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FLOW front

the magazine of choice for plastics professionals

Partnership & Collaboration

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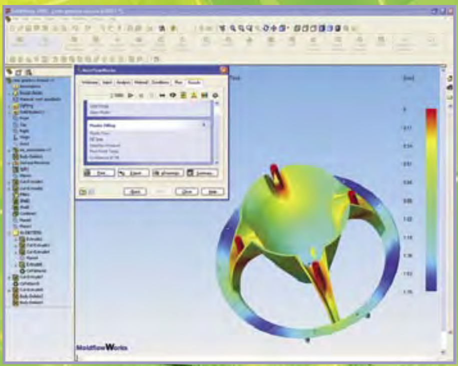

Collaborative Product Development Introduces Design Analysis Solutions to World's Largest Mainstream 3D Solid Modeling Community

Success Stories:

- Avenue Mould
- Cascade Engineering
- Group iNoPLAST
- Radici Plastics
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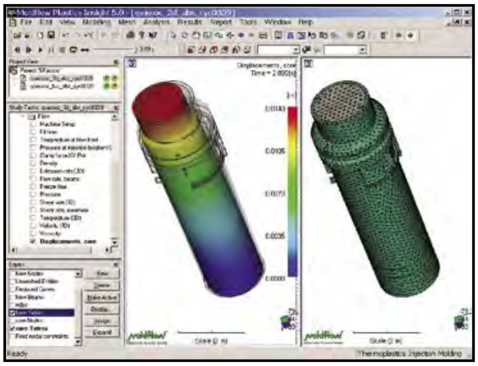
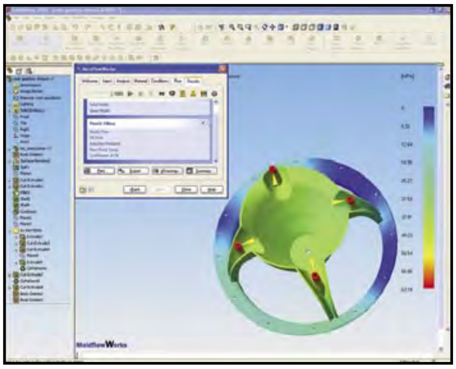


MPI 5.0 release enhances user productivity, improves simulation accuracy and provides new 3D analysis capabilities

cover story



MoldflowWorks gives SolidWorks users easy access to Design Analysis Solutions

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Strategic Partnerships — Working Together in a Competitive Marketplace

In the early 1990s, the software and services marketing buzzwords were concurrent engineering and collaborative engineering. The terms were based on the thought that those who implemented CAD/CAM/CAE products and practices were in a better position to interact with everyone involved in streamlining the design process. From a marketing standpoint, it sounded good; but in reality, it's taken a long time for companies to embrace the idea of creating a teamed effort among the work group — designers, engineers, analysts and customers. Change is difficult, but it is happening. Why? Because in today's global marketplace manufacturers have had to fundamentally change their approach to product design and fabrication in order to remain competitive and profitable. The idea of teaming was a natural evolution to address design-for-manufacture requirements.

While engineering teams learned how to work together internally, savvy manufacturers realized the importance of including customers and partners such as outsourcing entities in the collaborative schema. These strategies are central to product development success and ability to meet ever-shrinking production schedules.

One unique example of Moldflow's collaborative effort with its partners is expressed by Brian Houle, SolidWorks' partner program manager. "Both SolidWorks and Moldflow have aggressive development teams that like to make things happen quickly. When SolidWorks considered incorporating MoldflowXpress into SolidWorks 2005, there were some very tight deadlines to meet. The Moldflow team beat those expectations time after time, and worked well with SolidWorks engineers to deliver a fantastic product. On the marketing and sales side, it has always been tremendously easy to work with Moldflow. The best part is that the two companies can offer different perspectives and ideas, and learn from each other to be more effective. Moldflow is in many ways just like SolidWorks — a great group of talented people working hard to improve the design and manufacturing process for companies worldwide."

On the manufacturing side, we recently learned that B&B Molders, a Moldflow customer based in Mishawaka, IN, is "closing the loop" in terms of design for the manufacturing environment by implementing a range of Moldflow products. Steve Rorie, B&B Molders's operations manager, says, "In order to maximize value to the customer and to B&B, we must have accurate part design, supported by accurate tool design and construction, supported by an accurate process that's in control time after time." He and his collaborative team are using Process Optimization (Moldflow Plastics Xpert) to make improvements called for by the monitoring system (Shotscope). "In addition, the Moldflow Plastics Advisers (MPA) tools provide simulation capability before we ever start to cut steel, thus giving the mold maker a high level of confidence in the first shot performance without all the rework of the past," says Rorie.

As part of B&B Molders' collaborative effort, the organization continually strives to improve communications alongside technological updates. Rorie reports, "Thanks to the Moldflow products, we are able to communicate up-to-date 3D renderings and CAD data not only internally within our organization, but also back and forth between customers and secondary sources. In today's supply chain, there are multiple tiers of vendors that are part of the communications loop. So, without the ability of electronically transferring all the updated project-related data, you're fighting an uphill battle."

Using Shotscope, the B&B team transfers data directly to the shop floor through document screens. "Now we are able to seamlessly and electronically transfer the data out of the design engineer's hands and deliver it directly to the shop floor technician's hands," notes Rorie.

While collaboration can take many forms and can be executed in a variety of methodologies, there are some tips to help make it work successfully:

❑ Implement a distributed computing architecture, supporting synchronization, optimum scheduling and refinement of the information flow.

❑ Ensure a unified representation of all required design and manufacturing information that can be interpreted and visualized from different perspectives.

❑ Provide a set of computer-based tools that can be used by all members of the product development and manufacturing teams.

It remains true that changing processes from a traditional engineering approach to a collaborative environment can be challenging. But, by embracing changes in technology, the rewards and ROI are tangible and well worth the time and investment.

We'd like to hear about collaborative efforts that have helped your organization become more efficient. What innovative strategies have you initiated that help your design-for-manufacture processes? What does collaboration mean to your company? What steps did you and your team take to facilitate collaboration? What were some of the obstacles that you overcame? We'll include your commentary in future issues so that readers can benefit from your best practices and suggestions for improvement.

Laura Carrabine

Laura Carrabine
Editor

Cascade Engineering Gains Competitive Advantage with Moldflow Silver Certification

By Laura Carrabine, Editor

Cascade Engineering (Grand Rapids, MI) is a leader in engineered plastic systems and components. It provides innovative expertise and intelligent solutions for the automotive, solid waste and industrial markets. The company's capabilities range from compounding and testing, integrated design analysis and prototyping to large tonnage molding and plastics processing. Its global partnerships allow it to provide leading-edge products and services, while maintaining a strong commitment to lean manufacturing and environmental stewardship. The company employs approximately 1,200 people.

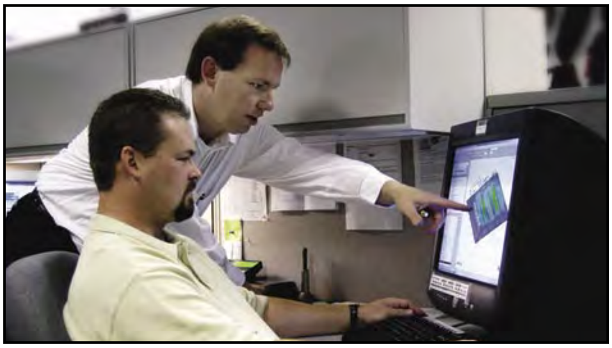
Paul Van Huffel, Don Kosheba and Richard Peek are senior engineers in Cascade Engineering's Center for Innovation (CFI). Their collective knowledge and experience allows them to develop solutions to improve product quality, reduce weight and provide better overall product performance. As a Moldflow beta test site, Cascade has been using Moldflow Plastics Insight® (MPI®) and Moldflow Plastics Advisers® (MPA®) products for three years. Their combined experience with finite-element analysis (FEA) and computer-aided engineering (CAE) — both mechanical and Moldflow — is 27 years. Using the technologies, they have been able to reduce mold costs significantly. "Before we implemented the software," says Kosheba, "we had to sample tools up to five times while making modifications before we could produce a good part. Today, we are able to bring a mold in and make good parts the first day."

"Once the customers understand the time we've spent and our commitment to improving expertise, they realize how our efforts and this certification can help fulfill their needs and expectations. We believe that Silver Certification gives us a competitive advantage." — Paul Van Huffel

The CFI team notes that their prior career experiences on the plant floor provided plenty of day-to-day instances of what was wrong with the mold process. "My desire to learn CAE was out of frustration that I saw on the plant floor," says Kosheba. "It was a daily battle to get molds to run properly. Once I started using CAE tools, I wanted to find solutions to these costly and time consuming problems."

Van Huffel says, "As I was finishing my plastics engineering degree, I started learning FEA in a product design class. I was instantly hooked on the idea of being able to predict problems before they happened. I could find the problem up-front and prevent it."

As a team, the three engineers all have had a keen desire to continually improve skill sets and maximally utilize software tools. Van Huffel says, "We are a company that is very dedicated to education enhancements. Technologies change daily in today's world. Since graduating from college, I have returned to take advanced calculus classes to enhance the way I use MPI and MPA." In addition, CFI has a macro on the Moldflow Community Center web site for calculating volumes of tetrahedrons to venting calculations or trapped air calculations.



Paul Van Huffel (standing) and Don Kosheba are Moldflow Silver Certified senior engineers in Cascade Engineering's Center for Innovation, where they use their expertise to develop solutions to improve product quality and performance

For these reasons, the CFI engineers completed the full suite of Moldflow training and advanced training courses and obtained Silver Certification in March 2004. "We believe," adds Peek, "that the training experience and certification have brought many benefits including helping us to maximize our use of MPI and MPA, leveraging results and using the information to our advantage as a competitive solutions provider."

Today, Van Huffel, Peek and Kosheba promote the Silver Certification to internal resources as well as to customers. "When we tell a customer that we are Moldflow Silver Certified," says Van Huffel, "we take the time to explain what that certification means in terms of advanced classes and extensive testing. Once the customers understand the time we've spent and our commitment to improving expertise, they realize how well equipped we are to help fulfill their needs and expectations. We believe that Silver Certification gives us a competitive advantage."

As further testament to Cascade Engineering's dedication to education, the company offers Cascade Engineering University (CEU). CEU strives to create value through knowledge and build individual and organizational competence. Its goals are to enlarge the capacity and capability of Western Michigan businesses and to improve the quality of life for people who live and work in Western Michigan. The school offers classes in program development, system design, educational opportunities, implementation of cultural development processes and development of partnerships with public and private entities. ■

For more information about Cascade Engineering, visit www.cascadeng.com

Avenue Mould Uses CAE Products and Expertise to Partner with Customers

By Laura Carrabine, Editor

Ireland based Avenue Mould has been a CAE user since 1992 and the company is one of the first moldmaking/toolmaking organizations to have the capability to carry out fill and cool simulation and analysis in-house. The team of toolmakers and manufacturing professionals at Avenue Mould specialize in molds for disposable medical products, personal care products and packaging that are designed for long service life with fully interchangeable cores and cavities.

Why use CAE?

According to Felim McNeela, Avenue Mould's managing director, moldmaking is a business with significant risks that are difficult to engineer out. "Traditionally, moldmaking is an inexact science — a black art," says McNeela. "The effort is prone to human error in both the design and manufacturing process. Customers often lack competence to accurately specify their requirements — the technical aspects of the business are managed by rule of thumb and/or intuition."

He says that this phenomenon leads to confrontational relationships with customers. "The most appropriate business model for moldmakers is to establish long-term relationships with customers that are profitable to both parties," McNeela adds. "Moldmakers need to identify and reduce risks and manage expectations."

To accomplish these mutually beneficial relationships and reduce costly risks, moldmakers, like Avenue Mould, are increasingly relying on CAE methodologies and software products. "Risk minimization facilitates the building of partnerships with customers," McNeela notes.

By implementing these strategies, Avenue Mould has developed competence and expertise in designing molds and in molding. The use of CAE software has also enhanced Avenue Mould's credibility and capabilities. McNeela says that the company realized its ROI in CAE several times over the years since it first installed the computer-based technologies.

However, the road to where Avenue Mould is today was not necessarily an easy one. First and foremost, the cost to invest in CAE in 1992 was quite high. The company partially overcame the funding issue by advance selling of analysis at discounted rates to a number of customers. In addition, skepticism toward CAE among the company's professionals who were slated to use it was significant. And, there were real concerns about training costs, learning curve time and on-going maintenance costs.

McNeela says, "At the time, we had limited CAD/CAE experience. To become proficient, we had to learn the UNIX operating system. Up to that point, we had relied on customer input to assist us interpreting results and to suggest iterations. We knew that if we implemented CAE in a serious manner, we needed to be serious about using it routinely so that knowledge retention would not be an issue."

While the cost of investment in CAE has become more affordable over the past decade, the financial return and customer satisfaction are highest in organizations that implement analysis routinely for every part or mold they design. Since 1992, the use of CAE technology from Moldflow Corporation has had a tremendous impact on several processes:

❑ **Mold Design.** The software allows mold designers to see the impact of design decisions at the design cycle — not later at the manufacturing stage where mistakes can be costly and time-consuming to repair. It has increased the awareness of the science of molding. Avenue Mould CAE users have become more expert mold designers. And, molds are designed for optimum injection molding and production from the onset of the process.

