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AberdeenGroup

The Design Reuse Benchmark Report

Seizing the Opportunity to Shorten Product Development

February 2007

Executive Summary

Design reuse. The idea is simple. Take past designs and repurpose them into new ones. The benefit? Starting with an already completed design allows engineers to avoid starting from scratch. Unfortunately, it's not that easy. Design models with hundreds of interrelated features can be very difficult to change. They often end up spending more time fixing models than if they had simply started from scratch. Yet, despite these problems, some engineering organizations are seeing considerable success.

Key Business Value Findings

- Top performers hit engineering targets on a 76% or better average. Laggards hit these same targets on a 26% or worse average.
- While facing challenges for design reuse, best in class companies are responding by *designing for modifications* (64%), *centralizing design data* (43%) and providing *design details in model* (43%.)

Implications & Analysis

- Top performers are more likely to dedicate resources to simplifying and verifying designs for reuse (21% vs. 0% for laggards, and 18% vs. 8%, respectively).
- A majority of these top performers integrate the preparation (71%) and verification (75%) of designs for reuse into the design phase.
- Best in class are more likely to utilize geometric search (3X) to find designs for reuse and automated checking technologies (2X) to verify designs are ready for reuse.
- Top performers are twice as likely to track the amount of time required to change existing designs into new ones (54% vs. 29%)

"We have seen a 30% reduction in design time for new products that are closely associated with preexisting products. New products that heavily rely on reuse we have seen an 80% reduction."

-John Burrill, Drafter Designer, Transpo Electronics

Recommendations for Action

- Dedicate resources to prepare and verify designs for reuse in the design phase.
- Implement geometric search technology to find designs.
- Deploy automated checking to verification that designs are ready for reuse.
- Use direct modeling technologies to modify existing designs into new ones.
- Leverage the expertise of 3rd parties to improve design reuse.

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Issue at Hand

Key Takeaways

- Top performers hit engineering targets on a 76% or better average. Laggards hit these same targets on a 26% or worse average.
- While facing challenges for design reuse, best in class companies are responding by designing for modifications (64%), centralizing design data (43%) and providing design details in model (43%.)

While all engineering organizations (100%) report that they are currently reusing designs, top performing ones are further along in the deployment of techniques and technologies to capitalize on design reuse. From product analysis, to NC programming and product design, these best in class companies are currently using these technologies to facilitate their design reuse strategies, or are planning to in the future (Table 1)

Table 1: Current Use and Future Plans for Reuse Initiatives

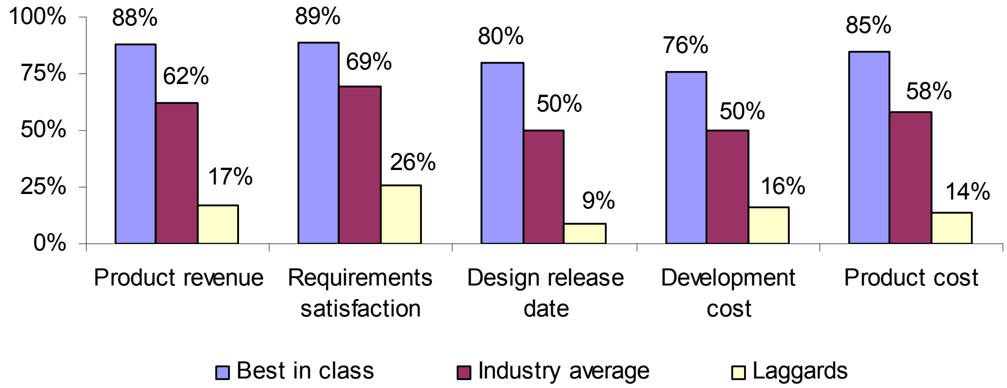
Reuse Initiatives	Currently Use	Plan to Use
Reuse of product designs	80%	20%
Reuse of simulation / analysis content	35%	24%
Reuse of NC programming content	29%	23%

Source: Aberdeen*Group*, February 2007

Separating the Wheat from the Chaff: Determining Best in Class

While the majority of engineering organizations have formal initiatives to increase reuse of designs, analyses and NC toolpaths, 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 1).

