

DIGITAL INDUSTRIES SOFTWARE

Unifying ECAD-MCAD PCB design through collaborative best practices

Executive summary

As designs continue to grow in scope and complexity, it is critical that ECAD and MCAD engineers collaborate throughout the product design cycle. An integrated ECAD/MCAD collaboration environment enables electrical and mechanical design teams to work together throughout the entire design process in real time. Efficient collaboration between ECAD and MCAD domains enables both to optimize their electronics designs within tight form-factor constraints while still meeting quality, reliability, and performance requirements. This paper describes four trends in electronic design that raise the urgency for following best practices of ECAD-MCAD collaboration and shares how Siemens solutions make it easier to instill those best practices and enable greater collaboration.

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ECAD/MCAD co-design

As designs continue to grow in scope and complexity, collaboration between the electronic and mechanical domains is becoming a must have.

Smaller IC packages compel system development companies to think more about the mechanical form factor of items and recognize the importance of collaboration between MCAD and ECAD. For example, as PCB designs face tighter requirements, problems resulting from electromechanical interference are becoming more common. Handling these kinds of problems across disciplines requires real-time collaboration – facilitated by automated tools and flows – and synchronized data.

But what do we mean by ECAD-MCAD collaboration? In product design, there are different domains and different areas of expertise. On one hand, there is the electronic domain, but of course, electronics can't exist on their own; they need to be packaged

and protected. This is where mechanical design domain comes in.

Simply put, ECAD-MCAD collaboration is the process of making sure the two domains know what the other is doing, as they both work in tandem towards a common goal.

For true ECAD and MCAD collaboration, it is essential that mechanical and electronic engineers work together *throughout the engineering project* to jointly bring a product to market. Cross-domain information must be shared incrementally throughout the project as changes occur. In this way, ECAD and MCAD collaboration allows teams to keep in sync and spot any errors or issues as they occur.

Mechanical and electronics co-design is an integrated approach to a system and product design that can help speed up product development by getting electromechanical projects right the first time

