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The Magazine of Choice for Plastics Professionals

MAY 2008



## Enterprise-Enabled Simulation

- ▶ Accessibility
- ▶ Configurability
- ▶ Process Integration
- ▶ Communication Focus
- ▶ Strategic Implementation

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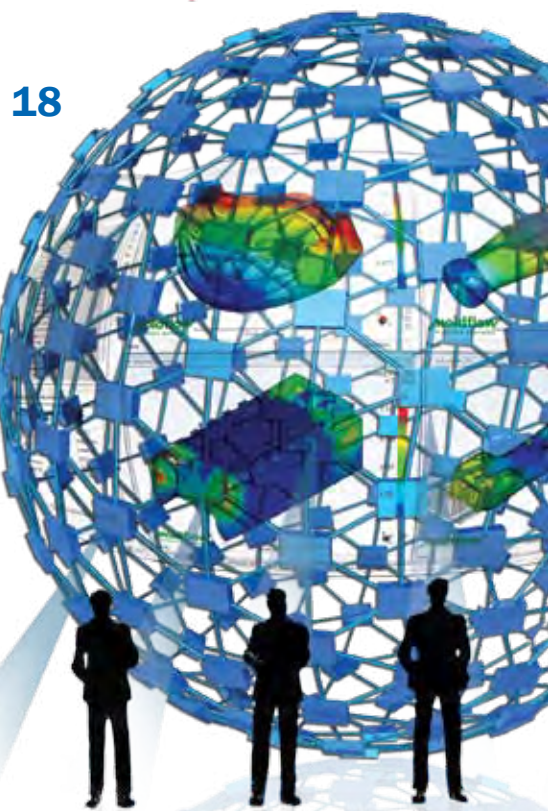
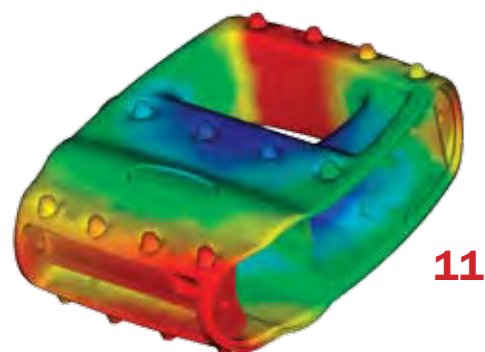
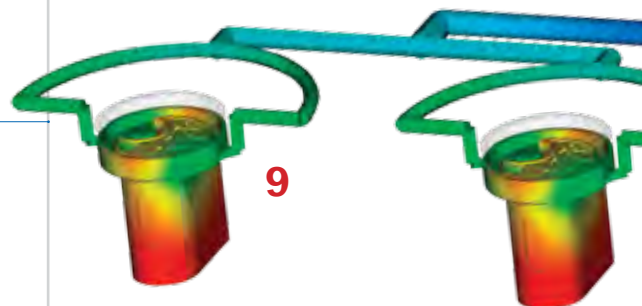
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Industrial  
Designer

Part  
Designer

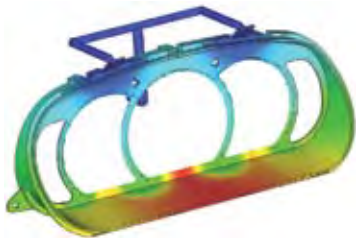
Mold  
Designer

Simulation  
Analyst

Production  
Engineer



# Simulation Has **Changed**



**Leading companies are adopting an enterprise - wide approach to simulation** and empowering everyone involved in new product development to analyze and optimize their stage of the process.

With the release of Moldflow Plastics Insight Enterprise Edition, Moldflow is leading the way for companies that want to implement Enterprise-Enabled Simulation to optimize their product design - to - manufacturing process.

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from the editor



# Enterprise-Enabled Simulation

**T**his issue of Flowfront focuses on a new paradigm for implementing plastics simulation technology in today's global enterprises. Enterprise-enabled simulation is about expanding the use of simulation technology beyond a single stage of product development. Moldflow is changing the way simulation technology is utilized to allow users at any stage of product development, from industrial design to process engineering, to access the technology, configure it to best meet their specific needs, easily integrate it into their work processes, communicate results among the entire design-to-production team, and take advantage of strategic, enterprise-wide implementation.

Enterprise-enabled simulation is about breaking traditional barriers to bring the benefits of simulation to a wider population, who will analyze a broader range of designs and perform those analyses not only to troubleshoot problems, but also to validate and, ideally, to optimize plastics part and mold designs at the earliest stages of product development. Read more about Moldflow's vision of enterprise-enabled simulation in our cover story, beginning on page 18.

In this issue, we also present highlights of our most recent releases of Moldflow Plastics Insight® (MPI®) and Moldflow Plastics Advisers® (MPA®) products. New features and enhancements introduced in MPI 6.2 and MPA 8.1 not only answer many user requests for improved usability and specific technology developments, but also support the enterprise-enabled simulation paradigm.

We examine some customer successes in the context of innovative molding technologies and automotive industry-specific applications. Find out how Mack Molding Company (Arlington, VT) uses 3D simulation on a gas-assisted injection molding design to optimize part and tool design, material selection and choice of molding process to assure product manufacturability and durability. Read our automotive industry spotlight to see how companies including Jaguar and Promold are using Moldflow simulation to improve product quality, address environmental concerns, and stay competitive in a rapidly evolving industry.

You will also find useful tips and techniques to help you communicate analysis results more effectively. Learn how to create a script to automate export of MPI results for viewing in Moldflow Communicator, and take advantage of three specific tips to help you streamline report generation using both MPI and MPA software.

Dr. Robert Malloy, Professor and Chairman of the Plastics Engineering Department at the University of Massachusetts Lowell, offers his perspective on designing for recycling. Dr. Malloy is a well-respected researcher and consultant in the areas of plastics processing, design, and recycling of thermoplastics and the author of many publications and patents, including a textbook on plastic part design.

Throughout this issue, you'll also see featured advertisements from our iMUG 2008 sponsors. This year's International Moldflow User Group conference takes place on May 20-22 in Detroit, MI.

Whatever role you fill in taking plastic parts from concept to manufacturing, you will find information here about Moldflow technology innovations, real-world applications, and business practices to help you optimize your product development process.

*Marcia Swan*



Marcia Swan, Editor

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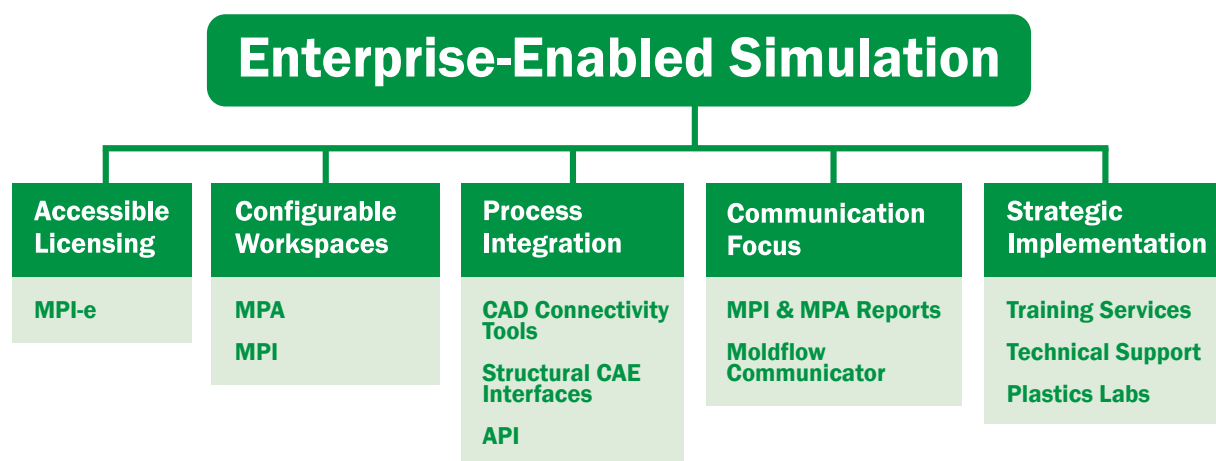


# Latest Releases

## of Moldflow Design Analysis Software Support Enterprise-Enabled Vision

By HANNO VAN RAALTE, PRODUCT LINE MANAGER, AND MURALI ANNAREDDY, DIRECTOR OF PRODUCT MARKETING

The latest releases of Moldflow Plastics Insight® (MPI®) and Moldflow Plastics Advisers® (MPA®) products support the company's vision of enterprise-enabled simulation to optimize plastic product development processes.



### Changes common to both MPI 6.2 and MPA 8.1 include these:

- **Complete 64-bit solution:** In MPI 6.2 and MPA 8.1, both the graphical user interface (GUI) and the analysis solvers natively support 64-bit operating systems (in previous releases, the GUI was a 32-bit application running on a 64-bit operating system). This enables more efficient handling of large models and improves overall product performance on Windows x64-based platforms.
- **Microsoft Windows Vista® support:** Support for Windows Vista Business, Enterprise and Ultimate Editions is added in MPI 6.2 and MPA 8.1.
- **Microsoft Office® 2007 support:** Project reports generated in Word and PowerPoint

formats are compatible with Microsoft Office 2007 Edition.

- **Configurable workspace options:** Task-specific user interface configurations can be saved and shared among various stakeholders across the enterprise.

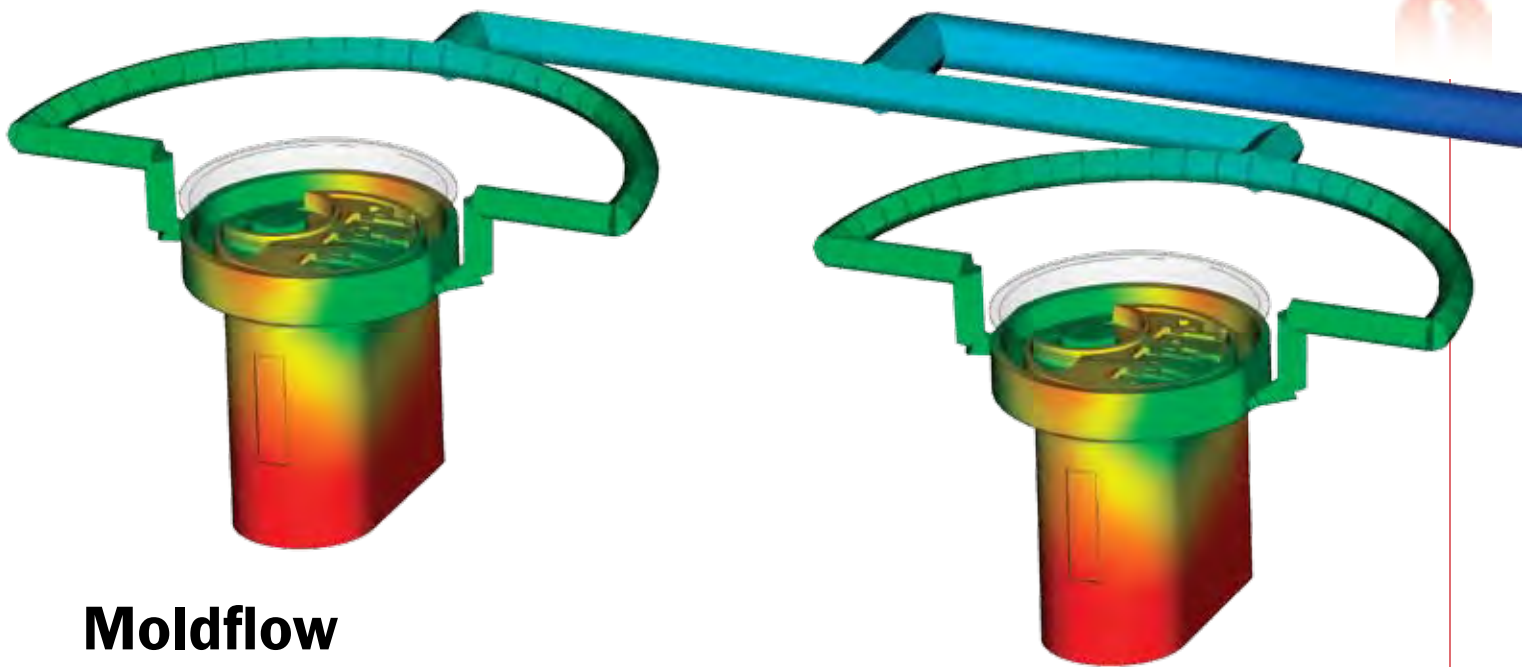
- **Product consistency enhancements:** MPI 6.2 and MPA 8.1 introduce terminology changes which have been implemented to improve consistency within each product and across all Moldflow products. Within each product, these changes reduce differences between online Help topics and what is displayed in the user interface, and also unify terms used to refer to similar features

of the Dual Domain™ and 3D analysis technologies. Across Moldflow products, these changes reduce product-specific differences in terms referring to similar analysis technologies, analysis sequences and results.

- **Moldflow Communicator compatibility:** MPI 6.2 and MPA 8.1 Revision 3 support export of Moldflow Results (\*.mfr) files that can be viewed in Moldflow Communicator 2.0. Moldflow Communicator is a free utility developed specifically for visualizing, quantifying and comparing Moldflow Results files.

*Details of product-specific changes are described on the following pages.*





## Moldflow Plastics Insight 6.2

Moldflow Plastics Insight (MPI) 6.2 introduces significant user interface enhancements and several new solver technologies to respond to customer requests and increase user productivity.

### User Interface Enhancements

#### Synergy Graphical User Interface Updated

The Synergy GUI has undergone a significant facelift in the MPI 6.2 release, with newly designed icons and a new background, terminology changes, and new commands. These changes follow similar changes implemented in MPA to enhance compatibility across product lines.

In particular, new icons used to indicate analysis status eliminate English language-dependent symbols used previously, making product localization more straightforward and enhancing usability in the global community.

