MANAGING PCB DESIGN DATA: REDUCING RISK BY BREAKING DOWN SILOS

April, 2015

➔ **Reid Paquin,** Research Analyst,
Manufacturing, Product Innovation & Engineering (PIE)

Report Highlights

p3

There are many consequences that result from poor design data management, but by far the top pressure is the impact on time to market goals

p7

Best-in-Class companies are 43% more likely than their peers to put each data element on the PCB under version control

p9

Where the Best-in-Class differentiate themselves is in their combination of software (PLM, PDM, PCB tailored tools) to manage their design data

p11

The Best-in-Class automate multiple functions (component management, front/back annotations, and DFM) to support the management of PCB design data

Based on the experiences of over 175 executives responsible for PCB design, this report will examine how successful companies have identified PCB design data management as a critical area within the business to improve engineering efficiency while meeting new product cost and quality targets.

ABERDEEN GROUP

Best-in-Class manufacturers are 30% more likely than their competitors to use electronics and embedded software to bring innovation to their products.

All companies today struggle with the pressure of meeting their time to market goals, but for those within the electronics industry, this is especially true. Competitors are consistently introducing new products to outdate others with the aim of undercutting profit margins. The window for capturing market share is now smaller than ever. Effective collaboration across the Printed Circuit Board (PCB) development team is essential to meeting time to market goals today. However, rising product complexity, manual processes, and frequent changes introduce large amounts of risk into the PCB new product introduction process. Data inconsistencies will result in manufacturing delays and excess cost that ultimately means a less successful product.

Based on the experiences of over 175 executives responsible for PCB design, this report will examine how successful companies have identified PCB design data management as a critical area within the business to improve engineering efficiency while meeting new product cost and quality targets.

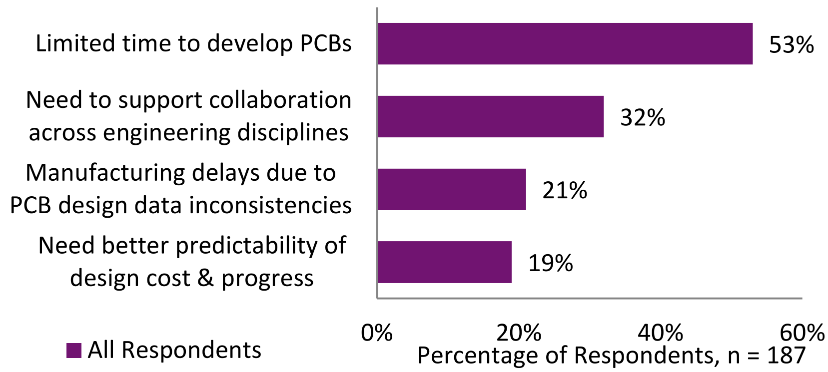
Sector Definition: PCB Design

PCB design is the development, design, engineering, and launch of the printed circuit board. It is not necessarily limited to companies that manufacture PCBs. It can also include companies whose sole purpose is PCB design.

Time Can't be Wasted When it Comes to PCB Design

As more items incorporate electronics every year, the need to efficiently design PCBs to meet those demands increases. In fact, last year's Aberdeen survey on embedded software found that Best-in-Class manufacturers were 30% more likely than their competitors to use electronics and embedded software to bring innovation to their products. However, these innovations come at the price of increasing product complexity, which, in turn, results in the need to manage complex product data. Also, PCB data is very dynamic – having concurrent design processes means the design evolves as different people work on it. There are unique considerations of PCB design data such as constraints, components, and libraries that impact the data management process. There are many consequences that result from poor design data management, but by far the top pressure causing companies to rethink the way they manage their PCB design data is the impact on time to market goals (Figure 1).

