HARMONIZING HARDWARE:

BRIDGING ECAD AND MCAD FOR SEAMLESS INTEGRATION

EMA Design Automation®

HARMONIZING HARDWARE

BRIDGING ECAD AND MCAD FOR SEAMLESS INTEGRATION

Establishing collaboration between ECAD and MCAD design teams is crucial for developing innovative, high-quality, and reliable products. A collaborative environment between electrical and mechanical teams:

- Ensures a cohesive design process
- Creates consistency
- Reduces errors
- Enhances communication
- Optimizes resource use
- Reduces costs
- Streamlines product development

This e-book will discuss how the differences between ECAD and MCAD designs complicate the design process and how efficient collaboration can be achieved.

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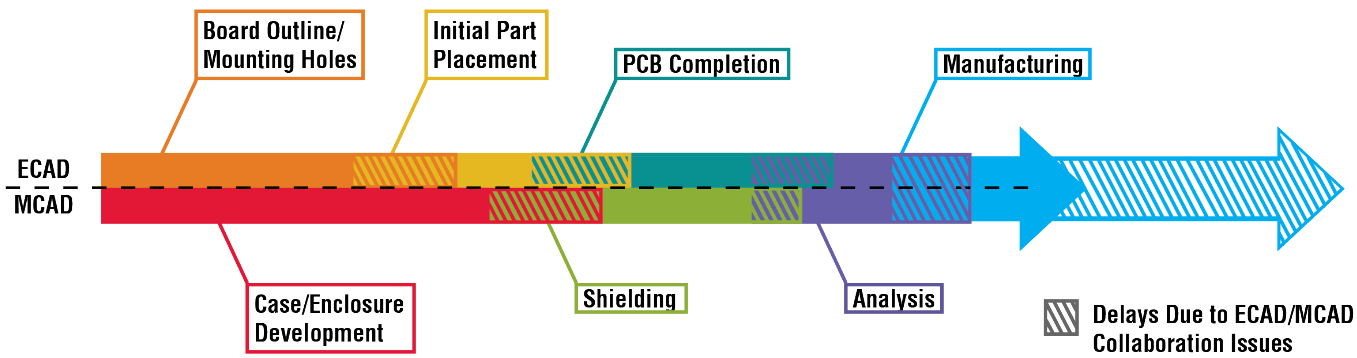
THE ECAD MCAD PRODUCT DESIGN PROCESS
CONCURRENT ENGINEERING

When creating a new product, most design schedules do not allow for ECAD and MCAD design activities to be done sequentially — it would be time consuming and leave teams waiting for feedback or updates. This leads to ECAD and MCAD teams designing concurrently or in parallel. Concurrent engineering, in which ECAD and MCAD teams are completing their designs simultaneously, is required to keep up with rigorous time-to-market demands. An example of a concurrent design timeline between electrical and mechanical teams is represented below:

Concurrent ECAD/MCAD Design Timeline



Step 1: Case/Enclosure Development

Typically, the physical housing of the product or mechanical design is started first and drives the board outline for the electrical team. The case development will also determine keepout areas and component height restrictions.

Step 2: Board Outline/Mounting Definition

With the physical enclosure in progress, the corresponding board outline can be determined as well as how the PCB will mount to the housing. In this process, the electrical team must ensure all components can be placed onto the size and shape of the proposed outline. This can lead to critical trade-off decisions for component selection, PCB layer stack up, and cost.

Step 3: Initial Component Placement

Critical components, such as connectors that interact with the mechanical housing, must be placed in exact locations to guarantee proper alignment with cut outs.

Step 4: Shielding

If applicable, mechanical shields are designed to protect sensitive circuitry from interference. These need to be incorporated into the PCBA to ensure proper form, fit, and function.

Step 5: PCB Completion

The remainder of the components are placed, connections are routed, and the board is checked for any errors.

Step 6: Analysis

While analysis is recommended throughout the product design process, at a minimum the PCB should be evaluated in 3D before sending the board to production. The same is true for any mechanical simulations required to address thermal, airflow, and vibration concerns with CFD analysis.

Step 7: Manufacturing

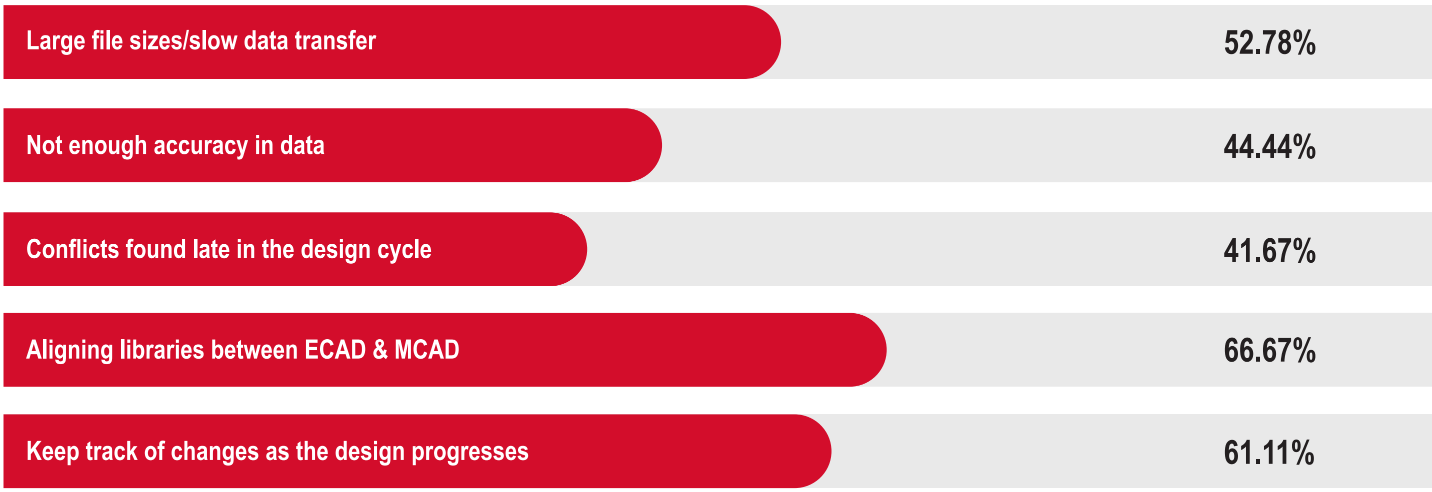
Both the PCB and mechanical housing are manufactured and assembled to create the final product.

