TECHtips

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Electronics Manufacturing Insights from ACI Technologies, Inc.

Computer Aided Design, Manufacturing, and Engineering

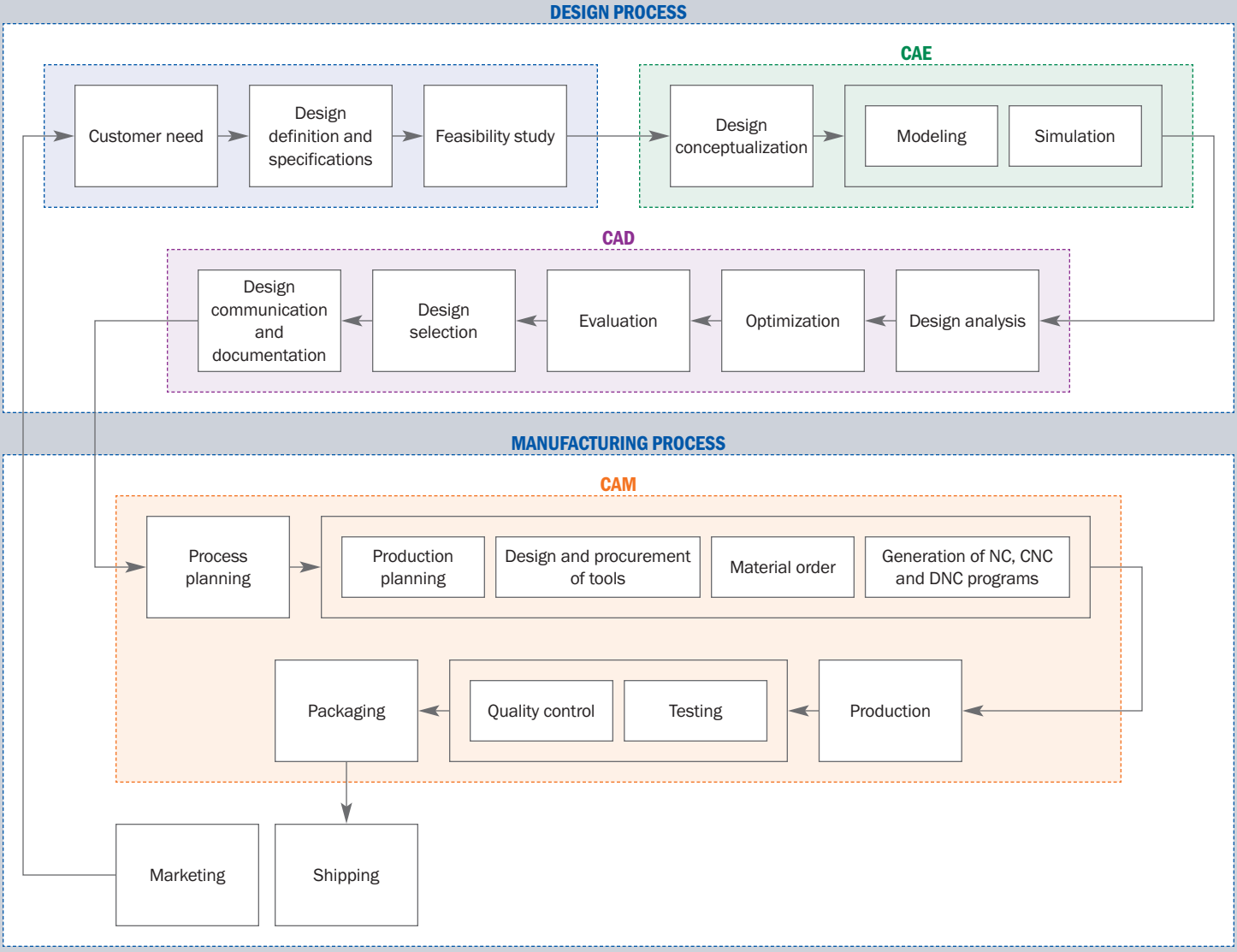

Figure 1: The product cycle from design to production.

