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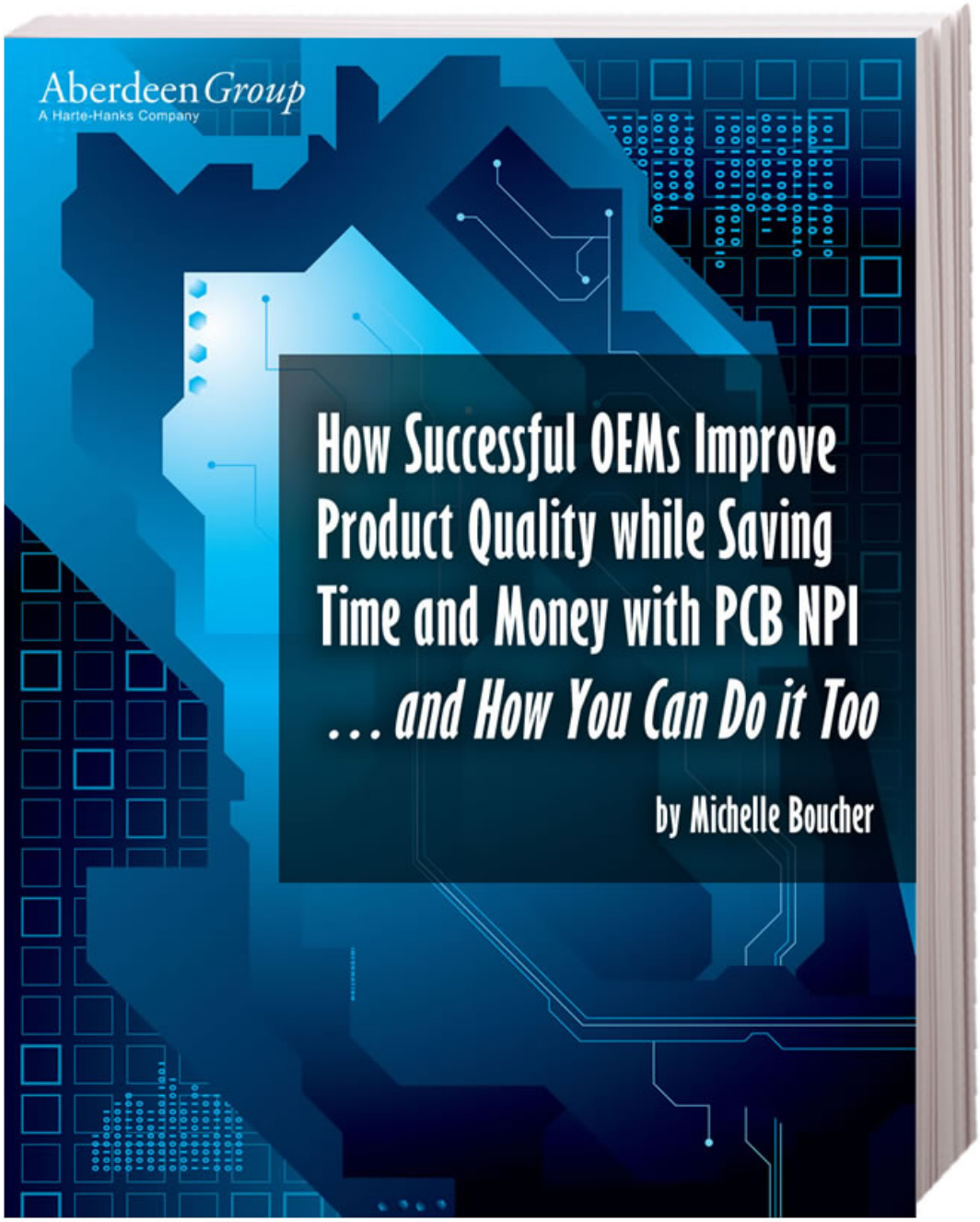
How Successful OEMs Improve Product Quality while Saving Time and Money with PCB NPI

... and How You Can Do it Too

by Michelle Boucher



Research Brief

Aberdeen Group
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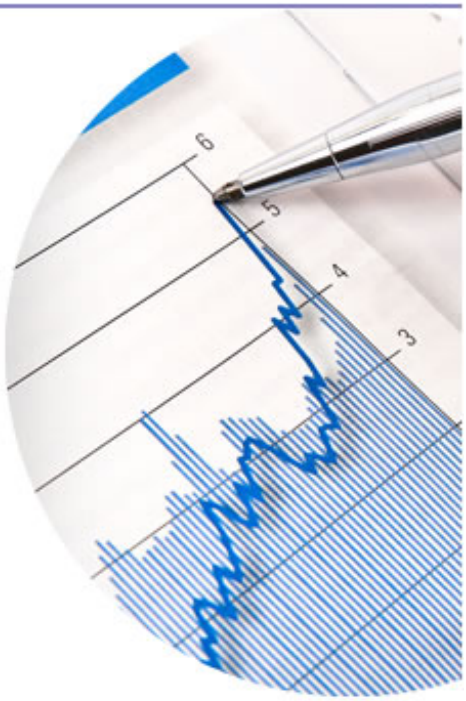
September 2012

How Successful OEMs Improve Product Quality while Saving Time and Money with PCB NPI…and How You Can Do it Too

Getting quality products to market as quickly as possible is critical to providing the competitive advantage needed to maximize new product revenues. Aberdeen's February 2010 report, *Why Printed Circuit Board Design Matters to the Executive*, showed that over 40% of electronic manufacturers feel new product speed to market and low cost products are the top pressures in the market. One critical aspect of producing PCBs is New Product Introduction, or NPI (sidebar).

RESEARCH BRIEF

Aberdeen's Research Briefs provide a detailed exploration of a key finding from a primary research study, including key performance indicators, Best-in-Class insight and vendor insight.

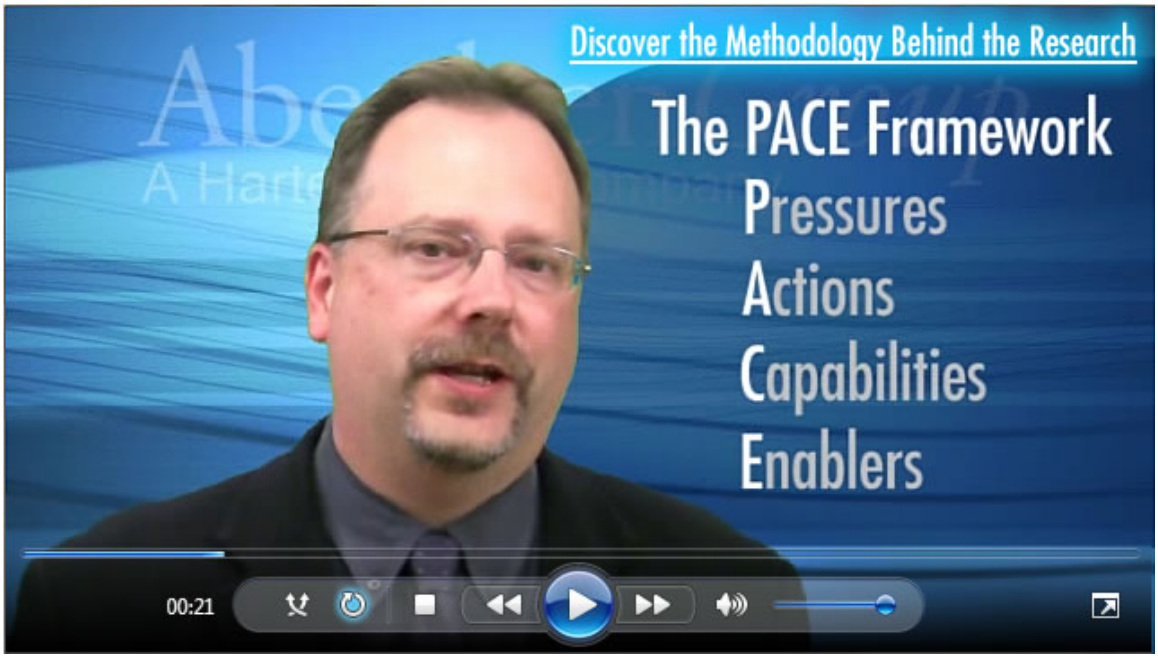


Given how much PCB production is typically outsourced, should product IP owners and those responsible for product design care about NPI? What impact does PCB NPI have on the overall product? What product benefits can be achieved by focusing on NPI? To answer these questions, Aberdeen analyzed the experiences of 145 companies responsible for designing PCBs. This paper identifies how Design for Manufacturability (DFM) and smoother handoffs between design and manufacturing avoid costly problems and wasted effort during NPI, resulting in improved efficiency and PCB quality, and, ultimately, higher product profitability.

