Aberdeen Group

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Simulation Driven Design Benchmark Report

Getting It Right the First Time

October 2006

Executive Summary

Get it done quickly. That's the message manufacturers are hearing from the market. They must develop more products that are more complex for their customers, but, most of all, they must get to market on time. When trying to figure out how to get things done more quickly, these manufacturers face a seeming paradox: should they take more time to perform simulations in design so they can save time and money in testing? Some have found the answer is not only" yes," but that early simulation assists them to hit their product development targets. How? Interestingly enough, it's actually quite simple.

Key Business Value Findings

- Best in class manufacturers their hit revenue, cost, launch date, and quality targets for 86% or more of their products.
- Best in class manufacturers average 1.6 fewer prototypes than all others.
- Best in class manufacturers of the most complex products get to market 158 days earlier with $1,900,000 lower product development costs.
- Best in class manufacturers of the simplest products get to market 21 days earlier with $21,000 fewer product development costs.

Implications & Simulation

- All best in class manufacturers use simulation in the design phase compared to only 75% of laggards.
- Best in class manufacturers are 63% more likely to provide CAD-embedded simulation to their engineers.
- Best in class manufacturers are 48% more likely to provide technologies to transfer models from CAD to independent preprocessors to their analysts.
- Best in class performers are 42% more likely than all others to provide specific examples to users for training.

Recommendations for Action

- Perform more simulation of product performance in the design phase.
- Provide CAD-embedded simulation capabilities to engineers.
- Use training materials and specific examples to get new users up to speed.
- Employ technologies that transfer geometry from CAD to independent pre-processors for analysts.
- Track requirements and regulatory product compliance prior to design release.

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Chapter One: Issue at Hand

Key Takeaways

- Manufacturers are improving product performance (72%) and development efficiency (51%) in order to address shortened time-to-market (70%) constraints.
- Manufacturers identify shorter time to market (72%) as a top business pressure to adopt early simulation, yet cite lack of time (44%) as the top challenge.
- Manufacturers are responding to challenges such as lack of expertise (39%) and complicated product behavior (28%) with formal training programs.
- Manufacturers, in fact, did not identify any of the expected cultural challenges in implementing early simulation as actual issues.

While the concept of using simulation early in the product development cycle initially emerged almost a decade ago, it remains a frequently pursued initiative today. Although one would expect an elevated level of use of simulation in the up-front design phase by now, in fact, the pressure for shorter time to market and engineering cultural challenges have prevented manufacturers from succeeding with this new paradigm. Yet some of these companies are overcoming these barriers to realize tangible business benefits.

The Ultimate Goal: Hit Ever-shrinking Time-to-market Windows

In one form or another, manufacturers adopting simulation earlier in the product development process are reacting to pressure for shorter time to market by improving quality and development efficiencies (Table 1).

Table 1: Top Five Business Pressures and Strategic Actions

Business Pressures		Strategic Actions	
Shortened time to market	70%	Improve product performance or quality	72%
Customer demand for new products	51%	Improve development efficiency	51%
Increasingly complex customer requirements	40%	Reduce base development costs	20%
Accelerating product commodization	30%	Develop markets via breakthrough innovation	18%
Threatening competitive products	20%	Iterate product design more often	16%

Source: AberdeenGroup, October 2006

Elgin Sweeper Company

"We are definitely pressured to get to design release more quickly in order to keep up with the competition. We need to get to market first to win market share. We're turning to simulation to minimize our testing phase of product development."

Jay Abrams, Elgin Sweeper Company

Based on the results of Aberdeen research, clearly the top pressure driving manufacturers to adopt earlier simulation is *shortened time to market* (70%). In response to this pressure, manufacturers are following two main strategies: *improving product performance or quality* (72%) and *improving development efficiency* (51%). At first glance, it's not immediately clear how these relate to one another or how they relate to simulation early in the product development process. However, follow-up interviews with survey respondents found that they were looking to early simulation to accomplish two goals: to arrive at a good design earlier and to minimize time spent in the verification and testing phase of product development.

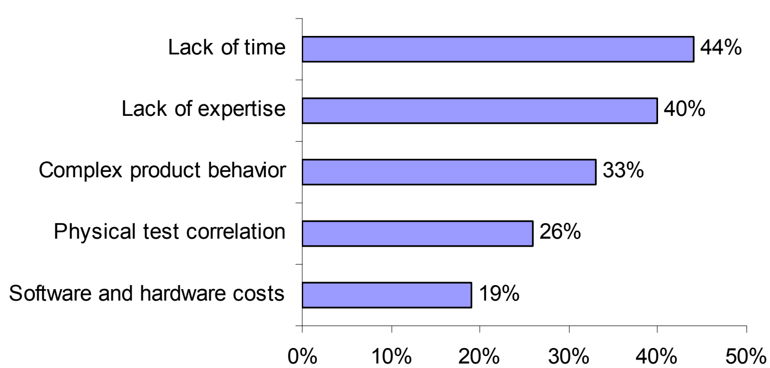
In addition to their time concerns, manufacturers identify *customer demand for new products* (51%) and *increasingly complex customer requirements* (40%) as secondary business pressures driving earlier simulation. Correspondingly, they are turning to strategies such as *improving development efficiency* (51%) and *iterating the product design more often* (16%).

