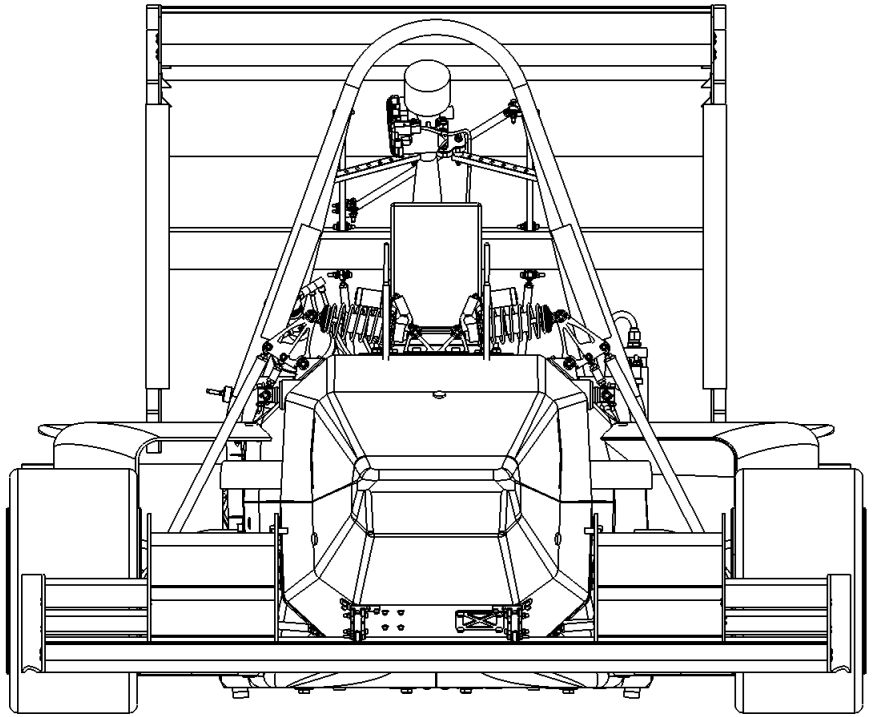
National University of Singapore

FTS 431: Formula SAE

Design of R20 Chassis Dept



Presented by **Lau Yu Da A0154969J**

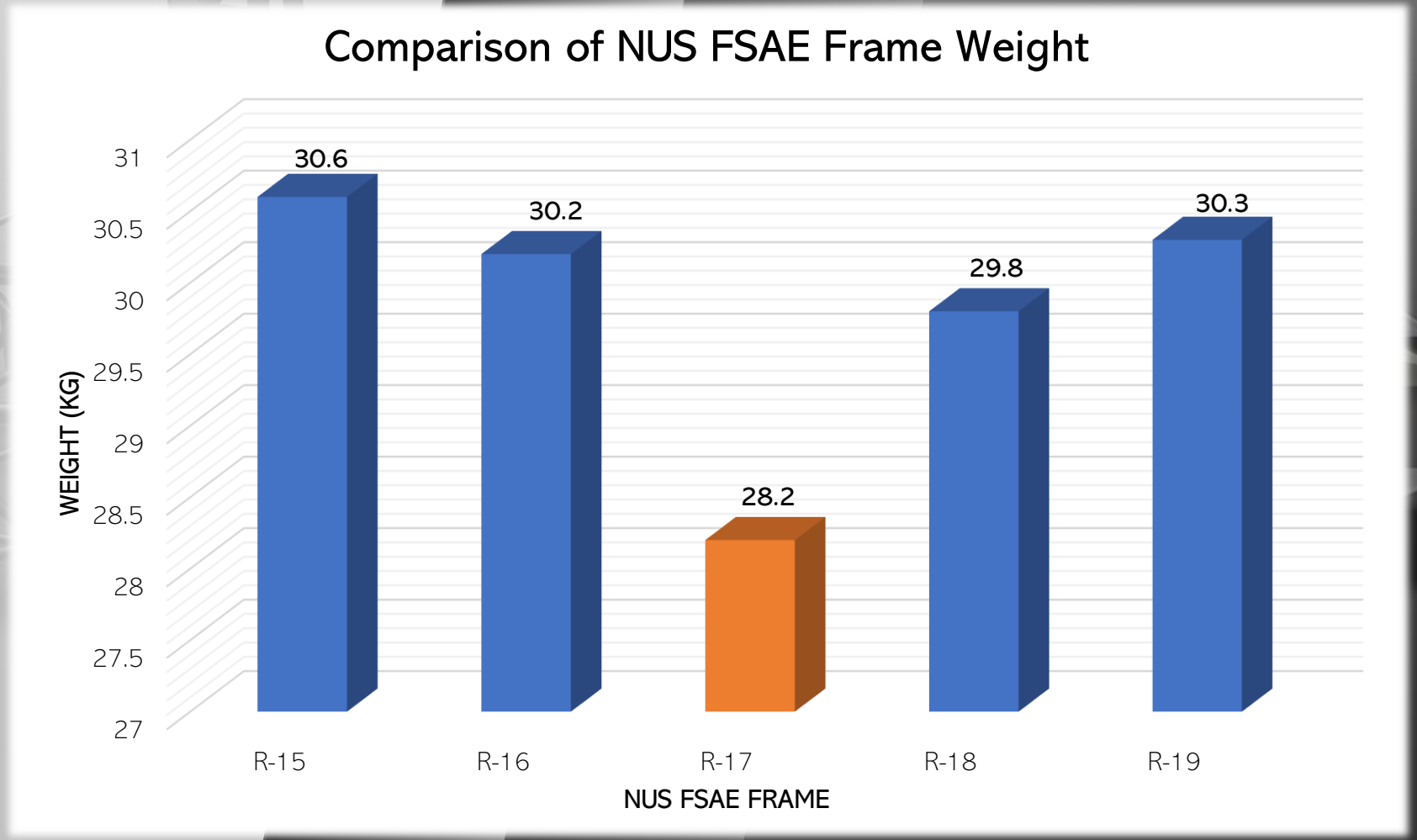
World Map

