MAXIMIZING PRODUCT DESIGN IN A COMPLEX MANUFACTURING ENVIRONMENT

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Tracy Woo, Research Analyst,
Product Innovation & Engineering (PIE), Manufacturing

Report Highlights

This report discusses the process of achieving continual improvement in product quality within a complex manufacturing environment.

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In this expanding global market, customers have many options to choose from. Thus, in order for companies to stay competitive, they must *distinguish* and *differentiate* their products.

At the heart of product development success is customer satisfaction. The customer determines the value of the product and the level of quality the product should have. After all, the customer decides whether a product is desirable or not through their purchasing decisions.

In this expanding global market, customers have many options to choose from. Thus, in order for companies to stay competitive, they must *distinguish* and *differentiate* their products. Companies tend to fall behind when they believe the status quo is good enough. To stay in the game, product development must include continuous performance improvement.

The Challenges of Product Development

Delivering what customers want seems simple enough, but getting there is the elusive goal every product-based company is chasing. A part of product success is just plain luck and the rest is in timing, quality, and cost. These three tenets are at the base of every successful innovation, which is why they are the top three driving pressures for companies to improve their product design process, shortened schedules (52%), competitive pressure (39%), and lower cost demands (31%).

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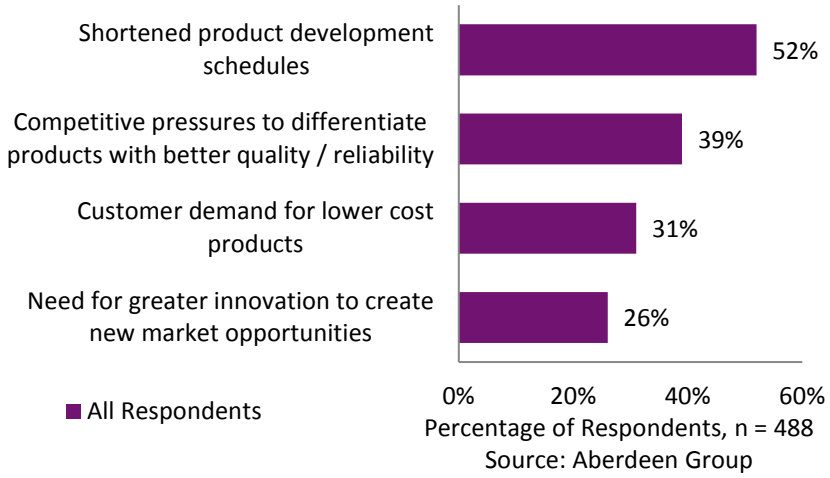
Figure 1: Shorter Project Schedules Increases the Need for Streamlining Product Development



Developing products is a complex cycle that starts with idea conception, moves into the design phase, and finally production. It's the responsibility of designers to create a product that addresses market desires and outshines the competition.

According to respondents in a survey conducted by Aberdeen Group, the market now demands a higher level of complexity in their products (40%) that can operate across varied environments (36%). In order to address these demands and compete in an expanding global market with limited development resources (36%), companies must find a way to differentiate themselves (31%).

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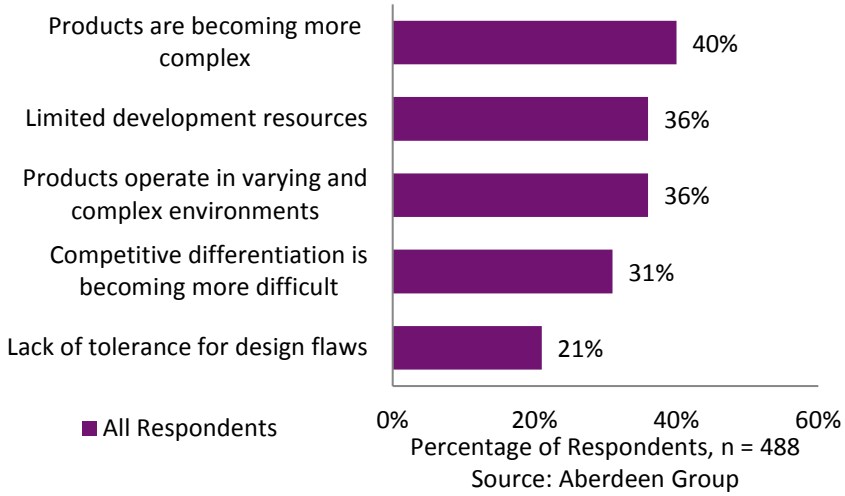
Figure 2: Rising Complexity in Product Development



