WHITE PAPER

3D Modeling and Analysis in EDA Applications

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Overview

For Electronic Design Automation (EDA) applications and designers, 3D physical analysis has moved into the mainstream, reducing the need to re-design and delivering more predictable product performance and reliability. Two main factors driving the need for precise 3D geometric modeling and analysis within the EDA industry are high frequency switching and characterization of manufacturing variations. Understanding the physical characteristics of wireless clients, advanced packaging, die stacking, and scaled manufacturing processes is critical to the delivery of high-quality products.

Physical analysis within EDA applications requires high-performance 3D geometry creation, modeling, meshing and display capabilities. These functions provide an understanding of complex behaviors in various electronic design areas, including:

- Integrated Circuit design and analysis
- Package and board power delivery
- Die-packaging thermal profiles and thermal-induced stress
- DFM IC library characterization
- TCAD process simulation
- IC critical path cross talk
- RF IC and system integrity

Today, technology exists to enable EDA application developers to rapidly introduce 3D capabilities within their applications and address the growing user demand for 3D modeling and analysis.

Development Strategy: Internal or Components

To incorporate 3D modeling and analysis into EDA application work flows, software vendors, as well as internal CAD groups, can leverage commercially available 3D software components. This choice can significantly reduce the risk of developing internal core competency in 3D. The risk is compounded by the fact that existing 2D design and layout competencies are not easily leveraged to address the complexities associated with 3D.

There are a number of factors to consider when deciding between internal development or use of component technology. These include:

- R&D resource allocation on core competencies
- Cost of hiring 3D domain experts
- Cost of training existing resources
- Development risk associated with unfamiliar technology
- Competitive factors such as time-to-market

For many developers the answer is clear. 3D software components enable them to get to market more quickly, with lower costs and risks.

Unique EDA Industry Needs

Today, a rich array of commercial 3D physical analysis tools exists outside of EDA, primarily used in mechanical design and analysis. However, these tools fail to meet both the productivity and accuracy needs of analysis within the IC flow or provide optimization necessary for EDA databases. The table below illustrates the characteristic differences that make mechanical analysis packages inefficient when applied to EDA problems:

Characteristic		EDA		Mechanical
Geometry		Dominated by layered polygons		Complex 3D shapes
Number of entities		Billions		Small; assemblies
Optimum analysis shapes		Anisotropic		Isometric
Data formats		GDS, Virtuoso, PCB		MCAD standards

Another critical difference is the user of the EDA Application. The EDA user typically has little or no experience in 3D modeling and meshing. A proper solution needs to deliver tight integration between electrical design such as IC layout, and 3D geometry creation, clean-up and meshing. This is to eliminate the need for the user to intervene and have 3D modeling expertise. Mesh types, shapes and sizes need to be automatically controlled using feedback from the solver to further reduce end-user know-how. In mechanical analysis this level of automation is not required since the typical mechanical designer is knowledgeable and accustomed to interactive and iterative design and analysis process. In the EDA flow, these

meshing decisions need to be automated, under the hood, and presented to the user in the form of results and/or hints to improve run time or accuracy.

Component Technology for the EDA Industry

Spatial Corp. is the leading provider of 3D software components for engineering applications. The company offers easily integrated components for 3D modeling, pre-processing and graphics display specifically designed for use within EDA applications and workflows. The components transform 2D IC, package and PCB layout data into 3D geometry for meshing and analysis by a proprietary solver. A variety of geometry simplification, meshing techniques and controls are provided to deliver both mesh accuracy and performance. Efficient pre-solver processing is critical to competitive analysis flows for thermal flow or electrical signal integrity. Spatial provides all the 'plumbing' necessary to develop an automated flow that creates efficient meshes for specific solvers without the user needing to become a 3D expert.

To address the EDA industry's performance requirements, Spatial provides thread-safe components for the development of multi-threaded applications. Multi-threaded EDA applications running on multi-core platforms address EDA users' insatiable appetite for efficient run times and high capacity.

Spatial components provide solutions for a variety of EDA 3D design and analysis needs. As stated above, these include:

- Integrated Circuit design
- Package and board power delivery
- Die-packaging thermal profiles and thermal-induced stressed
- DFM IC library characterization
- TCAD process simulation
- IC critical path cross talk
- RF IC and system integrity

Spatial's 3D Software Components for EDA Applications include:

3D ACIS® Modeler – 3D geometry creation and modification

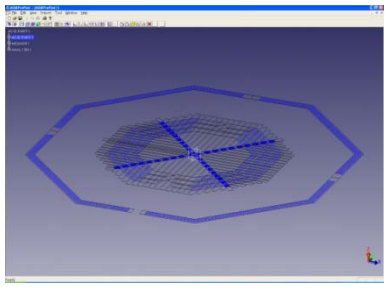
3D Mesh® – automated 3D mesh generation

HOOPS 3D Application Framework – 3D visualization and graphics system

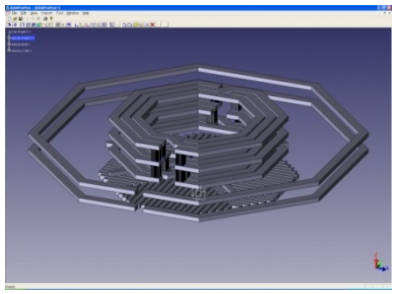
Example: Embedded Inductor Workflow

The following is an example of an embedded inductor workflow within an ACIS, 3D Mesh and HOOPS enabled application:

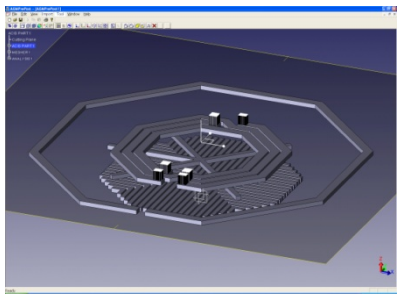
Step 1: The IC layout information is read into the 3D ACIS modeler as layers of 2D objects. Physical layout data selection occurs within a physical design tool such as Virtuoso® or can be exported from the layout database as a CADENCE GDS file. This example illustrates an embedded inductor within a CMOS IC. The inductor is created using a number of metal layers and vias.



