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Survey on Electronic Design Automation Tools and Software

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Abstract
Digital design flows with the technology of automation. The focus of this paper is serving various Electronic Design Automation (EDA) tools and software for different operating system and platforms. This paper has classified the EDA tools for every specific task. Hence in this research paper, the comparison of various EDA software development models has been carried out to calculate the performance of each model on behalf of some important features.

Keywords: Area, Crosstalk and Coupling Noise, Delay, Power Consumption, Yield, and Manufacturability.

I. Introduction

As the growth of integrated circuit is increasing exponentially; the need of Electrical Design Automation is increased. Some advanced geometric software was used for implementing integrated circuit. But for more complex circuit the geometric software was not capable to maintain the layer limits (YogeshDilip Save*et al.*,2013), so performance became lower.For solving those kinds of problems EDA software tools are used as well. Many software companies are working on EDA tools and analysis for more features and better performances.

EDA involves a diverse set of software algorithms and applications that are required for the design of complex next generation semiconductor and electronics products. The increase in VLSI design complexity poses a significant challenge to EDA; application performance is not scaling effectivelysince microprocessor performance gains have been hampered due to increases in power and manufacturability issues, which accompany scaling. Digital systems are typically validated by distributing logic simulation tasks among huge compute farms for weeks at a time. Yet, the performance of simulation often falls behind, leading to incomplete verification and missed functional bugs (Jan Schmidt *et al.*, 2014). It is indeed no surprise that the semiconductor industry is always seeking for faster simulation solutions.

This paper is based on the survey on EDA tools and software where the free and open source and proprietary source both platforms for EDA tools are described in a comparative way. Open-source EDA platforms have proven to be critical to improving the quality of EDA research by offering well-designed reference algorithms, highly tuned codingimplementations, and real-world experimental data. Instead, the proprietary platform provides a feasible approach to focus on a few key computing patterns and develop highly efficient solutions for complex Circuit.

II. Electronic Design Automation

Electronic design automation (EDA) is a category of software tools for designing electronic systems such as printed circuit boards and integrated circuits. The tools work together in a design flow that chip designers use to design and analyze entire semiconductor chips. EDA tools are that kind of software which takes deep challenges to design the complex integrated circuit by maintaining the characteristics of IC

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and analyzing the performance of different portion. EDA tools have system-level, high-level, logic-level, and layout-level. It has its own set of synthesis, verification, and analysis toolset. (P.K. Agarwal*et al.,* 1992). If the outcomes of the design are total power, power consumption, noise margin, timing diagram, these tools help for calculating the errors and actuating the desired findings.

III. Categories

EDA tools are categorized based on its different functions like schematic entry, PCB design, simulation, Gerber view, etc. Maintaining all the features EDA tools has two specific categories, (P.K. Agarwal *et al.,* 1992). one is Free and Open Source Software (FOSS) and other one is Proprietary Software.

IV. Free and open source Software

Open and free source software means a package of software where it can be used with a free license.

Proprietary Software has much more features and most of them can fill up maximum demands of a user. On the other hand, free software cannot provide all types of facilities so auser needs to use different tools for the different task. There a lot of free EDA software with open source.

Some of them are used as Synthesis tools, physical design tools, (L. Aigo*et al.,* 1995). FPGA tools and Simulator (Verilog and VHDL).

Synthesis tools: Synthesis is the process of translating the schematic and behavioral VHDL descriptions of the design into a low-level form suitable for the vendor place and route tools.(L. Aigo*et al.,* 1995). Most usable synthesis tools are- PLA generators, gate-array generators, gate-matrix generators, compactors, routers, placement systems, pad-frame generators, aligners, pitch matches, ICARUS Verilog, VERILATOR, ghdl, ChipVault, KiCad, Precision RTL, Leonardo Spectrum.

1) PLA generators: PLAs are popular because their generation can be automated, which frees the designer from spending valuable time creating random-logic gates. Since the PLA generator fixes the physical structure of the PLA, there arises the problem of accommodating the designer's special requirements (P.K. Agarwal *et al.,* 1992).
The PLA is folded to reduce the area required for the physical implementation.

2) Gate-matrix generator: A typical gate-array is built from blocks that contain unconnected transistor pairs, (M. Alidina*et al.,* 1994). although any simple component will do. An array of these blocks combined with I/O pads forms a complete integrated circuit and offers a wide range of digital electronic options (see Figure: 1). These blocks are internally customized by connecting the components to form various logical operators such as AND, OR, NOT, and so on.