Formula Student Competitions:

USA
Canada
UK
Spain
Italy
Germany
Netherlands
Austria
Hungary
Czech
China
South Korea
Australia

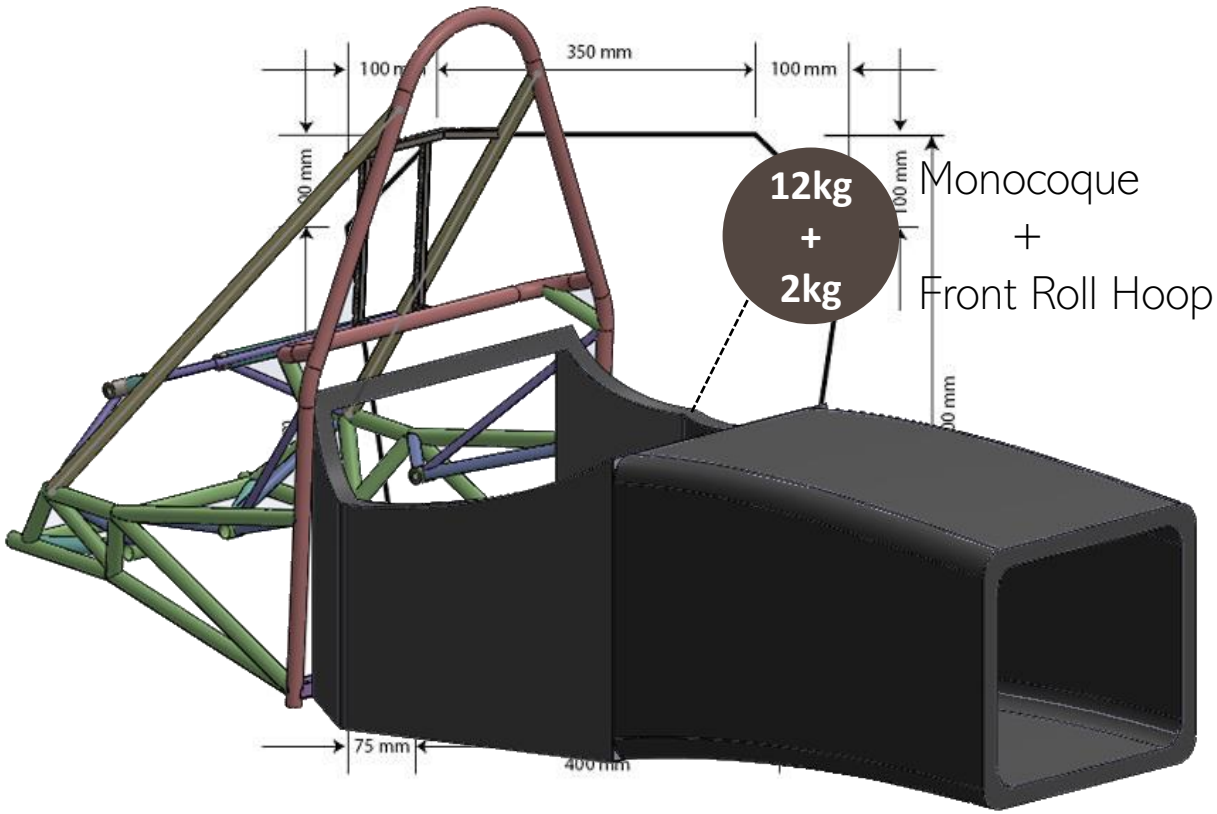
The best teams use a monocoque for the frame...

