



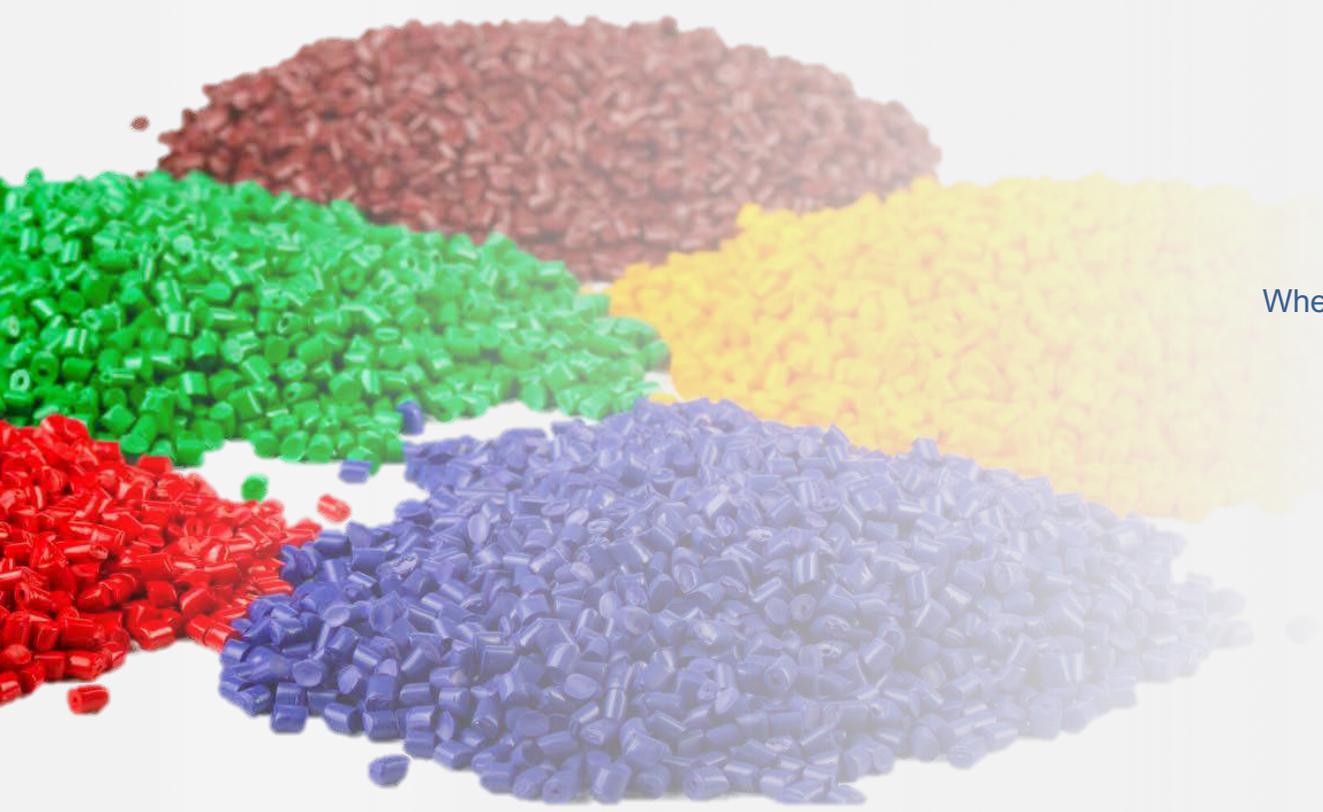
The How-To Guide for **DESIGNING** and **MOLDING BETTER** **PLASTIC PARTS**

Michelle Boucher | Vice President | Tech-Clarity

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Opportunities for Better Plastic Parts

Lower the Cost of Quality

What's the cost of poor-quality plastic parts? Tech-Clarity research finds that part quality is critical to product success, yet manufacturing defects in plastic parts is one of the top issues that negatively impacts product competitiveness. Unfortunately, it is hard to avoid manufacturing defects as 96% of surveyed manufacturers report finding them during mold trials. The cost is quite high as manufacturers find that correcting these defects during the mold trial adds 26% to the total cost of the mold. Imagine if you could lower some of that cost by making better decisions during design to avoid those issues before the mold trial?

This research study, based on a survey of 265 manufacturers, examines common challenges with plastic part and mold design, their impacts, and how to overcome them. The research reveals five best practices to help you ensure your plastic parts will be produced as designed.



How Do You Stay Competitive?

