

Mapping made easy: How the new VMAP interface standard can be utilized in ANSA towards smooth preprocessing

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Abstract

In most cases today, simulation has become complex both in terms of model and procedure complexity. Several different types of software take part in simulation procedures, to analyze the phenomenon as realistically as possible and produce reliable results. These different software types, however, do not use the same modeling parameters. For example, some of them use 3D elements, others deal with 2D elements, and others usually use different material models.

As a result, going through the steps of a simulation process, the information, including those for materials must be exchanged between the different software. To reduce errors, costs, and effort during this exchange of information, the creation of a “Material Data Exchange Interface Standard” is considered mandatory.

As part of the VMAP project, BETA CAE Systems is involved in the development of a common understanding and interoperable definitions for virtual material models in CAE. This project aims to the development of the “Material Data Exchange Interface Standard”. BETA CAE Systems has supported this format in its products, allowing engineers to apply (map) the results of a simulation on their current models, using the standard format, and proceed with their simulation process.

This presentation examines several use cases, in which exchanging information among different software, is required. In the illustrated case, we showcase how the proposed solutions support processes, such as mapping the results of a previous simulation written in the VMAP standard format on a current model, in a way that it can be used in a next simulation process step.

All steps required to transfer results from a simulation and utilize them as boundary conditions for the next simulation are performed in ANSA, with the application of the Results Mapper. ANSA Results Mapper is based on

interpolation and the proper method can be selected from among several options. Enhanced with an intelligent position mechanism, the ANSA Result Mapper allows the mapping of information between models, which are not located in the same coordinate space. The transformation of the donor part can be automatically performed, with a simultaneous transformation of tensor results, like stress and strains.

Another great benefit of using the ANSA mapping algorithm is that a modification of the model's mesh will lead to an automatic recalculation of the results, to preserve the initial values.

1. Why do we need the ITEA-VMAP Material Data Exchange Interface Standard

The main problem that the ITEA-VMAP Material Data Exchange Interface Standard tries to solve is to be able to keep the information that usually is lost among different simulation steps during a process. Using different software products, the user becomes unable to ensure that all needed information flows from the previous step to the next. In most cases, the user must run several checks to ensure not only that all the required data are transferred to the next simulation step, but also that these data are written in the correct format, in the same units. Considering the variety of the different software used during a process and the different data needed in each step, we can get a feeling about the complexity caused.

By adding a variety of different models, use of models in different positions, and the use of different unit systems, the complexity will increase even more.

The usage of a standard format will help to overcome such problems and reduce the required time and cost of running a simulation.

2. Mapping results

Responding to this challenge and focusing on supporting users to overcome all these obstacles, the ANSA Results Mapper has been further enhanced.

Using the ANSA Results Mapper the user can map several different formats, resulting from a previous simulation, on an existing target model.