❑ **Mold Test and Validation.** The use of CAE involvement at the mold design stage increases a sense of teamwork. There is less reliance on intuition, a more rigorous approach to problem-solving and mold test and validation are faster and more successful.

❑ **Customer Satisfaction/Retention**. In terms of marketing Avenue Moulds, the use of CAE promotes the company as a progressive, capable and credible organization. In addition, the software increases customer confidence and the probability of customer retention. Customers are more likely to become involved at the design stage and "buy-in" earlier. CAE helps increase product design capability.

The Future

McNeela says there is a paradigm shift in the manufacturing arena with some OEMs moving their manufacturing operations to lower labor cost countries. "Also OEMs are outsourcing non-core competencies. The implications of this trend mean only the most competent and efficient molders and moldmakers will prevail. Customers will require full-service contract manufacturers that can deliver a high level of competence in a range of processes and a high level of competence in project and risk management," notes McNeela.

Avenue Mould strives to become a full-service contract manufacturer and outsourcing partner by providing product design competence; mold design and manufacture; mold test and validation including launch stock production and contract molding.

Avenue Mould acquired Quality System Certification several times over, including ISO 9001 certification in 1991 and 2001.

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Using Shotscope with Multi-barrel Injection Machines

By David Duarte, Moldflow Corporation

With the release of Moldflow Manufacturing Solutions™ (MMS™) 2.0, there are a number of new enhancements to Shotscope® for process and production monitoring of the injection molding process. One of the enhancements allows users to monitor injection molding machines with more than one injection barrel. This new multi-barrel support enables our users to fully implement Shotscope in a heterogeneous production environment of single and multi-barrel equipment, resulting in the ability to improve production rates and decrease rejection rates across a broader range of equipment. The focus of this article is on this new feature and specifically how to configure Shotscope Production Manager to monitor a multi-barrel injection molding machine. It is assumed that the reader is familiar with the basics of how to configure a single barrel injection molding machine.

Configuring a Multi-barrel Machine

Although more than two injection barrels are in use at many facilities, the example in this article assumes a machine with two barrels. The following concepts can be extended to configure an injection molding machine with three or more barrels in a similar manner.

There are two types of multi-barrel machines: sequential and parallel. In a sequential multi-barrel machine, one barrel injects material first and when finished, the second barrel injects either a different color material, or a different type of material. There are a number of examples of this, such as over-molding rubber for sealing purposes in the automotive industry.

In a parallel multi-barrel machine, both barrels act independently. That is, both barrels can inject at the same time, at different times, or even with an overlap. An example of parallel injection is the use of a high percentage of regrind injected for the core of the part being produced to reduce cost, and a higher quality material injected to form the skin of the part for improved appearance, function or feel.

Sequential Barrels

A sequential multi-barrel machine is similar to a single barrel machine in terms of its configuration. There are some differences in the configuration that need to be understood. Data acquisition for barrels in a sequential multi-barrel machine begins when the first barrel starts injecting material. Data acquisition can end at various times, just like a single barrel machine except that in all cases the signal is taken from the second barrel. Using the analog channels of the machine interface unit (MIU) to collect data, they must be arranged so that they are grouped according to barrel. For example, make channels 1, 2 and 3 the pressure, velocity and displacement channels respectively for barrel 1; and make channels 4, 5 and 6 the corresponding channels for barrel 2.

These analog channels are configured in the Moldflow Foundation Configuration module by choosing Data Acquisition from the main screen (Figure 1).

Figure 1. Setting up data acquisition using the Moldflow Foundation Configuration module

Navigate to the Analog Signals page in the Data Acquisition Wizard by choosing the MIU to configure, clicking next, checking the box to the left of the MIU and clicking edit. Follow the wizard until you get to the Analog Signals page. In this page, select the Analog Ranges (V) for the different sets of channels. Using the A9800 MIU as an example, channels 1-8 are for the analog inputs. Each set of channels can be configured to use a different voltage range if required.

Note: if you are using an analog channel to trigger data acquisition, the channel must use positive voltages only.

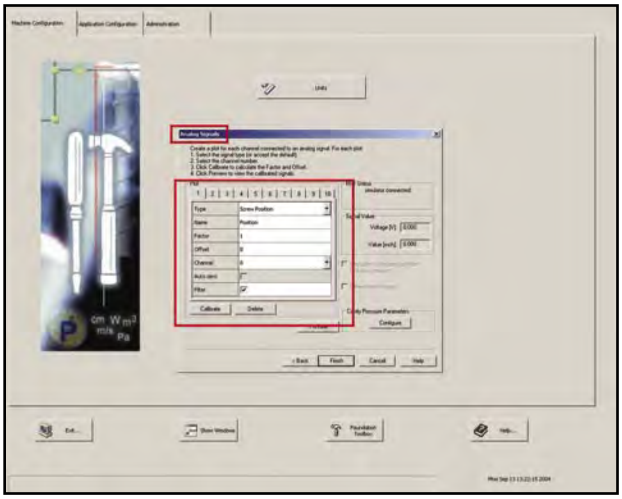

Figure 2. Configuring analog signals using the Data Acquisition Wizard

Enter the following information for each channel:

Name	The name of the channel, for example, Position
Type	The type of signal that is being input. It can be one of the following: • Screw Velocity • Screw Position • Pressure • Temperature • Other
Factor	The final signal value = the input voltage x Factor + Offset
Offset	
Auto-Zero	When Auto-Zero = Yes, the channel measurement values are offset by the average value for the first eight data points of the acquisition.

The calibration values for Factor, Offset and Auto-Zero must also be input at this time. For brevity, I will not discuss the actual calibration in this article. This information can be found in the Software Installation and Configuration Guide supplied with your software. It is also available for download at the Moldflow Community Center located at www.moldflow.com. Any customer who has current maintenance can access this information online.

Tip: Marks and parameters should be configured separately for each barrel and should have distinct names for easy identification. As marks and parameters cannot be sorted in the applications that use them, you should enter them in groups according to barrel. Enter the marks and parameters for Barrel 1 first, then the marks and parameters for Barrel 2.

One last consideration concerns material usage. Assuming Barrel 1 and Barrel 2 use different materials, you will need to create an artificial material blend. This blend is used to calculate how much material has been used in both barrels and accounts for the usage of each. For example, if 50g of PP is used in Barrel 1 and 100g of APO is used in barrel 2 for each shot, then you need to create a blend of PP (33%) and APO (67%).

Parallel Barrels

A parallel multi-barrel machine can be monitored with Shotscope without much additional configuration. The most important difference between a parallel multi-barrel machine and a sequential multi-barrel machine is that a parallel multi-barrel machine must have an A9800 MIU connected to each barrel. Data acquisition begins in each barrel independently as each is triggered by the actions of the barrel it is attached to. The two MIUs can be configured in the same way as for two machines. The data from each barrel is treated as if it comes from a separate machine. For clarity, name each MIU with a similar but different name. You can enter marks and parameters separately for each barrel. As the data is acquired separately, marks and parameters can be named the same for each barrel since they are monitored independently from each other. Similarly, there is no need to create an artificial material blend to account for usage.

Shotscope Production Manager

The final topic is bringing this all together in the Production Manager plant layout screen to allow at-a-glance visualization of the process status for a multi-barrel injection molding machine.

Configuration of the image for the multi-barrel machine is performed by editing the smon.ini file found in the bin directory. If you accepted the default locations during the installation process, this file can be found in the C:\ Program Files\ Moldflow\ Manufacturing Solutions 2.0\bin directory. There are a number of sections in this file. The section that we will be editing is the [#Machine] section. Open the file in a text editor such as Notepad by double clicking on it.

Tip: You must account for each barrel as if it were a separate machine in the [Main] section of the smon.ini file. To do this, make sure that in the line NumMachines = xx, the value for xx is set equal to the total number of barrels actively being monitored.

The [#Machine] section defines the machines visible in Shotscope Production Manager, identifying the machine type to be shown on the plant floor layout and its location on the screen. In this section you will enter:

Item	Description	Example
[#Machine]	Section header. Spelling and case must be exact. The # is the number of the machine in the smon.ini file. The total number of machines should match the NumMachines in the [Main] section of the file	[5Machine]
Name	Name of the machine as it appears in the database	Name=MC6
X	X coordinate of the machine icon on layout image	X=10
Y	Y coordinate of the machine icon on layout image	Y=10
Type	Defined type of machine. This is the name of the icon chosen for use in the bitmap directory	Type=xxx

In addition, the icon to be used must be defined in a section titled the same as the machine type chosen in [#Machine] section. In the following example, the machine type is Multi Barrel as defined in section [0machine]. The icon to be used is defined in section [Multi Barrel]. Offset is a zero-based integer to identify the first picture in the bitmap (generally = 0) and the Column is an integer identifying the total number of images in the bitmap. Available icons are found in the C:\Program Files\ Moldflow\ Manufacturing Solutions 2.0\bitmaps folder.

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Radici Plastics Finds Confidence in MPI Comparison with Molded Parts

By Giovanni Pioltini, Marketing & Technical Service Director, Radici Plastics

Radici Plastics, a division of Radici Group, represents a major international force in the engineering plastics market. Recently, Radici Plastics conducted a Moldflow Plastics Insight-based simulation study that compared data obtained from a molding simulation of a part and data obtained from molding trials of the same part.

At the onset, a mold for tensile testing was created according to ISO 527 requirements. The part was molded of Radilon A RV300, a polyamide 6.6 filled with 30 percent glass fiber.

The solid model used for filling and warpage simulation was obtained through direct measurements on the mold (Figure 1). The cavity size of the solid model was identical to the actual mold, including applied shrinkage.

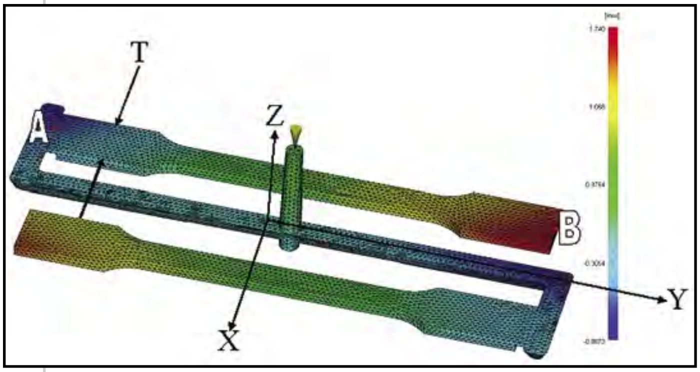


Figure 1. Solid model used for MPI simulations, showing reference points used for displacement measurements

Once the simulation was completed which included applying molding parameters, it was possible to compare the predicted warpage results with the actual molded part. At that point, it was necessary to find the best method to compare results. Options included:

❑ Execute manual control with measurement instruments (caliper and probe) with varying degrees of precision. The challenge was to set a common reference system for both real and predicted results.

❑ Recourse to visual control on a graduated scale basis, a simple but rather inaccurate procedure.

The Radici Plastics team selected a reverse engineering process, i.e., the virtual reconstruction of the molded part through an optical scanning device. Results of overlaying the images of the mold cavity (unwarped model) on the predicted warpage results and the scanned molded part are given in Table 1.

Table 1. Comparisons between predicted displacement and measured displacement values for the tensile test model shown in Figure 1

	MPI predicted displacement (mm)	Molded part displacement (mm)	Percent difference
A-B distance, Y direction	174.6	173.3	+ 0.7
A-B distance, Z direction	2.3	7.8	- 70.5
T distance (X direction)	19.43	19.15	+ 1.5

Once this first analysis of the tensile test application was concluded, it was necessary to make similar comparisons in a production application to confirm similar results could be obtained. An office chair headrest was consequently chosen for this case study application (Figure 2).

Figure 2. Solid model of the office chair headrest part used in the comparison study

One of the reference targets chosen for assessing obtained results was the position of the two supports. They had to be kept as parallel as possible, both to avoid blocking during construction and to allow height regulation in the assembled chair, while simultaneously maintaining the ideal distance between them of 123 millimeters. Injection point positioning was critical in terms of product aesthetics. Two options were considered, as shown in Figure 3: one central injection point between the two supports and two injection points, one on each support.

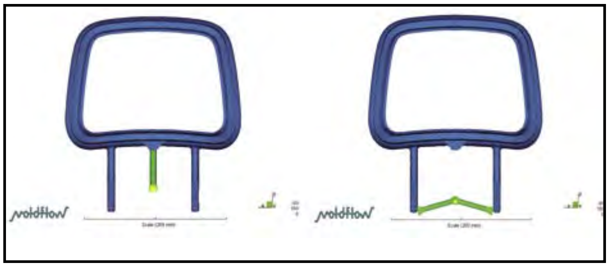


Figure 3. Simulation models showing injection location options studied: single injection point (left) and two injection points (right)

MPI simulations results are shown in Figure 4 and Figure 5.

