HOW TO SAVE TIME, REDUCE COSTS, AND IMPROVE THE QUALITY OF INJECTION-MOLDED PARTS WITH MOLD-FILLING SIMULATION

White Paper

SUMMARY

Producing high-quality, plastic injection-molded parts more quickly and cost-effectively than the competition has become a critical factor for manufacturing success in today's global market. Instead of engaging in slow, expensive prototype iterations and test cycles to satisfy manufacturing requirements, designers, moldmakers, and manufacturing professionals can leverage SOLIDWORKS® Plastics mold-filling simulation software to optimize parts for manufacturability, refine tooling to improve quality, and shorten cycle times to reduce manufacturing costs. Whether you design parts, create molds, or manage injection-molded production, SOLIDWORKS Plastics solutions will help you resolve your injection-molding challenges in software—rather than through costly, time-consuming prototyping iterations—so you can consistently achieve your product development and manufacturing objectives.

HAWK RIDGE SYSTEMS

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THE NEED FOR IMPROVING INJECTION-MOLDING PERFORMANCE

In nearly all types of product development—from consumer electronics and automobiles to children's toys and medical devices—the use of components made from plastic materials has steadily increased. There are several reasons for the continuation of this trend, which began decades ago. Plastic parts are generally less expensive to make and don't rust or corrode like metals. Plastics are lighter in weight than traditional materials, and because plastics are very pliable, they can be molded into more complex patterns and shapes, with more elaborate surface details. In short, plastics are better suited for meeting the product development needs of a growing number of today's manufacturers.

However, anyone involved in the production of plastic components knows that making plastic parts is more challenging and complicated than designing in metal. More than 80 percent of the plastic parts used in products today have to be injection-molded—the process of injecting liquefied plastic materials into a mold, cooling/solidification of the material, and ejection of the molded part. In many ways, injection molding is as much an art as a science.

Successfully producing injection-molded parts that are free of manufacturing defects requires a complex mix of time, temperature, pressure, material, and variations in tooling or part design. Designers, moldmakers, and manufacturing professionals must balance all of these variables to make quality parts.

- Does the part geometry meet draft and wall thickness requirements?
- How long should the injection/cooling/ejection cycle be? What's the optimal temperature for the material, cooling channels, and mold?
- What's the right filling/packing pressure and best material to use for a particular part?
- And, will the use of special inserts, side actions, additional injection gates, special secondary operations, or unique cooling channel designs improve part quality or shorten cycle times?

The traditional approach for answering these questions and producing quality parts is inefficient, expensive, and disjointed, resulting in slow, costly design iterations and test cycles that can actually compromise the rationale for using plastics and put a manufacturer at a competitive disadvantage. Part designers often rely on iterations with the moldmaker and the moldmaker's expertise to evaluate the manufacturability of a part, and balancing industrial design and manufacturing considerations takes time. Although moldmakers draw upon their experience and expertise to develop molds, they still need to create prototype molds to validate mold performance, typically after completing trial-and-error iterations that add time and cost to the process. Charged with optimizing production run cycles, manufacturing professionals frequently need to iterate with designers and moldmakers. Unfortunately, improving part quality at this stage is often difficult and generally only resolved through mold rework. With molds ranging in cost from $10,000 to more than $1 million, mold rework is a costly and time-consuming proposition.

Complicating the process further is the fact that in today's global economy, designers, moldmakers, and manufacturing professionals often are located around the world and speak different languages.

For example, internationally scattered injection-molding operations—such as having a designer in the United States, a moldmaker in China, and a manufacturer in Mexico—are much more common than in the past. The time and language barriers inherent to these arrangements make resolution of injection-molding challenges even more difficult. What's really needed is a common, accurate mold injection simulation platform that cuts across barriers and allows designers, moldmakers, and manufacturing professionals to collaborate more efficiently and effectively in a virtual simulation environment, without resorting to costly prototype mold cycles.