Figure 1: Time and Collaboration Driving Improvements



Source: Aberdeen Group September 2014

Time to market has consistently been the top pressure on product development and this is especially true in the electronics industry. In fact, *every year for the past five years*, time has been the number one pressure identified by companies surveyed looking to develop more successful products. The fast pace of market change means that products that are late to market have a shorter window for revenue opportunities before a competitor comes out with a newer version. As recent Aberdeen research has shown, the consequences of a delayed launch can severely impact the overall success of the product. To address this, the development process must be as efficient as possible, which includes streamlining access to PCB design data.

This also means that there is no time to waste working on an outdated wrong version of a file. There are many different engineers working on a PCB (radio frequency, analog, digital engineers, etc.) and they need a way to efficiently collaborate throughout the design phase. In addition, effective collaboration means the collective expertise of the development team is

"It's very tedious to manually keep schematic, layout, and FPGA signals in sync during the early design phases. The plan to solve this issue is to investigate more modern, integrated tools, which offer robust version control with visual comparison of differences between versions and automatic detection of signals being out of sync. There is lots of wasted effort checking and re-checking entire schematics for very complex designs."

~ Product Development Staff, Aerospace and Defense Contractor utilized, which results in a more efficient process. The need to facilitate this collaboration is further driving the need for better data management of the PCB data.

What is Considered Critical IP?

Survey respondents were asked what PCB design data is considered critical intellectual property:

- Design Data (schematic, layout): **92% of respondents**
- Libraries (symbols, footprints, models, etc.): **73% of respondents**
- Constraints (performance, manufacturing, etc.): **60% of respondents**
- Work in process: **35% of respondents**

Beyond the impact on time and collaboration that occurs with poor PCB design data management; there is the potential for increased costs from rework. Incorrect or inconsistent information being released to manufacturing causes errors that lead to delays and higher costs that hurts profitability. Clearly there are significant drivers causing companies to seek improvements in the management of PCB data. However, before we can start talking about better data management for PCB design, we first need to understand which data types should be considered critical (see sidebar).

It is not too surprising that data like schematics and layouts are considered to be critical IP. However, perhaps less obvious data types include libraries containing items such as symbols, footprints, models, and reuse blocks. Also, performance and manufacturing constraints should be included. Even work in process is considered to be important to a third of survey responses and considering the extremely fast pace at which PCB designs evolve and are released, this makes sense. Work in process includes the latest changes and who made them, visibility into the latest version of each data type, and an audit trail to provide traceability to ensure the multiple data types remain in synch. As we will see, all of these data types must be considered critical and effectively managed to be successful.

This causes the question to be asked, what are the challenges that need to be addressed to streamline access to the right PCB design data at the right time? There are numerous data types that must be managed, but also complex relationships and dependencies between these data types. This rising PCB complexity also plays a part in the next highest challenge identified by respondents, integration with existing data management tools (see sidebar). The PCB is generally one of many parts that go into a product. Enclosures for the PCB, as well as other mechanical parts, are designed using separate tools tailored for mechanical design. Given that all of the parts will go into a final product, it makes sense to store everything within a central location. Companies have made concerted efforts to improve access to the mechanical side of the design (investments in PLM, PDM, ERP, etc.); this approach must now be taken with the PCB. In fact, survey respondents report spending almost a quarter of their time (24%) just correcting PCB data integrity issues, precious time that could be spent on value added development work.

With the multiple engineering disciplines needed to design PCBs and the products they go into, effective collaboration between these groups is important. However, the rising trend of globalization and outsourcing has led to engineering teams that are spread across multiple locations or work for different companies. A data management system must be implemented to allow these distributed groups to work together. In addition, these companies must be able to adapt on the fly and manage any changes that may need to occur. The speed at which these changes occur, combined with the number of different file types impacted and the complexity of the data, makes the change management process uniquely complex. With the multitude of challenges and pressures that PCB manufacturers face, it is no surprise to see these companies start to identify areas they can improve.

What is Best-in-Class?