Source: Aberdeen Group

The Challenge in Finding Talent

- Lack of engineers in the hiring pipeline: 62%
- Company is not willing to pay for talent: 52%
- Rapidly changing skills in engineering positions / unable to keep up with technology: 27%

As shown in figure 2, an important distinction is that by eliminating design flaws (21%) companies can reduce product recalls and delays.

Increasingly, successful innovation depends on a company's ability to develop more complex products, a trend that has doubled in the past 15 years, seeing significant growth just in the past two years. Survey respondents noted an increase in components over the past two years: mechanical (13.4%), software (34.4%), and electrical (19.6%).

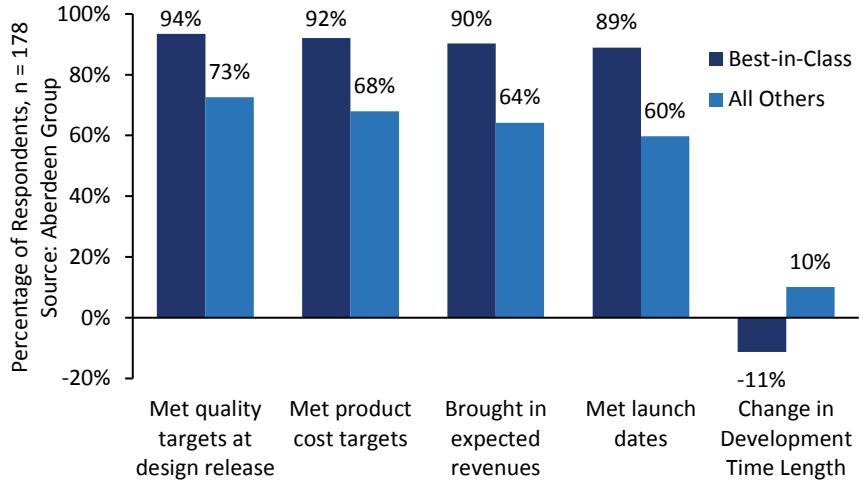
Once that differentiation is gained, it's equally important for the quality of the product to remain high. Flaws in the product design can, at best, mean a delay in product delivery, leaving potentially larger implications in a successful market introduction. At worst, it can mean loss of consumer loyalty and thereby market share.

Defining the Best-in-Class

To distinguish Best-in-Class companies, survey respondents were divided into two maturity classes — Best-in-Class (top 20%)

and All Others (bottom 80%). These classes were made based on five organizational performance metrics: quality, product launch dates met, product cost targets met, product revenue met, and change in length of development time (increase or decrease). Respondents were asked to identify the frequency at which products met these targets in the past two years. Figure 3 highlights the performance of the two maturity groups.

Figure 3: Multiphysics Leaders Perform



Best-in-Class companies consistently outperformed their peers, meeting their targets by almost 20% above All Others in quality, launch, cost, and revenue metrics. They were also able to decrease their development time by almost double that of All Others.

Successful Design Starts with a Common Process

The success of a product is highly dependent on several factors; alignment to market needs, level of quality, delivery time-to-market, and cost. The issue that companies struggle with is in delivering on these objectives while maintaining profitability. As stated in the previous section, the issue of labor resources plays

We Need Insight

Companies were asked what their major challenges were in getting insight into product development. Here's what they said:

- Too many manual processes (spreadsheets): 39%
- No method for visibility to data to support decisions: 31%
- Lack of expertise/resources: 19%

a huge factor into how well a company can deliver on its promises.