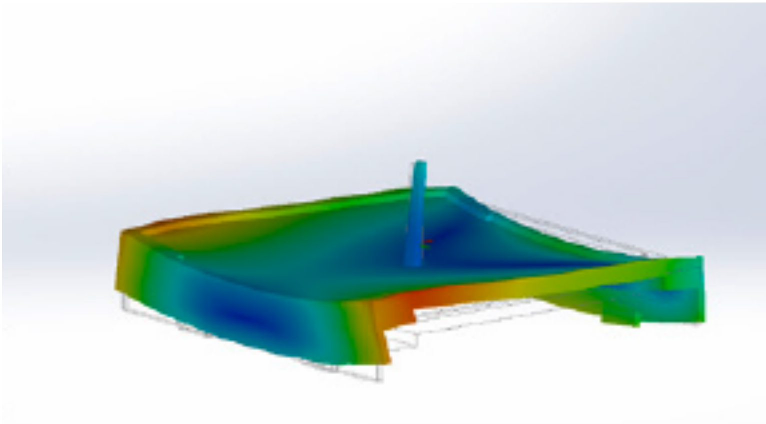
CONVENTIONAL INJECTION-MOLDED DESIGN AND TOOLING DEVELOPMENT DRIVEN BY MOLD PROTOTYPING

The traditional approach for designing injection-molded products, developing injection molds, and shooting parts relies on costly, time-consuming prototyping iterations.

INJECTION-MOLDED DESIGN AND TOOLING DEVELOPMENT DRIVEN BY MOLD-INJECTION SIMULATION

With fast accurate, injection-mold simulations, designing injection-molded products, developing injection molds, and shooting parts is more collaborative, accurate, and efficient, saving time and driving down costs.

INJECTION MOLDING CHALLENGES ARISE THROUGHOUT THE PROCESS



Every professional involved in the development and production of injection-molded parts and tooling—from the original designer to the moldmaker to production personnel—face unique challenges. Each has their own point of view, focus, and specific types of issues. Designers care about the design aesthetics—the look and feel of a part. Moldmakers contend with quality considerations and want to make sure that their tool produces acceptable parts. Manufacturing personnel want to make sure that production runs as smoothly and efficiently as possible. Despite having different perspectives and roles, everyone involved in the injection-molding process will benefit from having access to a plastics simulation environment.

Designers Face Manufacturability Concerns

While a designer initially concentrates on design requirements—including form, fit, and function—he or she increasingly needs to assess whether a particular design is manufacturable, especially for injection-molded plastics parts. The most beautiful and elegant possible design has no business value if the geometry cannot be manufactured at volume and then assembled and sold at a profit. Even though designers have access to tools for checking draft angles and wall thicknesses, they typically rely on their moldmaker's recommendations and the results of iterative testing conducted with prototype molds to minimize a range of potential manufacturing issues—tests that add time and cost to the process.

What Can Happen?

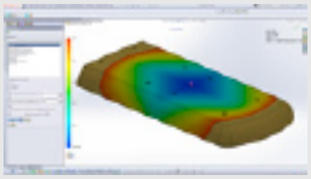
The potential for encountering quality issues on injection-molded parts is great, and because these issues need to be resolved before moving to production, so is the probability of unplanned iterations and modifications to both part and tooling designs. Manufacturing defects occur for a variety of reasons related to the mix of variables that influence injection-mold performance. For instance, part warpage, also called "potato-chipping" because of the wavy appearance of the part, happens when a part deforms after it is ejected from the mold. When a mold does not fill completely, air traps, sink marks, and flow marks can appear on the part. Did the designer allow for shrinkage of the part? Are the parting or weld lines (where different parts of the mold come together) in the preferred location?

Collaboration Demands Communication

Because designers need to eliminate a wide range of manufacturing defects from injection-molded parts, as well as work with manufacturing partners to optimize production, they need to collaborate effectively with their tooling and manufacturing colleagues to make changes related to manufacturability without overly compromising the industrial design of a part.

Language and time barriers can complicate this task, and designers need to understand the costs and delays associated with multiple design iterations with both the moldmaker and production personnel. However, because designers can't predict the future, they tend to over-rely on the expertise of their moldmaking and manufacturing partners, resulting in unanticipated iterations that create additional delays and unforeseen costs.

…A CASE IN POINT



As the world's largest manufacturer of emergency warning products, Electronic Controls Company

(ECCO) depends on the development of high-quality, injection-molded plastic parts. The company's backup alarms and warning lights for commercial vehicles—and red and blue warning lights for emergency vehicles—typically operate outdoors, where they are exposed to all types of weather conditions. In such an environment, ECCO often prefers to use plastic parts because they don't rust. With light lenses, using plastics for optical components is a necessity.

