SOLUTIONS FOR MOLD DESIGNERS

White Paper

Abstract

For CAE analysis tools to be truly useful, they must provide practical information that drives design decisions. Moldflow Plastics Advisers® (MPA®) solutions enable users to predict and solve injection molding manufacturing problems in the earliest stages of product development.

The Moldflow Mold Adviser module is a plastics flow simulation product for the midrange market, which allows mold designers to optimize single cavity, multi-cavity and family mold layouts, eliminate potential downstream problems and avoid costly rework and manufacturing delays. Optional add-on modules allow users to simulate more phases of the injection molding process and evaluate molded part performance and cooling circuit design.

This white paper describes the Moldflow Mold Adviser module and how its capabilities benefit mold designers.

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INTRODUCTION

Moldflow Mold Adviser software gives mold designers and mold makers the tools they need to verify part design manufacturability and quality and lay out and optimize the gate and runner systems for single-cavity, multi-cavity and family molds, as well as to predict processing requirements and quote mold jobs.

The Moldflow Mold Adviser module extends the capabilities of Moldflow Part Adviser to allow users to create and simulate plastic flow through single cavity, multi-cavity and family molds. Users can optimize gate type, size and location as well as runner layout, size and cross-sectional shape. Analysis results include cycle time, clamp tonnage, and shot size, all of which help the design-to-manufacturing team size the injection molding machine, minimize cycle times and reduce manufacturing waste.

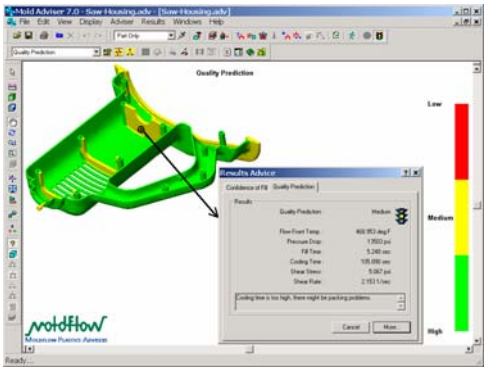
Optional Moldflow Mold Adviser add-on modules allow users to simulate more phases of the injection molding process and evaluate molded part performance and cooling circuit design.

Start with a 3D solid model of the part to be molded, then verify the basic part design manufacturability and quality before proceeding to mold-design tasks.

VERIFY PART DESIGN MANUFACTURABILITY AND QUALITY

Before mold designers begin to design a mold, they should verify that the part design meets basic manufacturability and quality requirements. This gives mold designers an opportunity to contribute their expertise even before the part design is finalized. To this effect, the Moldflow Mold Adviser module can be used in a part-only mode in which all the capabilities provided by the Moldflow Part Adviser module are available.[1]

[1] Refer to the *Solutions for Part Designers* white paper for detailed descriptions of Moldflow Part Adviser capabilities.



Use the part-only mode to review part manufacturability and quality aspects.

The part design analysis provides results that identify critical manufacturability and quality issues and recommend appropriate actions to address those issues. Thus, mold designers can verify that a part design will fill and predict the quality of the molded part. They can review potential gate locations and adjust gate locations to minimize the number of weld lines or relocate weld-lines to less-sensitive areas of the part. They can also review predicted air trap locations to determine where vents should be placed.

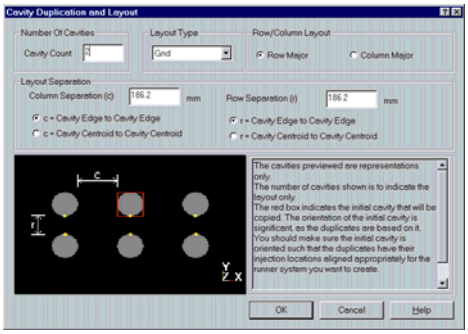
Sink Mark Analysis locates areas where sink occurs and estimates the depth of each sink. Sink marks are often associated with thick areas of a part, particularly on surfaces opposite to features such as ribs, bosses and gussets. Sink marks affect the visual quality of the part and are undesirable, especially on aesthetic surfaces. The mold designer can alert the part designer about potentially critical sink marks, and together, they can investigate design-change scenarios to eliminate them. However, in cases where part design changes are not possible, the Sink Mark Analysis becomes valuable to mold designers and process engineers to help them minimize the sink effect, for example through strategic gate placement or packing pressure application.