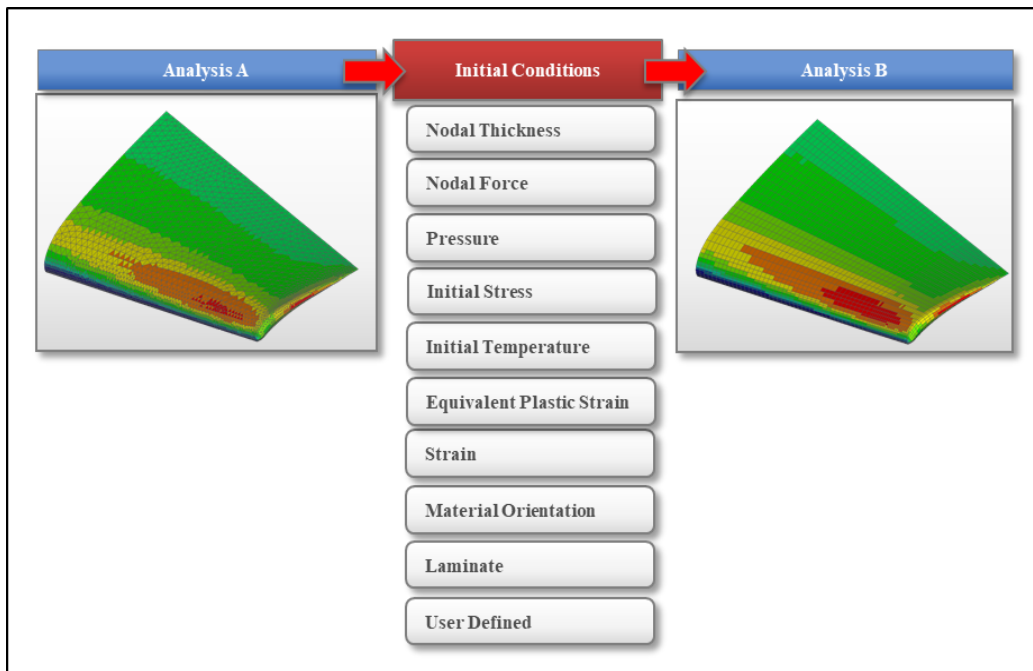


Figure 1: Available Mapping Results in ANSA Results Mapper.

The functionality provided offers the user the opportunity to preview the source file.

In this way, the user can investigate the properness of the source file for the model and obtain information about the results extracted from this source file.

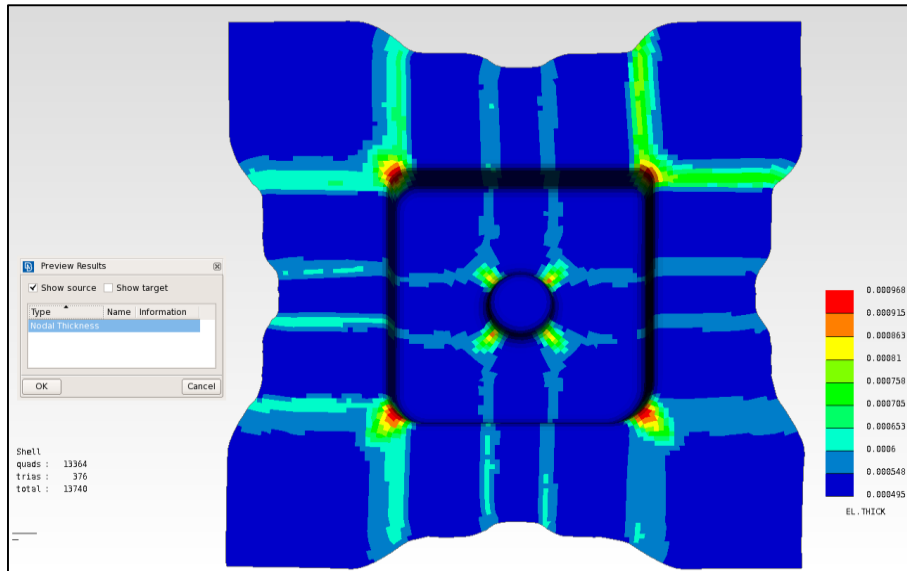


Figure 2: Preview of the source model and the available results

Even in the case that the source and the target files are not aligned on one another, the user can move and place the source file in a new location. In this way, the mapping procedure is performed avoiding any problem. During this procedure, Vector/tensor results are also transformed.

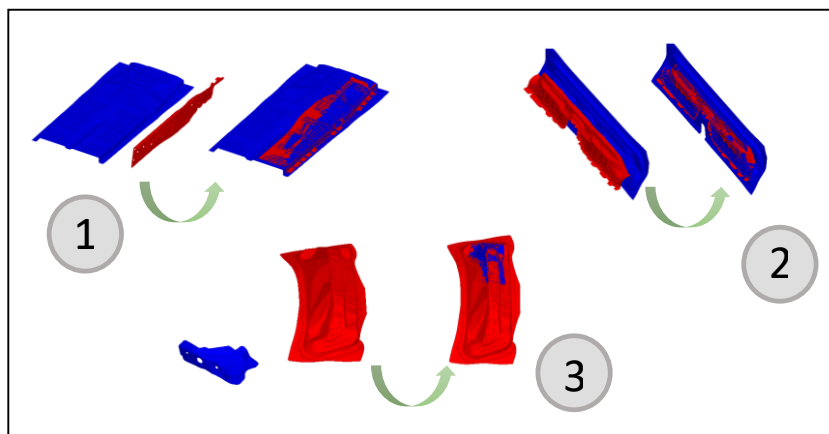


Figure 3: Different cases for automatically aligning source and target model

In this case the new transformation matrix of the source file is re-calculated. The user can also position the source file manually or insert the proper transformation matrix.

