

Overcoming the Top Five Challenges in Electro-Mechanical Product Development

The pressures of globalization and consolidation are complicating the business of product development in almost every industry. But nowhere is the impact being felt more profoundly than in the development of sophisticated electronic products, where companies must synchronize increasingly complex, multi-discipline development environments.

Electrical, mechanical and software development teams are often dispersed across different geographies, potentially working across different languages and cultures, and with different tools and applications. Added to that, traditional technologies do not allow for streamlined collaboration across these engineering silos. Instead of having robust integration that keeps these three disciplines fully informed via a unified data store, manufacturers often 'cross their fingers' and trust that their engineers can find time in their busy schedules to keep each other updated on progress. Unfortunately, in reality, this results in endless review meetings, frustrating re-work, delayed product launches, blown budgets and sometimes even expensive recalls of shipped products.

In this white paper, you'll get a better understanding of how the increasing inclusion of software and electronics is making product development more complex, and how you can find simple solutions that will unlock the process, eliminate the complexity, and unleash productivity – so that your development teams get back to what they do best: create winning products.

What’s not working – and why

Historically, the barriers to integrating electrical, mechanical and software engineering have been caused by a lack of strong process management, as well as technology gaps. Without an overarching structure to manage changes and provide timely communication during the product development cycle, engineers in different disciplines find themselves working on the wrong versions, and using out of date information, with no ‘single source of truth’ to guide and coordinate their actions. Typically, the technology required to improve the processes hasn’t been readily available.

The cost of these technology gaps is familiar to anyone working in the electronics industry; manufacturing or testing teams discover, at the last minute, that their electrical designs won’t work with their mechanical designs – triggering a frenzy of rework that can delay launches, erode quality, and drive up costs. The same dynamic occurs between embedded software and overall electronics configurations. Without a unifying framework to keep everyone on the same page at the same time, manufacturers are left dependent on jury-rigged solutions, hoping things will eventually work out.

Five common ways things go wrong

Almost every aspect of product development could benefit from improved process management and technology. Below, we’ve identified five specific operational challenges that account for some of the most frustrating problems

- **MCAD changes aren’t reaching electrical engineers quickly enough.** Here, an MCAD user makes a change after having distributed the original board outline via an Intermediate Data Format (IDF)–but doesn’t inform the electrical engineer. Meanwhile, the electrical engineer has completed final placement on the printed circuit board. The ECAD layout is now invalid– requiring significant rework and delaying Release to Manufacturing (RTM). Often, these kinds of problems remain uncovered until assembly, when the Printed Circuit Board (PCB) simply doesn’t fit into its enclosure.
- **ECAD working ahead of MCAD.** This scenario is a mirror image of problem #1 above; an ECAD designer adjusts a major component on the PCB to facilitate layout, but neglects telling the mechanical engineer. The design gets released– only to reveal an interference problem between components on the PCB and the PCB enclosure. With product launch just days away, the ECAD and MCAD designers scramble, working around the clock to resolve the problem. The result: a sub-optimal solution causing potential quality problems, a delay in delivery-to-market, and cost overruns.
- **Product is released with the wrong version of the software code.** This issue, which is easy to prevent, occurs more often than most companies want to admit. And when it does happen, another chaotic, time-consuming and costly scramble ensues, with test engineers, software engineers, and electrical engineers forced into late-stage debugging to determine why the product didn’t work correctly.

Cell phone cycle crunch

Time to RTM	
16 weeks	Mechanical engineer defines the initial board outline, keep-out regions, height restrictions, and the placement of critical components such as connectors. The MCAD designer sends this information to the ECAD designer through email via the IDF file format.
12 weeks	Electrical engineer loads the IDF file. Components are placed and traces are routed.
8–10 weeks	Mechanical engineer continues with the mechanical design.
6 weeks	Electrical engineer does a simulation on the PCB layout and finds signal integrity problems. The only way to resolve this issue is to move a major component to provide more spacing for the routes. In a rush, the PCB layout technician forgets to generate a new IDF file and send it back to the mechanical engineer.
3 weeks	Meanwhile, the Mechanical engineer has a problem fitting the battery and antennae into the tight package, so he decides to change the board outline slightly to give himself more room. Since this is a minor change, in the MCAD engineer’s opinion, he doesn’t send a new IDF file to the ECAD layout technician right away.
2 weeks	Final design review. Project manager tells the MCAD and ECAD engineers to send new IDFs to confirm synchronization of the design. Project is already delayed and needs to be completed. They discover that the designs are incompatible.
1 week	Meanwhile, a version of the board design has already been sent out by procurement to a board-shop to obtain a quote, so that, the quote is now invalid.
Release and beyond	The scramble to synchronize electrical, mechanical and software designs continues with late-night meetings and high-pressure workarounds required to pull things together. Manufacturing struggles to meet its launch commitments, and downstream quality problems erode relationships with valued customers.

Some cell phone manufacturers iterate back and forth between the mechanical and electrical design groups more than 100 times during development. This only introduces more opportunities for one engineer to be working with the wrong version of another engineer’s design. Here’s what a typical problem looks like in the real world.