While a concurrent product design process accelerates the project timeline, it places heightened focus on the collaboration and interconnectivity between ECAD and MCAD. When both teams are designing simultaneously, changes can occur at any time on either side, resulting in an iterative process and the potential for inter-disciplinary issues if not managed properly.

THE ECAD MCAD PRODUCT DESIGN PROCESS

UNDERSTANDING COMMON ISSUES

In a traditional concurrent design process many issues can occur, but they boil down to one over-arching theme: communication. In a recent survey, more than half of respondents noted issues with communication between ECAD and MCAD teams during the design process. The miscommunication was investigated further to determine the root cause, with many respondents reporting two or more of the issues below throughout their existing ECAD/MCAD design process:



Slow Data Transfer

The complexity of today's designs requires a large number of elements to obtain an accurate representation of the assembly which in turn, creates large file sizes. With some CAD programs, the length of time required to transfer this data between ECAD and MCAD departments can be extensive, resulting in slow data transfer, delays, and infrequent updates.

Conflicts Found Late

The size of design files and required time to transfer information leads to infrequent updates. Changes are often not communicated on time and conflicts are found too late in the design cycle, creating a ripple effect of design modifications for both ECAD and MCAD teams.

Aligning Libraries

Accurate 3D model libraries are required for successful collaboration. If the MCAD and ECAD teams are working off different libraries, the likelihood of discrepancies is increased for components and mechanical elements. This can lead to interconnectivity issues like improper alignment and collisions.

Not Enough Accuracy

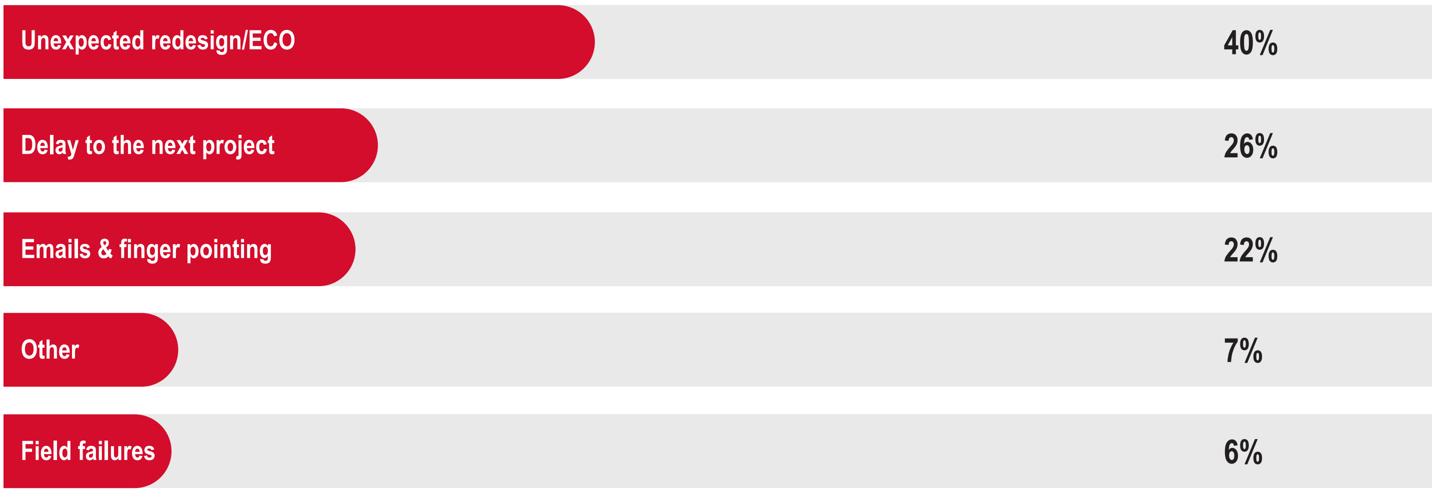
To combat typical slow data transfer rates, file sizes are often reduced to only critical data rather than the entire design, making the data rendered into the MCAD design environment either oversimplified or not entirely there. This will result in a low-resolution file when a high-resolution file is needed for full detailed checks.

Tracking Changes

With changes occurring frequently and sometimes simultaneously for both the ECAD and MCAD designs, manually tracking updates can be a burden that is difficult to keep up with. To eliminate confusion, real-time change tracking should document when changes occur, who implemented the change, and why.

