ACHIEVING PRODUCT DEVELOPMENT SUCCESS THROUGH A CONSOLIDATED SIMULATION PLATFORM

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Report Highlights

Based on the experiences of over 550 respondents, this report will explore how companies today are approaching product simulation. Specifically, it will look at how Best-in-Class companies turn to a consolidated simulation platform to reduce overall costs, improve operational efficiencies, and develop successful products.

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The push to more innovative and complex products helps to differentiate products from competitors; it also results in designers being forced to make trade-off decisions between the speed of development, product cost, and quality.

A great deal of success today hinges on an organization's ability to balance innovation, cost, time, and quality during product development. With tightening development schedules, increasing product complexity, and insufficient engineering resources, this balancing act can be a daunting task. Many have turned to simulation to help designers make better product decisions. The traditional way to manage and implement these simulation applications has been to take a siloed approach. However, this tactic can leave huge gaps in an organization's visibility into application performance and breed inefficiencies. As a result, Best-in-Class companies are consolidating their simulation platform to provide their employees with the tools needed to develop and optimize today's products.

Based on the experiences of over 550 respondents, this report will explore how companies today are approaching product simulation. Specifically, it will look at how Best-in-Class companies turn to a consolidated simulation platform to reduce overall costs, improve operational efficiencies, and design successful products.

Product Simulation is Critical for Success

"We have been able to generate more ideas and test concepts because of virtual simulation. More product development opportunities now exist. Innovative products will be able to be moved through the development process quicker."

~ Nicholas Findanis, Research and Applications Engineer, Pentair Environmental Systems

Aberdeen's research has shown that the timely launch of a new product offers an organization's greatest opportunity for increased profitability – especially in industries like Automotive or High Tech where the voice of the customer is becoming the number one priority. However, during this constant battle to meet product launch dates, designers cannot overlook the importance of products that are economical and of high quality. At the same time, companies need an improved understanding of product behavior to discover the innovations that will position their products for success. But as innovation is increased within a product, so too is the complexity of designing that product.

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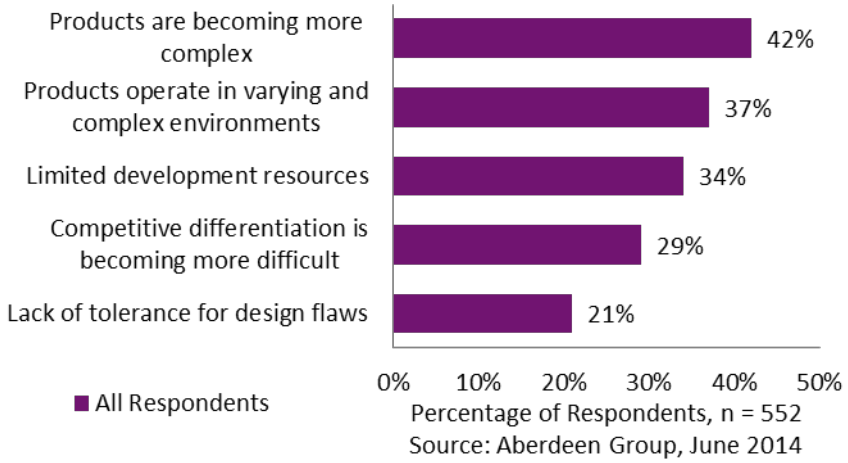
This results in designers being forced to make difficult trade-off decisions between the speed of development, product cost, and quality. Effectively balancing these factors is much easier said than done – trying to achieve this stability has its own inherent challenges (Figure 1).

Figure 1: Top Challenges for Product Development



Complexity is, by far, the overwhelming challenge felt by companies today when trying to develop new products – making it harder to evaluate the impact of different design alternatives. This complexity is across the board as well; no matter the industry, products are becoming increasingly elaborate in their use of mechanics, electronics, and embedded systems. The expansion in software and electrical/mechanical components, and resulting interactions between these systems, is the main driver behind this product complexity. In addition, the environments that these intricate products operate in are complex. This further complicates the decision process as insight into a variety of environments is required. Engineers need methods for assessing how multiple product designs behave in any environment that will not add substantial time to the constantly shrinking development schedules.