After realizing productivity benefits from using SOLIDWORKS Professional and SOLIDWORKS Premium design software, and the SOLIDWORKS Enterprise PDM product data management system, ECCO acquired SOLIDWORKS Plastics Professional mold injection simulation software to improve the manufacturability of plastic parts.

"Prior to 2012, we relied on our tool manufacturer to spot and address injection-molding issues," recalls Mechanical Design Engineer John Aldape. "However, when we received glass-filled nylon alarm enclosures with surface-knitting issues, we decided to investigate mold-filling simulation technology. We wanted to independently assess how a mold would fill and where knit lines would be, instead of waiting on iterations with the toolmaker."

ECCO chose the SOLIDWORKS Plastics solution because it is easy to use and simulates how the plastic will fill the mold, helping the company avoid manufacturability issues. By implementing SOLIDWORKS Plastics Professional software, ECCO has minimized iterations with its moldmaker, eliminated mold-related production issues, optimized parts for mold injection, and improved lens optics and product aesthetics.

Read the full story here: ECCO Case Study

Moldmakers Under Pressure to Cut Costs

To compete successfully, moldmakers are increasingly under pressure to develop tooling that produces quality injection-molded parts as quickly and affordably as possible. Of course, experienced moldmakers have broad knowledge regarding part manufacturability and the impact of changing the variables related to injection-molding production, particularly with simple part geometries. Nevertheless, as designers strive to imbue products with innovation and sophistication, even the most experienced moldmakers need to create a series of prototype molds and shoot many samples until they find the precise mix of injection-molding variables that will produce clean, blemish-free parts.

How Many Prototype Molds Are Necessary?

Although veteran moldmakers take pride in their ability to gauge the manufacturability of specific part geometries, and know things like the minimum thickness of ribs to support ejection from a mold, predicting the exact number of prototype molds required for configuring the injection-molding process, or the time and cost involved, is not as clear-cut. In addition to needing to validate that the final mold design will perform well, producing high-quality samples before ramping up to full-scale production, moldmakers usually need to conduct other trial-and-error prototype studies in order to reach the final mold design and specific injection recipe. For example, optimizing injection gate diameters, locating gates in the most advantageous locations, improving cooling channel performance, or using special secondary operations generally requires additional time and iterations.

Balancing Design and Quality Sensitivities

Moldmakers face the same communication and collaboration challenges as designers of injection-molded parts. They need to be able to explain why the original part design geometry has to be changed due to manufacturability issues. This is why prototype mold cycles are so entrenched in the injection-mold tooling enterprise, because they serve to justify why design changes are necessary by demonstrating the defects and quality issues associated with strictly adhering to the initial design. Designers want to know the reasons why the part design that they labored over needs to be altered, especially when such changes negatively impinge upon the design aesthetic. Moldmakers want to make quality parts, designers want to manufacture their designs, and prototype mold cycles are often the only way to reconcile the two.

Manufacturing Personnel Pushed to Reduce Cycle Times

Once manufacturing personnel receive the final mold from the moldmaker, they too need to evaluate the tool from a production standpoint to determine if there are other modifications that can be made to reduce cycle times without opening the door to additional manufacturing issues. When you are shooting 500,000 to one million parts at a time, saving one, two, or three seconds in cooling time per part can result in dramatic time and cost savings. However, just like moldmakers, manufacturing personnel are blind to what's actually going on inside the mold and have to rely on samples and tests to confirm that the tool will produce quality parts or discover that the mold requires additional rework.

Is Mold Rework Required to Speed Production?

The first question manufacturing professionals need to answer is: Will this mold, material, and injection recipe produce quality parts or not? It's critical for production personnel to verify mold performance because if they don't, they may end up shooting a million bad parts. Similar to the prototyping performed by moldmakers, manufacturing personnel need to run samples to confirm that there are no structural weaknesses in the parts, no undesirable deformation in large-sized parts, and no poorly reproduced areas on parts with features having high aspect ratios. They can use the same trial-and-error approach to try to speed production, but ultimately have to determine if speeding up production will save more money than the cost of mold rework.

