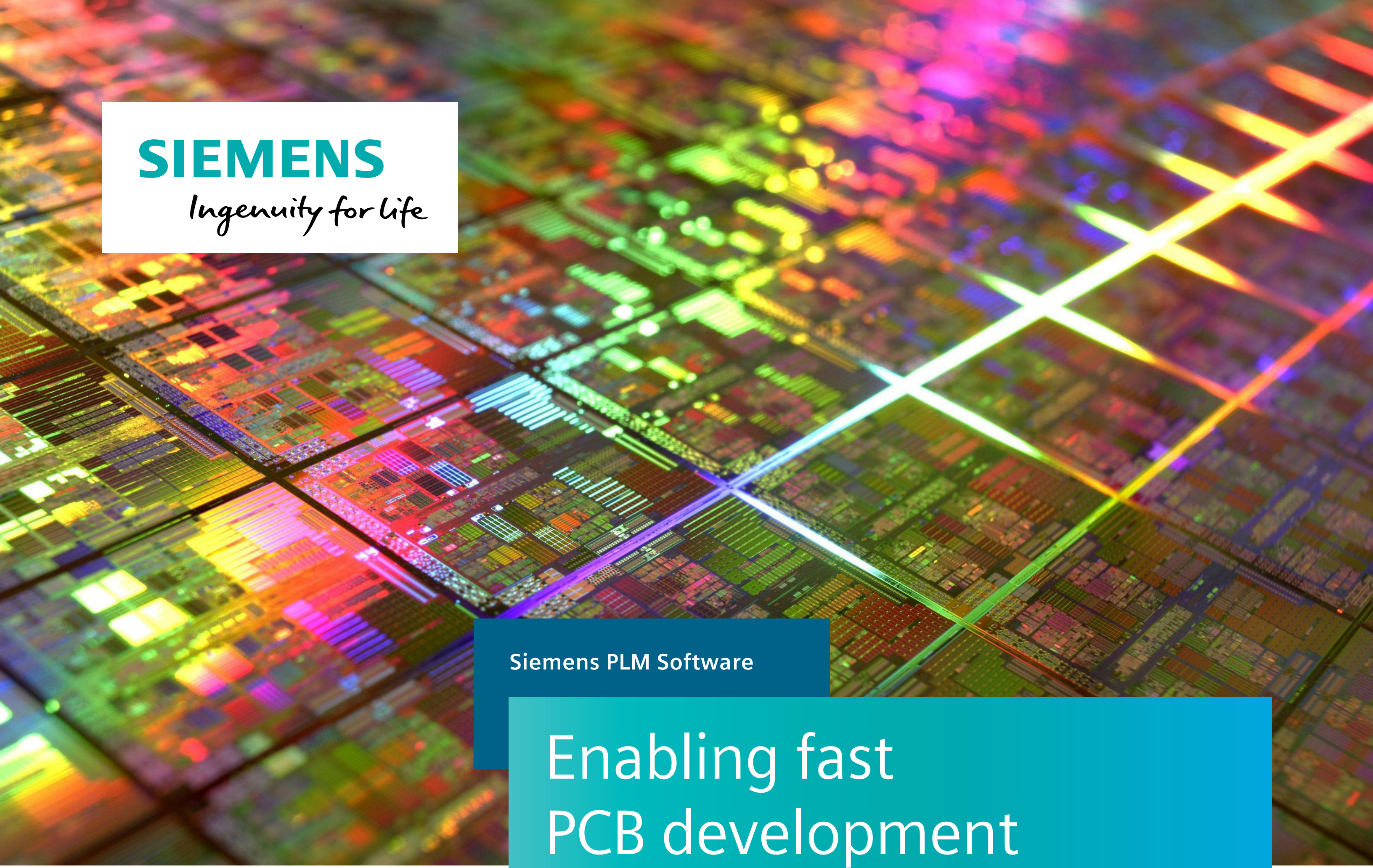

Siemens PLM Software

Enabling fast PCB development

Using enhanced collaboration to accelerate printed circuit board electromechanical design

Executive summary
Printed circuit board (PCB) designs, mechanical enclosures and related components need to mate, fit and be correct by design to eliminate re-spins, get designs to market quickly and minimize production costs. To make that happen, it's critical that electrical and mechanical engineers collaborate constructively throughout the product design cycle. Otherwise, product quality can suffer.