Terminology changes have been implemented to create more consistency between the MPI GUI and Help system and among all Moldflow products. The most notable changes are made

to analysis sequence names (for instance, Fill+Pack replaces Flow in the list of available analysis sequences for most molding processes), result names, and analysis technology (Dual Domain technology is referenced instead of using the Fusion product name).

New commands include a **Close All Documents** command available from the **Window** menu, as well as a new results **Scaling** toolbar available from the **View** menu, which allows dynamic adjustment of the minimum and maximum scale of the displayed result.

#### Configurable Workspace Options

MPI 6.2 introduces a **Workspace** tool, a key feature aimed at improving user productivity as well as reducing product complexity to broaden the use of MPI throughout the entire enterprise.

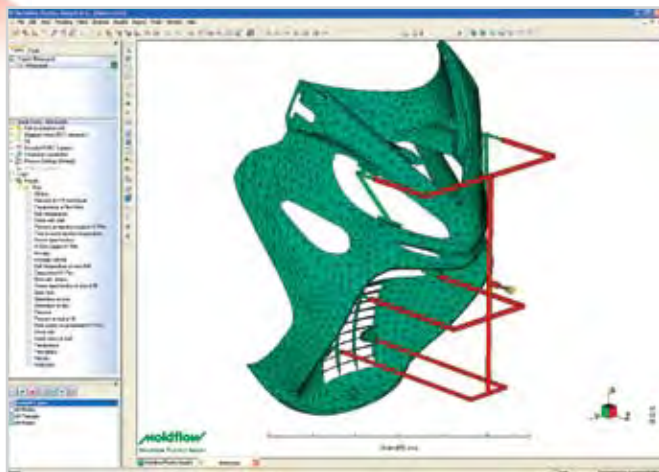
On a typical project, a majority of the user's time is spent in interacting with the user interface. A customized user interface that conforms to an optimal workflow for specific tasks has great potential to improve user productivity. MPI, with its ever-increasing product breadth, can pose daunting training

and usability challenges, especially to novice users.

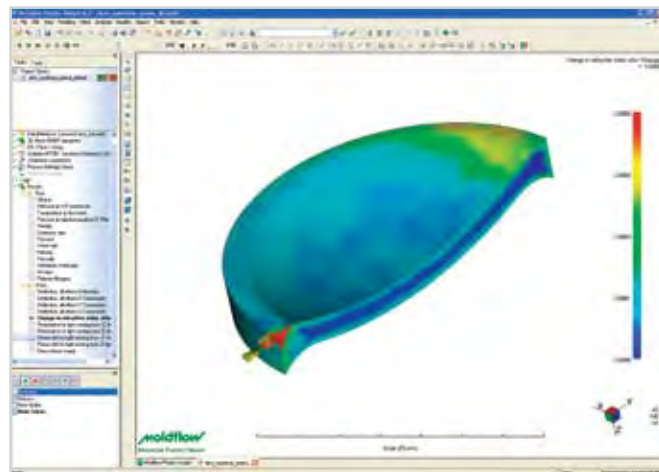
People in different roles in the product development process all would use MPI differently. For example, an industrial designer might want to perform a manufacturing feasibility study, a plastics engineer might want to evaluate material selection options, a structural engineer might be interested in analysis results such as weld line locations, fiber orientation and predicted displacement, while a molder might focus on machine selection and process setup parameters. The **Workspace** tool allows the user interface to be customized to fit a user's job function, knowledge, skill set and experience.

The following aspects of MPI can be customized and saved to a workspace file:

- Molding processes
- Analysis sequences
- Mesh types
- Databases (Thermoplastic/Thermoset materials, Coolants, Mold materials, and Molding machines)
- Analysis results
- Menu toolbars



1. Moldflow Mold Designer Workspace



2. Moldflow Optical Workspace

### ■ Meshing options

Several preconfigured workspace files are distributed with MPI 6.2 (identified as Moldflow workspaces). Besides these, you can set up personal (User) or shared (Company) workspaces.

## New Interfaces with Development Partners

### ➡ Export to Altair® Engineering's H3D Data Format

MPI 6.2 offers the capability to export the meshed model and results to Altair Engineering's H3D data format. Through this option, the MPI model and results can be visualized in Altair HyperView 9.0 and other Altair products that support the H3D format.

### ➡ Interface to Code V® Optical Design Software

MPI 6.2 features an interface to CODE V, optical design software from Optical Research Associates®. Through this interface, it is possible to export the optical properties predicted by a Birefringence analysis and use this information to investigate how the molding process affects the optical properties of lenses.

## MPI Enterprise Edition Enhancement Offers Increased Accessibility

For users of the MPI Enterprise Edition (MPI-e), new in MPI 6.2 is the ability to install the Moldflow Plastics Advisers (MPA) software

and access its suite of products using MPI-e tasks.

MPI-e users can leverage this increased accessibility to MPA and MPI products to allow more users throughout the enterprise to realize the benefits of injection molding simulation. In particular, part and mold designers as well as novice simulation users now can take advantage of MPA's guided user interface, model-specific design advice, and wizard-driven runner and cooling channel modeling tools.

## Solver Technology Enhancements

### 3D Flow Solver Speed Improvements

The Coupled 3D Flow solver offers a new AMG matrix solver option, and the code has undergone rigorous review and optimization to perform more efficiently. The average 3D Fill+Pack analysis sequence using the Coupled 3D Flow solver now runs in less than half the time required to perform the same analysis in MPI 6.1, without affecting the analysis results.

### ➡ New AMG Matrix Solver Option for Coupled 3D Flow Solver

An optional AMG solution method is available for 3D Fill+Pack analysis sequences using the Coupled 3D Flow solver. When this option is enabled, the average expected analysis time speed-up factor is 2.0 or more (where the speed-up factor is defined as the ratio of analysis time in MPI 6.1 to the analysis time

in MPI 6.2). The speed-up factor is model-dependent.

By default, the **AMG matrix solver selection option** is set to Automatic. This setting allows the 3D Flow solver to examine the model and determine whether or not the AMG matrix solution is advantageous. Various parameters influence the outcome of this setting, including the model size (number of elements in the mesh), the operating system, and the selected analysis sequence and analysis parameters.

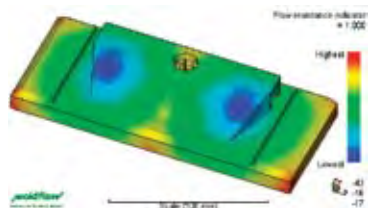
The AMG matrix solver does not provide a clear advantage for small models (fewer than 200,000 tetrahedral elements). The AMG matrix solver also uses more memory (up to 50% more). As a result of these two factors, on a 32-bit operating system, the AMG matrix solver will not be used when the solver selection option is set to Automatic.

### ➡ Coupled 3D Flow Solver Optimization

An additional average speed-up of 30% is achieved through code optimization and algorithmic improvements. The speed improvement depends upon several factors; key among these are the model size, selected molding process, selected analysis sequence (Fill or Fill+Pack), and the hardware configuration.

## New Advanced Gate Locator

MPI 6.2 introduces a new Advanced Gate Locator algorithm for



The new Advanced Gate Location analysis can simultaneously search for up to 10 gate locations and allows specified areas of the part to be prohibited from the analysis.

Midplane, Dual Domain, and 3D meshes, which can help with making important gating decisions. The Advanced Gate Locator offers significant improvement over the previous gate location algorithm with two new capabilities:

- Simultaneously search for and recommend up to 10 gate locations.
- Account for specific regions of the part geometry that have been prohibited from gating considerations.

The Advanced Gate Locator aims to identify gate locations that will produce the lowest injection pressure. Regions that should not be used for gating because of aesthetic, tooling or other reasons, can be excluded before starting the analysis by selecting specific nodes on the model that are designated as prohibited gate nodes. The Advanced Gate Locator will not consider prohibited nodes in searching for recommended gate locations.

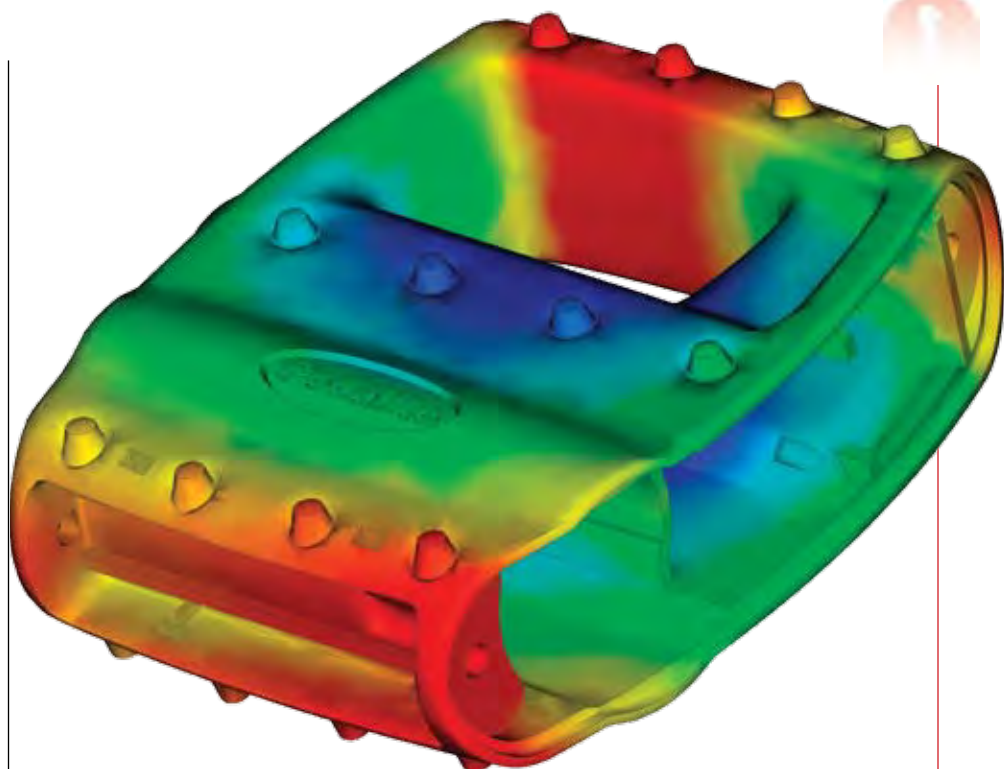
A Gate Location analysis sequence in MPI 6.2 uses the new Advanced Gate Locator algorithm by default. The previous gate location analysis algorithm has been renamed to Gate Region Locator.

### Expanded Scope of 3D Warp Analysis

#### 3D Warp Analysis Handles More Overmolding Configurations

Complex overmolded parts may have numerous configurations in which the various components are positioned. Previously, only a limited subset of these configurations could be properly simulated for warpage

*continued on page 12*



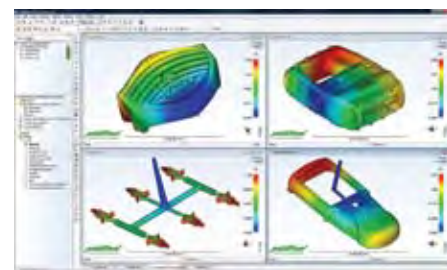
## Moldflow Plastics Advisers 8.1

MPA 8.1 delivers new technologies and key enhancements to help users analyze a broader range of parts with Advanced 3D technology, improve productivity with a redesigned user interface, shorten analysis preparation time with powerful and flexible modeling tools, interpret results more efficiently using new results visualization options, and increase collaboration with expanded communication capabilities.

### Extended Solution with Advanced 3D Technology

Advanced 3D analysis technology provides the ability to analyze accurately part (mold cavity) designs that have thick regions or abrupt changes in thickness. Geometry features such as these are not suitable for MPA's Standard Dual Domain analysis technology, which has been developed and fine-tuned for the thin-walled part geometry that is

most often encountered in plastic injection molding applications. The Advanced 3D analysis option dramatically increases the number of designs that can be successfully analyzed using MPA software. The Advanced 3D analysis also works with the Performance Adviser and Cooling Circuit Adviser add-on modules to evaluate part warpage and account for the effects of the cooling system, respectively.



Advanced 3D analysis option handles designs that have thick regions or abrupt changes in thickness.

*continued on page 13*



**Moldflow Plastics insight 6.2 | continued**

using 3D meshes. An improved algorithm in 3D Warp now establishes contacts between all components in single-shot and 2-shot overmolding applications, including part inserts.

The improved algorithm also is better able to tolerate small gaps between the meshes on different overmolding components. This is particularly important when working with components that have curved contact surfaces between them, where it can be challenging to ensure perfect contact between the meshes.

#### ➡ *3D Warp Analysis for Gas-assisted Injection Molding Applications*

Product designers can now evaluate the effect of hollowed-out gas channels on the overall part deflection. The 3D Warp analysis can be run in parallel on a multi-processor system. The **Isolate cause of warpage** option is also available, which can help to identify the source of warpage.

#### ➡ *Exclude 3D Cold Runner Elements from Analysis*

MPI 6.2 now offers the ability to assign a new **Cold runner (3D)** element property to tetrahedral elements. This allows the 3D Warp solver to identify which elements belong to the part and which to the cold runner system and to exclude the cold runners from the warpage analysis. This improves the accuracy of the part warpage predictions and reduces the analysis time. The new element property does not change the Coupled 3D Flow or Cool solvers.

### **Other Enhancements**

#### ➡ *New Micro-mechanics Model*

A new micro-mechanics model, the Mori-Tanaka model, has been implemented to provide more accurate shrinkage and warpage predictions of fiber-filled liquid crystalline polymer (LCP) materials. The Mori-Tanaka micro mechanics

model is much better able to capture the anisotropic nature of LCPs, and this significantly improves the calculation of mechanical properties for this special class of materials, which are often used in the connector industry.

The Mori-Tanaka model can be used with Midplane, Dual Domain and 3D analysis technologies. The model is used automatically if the selected material contains the appropriate material properties data.