Figure 1: Top Performers Hit Engineering Targets on 76% Average or Better



Source: AberdeenGroup, February 2007

This classification subsequently enabled differentiation between the "best practices" of the top performers and the practices of lower performing companies. 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 a 76% or better average.

"One of my biggest problems is that only a few people are trained in our CAD application and I need to get more people up and running on those software applications. The reseller we work with has helped immensely with training to get staff up to speed, they are my "go to" people that can solve any problems that come up."

-Marvin Straight, Design Engineering Manager, Anchor Industries

With the numbers quantifying a gap in performance, a lack of design reuse can be identified as a root cause of this difference. Companies that reuse designs shorten their design cycles impacting how often an organization can hit their design release date. As such, it should be no surprise that this is exactly where the largest gap exists between the best in class and laggard performers.

Design Reuse Top Challenges and Responses from Top Performers

While a majority of manufacturers are pursuing a number of reuse initiatives, why is there such a disparity of performance between them? Aberdeen research points to the fact that many organizations struggle to change existing designs into new ones (Table 2). Why the problem modifying designs? It points back to how the current generation of design tools fundamentally works.

Table 2: Top Four Challenges to Design Reuse

Challenges	
Model modification requires expert CAD knowledge	57%
Models are inflexible and fail after changes	48%
Users can find models to reuse	46%
Only original designer can change models successfully	40%

Source: AberdeenGroup, February 2007

Feature based CAD tools allow users to create a sequence of individual geometric features that collectively form a complete design. Very often, interdependencies are created within the sequence of features. This interdependency can be incredibly powerful in making broad sweeping changes, yet it can also be constraining. A change to a feature early in the sequence can force a later feature create invalid geometry.

The challenges manufacturing organizations face as a result are that *model modification requires expert CAD knowledge* (57%), *models are inflexible and fail after changes* (48%) and *only original designer can change models successfully* (40%). These findings are a testament to the fact that feature based model can be a barrier to design reuse. But these are challenges that can be solved. In fact, the best in class take very specific actions to increase design reuse despite these problems (Table 3).

Table 3: Top Four Responses to Design Reuse Challenges of the Best in Class

Responses of the Best in Class	
Train users to increase CAD skills	71%
Design for wide range of modifications	64%
Centralize design data in library accessible structure	43%
Detail design information in model (PMI)	36%

Source: AberdeenGroup, February 2007

In fact, 71% of best in class companies to train users to develop advanced CAD skills for model modifications, with 36% also planning on detailing design information in models to enable designers other than the original to successfully change models, and limit the reliance on 2D CAD data. While trying to meet these challenges head on, some companies have been leaning on the expertise of 3rd parties to help with training, freeing up resources to be able to focus on design. Top performing companies are also creating designs that are flexible, able to incorporate a wide range of modifications, with 64% using this as a means to further facilitate design reuse.

Chapter Two:
Competitive Maturity Assessment

Key Takeaways

- Top performers are more likely to dedicate resources to simplifying and verifying designs for reuse (21% vs. 0% for laggards, and 18% vs. 8%, respectively).
- A majority of these top performers integrate the preparation (71%) and verification (75%) of designs for reuse into the design phase.
- Best in class are more likely to utilize geometric search (3X) to find designs for reuse and automated checking technologies (2X) to verify designs are ready for reuse.
- Top performers are twice as likely to track the amount of time required to change existing designs into new ones (54% vs. 29%)

Given the maturity of design reuse strategies reported by all 100% of the survey respondents in the study, Aberdeen set a number of criteria for determining how top performers were actually engaged in design reuse from a process, organization, knowledge, technology, and performance management standpoint perspective (Table 4).

Table 4: Characteristics across the Competitive Framework

		Best in class	Industry average	Laggard
Process	Integrate **preparation** and **verification** of designs for reuse into the design phase	71% 75%	57% 54%	63% 43%
Organization	Apply dedicated resources to **simplify** and **verify** designs for reuse	21% 18%	17% 14%	0% 8%
Technology	Use **geometric search** technology	14%	10%	4%
	Use **checking technology** for **parameter consistency** and **model flexibility**	31% 30%	17% 15%	17% 15%
	Use **direct modeling** technology in the **Aerospace & Defense** and **Industrial Equipment** industry	75% 63%	43% 38%	-
Performance Measurement	Measure time to change an **existing design into a new design**	54%	30%	29%

Source: AberdeenGroup, February 2007

Special Efforts to Increase Design Reuse: Does it Pay Off?

