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Why Printed Circuit Board Design Matters to the Executive:

How PCBs Are a Strategic Asset for Cost Reduction and Faster Time-to-Market

February 2010

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Executive Summary

In today's competitive market place, companies are looking for new ways to differentiate their products. As a result, electronics have become a critical component of product development. With that, a focus on the Printed Circuit Board (PCB) design process offers a strategic advantage with opportunities to improve time to market, lower product cost, and provide product differentiation. This report offers guidance to achieve this by improving the PCB design process.

Best-in-Class Performance

Aberdeen used the following five key performance criteria to distinguish Best-in-Class companies. Best-in-Class companies achieve the following results:

- 88% of products launch on time
- 13% decrease in development time
- 86% of products meet product cost targets
- 11% decrease in product cost
- 88% of products meet quality targets at design release

Competitive Maturity Assessment

When compared to competitors, firms enjoying Best-in-Class performance shared several common characteristics that support PCB design including:

- 53% more likely to leverage design for manufacturability tools
- 36% more likely to have a formal process for managing component cost
- 36% more likely to optimize resources across multiple projects

Required Actions

In addition to the specific recommendations in Chapter Three of this report, to achieve Best-in-Class performance, companies must:

- Adopt a design for manufacturability strategy and implement the necessary tools to support this approach
- Synchronize design data across multiple locations to support collaboration
- Look for opportunities to take cost out of the PCB with a formal process for managing component cost

Research Benchmark

Aberdeen's Research Benchmarks provide an in-depth and comprehensive look into process, procedure, methodologies, and technologies with best practice identification and actionable recommendations

"Improvements to our PCB design process have saved us weeks and improved quality. We now use a team design approach where several designers work simultaneously on a board and enter their design constraints. This flow also allows schematic changes while the layout is still in progress. With this flow supported by the tool suite we use, we can reduce the turn-around time by several days and reduce errors during design handover significantly. Compared to our old methods we can now better re-use existing layouts which saves us several weeks of layout time for complex boards."

~ Roland Beck, Engineer, Philips Medizin Systeme Boeblingen

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Chapter One: Benchmarking the Best-in-Class

Aberdeen Group's June 2008 report, *Engineering Executive's Strategic Agenda,* found that one of the top pressures facing engineering executives today is increasing market demand to build "smarter" product. In response, manufacturers are embedding more electronics into their products. As a result, Printed Circuit Board (PCB) design has grown in importance within the overall product development process. However, has it become so important that the PCB and the process to develop it can actually impact time to market, product cost, and create product differentiation? If so, how? To answer that question, Aberdeen studied the experiences of 536 companies in January and February 2010 through a survey and interviews.

Fast Facts

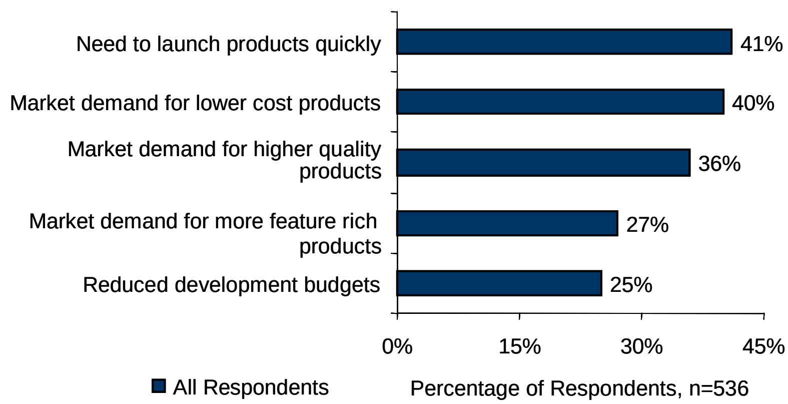
√ PCBs represent **31% of the overall cost** of the product

√ Best-in-Class practices result in **an average of $33,967 in savings** in prototype costs, for one PCB for moderately complex products

The Business Need for Improving PCB Design

To understand the external factors driving companies to improve how they design PCBs, survey respondents were asked to pick the top two pressures driving that improvement. The top pressures clearly speak to time, cost, and product differentiation (Figure 1).

Figure 1: Top Business Pressures Driving Improvement in PCB Design



Source: Aberdeen Group, February 2010

Today's development schedules are so tight, every aspect of the design is critical. There is no room for error. A delay in any part of the design will have a downstream impact on the entire product and subsequently, delay the product launch. Late to market means competitors can capture market share from you which ultimately leads to lost revenue opportunities. Companies have recognized this and are therefore looking to improve the PCB design process to make it more efficient. As a result, products will be able to launch to market as quickly as possible.

"A major challenge for us is the reduction in design time and cost. This is putting lot of pressure on the designers and we need strong tools to achieve these tight requirements."

~ Operations Manager, Semiconductor Company

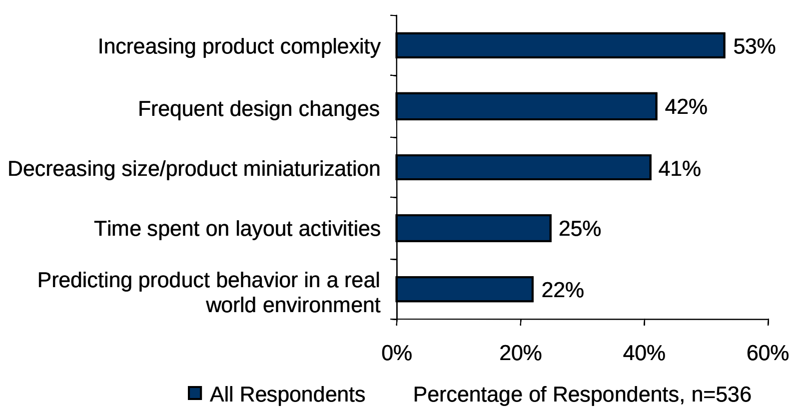
In today's economy, customers are more price sensitive than ever and they are demanding lower cost products. If you can not meet their price expectations, then they will find a competitor who will. Lower prices erode profit margins so, companies are looking for opportunities to take cost out of their products. This pressure is so great, they need to examine all aspects of the product to look for possibilities to take out cost. The PCB offers many opportunities for cost reductions and as a result, 40% of companies surveyed reported it as a top pressure driving them to improve the PCB design process.

