

EARLY FIBER DEPOSIT SIMULATION CAPABILITIES FOR DESIGNERS TO REDUCE COST AND PRODUCTION TIME

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SUMMARY: Articulate the value of providing the designer early manufacturing digital simulation capabilities. These simulation capabilities allow the design engineer the ability to access the “as built” definition of the high performance, advanced Composites parts very early in the design process. Optimally the manufacturing simulation is completed prior to programming the machine and incorporating upstream or downstream processes including Analysis. This simulation enables an early anticipation of the manufacturing problems at the design stage, better control of the manufacturing process, while ensuring a better compliancy between the real Shop Floor part and the virtually designed one. During the early design stage the designer has the ability to certify the “as built” definition of the component with the analysis directly in the manufacturing context. Finally, this paper will also include ways the designer can utilize the new design standards, such as tailored fiber direction, that the new manufacturing fiber deposit capacities now make possible.

KEYWORDS: 3D design, Resin Transfer Molding (RTM), 3D manufacturing, flow simulation, optimization, Computer Aided Design (CAD), hand lay-up

INTRODUCTION

Using the CATIA Composites Design Workbench (CPD) provides a dedicated infrastructure enabling the designer to capture and manage the complete “as built” definition of the composite component very early in the design process. The simulation of fiber deposit strategies provides the required infrastructure to enable the designer to specify the target manufacturing process very early in the design stage and better control the manufacturing operations.

Infrastructure to plug early fiber deposit simulation tools inside the V5 design environment, that give the designer the ability to predict how the actual fibers will be deposited in the mold, and thus anticipate potential fiber deposit problems. This ensures that the virtual component and the physical part are consistent, avoiding late iteration, trial and error on the Shop Floor, thus reducing cost and production time.

PART DESIGN IN MANUFACTURING CONTEXT

Designing in manufacturing context provides the designer with early manufacturing simulation capabilities that simulate the “as built” definition of the component early in the process. This is optimally done prior to programming the machine and incorporates all upstream and down processes involved in the manufacturing process.

The early anticipation of the manufacturing problems at the design stage gives the engineer better control of the manufacturing process. It also ensures compliancy between the Shop Floor and the virtually designed one. The designer has the ability to certify the “as built” definition of the component with the analysis very early in the design process. Finally, this opens the designer to new standards (tailored fiber direction) that the new manufacturing fiber deposits make possible.

Several manufacturing stages can be considered early in the process:

- Fiber deposit, for hand lay-up, tape laying or fiber placement
- Resin injection
- Curing

Fiber Deposit

For Hand Lay-up, design features include Material Excess, 3D Multi-Splice and Darts complemented by Simulayt’s AFM and ESI Group’s PAM-Quickform. These solutions along with the native V5 CPD fiber simulation, support lay-up strategies such as local seed point, seed curve or order of drape. The first release of PAM-Quickform was announced in February 2007. The simulation is capable of predicting the deformation of component parts.

For Tape Laying and Fiber Placement, the angle cut feature manages the minimum Tape Length constraint. Specific Fiber Simulation options are also available with enhanced fiber deposit strategies (guide curve or sectors) and propagation modes (parallel, fixed angle, helix, etc...).

Resin Injection

In the case of dry fibers, an additional step must be used to add the Resin. To support Resin Transfer Molding requirements and variants like VARTM or VARI, specific resin parameters such as resin viscosity for instance, are supported in the materials definition. The rest of the Design phase relies on the same features as for Hand Lay-up. The simulation phase in CATIA V5 relies on the PAM-RTM solution provided by ESI-Group [1]. PAM-RTM simulates the resin injection process in Resin Transfer Molding (RTM).