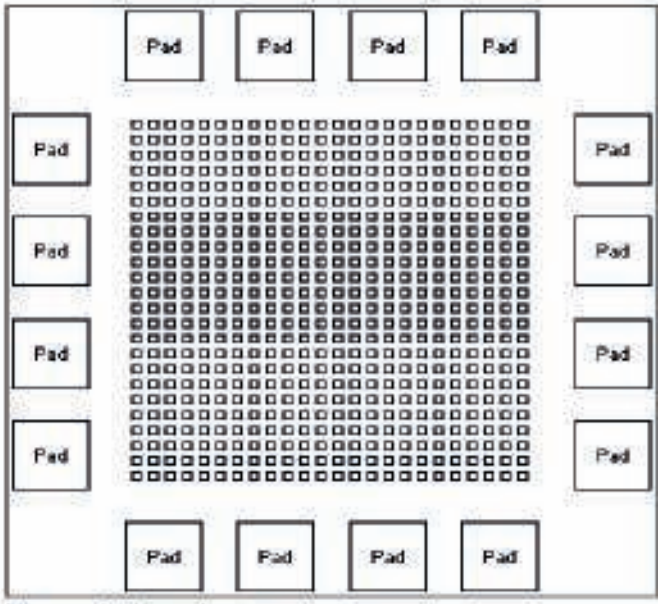

Figure 1: Gate-Arrays

3) Gate matrix Generator: The gate matrix is the next step in the evolution of automatically generated layout from the high-level specification. Like the PLA, this layout has no fixed size; a gate matrix grows according to its complexity. Like all regular forms of layout, this one has its fixed aspects and its customizable aspects.(M. Alidina*et al.,* 1994). In gate matrix layout the fixed design consists of vertical columns of polysilicon gating material. (M.

Alidina*et al.,* 1994). The customizable part is the metal and diffusion wires that run horizontally to interconnect (P. Ashar*et al.,* 1995) and form gates with the columns. Figure 2 is an example.

For batch simulation, the compiler can generate an intermediate form called VVP assembly. This intermediate form is executed by the "VVP" command. For synthesis, the compiler generates netlists in the desired format.

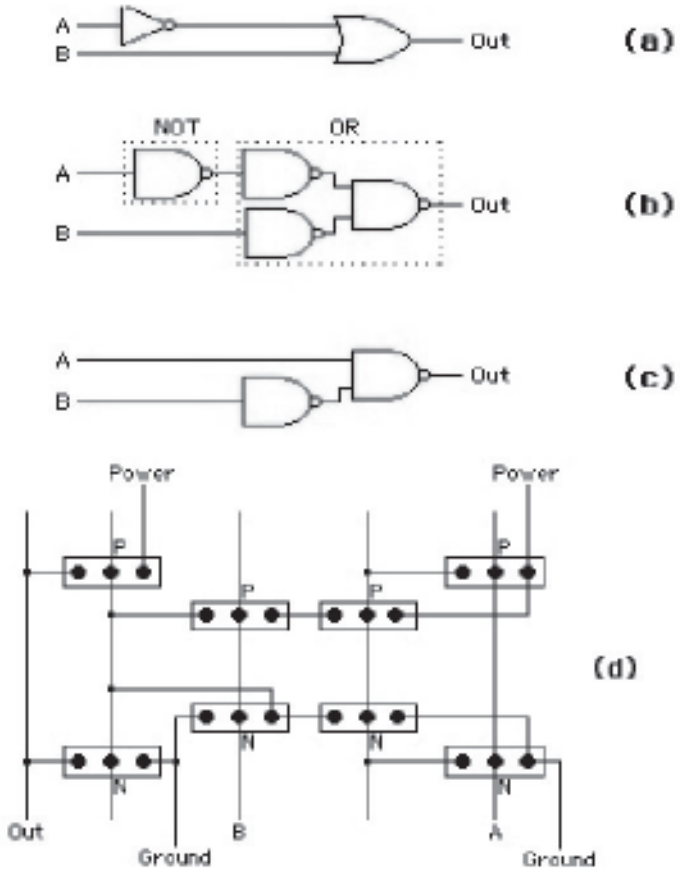

Figure 2: Gate matrix Generation: a) Original circuit b) Translation c) Optimization d) Layout generation.