LAY OUT AND OPTIMIZE THE MOLD DESIGN

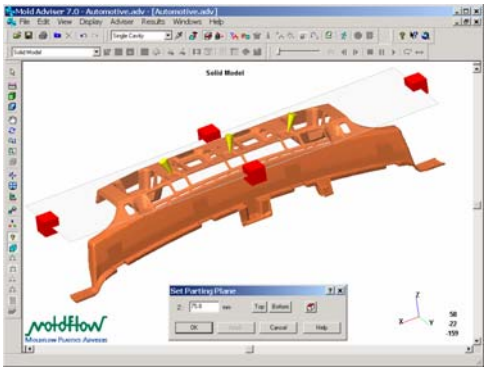
Once a part design is acceptable, the real work of the mold designer begins. The Moldflow Mold Adviser module builds on the capabilities of the Moldflow Part Adviser module to address issues specific to mold design. The Moldflow Mold Adviser module allows mold designers to lay out and optimize the gate and runner systems easily for single-cavity, multi-cavity and family molds, as well as to predict clamp tonnage, shot size and cycle time requirements, identify areas that need extra cooling, and quote mold jobs. Mold designers and tool builders can create and optimize the mold design, even while the part design is still evolving.

The number of mold cavities can be decided based on production requirements. Moldflow Mold Adviser provides tools to orient the part model within a mold cavity and lay out the specified number of mold cavities in various configurations. Typically, the part is placed in the mold cavity with all of the part details in the moving (or ejection) half of the mold.

Once a single part is oriented, mold designers can use the powerful geometry generation tools to lay out the entire mold. The first step is to indicate the number of cavities, identify the basic layout format (grid or radial or linear pattern) and specify the offset between the cavities. This will replicate the single part and create the multiple units. When the cavities have been generated, if necessary, the individual cavity orientations can be adjusted to simplify positioning the feed system to each cavity, and the parting plane can be identified.

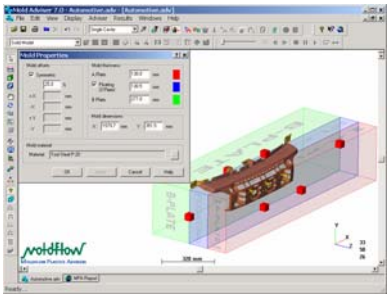


Indicate the number of cavities, identify the basic layout and specify the offset between the cavities.



Adjust the cavity orientations, and identify the parting plane.

The next step is to define the mold dimensions. The Moldflow Mold Adviser program lets designers specify a two- or three-plate mold and uses the information to estimate the minimum size of mold plates that are required. Cavities can be centered in the mold base or offset as required. Then the preferred shape and dimensions of the various components of the feed system (sprue, hot or cold runners and gates) must be indicated.

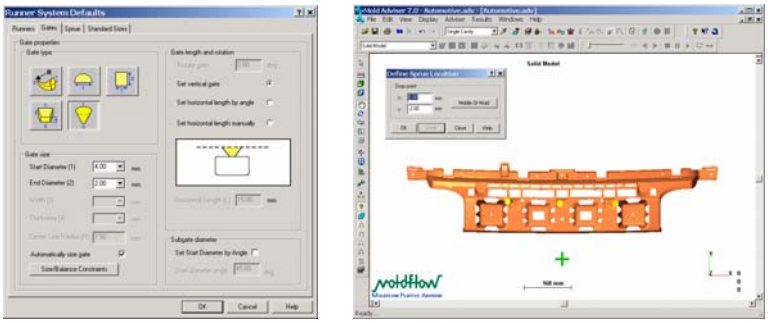


Specify the mold dimensions.

Designers can choose from a library of common runner cross sections and gate shapes. New in MPA 7.0 is the Runner System Adviser which will automatically size the Sprue, Runner and Gates. The user can mark portions of (or the entire) runner system for auto-sizing. The program calculates best dimensions for each marked segment of the runner system and automatically updates the model with these calculated dimensions. The designer can review the changes made and obtain feedback on the reason for the change in the dimensions. An optimized runner system helps to reduce scrap, improve productivity, and reduce production costs. By automating the runner system

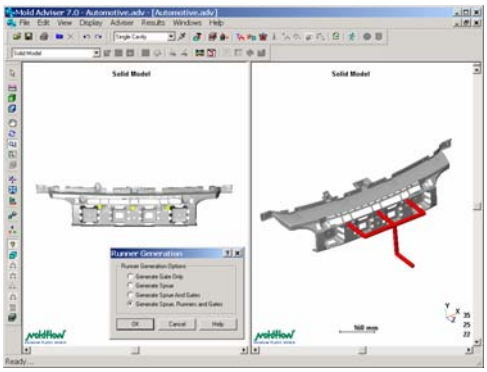
design process, mold designers will decrease the amount of time required to determine the most efficient feed system.