How has the structure of products changed?

Over the past two years, the amount of components in a given product has continued to rise, which increases complexity (All Respondents):

- **Number of Mechanical Components:** *14% increase*
- **Lines of Software Code:** *34% increase*
- **Number of Electrical Components:** *21% increase*

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The Hidden Impact of Being Understaffed

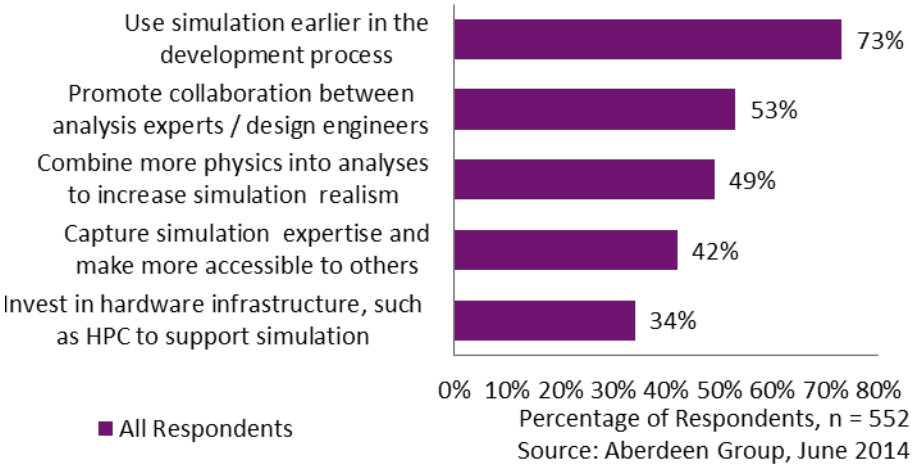
In a recent Aberdeen study of over 500 companies, the issue of understaffing in engineering or high skill positions was explored. Companies that were understaffed saw the following negative impacts:

- **Product Launch Dates Hit:** *16% decrease*
- **Product Cost Targets Met:** *11% decrease*
- **Quality Targets Hit at Design Release:** *10% decrease*
- **Product Revenue Targets met:** *11% decrease*

Engineers play a critical role in the success of any company that designs and delivers products. Being understaffed or lacking talent in this area can be detrimental to success.

However, complexity comes from more than just the actual products or their environments; there are external business intricacies that make product design a challenge as well. Changing consumer demands, globalization, an extended supply chain and design network, and regulatory compliance are additional concerns that affect designers. Adding to all of these challenges, development is restricted with reduced engineering resources, an often-overlooked but impactful force on a company (see sidebar). More effort is needed to address this complexity; with fewer people, companies need to look into methods to make their limited design resources more efficient. Organizations are looking toward virtual simulation to address these issues and assess product behavior as soon as possible (Figure 2).

Figure 2: Top Actions to Improve Product Assessments



Simulating product behavior has, historically, been integral to larger, complex industries like Automotive or Aerospace & Defense. However, with the many benefits of knowing how a product will perform prior to testing, simulation is being adopted by an increasing number of SMBs across a broad spectrum of industries. Using simulation earlier in the development process is the top strategy to improve how product

behavior is assessed. The insight that comes from simulation software guides designers to make the right product decisions throughout the development cycle.

Conducting these simulations requires a certain level of expertise, which can be a problem with the limited resources that most companies possess. To provide design engineers further support and to promote simulation use, organizations are stressing collaboration and knowledge capture with their more senior analysis experts. Some companies are beginning to invest in tools to provide simulation governance – where simulation best practices are captured, documented, and enforced. Better yet, best practices can be enforced within the simulation tool by leveraging standard interfaces to customize the model for unique workflows. This serves as a valuable resource to those less experienced with simulation, allowing them to take advantage of simulation with confidence.

