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The Transition from 2D Drafting to 3D Modeling Benchmark Report

Improving Engineering Efficiency

September 2006

— Underwritten, in Part, by —

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Executive Summary

Do more with less. The mandate hasn't changed for manufacturers. They must develop more products with increasing complexity to address customer and competitive pressures. Yet, there's no "give" in project timelines to adopt new technologies like 3D modeling to help them win. However, some manufacturers are not only adopting 3D modeling technology, but excelling at hitting their product development targets at the same time. How is it possible? 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 84% or more of their products.
- Best in class performers typically produce 1.4 fewer prototypes than average performers.
- Best in class performers average 6.1 fewer change orders than laggard performers.
- In total, best in class manufacturers of the most complex products get to market 99 days earlier with $50, 637 lower product development costs.

Implications & Analysis

How do they do it?

- Best in class performers are 40% more likely to have engineers use CAD directly to ensure they stay close to the design.
- Best in class performers are 24% more likely to take advantage of extended 3D modeling design capabilities. They are 55% more likely to use downstream capabilities.
- All (100%) best in class performers acquired new hardware when adding 3D modeling, compared to 53% of laggards.

Recommendations for Action

- Initially document design deliverables in electronic form.
- Allow engineers to use 3D modeling tools rather than allocating them to drafters.
- Deploy the advanced design and downstream capabilities of 3D modeling.
- Acquire hardware and data management tools to avoid 3D modeling problems.
- Measure design reuse on a periodic basis throughout the design process.

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Table of Contents

Figures

Tables

Chapter One:
Issue at Hand

Key Takeaways

- Driven by customers and competitors, manufacturers are pressured to develop more products that are complicated and bring them to market in less time.
- Manufacturers are striving for product innovation and greater operational efficiencies as the answer to the "do more with less" mandate.
- Manufacturers plan to add 3D modeling to 2D drafting instead of replacing it.
- Unclear benefits and lack of executive sponsorships are the roadblocks stopping some manufacturers from adding 3D modeling.
- The primary concern for those planning to add 3D modeling is user productivity.
- Past experience shows that the unexpected negative consequences of 3D modeling are slower application performance and management of CAD relationships.

While the emergence of 3D modeling tools occurred two decades ago, some vendors estimate that roughly 85% of the current CAD user base still primarily employs 2D drafting. Although one would expect the pace of migration from 2D drafting to 3D modeling to have accelerated, unyielding time-to-market constraints offer no opportunity for manufacturers to allow users to adapt to new paradigms and convert legacy drawings into new formats without being productive at the same time. Yet some manufacturers are not only accomplishing this feat, but excelling in top-line and bottom-line measures.

Variation on an Old Theme: Do More with Less

In one form or another, manufacturers considering a change in how they produce design deliverables are reacting to customer and competitive pressures by creating innovative products or improving operational efficiencies (Table 1).

Table 1: Top Five Business Pressures and Strategic Actions

Business Pressures		Strategic Actions	
Shortened time to market	65%	Improve product performance or quality	49%
Customer demand for new products	47%	Improve development efficiency	42%
Increasingly complex customer requirements	43%	Lower internal manufacturing costs	25%
Accelerating product commodization	29%	Develop markets with breakthrough innovation	17%
Threatening competitive products	27%	Decrease customer response time	17%

Source: AberdeenGroup, September 2006

In fact, manufacturers are caught between opposing business pressures. On the one hand, Aberdeen survey respondents report that their companies must develop more products and get them to market faster due to *shortened time to market* (65%), *accelerating product commodization* (29%), and *threatening competitive products* (27%). On the other hand, they also indicate that their companies must address *customer demand for new products* (47%) that are more complicated due to *increasingly complex customer requirements* (43%).

Accordingly, manufacturers are addressing these business pressures in two ways: through increased product innovation and operational efficiency. They aim to *improve product performance or quality* (49%) and *develop markets with breakthrough innovation* (17%). To achieve operational efficiency, they strive to *improve development efficiency* (42%), *lower internal manufacturing costs* (25%), and *decrease customer response time* (17%).

Overall, the message is clear. Business pressures are driving manufacturers to develop more complex products in less time. They are responding with product innovation and improvements in product development efficiency. This trend seems to be the continuation of an old theme: do more with less. It's likely not to change anytime soon.

Manufacturers Add 3D Modeling Instead of Replacing 2D Drafting

With various strategies in mind to address the business pressures of the day, many manufacturers are making 3D modeling part of the plan. Fully 71% of companies currently using 2D drafting are planning on using 3D modeling.

While one might think that these companies would switch completely to 3D modeling and eliminate 2D drafting, that is actually not the case. In fact, 77% of companies that use 3D modeling also use 2D drafting.

Case Study – Transpo Electronics

"The main reason we still use some 2D tools along with 3D tools is that most of our tooling partners simply aren't accepting 3D models yet."