THE ECAD MCAD PRODUCT DESIGN PROCESS
UNDERSTANDING COMMON ISSUES

These miscommunication issues can be time-consuming if caught, with 40% of respondents noting unexpected redesigns or an Engineering Change Order (ECO); however, if errors are not identified it can be detrimental to the success of the product, with 6% of respondents noting field failures from ECAD MCAD collaboration challenges.



Unexpected Redesigns

During the design process, unexpected redesigns can lengthen the project timeline and result in missed time to market goals. However, after a product is launched a formal Engineering Change Order (ECO) must be issued to manage revisions, improvements, corrections, or updates to the existing product. With new board spins easily costing 10's of thousands of dollars, both unexpected redesigns and ECOs result in additional design hours and expenses that were not accounted for in the initial proposal.

Delays

Inefficient and inaccurate data transfer often lengthens the time required to produce a design. While this can delay the product launch, it can also impact subsequent projects for both the electrical and mechanical teams.

Field Failures

If mistakes are not caught in the design process and products are released into the market, field failures can occur. This can result in product recalls, tarnished company reputations, unforeseen design iterations, and lost revenue. While field failures are unfortunate for many companies and consumer products in the market, they become critical for IPC Class 3 products, such as medical and aerospace designs, which require high reliability and continuous operation even when subjected to harsh environmental conditions.

The Blame Game

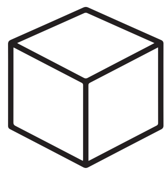
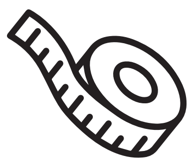
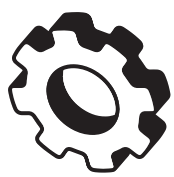
No one wants to be held responsible for errors within the product design process, but finger pointing and passing the blame doesn't resolve any issues. Implementing a streamlined process for ECAD/MCAD collaboration can help.

As many have already experienced, the challenges of ECAD/MCAD collaboration are real, and the consequences of miscommunication can be significant. To help better explore these issues and how to prevent them, it's important to examine how ECAD and MCAD teams approach design challenges, their individual perspectives on the design, and other areas where miscommunication can occur.

DESIGN PRESSURES AFFECTING ECAD & MCAD

FORM, FIT, AND FUNCTION

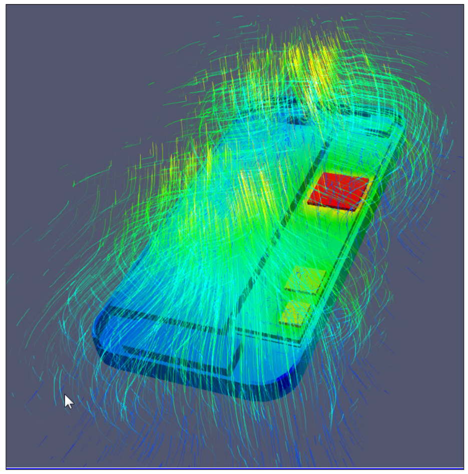
At a high-level, there are three common design challenges that both ECAD and MCAD teams face when creating a new product; however, each of these challenges have varying connotations depending on the electrical or mechanical design:

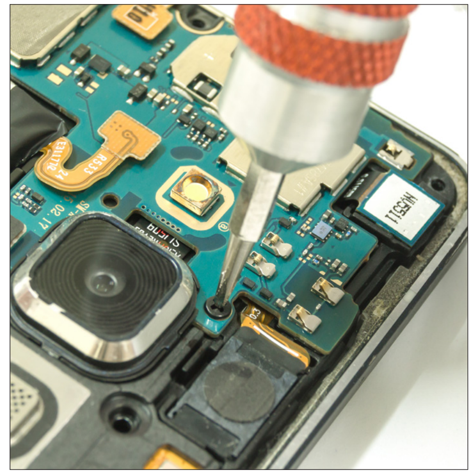
ECAD		MCAD
How does physical shape of the product effect electrical design elements?	 FORM	How does the electronic space requirements and functions affect the physical design shape?
Will all the electrical components fit onto the PCB and within the mechanical enclosure?	 FIT	What mechanical elements need to be incorporated to ensure proper fit?
Does the PCB assembly meet the design specifications and electrical requirements?	 FUNCTION	Is the final product optimized for user experience and does the interface function appropriately?

Each of these design challenges invoke different questions, additional considerations, and product design concerns for the electrical and mechanical teams. Identifying these product design concerns from an MCAD and ECAD perspective helps to create an understanding between teams, weigh critical design decisions, and improve collaboration.

PRODUCT DESIGN CONCERNS
THE MCAD PERSPECTIVE

The purpose of the MCAD team is to develop detailed designs of the physical components and systems comprised in the product. During a product design, mechanical engineers focus on:





Mechanical Design

When creating the mechanical housing, the MCAD team takes into consideration:

- Ergonomics
- User Experience
- Safety and Standard Regulations
- Performance Specifications
- Material Selection
- Manufacturability

These items can impact the size, shape, and features of the mechanical housing and therefore the form of the PCB.

Tolerance and Clearance

While the electrical engineer is concerned about the functionality of the PCB itself, the mechanical engineer looks at the product as a whole. The MCAD team must determine if there is enough tolerance and clearance for proper and safe operation including:

- Airflow
- Heat dissipation
- Vibration

The final assembly, including the PCB, components, and mechanical elements must be used to analyze adherence to appropriate clearances and optimize designs for performance and efficiency. Typically, analysis is performed with advanced computational fluid dynamics (CFD) simulations.