To define Best-in-Class companies, Aberdeen used four metrics that measure an organization's ability to deliver their products on-time, within cost, and without flaws. In addition, the change

Top Challenges for Managing PCB Design Data

Respondents were asked to select the top two challenges they feel when managing their PCB data:

Complexity of PCB data:
- **44% of respondents**

Integrating PCB design data with existing data management tools
- **43% of respondents**

Exchanging data with different sites, 3rd parties, and partners
- **42% of respondents**

Managing multiple Engineering Change Orders (ECOs)
- **35% of respondents**

in development time was factored in as limited time is by far the largest pressure that companies deal with today when it comes to PCB design. Aberdeen categorized participants as Best-in-Class, Industry Average, or Laggard; we also refer to a fourth category All Others (Industry Average and Laggard combined). Table 1 highlights the performance of the three maturity groups.

Table 1: Defining the Best-in-Class

Definition of Maturity Class	Mean Class Performance
Best-in-Class: Top 20% of aggregate performance scorers	87% of product cost targets met 87% of product launch dates met 91% of product quality targets at design release met 10% *decrease* in PCB development time over the last two years
Industry Average: Middle 50% of aggregate performance scorers	79% of product cost targets met 73% of product launch dates met 83% of product quality targets at design release met 5% *increase* in PCB development time over the last two years
Laggard: Bottom 30% of aggregate performance scorers	54% of product cost targets met 45% of product launch dates met 65% of product quality targets at design release met 21% *increase* in PCB development time over the last two years

Source: Aberdeen Group, September 2014

Clearly, the Best-in-Class are doing something right – they have effectively streamlined their design process, leading to greater efficiency and allowing them to decrease development time by 10% while their competitors have actually seen *increases* in development time. This improved process also leads to greater consistency within their designs, allowing them to meet scheduled launch dates. This has also allowed them to do a better job of avoiding data integrity issues that hurt quality, lead

Additional Metric Performance (past 2 years)

Change in warranty costs:

- **Best-in-Class - 22% Decrease**
- **All Others - 2% Increase**

Change in fabrication re-spins:

- **Best-in-Class - 20% Decrease**
- **All Others - 1% Decrease**

Change in scrap/rework:

- **Best-in-Class - 28% Decrease**
- **All Others - 16% Decrease**

Change in physical prototypes:

- **Best-in-Class - 17% Decrease**
- **All Others - 2% Increase**

Change in ECOs after release to MFG:

- **Best-in-Class - 15% Decrease**
- **All Others - 2% Increase**

to waste, and drive up costs. Their peers cannot say the same, which shows in their poorer overall performance.

Providing Best-in-Class PCB Design Data Management

Given the significant time pressures on the PCB development team, there can be no time wasted fixing data integrity issues. To address this, the Best-in-Class are 43% more likely than their peers to put each data element on the PCB under version control (Table 2).

Table 2: Control over PCB Design Data

Metric	Best-in-Class	All Others
Schematics and PCB layout are synchronized	95%	77%
Access to data is controlled based on user role	81%	58%
Schematics and BOM are synchronized	76%	57%
A single source of data exists for the PCB project	65%	57%
There is version control for each data element on the PCB	57%	40%

Source: Aberdeen Group, September 2014

They also are more likely to ensure the schematics, layouts, and BOM are synchronized. Working with outdated information results in wasted effort, rework, and scrap, all of which can derail a product's time and cost targets. Good collaboration is critical to working efficiently and shortening development time. To support collaboration within the PCB development team, across engineering disciplines, and with third parties, the Best-in-Class are 40% more likely than All Others to control access to PCB design data based on role. This means there is control over who can view it, as well as who can edit it and when. This user-based access also helps limit undocumented changes to the design, one of the top challenges identified earlier.