Overall, manufacturers are turning towards early simulation to save time in product development as well as to get to better designs. However, the ultimate goal is to meet the shorter time-to-market windows that are today's reality.

Early Simulation Cultural Challenges? A Misconception, Not a Reality

In the simulation-driven design trend, one would expect major cultural barriers to requiring engineers to perform simulation earlier in product development because they are being asked to do more in the same amount of time. In reality, the expected cultural challenges were not cited as major obstacles (Figure 2).

Figure 1: Challenges to Simulation-driven Design



Source: AberdeenGroup, October 2006

The Holland Group

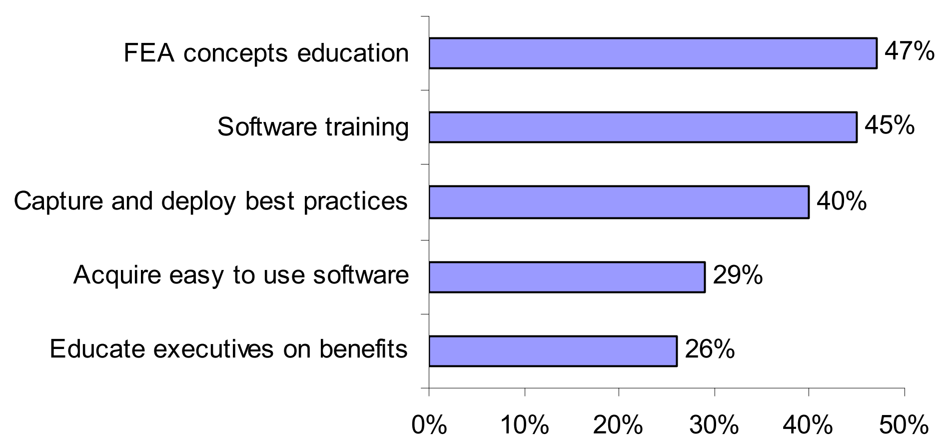
"We run analyses so we can test out a design before we actually spend money on a prototype. Overall, while it takes more time to run a simulation, we'll save time later by avoiding multiple rounds of prototypes."

Tave Hass, The Holland Group

In fact, the top challenge, *lack of time* (44%), aligns with the top business driver, *shortened time to market* (70%). However, some manufacturers are caught in a conflict between reducing time in the testing phase and spending more time in the design phase performing early analyses. Coming to the realization that a company must allow engineers more time to perform analyses upfront in order to save time and cost later in the development cycle in itself is a cultural challenge.

The challenges of *lack of expertise* (40%) and *complex product behavior* (33%) for performing simulation within engineering organizations provides ample motivation for manufacturers to respond with formal training rollout programs (Figure2). In fact, the top four responses to challenges in this case reflect just that.

Figure 2: Responses to Simulation-driven Design Challenges



Source: AberdeenGroup, October 2006

Manufacturers are *acquiring easy-to-use software* (29%) and providing *software training* (45%) in order to reduce the technological barriers of performing simulation for non-expert and infrequent engineering users. Simultaneously, manufacturers are pursuing *FEA concepts education* (47%) as well as programs to *capture and deploy best practices* (40%) in order increase the quality of analyses, so the results are more dependable and, consequently, yield better designs. These four tactics directly address the second and third top challenges: *lack of expertise* and *complicated product behavior*.

While some cultural issues, in fact, are inherent in the challenges indicated by survey respondents, many of the common perceptions are actually untrue. Less than 16% of manufacturers identified issues such as *only analysts perform simulation*, *difficult to get engineers to perform analyses,* and *little confidence in results* as challenges to performing simulation upfront.

Overall, the message is clear. Manufacturers are addressing the secondary challenges of lack of expertise and complicated product behavior with formal training and education programs and easy-to-use software. The paramount cultural challenge for manufacturers is grasping the reality that they must spend more time performing simulations upfront in order to save time in the testing phase. Outside of that, the cultural challenges to introducing simulation during design are minimal.

CTS Corporation

"Correlation to physical test is a large challenge for us. For one, the testing lab can't perfectly match the idealized setup within the finite element simulation tool. Also, the molded parts that are tested are slightly different because of manufacturing variation. And, finally, the material properties of our injection-molded parts are orthotropic, meaning they aren't the same in all directions. Correctly setting up the simulation to accurately reflect the reality of the actual material properties is difficult."