Finally, fierce market competition means companies need to be looking for new ways to differentiate their products and many companies are recognizing that the PCB provides many opportunities for this. Poor quality tarnishes a company's reputation where a high quality product will elevate a company's brand and may even allow that company to charge a premium for that quality. Electronics can be a source of poor quality and companies have recognized that by improving the PCB design process, they catch more problems that affect quality and as a result, they develop a superior product. Electronics also provide opportunities for new innovative features that further differentiate the product. By improving the efficiency of the PCB design process, companies have more time to add these features, enabling those companies to capture more market share and consequently boost revenues.

What Makes PCB Design Hard?

As the pressures indicate, improved PCB design practices create opportunities for faster time to market, lower product cost, and greater product differentiation. However, what challenges must be addressed in order to improve the PCB design process? Figure 2 displays these top challenges. Respondents were asked to pick their top two challenges.

Figure 2: Top PCB Design Challenges



Source: Aberdeen Group, February 2010

"We have a lot of difficulty around predictability – it is hard to declare and hit a commit date. The reason for this is constant engineering change. We are currently implementing a change control process to address this challenge."

~ PCB Department Manager, A&D Company

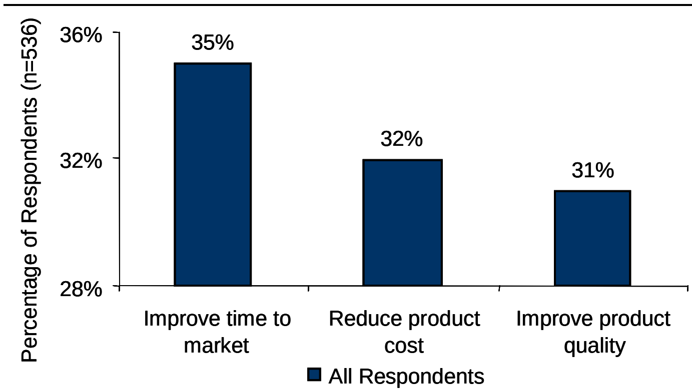
Today's products are extremely complex. In order to meet market demand for competitively differentiating features, many modern products have evolved into an integrated system of mechanical components, electronics, and software. Managing this system is complex in itself, but it also adds even more complexity to each aspect of the design. The result: more is needed from the PCB. Those involved with developing the PCB need to somehow figure out how to deal with things such as high density boards, multiple layers, and space constraints. All the while, new designs require the PCB to get smaller and smaller. The end result is that designing the PCB has become extremely challenging, which sets the designers up for errors. To address the top market pressures, it is imperative they have the ability to manage this complexity or mistakes will be inevitable, which will lead to quality issues, added cost, and product delays.

Change is inherent to the product development process. The very nature of innovation means there will be design iterations and changes. However, the impact of late changes means new design work is interrupted as designers are required to go back and redo work that was previously completed. The further along the design is, the more disruptive those changes are. This means designers need the ability to obtain insight into design behavior as early as possible. As a result, they can optimize the design and catch PCB design problems early, before they become the time consuming headaches that cause product delays that can ultimately impact time to market.

The Maturity Class Framework

To understand successful approaches to PCB design and the business impact it has upon companies, Aberdeen benchmarked the performance of study participants and categorized them as either Best-in-Class (top 20% of performers), Industry Average (mid 50%), or Laggard (bottom 30%). To ensure that organizations are categorized according to the criterion that most accurately represents what organizations are trying to accomplish, Aberdeen first identified the top business objectives for improving PCB design (Figure 3).

Figure 3: Top Objectives for Improving PCB Design



Source: Aberdeen Group, February 2010

Based on these answers, five key performance measures that indicate success with achieving these objectives were used to distinguish the Best-in-

Class from Industry Average and Laggard organizations. The performance of each of these tiers is displayed in Table 1.

Table 1: Top Performers Earn Best-in-Class Status

Definition of Maturity Class	Mean Class Performance
Best-in-Class: Top 20% of aggregate performance scorers	▪ 88% of products launched on time ▪ 13% decrease in development time ▪ 86% of products met product cost targets ▪ 11% decrease in product cost ▪ 88% of products met quality targets at design release
Industry Average: Middle 50% of aggregate performance scorers	▪ 75% of products launched on time ▪ 4% increase in development time ▪ 78% of products met product cost targets ▪ 5% increase in product cost ▪ 83% of products met quality targets at design release
Laggard: Bottom 30% of aggregate performance scorers	▪ 49% of products launched on time ▪ 12% increase in development time ▪ 55% of products met product cost targets ▪ 12% increase in product cost ▪ 66% of products met quality targets at design release

Source: Aberdeen Group, February 2010

The top objective for improving PCB design is to improve time to market. The Best-in-Class are far more successful with meeting this objective. In fact, they are 17% more likely to launch products on time than the Industry Average. In addition, the Best-in-Class have been able to reduce their development time by 13% while their lesser performing competitors have actually seen **increases** in development time. This means that the Best-in-Class have found ways to address the complexity of PCB design and identify problems early on in ways that have actually improved the efficiency of the development process, allowing them to get to market faster.

