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SHOW SPECIAL

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K2013 - WHAT'S AT THE SHOW

Make the most of simulation

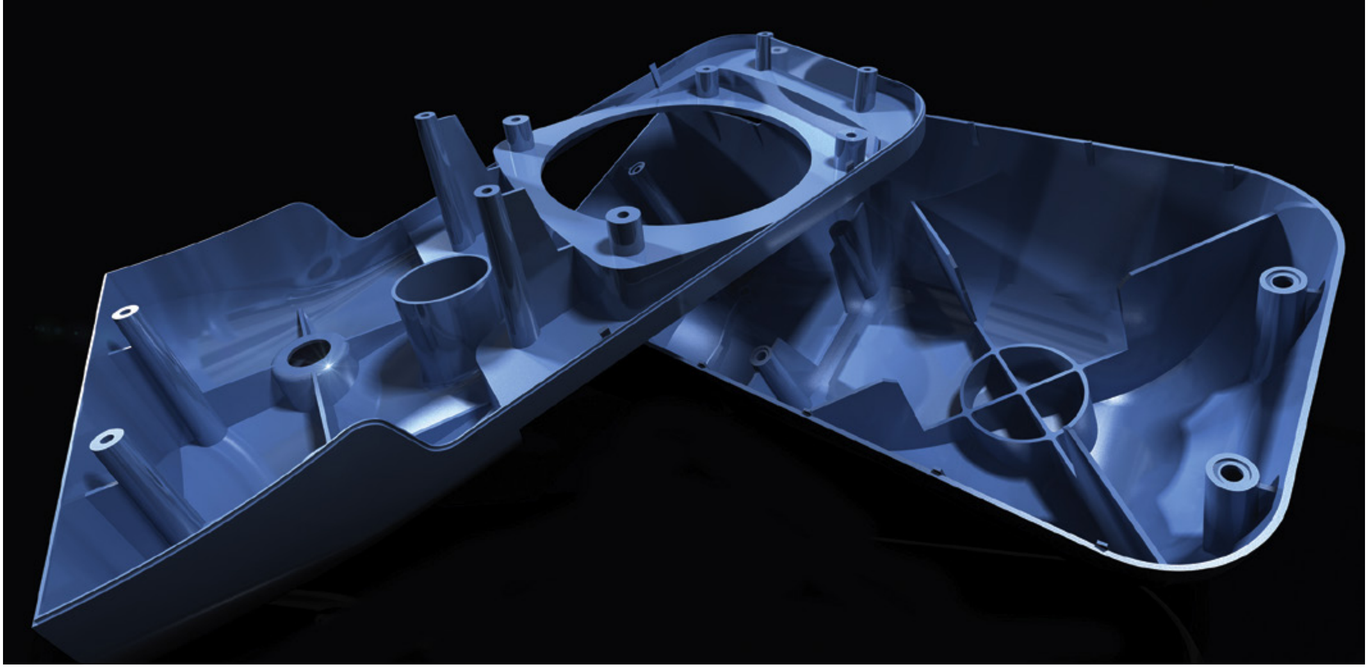

IMAGE: AUTODESK

Computer-based fill simulation is an invaluable design tool but is too often left out of the DFM process, writes André Eichhorn

Flow simulation tools such as MoldFlow, CADflow, Moldex3D and the like are simple to use and provide increasingly accurate predictions. Unfortunately, it is a fact that flow studies are not performed on every new component design during the DFM phase. Too often, an analysis will only be performed on a component once it is in production and causing issues. Flow analysis can then only confirm problem areas.

Performing a flow analysis during the DFM process means it is possible to change problem areas, saving a significant amount of money that would otherwise be spent on people traveling around and mould tools being modified. Figure 1 shows how precise flow analysis can be by comparing the filling pattern from a flow study with a physical short shot study from the final mould tool.

And a flow study should not only be used during DFM for troubleshooting - the final component design should be analysed again purely to ensure all final data is on hand to setup the basic process parameters on the injection moulding machine. For example, a very important aspect for the toolmaker is to ensure venting requirements are incorporated into the tool design. This will save a great deal of hassle by avoiding short shots and burn marks on complex components.

Incorporating a flow study into the DFM process means information can be provided to the toolmaker as a part of the Tool Specification Sheet, which also contains other tool and component design-related data for the tool designer. One AST Technology client found that specifying a flow study for every component requiring new tooling enabled it to reduce its trouble-shooting costs for problem tools in production by 70% (including costs for travel, resources, tool and component changes).

