RR

THE BENEFITS OF SIMULATION-DRIVEN DESIGN

December 2022

Sarah Gaffney
Manager
Research Data & Operations

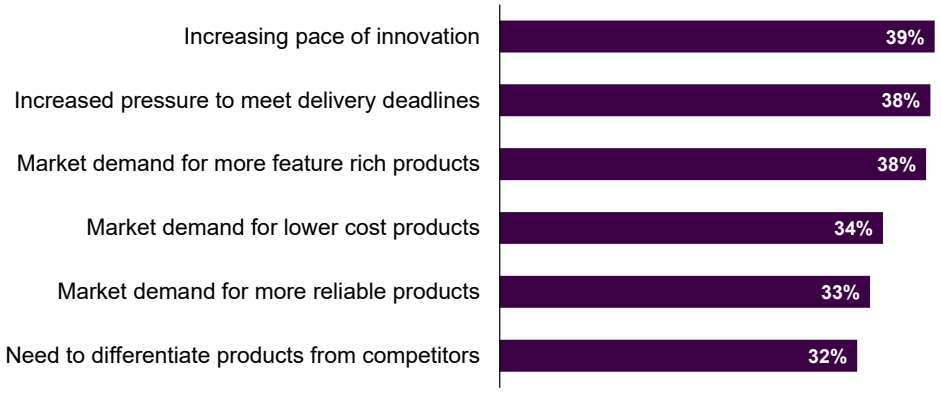
ABERDEEN
STRATEGY & RESEARCH
ILLUMINATE. INSPIRE. IGNITE.

This report explores simulation-driven design, defined as the use of simulation early in the design process. Driven by market pressures and challenges, Best-in-Class designers are increasingly applying simulation themselves during the design phase. This report shows best practices for simulation-driven design as well as the significant benefits of this design philosophy in improving cost, time-to-market, and quality. Ultimately, simulation-driven design results in more innovative products that are more likely to work the first time and less likely to require significant rework late in the design process.

Pressures and Challenges Reveal the Need for Simulation-Driven Design

The top priority of product designers is to launch innovative, high-quality products to the market quickly and cost-effectively. In the past, this meant completing the initial design and turning it over to a dedicated group of simulation experts for further design iteration and optimization. While the expertise of such groups is still highly regarded, many companies are looking for ways to disseminate simulation knowledge among engineers to prevent bottlenecks and increase process efficiency. A key strategy to implement simulation into the broader workflow is to frontload the design process with simulation. The market pressures and challenges affecting manufacturing organizations today are driving designers to bring simulation into the design process early and often (Figure 1).

Figure 1. Pressures Driving the Move to Simulation-Driven Design



% of respondents ranking each pressure as one of their top three

n = 262, Source: Aberdeen, December 2022

The Aberdeen maturity class framework is comprised of three groups of survey respondents. This data is used to determine overall company performance. Classified by their self-reported performance across several key metrics, each respondent falls into one of three categories:

- **Best-in-Class**: Top 20% of respondents based on performance
- **Industry Average**: Middle 50% of respondents based on performance
- **Laggard**: Bottom 30% of respondents based on performance

There may be references to a fourth category, All Others, which is Industry Average and Laggard combined.

Manufacturing Operations Management Benchmark Study

Aberdeen surveyed 262 manufacturing and engineering decision-makers across the globe who are involved with product development and operational initiatives at their organizations. Among the questions asked to participants were top pain points and challenges with their product design processes, technology utilization, and company performance metrics. Detailed survey demographics can be found at the end of the report.

Manufacturers are pressured to better understand product behavior during the design phase amidst increasing product complexity, tighter development budgets, and a competitive business environment. The need for greater innovation is critical, and it is a catalyst to create new market opportunities. On top of the need to innovate, there is immense pressure to differentiate products with better quality / reliability / richer functionality. Due to shortened development schedules and the need for quicker time-to-market, there is less time to develop innovative products.