Integration

The integration between the MCAD housing and the PCBA is critical for mechanical design success- specifically user-experience:

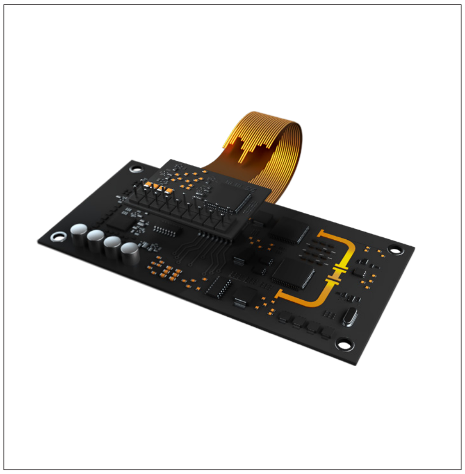
- Do the features on the PCB like buttons and switches interact correctly with the mechanical housing?
- Are connectors accessible? (Ex: USB ports for charging)
- Are mounting holes aligned for proper assembly?

If not, this can lead to a negative user-experience, frustrated customers, and costly redesigns.

The mechanical design will often drive the electrical design; however, the ECAD team has their own set of concerns throughout the product design process that must also be addressed for a successful product.

PRODUCT DESIGN CONCERNS
THE ECAD PERSPECTIVE

The purpose of the ECAD team is to design a printed circuit board that achieves the required product functionality while fitting within the constraints of the mechanical housing. As such, there are specific areas of interest that are of the up most importance to electrical engineers and PCB designers when collaborating with mechanical teams:

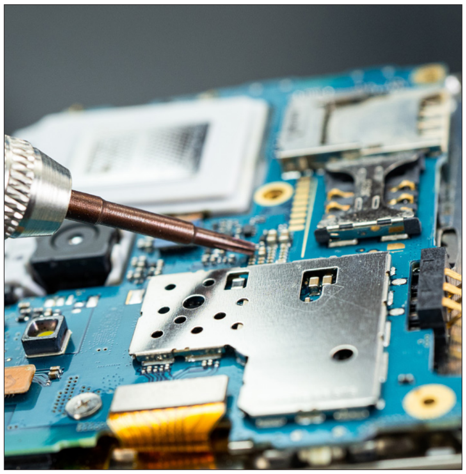


Bends

For rigid-flex designs, knowing when and where a bend must occur will greatly impact the final design. It is critical to:

- Visualize the bendable areas
- View bend interaction with other bends and the rigid PCB
- Evaluate the final bended design for collisions

Bends must be considered early in the design process and analyzed once component placement is completed to create a successful rigid-flex design.



Fit and Clearance

With two differing design environments, it's not uncommon for mismatches between the PCB and the mechanical housing. ECAD teams check the fit and clearance from an electrical standpoint:

- If any electrical interference or noise may occur
- If shielding or housing interferes with traces or copper pours
- If mounting hardware interferes with components or routing

If any shielding/housing overlaps with elements on the PCB such as traces, vias, copper pours, or components the electrical functionality of the design can be compromised.

Assembly Checking

The final PCBA, including mounting hardware and any mechanical components such as heat sinks, shields, and mechanical enclosures, must be analyzed. PCB designers will check if:

- Any components collide with each other
- Any components collide with the shielding or housing
- There is sufficient clearance between components and housing
- The mechanical housing interferes with the board

Obtaining a realistic representation of the final assembly allows electrical engineers to analyze how ECAD and MCAD portions interact to create a successful product.

PRODUCT DESIGN CONCERNS
A DETAILED EXAMPLE

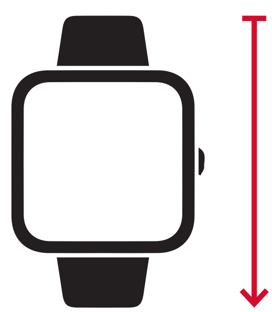
Designing or Upgrading a Smart Watch

For today's electronic consumer-driven products, engineers are faced with additional design challenges that affect the ECAD and MCAD design teams differently. For example, to compete with an overabundance of products on the market, designs are continuously improved for user-experience resulting in smaller, sleeker forms. This decreasing size of the mechanical housing has a direct impact on both electrical and mechanical design concerns:

ECAD

This user-driven product improvement adds complexity to ECAD designs by:

- Restricting the height of electrical components in the design.
- Increasing the complexity of component placement with height-restricted areas.
- Increasing the need for accuracy between mechanical and electrical elements to ensure proper fit and function.
- Incorporating rigid-flex elements to fit the board or boards within the housing constraints.



DECREASING THE SIZE OF THE HOUSING

MCAD

Decreasing the size of the enclosure increases the complexity of the mechanical design:

- Tighter manufacturing tolerances require additional precision and advanced manufacturing techniques.
- Smaller housing incurs additional mechanical stress requiring careful consideration of structural integrity and durability.
- Increased need for thermal management to analyze heat dissipation and determine the appropriate cooling solutions.
- Additional consideration must be given to material selection to achieve both the necessary strength and housing size.