T ₁₁	T ₁₂	T ₁₃	T ₁₄
-0.9999959668739297	0.0026218740806367544	0.0033475132914815957	0
T ₂₁	T ₂₂	T ₂₃	T ₂₄
0.0026216542927103813	0.9999957714822937	0.0006706154386333374	0
T ₃₁	T ₃₂	T ₃₃	T ₃₄
0.0003365053902686672	0.0006698234196224062	-0.9999992992978433	0
T ₄₁	T ₄₂	T ₄₃	T ₄₄
-0.010100898820950836	-0.021710700255552034	0.0017906415862290817	1

Reset Matrix Manual Position

Figure 4: Transformation Matrix is re-calculated

In case the source and the target model do not share the same units, the "Result Mapper" can convert the units to produce a reasonable result.

Map Results

Name: Default Results Mapper status: [dropdown]

Options Validation Align Mesh User Script Units Stamping

Source

Length meter [dropdown]
Mass kilogram [dropdown]
Time second [dropdown]
Temperature kelvin [dropdown]

Target

Length millimeter [dropdown]
Mass gram [dropdown]
Time millisecond [dropdown]
Temperature kelvin [dropdown]

Figure 5: Convert Units

The user can get an overview of the results and decide to rely on them or not.

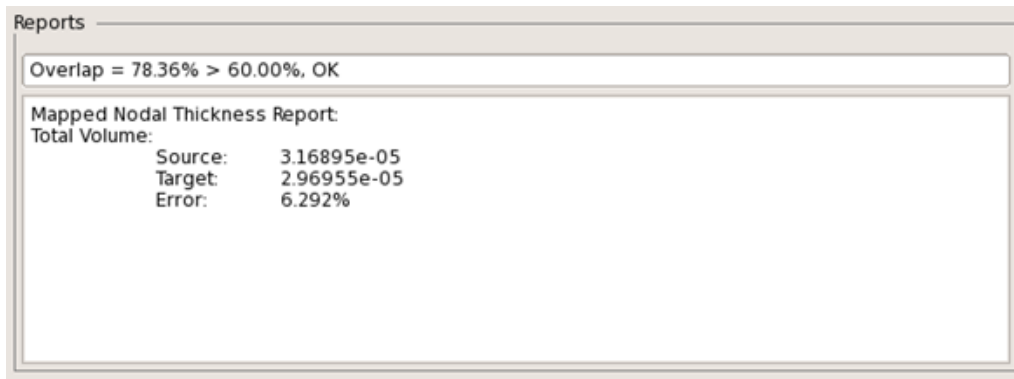


Figure 6: Validate Mapping Results

Furthermore, it has been decided that the VMAP standard will use the *.erhf5 format. Results of a simulation will be passed to the next simulation using this format.

ANSA Results Mapper has been upgraded to read the VMAP standard format (*.erhf5) and map any data stored in this file to the current model. All the available options mentioned above can be used in this case as well, to ensure an error-free/easy/smoothly process execution.

3. Using ANSA Results Mapping to map information coming from the ITEA-VMAP Material Data Exchange Interface Standard

The enhancements made to the Mapping Results ANSA to support the ITEA-VMAP Material Data Interface Template, using specific example files, are presented below. The example files were drafted during the ITEA-VMAP project to test and validate the New Material Standard format.

The first case is an example based on a Blow Forming simulation for a plastic bottle. A typical Blow Forming simulation consists of the following steps:

1. Blow molding simulation, in which actually the main material is molded.
2. Cooling simulation, in which the main part is cooled down
3. Shrinkage and warpage simulation in which the final residual strain and stresses are calculated.