When it comes to design reuse, manufacturers are faced with a fundamental choice. They can dedicate resources and force end users to prepare designs for reuse. In the end, they face two fundamental questions.

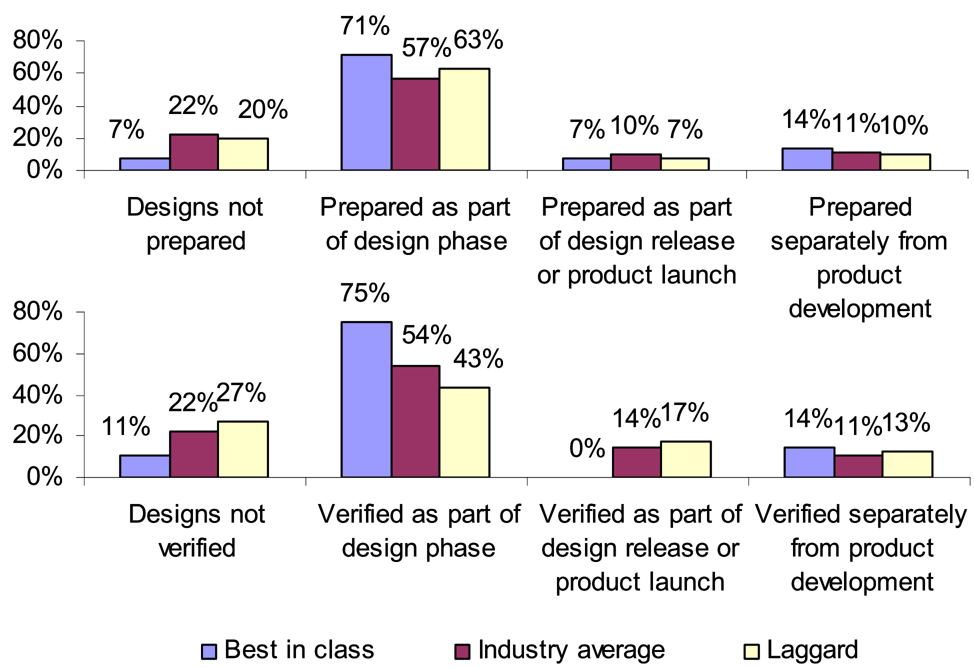
- Will the special effort make a difference?
- Will the special effort distract my designers and engineers from completing the design by my design release date?

Overall, Aberdeen research finds that the answer a special effort does make a difference. However only pursuing the special effort in an integrated fashion allows manufacturers to avoid potential distractions.

Process Efforts that are Integrated into Design is Key

While manufacturing organizations have a variety of choices of when to prepare and verify designs for reuse, the top performers clearly take an approach that is integrated (Figure 2).

Figure 2: Top Performers Integrate Design Reuse Preparation into Design



Source: AberdeenGroup, February 2007

As Figure 2 demonstrates, top performing companies are more apt to integrate the preparation and verification that designs are ready for reuse in the design phase (71% and 75%) as opposed to other means.

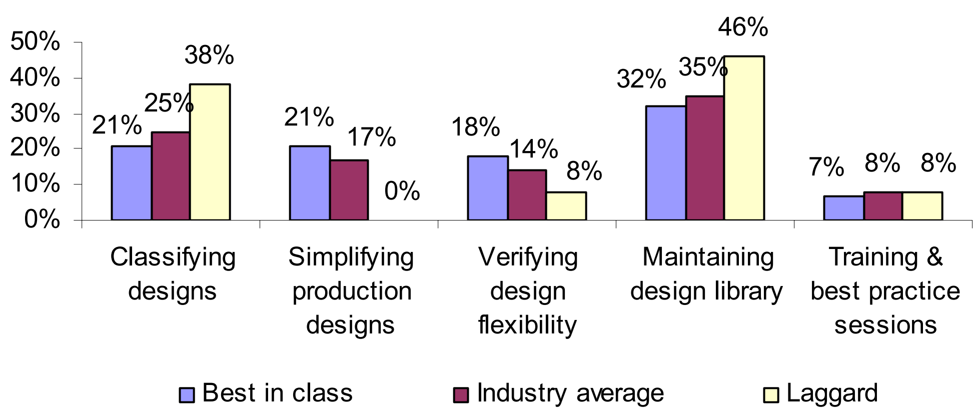
By being pre-emptive and preparing front, best in class companies can more readily make changes in the design phase and truly make their designs more flexible. Additionally, verifying that designs are in fact flexible is key. What's most important however is executing these activities at the right time in the product development process. In fact, the best in class performers execute the verification that designs are ready for reuse as part of the design phase and specifically not as part of the design release or product launch process.