Getting Ahead

What's most important to winning your customer's business? It doesn't matter if you are designing plastic parts or the mold; companies indicate quality, cost, and reliability are most important (see lower graph).

Unfortunately, if you don't meet these objectives, not only will you fail to win new business, but the final product will be less competitive (see graph on right).

What Hurts Competitiveness?

If you can't produce plastic parts as designed, the entire product will be

less successful. Companies rate manufacturing defects as the top issue to negatively impact competitiveness. Defects can range from cosmetic problems such as flow lines or burn marks to more severe issues that hurt the structural integrity. These problems ultimately gives customers the impression that the product suffers from poor quality.

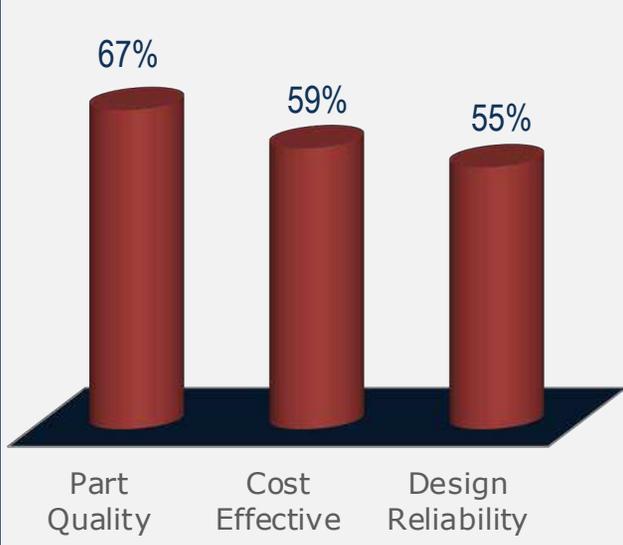
Other resulting issues include market delays and excess cost. Problems found during the mold trial will contribute to both of these issues as the troubleshooting, reworking of the mold, or part design changes consume both time and budget. During that time, a competitor may beat you to market, or you may have a reduced window of opportunity to collect revenue. Excess costs either cut into profitability or dictate a less competitive price.

Improve Design

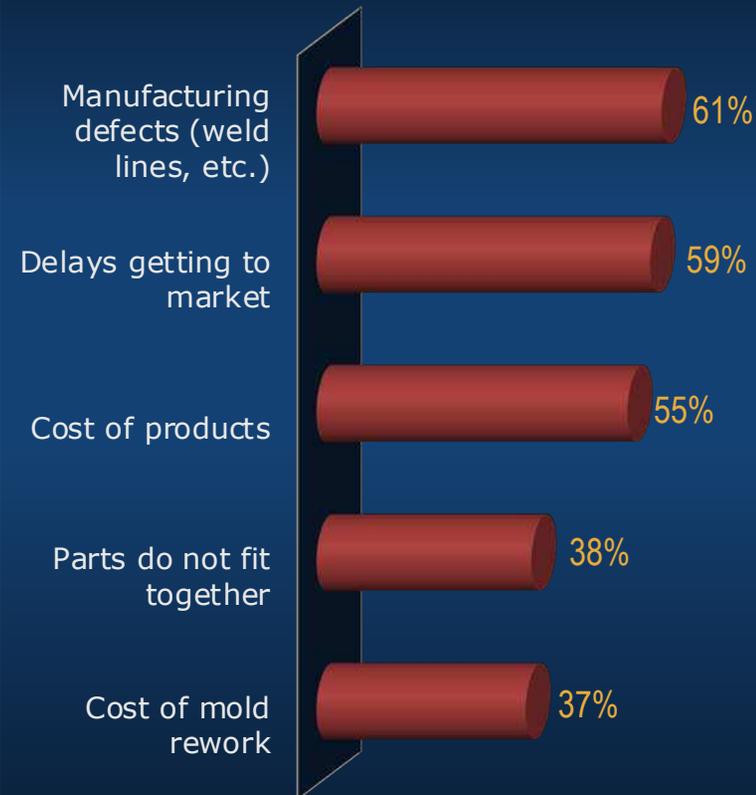
These problems reflect poorly on the entire product. Even an exceptional design will not realize its full market potential if the plastic parts give the impression the product is inferior. It's critical to properly design plastic parts and ensure the mold produces them as designed.

Companies rate **manufacturing defects** as the top issue to negatively impact competitiveness.

WHAT QUALITIES ARE CRITICAL TO WINNING YOUR CUSTOMER'S BUSINESS



WHICH ISSUES HURT THE FINAL PRODUCT'S COMPETITIVENESS?