Rigidity
Lightweight
Safety

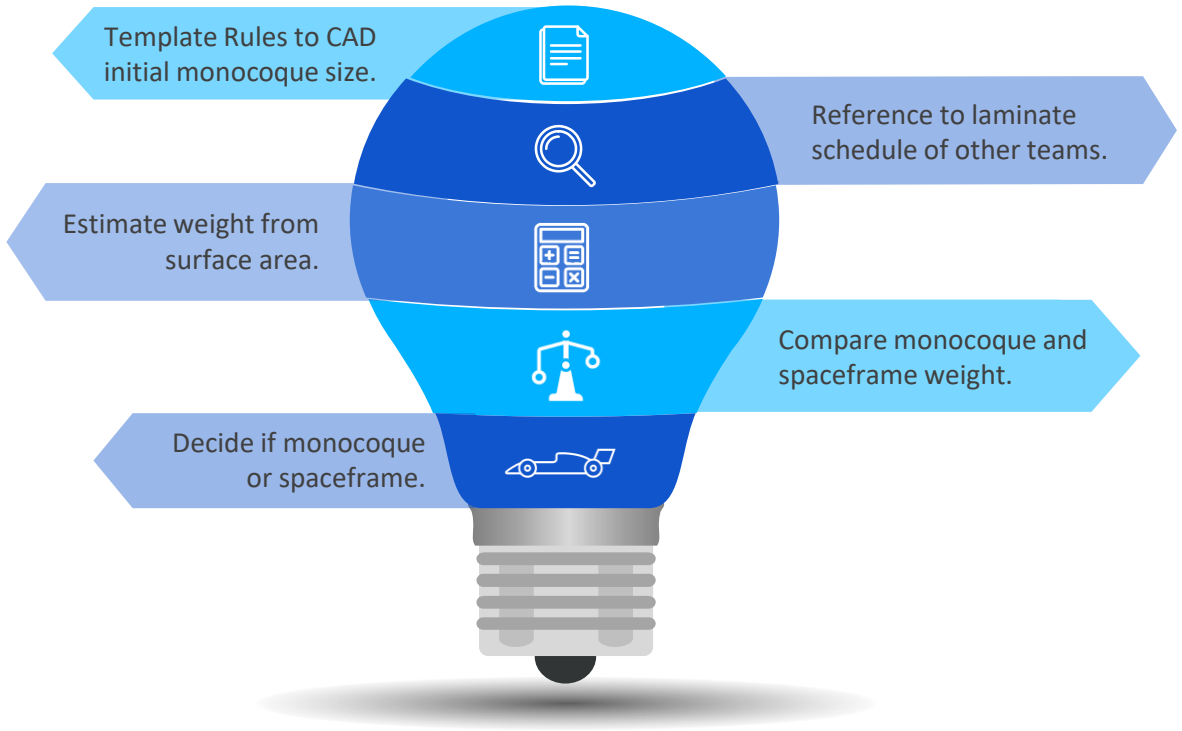


Preliminary Findings

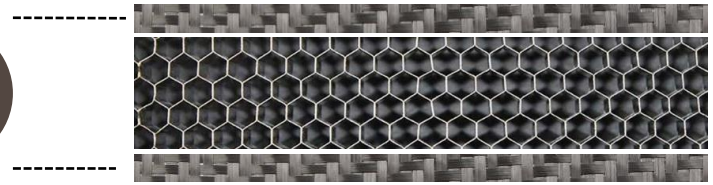
Validating Concept through Weight Savings



12kg + 2kg Monocoque + Front Roll Hoop



Carbon Fibre Facesheets **9kg**



3kg Honeycomb Core

Replaces 16kg of steel tubes

Three Stages of the Monocoque Project

Design

Determining the geometry and materials.

Manufacturing

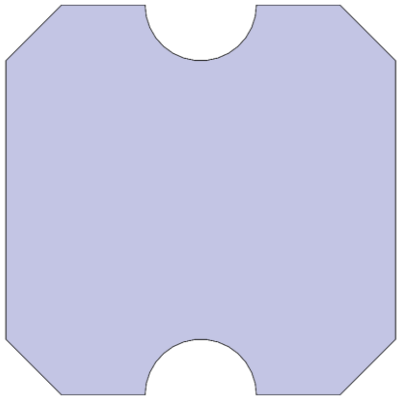
Overcoming 4 key challenges.

Testing

Understanding torsional stiffness of the monocoque.

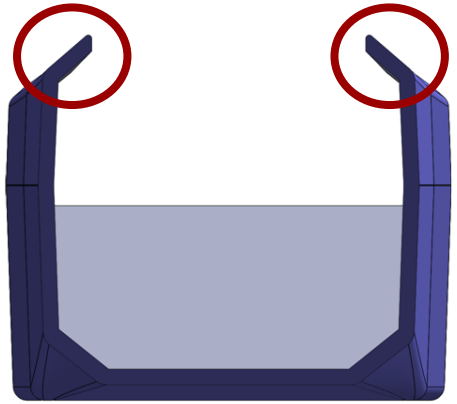
Shaping the Geometry of Monocoque

1 FSAE Rules