Improving quality is a top objective for improving PCB design and the Best-in-Class are 34% more likely than Laggards to meet their quality targets. As seen in the top market pressures, quality is something customers are demanding and it is something that can make or break a product brand. Companies that are able to achieve their quality targets are often rewarded with more demand for their products from customers who expect reliability and are willing to pay a higher premium for the product. Given that increasing complexity is the top challenge of PCB design, it is easy to inadvertently introduce quality issues into the design. The Best-in-Class have successfully addressed this with the improvements they've made to the design process.

Another top objective is to lower product cost. This is also a top market pressure and the Best-in-Class are successfully doing this by finding opportunities in the PCB to lower the cost. On average, companies report that the PCB represents 31% of the overall cost of the product. The Best-in-Class have invested in PCB design processes that enable them to take cost out of the PCB where their competitors have actually seen increases in product cost. Clearly, improving the PCB design process has a significant effect on the bottom line.

In addition, the Best-in-Class are able to save costs by reducing the number of physical prototypes. Table 2 shows the average number of physical prototypes required, based on PCB complexity.

Table 2: Number and Cost of Physical Prototypes Based on PCB Complexity

	Number of Physical Prototypes Required	Cost of One Physical Prototype
Simple PCBs	11.6	$3,967
Moderate PCBs	14.1	$8,929
Complex PCBs	16.1	$12,040

Source: Aberdeen Group, February 2010

PCB complexity was based on pin-to-pin connections, passive components, active components, number of leads per active part, average parts per square inch, average holes per square inch, and average leads per square inch.

When compared to their competitors, Best-in-Class companies are able to reduce the number of physical prototypes by 27%. Table 3 displays the resulting cost saving with a 27% reduction in physical prototypes.

Table 3: Best-in-Class Cost Savings Based on 27% Reduction of Physical Prototypes

	Number of Physical Prototypes Reduced	Resulting Cost Savings on One PCB Design
Simple PCBs	3.1	$12,483
Moderate PCBs	3.8	$33,967
Complex PCBs	4.3	$52,360

Source: Aberdeen Group, February 2010

The Best-in-Class PACE Model

Improving PCB design in ways that achieve corporate goals requires a combination of strategic actions, organizational capabilities, and enabling technologies that are summarized in Table 4.

Table 4: The Best-in-Class PACE Framework

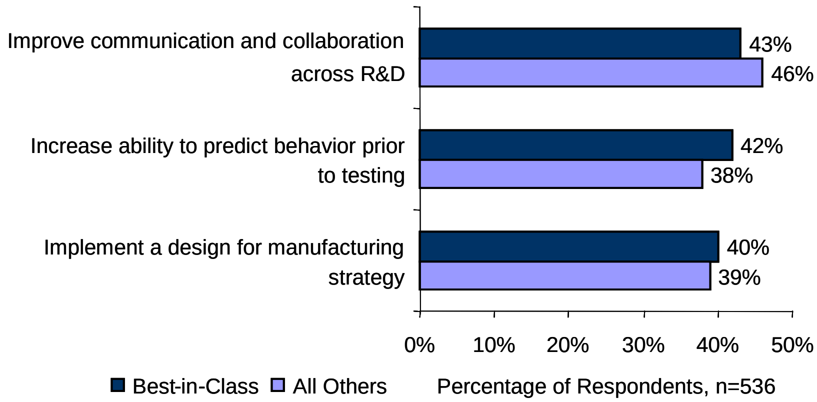
Pressures	Actions	Capabilities	Enablers
▪ Need to launch products quickly (before competitors) ▪ Market demand for lower cost products	▪ Increase ability to predict design behavior prior to physical testing ▪ Implement a design for manufacturing strategy	▪ Analysis is used to optimize the performance of electrical components ▪ Design teams work concurrently (conducting different development tasks in parallel) ▪ Formal process for managing component costs ▪ Primary design engineer(s) conducts PCB analysis ▪ Entire product design team works collaboratively with PCB engineers (Manufacturing, FPGA, Mechanical, Software engineers) ▪ Resources across multiple projects are optimized ▪ Design data is synchronized across distributed locations ▪ Define performance metrics prior to starting design ▪ Track number of ECOs created after initial layout is complete	▪ Centralized PCB part library ▪ Signal integrity analysis ▪ Thermal analysis ▪ Design for manufacturing tools ▪ Component selection tools that search multiple databases ▪ Integrated MCAD/ECAD design tools ▪ Tools to support using advanced fabrication technologies [High Density Interconnect (HDI), rigid-flex, embedded passives, and chip on board (COB)]

Source: Aberdeen Group, February 2010

Best-in-Class Strategies

Given the performance benefits enjoyed by the Best-in-Class, they are clearly doing a better job of addressing the top pressures to launch products on time, lower product cost, and differentiate their products with better quality and more features. They are doing this by focusing on the PCB design process and improving it in ways that will impact the success of the overall product. The top strategies implemented by the Best-in-Class are shown in Figure 4.

Figure 4: Best-in-Class Strategies to Improve PCB Design



Source: Aberdeen Group, February 2010

"Our focus on Design for Manufacturability (DFM) has led to large gains in cost reduction and increased reliability of our products. Success is measured by compliance with a Zero 0-km failure goal."

~ Engineer, Automotive Company

Interestingly, the top strategies pursued by the Best-in-Class are just as likely to be pursued by their competitors. This means the difference that leads to Best-in-Class performance is in how these strategies are executed.