Dave Pfaffenberger, CTS Corporation

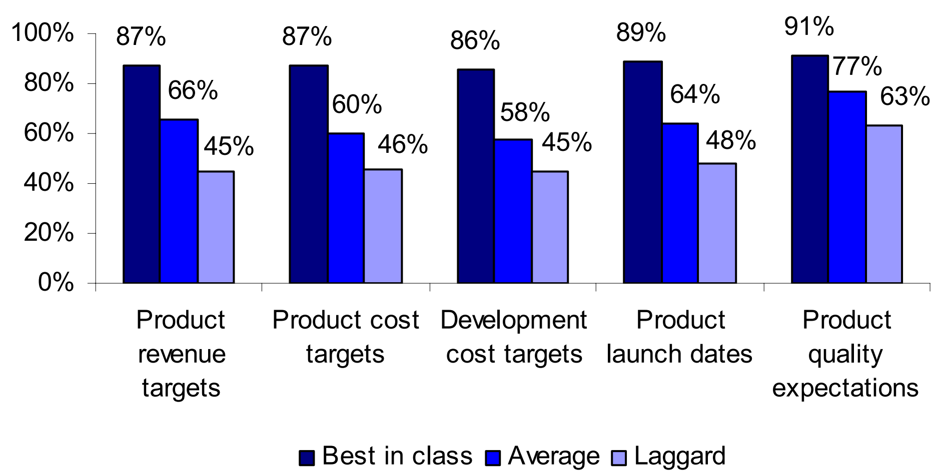
Chapter Two: Key Business Value Findings

Key Takeaways

- Best in class manufacturers their hit revenue, cost, launch date, and quality targets for 86% or more of their products.
- Best in class manufacturers average 1.6 fewer prototypes than other companies.
- Best in class manufacturers of the most complex products get to market 158 days earlier with $1,900,000 fewer product development costs.
- Best in class manufacturers of the simplest products get to market 21 days earlier with $21,000 fewer product development costs.

While some manufacturers are adopting simulation early in the product development cycle, Aberdeen research shows that they face serious challenges. While some are taking steps in response, their strategies and tactics are only as good as the results they deliver. To get a clear picture of which strategies and tactics are successful, Aberdeen categorized survey respondents by measuring five key performance indicators (KPIs) that provide *financial, process, and quality measures* (Figure 3). This classification subsequently enabled differentiation between the "best practices" of the top performers and the practices of lower-performing companies.

Figure 3: Best in Class Hit Targets on an 86% Average or Better



Source: AberdeenGroup, October 2006

Based on aggregate scores incorporating all five metrics, those companies in the top 20% achieved "best in class" status; those in the middle 50% were "average"; and those in the bottom 30% were "laggard." As expected, companies in the different performance categories show substantial differences – with best in class hitting all five marks at an 86% or better average.

Varying Prototype Costs and Time across Product Complexity

One of the primary reasons manufacturers pursue simulation early in the product development lifecycle is to test product performance virtually. Products that are virtually tested have a higher chance of passing physical prototype testing the first time. Overall, this translates to less time and lower development costs in the product development lifecycle.

Power Tool Manufacturer

"Most recently, not only were we able to reduce prototypes, but we were able to skip a prototype qualification phase altogether. Typically, we would develop machined prototypes, but in this case we went right to a prototype casting."

Translating reduced prototypes into hard costs and time depends on the complexity of the product. To get a clear picture of how prototype costs and time varied according to product complexity, Aberdeen categorized survey respondents' products by measuring three key indicators: *number of parts*, *length of development lifecycle*, and *number of engineering disciplines incorporated*. This measurement subsequently enabled differentiation of levels of product complexity. The following table describes the general characteristics of each of the product complexity categories from this study's research (Table 2).

Ricon Corporation

"Our products move through a range of motion. We could always visualize the movements in our heads, but we started using simulation as a means to virtually verify the motion prior to building prototypes."

Ray Reynolds, Ricon Corporation

Table 2: General Characteristics of Product Complexity Categories

Product Complexity	Number of Parts	Length of Development
Low	Less than 50	Between a week and a year
Moderate	Between 50 and 1,000	Between a month and 5 years
High	Between 50 and 10,000	Between 1 and 5 years
Very High	Between 1,000 and 100,000	Between 1 and 20 years

Source: AberdeenGroup, October 2006

Based on these product complexity categories, one can see a logical progression in the corresponding increase in time and costs as complexity increases (Table 3).

Table 3: Prototype Costs and Time per Product Complexity

Product Complexity	Time to Build Prototype	Cost to Build Prototype
Low	13 days	$7,600
Moderate	24 days	$58,000
High	46 days	$130,000
Very High	99 days	$1,200,000

Source: AberdeenGroup, October 2006

Avoiding Physical Prototypes with Virtual Prototypes

Is there any truth to the suggestion that using simulation during design eliminates unnecessary additional rounds of prototyping? The answer is "yes." Aberdeen research finds that the best in class average 3.0 prototypes compared to 4.6 for all other manufacturers.

Applying this difference of 1.6 prototypes to the different categories of product complexity yields compelling results. The best in class manufacturers of the products with very high complexity get to market 158 days earlier with $1,900,000 lower product development costs than average performers. At the opposite end of product complexity spectrum, the best in class manufacturers get to market 21 days earlier and spend $12,000 less on product development costs than average performers.

Plastics One

"Because we make over-molded electronics products, we've explored a few different types of simulations for different purposes. For one, we've used mold-filling simulations to determine the base placements for injection-molding gates. Also, because over-molding can be rough on electronics, we explore various scenarios of failed electronics components so that when we do experience problems, we know which scenario actually occurred."