Figure 4. Total displacement predicted using one injection point (left) and two injection points (right)

Figure 5. Displacement in the X-direction only predicted using one injection point (left) and two injection points (right)

Warpage in the X-direction showed unsatisfactory results for the case using a single injection point between the supports. However, using two injection points on the supports produced much more satisfactory results.

The final step in the comparison study involved manufacturing a mold to accommodate both injection location options, so molded parts could be compared with the simulation results for each option. See Figure 6 and Figure 7.

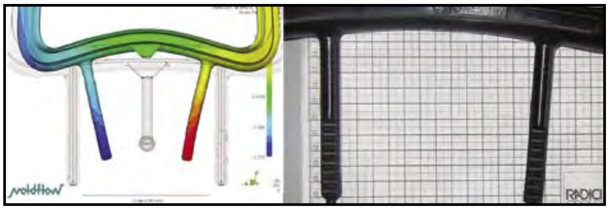


Figure 6. Displacement in the X-direction only using one injection point. Predicted displacement is 116.50 mm, and measured displacement is 113.85 mm

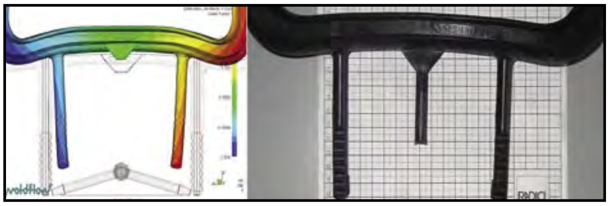


Figure 7. Displacement in the X-direction only using two injection points. Predicted displacement is 118.86 mm, and measured displacement is 118.05 mm

In summary, according to results obtained in the various comparisons (see Table 2), we found that the more recent releases of MPI yielded warpage predictions having a much higher degree of reliability than we found in the past. In particular, predicted warpage occurred in the same direction compared to warpage seen in the molded parts. Moreover, predicted values showed a good level of correlation in two out of three directions. In the third direction, discrepancies could still be qualified as relevant.

Table 2. Comparisons between predicted displacement and measured displacement values in the X-direction for the chair headrest as shown in Figures 6 and 7

	MPI predicted displacement (mm)	Molded part displacement (mm)	Percent difference
Displacement in the X-direction (all effects), one injection point	116.50	113.85	+ 2.3
Displacement in the X-direction (all effects), two injection points	118.86	118.05	+ 0.7

In conclusion, we at Radici Plastics believe that MPI simulations should not be used merely to verify or establish the best injection points. MPI simulations may also be used to establish how to reverse-design the mold in order to make the geometrical shape of the part as close as possible to the ideal shape as designed. The final purpose of this study was to reduce time-to-market for manufactured parts and the costs associated with mold fine-tuning. ■

For more information about Radici Plastics, visit www.radiciplastics.com

Material Properties, an Insight for Injection Molding Simulation

By Peter Farrington, Moldflow Corporation

The engineering involved in the transformation of a handful of plastic pellets into a useful part may cease to impress after a short time on the shop floor, but the tortuous thermal and mechanical gradients encountered by the material during each injection molding cycle cannot fail to astonish. For example, molten material may enter the cavity at a shear rate of a million reciprocal seconds and in the next instant adhere to the wall and cool to the mold temperature.

The properties required to accurately simulate each cycle are compiled in the material database included with Moldflow's Design Analysis Solutions software. This information can be used to track the material's transformation from pellets to part.

Material Properties for Injection Molding

The properties of thermoplastic materials in the Moldflow database can be resolved into four general categories:

❑ **Flow.** The first category is related to material flow and the variation of the viscosity with flow rate, temperature and pressure. The transition temperature, Ttrans, defines the temperature at which material flow ceases and also falls in this category. With this information, we can characterize the fluidity of the material under processing conditions to simulate mass transfer throughout the molding cycle.

❑ **Thermal.** The second category comprises all the thermal properties. These include the thermal conductivity, k, and specific heat capacity, Cp, which each contribute to the thermal diffusivity of the material. From the thermal diffusivity, it is possible to determine the heat transfer from the part to the mold and cooling circuit. The ejection temperature also falls into this category, since it is used to establish the cooling time of the material.

❑ **Volumetric.** The volumetric properties include the solid and melt densities, but the variation in density with temperature and pressure is characterized by the pvT model. With this information, we can determine all the volumetric changes due to compressibility, thermal expansion and contraction at all temperatures and pressures throughout the cycle and especially, the volumetric shrinkage that occurs during solidification through the crystalline or glass transitions.

❑ **Mechanical.** A final category includes the mechanical properties such as the tensile and shear moduli of the material, the Poisson ratio and the axial and transverse coefficients of linear thermal expansion. These properties determine the resistance of the material to volumetric shrinkage and have a profound influence on the shrinkage and warpage predictions.

Table 1: Material Property Categories

Flow	Thermal	Volumetric	Mechanical
Viscosity Transition temperature	Specific heat capacity Thermal Conductivity	Density pvT relationship	Tensile modulus Shear modulus Poisson ratio Coefficients of thermal expansion

Dominant Properties during the Molding Cycle

The injection molding cycle can be broken into filling, packing and cooling phases. The material undergoes different transformations, and different material properties will dominate each phase.

❑ **Filling.** The filling phase involves the closure of the mold and the injection of molten material until the cavity is filled. During this phase, the screw moves forward to inject the material under velocity or position control. The material in contact with the mold wall rapidly freezes, but molten material flows through the core of the part towards the flow front. The geometry of the core changes as the frozen layer develops. In the filling phase, the flow and thermal properties of the material are most important.

❑ **Packing.** At the end of the filling phase, a transition occurs and screw movement continues under pressure control. The transition is usually based on stroke, time or pressure, and marks the beginning of the packing phase. The pressure applied during this phase is prescribed by the packing profile. There is some convection of mass and heat in this phase but flow is limited to unfilled regions, or locations where volumetric shrinkage occurs, as the material cools and solidifies. The frozen layer thickens according to the convection of material and conduction of heat to the mold. Ultimately, the gate freezes and flow into the part ceases. In the packing phase, the significance of the flow properties diminishes, and the thermal and volumetric properties determine the ultimate shrinkage of the material.

❑ **Cooling.** The cooling phase of the cycle allows the material to solidify with no applied pressure. The screw is reciprocated as a charge of material is prepared for the next shot. After the prescribed cooling period, the mold is opened and the part is ejected. In the cooling phase, the thermal and mechanical properties dominate the dimensional changes in the material.

Table 2: Dominant Property Categories during the Molding Cycle

Filling	Packing	Cooling
Flow Thermal	Thermal Volumetric	Thermal Mechanical

Impact of Material Properties on Injection Molding

To examine the significance of different material properties during different phases of the molding cycle, a series of simulations was performed using a fan-gated part with a glass-filled polypropylene resin. The results are summarized in Table 3. The first column indicates the magnitude of the variation of the material property applied in the simulation. The viscosity, conductivity and mechanical properties were varied by ±50 percent, and the transition temperature and the pvT model were shifted by ±20 degrees C. The variation of the filling pressure and frozen layer thickness are indicated in columns two and three and predicted shrinkages are shown in columns four and five.

Table 3: Sensitivity of Simulation to Material Properties

Polypropylene (30% GF)	Filling Pressure	Frozen layer at end of fill	Parallel shrinkage	Perpendicular shrinkage
Viscosity +50%	12.5%	-1.4%	0.3%	5.0%
Viscosity -50%	-18.8%	2.0%	-0.4%	-6.8%
Ttrans +20C	0.4%	32.9%	2.2%	1.8%
Ttrans -20C	0.0%	-28.6%	-8.9%	-0.5%
Conductivity +50%	10.6%	35.1%	0.5%	4.9%
Conductivity -50%	-5.5%	-15.6%	1.0%	-0.8%
pvT +20C	0.0%	0.3%	0.0%	0.3%
pvT -20C	0.0%	-0.3%	0.9%	1.7%
Mechanical +50%	0.0%	0.0%	-3.1%	0.8%
Mechanical -50%	0.0%	0.0%	2.4%	-0.4%

A number of interesting conclusions can be drawn from this data set. For instance, it is clear that the filling pressure is not directly proportional to the viscosity of the material. A 50 percent increase in the viscosity leads to a 12.5 percent increase in the filling pressure, whereas a 50 percent decrease in the viscosity results in an 18.8 percent decrease in the filling pressure at the default processing conditions. The disproportion of this relationship arises from the complexity of the filling process and variations of the viscosity with the temperature and shear rate. Sensitivity experiments with the transition temperature and thermal conductivity indicate the evolution of the frozen layer is not an important factor in the filling pressure predictions. There is little correlation between the filling pressure and the frozen layer fraction when these properties are varied.

As expected, the shrinkage result was influenced by the mechanical and volumetric properties used in the simulations. However, it is clear that the evolution of the frozen layer plays a key role in the shrinkage predictions. This influence is likely to be related to the flow-induced stress that develops near the solid boundary of the material.

Although it is rather simple to describe the phases of the injection molding process and the variety of material properties required in the simulation, these properties may influence the process in ways that are difficult to anticipate. The sensitivity of the simulations to incremental changes in the material properties can reveal some unexpected interactions and help elucidate the molding process. ■

For more information on material properties for use in Moldflow simulations and Moldflow's material testing services, contact Moldflow Plastics Laboratories, e-mail mpl@moldflow.com, or visit www.moldflow.com

Collaborative Product Development Introduces Design Analysis Solutions to World's Largest Mainstream 3D Solid Modeling Community

By Marcia Swan, Moldflow Corporation

In today's competitive, technology-driven industries, manufacturers of injection molded plastic products are challenged to operate at increasing efficiency levels to compete in the global marketplace. For more than 25 years, Moldflow Corporation has delivered software products that embody the company's underlying philosophy of providing "process-wide plastics solutions" to answer this challenge.

From its inception, Moldflow has been strongly committed to research and innovation, investing in internal research and development efforts as well as partnering with customers, academic and industrial research organizations and suppliers of compatible technologies. Today, the company remains committed to reaching an ever broader market with innovative technologies that help users take control of the entire plastics injection molding design-through-manufacture process.

Our vision to help our customers optimize each aspect of the plastics injection molding process has led us to expand our product offerings from our well-established base in the plastics CAE market with solutions developed especially for product designers working with 3D CAD tools to solutions for manufacturers who want to optimize production processes:

❑ In 1997, we drove the innovative concepts of analysis driven design to an audience beyond CAE analysts. Putting CAE analysis tools directly into the hands of plastic part designers became not only possible but practical with the advent of our patented Dual Domain technology and the Moldflow Plastics Advisers (MPA) product line.

❑ In 1999, we began our expansion to the shop floor with the introduction of Moldflow Plastics Xpert (MPX) technology, using our expertise in design driven optimization to bring the benefits of simulation to the production environment.

The ability of participants in all stages of the process to interact and communicate increases an organization's flexibility and agility to respond swiftly to changes in market pressures and competitors.

With the release of Moldflow Plastics Advisers version 7.0 in December 2003, Moldflow delivered a new generation of software products targeted at a broader segment of the supply chain where demand for a more sophisticated and powerful product in a competitive price range was evident. The MPA 7.0 release provided another vehicle to move the process of design analysis from the exclusive realm of the engineering specialist into the broader market of product and tooling designers. By partnering with leading CAD suppliers, including SolidWorks Corporation, Moldflow has made it even easier for designers to access MPA technology.

Designers Gain Benefits of Analysis

With the development of Moldflow Plastics Advisers products, Moldflow delivered practical analysis tools for plastics part and mold designers. MPA products were created specifically for part and mold designers, people for whom running injection molding simulations is not necessarily their primary job, to optimize their designs for manufacturability. These analysis tools are best used in the earliest stages of part and mold design to address basic manufacturability and quality issues. MPA products are 3D solids-based to allow direct analysis on CAD models, and versions of MPA have been integrated with many mainstream CAD products to provide access to analysis tools within the CAD software environment.

It was a natural progression to extend our strategy of analysis driven design to this broader, CAD-based market, not only by developing new technologies ourselves but by pursuing collaborative partnerships with providers of complementary technologies and leveraging third-party distribution channels.

Collaboration Delivers Design Analysis to a Broader Audience

In a stellar example of collaboration among providers of complementary technologies, in June 2004, Moldflow and SolidWorks Corporation jointly announced the introduction of MoldflowXpress, an entry-level plastics design validation tool that shipped with every seat of SolidWorks 2005. The worldwide SolidWorks user base now has the opportunity to experience the benefits of design analysis directly.

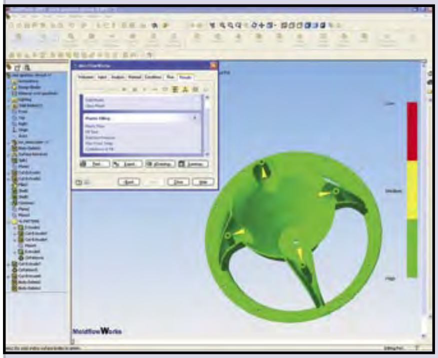
SolidWorks and Moldflow came to this partnership with different perspectives but a common goal: to improve the design and manufacturing process for companies worldwide.