Abstract

The lack of interactive collaboration impacts all stages of product development, from concept through fabrication. The result can be:

- No consistent, continuous communication to keep electronic computer-aided design (ECAD) and mechanical computer-aided design (MCAD) data synchronized
- No what-if evaluations to avoid costly and time-consuming design iterations
- No process to negotiate proposed changes between the ECAD and MCAD domains
- No methodology for early validation of design intent

Electronic documents, sticky notes, emails and even technology specifically designed to enhance collaboration often fall short. One-way communication between domains doesn't provide direct design feedback and lacks change control. Simple 3D visualization enables electrical engineers to see what the mechanical guys are complaining about when they say the board outline doesn't fit or a component is too tall. But visualization alone doesn't enable those same engineers to propose changes or collaborate. Further, internally built collaboration processes, which can be expensive to maintain, have to be tested and verified with each new release of the underlying ECAD and MCAD tool suites.

Two major challenges arise with ECAD-MCAD collaboration: The first is the communication format, and second is making sure the PCB adheres to mechanical demands as early as possible to avoid changes in later stages of the design cycle. Let's focus on the first challenge, the communication format. Many companies still use the Intermediate Data Format (IDF) to transfer information between electrical and mechanical systems. Although the format has evolved over the years, IDF is still a static file transfer of an entire database. Although it works, it is extremely difficult to know what and where something changed just by reviewing the imported file. As a result, it is often necessary to also provide written documentation and/or marked-up drawings to ensure changes are clearly communicated and nothing is lost during this process because missing, or missed, design information increases the overall PCB design time.

Fortunately, Siemens PLM Software's state-of-the-art ECAD-MCAD collaborative software is designed to solve challenges such as these. Using Solid Edge® PCB Design and Collaboration software enables you to consider mechanical requirements during layout, and efficiently communicate design intent between ECAD and MCAD systems. With it, the user can preview and consider design proposals, then accept, reject and counter proposed changes across disciplines at any time throughout the design process. Collaboration is effective and convenient because electrical and mechanical engineers work in their respective tools.

Benefits of using 3D technology to enhance collaboration

Increase productivity	Improve design robustness	Increase collaboration and efficiency	Achieve first pass success
• Enables what-if scenarios to avoid time-consuming design iterations • Allows ECAD and MCAD designers to co-design in their own environments without learning new tools • Provides more time for new projects due to fewer design iterations	• Facilitates the optimization of today's complex compact form factors • Ensures higher quality, reliability and performance • Inherently less error prone and therefore reduces risk	• Provides consistent iterative communication throughout the development process • Accelerates decision making to mutually agreed changes • Left shifts 3D clearance and collision checking into the ECAD domain	• Provides an integrated process to avoid rework due to electromechanical issues • Reduces design iterations by verifying design intent throughout the development process • Increases the probability of meeting the product target launch

Figure 1. Benefits of ECAD-MCAD collaboration.

Communication and collaboration between ECAD and MCAD is enhanced by working in an integrated 3D CAD environment. More than merely an interpretation of 2D information, 3D viewing is a photorealistic view of how the design will be fabricated, one that provides superior visualization of complicated structures. With an integrated 3D view of the layout, issues in communication can be identified easily, and effective collaboration on critical design items across domains ensures the design intent is maintained. Both electrical and mechanical engineers can immediately validate PCB designs to identify over- and under-constrained areas in the design, thereby freeing up real estate and reducing the number of potential electrical concerns. The end result: A reduced number of prototypes and more robust designs that enable you to get your product to market faster and at lower cost.