Steve Heckman, Plastics One

Obviously there are very real benefits in early simulation that translate into a direct impact on time to market and product development costs.

Chapter Three:
Implications & Simulation

Key Takeaways

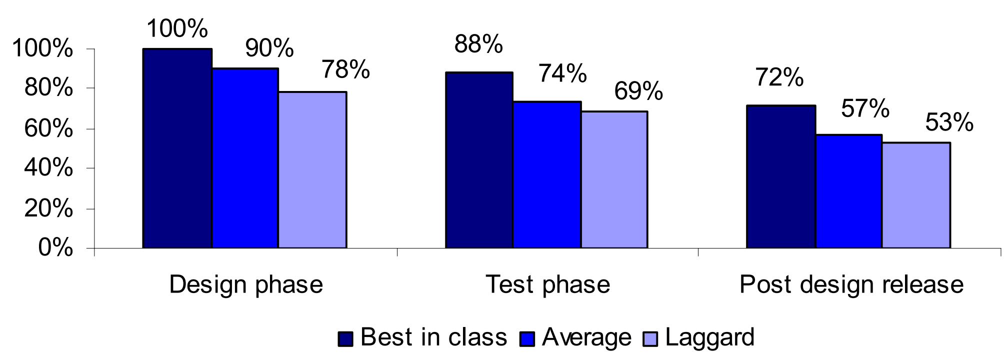
- All best in class manufacturers use simulation in the design phase compared to three out of four laggards.
- Best in class manufacturers are 63% more likely than all others to provide CAD-embedded simulation to their engineers.
- Best in class manufacturers are 48% more likely than all others to provide technologies to transfer models from CAD to independent preprocessors to their analysts.
- Best in class performers are 42% more likely than all others to provide specific product simulation examples to users for training.

As noted earlier, the aggregated performance of surveyed companies determined whether they ranked as best in class, industry average, or laggard. In addition to having common performance levels, each class also shares characteristics and practices in four key categories – processes, organizational structure, technology usage, and performance measurement.

All Best in Class Performers Utilize Simulation in the Design Phase

While many manufacturers have focused on adopting simulation earlier in the product development process, best in class performers employ simulation throughout the product development lifecycle (Figure 6).

Figure 4: Best in Class Perform More Simulations Earlier



Source: AberdeenGroup, October 2006

In fact, every single one of the best in class performers surveyed for this report uses simulation in the design phase as opposed to roughly three out of every four laggards. And not only is this difference in the design phase, but the 20% difference continues in the test and post-design release phases.

Finally, one can see that the best in class performers place the highest emphasis on performing simulation upfront in the design phase as opposed to during the other phases of development. Overall, this early use enables those leading manufacturers to reduce the number of prototypes necessary to pass quality tests as well as to avoid unnecessary change orders after design release.

Smith Aerospace

"We perform analyses to make sure we are arriving at the most weight and cost effective design. In short, we want to get the biggest bang for our buck. Additionally, an analysis identifies all the potential failure modes whereas building and breaking a prototype will reveal just one… the one that broke the prototype."

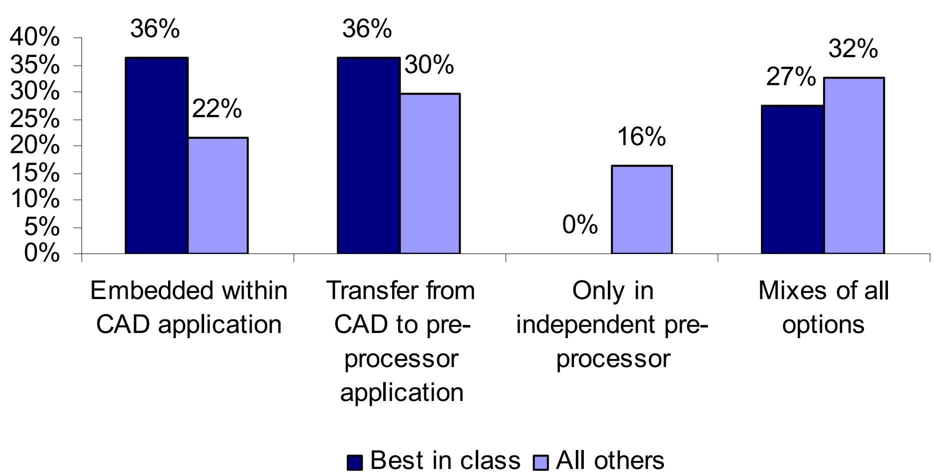
Jochen Hessemann, Smith Aerospace

Familiar Environments: Engineers Access Simulation through CAD

Given that many manufacturers are performing simulations early in the design phase of product development, the next question is "how is this being accomplished?" Traditionally, the responsibility for completing simulations has commonly fallen on the analysis group dedicated to the task. However, the current, ongoing trend is to push the simpler and directional analyses upstream, into the hands of product engineers, as way of augmenting the efforts of the dedicated analyst groups.

How can companies get engineers to take on this additional task? Common sense says to make it simple and easy to do. This starts with how the engineers access simulation capabilities (Figure 8).

