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How SMBs Save Time and Money by Reducing Physical Prototypes with Simulation

In today's uncertain economic environment, manufacturers running on ever thinning margins can hardly afford to launch products with performance problems – there may not be opportunity to recoup those precious development dollars. Seeking to mitigate risk has become a top goal for many, especially when it comes to validating performance with physical prototypes. Iterative build and test cycles add additional cost and consume valuable time in the schedule. More importantly, designs are often too constrained late in the process to properly address problems identified during testing, forcing many to adopt meager design compromises to get the product out the door.

While many struggle with physical prototypes, some manufacturers have pursued a different approach and are reaping the benefits. The Best-in-Class leverage simulation as a means to not only identify and troubleshoot performance issues, but also seek an optimal balance with product costs. And while many small and medium sized businesses concede the advantages that early simulation grants, many concerns exist about the practicality of simulation in smaller organizations. Are simulation experts required to be successful? What is the best way to increase confidence that the results are right? What benefits can be realistically expected with success?

This Sector Insight produces not only answers to these questions but also provides guidance on how to get started.

Getting Performance Right the First Time

Research from Aberdeen Group's June report *The Engineering Executive's Strategic Agenda;* found that one of the top strategies for engineering executives today is to get product performance right the first time. This is no small order, especially given the complexity of today's products. Aberdeen Group's *Engineering Evolved* report delved deeper into this topic to understand what exactly companies are doing to accomplish this lofty goal. Related to this, an interesting question is, how can small and midsize companies with their fewer resources, be successful in getting product performance right the first time?

The first step to answer this question is to understand the pressures driving companies to adjust how they improve the performance of their products (Table 1). What is interesting is that the size of an organization doesn't make much difference when it comes to these top pressures. While the percentages may change, the same top three themes emerge whether a

Sector Insight

Aberdeen's Sector Insights provide strategic perspective and analysis of primary research results by industry, market segment, or geography

Sector Definition

For the purposes of this study, small to midsize organizations will be defined as those companies reporting revenue under $50 Million to $1 Billion

company is big or small. The themes of these pressures are build better products, faster, at less cost.

Table 1: Top Five Pressures Driving Change in How Product Performance is Improved

Pressures	SMB	Large
Shortened development schedule	50%	52%
Need to reduce development costs	33%	27%
Demand for increased product quality / reliability	27%	23%
Demand for smarter / more feature rich products	22%	14%
Increased competition	21%	13%

Source: Aberdeen Group, November 2008

While the drivers may be the same, the options an organization has available to act on those pressures changes significantly from the SMB to the large organization. SMBs face a range of obstacles that challenge their ability to improve product performance (Table 2).

Table 2: Top Five Challenges of Improving Product Performance

Challenges	SMB
Predicting product behavior in a real world environment	29%
Frequent design changes	28%
Lack of visibility to cost and schedule implications of design decisions to meet performance criteria	26%
Increased product complexity	23%
Finding problems/errors late in the design cycle	19%

Source: Aberdeen Group, November 2008

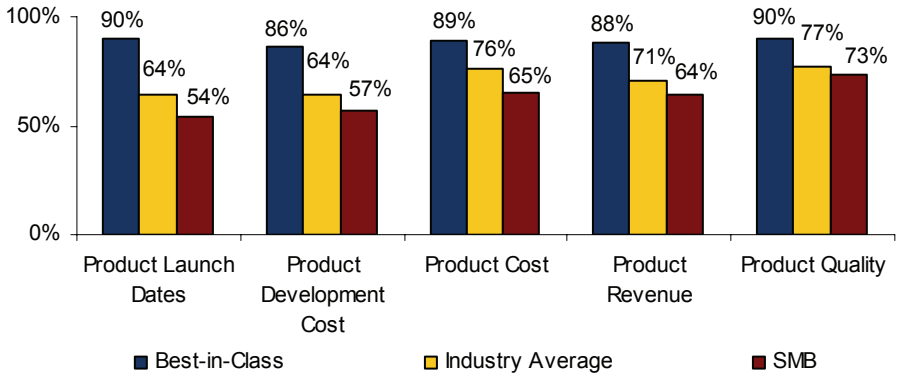
Interestingly, there is no stand out challenge that is shared by all of these organizations. Each of these challenges represents a core problem that organizations must overcome. Taken together, they highlight the difficulty of assessing product performance which is required to get it right the first time.

