Bringing reality to PCB design

Summary

PCB assemblies are three dimensional entities, yet we design them using 2D software. Does this inhibit the design process and what would be the benefits of an ECAD system that actually does support real-time 3D design?

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In a fundamental shift that redefined how products are created, the transition of engineering design from manual drafting-based methodologies to Computer-aided Design has transformed design in virtually all branches of engineering. The application of CAD in the electronics industry is no exception, and has revolutionized the way engineers work and the products that can be developed. You won't find too many engineers that would be willing to go back to the old methods.

What you would be going back to is laying out strips of tape and sticking graphics shapes on a flat sheet to create the tracks, footprints and connections that represent the electrical version of the design's schematic. The birth of ECAD – as in other engineering branches – was essentially the wholesale transfer of that traditional process into the computer software domain. ECAD applications have evolved at a rapid pace since that time, but the roots are firmly planted in the two-dimensional approach of working with board layouts as an essentially 'top-down' process.

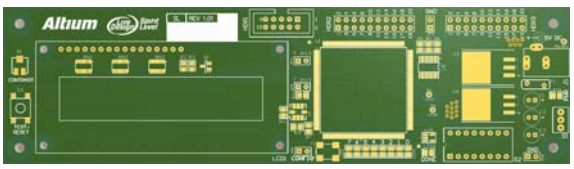
The original 2D mindset was all that was needed to design simple, single-layer boards where there was little concern for component dimensions beyond the basic footprint area. Today's complex board designs bear little resemblance to their predecessors, and have evolved to a point where virtually all boards involve multiple layers with electrical connections in the vertical dimension. This and the need to consider the space and position occupied by component bodies from a mechanical, thermal and visual design perspective means we are actually 'working' in 3D when designing PCBs – at least, we are from conceptual standpoint.

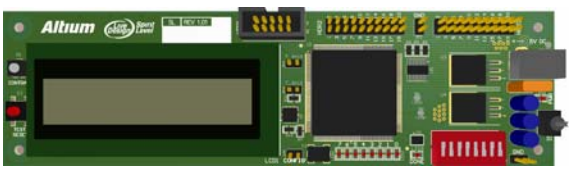
The third dimension

To deal with this added dimension of design complexity, advanced ECAD applications have evolved to cope by adding features such as the ability to switch between color-coded layers, alter layer transparencies and even render a 3D image of the board as a post-design check.

The need to consider all dimensions is not unique to ECAD however, and it's an interesting exercise to consider the parallel development of CAD systems in the other engineering disciplines. Many of those engineering fields, for example mechanical and architectural design, also have their roots in a two-dimensional drafting approach but the CAD tools evolved to incorporate 3D capabilities over 20 years ago. As a result the accepted – or even 'normal' – way to inspect, alter and review the design of say a new car or building is in an interactive 3D CAD environment.

To be fair though, ECAD is still a largely 2D engineering exercise where a 'flat' circuit board is ultimately created from multiple 'flat' layers, and in some cases 3D versions of the design might be passed to the MCAD environment for checking. Indeed, it's not that surprising that ECAD systems have traditionally offered minimal 3D capabilities when compared to their engineering CAD peers.

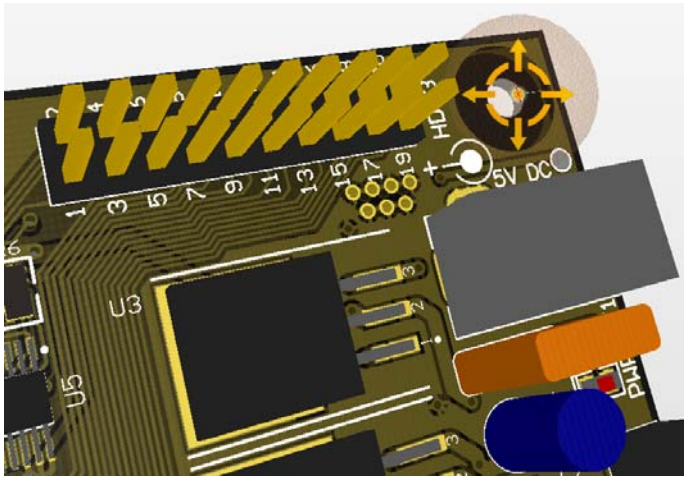




While it has previously taken a low profile however, there is no question that 3D is playing a more important role in electronic product design as board complexity increases, so today's CAD systems need to offer meaningful capabilities in this area. We have the situation where engineers are visualizing in 3D while they design, the end goal – a board