The top challenge of PCB design is design complexity. Typically, there are several people involved just in the PCB design and beyond that, other engineering disciplines work on other aspects of the overall product. Given the level of complexity, it is important that each person on the development team is aware of what others are doing. They need to know about changes made by someone else that impact their part of the design. Also, better collaboration means the collective expertise of the development team can be leveraged to find an optimal solution to a design problem. In addition, better collaboration means that all development resources are used more efficiently, which leads to shorter development times.

"Signal Integrity, Thermal, EMI/EMC analysis have all helped reduce the product development cycle time. These analyses have also increased product performance first time."

~ Operations Manager, Semiconductor Company

The number of engineering changes is also a top challenge of PCB design. A strategy that enables designers to obtain early insight into behavior, allows them to catch problems earlier in the process. It also makes it easier to look for opportunities to take cost out of the PCB.

Similar to the previous strategy, catching potential manufacturing problems early means the problems can be corrected before the design is released. Released designs that are found to have manufacturability problems create delays and drive up cost. Production must be halted while engineering scrambles to correct the problem. Typically the solution is whatever is fastest, not the most cost effective. Manufacturability problems also create scrap and require rework, further driving up cost.

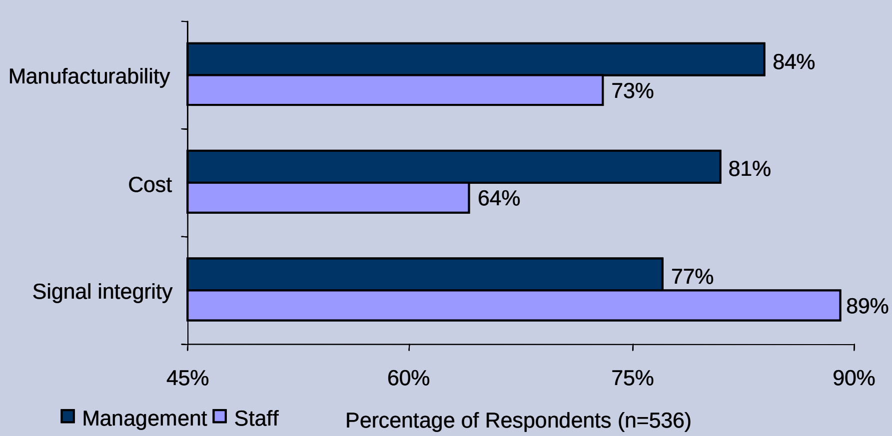
Aberdeen Insights — Strategy

From a managerial perspective, one of the bigger challenges of PCB design is that the PCB is a bit of a black box. It is fairly easy to visualize what the mechanical part of the design does and its value can be easily demonstrated. Demonstrating the value of a board with a lot of components on it is not as straightforward. A very specialized technical skill set is required just to understand the logic behind it, never mind the value it provides the overall product. As a result, needed improvements to the PCB design process are not always considered by management. However, with development schedules getting shorter and customers becoming more budget conscious, managers can no longer afford to ignore the PCB. As reported by survey respondents, the PCB represents 31% of the overall cost of the product. The benefits enjoyed by the Best-in-Class prove that a focus on the PCB significantly contributes to improving time to market and lowering product cost.

The top strategies deployed by companies show they are looking for ways to improve efficiency and look for ways to lower product cost. However, as there is no differentiation between the Best-in-Class and their peers; clearly just having these strategies will not make the difference in performance. It is something more, but what is it?

So that managers can better understand how to successfully execute these strategies, it is helpful to understand the differences in perception between management and the staff. When asked about design strategy, there is a striking difference between what management thinks the staff is designing for versus what the staff is actually designing for (Figure 5).

Figure 5: PCB Design Strategy Perception Differences between Management and Staff



Source: Aberdeen Group, February 2010

continued

Aberdeen Insights — Strategy

Directors and above think the PCB is designed for manufacturability and cost, which is consistent with the top strategies. However, when presented with the same list of options, the development team reports they actually design for technical performance such as signal integrity and reliability. When compared to the management team, they are much less concerned about designing for cost and manufacturability. Why the disconnect? The development team works with what they have. The capabilities they have in place enable them to design for things like signal and power integrity. Because management is unaware of this, changes are not made to adopt the capabilities that lead Best-in-Class performance.

"Our ability to integrate the ERP system, schematics, mechanical design tool, and simulation tools with PCB design has been what has made the biggest difference in our process. This level of integration enables us to reduce the number of re-spins and R&D time. Time, money and resources can be utilized in other areas because of the reduced re-spins and saved R&D time."

~ Manager, Industrial Equipment Manufacturer

In the next chapter, we will see what the top performers are doing to achieve their success.

Chapter Two:
Benchmarking Requirements for Success

Chapter One demonstrated the pressures driving PCB design improvement It also described the business opportunities offered by successful execution of strategies to improve PCB design. Chapter Two explores the capabilities and enabling technologies the Best-in-Class use to execute those strategies, allowing them to enjoy a competitive advantage.

Case Study — Esterline - CMC Electronics Inc.

Esterline - CMC Electronics is a world leader in the design, manufacture, sales and support of high-technology electronics products for the aviation and global positioning markets. CMC Electronics focuses on gaining a leadership position in growing niche markets where products and systems of the utmost quality, highest reliability and most innovative features are required. The company is a major supplier to the aerospace and high-technology industries, airlines, military agencies and government customers around the world. Because they both design and manufacture their products, they have an excellent perspective on PCB development and know what needs to be done to ensure an efficient design process that results in a high quality product.

The development team for CMC Electronics is spread across multiple locations. To support better communication and greater efficiency, they support practices such as in process reviews and final documentation reviews with electronic workflows that automatically route to the right person, ensuring everything stays on schedule. They also use a centralized data repository that is leveraged by all sites. "The use of common and centralized libraries has enabled transparent inter-site transfers," says Alain Fouquet, ECAD section leader at CMC Electronics.