John Burrill, Transpo Electronics

Follow-up interviews with Aberdeen survey respondents show that the motivation to continue use of 2D drafting varies widely. For some, 2D drafting is better suited for conceptual engineering when users don't want to commit to part numbers and the complexity of assemblies. Others are constrained by the absence of 3D modeling in their supply chain. If their suppliers can't use 3D models, they certainly can't provide them as a deliverable. Regardless of the reasons, manufacturers are planning to add 3D modeling to 2D drafting instead of replacing it.

Case Study – Safeworks

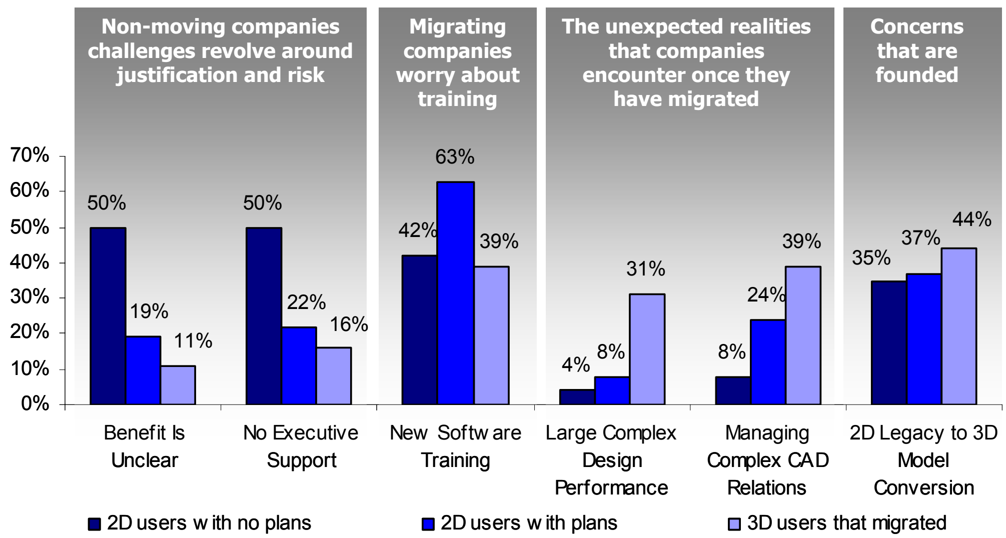
"For the most part, we've decided to design all new products in 3D. However, one thing that isn't clear is our strategy on what to do with all of our legacy 2D drawings. Should we go back and revise all legacy data? Should we convert as we go? We haven't made a clear decision about that yet."

John Albers, Safeworks

Concerns with 3D Modeling Vary Widely

The transition from 2D to 3D is an old, but still active trend, so one might expect the wealth of knowledge gained from past migrations to be widely available and leveraged by those considering migration. However, this is not the case, as shown by the widely varied challenges reported by those who have no 3D modeling plans, those who have 3D modeling plans, and those who have already implemented 3D modeling (Figure 1).

Figure 1: Challenges to Using 3D Modeling



Source: AberdeenGroup, September 2006

The biggest challenges for manufacturers without plans for 3D modeling concern justification. Much more than those manufacturers who have 3D migration plans and those already using 3D modeling, this group does not understand the benefits of 3D modeling and can't gain the support of executives. Consequently, it comes as no surprise that they are not planning to use 3D modeling.

The primary concern for manufacturers with plans for 3D modeling is software training. The implicit issue is user productivity. Again, Aberdeen findings show that these manufacturers are under pressure to develop more products that are more complicated in less time (Table 1). They gain no reprieve from these pressures to get their users up to speed in a timely fashion.

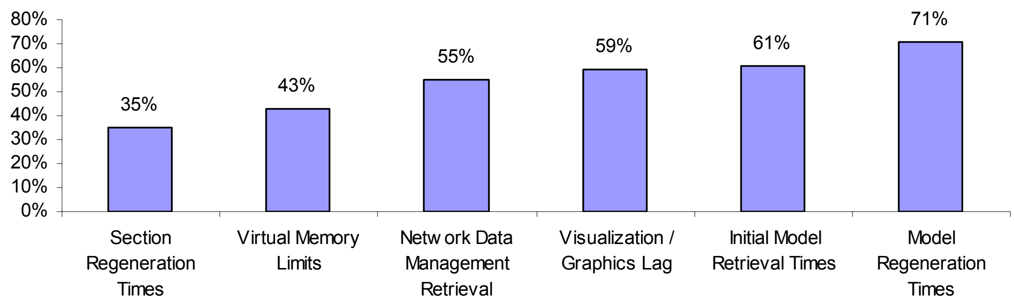
Case Study – Ovalstrapping

"Training after switching over to 3D tools was a major challenge. The issue wasn't really the concepts of 3D modeling such as definition of features or parameters. The outstanding issue was educating the users on where the functionality was located within the application."

Phil Jones, Ovalstrapping

While training users in the face of project development deadlines is a valid concern, there are hidden barriers on the road to successful 3D modeling. Most notably, the slow application performance of large and complex designs as well as the difficulties of managing complex CAD relationships are issues recognized by those who already using 3D modeling and not recognized by those who are not. The slow application performance of large and complex designs can be further broken down into a number of specific issues (Figure 2).

