Quality Control in Scientific Molding

Improving Reliability of Injection Molded Subassemblies using Empire’s Process Development Workbook
Scientific Molding: Precise Processes for Better Molded Parts

Scientific molding is a well-recognized approach to improve the quality of injected molded parts and assemblies. Materials, machine run speeds and even weather can have a notable impact on finished quality. The scientific molding approach identifies and controls key processing factors to ensure consistently high quality from operator to operator, shift to shift and part to part.

In many manufacturing settings, a gap exists between the principle and application of a disciplined scientific molding approach. But Empire’s approach is different; it captures the power of scientific molding knowledge, originated by the process engineering school at University of Massachusetts Lowell, and brings it to the floor.

The result?

- Reduced scrap
- Lower rejection rates
- Consistency of execution

Empire’s Process Development Workbook (PDW)

Empire’s Process Development Workbook (PDW) is the cornerstone of our scientific molding approach. Through people, process, and technology, PDW improves the repeatability and reliability of our customer’s injection molded assemblies. This e-book provides insights into scientific molding and the application of our Process Development Workbook (PDW) for improved quality in plastic injection molded parts, optics, and assemblies.

Quality Control Using PDW

Using the PDW on our facility-wide Wi-Fi, our engineers and operators are able to define variables and test, apply and document them right on the floor, run after run. This disciplined approach removes the guesswork from the process, resulting in a higher-quality and lower-cost end product.

The PDW lets us find the parameters that will result in the best part consistently, rather than changing the settings when transferring a mold to a different press, for example. By scientifically determining which limits will work instead of using trial and error to validate a process, industrial customers such as medical device manufacturers are ensured higher acceptance rates, better-performing finished assemblies, and consistently superior aesthetics.
The key to determining the correct parameters is focusing on material properties and specifications in advance of machine settings. Once our engineers use the PDW to evaluate temperature, cavity pressure, flow rate and cooling rate, they can then to verify the settings needed to replicate optimal conditions. This materials-based approach helps to:

- improve accuracy
- prevent part problems such as cracking, overstressing and visual defects
- ensure that the part will perform properly under the required conditions
- reduce cost and speed delivery

By maintaining controlled environments and strict documentation door to door, we are able to continually challenge and improve the effectiveness of our processes. Customers benefit from our technicians’ expertise and involvement in all phases of the operation, from mold design to quality control. Matched with our leading technology, Empire’s rigorous approach to scientific molding helps you get the most out of your medical device or optics program.

*The PDW approach helps us easily determine the best mold conditions for your plastic part. We are leveraging the PDW for in-house optics manufacturing, reducing time to market and program cost.*
PDW Data Improves Manufacturability

The following are examples of mold properties tracked using the PDW. By evaluating these detailed metrics, Empire can better pinpoint which parameters will result in the highest-quality part.

**Mold Balance Study**
With this study we are able to determine if the mold is capable of distributing plastic pressure equally to all cavities. This is a building block for a robust mold and ultimately results in a higher quality of product throughout all cavities.

![Cavity Balance Chart](chart1)

**Pressure Drop Study**
This procedure determines the intersection of the plastic flow path in relationship to the plastic pressure that is needed at each of the following sections: the nozzle tip of the molding press, the sprue, the primary runner, the secondary runner, the gate and end of cavity. We can identify any pressure loss areas quickly and make necessary changes to the mold, ensuring a continuous flow of the melt front. This improves dimensional stability and reduces cosmetic issues.

![Pressure Drop Chart](chart2)

**Rheology Study**
Through these studies we can identify the optimum fill rate by using the molding press as a rheometer, flowing the material into the mold. Producing viscosity values and plotting them during changes in injection speeds let us identify the material’s optimum set point, resulting in no variation in the viscosity.

![Rheology Curve](chart3)

![Effect Of Flow Rate](chart4)
Scientific Molding in Fully Automated Manufacturing

The use of robotics helps ensure more cost-effective and exact plastic production. Automation:

- eliminates human error
- reduces production time
- reduces injection molded assembly costs
- improves process repeatability

While a high degree of automation has proven benefits to customers, it also increases the complexity of setup, making technology like the PDW critical. At Empire Precision, the PDW is in use within its fully automated white room manufacturing cells.

Along with the PDW, automation has been a key part of Empire’s commitment to lean manufacturing.
Scientific Molding of Plastic Optics

Polymer optics are often the most complicated and expensive part of an assembly, which means getting things right the first time is paramount. As one of the only injection molders to also produce plastic optics, Empire Precision is improving repeatability and finished assembly quality by applying the scientific molding process and PDW to optical manufacturing. Various elements of the workbook can be adapted to optics, including:

- mold balance study
- gate freeze analysis
- fill diagnostics
- process window study
- high-low study to set process limits

Like with injection molded opaque plastic parts, running parts outside parameters can result in performance or aesthetic issues, such as distortion. The ability to understand and duplicate outputs for plastic optics can help prevent issues that might otherwise compromise optical quality.

PDW Application for Medical Devices

The ability to identify, record and repeat mold conditions with the PDW is advantageous in various molding scenarios, including:

- **High volumes, many runs** – By identifying and recording ideal parameters at the beginning of a medical device assembly project, Empire engineers can run tens of thousands of parts a month with minimal variation in quality.

- **Variable run schedules** – Some parts require only occasional volume runs, while some customers will request parts that have been out of production for years at a time. The PDW approach is particularly critical for tooling that’s put back in service; knowing past product performance ensures quick setup and accurate results.

- **Moving a mold to another machine** – It is sometimes necessary to move a mold to another press or begin production on a second press to speed delivery time for our customer, and the PDW helps us accomplish this efficiently.

- **Correcting part problems** – Occasionally, variations or problems will arise in a part. Having a detailed record of all the runs of that part allows engineers to pinpoint the condition that caused the anomaly and quickly correct it, keeping our customers’ timelines on track.
Medical Device PDW Examples

Automation reduces production cost and time for a surgical stapler part
For years we had been using a bridge tool for a customer’s program that required manual degating, trimming and milling of the part. However, by introducing a robot to remove the part from the mold and place it in an automatic degating system, we were able to reduce multiple steps in the process and cut handling costs in half. Integration of Empire’s PDW with our robotic technologies further improves efficiency in our process.

Strategy and technology eliminate defects in a polycarbonate part
A polycarbonate part was not designed correctly, and applying too much pressure caused pins to break and resulted in defects. We decided to run the part in our MuCell machine; in doing so, we were able to fill out the part without pressure and complete the mold without breaking pins. Because we had tracked the original mold properties using the PDW, switching between machines was simple.

Empire’s PDW for Your Program
For injection molded product programs such as medical devices, the scientific injection molding process and PDW can ensure consistent quality and speed time to market. To learn more about how Empire’s advanced technology and disciplined approach can help your medical device program, contact us at info@empireprecision.com.

If you’re frustrated with the quality of your molded parts, you can also request a no-cost evaluation. We’ll take an in-depth look at your tooling, process and parts, determine trouble spots, and recommend a path forward.

ABOUT EMPIRE PRECISION PLASTICS
Empire Precision (http://www.empireprecision.com) has a 20-year legacy of partnership with its customers in solving their most challenging injection molding problems. Empire provides medical device, consumer, industrial and military/aerospace customers with plastic molded parts and assemblies, from prototype to high volume manufacturing and assembly. Their comprehensive in-house capabilities allow for faster time-to-market and better finished quality, improving profit margins for their customers. Empire Precision Plastics is ISO 9001:2008 and 13485:2003 Certified.

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