# Background

**McMurtry**

- A small startup company, currently with 4 mechanical engineers.

- We are engaged in mechanical design for automotive components, primarily composite, and use analysis and optimisation within our current workflow

- We have ambitious goals, so there is a significant amount of work to be split between the team, hence the need for a time-efficient process for composite design and analysis

# Why Optiassist?

- We reviewed the market for composite analysis, optimisation and layup book software, capable of integrating with our existing software (NX Advanced Simulation)

- In house layup required a simple way to generate layup books, with large numbers of composite parts to be released in a short time

- We wanted a simple way of translating FE specified layups to layup books for the laminators themselves.

- As a startup company with a large workload, we needed a way of reducing the time taken to specify the laminate itself – using Optiassist enabled a quick turnaround and reduced the engineering overhead.

- Genesis with Optiassist was a similar price to Simcentre Composites

# What is Optiassist used for?

- Primarily we use Optiassist as a tool to speed up the analysis workflow and reduce the time taken from analysis to released laminates

- We also use GRM design toolkit for machined component topology optimisation

- Initially we focussed on chassis components, but recently have applied it to bodywork also

- Optiassist allows us to generate ply patches (PCOMPG) – not possible with our NX license and to Generate layup books used directly in component manufacture

# Overview of our process

The following slides will demonstrate the workflow for a composite component using Optiassist and Genesis

1. Initially, the geometry is defined in NX, with general laminates applied all over for quick studies and performance evaluations within NX Advanced Simulation. At this stage, resolving local issues and optimisation of the laminate is not considered.

2. Once the geometry is beginning to mature, the Nastran deck is exported to Genesis/Optiassist and is run to check consistency between the solvers.

3. A basic laminate (the minimum we would accept) is applied all over, as well as cores where it is definitely required.

4. Local pull out laminates and inserts (from hand calculations & test data) are added to the laminate.

5. An initial optimisation study is run with a candidate core ply, to understand where core is most beneficial

6. Once this is completed, the candidate plies are revised to add woven and UD plies, typically in square patches. This optimisation is then run once again, to suggest the required laminate all over the car.

7. The proposed laminate is then refined and simplified for manufacturing feasibility

8. If any geometry changes are required they are implemented and the laminate is re-imported, or a new optimisation is run

9. A laminate guide is exported

10. Manufacture begins

# Illustrating our process

The process discussed will be applied to a subframe

This is a two-part shell component, which acts as a large bracket, taking chassis and drivetrain loads in particular, as well as other functions