Figure 2: Application Performance Challenges of 3D Modeling



Source: AberdeenGroup, September 2006

These issues are the result of different hardware shortfalls. Inadequate processor speeds and lack of memory cause slow section regeneration times, model regeneration times, and initial model retrieval times. Inadequate graphics cards result in visualization and graphics lag. Network bandwidth impacts data management retrieval. And memory limits are an inherent limitation of 32-bit systems that are addressed by 64-bit machines.

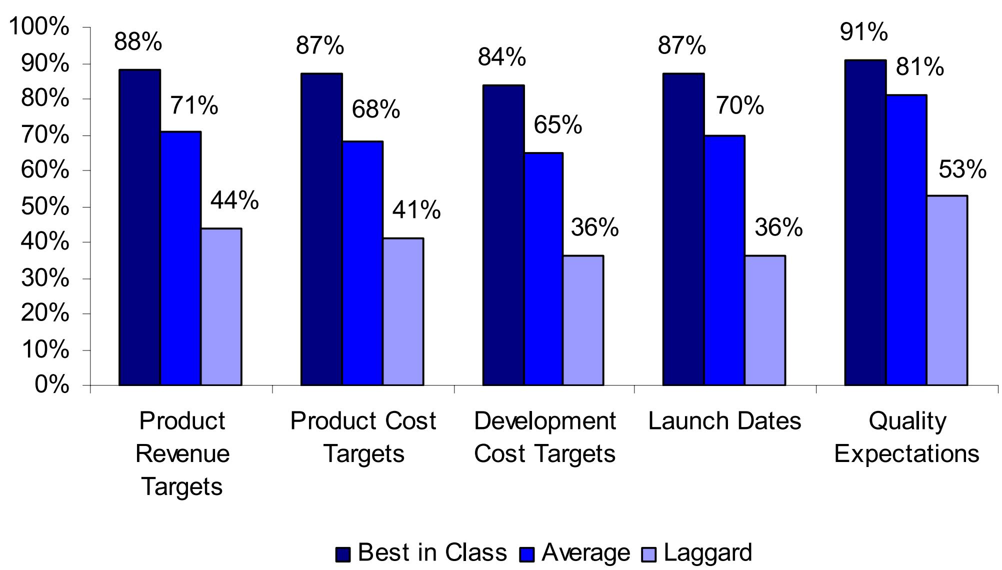
Chapter Two:
Key Business Value Findings

Key Takeaways

- Best in class manufacturers their hit revenue, cost, launch date, and quality targets for 84% or more of their products.
- Best in class performers typically produce 1.4 fewer prototypes than average performers.
- Best in class performers average 6.1 fewer change orders than laggards.
- In total, best in class manufacturers of the most complex products get to market 99 days earlier with $50,637 lower product development costs.

While the majority of manufacturers are planning to adopt 3D modeling, Aberdeen research shows that they face both serious known and unknown 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 84% Average or Better



Source: AberdeenGroup, September 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 84% or better average.

Replacing Physical Prototypes with Virtual Prototypes

One of the promised benefits of using 3D modeling is reducing the number of physical prototypes required to develop a product. Instead, 3D modeling software allows manufacturers to develop virtual prototypes in order to catch issues before any capital investment is made in physical prototypes.

> The best in class manufacturers of the most complex products get to market ***41 days*** earlier with ***$14,733*** lower product development costs than average performers because of fewer prototypes.

In theory, best in class manufacturers should be developing fewer prototypes. However, the more complex a product is, the higher its costs and the longer the time required to build it. To get a clear picture how costs and required development time varied according product complexity, Aberdeen categorized survey respondents' products by measuring three key indicators: *number of parts in the product*, *length of product development lifecycle*, and *number of engineering disciplines incorporated*. This measurement subsequently enabled differentiation of levels of product complexity and their typical time and cost to build (Table 2).

In fact, the theory that best in class manufacturers develop fewer prototypes holds true. Aberdeen research showed that for each product development cycle they average 1.5 prototypes compared to 2.9 prototypes for average performers.

Table 2: Prototype Costs and Time per Product Complexity

Product Complexity	Time to Build	Cost to Build
Very complex products	29.6	$10,524
Moderately complex products	13.7	$3,959
Simple products	15.1	$2,290

Source: Aberdeen*Group*, September 2006

The difference of 1.4 prototypes has a direct impact on time to market and product development costs. The best in class manufacturers of the most complex products get to market in 41 days with $14,733 lower product development costs than average performers. The best in class manufacturers of the simplest products get to market 21 days earlier and spend $3,206 less on product development costs than average performers. All in all, virtual prototyping pays off for best in class performers.

Case Study – Rincon Corporation

"In the past, we usually found interference issues when we went to put together the prototype physical assembly of the product. For example, someone might have forgotten about the head of a bolt that would clash. Using 3D tools, we find those issues virtually because an interference check highlights the problem on the screen. This has directly contributed to us going from a 9-to-12 month development cycle down to six months."