Optimizing Injection-Molded Tooling

In their attempts to optimize production cycle times for specific injection molds, production personnel may try different recipes, changing the length of cooling time in the mold, or raising or lowering injection pressure during filling and packing. They may also adjust temperatures in the mold cooling system as part of their efforts to shorten cycle times. Yet, just like designers and moldmakers, what they really need is access to a common mold-filling simulation environment that provides them with a view of what's happening inside the mold and insights into the effects of changing these variables without having to shoot a part. This common platform can also improve collaboration with the designer and moldmaker regardless of language and time barriers.

…A CASE IN POINT

The Center for Advanced Medical Learning and Simulation (CAMLS) collaborates with medical device manufacturers by combining cutting-edge simulation technologies with research and innovation to move the latest advances in healthcare into practice. For example, CAMLS collaborated with Cooper Surgical, Inc., on the development of a new device for conducting sono-hysterosalpingography

(sono-HSG), an ultrasound exam for studying the contour of the uterine cavity and the patency of the fallopian tubes to determine potential fertility issues. Instead of using a contrast medium and separate procedures like traditional devices, the ABBI® (Air Based Bubble Infuser) uses saline infused with air bubbles, an approach that is less painful and uncomfortable for patients, and allows physicians to perform both exams in a single procedure.

CAMLS used SOLIDWORKS solutions on the project, including SOLIDWORKS Plastics simulation software to optimize the injection mold used to produce the device housing/handle. "Our injection-mold specialist used SOLIDWORKS Plastics software to determine where the gating locations should be to minimize the appearance of sink marks and knit lines," says Chief Engineer Mario Simoes. "The simulations also enabled us to understand that by keeping the device in the mold a little longer and at higher pressure, we could contain the sink marks to an acceptable level. SOLIDWORKS tools saved us time while improving quality."

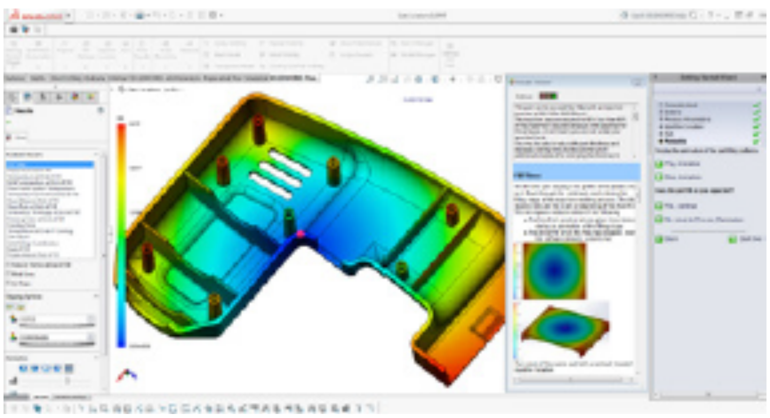
With SOLIDWORKS solutions, CAMLS cut development time by 30 percent, accelerated time-to-market, improved quality, and optimized production mold performance.

Read the full story here: CAMLS Case Study

SOLIDWORKS PLASTICS – STREAMLINE INJECTION-MOLD TOOLING DEVELOPMENT WITH MOLD INJECTION SIMULATION AND ANALYSIS

Everyone associated with the development and production of injection-molded parts and tooling—including part designers, moldmakers, and production personnel—can contribute to streamlining the process by having access to SOLIDWORKS Plastics simulation and analysis software. With a common, visual injection molding simulation environment, you can overcome language barriers and collaborate more effectively, enabling you to evaluate part manufacturability, validate mold designs, and optimize injection-molded tooling without incurring the delays and expense of making prototypes, conducting tests, and shooting samples.