The Benefits of Success - Aberdeen Analysis

Despite the challenges, some companies are very successful with getting performance right the first time. How are they accomplishing this? To find the answer, Aberdeen Group's *Engineering Evolved* study surveyed over 250 manufacturers about the strategies they use to improve product performance. Aberdeen benchmarked respondents according to key performance criteria. Using these metrics, Aberdeen classified companies into the top 20% (Best-in-Class), the middle 50% (Industry Average) and the bottom 30% (Laggard) of performers. Figure 1 displays the aggregated

performance of the Best-in-Class, Industry Average, and small to midsize businesses.

Figure 1: Performance Benefits Enjoyed by the Best-in-Class



Source: Aberdeen Group, November 2008

SMBs fall behind the Industry Average in all five of these areas, while the Best-in-Class are able to address their challenges in a way that allows them to meet their targets on an 86% or better average showing that SMBs would benefit significantly by adopting some of the practices of the Best-in-Class.

The Cost of Physical Prototypes

One of the ways to verify product performance is to rely on physical prototypes. While physical prototypes are a very effective way to assess performance, they can also be very expensive in terms of cost and time. In addition to physical prototypes, the Best-in-Class take advantage of other methods to assess product performance that allow them to reduce physical prototypes by 37% when compared to the Industry Average. This leads to substantial cost and time savings. To understand the effect of a 37% reduction in physical prototypes: Aberdeen's September 2007 *Engineering Decision Support: Driving Better Product Decisions and Speed to Market* identified the average cost and time required to build a single prototype (Table 3). According to May 2008's *Best Practices for Migrating from 2D to 3D CAD* on average, manufacturers build 6.9 prototypes. The end result of building 37% fewer prototypes based on product complexity is show in Table 3.

In addition to wasted time and cost, waiting to assess performance with physical prototypes creates additional problems that could be avoided. This means most problems will not be found until late in the design cycle. At this time, there are far more constraints on the options available to address problem. This often leads to last minute changes that result in higher than anticipated costs as well as unexpected delays. For success, the Best-in-Class do more to obtain insight into product behavior.

Table 3: Average Prototype Costs and Savings

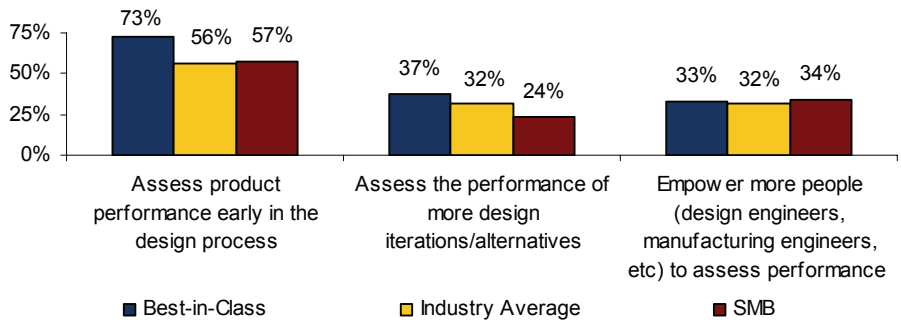
	One Prototype		6.9 Prototypes		Average Savings of a 37% Reduction	
Product Complexity	Time Required	Cost	Time Required	Cost	Time Saved	Cost Saved
Low	13 days	$7,600	90 days	$52,516	33 days	$19,449
Moderate	24 days	$58,000	166 days	$400,780	61 days	$148,423
High	46 days	$130,000	317 days	$898,300	118 days	$332,673
Very high	99 days	$1,200,000	683 days	$8,292,000	253 days	$3,070,825

Source: Aberdeen Group, September 2007 and November 2008

Strategic Actions of the Best-in-Class

What is the secret of the Best-in-Class? The answer begins in the strategies that these leaders adopt: assess performance early, more often, and by more people (Figure 2). While the last of these strategies is not particularly differentiated, the Beast-in-Class realize their advantage with the combination of all three of these strategies and in the way they execute on them. To execute these strategies, they leverage simulation.

Figure 2: Strategies of the Best-in-Class



Source: Aberdeen Group, November 2008

"Simulation has become an important part of the product development process. Key analysis activities are included in all of our product development plans. We can utilize simulation tools to significantly reduce the number of variables that require testing. It is also a key component in improving knowledge."

~ Engineering Manager
Automotive Supplier

Why is this? Simulation provides a mechanism to predict product behavior earlier in the development cycle when there is the most time and more options to address problems. It also makes it possible to see the effect lower cost alternatives. This lowers the overall cost of the product early on in the design phase while still ensuring the product achieves performance goals.