Minimum area of the monocoque is **limited** by the template rules: cockpit template and foot well template.

2 Torsional Stiffness

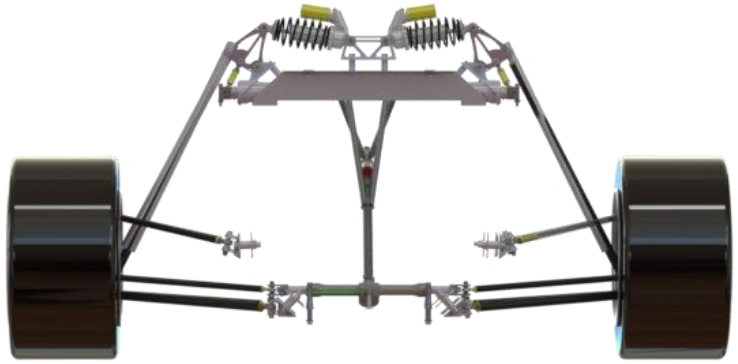


Frame is modelled as springs in series:

$$\frac{1}{K_T^{Total}} = \frac{1}{K_T^A} + \frac{1}{K_T^B} + \frac{1}{K_T^C}$$

Added flanges at cockpit rim to **increase** local stiffness to for **higher** torsional rigidity.

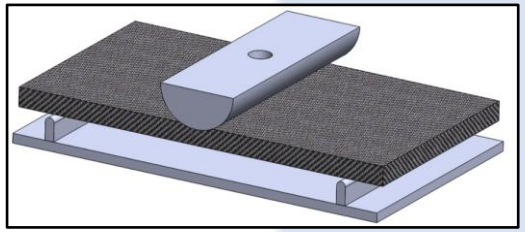
3 Component Packaging



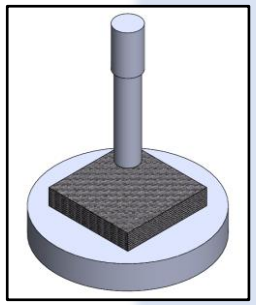
Designing to catch front suspension inboard points, ARB mounts, steering mounts for **excellent** dynamic performance.

