Aberdeen Group

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The Digital Product Development Benchmark Report

Migrating to a paperless process

March 2007

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Executive Summary

The message from the executive suite is a hard one. Deliver more products of increasing complexity on smaller budgets. With little or no time to proactively control the oncoming wave of digitization of their product development process, most manufacturers are simply caught between a rock and a hard place. Yet some of these companies are not only mitigating this rising tide of electronic information in the product development process, they are leveraging it for competitive advantage. How is it possible? Interestingly enough, it's quite simple.

Key Business Value Findings

- Best in class manufacturers hit their revenue, cost, launch date, and quality targets for 91% or more of their products.
- By building one fewer prototype than all others, top performers gain between a 13 to 99 day time to market advantage and spend between $7,600 and $1,200,000 less in development costs depending on product complexity.
- By executing 5.4 fewer change orders than all others, top performers gain a 51 day time to market advantage and spend between $8,000 and $32,000 less in development costs depending on product complexity.
- Best in class performers have a 16% higher rate of design reuse than laggards.

Implications & Analysis

- Top performers are 19% to 22% more likely than laggards to digitally prototype a product's performance in all phases of product development.
- Top performers are 34% more likely to use digital communications between engineering and manufacturing instead of paper.
- Top performers are 35% more likely to assess a product's manufacturability prior to design kickoff.
- Top performers are 43% more likely to use electronic forms and twice as likely to use lifecycle states and workflows to notify product development stakeholders that information is ready to use.

Recommendations for Action

- Automate the creation of manufacturing documentation to reduce design times.
- Digitally prototype your product's performance to minimize physical prototypes.
- Deliver electronic manufacturing documentation to reduce production errors.
- Digitally prototype your product's manufacturability to reduce change orders.
- Electronically notify development stakeholders to avoid time delays.

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Chapter One:
Issue at Hand

Key Takeaways

- Manufacturers must develop more products of increasing complexity and quality despite decreasing product development budgets.
- In response to these business pressures, product development organizations are focusing on increasing engineering and overall product development efficiency.
- The top challenges to digitizing the product development process are accessibility to electronic information and acceptance of that information as the source of truth.
- In response to these challenges, manufacturers are turning towards technology solutions and formal process change.

Hardcopy drawings. They have been the lifeblood of product development for the past century. But the advent and proliferation of the computer into nearly all aspects of society has changed that mantra for manufacturers. Like it or not, almost all product information is being authored electronically. Despite this fact, accessibility, consumption, and the acceptance of digital product information as the source of truth have all been barriers to many manufacturers truly running a digital product development process. On the other hand, leading manufacturers are not only overcoming these challenges, but excelling at the top and bottom lines.

The Name of the Game is Efficiency

Overall, the message to manufacturers is a simple but very difficult one; develop more products of increasing complexity on smaller budgets. In reaction, engineering and manufacturing organizations are pursing strategies to increase efficiencies across the board (Table 1).

Table 1: Top Business Pressures and Strategies for Digital Development

Business Pressures		Strategies	
Demand for more products	37%	Increase engineering efficiency and throughput	54%
Decreased product development budgets	35%	Streamline entire product development process	51%
Requirements for higher complexity products	29%	Decrease manufacturing errors and costs	35%
Increased customer sensitivity to product quality	28%	Improve product quality and / or performance	28%
Increased competition	27%	Earlier verification of product with customers	15%

Source: Aberdeen*Group*, March 2007

Traditional pressures that manufacturers have been feeling for years are capturing mindshare. Volumes of new products, increasingly complex customer requirements and quality are all important in the face of increasing competition. Yet while none of those business pressures dominates, one thing is direly clear; many of them directly oppose the second highest one; *decreased product development budgets* (35%). The conflict can be summed up simply and concisely. How can you develop more products that are increasingly complex and of higher quality with smaller budgets?

The answer to that question is clear. Increase efficiency. In fact, manufacturers are primarily adopting strategies to *increase engineering efficiency and throughput* (54%) as well as *streamline entire product development process* (51%). Compared to these top two strategies, costs, product performance and verification are second priorities.

"Our industry, the manufacturing of financial equipment, is very focused on cost. For us to be profitable as well as competitive, we have to reduce costs on the manufacturing and get more efficient in engineering."