- **Breakdowns in configuration management.** When each design discipline (ECAD, MCAD, CAE) has its own data configuration models, things can quickly fall through the cracks. Sure, the PCB BOM is generated, but it may not include all the necessary mechanical components (such as heat sinks or connectors) that are part of the MCAD data configuration. And since software designers often operate independently, the overall project manager may not know which software executables are required, and which versions of the product they should be kitted with.
- **‘Silo-ed’ software development.** Even when manufacturers apply standard change management processes in product development, software development is usually excluded. The host of best-of-breed applications for bug tracking and software change management (e.g., IBM Rational® ClearCase®, and ClearQuest®) can help, but these solutions are rarely integrated into the enterprise change management solution. So when there are problems, project managers find themselves in the dark, wondering what are the software bugs that relate to different change orders, what are the potential delays to overall product release schedules due to software fixes coming in late, and in some cases—what the problem actually is!

What to fix – and how to fix it

The previous five product development problems are driven by the common challenge of making sure the entire product development team is always working with the most current designs and software versions. Some of the problems are so similar that they share a common solution as well.

MCAD-ECAD integration

Tackling the integration of mechanical and electrical designs requires two key capabilities. First, everyone – regardless of their engineering specialty – must be informed immediately when designs are changed in a way that impacts them. Notification should be done automatically. Mechanical engineers, for example, must be able to view an electrical design file and quickly identify differences from their previous mechanical design. PTC’s solution – InterComm™ Expert – automatically creates an intelligent representation of the ECAD design that’s viewable by any authorized user. Even mechanical design teams can get quick, easy access to all electrical designs without having to either load a new IDF file, or learn how to use an expensive and complex ECAD tool.

Beyond that, PTC’s InterComm EDACompare solution enables users to automatically compare any two versions of a design to determine exactly what is different – from an attribute level such as a reference designer, to electrical connectivity or Netlist, to geometrical changes such as signals being re-routed. For many electronics companies, InterComm Expert and InterComm EDACompare provide a low-cost solution that’s easy to implement and easy to use – providing solid value right out of the box. This is a powerful advancement in both technology and process control that can improve concurrent design between electrical and mechanical teams.

Tracking software changes

An industrial equipment manufacturer needs to deliver a customized version of a robotics assembly to a major customer. The product is ready to ship with updated software code specific to the customer, when, at the last second, a field change to the software is required. Where will the manufacturer find details relating to the specific version of the software loaded on the device, along with the specific software tooling (compilers, etc.) required to rebuild the software in the future? Where will the new, as-maintained configuration of the equipment be stored, so that support technicians dealing with future problems know which version of the software they are dealing with? Companies need to have access to the latest software in order to meet deadlines and prevent quality issues.

Change identification in action

InterComm EDACompare, PTC’s standard solution for change identification in the electronic design process, identifies what has changed between PCB designs.

- Compare versions of the schematic, PCB layout or manufacturing artwork to identify changes
- Compare changes based on attributes or geometry
- Identify changes in the design made by manufacturing
- Identify the impact of an ECO when introduced into a design
- Support decision-making regarding differences
- Highlight changes in InterComm Expert, immediately highlighting the impacted areas of the design

Here’s how InterComm EDACompare works in practice:

1. An ECAD engineer creates a new design version and generates an InterComm *.eda normalized representation with the push of a button.
2. The Project Manager (PM) runs InterComm EDACompare to compare this new version to the previous version.
3. PM reviews a Web-based report of the differences.
4. PM finds a difference that could have a meaningful impact, such as the location of key components (such as memory).
5. PM clicks on the change shown in the difference report, automatically opening InterComm Expert, which highlights the specific change.
6. PM analyzes the change, identifying that there is a potential interference problem. PM marks up the change in InterComm Expert with the note: “potential interference problem”.

7. PM requests the IDF file from the ECAD designer, and then opens it in ProductView (visualization tool from PTC), and compares it to the previous MCAD 3D model to verify that there is an interference problem.
8. Identifying a problem, PM calls an immediate design review where the team reviews the marked-up InterComm and ProductView normalized representations of the design.

Managing the Bigger Picture

Change identification tools are critical when it comes to ensuring designs are 'right the first time'. But when it comes to the bigger picture of enabling full collaboration around ECAD-MCAD process management, a more comprehensive solution is required – one that provides the following core capabilities:

- Design data management. A comprehensive solution must integrate data from your design tools and your ECAD workgroup managers. It must also enable easy-to-use version control of IDF files.
- Process flow management. One of the big challenges of ECAD-MCAD integration is the management of process flows between the two disciplines. Meeting that challenge requires enterprise access to design data and project status, and automatic routing of the latest designs to whoever needs them.
- Tool integration. Enterprise process management must be available in a normalized, tool-independent format that is accessible to the enterprise, while supporting all leading ECAD & MCAD tools and formats, as well as IDF visualization.

Although PTC's InterComm solutions for improving the MCAD-ECAD collaboration process can be used without a Product Lifecycle Management (PLM) solution, adding PTC's Windchill® (Product Lifecycle Management software) enables the capabilities described above. Windchill ensures that all parties in the product development process are working with the correct, most up-to-date versions, while enabling a much greater level of automation and collaboration.