A flow study can reveal a huge amount of data. Here we examine the main areas that can be analysed and the benefits that can be realised:

Gating and material selection

Once a component design is meshed and prepared for the analysis it is possible to test several gating solutions and evaluate moulding materials. This can be done without additional effort as long as the component geometry does not change (otherwise a new mesh needs to be created). Most flow analysis applications also provide the opportunity to design the anticipated coldrunner layout; it is always good practice to include the coldrunner geometry in the analysis as some performance loss will result from it.

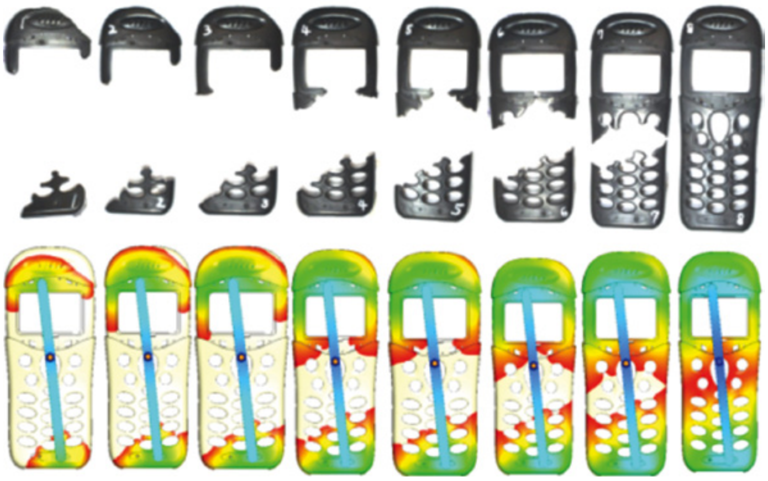

Figure 1: A benchmark study showing short shots against the filling pattern obtained from a flow analysis

Filling, injection time and venting

This will provide a good overview of how the part will be filled in each area and how the melt front performs with regards to hesitation, weld lines and gas traps. The fill time can also be calculated, which has a direct impact on the cavity filling pressure and material shear rates.

Filling pressure and clamp force

In this area the prediction of filling pressure - and from this the required clamp force - can be calculated. This is extremely useful to determine the appropriate moulding machine size to make the component. It also needs to be understood that the predicted filling pressure only refers to the component geometry; additional pressure losses will be created by coldrunners, hotrunners and even the machine nozzle itself. These feed elements can very easily add another 50-70 MPa to the filling pressure determined by the flow study.

Material shear rates

High material shear is often a key cause of issues related to the mechanical properties of a component. Shear stress is a measure of the tension created between molecules within the plastic and is caused by the flow of the plastic layers relative to each other - too much stress causes the molecules to break. Each polymer material has a recommended maximum shear rate (for example, 40.000 1/s for PC). Most commonly, the highest shear is created at the gate point and is caused by the gate point being too small a diameter or the wall thickness being too thin. It is important to remember that a faster filling time not only increases the filling pressure but also any negative shear effects.

Cooling time and shrinkage

The overall cooling time of a component can be determined and this gives a good indication of the final cycle time (determined by adding in the time for injection and the mechanical movements of the mould tool). Within most flow study applications, it is also possible to incorporate the cooling channels from the mould tool design to gain a more precise prediction of the cooling time, as well as volumetric shrinkage and deflection.

The cooling time will directly affect the volumetric shrinkage, which is basically an indication of areas of high risk of sink marking. While this is a cosmetic issue, each sink mark on the component is an indication of thick areas that will require longer cooling times as well as loss in filling and packing performance.

Part deflection

Overall part deflection is most often an area of key interest and shows quite precisely how the part performs in terms of deflection on each axis. This can be used to define the overall shrinkage required while designing the tool. Part deflection is determined by a combination of all of the factors described earlier - a change in any one of them will have a direct effect on the overall deflection of the component.

If a part in production exhibits a high distortion, the normal response is to extend the cooling time to 'freeze' the distortion. This , however, creates a lot of internal stress, which will be released over time as the part undergoes post shrinkage. Any post-moulding process that exposes the part to heat will accelerate this process. As a result, it is always good practice to ensure distortion is within the specification by working on the component design rather than attempting to process around the issue.

In summary, considering how precise and fast today's flow analysis applications are, it is always worth the investment in a study for every new product. The issues highlighted and the information gained will help both the component designer and the tool maker towards the end goal of achieving a high quality moulded component, as well reducing the cost and wasted time of troubleshooting later on.

About the author:

André Eichhorn is general manager of Germany-based AST Technology. This is the latest instalment in a series of articles in which he discusses how part and moulding problems can be overcome at the start of any project by the application of Design for Manufacturing techniques. You can read the most recent articles in this series **here**, **here** and **here**.

You can also visit AST Technology at the K-Fair. Find the company in Hall 1, Stand E36.

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