\- Scott Mayes, Comco

The Right Match: Solutions for Technology and Cultural Challenges

While manufacturing organizations are facing the reality that product information is increasingly authored in digital forms, there are serious challenges to digital product development approaches (Table 2).

Table 2: Top 5 Challenges and Responses to Digital Product Development

Challenges		Responses	
Accessibility to digital product information	53%	Adoption of new and enabling technologies	69%
Acceptance of digital documentation as source of truth	51%	Deployment of process changes	64%
Consuming detailed design digitally instead of on paper	28%	Formalize an accountable role to implement change	26%
Authoring detailed design digitally instead of on paper	24%	Mentor users on new processes	22%
Consuming concept designs digitally instead of on paper	16%	Formalized training programs	16%

Source: AberdeenGroup, March 2007

Most notably, engineering and manufacturing organizations primarily face challenges in the form of *accessibility to digital product information* (53%) and *acceptance of digital documentation as source of truth* (51%). Interestingly enough, these two challenges are very different in nature. The first issue is a technology problem of how to allow the right product development stakeholders to get to the right product information at the right time. The second is a cultural issue in convincing product development stakeholders that the master record for product information resides in electronic form and not in paper form.

On a positive note, these organizations seem to be responding with the right solution in mind. They predominantly plan for the *adoption of new and enabling technologies* (69%) and *deployment of process changes* (64%). With these two responses, these companies are attempting to directly address the technology and cultural challenges of adopting a digital product development process. Data management solutions or other solutions with data management capabilities can certainly expose the right product information to the right product development stakeholders at the right time. Also, process change is a common mechanism to bring about formal cultural change and drive it home in the minds of product development stakeholders.

> "We have been struggling with creating the digital media as well as delivering it to the shop floor. We are trying to move beyond 2D drawing and deliver intelligence via 3D model to the floor. To do this we are looking at implementing a PLM system and implementing viewers that will allow the shop floor to query the PLM system so they can have dimensions straight off of the CAD data."
>
> -Paul Wilson, CAE Engineer, ADC

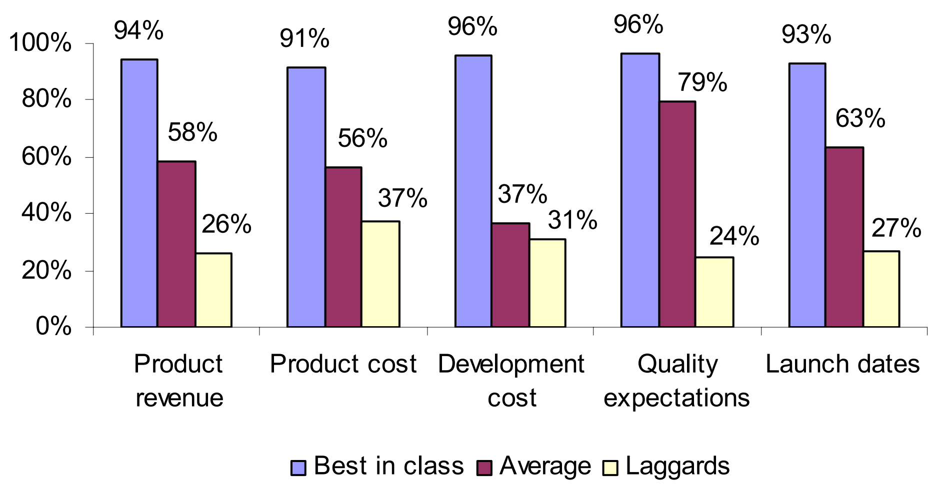
Chapter Two: Key Business Value Findings

Key Takeaways

- Best in class manufacturers their hit revenue, cost, launch date, and quality targets for 91% or more of their products.
- By building one fewer prototype than all others, top performers gain between a 13 to 99 day time to market advantage and spend between $7,600 and $1,200,000 less in development costs depending on product complexity.
- By executing 5.4 fewer change orders than all others, top performers gain a 51 day time to market advantage and spend between $8,000 and $32,000 less in development costs depending on product complexity.
- Best in class performers have a 16% higher rate of design reuse than laggards.