4) Compactor: Compactor is a most important tool in the synthesis process. One-dimensional compaction uses information about components and their connecting wires. The wires that run perpendicular to the direction of compaction link a set of components into a single track that will adjust together.

5) ICARUS Verilog: Icarus Verilog is a software of digital analysis. Verilog is used as simulation and synthesis tool (M. Bae *et al.,* 1998). It operates as a compiler, compiling source code written in Verilog into some target format.

6) KiCad: KiCad is an open source EDA software for Windows, OSX, and Linux. Create PCB circuits and synthesis.

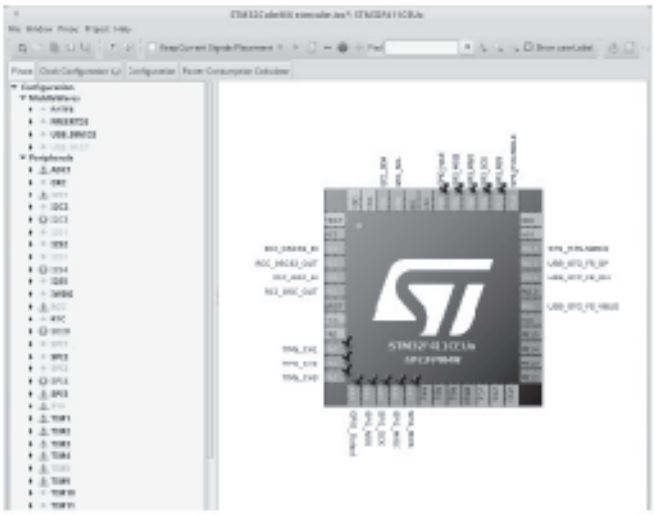

Figure 3: KiCad interface

KiCad uses two separate types of library: symbols (.lib) and footprints (. pretty) (M. Bae *et al.,* 1998). Symbols are used to draw the schematic. Once symbols have been placed into the schematic, footprints are assigned to them, and then these are used to lay out the circuit board.

Physical layout tools: Physical layout tools are that kind of tools which actually used for metal layout implementing of an IC and make a netlist of connections. (Harinarayan V. *et al.,* 1996). There is a huge collection of the free and open source physical layout tools of different companies like Tanner, Magic layout tools, MICROWIND, Alliance CAD Tools, OCEAN, , Irsim, Gtkwave, Electric, Toped, Netgen, Dragon, SystemC, SPACE.

7) Tanner: Tanner is a most leading software in physical layout tools. It earns a very good reputation for its design, layout, and verification of analog/mixed-signal (AMS). Tanner Waveform Viewer provides an intuitive

multiple-window, multiple-chart interface for easy viewing of waveforms and data in highly configurable formats.

8) Magic Layout Tools: Magic is a mixed signal type software.

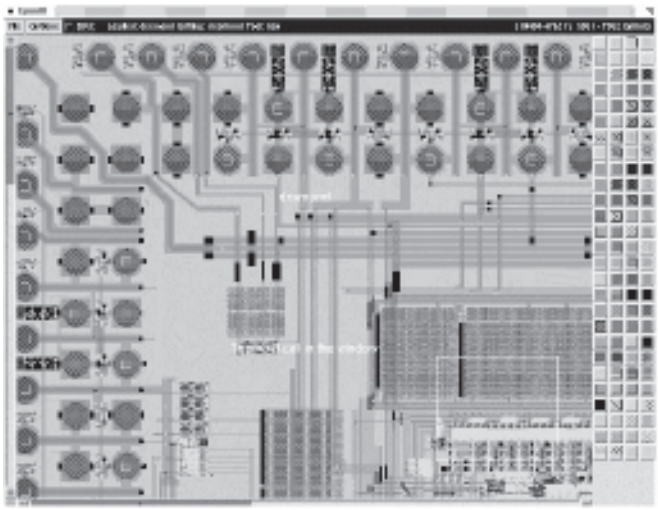

Figure 4: Magic Layout Tools

It offers open source licenses for VLSI engineers. Its core algorithm makes it more popular and it is widely used in the whole world. This figure is taken, from Magic version *Fernando Domene; et al., 2015; P. W. Wolniansky, et al., 1998;* (M. Bae *et al.,* 1998). It shows off a number of features of this software, including the cell manager window, the tech manager window, the toolbar, the console command-line entry window, and pop-up dialog boxes.