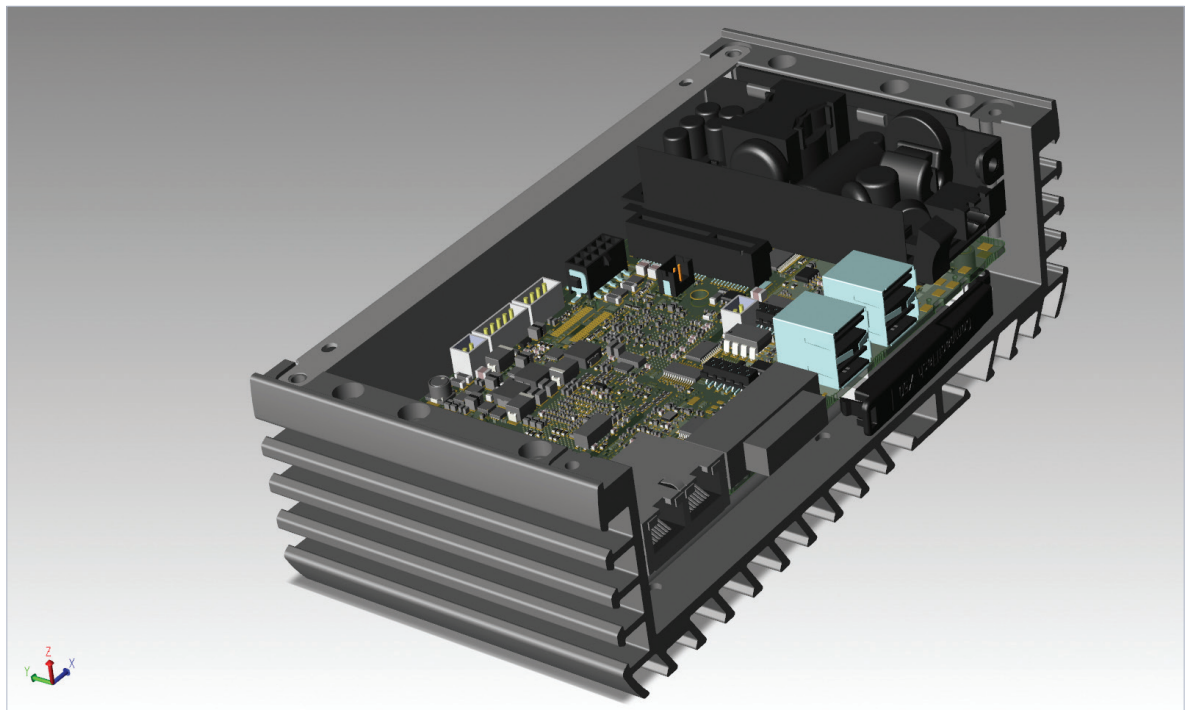


Figure 1. As PCB designs face tighter requirements, problems resulting from electromechanical interference are becoming more common.

Four trends in electronic design

Currently, four trends in electronic design are impacting design and manufacturing in such a way as to raise the urgency for following best practices when it comes to ECAD-MCAD collaboration. Let's start with a summary of these electronic design influencers.

Compute power

Since the advent of the microprocessor, we've seen an astronomical increase in the compute power that chips can deliver – a trillion-fold over six decades! This phenomenal growth roughly follows Gordon Moore's prediction in 1965 that the number of components in an integrated circuit would double every year – later revised to a doubling of the number of transistors roughly every two years.

Despite this miraculous and continuing achievement, we've come to take it for granted, and consumers do too. Consumers simply expect their smartphones and their high-tech devices to keep getting faster and faster. But this never-ending hunger for faster is stretching the limits of what technology itself can deliver.

With the demise of the benefits available via technology shrinking, increasing performance in semiconductors will no longer rely on ever-smaller process nodes or the use of multicores. We are working in nanometers within ICs these days, and a nanometer equates to just five atoms of silicon – an incredibly small amount. Can process nodes get any smaller? Even with multicores, we're reaching the limits of performance that can be achieved in a 2D IC design.

Therefore, future performance gains in semiconductors will be driven by, among other factors, advanced packaging flows. We are already starting to see an increase in the use of 3D ICs in which chips are effectively stacked on top of each other. These 3D ICs require advanced design packaging techniques, such as support for stiffeners and

integrated heat spreaders, increasing the demand for powerful 3D mechanical design tools.

Engineering discipline convergence

The second trend is engineering discipline convergence, particularly in the domains of electronic and mechanical design. Traditionally, an electrical engineer would not think too much about how or whether their electronics design would fit in the final, mechanical system. That was the mechanical engineer's job; something that he or she would worry about once the electronic stuff was done. Mechanical and electronic engineers largely worked in silos until the parts were complete.

At present, the "smaller, denser, faster" mantra associated with today's products is magnifying the importance of ensuring that electromechanical compatibility is addressed prior to the first fabrication – waiting until manufacture to validate electronic and mechanical compatibility is clearly leaving things until too late. Mechanical and electronics disciplines need to sync up earlier as they work better if they're integrated every step of the way. The compatibility of the printed circuit board and all the associated electronic components with the housing and all associated mechanical hardware should be designed-in using a correct-by-construction methodology.

Fortunately, the advanced technology available with the latest design tools addresses the challenges of getting disparate engineering teams to work together by enabling multi domain collaboration during electronic systems design, leading to shorter design cycles and improved product quality.

Sustainability

A third trend, one that is very important for Siemens, is sustainability. The environmental impact of the manufacture of electronic devices is starting to get more scrutiny, as is the worldwide energy consumption of devices during their working life.

Consumers want and expect OEMs to move towards sustainable manufacturing practices, making products that are less resource intensive, cleaner to produce, and easier to reuse or recycle.