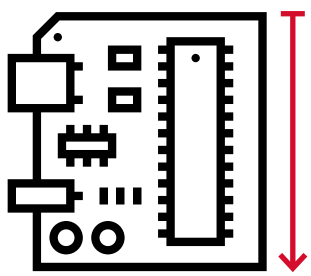
PRODUCT DESIGN CONCERNS
A DETAILED EXAMPLE

The decrease in product size also influences the area of the PCB, as the shape and size of a board is often driven by the product's mechanical housing. Couple this with the increasing complexity of the PCB itself, and the ECAD and MCAD teams are faced with additional design concerns that must be addressed:

ECAD

Decreasing the area of the PCB increases the design complexity for electrical engineers by:

- Fitting all the required components and connections within the PCB.
- Requiring a design configuration with multiple boards connected together.
- Minimizing signal integrity issues due to a high density board.
- Requiring additional PCB assembly techniques and verification for smaller parts.



DECREASING THE AREA OF THE PCB

MCAD

Decreasing the area of the PCB increases the complexity from a mechanical standpoint due to:

- Poor heat dissipation for PCBs with less surface area.
- Decreased area for screws, mounts, or structural support.
- Incorporating robust support structures to combat damage from mechanical stress and vibration.
- Ensuring placement of user interface elements remain ergonomic and accessible.

With differing areas of focus and importance, it is likely there will be some trade off decisions between ECAD and MCAD designs, such as increased component cost for a low-profile, height-restricted area. To make these trade-off decisions efficiently, both ECAD and MCAD concerns need to be communicated efficiently throughout the design process; however, communication can be hindered by the differing software environments and terms used by the electrical and mechanical disciplines.

ECAD VS. MCAD
SPEAKING DIFFERENT LANGUAGES

The most obvious difference between the electrical and mechanical teams is the software environment used throughout the design process. With each software optimized for electrical or mechanical design, a gap is created making it more difficult to collaborate between ECAD and MCAD environments. Each software environment has its own unique, internal platform consisting of the code necessary for proper operation, but this often prohibits integrated communication between tools.

Communicating between the inner workings of software environments isn't the only obstacle created from differences between disciplines; there can also be misunderstandings between the terms used within the ECAD and MCAD design teams. Often terms used in one discipline have a different meaning in the other and vice versa:

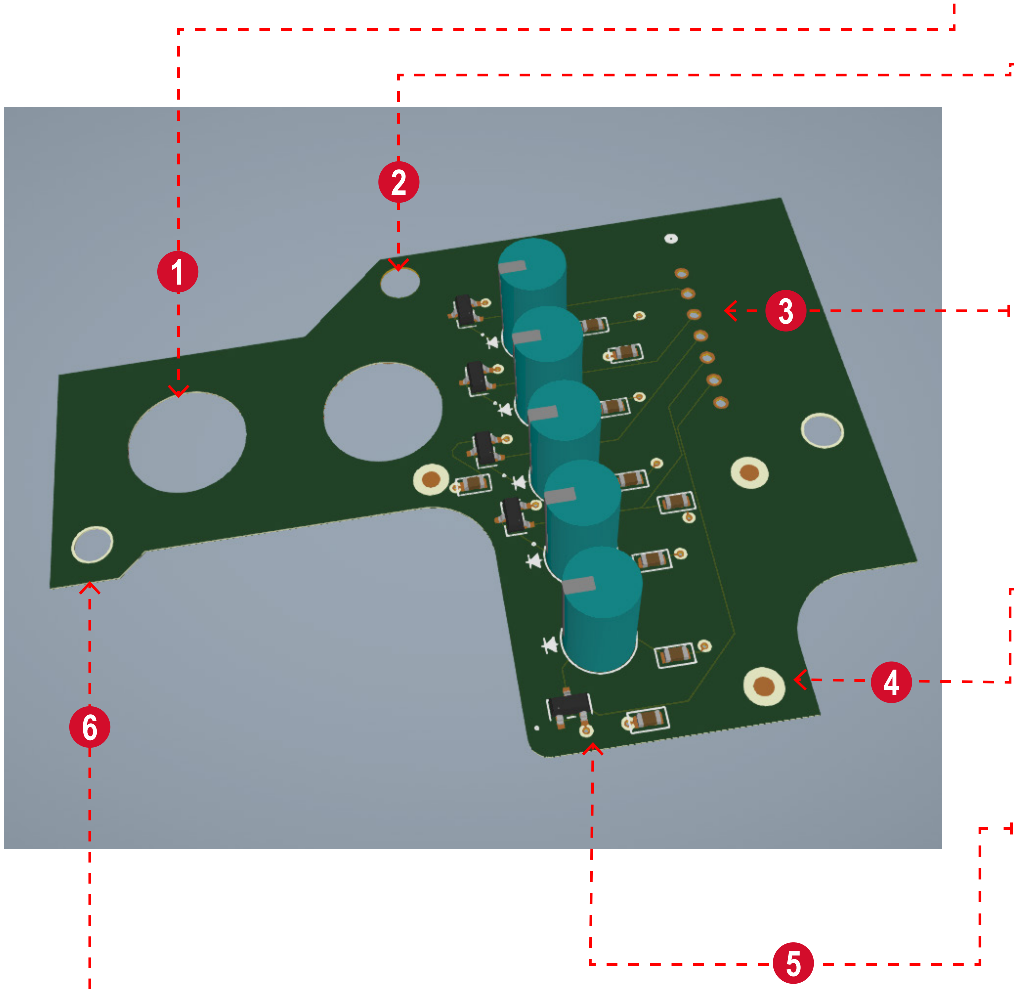
ECAD		MCAD
Individual element used to build electrical circuits represented with a 2D PCB footprint and 3D model.	Part	Individual element of the assembly or the building blocks of the mechanical design represented with 3D models.
Traces on the PCB establishing connections between parts.	Routing	Hollow cylindrical structures used for transporting fluids, gases, and more.
The final PCB assembly including components and mounting hardware.	Assembly	A collection of physical objects that make up a mechanical system.
Pictorials and information required to fabricate and assembly the PCB.	Drawing	Sketch containing required information to manufacture a part.
List of all the components needed to manufacture and assemble the PCB.	BOM	List of all the assemblies and parts needed build the product (the PCB being one or more of them).
Used to provide a unique identifier for each component on the PCB.	Reference Designators	Does not Exist. MCAD teams typically use part numbers or assembly numbers to identify components.