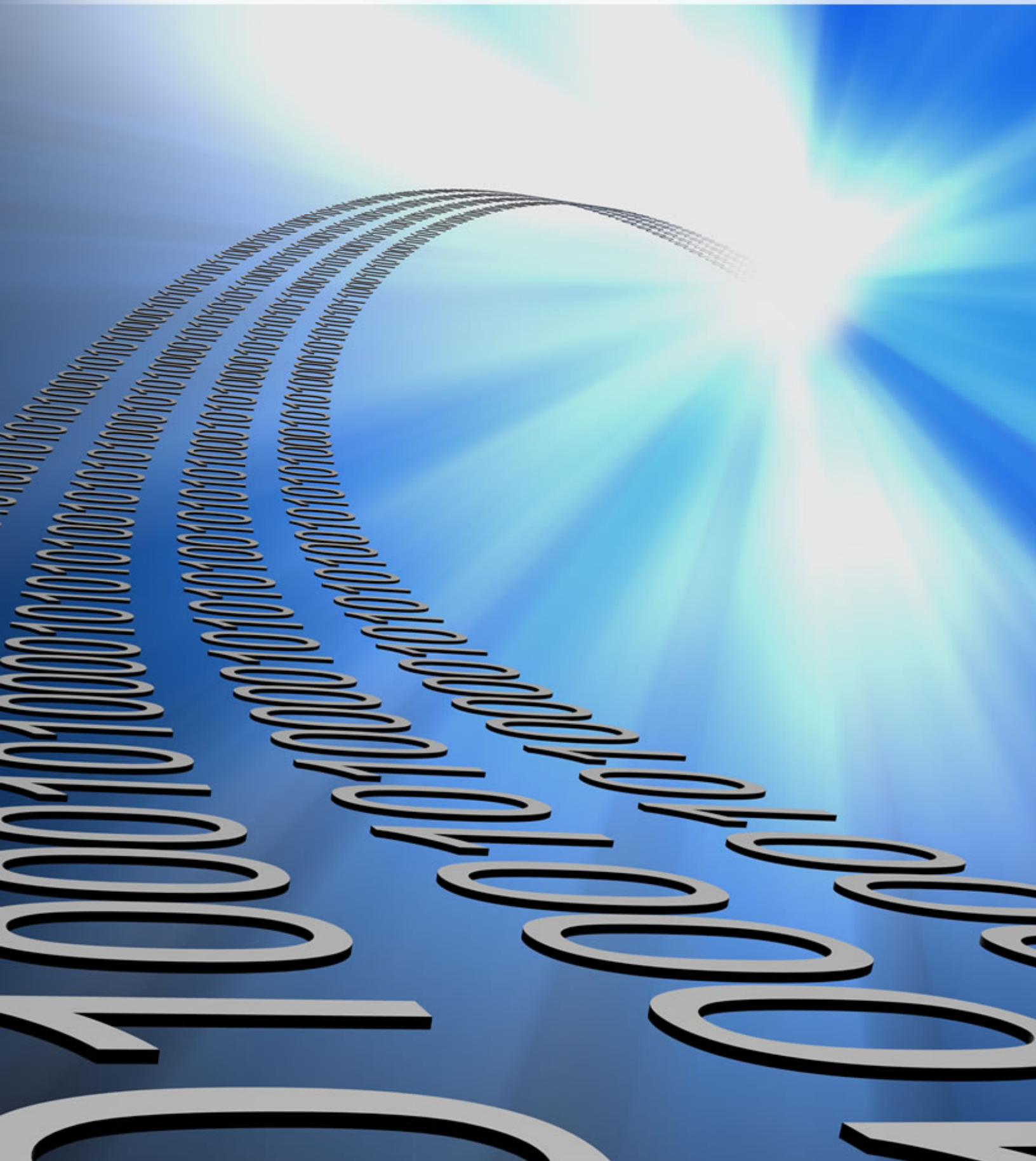
NEW PRODUCT INTRODUCTION

New Product Introduction (NPI) is an important business process that guides the flow of information between product design and product manufacturing. It starts at manufacturing hand-off and ends at the start of volume production. It involves all the business processes associated with verifying manufacturability, preparing data for manufacturing operations, and managing the engineering aspects of getting a new product into successful volume manufacturing.

View our video on PCB:



How Critical Is PCB NPI to the Overall Product?



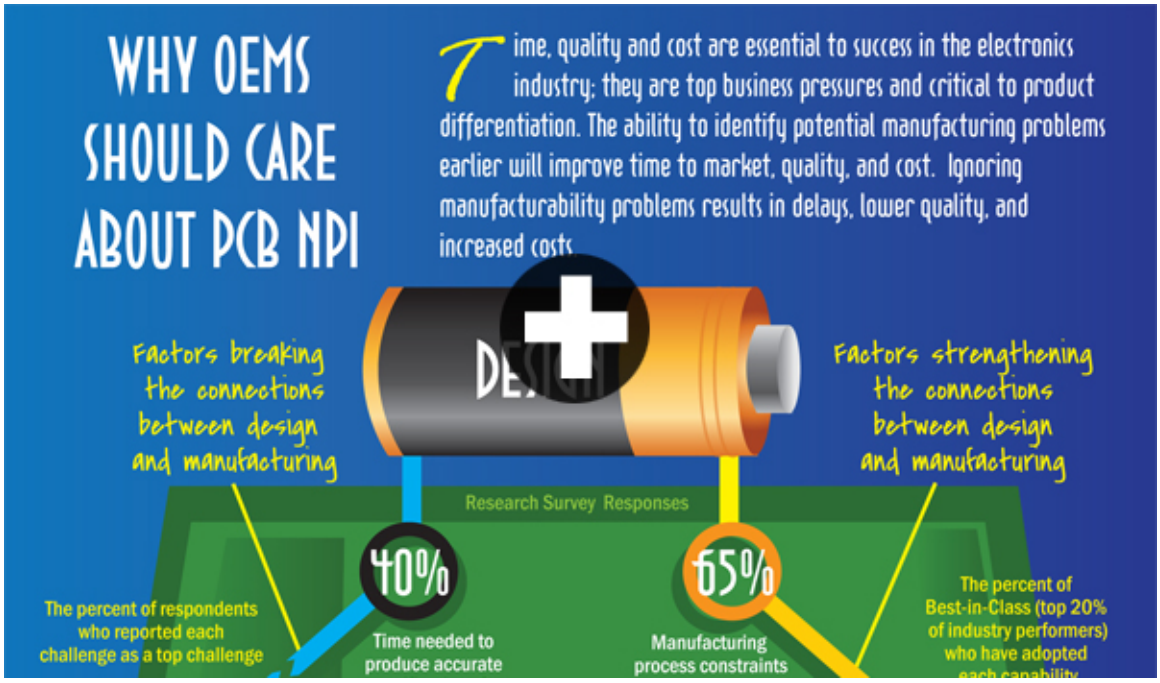
How Critical Is PCB NPI to the Overall Product?

Just how critical is the PCB to the overall product? Survey respondents report that on average:

- 39% of the cost of the entire product comes from the PCB assembly
- 37% of the product development budget goes toward the development of the PCB assembly
- 38% of the time required to develop the entire product is spent on the PCB assembly

With so much investment going into the PCB, companies cannot afford a "throw it over the wall" approach to the NPI process. Companies need to protect their investment in the PCB and ensure that what is designed is actually what is manufactured. Otherwise, quality issues and delays introduced during NPI and manufacturing could put that investment at risk. This is even riskier when an outside party is doing the actual production.

