

# **Nimble Product Design: CAD/CAM/CAE for the Small to Mid-Sized Enterprise**

June 2007



## Executive Summary

Despite demands for more complex products at lower costs and in less time, best in class Small to Mid-sized Enterprises (SMEs) hit their product development goals 80% of the time. This report serves as a guide for SMEs that seek to achieve similar business success.

### Best in Class Performance

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Five key performance criteria were used to identify the Best in Class small to mid-sized companies. Mean performance for the Best in Class in the following three business areas was:

- Achieve target product cost: 88% of the time
- Hit or beat development budgets: 80% of the time.
- Reach goals for product revenue: 91% of the time

### Competitive Maturity Assessment

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Survey results show that firms enjoying Best in Class performance shared several common characteristics:

- More likely to execute formalized design processes (50% vs. 23%) with the support of data management lifecycle state (31% vs. 13%) and workflow (28% vs. 10%) technology.
- More likely to provide combined CAD and CAE tools to engineers (25% vs. 10%) and combined CAD and CAM applications to machinists (19% vs. 13%).
- More likely to capture and reuse design (67% vs. 31%), simulation (25% vs. 15%) and manufacturing (17% vs. 5%) knowledge in CAD, CAM and CAE templates and wizards.

### Required Actions

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In addition to recommendations listed in Chapter 3, to achieve higher performance SMEs must:

- Formalize design processes with support from lifecycle state and workflow technology.
- Provide design tools with combined CAD and CAE capabilities to your engineers.
- Capture and reuse knowledge through emerging technologies such as CAD, CAM and CAE templates or wizards.

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#### Industrial Equipment Manufacturer

It is always a cost battle. The customer doesn't want to spend and our management is looking for cost reductions. With the price of steel going up and fuel surcharges on deliveries, it is hard to find ways to cut cost and keep quality where everyone wants it.

**-Engineer**

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## Chapter One: Benchmarking the Best in Class

### Caught Between a Rock and a Hard Place

“We want more capable products at lower price points in less time,” summarizes the demands of today’s customer on the products of discrete manufacturing SMEs (Table I).

**Table I: Top 5 Pressures on Small to Mid-Sized Manufacturers**

Pressures	Response
Cost pressures from customers	47%
Demand for shorter product development cycles	41%
Increasing complexity of products	31%
Increased competition	22%
Globalization of target markets	14%

Source: Aberdeen Group, June 2007

This combination of conflicting business pressures make survival so hard for companies running on thinner margins. How can you develop more capable and more complex products in less time? How can you turn a profit if you increase engineering or manufacturing bandwidth and thereby your development costs? These difficult questions constitute the stacked deck facing many engineering organizations when bringing new products to market. In the face of such great odds, some companies are not only surviving, but exceeding.

### Maturity Class Framework

Given the challenges of new product development, small to mid-sized manufacturers are pursuing a wide variety of strategies and tactics to make a difference. However, strategies and tactics are only as good as the results they deliver. To clearly understand which ones impact business performance, Aberdeen categorized survey respondents by measuring five key performance indicators (KPIs):

- Percentage of projects hitting product launch date
- Percentage of projects achieving or beating development budgets
- Percentage of projects achieving targets for product costs
- Percentage of projects achieving targets for product revenue
- Percentage of projects meeting product quality expectations.

Figure I summarizes the mean performance of the best in class, industry average and laggards across these five KPIs.

#### Maturity Framework Key

The Aberdeen Maturity Framework defines enterprises as falling into one of the three following levels of practices and performance:

*Best in class (20%)* — practices that are the best currently being employed and significantly superior to the industry norm

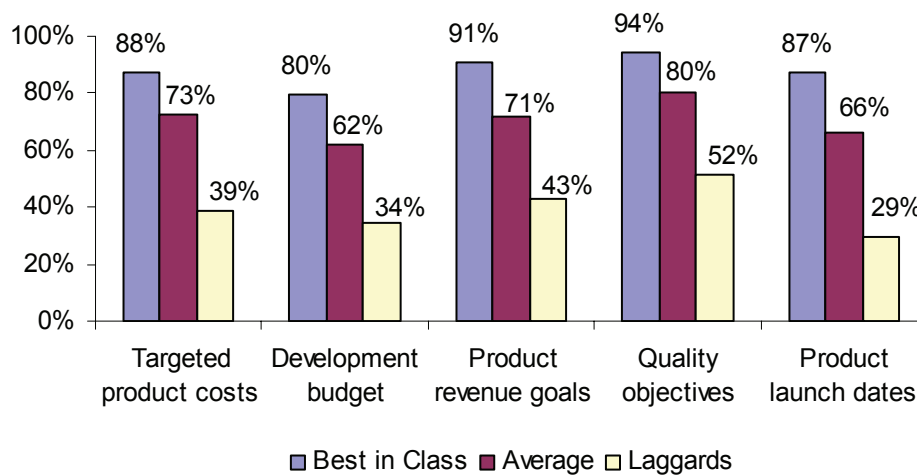
*Industry norm (50%)* — practices that represent the average or norm

