UNLEASHING THE FULL POTENTIAL OF ANSA MESHING CAPABILITIES FOR RTM ANALYSIS

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Molding, RTM, mesh, laminates, layers, material angle, morphing, DFM, properties, middle surface, symmetry, automation

1. INTRODUCTION

The progress of science and technology supplies industry with new methods and processes, which provide various improvements and quite often a holistic new approach that replaces traditional methodology or materials. Of course, frequently the target is to improve mechanical strength, while the weight and consequently the cost are minimized. Can both opposing prerequisites be fulfilled? Resin Transfer Molding could be a promising solution to this question.
Usually, new methods in industry need to be inherited by the CAE community and this poses new challenges to the software vendors to deliver solutions that meet the new requirements and approaches. Moreover, specialized solutions may need expertise on specific fields. Is it possible for vendors to cover every specialization in depth?
A commendable collaboration of ANSA with Moldex3D has proved that pre-processing challenges can be tackled effectively. In a particular case, RTM special layered mesh, combined with the complexity of the model geometry, posed a challenge to achieve adequate accuracy, while maintaining the mesh quality and flow at a satisfactory level.

2. ABOUT RTM

<u>What is RTM?</u>

Resin Transfer Molding (RTM) is a vacuum-assisted, resin transfer process with a flexible solid counter tool for the B-side surface compression. This process yields increased laminate compression, a high glass-to-resin ratio, and outstanding strength-to-weight characteristics. RTM parts have two finished surfaces.

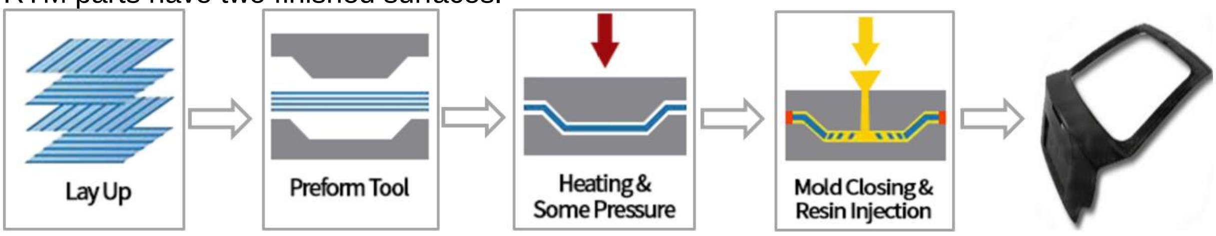

Figure 1 – RTM process

What are the benefits?

There are several benefits to using the resin transfer molding process over the alternative processes available. Some key benefits include:

- High mechanical performance
- Labors saving
- Repeatability
- Faster production
- High surface finish

3. THE CHALLENGES

Given a 3d solid geometry of a part, the result delivered by ANSA is a layered mesh, tolerating few pentahedral and tetrahedral elements.

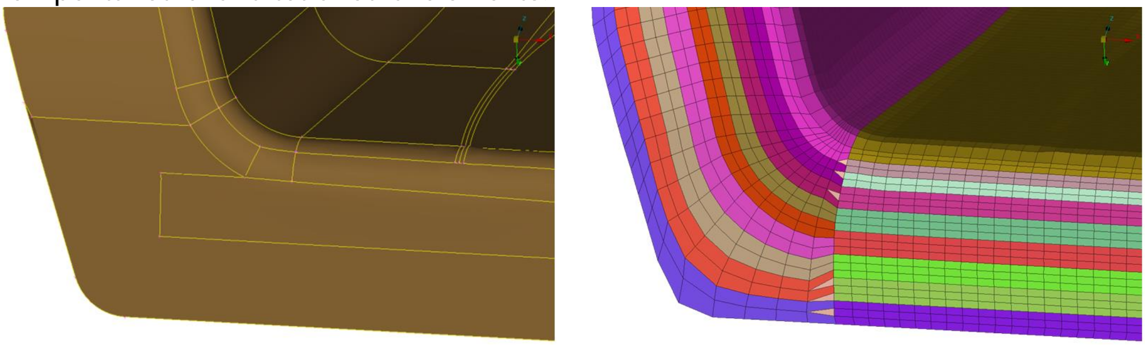

Figure 2 – Given geometry and result layered mesh

In more details, the element layers that fill the volume should:

- Have equal thickness distribution, according to the local part's thickness
- Capture accurately the depiction of the real model
- Distribute the drop-off elements on part's thickness
- Maintain acceptable elements quality

The complexity of the mesh is further elevated due to the variable number of laminates per area of the part. Moreover, each laminate is simulated with a defined number of solid elements mesh layers.

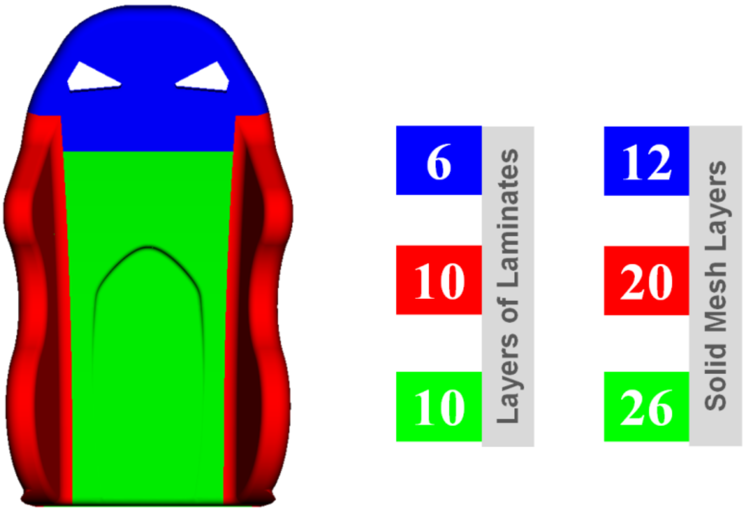

Figure 3 – Number of laminates and elements layers distribution along the part area

This means that at the locations where the number of laminates changes, some of the mesh layers will be required to smoothly finish, without arising hanging edges or intersections. Here come the drop-off pentahedral elements which serve this transition.
Additional to that, at locations where three different numbers of laminates meet, they have to be detected and convert drop-off elements to tetrahedra.

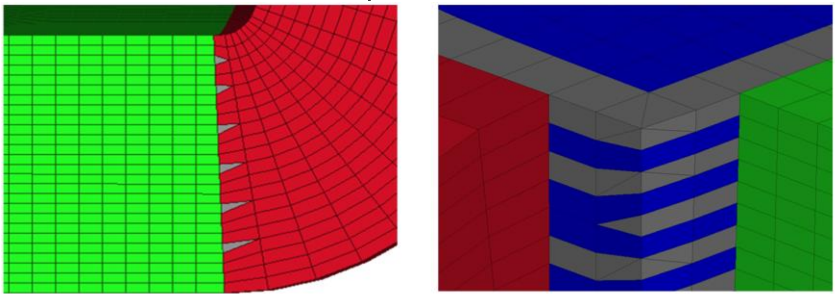

Figure 4 – Locations where two or three different number of mesh layers meet

4. BUILDING THE MODEL

Geometry & Meshing

The starting step is the preparation to work on the symmetric model in order to reduce working time and deliver really symmetric mesh. Next step is the middle surface extraction, which holds thickness information of the solid geometry.