There is also continuing customer demand for lower cost products, despite their concurrent cry for richer functionality and "smart" product features. For example, high-tech manufacturers are always looking to create the next best gadget or electronic device that can be adopted by people everywhere, but they need to keep in mind the price that consumers will actually pay and ensure their operating costs don't outweigh the size of their buyers' pockets. Aberdeen's research shows that the greatest market pressure for high-tech manufacturers is to ensure customer satisfaction (zero defects, performance, cost expectations, etc.), with 41% of high-tech companies in Aberdeen's latest study rating it as one of their top three pressures. Applying simulation in the design process helps reduce operating costs by preventing time and money spent fixing design flaws in later stages.

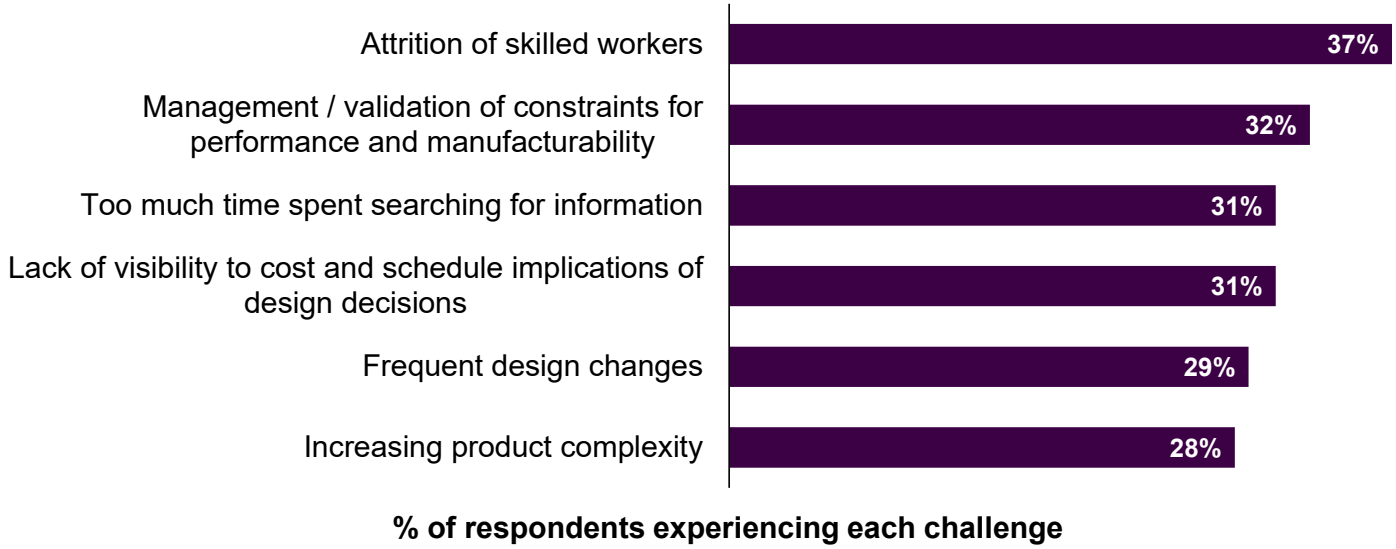
These pressures and the need for simulation earlier in the design process are mirrored in the challenges that designers now face with their product innovation processes (Figure 2).

The greatest market pressure for high-tech manufacturers is to **ensure customer satisfaction** (zero defects, performance, cost expectations, etc.), with

41%

of high-tech respondents rating it as one of their top three pressures.

Figure 2. Development Challenges Leading to Simulation-Driven Design



n = 262, Source: Aberdeen, December 2022

Attrition of skilled workers is the number one challenge designers face today, but with a simulation solution that is easy to use and accessible, product development teams can empower non-experts to handle tasks previously managed by design optimization experts. Challenges around the validation and constraints for performance and manufacturability speaks directly to the need for simulation solutions to effectively test product performance in all environments and situations and plan for any complexities during production. Simulation solutions that are integrated with centralized databases or business applications help reduce time spent searching for information and lack of visibility into cost and schedule implications. To dissipate the tension created by these pressures and challenges, Best-in-Class designers are acting. Faced with longer design time, shorter time-to-market needs, and quality issues, they have discovered a better way to product innovation: simulation-driven design.