How the Best-in-Class Execute their Strategies

By leveraging simulation, the Best-in-Class are able to assess performance earlier, more often, and empower more people to do so. However, to be truly successful, they need to do more than leverage technology. They need

the proper procedures in place to support the processes. They need to embrace an organizational structure that will empower the staff. Finally, they need to capture the right information and track the correct performance metrics. Table 4 lists these differentiated capabilities the Best-in-Class possess when assessing mechanical product behavior.

To make it possible to assess performance early in the design process, the Best-in-Class make additional performance data available to the entire staff. Capturing what happens during physical tests and making that available to design engineers is key. With greater insight into past behavior, they can apply it to future simulations that can be conducted earlier in the design process. Metrics enable a continuous improvement process by making it easier to focus on where things went wrong in the past and making sure those scenarios are captured in future simulations. Metrics the Best-in-Class track include the root cause of ECOs, the root cause of scrap and rework, and failures that were missed in simulations. By capturing all of this data and making it available, the Best-in-Class are making it possible to assess product performance early with even greater accuracy.

Another important strategy is to evaluate more iterations and alternatives. By evaluating more options, different ideas can be examined which will lead to greater innovation and a more optimal design. Product material has a significant impact on performance as well as cost. To execute this strategy, the Best-in-Class evaluate different materials to arrive at the optimal choice. They also make sure their simulations are as close to real world environment as possible by conducting multi-physics simulations. This allows them to more fully understand how the product will behave in a variety of environments.

Table 4: Capabilities of the Best-in-Class for Mechanical Simulations

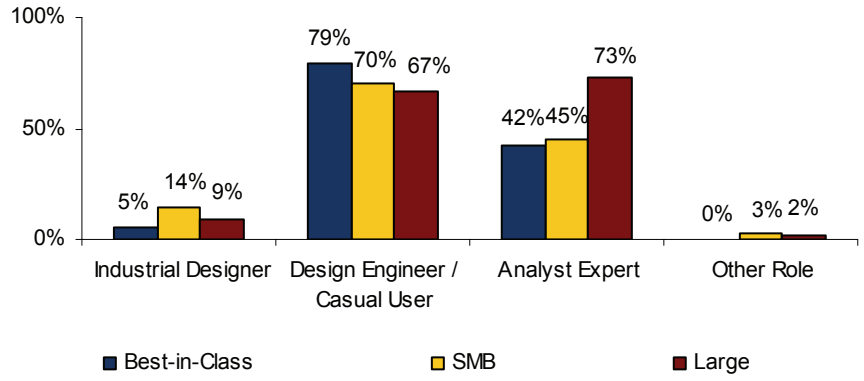
	Best-in-Class	Industry Average	SMB
Measure track testing failures missed with simulations	60%	25%	34%
Measure/track number of simulations conducted	53%	28%	30%
Measure/track number of ECOs resulting from failures in test lab	63%	38%	46%
Measure/track root cause of ECOs	71%	49%	50%
Measure/track root cause of scrap / rework / defects	65%	59%	51%
Design engineers leverage simulation results to optimize design	78%	77%	72%
FEA expert accountable for analyses performed by others	80%	41%	34%
Evaluate different materials to determine optimal choice for performance	94%	71%	71%
Multi-physics simulations (i.e. thermal and structural simultaneously)	50%	40%	31%
Use physical test results to improve simulation or model accuracy	82%	67%	68%
Analysts have access to test lab results	71%	61%	63%

Source: Aberdeen Group, November 2008

Who Performs the Analysis

Empowering more people to conduct simulation is especially important to small and midsized companies. One of the biggest differences between small and large companies is the number of resources they have available. Bigger companies with larger staff are far more likely to have an analyst expert conduct simulations than a smaller company (Figure 3). Instead, smaller companies often rely on the design engineer or casual user to assess performance. However, this does not mean they will be less successful as the Best-in-Class are also more likely to rely on design engineers. The Best-in-Class are successful because they have taken steps to empower their casual users.

Figure 3: Who Performs the Analysis?



Source: Aberdeen Group, November 2008

The Best-in-Class partly address this by capturing the right data and making it available to everyone who will be evaluating performance. In addition, ensuing accountability is important as well. For this, the Best-in-Class have one expert accountable for the simulations performed by others. This expert is available to oversee the entire process and ensure the right information is made available to design engineers. The effect of this is that a central person to oversee everyone, empowers more people to leverage simulation.