View the PCB NPI infographic:

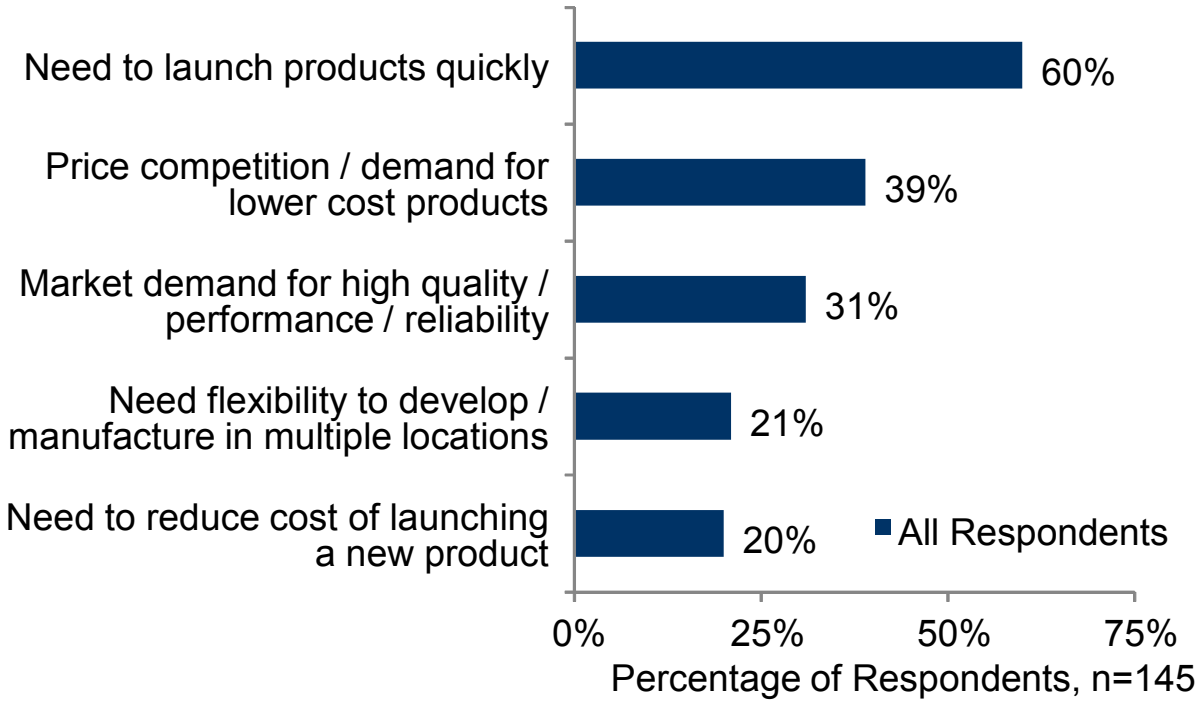


The OEM Business Need for Improving NPI

The OEM Business Need for Improving NPI

When survey respondents were asked to pick the top pressures driving companies to improve PCB design and manufacture, they chose time to market, low cost, and quality (Figures 1 and 2).

Figure 1: Pressures on PCB Design & Manufacturing Improvement



Source: Aberdeen Group, August 2012

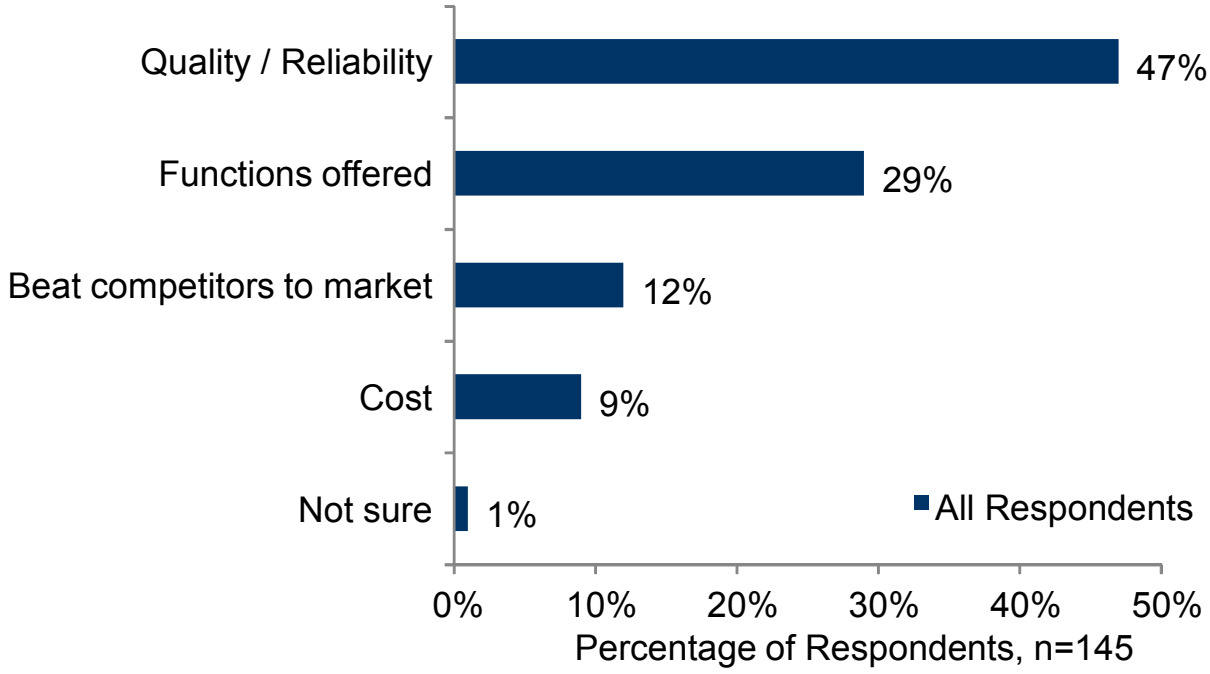
Because of a rapidly changing market for electronics, the window of opportunity for top product profitability is short, which makes time pressures more pronounced than in other industries. This intensifies the pressure to launch products as quickly as possible to recoup investment and maximize revenue opportunity before a competitor makes the product obsolete. With these time to market pressures, companies must look for every opportunity to take time out of the process to stay competitive in the market.

As Figure 1 shows, cost and quality also play critical roles in a product's success in the market. Companies typically will turn over every rock to find opportunities to take costs out of design and manufacturing.

"From the PCB Designer perspective, the more significant advantages to using [an integrated data exchange format] includes reduced overall risk of errors in fabrication and assembly, more on-time deliveries of fabricated and assembled PCBs, and less time spent correcting errors and resending data sets because of missing files."

~ Kent Balius, Vice President, Global Front End Engineering, Viasystems

Figure 2: Greatest Competitive Differentiators for Products



Source: Aberdeen Group, August 2012

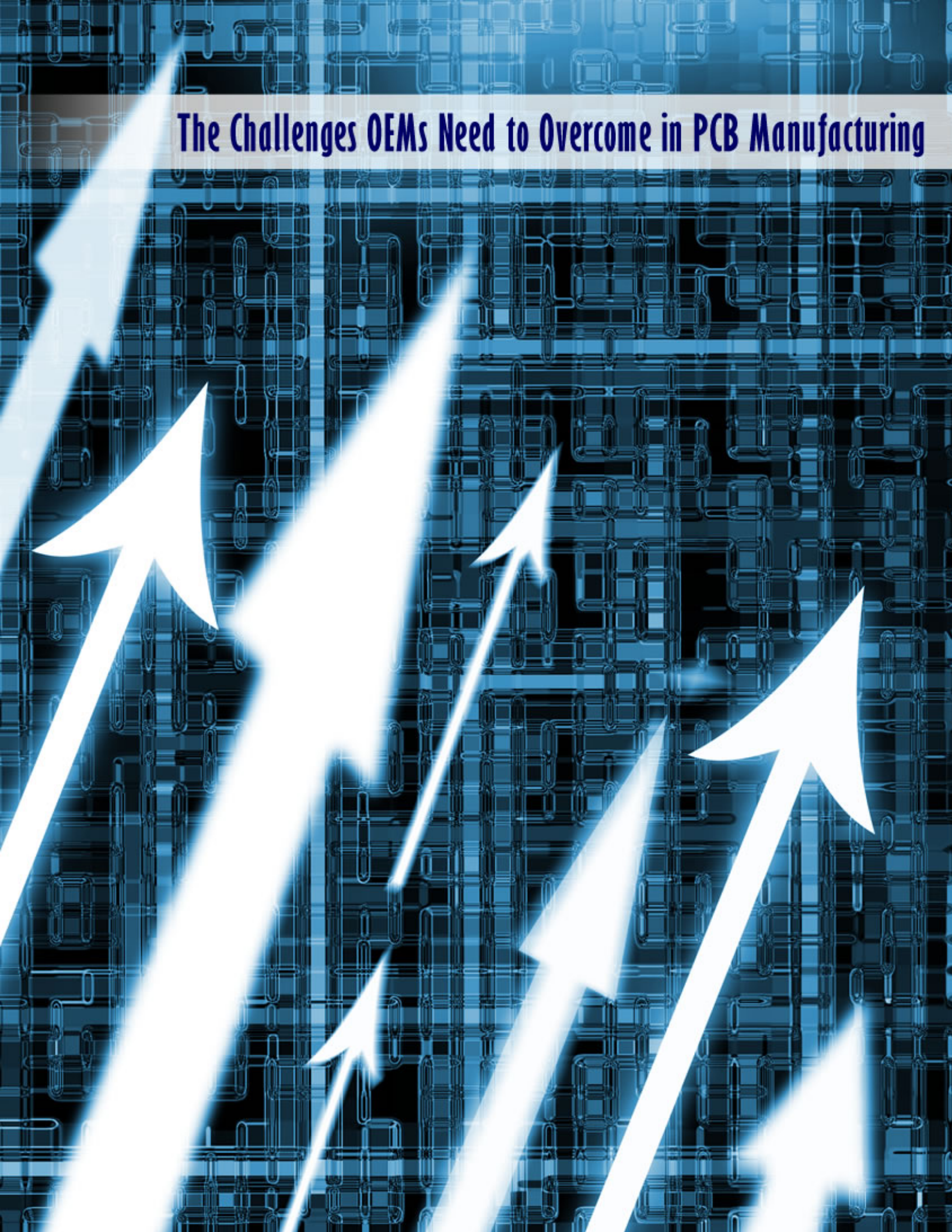
Almost half of the electronics companies in this study identified product quality and reliability as the strongest competitive differentiator for a product. Superior quality and reliability permits organizations to compete on the value of the product without sacrificing margins. As a critical product differentiator, OEMs cannot afford to allow quality problems to be introduced during manufacturing.