In addition, to address the challenge of understanding complex products in complex environments, companies are combining more physics into their simulations. In the real world, products are often simultaneously subjected to multiple physics. Trends in miniaturization, increasing power density, sustainability, and advanced material utilization are driving this increasing need for multiphysics simulation. Evaluating these physics makes the simulation even more accurate. The complexity of these products means there is more to process to run the analysis. Many are turning to enablers such as High Performance Computing (HPC) to improve these computational intensive analyses, enabling engineers to receive results much faster. Analyses that are done in less time are, in turn, easier to iterate. This allows a designer to evaluate multiple trade-offs, providing a more optimal solution and successful product. Consequently, Best-in-Class companies are able to realize even more value

Computer Aided Engineering (CAE)

CAE is a broad term that is used to describe software tools that allow engineers to simulate physical phenomena for their parts and products in a virtual environment.

There are multiple fields and phases that make up CAE which include: Computational Fluid Dynamics (CFD), Finite Element Analysis (FEA), Multibody Dynamics (MBD), etc.

"Using simulation software early, combining more physics, and encouraging collaboration has reduced our development costs. It has also improved the performance of our initial prototypes. As a result, our products have greater assurance of reliability and durability."

~ James Smith, Lead Mechanical Engineer, Sechan Electronics, Inc.

What is Best-in-Class?

To identify best practices for product development, Aberdeen measured survey participants' ability to meet their product goals and the change in overall development time for the past 2 years. Aberdeen categorized participants as Best-in-Class (top 20% of performers), Industry Average (mid 50%), or Laggards (bottom 30%)… we also refer to a fourth category, All Others (Industry Average and Laggards combined):

Product launch dates hit:

- **Best-in-Class - 89%**
- **Industry Average - 69%**
- **Laggards - 38%**

Product cost targets met:

- **Best-in-Class - 88%**
- **Industry Average - 68%**
- **Laggards - 38%**

Quality targets hit at design release:

- **Best-in-Class - 91%**
- **Industry Average - 78%**
- **Laggards - 63%**

Product revenue targets met:

- **Best-in-Class - 88%**
- **Industry Average - 71%**
- **Laggards - 41%**

Decrease in length of development cycle (past 2 years):

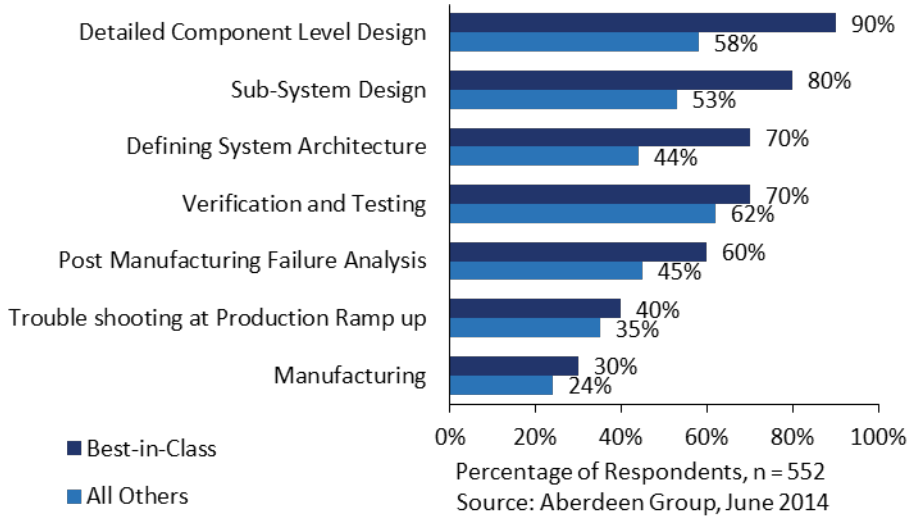
- **Best-in-Class - 22%**
- **Industry Average - 13%**
- **Laggards - 8%**

from their investments in simulation tools through investments in HPC.