#### ➡ *Simulate Rapid Heating and Cooling Processes*

In the conventional injection molding process, the mold is maintained at a near-constant temperature throughout the molding cycle. However, newer molding techniques have been developed which use a variable mold temperature. The mold is maintained at a hotter temperature during the filling phase to facilitate filling and achieve smooth surface appearance. During the packing and cooling phases, the mold is switched to a much cooler temperature to assist in freezing the part and decrease the cycle time.

MPI 6.2 allows variable mold surface temperature profiles to be set up for use in Fill and Pack analyses. Variable temperature profiles can be specified on all element types (cavity, cold runners, cold sprue, cold gates and part beam) except hot runner elements.

#### ➡ *Venting Analysis for 3D Reactive Molding and Microchip Encapsulation Processes*

Because the injection pressures are often very low in reactive injection and microchip encapsulation molding processes, the build-up of air pressure in the unfilled cavity due to inadequate venting can influence the material flow during filling.

MPI 6.2 offers the capability to specify venting analysis locations

and vent sizes, which are then considered in the flow analysis when the option to perform venting analysis is enabled. The venting analysis calculates the air pressure build-up in the unfilled cavity, based on the venting locations and sizes, and accounts for the influence of the air pressure on the filling pattern. This feature is supported for 3D Reactive Molding and 3D Microchip Encapsulation molding processes only.

#### ➡ *User-specified Gate Size for 3D Meshes*

The new **Gate contact diameter** setting allows the gate size to be specified at a single injection point on 3D meshes that do not have a runner system and gate(s) explicitly modeled.

#### ➡ *New Annular Beam Element Formulation*

A new formulation to represent annular hot runners explicitly improves analysis accuracy using Midplane and Dual Domain analysis technologies.

#### ➡ *Pack and Warp Analysis of Thermoset Materials Extended to All Mesh Types*

In MPI 6.2, it is now possible to simulate the packing, shrinkage and warpage characteristics of thermoset materials for Reactive Molding and Microchip Encapsulation processes using Midplane and Dual Domain analysis technologies. ■

**Moldflow Plastics Advisers 8.1 | continued****Focus on Productivity and Ease-of-use**

MPA 8.1 features a panel-based user interface that has been designed to streamline project management tasks, improve access to analysis results and supplemental information, and enhance user productivity, while maintaining the familiar, guided workflow established in previous MPA releases.

**Powerful and Flexible Modeling Tools**

Runner and cooling channel layouts can be quickly and easily imported from CAD systems or created using new modeling planes, snap tools, and visual cues to aid in precise positioning.

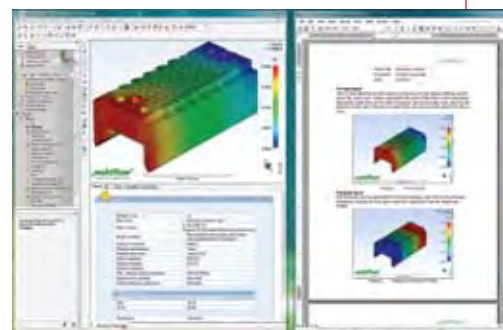
- New **Runner System Wizard** produces a complete feed system automatically based on user-specified sprue, runner and gate properties.

**Increased Collaboration**

Enhanced report generation capabilities make it possible to automatically generate reports in Microsoft® Word® or PowerPoint® formats in addition to web-ready HTML format, to easily communicate valuable analysis results across the enterprise.



*The panel-based user interface design streamlines workflow, provides uninterrupted access to the model, and improves overall user productivity.*



*Easily create project reports in Microsoft Word or PowerPoint formats.*

**Configurable Workspace Options**

Show or hide panels and toolbars to customize the workspace configuration for a specific workflow. For example, create one workspace to support tasks prior to running an analysis and a second workspace for reviewing and comparing results.

Save the customized workspace to a file for later reuse or sharing with other MPA users across the enterprise.

MPA provides two pre-configured workspaces and remembers the last-used workspace configuration when you reopen the software. You can easily switch from one workspace configuration to another at any time.

- Modeling planes feature aids in quick and easy creation of runner and cooling channel segments.
- Visual cues are offered when modeling runner segments to assist in their creation.
- Export optimized runner and cooling channel layouts for reuse in a CAD system.

**Intuitive Results Interpretation**

New results visualization options allow for the comparison of results from multiple analysis iterations to realize design improvements and better understand plastics material behavior. New **Dynamic Help** functionality allows users to quickly understand those results that have the greatest impact on optimizing their part and mold designs.

**Smart Tools**

MPA 8.1 features a redesigned **Cost Adviser** that facilitates detailed part cost analysis. Association with the model allows evaluation of how changes to part design, mold design, material choice, and processing conditions affect part cost. After the **Cost Adviser** is set up for a given project, it will track the changes to the model, material and processing conditions automatically and display the current cost based on material usage, cycle times, post-molding costs, operating costs and overheads. ■

*For more information about MPA 8.1 and MPI 6.2, contact your local Moldflow representative or visit [www.moldflow.com](http://www.moldflow.com).*



# Industry Spotlight:

## Automotive Customers Implement Simulation to Address Critical Issues

BY BRIAN SATHER, TECHNICAL MARKETING SPECIALIST

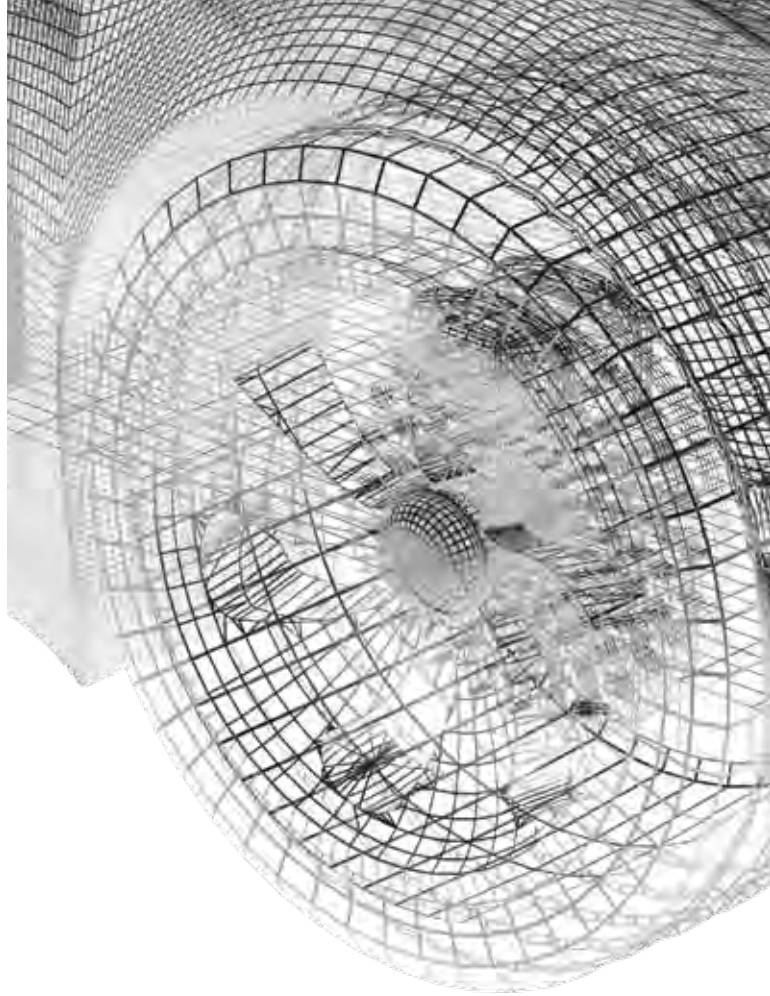
**Even with all the current instability in the automotive industry, executives are still reporting the major issues they face have not changed much in the past few years. According to KPMG's 2008 Global Auto Executive Survey, product quality, cost reductions, harnessing new technologies, and global competition are the major challenges, with environmental issues becoming more notable.**

**F**rom a consumer standpoint there has been a definite shift in purchasing considerations over the last two years. Concerns about safety and serviceability have gone down while interest in environmental friendliness and alternative fuel sources has risen significantly.

Now, more than ever, major automakers and their suppliers are harnessing Moldflow simulation to improve their product quality, make their products more environmentally friendly, and stay competitive in their market.

### Product Quality

For over 75 years Jaguar, based in Coventry, England, has manufactured vehicles that deliver a unique blend of style, luxury, and performance. As a premium car maker, they consider product quality to be paramount. According to a review in New London, Connecticut's *The Day* newspaper, "Jaguar's quality is ranked above that of its European rivals, Mercedes-Benz, BMW and Audi." With world-class engineering talent and advanced design and optimization tools, Jaguar continues its rich and distinguished heritage of innovative automotive manufacturing.



One challenge Jaguar has had to surmount is due to the increasing number of plastic parts being used in interior, exterior, and under-hood applications. Until recently, the company had been leaving analysis of their plastic parts to their suppliers and had not been performing up-front work in-house to optimize their designs for manufacturability. This often resulted in late design changes, costly rework, and the risk of entire programs being late for crucial milestones.

On a center console finisher for their new Jaguar XF interior, they identified multiple problems in the parts coming from the original mold design. Air traps, poor fiber orientation, sink marks, and unacceptable warpage resulted in a 42% scrap rate at an estimated cost of \$1 million in scrap and rework.

In an effort to address these issues as early as possible in the product development cycle, Jaguar invested in Moldflow Plastics Insight® (MPI®) software to test three different changes to the thickness in the center of the part where filling hesitation was occurring. On the third iteration, they found the optimum wall thickness that produced a uniform filling pattern, appropriate fiber orientation, and minimal volumetric shrinkage. This design iteration





*In total, 181 new plastic component designs were validated and optimized for the new Jaguar XF sport sedan using MPI software.*

also removed the weld lines entirely and pushed the air traps to the edge of the component.

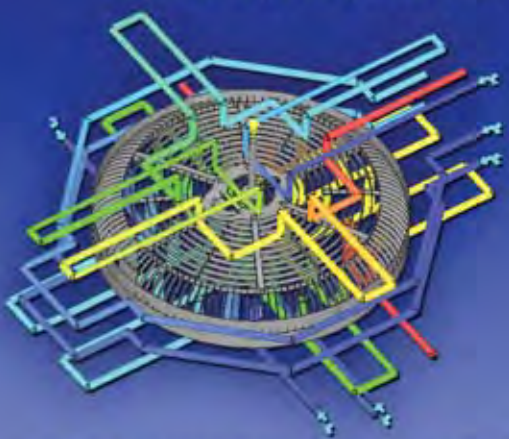
Once the proper wall thickness was found for the part design itself, the engineers used MPI to optimize the processing parameters and cooling system to minimize the amount of warpage that occurred in the molded part. After several iterations, the displacement in a critical area was reduced from 12.8 mm to 1.2 mm. In production, this resulted in a 13% decrease in the scrap rate due to warpage.

After the optimization, the total scrap rate was reduced from 42% to 7%, with most of the remaining scrap due to the veneer in-mold decoration. The cost savings on this project alone due to the reduced amount of scrap and improved production efficiency is estimated at over \$1.1 million.

In total, 181 new plastic component designs were validated and optimized for the new Jaguar XF sport sedan using MPI software. With the successful implementation of MPI, Jaguar is now able to fully control the part and mold and ensure the designs of each are fully optimized. Their dependency on suppliers to get it right has been minimized along with the number of late design changes, the amount

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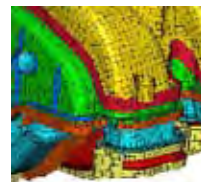
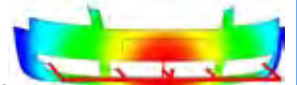
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## Industry Spotlight | Automotive Customers

of rework, and the risk of programs missing their set milestones.

### Environmental Friendliness

Over the past twenty years, automakers have made evolutionary gains in fuel efficiency from improvements and innovations in powertrain design. However, these improvements have been countered by increases in vehicle weight because of the use of higher strength steels and other heavy safety features such as airbags. For example, a 2008 Chevrolet Cobalt with significant improvements in engine efficiency still gets the same mileage as a similar 1988 model, because the Cobalt weighs 17% more.

To address environmental concerns, many automotive component manufacturers now are focusing on finding ways to reduce carbon dioxide emissions by optimizing their plastic part designs to reduce mass while still maintaining product performance and quality. This strategy not only helps improve fuel economy of the vehicles in which their parts are installed, but it also reduces the consumption of raw materials, the

energy needed for manufacturing, and the need for replacement parts.

Promold, an engineering consultancy firm based in Paris, France, offers MPI analysis services to their customers. Promold was contracted by Valeo, a major supplier of automotive components to well-known vehicle manufacturers, to optimize the design of a new headlamp housing for a Renault sedan. The initial design weighed 244 grams with a wall thickness of 2.15 mm. The constraints for manufacturing were that the parts must be produced on an 800-metric-ton molding machine and there could be no weld lines in the vicinity of where the primary headlamp bulb would be installed.

Promold used MPI software to virtually experiment with three material options (polycarbonate, nylon, and PBT), five different part thicknesses ranging from 2.15mm to 0.8mm, and six different gating configurations. The experiment was set up to use the full capacity of the designated molding machine's 174 MPa maximum injection pressure so the wall thickness could be reduced as much as possible. The first step was to evaluate the three materials based on their



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flow characteristics to minimize the pressure required to fill the part. Next, the wall thickness and number of gates were optimized simultaneously to ensure the parts did not exceed the injection pressure limit of the machine and no weld lines were created in critical areas.

The experiment resulted in the selection of the PBT material for a design with a wall thickness of only 1.2 mm that used a 5-gate hot-runner system. The final weight of the part was 41% less than the original design and took advantage of the full capability of the molding machine used. Performance and quality criteria were also met, with no weld lines in any critical areas of the part and no sacrifices in strength due to the thinner walls.

Obviously, saving 100 grams in the weight of a headlamp housing is not going to have a significant effect by itself on the fuel economy of a vehicle. However, with plastics approaching 10% of the average total vehicle weight, incorporating these methods into the best practices of an organization will ensure that all new products developed will be optimized for mass, and taken together, they can have a sizable impact on a vehicle's fuel efficiency. Also, less material consumed and reduced amounts of energy required during production present opportunities for cost savings in conjunction with improved environmental friendliness.