assembly – is a 3D entity, but the design tool being used is restricted to the 2D realm. The computer hardware being used is most likely capable of rending real-time 3D images thanks to modern graphics cards and the standard DirectX® software interface, so it is technically possible and there are no real cost penalties in this approach.

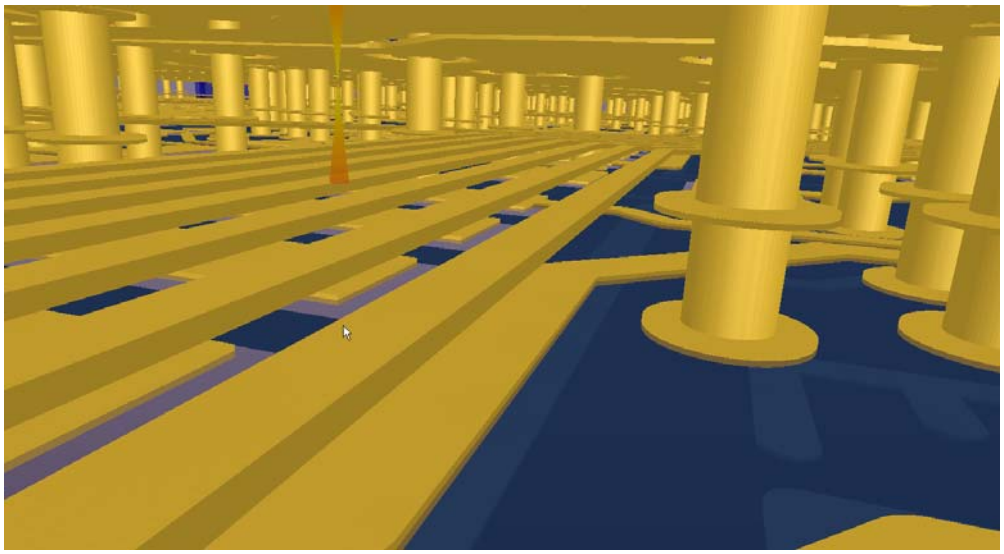
Let's go 3D



When implemented in ECAD, the ability to view and manipulate a board design in a real-time 3D environment opens up a range of practical and workflow advantages that allow you to make more informed design decisions and work in a more intuitive way. In same way that CAD systems in other engineering fields let you view a 3D rendered version of the design from all angles, including the inside of objects, 3D ECAD lets you see a realistic view of every aspect of the complete board.

In real terms this means the capability to 'fly' around and inside the board in real time, while viewing fully-rendered pads, cut-outs, via barrels, solder mask expansions, silk screen overlays, plus tented and hidden vias from either the board surface or internally. Having such a realistic view of all board details allows you to accurately inspect the board prior to manufacture, which makes it easier to detect design faults and make decisions regarding board surface overlays and coating finishes.

As the board design is being developed, having 3D capabilities also means you can directly view the board's internal layer stackup for making more accurate spacing judgments when placing blind or buried vias. Zooming and rotating around the external view of board also helps you make more informed decisions when placing components – for example by helping you visualize the airflow around the board when making thermal judgments, or by simply providing a realistic view of the board assembly for aesthetic 'fine tuning'.



If 3D visualization is a unified part of the board editing system, the option exists to make edits while using multiple and mixed views of the board layout in both 2D and 3D formats. By including a configurable viewing panel, the system could be arranged to show say a static internal view of a board area while external changes are being made to that section in a real-time 3D viewing panel. Other possibilities that can make board design easier, more realistic and faster include A-A and B–B cross-section slices of the board, the ability to see and color 3D component bodies, plus the ability to save and load custom 2D/3D view configurations.