*Laggards (30%)* — practices that are significantly behind the average of the industry

#### Design Service Provider

Our design and development process is actually what we market as a tried and true process that will produce deliverables in a quick, cost effective time frame. We also teach different innovation processes to help our clients come up with new products as well as improve their present product line. Because of our process, we can give our clients a number of different options and come to a quick decision on which path to pursue in a very timely fashion.

**Figure 1: Best in Class Hit Targets on an 80% or Better Average**



**High Tech Manufacturer**

We have two major distribution channels, one for components used by OEMs, and one direct to end user. Price pressure in the OEM channel is severe; while the pool of competitors is small, all of them are fighting over share with an equally small number of customers. On the direct channel, customer demands for new functionality are short fused, and R&D money is scarce; both factors drive demand for shorter product development cycles.

Source: Aberdeen Group, June 2007

Best in class companies are twice as likely as laggards to hit their *targeted product costs*, *development budgets* and *product revenue goals*. Moreover, they are three times as likely as laggards to get to market on time by hitting their *product launch dates*.

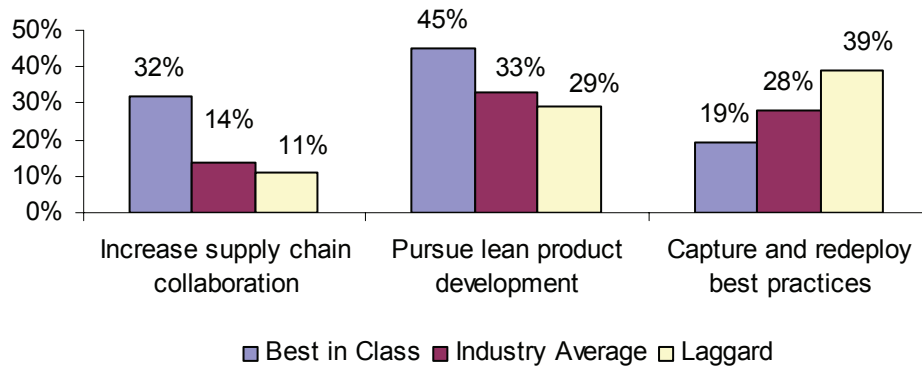
**Strategies of Best in Class Performers**

Choosing among a wide variety of options, the best in class are adopting new strategies while the laggards are chasing strategies that have already been proven by the best in class (Figure 2).

- **Increase supply chain collaboration** – The best in class are almost three times as likely to focus on increasing the ability to collaborate within the supply chain. More interestingly, 60% of SME respondents to this survey are Original Equipment Manufacturers (OEMs) whose objective undertaking this strategy is to increase the efficiency of the supply chain *below* them as opposed to *above* them.
- **Pursue lean product development principles** – Aberdeen research from [The PLM for Small to Medium-Size Manufacturers Benchmark Report](#) shows that while SME products have the same complexity as large manufacturers, they simply don't have the infrastructure to support product development. Employing lean product development principles allows the product development stakeholders to eliminate wasteful activities, activities they can ill afford to support. More details on how to implement this strategy can be found in the recently published [Lean Product Development Benchmark Report](#).
- **Capture and redeploy best practices** – SMEs are capturing the knowledge and best practices of engineers and machinists to increase efficiency as a means to mitigate the risks of an aging workforce in the same manner as larger manufactures. Among SMEs however, laggards

are twice as likely to be engaged in this activity currently. In contrast, the best in class have pursued this strategy already and have it in place.