9) MICROWIND: Microwindis a user-friendly mixed signal EDA tools which also has a plenty of uses (H. B. Bakoglu*et al.,*1990).

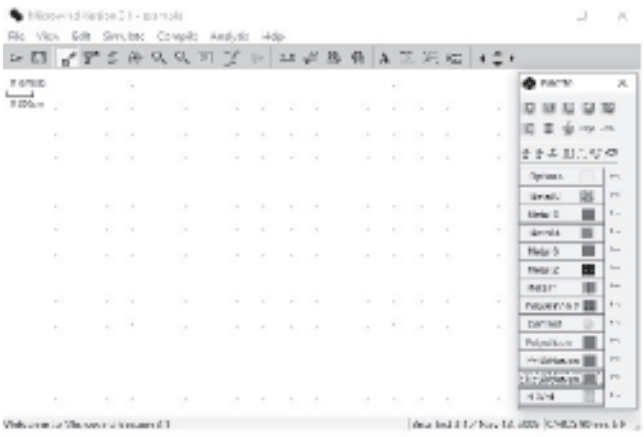

Figure 5: Interface of MICROWIND

Microwind integrates traditionally separated front-end and back-end chip design into an integrated flow, accelerating the design cycle and reduce design complexities.

10) Alliance CAD Tools: This software is usually used for designing the flow from VHDL up to layout, (VHDL Compilation and Simulation, model checking and formal proof, RTL (W. Athas*et al.,* 1995), and Logic synthesis, Data-Path compilation, macro-cells generation, place and route, layout edition, Netlist extraction (M. Bae *et al.,*1998), and verification, Design rules checking. It is a complete set of free CAD tools and portable libraries for VLSI design. It includes a VHDL (Barclay T. *et al.,*1990), compiler and simulator, logic synthesis tools, and automatic place and route tools. A complete set of portable CMOS libraries is provided, including a RAM generator, a ROM generator and a data-path compiler (H. B. Bakoglu*et al.,*1990).

11) Electric: Electric is mixed signal type software for complex IC designing. It is a sophisticated electrical CAD system that can handle many forms of circuit design, including custom IC layout (ASICs), schematic drawing (N. Dutt*et al.,* 1996), hardware description language specifications, and electro-mechanical hybrid layout.

12) FPGA tools and Simulator: These tools are used for hardware modeling, operator simulation, function simulation, timing simulation, and visualization. Xilinx, ISE™ WebPACK™ Software, Altera Quartus® II Software are the most common tools for FPGA (H. B. Bakoglu*et al.,* 1990)and Simulation. FIZZIM, FEDORA electronic lab, GHDL VHDL simulator, EMACS - text editor, TCE, C to Verilog translation, GEDA project, KICAD (H. H. Chen *et al.,*1995). XCIRCUIT, Fritzing, QUCS are also the usable software for FPGA and simulating.

13) ISE™ WebPACK™ Software: ISE® WebPACK™ design software is the industry´s only FREE, fully featured front-to-back FPGA design solution for Linux, Windows XP, and Windows 7.(N. Dutt*et al.,* 1996). It gives the features like Micro Blaze Microcontroller

System, design Preservation, Project Navigator, CORE Generator, Power Optimization ISE Simulator (ISim), XST Synthesis, Timing Driven Place & Route, Smart Guide, and Smart Xplorer.

14) Altera Quartus® II: the company Altera provides the Quartus® II software for analysis and synthesis of HDL designs,(W. K. Chen *et al.,* 1993), which enables the developer to compile their designs, perform timing analysis, examine RTL diagrams, simulate a design's reaction to different stimuli, and configure the target device with the programmer.

15) Fizzim: Runs on Windows, Linux, and Apple, anything with java. Familiar Windows look-and-feel. Visibility (on/off/only-non-default) and color control on data and comment fields. Multiple pages for complex state machines.(Mumick I. S. *et al.,* 1994), "Output to clipboard" makes it easy to pull the state diagram into given documentation.

16) Fedora: This software is actually based on Linux operating system. Red-hat is the sponsor of this tool. These tools for Specific Integrated Circuit (ASIC), Design Flow process. Among all these, Fedora users benefit (for free) the experience of an EDA/CAD team who has working knowledge in the ASIC industry (Mumick I. S. *et al.,* 1994), This EDA/CAD team works closely with upstream to provide Fedora users the latest updates and enhancements brought forward.