While many manufacturers are considering the adoption of a digital product development process, Aberdeen research shows that they face challenging issues. 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 are *financial, process, and quality measures* (Figure 1). This classification subsequently enabled differentiation between the "best practices" of the top performers and the practices of lower performing companies.

Figure 1: Best in Class Hit Targets on an 91% Average or Better



Source: AberdeenGroup, March 2007

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 91% or better average.

Varying Prototype Costs and Time across Product Complexity

One of the primary reasons manufacturers aim to capture more product information electronically is to digitally prototype their product. As a result, they can reduce physical prototypes and in turn, save time and development costs. However, the exact time and costs saved depends on a product's complexity. To clearly understand this relationship, Aberdeen categorized survey respondents' products by measuring three key indicators: *number of parts*, *length of development lifecycle*, and *number of product configurations*. This measurement subsequently enabled differentiated levels of product complexity as described in the following table (Table 3).

Table 3: General Characteristics of Product Complexity Categories

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

Source: AberdeenGroup, October 2006

Based on these product complexity categories, one can see a logical progression in the time and cost to build a physical prototype based on product complexity (Table 4).

Table 4: Prototype Costs and Time per Product Complexity

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

Source: AberdeenGroup, October 2006

Digital Prototypes Results in Fewer Physical Prototypes

Is there any truth to the suggestion that using digital prototypes during the product development process removes unnecessary additional rounds of prototyping? The answer is "yes." Aberdeen research finds that the best in class average 5.1 prototypes compared to 6.1 for all other manufacturers. Applying this difference of a single prototype to the different categories of

> "With our 3D modeling design software, we can prototype on the screen instead of physically. It's faster overall."
>
> -Cliff Busby, Sturm, Ruger & Company

product complexity yields compelling results.

- The best in class manufacturers of the products with very high complexity get to market 99 days earlier with $1,200,000 lower product development costs than average performers.
- At the opposite end of product complexity spectrum, the best in class manufacturers get to market 13 days earlier and spend $7,600 less on product development costs than average performers.

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

Earlier Collaboration on Digital Prototypes Reduces Change Orders

Another quantifiable value proposition associated with digitizing the product development process is the reduction of change orders. The idea is that if a you can fully addressing design issues up front, manufacturers experience fewer change orders downstream.

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 5). 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.

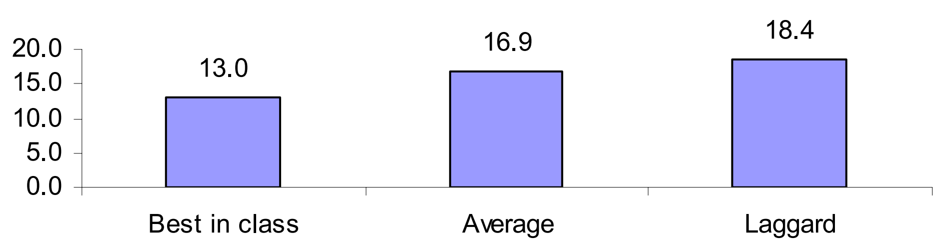
Table 5: Change Order Costs per Product Complexity

Product Complexity	Cost of Executing Change Orders
High	$5,886
Moderate	$2,021
Low	$1,492

Source: AberdeenGroup, March 2006

Is it true that top performers execute fewer change orders than laggards? Survey findings also confirmed that the answer is “yes” again. In fact, the top performers average 5.4 fewer prototypes than laggards (Figure 2).

Figure 2: Best in Class Hit have Execute 5.4 Fewer Change Orders



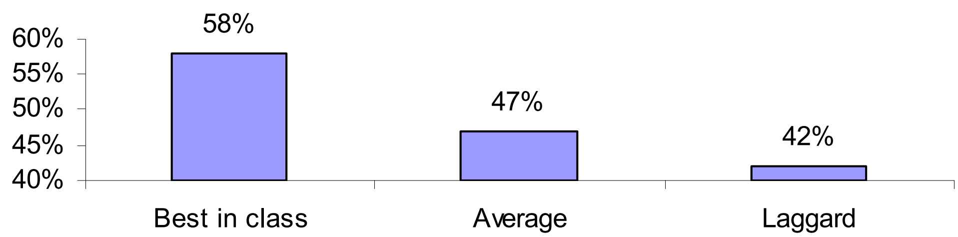
Source: AberdeenGroup, March 2007

This difference has a direct impact on time to market and product development costs. Best in class manufacturers of the most complex products get to market 51 days earlier with $32,000 lower product development costs than average performers. The best in class manufacturers of the simplest products get to market 51 days earlier with $8,000 lower product development costs than average performers. Again, these advantages of "getting it right the first time" translate into a real-world financial benefit.