MoldflowXpress is based on Moldflow Plastics Advisers technology and fully integrated with the SolidWorks 2005 software. The easy-to-use, wizard-driven analysis tool predicts whether a 3D solid model of an injection-molded plastic part will fill based on geometry, injection location, type of material and basic processing conditions. "Adding the power of Moldflow technology to the SolidWorks 2005 product offers users a plastics design validation tool that can be used as a first step in determining the manufacturability of their injection molded plastic part designs. We believe that once users experience the benefits of analysis early in the part design stage, they will make it an indispensable step in their product creation strategy," noted Roland Thomas, Moldflow Corporation's president and CEO.

SolidWorks Corporation CEO, John McEleney, commented on the introduction of MoldflowXpress, "We developed

Step Up to MoldflowWorks

The release of MoldflowXpress put an entry-level plastics design validation tool on the desktop of every SolidWorks user worldwide. MoldflowWorks is the next logical step for any SolidWorks user who wants access to more than basic design validation functionality.



Confidence of Fill

Fill Time

Injection Pressure

MoldflowWorks key features include:

❑ A grade-specific materials database containing approximately 8,000 plastics

❑ Multiple analysis options, including fill analysis, optimal injection location placement and prediction of visual defects such as sink marks, weld lines and air traps

❑ Analysis process parameter control allowing users to specify mold and melt temperatures, maximum injection pressure and the injection time for any analysis

❑ Intuitive results, including Moldflow's unique Confidence of Fill plot, which provides an indication of the ease or difficulty of filling a part with melted plastic; a fill time plot for visualizing the flow of molten plastic through the part; injection pressure and flow front temperature distribution plots; and weld line and air trap location predictions

❑ A seamlessly integrated user interface that allows access to all functionality from within SolidWorks 2005

Standalone versions of Moldflow Part Adviser and Moldflow Mold Adviser offer even more functionality to enhance communication and facilitate mold design tasks. For more information about MoldflowWorks compared with other MPA products, visit www.moldflowworks.com.

SolidWorks software with the vision to deliver 3D tools to everyone involved in the engineering and design process. MoldflowXpress continues that vision even further and is a natural progression in extending our commitment to providing powerful 3D tools for all. We believe this strategic combination of technologies will directly benefit our customers' product creation process and provide a path to utilize analysis in their overall product design strategy."

The benefits of analysis driven design as well as those of technology partnerships have been touted by industry analysts, too. Charles Foundyller, CEO of Daratech, Inc., observed, "In order to achieve efficiencies and accelerate product delivery in today's competitive global market, manufacturers are being driven to employ an analysis strategy into their worldwide operations. Products like MoldflowXpress provide companies the information necessary to integrate the functional specialties involved in a product development cycle early enough to have a positive impact on their bottom line."

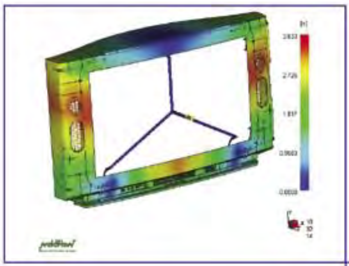
Integrated Solution Takes Designers to the Next Step

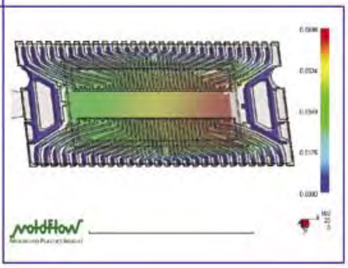
MoldflowXpress is an entry-level solution that introduces SolidWorks users to the potential benefits available to them through using basic design validation tools during the design process. Moldflow now offers SolidWorks users an easy way to add design analysis capabilities beyond the basic functionality provided by MoldflowXpress with the introduction of MoldflowWorks for SolidWorks 2005.

"Products developed by companies such as Moldflow and SolidWorks are judged on the value they deliver to customers," said Chris Garcia, vice president of research and development for SolidWorks Corporation. "With Moldflow and SolidWorks, the value proposition is clear and simple. In order to optimize material usage and material flow during design and to otherwise avoid production delays downstream, engineers designing plastic parts or injection molds need to validate those designs upfront with an embedded tool designed specifically for SolidWorks software. This critical design validation process begins with MoldflowXpress, and can now be extended with MoldflowWorks."

It takes a great deal of commitment to bring about such a successful integration of technologies. Perhaps the greatest benefit to end users is that together, Moldflow and SolidWorks can offer different perspectives and ideas, which together provide effective tools not only to optimize product designs, but to improve the design-through-manufacturing process. ■

For more information about Moldflow's Design Analysis Solutions, go to www.moldflow.com. For more information about SolidWorks, go to www.solidworks.com





Rational Selection of Thermoplastics

By Dr. Patrick Coulter, Granta Design Limited

If it is choice you are looking for, try thermoplastics. There are in the region of 50,000 different plastic materials on the market.

The astounding choice and range of properties follows from the arithmetic of combining numerous possible base resins, fillers and additives to produce ready-to-form materials with precisely tailored properties. The choice means enormous scope for design and design optimization in fast-moving and competitive industries such as electronics, electrical, medical and automotive.

Examples of base resins, fillers, additives

	Base Resin	Filler	Additive
Cheap	PE, PP	Mineral Glass	Color Flame retarder UV resistance Lubricant
Medium	ABS+PC blend	Carbon fiber	
Expensive	PEEK		

We love choice, of course, until we have to make a decision! So which thermoplastic? How to make that decision? Of the two tried and tested ways, the first and most widely applied in materials selection is experience.

It may be your experience: What did I use last time? What materials am I familiar with? Or it may be the experience of others: What does our most experienced engineer recommend? What does the supplier recommend for my application?

Experience works, but is limited to the experience that exists or to which you have access.

Drivers in material selection

Situation	Design Needs
New product	meet performance requirements; get closer to optimum, earlier
Cheaper product	cheaper material-process combination for same performance
Better performing product	material that enables, e.g., lower weight, smaller size, etc.
Product differentiation	balance aesthetic (so called 'industrial design') and technical aspects
New environmental regulations	optimum balance of eco-cost, financial-cost and performance
Food/drug agency requirements	systematic, auditable, repeatable decision-making

The second way to make the decision is by a rational analysis of the problem.

An industry colleague told me recently that he had made a better component using a material that no supplier would recommend for the application. He had discovered the improvement by applying a rational, property-based analysis to the problem. In doing so he has given his firm a competitive edge, the source of which his competitors are probably not even aware of at this stage. It is this approach which we call 'Rational Selection' of materials.

The rational method offers a means to both complement and surpass experience in materials selection. It offers the prospect of discovering better, cheaper and faster ways of working.

On the face of it, rational materials selection looks easy. The logic goes like this: material properties determine the material's relative suitability for a given application. Those properties can be measured and those of different materials compared and the best material can be chosen. Right?

Wrong, as it turns out. Actually implementing rational selection, for the general case, meets a series of nasty obstacles.

Obstacles to Rational Selection

Computer-based tools for materials selection have been around for over 20 years. From the product designer's perspective, they have delivered good information sources, but attempts at 'rational selection' have, by and large, not worked. This is because the technical barriers of a working system have been formidable and it has taken a long time to work through them.

Let's go through these obstacles.

❑ **Data collection.** You can't select materials that you don't know about. A working system needs technical data on thousands of materials. To collect and computerize information from 400 or so suppliers — and then keep them up to date — is a difficult task. There have been many attempts to build such collections, but the leader in terms of pure size and currency is that developed by IDES Inc. Their database contains technical datasheets for around 50,000 materials.

❑ **Comparability and Standards.** To compare materials on the basis of properties (for instance, 'which material is the stiffest'), the properties must be measured according to the same standards and test conditions. But they are not! Bring together 20 material datasheets at random from around the world and you'll find there is a lot of anarchy out there. To bring order out of chaos, CAMPUS was formed in the early 1990's by a group of plastics producers including big names such as BASF, Bayer, Dow, DuPont, Degussa and Ticona. The CAMPUS group agreed to report materials properties according to a finite list of tightly defined international (ISO) standards. This approach has met with success; today's CAMPUS database contains 6,000 grades from 27 producers. CAMPUS is the best-organized 'grade-specific' database available and comparisons between different materials on the basis of mechanical, thermal or electrical performance are easy to make.

❑ **Holes in the data.** Go to any material database and tell it you are looking for a material with yield strength greater than zero, flexural modulus greater than zero, heat deflection temperature greater than zero density greater than zero. How many materials will it find? Of course, the answer should be all of them! But in practice, you'll be lucky to get back one quarter. This is the 'holes in the data' problem. It arises because testing is expensive and vendors don't run every test, or they run slightly different tests from each other. Around 15 years ago, RAPRA decided to tackle the problem and developed PLASCAMS. The PLASCAMS database had no holes — every material represented could be compared with every other material for as many property criteria as you wanted. To achieve this feat, the database contained a few hundred 'generic materials' that were compiled by experts from knowledge of thousands of actual vendor grades. So, for instance, hundreds of 30 percent glass filled nylon-6 materials from different vendors would be represented by just one generic material in PLASCAMS. The downside of this approach was that it doesn't lead you directly to a specific material from a specific vendor.

❑ **Price.** Price is a specific instance of the 'holes in the data' problem. Price is mandatory for any rational selection exercise. How many real products are designed without minimizing cost? However, you will be hard pressed to find a price per kilogram or per pound on any material datasheet.

❑ **Selection Method.** So far, I've described data obstacles. But what about the selection method? What I do to the data in order to reveal the optimal material for my design requirements? Unfortunately, two obvious methods don't work for real design problems. Obvious method 1 is to select on property limits: "I want material cheaper than A and stiffer than B." Obvious method number 2 is to use weightings: "I value cheapness 2x and stiffness 3x." The reasons why these don't work become clear below. A method that does work was published in 1991 by Mike Ashby in the book *Materials Selection in Mechanical Design* and implemented in the educational software package *Cambridge Materials Selector* from Granta Design Limited. The method involves four main concepts: screening on 'constraints', ranking on 'objectives', the use of 'performance indices' and 'Ashby bubble charts'.

Are five problems not enough? Here are two more. Material choice is intimately connected with choice of manufacturing route and vice-versa. How do we factor that in? And what about 'further information' that assists material decisions, such as handbooks, vendor web sites, etc.?

With so many problems, it is not surprising that real progress in rational selection has been a long time coming.

Optimal Polymer Selector

Fast-forward to summer 2004. Granta Design Limited has just made the second major release of its CES Optimal Polymer Selector (OPS) package, making the bold claim "the most powerful plastics selection tool ever built." We justify this claim on the basis that the latest OPS overcomes all of the obstacles described above with all solutions combined into a single package. This is illustrated in the diagram.

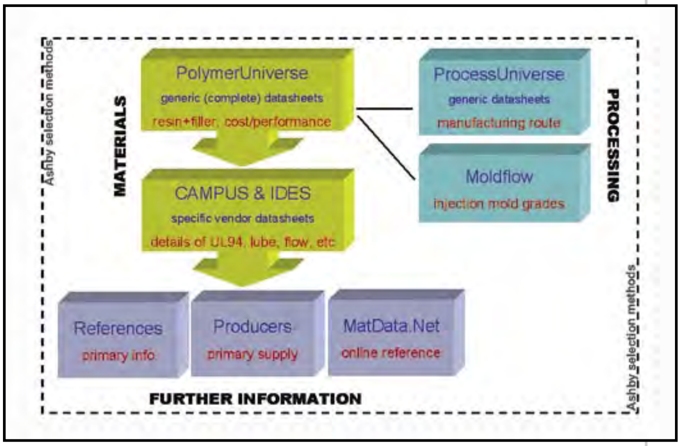


Figure 1. Structure of the Optimal Polymer Selector

How OPS rational selection works is nicely illustrated by a case study.

Case Study: Housing for an Electrical Connector

Glass-filled polybutalene terephthalate (PBT) is a standard choice for electrical connector applications. But what if something changes the design requirements? A driver of change is the WEEE regulations — lead-free solders may require higher temperatures for soldering and structural integrity of our plastic component.

The first step in application of OPS is the thinking part: the function-objective-constraint analysis shown in the table.

Case study function-objective-constraint analysis

Function	Safe containment of electrical components Better thermal resistance than the usual PBT material
Objective	Minimize cost for specified stiffness
Constraints Tensile Elongation Heat Deflection Temp. 1.8 MPa Tensile Strength, break Moisture Resistant High Resistivity Dimensional Stability out of mold Filler Content Injection Moldable	 > 2% > 420F / 230C > 15 ksi / 100 MPa < 0.35% absorption at 24 hrs > 1e1015 Wm .cm < 0.01 < 40%

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All eight constraints are straightforward material properties in this case, but the objective — the thing we want to make as small as possible — turns out to be a strange beast: a combination of three properties and a square-root.

$$M_1 = \frac{\rho \times c_m}{\sqrt{E}}$$

In this case, we conclude the design is 'stiffness limited' and that the primary mode of loading is in bending rather than tension. From this, the correct performance index is: cost per unit volume over square root of the stiffness. In terms of material properties of the database this is: density x price per unit mass divided by the square-root of modulus. In passing, I should note that nearly all objectives correspond to combinations of properties like this. That's because, in the general case, we are interested in minimizing or maximizing something (e.g. cost, weight, environmental impact, etc.) per unit of function (e.g. stiffness, strength, etc.).

