MAKING COMPLEX WIRE ASSEMBLIES SIMPLE WITH INTEGRATED HARNESS DESIGN SOFTWARE

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Report Highlights

Though typically comprising only 30% of an electrical system, wire harness system problems are responsible for half of all electrical system faults. However, there is a solution: electrical system reliability is greatly enhanced through the use of an automated wire harness design solution.

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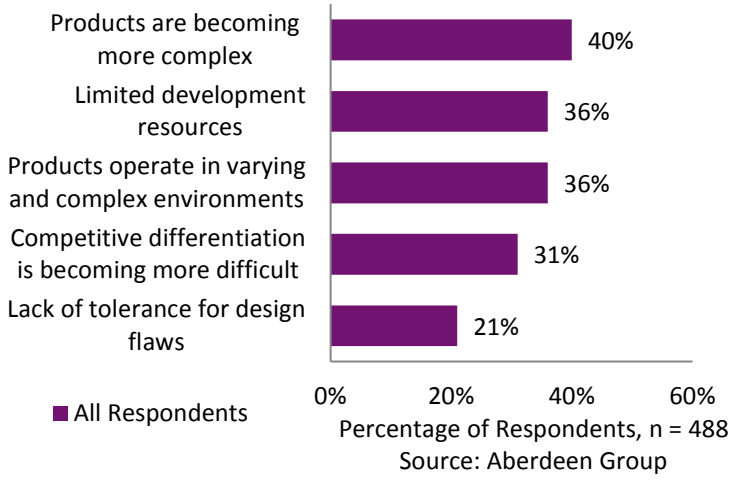
Over the years, wire harness design has become as complex as the systems they reside in. Many CAD tools have evolved to include a feature dedicated to wire assemblies, but the major issues seen by manufacturers have yet to be resolved.

The nature of wire harness design has changed considerably in the last decade. In the past, the idea of a platform dedicated to wire harness design seemed extraneous. However, the strict demands of higher quality and more durability in smaller spaces has forced manufacturers to investigate a solution beyond manually generated spreadsheets.

The Challenges of Modern Wire Harness Design

As wire harness complexity increases, component numbers and circuit density have also risen substantially. And in the race to deliver complex, high-functioning products before competitors, companies face a variety of challenges both internally and externally. In a recent survey by Aberdeen Group, some of the top challenges included: rising complexity (40%), limited development resources (36%), and product operating environment (36%).

Figure 1: Rising Complexity in Product Development



Increasingly, successful innovation depends on a company's ability to develop more complex products, a trend that has doubled in the past 15 years, and has seen significant increase just in the past two years. Survey respondents noted an increase in components

over the past two years: mechanical (13.4% increase), software (34.4% increase), and electrical (19.6%).

Once that differentiation is gained, it's equally important for the quality of the product to remain high. Flaws in the product design can, at best, mean a delay in product delivery, leaving potentially larger implications in a successful market introduction. At worst, it can mean loss of consumer loyalty and thereby market share.

Shortcomings in Conventional Methods

Traditional practice followed by manufacturers placed the design of the wire harness at the last stage in the final system prototype. In these final prototyping phases, where system adjustments are made, changes are possible due to the ability to modify and re-route the wire harness assembly.

Conventional practice in major industrial systems begins with the general specification of the electrical system, along with the circuit schematic for its underlying subsystems. These subsystem schematics go on to define requirements for the associated wire assembly connections. But in spite of this increase in complexity, wire harness design remains largely a manual process. As such, wire harness manufacturers face many challenges:

- ➔ **The overflow in connectors and terminals.** Proprietary control over connector designs has flooded the market with a variety of connectors, but they are rarely duplicated due to intellectual property rights. Consequently, a standard for connector sizing and shape does not exist. Little, if any, commonality exists between connectors and terminals. And even worse, major industrial equipment suppliers are globally distributed. Since these products are

Definition: Wire Harness

Also known as a cable harness, cable assembly, or wiring assembly, Wire Harness is a combination of cables or wires used to transmit signals or electrical power. The harness comes in the form of straps, cable ties, cable lacing, sleeves, a conduit, a weave of extruded string, or some combination of these.

Collaboration is Necessary

What are the major challenges in your product development process?

- Collaboration (locations, suppliers, internal): 39%
- Disconnected processes / siloed departments: 30%
- Frequent engineering changes (ECOs / ECSNs): 26%
- Product Complexity: 25%
- Data Quality: 18%

shipped pre-validated, sources will not allow for the connector design to change.

➔ **Little regulation exists.** Unlike other functional components such as lamps or safety assemblies, wire harnesses are not required to meet any governing body mandate. As such, design flaws can result in serious hazards.

➔ **Wire harness assemblies are manually checked.** Wire harness assemblies are checked using an assembly board. And the connector of each wire end is manually plugged into matching components to check circuit continuity and correct connections. However, this process relies solely on the tester and is not automated.