NPI involves the flow of information between product design and product manufacturing to ensure that what was designed is what is manufactured. The impact of the NPI process on product success is underscored by the fact that 85% of study participants reported that problems with the PCB assembly have a moderate to significant impact on product differentiation. By not paying attention to NPI during PCB design, organizations put the very qualities that differentiate their products from competitors at risk. This is exacerbated when dealing with a third-party manufacturer.

"As a result of our NPI strategy we have more control over cost and planning of a new product. Alarms are set much earlier in the design process, reducing cost associated with poor quality or not in line with requirements..."

~ Product Development Manager, A&D Company

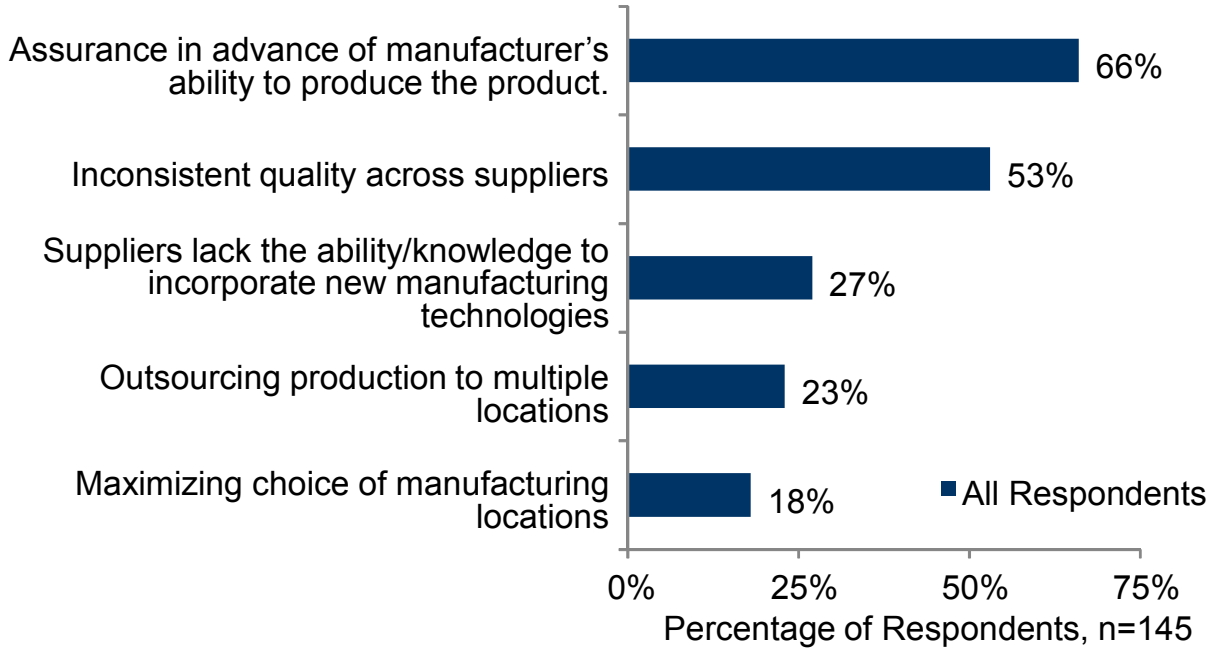
The Challenges OEMs Need to Overcome in PCB Manufacturing



The Challenges OEMs Need to Overcome in PCB Manufacturing

Two sets of challenges interfere with an effective NPI process. The first set is the use of third-party manufacturing partners (Figure 3). The second set involves the data needed for NPI (Figure 4). In each case, respondents selected the top two challenges faced by his or her organization.

Figure 3: Challenges of Outsourcing Manufacturing Operations

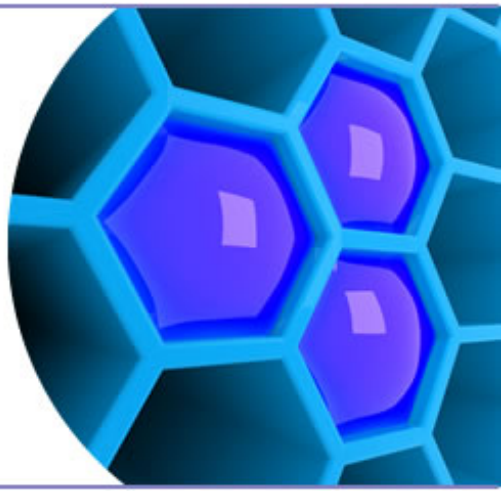


Source: Aberdeen Group, August 2012

Figure 3 points to the importance of visibility into supplier capabilities and potential manufacturability issues during the design stage. Design organizations that adopt a "throw-it-over-the-wall" approach to manufacturing expose themselves to the risk that a supplier cannot produce the product as designed. By the time these organizations discover problems with the design, or that the manufacturer lacks the ability to manufacture the PCB, they have wasted valuable time. Other challenges in Figure 3 may end up being root causes of actual manufacturability issues. The remaining challenges speak to the need for greater flexibility to be able to work with the right manufacturers. Without this flexibility, organizations cannot easily transition between manufacturers, further exposing them to wasted time and product compromises by using the wrong supplier.

"Since I've been generating [an integrated data exchange file] it takes roughly 10% of the time and eliminates different post-process steps (drill, pick+place, etc). It's been great."

~ Ed Piekos, PCB Design, Maxim



This first set of challenges can be addressed with better insight into manufacturing capabilities and limitations during the design process. Design for Manufacturing (DFM) is critical to improving the efficiency of NPI. This strategy forms the bedrock of Best-in-Class performance. The sooner potential problems are identified, the more design options are available to address them. Organizations adopting this strategy reduce wasted time and improve product cost and quality. The Best-in-Class further seek to streamline the hand-off between design and manufacturing.

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STRATEGIC ACTIONS OF THE BEST-IN-CLASS

Best-in-Class organizations are more likely than competitors to adopt three key strategies:

Involve manufacturing earlier in the design process

- **36%** of the Best-in-Class
- **32%** of their competitors

Streamline the hand-off from design to manufacturing

- **28%** of the Best-in-Class
- **17%** of their competitors

Reduce NPI complexity with more integrated data formats

- **16%** of the Best-in-Class
- **3%** of their competitors

Note: study participants were asked to report only their "top" strategy.

