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A Survey on 3D Visualisation Tool for Printed Circuit Boards

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***Abstract*— Printed circuit boards are designed to handle electronic components for its functional delivery. The geometric modelling and visualisation in 3D of the printed circuit board's components, footprints and layout are important to any design engineer. The visualisation of the results of thermal analysis performed on the printed circuit board is also equally important. This paper discusses briefly the various concepts which drive the development of a 3D visualisation tool which will be integrated with Electronic Package Thermal Analysis (EPTA), a software which is developed by the Indian Space Research Organisation (ISRO), and will visualise in 3D the printed circuit board and its components as well as the results of thermal analysis of the printed circuit board. Some similar real-world printed circuit board and thermal analysis visualisation tools similar to the tool being developed are also discussed.**

Keywords*— Visualisation; three-dimension; thermal analysis; printed circuit board; EPTA

I. INTRODUCTION

The design engineer is very much interested in visualising the printed circuit board and the components which make it up on the computer monitor. This is because before the actual physical design of the circuit takes place, the design engineer can find out what components are present on the printed circuit board, whether the desired components are present, whether the components are placed in the desired positions and to also determine what are the unnecessary components. Apart from this, visualising the results of thermal analysis of the printed circuit boards is also very important because it allows those persons who are not proficient in thermal analysis to view those results in a pictorial manner which is easier to understand for them. Most of the commercial printed circuit board design and thermal analysis tools provide this visualisation component.

The Indian Space Research Organisation (ISRO), the premier space research organisation in India, is currently developing a tool called Electronic Package Thermal Analysis (EPTA), whose main role is to perform thermal analysis on the printed circuit boards. A 3D visualisation tool which will be integrated with EPTA is to be developed which will visualise the printed circuit board, its components and the results of thermal analysis on the printed circuit board in 3D. This paper discusses the various concepts involved in the development of this tool and also a few commercial printed circuit board visualisation and thermal analysis visualisation tools similar to the tool being developed.

II. CONCEPTS INVOLVED IN THE DEVELOPMENT OF THE TOOL

This section briefly explains the concepts that are involved in the development of the 3D visualisation tool for EPTA.

A. Printed Circuit Board

[1] describes about the printed circuit board. A printed circuit board is a simple electronic device which comprises of a base made up of an insulating material such as fiberglass or plastic. A conducting material such as copper or silicon is etched inside this base. The electronic components such as resistors, capacitors, transistors, diodes, integrated circuits etc. are soldered to the base. The circuits which are etched on the board will allow electricity to pass from one component to another, so that they can work together to perform some specific functionality.

Before printed circuit boards were invented, vacuum tubes were used. The components making up an electronic device were connected together by either soldering them to tube sockets or to each other. This was quite expensive. The advent of printed circuit boards made the connection of components easier and less expensive. Printed circuit boards have enabled the development of smaller and more compact electronic circuits.

Printed circuit boards are used in all but the simplest electronic devices. Be it a simple electronic device like a beeper or more complex and sophisticated devices like computers, mobile phones, televisions and washing machines to name a few, all these devices contain a printed circuit board.

Fig. 1. A printed circuit board

B. *Visualisation*

[2] explains visualisation. Visualisation is defined as the art of creating a graphical rendition of a concrete thing or an abstract idea. Examples of visualisation range from ancient examples like cave paintings to more modern examples like the designs of buildings, vehicles and electronic devices among others. Computer visualisation is defined as the study of generating images on the computer monitor. With the evolution and increase in accessibility of the computer technology, computer visualisation has also grown in importance and relevance and has become indispensable, especially for engineers and scientists.

3D visualisation is a type of computer visualisation which makes use of computer programs to generate 3-dimensional representations of natural or man-made objects which can be manipulated and altered. These representations can be effectively communicated to other people. 3D visualisation removes the need to generate the actual physical object while the design is still allowed to be tested for certain variables within a virtual environment.

3D visualisation is used a large number of commercial applications such as designing a line of lamps to test whether they can be made more efficiently using the available design requirements and resources, simulate a car crash and collect results from that simulation to make the cars more safer, creating a virtual tour of the hotel rooms which highlight on its best features etc.. 3D visualisation is a very important tool for scientists. Scientists use 3D visualisation to graphically explain their ideas and discoveries and those ideas that can only be imagined and not seen with the naked eye, such as the Earth's internal structure, atomic structure etc. 3D visualisation is also used in architectural applications to visualise the floor plan of a house, building, office complex or a monument and make the necessary changes before actually starting to build them.

With the improvement in technology, the 3D visualisation technology will also improve.

C. *Thermal Analysis*

[3] provides a brief description about thermal analysis.

Thermal analysis is defined as a branch of materials science in which the material properties are studied as their temperature changes. The main aim of thermal analysis is to find how the temperature affects the other facets of physics.

There are various types of thermal analysis. Each of them are different from each other in terms of the property measured. These are:

1) Dielectric Thermal Analysis: The property measured is dielectric permittivity and loss factor.
2) Differential Thermal Analysis: The property measured is temperature difference.
3) Differential Scanning Calorimetry: The property measured is heat difference.
4) Dilatometry: The property measured is volume.
5) Dynamic Mechanical Analysis: The property measured is mechanical stiffness and damping.
6) Evolved Gas Analysis: The property measured is gaseous decomposition of products.
7) Laser Flash Analysis: The property measured is thermal diffusivity and conductivity.
8) Thermogravitimetric Analysis: The property measured is mass.
9) Thermomechanical Analysis: The property measured is dimension.
10) Thermo-optical Analysis: The property measured is optical properties.