While these tools have been very helpful, Fouquet credits their Design for Manufacturability (DFM) strategy as the most beneficial thing CMC Electronics has done to improve PCB design. "DFM validation of the PCB designs prior to release increases the manufacturability of the bare boards. PCB designs are right the first time with fewer re-spins," comments Fouquet. "To accomplish this, we use a DFM tool that catches issues the PCB design tools alone wouldn't catch. As a result, we have confidence that the board design has all the required manufacturing information when it is sent to the shop. This means we avoid production delays due to missing information." The tools are also used to catch potential manufacturing problems such as when a trace is too close to a mounting hole. "If problems like this are not caught before the design is released, the worst case scenario is a re-spin of the entire board, which adds cost and delays," reports Fouquet. "We avoid this and in fact have boards with 2,500 components that are right at initial release."

continued

Fast Facts

Compared to all competitors, the Best-in-Class are:

√ **53%** more likely to leverage design for manufacturability tools

√ **36%** more likely to have a formal process for managing component cost

√ **36%** more likely to optimize resources across multiple projects

Case Study — Esterline - CMC Electronics Inc.

While the improvements on the PCB are obvious, Fouquet credits the improvements as being much bigger than that and have an impact on the company's performance. "We have much better control over our design cycle and our deliveries are on time," observes Fouquet. "What this means for the company is we do a better job of meeting our customers' needs so, we are more successful."

Competitive Assessment

Aberdeen Group analyzed the aggregated metrics of surveyed companies to determine whether their performance ranked as Best-in-Class, Industry Average, or Laggard. In addition to having common performance levels, each class also shared characteristics in five key categories: (1) **process** (the approaches they take to improve PCB design); (2) **organization** (defined ownership of processes and collaboration among stakeholders); (3) **knowledge management** (how data is managed and exposed to key stakeholders); (4) **performance management** (metrics captured and tracked to improve business results); and (5) **technology** (the tools that enhance and support PCB design). These characteristics (identified in Table 5) serve as a guideline for best practices, and correlate directly with Best-in-Class performance across the key metrics.

Table 5: The Competitive Framework

	Best-in-Class	Average	Laggards
Process	Analysis is used to optimize the electrical performance		
	72%	58%	50%
	Design teams work concurrently (conducting different development tasks in parallel)		
	68%	63%	57%
	Formal process for managing component costs		
	60%	48%	38%
Organization	Primary design engineer(s) conducts PCB analysis		
	69%	61%	62%
	Entire design team works collaboratively with PCB engineers (Manufacturing, FPGA, Mechanical, Software)		
	68%	61%	55%
	Resources across multiple projects are optimized		
	61%	49%	39%
Knowledge	Design data is synchronized across distributed locations		
	57%	44%	39%

	Best-in-Class	Average	Laggards
Performance	Performance metrics are defined prior to starting design		
	62%	53%	47%
	ECOs created after initial layout is complete are tracked		
	58%	48%	46%
Technology	PCB design tools currently in use:		
	▪ 86% Centralized PCB part library ▪ 76% Signal integrity analysis ▪ 69% Thermal analysis ▪ 67% Design for manufacturing tools ▪ 56% Multiple database component searching tools ▪ 54% Integrated MCAD/ECAD design tools ▪ 47% Advanced fabrication technology tool	▪ 75% Centralized PCB part library ▪ 68% Signal integrity analysis ▪ 59% Thermal analysis ▪ 44% Design for manufacturing tools ▪ 39% Multiple database component searching tools ▪ 48% Integrated MCAD/ECAD design tools ▪ 39% Advanced fabrication technology tool	▪ 71% Centralized PCB part library ▪ 62% Signal integrity analysis ▪ 55% Thermal analysis ▪ 44% Design for manufacturing tools ▪ 41% Multiple database component searching tools ▪ 39% Integrated MCAD/ECAD design tools ▪ 31% Advanced fabrication technology tool

Source: Aberdeen Group, February 2010

Capabilities and Enablers

Based on the strategies deployed to support PCB design, the findings of the Competitive Framework and interviews with end users, Aberdeen's analysis of the Best-in-Class reveals there are three key areas companies must focus on to optimize their PCB design process in ways that will improve time to market, lower product cost, and enable greater product differentiation:

- Improve communication and collaboration among the development team
- Support a design for manufacturability strategy
- Enable the ability to obtain early insight into the final product and how it will behave

Processes, organizational responsibility, knowledge management, performance management, and technology all play a role in supporting these three things.

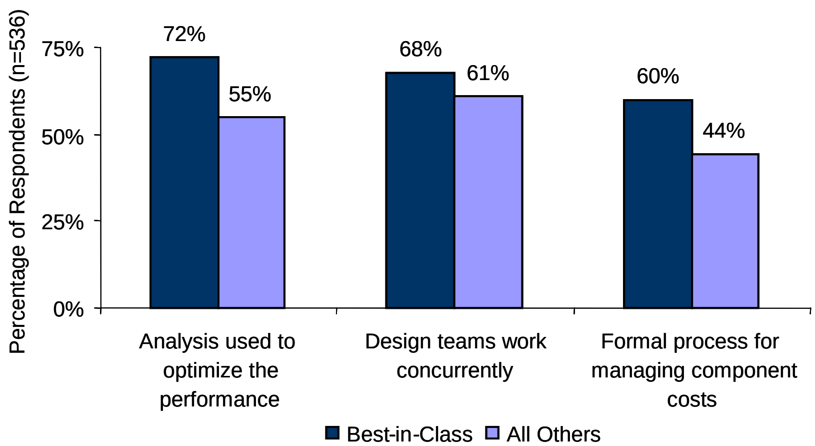
"Our centralized library and common design tools make it easy to move and shift projects from one R&D site in the world to another."