Common Design Challenges

Design for Manufacturability

We asked part and mold designers about their top challenges. The differences in their responses indicate a difference in priorities. While defect-free plastic parts are critical to product success, avoiding manufacturing defects remains a top challenge, especially for part designers. Part designers are more likely to be aware of the repercussions of parts with manufacturing defects, but it is hard for them to predict where those defects will occur.

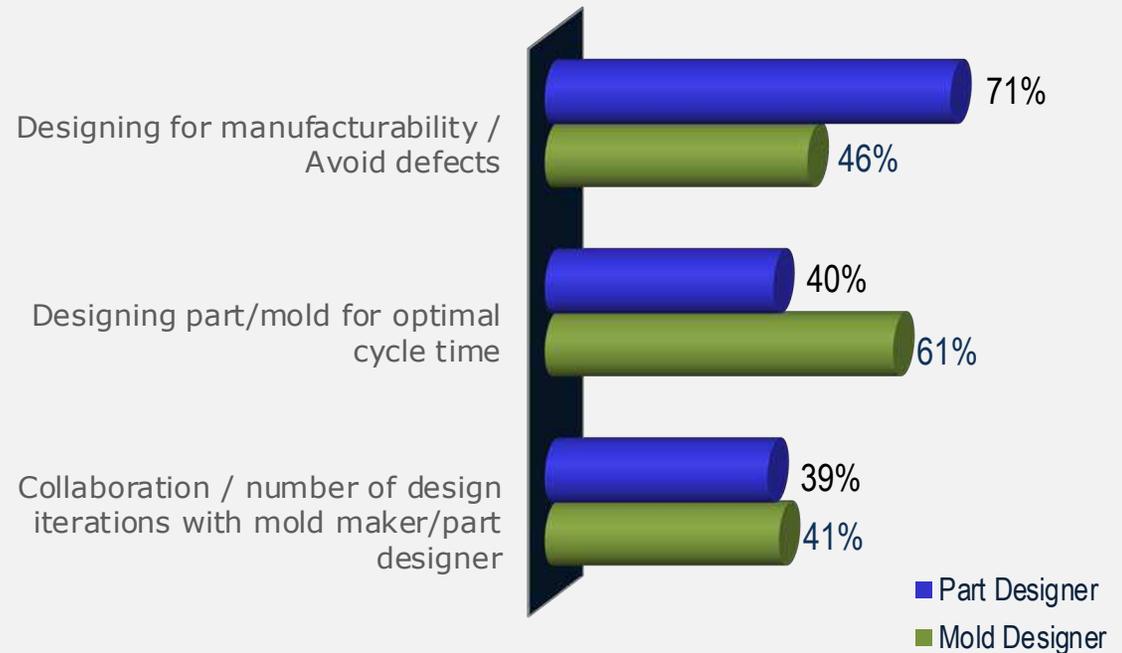
Cycle Time

Interestingly, while mold designers also consider avoiding defects a top challenge, optimizing for cycle time is an even bigger challenge. The mold designer is closer to the production process, so he or she is probably more aware of the value of a second in cycle time. Shaving off just a second or two can equate to thousands of dollars saved.

Collaboration

The fact that these challenges rank so high show they are very hard to solve, despite their importance. Addressing these challenges depends on decisions made by both the part and mold designer so effective collaboration is critical, yet it is also a big challenge. Part and mold designers tend to work in silos, often not even for the same company or even same geographic region so collaborating is a big issue.

TOP CHALLENGES COMMON TO DESIGNING BOTH PLASTIC PARTS AND MOLDS



The Impact of Manufacturing Defects

96% Find Manufacturing Defects During Mold Trials

Unfortunately, part designers and mold designers are not doing a good job solving these challenges as 96% report finding manufacturing defects during trials over the last two years. The graph reveals the most common defects.