*"Product development is now commodity, you must introduce product optimization and a real time 'analytical vision', if not, your competitors will..."*

## Going Forward

Executives and directors in all major automotive companies have recognized the importance of using simulation to stimulate innovation and to get products to market as fast as possible. Those that have implemented Moldflow injection molding simulation software have seen great success in improving product quality and increasing environmental friendliness of their plastic products, as the examples described here have shown.

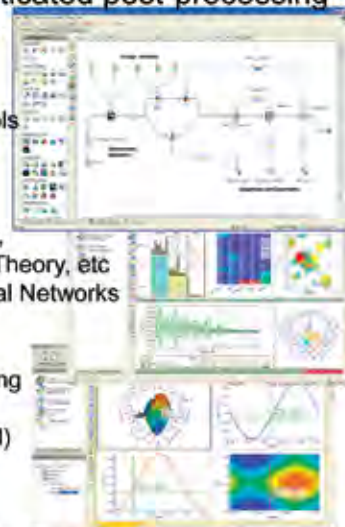
Carlos Ghosn, CEO of Renault and Nissan, is largely credited with the complete turnaround of Nissan since 2005. Ghosn outlines a strategy of, "...using less and less prototypes, more digital simulation to decrease time-to-market," in his company's 2009 Strategic Plan.

"Product development is now commodity, you must introduce product optimization and a real time 'analytical vision', if not, your competitors will," notes

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John L. Sullivan, Ford's Director of Process, Methods, Tools, and Information at a recent CAE conference.

Going forward, companies in the automotive industry, in particular, can benefit from using simulation throughout development to optimize every plastic product they produce. The greatest potential benefits come from moving beyond using simulation just to discover and avoid potential problems and instead using simulation to truly optimize designs to address criteria that have been identified as mission-critical to their businesses.

Moldflow's vision of enterprise-enabled simulation (see cover story on page 18) supports the immediate needs of the automotive industry by providing a methodology that enables everyone involved in new product development, from industrial designers to process engineers, the ability to perform analyses and improve the design early and often. This type of implementation allows for the designs to be tailored to whatever the best practices of the organization dictate, whether it be product quality, environmental friendliness, time-to-market, or any trend currently shaping the industry. ■





# Enterprise-Enabled Simulation

By BRIAN SATHER, TECHNICAL MARKETING SPECIALIST

**Enterprise-enabled simulation is a methodology for implementing analysis software into the best practices of any organization that designs and develops new products.**

**A**t its core, enterprise-enabled simulation is focused on empowering everyone involved in new product development to confidently analyze their own designs and use the results to optimize parts for both manufacturability and performance.

Organizations involved in the design and manufacture of plastic parts are facing continuous pressure to get innovative products to market faster than ever. These compressed development cycles often result in simulation only being used to troubleshoot or validate part and mold designs in the latter stages of development. Failure to perform simulation early not only results in a greater likelihood of defective parts, but also in lost opportunities to optimize the product for both manufacturability and performance.

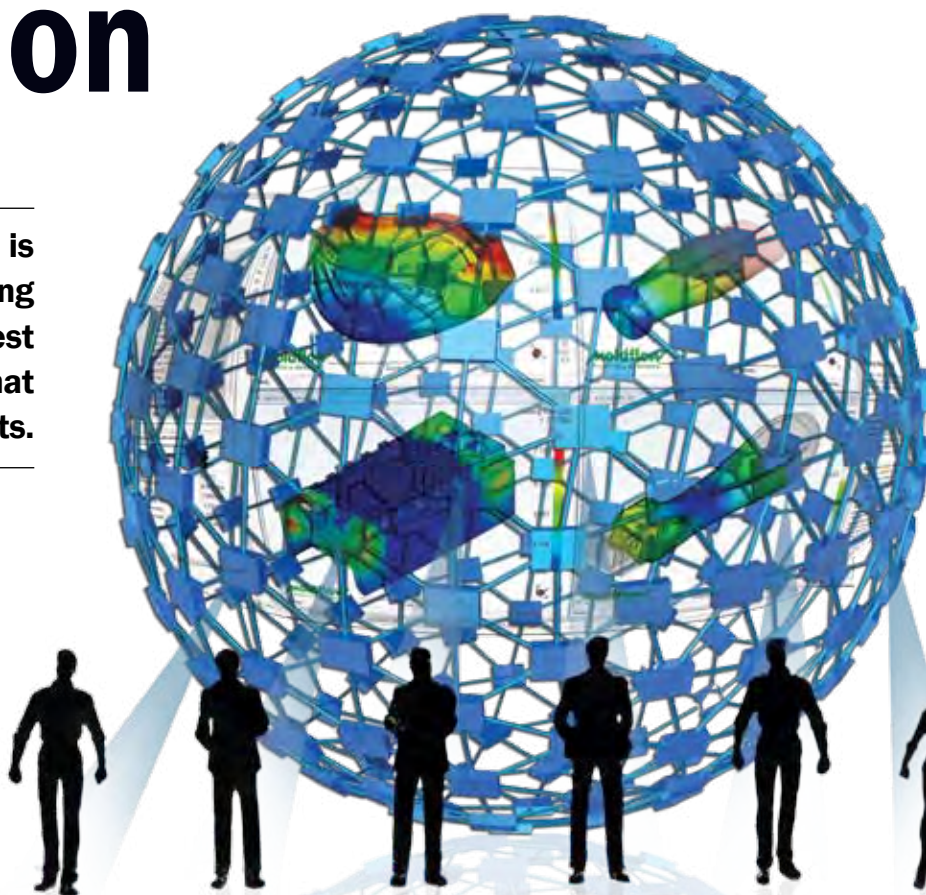
The question now being posed by these organizations is, "How do we incorporate simulation into our best practices so designs can be optimized using analysis results?"

## A Brief History of Simulation Use

Thousands of companies around the world currently employ simulation to some extent, and many view it as a competitive differentiator. Over the course of three decades, the manner in which these businesses use simulation has evolved as the accuracy and speed of the software improved and as they looked for new ways to outpace their competitors.

## Using Simulation as a Troubleshooting Tool

When simulation tools first gained widespread use, it was typically to fix a problem discovered in production environments or even in end-use applications. A single analyst would then troubleshoot the problem and determine a solution given the existing constraints. Of course, even if the analyst was successful, valuable time and material had already been wasted, driving up costs.





## Using Simulation as a Validation Tool

As simulation tools and computers grew faster, the next logical step was to validate part or mold designs prior to committing to the mold build. Any errors in the designs could be communicated by the simulation expert to the engineer responsible, and the issue could be fixed prior to steel ever being cut.

While this results in more value being realized from the use of simulation, there is still the potential for significant hidden costs because parts and molds are not being optimized. For example, without optimization, companies are not determining if a part could be made thinner, which would reduce material usage, decrease cycle times, use less energy, and lower overall costs.

The problem with using simulation to troubleshoot existing problems or validate designs is that both of these approaches focus on problem-fixing and problem-avoidance, rather than on trying to create truly optimized designs.

## Current Trends in Simulation

Global competition, concerns about the environmental impact of new products, and shortened time to market are the critical pressures that businesses designing and manufacturing plastic parts are currently facing. From an engineering standpoint, these pressures translate into the need to optimize product designs so each part is manufactured at the lowest cost, with the least amount of material, and in the shortest development cycle possible.

## Simulation Driven Design

Industry leaders are responding to these pressures by implementing simulation earlier in the development stages to actually drive the design of the part. Using this method, designs are analyzed and

improved iteratively so potential problems are solved preemptively and products are optimized prior to starting production. This method has proven to be extremely effective because quality is now designed into the product and less testing is required in the later stages, which improves the overall efficiency of new product development.

Paul Hornikx, Mechanical Engineer in Microsoft's hardware division, speaks of the problems with not utilizing simulation early: "Being late, and not knowing about it until the end, is very costly. Airship, losing shelf space, flying engineers all over the place, lost engineering time for the next programs, and the stress on the engineering group is phenomenal." He adds, "This should all be incentive to do analysis as early as possible."

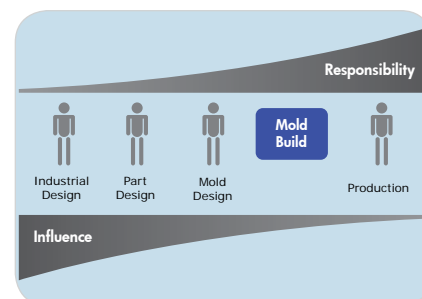
Hornikx utilizes simulation early in product development, performing analyses on industrial design concepts prior to adding the internal engineering features. Recently, during the design of a bottom case for a new keyboard, he found that a thick section around the perimeter of the part would have created a tension ring that would cause the part to warp significantly.

Using the simulation results, Hornikx went back to industrial design with two options: move the parting line or reduce the thickness of the sidewalls. He was able to negotiate a 1.5 mm reduction in the thickness, which instantly removed a majority of the warpage from the part.

## Challenges in Achieving Widespread Simulation Use

An inherent problem with plastics product development is that people involved in the early stages of design have the most influence on manufacturability, but it is the production engineers at the end of development who are responsible for optimizing the process. Pushing

simulation into the earlier stages of design counters this effect but presents its own challenges due to time constraints, lack of expertise, and also because of the current way simulation software is priced and sold.



## No Time for Simulation

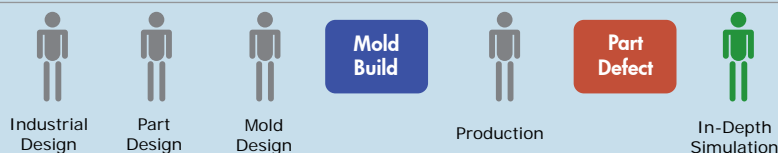
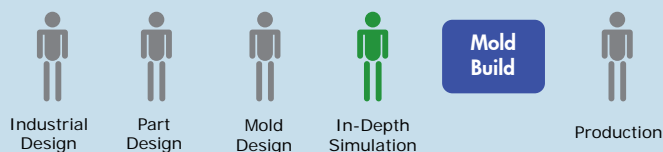
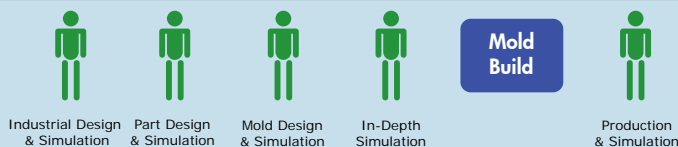
Without question, running multiple analyses at each phase in the design of a new product will increase the quality and manufacturability of the part. The problem is that each analysis can take anywhere from a few minutes to several hours to complete, due to model preparation, actual processing time, and results interpretation. With already compressed development cycles, the amount of time available to run these analyses is very limited.

The challenge is to make simulation as lean as possible for each type of user, thus reducing the amount of "waste" in the form of superfluous results and extended analysis times.

## Simulation: "Experts Only" Please

Typically, the use of injection molding simulation is isolated to only a few engineers within an organization whose primary job function is running analyses for the rest of the development group. This has been the case for two reasons: the intricacy of the injection molding process and the complexity of the simulation application.

Crafting a successful injection molding process requires a thorough understanding of the multitude of

*Simulation as a troubleshooting tool**Simulation as a validation tool**Enterprise-enabled simulation*

variables that must be skillfully manipulated to get an acceptable part. While the latest processing methodologies and technologies have turned injection molding from an art form to a science, anyone new to the process would be overwhelmed with the amount of options available.

Due to all these variables, and also because of the many variants of the injection molding process itself, even the most carefully designed simulation application has an intimidating amount of features to navigate. The leading simulation products currently offer multiple meshing options, thousands of material choices, support for several different molding processes, and options for viewing shrinkage, warpage, and other potential part defects. While all these tools are required by the expert user, having this many options dissuades people who are unfamiliar with simulation from using the product.

The question going forward is, "How does one simulation package accommodate people with little simulation experience while still maintaining the functionality the expert user demands?"

## The Pricing Model for Simulation

The way simulation is priced and sold has always been based on

the presumption that organizations allocate simulation to only a few dedicated users. While the cost is certainly justified when considering the savings dedicated users provide, there are very few companies that are able to purchase a copy for every occasional user in new product development.

Because designers will never be full-time simulation users, they only need access to the simulation software when they are ready to run an analysis on their current design iteration. This type of use is not efficient with the way simulation is currently licensed, because a majority of the time the designer is designing, not analyzing.

What is needed is a system where all licenses purchased are being used as much as possible by as many people as possible to maximize the value of simulation.

## The Solution: Enterprise-Enabled Simulation

To overcome the challenges of time constraints, lack of expertise, and the way simulation is priced and sold, businesses are turning to enterprise-enabled simulation to optimize their new products and development cycles.

Fortunately, new enterprise-enabled simulation solutions have been created that give everyone involved in development the tools

they need to analyze their piece of the design and use the results to optimize their work.

A shared licensing system is used in enterprise-enabled simulation, where every seat purchased is placed into a pool where it becomes accessible to anyone involved in new product development. For occasional users, this means they have the ability to access the software whenever they need it without requiring their own individual license. Because each user does not need a dedicated license, businesses can assess what their simulation needs are and determine the optimum number to purchase so each license is used efficiently. This is also the ideal system for growing companies, because it is easily scalable by simply adding more licenses as simulation use becomes more common or more users are added.

Enterprise-enabled simulation can be customized to a specific job function and the types of analyses and results required at a particular stage of development. For example, industrial designers may only require a simple filling analysis, whereas mold designers need to be able to simulate filling, cooling, warpage, shrinkage, and so on. The software can be configured at every level, from meshing options to the selection of the material, available processing methods, and default results displayed.