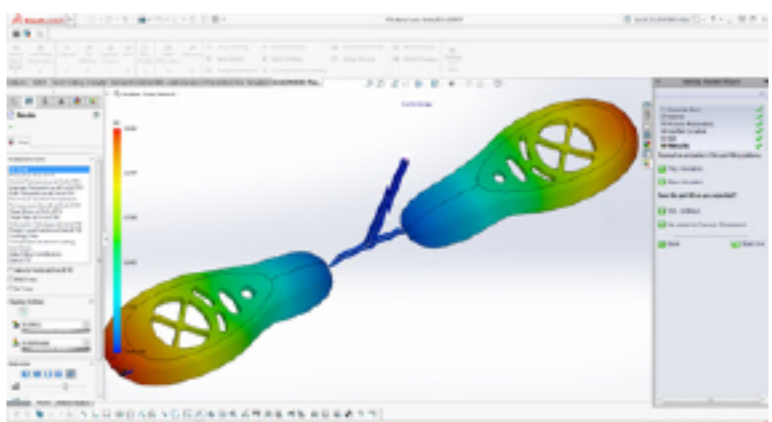
Mold Injection Simulation for Designers



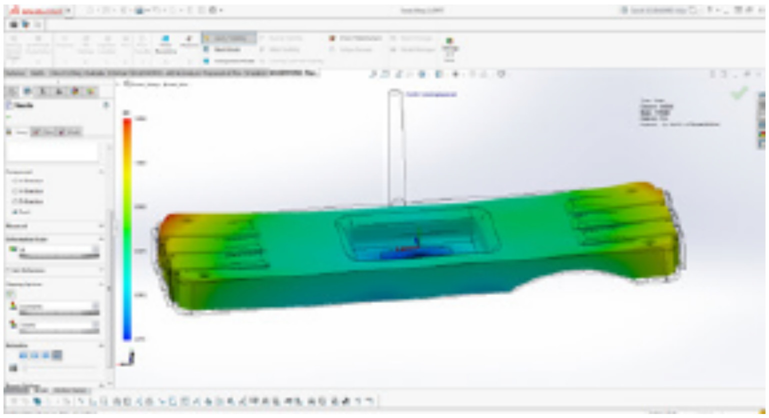
SOLIDWORKS Plastics Standard software enables plastics part designers to evaluate the manufacturability of injection-molded parts during the early stages of design. By simulating the mold injection process, you will understand how the mold will fill, whether there are any air traps or voids, and where parting/weld lines will be. With these tools you will consistently deliver designs that don't require manufacturing modifications—reducing the need for multiple iterations with the moldmaker—and be able to confer with moldmakers and manufacturing colleagues anywhere in the world.

Mold Injection Simulation for Moldmakers

SOLIDWORKS Plastics Professional software gives moldmakers an accurate, easy-to-use way to perform prototype mold iterations in a virtual simulation environment. With the ability to quickly create and analyze single-cavity, multi-cavity, and family mold layouts, including sprues, runners, and gates, you can more efficiently and affordably deliver high-quality tooling than is possible through traditional means. You can even determine maximum injection pressure requirements and machine size, balance runner systems, and estimate cycle time, clamp tonnage, and shot size, enabling you to optimize feed system design, avoid costly mold rework, and keep design and manufacturing personnel in the loop.



Mold Injection Simulation for Manufacturing Professionals



SOLIDWORKS Plastics Premium software provides manufacturing professionals with the advanced simulation functionality required to optimize injection-molded tooling. Using these additional tools, you can design and analyze simple or complex mold cooling line layouts, optimize cooling system design to minimize cycle times and decrease manufacturing costs, and optimize part geometry, mold design, material selection, and processing parameters to reduce or eliminate molded part warpage. The software allows you to predict what's going on inside the mold, enabling you not only to share your findings with designers and moldmakers, but also to justify the changes that save your company time and money.

GAIN A COMPETITIVE ADVANTAGE BY OPTIMIZING INJECTION MOLDING

As more and more of today's successful products contain plastic components and the trend toward greater use of plastics continues, manufacturers can gain a substantial competitive advantage by leveraging SOLIDWORKS Plastics simulation technology to shorten injection-molded part and tooling development cycles, while simultaneously improving the quality of injection-molded parts. Instead of continuing to absorb the delays and expenses related to conducting traditional prototype mold iterations and test cycles to satisfy manufacturing requirements, your company can utilize SOLIDWORKS Plastics simulation software to optimize parts for manufacturability, refine tooling to improve quality, and shorten cycle times to reduce manufacturing costs.

Whether you are a part designer, a moldmaker, or an injection-molding manufacturing professional, SOLIDWORKS Plastics mold injection simulation software can help you do your job better and resolve the many challenges that you face. By saving time, reducing costs, boosting quality, improving communication, and supporting collaborative workflows, SOLIDWORKS Plastics software will enable you to more consistently contribute to your organization's success.