> "Our focus is procedural; we try to design the part dimensionally speaking early in the design phase to be as robust as possible. This allows us to make minor changes to a big family of parts without having to go back to the drawing board."
>
> -John Burrill, Drafter Designer, Transpo Electronics

Who Prepares and Verifies Designs? Dedication Reaps Rewards

In addition to deciding when in the product development process to prepare and verify designs, manufacturers must decide who will perform these activities. All in all, some approaches are more common amongst leaders and others by laggards (Figure 3).

Figure 3: Top Performers Dedicate Resources to Design Reuse



Source: AberdeenGroup, February 2007

As Figure 3 demonstrates, better-performing companies are dedicating resources to simplify production designs (21% vs. 0%) and verifying design flexibility (18% vs. 8%) at a higher than laggard companies. By following up with *verifying design flexibility* the best in class are more likely to avoid the pitfall voiced by 48% of companies overall in Chapter 1 of *inflexible models that fail after changes.*

Laggard companies meanwhile have statistically placed more emphasis on the *maintenance of design libraries* (46%) and *classifying designs* (38%). While it is beneficial to have these practices in place, it is clearly not a differentiator of best in class behavior, and in fact signifies that they are dedicating resources to the wrong tactics overall.

Enabling Design Reuse: Applying Technology to Make a Difference

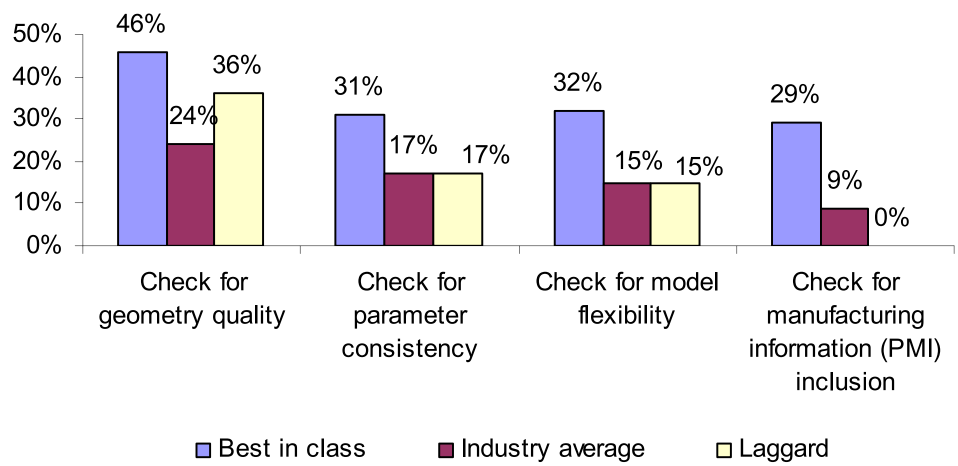
With the top performers integrating dedicated resources to the preparation and verification of design models in the design phase of the product development process, can technology offer further improvements?

Automating Design Verification: Leveraging Checking Technology

Before a design can be reused, it must conform to a number of characteristics that are standard for the manufacturer. Geometry quality is critical important if NC toolpaths will be generated from the model. Parameter consistency and compliance to standards is important to the success of end user searches for the part. Model flexibility is critical to modification of an existing design into a new design. It's also important to include manufacturing information as more and more companies turn to drawingless models according to the ASME Y14.41 standard.

Checking all of these characteristics manually is labor-intensive and time-consuming. To address this potential time-sink, checker technologies automate the verification of these characteristics. Because of the benefits in time savings these technologies offer, it is no surprise that the top performers are more likely to leverage them (Figure 4).