The next step is to indicate the sprue location, which can either be at the center of the mold base or offset. Once the sprue location is established, mold designers can choose either to allow the Moldflow Mold Adviser software to create the feed system automatically or to create all or a portion of the feed system manually.



Specify the default runner sizes and shapes, and then define the sprue location.

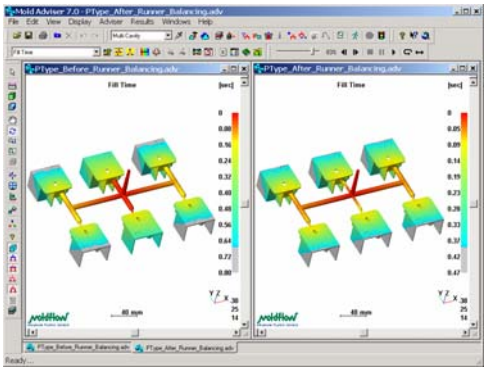
The Moldflow Mold Adviser program will attempt to design a naturally balanced feed system. In a naturally balanced feed system, all cavities fill at the same time and experience the same pressure. The benefit of such a system is that parts produced in the same cycle will have the same quality.



The program has an intelligent automatic runner layout capability.

If a naturally balanced feed system is not possible, the designer will be required to size the runners proportionally to achieve a balanced state artificially. This process, commonly referred to as runner balancing, is a major factor in mold-design optimization

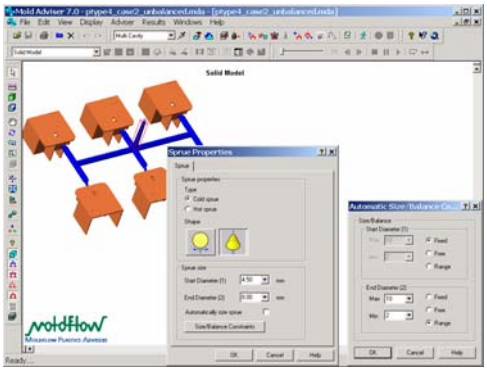
and is absolutely necessary in the case of family molds, where the cavities are of different sizes and shapes. An unbalanced feed system will produce parts of variable quality.



The balanced runner system (on the right) fills each cavity at the same time, resulting in consistent part quality.

The goal of balancing the feed system is to achieve similar filling times and pressures for all mold cavities while minimizing the amount of material used in the feed system.

With the Runner Balance Analysis provided in the Moldflow Mold Adviser software, mold designers can set up and balance tool configurations of all types, very quickly and easily. Users have the option of selecting specific runner segments for balancing, or they can set maximum and minimum limits on each segment so that they have an added measure of control.



The Runner Balance Analysis lets you specify constraints to set up an artificially balanced runner system.

Additionally, users can input their standard cutting tool sizes into the Moldflow Mold Adviser program, and the Runner Balance Analysis will automatically balance the runner system so that it can be milled in these specified sizes. Users can choose to

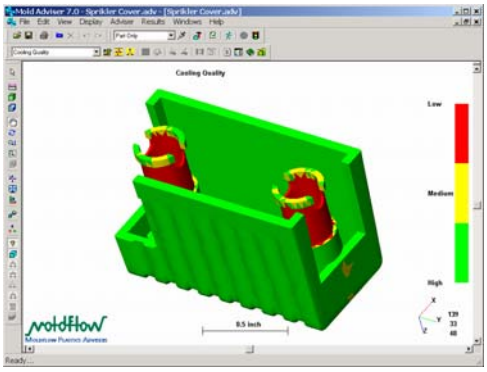
review the runner-balancing results segment by segment, or apply the results to all segments automatically.

DETERMINE MOLDING PROCESS CONDITIONS

With the Molding Window Analysis, users are given an interactive molding window in which the entire 3D space containing all acceptable process conditions is plotted. Users can interact with this space directly by clicking on various points to determine the processing parameters at a particular point, or by accepting the automatically calculated and optimized parameters and proceeding directly to a Plastic Flow Analysis.

The size of the molding window can be used to compare material grades, provide a measure of part design quality, evaluate and select gate locations, and evaluate changes to part design. The shape of the molding window can be used to determine optimal processing conditions and to evaluate the sensitivity of the cavity design to change in the molding process.

The Cooling Quality analysis produces results that show areas of heat concentration and the extent of variation in mold temperature and freeze time across a part. Mold designers can use these results to determine areas that will require more cooling, so the cooling system can be designed to achieve the most uniform cooling possible.



Mold designers can use Cooling Quality Analysis results to design more efficient cooling systems.

