2nd Phase



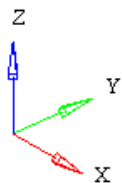
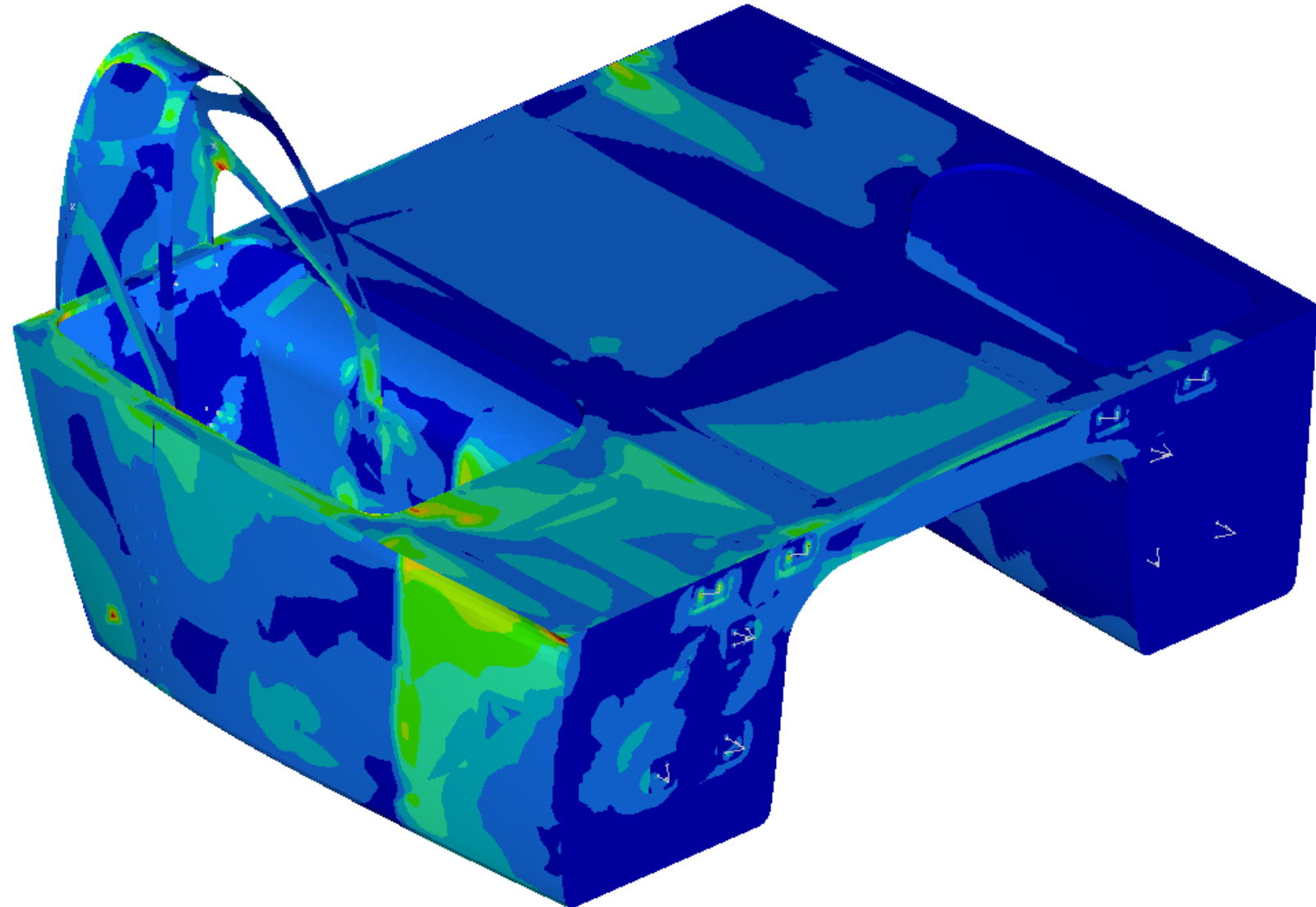
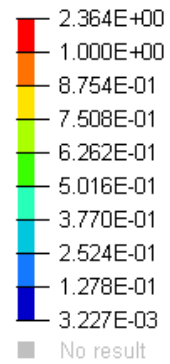
Composite Optimisation – 3rd Phase

- 3rd Phase
 - Ply Cleaning
 - Create tapes & patches that are compatible with the building method
 - Still needs to pass Failure Criteria



Composite Optimisation – Results

Contour Plot
Composite Failure(Ply Failure, Extreme)
Simple Average



Building the Car





Questions ?

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Project Engineer

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