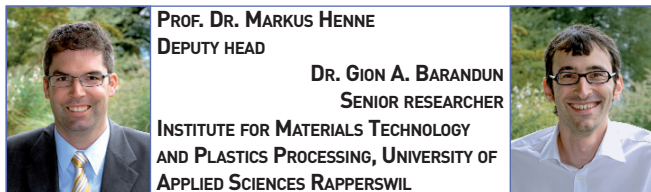


# myRTM, a new tool for RTM process design

The Institute for Materials Technology and Plastics Processing (IWK) has developed a user-friendly software program to simulate RTM processes. Thanks to a new approach based on cellular automats, fast and reliable process design is just a few clicks away. myRTM is free and available for immediate download.



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**R**esin Transfer Moulding (RTM) is a manufacturing technique for high-quality fibre reinforced composites. Figure 1 shows a schematic diagram of the process sequence. First, a textile with a thermoplastic binder is softened by infrared heating. This soft mat is transferred rapidly to a forming tool that is closed and cooled. A mechanically-stable preform is then ejected. Alternatively, other textile processes such as sewing, knitting or stitching may be applied to preform the textile structure. After any necessary trimming, the preform is placed in the heated RTM tool for the actual injection process, where a liquid thermosetting resin is injected into the dry perform. The mould cavity fills and the resin system undergoes chemical curing. When the part has become strong enough, it can be de-moulded and tempered. Following any necessary finishing steps, the component is ready for use.

- The main advantages of resin transfer moulding are:
- Highly integrated and complex design which results in a lower number of pieces and reduced assembly cost;
  - Multi-material solutions may be produced by incorporation of metallic parts (inserts);
  - Low-investment production facilities;
  - Uncomplicated material handling (reinforcing fibres & resin systems).

As the air transport industry is under increasing pressure to cut costs, the costly material logistics for prepregs and the high investment cost of autoclaves favour substituting the simpler RTM technology – with almost equal product quality.

RTM processes are closed processes, i.e. during injection, the mould cavity is open only to the vacuum vent and the inlet where liquid resin mix is flowing in. For this reason, it is difficult to follow the mould filling process or to control it in any way. At best, sensors can deliver a signal at the instant the filling front reaches them. Suitable process control is decisive in ensuring process repeatability and the quality of the finished component. If either the injection points or