Best-in-Class Product Simulation

The strategies discussed in the previous section help companies get better use and value from their simulation tools, but deployment is another matter. By examining the actions taken by the most successful companies, we can determine what it is that separates these companies from their peers (see sidebar). The Best-in-Class clearly have much tighter control over their new product development and introduction (NPDI). Even in the face of all of the challenges and roadblocks discussed, these companies put out high quality products in the timeframe intended, and at a low cost. Also the 22% reduction in overall development cycle plays a huge role towards the continued success for the Best-in-Class, as shrinking development schedules is still the top pressure felt by all companies. Where these successful companies start to separate themselves is in their reliance on simulation throughout the product ideation and design process (Figure 3).

Figure 3: Simulate Early, Simulate Often, to Optimize



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To maximize development efforts, simulation software should be used to analyze component and system-level behavior, as well as subsystem interactions before physical prototyping. Early simulation ensures that designs are validated from the beginning, saving time and money. Simulation makes it easier to conduct trade-off analyses to determine the optimal system architecture upfront. In addition, designers are able to quickly explore the performance of numerous design alternatives at a rapid pace. This ability to analyze multiple alternatives allows for an important practice: optimizing the design (for cost, quality, or performance). While the Best-in-Class are far outpacing their competitors in all stages of product development (especially early in a product's lifecycle), improvement is needed by every maturity group when it comes to the production and manufacturing phase. With the right software, simulation can become an integral part of the design process, not some separate function with its own tools and processes.

All simulation solutions are not created equal; the question to ask is what features are important. Best-in-Class companies indicated that integration with CAD, reliability, and accuracy are the most important factors to look for. This comes as no surprise; if a designer does not trust the simulation results, they will not use the tool. But not far behind are the actual capabilities that the simulation software possesses. Coupling physics is a capability that is growing in importance and requires powerful tools to conduct. Meshing is also one of the most critical aspects of simulation and the area where bottlenecks can most likely occur. It is telling that these capabilities are rated closely to the actual cost of software. This reinforces that the top focus for successful companies today is to conduct realistic simulations that reliably predict product performance.

"The more detailed models we are using are giving us a better understanding of our virtual prototypes. We are able [to] estimate the sensitivity of our products and define production tolerances accordingly. This helps a lot, not only during product development, but also during [mass] production."

~ Peter Benko, Product Development Engineer, GRANTE Antenna Development and Production Corporation

What Features are Important?

Respondents were asked to select which features were the most important for simulation software from a list of 14 qualities (Best-in-Class respondents):

Reliability – 76%
Accuracy – 76%
Integration with CAD – 70%
Depth of Capabilities – 67%
Solver Speed – 65%
Meshing Capabilities – 63%
Cost – 61%

Expanding Simulation Needs

Respondents were asked, if your needs are not met by one simulation tool for a given physics (for example fluid), are you willing to purchase and learn an extra simulation tool to meet all analysis criteria (for example purchase, learn, and use another fluid simulation tool):

Yes – 76% of all respondents

No – 24% of all respondents

"We have had some problems pop up 10 years after first analysis. Native CAE/CAD files from 10 years ago are more or less useless. Rich, neutral CAD and CAE file formats for data archival and exchange are needed."

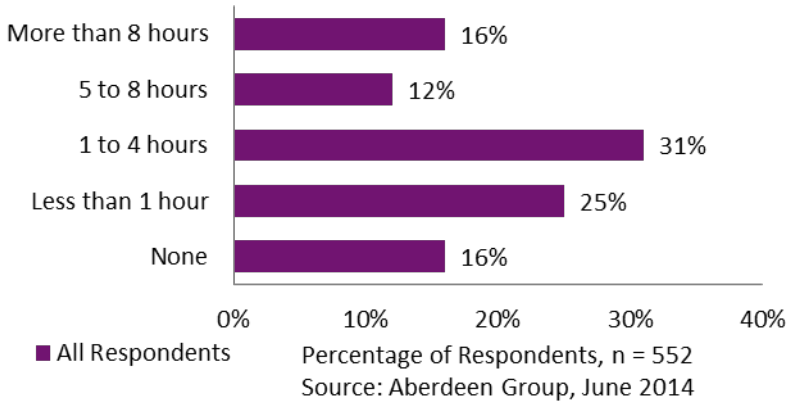
~ Product Development Manager, Large Industrial Equipment Manufacturer