The key to integrating simulation into new product development is to ensure everyone is comfortable using the software and confident in their results. The enterprise-enabled simulation methodology includes training programs specifically designed for different user levels, technical support for help with tackling the tough issues, and many other critical support features to ensure simulation becomes part of the company's best practices.

Enterprise-enabled simulation is about more than just the application; it is also about a technology partnership with the

*continued on page 22*





## The Benefits of Enterprise-Enabled Simulation

Some of the specific benefits that can be realized through the use of enterprise-enabled simulation include these:

**Faster time-to-market:** As more users learn about and benefit from the value of simulation, development cycles will inherently move faster, allowing companies to outpace their competitors at every turn.

**Empowered engineers:** Designers throughout the development cycle now have the capability to improve upon their design using results from their own analysis.

**Reduced product costs:** Optimized designs mean shorter cycle times, lower part weights, and less scrap, which all result in huge returns for the organization.

**Improved part quality:** Parts with designed-in quality will cost less to manufacture and support over their lifetime and typically use less material and energy to produce.

**More products per year:** Engineers spend less time troubleshooting at the end of the product development process, so they have more time to work on new products.

**Increased innovation:** With a new set of tools and skills, engineers can experiment with new designs and processes more often to create truly innovative products.

## What to Look For in Enterprise-Enabled Simulation Software

When looking for an enterprise-enabled simulation software product, consider the following key points:

**Accessibility:** Simulation must be easily accessible by any member of a design-to-manufacturing team. This means going from only a few users to many users and enabling even occasional users quick and easy access to the simulation technology that will allow them to optimize their input to the design.

**Configurability:** The user interface and number of analysis options should be configurable based on job function, knowledge, skill, and experience. If someone is involved in industrial design or part production, the software should be customizable in such a way that makes it easy to learn and use with minimal training and support requirements, while still maintaining all the functionality the expert user requires.

**Process integration:** Enterprise-enabled simulation software should integrate easily with existing applications, especially 3D CAD and CAE software, as well as proprietary, company-specific applications.

**Communication focus:** Valuable simulation results are only as good as your ability to communicate them to other members of a design-to-manufacturing team. The software should export to a number of industry standard formats, including Microsoft Word and PowerPoint and HTML-based web reports, as well as offer free results viewing software so engineers outside the organization can have full access to the analysis results.

**Strategic implementation:** Enterprise-enabled simulation must come with a strategic implementation plan that covers everything from licensing to training, technical support, and material testing to maximize the return on investment and ensure simulation is incorporated into the best practices of the organization.

**Enterprise-Enabled Simulation | continued**

software provider for long-lasting, cooperative growth and success.

## Using Simulation throughout Development

While it is important to utilize simulation as early as possible in development, such as the analysis of Microsoft's keyboard during industrial design, it is also critical for design and tooling engineers to take advantage of simulation tools to optimize their work as well.

## Design Engineering

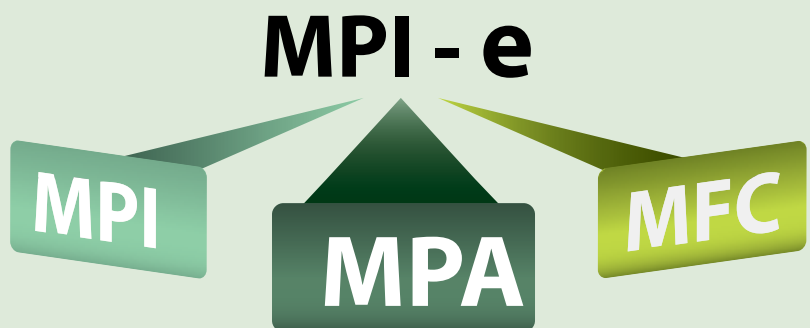
Many firms contracted to design plastic parts, especially for the automotive industry, view molding feasibility analysis as the responsibility of the mold shops, and therefore, simulation typically is not performed at a time when the part design could be optimized for molding. This has resulted in some automakers requiring simulation results to be included in the approval process for product designs while others are taking matters into their own hands.

Glenn Reed, Mechanical Technical Expert at Ford Motor Company, uses simulation to assist in overseeing the supplier development of CD/DVD players and in providing them with technical support. He uses simulation as his "Expert Checker" to analyze incoming designs from his suppliers for anything from short shot conditions to the potential of sink and warpage.

Reed's viewpoint is that designers and engineers are in the best position to impact the cost of the part and that true optimization re-

# Moldflow Plastics Insight Enterprise Edition

With the advent of Moldflow Plastics Insight Enterprise Edition™ (MPI-e™), Moldflow is leading the way for companies that want to implement enterprise-enabled simulation to optimize their product development cycles. MPI-e is an enterprise-enabled simulation software suite that comprises all of Moldflow's core products:



### Moldflow Plastics Insight®

In-depth simulation of more than 20 different molding phases and processes

### Moldflow Plastics Advisers®

Easy-to-use simulation to optimize designs for manufacturability

### Moldflow Communicator™

Visualization, quantification, and comparison of Moldflow results

The key features of MPI-e that enable it to perform as an enterprise-enabled simulation solution include a task-based floating license system, customizable workspaces, multiple importing and exporting capabilities, and extensive reporting and communication tools.

MPI-e is based on tasks that float on a network, giving both occasional and dedicated users access to the full suite of simulation tools. The MPI-e Dashboard allows users to see the usage of licenses on the network and to reserve,

check out, or check in tasks easily. The Dashboard also ensures that all licenses are used efficiently by providing users the information they need to determine which task level is required for the analysis they need to perform.

Customizable user workspaces included in MPI-e can expose the user to as much or as little of the functionality as required. Profiles can be created for novice users so they are guided through the analysis process to find typical

problems specific to their job function. For more advanced users, more functionality and flexibility can be given to ensure they have the resources needed for their phase of the design process.

MPI-e integrates with existing design applications using robust CAD interfaces, making it quick and simple to import 3D solid geometry that is ready for analysis. MPI-e also includes interfaces that link Moldflow results to leading structural CAE applications to ensure that



quires design iterations that are improved through the use of simulation. He proudly carries the torch and preaches to managers and engineers around him to develop and share a "Simulation Attitude!"

## Mold Design

Mike McCullough, Process Engineer at OEM/Erie, a Tier 1 and 2 supplier to General Motors and Chrysler, estimates that they see an average savings of \$7500 on each mold by utilizing simulation

during design. McCullough says, "The savings come as a result of decreased prototype time to get good parts, optimizing gate locations early in the process, accurately predicting cooling patterns, eliminating mold retooling and freight costs, and material savings due to fewer defects."

Beyond this, OEM/Erie has used simulation to add a new competency to their portfolio: in-mold decorating (IMD). After taking on a project for International Truck and Engine Corporation for

three interior consoles, simulation was used extensively to place the gates, design the runner systems, and optimize the cooling layout.

McCullough notes, "Overall, [simulation] predicted the thermal effects of the in-mold decoration material quite well. Simulation is critical for successful IMD as the gating, filling and process conditions can make or break your quality." ■

structural analyses performed on injection molded plastic parts are of the highest possible accuracy. MPI-e also features an application programming interface (API) that can be used to customize outputs and interface with other software applications used across the organization.

The enterprise-wide implementation of MPI-e means everyone within the organization has access to open up the software to interpret the results of an analysis. To communicate results outside the enterprise, MPI-e also includes advanced reporting tools that create Microsoft Word, PowerPoint or internet-ready reports. MPI-e can also export results to the Moldflow Communicator, a free product that allows anyone to visualize, quantify, and compare simulation results.

## The Moldflow Advantage

When you purchase a Moldflow product, you are investing in a technology partnership founded on new product innovation and world-class customer support and training. With close to 300 employees in 15 different countries, Moldflow is a truly global company able to provide all our customers with local sales and technical services. Some

of the additional services Moldflow offers include:

### ■ Material testing –

Moldflow's software currently contains the largest database of materials characterized for use in CAE with over 8000 different resins available. If a particular material is not already in the database, Moldflow has two state-of-the-art labs, one in the US and one in Australia, that can fully characterize both commercial and proprietary grades of resins. Patented tests performed in Moldflow's labs are specifically designed to ensure that analysis results accurately reflect what happens in real-world molding, so design changes can be made with confidence.

### ■ Expert-led training –

The key to maximizing the investment in simulation is to train users so they feel comfortable using the software and confident in their results. Moldflow offers a variety of training options including expert instructor-led courses that are available either on-site or in one of the Moldflow Center for Professional Development classrooms. Along with training, Moldflow also offers a formal

program where users are evaluated on their level of simulation knowledge and are able to earn bronze, silver, and gold level certifications.

### ■ Technical support –

Moldflow's technical support engineers are highly trained in software usage and typically have extensive experience in the injection molding industry. Whether you are having issues with licensing or need help running a problematic analysis, the support engineers are there to help. And, with engineers in 15 different countries, we are able to provide that support locally to make sure you are getting the best possible service.

Steve Papa, Applications Engineer at SABIC Innovative Plastics, notes, "A competitor has been trying to get me to look at their software, supposedly as good and cheaper to purchase. A big reason I am not interested in looking at their product is because of Moldflow's technical staff. They are truly the differentiators and are a big reason why I will always stick with Moldflow."

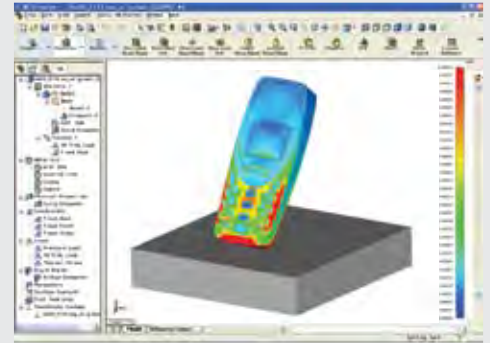
To take the first steps towards optimizing your product development cycle using enterprise-enabled simulation, visit us at [www.moldflow.com/enterprise](http://www.moldflow.com/enterprise).



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# 3D Gas-Assisted Injection Molding Simulation Streamlines Concept-to-Production

By MARCIA SWAN, EDITOR



For companies involved with gas-assisted injection molding, Moldflow's MPI/Gas simulation software provides know-how needed to understand this complex process and ensure that part designs, mold designs and the molding process itself are optimized before production or even tooling begins.

*Mack Molding Company evaluated MPI/3D Gas simulation during the development of this new mass transit seat design.<sup>1</sup>*

Companies like Arlington, Vermont-based Mack Molding Company are using 3D process simulation to realize more fully the advantages inherent in the gas-assist process to produce the high-quality parts efficiently and economically.

Gas-assisted injection molding is a versatile process that provides tremendous flexibility in the design and manufacture of plastic parts. Compared to conventional injection molding, the gas-assisted process has the potential to produce hollow, lightweight, rigid parts that are free of sink marks and less likely to warp. Additional advantages include material savings, reduced cycle time, reduced pressure and clamp force tonnage requirements, and the ability to consolidate thick and thin sections in a single part.

Because the process involves the dynamic interaction of two dissimilar materials flowing within typically complex cavities, optimizing product, tool and process design for gas-assisted injection molding can be quite complicated. Furthermore, experience with conventional injection molding is not sufficient to address the specialized requirements of the gas-assisted process, especially in designing the gas-channel net-

work, optimizing gas penetration and optimizing the processing window.

## Process Overview

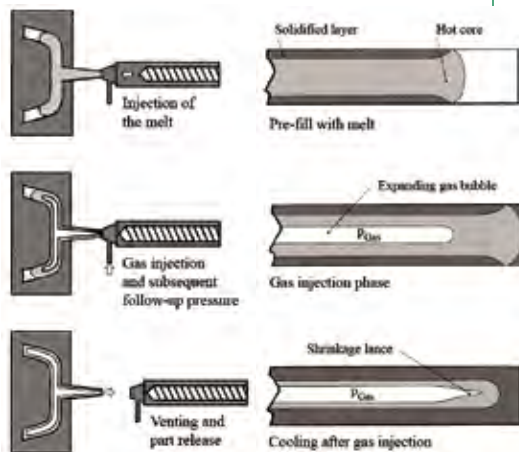
The gas-assisted injection molding process begins with a partial or full injection of polymer melt into the mold cavity. Compressed gas (typically nitrogen) is then injected under pressure control or volume control into the core of the polymer melt to help fill and pack the mold. Gas may be injected either through the nozzle of the molding machine, or by direct injection into the mold or into a runner.

## Short-shot vs. Full-shot Techniques

In the short-shot gas-assist process, the cavity is partially filled with plastic before gas is injected to complete cavity filling by pushing the plastic into the unfilled areas of the part. Maintaining gas pressure after the cavity is filled helps to pack the plastic and compensate for plastic shrinkage.

In the full-shot gas-assist process, gas injection starts only after the cavity is completely

filled with plastic. A variant of the full shot process incorporates an overflow well (or overspill) at the end of a gas channel. An overflow well is a secondary cavity, typically controlled by a valve gate, into which the gas can displace polymer and thereby penetrate further into the part. The gas packs the cavity by penetrating into the regions where the plastic is shrinking, and the extent of gas penetration is directly influenced by the shrinkage characteristics of the material.



*Stages and sequence of the gas-assisted injection molding process.<sup>2</sup>*



## Typical Applications

Typical applications for the gas-assisted process can be classified into three categories:

- **Tube- or rod-like parts**, where the process is used primarily for saving material, reducing the cycle time and incorporating product function into the hollowed section(s) .
- **Large, sheet-like, structural parts** with a built-in gas-channel network, where the process is used primarily for reducing part warpage and clamp tonnage requirement, as well as to enhance rigidity and surface quality.
- **Complex parts** comprising thin and thick sections, where the process is used primarily for decreasing manufacturing cost by consolidating several assembled parts into a single part design.












## Moldflow Solutions for Gas-assist Applications

MPI/Gas software allows users to study polymer and gas flow behavior within a part model and examine the influence of design and process modifications on the polymer/gas system. Simulation results provide information to optimize product design, including gas channel layout and size; position polymer and gas injection points; and detect and avoid common problems such as gas permeation or fingering, gas blow-through, poor gas penetration and short shot.