Digital Accessibility Increases Part and Design Reuse

Another area commonly targeted for improvement in the product development process is design reuse. Increased levels of design reuse lead to reduced product development costs and higher rates of hitting product launch dates because it lowers the overall effort to take the product to market. Aberdeen research has found that the best in class performers see a markedly higher rate of design reuse compared to laggards (Figure 3).

Figure 3: Best in Class Hit have 16% Higher Rate of Part and Design Reuse



Source: AberdeenGroup, March 2007

In the context of part and design reuse, the foremost barrier to success is a simple one; finding the part or design is difficult. What is the primary means to combat this challenge? Make it easy to find parts and design. In this light, a digital product development process becomes part of the solution. As more product information is captured digitally and exposed, engineering and manufacturing stakeholders can more easily find designs. As a result, companies with higher rates of part and design reuse realize lower product development costs and hit their product launch dates more frequently.

> "Almost all of our designs start with an existing model so we can leverage change of that model to create new designs. By leveraging the family table functionality through our CAD tool, we have been able to reuse generic designs with different design parameters. There is reuse in nearly everything we do. If it we did not reuse we really wouldn't be able to meet our performance targets.
>
> -Mike Easter, Manager of Engineering Services, Thomas Built Buses, Inc.

Chapter Three:
Implications & Analysis

Key Takeaways

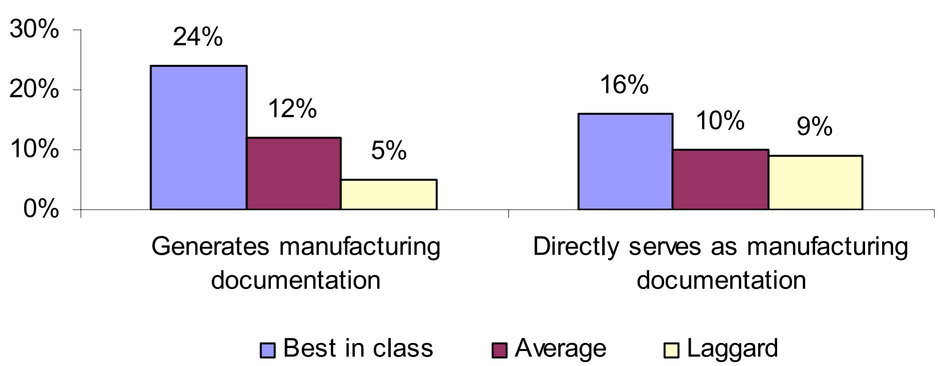
- Top performers are over 4 times as likely to use design models to generate manufacturing documentation and 78% more likely to adopt drawingless models.
- Top performers are 19% to 22% more likely than laggards to digitally prototype a product's performance in all phases of product development.
- Top performers are 34% more likely to use digital communications between engineering and manufacturing instead of paper.
- Top performers are 35% more likely to assess a product's manufacturability prior to design kickoff.
- Top performers are 43% more likely to use electronic forms and twice as likely to use lifecycle states and workflows to notify product development stakeholders that information is ready to use.

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 organizational, process and technology characteristics.

Digital Design Models as the Basis of Manufacturing Documentation

When considering the digitization of the product development process, its logical to start where most product information is created: the engineering organization. While design models fulfill a variety of purposes, the top performers are taking advantage by using them to specifically generate manufacturing documentation (Figure 4).

Figure 4: Top Performers Automate Manufacturing Documentation Creation



Source: AberdeenGroup, March 2007

What's the advantage to this approach? Many Computer Aided Design (CAD) applications directly use design models to generate drawing views. This fundamental and automated approach is far faster than generating each view manually. Additionally, some top performers are using design models to avoid engineering drawings completely. With a drawingless model approach, the manufacturing organization can use the design model directly instead of relying on engineering drawings. Removing the creation of this deliverable saves time in the design phase. Overall, these two uses for design models saves time to market by compressing the design phase of the product development process. As a result, the top performers hit their launch dates more consistently.