ECAD VS. MCAD
SPEAKING DIFFERENT LANGUAGES

There are some scenarios when terms used during the mechanical design creation can have multiple connotations in the electrical design. These must be mapped to the correct ECAD term for successful communication of design elements:

MCAD Process: Cut

During the mechanical design process, a cut refers to a feature or operation that removes material from a 3D model, creating a void or space within a solid body. A cut in the MCAD model can be mapped to multiple ECAD features.



ECAD Features

1. Cut Out
The removal or opening in the PCB to accommodate various functional or practical requirements such as mounting support and openings for cable pass-through.

2. Non-Plated Hole
A hole that has been drilled through the PCB but does not have a conductive coating. These holes are typically used for mounting, component alignment, and tooling.

3. Plated Hole
A hole that has been drilled through the PCB and plated with a layer of conductive material that are used to establish electrical connection between different layers of the PCB or mount components.

4. Hole
A featured on the PCB used during manufacturing and assembly for alignment, fixture attachment, and precise component placement or alignment.

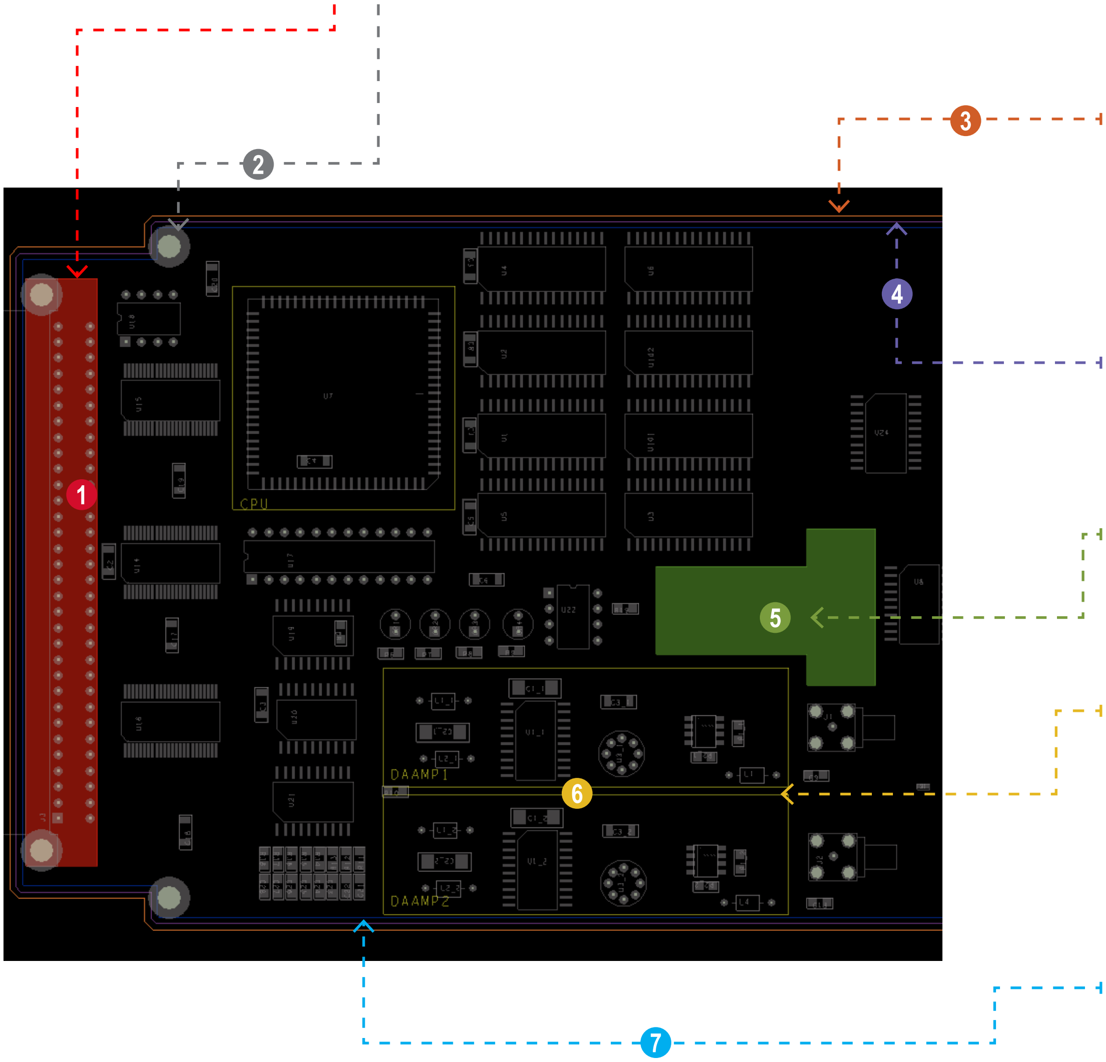
5. Via
A small hole that allows electrical connections to pass through different layers of the PCB.