Figure 4: Top Performers Use a Variety of Checkers for Verification Automation



Source: AberdeenGroup, February 2007

In fact, top performers are twice as likely to perform checks for *parameter consistency* (31% vs. 17%) and *model flexibility* (32% vs. 15%). Furthermore, a third of the top performers check for *manufacturing information inclusion* compared to none of the laggards. How do these technologies help? There are a number of bottom line differences associated with each.

- As 48% of all companies are taxed with *inflexible models that fail after changes*, the top performers are using these technologies to make sure that their design models are in fact flexible and do not fail after changes.

- Their use of parameter consistency checks allows them to make sure their designs match company naming standards and thus be easier to find.
- Lastly, the best in class are pursuing the inclusion of PMI (product manufacturing information) in models (29%) for a reduced reliance on drawings for manufacturing. In this scenario models are actually easier to reuse because engineers don't have to manage the relationship between the drawing and model, all the information needed to manufacture the design is right in the model itself. Companies that use this drawingless scenario are also less prone to mistakes that can be made from the interpretation of traditional 2D design data.

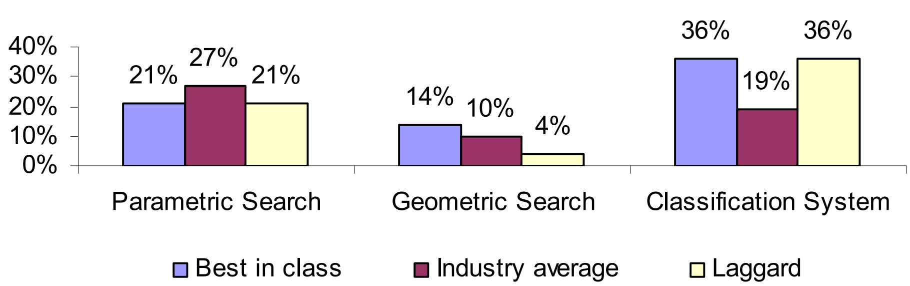
"Our company is very interested in exploring the geometric search functionality. This shape indexing software will help us run a search against our database to come up with pre-existing parts that can be reused."

-Manager of Engineering Process Development, Automotive Manufacturer

Finding Designs to Reuse: Leveraging Search Technology

While design reuse has its unique problems, it also has this similarity with the problems of part reuse: if you can't find the design model, you can't use without changes or reuse it to make a new design. And while all manufacturers are using different long standing technologies to address this problem, the best in class are investing in an emerging technology called geometric search that makes a difference.

Figure 5: Top Performers Leverage Nascent Geometric Search Technology



Source: AberdeenGroup, February 2007

In fact, the best in class are three times as likely to use geometry search compared to laggards. This is in part due to the minimal amount of effort required. A design that can be reused is found not through some complicated combination of parametric words or through a hierarchical classification system, but based on the geometry of the design. By reusing the geometry of previous models, the fundamental cornerstone of previous designs can be repurposed.

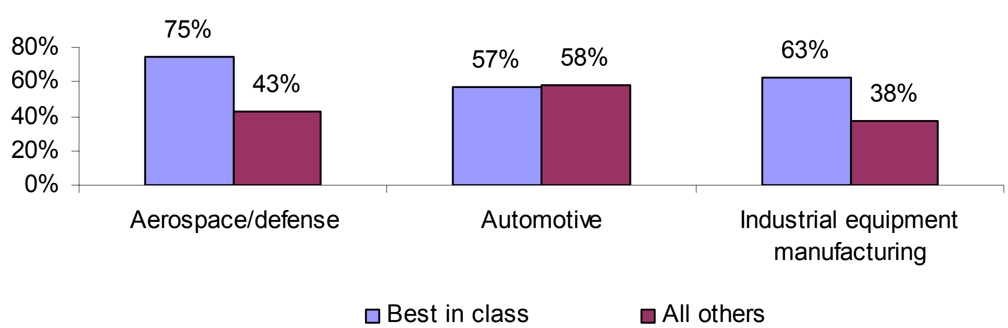
Once You Find it, How Can You Change it? Leveraging Direct Modeling

With the best in class leveraging new technology to find designs, what is the best way to modify a design once it is found?

