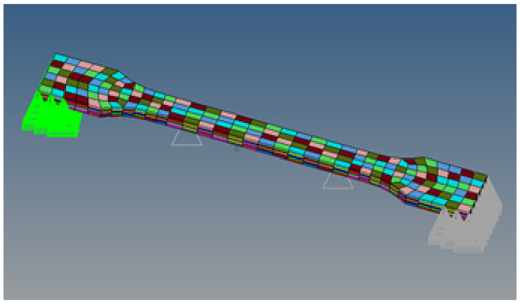
From Manufacturing to Design Validation

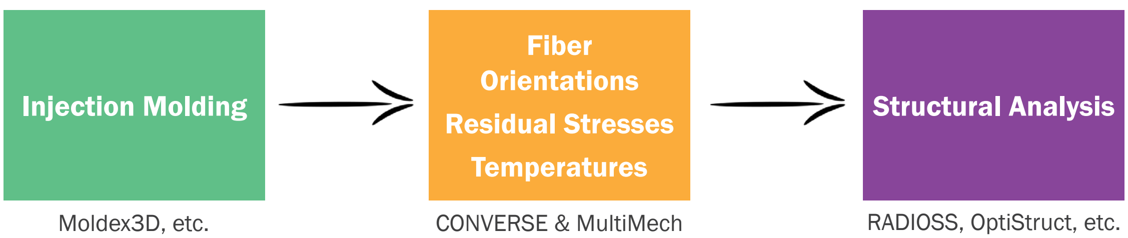
In the previous newsletter, we introduced the topic of injection molding process simulation and the influence of the manufacturing process on structural analysis. The strength and stiffness of a part can be inaccurately represented if the manufacturing process conditions are not properly considered. This results in a different calculation of system natural frequencies or improper estimation of the energy absorbing characteristics.



We continue on this topic, extending the scope to advanced technologies available in the Altair Partner Alliance (APA) to help solve the problem of proper design validation with fiber reinforced plastics. The anisotropy is captured by mapping fiber orientations to solver material cards from Moldex3D as previously mentioned. However, the mesh used for injection molding simulation is most of the time different than that which is used in a structural analysis. In addition, even if the constituent properties (fiber and matrix) are linear, the overall composite behavior can have a nonlinear behavior. Not only do the fiber orientations introduce a directional effect, the residual stresses, temperature profiles and part geometric distortion (like shrinkage or warpage) induced during the manufacturing process have a significant role in the part performance. Depending on the application, strain rate effects may also need to be captured.

To address these needs, multiple partner technologies from the APA are available to the user - CONVERSE (PART Engineering) and MultiMech (MultiMechanics). Each product technology offers nice capabilities to bridge the connection between manufacturing and design validation through structural analysis. A couple of case studies available under the partner resource library highlight the main workflows and the impact of considering the manufacturing process conditions to structural analysis such as customer Valeo using CONVERSE which shows the difference in natural frequencies.

The basic flowchart shown below explains the concept of transferring information from injection molding to structural analysis using tools in the APA. Users can refer to individual product's documentation to learn about support for various solvers and different mapping options available.



The mapping can happen as a straight solver material card or a user material subroutine that plugs into the structural solvers. What this exercise will demonstrate is that by considering the injection molding process and obtaining the material properties that are orthotropic or anisotropic, the structural response will be different from the conventional isotropic modeling. Whether the results are accurate or not requires further investigation and comparison with experimental procedures. The differences can arise due to various factors like reliable and repeatable test measurements, the extent of correctly modeling the process parameters for injection molding, or the options used in transferring that information to a structural solver. Variations in different manufacturing process conditions for the same part geometry can introduce different characteristics. In many structural engineering departments, the assumptions made for the manufacturing process simulation are not always known to be captured in the structural analysis. This situation is also true with OEMs & suppliers, where the supplier provides the final design, but maybe not all information necessary for a full system simulation. However, the outlined methodology encourages cross disciplinary teams or OEMs and suppliers to work together in being aware of different factors that influence the performance and ask the right questions upfront.

You can find some additional documents on the partner resource library that may be helpful (member access required).
CONVERSE and OptiStruct tutorial

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