Figure 2 shows the result, plotted as an Ashby bubble chart based on the 'no holes' generic PolymerUniverse database. Axes are on log scales and the bubble size represents the range of typical properties.

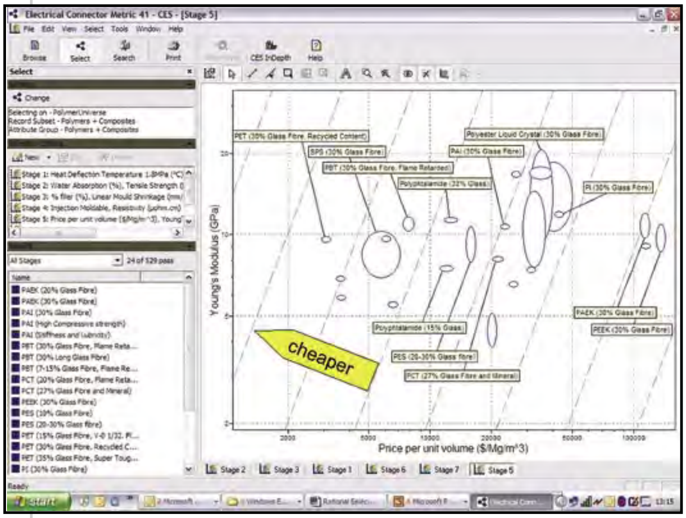

Figure 2. Ashby bubble chart with price as main criterion

Recycled glass-filled PET is a cheaper option than PBT. Glass-filled SPS (syndiotactic polystyrene) is also in consideration. The chart shows 24 further materials (out of an original 529) that meet the technical criteria, but are significantly more expensive per unit of 'bending stiffness'.

Now for some 'what ifs'. Figure 3 shows us the trade-off between cost per unit of function and resistance to temperature. The best materials are always those close to the trade-off surface. So if PET, PBT and SPS materials fail due to heat, the next best choices are polyphthalamde materials, a few times more expensive, followed by polyimides, an order of magnitude more costly.

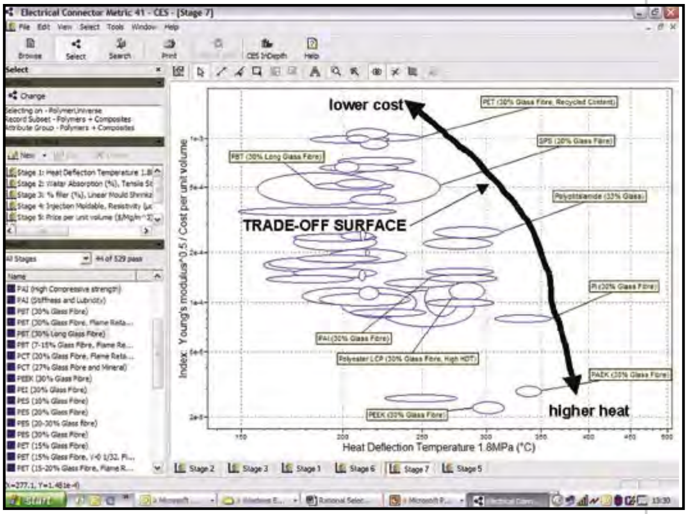

Figure 3. Trade-off between cost and resistance to temperature

Now, what if either miniaturization or low weight take precedence over cost? Figure 4 shows that then another material family, glass-filled liquid crystal polyesters (LCPs) become the best.

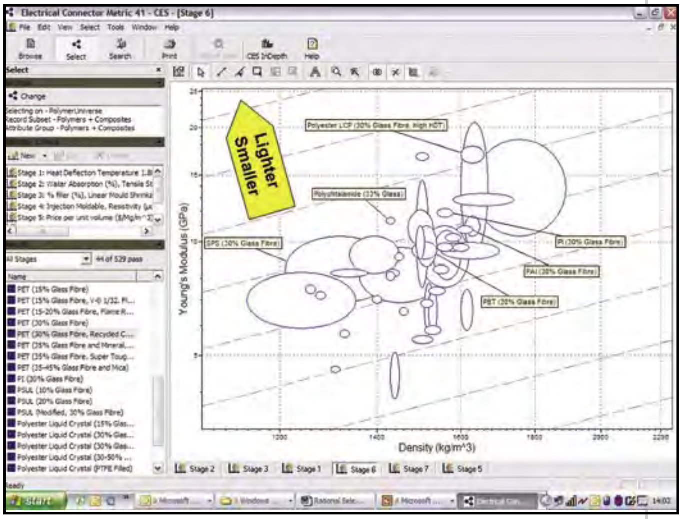

Figure 4. Ashby bubble chart with low weight as main criterion

The list of what if's can go on: what if resistance to motor fluids or acids or bases is needed? (OPS contains RAPRA's ChemRes ratings for this purpose.) What if the connector must be transparent? Rational selection gives the designer the power to optimize with an authority only limited by the depth of the initial analysis.

Having now decided on, for example, glass filled polyphthalamde, we can choose specific grades and suppliers using either the CAMPUS or IDES databases. IDES has the advantage of size and CAMPUS the advantage of excellent comparability.

OPS identifies 118 glass-containing grades in IDES from eight alternative suppliers (Figure 5). The 118 can be narrowed in OPS based on detailed requirements such as UL94 rating, weathering resistance, lubricity, or processing attributes such as flow.

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Teuco Guzzini SpA Teams with Universita Politecnica delle Marche to Conduct Moldflow Studies

Collaborative research projects determine best practices

By Roberto Onori, Technical Manager, Teuco Guzzini SpA

Tueco Guzzini SpA is the leader in Italy and Europe for the production of innovative bath and spa products (see sidebar). While Teuco management is keenly aware of its customers' demand for highly aesthetic and functional designs, the company faces challenging time-to-market issues in order to meet new product delivery schedules.

Many of the company's components are plastic. Therefore, one of the most important objectives for the company is to implement best-in-practice plastic injection molding processes and technologies, including implementing simulation software. To achieve these goals, Teuco's technical department established a research partnership with the Design and Methods Group of the Mechanics Department of the Engineering faculty of the Universita Politecnica delle Marche.

The collaboration produced interesting results that are described in two mechanical engineering degree theses titled "Optimization Tools in the Design of Plastic Components" by Alessio Bacchiocchi, and "Definition of a Virtual Model for the Simulation of Multi-Material Molding" by Cristina Giglioni.

The first thesis addresses Teuco's need to evaluate Moldflow Plastics Insight (MPI) simulation software within the flow of information associated to the product development process. The study was aimed at the company's need to understand the advantages and the possible disadvantages created by its application. Bacchiocchi's work includes the evaluation of the software's performance on different product typologies, as well as identifies the best parameters such as type of meshing, shop floor parameters and material characteristics in the cases that are of greatest interest to the company.

Thanks to Teuco's cooperation, it was possible to refine the parameters through an accurate comparison with experimental tests. The final result demonstrates the real benefits of the adoption of a CAE tool in terms of development times and optimization of the product already undergoing a feasibility study of the mold.

In addition, the study determined the necessity to establish a multi-disciplinary team. To manage the simulations, it was necessary to possess good knowledge of the production process and the physical phenomena involved and of the mathematical model used by the software to describe them. To make the most of the program, it was important that during the fine-tuning process, an attempt was made to understand the molding parameters used by the company for production that most influence the accuracy of the simulation.

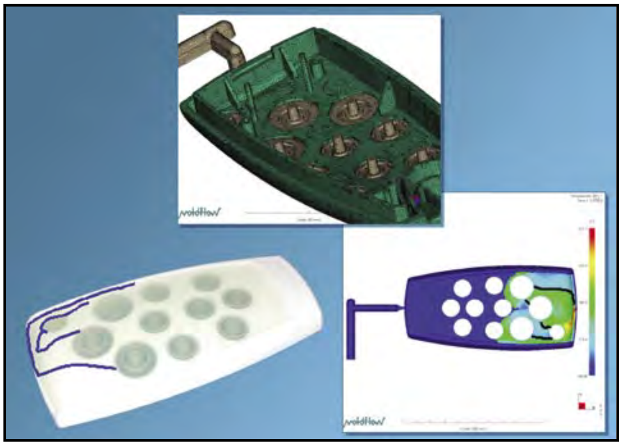
Co-injection technology, which increases the likelihood that scrap materials can be recycled, is the most obvious advantageous example of multi-material molding. Today, the development in this field is aimed at maximizing the quantity of recycled material that can be used in the production of a component; therefore, minimizing production costs. Another example is that of multi-component overmolding. In this case, the advantage of obtaining an object made up of two distinct parts in a single molding cycle is twofold:

- ❑ The process reduces the costs of subsequent assembly.
- ❑ Product quality is enhanced.

The research undertaken by Giglioni dealt with the analysis of particular Teuco components to evaluate the characteristics of the overmolding simulation. The study focused on two different overmolding problems:

- ❑ To investigate excessive material mixing among mold cavities.
- ❑ To evaluate the level of adhesion between two materials.

With reference to the first point, Moldflow does not have a definitive answer to the problem. However, via the interpretation of the temperature profiles at the interface of the two components, together with knowledge of the material characteristics, MPI can provide an accurate answer for the design requirements.



Simulation of overmolding application using MPI. Mesh detail shows the two components. Simulation results correlated well with the molding trial

The evaluation of the level of adhesion between the two materials is more difficult to determine and requires more fine-tuning. Above all, the adhesion depends on the materials' chemical characteristics. Evaluating the adhesion between two materials on the basis of the temperature profiles is only possible once the numeric-experimental comparison at the press for every material

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couple has been carried out. Furthermore, the evaluation of "good" adhesion is a product specification, which takes on a different meaning every time and evaluation requires sufficient experience regarding software settings.

In all, outlining a model on the basis of how to evaluate adhesion between components beginning with the temperature results supplied by the software proves to be advantageous. This phenomenon is especially true when Teuco provides detailed information associated with the different types of materials used for its products. Giglioni's thesis also tested the applicability of MPI on the products analyzed and the results obtained confirmed the characteristics identified in a previous study.

In conclusion, the collaboration between Teuco and the university research center continues today. Since its inception, the effort has produced positive results including helping Tueco's research team to fully evaluate MPI, as well as provide a research/training environment for students to interact with real world commercial applications. ■

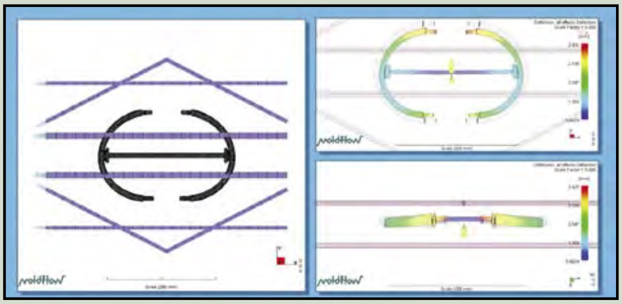
For more information, visit www.dipmec.univpm.it/disegno.htm

Teuco Guzzini SpA Uses Moldflow as a Competitive Advantage

Since 1972, Teuco Guzzini SpA (Montelupone, Italy) has been an innovator for bathroom designs. The company offers modern shower stalls, saunas and bathtubs with new hardware devices and comfort accessories. The company creates highly aesthetic and functional products that complement today's ergonomic bathroom designs and discerning consumers' requests. Teuco engineers and designers combine an expert knowledge of methacrylate molding techniques with utmost attention to environmental concerns. Methacrylate is a plastic material that is ideal for the production of showers and bathtubs.

Teuco Guzzini creates highly aesthetic and functional products that complement today's ergonomic bathroom designs and discerning consumers' requests

Teuco specializes in developing multifunctional whirlpool bathtubs and showers fashioned from methacrylate and tempered glass. Teuco's line of whirlpool bathtubs was introduced in 1978 and continues to be enhanced and updated with new functions and features. The popular multifunctional shower product line with sophisticated massage and steam sauna capabilities was introduced in the 1990s. The Hydrosonic whirlpool product was launched in 1998 and offers whirlpool-like features along with penetrating ultrasound beams to provide the ultimate in-home spa experience. As testament to its innovative designs, the company's first product, the Shower Round that debuted in 1972, is a permanent exhibit at the Museum of Modern Art in New York.



Moldflow analyses help Teuco Guzzini to optimize the qualitative aspects of molding, including part deformation

Like every manufacturer competing in today's global marketplace, Teuco continually looks for methodologies to reduce time to market for new products. To achieve this, the company has implemented many processes, both organizational as well as technical, for all its products including the use of Moldflow's Plastics Insight (MPI) simulation software. MPI allows Teuco engineers to reduce the number of product design changes that are typically part of the product development cycle.

As part of this strategy, Teuco established a collaborative relationship with the Universita Politecnica delle Marche to conduct a study to fine-tune and set up the optimal Moldflow implementation using Teuco materials.