"Better tools that define the process for interfacing and handing PCB data back and forth with design service bureaus would really help us. We could use tools that improve these processes:

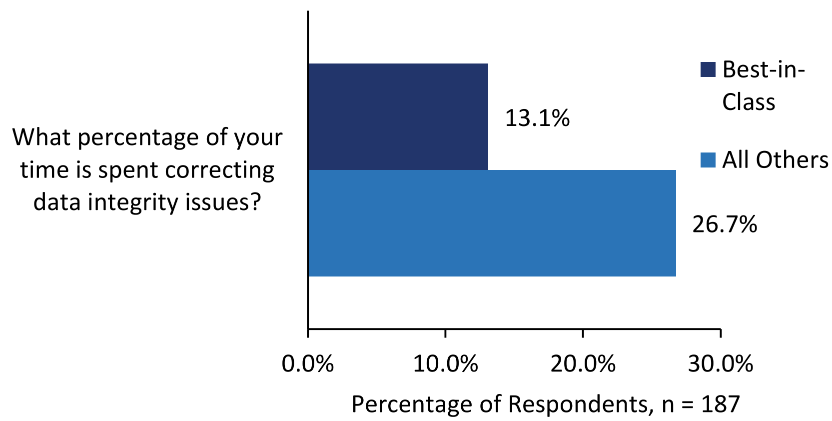
- Schematic to PCB layout process
- Library sharing/control process
- Process for handing layout data back and forth
- Process for review with service bureau

A defined process would help avoid errors such as out of sync databases, libraries changed without knowledge, and poor communication of design changes/corrections."

~ Product Development, Large Aerospace & Defense contractor

As we saw earlier, designers spend roughly 24% of their time correcting data integrity issues. However, as a direct result of these capabilities, Best-in-Class designers have cut that wasted time almost in half (Figure 2).

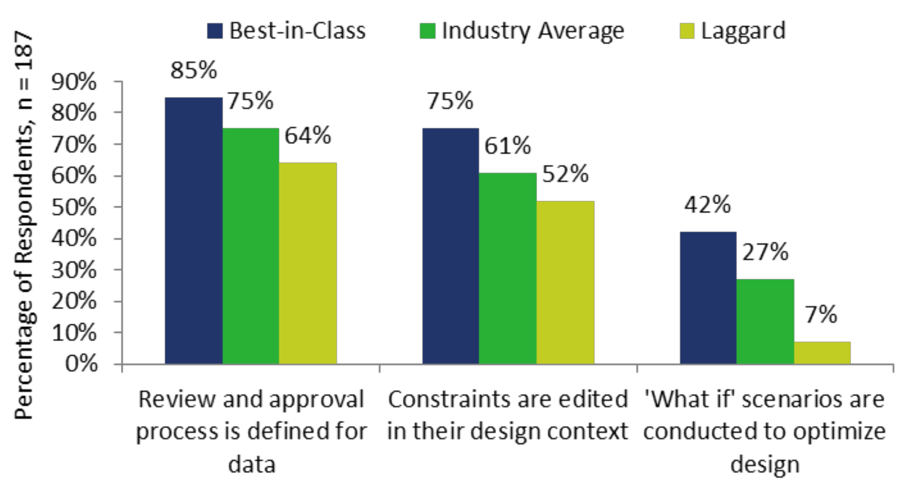
Figure 2: Data Integrity Issues Account for Hidden Waste



Source: Aberdeen Group, September 2014

Furthering this focus on change management, 85% of Best-in-Class companies put a formal process in place to review and approve PCB design data (Figure 3).

Figure 3: Optimizing the PCB Design



Source: Aberdeen Group, Septemeber 2014

"We needed to improve the use of a common set of parts, so we created a library of common resistors, capacitors, inductors for re-use."