**Figure 2: Top Strategies across Competitive Framework**



Source: Aberdeen Group, June 2007

**Best in Class PACE Model**

Any strategy can be pursued using a number of tactics, each with a different effect on the key performance metrics cited above. By understanding the practices of the best in class small to mid-sized enterprises, one can adopt tactics that have previously proven to impact business performance successfully. Successful application of these tactics requires a combination of organizational capabilities, processes and enabling technologies:

**Table 2: Best-in-Class PACE Framework**

Pressures	Actions	Capabilities	Enablers
<ul style="list-style-type: none"> <li>• Cost pressure from customers and demand for shorter product development lifecycles</li> </ul>	<ul style="list-style-type: none"> <li>• Increase supply chain collaboration</li> <li>• Pursue lean product development</li> </ul>	<ul style="list-style-type: none"> <li>• Design process is formalized and consistently followed</li> <li>• Analysis of product’s performance required prior to prototyping or release to manufacturing</li> <li>• Feedback on the manufacturability of the product is a formal step in the product development process</li> <li>• Release of designs to manufacturing is formalized</li> <li>• Design expertise of designers / engineers is captured and reused</li> <li>• Best practices of expert machine operators are</li> </ul>	<ul style="list-style-type: none"> <li>• Setup analyses and review results directly within CAD</li> <li>• CAM application embedded within CAD application</li> <li>• CAD uses wizards or templates for the creation of design</li> <li>• Analyses setup through wizards or templates</li> <li>• NC toolpaths created through CAM wizards or templates</li> <li>• CAE files stored in PDM</li> <li>• CAM files stored in PDM</li> </ul>

		<p>captured electronically</p> <ul style="list-style-type: none"> <li>• Employees outside engineering use CAD applications for markup, feedback and changes</li> </ul>	<ul style="list-style-type: none"> <li>• Use PDM lifecycle states</li> <li>• Use PDM workflows</li> </ul>
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Source: Aberdeen Group, June 2007

### Aberdeen Insights – Part 1

Companies are faced with an age old decision on how to develop products and bring them to market at low prices. It is the same story for small to mid-sized manufacturers as for larger ones: Make more complex products that have more capabilities on a shortened schedule, and make it cheap.

This “same old game” has dire implications for SMEs. The dramatic differences in the capabilities of best in class and laggard performers to hit budgetary constraints, revenue goals and product cost targets directly influence how these companies will fare on the top and bottom lines. With larger companies, missing revenue or budgetary goals translates into missed quarterly performance projections and ultimately impact shareholder value. Larger manufacturers often have a better chance to recover due to their larger cash reserves and ability to take on larger debt. For small to mid-sized manufacturers that operate on thin profits, however, missing these same fiscal objectives can result in shutting down the company. These performance differences directly translate into the ability to stay in business.

## Chapter Two: Benchmarking Requirements for Success

As noted earlier, the aggregated performance of surveyed companies determines whether they ranked as best in class, industry average or laggard. In addition to common performance levels, each class shares process, organizational, knowledge management and technology characteristics (Table 2).

**Table 3: Competitive Framework**

Characteristics	Laggard	Industry average	Best in class
<b>Design Process:</b> Process is formalized and consistently followed	23%	52%	50%
<b>Product Performance Analysis:</b> Required prior to prototyping or release to manufacturing	23%	43%	50%
<b>Product Manufacturability Assessment:</b> Formal step in your product development process	18%	49%	78%
<b>Design Release:</b> Release of designs to manufacturing formalized	33%	58%	67%
<b>Organizational Design Feedback:</b> Employees outside engineering use CAD applications for markup and feedback	10%	32%	28%
<b>Shop Floor Feedback:</b> Shop floor machine operators provide feedback and suggestions on products manufacturability	28%	57%	67%
<b>Design Expertise:</b> Designers / engineering knowledge is captured and reused	31%	56%	67%
<b>Manufacturing Expertise:</b> Expert machinist's knowledge captured electronically	5%	8%	17%
<b>Integration:</b> Setup analyses and review results directly within CAD	10%	21%	25%
<b>Integration:</b> CAM application embedded within CAD application	13%	4%	19%
<b>Automation:</b> CAD uses wizards or templates for the creation of design	21%	42%	39%
<b>Automation:</b> Analyses setup through wizards or templates	15%	16%	25%
<b>Automation:</b> NC toolpaths created through CAM wizards or templates	23%	12%	36%
<b>Manufacturability Feedback:</b> CAM tool captures product manufacturability suggestions	8%	5%	22%
<b>Lifecycle States:</b> Use PDM lifecycle states	13%	14%	31%
<b>Workflows:</b> Use PDM workflows	10%	13%	28%

Source: Aberdeen Group, June 2007

## Organizational Capabilities and Technology Enablers

These process, organizational and knowledge management characteristics and technology enablers come together to form a working solution that translates to competitive advantage.

### • Formalized Processes with Lifecycle State and Workflows

Given that past research from [The PLM for Small to Medium-Size Manufacturers Benchmark Report](#) shows that SMEs must cope with the same product development complexity with fewer resources, removing uncertainty and inefficiency from the product development process can offer benefit.