Such a structured, proactive approach has contributed to the positive acceptance of the technology at Teuco. The company is focusing on optimizing the qualitative aspects of molding such as part seams, quantities and residual deformations. In addition, Moldflow is used to analyze overmolding simulation processes. As a result, an excellent congruence was achieved. These and other activities have helped Teuco realize best practices in terms of using Moldflow software, as well as benefits realized as a result of partnering with Italian universities for collaborative research projects. ■

For more information about Teuco Guzzini SpA, visit www.teuco.it

Moldflow Plastics Insight Release 5.0 Delivers Unprecedented Functionality and Innovation

By Murali Anna-reddy, Moldflow Corporation

Moldflow Plastics Insight® (MPI®) software has become the industry's most widely used plastics design analysis software. The MPI product suite represents the most comprehensive suite of definitive tools for simulating, analyzing, optimizing and validating plastics part and mold designs. The release of MPI 5.0 in August 2004 reinforces Moldflow's leadership when it comes to new product innovation.

MPI 5.0 Highlights

Making a significant leap forward with a focus on enhancing user productivity, MPI 5.0 provides a broad range of modeling and meshing enhancements and tools that reduce the time required to create an analysis-ready model. In addition, the product offers enhanced geometry troubleshooting diagnostics, clean-up tools and an automatic mesh fix wizard.

MPI 5.0 offers new simulation capabilities and improved solver performance for analyzing thin-walled part designs using midplane and MPI/Fusion meshes. User interface enhancements help companies increase productivity with new tools for comparing project studies, synchronizing result selection and result properties and displaying and manipulating models in less time than ever. Numerous solver enhancements include the ability to simulate mold core deflections and evaluate the flow of one or two different materials injected into two separate geometries in a sequential process. Using MPI 5.0, filling and packing analyses run up to 40 percent faster than in previous versions of the software. Also new are a fast fill solver and options to control the opening and closing of sequential valve gates.

New 3D innovations help users simulate the gas-assisted injection molding process and evaluate the effect of polymer or metal inserts on the cooling and warpage of the plastic part. In addition, the software helps predict core deflection, packing and warping of thermoset materials and dynamic paddle-shift in the microchip encapsulation process. Other enhancements include more robust and efficient 3D mesh generation and a new 3D probe result for examining result values through the part thickness.

Powerful and easy to use, Moldflow Plastics Insight modules allow you to analyze nine unique molding processes.

Thermoplastics processes

1. Injection molding
   - ❑ Insert overmolding
   - ❑ Two-shot sequential overmolding
   - ❑ Hot runner systems
   - ❑ Dynamic Feed® systems
2. Gas-assisted injection molding
3. Co-injection molding
4. Injection-compression molding
5. Microcellular (MuCell®) injection molding

Reactive processes

6. Thermoset injection molding
7. RTM/SRIM processes
8. Microchip encapsulation
9. Underfill encapsulation

For more information about all 19 MPI modules, visit www.moldflow.com

Improve Productivity

Time spent on a typical project can be broken into several phases, including model import, mesh preparation, process condition setup, analysis run and result review. Through numerous enhancements, many of which were user-driven, the MPI 5.0 release aims to reduce the time spent in each of these phases, thus shrinking the total project time and increasing user productivity.

Modeling Enhancements

❑ **Geometry clean-up tools.** Imported geometry (IGES, Parasolid, STEP, Pro/ENGINEER and CATIA V5 models) can be plagued by issues such as gaps, holes, overlapping and intersecting edges. These problems can introduce inaccuracies in the mesh if they are not corrected. New tools are available in MPI 5.0 to view and correct geometry issues and thereby prevent the mesh from inheriting these geometry problems.

❑ **Allow specification of parting plane.** Solid models that are part of an assembly tend to be oriented in the final assembly orientation when first imported into MPI. However, this orientation may not coincide with the default mold opening direction, thus introducing a discrepancy in the predicted clamp force. Two new features address this issue. First, an easy tool is provided to reorient the model in the default mold opening direction. Should the user choose not to reorient the model, the second feature allows the user to specify the true mold opening direction, which is then used to calculate the correct clamp force value.

❑ **Define translation vector by picking two points.** The implementation of this user-requested feature allows selection of two reference points to define the translation direction and distance, instead of having to specify those values manually.

continued on next page

Meshing Enhancements

❑ **Chord height specification**. Meshing of curved surfaces or edges can be quite challenging as users attempt to strike a balance between accurately capturing the geometry intent and minimizing the overall mesh size (number of elements). A new chord height option simplifies this task by allowing the user to specify the maximum allowable deviation between the true solid model surface or edge and the meshed surface or edge.

❑ **Mesh fix wizard**. The mesh fix wizard integrates common mesh fixing tools into a logical sequence to improve the efficiency and success of mesh fixing. The wizard walks the user through a series of mesh fixing steps. At each step, the user is provided feedback on the incidence and location of the issue, both before and after the mesh fixing step is applied.

❑ **Limit diagnostics to visible entities**. The option to limit mesh diagnostics to visible entities speeds up diagnostic calculation, especially for large models.

User Interface Enhancements

❑ **Project study comparison table**. This feature addresses customer requests to provide a tool that captures key differences in various studies of a project. Most projects involve multiple studies and iterations, creating a challenge to keep abreast of the differences in various studies. This tool empowers users in converging on their project objectives and greatly improves their productivity.

❑ **Result synchronization options.** When two or more studies are open, the view orientation can be locked or synchronized among all the studies. This feature has been extended to include XY plots, static plots and animations. Besides synchronizing the plot/animation selection, you can also synchronize its properties (plot scale, mesh display, etc.).

❑ **Table to edit all valve gates**. Access all of the sequential valve gate controllers from a central location to quickly adjust the settings and evaluate different closing and opening scenarios.

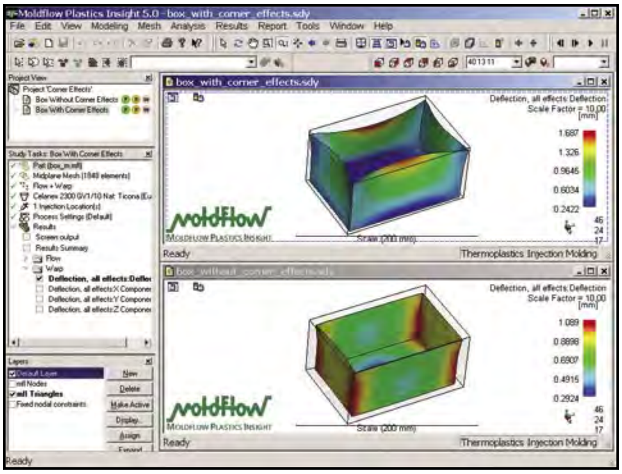
❑ **Model display speed-up**. Nearly every model manipulation task can be accomplished faster in MPI 5.0. This includes model display, model orientation, model update, entity selection and diagnostic generation. These tasks constitute a bulk of the time spent in the pre- and post-processing phases of a project.

Get Results Faster

❑ **Fast fill solver**. A new fast fill solver based on non-Newtonian, non-isothermal and incompressible plastic flow is available in MPI 5.0. This solver can be used to run several preliminary filling analyses to quickly review flow pattern, iterate gate locations and number of gates. The fast fill solver also may be useful in validating the mesh quality.

❑ **Solver speed-up**. As part of our ongoing commitment to improve solver performance, in MPI 5.0, filling and packing analyses of unfilled materials using Midplane or Fusion models can be completed 20 to 40 percent faster, while for fiber-filled materials, analyses are now 10 to 20 percent faster.

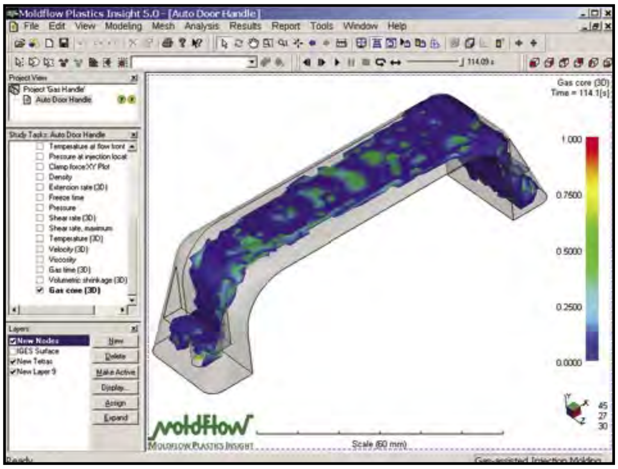
❑ **New sequential valve gate options**. Newer industry practices for opening and closing sequential valve gates are supported in MPI 5.0. These include opening and closing by screw position, by percent of volume filled, by specified pressure and by the flow front reaching a reference location.



❑ **Corner effects**. Corner effects result from the increased residual stresses on the inside of a corner or curve due to the mold restraint effect. The inclusion of corner effects improves the accuracy of warpage prediction using Midplane and Fusion models that have corners or curved topology.

Perform the Broadest Range of 3D Analyses

Moldflow fortifies its lead in 3D simulation innovation and extensibility with major new capabilities in MPI 5.0, including:



❑ **MPI/3D Gas-assisted Injection Molding**. Simulate the filling and packing of gas-assisted injection molding processes. The use of 3D tetrahedral mesh eliminates the need to employ special modeling techniques to represent the gas channels. This substantially reduces model preparation time and facilitates a more accurate

continued on next page

representation of the part model. Gas-assist applications that were previously unsuitable for modeling with midplane mesh now can be analyzed. These include thick applications such as door handles, furniture armrests, etc.

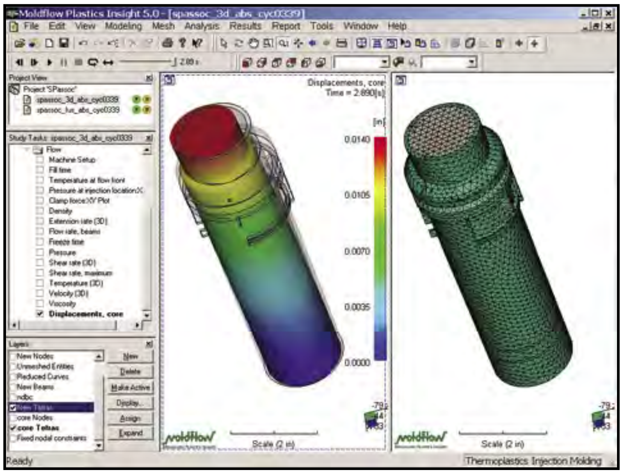
❑ **MPI/3D Part Insert Overmolding**. Simulate the effect of polymer or metal inserts on the cooling and warpage of the plastic part.

❑ **MPI/3D 2-Shot Sequential Overmolding**. Simulate the net warpage of up to two different materials injected into two separate geometries in a sequential process.

❑ **MPI/3D Meshing Enhancements**. Several enhancements have been implemented to improve the robustness and efficiency of the meshing process and the quality of the resultant mesh. The 3D mesher in MPI 5.0 is more tolerant of poor surface meshes with long triangle edges. It also reduces the total number of tetrahedral elements required to represent a model, thus allowing 3D analyses to be completed faster. 3D meshes are now more uniform with improved aspect ratios.

❑ **MPI/3D Dynamic Paddle-shift Simulation**. Paddle shift is a complex phenomenon which adversely affects microchips and which may lead to warpage and failure. MPI 5.0 features an iterative plastic filling and paddle-shift analysis which improves the accuracy of the predicted paddle deformation and allows the designer to evaluate corrective measures.

❑ **MPI/3D Reactive Molding**. Simulate the packing phase and warpage of unfilled thermoset materials using a 3D analysis model. This is an extension to the previous capability to simulate the filling phase and curing aspects of the reactive molding process.



❑ **Core Shift Analysis**. A core is the part of a mold which shapes the inside of a molded part. Core shift is the spatial deviation of the position of the core and is caused by non-uniform pressure distribution over the surface of the core. Core shift analysis is supported with Midplane, Fusion and 3D meshes, although the core itself always must be modeled as 3D tetrahedral mesh.

❑ **3D Probe XY-Plot**. A new plot is available to view an XY plot of any result value through the part thickness. This plot can be quite useful in quickly evaluating the variation in key analysis results (such as temperature, volumetric shrinkage, etc.) through the part thickness.

General Enhancements

MPI 5.0 also offers standard verification cases to validate the accuracy of key analysis solvers and solver support for hardware with Red Hat and SuSE Linux operating systems equipped with 64-bit Intel Itanium 2 and AMD 64-bit Opteron processors, respectively.

What People Are Saying

❑ **Paul van Huffel, senior engineer at Cascade Engineering:** "The addition of corner effects to the warpage analysis and the new core deflection analysis will have a significant positive impact on our development of new products and molding technologies. Our customers stand to gain substantially from our use of this improved toolset."