Raymond Reynolds, Rincon Corporation

Catching Issues before They Become Change Orders

The advantage of virtual prototyping has additional benefits. By more fully addressing design issues up front, manufacturers experience fewer change orders downstream than laggards.

The best in class manufacturers of the most complex products get to market ***58 days*** earlier and pay ***$35,904*** less in product development costs than average performers because of fewer change orders.

By applying the same classification of product complexity to the cost of executing change orders, we see there is a marked differentiation here also (Table 3). Executing change orders for more complex products commonly takes more time and requires due diligence because more engineers must be coordinated, and the issues are generally more complex. The time to execute a change order, however, was the same – 9.5 days – across all product complexity levels.

Table 3: Change Order Costs per Product Complexity

Product Complexity	Cost of Executing Change Orders
Very complex products	$5,886
Moderately complex products	$2,021
Simple products	$1,492

Source: AberdeenGroup, September 2006

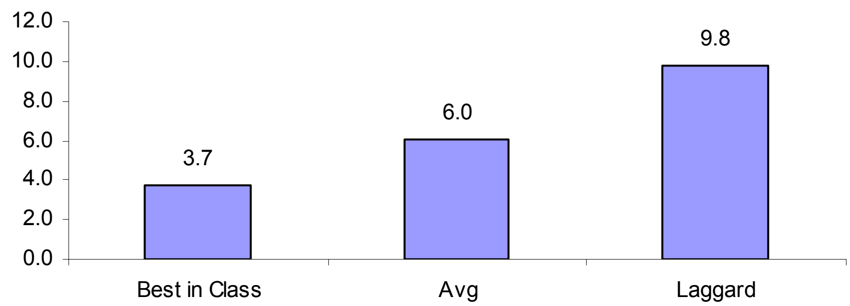
Survey findings also confirmed the theory that best in class performers execute fewer change orders (Figure 4). In fact, best in class performers execute 6.1 fewer change orders per product development lifecycle than laggard performers.

Case Study – Large Military Aerospace Supplier

"After doing an internal analysis, we found that the root cause of 30% to 40% of all nonconformances were due to 2D drawing inaccuracies. After we realized that, we quickly moved to 3D technology."

The difference of 6.1 change orders also has a direct impact on time to market and product development costs. Best in class manufacturers of the most complex products get to market 58 days earlier with $35,904 lower product development costs than average performers. The best in class manufacturers of the simplest products get to market 58 days earlier with $9,101 lower product development costs than average performers. Again, these advantages translate into a real-world financial benefit.

Figure 4: Number of Change Orders per Product



Source: AberdeenGroup, September 2006

Additive Benefits

All in all, the benefits described so far are impressive – and they add up. The costs and time saved in developing prototypes are realized prior to design release. The costs and time saved in executing change orders happen after the design has been released. Both sets of benefits can be realized simultaneously (Table 4).

Table 4: Total Best in Class Advantages in Time and Cost

Product Complexity	Time Saved	Costs Saved
Very complex products	99 days	$50,637
Moderately complex products	77 days	$18,266
Simple products	79 days	$12,307

Source: AberdeenGroup, September 2006

Overall, the savings that the best in class are realizing both in time to market and product development costs are both substantial – and reveal how the best in class are hitting 84% or more of the targets for launch dates and product development costs.

Chapter Three: **Implications & Analysis**

Key Takeaways

- Best in class performers are 40% more likely to have engineers use CAD directly to ensure they stay closer to the design.
- Best in class performers are half as likely to document any design deliverables on paper. They are 12% more likely to completely develop them electronically.
- Best in class performers are 24% more likely to use the extended design capabilities of 3D modeling and 55% more likely to use its downstream capabilities.
- All (100%) best in class performers acquired new hardware when adding 3D modeling compared to 53% of laggards.
- Best in class performers are 50% more likely to measure performance at design release or periodically. Laggards are 49% more likely to never measure performance.

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 – organizational structure, processes, technology usage, and performance measurement.

Getting Engineers Closer to Design

In the modern manufacturing era, the person responsible for creating the design deliverable has often been different (i.e., the drafter) from the person ultimately responsible for the performance of the product (i.e., the engineer). However, the skills of the drafter have evolved over time as the drawing medium has changed from ink and Mylar to electronic 2D drafting and, finally, to 3D modeling.