The Cost of Defects

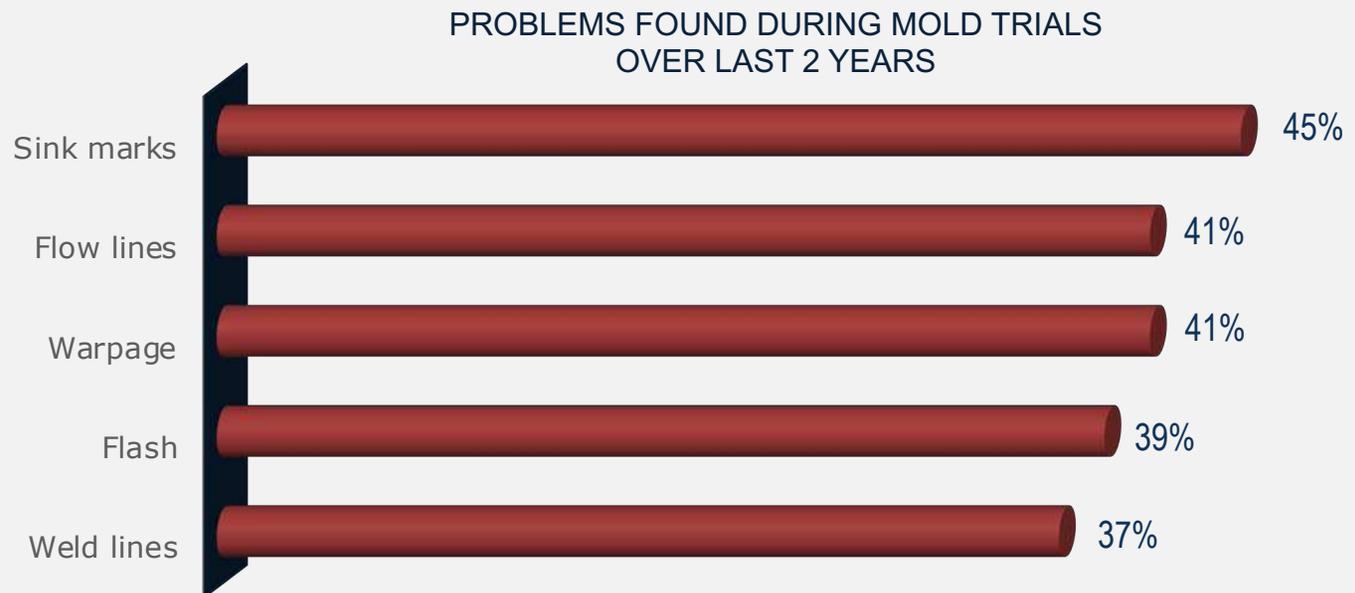
The impact of these challenges is significant. On average, correcting defects adds an additional 26% to the total cost of the mold. The more complex and expensive the mold, the more it costs to make corrections. Even lower cost molds see a significant impact, adding 18%. Part and mold designers need better ways to connect, as well as better insight into the impact of their decisions, so that they can avoid these extra costs.

That extra cost comes during the mold trial. A mold trial cycle involves a sample run, inspection, corrective action, and then another sample run. Corrective actions include

reworking the mold, adjusting the cooling lines, and modifying the part design. They also go through a trial and error process of adjusting process parameters. Survey respondents report it takes an average of seven mold trial cycles to produce production ready parts, with each cycle lasting about 14 days. A reduction of just two cycles could allow you to get production parts a month earlier.

Mold Cost	Percent Added Cost Due to Defects
Lower Cost Mold (\$5000 - \$40,000)	18%
Mid-Priced Mold (\$41,000 - \$80,000)	25%
Higher Cost Mold (\$81,000 - \$200,000+)	30%

On average, correcting defects adds an additional 26% to the total cost of the mold.



The Needs of Part and Mold Designers



As a result of this research, we identified several crucial needs that must be met to produce better plastic parts.

Part Designers Need:

- Insight to design for manufacturability/avoid part defects
- Better collaboration with mold designers
- Improved understanding of the impact of material choices
- Guidance on design decisions such as draft angles or where to place ribs

Mold Designers Need:

- Insight to avoid manufacturing defects
- Part designers to use the latest technology to help them understand the impact of their design decisions
- Insight to improve cycle time
- Guidance on design decisions for cooling lines, ejector pins, gate locations, and parting lines

To meet these needs, we recommend the following five actions to improve plastic part and mold design.

1. Facilitate Collaboration

Collaboration Leads to Better Designs

Decisions made by part and mold designers are interdependent so collaboration between both is critical. Mold designers have a lot of in-depth process knowledge that will add value to the part design process, while the part designer understands the part requirements better. Unfortunately, the silos between part and mold designers make collaboration a significant challenge.

As hard as it may be, improving collaboration is worth the effort. Better collaboration can catch issues like perhaps a part is gated in an area that will impact aesthetics. Perhaps the wall thickness is too thick in one area that will lead to warpage. By working together, the mold designer has a better understanding of the part requirements and the part designer has insight into critical issues that will lower

the cost of the mold, reduce cycle time, and reduce the risk of manufacturing defects.