The Traditional Simulation Platform Approach

As products get more and more complex, so too does the simulation needed to accurately predict product performance. The traditional way to manage and implement these applications has been to take a siloed approach. As a result, additional tools are purchased to meet the needs of designers (see sidebar). On the surface, this appears to be a sound tactic, providing your employees with the tools needed to succeed. But for large companies, this can result in over a hundred different CAE tools across numerous vendors. This approach can leave huge gaps in an organization's visibility into application performance and make it much harder to detect and address problems with simulation applications, which can lead to poor user experience and operational performance. The inefficiencies of this simulation platform approach can really add up.

First, there is the sheer overhead of managing multiple simulation vendors. Companies use large amounts of resources for things like install costs, wasted licenses, or parallel licenses in multiphysics simulation. These are sunk costs that add up over time and severely impact the bottom line. There is also the fact that implementing multiple point solutions can attribute to data format and transfer issues, especially across departments or geographies in the organization. Homegrown tools are required to manage data translations from one vendor tool to another – further increasing costs to the business. Also, managing multiple data formats is an overlooked time-sink for engineers conducting analyses (Figure 4).

Figure 4: Time Added from Multiple Data Formats



Survey respondents indicated that, on average, 3.6 hours were added to analysis time as a result of multiple data formats. Further, 16% of respondents indicated that at least **an entire workday (over 8 hours) is added per analysis**. This is time that engineers cannot afford to spend on non-value add activities. Because of this, simulation solutions based on open standards for communication (ex. Functional Mock-up Interface (FMI)) are critical to provide interoperability across simulation tools. Further, the use of multiple simulation vendors can severely impede collaboration between designers. Products today rely on multiple disciplines of engineering (electrics, structures, fluids), which makes teamwork essential. Combine the fact that most companies have team members that are geographically dispersed and it makes collaboration, the second highest action that companies are trying to undertake, a real challenge. Reducing the number of vendors and working on an integrated simulation platform is what the Best-in-Class rely on to aid their collaboration efforts.

This inefficiency extends beyond the designers themselves as other departments also can struggle as a result of numerous simulation solutions. Indeed, when examining companies that have made efforts to consolidate their simulation portfolio, the

"Data needs to be backwards compatible. Not all of us work on the same versions of the simulation software. Some of the original standard analysis templates were created in much older versions, which are not available anymore. Therefore, we cannot assess the standard analysis in its original form, even if you do import it successfully into a current version, the current version will apply default settings to the analysis, which are not the same as they were before, thus changing the analysis without you realizing it."

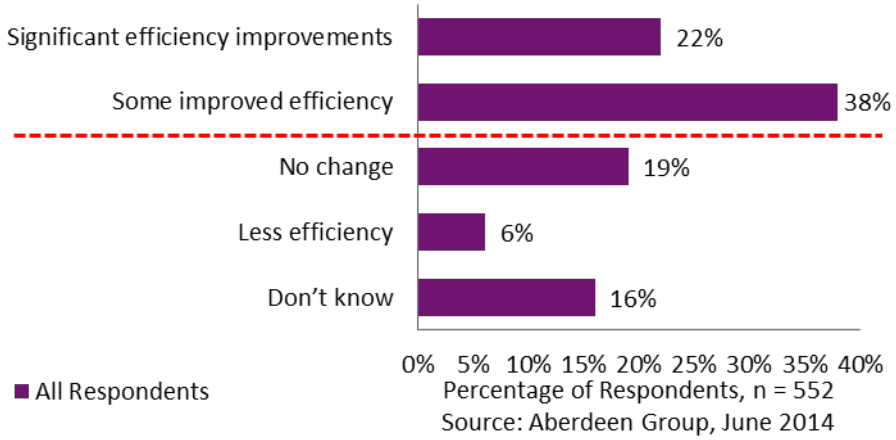
~ Product Engineer, Large Automotive Manufacturer

"We need to ensure that our company uses the same software at all sites, we have a situation where in the UK and one site in the US we use [vendor 1] but a second site in the US uses [vendor 2]. Model data is not transferable between the two packages."