> "We are using direct modeling because we get many STEP files and during development and concept changes and we want to control these files. The other way we are trying to use direct modeling is to capture ECO changes, so the original revision is captured in the first features and then direct modeling is used to capture every change after that."
>
> -Aerospace Manufacturer

The problem with traditional CAD technologies and design reuse is that a single design is composed of many features which have interdependencies. While these interdependencies are powerful during the work-in-process phase of design, it becomes constraining for design reuse. As a result, companies overall are faced with: *designs often being inflexible and unable to adapt to changes* (48%) made by users that are either a) not e*xperts with the CAD system,* with 57% of companies finding this to be the reality, or b) from users that *did not originally create the design*, voiced by 40% of companies overall (Table 2). As in many other cases, a new technology has emerged that changes this paradigm. And the top performers in certain industries are leveraging it (Figure 6).

Figure 6: Top Performers in Some Industries Leverage Direct Modeling



.Source: AberdeenGroup, February 2007

Through the use of direct modeling technology, the model allows for the modification of geometry without the basis of features, removing the complexities faced by companies above by allowing flexible designs that can be modified by any engineer, even new engineers with more limited skills.

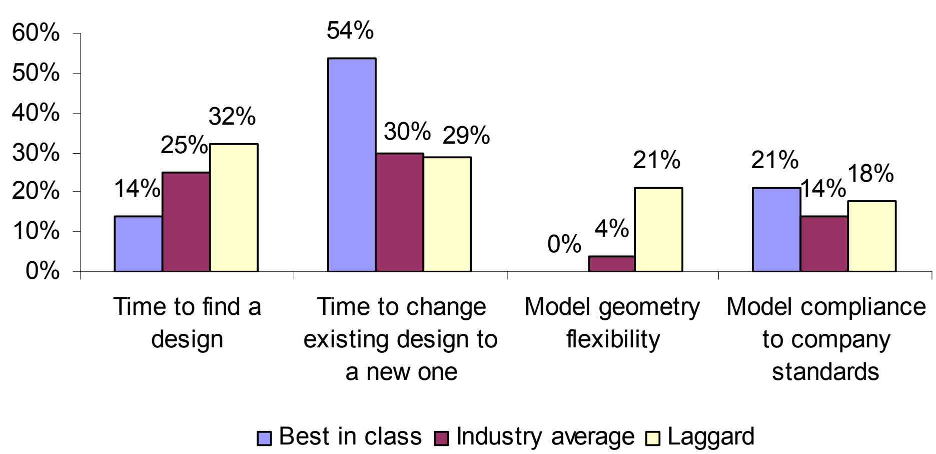
This technology has seen varying rates of adoption by different industries. Figure 6 looks at the relative adoption among three discrete industries: aerospace and defense, automotive, and industrial equipment manufacturers by the best in class users in those industries and all other companies. Overall, aerospace and defense companies are more likely than all other companies to be using direct modeling. In speaking with several aerospace and defense companies in follow-up interviews, a large reason for the usage of direct modeling was due to the ease of collaboration with a number of vendors. The engineer then went on to describe that direct modeling was particularly useful for those in FEA, so that the models could be updated without having to worry about dependencies. Changes can be made easily to optimize the model for analysis.

Staying Focused by Tracking Time to New Design

> "For our industry, when exploring concept designs, we have between two or three different vendors changing models and not always creating histories. As the design authority, we have no reason to create the history over again when we need a change or the vendor requests a change."
>
> ~ Aerospace Manufacturer

As a result of their use of technology including checks to ensure models remain flexible and including verification up front in the design phase, top performers are focused on the overall goal: time to get to the new design. Specifically 54% of best in class companies are using this as a metric to monitor the success or failure of their design reuse strategy. Because 48% of these best in class companies are also better equipped with *centralized design data in libraries,* these top performers are actively mining pre-existing designs to reuse for current designs. In contrast, 32% of laggard companies and 25% of average define success by the *time it takes to find a design*. Since these companies have yet to centralize design data into a library-structured repository, it will be a more time-consuming process to find designs that can be repurposed.

Figure 7: Metrics to Assess the Success of Design Reuse



Source: AberdeenGroup, February 2007

Chapter Three:
Recommendations for Action

Key Takeaways

- Dedicate resources to prepare and verify designs for reuse in the design phase.
- Implement geometric search technology to find designs.
- Deploy automated checking to verification that designs are ready for reuse.
- Use direct modeling technologies to modify existing designs into new ones.
- Leverage the expertise of 3rd parties to improve design reuse.