Having advanced 3D layout capabilities can be even more beneficial when collaboration efforts are interactive and well integrated. Being able to view and understand information in 3D enables the design of better layouts from the start, both electronically and mechanically. With 3D design, the engineer has more control over design intent, better communication with mechanical engineers and, ultimately, higher-quality designs.

The advanced 3D layout functionality in Solid Edge PCB Design and Collaboration provides the capability to visualize and validate a PCB design as if it were already manufactured. For example, to prevent collision detection when the PCB is placed in the enclosure or system, engineers must take component and mechanical clearances into account. There is no better way to do that than with advanced 3D layout, which allows the electrical engineer to have greater visibility into the mechanical aspect of the design.

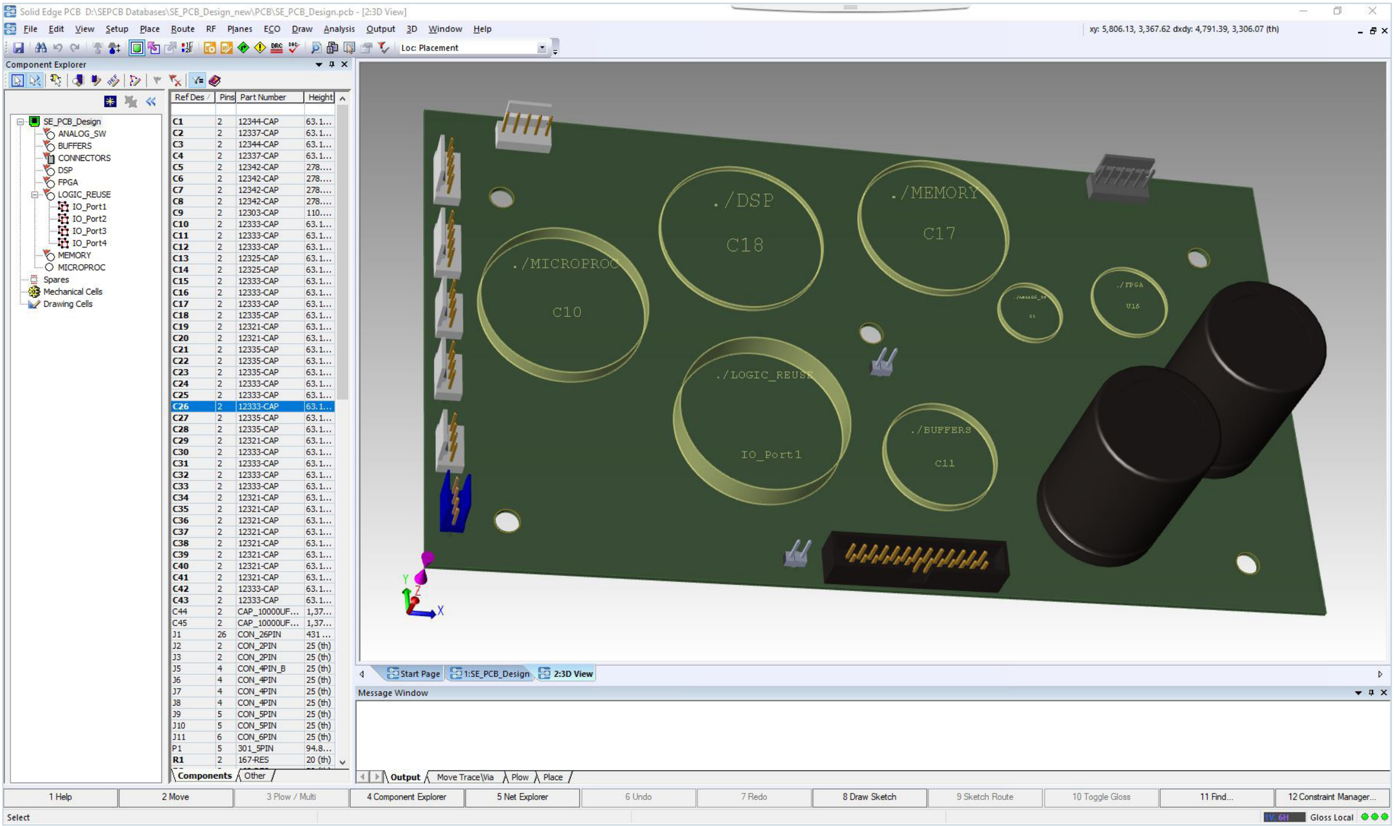

Figure 2. 3D planning groups are a useful strategy for minimizing PCB real estate.

So how does advanced 3D design software work in the development of PCB designs? Imagine you are an electrical engineer collaborating in real-time with your mechanical engineering counterpart. With the click of your mouse, you're able to preview the project's PCB outline along with all the cutouts, cavities and mounting-hole locations in 3D as designed by the mechanical engineer to fit the end product. You simply accept what you agree to and you're ready to begin placing components.

Next, imagine during component placement you discover the mechanical engineer was overly optimistic that the end product's enclosure would fit the PCB design from the board outline provided. Using Solid Edge PCB Design, the electrical engineer can make changes, additions, even deletions, and then propose those design changes to the mechanical engineer. For example, by adding some length to the board outline, sliding over one of the mounting holes and deleting another, changes can easily be proposed back to mechanical engineering for consideration.

The process of proposing and counter proposing can take place between electrical and mechanical engineers continuously and in real time until a final agreement is reached. These kind of collaborative exchanges ensure both the PCB and the mechanical design will be correct by design and that no unexpected surprises will be encountered when assembling the end product.