According to the European Commission, over 80% of a product's environmental impacts are determined during the design phase. How a product is designed affects what materials are needed to make it, how much energy it will use during its lifetime, and how well it can be recycled at the end of its useful life. This is an area where both electronics and mechanical design have a major role to play, and Siemens has several initiatives underway to help designers implement sustainable design practices and build sustainable products. For example:

- NX Sustainability Impact Analysis brings valuable environmental impact assessments to the early stages of the design process.
- NX Performance Predictor enables users to simulate parts they are designing in real-time, while exploring different design and material choices.
- NX Molded Part Designer provides users the ability to create, manage, and validate their molded part design features in the context of their 3D design data.

AI in electronics design

A fourth trend is the rise of AI in electronics design. AI might be considered a product of electronics, yet AI can also help with electronics design.

One of the significant challenges for efficient PCB design is the steep learning curve involved in understanding the domain and learning the EDA tools. Understanding how and why different objects of a design are connected and how to efficiently use the design tools is rarely covered in any formal college or university education program. Engineers typically learn on the job.

AI can help them up the curve by mining completed designs. Mining involves going into designs that have already been completed to mine them for patterns of how tools are used. AI software captures that knowledge in a reusable form to either guide engineers through the design process better or take charge directly of elements of design itself. This is an area where we're just starting to see just how significantly artificial intelligence can help PCB engineers with tasks like component model creation, place-and-route, managing design constraints, and much more.

The importance of ECAD-MCAD collaboration

It's critical that ECAD and MCAD engineers collaborate throughout the product design cycle. An integrated ECAD/MCAD collaboration environment enables electrical and mechanical design teams to work together throughout the entire design process in real time.

Now that we have more of an understanding of the context, we will discuss some of the specific reasons

that an efficient and effective ECAD-MCAD collaboration is so important.

First, it increases productivity by enabling what-if scenarios – i.e., “What if such and such a thing happens?” – while at the same time allowing ECAD engineers and MCAD designers to co-design in their native environments.

Second, it supports a shift left of various design and verification tasks. For example, it enables a shift left of 3D clearance checking into the ECAD domain. So instead of having to wait for the physical part, teams can start these activities earlier in the design phase.

Third, because the design intent is verified throughout the product development process, it helps designers achieve first-pass success by

avoiding rework due to electromechanical issues that might crop up later.

Finally, and this is not an exhaustive list, new multi-domain collaboration tools enable teams to establish and maintain a digital thread and a digital twin of their designs and products, shortening development time and facilitating correct-by-construction design.

Ways ECAD-MCAD collaboration can be improved

Even so, a lot of engineering development teams still struggle to break free of legacy practices, which were perfectly good in their day but fall short in the present day. These unwieldy methods include people working in engineering silos and relying on manual information exchange between teams, calling each other up, sending emails, sharing information when it's too late or not at all, etc.

What are some of the impediments preventing system development companies from effectively adopting ECAD-MCAD best practices and reaping the competitive advantages these deliver?

One might be called “discipline convergence failure.” In other words, what happens when ECAD and MCAD teams are not collaborating as well as they should? A study by the Aberdeen Group found that sub-optimally collaborating organizations missed new product objectives, even when dedicating additional resources to compensate for avoidable issues and delays, and they required numerous engineering change orders.

Another area where collaboration could be improved arises when organizations are still relying on extra tools outside their software-design suite. These companies are often mired in old habits of using email, PDFs, images, and spreadsheets to share information, or individual design teams are missing large amounts of data, making the use of outdated data-sharing tools necessary.

Collaboration is also hampered by not identifying issues early in the design process or discovering them too late; a high reliance on physical prototyping or a lingering dependence on making a physical prototype; and unexpected project delays or cost overruns due to a lack of communication. There's still much more room for improvement, especially when we consider the wasted horsepower in today's tools and what they can achieve.

Keys to successful ECAD-MCAD collaboration

Efficient collaboration between ECAD and MCAD domains enables both to optimize an electronics design within tight form-factor constraints while still meeting quality, reliability, and performance requirements.