Multiple loadcases are applied for dynamic and functional requirements (stiffness constraints) as well as fatigue and abuse loads (strength constraints). These are all optimised in parallel.
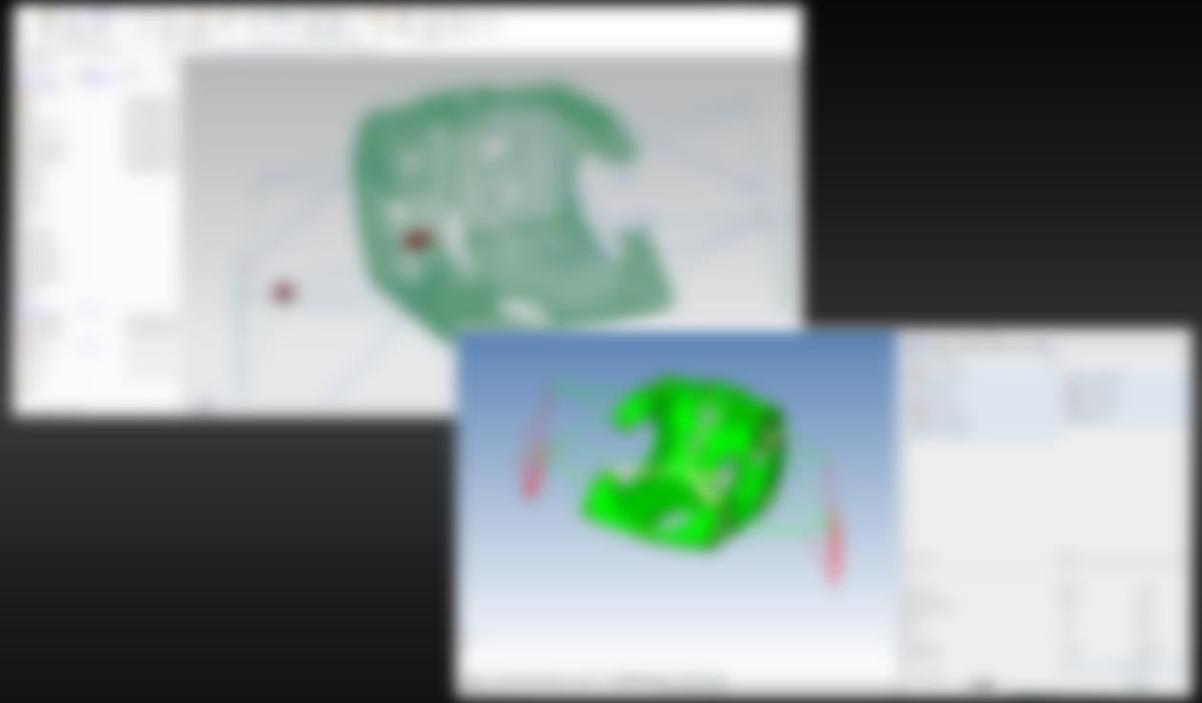
# Step by step optimisation of a subframe

**Model Import**

.dat file imported from NX Nastran, which brings the materials, meshes and boundary conditions/loadcases into Gensis/Optiassist

Typically a comparison run will be carried out to ensure the import was successful

# Step by step optimisation of a subframe

**Set minimum laminate**

Only add the minimum amount of material needed for feasibility, and from hand calculations/tests (eg: around attachment points) into the model before letting Genesis adding more where necessary to meet the structural requirements

**Set candidate core plies**

Determine where core is necessary/desired or run a core optimisation to find out the optimum locations
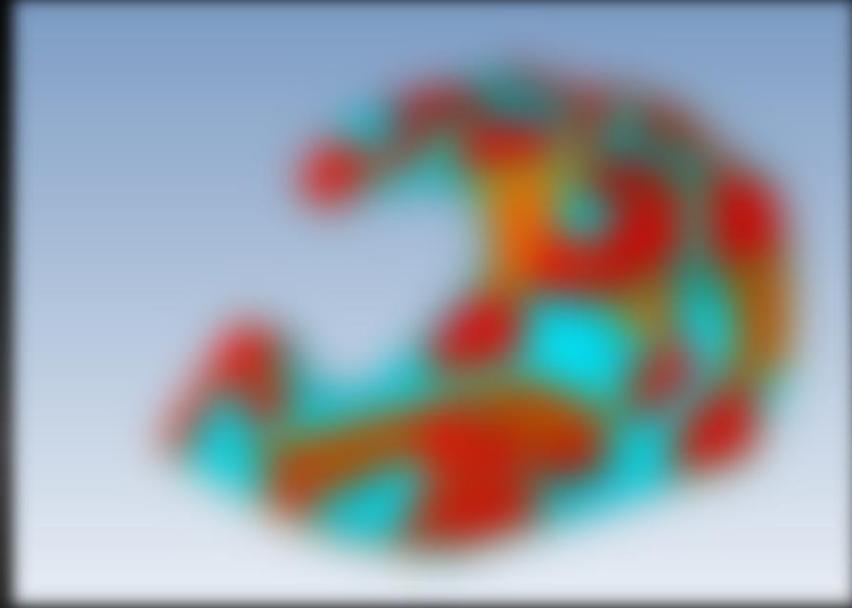
**Set candidate plies**

Determine where additional plies are required, or most beneficial for the constraints and targets

For this case, optimise with grid edge length grouping (sized patches)