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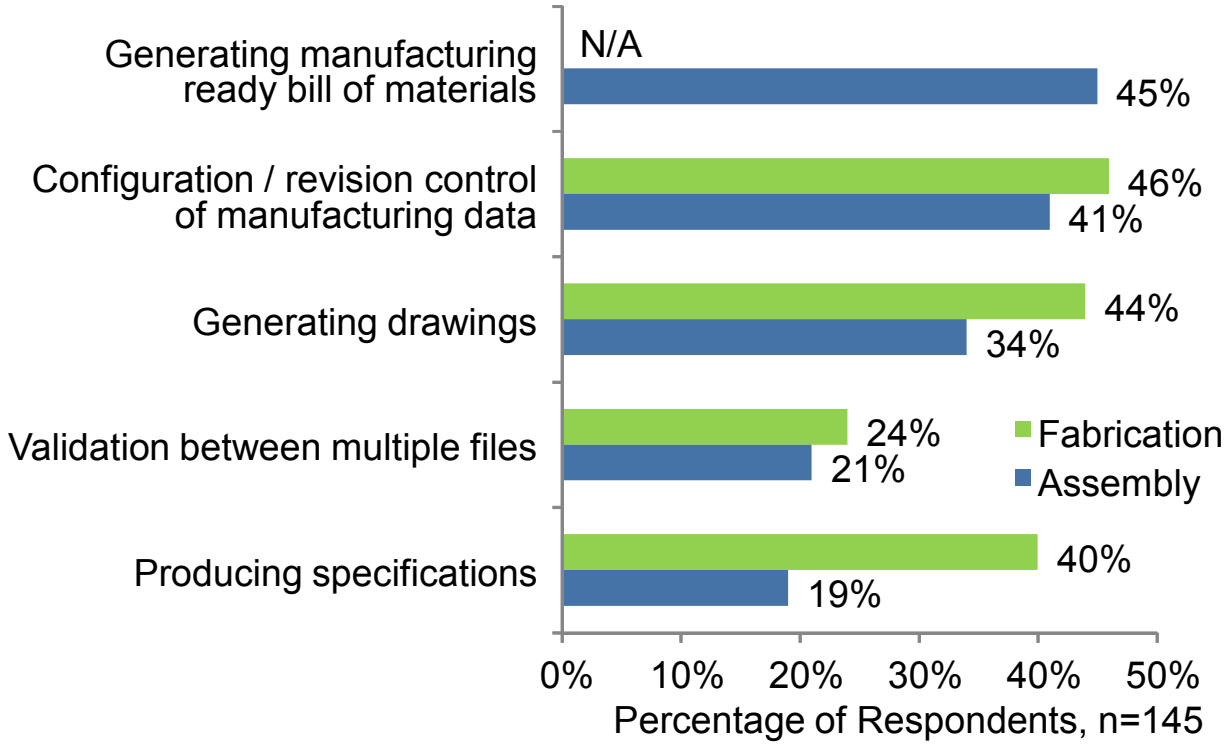
Figure 4: Top Challenges Handing Off PCB Design Data



Source: Aberdeen Group, August 2012

Figure 4 describes the challenges associated with handing off data to manufacturing. This process is complicated by the complexity and diversity of the data. Preparing for PCB fabrication and assembly involves communicating a large amount of information. PCB data needed for manufacturing consists of multiple, disconnected file types that must be created quickly and can easily get out of synch. This data typically includes:

- Drawings
- Manufacturing Bill of Materials (BOMs)
- Specifications

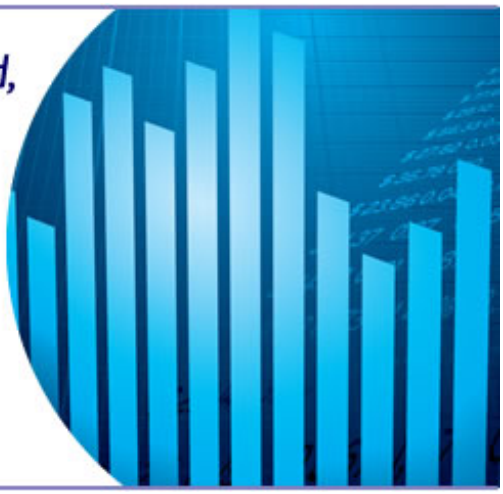
However, all files must accurately reflect the latest changes to ensure the PCB is produced as designed. Inaccuracies and outdated information lead to errors and, in turn, to production delays, increased scrap, and higher cost.

The Best-in-Class stand out from their competitors in their ability to address this second set of challenges. As a top strategy to improve the release of the PCB design to manufacturing, these leaders are 5.3 times as likely to use integrated data exchange formats to transfer design information to manufacturing suppliers.

Integrated data exchange formats automate the "bundling" of the multiple data types and create logical links between them. These logical links allow the software tools needed to prepare the data for NPI to work with the data directly, a process that is much faster and less error-prone than manual manipulation. When an integrated format is used, the data in the drawing is in the same data structure as the BOM and PCB layers data. Without integrated design formats, drawing data must be manually connected to the BOM, which puts data integrity and quality at risk. The danger of manual interpretations means the PCB may not be produced as it was designed. Enabling this level of automation maintains data integrity and avoids quality issues so that the PCB is manufactured exactly as designed, without putting critical product differentiation at risk.

"Based on the data we've assembled, Viasystems has concluded that a validated and complete intelligent [integrated data exchange file] carries a five-times lower risk of errors in NPI tooling."

~ Kent Balius, Vice President,
Global Front End Engineering, Viasystems



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INTEGRATED DATA EXCHANGE FORMATS

Traditional approaches to handing off data from design to manufacturing involve multiple files. Files include required images for the copper conductor, solder mask, silkscreen, plus drilled hole locations, board cutouts and other machining operations as well as the BOM. Gerber files are an example of file types involved in a traditional hand-off. For a simple 2-4 layer board, this could be 9 different files, each requiring thought and time to create. Sets of these files must go to fabricators and assemblers and all files must be at the right revision. The manufacturer must then reverse engineer the files by manually integrating them, which leads to a slow, error prone process. The entire process eats up valuable time and can introduce quality issues. An integrated data exchange file format creates a single definition of the PCB for manufacturing so that time is not wasted creating and managing all those files and the manufacturer can work directly with the data, avoiding manual manipulation. Examples of integrated data exchange formats include ODB++ and GENCAM.

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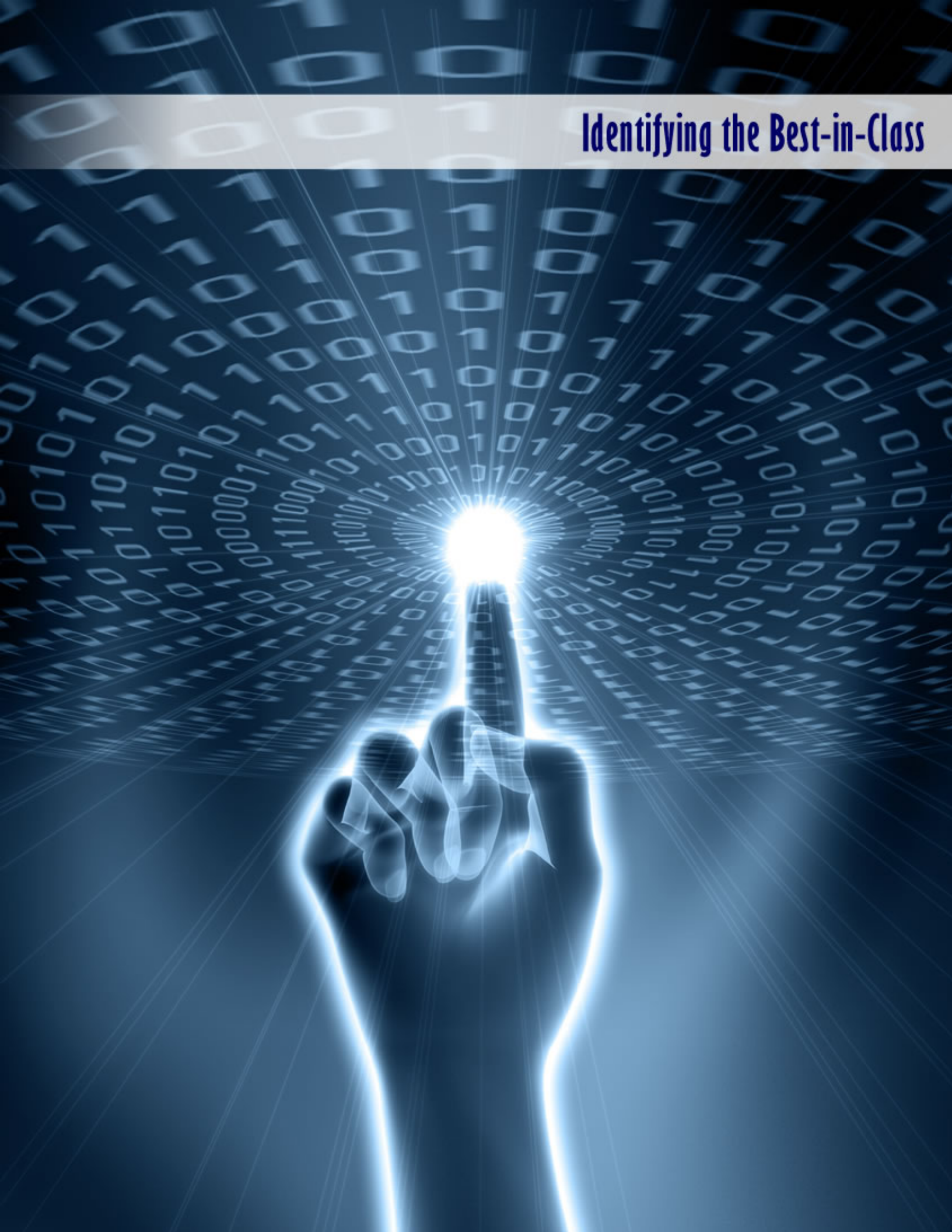
Identifying the Best-in-Class



Identifying the Best-in-Class

To identify the processes that improve NPI efficiency and lead to greater product success, Aberdeen benchmarked study participants and categorized them as either Best-in-Class (top 20% of performers), Industry Average (mid 50%), or Laggard (bottom 30%). Table 1summarizes the performance criteria and results used to define each maturity class.