Consider Integrated Platforms

Consider platforms that facilitate better collaboration and provide each designer with access and visibility to what the other does. Another benefit of an integrated platform is that it streamlines the change workflow. A change made to the part can automatically update in the mold design. This prevents anyone from working with outdated information, thus eliminating another potential source of errors.

“ Come to the table early and often during the development process. Understand the physical and aesthetic requirements of the final part. ”



Josh Leedle

Senior Industrial Designer and Ergonomic Specialist
SPECIALTY ENGINEERED MATERIALS SUPPLIER

“ Accept constructive advice from the mold-maker. ”



Product Engineer

MEDICAL DEVICE COMPANY

“ Involve the mold-maker earlier in the design process. ”

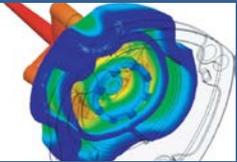


Senior Mold Designer

AEROSPACE AND DEFENSE COMPANY

2. Use Technology to Supplement Experience

“ Part designers must have tooling knowledge and tool room machining knowledge. They must be able to predict the undercuts while designing part surfaces. If a part designer knows this, he/she can significantly reduce the complexity of the mold design and ultimately the cost of the mold. ”



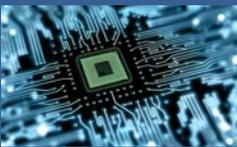
Jegannath.D.P
CAE Specialist
EASI ENGINEERING

“ You must consider how the part is to be manufactured and not solely focus on the aesthetics. ”



Thomas McHale
Design Engineer
AVENUE MOULD

“ Find a way to deal with the succession planning. ”



John Winter
Director of Engineering
BIRD TECHNOLOGIES

Expert Knowledge Needed

Plastic part and mold design are challenging. They require expert knowledge of plastic behavior, thermodynamics, and more. The impact of numerous variables must be considered to make the right decisions, yet it is hard to consider all factors simultaneously. Unfortunately, it will only get harder as 64% report the injection molding process is only getting more complex. Further, it takes years to develop the level of expertise to make the right decisions; yet, over the next several years, many companies will lose that expertise as the most experienced engineers approach retirement.

Plan for Retirements

Of those companies who have not invested in technology to support design processes for injection molding, only 13% use company guidelines to help avoid manufacturing defects. The rest rely on their personal experience or advice from others. That will work for now, but what happens when that experience is no longer available as a resource?

Technology Can Help

Mold designers recommend using technology for both part and mold design. Software tools offer many capabilities that capture best practices and guide better design practices. Leading plastic part and mold design solutions have automated capabilities to add draft, check parting lines, ensure standard clearances are maintained, and more. 3D CAD also makes it easier to identify interferences. For example, a mold design can get so complex, it can be easy to miss conflicts with cooling lines or ejector pins, but the right software will automatically identify expensive interferences like this for you. CAD libraries of common components or mold base assemblies can also save design time and encourage greater reuse. Combined, all of these capabilities save time and support better quality designs.