Deciding the Monocoque Laminate Schedule

Testing
3-Point Bending and Perimeter Shear.



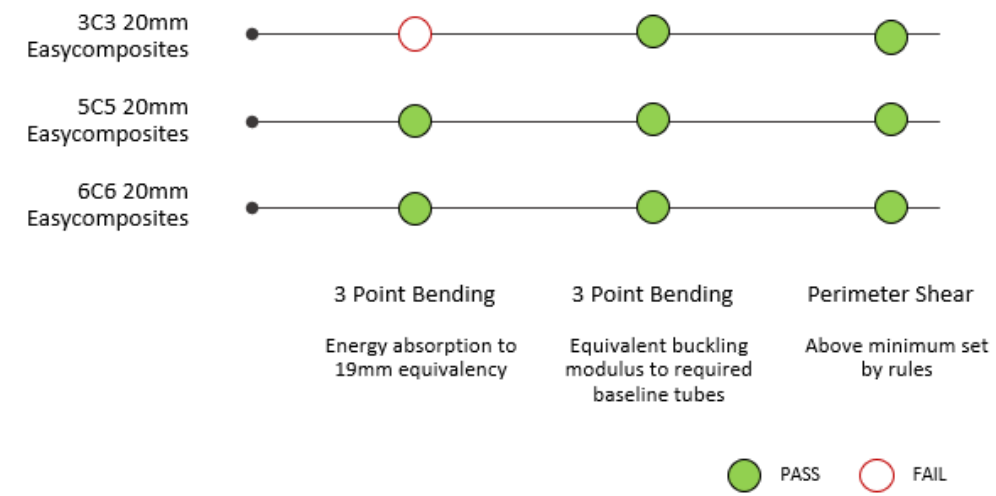
- The **more** the number of plies, the **stiffer** the sandwiched panel.
- The **more** the number of plies, the **higher** the peak force.

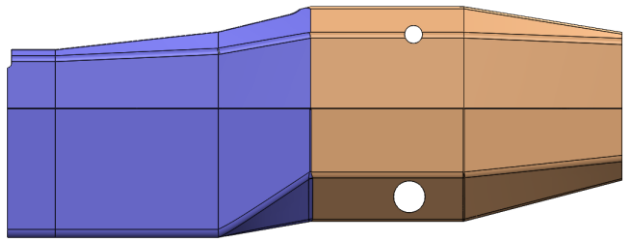


- The **more** the number of plies, the **higher** the peak force.
- The thickness of the core **does not** affect the peak force.

Results
Meeting requirements to pass SES.