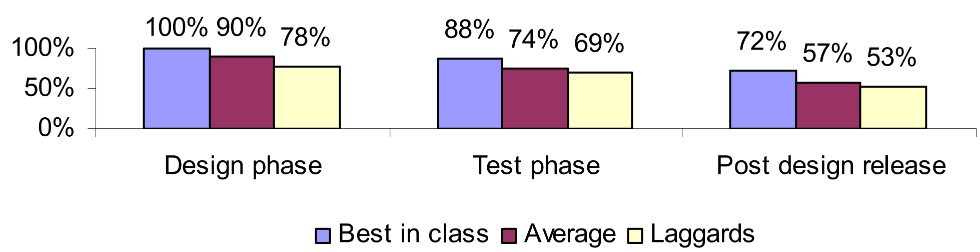
"We first build a solid model. We then develop an engineering drawing that's associated with that model. We then output that to a pdf as well as a DXF. We deliver the pdf to the shop floor. Our suppliers use the DXF for laser cutter programming. Overall, we've pretty much gone paperless."

-Jim Collins, Conair

Improving Product Performance through Digital Prototyping

As we've already seen, the top performing manufacturers are gaining time to market and development cost advantages because they are building fewer prototypes. How are they doing it? Based on research from *The Simulation-driven Design Benchmark Report*, the top companies are avoiding physical prototypes by running simulations in all phases of product development (Figure 5).

Figure 5: Top Performers Assess Performance in all Development Phases



Source: AberdeenGroup, March 2007

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

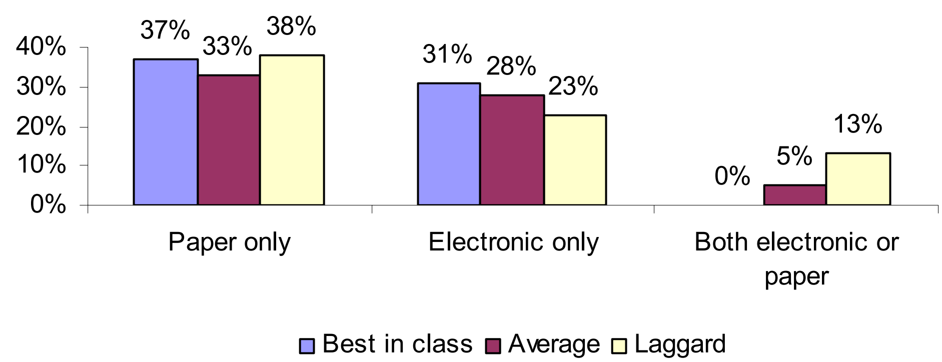
-Jochen Hessemann, Smith Aerospace

What's the benefit of running more simulations in more phases of product development? They allow product engineering to digitally prototype the performance of the product instead of building costly physical prototypes. The result? Development costs go down and engineering can use the time it would have taken to build a prototype to release the design early or even improve product performance more. Overall, this is a primary contributing factor to the fact that the top performers build one less prototype than laggards. The result is less development costs and shortened time to market.

Enabling Design for Manufacturability with Electronic Handshakes

Another important part of the digitalization of the product development process is the handshake between engineering and manufacturing. While engineering may author all production documentation in digital forms, it can still be delivered to the manufacturing organization on paper, in electronic form or some combination of both (Figure 6).