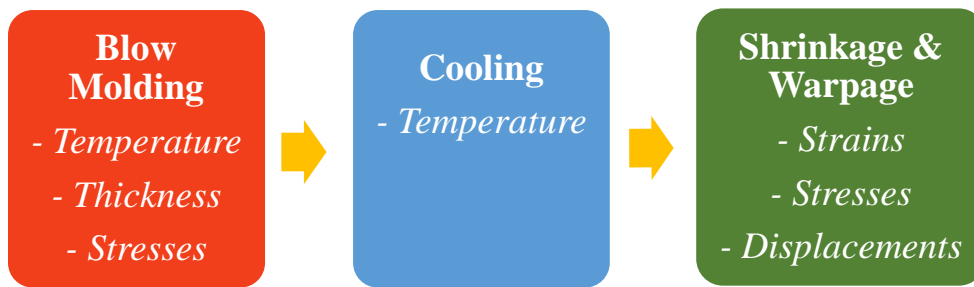


Figure 7: Blow Forming Simulation

After each simulation step, different output data (like temperature, thickness, principle strains) will be mapped on the FE-Model to be used as initial conditions for the next simulation step.

The first step of the process delivers the Nodal Thickness of the Model in the current VMAP format which we then map it on our current model.

Before applying the mapping, using the preview option of Results Map we can easily identify the position of the source and target model, as well as the available results in the source file.