6. Mounting Hole
A hole designed specifically for mechanical attachment of the PCB to an enclosure, chassis, or other PCB.

ECAD VS. MCAD
SPEAKING DIFFERENT LANGUAGES

MCAD Process: Extrusion

During the mechanical design process, an extrusion adds material to the 3D model, creating a feature. An extrusion in the MCAD model can be mapped to multiple ECAD features.



ECAD Features

1. Via Keepout
A designated area on the PCB where no vias are allowed.

2. Route Keepout
A designated area on the PCB where no traces or connections are allowed.

3. Design Outline
The physical boundary or shape of the PCB. Represents the external dimensions where the board will be cut from the base material.

4. Route Keepin
A designated area on the PCB where traces or signal paths are confined to.

5. Package Keepout
A designated area on the PCB where no components are allowed.

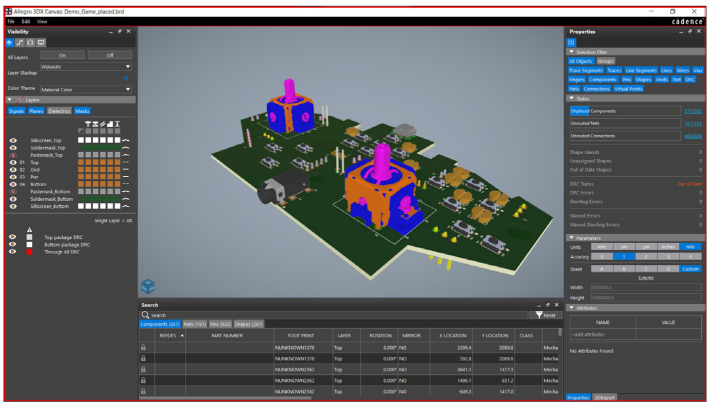
6. Place Region
A designated area on the PCB for component placement. Place regions can be used to restrict component height or place similar circuitry together for an optimized layout.

7. Place Keepin
A designated area on the PCB where components are confined to.

After evaluating how ECAD and MCAD teams view the product design process, the areas of importance, and the differences between software environments and disciplines, it's easy to see how miscommunication and collaboration difficulties can arise. These miscommunication issues and the effects can be resolved by bridging the gap between electrical and mechanical design environments and improving collaboration between teams.

HOW TO BRIDGE THE GAP
CREATING A SINGLE SOURCE OF TRUTH

For both ECAD and MCAD teams to review the product design for specific areas of concern, a single source of truth must be created. Often, physical prototypes are built to verify a design before mass production; however, stringent project timelines don't typically allow for thorough analysis of any required design modifications. To streamline this process, a full digital prototype encompassing all electrical and mechanical elements should to be created within the CAD environments using a software solution that leverages key features which enable efficient communication and collaboration:

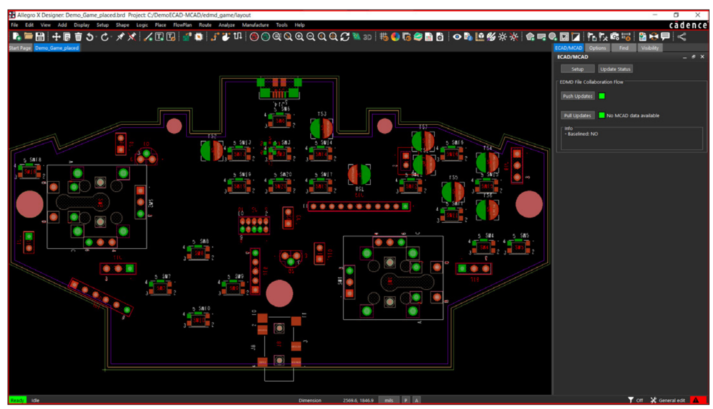


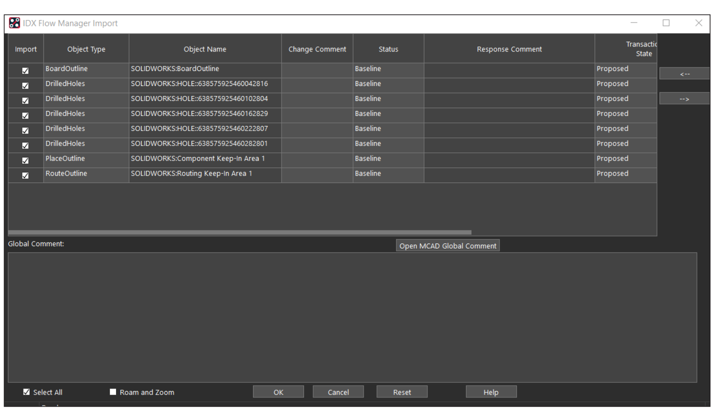
Intelligent Data

Detailed, intelligent data is required to obtain a realistic representation and full digital prototype. Low-resolution boxes indicating where components are located on the PCB is no longer enough to guarantee proper interaction in the final assembly.

Native Design

For improved efficiency, collaboration between teams needs to happen natively within the respective CAD tools. With a native approach to collaboration, the file sizes are reduced, increasing the speed at which information is communicated and adopted into the design. Along with importing or exporting a baseline design, both the ECAD and MCAD environments should accept incremental updates and convert models into their native format. This eliminates lengthy files transfers and error-prone email communication.