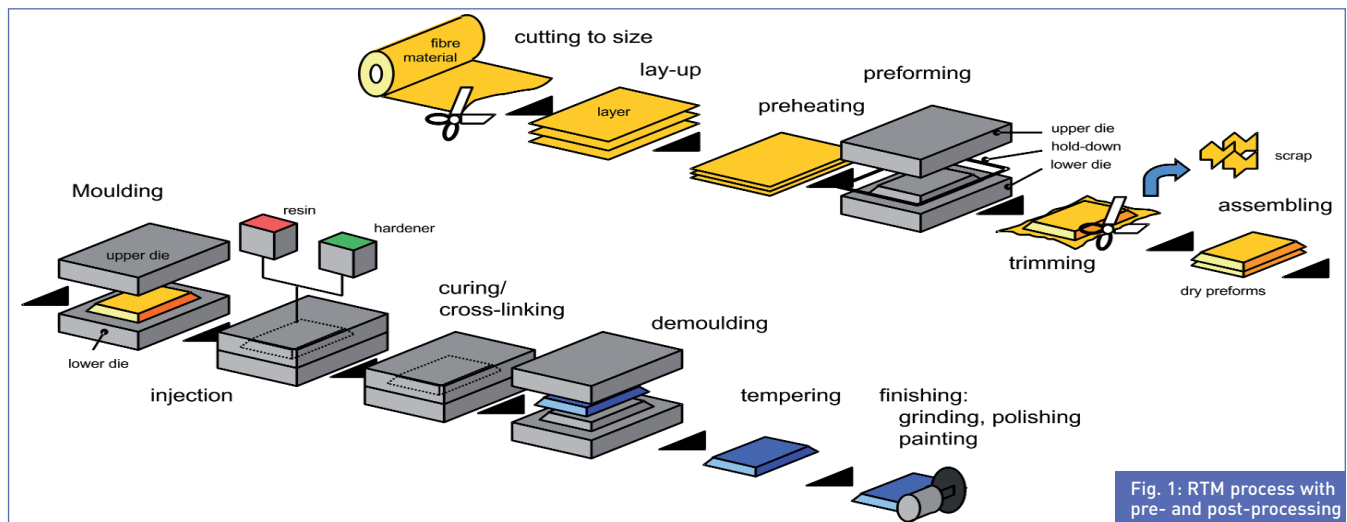


Fig. 1: RTM process with pre- and post-processing

the mould evacuation points are incorrectly chosen, then air pockets may appear, impairing product quality. Apart from this, the process should be laid out so as to achieve the shortest possible cycle time and hence the highest productivity. Process simulations based on FEM allow the accurate numerical calculation of mould filling processes. In real life, liquid moulding may be influenced by many additional effects, which are hard to consider in numerical simulations. Especially, race tracking effects in areas of low porosity are dominating the propagation of the flow front. Because of these reasons, it is crucial that the software user has deep knowledge of liquid moulding processes, that will help him program a simulation process and interpret the results. Additionally, many features of commercial software, such as thermal simulation and cure kinetics, may have negligible influence on most infusion processes and are therefore not useful. For these reasons, process simulation is seldom used in practice. In particular, process simulation is not applied in small- and medium-sized enterprises because of the high software licensing costs, missing material data and the fact that engineers lack the necessary knowledge to apply simulation tools. On top of all this, the algorithms currently available for efficient iterative optimisation of the process require too much computing power. Depending on the number of elements and the geometrical complexity of the component, a single run can take from a few minutes to several hours. Consequently, an optimisation that may require several hundreds to some thousands of iterations is time-consuming and may prove unfeasible due to limited computing capacity.

### + More information

Further details, including a user tutorial and download of the myRTM software, are available on the website [www.myrtm.ch](http://www.myrtm.ch)

### Cellular automats

myRTM takes a new approach to the simulation of resin injection processes, which is based on the concept of cellular automats. Numerical simulations using cellular automats are easy to implement and generally require fewer calculations. Therefore, they can substantially reduce the computing time required. In developing the package, the least frequently used features of the commercially available software were consciously set aside, priority being given to user-friendliness in general and clarity of visualising the process in particular. The digitised description of the component is imported directly from a CAD system or via finite-element (FE) software. Basic validation of the nodes – to ensure a more or less even distribution – is done in the pre-processing routine. Additionally, gates, injection pressure and permeability distribution are applied.

Resin viscosity and vacuum pressure should be provided before starting the simulation. In fact, this is the only data needed by myRTM. With just a few clicks of the mouse, myRTM displays the injection process (Figure 2).

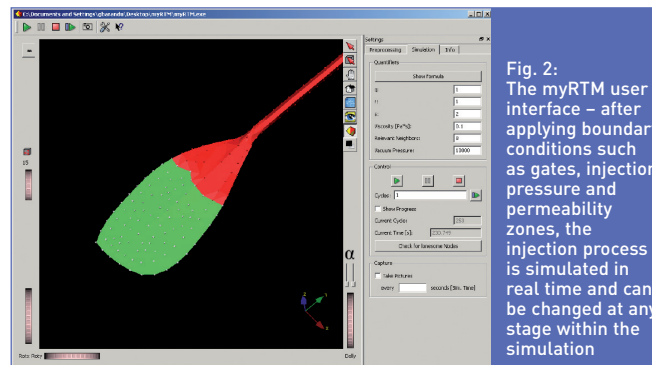


Fig. 2: The myRTM user interface – after applying boundary conditions such as gates, injection pressure and permeability zones, the injection process is simulated in real time and can be changed at any stage within the simulation

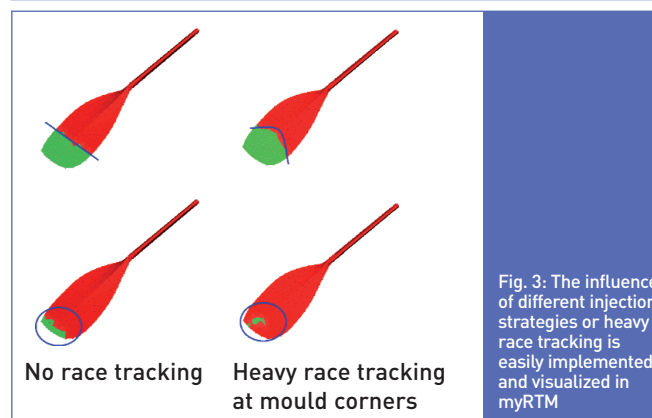


Fig. 3: The influence of different injection strategies or heavy race tracking is easily implemented and visualized in myRTM

The areas of different permeability in the fibre reinforcement can be modified during the simulation. Additional gates may be added at any point in time to implement concepts such as cascade injection. The injection pressure can be altered and the effect of race tracking observed, considering different injection strategies. Such features make it possible to obtain the highest possible reliability for a RTM process. Fig. 3 shows a case study for a whitewater paddle, where the influence of race tracking is visualised.

The input parameters from simulation are then transferred to the manufacturing process. In the case of the whitewater paddle, a two-point cascade injection strategy using gates at the top of the shaft and at the root of the blade is implemented. Thanks to the preliminary process design with myRTM, the paddle is produced without any dry spots in a very efficient and reliable injection process (Figure 4).



Fig. 4: Comparison of experimental and numerical tensile curves in the warp direction

More information: [www.myrtm.ch](http://www.myrtm.ch)