The latest release of MPI/Gas software extends 3D analysis capabilities to simulate part warpage. Now part designers, mold designers and process engineers can use simulation results to:

- Aid in material selection, including materials with fibers or fillers.
- Optimize part design including gas channel networks to promote desired gas penetration.

- Evaluate mold design options including gas entrance options and their impact on gas penetration.
- Determine appropriate process conditions to achieve successful molded parts.
- Predict effects of gas channels on the post-molding shrinkage and warpage of the final part.
- Quantify benefits of the gas-assist process compared to conventional injection molding.

MPI/Gas Capabilities		
Analysis Type	Analysis Technology	
Fill		
Fill+Pack		
Fiber Fill+Pack		
Cool		
Warp		
Stress		
<div> Midplane Model  3D Model  </div>		

## Customer Analysis Using MPI/3D Gas Simulation

Mack Molding Company is a leading custom plastics molder and supplier of contract manufacturing services. The company operates six injection molding facilities in the eastern United States, with 120 injection molding machines ranging from 28 to 4000 tons of clamp force, shot sizes from 0.6 to 800 ounces, and expertise in specialty molding processes, including solid injection, structural foam, overmolding, internal and external gas-assist, and two-shot molding.

Dr. Michael Hansen is a Senior Technical Development Engineer at the company's Arlington, Vermont headquarters plant. Hansen is a proponent of molding simulation and supports incorporating the technology into everyday workflow.

*Using molding simulation allows us to test and verify key aspects of a new product design during development.*

"Using molding simulation allows us to test and verify key aspects of a new product design during development. Results help us to confirm material selection, streamline part and mold design and verify processing parameters, even for our most challenging applications," he notes.

Hansen has been working in conjunction with BASF, the world's leading chemical company, to evaluate 3D simulation capabilities. Here, he presents an analysis that illustrates the utility of the MPI/3D Gas software for an innovative gas-assisted injection molding application.

### Mass transit seat

For a new seat design for mass transit vehicles, the gas-assist process using a reinforced composite resin was chosen to meet requirements of efficient use of material, aesthetics, and product structural performance criteria. Tooling considerations included filling the part from a single, central location on the part to avoid knit lines and placing gas pins and overflow wells in locations that would not be visible when the finished product was installed.

Using MPI, Hansen was able to import the 3D CAD model directly, eliminating the need to prepare a special model for molding simulation. Hansen used MPI/3D Gas simulation to investigate gas penetration patterns, gate and gas pin locations, overflow well location and size, as well as processing parameters including gas delay time, gas pressure, plastic fill time and clamp force, among others.

Molding trials showed good agreement with simulation results.

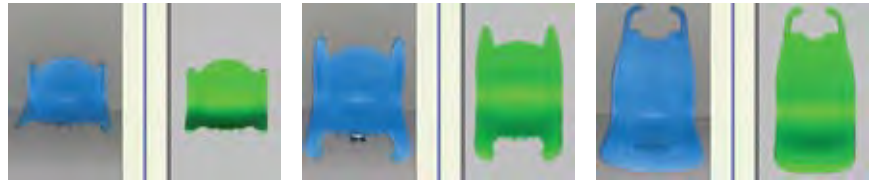
For this application, optimizing part and tool design, material selection and choice of molding



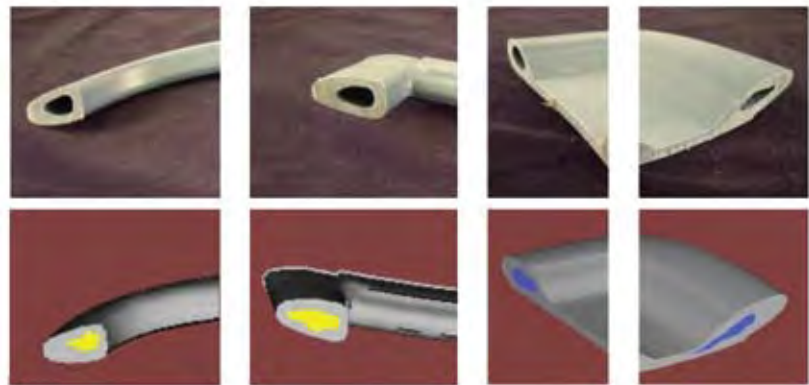


technique were essential to assuring manufacturability and durability of the finished product. Hansen emphasizes, "Using CAE tools is a key factor in time-to-market and achieving a smoother transition from concept to real-life production." ■

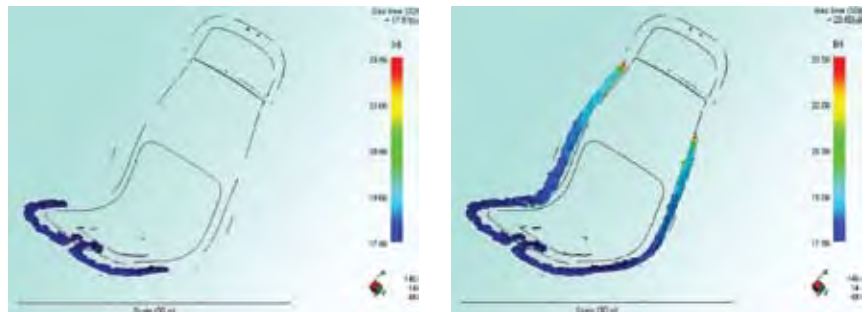
Mack Molding Company provides design through FDA-approved manufacturing services to the medical, commercial, computer and business equipment and transportation markets. With 87 years of plastics expertise, the company integrates product development, custom injection molding, sheet metal fabrication, and full product assembly in ISO 9001 and ISO 13485 environments. Product development resources include design, prototyping and extensive engineering services.



Molded short shots (shown in blue at left in each pair of images) produced at intervals throughout the cycle corresponded closely to the predicted plastic filling pattern at the same times (rendered in green at right in each pair of images).<sup>3</sup>



Cross-sections cut through gas channels showed that the gas penetration in the molded parts (at top in each pair of images) also corresponded closely to the predicted gas penetration (at bottom in each pair of images).<sup>4</sup>



MPI/3D Gas simulation results helped to confirm the design of the gas channel pattern.<sup>5</sup>

Images provided courtesy of Mack Molding Company:

<sup>1, 3, 4, 5</sup> Michael Hansen, Ph.D., Mack Molding Co., "Gas-assisted Mass Transit Seat: Comparing Real-life Molded Part Data with Simulated 3D Numeric Mold Filling Results," Society of Plastics Industry Conference, Memphis, TN, April 2007.

<sup>2</sup> Michael Hansen, Ph.D., Mack Molding Co., "Gas-assist Injection Molding: An Innovative Medical Technology," MD&DI, August 2005.



# Tips to Facilitate Report Generation

By MATTHEW JAWORSKI, TRAINING SERVICES MANAGER

**Moldflow Plastics Insight® (MPI®) and Moldflow Plastics Advisers® (MPA®) products both offer an easy-to-use Report Generation Wizard that helps users to summarize and communicate analysis results with others.**

In addition to preparing reports in the default HTML format, users can also produce reports in Microsoft® Word® document (\*.doc) and PowerPoint® presentation (\*.ppt) formats. Extensive documentation and examples of how to create reports can be found in the MPI and MPA product Help systems (**Help > Search Help > Contents (tab) > Working with Reports or Help > Tutorials > Generating Reports**).

This article presents three useful tips related to report generation, including how to use the **Plot Note** tool, how to save images with multiple results or studies, and how to avoid report viewing errors when saving reports with embedded animations in \*.doc or \*.ppt formats.

## **Tip 1: Add a Plot Note to a Result**

The **Plot Note** tool offers a useful way to add text comments that are associated with a particular result plot, and the notes are saved with the study. When a result image with an associated plot note is added to a report, the text of that plot note is used as the initial image description in the report. Any changes made to this text once it has been included in the report will only appear in the report; the text of the plot note itself remains unchanged.

This feature is particularly useful when generating many reports that use similar text or when including long, explanatory descriptions. The procedure to add a plot note to a result in an open study is as follows:


- 1 Display a result plot.

*NOTE: This feature is available only for analyses that produce at least one graphical result plot.*

- 2 Click  (**Results > Plot Notes**).

The **Plot Notes** tab of the **Notes** panel appears and becomes active.

- 3 Enter the text to associate with the displayed result plot in the space provided.

- 4 Click  (**File > Save Study**) to ensure that the note text is retained with the result in the study.

*NOTE: Each plot note is associated with a single result plot.*

For our example cell phone cover part (Figure 1), we have already successfully completed a Dual Domain Fill analysis using MPA 8.1 software. Figure 1 shows the results of adding plot notes to a **Pressure at end of fill** result.




## **Tip 2: Capture Split Windows or Multiple Studies in One Image**

When discussing multiple results of one study or comparing results of more than one study in a project report, it is often useful to view a single image that presents all of the results or studies simultaneously instead of having to scroll through separate report images that may span several pages. The **Image Capture Option** feature specifies the portion of the Graphics Display Area that is captured when copying an image to the clipboard or saving an image to a file. The options are:

- **Active View** causes the active view in a split window, or the window of the active study if it contains only one view, to be captured.
- **All Views** causes all (up to four) views in a split window of the active study to be captured.
- **Graphics Display Area** causes all of the windows displayed in the Graphics Display Area, including the Analysis Log/Results Summary pane if you chose to display it, to be captured.

When the captured image is saved to a file, it must be added manually to a project report.

To capture four results of one study in a single image, follow this procedure:

- 1 Open a study that includes results.
- 2 Use the  **Horizontal Split** and  **Vertical Split** tools on the **Viewer** toolbar (**View > Toolbars > Viewer**) to create four views in the active study window.
- 3 Select **View > Lock > All Views**.  
This synchronizes the rotation, panning and zooming of all views in the split window.
- 4 Use the  **Rotate** tool on the **Viewer** toolbar to rotate the model to an appropriate viewing angle.
- 5 Display a different result in each view.
- 6 Select **Edit > Image Capture Option > All Views** to capture all four split views in the active study window (see Figure 2).
- 7 Select **Edit > Save Image to File**.
- 8 Navigate to the location in which you want to save the image file.
- 9 In the **File name** text box, enter a name for the image file.
- 10 Select the desired image file format from the **Save as type** drop-down list, and then click **Save**.

To capture results of multiple studies in a single image, follow this procedure:

- 1 Open at least two studies that include results.
- 2 Use the **Window > Tile Horizontally** or **Tile Vertically** tools to make all of the study windows visible in the display.
- 3 Display the result(s) of interest in each study.
- 4 Select **Edit > Image Capture Option > Graphics Display Area** to capture all windows displayed (see Figure 3).
- 5 Select **Edit > Save Image to File**.
- 6 Navigate to the location in which you want to save the image file.
- 7 In the **File name** text box, enter a name for the image file.
- 8 Select the desired image file format from the **Save as type** drop-down list, and then click **Save**.

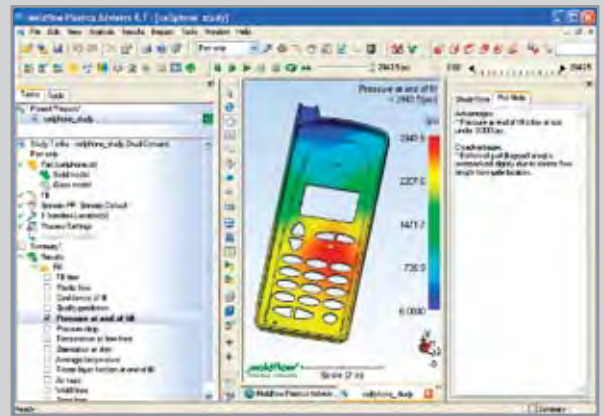


Figure 1: Plot note added to Pressure at end of fill result in MPA 8.1.

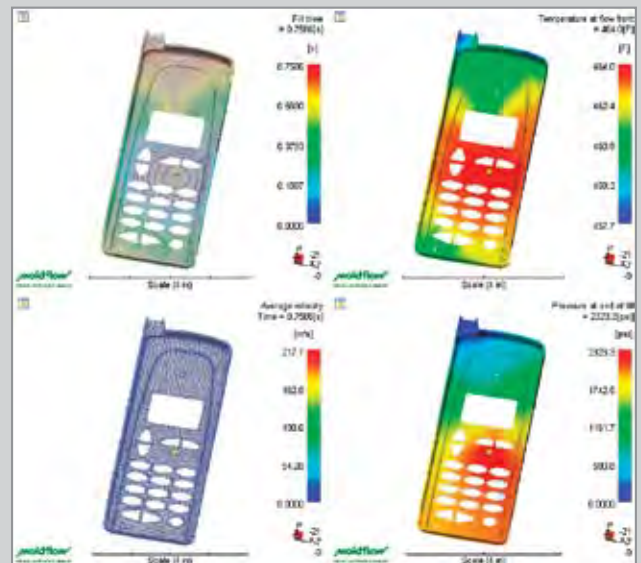


Figure 2: Example of a single captured image showing multiple results from one study in split views.

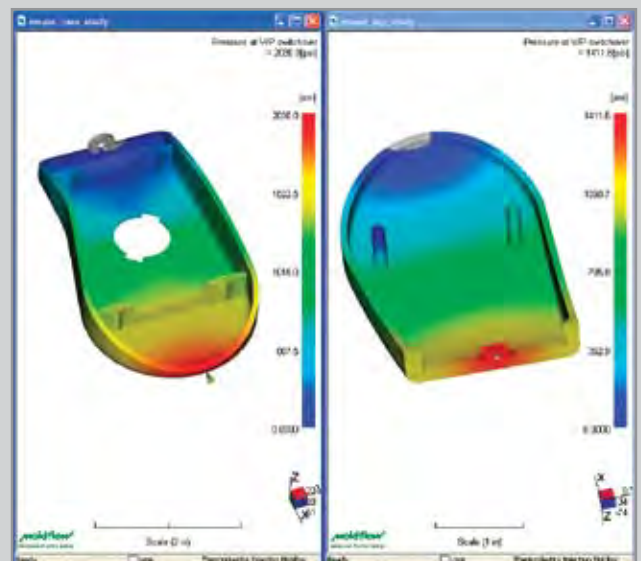


Figure 3: Example of a single captured image showing results from two studies in windows that have been tiled vertically.