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	▪ 86% of product launch dates met ▪ 85% of product cost targets met ▪ 88% of product quality targets met ▪ 20% reduction in length of NPI cycle over the last 2 years ▪ 15% reduction in total cost of assembled and tested PCBs over the last 2 years
Industry Average: Middle 50% of aggregate performance scorers	▪ 68% of product launch dates met ▪ 70% of product cost targets met ▪ 78% of product quality targets met ▪ 7% reduction in length of NPI cycle over the last 2 years ▪ 1% increase in total cost of assembled and tested PCBs over the last 2 years
Laggard: Bottom 30% of aggregate performance scorers	▪ 55% of product launch dates met ▪ 51% of product cost targets met ▪ 64% of product quality targets met ▪ 8% increase in length of NPI cycle over the last 2 years ▪ 7% increase in total cost of assembled and tested PCBs over the last 2 years

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OTHER PERFORMANCE IMPROVEMENTS OF THE BEST-IN-CLASS

In addition to the performance gains defining the Best-in-Class, Aberdeen's research revealed that these leaders have experienced the following improvements over the last 2 years:

- **15% reduction** in NPI costs
- **18% reduction** in length of development cycle
- **14% reduction** in fabrication re-spins
- **15% reduction** in transition time between prototype and volume production
- **10% reduction** in engineering change orders (ECOs) after first release to manufacturing
- **11% reduction** in manufacturing hand offs (time to transition design information into manufacturing model)
- **14% improvement** in gross profit margins on new products

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These results are directly related to the strategic emphasis the Best-in-Class place on DFM, as well as streamlined handoffs and communication with manufacturing using integrated data formats. Improved NPI performance places the Best-in-Class in a more competitive market position. These organizations better manage their business by avoiding unexpected problems in the hand-off from design to volume production. This enables them to meet time-to-market, cost, and quality goals more consistently than their competitors.

"[An integrated data exchange format] is the most intelligent CAD/CAM format available today, capturing all CAD/EDA database, PCB fabrication and assembly knowledge in one enhanced single, unified database"

~ Cirexx International

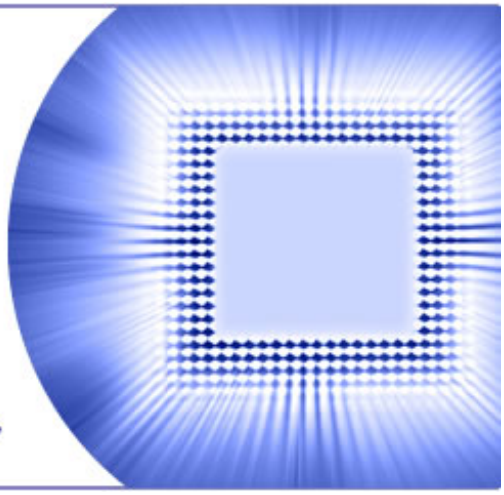
Best-in-Class Steps to Success

Best-in-Class Steps to Success

By comparing Best-in-Class processes to their competitors, Aberdeen identified the best practices most likely to permit organizations to improve their own performance. Best-in-Class practices fall within four themes, aligned to the three core business pressures driving improvements to NPI, and the protection of product intellectual property (IP).

"With the beginnings of an NPI strategy taking shape, we have already realized that the earlier manufacturing issues are identified, will improve delivery time."

~ Product Development Management, Public Sector



Steps to Improve Time to Market

To save time during the NPI process, the Best-in-Class focus on continuous improvement by learning from past mistakes to avoid future delays (Figure 5). Accordingly, these companies ensure engineering has access to manufacturability information and past experiences to foster better design decisions that promote downstream efficiency. Best-in-Class companies are consistently more likely to have critical capabilities than all other companies in all categories Aberdeen measures for time to market in PCB production. These steps permit the Best-in-Class to meet product launch dates 26% more often than the Industry Average as well as reducing development time by 18% and the length of the NPI cycle by 20%.

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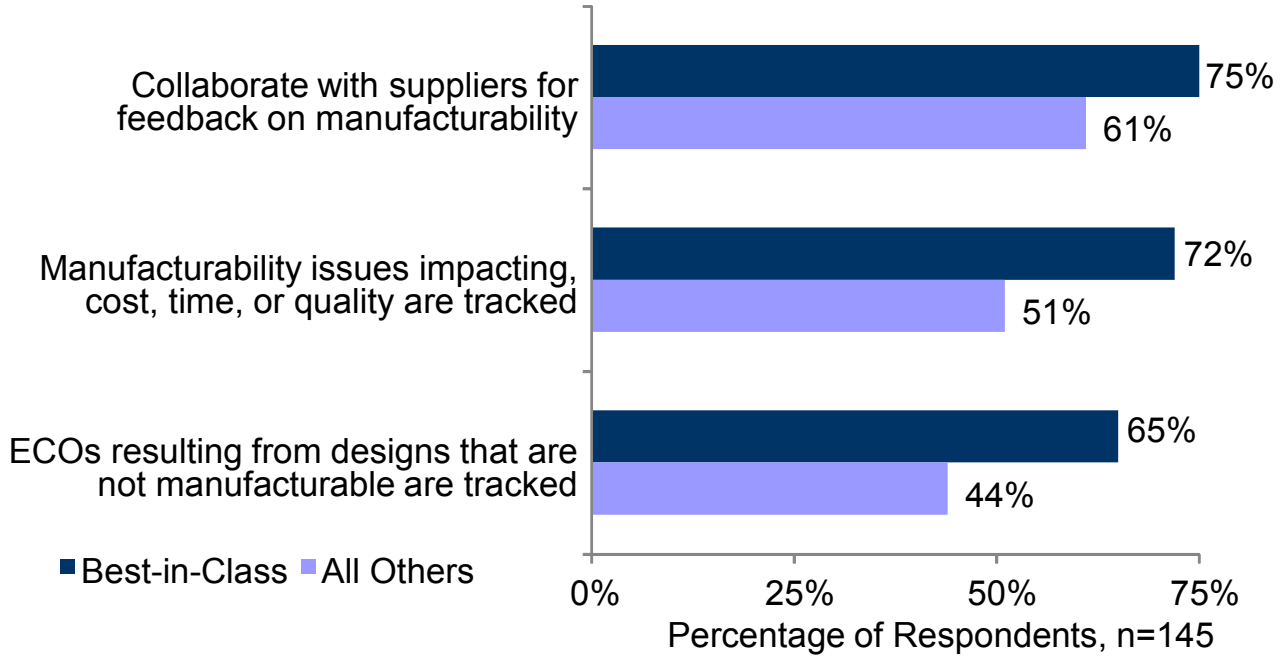
Figure 5: Steps to Improve Time to Market



Source: Aberdeen Group, August 2012

The Best-in-Class collaborate with suppliers to understand their capabilities, and this understanding helps engineering learn how to improve the manufacturability of the PCB. This reduces the risk that the supplier will not be able to produce the board, while also nurturing engineering expertise. Better collaboration with suppliers reduces the risk of delays from late discovery of manufacturability problems, or a supplier who overpromised on its capabilities and cannot produce the part as designed.

"There are MANY advantages to [an integrated data exchange format]. The most significant benefit is that data intelligence in maintained. Not only that, but it significantly reduces engineering's cycle time due to the fact that the reverse engineering aspect is eliminated. And face it, if the job is in engineering, it's not being built – therefore you want to do all you can to get the job to the production floor as quickly and accurately as possible."

~ Mike Tucker, Director of Engineering, Colonial Circuits

Even though the Best-in-Class are consistently more likely to have the critical capabilities needed to outperform All Other companies in time-to-market, their tracking of manufacturability issues really stands out. Almost three-quarters of all Best-in-Class companies have the ability to effectively track those issues. Only half of All Other companies have this ability. This by itself can lead to increased risk for All Other companies, which directly contributes to their lower aggregate performance as shown in Table 1. Tracking manufacturability issues increases visibility, so that others can learn from the issues and avoid similar problems in the future, making it easier to meet schedule, cost, and quality targets.