Best-in-Class Firms Push Simulation to Designers

Aberdeen defines **simulation-driven design** as the use of simulation early in the design process, and the principle of simulation-driven design is simple. Because design engineers outnumber simulation experts by 5:1 or 10:1, workflows that isolate a simulation specialist group can lead to bottlenecks in the design process. Best-in-Class firms, defined by Aberdeen as the top 20% of companies based on their performance in self-reported metrics (Table 1), have thus responded by introducing simulation directly into the design environment so they can eliminate bottlenecks in specialist teams. Expressed as a proverb: “Give a person a fish and you feed them for a day; teach a person to fish and you feed them for a lifetime.” In short, the simulation specialist group is better used as a leveraged resource to design engineers, advising them as they simulate for themselves, rather than doing it for them on an on-going basis. The shift in workflow and the availability of technology have made way for modelling and simulation analysts to act as a bridge between the experts and the engineers, working with both groups to refine designs.

Table 1. Maturity Matrix for Best-in-Class Designers

Performance Metric	Best-in-Class	All Others
Average percentage of products meeting revenue targets	88.2%	66.1%
Average percentage of complete and on-time shipments	91.5%	66.2%
Average percentage improvement (decrease) in time to market over the past year	- 87.2%	- 29.4%

n=262, Source; Aberdeen, December 2022

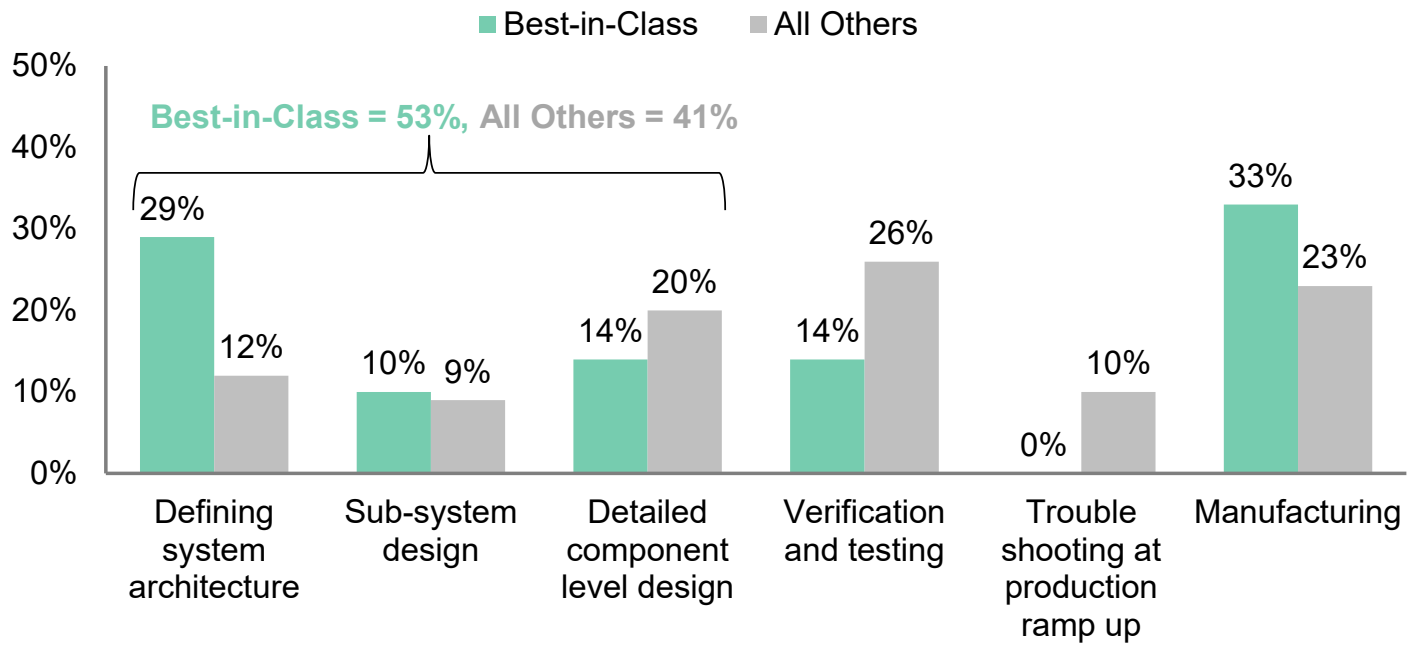
Aberdeen's research verifies the importance of simulation-driven design among Best-in-Class designers. Compared to All Others, Best-in-Class companies are 56% more likely to invest in simulation capabilities (73% of Best-in-Class companies currently use simulation compared to only 46% for All Others). Moreover, the value proposition of simulation for Best-in-Class manufacturers has shifted into the design stages of product development, while All Others are more likely to value simulation in later stages (Figure 3).