~ Engineer, A&D Company

Process

Standard processes provide structure and repeatability to the PCB design process and ensure that the processes that are proven to work are consistently followed. The most differentiated processes implemented by the Best-in-Class are shown in Figure 6.

Figure 6: Best-in-Class PCB Design Processes



Source: Aberdeen Group, February 2010

To obtain early insight into how the PCB will function, the Best-in-Class are 31% more likely than their competitors to have a formal process to analyze the PCB performance. This enables them to look for opportunities to improve performance, catch problems, and identify areas to take out cost. Because this is done during the design process, it is a lot easier, faster, and cheaper to make design adjustments than waiting for physical prototypes to be built.

The Best-in-Class also make it possible for the PCB design team to work concurrently, meaning design tasks are completed in parallel. This process improves efficiency so that the PCB design is completed in less time, supporting the Best-in-Class' ability to reduce development time by 13%.

Finally, to address market pressures to lower product cost, the Best-in-Class are 36% more likely than their competitors to have a formal process to evaluate cost during design and look for ways to reduce component costs. This is a contributing factor to their ability to reduce cost by 11%.

Organization

While the PCB design processes are critical, steps must be taken to get the most out of the available organizational resources (Figure 7).

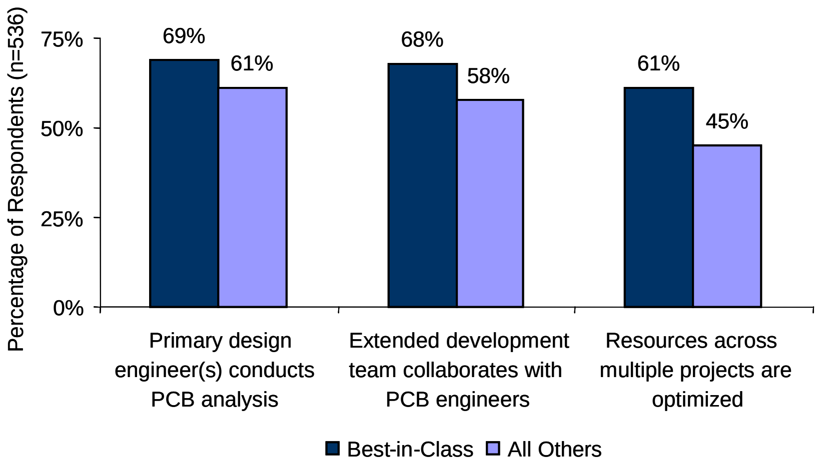
"Our signal integrity simulation software has been an excellent tool for designing the board right the first time. This helps with functionality as well as regulatory compliance."

~ Norman Pyle, Sr. Electrical Engineer, Pelco

"Having several engineers working simultaneously on one schematic saved a lot of time and reduced the possibility of errors during integration of schematic sheets drawn by different engineers."

~ Roland Beck, Engineer, Philips Medizin Systeme Boeblingen

Figure 7: How the Best-in-Class Leverage Organizational Resources



Source: Aberdeen Group, February 2010

The Best-in-Class have a process in place to analyze PCB performance during the design process. To support this, the primary design engineers are responsible for conducting this analysis. This means they can leverage the analysis results to make better design decisions as they design. This is more efficient than handing the design over to an Analyst expert every time an analysis needs to be conducted. The end result is the design engineer is more likely to make educated design decisions that improve quality and lower product cost.

"A team oriented approach to PCB design has improved communication and reduced design times."

~ Engineer, A&D Company

The Best-in-Class have a process in place so that the PCB design tasks are conducted in parallel. To support further collaboration, they support an organizational structure to enable those outside of the PCB design team (such as manufacturing, mechanical, and software engineers) to collaborate with the PCB engineers. This supports a design for manufacturability strategy as well as helps to avoid problems due to incompatibilities between different design aspects of the overall product.

Finally, the Best-in-Class are 36% more likely to make sure they leverage their PCB design resources across multiple projects. This ensures optimal efficiency which results in shorter development time.

Knowledge Management

The Best-in-Class have a process in place for PCB design tasks to be completed in parallel. To support this, they are 36% more likely than their competitors to synchronize design data across distributed locations. This supports better collaboration so that each person is working with the latest design information and is aware of changes that will affect the part of the design he or she is working on.

Performance Management

In order to ensure the final product meets the design requirements and will be the product customers want, it is important the design criterion is clearly defined. The Best-in-Class assess product performance throughout the design process, but to make sure the PCB performs as required, it is important those performance metrics are defined prior to beginning any design work. This will ensure that when performance is analyzed, it is measured against the correct criteria and the designer knows what is required from day one. This also avoids engineering change orders (a top challenge) that are a result of performance criteria not being met.

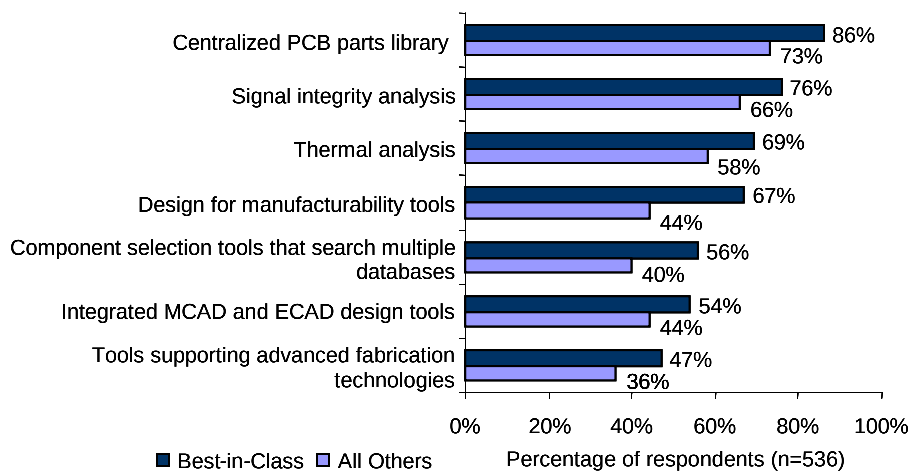
"Having a global library has really helped us. We released the standard for symbol, pattern, and attributes to all sites. This has saved us money and improved our PCB quality."