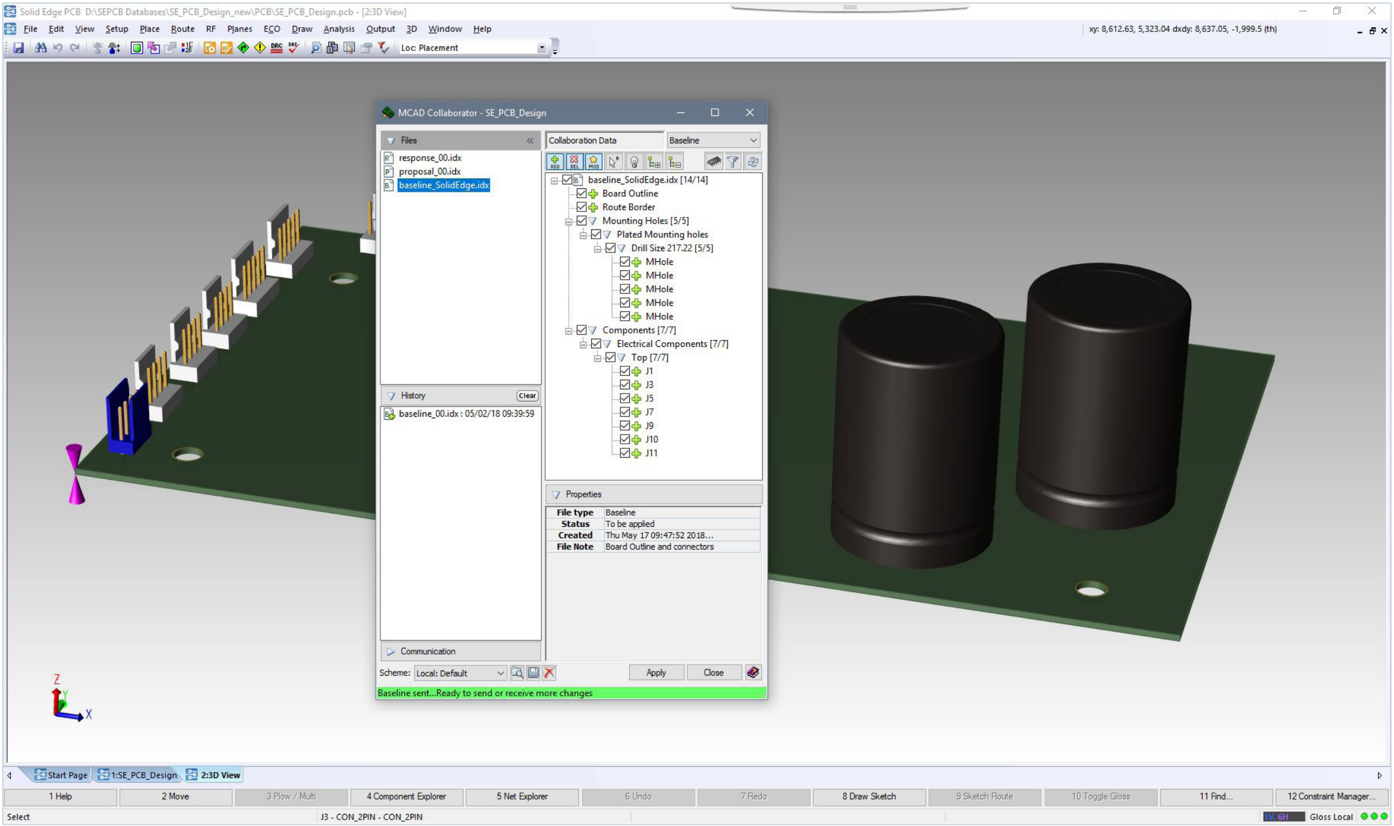

Figure 3. Solid Edge PCB Design provides an integrated ECAD-MCAD collaboration environment that allows electrical and mechanical engineers to be fully synchronized.

Solid Edge PCB Design is an advanced design tool that provides many benefits for effective ECAD-MCAD collaboration, including the ability to:

- Determine PCB real estate when minimal environments are required
- Eliminate costly design re-spins of printed circuit designs and mechanical enclosures with virtual prototyping and early detection of interference issues