Best-in-Class companies are

56%

more likely to **invest in simulation** than All Others (73% vs. 46%).

Figure 3. Best-in-Class Pushes Simulation to the Design Phase



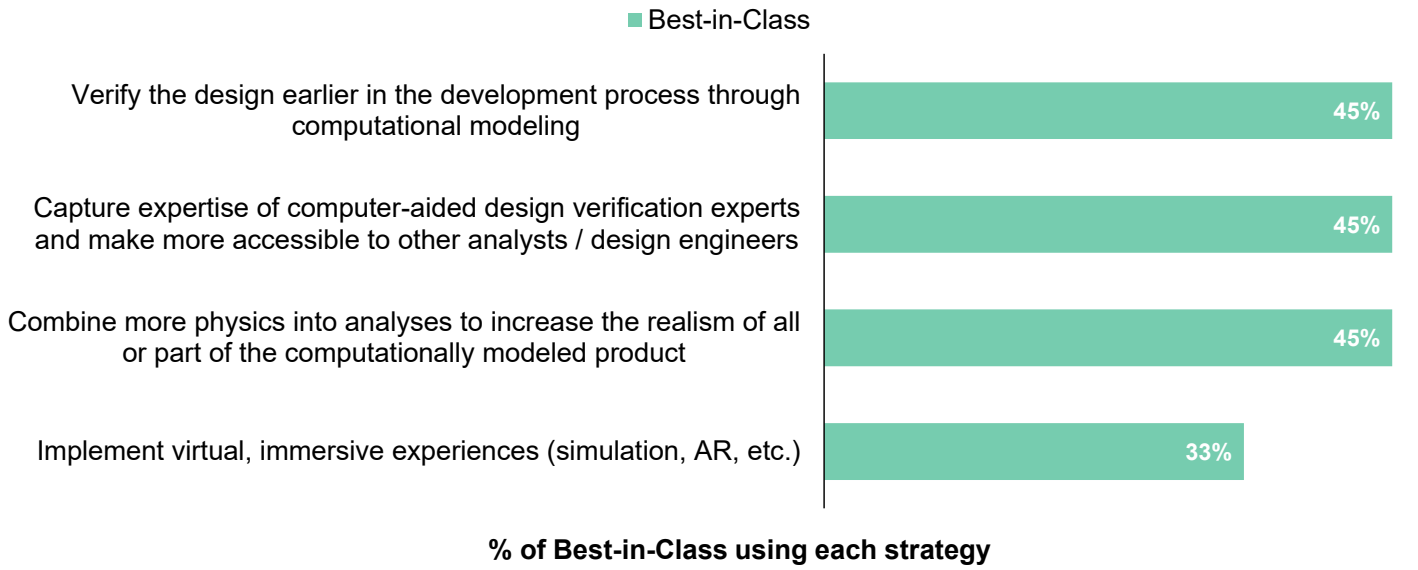
% of respondents citing that simulation has the biggest impact at this stage (select one)

n = 262, Source: Aberdeen, December 2022

Among Best-in-Class firms, 53% say simulation has or can have the greatest impact for their organization for design-centric stages of product development, including defining system architecture, sub-system design, and detailed component level design. Only 41% of All Others say the same, with the peak for these firms being at the verification and testing stage. The Best-in-Class are also utilizing simulation during manufacturing to optimize processes such as production, inventory, assembly, and transportation. The versatility of simulation use cases displayed by the Best-in-Class shows they value it as a tool to streamline the entire product lifecycle to get high-quality, complex products out the door as quickly as possible.