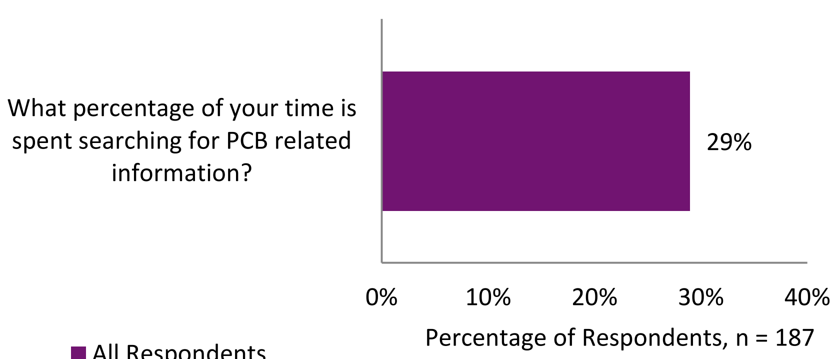
~ Product Development Staff, Aerospace and Defense Contractor

The Best-in-Class are also more likely than their peers to have the ability to edit constraints in their design context. This helps to manage the design complexity by enabling constraints to drive the design workflow. In addition, it makes it a lot easier to visualize the impact of the constraint, which helps to reduce errors. Where the Best-in-Class have the largest advantage however, is in their use of 'what if' scenarios. This allows them to more fully understand the impact of their design decisions to arrive at a more optimal design that simultaneously meets quality and cost targets, while still releasing designs on time. It is this action that allows Best-in-Class companies to enjoy such superior metric performance. Without a streamlined design data management process, like the Best-in-Class possess, these 'what if' scenarios cannot be conducted.

Technology Provides Enterprise-Wide Visibility

When it comes to managing PCB design data, technology plays a large role towards the overall success. In fact, survey respondents report spending 29% of their time just searching for PCB related information (Figure 4).

Figure 4: Time Spent Searching for PCB Information



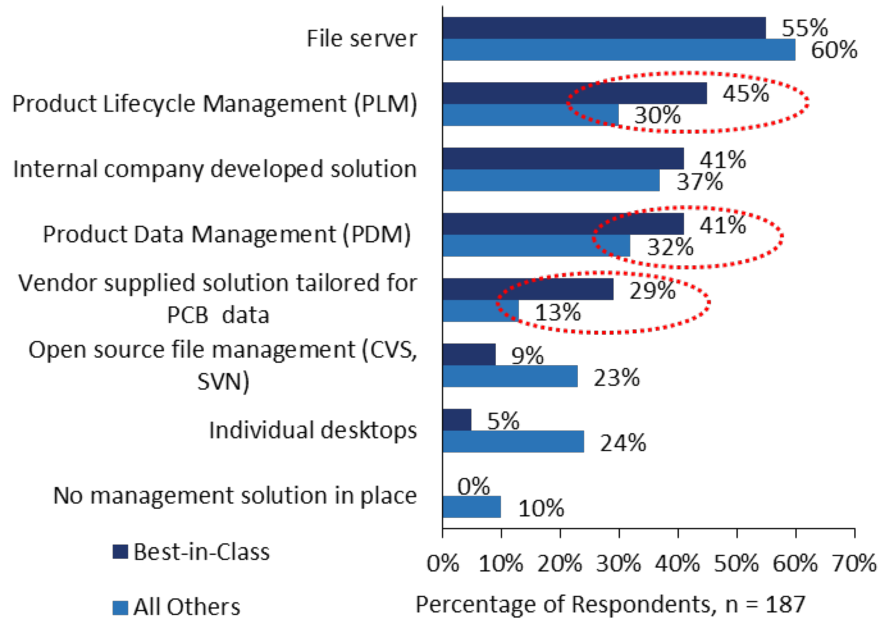
Source: Aberdeen Group, September 2014

"A formal data management solution for PCB data would be very valuable. Currently our PCB data resides in folders writeable by virtually anyone in the company. We have had instances where work has been overwritten because two designers had been working on the same files."

~ PCB Design Manager, Large Telecommunications supplier

This includes time spent providing others with information, preparing for design reviews, and searching for the latest data to implement design changes. There are many different data elements that need to be managed to successfully support PCB development and there are several different solutions companies use to manage their PCB design data. When the solutions are split by the maturity groups, a few notable differences appear (Figure 5).