~ Product Developer, Medium Industrial Product Manufacturer

impact that consolidation has on the operational efficiency of an IT group is clear (Figure 5).

Figure 5: The Impact on IT Efficiency by Consolidation



Currently, 43% of respondents are not happy with their model size and 87% expect it to grow in the future (see sidebar). As companies strive to push their levels of product insight further, the size of simulation models is going to continually increase. This has a direct impact on the IT department, however. Larger models combining multiple physics require more computing power (HPC). If IT groups have to manage multiple simulation vendors, each requiring separate HPC licensing, they can end up with under-utilized HPC licenses.

Reducing the number of simulation vendors can be a real benefit to the IT department. Multiple, disparate CAE tools often require the IT group or engineering teams to glue workflows together with scripting or other software components. This further dilutes IT resources. Indeed, over half of all respondents indicated that consolidation improved their IT operational efficiency, while only 25% said it did not have a positive impact. Beyond the operational efficiency, there is the fact that managing the infrastructure of a simulation platform can be an IT specialty. These are employees who are skilled, hard to find,

Fast Facts - Model Size

What is the average size of your models? (Structure):

- **1,335,062 Nodes**

What is the average size of your models? (Fluid):

- **9,159,235 Cells / Elements**

With your current model size, are you able to analyze the details and parameters that will give you answers about design tradeoffs?

- **Yes – 57%**
- **No – 43%**

In the future, do you expect to have to handle larger models?

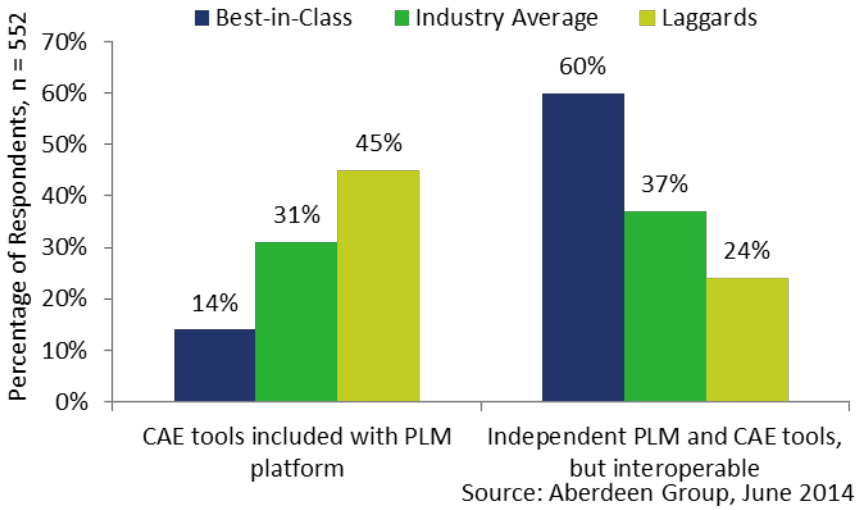
- **Yes – 87%**
- **No – 13%**

and expensive. Minimizing the number of simulation vendors lowers the risk and exposure to that staffing requirement.

This may not seem like an issue currently in your company, but as model sizes grow, the strain on IT efficiency will intensify. This lack of awareness can be the result of ignoring IT's feedback on simulation decisions (see sidebar). When we drill down, we see that the Industry Average and Laggards were 40% more likely than the Best-in-Class to get zero input from IT support when making simulation software decisions. While IT should not be the final decision maker, input should be gathered from this group as they have an integral role in simulation software assets achieving high utilization rates.

This all comes back to the mindset of management when they are exploring simulation software – should simulation be part of an overall system, or an independent enterprise decision (much like PLM, ERP, or CAD)? We can again turn to the Best-in-Class to see the approach they take, and noticeably, they view simulation software as an enterprise decision of its own (Figure 6).