We Need Insight

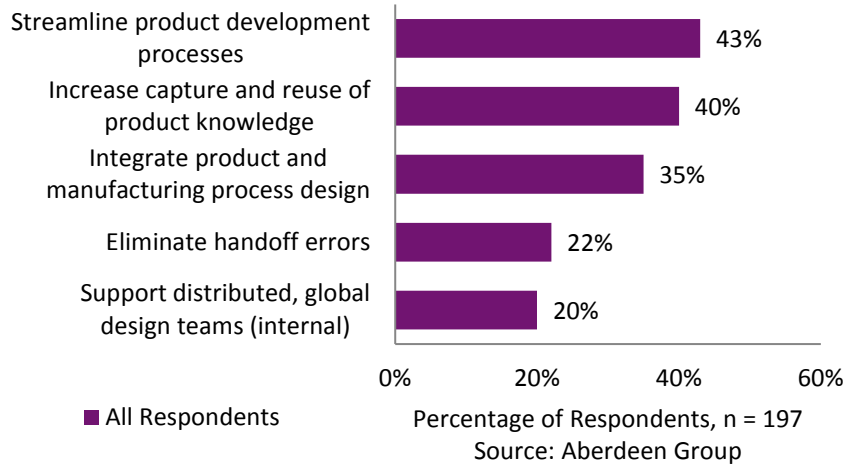
Companies were asked what their major challenges were in getting insight into product development. Here's what they said:

- Too many manual processes (spreadsheets): 39%
- No method for visibility to data to support decisions: 31%
- Lack of expertise/resources: 19%

Overcoming Convention

The challenges for wire harness manufacturers may seem largely out of their control. However, internal changes can be made to alleviate these inefficiencies by streamlining the product development process through automated solutions (43%), increasing capture and reuse of knowledge (40%), and by promoting collaboration through integrating product design and manufacturing (35%).

Figure 2: Increase Efficiency through Streamlined Processes



The advantage of streamlining processes through automation is that manufacturing efficiency increases, quality is improved, worker productivity is boosted, and there are fewer schedule or budget errors due to post-release modifications.

Defining the Best-in-Class

To distinguish Best-in-Class companies, survey respondents were divided into two maturity classes — Best-in-Class (top 20%) and All Others (bottom 80%). These classes were made based on five organizational performance metrics. To what extent did the surveyed respondent's companies meet product launch dates, cost targets, quality targets, or product revenue targets, and the amount change of in development time. Respondents were also asked to identify the frequency at which products met these targets in the past two years. Figure 3 highlights the performance of the two maturity groups.

Figure 3: Best-in-Class Optimize Operations

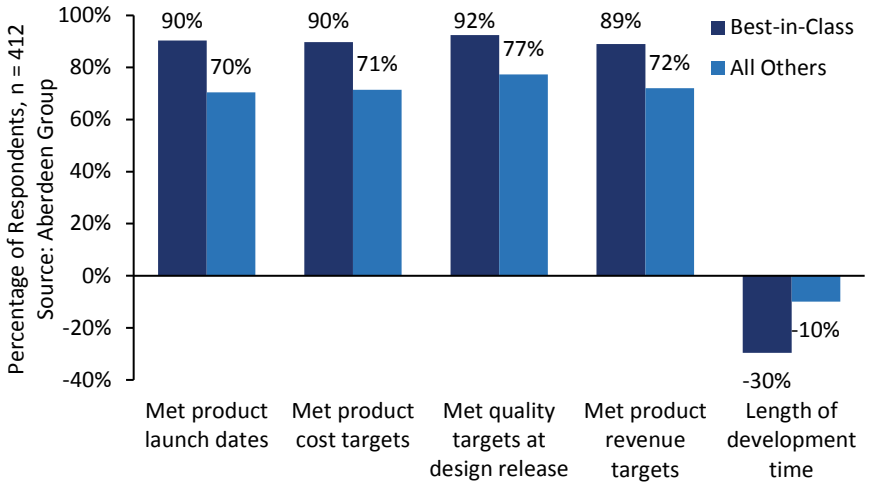
How Do You Support Manufacturing Efficiency?

- Promote collaboration between product design and manufacturing: 44%
- Improve the efficiency of manufacturing operations: 35%
- Increase focus on Lean and operational excellence initiatives: 28%
- Promote collaboration and coordination with the supply chain: 25%

The Best-in-Class Distinguish Themselves

Other performance metrics that separate the Best-in-Class from All Others:

- Met Development Budget
  Best-in-Class: 91%
  All Others: 63%
- Met Performance Criteria at the First Physical Prototype
  Best-in-Class: 86%
  All Others: 66%
- Change in Product Cost (Increase or Decrease)
  Best-in-Class: - 3%
  All Others: + 5%



Best-in-Class companies consistently outperformed their peers. They met their targets by almost 20% in each metric for quality, launch, cost, and revenue. They were also able to decrease development time by almost twice that of All Others. This performance indicates the Best-in-Class are taking tangible steps to separate themselves from other companies.