# Optimisation outputs
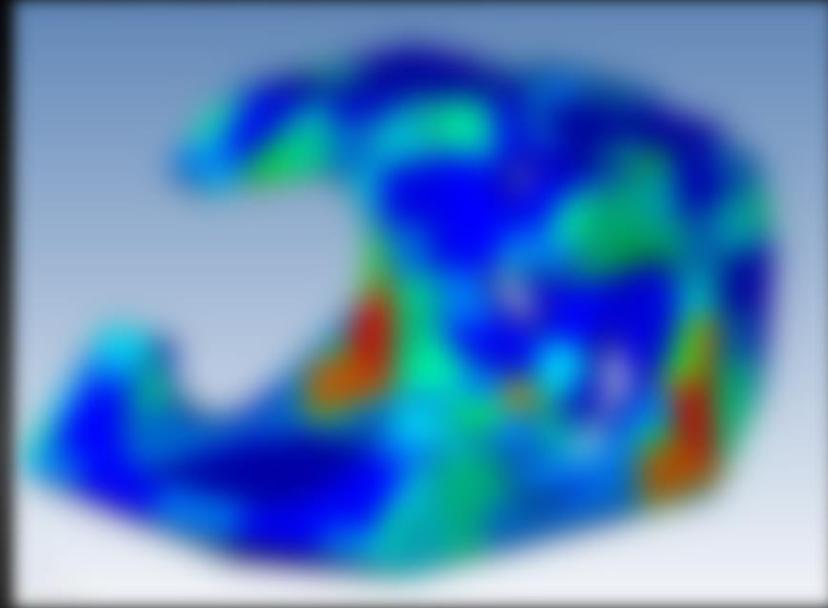
## Laminate thickness plots



**Baseline model**

Laminate sized to be stronger than the bolts (protect the chassis)

Core in optimised areas, general laminate throughout

Low level of optimisation

**Optimised Model**

50mm patches create a continuously varying laminate thickness through the part

No core – simplified manufacture

Optimised to ensure sufficient strength and reserve factor for all loadcases whilst simultaneously meeting the target stiffnesses

# Further improvements



Local displacements in certain loadcases indicate reinforcements would be beneficial

Multiple locations are feasible to reinforce, but where is most suitable?

Using RDM, a volume around the existing elements in created, and topology optimisation is used to understand the regions that are most beneficial to increasing stiffness

# Topometry with RDM
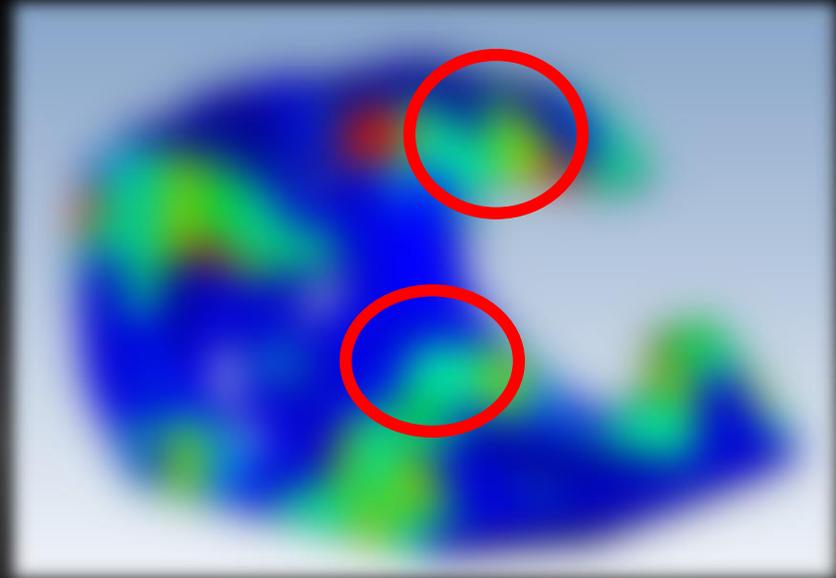


After RDM, bulkheads/reinforcements were modelled in and topometry optimisation was carried out on the updated geometry