### **Tip 3: Set File Type Association to View Report Animations Properly**

When generating project reports in \*.doc or \*.ppt formats, two preliminary steps are necessary.

1. The appropriate Microsoft program must be installed on the computer on which the report is generated. Reports can be viewed using the appropriate Word or PowerPoint program in the Microsoft Office 97 suite or later versions.
2. All Windows systems must have required file type association settings in order for the reports to display embedded images and animations properly.

To display embedded animations in \*.avi format in \*.doc or \*.ppt reports, the \*.avi animation file type should be associated with the default Microsoft Windows Media Player. If the \*.avi file type is associated with another program, embedded animations may not display properly when the generated report is view using the Microsoft Word or PowerPoint program.



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### **To check and change \*.avi file type association setting, follow this procedure:**

*NOTE: It is recommended that you close all programs before proceeding.*

- 1 From the **Windows Start** menu, select **Control Panel**.
- 2 On **Windows XP** systems:
  - a. From the **Name** list, select **Folder Options**. The **Folder Options** dialog opens.
  - b. Select the **File Types** tab.
  - c. Scroll through the **Registered file types** list and find **AVI** in the **Extensions** list. The **Details for 'AVI' extension area** should show that files with extension \*.avi open with Windows Media Player.
  - d. If another program is associated with the \*.avi extension, click the **Change** button. The **Open With** dialog appears.
  - e. Select **Windows Media Player** from the Programs list. Ensure that the **Always use the selected program to open this kind of file** option is turned on. Click **OK** to accept the selection and return to the **Folder Options** dialog.

#### **On Windows Vista systems:**

- a. From the **Name** list, select **Default Programs**. The **Default Programs** dialog opens.
  - b. Select **Associate a file type or protocol with a program**. The **Set Associations** dialog opens.
  - c. Scroll through the **Extensions** list and find the \*.avi extension. The **Current Default** column should show that files with extension \*.avi open with Windows Media Player.
  - d. If another program is associated with the \*.avi extension, click the **Change program** button. The **Open With** dialog appears.
  - e. Select **Windows Media Player** from the **Recommended programs** list. Ensure that the **Always use the selected program to open this kind of file** option is turned on. Click **OK** to accept the selection and return to the **Set Associations** dialog.
- 3 When the \*.avi file type is set to open with Windows Media Player, click **Close** to accept these settings.
  - 4 Close the Control Panel.

*NOTE: Changing the file type associations as described restores Windows default behavior and file type associations, which other graphic programs might have overridden. Changing these file type association settings should not cause problems when using any other programs. ■*

# Automating the Creation of Results Files Using the Moldflow Plastics Insight API

By MATTHEW JAWORSKI, TRAINING SERVICES MANAGER

There is a saying that “knowledge itself is not fully realized unless it is shared.” The knowledge gained from performing CAE analysis is no exception to this statement. One of the best ways to communicate analysis results to others is to share the actual results themselves.

**M**oldflow Plastics Insight® (MPI®) and now Moldflow Plastics Advisers® (MPA®) users can export Moldflow Results files (\*.mfr) for use with Moldflow Communicator. Moldflow Communicator is a free utility developed specifically for visualizing, quantifying and comparing Moldflow Re-

sults files; download it from [www.moldflow.com/communicator](http://www.moldflow.com/communicator).

Moldflow results files can contain a specified number of results from one or two studies in a project, thus allowing users and non-users alike to share analysis results and design knowledge within distributed product teams and across organizations. However,

the manual process of marking results for export can be tedious, especially if more than one study is involved. This article shows you how to automate the creation of \*.mfr files in MPI using the Application Programming Interface (API), which is an Object Linking and Embedding (OLE) programming interface.

**Objective:**  
Automate MPI \*.mfr file creation for any study with Dual Domain Fill+Pack analysis results.

## Step 1: Preparation

For our example lid part (Figure 1), we have already successfully completed a Dual Domain Fill+Pack analysis and customized any plot properties by right-clicking on a desired plot and selecting Properties. Figure 1 shows the results of changing the Fill time plot properties to display as contour lines.

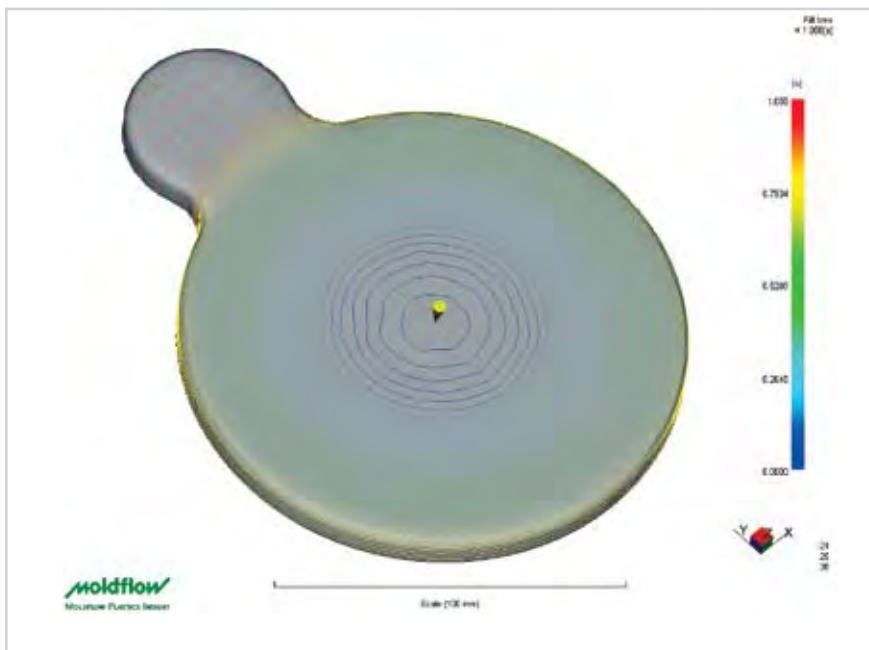



Figure 1: Fill time plot with properties modified to display contour lines.



## Step 2: Recording a Macro

You do not have to be a guru in computer programming to use the API functionality effectively. The easiest way to get started is to record the steps you want to automate using the macro recording tool in MPI's user interface, Synergy. The procedure to record a macro for marking and exporting results to an MPI \*.mfr file is as follows:

- 1 Click  (**Tools > Start Macro Recording**).
- 2 Right-click on a result name in the list of results and select **Mark for export**.

An asterisk appears after the result name indicating it has now been marked for export.

*NOTE: Analysis logs are exported by default. To exclude all analysis logs from the Moldflow Results File, right-click the Logs checkbox, then select Unmark for export.*

- 3 Repeat to mark additional results for export in the same way.

In this example, we have marked six results for export: Fill time, Pressure at V/P switchover, Volumetric shrinkage at ejection, Average velocity, Bulk temperature, and Temperature at flow front (see Figure 2).

*NOTE: MPI 6.2 and MPA 8.1 allow you to export a maximum of eight results per solver type from each study.*

- 4 Click  (**File > Export**).
- 5 Navigate to the location in which you want to save the export file.
- 6 In the File name text box, enter a name for the export file.  
  
In this example, our file name is **fill.mfr**.
- 7 Select **Moldflow Results File (\*.mfr)** in the **Save as type** drop-down list, and then click **Save**.
- 8 A confirmation dialog appears to inform you the results were exported successfully. Click **OK**.
- 9 Click  (**Tools > Stop Macro Recording**). The **Save Macro** dialog appears.
- 10 Navigate to a directory of your choice, enter a name for the macro in the **File name** box, and then click **Save**.

The new script is saved with a \*.vbs file extension, and it now can be used as a Visual Basic script. In this example, our script name is **mfr\_export.vbs**, and it is saved in the directory C:\My MPI Projects\scripts.

*NOTE: The default script location depends on the operating system and installation parameters, but you can modify the location by changing your preferences within Synergy (File > Preferences > General (tab) > Project directory).*

**Table 1: Macro Recording:**

1. SetLocale("en-us")
2. Set Synergy = CreateObject("synergy.Synergy")
3. Synergy.SetUnits "Metric"
4. Set PlotManager = Synergy.PlotManager()
5. PlotManager.MarkResultForExport "Fill time", True
6. Set PlotManager = Synergy.PlotManager()
7. PlotManager.MarkResultForExport "Pressure at V/P switchover", True
8. Set PlotManager = Synergy.PlotManager()
9. PlotManager.MarkResultForExport " Volumetric shrinkage at ejection", True
10. Set PlotManager = Synergy.PlotManager()
11. PlotManager.Mark Result ForExport "Average Velocity", True
12. Set PlotManager = Synergy.PlotManager()
13. PlotManager.MarkResultForExport "Bulk Temperature", True
14. Set PlotManager = Synergy.PlotManager()
15. PlotManager.MarkResultForExport "Temperature at flow front", True
16. Set Project = Synergy.Project()
17. Project.Export "C:\Temp\mfr\_Export\fill.mfr", True, True

Table 1 shows the contents of the recorded macro. *NOTE: The numbers listed before the script lines in Table 1 are there for reference only.*

- Line 1 ensures the locale in which the script was recorded, in this case English – US, is also the locale in which the script is played back to avoid any locale-related character issues.
- Line 2 creates an OLE automation object that starts the most recent version of Synergy.  
*NOTE: Only one version of Synergy is able to run at any time when using the API.*
- Line 3 defines the default units. English can replace Metric in this line to use English measurement units by default.
- Lines 4, 6, 8, 10, 12, and 14 initialize the PlotManager object using the Synergy PlotManager class. Only one statement is needed, but the recorded script treats each user interface action as a discrete action, thus resulting in the redundancy.
- Lines 5, 7, 9, 11, 13, and 15 mark our selected results for export using the PlotManager class.  
*NOTE: The MarkResultForExport function is sensitive to result name changes, so this script may not be compatible with future or previous MPI releases if the result names are different.*
- Line 16 initializes the Project object using the Synergy Project class.
- Line 17 exports the \*.mfr file to the path specified using the Project class. The True text is for the dialog box decisions associated with this export command.



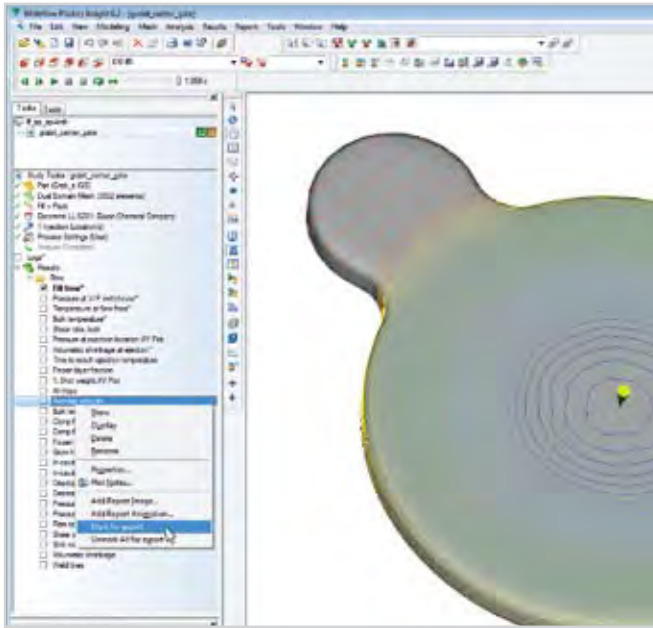


Figure 2: Results marked for export are indicated by an asterisk after the result name in the Study Tasks pane.

### Step 3: Using a Saved Macro

Now we can use the saved macro script to export the selected results automatically from any Dual Domain analysis that has Fill+Pack results, without having to mark each result for export manually. The procedure for playing a saved macro is as follows:

- ❶ Select  (**Tools > Play Macro**). The **Open Macro** dialog appears.

Navigate to the location where the desired macro file is stored. In this example, our macro file was saved in the **C:\My MPI Projects\scripts** folder.

*NOTE: The default macro location is system and install dependent.*

- ❷ Select a script, then select **Open**. In this example, we open the **mfr\_export.vbs** file.
- ❸ The script plays.

*NOTE: You must use the MPI command line if the script requires command line arguments, unless the script prompts for user input.*

### Step 4: Modifying the Macro Script

We could easily stop here, but what if we want to make modifications to further enhance the automation or usability of the script? Below are some examples of enhancements that could be added to improve the script, such as adding explanatory comments, checking for errors, and adding a pop-up window to allow user-specified file name changes during export.

#### Example Modified Script Segments to Automate MFR File Creation: Help, Comments and Explicit Option

1. '@ DESCRIPTION
2. '@ This command will automatically export specified MPI Dual Domain
3. '@ Fill plots into an MFR file for one study.
4. '@
5. '@ Plots are Fill time, Pressure at V/P switchover, Volumetric shrinkage
6. '@ at ejection, Average velocity, Bulk temperature, Temperature at flow
7. '@ front
8. '@
9. '@ SYNTAX
10. '@ mfr\_export
11. '@
12. '@ DEPENDENCIES/LIMITATIONS
13. '@ 1. User must open a study in MPI Synergy before using this command
14. '@ 2. The study must have fill analysis results for a Dual Domain mesh
15. '@ 3. Script valid for MPI 6.x result plot names
16. '@
17. '@ HISTORY
18. '@ Created by MJJ; 14/Mar/08
19. '@@
20. Option Explicit
21. Dim CustomText, FileName, Fpath1, Fullpath, FullPathMsg, FullPathTitle
22. Dim fso, Plot, PlotManager, Project, StudyDoc, Synergy

■ **Lines beginning with the single quote character (')** are comment lines and are ignored when the script is executed. It is generally considered good practice to add explanatory comments at the beginning of scripts for future reference.