Steps to Enhance Product Quality

The Best-in-Class maintain quality criteria by identifying potential quality problems during design before releasing anything to the manufacturer (Figure 6). These capabilities, combined with their use of integrated data formats, have contributed to the Best-in-Class's ability to reduce engineering change orders (ECOs) after first release to manufacturing by 10%. They also cut the time needed to transition design information into the manufacturing model by 11%.

"By improving our NPI process, we have fewer revisions, less lead time is needed, and the PCB is often right the first time."

~ Product Development, A&D Company

These capabilities position the Best-in-Class ahead of their competition by helping them differentiate their products with better quality, the top method for competitive differentiation. As a result, the Best-in-Class's brand reputation tends to be superior, enabling them to enjoy a price premium for their products. This contributes to the 14% improvement they are seeing in their gross profit margins for new products.

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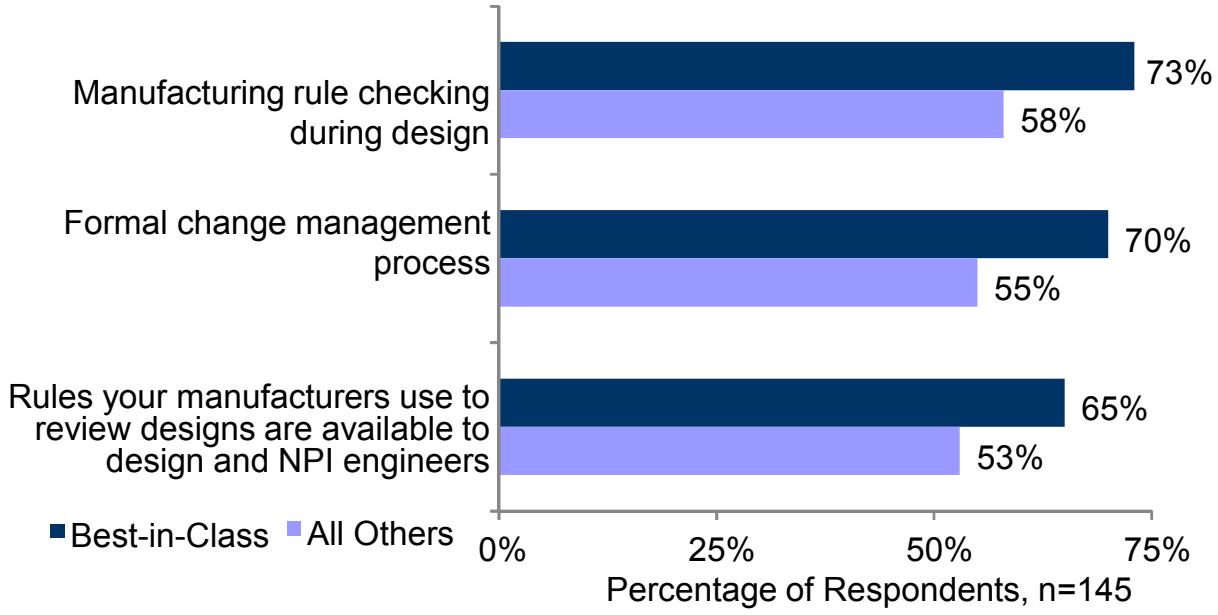
Figure 6: Steps to Improve Quality



Source: Aberdeen Group, August 2012

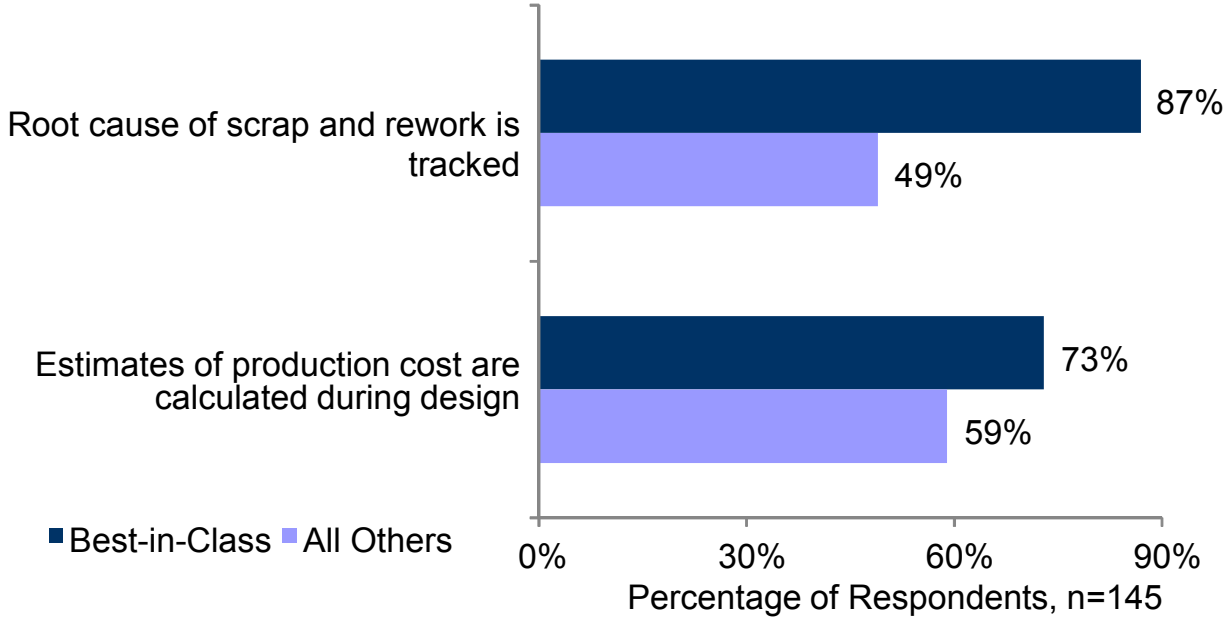
Again, we see that the Best-in-Class have the needed capabilities to outperform All Other companies in quality. Between three-quarters and two-thirds of Best-in-Class companies have critical quality capabilities, while only just over half of All Others have these important capabilities. These capabilities allow Best-in-Class companies to identify potential design problems that would prevent the manufacturer from producing the PCB. This minimizes the risk that a supplier cannot produce the part. And once again, these types of capabilities can lead directly to the performance discrepancy shown in Table 1.

> *"So far, we have seen a massive improvement in the quality of the data pack provided to fabricators and assembly houses. We now have consistent data and a simplified process to ensure data is correct."*
>
> ~ Engineer, Consumer Electronics Company

Steps to Reduce Cost

To manage product cost, the Best-in-Class give engineering access to key data that helps them make decisions to take cost out of products (Figure 7).

Figure 7: Steps to Reduce Cost



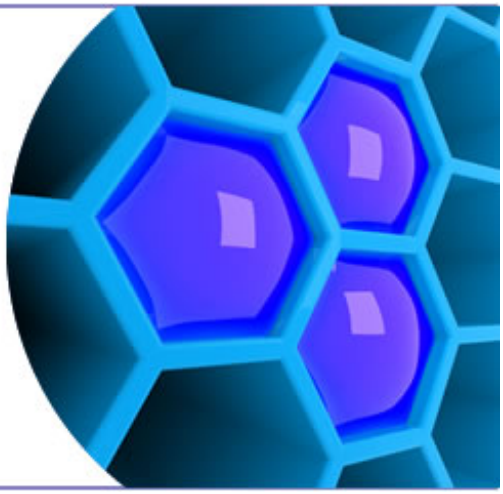
Source: Aberdeen Group, August 2012

Almost all Best-in-Class companies (87%) track root causes for scrap, compared to half of All Other companies. By identifying the root causes that result in scrap and rework, the Best-in-Class can identify practices that lead to waste and avoid these mistakes in the future. Even with cost estimating, the Best-in-Class are 24% more likely to make production cost estimates available to engineers during design. This enables engineering to consider design alternatives that can be produced at a lower cost.

As Table 1 shows, these capabilities enable the Best-in-Class to meet product cost targets 31% more often than their competitors.

"Because of our NPI approach, we have reduced design cycles and less prototypes are required."

~ Engineer, Telecommunications Company

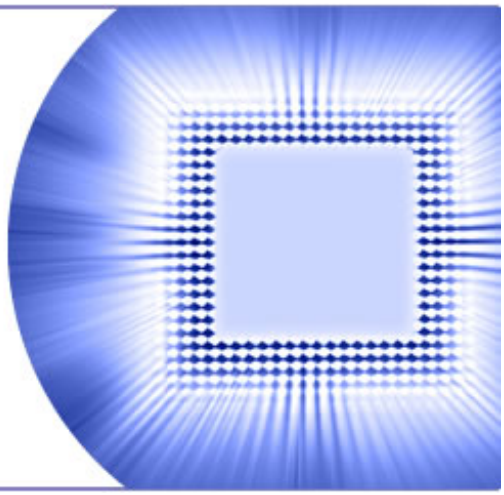


Steps to Protect Product IP

Organizations risk exposing valuable product IP when they share design data with suppliers - even with trusted partners.