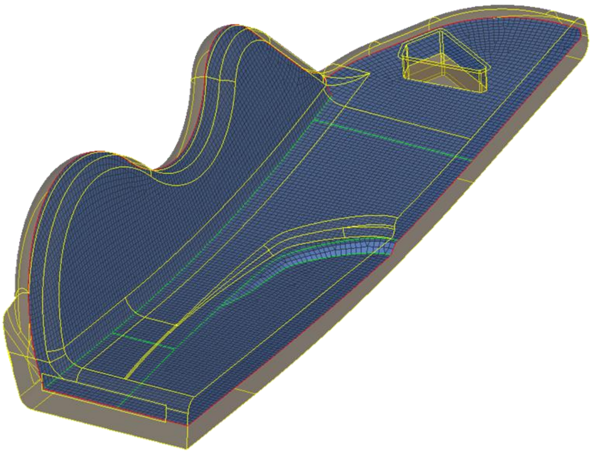

Figure 5 – Symmetric 3d model and mesh representing the middle surface

The relatively thick model emerges problems at sharp edges areas, since elements extrusion is prone to intersections. The solution for this is to convert locally the edge to fillet.

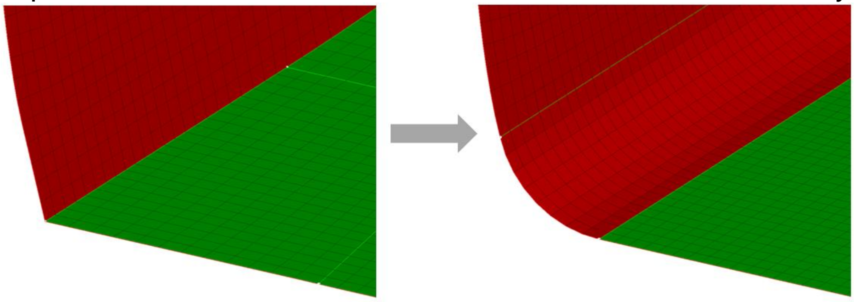

Figure 6 – Convert middle surface from sharp to fillet

Then, the advanced Laminate tool takes over to model the three different areas of the model with the specific parameters for layers, materials and angles.

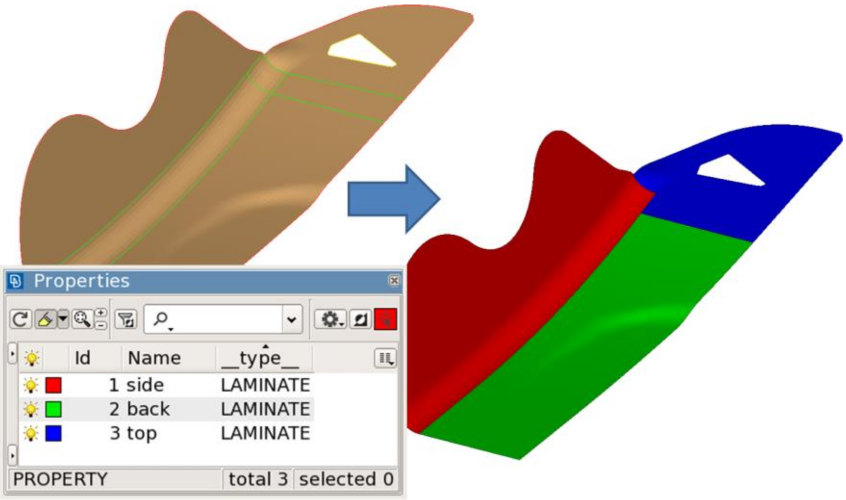

Figure 7 – Set laminate properties

The conversion from layers to solid elements overcomes a diversity of specifications such as, variable number of layers for each of the three model areas, equal distribution of the drop-off pentahedral elements along the thickness, same property ID for identical layers and local linear layers thickness distribution in order to fill the solid geometry. The automation with the ANSA Python API is necessary to transfer the information of the layers to the generated solid elements.