Route it Correctly

Mistakes made during the wire assembly generally occur due to wiring complexity, but its position at the tail end of the design process certainly doesn't help either. Often, the original design did not make allowances for large bundles of wire, their heat, or spatial restrictions. But with the right tools and capabilities, the intricacies of wire harness assembly can be made easier, and with fewer errors. Best-in-Class manufacturers will take these steps to avoid disastrous wiring scenarios:

➔ **Integrate with your PCB tools.** One of the worst, most common mistakes a wire assembler can make is simply cutting the wires too short, as the entire assembly must be scrapped. Designers are susceptible to a variety of errors including mismatching wire capabilities, incorrect bend

radius, wrong temperature or chemical resistance, or just losing site of the entire system. And these errors generally arise when manual methods such as a drawing tool or spreadsheet is used to design and list connections. Human error is intrinsic to the practice itself, but can lead to unscheduled rework and modifications further down the road. However, these issues can easily be avoided through automatic integration between the schematic, harness layout, and manufacturing tools. Best-in-Class manufacturers are 62% more likely to use historical data and real-time data to optimize decision making (see Figure 4).

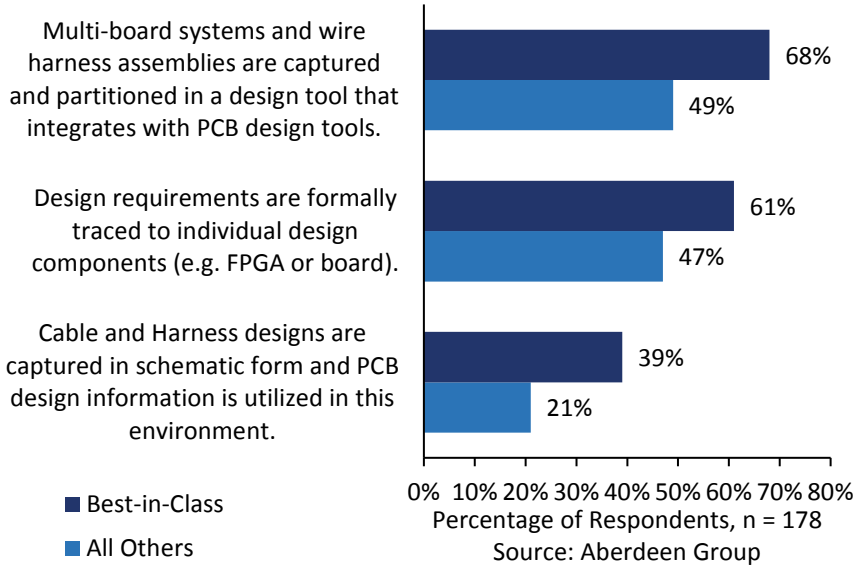
➔ **Trace design requirements to its connections and components**. The number one overarching goal of any wire assembly is ensuring that routing is done correctly. The best way to do so is to trace each connection to its owner and destination using a solution with automation capabilities. Wire harness assemblies are costly and timely to make, and those routed incorrectly render the entire system useless. Best-in-Class manufacturers are 30% more likely to trace design requirements to each individual component as compared to All Others.

Best-in-Class Designs with Manufacturing

Which of the following practices does your company follow to support manufacturing?

- Manufacturability analysis (DFF/DFA/DFT) occurs at multiple stages across the design cycle
  Best-in-Class: 79%
  All Others: 67%
- Design-to-manufacturing process enables design anywhere, build anywhere
  Best-in-Class: 64%
  All Others: 44%
- Component library contains physical models with manufacturability characteristics
  Best-in-Class: 52%
  All Others: 47%
- Manufacturing and test feedback can be captured and viewed in the design tools
  Best-in-Class: 45%
  All Others: 20%

Figure 4: Best-in-Class Use Real-Time Data for Predictive Insight



- **Standardize operational KPIs across the enterprise**. Create one set of KPIs to ensure everyone is working towards the same goal. Since KPIs are used to measure company performance against its own objectives, it's important to ensure consistent KPIs that are measured in the same way. KPIs analyzed with differing standards can make for inconsistent quality. Best-in-Class companies are 23% more likely to standardize their KPIs than All Others.
- **Use an automated solution**. Considering the advances in wire assembly design solutions, it's surprising so many manufacturers still use manual methods. Assemblies done by hand without any restriction checking are bound to introduce errors. Capturing cable and harness designs in the schematic and layouts eliminates errors in the circuit and its ensuing assembly. Best-in-Class are 2x more likely to capture cable and harness designs in the schematic and PCB layout as compared to All Others.

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Key Takeaways

Electrical system reliability is directly tied to the quality of its wire harness layout. A wire layout that has consistent data transfer from design to assembly will completely eliminate electrical faults in wire connections. Similarly, the quality checks of a wire harness help eliminate errors and defaults.

Manufacturers can achieve this level of performance by using an automated wire harness design solution. In design size, the wire harness is roughly 30% of an electrical system. However, it is responsible for more than half of the electrical system faults. The importance of eliminating those errors could be the difference between failure and success.

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