Figure 6: Top Performers 34% More Likely to Have Electronic Handshake



Source: AberdeenGroup, March 2007

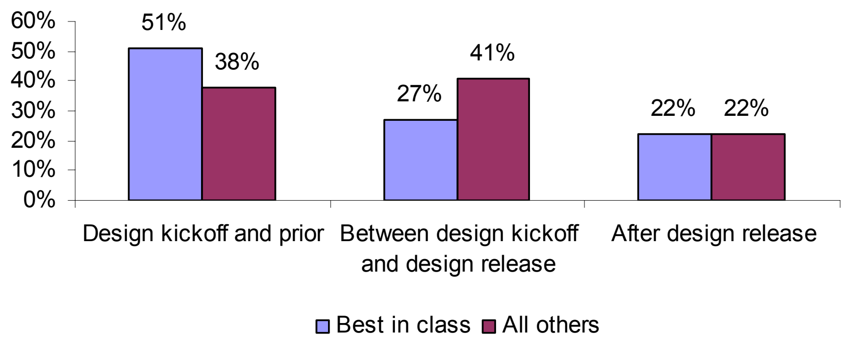
While many organizations of varying performance still use paper, the top performers are 34% more likely to deliver production documentation electronically. Why the preference? The motivation comes from the issues associated with printed documentation. As soon as an engineering drawing or specification is printed and handed to manufacturing, it can be outdated by changes. The result? Incorrect parts are ordered. The wrong parts are assembled together. Parts are machined to the wrong specifications. Development costs are driven up and product launch dates are missed. Making the cultural change to an electronic handshake between engineering and manufacturing eliminates many of these problems. The next time the manufacturing organization retrieves the electronic documentation; they are consuming the latest version that is up to date and accurate.

"We have the documentation and process in place to allow coordination between manufacturing and engineers, by providing several websites to allow engineers to view the actual process information."

-Paul Wilson, CAE Engineer, ADC

While reducing errors in the handshake between engineering and manufacturing has definitive benefits, the two organizations must also work together to assess a product's manufacturability. Depending on the manufacturer, this activity can take place early or late in the product development process (Figure 7).

Figure 7: Top Performers 35% More Likely to Assess Manufacturability Early



Source: AberdeenGroup, March 2007

Interestingly enough, the top performers are 35% more likely to first assess a product's manufacturability at design kickoff and prior than all other respondents. What's the impact? Assessing a product's manufacturability earlier in the product development process has two distinctive advantages.

- **Addressing manufacturability early decreases product costs**: As a product progresses through the product development process, design flexibility becomes more and more constrained. By suggesting design for manufacturability changes very early, when the design is most flexible, more of these changes can be adopted. As a result, recurring product costs can be decreased.
- **Addressing manufacturability early translates to fewer change orders:** The manufacturability of a product, to varying degrees, must be addressed sooner or later in the product development process. If they are addressed prior to the design phase, they can be accommodated with informal processes. If they are addressed after design release, the formal change process must be invoked. As each change order is executed, development costs increase and changes of hitting product launch dates dwindle.

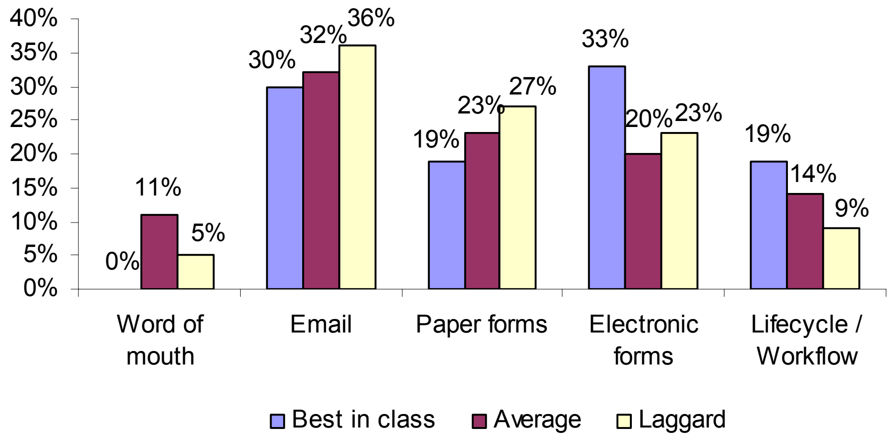
"We keep our design data on a central server with a viewer application so our manufacturing folks can access it. We then hold frequent meetings throughout the project and the manufacturing folks look at manufacturability. It's part of our ISO process."

- Gerald Johnson, Garret Electronics

Electronic Notification Enables Digital Product Development

Once digital prototypes are used as basis for manufacturing documentation, assessment of a product's performance and its manufacturability, organizations can look at the process overall to understand where further efficiencies can be gained. An important recurring opportunity to save time and money is the notification of stakeholders that product information is ready for use. Manufacturers are using a wide variety of mechanisms for notification today (Figure 8).