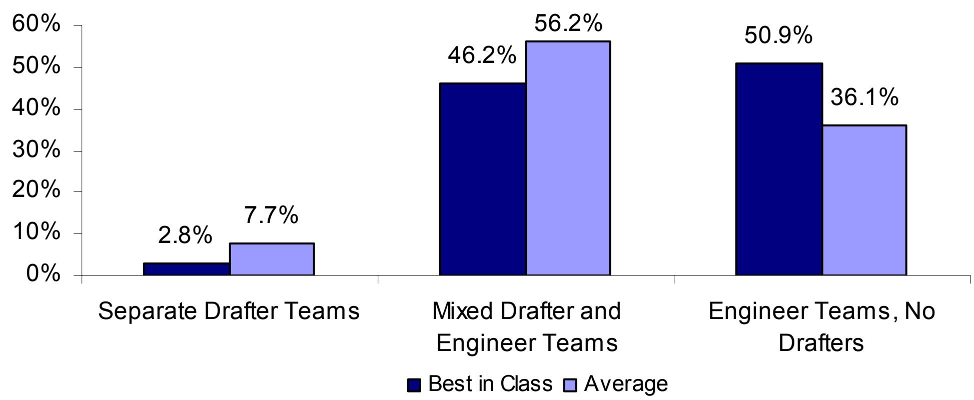
Case Study – Bleck Design Group

"Our engineers use design tools directly instead of CAD specialists. It's really a staffing decision when it comes down to it. Hiring someone that doesn't add value beyond building a model doesn't make sense. It's like hiring typists for writers!"

Jim Bleck, Bleck Design Group

The age of 3D modeling, however, has caused many manufacturers to re-evaluate this division of labor. Some have seized the opportunity to reduce staffing by placing the design tools directly in the hands of engineers instead of hiring drafters at all. Aberdeen findings show the best in class are following this trend (Figure 5).

Figure 5: Organizational Approaches across the Competitive Framework



Source: AberdeenGroup, September 2006

> **Case Study – CACO Pacific Corporation**
>
> "We have several different types of engineers using our CAD tools, varying from mold designers, hot runner designers, and EDM electrode designers. It's a must because to design our injection molds, you have to have a lot of specialized knowledge about our products and how they work."
>
> *Bill Sigsworth, CACO Pacific Corporation.*

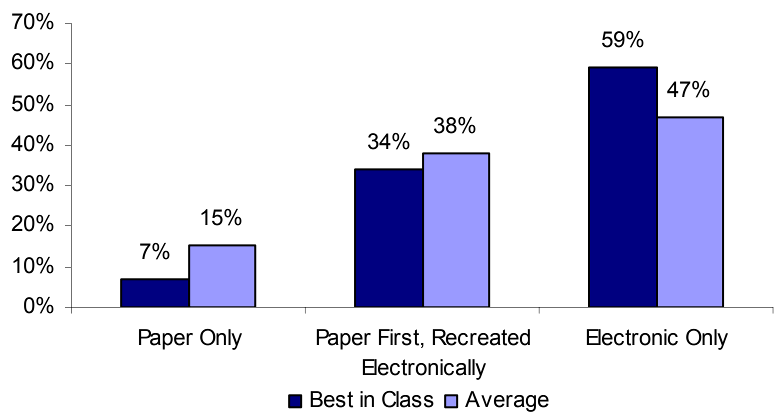
In fact, having separate teams of drafters and engineers seems to be phasing out, with best in class performers leading the trend. Furthermore, best in class performers are 41% more likely to place the design tools in the hands of the engineers.

Aberdeen's follow-up interviews uncovered some of the reasons behind the change. In some cases, the products were of such high complexity that the company wanted to remove the insulating layer that a specialist drafter represented, so that the engineer could get closer to the product. In addition, staffing drafters posed an overhead that didn't necessarily add value to the development of the deliverable. Exemplifying this trend, the best in class companies aim to get their engineers closer to the design by having them use the CAD tools.

The Transition from Paper to Electronic Formats

Those with no 3D modeling plans (27%), those with 3D plans (22%), and those already using 3D modeling agree (26%): the process change required by 3D modeling is a challenge. While this overall process change can affect specific processes throughout a company, fundamentally designers and engineers must decide what formats and forms they will use to document a design. Overall, the trend is for design deliverables to start out and stay in electronic forms rather than moving from paper to electronic form (Figure 6).

Figure 6: Paper and Electronic Approaches across the Competitive Framework



Source: AberdeenGroup, September 2006

Aberdeen research shows that best in class performers are more likely to start out in electronic form rather than paper. In addition, they are half as likely to document any design deliverables on paper. This is important because electronic design deliverables facilitate collaboration across distances and supply chains better than paper deliverables.

Case Study – Radiation Shielding

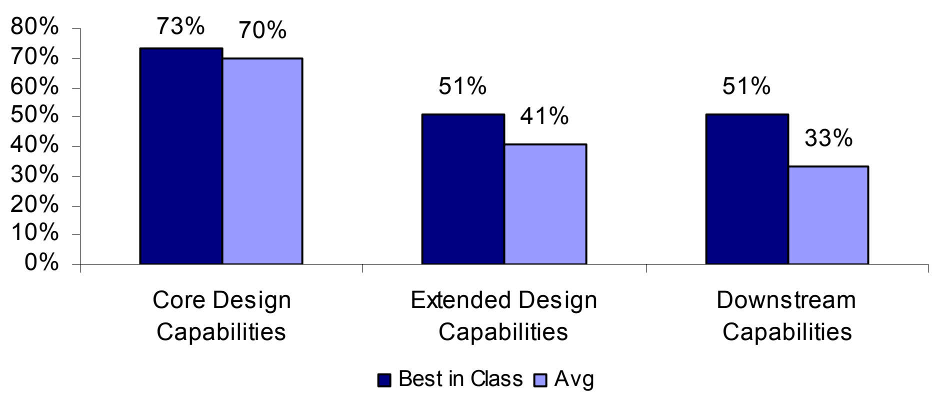
"I start with an idea in my mind and sketch it out on a napkin because it's quick. I put it into computer for one reason. It tells me where I have made mistakes."