TABLE OF DATA

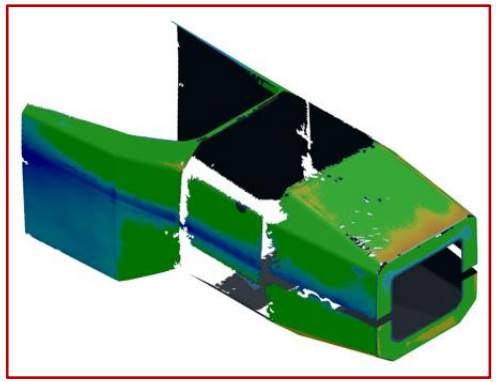




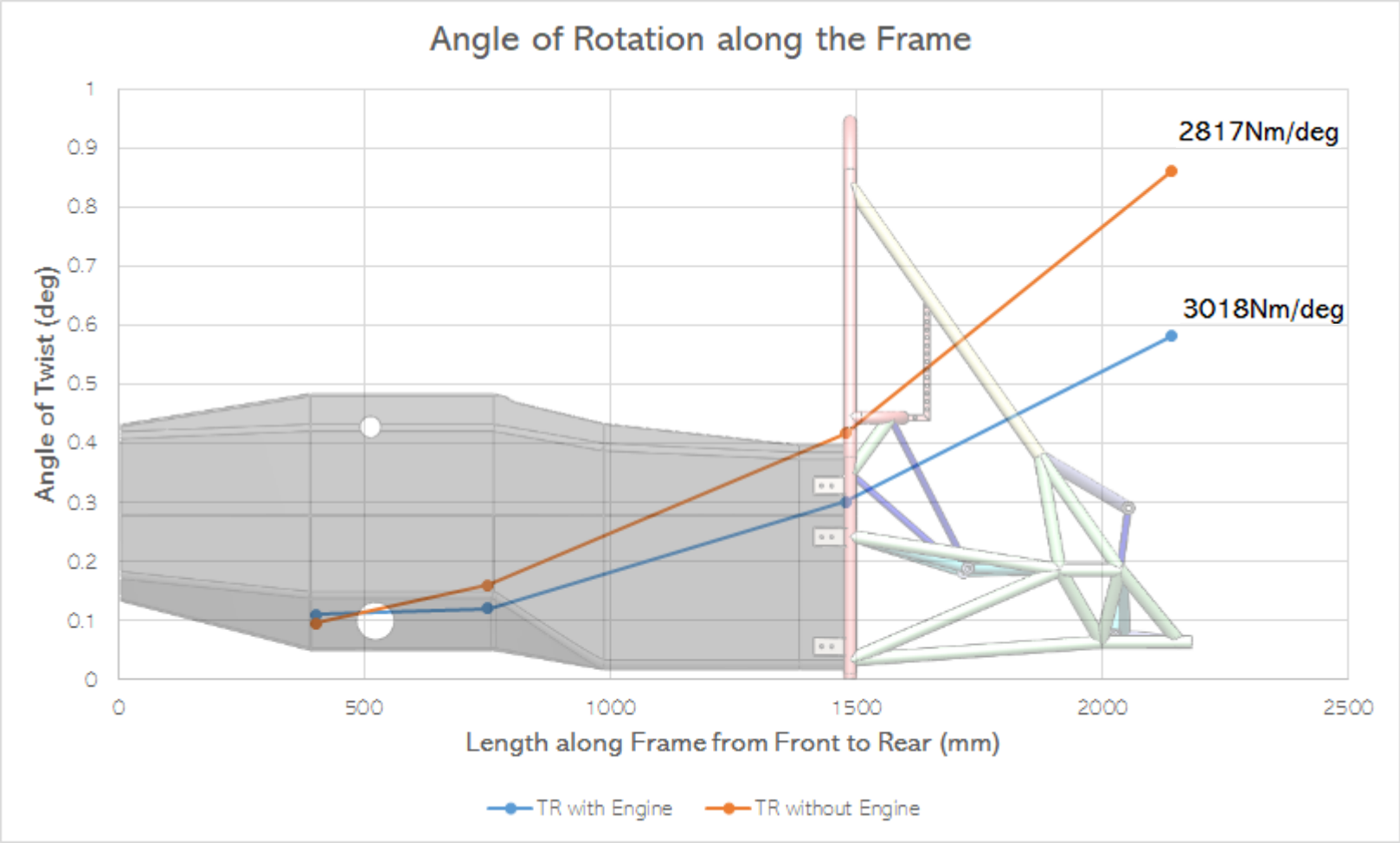
5C5 20mm Easycomposites
[0/45/0/45/0/Core/0/45/0/45/0]

3C3 20mm Easycomposites
[0/45/0/Core/0/45/0]

Transferring Monocoque in CAD to a Physical Product

Key Questions	1 How to construct the mold?	2 How to join the two halves?	3 How to jig and locate points?	4 How to validate dimensions?
Method (s)	▪ 2 halves with horizontal split line ▪ CF mold for stiffness and similar CTE	▪ K1 gap between halves ▪ Double lap joints (4 plies each face) ▪ Jig with CF mold	▪ Acrylic jigs with reference to welding table ▪ Drill bushing for hole concentricity	▪ Probing CMM ▪ Scanned model about 0.5mm deviation from CAD model
Illustration				

Lessons from Torsional Rigidity Test Results



1

Chassis TR achieved **3018Nm/deg**, meeting objective of **2800Nm/deg** at start of design phase.