- Provide ECAD and MCAD teams with a consistent and continuous communication channel for synchronizing designs even as designers work in the comfort of their own systems
- Achieve fast, real-time collaboration on what-if scenarios
- Provide immediate feedback on evaluations, preventing time-consuming rework
- Ensure that quality, reliability and performance are optimized within tight form-factor constraints

Co-design enables first-pass success in the design of electromechanical products

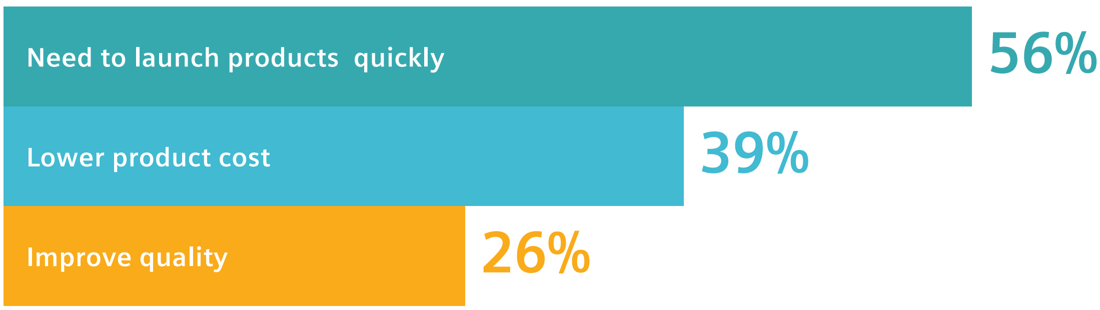

Figure 4. Top pressures to improve the design process.