Rod Hutchinson, Radiation Shielding

Leveraging Electronic Design Deliverables

Best in class performers are also more likely to use the wide range of extended design and downstream capabilities that complement 3D modeling (Figure 7).

Figure 7: CAD Capabilities across the Competitive Framework



Source: AberdeenGroup, September 2006

Specifically, best in class performers are 24% more likely to use extended design capabilities (51% versus 41%) such as *configuration logic and knowledge*, *assembly family tables*, *large assembly management*, *simulation and analysis*, *complex surfacing,* and *model quality checks*. These capabilities allow the best in class performers to automate, virtually prototype, and reuse designs at a much higher rate than the basic 3D modeling capabilities allow. The result is a better design.

Case Study – Accuray

"We use simulation capabilities in the design of our cancer treatment machines. Our fully articulated machine directs high-energy x-ray beams at tumors, yet we have to make sure that there are no other collisions with the patient or anything else in the room."

Ken Schulze, Accuray

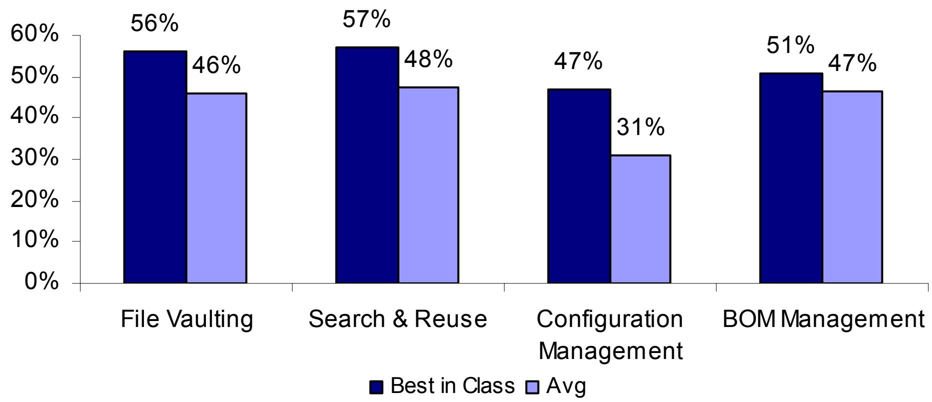
What's more, best in class performers are 55% more likely to use downstream capabilities (51% versus 33%) such as *tool design*, *machining toolpaths,* and *quality / inspection toolpaths*. These capabilities enable downstream departments to start on their deliverables before the design is actually complete. When changes are made, the modeling software updates all design deliverables, saving users the time and effort of manually propagating the change to all product features affected by it. This capability enables concurrent product development because it allows downstream departments to start their work earlier without fear of starting over when changes occur. Ultimately, concurrent work compresses the product development process, allowing manufacturers to hit their launch dates.

The message here is clear. Use the extended design capabilities and downstream capabilities of 3D modeling to automate, virtually prototype, reuse designs – ultimately to get to a better design and enable concurrent product development, This, in turn, reduces product development costs and time to market.

Necessities for Success: Data Management and Hardware

While best in class performers are taking advantage of 3D modeling's extended and downstream capabilities, many manufacturers run into the unexpected negative consequences of managing complex CAD relationships (39% in Figure 1). To address this issue, best in class performers are taking greater advantage of core data management technologies than their laggard peers (Figure 8).

Figure 8: Data Management Technology across the Competitive Framework



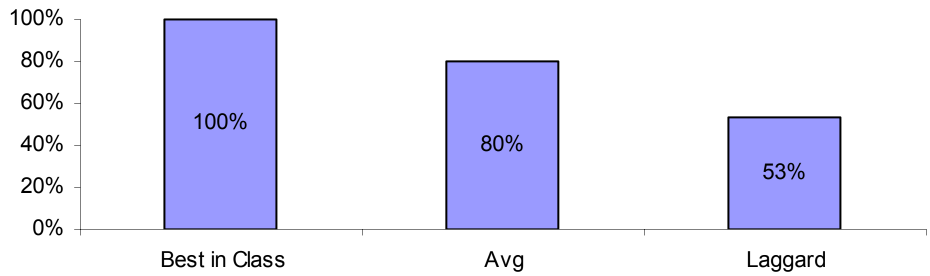
Source: AberdeenGroup, September 2006

> **Case Study – Terex Cranes**
>
> "Although we're currently migrating from 2D to 3D, we don't plan on using extended CAD capabilities. However, we will be passing 3D models to our suppliers, whom we do expect will use capabilities like toolpath generation.
>
> We're also going to use data management to ensure that no two people can make conflicting changes to the same drawing. Down the road, we plan to use it to collaborate with our sister company in Germany."
>
> *Kyle Gerber, Terex Cranes*

Specifically, they are using many of the core capabilities of data management such file vaulting, search and reuse, and bill-of-material management. But most significantly, they are taking advantage of the configuration capabilities. Many 3D modeling applications have separate files for each part. An assembly is often another separate file. While the 3D modeling application can look into a directory and understand what files to retrieve into memory, users have difficulty understand versions of files and the interrelationships between them, especially in product models with more than 100 parts. Data management solutions often include specific functionality to understand these relationships, so that users do not need to manage the files manually.