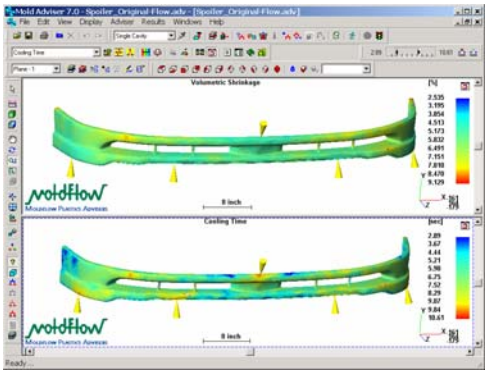
ANALYSIS EXTENSION MODULES

New in the MPA 7.0 release are two optional, add-on modules to Moldflow Mold Adviser, which allow users to simulate more phases of the injection molding process and evaluate molded part performance and cooling circuit design. These two modules are commercially available as Moldflow Performance Adviser and Moldflow Cooling Circuit Adviser.

Moldflow Performance Adviser

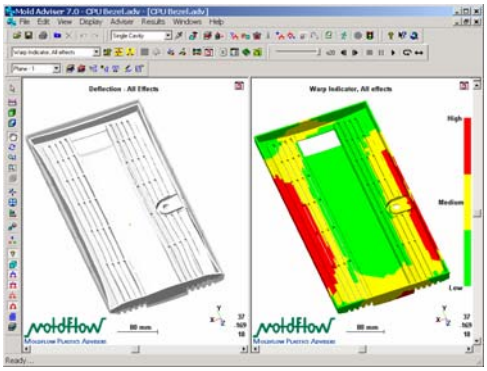
The Moldflow Performance Adviser module extends the capabilities of Moldflow Mold Adviser to simulate the packing phase of the injection molding process to predict and minimize undesirable part shrinkage as well as provide a warpage indicator that indicates if a part is likely to warp or deform beyond acceptable levels. Thus, the Moldflow Performance Adviser provides two key functionalities: a packing analysis and a warpage indicator analysis.

Packing represents the second stage of the injection molding process and holds the key to achieving the right balance between part quality, part cost and cycle time. Mold designers can set up and evaluate packing profiles to determine the optimal packing pressure and duration of packing. Through the results of the packing analysis, mold designers can identify areas of high, non-uniform volumetric shrinkage, which could contribute to part warpage, and view the distribution of cooling time to identify areas that dictate cycle time.



Moldflow Performance Adviser provides key packing phase results to minimize shrinkage variations.

The warpage indicator analysis produces a series of results the first of which is the deflected shape of the part. This plot is extremely useful in visualizing the part shrinkage and warpage. Users can also scale the deflected shape for better visualization of part deformation. Having visualized the net shape of the part, the mold designer can next evaluate specific areas of the part that need to be within specified warp level. A unique warpage indicator tool was developed specifically for this purpose.



Mold designers can visualize part deformation and evaluate if specific areas are within tolerance.

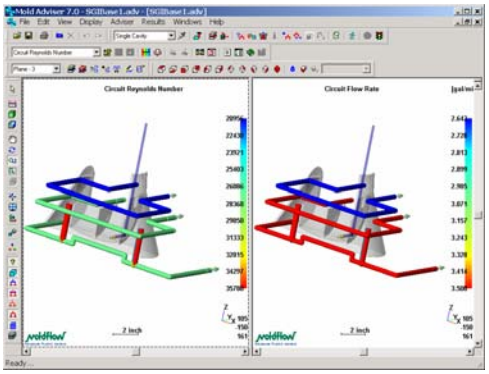
The Warpage Indicator result is a traffic-light plot (analogous to the Confidence-of-Fill plot) that highlights the areas where part warpage exceeds a user-specified, acceptable warpage level relative to a user-specified reference plane. Users can investigate further for additional information on the source of warpage and obtain recommendations to fix the problem. Users evaluate whether changes made to the part or mold design or to the material or process conditions will bring the part warpage to within acceptable levels.

Moldflow Cooling Circuit Adviser

The Moldflow Cooling Circuit Adviser module extends the capabilities of Moldflow Mold Adviser to simulate the cooling phase of the injection molding process so that users can optimize their mold designs for uniform cooling and minimum cycle times.

Mold designers can leverage several options to design their cooling circuits, including importing from a CAD system, using an

automatic wizard or using highly efficient modeling tools that are integral to Cooling Circuit Adviser. The cooling circuits can incorporate circular and semi-circular channels, hoses, baffles and bubblers. Once after the cooling circuits are laid out and cooling entrances to each circuit specified, the user can launch a cooling analysis. Analysis results such as pressure drop, Reynolds number, flow rate and coolant temperature can be used to help identify inefficient circuits, while the part surface temperature result is useful in spotting non-uniform cooling patterns which can potentially induce warpage in the part.