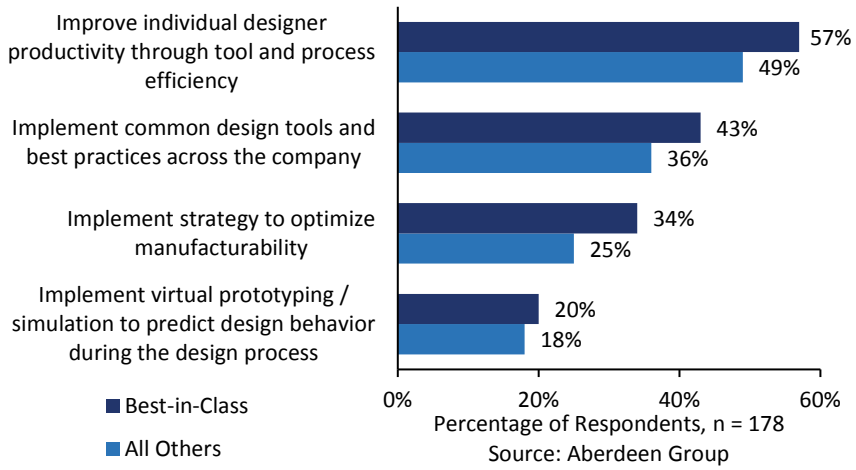
The Best-in-Class Distinguish Themselves

Other performance metrics that separate the Best-in-Class from All Others:

- Overall Product Cost Decrease
  Best-in-Class: 12%
  All Others: 7%
- Lifecycle Cost Targets
  Best-in-Class: 83%
  All Others: 66%
- Decrease in Number of Engineering Change Orders (ECOs) After Design Release
  Best-in-Class: 15%
  All Others: 6%

Best-in-Class companies have turned to improving productivity at the individual level (57%) through streamlining the design process and its corresponding tools. In many companies, product design is a fragmented and disjointed process, making the ability to coordinate and manage their overall development extremely difficult. The Best-in-Class understand the importance of finding a common design solution, as they are 19% more likely to implement a company-wide solution with best practices documented.

Figure 4: Best-in-Class Companies Use Common Tools



The realization of complex products requires a huge amount of coordination between upstream and downstream departments. The growing development schedule challenge means there is little room for delays during any part of the cycle. Best-in-Class companies prevent unnecessary delays from occurring by optimizing their designs for manufacturing (36% more likely) and verifying their designs (11% more likely) through simulation or virtual prototyping.

Optimize for Manufacturability

The final cost and delivery of a product is determined by its manufacturability. A product that is designed only for fit and function without any thoughts to its future fabrication can lead to disastrous results down the line. Eighty percent of the product budget is used in the first phases of development. After the process of product conception, testing, and prototyping, the path of a product is committed. Materials and tooling have been purchased and the assembly process is put in place. To make any modifications at this point will result in huge expenses. Following the Rule of 10, in each subsequent phase, the cost rises 10 times to fix any mistakes. As a result, the Best-in-Class follow these steps to optimize for manufacturability:

- **Collaborate with manufacturing during the design process**. Focus during the early phases of product design on its manufacturability. This process is simplified when collaborating closely with manufacturing from the early stages of development through prototyping and testing phases. Changes made initially are easily adapted and less costly than modifications during production. Modifications to a design are most flexible and easily implemented early on. Sixty-eight percent of Best-in-Class companies collaborate with manufacturing during the design stages. (see Figure 5).
- **Create a feedback loop**. Continuous improvement of the design process is best achieved by feeding manufacturing data back into product lifecycle management (PLM) systems. PLM and manufacturing systems have traditionally been two very distinct segments in the development process. However, shorter project schedules have forced the combination of these two segments for a leaner manufacturing process. In closing the loop