2

Engine contributes to **approximately 200Nm/deg**. Data used to develop future simulations.

3

Gradient of the graph indicates rear spaceframe is the **least stiff** and cockpit opening **loses stiffness**.

Summary

Positioning NUS Formula SAE to be Champions

How will the chassis department contribute to the success of the NUS FSAE team?

Design successfully passed SES and incorporated other departments' components.

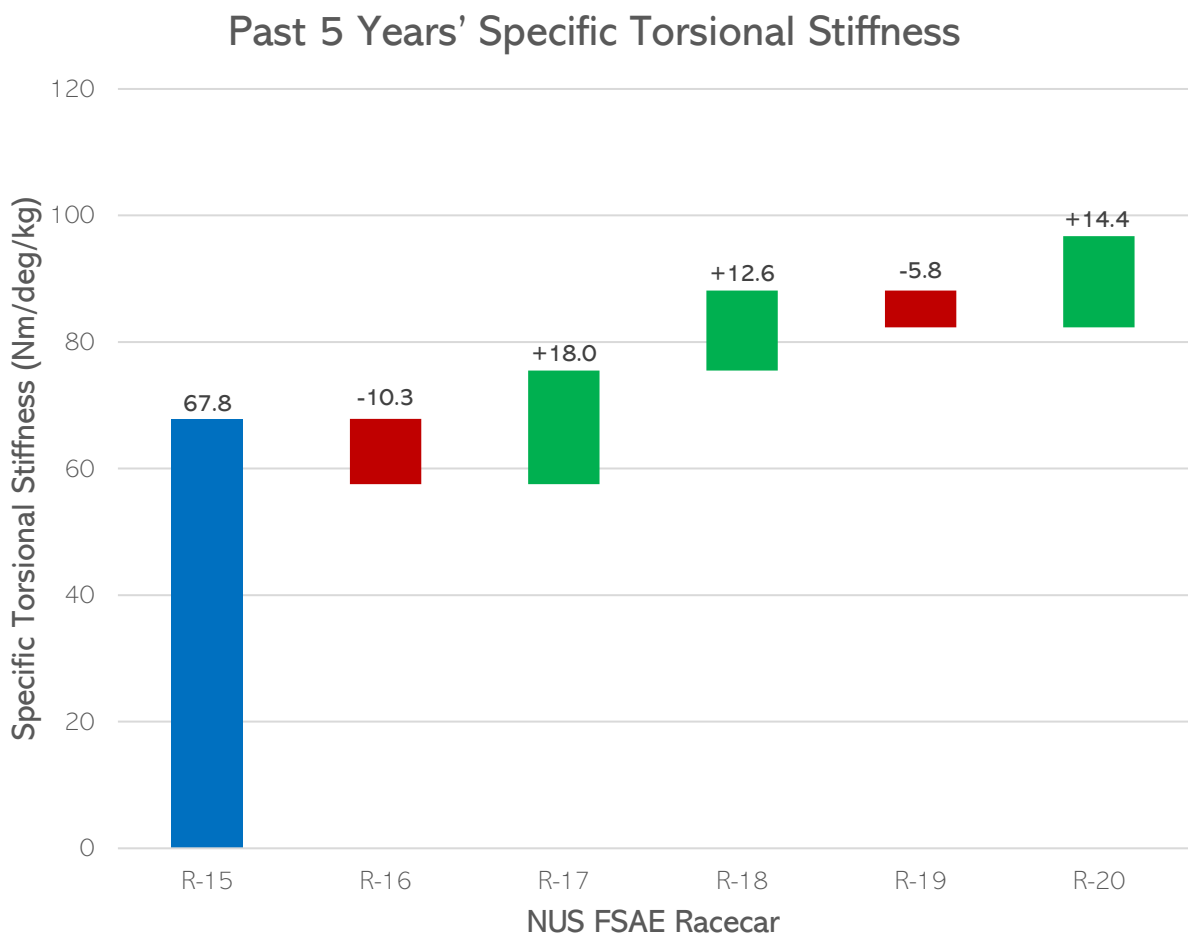
Addressed manufacturing challenges by sourcing new suppliers and developing new manufacturing processes.