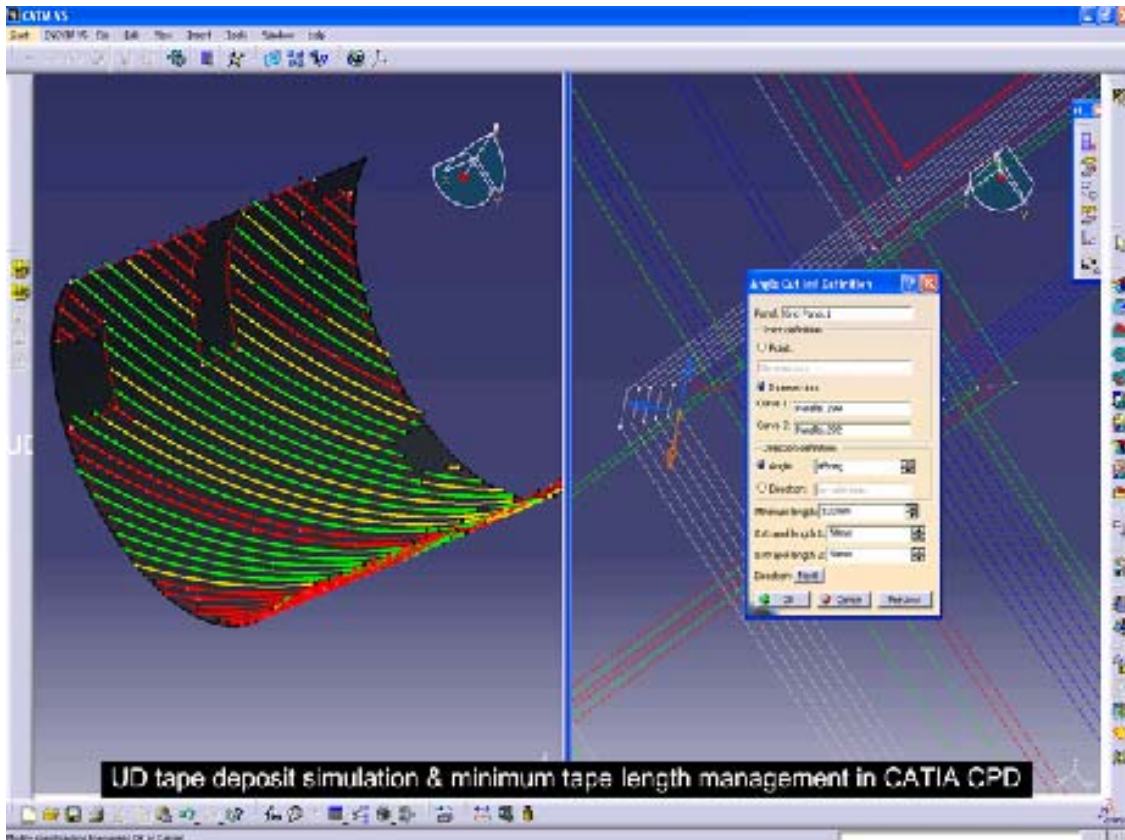


Fig. 1 Unidirectional tape deposit & minimum tape length.

There are benefits of using an embedded RTM solution in CATIA. For example, the RTM model is linked to the CATIA model and automatically updates when you change the mesh and geometry. Boundary conditions are applied on geometrical entities like surfaces and edges, and not directly on the mesh.

Curing

A dedicated skin swapping feature can be used to transfer the design from the original OML surface to the tooling surface accounting for spring back effects. Such a spring-back computation can be performed as part of curing simulations. Ply information is transferred from CPD prior to running Analysis solvers like ABAQUS, with cure-thermal-mechanical capabilities. Dedicated non-isothermal simulations can also be performed with PAM-RTM solution [1].