A new dimension in board design

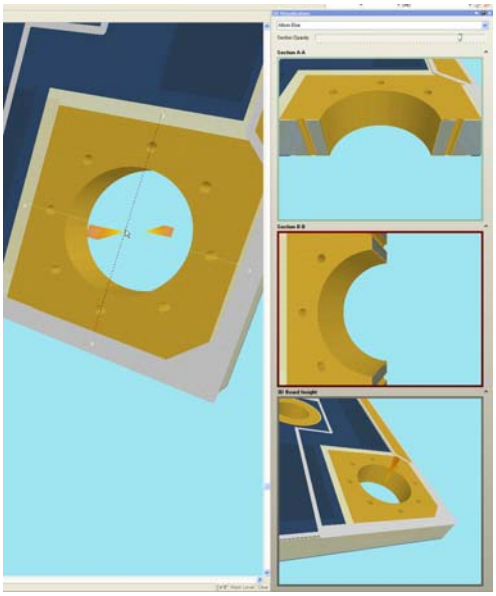
From a product design perspective an ECAD system with real-time 3D capabilities can help to keep one step ahead of the competition by allowing you to produce a more visually professional result with fewer board revisions. A full and realistic view of the board is available at all times during development, allowing you to make accurate visual design judgments and trap errors before they propagate through to the manufacturing stage. Ultimately, this allows you to produce a better-designed board in less time, which reduces costs and makes your board stand out in the market – a considerable advantage for board design contractors in particular.

Beyond the direct practical advantages developing PCBs using real-time 3D, it is simply a more natural and tactile way to work since you are manipulating and viewing a realistic representation of the final result. This adds up to a more enjoyable user experience that will allow you to work faster and produce superior results.

PCB layout engineers and designers have actually been working in the 3D space since single-layer boards gave way to multi-layer designs all those years ago. It's just that the 3D visualizing has been happening in engineer's heads rather than in the software tools they've been using. With everything in place for 3D-based board development to be a reality – the need, the concepts and computer hardware – all that's required is ECAD software that seamlessly supports it in the board layout environment.

Altium has taken this step forward by including advanced 3D visualization in its latest product release – Altium Designer 6.8. By taking advantage of DirectX capabilities, PCB Visualization allows you to customize and configure the design view for both 2D and 3D displays so that you can inspect and edit objects such as pads, via barrels, tented vias (both on the surface and internally) from a 3D perspective – and all in high detail.

Three simultaneous 3D views are available in a fully configurable 3D Visualization panel, which includes the ability to define board cross sections and the depth of 3D detail by varying the level of 'through-board' opacity. These settings can also be saved so you can recall favorite 2D/3D view setups easily.



The real-time 3D viewing capabilities of Altium Designer are further enhanced by the ability to setup the colors of the workspace, copper, and component bodies (as defined by a 3D footprint attribute) on the board. Opacity and color setting also can be specified for Solder Masks, Board Core, and Silkscreen, allowing you to define exactly how the board assembly is displayed in 3D.

To help you navigate the board in 3D mode, Altium Designer includes an innovative '3D sphere' feature that helps you to control the direction to spin and rotation of the board in the 3D space, plus new fast mouse zooming and panning configurations. These features help you move around in the 3D environment in an intuitively way, but this can be taken to the next step by investing in a latest generation 3D navigation device like the 'SpaceNavigator' 3D mouse from 3Dconnexions. This device is fully supported in Altium Designer, and when combined with the real time graphics of PCB Visualization, lets you experience the freedom of feeling like you are directly reaching into the display and exploring the design in a detailed 3D world.

Altium Designer's 3D Visualization offers a new and enhanced way to work with PCBs – one that also signals a future path for ECAD, which is becoming increasingly connected to the interdependent role that MCAD plays in electronic product development. From an immediate perspective though, 3D Visualization will help you get the connectivity and physical attributes of your design right the first time by providing an unprecedented level of reality when viewing PCB assemblies. The 3D environment is also a more natural and easy place to work in, and even offers the prospect of making complex PCB design enjoyable – once you've tried it, you'll find it hard to go back.

See Altium Designer's new 3D Visualization in action at *http://www.altium.com/DEMOcenter/AD68/1*.