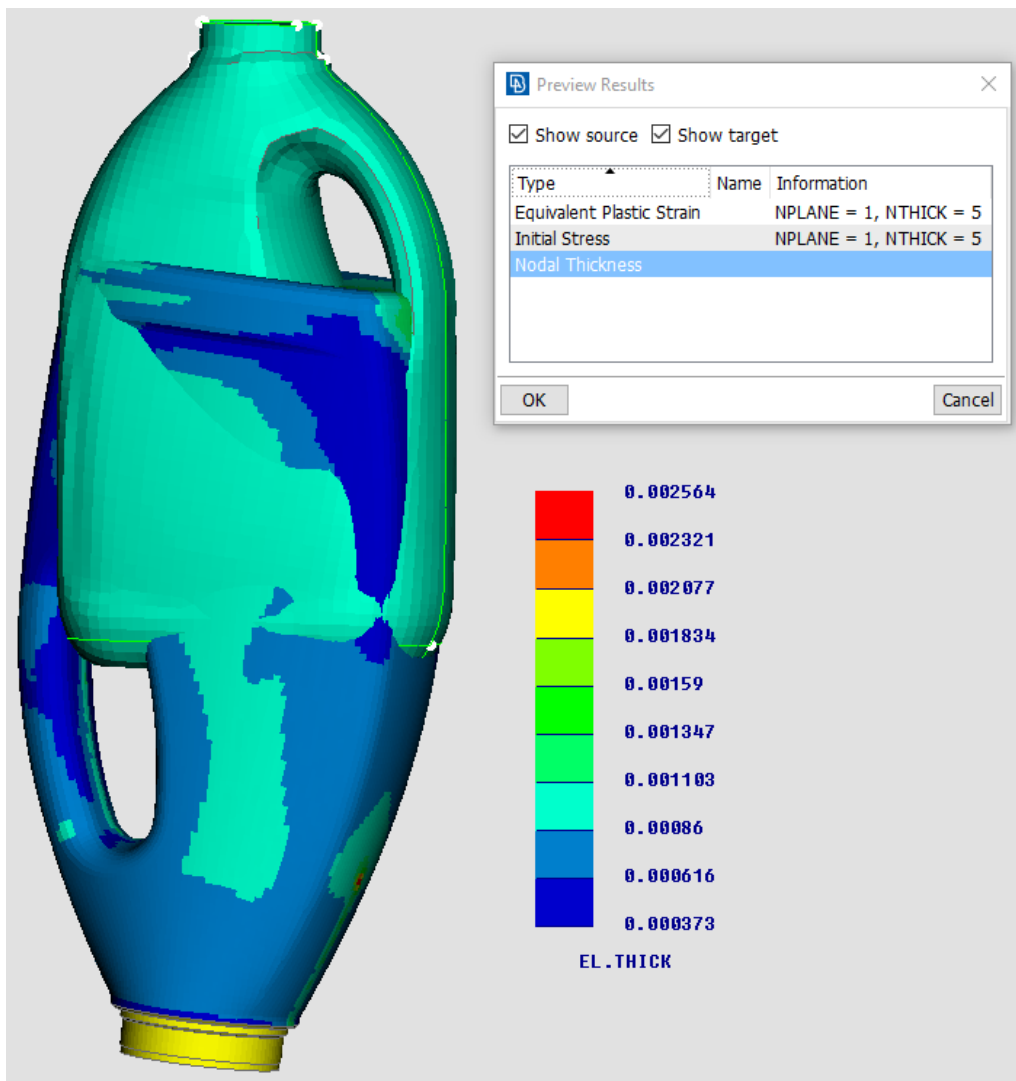


Figure 8: Preview of target and source file (courtesy of Dr. Reinold Hagen Stiftung)

The source and target model can be automatically aligned to map the desired results on our model.