First-pass success in the engineering domain is generally defined as the ability of a product to function as designed, or be correct by design, after the first pass of fabrication and assembly. Although first-pass success is a crucial goal for every design team, the increasing electromechanical complexity and density of today's products are making this goal more and more elusive.

In an April 2018 survey conducted by the Aberdeen Group entitled, "Winning the PCB Trifecta via 'Correct by Construction' Design Principles," 56 percent of companies cited the need to launch products quickly as their top priority for improving the design process, ahead of reducing product cost and improving quality (figure 4).

The survey also noted that best-in-class companies are 49 percent more likely to meet product-launch targets. Clearly, achieving first-pass success is a key component of launching products quickly, thereby meeting or exceeding the product launch target.

So how can teams move towards an effective ECAD-MCAD co-design process? Part of the answer lies in the data format used to communicate between the domains. Many companies still use IDF, which was developed in 1992 to transfer information between mechanical and electrical systems. However, this format is merely a static file transfer of the entire design database. It doesn't provide the type of communication needed for today's ever-increasing complexity.

Generic and error-prone one-way file transfers that don't provide direct design feedback, such as IDF and Drawing Exchange Format (DXF), are no longer acceptable options. File formats that enabled entire databases to be transferred between environments were certainly better than paper, but they had limitations too, such as lack of change control. Either side could make any change they wanted without validation from the other. With this methodology, neither the electrical nor the mechanical engineer knew what had changed since the last time the entire database was exchanged, so each would have to delicately merge the new design with the updates that had been made since the last revision. As a result of these limitations, full database transfers were typically only used at the beginning and end of electronics design.

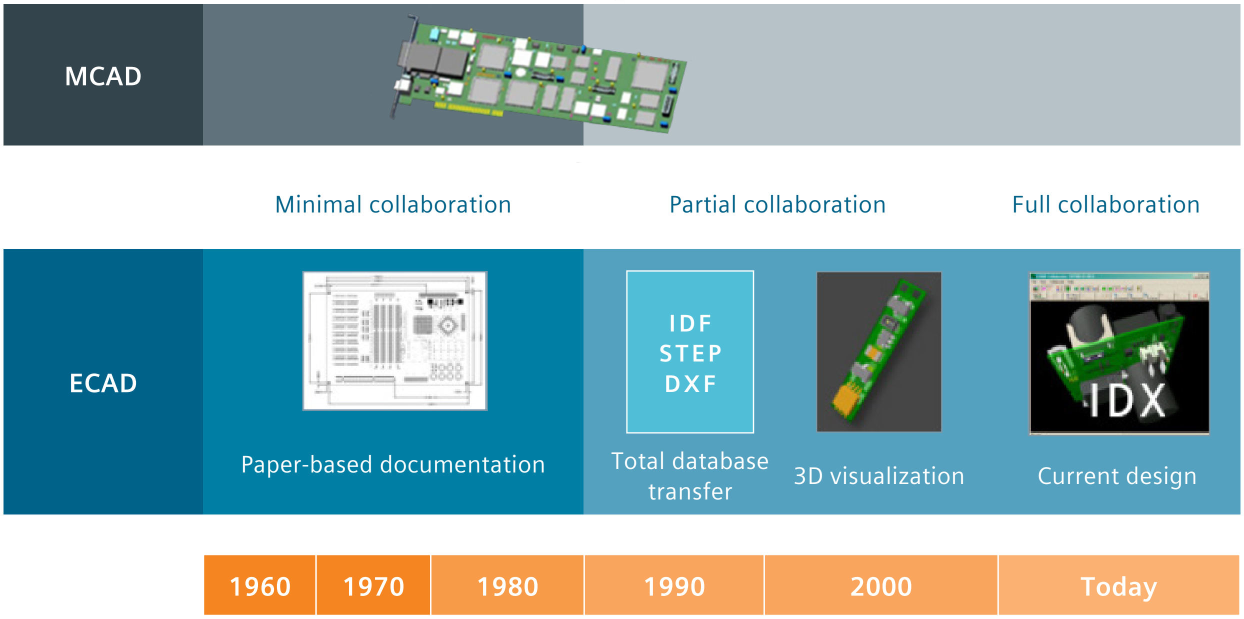

Figure 5. The evolution of ECAD-MCAD collaboration.