Eliminating software silos

Integrating software into product development is challenging because software engineering often occurs in a 'silo-ed' organization – and is frequently outsourced. As a result, tying software development into the broader product development process has proven to be difficult. The problems are familiar to anyone in the industry:

1. An electrical engineer completes design work, and the project manager releases the product to manufacturing with the most current version of the software executables. Manufacturing produces the board, then loads the software—and it doesn't work. After a flurry of debugging, the team realizes they're not working with the latest version of the software. It's a show-stopper.
2. Mechanical and electrical designs are moving along according to plan, but the mechanical and electrical engineers don't know the status of the software development. They have no way of tying their work into the software engineering process – and no way to work in parallel and sync things up.

Even though software engineers might be working with a robust Software Configuration Management (SCM) system such as Rational ClearCase for version control and configuration management, those systems have not been accessible to MCAD and ECAD users – until now. PTC's Windchill PLM system can now integrate directly with many of the leading Software Configuration Management systems such as Rational ClearCase. This integration means software engineers can dynamically link the correct version of a software executable or other artifact – even a software design document stored in the SCM system – with Windchill, enabling the entire team to work with it as part of the overall product structure. Windchill becomes the unifying system providing common access and visibility across all software development silos – as well as across mechanical and electrical engineering teams.

Windchill also fully supports other key business initiatives associated with reducing product development costs, improving quality, and speeding time-to-market:

- Enforcement of more consistent product development processes across different software development teams
- Greater software component re-use across teams and products
- Leveraging Web-based collaborative project management tools that link directly to the software development process
- Global configuration management, creating a single system to pull together all MCAD, ECAD and software design elements into a single, global configuration of the product

Embedded software development collaboration—by the numbers

Some large companies are using Windchill specifically to drive collaboration both across their software development organizations and between hardware and software development teams. Here's a scenario of the vision they're achieving with Windchill:

1. An engineer links the released executable from the Software Configuration Management system, such as Rational ClearCase, to the correct software part in Windchill.
2. The product is released for prototype and test.
3. Testing finds a problem: a key feature of the product doesn't work. Since the user interface to the product is governed by software, it is unclear whether the hardware or the software is the problem.
4. Test engineer creates a problem report in the Windchill enterprise change management process, linked to affected components (hardware and software).
5. A change investigation task is assigned to both the hardware and software teams, routed to their email inboxes by Windchill.
6. At the same time, a bug report is automatically created in a bug-tracking system such as Rational ClearQuest, and is automatically cross-referenced to the change investigation in Windchill, and is then assigned to the appropriate software developer to investigate.

7. The bug report is linked to a specific version of the software code managed in the Rational ClearCase system, which is already linked to the affected software part in the configuration managed in Windchill.
8. The software executable is updated in Rational ClearCase, and is tested by software QA.
9. The new version is linked to the part managed in Windchill.
10. Windchill assigns the task to test the product again.
11. Testing is complete.
12. The enterprise change request is closed in Windchill.
13. Lastly, Windchill automatically closes the ClearQuest bug report to synchronize status of the change in both systems.

Getting it done

Many electronics companies have tried a variety of approaches to solving the product development challenges discussed here. Yet, until now, there hasn't been a practical way to ensure timely, effective communication across the spectrum of electrical, mechanical and software engineering disciplines. The convergence of InterComm and Windchill – and the integration of Windchill with Software Configuration Management systems like Rational ClearCase – has created the opportunity for vast improvements in communication and collaboration. The result? Fewer late-stage problems, better on-time delivery, higher quality, and lower development costs.

Every electronics manufacturer has unique concerns when it comes to moving toward seamless integration across the product development process. Yet, at the same time, each manufacturer will face many common milestones as they pursue the vision of full synchronization across all three engineering disciplines. That vision looks like this:

- An automated process for communicating incremental changes back and forth between ECAD and MCAD.
- Automating the ability of electrical and mechanical engineers to compare versions of electronic files. This capability replaces the practice of exchanging big IDF files and manually determining how things have changed, and the impact of those changes.
- Automatically comparing the latest version of the ECAD design to the latest version of the MCAD design upon check-in, to determine if the differences between designs are meaningful, and automatically notifying impacted parties of those changes.
- Automating the exchange of information to ensure that hardware and software development are synchronized.

Making a Difference for 35,000 Product Development Companies

PTC has helped many of the world's leading companies during the past 20 years. Our experience gives us a unique view of the challenges that firms – both large and small – are facing today around communication, collaboration, data management and control. Right now, more than 35,000 companies are using PTC solutions to improve product development and to gain a competitive edge.

For product design, electronics firms rely on PTC's Pro/ENGINEER, the acknowledged 3D MCAD leader in the industry. With more recent developments – i.e., our acquisition of InterComm, our strategic alliance with IBM, and our full integration with Rational ClearCase – PTC has further strengthened our offerings. And with Windchill, PTC offers the first-ever solution for seamless workflow across electrical, software and mechanical engineering.