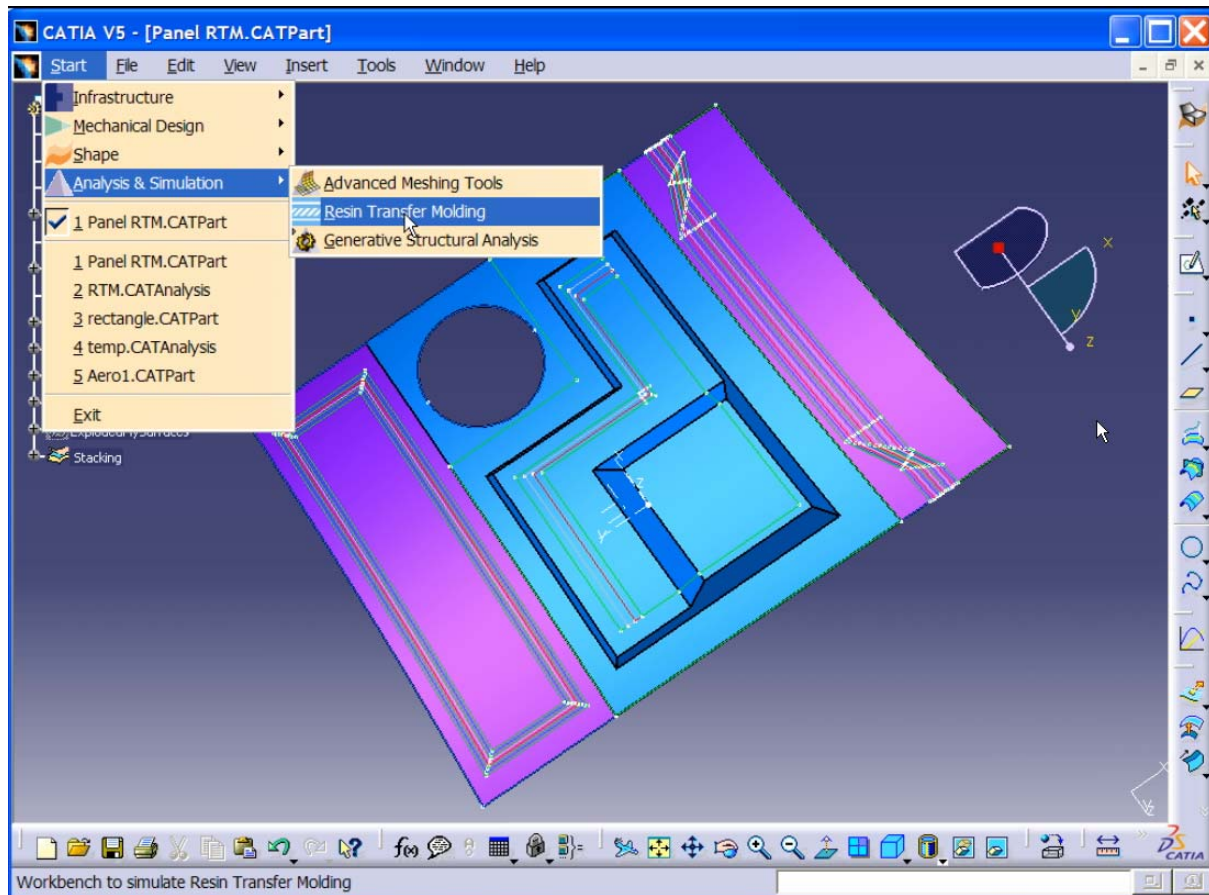


Fig. 2 PAM-RTM embedded in CATIA V5.

CONCLUSION

The premise behind creating a closed loop in the design, simulation and manufacturing process is the goal all Composite designers and manufacturers should strive to achieve. One can expect an overall gain of 30% when using the integrated approach to develop complex composites compared to the traditional non integrated approach. This can be accomplished by ensuring the virtual component and the physical part are consistent, avoiding late iteration, trial and error process, and finally reducing cost and production time.

Both the design and manufacturing processes are so complex that design engineers alone can not consider all the implications their decisions will have on manufacturing processes. By ensuring that manufacturing engineers help in the design process reduces the investment and time required. At the same time, part quality and production efficiency is improved. These practices can bring benefits for projects of all sizes.

The Composite Part Design workbench of Dassault Systèmes along with industry leaders provide unique capabilities for the designer to work in a functional context, get accurate feedback from simulation and manufacturing, and even anticipate and avoid problems early in the process.

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