Additional data supports the thesis of the ongoing shift to designer use of simulation among Best-in-Class firms. When asked about their strategies to improve their product development processes, respondents at Best-in-Class companies said they are working to verify designs earlier, bring expertise to non-experts, focus on physics, and implement more virtual experiences in general (Figure 4).

Figure 4: The Shift to Simulation in Design Among the Best-in-Class



n = 262, Source: Aberdeen, December 2022

Under simulation-driven design, the Best-in-Class ensure success in a number of ways. In this new designer-centric model, simulation experts collaborate extensively with design engineers as they simulate for themselves. In addition, Best-in-Class firms capture the expertise of CAE experts and make it more accessible to design engineers. Finally, 45% of the Best-in-Class are working to verify the product design earlier in the development process through computational modeling. This last step is critical to assuring the product's proof-of-concept works right the first time.

This shift to design engineer use of simulation is part of a larger trend of simulation deployment to non-experts. As stated earlier, the top product development challenge for manufacturers is the attrition of skilled workers, which in this context would refer to simulation experts who have honed their knowledge of simulation over decades. As these experts change jobs or transition out of the workforce, a skills gap develops, leaving design teams to either find talent to quickly fill those roles or solutions to advance the skills of their existing team members to take on those roles.

The competitive talent market today along with the Great Resignation, an ongoing economic trend in which employees are resigning from their current jobs since the COVID-19 pandemic began, has led many organizations to turn to technology. When deciding to invest in a simulation solution, Aberdeen's research shows that the number one decision criteria is ease of use (see sidebar). Ease of use is critical to ensure adoption among non-experts and offset this skills gap. As Best-in-Class organizations move to simulation-driven design and invest in easy-to-use solutions, they are also careful to capture and share simulation best practices and expertise, making it available to non-experts. This encourages and enables non-experts to get up-to-speed with modern simulation techniques.

Other top criteria include integration with CAD models and the ability to move assemblies precisely through their complete range of motion. For the full benefit of simulation, simulation capabilities need to be available within the design environment. Integration makes it much faster and simpler to make changes to design based on simulation results, thus increasing efficiency of the entire design process. Additionally, integration with CAD makes simulation more scalable because the iterative process of going back and forth between design and testing is less time-consuming, allowing developers to work on more projects in a given timeframe.

For example, an aerospace and defense manufacturer who is working to develop aircrafts that utilize less fuel for both sustainability and cost reasons needs to test lighter materials or different parts in various environments, such as inclement weather, turbulence, and emergencies. Integrating simulation into the CAD platform allows designers to conduct tests, return to the design application to make adjustments around material type, shape, and conditions, and re-simulate without ever leaving the platform. They can scale the number of simulations they're able to run on the working design because integration minimizes the time spent transitioning from one application to the other.

The Benefits of Simulation-Driven Design

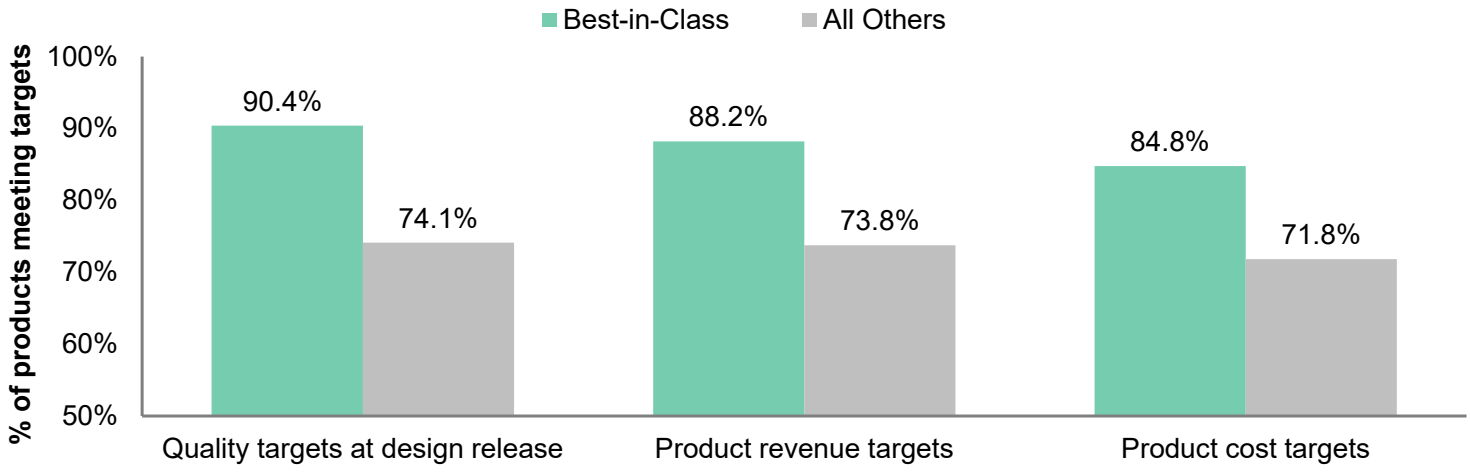
Does simulation-driven design pay off? Aberdeen's evidence strongly suggests it does. Best-in-Class firms implementing simulation-driven design enjoy significant benefits in product development cost, revenue, and quality (Figure 5, at the top of the following page).