Find out more about Cascade Engineering's use of Moldflow technology in "Cascade Engineering Gains Competitive Advantage with Moldflow Silver Certification," in this issue of Flowfront

❑ **Gal Sherbelis, owner of GS Design:** "The highlights of the release for me are two new and very significant features – core shift analysis and full 3D gas injection analysis that will enable the analysis of virtually any gas-injected geometry. Prior to using MPI 5.0, the ability to simulate gas injected parts was limited. Thick sections had to be modeled with beam elements. Being able to model complex thick sections as true 3D features will solve this problem. MPI 5.0 delivers significant improvements on three fronts: reduction in modeling time; reduction in analysis time; and new features. For example, the new mesh repair wizard goes a significant way towards complete model creation. It automatically removes many problems, reducing the amount of sites in the model that require manual clean-up. I found an approximately 25 percent reduction in analysis time on large Fusion models with and without fiber analysis." ■

To find out more about MPI 5.0, visit www.moldflow.com or contact your local Moldflow representative

Taking Fiber Composites Mainstream

Saint-Gobain engages Sbarro to promote the many merits of fiber

By Serge Jonnaert, Moldflow Corporation

Fiber composites continue to be adopted as substitutes for metal and aluminum, especially in automotive plastics. The benefits are numerous, from reduced weight to higher flexibility to higher impact and corrosion resistance. Composites currently represent about five percent, or about 35 kgs, of the weight of vehicles and are used especially in body panels, underbody components, dashboard inserts, door modules, seats, backrests and engine parts.

To introduce its entire gamut of fiber composites, Saint-Gobain Vetrotex recently invited its premier automotive customers to Yverdon-les-Bains in Switzerland. The exclusive event was co-hosted by Franco Sbarro, the highly esteemed automotive designer who has become an icon in the automotive industry by adorning the annual Geneva and Paris auto shows with his exotic adaptations of a broad variety of production cars, from pint-size city cars to sports cars, SUVs, motor cycles and even tractors.

What sets Mr. Sbarro apart is that since the inception of his studio 30 years ago, his vehicles have been made using glass fiber. Through the years, he has developed a broad understanding of fiber composite materials, their behavior and how they can be used for automotive applications. Hosting part of the event at his automotive design school Espera Sbarro, just across the border in Pontarlier (France), he not only shared some of his experiences, but more importantly, his design philosophy. The emphasis was on being passionate about design and having fun in the process. A quick tour of the Sbarro automotive museum's large collection confirms that Mr. Sbarro is true to his word.

The Sbarro automotive museum showcases a large collection of innovative automotive designs incorporating fiber composites

There is more involved with the industrial mass production of automotive parts than the one-off, hand-crafted Sbarro vehicles. But more and more auto makers are switching out metal and aluminum parts for glass-reinforced polypropylene or polyamide composites.

To illustrate the use of fiber composites, Saint Gobain presented a car-size demonstrator comprising numerous parts provided by Peguform, Faurecia, Quadrant, Jacob Kunstofftechnik, CIE Automotive, Sotira and EPM Technology, leading suppliers to such companies as Audi, BMW, Citroen, Ford, Mercedes Benz, Nissan, Opel, Peugeot, Renault, Volvo and Volkswagen.

The "demonstrator" illustrates the widespread use of fiber composites in automotive applications

With about 30 percent share, Saint-Gobain has a commanding lead of the global market of fiber composites, the consumption of which is estimated at three million kilotons (2003). While increasingly common in the automotive industry, the use of fiber has still to reach its full potential in broader injection molding applications for anything from consumer goods to packaging.

Too few manufacturers are familiar with the processes and as its leading provider, Saint-Gobain hopes to appease concerns regarding the use of fiber. With fun and engaging events such as the one in Yverdon-les-Bains, we are sure that they will succeed. ■

For more information on Saint-Gobain, go to www.saint-gobain.com

for more information on Sbarro, go to www.espera-sbarro.com.fr

Group iNoPLAST Uses Moldflow Software to Improve Productivity and Gain New Business

By Catherine Baghdiguian, Moldflow Corporation

One of France's foremost and most innovative equipment manufacturers uses Moldflow Plastics Insight® (MPI®) software in its patented serial injection system.

Group iNoPLAST is an automotive equipment manufacturer headquartered in St. Desirat, France with several other operations throughout France. Its customers include global automotive organizations such as Renault, Volvo, BMW and Mercedes, among many others. The company designs and fabricates components including spoilers, air foils, hood trimming, radiators, panels, bumpers and other components for both passenger cars and heavy trucks.

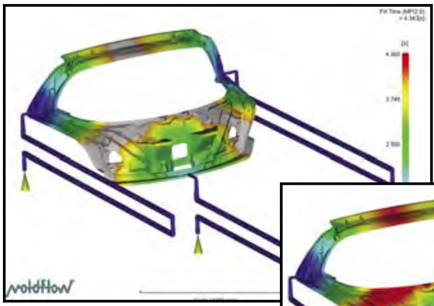
Its headquarters operates several production units for casting, injection/compression molding, thermoplastic molding and painting. Its Douai operation operates casting, compression, injection molding, PPE and painting units. Two sites in Normandy maintain distribution operations. The company as a whole employs approximately 1,600 people.

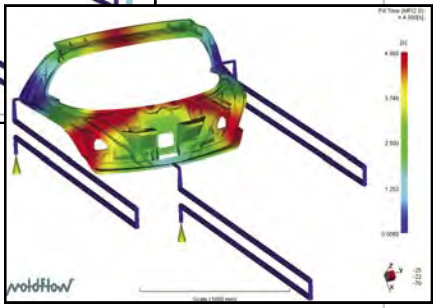
iNoPLAST designs and manufactures parts and complete systems from composite and thermoplastic materials for use in cars as well as utility and industrial vehicles. The company was established in 1976 and has become world renowned as a result of its use of technology in the transformation and painting of composite materials.

iNoPLAST's highly innovative production system — the patented multi-barrel INOROC — is a sequential injection system that uses multiple feed barrels. The operator selects the stroke, barrel diameter and filling speed, and opens and closes the barrels as required. This process allows the company to make parts of much better quality than its competitors. iNoPLAST knows that it must always remain creative in its approach to concepts, processes and organization to maintain its competitive edge through the use of innovation and technology.

At its headquarters, iNoPLAST engineers use Catia for computer-aided design and Moldflow Plastics Insight (MPI) analyses for validating the structural integrity and filling of parts. Using the CAD and CAE tools helps iNoPLAST assure its customers that component specifications are accurate. Molds are built in France, Italy and Portugal before production begins at St. Desirat.

MPI software was implemented in 2000 to ensure that parts fill properly and to locate optimal injection gates. The software helps the design team determine where weld lines will occur. According to one iNoPLAST representative, "The results were immediate and spectacular. We used 30 percent less material on some parts and injection gating sites changed remarkably. For example, one automotive front panel now weighs two kilograms, compared to three kilograms before we used MPI.

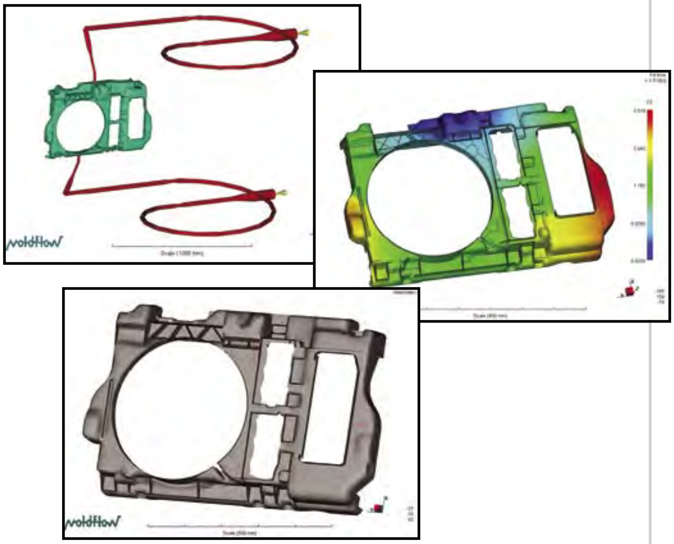




iNoPLAST implemented MPI software to ensure that parts, such as this rear door lining, fill properly

"We also discovered that part strength was enhanced by positioning the weld lines correctly. The minimum breaking strength of the automotive front panel was 250 kilograms. We improved this by 30 percent by changing the basic parameters using MPI. The software suggested injecting 40 percent of the material at point A and 60 percent at point B. So, now the part has a breaking strength of 340 kilograms."

The company's return on investment was realized from this single operation using MPI. The phenomenon also allowed iNoPLAST to enhance its reputation as a world-class manufacturer as well as obtain new contracts. For instance, Peugeot called on iNoPLAST to create automotive front panels for its newest models, including the 607, 407 and 206 vehicles. As a direct result, production of the 407 front panels increased from 1,200 to 2,000 parts per day.



Moldflow analysis helps iNoPLAST designers to optimize filling patterns and minimize weld lines in automotive parts such as this front panel for the Peugeot 407 model

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Collaboration Pressures Change Tracking

By Ken Versprille, Ph.D., PLM Research Director, Collaborative Product Development Associates, LLC (CPDA)

Collaboration is positioned as an enabling technology intended to reduce product development time between both internal organizations and partner supply chain companies. Commercial collaboration and visualization solutions promise to not only speed development, but also minimize the errors that often occur through miscommunication. But research has shown that the use of collaboration technology without attention to a consistent methodology for tracking the volatile changes that can occur during in-process design and tooling can rapidly cause havoc. It can also increase the operational overhead burden on designers and manufacturing process engineers.

All parties in product development agree that collaboration technology improves workgroup interaction. Tools such as online Internet collaboration enable rapid change to a product design without the inherent delays experienced in face-to-face meetings or the more traditional workflow that calls for "FedEx design data and wait for feedback." Improved workgroup interaction, however, facilitates an increased evaluation of design alternatives and acceptance of product change. The result is that the sheer speed of product change can quickly spiral out of control. Without a steadfast approach for design change tracking (which changes are approved and which are exploratory), collaboration tools can complicate and actually slow the design and manufacturing planning process.

Finding Pragmatic Solutions

How might these difficulties be avoided? Many manufacturing supplier companies are not large enough to need extensive data management tools and their associated, formal change management applications. Even larger companies who have previously invested in formal change management tools have found that these solutions fail to tackle the core complexities found within in-process design and manufacturing collaboration. Design starts out as exploratory in nature and matures as more parties provide input on the proposed solution. Managing such rapid, in-process change contrasts with the stated goal of the more formal change management systems provided by vendors, which pursue a mission of documenting an approved state together with the approval audit trail downstream in the product development process as final designs transition into manufacturing.

Users who are rapidly expanding their adoption of commercial design collaboration and visualization tools indicate that the "openness" and flexibility provided by those tools are, in fact, leading to more product model changes in an even more compressed time period. An engineering workgroup or supplier organization which was comfortable in tracking progress on its designs without the need for a commercial change tracking mechanism, now suddenly finds itself embroiled in a confusing array of overlapping model changes without any documented cause and effect relationships for its decisions. Adopters of design collaboration and visualization technology must tie their use to a change tracking solution of appropriate scale to avoid the stumbling blocks arising from rapid design changes occurring from all members of the product design team.

Minimizing Operational Concerns

The growth in collaboration means that designers and engineers find themselves much more engaged in operational aspects of product development. Designers can rapidly assess the recommendations of manufacturing process engineers on alternative solutions to reduce the cost in production. Such alternatives, however, need to be tracked while they are being evaluated. The crisis in managing change during the design process reaches its pinnacle when a given designer or sub-team needs to resolve an immediate design issue without having the overall design context changing during the process. The team must buffer itself from on-going product changes until they complete this critical task. Only after a fixed point in their workflow has been reached can they accept the most recent model changes being constantly delivered from other product designers or manufacturing process engineers.

In response to these issues, some companies have begun to import change management and data management processes, tools and methods from release management, and are applying them to design collaboration. The approach generally results in better reconciliation and improved data consistency and integrity. But they note it can also increase overhead on designers and engineers and in some cases slow their work.

Research has shown that all users report an overriding need for consistency in dealing with the frequent changes that occur to product data throughout the entire design and manufacturing process. The product design phase lives by change. Those changes flow not only from the design team but also from downstream manufacturing process planning, which is now done parallel to the product design. Since the business goal of collaboration is to eliminate time and cost, the appropriate solutions should deal with the real-world design environment as a complex network of simultaneous changes across the entire product development and manufacturing effort.

Balancing Your Response

A design-oriented change tracking facility offers the promise of smoother coordination. But, the ability to interface or integrate a change tracking facility with the collaboration process can pose different challenges depending upon the underlying infrastructure and

continued on next page

analyst says continued from page 27

data architecture of the design collaboration tool being deployed. An analysis of the varied commercial implementations for design collaboration available in today's market provides a classification scheme for their different technical approaches. From those classifications, guidance can be obtained on the scale of change tracking required and key issues that need to be addressed when integrating a change tracking solution (both tools and processes) with design collaboration.

A study of the physical hardware infrastructures upon which design collaborations solutions depend identifies four basic configurations: standalone client, client/server, peer-to-peer and server/server. Superimposed upon those infrastructures, the data distribution of the collaboration solution (where the data resides), as well as the data formats and access methods implemented by the solution, reveal the need to emphasize varied aspects of change tracking. Those critical aspects depend on where the chosen design collaboration tool falls in its categorization.

In standalone client solutions where users themselves control the transfer of data between team members, simple time stamping of model changes together with tools and processes to track the collaborators who received those changes may be sufficient, whereas in both client/server and peer-to-peer implementations, one important recommendation indicates that users suppress file overwrites with revisions — each change should be saved and tracked in a new part file. A further analysis of disparate collaboration software, such as a CAD authoring product and a visualization application, leads to a recommendation that users automatically trigger the re-generation of the "abstracted" viewing data file whenever the CAD model is saved, and the need to track linkages between the two disparate database files.