In the electronics industry of today, companies emphasize better quality, lower cost, and shorter lead time on their products in order to keep up with their competitors. ACI Technologies (ACI) has been utilizing Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Engineering (CAE) in its development of advanced electronics systems. CAD utilizes computer systems to assist in the creation, modification, analysis, and optimization of a design [1]. Some of the more common programs to perform this type

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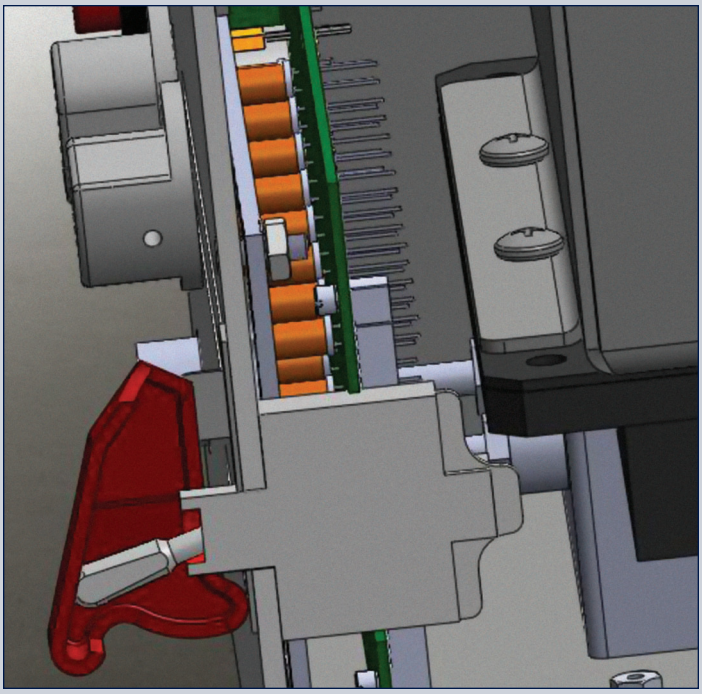

Figure 2: CAM assembly model containing COTS and custom parts to check for interferences.

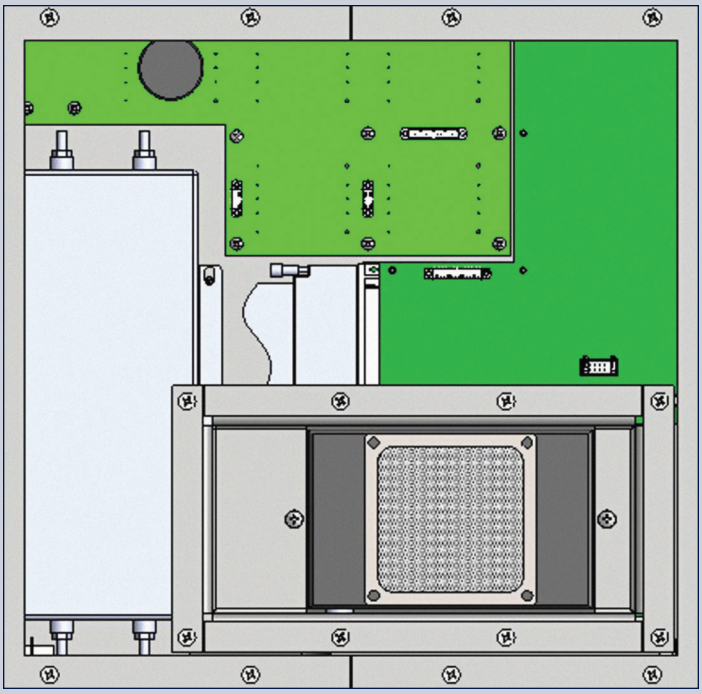

Figure 3: Three dimensional model showing how board shape (green) was designed to fit with other COTS components (grey).

of design work are SolidWorks, Creo, NX, and AutoCAD. CAM software will check for interference between parts in an assembly and allow the real time editing of the part from the assembly if necessary. There are many computer design tools for printed circuits as well. Most of these enable the designer to lay out a circuit, define integrated circuit parameters (package and pinouts), and then go directly to the printed circuit board (PCB) layout and check that all circuits are completed according to design rules. Cadence and PADS are common tools in the circuit design and PCB layout arena. CAM allows a manufacturer the ability to use computer systems to plan, manage, and control manufacturing operations with internal or external plant production resources. Mastercam and Autodesk Inventor are popular CAM software tools. CAE is focused on using Finite Element Analysis (FEA) to analyze CAD geometry in its operational environment in an attempt to refine and optimize the design in pre and post production form. ANSYS, COMSOL, and Creo Simulate are examples of CAE software. Almost all of the CAD/CAM/CAE software available has the ability to create 3-D models of each part in an assembly, and then place the parts together using the proposed "mating" surfaces. Figure 1 illustrates design through production of the product cycle.