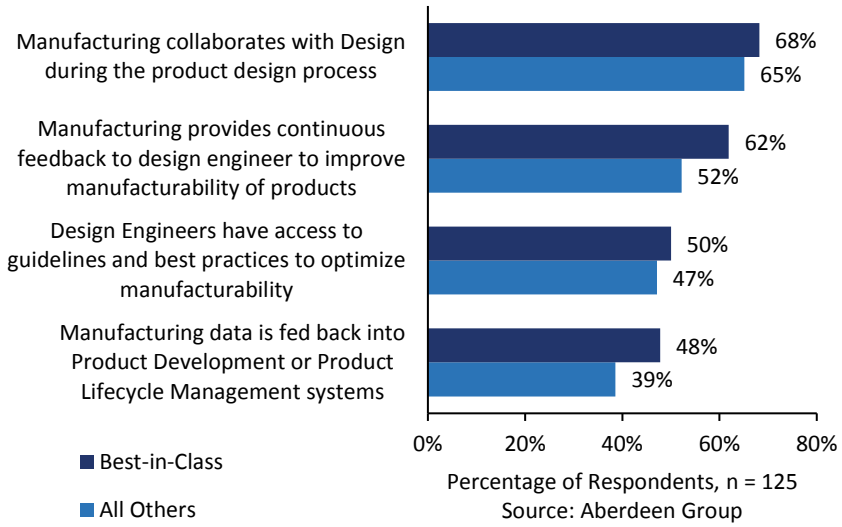
Which Features Do You Look for in a Simulation Solution?

- Accuracy: 76%
- Reliability: 76%
- Integration with CAD: 70%
- Depth of Capabilities: 67%
- Cost: 61%
- Ease-of-use for Non-Experts: 50%

between PLM and manufacturing systems, the idea is to share insightful data to engineering, the factory floor, and to senior management. The resulting outcome is a streamlined product delivery cycle that eliminates redundant manual processes and waste. The Best-in-Class are 19% more likely to have manufacturing provide continuous feedback than All Others. They are 23% more likely to have data fed back into PLM systems than All Others.

➔ **Document and enforce best practices.** The easiest way to ensure design for manufacturability is to create guidelines and best practices that the entire design team can follow. Agreed upon best practices should be enforced to ensure the company is maximizing the benefits of a multiphysics simulation solution. Fifty percent of Best-in-Class companies give design engineers access to best practices for optimized manufacturability.

Figure 5: Best-in-Class Companies Collaborate



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Without collaboration between design and manufacturing, errors, bottlenecks, and delays will occur making it harder to optimize for manufacturability. Tying the as-built plan into the design provides a platform in which design for manufacturing is a natural part of the workflow, making the process more streamlined, ultimately resulting in higher-quality products.

Simulation-Based Design

Best-in-Class companies use simulation solutions to enable them to move nimbly through their product design process without overspending on overhead. The benefits of simulation far outweigh the start-up cost and setup in the long run since it provides a risk-free, low-cost environment that allows designers to consider hundreds, if not thousands of iterations of the same design. In order to properly integrate simulation into your development process, follow these Best-in-Class steps:

- **Front-load design verification in the product development process through expert collaboration.** Make your most rigorous analysis and proofing during the first few stages. Have expert CAE users evaluate concepts early on. Just as in designing for manufacturing, changes made initially are easily adapted and less costly than those made later in the product lifecycle. The sooner design iterations are explored, the more flexibility for change is possible and the less room for error downstream. Best-in-Class companies are 16% more likely to have expert CAE users deployed early in the design process than All Others (see Figure 6).
- **Leverage data from multiple sources.** Effectively using multiple data sources in simulation can be challenging. Consolidating the data into one easily accessible and readable format can be a time consuming task, especially with sketches that are not easily transferrable to other

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Design Products Correctly — The First Time