Figure 5: Software to Manage PCB Design Data



Source: Aberdeen Group, September 2014

The most common PCB design data management method, no matter the company, is the use of file servers. This is not a surprise, as file servers can be an inexpensive way to store PCB data within an organization, but they do have limitations. It is difficult to collaborate between groups and partners, there are security concerns, and version control becomes a much bigger liability if file servers are the only data management tool in use. Where the Best-in-Class differentiate themselves is in their use of software to manage their PCB design data. The Best-in-Class are 50% more likely than their competitors to use PLM to manage

PCB data, which clearly means there is a lot of value in using PLM to manage the entire system.

However, some data types are less suited to be managed by PLM or PDM and work better as an integration into PLM. Complex PCB data like simulation models, front/back annotations, contraints, design variants, component placement, and WIP can be difficult to manage in a traditional PLM solution. A proper system should understand the PCB data and the engineers should be able to use it easily. This is why a growing proportion of successful companies are turning to specialized solutions taliored to PCBs. One thing is clear from Figure 5, a dedicated system is what Best-in-Class companies have started to rely on to manage the many intricacies of PCB design data.

Integrating PCB design data to other design data (MCAD, ECAD, software) is also a challenge for companies that do not rely on software solutions (see sidebar). The Best-in-Class are more likely than competitors to integrate PCB data with internal solutions like PLM and ERP. However, 36% are also doing a manual integration. This means the Best-in-Class are taking several different approaches without a definitive one that works best, although manual integration is probably the least desirable. Poor performing companies either rely on manual integration or, in a worst case scenario, do not even bother to integrate. The key point is that the design data needs to be integrated, it is an important step to executing a strategy for better collaboration across engineering disciplines.

Enablers for Success

The Best-in-Class also use a variety of enablers or tools to support the management of PCB design data (Figure 6 below). Key to their success is the many data elements they manage and make centrally available. The data elements include libraries,

Integrating with other design data

Respondents were asked to identify how they integrate their PCB design data with other design data (MCAD, ECAD, software, etc.)

Integrated with a customized solution:
*Best-in-Class – **36%***
*All Others – **24%***

Integrated with Product Lifecycle Management (PLM):
*Best-in-Class – **32%***
*All Others – **26%***

Integrated with Enterprise Resource Planning (ERP):
*Best-in-Class – **18%***
*All Others – **12%***

Manually integrated:
*Best-in-Class – **36%***
*All Others – **61%***

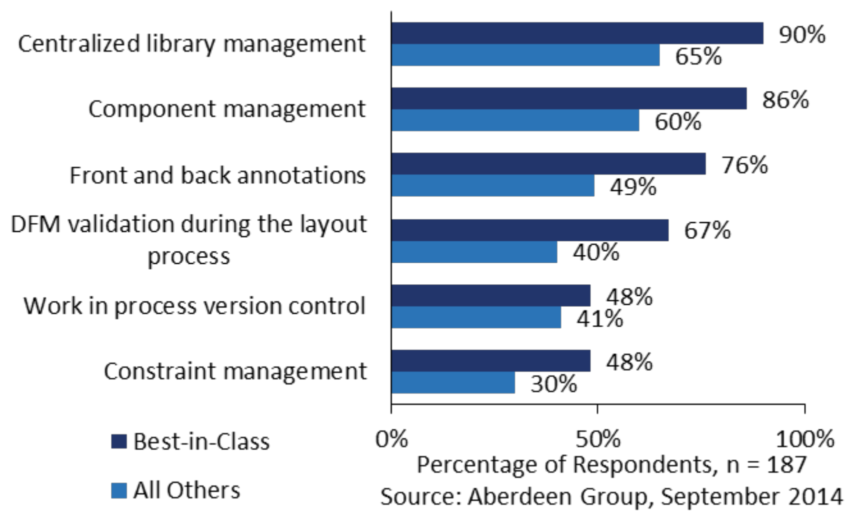
No integration done:
*Best-in-Class – **5%***
*All Others – **13%***

"We design PCBAs for integration into DC motors. Conflicts can occur between the component layout of the board and components of the mechanical design. In one case, we had to re-design due to the heat impact of the mechanical parts on electronic components. In another, we had to re-design because the stack-up of the two teams did not match up and mechanical parts came into contact with electronic components. Each case cost us significant delays and tooling and other development costs."