Enabling Technologies Used

Simulation covers a wide variety of ways to assess performance. Table 5 lists the most commonly used mechanical simulations used by small and midsize companies.

To support the capabilities, the Best-in-Class conduct a wide range of different types of simulations to get a truer picture of real world behavior. Multiple physical phenomena are at play in the real world so by looking at the responses to different types of analysis, the simulation becomes an even better predictor of what will happen in the real world.

The Best-in-Class provide further support to design engineers or causal users by using simulation tools embedded within CAD. They also take advantage of automatic meshing tools. By creating the mesh automatically, less time is needed to prepare models for simulation. It also makes it easier for casual users who may be less experienced with determining the proper way to mesh a model. This is something SMBs should look to take even more advantage of.

Table 5: Enablers of the Best-in-Class for Mechanical Simulations

	Best-in-Class	Industry Average	SMB
Structural	100%	88%	87%
CAE tools embedded within CAD	71%	68%	70%
Material properties library/database	88%	69%	68%
Fatigue	75%	63%	54%
Dynamic	69%	67%	54%
Thermal	80%	65%	53%
Mechanical vibration	69%	69%	51%
Automatic meshing	69%	49%	50%
Design translation tools	69%	59%	50%
Control over meshing elements	56%	46%	41%
Fluid	57%	53%	40%

Source: Aberdeen Group, November 2008

"Simulation has helped us greatly reduce testing costs and provide focus to the tests we do perform. We have gained understanding of very complex failure mechanisms that we wouldn't have understood otherwise. However, there is still a lot of complex dynamic behavior we cannot predict until we have a prototype."

~ Engineer
Industrial Equipment Manufacturer

What to Look for in a Solution Provider

SMBs are driven to act by the same pressures as large companies so the qualities they value in a vendor are very similar to those of a large company. However, the desire to rely less on an analyst expert and more on the design engineer or casual user affects the qualities they need in a vendor. Table 6 lists those vendor qualities that SMBs rate as most important when selecting a simulation vendor.

Most important to SMBs is demonstrated success in projects similar to those at their own company. For them, this is the greatest indicator of success with the simulation solution at their company. Related to this is a recommendation from a peer. Peer recommendations are even more important to SMBs than to large companies as they provide further evidence that the vendor's simulation solution will be successful at their company.

SMBs tend to be more price sensitive than larger companies and therefore, cost is also important criteria when SMBs evaluate a vendor. The vendor's domain expertise and the ability to integrate the solution into the existing design process are equally important to SMBs, although these qualities tend to be more valued in a larger company. This is because as long as the vendor is good at what is important to an SMB, which they would know

from demonstrated success in similar projects and peer recommendations, the rest is less important to them. Finally, SMBs value their partnerships and look for a vendor who will be committed to good service

Table 6: Qualities of a Vendor

	SMB	Large
Demonstrated success in similar projects	46%	49%
Cost of solution offered	45%	37%
Recommendations by peers	26%	16%
Ease of use of solution offered	25%	26%
Domain expertise	21%	42%
Ability for solution to easily integrate into existing design process	21%	28%
Commitment to customer service	18%	12%

Source: Aberdeen Group, November 2008

Required Actions

As the significant benefits enjoyed by the Best-in-Class indicate, simulation can lower costs, reduce development time, and support the ability to build better products. To accomplish this, three key themes emerge from the capabilities the Best-in-Class adopt that SMBs will benefit from:

- **Enable simulations to be conducted earlier in the process**. Capture metrics during physical testing that can be applied to future simulations to provide even better insight into product behavior early in the design process. The Best-in-Class are 76% more likely to do this than SMBs.
- **Empower design engineers and casual users.** Use simulation results are to optimize designs and provide those running simulations with access to test lab results. The Best-in-Class are 13% more likely than SMBs to share access to test lab results.
- **Evaluate more alternatives and iterations.** Conduct different types of simulations and obtain more information about material choices to ensure it is optimal from a performance and cost perspective. The Best-in-Class are 61% more likely than SMBs to conduct multi-physics simulations.

For more information on this or other research topics, please visit www.aberdeen.com.

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Related Research	
Engineering Evolved: Getting Mechatronics Performance Right the First time; November 2008 *Engineering Decision Support: Driving Better Product Decisions and Speed to Market*; September 2007	*Best Practices for Migrating from 2D to 3D CAD*; May 2008 *The Engineering Executive's Strategic Agenda;* June 2008

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