~ Engineer, Automotive Company

Technology

The Best-in-Class use a variety of technologies to support PCB design. With these technologies, they are able to improve efficiency, lower product cost, and add features to competitively differentiate the product (Figure 8).

Figure 8: Technologies Supporting PCB Design



Source: Aberdeen Group, February 2010

The Best-in-Class use several technologies that support collaboration and enable them to take advantage of the same information, regardless of where they are. The Best-in-Class are 23% more likely to use integrated MCAD/ECAD tools. This supports the ability for those in the PCB group to collaborate with the mechanical engineers. This provides a very easy mechanism to communicate changes on the mechanical side, such as a dimension shift in an enclosure, to those working on the PCB. As a result, each engineering group is aware of issues such as potential interferences or a need for better venting, before they become problems. The Best-in-Class also use a centralized parts library and leverage tools that enable engineers to search across multiple databases for components. This ensures everyone on the team, no matter where they are, has access to the same parts. As a result, Best-in-Class companies reduce the number of unique parts they use, thus lowering costs.

"Implementing MCAD integration has been most helpful. It allows our mechanical and electronics engineers to get it right the first time."

~ Tony Karavidas, Engineer, Leica Geosystems

To obtain early insight into PCB performance, the Best-in-Class take advantage of many types of analyses. Two of the most differentiated are signal integrity and thermal. With these tools they have a better idea of how the PCB will perform, before even a prototype exists.

"The thing that has been most helpful for our PCB design process has been signal integrity simulation tools. This tool helped to reduce PCB re-layout due to signal integrity issues. This has helped reduce operating costs."

~ Engineer, Consumer Electronics Company

Finally, designing for manufacturability is a top strategy, but the Best-in-Class are 52% more likely to put the tools in place to enable them to execute on this strategy. As a result, they are able to catch potential manufacturing problems before they manifest themselves on the production floor, saving a lot of money. The Best-in-Class are also 31% more likely to use leverage design tools that enable them to take advantage of new fabrication technologies such as High Density Interconnect (HDI), rigid-flex, embedded passives, and Chip on Board (COB). Leveraging these technologies saves money, but it is not always easy to take advantage of them. With design tools specifically intended to take advantage of these technologies, much of the process is automated making it easier to benefit from the technologies.

Aberdeen Insights — Technology

Designing for manufacturability is a top strategy for improving PCB design. While this is often a concern for other aspects of product development, such as the mechanical components, it has not been rated as important in previous Aberdeen research as it is for electronics. Why is this?

Research from Aberdeen's June 2009 report, *Assembly, CAM, and Process Planning for Today's Manufacturing Engineer: Boosting Production Productivity while Lowering Costs,* found that the top challenge of production planning for electronics manufacturers is a lack of collaboration between design and manufacturing engineers. In fact, they are 35% more likely to rate it as a top challenge compared to other industries. In addition, electronics manufactures are 65% more likely than other industries to implement strategies to improve collaboration between design and manufacturing engineers. Clearly, electronics production feels more pain from manufacturability issues than the production of non-electronic parts. One of the reasons for this is time to market. While all manufacturers are in a race to get their products to market as soon as possible, the pressure is even greater for electronics. Electronics become outdated even faster than for most other industries so, there is an even shorter window to optimize profits on new products. In addition, electronics production tends to require frequent changeovers. Forty-nine percent (49%) of electronics manufacturers report changeovers occurring several times in just one day. With this much pressure to move things along as quickly as possible, there is little time to address manufacturing problems with the design.

continued

Aberdeen Insights — Technology

Aberdeen Insights — Technology
What's interesting is that clearly companies have recognized this as an issue they need to address, but surprisingly, more companies have not implemented design for manufacturability tools. With the Best-in-Class being 52% more likely than their competitors to implement these tools, it is the most differentiated technology in PCB design. Clearly this technology makes a difference that contributes to Best-in-Class success.

Chapter Three: Required Actions

Whether a company is trying to move its performance in PCB design from Laggard to Industry Average, or Industry Average to Best-in-Class, the following actions will help spur the necessary performance improvements:

Fast Facts

√ Implement design for manufacturability tools to support a design for manufacturability strategy

√ Synchronize design data across multiple locations to support collaboration

√ Look for opportunities to take cost out of the PCB with a formal process for managing component cost

Laggard Steps to Success

- **Optimize resources across multiple projects.** Getting the most out of existing resources will improve efficiency, helping to reduce development time. The Best-in-Class are 56% more likely to do this.
- **Implement a formal process for managing component cost**. This enables more visibility to cost during the design process, making it easier to take cost out of the product. The Best-in-Class are 58% more likely to have a cost management process.
- **Deploy design for manufacturability tools.** These tools save costs by catching manufacturing issues during the design process. The Best-in-Class are 52% more likely to leverage these tools to support a design for manufacturing strategy.