~ PCB Designer, Medium Automotive Supplier

components, constraints, and simulation results. This supports their strategy to promote greater reuse and saves time because central management means time isn't wasted searching for information. In addition, the Best-in-Class are more likely than their competitors to automate their version control. This helps them address the speed at which changes come in and ensures the development team continues to work with the latest version of the data. Also if we think back to the original question of what should be considered critical IP, it turns out Best-in-Class companies are 57% more likely to view WIP as such. Forty-eight percent of Best-in-Class companies currently place WIP under version control, but another 26% plan to implement it. However, all companies should look to implement a version control system that understands their PCB data and the relationships between each data element.

Figure 6: Processes Automated through Software



Further, the Best-in-Class are also 56% more likely than their competitors to use front and back annotations. Front annotations send changes from the schematic to the corresponding layout. Back annotations do the reverse and send changes from the layout to the schematic. This ensures the schematic and layout remain synchronized, reducing the chance for data integrity errors; a major roadblock experienced by all companies. Also, there are large amounts of waste and rework that can occur after a design is released to manufacturing if the design is not validated. This is why Best-in-Class companies are 68% more likely than their peers to use design for manufacturability (DFM) validation; so that they can catch errors that would increase costs and cause production delays.

Key Takeaways and Recommendations

The PCB design data management process is one that is inherently complex but often overlooked within a company. The complexity of PCB data combined with the rapid pace of change means there are too many opportunities for data inconsistencies. Not catching these errors till it is too late results in increased manufacturing costs and delays. With shortened development schedules, engineers do not have time to waste searching for information or correcting data integrity issues. To address this situation, the Best-in-Class are taking steps to streamline access to data as well as keep it synchronized. Those companies looking to implement a Best-in-Class PCB design data management system should:

- **Implement version control for each data element on the PCB. This helps to make sure engineers are working with the latest version of each data type.**
- **Control access to PCB data, based on role. This ensures data integrity as changes are only made when appropriate and by the right people.**
- **Conduct 'what-if' scenarios to optimize designs. This allows designers to make more informed decisions, enabling them to balance conflicting design criteria to**

keep costs down, quality up, and meet development deadlines.

- **Turn to a formal solution (PLM, PDM, etc.) to manage the entire system. Open source file management and individual desktops cannot keep up with the fast paced nature of changes within the electronics industry.**

- **Provide interoperability across all design data (MCAD, ECAD, embedded software). To design the most successful products, they must be viewed as an overall system - without integration between PCB data and other design data this is not possible.**

For more information on this or other research topics, please visit www.aberdeen.com.

Related Research

NPI Velocity in Discrete Manufacturing: The Hidden Cost of Late Products; November 2014

PCB Design: A Guide to Optimizing Design Engineers; March 2014

The Engineering Workforce Problem: Doing More with No More April 2013

How Successful OEMs Improve Product Quality while Saving Time and Money with PCB NPI…and How You Can Do it Too; September 2012

Author: Reid Paquin, Research Analyst, Manufacturing, Product Innovation & Engineering (PIE) (reid.paquin@aberdeen.com)

About Aberdeen Group

Since 1988, Aberdeen Group has published research that helps businesses worldwide improve their performance. Our analysts derive fact-based, vendor-agnostic insights from a proprietary analytical framework, which identifies Best-in-Class organizations from primary research conducted with industry practitioners. The resulting research content is used by hundreds of thousands of business professionals to drive smarter decision-making and improve business strategy. Aberdeen Group is headquartered in Boston, MA.