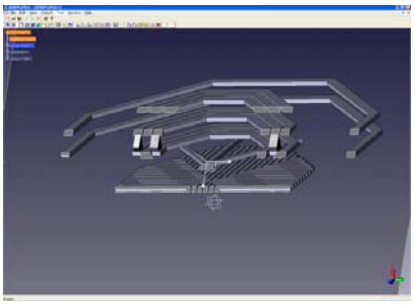
Step 2: ACIS uses the information found in the foundry PDK (process design kit) to extrude each metal layer, and dielectric along with the vias. This can be a straight 3D extrusion or include tapers or other sidewall profile details.



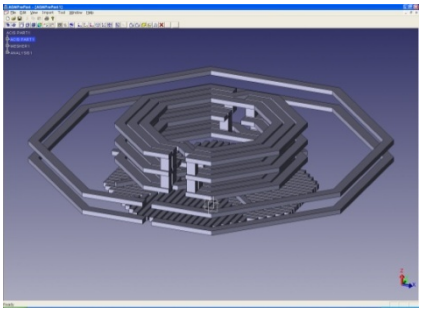
Step 3: An ACIS cutting plane illustrates the packets of vias. The massive number of vias may complicate the electro-magnetic (EM) simulation leading to excessive run times. The vias can be replaced with a small number of electrically-equivalent larger vias during data import or once in ACIS. ACIS provides utilities to examine, clean-up and modify the 3D model to improve accuracy or runtime performance of a downstream simulation.



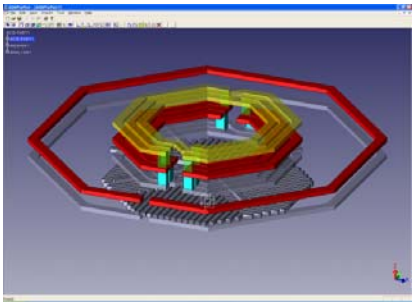
Step 4: The cutting plane can be used in any arbitrary xyz orientation to examine the 3D model.



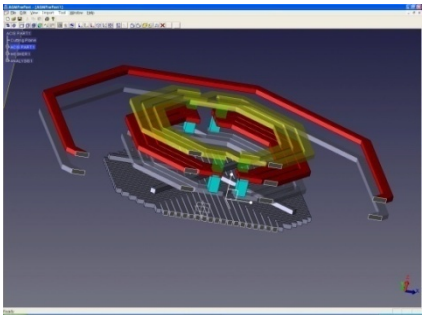
Step 5: The 3D model is simplified with electrically equivalent larger vias.



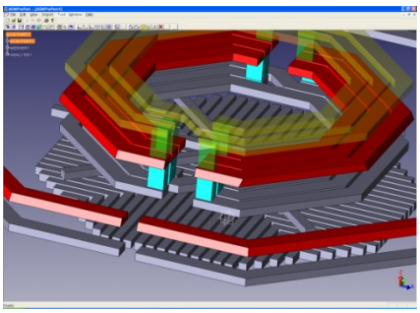
Step 6: Both geometry and related attributes are read into ACIS. Commonly used attributes are metal layers, materials, and netlists. These attributes can be used to colorize the model. Transparency is available to improve visualization.



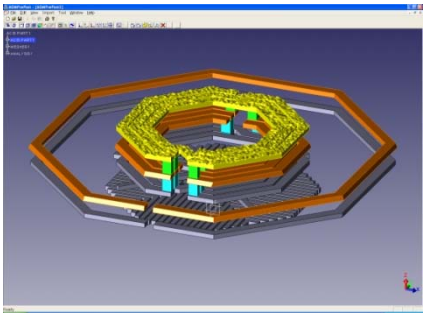
Step 7: The effects of using the cutting plane can be seen on the simplified model with the use of color and transparency attributes.



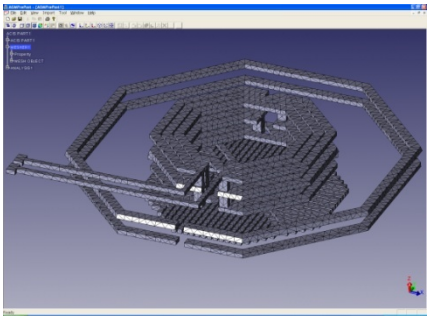
Step 8: ACIS supports pan and zoom to examine the model in detail.



Step 9: Thus far, the layers have been planar. However, texture can be added to a layer by providing a surface map or a set of offset points to deform the surface using some specified pattern. DFM applications such as CMP (Chemical Mechanical Polishing) can benefit from these kinds of model modifications.



Step 10: Wires to the pads are now added for a complete mesh. Application developers have access to a rich set of meshing utilities. These include primitive elements, volumetric and surface meshing, and controls such as size limits and growth rates. Error signals from the solver are available to implement in iterative meshing.



Summary

Spatial Corp. offers software developers and internal development organizations 3D software components tailored to the needs of the EDA industry. Component technology represents hundreds of man years of development and provides a cost-effective, proven and reliable alternative to internal development. The use of component technology allows application developers to maintain focus on their core competencies, deliver technology leading applications and accelerate their time-to-market.

To learn more how Spatial can help address your development challenges go to: http://www.spatial.com/solutions/eda-3d-analysis-suite