For successful electronics and mechanical collaboration, it's important that the two domains have knowledge about the current state of the other. The design tools must have the capability of communicating with the other domain.

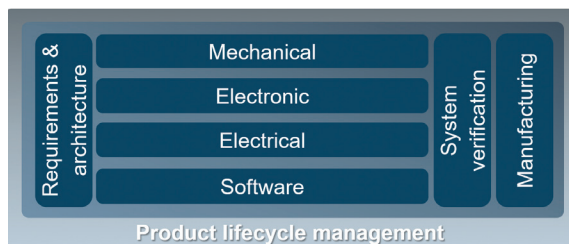


Figure 2. A multi-discipline, multi-domain workflow supports real-time collaboration.

What is needed for successful collaboration is a process that reliably automates the collaboration within the design tools, allowing designers to focus on the task at hand and not spend time worrying about whether the other domain has the right information. All the time that designers are focused on making collaboration work and doing that checking, they're not concentrating on the core task at hand. Collaboration needs to be highly automated, and teams must be able to have this collaboration instantly and on the fly versus waiting to the end. It is paramount that each domain has the confidence that the other has the latest content to ensure that product development progresses in a synchronized way.

The most successful organizations tend to take a model-based design approach. Model-based design transforms the systems engineering approach from document-centric to model-centric. System engineers develop models of the system instead of documents, thus enabling the most accurate and comprehensive digital twin.

The model-based design methodology also supports concurrent electronics PCB and mechanical design. This is an integrated approach to design and verification that eliminates redundancy and rework across design disciplines. It helps reduce design iterations through product validation in the virtual domain, instead of waiting for physical prototypes. Reducing physical prototypes has a dramatic effect on cost and development cycle time.

All this is addressing the fact that most product concepts change rapidly, especially during the early phases of a design, and electronics products are no exception.

Take the example of a product being developed and the design is nearing completion, the mechanics are in place and ready for refinement, and the team are preparing for tuning quotations and concluding design work. They check back with the electronics team and learn that a large component had been added some time ago that they didn't know about and that cannot be moved, even though it collides with a mechanical housing. What now? Should the mechanical team rethink its housing design? Should the electronics team rip up their layout and accommodate the housing? The answer, of course, depends on the specific design.

Typically, by the time ECAD gets the data from MCAD, the mechanical engineers have already started fabricating the housing or the envelope where the electrical product is going to sit.

At this point, making changes is extremely costly if you're going to make a change that is going to come from the direction of the electronics domain. Usually, once the mechanical envelope is set, it's set – you're not able to adjust it.

Having earlier insight of these issues through a robust collaboration process would have caught this issue early and made the change less painful.