Decision Criteria for Simulation Solutions

- Ease of use: 38%
- Ability to model and simulate physics-based problems: 37%
- Ability to build multiple parts together: 35%
- Integration with CAD models: 33%
- Ability to move assemblies precisely through their complete range of motion: 28%
- Accuracy: 26%

% of respondents citing that they look for each capability when selecting a simulation solution

Figure 5. Simulation-Driven Design Users Meet Targets



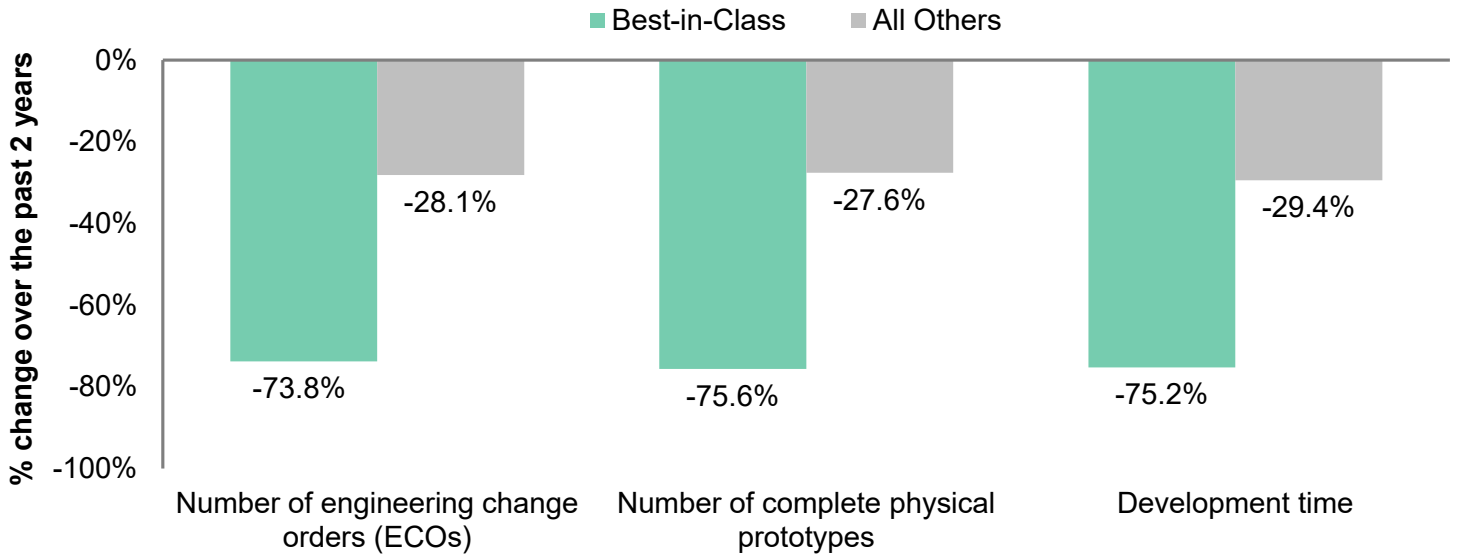
n = 262, Source: Aberdeen, December 2022

Best-in-Class designers that deploy simulation earlier in the design process easily outperform All Others by developing products that are more likely to meet their quality, revenue, and cost targets. This success is directly attributable to pushing simulation to design engineers and allowing them to iterate and innovate themselves. This results in optimized, breakthrough product designs.