Similarly, many manufacturers are experiencing application performance problems with large and complex designs (31% in Figure 1). The biggest problem is model regeneration (71% in Figure 2). Accordingly, the best in class performers address these performance issues directly by upgrading the hardware these 3D modeling applications run on (Figure 9).

Figure 9: Hardware Upgrades across the Competitive Framework



Source: AberdeenGroup, September 2006

In fact, all best in class performers surveyed purchased new hardware when they migrated to 3D modeling software. Laggards were dramatically less proactive, with only 53% purchasing new hardware when migrating to 3D modeling. The conclusion is clear: best in class performers proactively address the challenges of 3D modeling by supporting it with data management and new hardware.

Case Study – Isothermal Systems Research

"Our strategy from a computer hardware perspective is to continually improve; we're always looking for better performance. We start by purchasing a new workstation for every engineer. After three years, we move those machines to someone else in the company and purchase new computers for the engineers. We cycle through that hardware lifecycle continuously."

Matt Feider, Isothermal Systems Research

Checking Performance before Design Release

While virtual prototyping offers quantifiable benefits downstream, many manufacturers seek more immediate additional benefits by employing 3D modeling capabilities that enable reusing existing parts and morphing an existing part into a new one. Aberdeen findings show that the top three measures manufacturers are using to assess 3D modeling focus on this benefit (Table 5).

Table 5: Top Three Performance Measurements for 3D Modeling

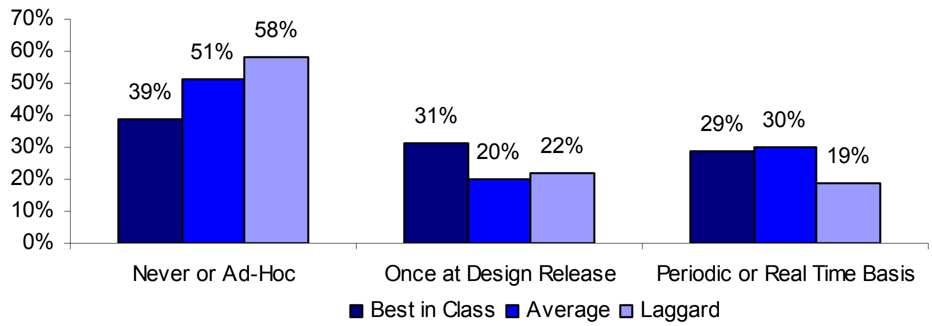
Product Complexity	Best In Class	Average
First-time compliance with good modeling practices	56%	50%
Time required to find a design	52%	64%
Percent of reuse of models / parts	52%	52%

Source: AberdeenGroup, September 2006

In fact, all of these measures are interrelated. First-time compliance with good modeling practices ensures that users can transform an existing design into a new one without having to re-create most of it. Of course, engineers must find the design before they can use it, so retrieval time is an important measure. Finally, the bottom-line measure for gauging savings is the percent of a design that is composed of existing models and parts. This is important because by reusing existing parts manufacturers can eliminate testing qualifications and avoid additional tooling.

Finally, while *what* measures are tracked is important, *when* they are measured is equally important. While many companies never track performance measures or track them only in some ad-hoc manner, best in class performers are more likely to check performance at design release (Figure 10).

Figure 10: Measurement Frequency across the Competitive Framework



Source: AberdeenGroup, September 2006

In fact, best in class performers are 50% more likely to measure 3D model quality at that critical juncture before capital investments are made in developing prototypes for verification and validation. What's more, they are 50% more likely to measure on some periodic or real-time basis. Interestingly enough, laggards are 49% more likely to never measure or measure in an ad-hoc manner. Measuring on a periodic basis throughout the design process is more beneficial than measuring once at design release because the design is less constrained earlier in the product development process. Important decisions affecting product costs that can be made early in the design process may not be possible at design release.

Overall, the message is to measure on some basis to ensure that designs can, first, be found and, second, modified to create a new design when needed.

Chapter Four: Recommendations for Action

Key Takeaways

- Initially document design deliverables in electronic form.
- Allow engineers rather than drafters to use 3D modeling tools.
- Deploy the extended design and downstream capabilities of 3D modeling.
- Acquire hardware and data management tools to avoid 3D modeling problems.
- Measure design reuse on a periodic basis throughout the design process.

Regardless of the fact that manufacturers must develop more products that are more complicated in the face of unrelenting time-to-market constraints, they must find ways to implement new 3D modeling technology while still hitting product development targets. The following actions can help them address these challenges 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.