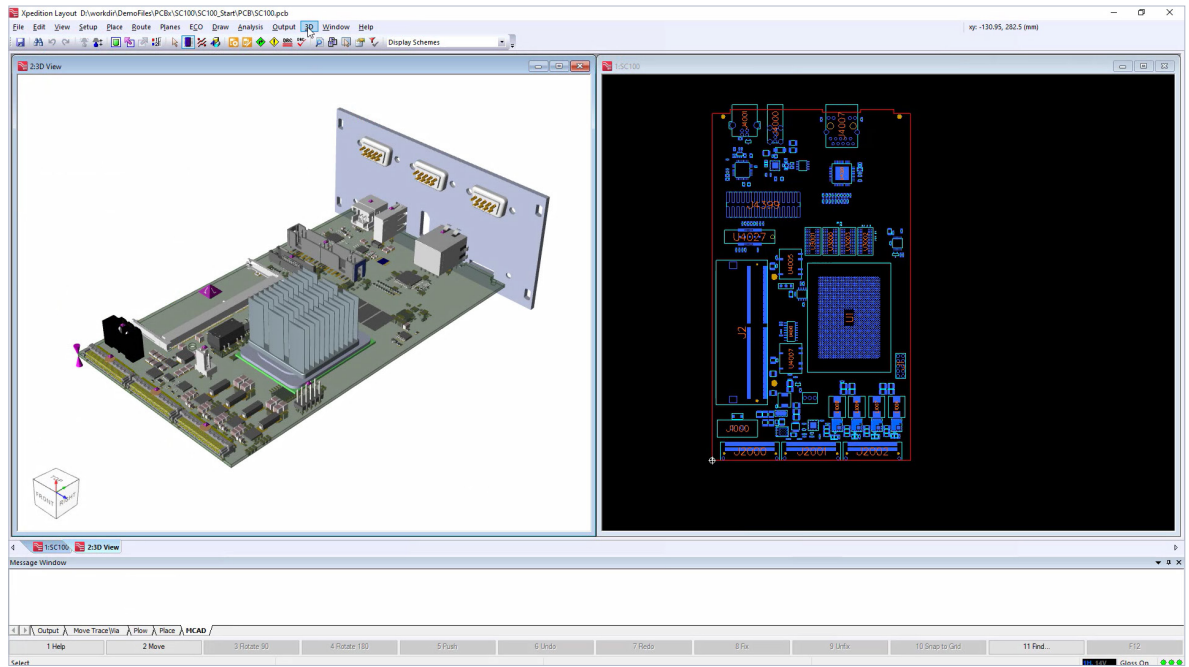


Figure 3. The exchange between ECAD and MCAD should be seamless, so data passed between them remains correct and accurate.

A toolkit for collaborative engineering

Now that we've discussed some of the reasons collaboration is so important as well as some of the obstacles to its adoption, it's time to look at the solutions out there that support ECAD-MCAD collaboration.

While it is better to source your ECAD-MCAD tools from the same vendor, whether that is practical depends on where you're starting from, as changing design tools is no small undertaking and needs to be considered carefully.

However, sourcing all design tools from the same vendor has huge benefits. For example, they are,

or should be, guaranteed to work together.

Delivering on this guarantee is why Siemens engineers spend a significant part of their planning time ensuring alignment between the different design tools in our portfolio.

A single vendor solution has the additional benefit in that enhancements in one tool are available in the others – there is no lag while waiting for another vendor to catch up with the latest enhancement. This alignment in tool development ensures compatibility from day one of a new version release, something that cannot be achieved when the design tools come from different vendors.

At the same time, as most electronics and mechanical design tools align with industry standards of collaboration, Siemens design tools must do the same. For example, the IDX format ensures that if collaboration is necessary with a different vendor, users can be assured that the Siemens tool sets are compliant to the same standard.

Additionally, within the collaboration files, Siemens has layered in additional capabilities that are not available with other tool combinations. Yet, these additional capabilities do not prevent the files from working with other tools, so teams can collaborate

using the same data with different tools from different vendors, and everything works well together.

The Siemens portfolio operates in an open ecosystem where compatibility is supported throughout by industry standards so customers can mix and match with confidence. This open way of working will bring good results in a robust and reliable process. However, if you want to achieve the best success, invest in a portfolio from a single vendor, such as Siemens, for data management and electronics, mechanical, and electrical design.

Accelerating PCB design

Within the Siemens Xcelerator business platform ecosystem, teams have the highest potential for success when they take advantage of all the capabilities each tool in the Siemens Xcelerator open digital business platform offers, whether it's Xpedition™, NX™, Teamcenter®, or HyperLynx™. And Siemens is dedicated to enhancing these

best-in-class tools and maintaining their industry-leading status.

Siemens tools for mechanical and electronic design are continually refreshed between every major new enhancement, which come every six months. In other words, Siemens develops two releases per year in every single tool with monthly updates.