Quality targets are better achieved with simulation-driven design due to the ability to view designs under different motion, vibration, pressure, and other conditions prior to verification and testing and fix structural issues early in the design process. Thinking back to goals of meeting customers' expectations around features, time-to-market, and cost, manufacturers utilizing simulation-driven design to meet these needs are more likely to sell their products and bring in predicted revenue. Simulation-driven design helps manufacturers create cost-effective products in many ways. This design strategy can reduce time and money spent in design phases by streamlining design workflows, decrease costs of creating physical prototypes (see Figure 6, next page) during verification and testing because of the simulations already run on the designs in a virtual environment, and prevent costs of non-quality from warranties and recalls later down the line.

Best-in-Class firms have also enjoyed improved development metrics since adopting simulation-driven design, saving product rework time, reducing prototype development, and decreasing development time (Figure 6, at the top of the following page).

Figure 6. Simulation-Driven Design Boosts Performance



n = 262, Source: Aberdeen, November 2022

As all design engineers know, the cost of a design misstep is great. The later a design problem surfaces, the more it costs to fix or rework the issue. Simulation-driven design remedies this issue by pushing simulation into the earlier stages of product design. This pays off big, resulting in a 74% decrease in the number of engineering change orders (ECOs) issued after release to manufacturing over the past two years. All Others, who have not implemented simulation-driven design, experienced only 28% fewer ECOs. When designers and manufacturers are dealing with many parts, like high-tech and medical products with hundreds of semiconductors and chips or industrial and automotive products with different gears and systems, there are numerous opportunities for designs to be sent back to engineers. Rework after designs have gone into production results in time and money lost from scrapping all units made to date and rescheduling outgoing shipments. Simulation-driven design can prevent these disruptions by identifying potential issues early in the design process.

As a result of increased virtual prototyping, Best-in-Class design engineers also save time and money by building 76% fewer physical prototypes, compared to only a 28% decrease for All Others. These benefits have led to a 75% decrease in the length of development time for Best-in-Class companies over the past two years, while All Others only improved by 29%. By getting higher-quality, lower-cost products to market

faster, Best-in-Class companies are positioned to stay ahead of the pack and continue setting the pace of innovation.

Measurements for these benefits of simulation-driven design are made possible by comprehensive performance management capabilities (see sidebar). Best-in-Class companies are more likely to measure and report on key metrics and make these metrics accessible to business leaders. They are 22% more likely to utilize mobility enabled KPI monitoring, which means they provide access to real-time KPIs on mobile devices. This allows manufacturing, design, and business leaders to access these metrics anywhere at any time to keep operations running smoothly. They are also 24% more likely to measure and report the cost of quality management (67% vs. 54%) and 38% more likely to measure and report the impact of it (62% vs. 45%). Visibility into cost and ROI metrics for quality helps determine how operating costs and revenue predictions are fluctuating for certain designs based on internal and external needs. Lastly, they are 32% more likely to leverage role-based actionable intelligence for these metrics. This shows that Best-in-Class companies don't just enable access to these KPIs, but they go one step further and provide insights for leaders to take action based on the results.

Key Takeaways & Recommendations

For designers pressed to produce innovative new products, the addition of simulation within design, couldn't come at a better time. The pressures and challenges of manufacturing today are driving Best-in-Class firms to push simulation directly to the desktops of designers. Simulation-driven design overcomes the unfortunate reality of outsourced simulation and challenges from the skills gap. The benefits of simulation-driven design are compelling, resulting in more innovative products developed faster, meeting time-to-market, quality, and cost targets.

To capture these benefits, and dissipate mounting manufacturing pressures and challenges, Aberdeen recommends that design engineers meet their goals through simulation-driven design:

- **Deploy simulation-driven design for product innovation.** The reason the Best-in-Class have decreased their number of physical prototypes in the past two years by 77% is because they switched to virtual prototypes and virtual testing. This has allowed them to explore hundreds of design iterations (or more), freeing them up to identify and concentrate on the most innovative designs with the highest breakthrough potential.