Benefits

Product development costs can be reduced in pre-production design verification. The creation of engineering samples and the coordination of the various engineering disciplines can help verify all phases of the product before committing to costly tooling costs. This reduces the time and costs associated with rework due to unforeseen interferences. The designers can check assembly tolerances and perform stack up analyses of the final assemblies using solid models of the individual components (Figure 2). Commercial off-the-shelf (COTS) parts are frequently available from the component manufacturers in multiple 3-D formats in order to seamlessly use their components in new customer designs. Design engineers can also use these models to perform stress and thermal analyses by including actual material properties of the components.

3-D CAD software can also be used to make additive manufactured prototypes using a process called stereo lithography. Stereo lithography works by utilizing a laser to solidify a liquid polymer on the surface. A platform moves the hardened polymer down about a tenth of a millimeter and the laser hardens the next layer. This process is repeated until a full three dimensional model of the part has "printed." There are many stereo lithography companies that can import a 3-D CAM file and print a full size polymer model of the component. The quick turn ability of this process allows a functional prototype to be in the hands of the design team within a day of laying out a part. The speed and low cost of the stereo lithography process can allow the developers to mock up an assembly and check form and fit before cutting metal or making expensive molds. Minor changes can be implemented even before pre-production runs are started.

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With the use of CAD/CAM/CAE software, the ACI design team has been able to build prototype electronics to prove out designs. The following section gives a brief overview of a past project where CAD/CAM/CAE were used to layout the components and set the overall dimension requirements of PCBs. The considerations and process that was followed are described here.

Project Design Constraints

This project modeled some COTS components in detail using SolidWorks to create a 3-D rendering of the parts. Some 3-D models were available from the manufacturer; some were created from 2-D drawings, and when there were no drawings or models available, ACI created models by measuring the actual components.

Custom components that were needed to interface with our housing and COTS parts were then designed. Using the overall size requirements for the system, the preferred form factor for each subsystem, and the size and material constraints of the COTS components, the layout of the custom assembly components could be completed (Figure 3).

Using the solid models to define the spacing of user interface components, PCB outlines, keep out areas, and mounting locations were defined and documented. The board's physical dimensions were forwarded to ACI layout engineers along with the circuit schematics and bill of materials for each board. Using this method, even the PCB layouts were completed with a significant cost and time savings over the three to four turns usually required.

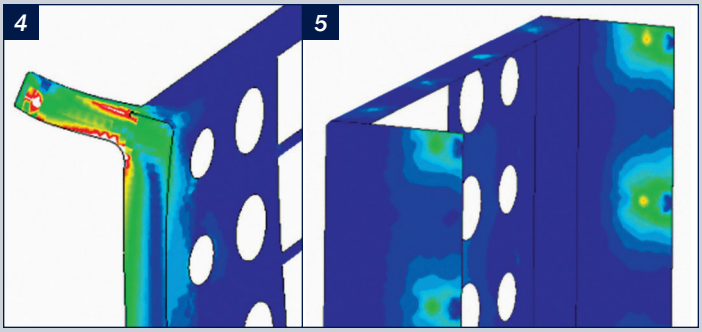

Figure 4: Stress analysis of aluminum bracket showing overstress at mounting tab.

Figure 5: Stress analysis of redesigned bracket showing less stress in solid model.

Originally, the boxes that housed the systems were to be made from steel. Weight restrictions that were later imposed on the project required the material to be changed to aluminum. The computer models were then changed to reflect the material change. After changing the three dimensional model of the assemblies, a simulated stress analysis was done to find any stress points that may cause premature failure (Figure 4). The weak points that were found were redesigned and strengthened, and the stress analysis was run again (Figure 5). Once the components were found to be strong enough, drawings were created from the models and the parts were fabricated in aluminum.

As the project developed, customer-added requirements were quickly evaluated by ACI and changes which impacted other components were found using the modeling software's interference detection feature. Sometimes a clearance hole was needed or electronic components were moved on the board. Other times it meant finding a place to mount a hardware part that did not interfere with the current layout of a printed circuit board. The PCB layout software used in the project allowed quick modification of the circuit boards and verification of the interconnections between electrical components.

Conclusion

The use of Computer Aided Manufacturing requires the synchronization of the many different engineering disciplines that go into a preliminary design of a new product. Each member of the team must be aware of the constraints of their section of the design, whether imposed by the customer requirements or by another's discipline. The ACI team was in constant contact with each other throughout the design phase to ensure that any changes from one group did not adversely impact others.

For more information regarding Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Engineering (CAE) at ACI, please contact the Helpline at 610.362.1320 or via email to helpline@aciusa.org.

Reference:

[1] Groover, M.P. and Zimmers, E.W. *CAD/CAM Computer-Aided Design and Manufacturing*. Prentice Hall, Englewood Cliffs, NJ. 1984.

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