Design reuse is not just a ideal for the best in class, it is an actual strategy backed by the integration of design reuse preparation and verification in the design phase, and fully leveraging current technology to ensure that designs maintain flexibility after changes. Regardless of whether your company falls into the "best in class" "industry average" or "laggard" criteria, the following recommendations rooted in best practices from the companies surveyed can help companies in their design reuse strategies.

Laggard Steps to Success

1. *Set priorities on CAD training - leverage 3rd party expertise*

   Several companies in follow-up interviews explained how they found success through leveraging their software provider or reseller for support on training (see Chapter 1). Using external resources for training will free up resource-constrained companies to focus on the design process rather than training new or relatively inexperienced users.

2. *Design for a wide range of modifications*

   Follow the lead of 64% of top performing companies that are creating designs that are flexible, able to incorporate *a wide range of modifications* to further facilitate design reuse.

3. *Apply resources to the preparation and verification of designs for reuse*

   Instead of focusing resources on the *maintenance of design libraries* and *classifying designs,* laggard companies should devote engineers to *simplifying production designs* and *verifying design flexibility.*

Industry Norm Steps to Success

1. *Integrate preparation and verification of designs for reuse in the design phase*

   Execute the verification that designs are ready for reuse in the most critical phase-early on in the design phase as opposed to design release or product launch processes.

2. *Enable checks for geometry/quality, parameter consistency*

Automate checking tools to ensure that designs are flexible and will not fail after changes. Place priority especially on evaluating geometry search technology. By reusing the geometry of previous models, the fundamental cornerstone of previous designs can be repurposed.

3. *Deploy geometric search technology to find designs for reuse*

   As a quick means to enable users to find designs quickly and easily, deploy geometric search capabilities. It's a technology with a lower threshold for deployment compared with classification systems and design libraries and a lower effort for end users to use.

Best in Class Next Steps

1. *Investigate direct modeling technology*

   While already a practice in place of several discrete industries, best in class companies can benefit from this technology to allow for the modification of geometry without the basis of features, enabling flexible designs that can be modified by any engineer.

2. *Maintain flexibility in designs through the use of PMI*

   As drawingless models become more prevalent, so too will the importance of maintaining model flexibility. By including PMI (product manufacturing information) to enable designers successfully change models, and limit the reliance on 2D CAD data.

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Appendix A:
Research Methodology

During January 2007, Aberdeen Group and *Cadalyst*, *CADwire.net,* and *Desktop Engineering,* examined the experiences and intentions of more than 150 enterprises regarding their design reuse methodologies.

Responding enterprises included the following:

- ***Job title/function**:* The research sample included respondents with the following job titles: engineering and design staff (37%), engineering and design managers (27%), senior management (CEO, COO, CFO) (9%), engineering and design directors (8%).
- ***Industry**:* The research sample included respondents predominantly from manufacturing industries. Industrial equipment manufacturers represented 22% of the sample. Automotive manufacturers accounted for 18% of respondents, closely followed by aerospace and defense at 18%. Construction/architecture/engineering represent 8% of the sample, closely followed by medical devices at 5%. 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 83% of respondents. Remaining respondents were from Europe at 11% and the Asia-Pacific/South Central region at 5%.
- ***Company size**:* About 55% of respondents were from small businesses (annual revenues of $50 million or less), 29% were from midsize enterprises (annual revenues between $50 million and $1 billion), and 16% 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 Design Reuse Benchmark Report*. Their sponsorship has made it possible for Aberdeen Group, *Cadalyst*, *CADwire.net* and *Desktop Engineering* to make these findings available to readers at no charge.

Table 5: 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, February 2007

Table 6: 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, February 2007

Table 7: Competitive Framework

Competitive Framework Key
The Aberdeen Competitive Framework defines enterprises as falling into one of the three following levels of practices and performance: *Laggards (30%)* —practices that are significantly behind the average of the industry, and result in below average performance *Industry norm (50%)* — practices that represent the average or norm, and result in average industry performance. *Best in class (20%)* — 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, February 2007

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)
- *Next Generation Product Documentation Benchmark: Getting Past the 'Throw it Over the Wall Approach'*

  (December 2006)
- *The Multi-CAD Design Chain Benchmark Report*

  (December 2006)

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

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