Figure 8: Top Performers Notify Development Stakeholders Electronically



Source: AberdeenGroup, March 2007

> "While we have a PLM tool with centralized data management and change management capabilities, our change process is driven by a paper-based process and a master data coordinator role."

Based on the data, average and laggard performers more frequently use older mechanisms of notification, such as word of mouth, email and paper forms. Most of these forms of communication can be forgotten, not forwarded or simply lost. As a result, the notification may not spread out to all of the appropriate product development stakeholders causing delays.

Top performers, on the other hand, are more likely to turn to electronic notification mechanisms such as electronic forms (change orders and design release forms), lifecycle state changes and workflows. These forms of communication are persistent with a user within Product Data Management (PDM) or Product Lifecycle Management (PLM) systems. As a result, they cannot be lost. In fact, these technologies can send reminders for notifications that are forgotten or ignored after a set period of time.

Overall, the primary product development target that is affected is product launch date. By removing the delays associated with older mechanisms of notification, the top performers hit their launch dates more frequently. The secondary impact affects product costs, development costs and quality because delays in communications can frequently result in errors in the product development process.

Chapter Four: Recommendations for Action

Key Takeaways

- Automate the creation of manufacturing documentation to reduce design times.
- Digitally prototype your product's performance to minimize physical prototypes.
- Deliver electronic manufacturing documentation to reduce production errors.
- Digitally prototype your product's manufacturability to reduce change orders.
- Electronically notify development stakeholders to avoid time delays.

Despite the fact that executives are demanding more products that are increasingly complex on smaller budgets, engineering and manufacturing organizations must find a way to leverage the trend of digitalization of product information in the product development process. The following actions can assist them in 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.

1. *Automate the creation of manufacturing documentation to reduce design times*

   Instead of manually creating views for engineering drawings, top performers use design models for automated view creation or as drawingless models. Leverage these approaches to save time in the design phase.

2. *Digitally prototype your product's performance to minimize physical prototypes*

   While many manufacturers build physical prototypes to understand a product's behavior, best in class performers digitally prototype products through simulation. Lower product development costs by adopting this approach.

3. *Deliver electronic manufacturing documentation to reduce production errors*

   Most manufacturers depend on paper-based release of designs to manufacturing. Top performers release designs electronically resulting in fewer manufacturing errors.

4. *Digitally prototype your product's manufacturability to reduce change orders*

   Many manufacturers assess a product's manufacturability late in the development process and as a result, experience more change orders. Instead, top performers assess manufacturability prior to design kickoff.

5. *Electronically notify development stakeholders to avoid time delays*

   Instead of using manual notification, top performers use electronic forms, lifecycle states or workflows to notify product development stakeholders that product information is ready for use. Adopt this approach to reduce time delays

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Appendix A: Research Methodology

During March 2007, Aberdeen Group, *Cadalyst* and *Desktop Engineering* examined the experiences and intentions of more than 180 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 impacts 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 managers (32%), engineering and design staff (30%), engineering and design directors (6%), consultants (5%) and executive management (CEO, COO, President) (4%).
- ***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 16% of respondents closely followed by automotive at 13%. Producers of consumer durable goods and medical device manufacturers comprised 7%. Other sectors responding included metal and metal products, computer equipment and peripherals and consumer electronics.
- ***Geography**:* Nearly all study respondents were from North America, accounting for 88% of respondents. Remaining respondents were from the Europe at 7% and the Asia-Pacific region at 2%.
- ***Company size**:* About 44% of respondents were from midsize businesses (annual revenues between $50 million and $1 billion), 43% were from small enterprises (annual revenues of $50 million or less), and 14% 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 *Digital Product Development Benchmark Report*. Their sponsorship has made it possible for Aberdeen Group, *Cadalyst* and *Desktop Engineering* 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, March 2007

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, March 2007

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, March 2007

Appendix B:
Related Aberdeen Research & Tools

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

- *Managing Product Relationships: Enabling Iteration and Innovation in Design* (August 2006)
- *Product Lifecycle Collaboration Benchmark Report: The Product Profitability "X Factor"?* (August 2006)
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