Figure 5: Best in Class Provide Engineers CAD-embedded Simulation



Source: AberdeenGroup, October 2006

While a number of options for accessing simulations are available to engineers, only few are typically used. These include simulations *embedded within the CAD application* and *transferred from CAD to preprocessor applications*. The first option, embedding simulation capabilities within a CAD application, keeps the engineer in a familiar environment and removes the additional step of transferring geometry over to another application. Sometimes this second option is necessary for an advanced setup such as finite element mesh adjustment and additional geometric idealizations. Development of simulation models *only within independent preprocessors* requires users to duplicate the design geometry.

ARA Engineering

"CAD embedded simulation can be very fast and accurate for the fundamental assessments of your product. We use these in the middle of the design cycle to directionally confirm our design decisions as we proceed."

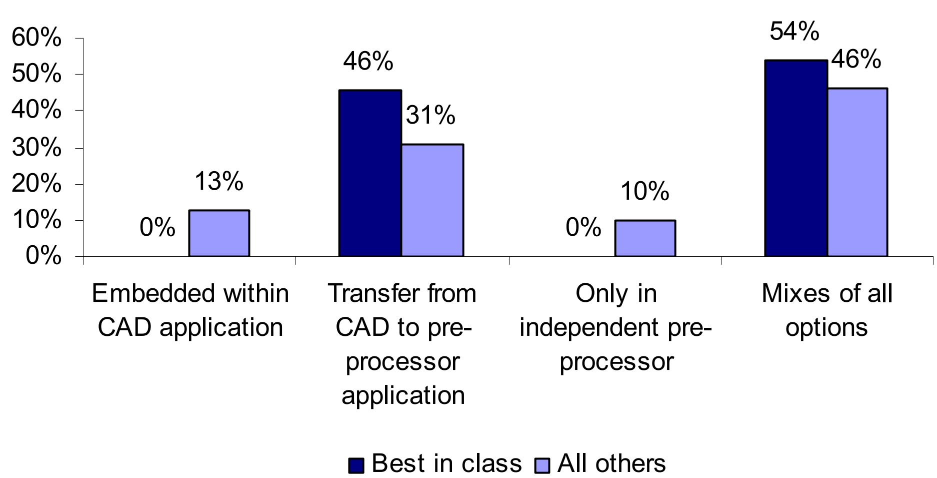
Roxanne Abul-Haj, ARA Engineering

Overall the best in class are 63% more likely than all other manufacturers to access simulation capabilities directly within CAD applications (35% versus 22%). Conversely, the best in class never utilize independent preprocessors. Some manufacturers do transfer from the CAD application to an independent preprocessor, but there is no significant difference between best in class and all others in this practice. All in all, the conclusion is clear. The best in class provide access to simulation capabilities for their engineers directly through CAD applications and through independent preprocessors only when necessary.

Design Reuse: Analysts Transfer from CAD to Preprocessors

A similar question – how are simulations accessed by analysts – yielded dramatically different results (Figure 9).

Figure 6: Best in Class Provide Experts Independent Simulation Tools



Source: AberdeenGroup, October 2006

As shown, none of the best in class manufacturers have their analysts' access simulation capabilities in CAD applications. Given that many simulation vendors purposefully do not expose all simulation capabilities, especially the advanced ones, through CAD applications, analysts find that they can't even setup advanced analyses. However, those analysts do want to take advantage of the modeling work that has already taken place. As a result, analysts at many manufacturers perform a *transfer from CAD to a preprocessor application* in an effort to reduce the overall simulation cycle. Interestingly enough, because analysts want to take advantage of the already completed design work, they never develop the entire model *only in an independent preprocessor.*

Smith Aerospace

"We export geometry from the CAD tool and import it into a standalone package. Besides saving time, when we transfer geometry we know we are analyzing the exact design the engineer developed. Re-creating it can introduce mistakes in the geometry and might not accurately represent the design you'd want to analyze."

Jochen Hessemann, Smith Aerospace

On the whole, at best in class manufacturers compared to other companies, analysts are 48% more likely to transfer from the CAD application to an independent pre-processor instead of accessing simulation capabilities through a CAD application or building the simulation model independent of the CAD application.

GHSP

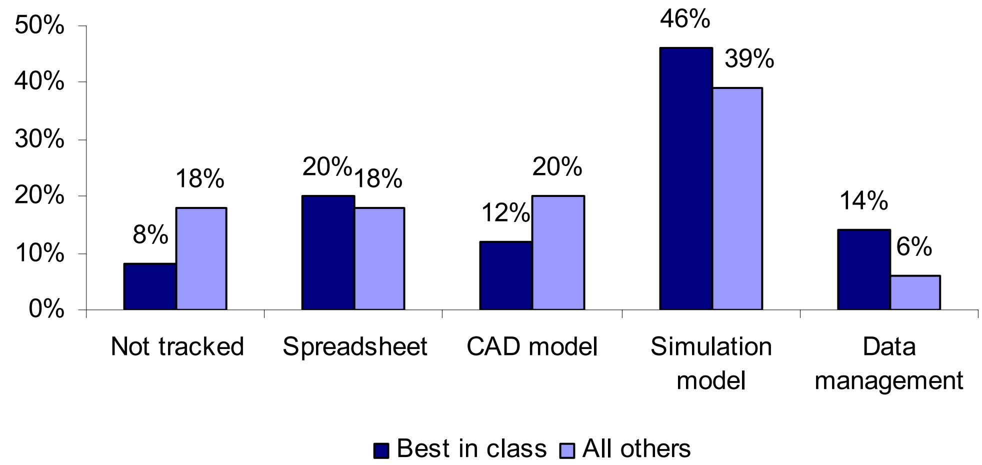
"We use standalone analysis tools because the capabilities are more encompassing. We do take the geometry from the CAD tool into the standalone tool so we don't have to create the geometry there."