In 2010, the Interdomain Design Exchange format (IDX) was introduced. It is an Extensible Markup Language (XML) messaging format that is based on the Prostep ECAD Design and MCAD Design (EDMD) open schema for the incremental exchange of information between ECAD and MCAD tools.

Solid Edge PCB Design uses the Prostep iViP data transfer standard IDX XML schema. This data exchange format was developed specifically to enable ECAD and MCAD teams to collaborate in real time and propose, preview, accept, reject and counter propose design intent from the earliest stages of PCB design and component placement. By using an IDX format, engineers are able to synchronize their data more efficiently and collaborate more effectively on critical design items between domains, thereby establishing the design intent is properly implemented.

The IDX format allows designers to collaborate and identify issues much more effectively throughout the design process compared to the previous IDF format because it:

- Provides support for the establishment of a baseline set of data. Once the baseline is established, all subsequent exchanges of information will include only the incremental changes
- Represents IDX data in a single file whereas IDF data is split across two files
- Provides the ability to evaluate proposed changes prior to accepting them. Additionally, the acceptance or rejection of proposed changes is not an all-or-nothing proposition. Instead, it is done on an object-by-object basis
- Offers the ability to include notes, documenting the justification for any proposed changes

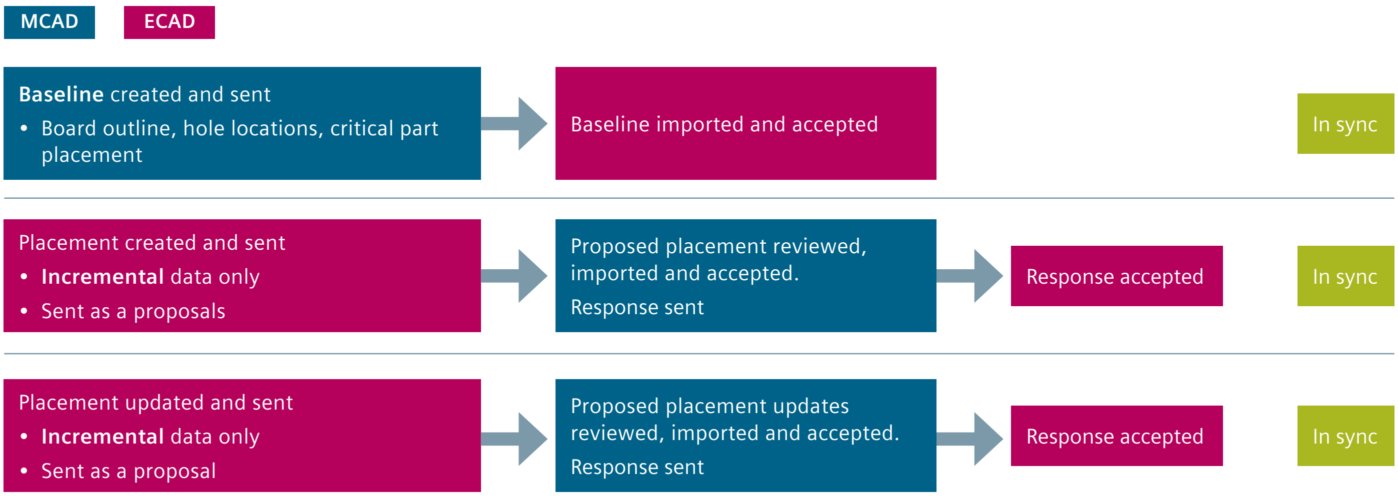

Figure 6. Typical ECAD-MCAD co-design process flow using IDX.