Here it is clear that the improved loadpaths significantly reduced the amount of material required (due to significantly less bending in the structure), reducing weight and improving the stiffness

# Optimisation comparisons

Different levels of optimisation can be applied to get balance complexity and performance, with target stiffnesses and failure index constraints ensuring no failure of the part for all loadcases

| Method | Characteristic displacement (normalised) | Mass (kg) |
|---|---|---|
| **Initial Model** | 1 | 3.98 |
| **Topometry Optimised, 50mm patches** | 0.74  (stiffness **+35%**) | 3.21 (**-19%**) |
| **Topometry Optimised, 50mm patches with RDM braces** | 0.43 (stiffness **+132%**) | 2.35 (**-41%**) |

# Step by step optimisation of a subframe

Optiassist allows a quick transition from design/analysis to production

1. Check angles and balance of the laminate

2. Combine plies to improve manufacturability

3. Generate the layup book

4. Add dimensions where necessary and show the ply angle rosettes

5. Generate views to show the ply locations to assist templating

6. Apply a company template to the PPT

7. Export CAD file of plies for thickness updates in CAD
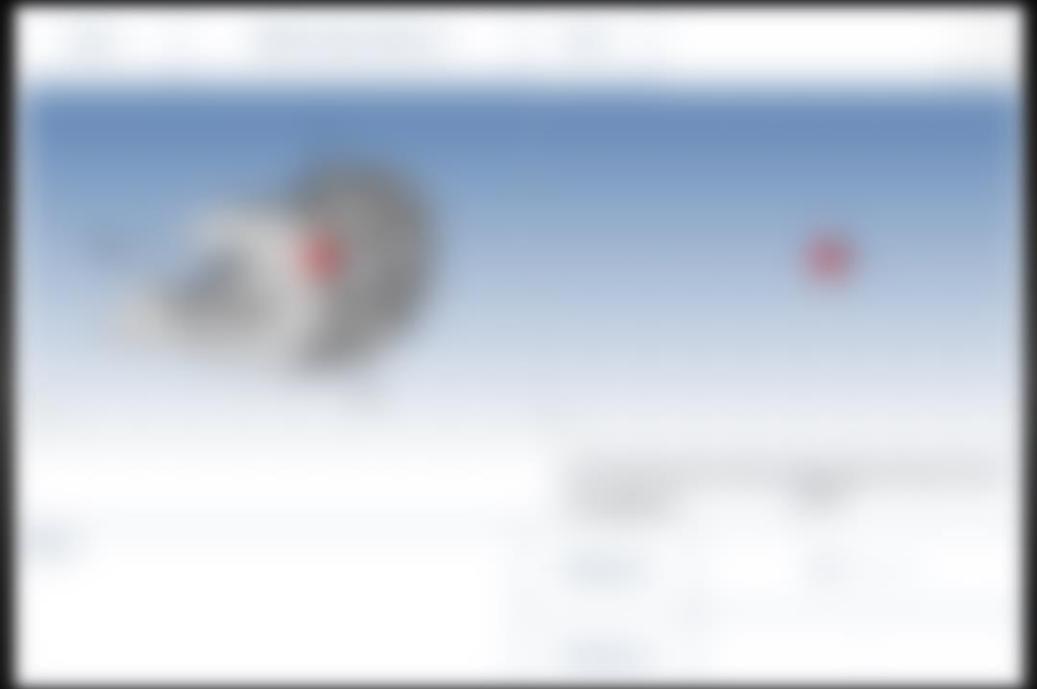
# Step by step optimisation of a subframe

Manufacture and test the part

# Conclusion

Within a small startup company, the benefits of Optiassist are magnified;

- Cost is reduced due to the integrated software package
- Structural efficiency reduces mass and improves performance
- Analysis and laminate specification/optimisation/improvement time taken is significantly improved and streamlined – *reduced engineering overhead*
- FE laminates are presented directly into the layup books – *reduced engineering overhead and improved communication for manufacture*
- Less material can be used – *cost savings*