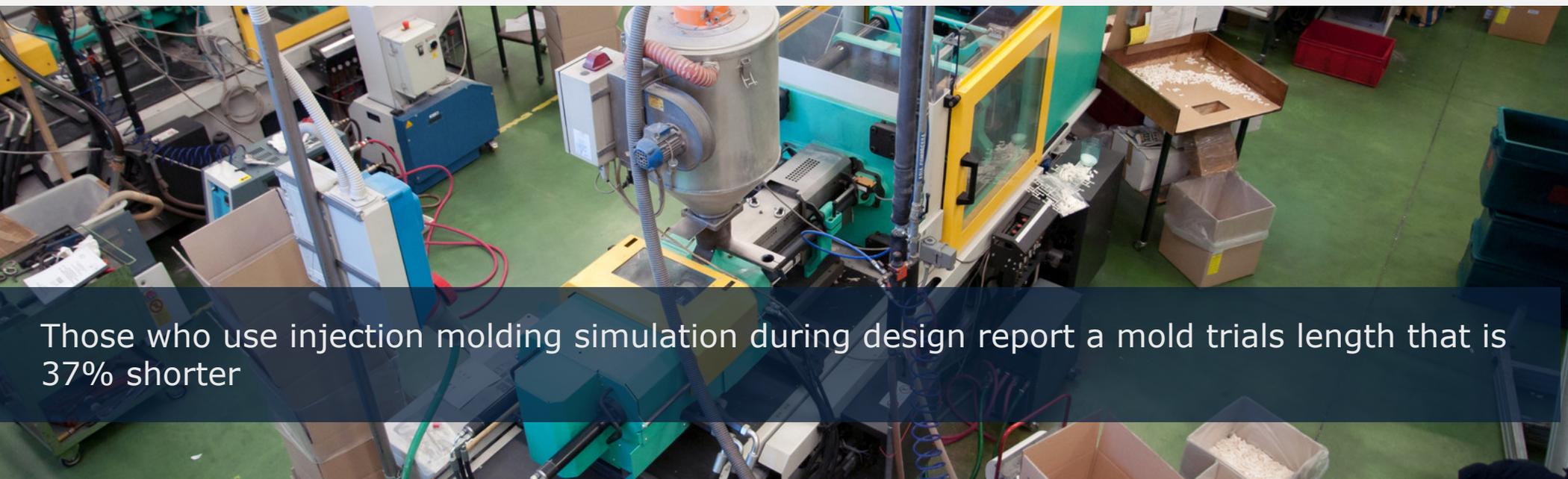
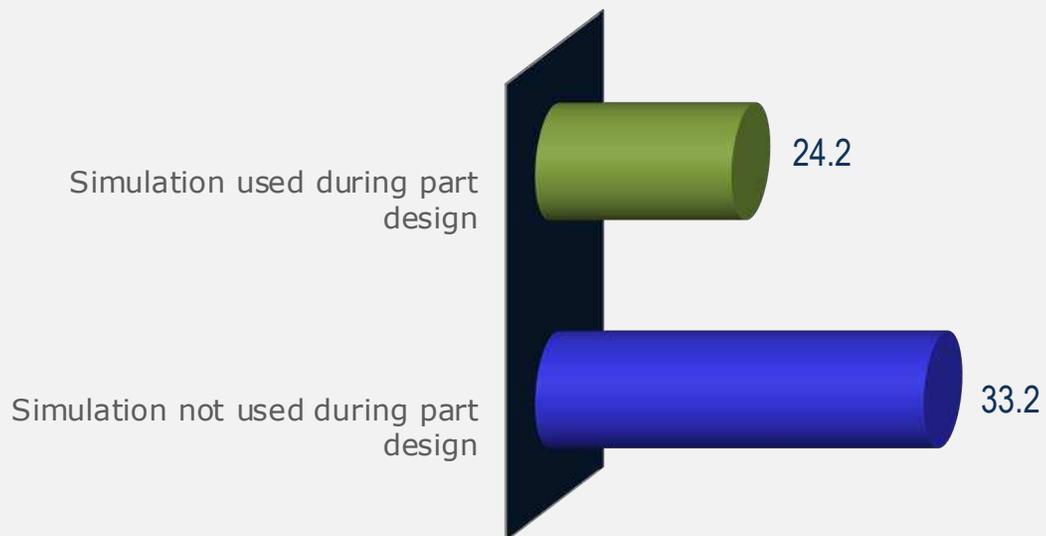
4. Use Injection Molding Simulation Early and Regularly

How You Use Simulation Matters

While injection molding simulation helps, some companies see even more benefit than others. The difference is in how they use it. By using simulation early and often during part design, you have the most opportunity to optimize the part design for injection molding. Consequently, you are less likely to find problems that will extend the length of the mold trial.

In fact, those who use injection molding simulation during design report a mold trials length that is 37% shorter than those who do not use simulation during design. Some part designers might think it is really up to the mold designer to design around problems and fix them. However, imagine what an advantage you would have if you could get production-ready parts 37% faster?