■ **Lines 1-18** use the '@ prefix to signify help text for a command. Line 19 uses the '@@ prefix to signify the end of the help lines. If the script file (**mfr\_export.vbs**) is placed in the MPI installation commands directory, typing "**help mfr\_export**" in the Synergy command line will extract the help header information and display it as command help, as shown in Figure 3.

■ **Line 20** forces explicit declaration of all variables in that script (e.g. Dim in lines 20-21), which helps reduce programming errors. For instance, if you attempt to use an undeclared object name, an error occurs.

■ **Lines 21-22** declare object variables and allocate storage space.

```

23. Set Plot = PlotManager.FindPlotByName("Fill time")
24. If Plot Is Nothing Then
25. MsgBox "No Fill time plot in result set",, "ERROR"
26. WScript.Quit
27. End If

```

- ➡ **Line 32** populates the FullPath object with an assembly of the project directory and user entered export file name (e.g. CustomText object contents).
- ➡ **Line 33** exports the selected results to the user defined mfr file in the current project directory.
- ➡ **Line 34** populates the FullPathMsg object with a message indicating where the file was stored.  
*o VbCrLf is a Visual Basic Carriage Return Line Feed which simply moves to the next line.*
- ➡ **Line 35** populates the FullPathTitle object with text.
- ➡ **Line 36** uses the MsgBox function to display a message box with the text in line 34 and the title text from line 35.



- 28.** Set Project = Synergy.Project()
- 29.** CustomText = InputBox("Enter the file name for the exported MFR file without an extension:" & vbCrLf & "EX: fill.mfr", "Export MFR File Name")
- 30.** Set fso = CreateObject("Scripting.FileSystemObject")
- 31.** Fpath1 = fso.GetAbsolutePathName(".")
- 32.** Fullpath = Fpath1 & "\" & Customtext
- 33.** Project.Export Fullpath, True, True
- 34.** FullPathMsg = "The MFR file was successfully saved in:" & vbCrLf & Fullpath
- 35.** FullPathTitle = "MFR Export Successful!"
- 36.** MsgBox FullPathMsg,, FullPathTitle

- ➡ **Line 28** initializes the Project object with the most recent Synergy project.
- ➡ **Line 29** populates the CustomText object with user input generated from a pop-up input box with guided instructions.  
*Alternatively we could have used this line to obtain the user specified full path location and \*.mfr file name for saving (e.g. C:\Temp\MFR\_Export\fill.mfr).*
- ➡ **Line 30** initializes the fso file system object.
- ➡ **Line 31** uses the fso object to obtain the current MPI project directory the active study is in.

A fully functional version of the modified script described in this article is available to registered MPI customers on the MPI Community Center web site in the **Training Material > Macro Exchange - Scripts** area; select **Export MFR fill results to a file**. Download this script onto your local computer and use Step 3 to try it out for yourself.

NOTE: Moldflow Results files exported from MPI 6.2 must be viewed with Moldflow Communicator 2.0.

Extensive documentation and more examples of using the API can be found in the MPI Help (**Help > Search Help > Contents (tab) > Application Programming Interface (API) or Help > Tutorials > Automating MPI.** ■

# Taking Concurrent Engineering One Step Further: **Consider Recycling**

By ROBERT MALLOY, PROFESSOR, UNIVERSITY OF MASSACHUSETTS LOWELL

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**Developing new plastic products is always an interesting challenge that can be approached in a variety of different ways.**

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**T**he products we develop must satisfy a variety of criteria, be aesthetically pleasing, functional over the product's service life, safe, economical and they must be manufacturable. Historically, plastics products, like many other products, have been developed using the so called "Over the Wall Approach to Design". In many ways, it is human nature that the designers of new products want their own ideas to drive the development. In reality however, this approach to product development does not lead to the most efficient product designs, at least not in a timely manner. This series and compartmentalized approach to design, where there is limited communications between the various professionals involved in the development process, is common. Those involved in the early upstream concept stages of design, such as industrial design, establish the shapes that the engineers, tooling designers and manufacturing engineers must bring to fruition. In many cases, the part geometries established by the industrial designers and the product designers are in fact found to be difficult or impossible to manufacture once these proposed part designs reach the eyes of the tooling designer. In such a case, the tooling designer will recommend changes and a more manufacturing friendly design can be jointly developed. However, it should be noted that the x-axis in figure 1 is time, and movement to the left along the x-axis is wasted time. Delays in new product development are almost always traced back to a lack of coordination between various parties involved in the product development process.

The solution to this all too common problem is not complicated. It is simply a matter of management philosophy. The same product development groups shown in figure 1 must function more like a team with greatly improved communications. Conceptually, "Concurrent Engineering" as it is commonly called, is like putting all of the professionals involved in the product development process in one room, with no walls between them. When the industrial designer



or the product designer propose a geometry, the manufacturing engineer or the tooling designer can weigh in immediately and bring manufacturing issues to the forefront before detailed designs are developed. This improved communications leads to more well-balanced product designs that are achieved in a much more timely manner. There are no surprises as the product develops because everyone involved in the product development process has had input into the key design decisions.

While the concept of concurrent engineering is well understood, it is not easily implemented in practice, largely for one very understandable reason. Looking back many years, there were days when very large corporations did in fact employ all of the professions involved in new product development. Some companies did employ designers, mold makers, tool builders, and did molding/manufacturing in house. In such a case, it would be relatively easy to literally put everyone involved in the same room. Such a business model is rare today. The reality today is that for the most part, corporations run lean. The use of vendors for each of these product development functions is the norm, for good or bad. The advantages of vendor-based product development are numerous in terms of economics and product quality when managed effectively. Vendors that possess capabilities closely matched to the new product can be utilized. However, from a concurrent engineering perspective, the logistics of bringing all of these people together, in the same room, so to speak, becomes an issue. In some ways, it is



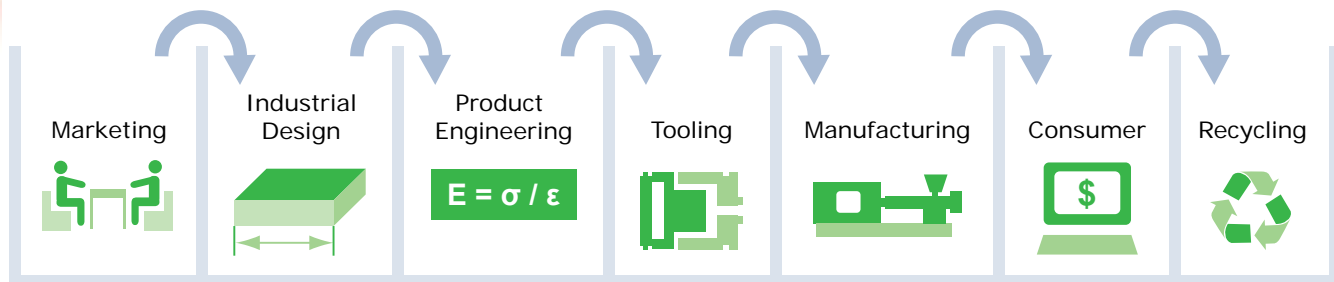


Figure 1

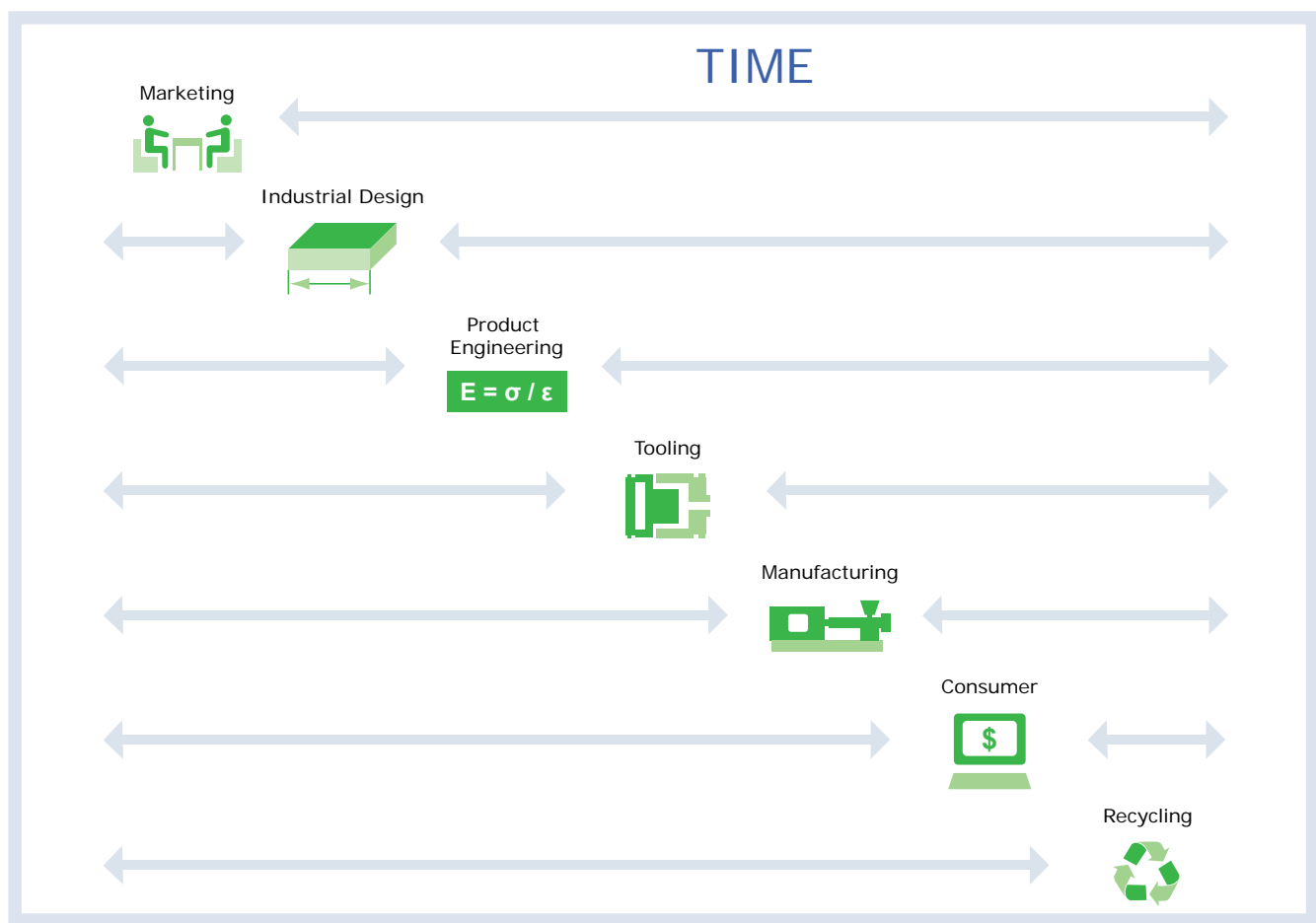


Figure 2

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actually much easier to be in the same "virtual room" today thanks to the wonders of internet-based communications. However, this can only happen when project managers make sure this does happen. The single most important action is to identify all vendors involved in the project up front and ensure that the lines of communication are well established. The practice of designing products and then going out for tool bids is the ultimate example of the over the wall approach to new product development. If concurrent engineering is to be practiced, designers, by definition, must have the ability to run their ideas past tooling and manufacturing groups before their designs are finalized.

The concurrent engineering and design concepts described above are well known and well established. But perhaps we need to take this concept of concurrent engineering one step further in terms of designing new products in a more environmentally friendly manner. The products we design today, with very few exceptions, have been designed with little or no input from anyone who needs to deal with the product after it is used by the consumer. The plastic products we design and manufacture today will all have some impact on our environment after their useful service life has expired. Landfilling, incineration, composting (in the case of biodegradable or compostable plastics), reuse and recycling are all possibilities. Recycling in some way, shape, or form, is clearly an admirable goal for any new product. If we design and develop new plastics products without consulting the "recycler", we are guilty of practicing the over-the-wall approach to design as it relates to the environment. The design of a product has a very significant impact on the recyclability of the product. It is important to note that designers do not determine if a product will in fact be recycled, but designers do have a direct impact on the "ease" of recycling a product, which does impact the likelihood of recycling.

Like concurrent engineering itself, this environmental design concept is simple; bring the recycler into the room when new products are developed, so that they can provide their insight when important design decisions are made. As with any input, the project leader may choose to take or ignore the advice, but at least an informed decision can be made with respect to potential recyclability. The primary objective of the product designer is to design a functional product economically, but if the product can also be more easily recycled, that is a plus. Even very simple design changes can have a very significant impact on the recyclability of a product. Materials of construction, ease of disassembly, coding, methods of decorating are but a few of the important areas of concern. Replacing screws and inserts on an electronics enclosure with snap fits would make the enclosure more recyclable. The recyclability should not be the sole factor in driving the design but should be taken into consideration as a factor. Likewise, if

several materials were being considered for a new plastics part, and one was more recyclable than the others, that should be considered along with other material properties being considered.

The concept of involving the recycler when making major design decisions is simple, but the practice of doing so is not as easily implemented in most cases for one simple reason. The "recycler" is not always easily identified. In a limited number of cases, where the plastics recycling infrastructure is well established, it is a reasonable expectation to include the recycler as part of the product development team because the recycler is easily identified. Designers of HDPE bottles can look to trade associations and commercial recyclers for guidance without difficulty. However, the limited plastics recycling infrastructure means that designers of most plastic products, even designers who have the desire to consider the recyclers input, may not have the option to do so. As we move forward in time, the plastics recycling infrastructure will continue to develop, and the simple concept of involving the recycler in the early stages of product development will hopefully become more of a widespread reality. ■

*Currently serving as the Department Chair at the University of Massachusetts Lowell, Prof. Malloy remains an active educator and researcher in the areas of plastics product design, polymer processing, recycling of thermoplastics. UML now offers on-line graduate classes in plastics. Go to <http://plastics.uml.edu>.*



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