Industry Average Steps to Success

- **Synchronize design data across distributed locations.** The Best-in-Class are 30% more likely to synchronize their data which makes it easier to support concurrent design between team members and thus improve product development efficiency.
- **Catch manufacturing issues during design with design for manufacturability tools.** Finding problems with manufacturability during the design process save both time and money. The Best-in-Class are 52% more likely to leverage these tools.
- **Implement component selection tools that search across multiple databases.** Take advantage of all the standard corporate parts in addition to lowering cost by reducing the number of different components used. Best-in-Class companies are 44% more likely to take advantage of these searching capabilities.

Best-in-Class Steps to Success

- **Further improve the execution of a design for manufacturability strategy with manufacturing process simulation.** The Best-in-Class are already 29% more likely than their competitors to use this technology, but adoption is still low with only 22% currently using it.
- **Improve collaboration across engineering disciplines with integrated MCAD/ECAD tools.** Integrated design tools improve

communication between engineering disciplines, making it easier to communicate changes and catch conflicts before they become problems. Fifty-four percent (54%) of the Best-in-Class already do this, but more could benefit.

- **Improve collaboration within the electronics team with integrated FPGA/PCB design tools.** Leveraging integrated tools makes it easier to work together to improve the overall performance of the PCB. Forty-two percent (42%) of the Best-in-Class already take advantage of this integration, but greater adoption would further improve performance.

"Design for manufacturability reviews before release have helped reduce the cost of rework and re-spinning the boards. All collaborative tools and technologies facilitate communication with engineers, vendors, and others whose input is valuable during the design development cycle. The more we all talk, the better and more predictable the outcome."

~ Engineer, Telecommunication Company

Aberdeen Insights — Summary

A focus on PCB design can offer a strategic advantage by improving time to market, lowering product cost, and creating more product differentiation. Ignoring the PCB and not providing the resources needed to improve the process can actually result in longer development times and additional cost. To enjoy performance similar to the Best-in-Class, companies need to:

- Improve communication and collaboration among the development team
- Support a design for manufacturability strategy
- Enable the ability to obtain early insight into the final product and how it will behave

Appendix A:
Research Methodology

Between January and February 2010, Aberdeen examined the use, the experiences, and the intentions of 536 enterprises in a diverse set of industries. Aberdeen supplemented this online survey effort with interviews with select survey respondents, gathering additional information on their strategies, experiences, and results.

Responding enterprises included the following:

- *Job title:* The research sample included respondents with the following job titles: Executive level manager (4%); VP/Director (5%); Manager (17%); Engineers (70%); and other (4%).
- *Industry:* The research sample included respondents from a wide cross section of industries. The sectors that saw the largest representation in the sample were: aerospace and defense (26%), consumer electronics (21%), telecommunications (19%), automotive (14%), medical devices (10%), and industrial equipment (8%).
- *Geography:* The majority of respondents (57%) were from North America. Remaining respondents were from Europe (24%), the Asia / Pacific region (16%), and from the rest of the world (3%).
- *Company size:* Forty-four percent (44%) of respondents were from large enterprises (annual revenues above US $1 billion); 37% were from midsize enterprises (annual revenues between $50 million and $1 billion); and 19% of respondents were from small businesses (annual revenues of $50 million or less).
- *Headcount:* Sixteen percent (16%) of respondents were from small enterprises (headcount between 1 and 99 employees); 28% were from midsize enterprises (headcount between 100 and 999 employees); and 56% of respondents were from large businesses (headcount greater than 1,000 employees).

Study Focus

Respondents completed an online survey that included questions designed to determine the following:

√ What is driving companies to improve PCB design

√ The challenges of PCB design

√ The actions these companies are taking to improve PCB design

√ The capabilities and technology enablers they have in place to support PCB design

The study identifies emerging best practices to support PCB design and to provide a framework by which readers could assess their own capabilities.

Table 6: The PACE Framework Key

Overview
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 2010

Table 7: The Competitive Framework Key

Overview	
The Aberdeen Competitive Framework defines enterprises as falling into one of the following three levels of practices and performance: **Best-in-Class (20%) —** Practices that are the best currently being employed and are significantly superior to the Industry Average, and result in the top industry performance. **Industry Average (50%) —** Practices that represent the average or norm, and result in average industry performance. **Laggards (30%) —** Practices that are significantly behind the average of the industry, and result in below average performance.	In the following categories: **Process —** What is the scope of process standardization? What is the efficiency and effectiveness of this process? **Organization —** How is your company currently organized to manage and optimize this particular process? **Knowledge —** What visibility do you have into key data and intelligence required to manage this process? **Technology —** What level of automation have you used to support this process? How is this automation integrated and aligned? **Performance —** What do you measure? How frequently? What's your actual performance?

Source: Aberdeen Group, February 2010

Table 8: The Relationship Between PACE and the Competitive Framework

PACE and the Competitive Framework – How They Interact
Aberdeen research indicates that companies that identify the most influential 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 those decisions.

Source: Aberdeen Group, February 2010

Appendix B: Related Aberdeen Research

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

- *Printed Circuit Board Design Integrity: The Key to Successful PCB Development*; April 2007
- *PLM in Electronics: Turning Products into Profits*; June 2007
- *Electronics – Correct by Design*; January 2007
- *Assembly, CAM, and Process Planning for Today's Manufacturing Engineer: Boosting Production Productivity while Lowering Costs*; June 2009
- *System Engineering: Top Four Design Tips to Increase Profit Margins for Mechatronics and Smart Products*; October 2009
- *System Design: New Product Development for Mechatronics;* January 2008
- *Embedded Systems Development: Three Proven Practices for Speed and Agility*; March 2009
- *Engineering Evolved: Getting Mechatronics Performance Right the First Time,* November 2008
- *The Engineering Executive's Strategic Agenda;* June 2008

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

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