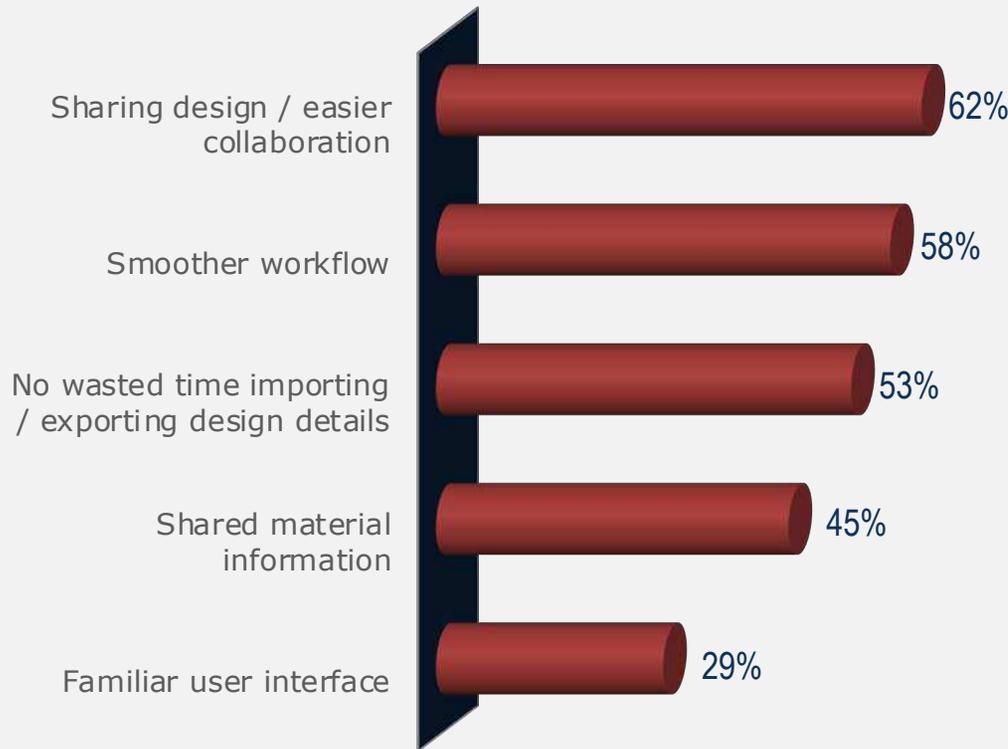
LENGTH OF MOLD TRIAL (WEEKS)



Those who use injection molding simulation during design report a mold trials length that is 37% shorter

5. Integrate Injection Molding Simulation and Design

MOST HELPFUL ASPECTS OF INTEGRATED DESIGN AND ANALYSIS



Limit the Barriers to Simulation During Design

Using injection molding simulation during part design can be extremely beneficial and can allow you to have production ready parts weeks or months earlier. However, the time savings at the end may mean adding a little time during design to conduct the analysis.

One way to streamline the design and simulation process is to use a simulation solution that integrates with the design solution. The graph reveals what those who use an integrated solution find most helpful. Design engineers and analysts find that sharing design details and collaborating in much easier when the solutions are integrated.

Integration Streamlines the Workflow

When the solutions are separate, much work goes into preparing the geometry for analysis. First, you must import the design model into the simulation solution. Just as an automated language translation from English to Spanish may not be perfect, importing design geometry into a new program is not always perfect, and surfaces may need to be cleaned up. Then with each design change, you have to go through the process of importing and cleaning up the geometry again. When the solutions are integrated, the process of preparing the model for analysis is much more streamlined. Even better, you can run more iterations without going through the tedious process of preparing the model each time, so there is less of a barrier to using simulation.

Another helpful feature of an integrated solution is that you don't have to waste time defining material properties that were already defined in the design model. The simulation can reuse all that material data for the analysis.

Invest in new technology, this will help come up with better quality products.