Research shows that the best in class are adopting exactly this sort of action. They are twice as likely as laggards to execute a formalized design process (50% vs. 23%) and at least twice as likely to have formalized activities to analyze the performance of the product, assess product manufacturability and to release the product to manufacturing.

From a technology perspective, the best in class are at least twice as likely as laggards to leverage Product Lifecycle Management capabilities such as Lifecycle States (31% vs. 13%) and Workflow (28% vs. 10%) to automate the processes and ensure that no steps are skipped.

### • Combining CAE with the CAD for the Engineer

Despite the fact that SMEs have fewer resources, engineers are still held responsible for product performance. Without the support of an analysis group, SME engineers must perform simulation work on their own, even in situations where these employees don't have the time to learn advance and complex simulation and analysis applications.

To compensate, the best in class are supplying simulation and analysis capabilities through a familiar environment that engineers and designers use to model a product: the CAD application. Overall best in class performers are two and a half times more likely than laggards to place CAD enabled simulation in the hands of the engineer (25% vs. 10%). Further research on moving simulation capabilities into the design phase can be found in the [Simulation-driven Design Benchmark Report](#).

### • Combining CAD and CAM Capabilities for the Machinist

Where the engineer must take on many responsibilities, including simulation and analysis, the same is expected of the shop floor machinists. In fact, the best in class are more likely than laggards to have the machinist assess product manufacturability (67% vs. 28%) in addition to their traditional responsibilities such as creating NC toolpaths. From an emerging technology perspective, the best in class SMEs are providing them with combined CAD and CAM applications (19% vs. 13%) that allow them to capture manufacturability feedback and suggestions (22% vs. 8%).

### Design Service Provider

Most of our work includes DFM and DFA early on as well as vendor involvement. Occasionally we will also do DFMEA's and tolerance analysis as well.

We do the analyses, FEA and CFD, during our design cycle as needed depending on the complexity of the design.

### Automotive Supplier

Formalized design process helps if there is discipline to stick to them. We have very good formalized design process. But mostly we are at mercy of customer's whims and scope changes. The discipline to follow formalized process is the key to improve product development.

Short to very short development cycles and the push to release production tooling before analysis is complete destroys the discipline required to execute to processes.

- **Capture and Reuse Expertise through Wizards and Templates**

In a fashion similar to their larger peers, SMEs are explicitly attempting to capture and reuse design knowledge and, to a lesser extent, machining knowledge. In fact, those best in class are twice as likely as laggards to capture and reuse design knowledge (67% vs. 31%). They are also three times as likely to capture manufacturing and machining knowledge (17% vs. 5%).

Where some SMEs are capturing that knowledge in text, others are using existing capabilities of CAD, CAM and CAE technologies. Further, best in class are more likely than laggards to capture design knowledge in templates (39% vs. 21%), capture simulation knowledge in templates (25% vs. 15%) and capture machining knowledge in templates (36% vs. 23%).

**Automotive Supplier**

We have templates and they save time. However, they can not address all cases. Unique cases appear from time to time, making templates less effective. Also, requirements and regulations change so rapidly that template developers with limited resources cannot keep up.

**Aberdeen Insights – Part 2**

Formalized processes are typically associated with larger enterprises trying to squeeze out inefficiencies. Many assume that SMEs do not formalize their processes because they lack the time to document processes or to enforce compliance to the process. Despite these obstacles, the best in class have realized the removal of inefficiency is *more* important for SMEs because they lack the proper product development resources.

From an engineering and shop floor machinist perspective, the few resources within SMEs must take on more responsibilities. As a result, engineers at best in class SMEs are pursuing combined CAD and CAE environments enabling them to analyze and improve product performance virtually instead of physically. Additionally, machinists at best in class SMEs are using combined CAD and CAM environments to more easily capture assessments of product manufacturability and as generate NC toolpaths.

Much like their larger peers, SMEs are realizing that their employee knowledge-base is both valuable and vulnerable to retirement and job changes. As a result, best in class SMEs are consciously capturing design, simulation and machining knowledge and placing it in templates and wizards within CAD, CAE and CAM applications.

## Chapter Three: Required Actions

Although SMEs are developing products with higher complexity under increasing pressures, many are uncovering new methods that yield greater efficiencies and savings. The best in class performers are employing specific tactics for competitive gains. Whether a small to mid-sized manufacturer is trying to maneuver its performance from “Laggard” to “Industry Average” or “Industry Average” to “Best in Class” categories, the following actions will help spur the necessary performance improvements:

### **1. Formalize design processes with specific activities**

Best in class SMEs execute formalized design processes. They require analyses and assessments of product manufacturability in design. They also follow formalized design release procedures.