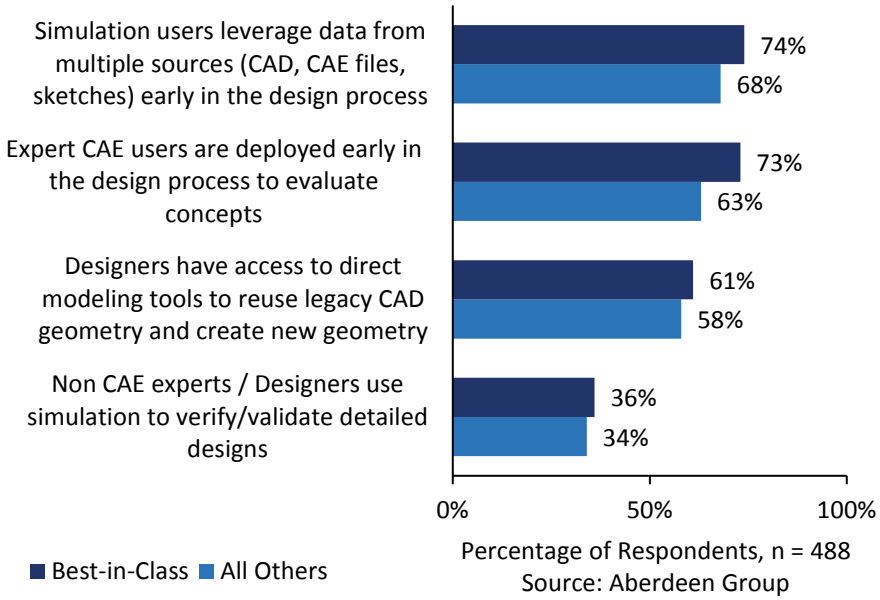
Company performance was measured over a span of two years. The goal was to see how performance metrics changed with the incorporation of a simulation solution versus those who used none at all (i.e. manual or hand calculations). Here's where they stood:

- **Change in overall product cost**
  Simulation Users: 13% *decrease*
  Manual Calculation Users: 2% *increase*
- **Change in number of change orders after release to manufacturing**
  Simulation Users: 10% *decrease*
  Manual Calculation Users: 8% *increase*
- **Change in number of partial physical prototypes**
  Simulation Users: 12% *decrease*
  Manual Calculation Users: 3%

formats. Still, the use of each form contributes valuable information, where the combination of the parts result in a more complete picture of an optimized design. Seventy-four percent of the Best-in-Class use data from multiple sources in the initial phases of design.

➔ **Reuse legacy CAD geometry.** For engineering teams, reusing 3D models in their design has always been of great interest. After all, the benefits of design reuse are high — less work, leading to increased productivity. Still, engineering teams have generally approached reuse on an ad hoc basis, not making a formalized process a priority. However, a growing global market is forcing higher product quality, and shorter lead times. Companies are now taking steps to make their design practices as efficient and productive as possible through the reuse of existing designs. Sixty-one percent of Best-in-Class companies have access to direct modeling tools to reuse legacy CAD geometry for new designs.

Figure 6: Best-in-Class Companies Use Simulation at All Stages of Development



Best-in-Class companies keep their engineers focused on innovation, to bring the next great product to market. They do so by eliminating time-wasting measures and redundant processes. Best-in-Class actions call for reusing existing designs, using simulation early in the design process, and making simulation accessible to both experts and newer users in order to validate designs. The final, critical step in development lies in making modifications to the design as early as possible to keep cost at an absolute minimum. Simulation use in verifying designs must be done in the early stages in order to reap the true benefits.

Key Takeaways

In this era of "better-faster-cheaper," what companies are finding is that cheaper and faster isn't better. Consumers are demanding more complex products at higher quality than the previous version. How does a company keep up with these contrasting demands? The difficult answer is no organization

can improve all aspects of product development at once. What they can do is implement Best-in-Class practices in a systematic fashion by following these steps:

- ➔ **Implement common design tools.** Easily achieve this through the use of a core solution company-wide. Document best practices for ease of adoption.
- ➔ **Redefine your workflow.** Getting the most out of simulation means creating a process that incorporates its use early in the design phase as well as in troubleshooting or post-production.
- ➔ **Collaborate with manufacturing.** Prevent costly modifications further down the road by designing with manufacturing.

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Related Research

The Changing Landscape of Product Development: Implementing Agile Across the Enterprise; May 2016

Computer-Aided Design (CAD) Data Management: Maximizing Development Productivity; April 2016

Streamline Product Development Through Optimized Product Lifecycle Management (PLM); February 2016

The Path to Product Success: Listen to Your Customers; December 2015

Author: Tracy Woo, Research Analyst, Product Innovation & Engineering (PIE) and Manufacturing (tracy.woo@aberdeen.com)

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