Mike Hoyt, GHSP

Tracking Configurations with the Simulation Model or Data Management

During the setup of a simulation, many simplifications and idealizations are made to designs in an effort to minimize mesh times and computation solve times. While this is a common occurrence, many users don't make the effort to accurately capture the derived configuration of the model that was analyzed. This can cause issues if the product later fails and a root cause investigation is required as part of a change process because the details of the simulation configuration were not documented. Overall, there are a number of options manufacturers can use to track these simulation configurations (Figure 7).

Figure 7: Best in Class Track Simulation Configurations



Source: AberdeenGroup, October 2006

In fact, most of the best in class performers use the simulation model as a means to track the configuration of the product that was actually analyzed. In addition, they are more than twice as likely to use data management to track the simulation configuration through a centralized data management tool.

Overall, the conclusion is that the best in class track simulation configurations at least in some way, most frequently by using the simulation model or by using data management tools (and using them twice as frequently as other manufacturers).

Educating the User: Formalized Training Programs

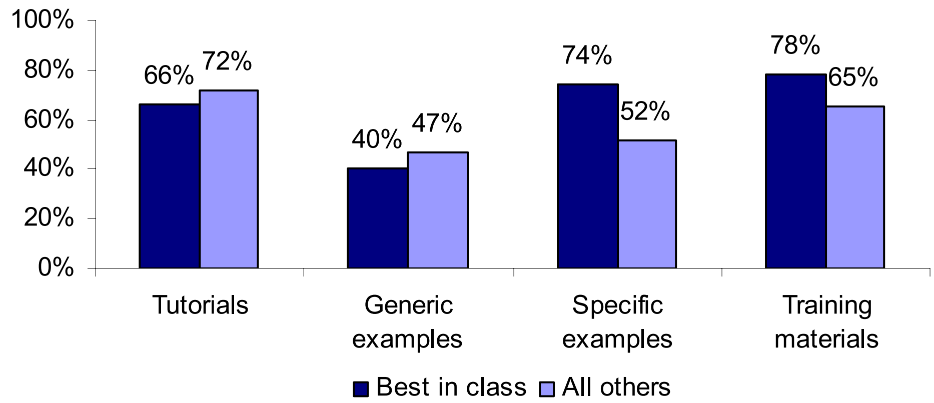
Based on the fact that manufacturers are beginning to assign the simpler analyses to their engineers, it's easy to see why training, education, and easy-to-use software are the highest ranked responses to the challenges of adopting simulation in the design phase of product development. A closer look reveals that the best in class train and educate their users by variety of means (Figure 8).

Liebherr Mining

"As far as training goes, we use all the available means to get users up to speed. We utilize outside training in addition to inside training. We have many users that are experienced and can pretty much coach them on the job."

Vladimir Pokras, Liebherr Mining

Figure 8: Best in Class Performers Provide Formalized Training Programs



Source: AberdeenGroup, October 2006

> **KONE Elevators and Escalators**
>
> "We actually use the Web help fairly extensively. We email questions to our software vendor support group, and they post answers on their Website."
>
> *Andy Jahn, KONE Elevator and Escalator*

Best in class manufacturers are more likely to provide three types of training list here more than other companies and two of them markedly more than all other companies. Specifically, a large percentage of best in class manufacturers use tutorials (66%), specific examples (74%), and training materials (78%). Tutorials and training materials help these companies provide both *FEA concepts education* and *software training*. Specific examples help address concerns about evaluating *complicated product behavior* by showing users how to apply the software to the manufacturer's specific products. Interestingly, best in class performers are 42% more likely to provide specific examples to their users (74% vs. 52%) than other companies.