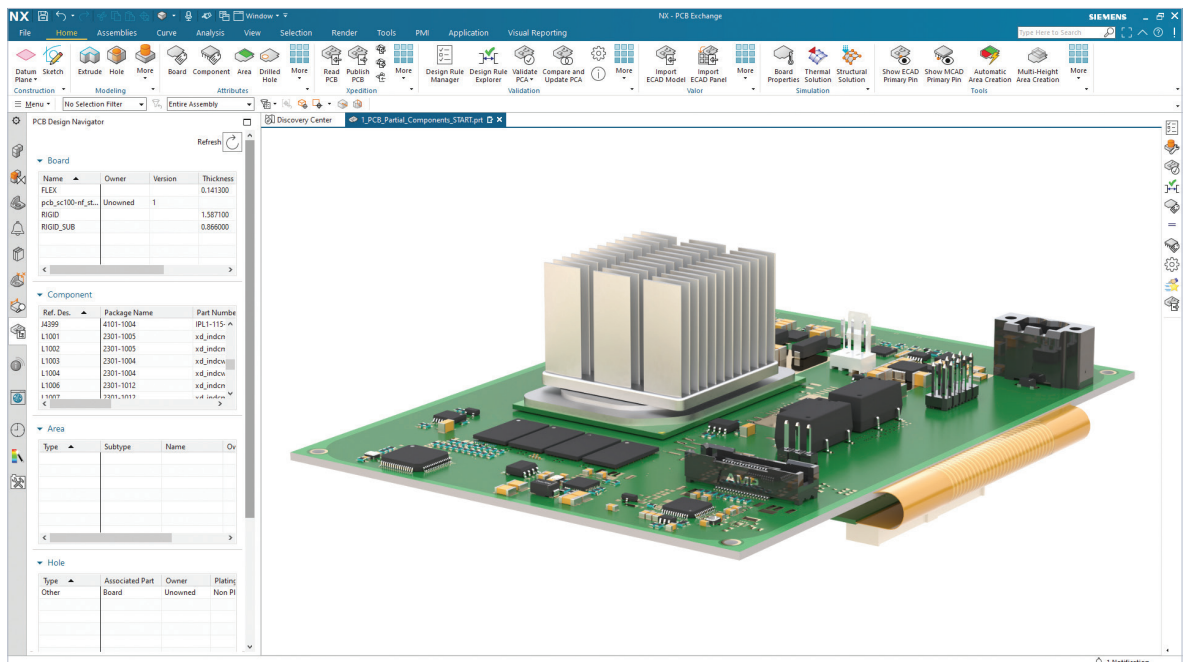


Figure 4. A populated rigid flex PCB, rendered entirely in NX.

Several years ago, Siemens made a significant investment in the electronics domain by acquiring Mentor Graphics. And since the inclusion of the Mentor EDA design tools into the Siemens Xcelerator business platform, Siemens has been making significant improvements, not only to design capabilities but to provide the most reliable and robust collaboration experience available today.

Miniaturization, flexibility, and complexity all feature highly in the needs of today's designers. Between Xpedition for electronics design and NX for mechanical design, teams can collaborate on embedded passives, rigid board cavities, RF conductive shapes, nested cells, groups, PCB variants, and much more.

Siemens has introduced full collaboration capability for rigid flex designs, which is unique in the mechanical domain. Rigid flex designs are prominent in today's products, as miniaturization and the improvement in quality and reliability demand it.

Design validation tools and methods are implemented and common across the Siemens Xcelerator business platform. System development teams can run a design rule analysis and the mechanical tool using the same data as they used in the electronics tool. It's very important that both domains have the same information.

Another exciting development at the intersection of the electronics and mechanical design domains is support for wire bonds within NX. The ability to design with wire bonds is not new in the electronics domain, however, being able to represent them in the mechanical world is significant. NX can read wire bond data created from Xpedition and represent it in the three-dimensional world, allowing designers to visualize and validate this data directly in the mechanical domain.

Armed with the battery of tools and capabilities from Siemens DISW, ECAD-MCAD collaborators benefit from established workflows, enabling teams to keep in sync and spot any errors or issues as they occur and helping speed up product development by getting electromechanical projects right the first time.

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