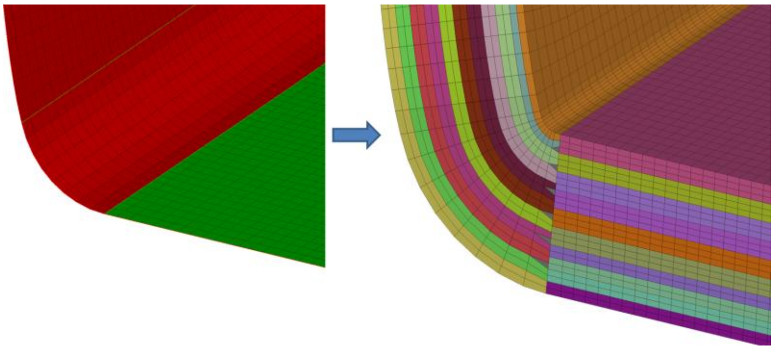

Figure 8 – From middle surface to layered solid mesh

Even when the layered mesh is generated, it still needs to be accurately adapted to the solid geometry bounds. Evolving the Morphing tool capabilities, the outer mesh areas fit to the outer skin, providing an accurate depiction of the model, while the shape modifications are smoothly transitioned to the inner elements.

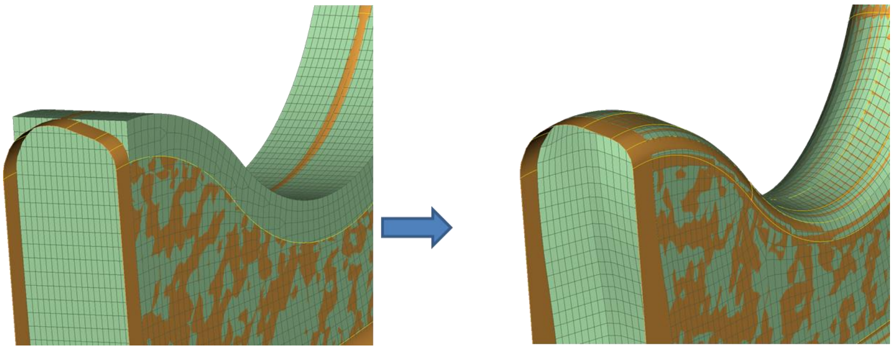

Figure 9 – Solid mesh layers capturing the real shape

As a final step the model integrity and quality is interrogated by applying several checks. Then with few actions the complete model is build out of the symmetric one, marking also the melt entrance points.
The final result proves a credible model that can be imported into Moldex3D for RTM solution. The overall process is an indisputable proof of the harmonic and effective collaboration of ANSA and Moldex3D for escalated potentiality and broadened capabilities.

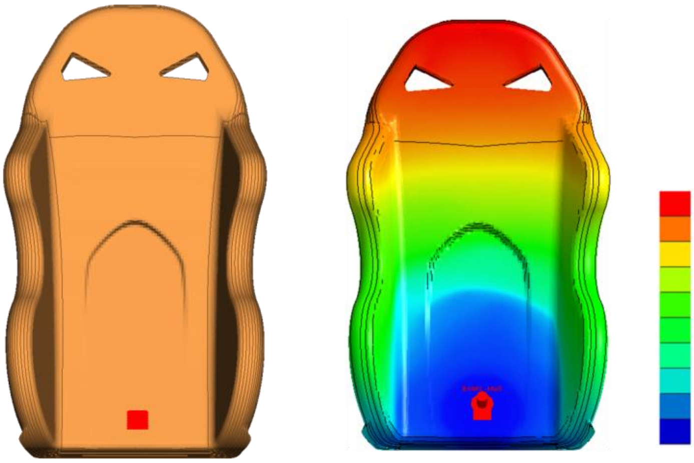

Figure 10 – Final model

5. CONCLUSIONS

The vast range of functions and tools for geometry and meshing, covering various solutions and disciplines, provide a great flexibility, broadening pre-processing capabilities. The process efficiency can be further improved by automation and customization capabilities, utilizing the ANSA Python API.
The harmonic tools and functions cooperation enhance potentiality, supplying upfront solutions for new disciplines. This is elevated by the possibility to interoperate with various other software and exchange information, serving as a complete simulation solution.