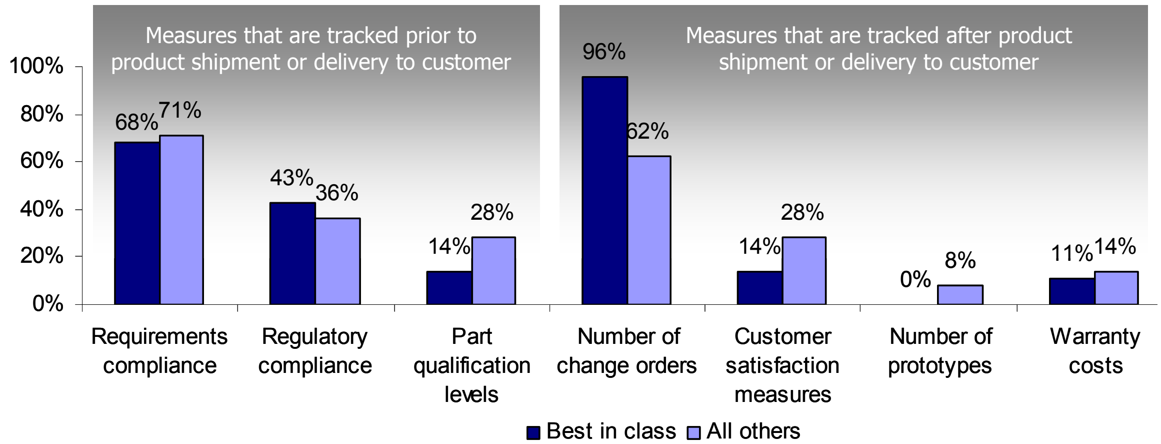
Overall the conclusion is clear. The best in class performers are much more likely to provide training materials to their users to address their *lack of expertise* and *complicated product behavior* – the primary challenges they cited to performing simulation earlier in the product development cycle.

Keeping an Eye on Requirements and Change Orders

> **Large Aerospace and Defense Contractor**
>
> "We get requirements from the customer regarding fatigue life, deflection, weight, natural frequencies, and other areas. The goal is to get as close to all of them as possible."

Overall, the ultimate goal is to manufacture a product that wins in the market or satisfies the customer's needs. How do manufacturers ensure this is in fact the case? A wide variety of optional tactics are available (Figure 9).

Figure 9: Manufacturers Track Compliance to Requirements and Change Orders



Source: AberdeenGroup, October 2006

Prior to design release, the majority of manufacturers primarily track requirements compliance. Tracking compliance to product performance requirements acts as a key enabling mechanism for early corrective action to work-in-process design. Additionally, a large number of manufacturers track regulatory compliance. With the number of regulations increasing worldwide, this comes as no surprise. Interestingly enough, tracking part qualification levels, a common practice in many industries, is markedly lower for best in class performers compared to laggards. Overall, these measures are commonly verified through simulation prior to the development of a product prototype.

After design release, many manufacturers track the number of change orders logged against a specific product. Companies use this measure to conduct a "post-mortem" judgment on the practices used during that product's development. Specifically, best in class manufacturers are 55% more likely than other companies (i.e., 96% versus 62%) to track the number of change orders against a product. Outside of this measure, other post-design-release measures are infrequently used. Because simulation should be able to predict product failures that are the root cause of many change orders, manufacturers use this "post-mortem" judgment to identify the simulation approaches used associated with that product as good or bad.

The conclusion is clear. Best in class performer most commonly measure product performance by evaluating requirements and regulatory compliance prior to design release and by tracking the number of change orders after design release.

Chapter Four: Recommendations for Action

Key Takeaways

- Perform more simulation of product performance in the design phase.
- Provide CAD-embedded simulation capabilities to engineers.
- Use training materials and specific examples to get users up to speed.
- Employ technologies that transfer geometry from CAD to independent preprocessors for analysts.
- Track requirements and regulatory product compliance prior to design release.

Regardless of the fact that performing more analyses upfront in the design phase takes more time, manufacturers are engaging in this practice to save time and money in creating physical prototypes, so they can hit shrinking time-to-market windows. The following actions can help them address the challenges of early simulation as well as enable them to improve their performance levels from "laggard" to "industry average," or from "industry average" to "best in class," or even from "best in class" to number one in their market.

Laggard Steps to Success

1. *Perform more analyses in the design phase.*

   Use simulation capabilities to virtually prototype products in the design phase to save prototype costs and time in the testing phase.

2. *Don't force engineers to use independent preprocessors. Adopt CAD-embedded simulation capabilities instead.*

   Requiring engineers to perform new tasks in completely such new and unfamiliar applications as independent preprocessors increases the barriers to success. Instead, provide simulation capabilities through CAD tools, an environment with which they are more familiar.

3. *Employ training materials and specific examples of company products to bring users up to speed.*

   Training materials will enable users to understand FEA concepts as well to use new simulation software applications. Examples that are specific to your business and products will help users better understand how apply the technology in their everyday work.

Industry Average Steps to Success

1. *Provide analysts with the ability to transfer geometry from CAD to independent preprocessors instead of CAD embedded simulation.*

Simulation capabilities embedded within CAD applications are consciously limited in an effort to make things simpler for engineering users. Analysts need access to the advanced capabilities in independent preprocessors. However, transferring geometry from the CAD application to these independent preprocessors allow them to take advantage of and reuse designs, shortening the time required to perform analyses.

2. *Measure the number of change orders as lagging indicator of best practices.*

   Manufacturers should track the number of change orders related to failed product performance as a post-design-release measure of the successful use of simulation in the design phase. It will also facilitate efforts to continuously improve the use of simulation.

3. *Track the simulation configuration through simulation models or data management.*

   In order to understand what was simulated after the product has been released and launched, formally track the product configurations along with the idealizations and simplifications required by simulations through a simulation model or data management tool.