Figure 6: Should Simulation be part of PLM?



Source: Aberdeen Group, June 2014

Who is Involved in Simulation Software Decisions

Who is a decision maker when making investments in simulation software (% of all respondents):

Management - 56%

Analyst / Simulation Expert - 36%

Engineer Involved in Early Stage Design Process - 16%

Test / Validation Engineer - 10%

Manufacturing Engineer - 6%

IT Support – 5%

Simulation has become so critical to success; any company that designs and delivers products must elevate the selection of their simulation platform. A simulation system that is "Best-in-Class" is what matters most. Relying on a system that is an add-on to PLM can struggle to provide the necessary depth and fidelity needed for today's complex products. This results in additional packages to be purchased and implemented, leading to the stovepipe approach that causes so many hardships in a company. The C-level is starting to realize that one of the most important selection criteria for simulation software is an integrated suite that can handle all of their designers' needs.

A Consolidated Simulation Platform

Organizations must look for ways to consolidate, or reduce, the number of vendors that they use to build an effective simulation platform. Consolidation of simulation software all comes back to saving time and costs. The benefits of taking a consolidated approach are clear when looking at the metric performance (Table 1).

Table 1: The Benefits of a Consolidated Simulation Platform

Metric	Consolidation	No Consolidation
Product launch dates met	87%	70%
Product cost targets hit	85%	65%
Change in TCO (software) last 12 months	7% Decrease	3% Increase
Change in the length of development time	22% Decrease	13% Decrease
Change in time to prepare models for analysis	17% Decrease	8% Decrease
Change in time from set up to results analysis	17% Decrease	8% Decrease
Change in computer processing time of analyses	11% Decrease	8% Decrease

Source: Aberdeen Group, June 2014

The improved simulation efficiency of consolidation shows directly in the faster preparation, setup, and processing time of analyses. This faster simulation time allows for product launch

dates to be met more easily. Also, the 22% reduction in overall development time points to the improved design collaboration that simulation consolidation brings. Elevating the selection of simulation and implementing a consolidated platform reduces costs, saves time, and enables better design collaboration. This allows a company to efficiently simulate models with high fidelity, optimized for multiple objectives.

Key Takeaways and Recommendations

Every company is looking to improve how they do business. Simulation is a technology that has sharply increased in recent years because of the many benefits it can bring to engineers. However, there are best practices that should be followed when implementing this technology. Multiple point solutions do not perform as well as an integrated simulation suite. There is good news, though; we can learn from those companies out there that have implemented an effective simulation platform. The reasons for consolidating your simulation platform are simple:

- **Managing numerous simulation vendors can be onerous.** As the number of simulation providers increases, so too does the overhead for managing these systems. Users who made efforts to consolidate their simulation portfolio saw a 7% decrease in overall total cost of ownership for the past twelve months, those who did not consolidate had a 3% increase.

- **Data management and sharing can be problematic across multiple systems.** Don't be one of those worst case scenario respondents who saw over a full day's work added per analysis because of data issues. A consolidated simulation platform built on open standards is what the Best-in-Class utilize to standardize their model data. This allows them to spend their time analyzing results, instead

of combing through obsolete analysis templates. This notion is backed up by their 22% lowered overall development time and the 89% of product launch dates they meet.

➔ **Collaboration is a hurdle when not using the same system.** Globally dispersed teams comprised of multiple disciplines of engineering can be a challenge to manage. This is especially true for companies who do not have a consolidated simulation platform. Visibility across a dispersed development team is always an issue on disparate systems and work from one group may end up not being compatible with another.

➔ **IT operational efficiency can be significantly improved.** Simulation is a computational intensive analysis, especially those simulations containing multiple physics. Supporting too many simulation vendors only further strains IT resources within an organization. Technology like HPC can help speed the time needed to get results, but some of the largest efficiency and utilization gains can come from consolidation (as Table 1 illustrated).

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Related Research

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What Drives Success For Best-in-Class Product Developers?; May 2014

Bridging the Gap Between Product Development and Operations; June 2014

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