"More often than not we get it right the first time, and have a continual improvement process due to our NPI strategy."

~ Engineer, Automotive Company



The Best-in-Class address this concern by limiting the data they share to specific subsets of the manufacturing product model (Figure 8). This ensures that suppliers do not have access to all design information, only what they need, limiting the exposure of IP. This provides greater certainty when working with suppliers, and helps reduce the risk that competitors exploit compromised trade secrets and other product IP to erode the profitability of a company's products or its overall market position. As with our previous data, between two-thirds and three quarters of the Best-in-Class have these capabilities, while All Others are around or below 50%.

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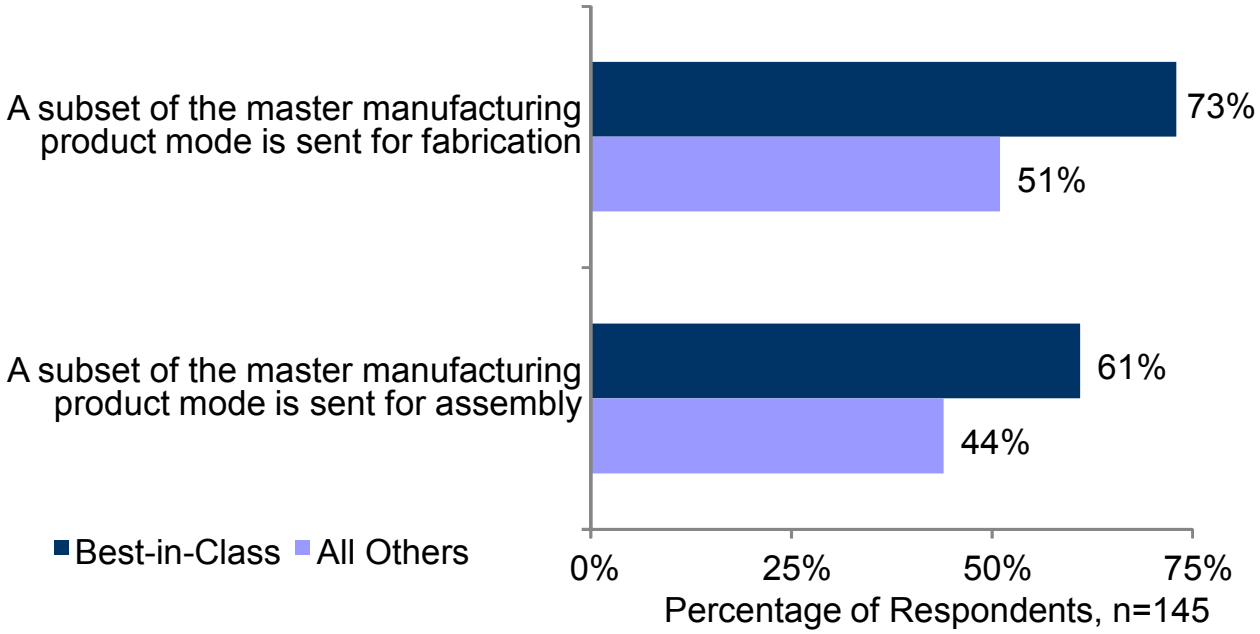
Figure 8: Steps to Protect Product IP

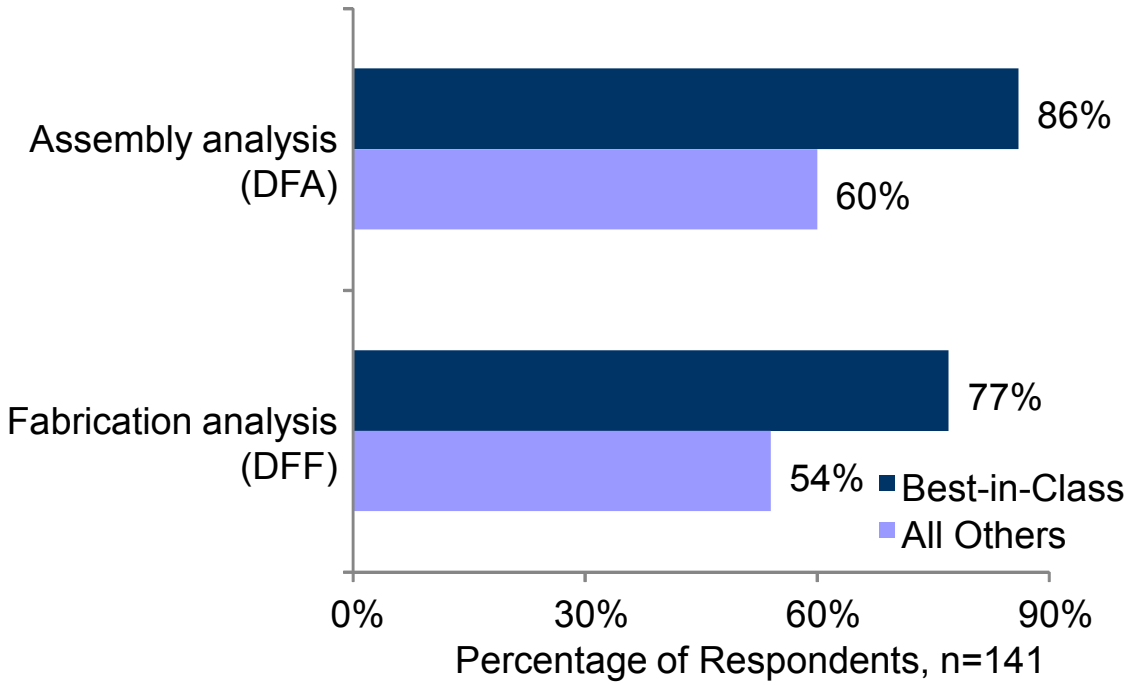


Source: Aberdeen Group, August 2012

Automating Manufacturability Analysis with DFM

The Best-in-Class use two key sets of DFM tools to support these processes: Design for Assembly (DFA) and Design for Fabrication (DFF). Using the tools throughout the design process allows the Best-in-Class to take advantage of manufacturing knowledge, continuously improve, and make better design decisions in less time. As a result, the Best-in-Class are better positioned to identify manufacturability problems that affect time, cost, and quality. Almost all Best-in-Class (86%) use these tools, while All Other companies are between 50% and 60% usage (Figure 9). Again, Table 1 shows the impact these tools can have on overall NPI results.

Figure 9: DFM Tools Used Regularly Throughout Design



Source: Aberdeen Group, August 2012

Key Insights and Steps to Being Best-in-Class

Key Insights and Steps to Being Best-in-Class

The business world is built on results. Taking Table 1's results and looking at the capabilities and tools Aberdeen found to correlate with Best-in-Class performance, we can draw some conclusions as to how companies can close the performance gap and approach Best-in-Class performance.

Organizations seeking similar results as the Best-in-Class should:

- **Focus on manufacturability issues during design to reduce risk in the NPI process**. This involves facilitating collaboration between design and manufacturing, as well as tracking information on past problems. This builds knowledge around issues that cause manufacturing problems, so they can be identified earlier in the process, avoiding delays. This supports the Best-in-Class's ability to meet product launch dates 26% more often than the Industry Average.
- **Improve product quality by applying manufacturing rules to designs.** This allows potential manufacturing problems to be identified earlier, when it is easier to evaluate alternatives that ensure the PCB is produced as designed without sacrificing quality. Catching quality issues during design has allowed the Best-in-Class to reduce ECOs after first release to manufacturing by 10%.
- **Make production costs available to the engineer to support cost optimization** so that more economical design alternatives can be considered. This helps the Best-in-Class meet product cost targets 31% more often than their competitors.
- **Make sure you have intelligent data hand-off between design and manufacturing through DFM analysis tools throughout the design process**. These tools provide a foundation that will help OEMs meet their time, cost, and quality goals.

> *"By switching to [an integrated data exchange format], we have enjoyed the following benefits: 52% reduction in CAM import time, 34% reduction in CAM DFM/DRC (Design Rule Checking), and 80% reduction in FMEA (Failure Mode Effects Analysis."*
>
> ~ Kent Balius, Vice President, Global Front End Engineering, Viasystems

In aggregate, The Best-in-Class enjoy a competitive advantage by paying attention to the connections between a streamlined NPI process and product differentiation and profitability. In contrast, their competitors who are not taking the same steps as the Best-in-Class expose themselves to the risk of delays, increased costs, and lower quality.

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