Best in Class Next Steps

1. *Track requirements and regulatory compliance more heavily prior to design release.*

   While tracking change orders is a good lagging indicator of the successful application of simulation to a product's performance, measuring leading indicators such as requirements and regulatory compliance will result in minimizing prototype costs and time.

2. *Reinforce use of CAD-embedded simulation capabilities — instead of independent preprocessors — for engineers.*

   While using an independent pre-processor provides access to advanced simulation capabilities, manufacturers should reinforce the use of the simulation capabilities embedded in CAD applications. This way, engineers can avoid learning a new application that they will infrequently use. Overall, this practice will lower the barrier to performing simulation earlier in the design phase.

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Appendix A:
Research Methodology

During August 2006, Aberdeen Group and *Desktop Engineering* and *NAFEMS* examined the experiences and intentions of more than 270 enterprises regarding their mechanical design simulation methodologies. Responding engineering executives completed an online survey that included questions designed to determine the following:

- The degree to which mechanical design simulation impacts corporate strategies, operations, and financial results
- The structure and effectiveness of existing mechanical design simulation
- The benefits, if any, that have been derived from mechanical design simulation initiatives

Aberdeen supplemented this online survey effort with telephone interviews with select survey respondents, gathering additional information on mechanical design strategies, experiences, and results.

The study aimed to identify emerging best practices for mechanical engineering and design and provide a framework by which readers could assess their own mechanical design capabilities.

Responding enterprises included the following:

- ***Job title/function****:* The research sample included respondents with the following job titles: engineering and design staff (34%), engineering and design managers (25%), internal consultants (11%), engineering and design directors (7%), and senior management (CEP, COO, CFO) (6%).
- ***Industry****:* The research sample included respondents predominantly from manufacturing industries. Automotive manufacturers represented 22% of the sample. Manufacturers in aerospace and defense accounted for 21% of respondents. Industrial equipment manufacturers followed at 16%. Other sectors responding included computer equipment and peripherals, high technology, telecommunication manufacturers, services, and logistics.
- ***Geography****:* North American respondents accounted for 46% of respondents followed closely by EMEA respondents at 43%. Remaining respondents from Asia-Pacific region and South America represented the remaining 11% of the respondent pool.
- ***Company size****:* About 33% of respondents were from small businesses (annual revenues of $50 million or less), 40% were from midsize enterprises (annual revenues between $50 million and $1 billion), and 28% of respondents were from large enterprises (annual revenues above US$1 billion).

Solution providers recognized as sponsors of this report were solicited after the fact and had no substantive influence on the direction of the *Simulation-driven Design Benchmark*

Report. Their sponsorship has made it possible for Aberdeen Group, *Desktop Engineering,* and *NAMFEMS* to make these findings available to readers at no charge.

Table 4: PACE Framework

PACE Key

Aberdeen applies a methodology to benchmark research that evaluates the business pressures, actions, capabilities, and enablers (PACE) that indicate corporate behavior in specific business processes. These terms are defined as follows:

Pressures — external forces that impact an organization's market position, competitiveness, or business operations (e.g., economic, political and regulatory, technology, changing customer preferences, competitive)

Actions — the strategic approaches that an organization takes in response to industry pressures (e.g., align the corporate business model to leverage industry opportunities, such as product/service strategy, target markets, financial strategy, go-to-market, and sales strategy)

Capabilities — the business process competencies required to execute corporate strategy (e.g., skilled people, brand, market positioning, viable products/services, ecosystem partners, financing)

Enablers — the key functionality of technology solutions required to support the organization's enabling business practices (e.g., development platform, applications, network connectivity, user interface, training and support, partner interfaces, data cleansing, and management)

Source: Aberdeen Group, Month 2006

Table 5: Relationship between PACE and Competitive Framework

PACE and Competitive Framework How They Interact
Aberdeen research indicates that companies that identify the most impactful pressures and take the most transformational and effective actions are most likely to achieve superior performance. The level of competitive performance that a company achieves is strongly determined by the PACE choices that they make and how well they execute.

Source: Aberdeen Group, Month 2006

Table 6: Competitive Framework

Competitive Framework Key
The Aberdeen Competitive Framework defines enterprises as falling into one of the three following levels of FIELD SERVICES practices and performance: *Laggards (30%)* — FIELD SERVICES practices that are significantly behind the average of the industry, and result in below average performance *Industry norm (50%)* — FIELD SERVICES practices that represent the average or norm, and result in average industry performance. *Best in class (20%)* — FIELD SERVICES practices that are the best currently being employed and significantly superior to the industry norm, and result in the top industry performance.

Source: Aberdeen Group, Month 2006

Appendix B:
Related Aberdeen Research & Tools

Related Aberdeen research that forms a companion or reference to this report includes:

- *The Product Innovation Agenda Benchmark Report* (September 2005)
- *The Product Lifecycle Management for Small to Medium-Size Manufacturers Benchmark Report* (March 2006)

Information on these and any other Aberdeen publications can be found at www.Aberdeen.com.

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