### **2. Provide design tools with combined CAD and CAE capabilities to engineers**

Best in class SMEs provide combined CAD and CAE design tools to engineers so they won't be burdened with learning new applications in addition to their existing wide range of responsibilities.

### **3. Provide applications with combined CAD and CAM capabilities to shop floor machinists**

Best in class SMEs provide combined CAD and CAM applications to shop floor machinists so they can provide manufacturability feedback and suggestions in addition to generating NC toolpaths.

### **4. Capture and reuse knowledge in the form of CAD, CAM and CAE template**

Best in class SMEs are capturing design, simulation and machining know-how in the form of CAD, CAM and CAE templates. They are then using those templates to automate common tasks as well as proliferate best practices.

### **5. Automate and enforce design processes with lifecycle states and workflows**

Best in class SMEs use a combination of lifecycle states and workflows to automate as well as enforce the formalized activities and processes.

#### **Mining/Oil/Gas Company**

We are sharing solid modeling files with our major customer. This creates numerous opportunities to request customer controlled changes and enhancements. We can discover discrepancies early in the process and work as an extension of our customers engineering group. The disadvantage is that we are working around the bureaucracy of our customers purchasing and quality groups, creating configuration control issues.

**-Engineering Manager**

### Aberdeen Insights – Part 3

To improve business performance, best in class SMEs have adopted certain types of processes, organizational traits, knowledge management characteristics and technology. When considering how to adopt some of these changes to make a difference in your company's performance, you may be asking the daunting question, "where do I start?"

In general, changing processes makes the best starting point as it inherently determines who must complete what activity in a specific sequence. Each of the steps in the sequence should have an objective or goal to be accomplished. Utilizing a formalized process with clear objectives defined for each step, you can then determine which, if any, of the following technologies might be required.

When determining the sequence of technologies to implement, pursuing technologies that author product information, such as CAD, CAE and CAM applications, is by necessity the place to start. Without data to manage or automate, some of the follow on technologies such as lifecycle states and workflow cannot be applied realistically.

As you move forward, keep the overall purpose of your changes in mind. Ultimately, the objective is to bring about a change in business level performance.

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## Appendix A: Research Methodology

During June of 2007, Aberdeen Group and IEN (Industrial Equipment News) examined the design and implementation strategies of more than 290 enterprises. Aberdeen supplemented this online survey effort with telephone interviews with select survey respondents, gathering additional information on strategies, experiences, and results. Responding enterprises included the following:

- **Job title/function:** The research sample included respondents with the following job titles: 34% Manager, and 11% in Senior Management (President, CEO or COO). In addition, 18% were Staff, with the remaining sample falling into VP, Director or Consultants.
- **Industry:** The research sample included 39% of respondents from Industrial Equipment Manufacturing, with another 28% from Aerospace/Defense companies. Another 20% accounted for Metals and Metals Products companies, with the remaining respondents in Construction/Architecture/Engineering, High Tech organizations, etc.
- **Geography:** The majority of respondents (83%) were from North America. Remaining respondents were from the Asia-Pacific region (8%), and Europe (7%).
- **Company size:** A full 52% of respondents were from small businesses (annual revenues of \$50 million or less). Another 33% were from midsize enterprises (annual revenues between \$50 million and \$1 billion); 15% 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 Nimble Product Design: CAD/CAM/CAE for the Small to Mid-Sized Enterprise Benchmark Report. Their sponsorship has made it possible for Aberdeen Group to make these findings available to readers at no charge.

**Table 4: PACE Framework**

<b>PACE Key</b>
<p>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:</p> <p><i>Pressures</i> — external forces that impact an organization’s market position, competitiveness, or business operations (e.g., economic, political and regulatory, technology, changing customer preferences, competitive)</p> <p><i>Actions</i> — 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)</p> <p><i>Capabilities</i> — the business process competencies required to execute corporate strategy (e.g., skilled people, brand, market positioning, viable products/services, ecosystem partners, financing)</p> <p><i>Enablers</i> — 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)</p>

Source: Aberdeen Group, June 2007

**Table 5: Competitive Framework**

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

Source: Aberdeen Group, June 2007

**Table 6: Relationship between PACE and Competitive Framework**

<b>PACE and Competitive Framework How They Interact</b>
<p>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.</p>

Source: Aberdeen Group, June 2007

## Appendix B: Related Aberdeen Research

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

- [Profitable Product Development for SME's Benchmark Report](#), March 2007
- [The Design Reuse Benchmark Report](#), March 2007
- [The Simulation-Driven Design Benchmark Report](#), October 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](http://www.Aberdeen.com).

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