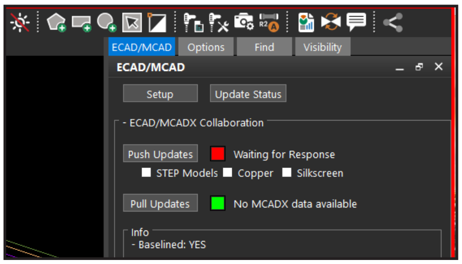


MCAD and ECAD Aware

Differences between disciplines, such as naming conventions and terms, can be resolved with a system that is MCAD and ECAD aware. This will associate mechanical elements (parts, drawings, and assemblies) with the electrical design. Additionally, the MCAD team must have a way to effectively communicate design constraint requirements to the electrical team and vice versa.

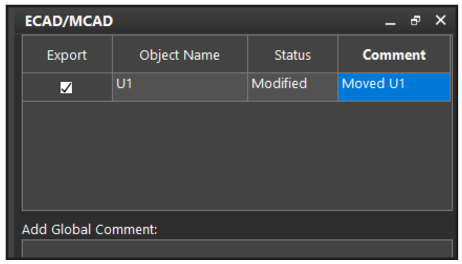
HOW TO BRIDGE THE GAP

CREATING A SINGLE SOURCE OF TRUTH



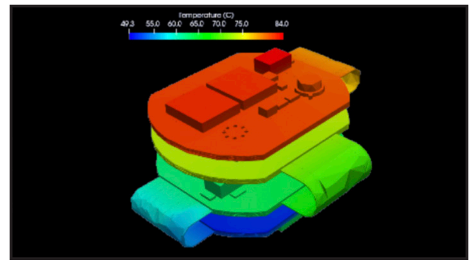
Collaborative

With a concurrent design process, changes can come from either the mechanical or electrical team. Your software solution needs to be able to support bi-directional updates and create a collaborative environment for the product design process.



Traceable

Eliminate finger pointing by tracking actions such as accepting or rejecting changes to the design. These actions should be communicated to both the ECAD and MCAD teams in real-time, creating a version history to document the product's development and progress.

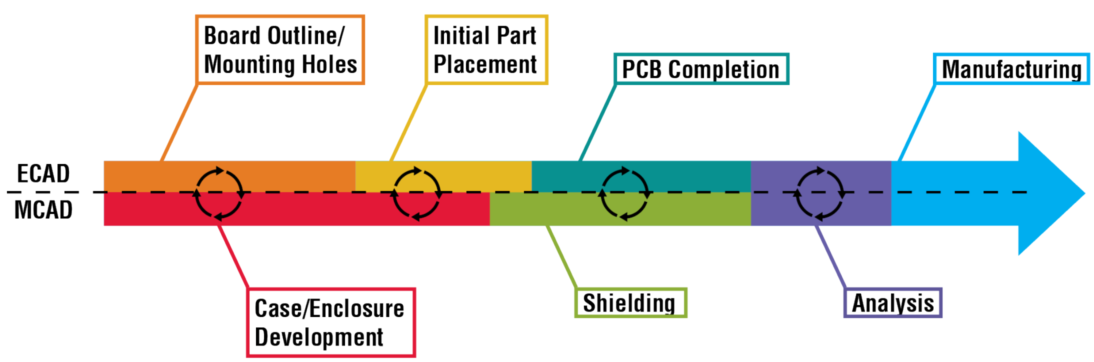


Simulation-Ready

Seamless integration between ECAD and MCAD allows for more accurate digital prototyping and high-fidelity simulations. By analyzing a full digital prototype, both teams can achieve a comprehensive assessment of the entire assembly, providing a realistic representation of field performance.

Incorporating a software solution into your existing ECAD/MCAD design process which includes these key features will enable real-time, bi-directional synchronization and reduce the current variability found in the concurrent product design timeline.

Concurrent ECAD/MCAD Design Timeline with Seamless Multi-Disciplinary Communication



Achieving seamless collaboration between ECAD and MCAD design teams creates a cohesive design environment and reduces errors, allowing designers to focus on innovation instead of troubleshooting and rework.

ACHIEVING SEAMLESS COLLABORATION
CADENCE ECAD/MCAD CONNECTORS

The key to a successful ECAD/MCAD design is creating a single source of truth through a full digital prototype which can be accessed, analyzed, and modified by either the electrical or mechanical teams. This can be achieved with the Cadence ECAD/MCAD Connectors. Cadence ECAD/MCAD Connectors allow designers to implement a seamless collaboration process and bridge the gap between electrical and mechanical designs directly within your OrCAD X or Allegro X design environments with:

- Support for multiple MCAD tools
- Bi-directional integration
- Native CAD model creation
- Baseline import and export file support
- Incremental updates
- Approval or rejection of changes
- Change tracking and version history
- Synchronized libraries

Leveraging Cadence ECAD/MCAD Connectors enables electrical and mechanical teams to collaborate early and often, identify errors or opportunities for optimization, and keep schedules and costs predictable.

Cadence ECAD/MCAD Connectors Support:

CATIA
SOLIDWORKS
AUTODESK® FUSION 360™
creo®
PLM Software SIEMENS NX

EMA Design Automation is a leading provider of the resources that engineers rely on to accelerate innovation. We provide solutions that include PCB design and analysis packages, custom integration software, engineering expertise, and a comprehensive academy of learning and training materials, which enable you to create more efficiently. For more information on ECAD/MCAD Collaboration and how we can help you or your team innovate faster, contact us.

To learn more go to:

www.ema-eda.com/solution/ecad-mcad-collaboration

info@ema-eda.com