Case Study – Advanced Dynamics

"We are roughly halfway through a two-to-three year initiative and starting to realize concrete benefits. Being able to collaborate closely with our clients during design reviews to dynamically modify designs to satisfy their specific needs has been invaluable. This capability has helped us win over $20 million in business so far."

Fergus Groundwater
Advanced Dynamics

Laggard Steps to Success

1. *Do not employ separate teams of drafters and engineers.*

   Organizational structures with separate drafting teams put more distance between engineers and their products. For engineers, who are ultimately responsible for product performance, close proximity to the design is critical.

2. *Document all design deliverables in electronic form.*

   For historical, security, and legal reasons, it is important at some point to develop electronic forms of all design deliverables. Paper development followed by re-creation in electronic form is an important first step.

3. *Acquire or access new hardware when migrating to 3D modeling.*

   Performance is critical to the early success and acceptance of 3D modeling applications in the design process. Acquiring new hardware can prevent a variety of performance issues that commonly plague 3D modeling users.

4. *Take measures to support design reuse throughout the design process.*

To ensure that the percentage of models and parts reused in the product increases, add measures to your design process that track how easily users can find and reuse designs such as time to find designs and first-time compliance to best modeling practices.

Industry Norm Steps to Success

1. *Give engineers 3D modeling tools.*

   Providing engineers with 3D modeling tools directly allows them to efficiently explore more design iterations and uncover problems virtually, resulting in more complete and higher quality products.

2. *Deploy 3D modeling extended design capabilities.*

   Use the extended design capabilities of 3D modeling including configuration logic capture, simulation, complex surfacing, assembly management, and model quality checks to arrive at better designs.

3. *Deploy 3D modeling data management.*

   Use core data management capabilities to manage the complex relationships between parts and assemblies. These capabilities remove the burden of manually managing CAD file configurations in folder structures.

4. *Measure design reuse at design release.*

   Measure levels of model quality and percentage of design reuse at design release. This will lower product costs and product development costs by reusing parts and designs.

Best in Class Next Steps

1. *Initially document design deliverables in electronic form.*

   Developing design deliverables facilitates collaboration across geographies and the supply chain more easily than paper.

2. *Deploy 3D modeling downstream capabilities.*

   Use the associative downstream capabilities of 3D modeling such as tool design, machining toolpaths, and quality / inspection toolpaths. As a result, changes will propagate automatically. This will ultimately enable concurrent engineering, which compresses the product development lifecycle.

3. *Measure design reuse on periodic basis.*

   Measure levels of model quality, time to find designs, and percentage of design reuse continuously on a periodic basis throughout the design process. Tracking these measures will enable engineers to make decisions leading to proactive actions early in the design process when the design is much less constrained than it is by the time design release occurs.

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Appendix A: Research Methodology

During August 2006, Aberdeen Group and *Cadalyst*, *CADInfo.net*, *Desktop Engineering,* and *MCADCafe* examined the experiences and intentions of more than 520 enterprises regarding their mechanical engineering and design methodologies.

Responding engineering and design executives completed an online survey that included questions designed to determine the following:

- The degree to which mechanical engineering and design impact corporate strategies, operations, and financial results
- The structure and effectiveness of existing mechanical design technologies
- The benefits, if any, that have been derived from mechanical engineering and design efficiency 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 (39%), engineering and design managers (27%), senior management (CEO, COO, CFO) (8%), engineering and design directors (5%).
- ***Industry**:* The research sample included respondents predominantly from manufacturing industries. Industrial equipment manufacturers represented 24% of the sample. Manufacturers in aerospace and defense accounted for 12% of respondents, closely followed by automotive at 10%. Producers of metal and metal products comprised 7% of the sample, closely followed by medical devices at 6%. Other sectors responding included computer equipment and peripherals, high technology, telecommunication manufacturers, services, and logistics.
- ***Geography**:* Nearly all study respondents were from North America, accounting for 88% of respondents. Remaining respondents were from Europe at 6% and the Asia-Pacific region at 4%.
- ***Company size**:* About 61% of respondents were from small businesses (annual revenues of $50 million or less), 30% were from midsize enterprises (annual revenues between $50 million and $1 billion), and 9% 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 Transition from 2D Drafting to 3D Modeling Benchmark Report*. Their sponsorship has made it possible for Aberdeen Group, *Cadalyst*, *CADInfo.net*, *Desktop Engineering,* and *MCADCafe* to make these findings available to readers at no charge.

Table 6: 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 7: 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 8: 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:

- *Managing Product Relationships: Enabling Iteration and Innovation in Design* (August 2006)
- *Product Lifecycle Collaboration Benchmark Report: The Product Profitability "X Factor"?* (August 2006)
- *The Product Lifecycle Management for Small to Medium-Size Manufacturers Benchmark Report* (March 2006)
- *Design for Sourcing: Improving Product Lifecycle Profitability* (March 2006)
- *The Global Product Design Benchmark Report* (December 2005)
- *The Product Innovation Agenda Benchmark Report* (September 2005)

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

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