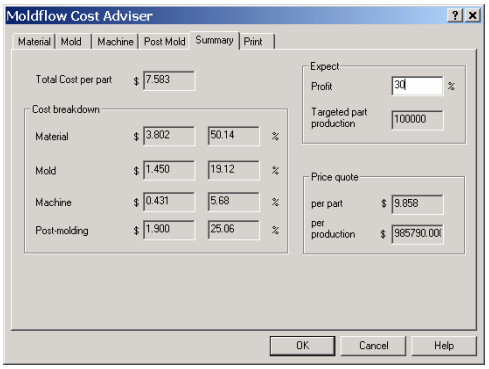


Cooling Circuit Adviser results can help identify inefficient cooling circuits.

FACILITATE DESIGN TEAM COMMUNICATION

Manufacturing plastic parts is a collaborative effort. To minimize manufacturing problems, part designers, mold designers, material suppliers, molders and others all should be involved as early and as often as possible in the design process.

Moldflow Mold Adviser features a Cost Adviser tool that helps users estimate the total job cost. The Cost Adviser in the Moldflow Mold Adviser module considers resin cost, mold manufacturing cost, molding machine operating cost, and the cost of post-molding operations. A cost summary indicates the percentage of the total cost that is associated with each of these variables.



The Cost Adviser tool helps mold designers estimate total job cost.

MPA software automatically generates Internet-ready reports to facilitate communication among all members of the design-through-production team. Using these reports enables team-driven design optimization by allowing early review and feedback about manufacturing constraints from mold designers.

ABOUT THE MOLDFLOW PLASTICS ADVISERS PRODUCT LINE

Moldflow Plastics Advisers® (MPA®) solutions bring the benefits of injection molding simulation directly to the desktops of part and mold designers, enabling users to predict and solve injection molding manufacturing problems in the earliest stages of product development. Manufacturing constraints can be considered at the same time as form, fit and function.

Test Every Part and Mold Concept

MPA products are easy to learn and use and do not require extensive training or plastics expertise. With the power of Moldflow's patented Dual Domain™ technology, users can work directly from 3D solid CAD models without the need to manually create or even view a finite-element mesh, saving hours to days to weeks of model preparation time. Plus, MPA modules are integrated with the world's leading 3D CAD systems, allowing users to work directly from within their familiar CAD environment.

Get Answers, Communicate Results

Intuitive result displays and detailed design advice help users to quickly optimize part and mold designs. An automatic, Web-

based report generator facilitates communication of results among all members of the design-to-manufacturing team. An innovative, e-mail based Connect to Consultants tool facilitates collaboration between a user and a designated plastics simulation expert to assist with results interpretation, problem troubleshooting and identifying design alternatives.

Entry-level Solution for Part Designers

Moldflow Part Adviser is a plastics flow simulation tool that has been developed with the specific needs of part designers in mind. Users do not need to be dedicated analysts to benefit — even occasional users can quickly assess the manufacturability and quality of plastic part designs for injection molding applications early in the design process.

Mid-range Solution for Mold Designers

Moldflow Mold Adviser extends simulation capabilities beyond the part cavity to allow mold designers to create and optimize gate and runner systems for single cavity, multi-cavity and family molds. Optional extension modules also allow users to evaluate molded part performance and cooling circuit design. Moldflow Mold Adviser is targeted at the mid-range market to provide the optimal balance of functionality to address critical mold design parameters, before the mold construction begins.

Link Design to In-depth Analysis

MPA users who need more detailed predictions about all phases of part and mold design, manufacturing and resulting part quality, or who want to investigate alternative manufacturing processes to injection molding, can take advantage of the complete suite of advanced plastics process simulation tools provided by Moldflow Plastics Insight® (MPI®) software. MPI products simulate a broad range of thermoplastic and reactive molding processes and support all design geometry types associated with plastics molding processes. MPA model, material and process data can

be exported in a format compatible with MPI software and used as input to perform in-depth MPI analyses.

Link Design to Manufacturing

MPA software also can export a file that can be input to Moldflow Manufacturing Solutions™ (MMS™) software. MMS software interfaces with the injection molding machine controller and allows users to set up, optimize, monitor and control the injection molding process with a simple, systematic, and documentable method. The MPA output file provides starting points, including shot size, injection velocity and cooling time, for the MMS optimization functions.

For more information about Moldflow Plastics Advisers software and other Moldflow software products and services, visit www.moldflow.com