Evolving Requirements

The experience of users has shown that the requirements imposed on change tracking within design collaboration environments are not fully satisfied by the current commercial change tracking solutions. These issues have resulted in a proposed set of additional requirements and an ongoing debate between vendors and users for possible solutions.

In the mean time, for OEMs, we offer a critical recommendation: while in design collaboration, begin to look at processes for any needed ties into document management or full PDM (depending upon which is employed). Access to product structure and the currently approved (or agreed upon state) of a product design are significant design collaboration issues.

On the supplier side, our recommendations highlight the need for a more disciplined yet simple approach to project management and change tracking in design collaboration. ■

Ken Versprille is a partner and PLM Research Director at Collaborative Product Development Associates, LLC (CPDA), 222 Grace Church Street, Port Chester, NY 10573 (formerly the PLM group of D.H. Brown Associates, Inc.). CPDA specializes in in-depth analysis of design and computing technologies to support product lifecycle management and information technology. For more information, visit www.cpd-associates.com. Ken can be reached at kenv@cpd-associates.com or 603-424-7992

real world success continued from page 6

In 1993, Avenue Mould moved to a new headquarters and in 1998, it constructed its own mold test and validation area as well as a Class 100,000 clean room. It acquired certification to ISO 13485:2003 (Manufacture of Medical Devices) for its mold validation facility in July of this year. The company believes it is the only moldmaker anywhere to have acquired this certification. Avenue Mould has been recognized in the UK Plastics Industry Awards as "Toolmaker of the Year" in each of the last four years as a finalist or winner of this prestigious award. ■

For more information about Avenue Mould, visit www.avenuemould.com

design & molding continued from page 26

Using MPI helps iNoPLAST designers to reduce weld lines thanks to the way molds are filled, as well as to regulate material temperature — a vital function as a cold material comes in contact with a hot mold — and to account for fiber orientation.

The MPI learning curve at iNoPLAST was expedited quickly. Operators need to be very familiar with finite-element analysis and understand the transformation that occurs in the manufacturing process. Once management, the design team and shop floor operators saw how powerful an impact could have, everyone was convinced its use was necessary and important.

In today's fiercely competitive automotive marketplace, equipment manufacturers must do everything they can to achieve and maintain a leading position. For iNoPLAST, being a leader is a long-term commitment. Companies that embrace this ambition must continue to strive for improvement with the use of technology and a competent workforce. This combination enables companies like iNoPLAST to deliver innovative, high-quality, robust products, and that is why iNoPLAST purchased and implemented Moldflow's MPI solution. ■

For more information about iNoPLAST, visit www.inoplast.com

tips & techniques continued from page 8

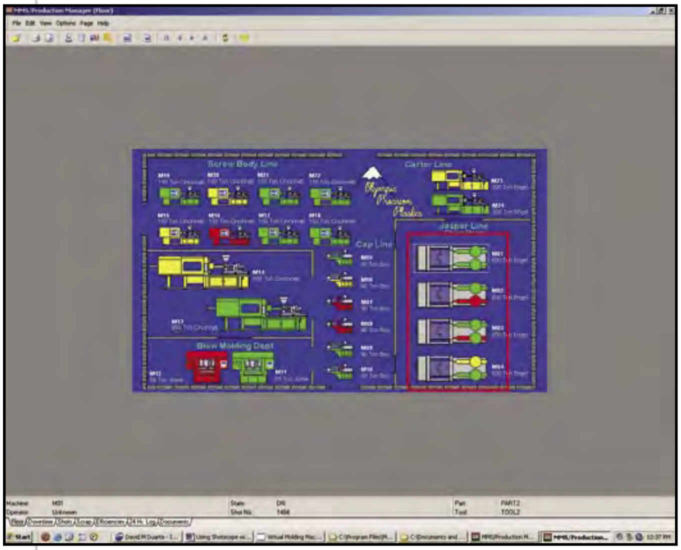

Figure 3. Plant floor image in Shotscope Production Manager showing multi-barrel machines

When finished, this [#Machine] and [Type Name] section should look similar to:

```
[0Machine]
Name=M01
X=535
Y=180
Type=Multi Barrel
[Multi Barrel]
Offset=0
Columns=3
Image=\\computer network name\mms\bitmaps\big_
multibarrel1.bmp
```

The resulting image on the plant floor layout should look similar to the multi-barrel machines bordered in red in Figure 3. ■

For more information about Shotscope and all Moldflow Manufacturing Solutions products, visit www.moldflow.com

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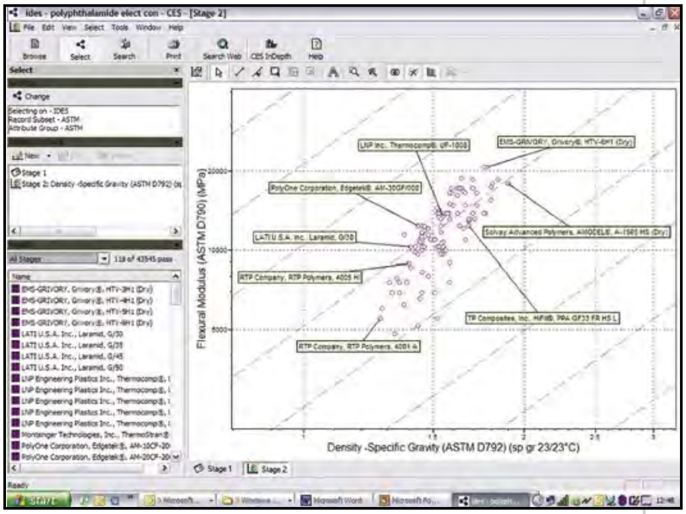

Figure 5. Selection stage based on IDES

'Further information sources' can be searched directly from OPS via Granta's MatData.Net service — for instance, environmental stress cracking information from NPL, joining information from TWI (The Welding Institute), or ASM's Engineered Materials Handbook. Suppliers can be contacted for specific advice or their Web sites searched; OPS provides these.

A final note on processing: injection molding simulation is a pre-requisite to part manufacture in many cases. By arrangement with Moldflow Corporation and as a service to their software users, OPS lists all the grades that can be directly simulated with Moldflow's Design Analysis Solutions packages without additional gathering of rheological data.

Finally

So there you have it. Huge strides have been made to make rational selection possible; the benefits to come will affect everybody designing with thermoplastics. What is the next frontier? In my view, it is the integration of rational selection in design with corporate processes — in particular to bridge the gap between technical and commercial — in procurement, cost reduction and preferred supply. Watch this space! ■

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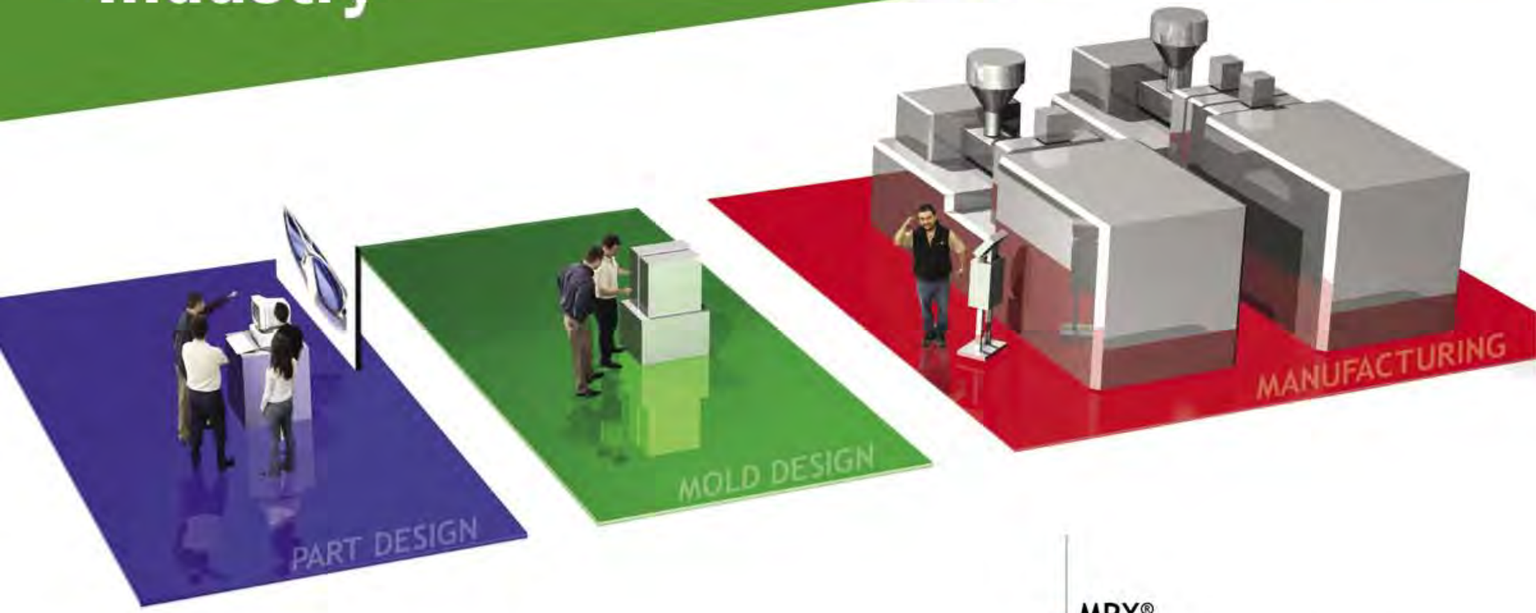
Moldflow Delivers Process-wide Plastics Solutions for Today's Manufacturing Industry



Moldflow Part Adviser®
Part Design Optimization

Moldflow Mold Adviser®
Mold Design Optimization

Moldflow Plastics Insight®
In-Depth Simulation for Design Validation and Optimization

CAD Connectivity Tools
Solid Model File Transfer and Optimization

MPX®
Automated Process Setup & Optimization

Shotscope®
Process Monitoring & Analysis

Altanium®
Hot Runner Process Controls

Celltrack™
Production Management

Automation is the imperative in today's intensely competitive global economy. Product designers and manufacturers must continually gain efficiency, improve quality and drive down their costs. Wherever you operate in the plastics design through manufacture process, Moldflow has a solution for you. Our complete suite of products and services significantly reduces operating costs of the manufacturing process, improves assembly through greater reliability and quality and streamlines the product introduction process.

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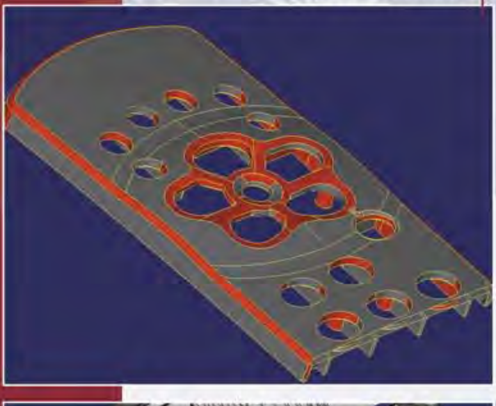
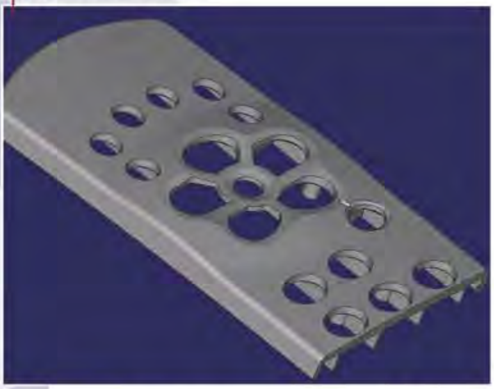
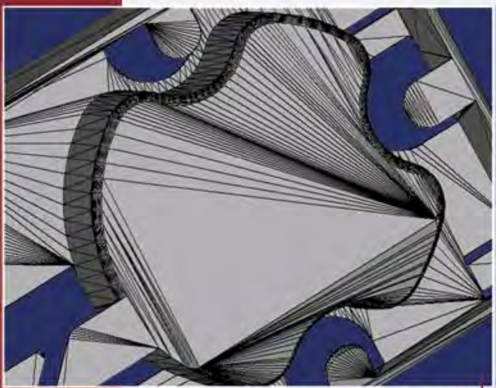
Defective STL model

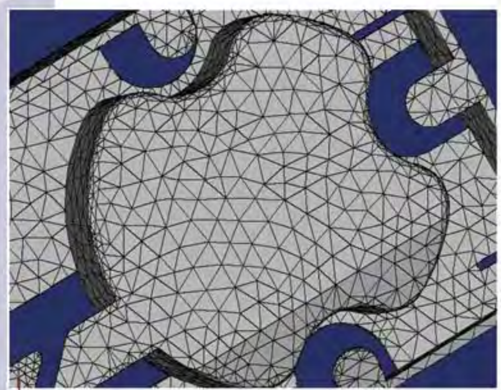


Repaired STL model





Original surface mesh



Optimized surface mesh

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