Here is an example of using an IDX flow to exchange data between domains:

At a high level, a flow using IDX to exchange data between the ECAD and MCAD domains can be described as follows (figure 6):

1. First, the mechanical engineer creates the board outline, including mounting holes and any part and/or route restrictions. Critical components such as board-to-board connectors or parts that interface with the enclosure are also placed. The mechanical engineer then exports a baseline IDX file to the electrical engineer. Once the electrical engineer accepts the file, the two domains are in sync.
2. The electrical engineer places components and sends an incremental IDX file to the mechanical engineer, who reviews the component placement and either accepts or rejects the proposal. A response file is then sent back to the electrical engineer designer, who accepts the response file, putting the two domains in sync once more.
3. The process continues as the electrical engineer performs engineering change orders (ECOs) and updates the component placement. A new incremental IDX file is sent to the mechanical engineer for review. As before, the mechanical engineer reviews the updated component placement and either accepts or rejects the proposal. This process continues until all placements have been accepted.

Recall that anything that is accepted or rejected by the electrical engineer or the mechanical engineer is not all-or-nothing, but rather it is done on an object-by-object basis. In the case of rejections, the objects that are not accepted are clearly conveyed to the originator and the process loops until the ECAD and MCAD domains are once again in sync.

The IDX format is adaptable to a company's workflow in either a synchronous or an asynchronous use model. ECAD-MCAD co-design using IDX allows electrical and mechanical engineers to each work in their native environments; there is no need to learn new tools.

ECAD-MCAD co-design best practices

A design team's adherence to ECAD-MCAD co-design best practices will maximize the many benefits that can be realized in achieving first-pass success. These enabling practices include:

- Using the IDX data format instead of the IDF data format to establish a baseline set of data and confirm that all subsequent exchanges of information only include incremental changes
- Driving the baseline from the MCAD domain, defining not only the board outline but also the location of mounting holes, restricted areas and critical components
- Using the IDX notation functionality to improve the communication and documentation of changes as well as traceability. This is especially important to help convey the reasoning when a proposed change is rejected
- Leveraging the co-design process to synchronize electrical and mechanical data early and frequently, ensuring ECAD-MCAD compatibility throughout the product development process

Conclusion

Processes that facilitate collaboration across disciplines are vital to the success of today's smaller-denser-smarter products. ECAD-MCAD co-design has long been recognized as a potential enabler for increasing productivity and ensuring robust designs. However, many companies struggle with implementing an effective and efficient collaboration process. With the IDX data format, designers are able to synchronize their data more efficiently and collaborate more effectively on critical design items between domains, thereby establishing the design intent is properly implemented.

Solid Edge PCB Design and Collaboration provide a powerful solution to aid ECAD-MCAD collaboration, eliminating costly electromechanical issues during new product development and increasing the probability of achieving first-pass success.

There are many benefits to using best-in-class technology such as Solid Edge PCB Design and Collaboration. Improved collaboration provides increased productivity by enabling what-if scenarios, allowing ECAD and MCAD engineers to co-design in their native environments and providing more time for design teams to work on new projects as a result of fewer iterations. Design robustness is also improved by facilitating the optimization of today's ever-shrinking form factors, thus enabling higher product quality and ensuring a process that is inherently less error-prone, thereby reducing risk. Consistent and iterative collaboration accelerates decision-making and increases efficiency across the entire process. Design intent is verified throughout the product development process.

Siemens PLM Software

Headquarters
Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 972 987 3000

Americas
Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 314 264 8499

Europe
Stephenson House
Sir William Siemens Square
Frimley, Camberley
Surrey, GU16 8QD
+44 (0) 1276 413200

Asia-Pacific
Unit 901-902, 9/F
Tower B, Manulife Financial Centre
223-231 Wai Yip Street, Kwun Tong
Kowloon, Hong Kong
+852 2230 3333

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