Thermal analysis has many practical applications. It is widely used in the polymer, metal and food packaging industries. Thermal analysis is also very important in the area of critical applications. Thermal analysis is performed for critical applications such as spacecraft, missiles, aeroplanes etc. to determine how they will be affected by adverse temperature and other environmental factors.

III. COMMERCIAL PRINTED CIRCUIT BOARD AND THERMAL ANALYSIS VISUALISATION TOOLS

In this section a list of printed circuit board visualisation tools as well as thermal analysis visualsation tools which are similar to the 3D visualisation tool being developed for EPTA are discussed in brief.

A. *IDF-TO-3D, 3D Export and EAGLE'up*

[4] explains in brief about 3 visualisation tools for printed circuit boards, which are IDF-TO-3D, 3D Export and EAGLE'up.

IDF-TO-3D is an online application which can be used to be visualise the printed circuit board in 3-D in STEP and STL format. The data which will be visualised is stored in IDF files. It can be used along with another software called CadSoft EAGLE PCB Design software by using EagleIDFExporter.ULP to importing the IDF file to the IDF-TO-3D application.

3D Export is another tool which is also used in conjunction with EAGLE. It uses EagleIDFExporter.ULP to export the IDF files, imports the IDF files into the CAD applications and uses the IDF-TO-3D tool to render simple 3D PDF files

.EAGLE'up is a collection of tools which, as is the case with IDF-TO-3D and 3D Export, is also used with EAGLE. It allows the user to import the board layout with its components placed in the correct positions, generating realistic images of the faces of the printed circuit board, editing the printed circuit board and its components and adding more boards and the ability to rotate and zoom the printed circuit board.

B. *PCB Visualiser*

[5] describes about online visualisation tool which is developed by the Belgian firm Eurocircuits. It allows the user to upload the data to present an layer-by-layer interactive image of the printed circuit board and also generate a manufacturability report. Users can verify that the CAD output and the design and match to confirm the matching of order and data. The report has 3 components. The tool will check whether the data files, the size of the board the and

number of layers that make up the board of the match the order and that the production parameters of the board, such as minimum track and isolation and annular rings, will fit in the selected Eurocircuits service. The tool will also check the relative copper density across the printed circuit board at the same time in order to achieve even plating across the board.

C. .idf-to-SketchUp Converter

[6] mentions about a tool called .idf-to-SketchUp Converter which is developed by a firm called RS Components. It is used to convert the .idf files to a format called Collada, which is the file format used by Google SketchUp, which is a tool used for building virtual models of 3D objects. This tool was developed to solve the problem of SketchUp not supporting .idf files.

D. Altium's 3D PCB Visualisation Engine

[7] briefly describes about a 3D PCB Visualisation Engine developed by the Australian firm Altium. This tool can be used along with the company's other product called Altium Designer from version 6.8 onwards. It allows designers to visualise how the manufactured board will look. It also provides support for rotating and flipping the printed circuit board designs, supporting navigation around the components, zooming the board to explore the tracks and traces in the printed circuit board and to explore the inner layers in the printed circuit board.

E. Design Force

[8] explains briefly about a design tool called Design Force developed by the Japanese corporation Zuken. Design Force allow the designers to analyse the printed circuit board and integrated circuit packages in 3D. It provides support for both DirectX and OpenGL graphics and also for switching between 2D and 3D visualisation modes.

F. RadTherm and WinTherm

[9] describes about two thermal analysis visualisation tools called RadTherm and WinTherm.

RadTherm is a cross-platform heat transfer analysis software for system-level Computer-Aided-Engineering (CAE) applications. It has a very user-friendly graphical user interface which is used along with radiation module in order to establish the boundary conditions for multi-bounce radiation, conduction and convection with one-dimensional fluid flow.

WinTherm is also a cross-platform heat transfer analysis software. Its primary use is in component-level modelling and simulation. It can provide the heat transfer solution for models having up to 20,000 thermal nodes. WinTherm is very user friendly i.e. it allows users who are not from the thermal engineering background to analyse their thermal components in an accurate and quick manner.

G. Coolit v.11 and CoolitPCB v.7:

[10] explains about Coolit v.11 and CoolitPCB v.7, which are thermal analysis visualisation tools.

Both of these thermal analysis visualisation tools are developed by an American firm called Daat Research Corporation. They use colour fog to depict variations in temperature or pressure and also to control opacity. They also provide automatic flow visualisation and animation. Coolit v.11 alone provides major improvements in the import capability of CAD models, while CoolitPCB v.7 alone adds new components triangular prisms and inclined baffles in its library.

IV. CONCLUSION

This survey paper contains a brief description about the various concepts involved in the development of a tool used to visualise the printed circuit boards and the results of the analysis on these printed circuit boards in 3D. Some commercial real-world printed circuit board visualisation and thermal analysis visualisation tools similar to the 3D visualisation tool being developed have also been discussed.

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