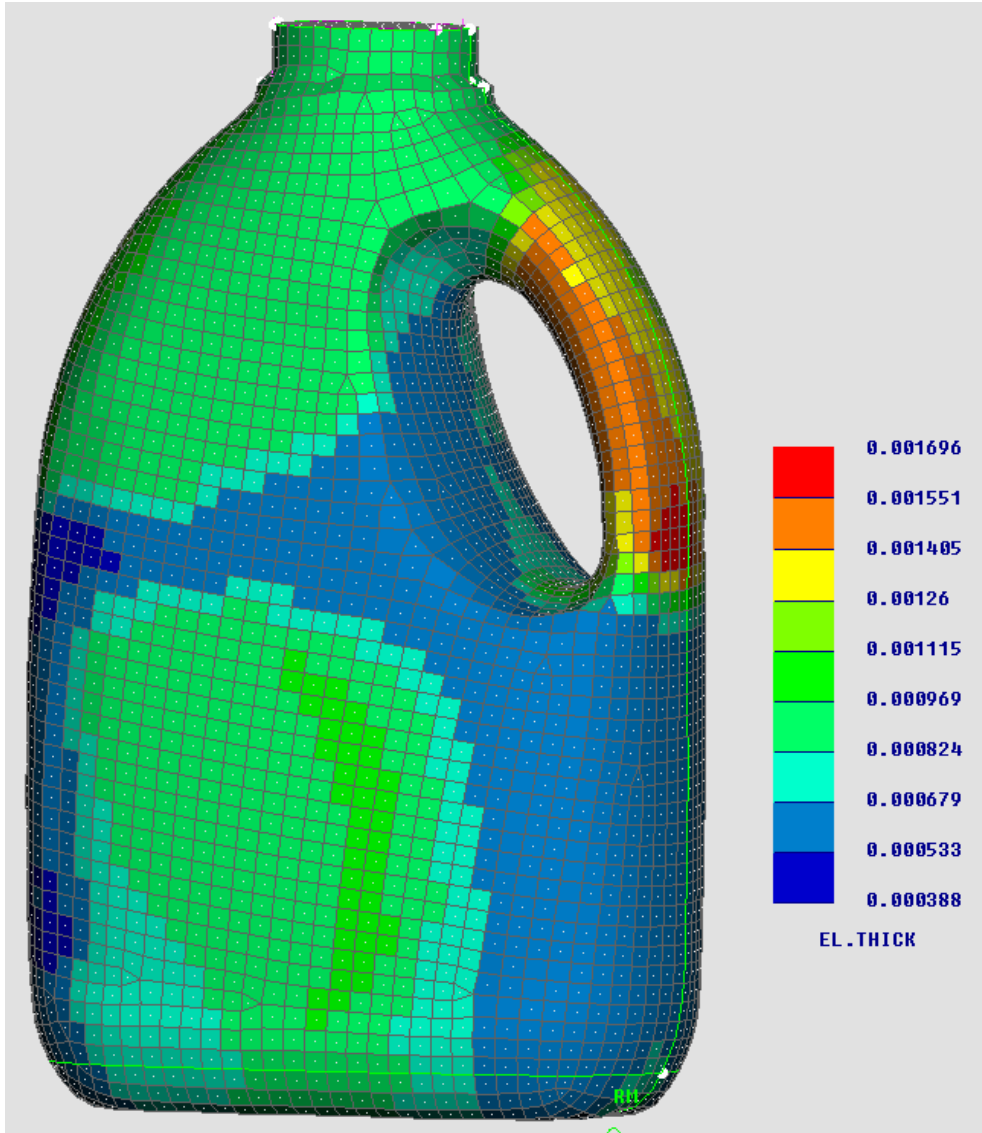


Figure 9: Target model after mapping the nodal thickness

The second case is an example based on the creation of composites parts for lightweight vehicles. A typical procedure consists of the following steps:

1. Draping: forming the 2-D fabric into the 3-D geometry
2. Molding: infiltration of the dry-formed fabric with resin
3. Cooling

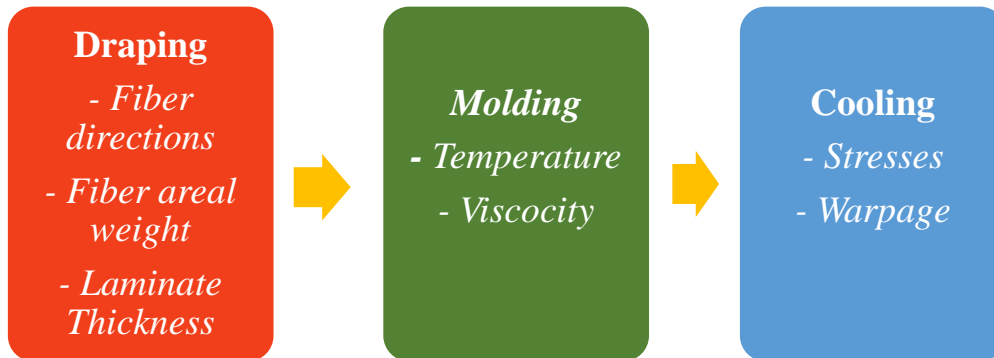


Figure 10: Typical Resin Transfer Molding (RTM) simulation

Resin Transfer Molding (RTM) is an established technology to produce complexly shaped composite parts.

After each simulation step, different output data (like temperature, laminate thickness, fiber orientations) will be mapped on the FE-Model to be used as initial conditions for the next simulation step.

In this use case we will read the Laminate Properties and the additional fiber directions of each layer for each element resulting from the first simulation of the described process. This information will be mapped to continue the process.

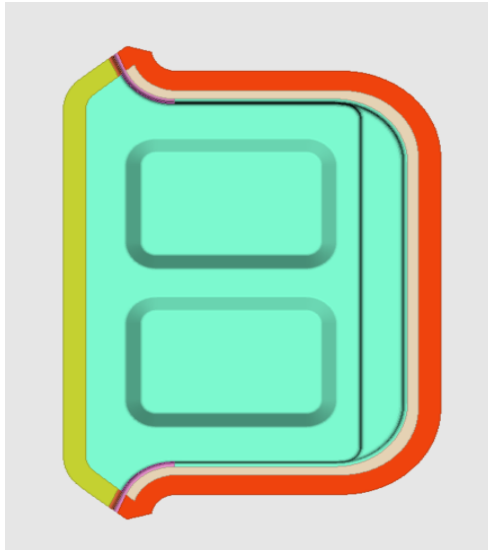


Figure 11: Initial Model (courtesy of AUDI AG & Karlsruhe Institute of Technology)

The information provided in the VMAP file is applied on a specific area of the model. More specifically the resulted laminate property holds the information regarding the existing number of layers with their thicknesses and orientation (Figure 12).