17) TCE: TCE is a toolset for designing application-specific processors (ASP) based on the Transport triggered architecture (TTA). The toolset provides a complete co-design flow from C programs down to synthesizable VHDL and parallel program binaries. Processor customization points include the register files, function units, supported operations, and the interconnection network.

18) MultiSIM: Multisim is an industry standard design/simulation software. Multisim is an easy-to-use and graphical simulation software. Engineers can run simulations with virtual instruments, such as an oscilloscope, that mimic how an engineer would simulate in the real world. In professional world engineers benefitted from the visual-style of design and simulation, which is highly advanced in terms of accuracy. As schematics get more complex, the design can naturally become difficult to understand. But with Multisim, engineers can handle and keep track of various functional modules and their respective interconnections.

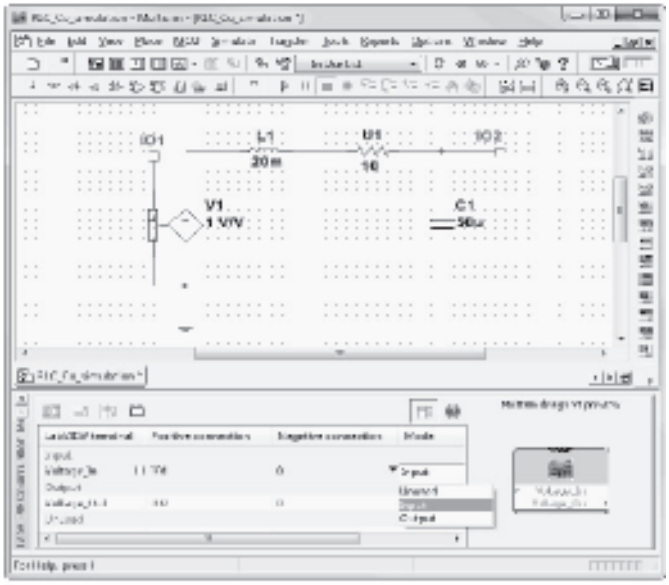

Figure 6: MultiSIM Interface

V. Proprietary Software

Proprietary software is that kind of software which is restricted to copyright, share or distribute. This software can be owned by an individual or a company that has a license provided by the publisher. (Mumick I. S. *et al.,* 1994), They are typically closed-source, meaning the developer does not provide the source code to anyone outside the company. Proprietary programs are licensed to end users under specific terms defined by the developer or publisher. These terms often restrict the usage, distribution, and modification of the software.

Most commercial software is proprietary because it gives the developer a competitive advantage.

Synopsys, Cadence, Mentor Graphics are most reliable and commonly used premium EDA tools in the world of IC complexity. TERADYNE, Altera, Spansion, Numonyx, Lattice, Scheme-it, CircuitLab, KtechLab, Target

3001! EDWinXP, TINA, NI Circuit Design Suite, CometCAD, CADint, ViewPlot are also the proprietary software.

1) Synopsys: Synopsys is a VLSI Debugging software. The application of this software is a specification of the integrated circuit, including logic synthesis, behavioral synthesis, place, and route, static timing analysis, formal verification, HDL, SystemC, System Verilog/Verilog, VHDL simulation as well as transistor level circuit simulation. The simulators include development and debugging environments which assist in the design of the logic for chips and computer systems.

2) Cadence: Cadenceenhances schematic editing efficiency of even complex designs through hierarchical and variant design capabilities.

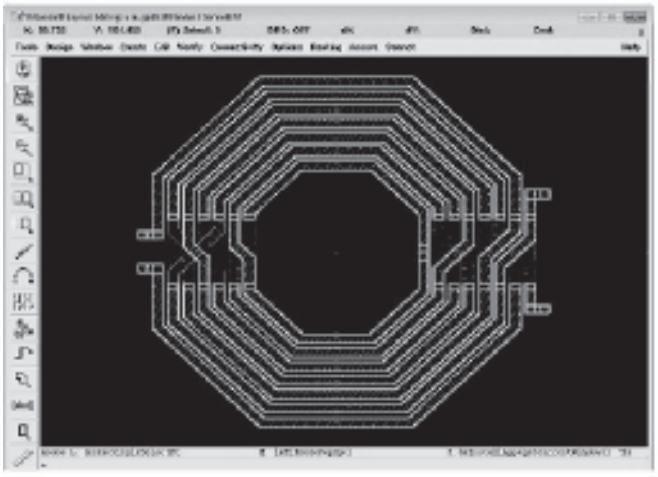

Figure7: Cadence Software Interface

It integrates with a CIS to promote the use of preferred, current parts and accelerates the design process andreduces project costs. Besides Cadence is a leading EDA and System Design Enablement provider delivering tools, software, and IP to help you build great products.