Product Manager
CONSUMER PRODUCTS COMPANY

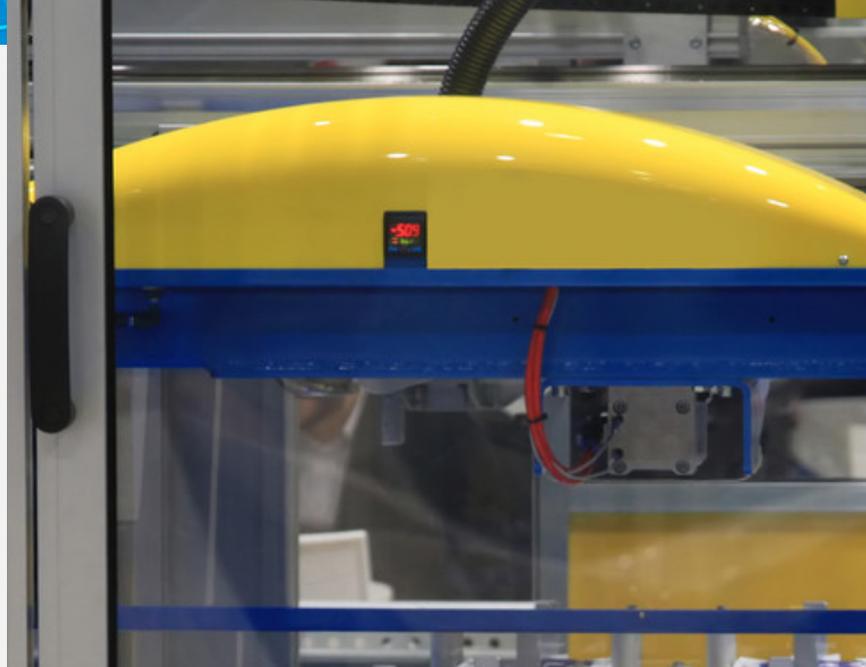
Conclusions

Quality Is Critical, but Hard

Quality plastic parts are critical to a product's overall success. As with many things, the product is only as strong as the weakest link. If your plastic parts are of low quality, it will reflect poorly on the entire product, and it will be less competitive. Consequently, manufacturing defects are the top issue that hurts the competitiveness of the final product. Unfortunately, 96% report finding manufacturing defects during mold trials. Correcting these manufacturing defects during the mold trial adds an average of 26% to the cost of the mold.

The Right Technology Will Help

Solving these challenges is not easy. Numerous variables impact the quality of plastic parts, and it can be nearly impossible to predict what will happen during the molding process without help. The right technology can make a significant difference. In fact, 97% of those who use injection molding simulation find it a useful tool to help produce quality parts. Also, the earlier it is used, the better. Those who use it during part design find the length of their mold trials are 37% shorter than those who do not use it during part design. This is likely because the additional insight from the simulation helps them identify potential problems early on. Thus, they can optimize the design for injection molding so they find fewer issues during the mold trial.



Correcting for manufacturing defects during the mold trial adds an average of 26% to the cost of the mold.



Recommendations



Recommendations and Next Steps

Based on industry experience and research for this report, Tech-Clarity offers the following recommendations:

- Facilitate collaboration between part and mold designers. Mold designers can provide insight to optimize the part design for injection molding, and part designers can clarify part requirements for the mold designer.
- Use technology to supplement experience. Modern software tools contain many automated features that will guide designers.
- Support design for manufacturability with injection molding simulation. Injection molding simulation will catch many manufacturing defects during design so that you can correct them early on, reducing the number of problems found during the mold trial.
- Use injection molding simulation early and regularly. The earlier you use injection molding simulation during part design, the more you can optimize the part for injection molding, so there is less risk of manufacturing defects, and the mold design can optimize cycle time.
- Integrate injection molding simulation and design. An integrated solution streamlines the process of preparing the design model for analysis, reducing a barrier to simulation.

About the Research

Data Gathering

Tech-Clarity gathered and analyzed 265 responses to a web-based survey on plastic part and mold design. Survey responses were gathered by direct e-mail, social media, partners, and online postings by Tech-Clarity.

Industries

The respondents represent primarily process manufacturing industries. 28% were from Automotive, 22% Industrial Equipment & Machinery, 21% Engineering Services, 20% High Tech & Electronics, 20% Life Sciences, 19% Consumer Products, 11% Aerospace & Defense, and others.*

Company Size

The respondents represent a mix of company sizes, including 36% from smaller companies (less than \$100 million), 43%

between \$250 million and \$1 billion, and 21% over \$1 billion. Company sizes were reported in US dollar equivalent.

Geographies

Responding companies report doing business in North America (66%), Western Europe (39%), Asia / Pacific Rim (42%), Latin America (22%), Eastern Europe (18%), Middle East (16%), and others including Africa.*

Role

The respondents were comprised of 27% Manager level, 25% Directors or VP, 5% Executive, and 42% individual contributors.

Organizational Function

Of the respondents, 47% were in product design and engineering roles, 9% manufacturing engineering, 9% in

manufacturing, 9% in product management, and the remainder were from a variety of organizational functions including Quality, Program Management, and others.

* Note that the values may total greater than 100% because companies reported doing business in multiple industries and geographies



The respondents represented a mix industries, company sizes, and geographies.

Acknowledgments



Michelle Boucher

Vice President
Tech-Clarity

About the Author

Michelle Boucher is the Vice President of Research for Engineering Software for research firm Tech-Clarity, an independent research and consulting firm that specializes in analyzing the business value of software technology and services. Michelle has spent over 20 years in various roles in engineering, marketing, management, and as an analyst.

Michelle graduated magna cum laude with an MBA from Babson College and earned a BS in Mechanical Engineering, with distinction, from Worcester Polytechnic Institute. She is an experienced researcher and author having benchmarked over 7000 product development professionals and published over 90 reports on product development best practices.

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