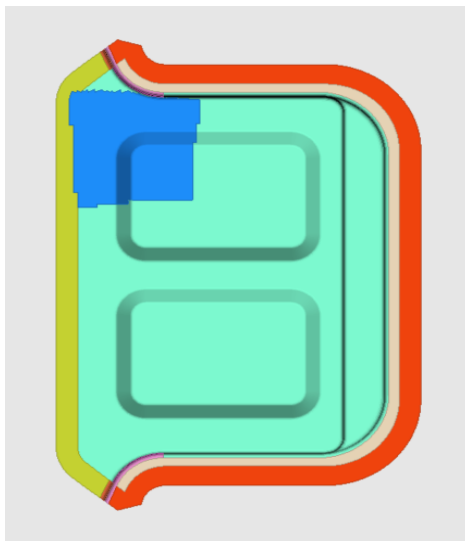


Figure 12: Current Model after mapping the Laminate Information (courtesy of AUDI AG & Karlsruhe Institute of Technology)

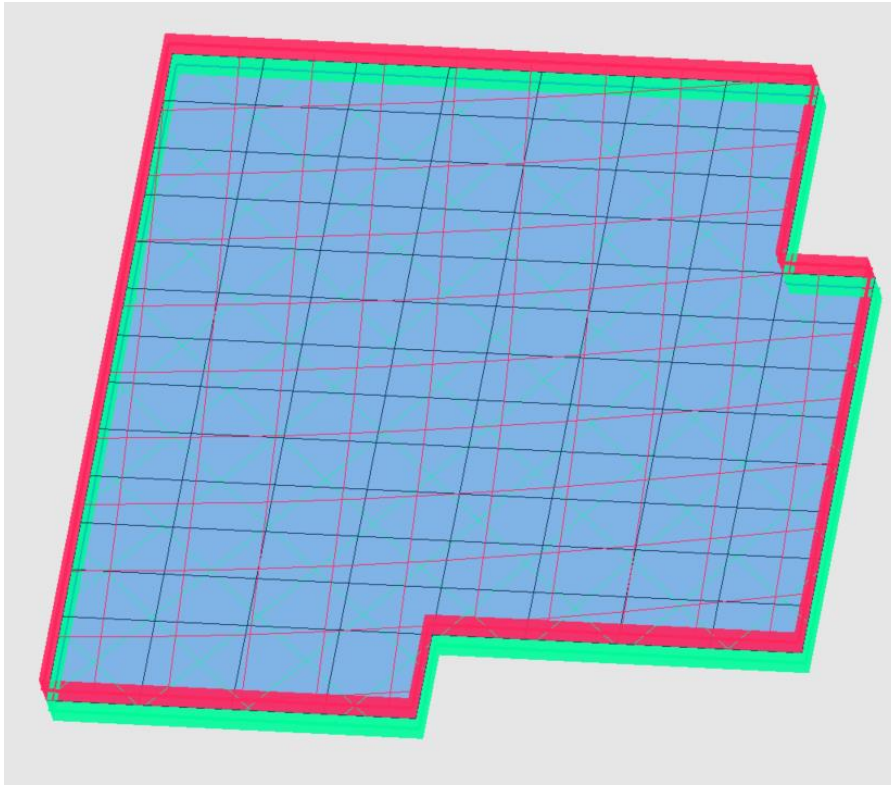


Figure 13: *Laminate Property created from the Results Mapping tool*

4. Conclusions

The development of a new "Material Data Exchange Interface Standard" is considered mandatory. This standard format will hold all the needed information for each step of the process. Thus, in each step, we need to extract only the needed information and apply it to the current status/model.

Furthermore, we must keep in mind that the format is dynamic. That means that new information can be added in the future. This way, the tool that grabs the needed information and maps it into the current model must be flexible, so that it can easily be enhanced with the new options.

BETA CAE Systems responds to that challenge by implementing the new standard format in the existing processes and enhancing the Results Mapper in a way that can not only read this new format but also take advantage of all the functionality that was already available in the tool.

Implementing the new standard in the existing process implies the communication of the pre-processor with any solver participating in the process. The interoperability among the different solvers that ANSA offers, serves this scope in the best way.