3) Mentor Graphics: Mentor Graphics is a leader in electronic design automation. The application of mentor graphics integrated circuit layout, IC place and route, IC Verification, IC Design for Manufacturing, (Harinarayan V. *et al.,* 1996), Schematic editors for electronic schematics.

Figure 8: Mentor Graphics

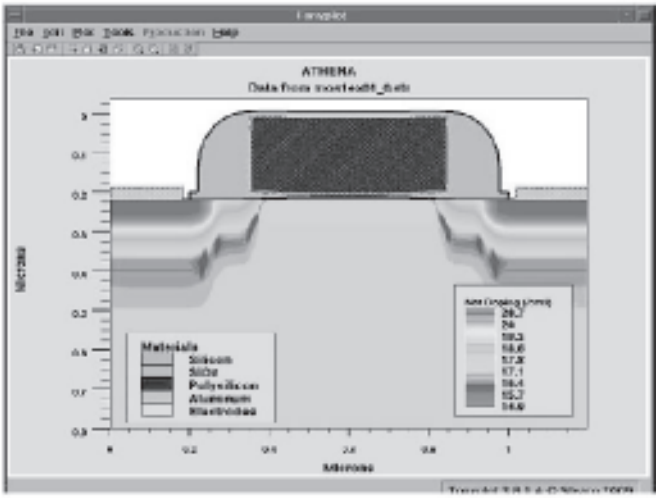

Figure 9 : TCAD Silvaco Interface

4) TCAD Silvaco: Silvaco is a leading EDA provider of software tools used for process and device development and for analog/mixed-signal, power IC, and memory design. Silvaco delivers a full TCAD to signoff flow for vertical markets including displays, power electronics, optical devices, radiation, soft error reliability, advanced CMOS process and IP development. Silvaco complements its design tools with a comprehensive portfolio of processor and networking IP for the automotive cloud- based enterprise level IP management solution.

5) Minimos:Minimos is a two- and three-dimensional device and circuit simulator, integrated with a TCAD framework. MINIMOS is a software tool for the numerical simulation of

field-effect transistors such as silicon bulk and SOI MOSFETs, and gallium arsenide MESFETs. The fundamental semiconductor equations, consisting of Poisson's equation and two carrier continuity equations, are solved numerically in two- and three-dimensional domains. Finite differences are employed for space discretization and the Backward Euler method (S. Selberherr*et al.,* 1987) for time discretization. MINIMOS generates an adaptive grid and has an automatic time step control.

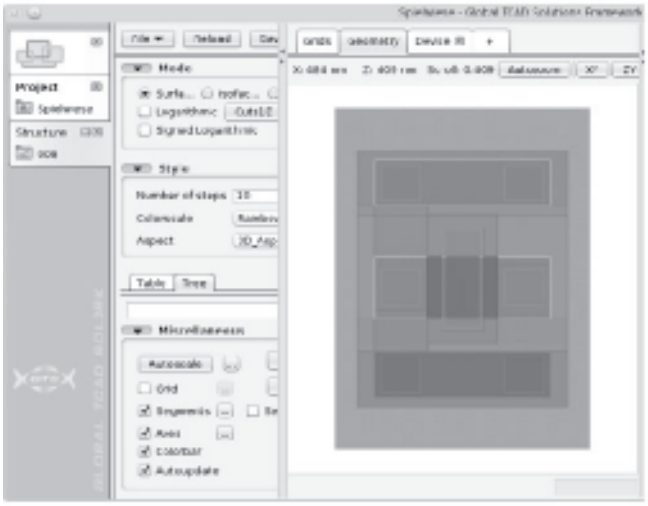

Figure 10: Minimos Software Interface

6) Autodesk EAGLE: Autodesk expands its cadre of using digital tools by acquiring CAD Soft EAGLE, a popular easy to use print circuit board (PCB) site.