Capabilities to Improve Measurement, Accessibility, and Usage of Operational Performance Insights

Mobility enabled Key Performance Indicator (KPI) monitoring

- Best-in-Class: 67%
- All Others: 55%

Cost of quality management measured and reported

- Best-in-Class: 67%
- All Others: 54%

Impact (ROI) of quality management measured and reported

- Best-in-Class: 62%
- All Others: 45%

Role-based actionable intelligence is provided in business metrics

- Best-in-Class: 49%
- All Others: 37%

% of respondents using each capability

- **Deploy simulation-driven design for improved time-to-market.** Best-in-Class designers improved their length of development time by 75% over the past two years – 2.5 times the rate of improvement by All Others. The potential for scalability with simulation-driven design allows companies to conduct more tests faster and earlier, ensuring the right designs make it out the door.

- **Deploy simulation-driven design for higher quality.** Best-in-Class firms have a current success rate of 90% when it comes to meeting their product quality targets. Plus, Best-in-Class products are more likely to work right the first time and less likely to require rework, as the Best-in-Class improved their ECOs, after release to manufacturing, by 74% over the past 2 years.

- **Deploy simulation-driven design to reduce costs.** 85% of products developed by Best-in-Class companies achieve cost targets, compared to only 72% of products at other organizations. With lower operating costs, the Best-in-Class are able to sell their products at an affordable price point as well as redirect funds to strategic initiatives and business development.

The world is constantly changing, and innovation begins with accepting that the world is open to new ways of doing things. The Best-in-Class have made the leap to simulation-driven design, and others should consider doing the same. The use cases for simulation are endless, so organizations should determine which path toward simulation-driven design is the best for them. For those who have already implemented it, they should think about taking next steps to develop actionable insights from simulation results and performance metrics to identify new opportunities for innovation and business growth.

Thomas Edison once said that genius was “One percent inspiration and 99 percent perspiration.” Simulation-driven design updates Edison’s maxim for design genius, allowing design engineers to innovate through iteration via virtual prototyping and virtual testing. This new way of doing things eliminates the “perspiration” of physical prototyping. And designers are now free to test hundreds (or thousands) of design alternatives until they are “inspired” by the most innovative product design choice. Edison tried over 1,000 physical prototypes of the incandescent light bulb, before discovering that the lowly bamboo-based carbon filament yielded a bulb that lasted over 1,200 hours. In choosing simulation-driven design, engineers get the best of both worlds: innovative products that also meet time-to-market, cost, and quality targets.

Manufacturing Operations Management Benchmark Survey Demographics

- 262 respondents
- 8 countries: USA & Canada (38%), UK & Ireland (34%), Australia, New Zealand, India, & Singapore (28%)
- 17 industries, including aerospace & defense, automotive, industrial, high tech, medical devices, chemicals, etc.
- Annual revenue: Less than $100 million (24%), $100 million - $1 billion (42%), More than $1 billion (34%)
- Target Roles & Responsibilities: Manufacturing/production (72%), Product development/engineering (13%), Corporate management (9%), Quality management (6%)

Related Research

- *The Four Building Blocks to Unleash Continuous Innovation*; April 2022
- *Harnessing the Cloud to Boost Digital Design and Drive Game-Changing Efficiencies*; September 2021
- *Simulation: The Secret Weapon to Cut Costs, Accelerate Innovation, and Boost Quality*; September 2020

About Aberdeen Strategy & Research

Aberdeen Strategy & Research, a division of Spiceworks Ziff Davis, with over three decades of experience in independent, credible market research, helps **illuminate** market realities and inform business strategies. Our fact-based, unbiased, and outcome-centric research approach provides insights on technology, customer management, and business operations, to **inspire** critical thinking and **ignite** data-driven business actions.

This document is the result of primary research performed by Aberdeen and represents the best analysis available at the time of publication. Unless otherwise noted, the entire contents of this publication are copyrighted by Aberdeen and may not be reproduced, distributed, archived, or transmitted in any form or by any means without prior written consent by Aberdeen.

18567