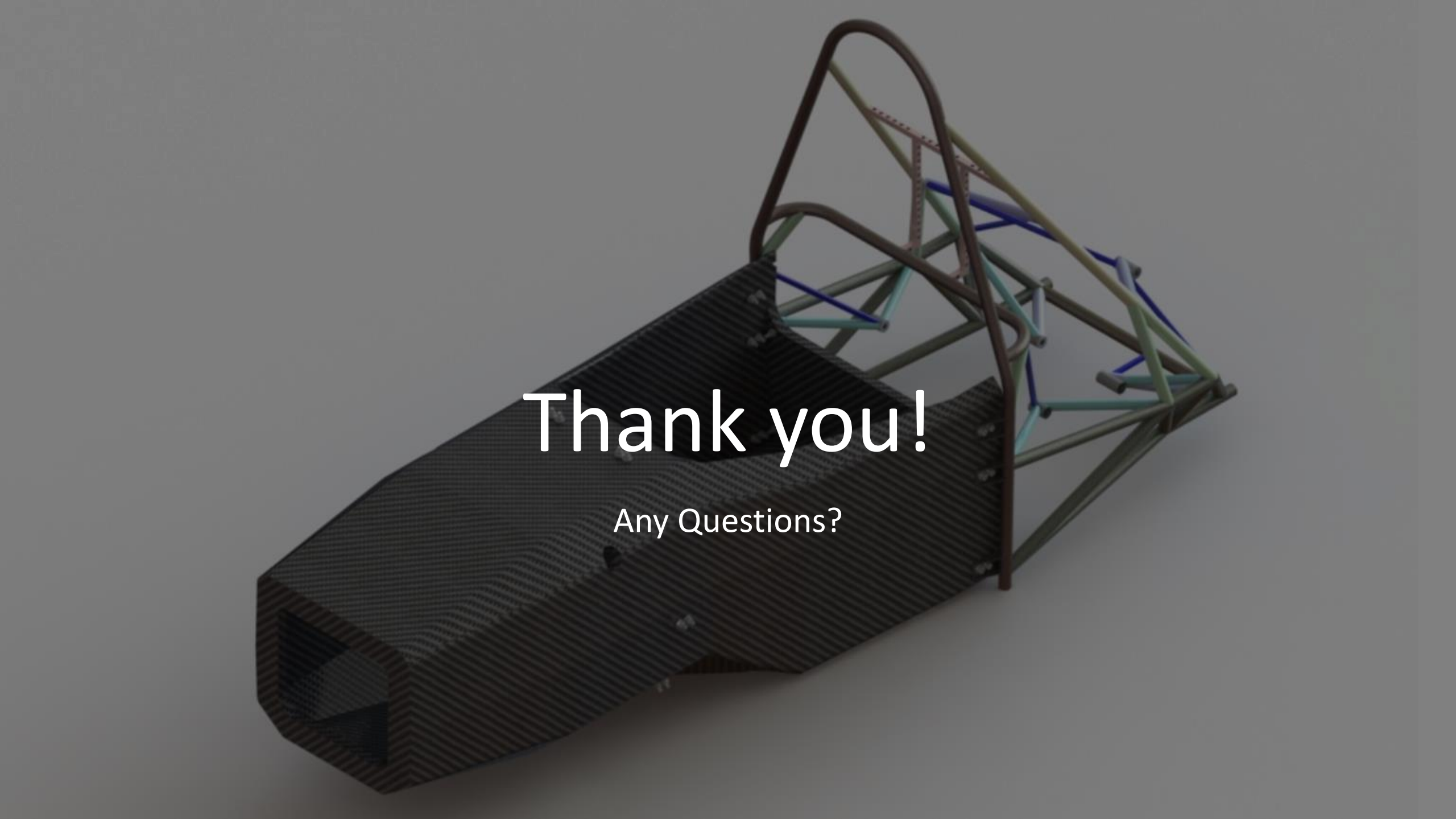
Validated TR target achieved with testing and analysed future areas to work on.

Improvements from previous racecars

Unlocking future possibilities

Top 10 at Michigan by 2021




Thank you!
Any Questions?

Annex

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