This Software assures that how to learnpeople to making PCB design more affordable and accessible with the new designing method for EAGLE PCB design software. Eagle more popular for simulation with spice system like LTspice and PCB designing like as PCBSim. Mainly it is a schematic type design and runs on POSIX style system. It supported all kinds of the platform like Mac, Linux, and Windows.

7) PCB Investigator: PCB Investigator is a layout designing tool which improves

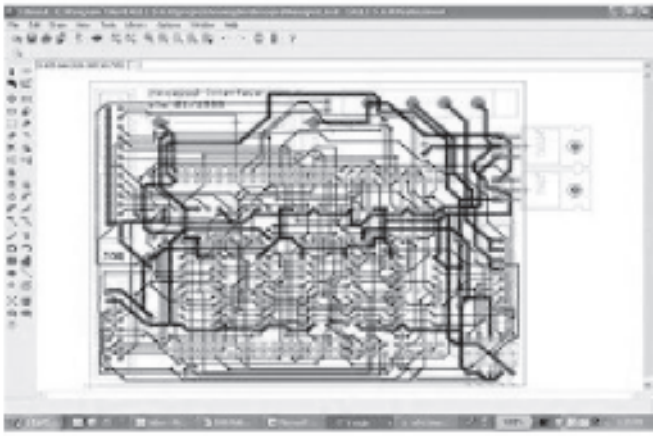

Figure 11: Autodesk Eagle

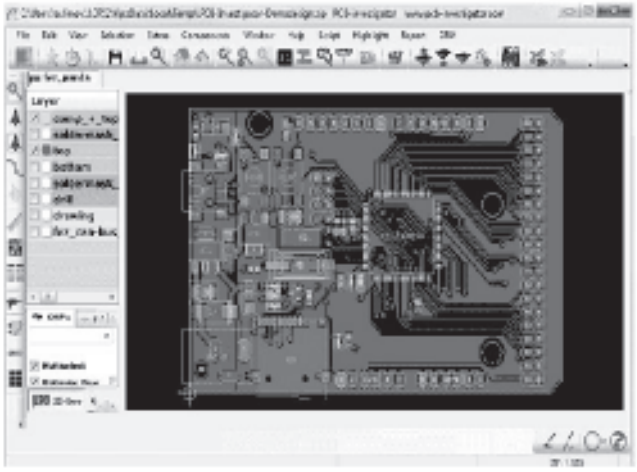

Figure 12: PCB Investigator

the development process and makes more simple and secure of layout design.

The CAD Software created is extremely easy to use and user-friendly. PCB Investigator is provided by EasyLogix Schindler &Schill GmbH. PCB Investigator Scripts and PCB-Investigator C# extension scripts are automating E-CAD related tasks.

The feature of Import/Export ODB++, Gerber274x, and Excellon with PCB-Investigator (AnsgarWego*et al.,* 2001). These data formats work with all CAD design tools e.g. Mentor Graphics, Cadence etc

VI. Comparative Analysis

Choosing the best type of software depends on user business needs and objectives. The best way to compare is to look at some of the biggest differences between the two types-

Table 1: Compare between software based on user needs and objectives.

Types	Proprietary software	Open source and free software
Development	Creators are the ones that generally handle the development and fixes, meaning it is under their discretion	Development is handled through 'mass collaboration'. As a result, development and fixes usually continue as long as the community is active
Support	Usually have a dedicated FAQ, manuals, and options to contact someone.	There are not many support options such as a dedicated and organized FAQ or contacting someone may not be available.
Flexibility	Tends to have only as much flexibility as the creators intended.	Can modify the functions and even add community created modifications or features to suit your needs
Cost	Price model includes the right to use the software.	No cost associated with the software
Features	Can give maximum features and a better interface fora user.	All the features cannot be given in one.
Accuracy	Most of the time it provides higher accuracy.	The outcomes are not totally accurate all the time.
Efficiency	Always performs with better efficiency.	Remains in average level.

VII. Conclusion

In the age of technology and automation, software is being used more and more in day-to-day tasks. No matter what type of uses the software has, there are two overarching types: premium and open source. This survey actually focused on the two types of software and discussed the topics of development, support, flexibility, and cost.

The premium software holds the source code safe and encrypted. Meaning, the user can't copy, modify, or delete parts of the code without some type of consequence. It can go from voiding the warranty to even legal repercussions.

Open source software is completely opposite. It allows users to copy, modify, or delete parts of the code under their own discretion. The user is able to use functions of the open source on their own program with no consequence.

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