

PCB Market Trends 2015

Evolving Technologies Change the Supply Chain

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MARKET AND VENDOR SUMMARY

This GSEDA report provides an update on the worldwide EDA PCB segment and sub-applications in 2015. It includes market share revenue reported by EDA vendors in this segment in 2013 and 2014, design tool developments and company acquisitions during those years. The annual forecast to 2019 is located in Appendix A at the end of the report.

TOP FIVE VENDORS

Worldwide revenue for the EDA Industry grew 7.7 percent in 2014 to \$6,390.1 in millions of dollars. Revenue for the PCB application of EDA grew 5.3 percent over 2013, to \$853.1 (includes PCB + Cable/Wire Harness) in 2014.

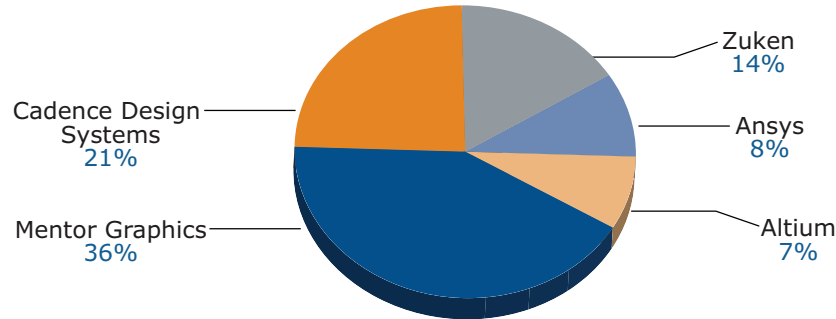
As illustrated in [Figure P-1](#), Mentor Graphics continues to maintain a strong 36% share of PCB TAM (total available market) and control over the market. Cadence, Zuken, Ansys and Altium, along with Mentor Graphics control 86% share of worldwide EDA PCB revenue. As noted by Mentor Graphics in its third quarter 2015 10K report, price competition is intense in the EDA PCB market. The complexity of advanced ICs/SOCs, PCB designs and materials, and electronic systems bring new technical challenges and competition.

Mentor Graphics and industry competitors used assets during the last decade to address competitive erosion of revenue, as well as to grow engineering power. Through collaborative agreements, mergers and acquisitions, Mentor balanced its regional strengths and focused on emerging technologies in advanced automotive and industrial applications. Consolidation of multiple companies across industries can be a two-edged sword. Consolidation can generate economies of scale that drive down prices. It also yields an expansion of products into new applications and customer base that increase revenues. Mentor’s acquisitions include:

Acquired	Date	Technology
Tanner EDA	May 2015	Custom Design
Flexras Technology	January 2015	Develops technology to reduce timing requirements for prototype, validation and debug of ICs and SOCs.
BDA	2014	FASTSpice
Valor	2013	Board processes
Flomerics	2012	MCAD/ECAD

These acquisitions enhanced Mentor’s ability to expand its solution base into system integration and platform directions. As of November 2015, Mentor has updated the Valor Process Preparation software. This new SW applies advanced process simulation and automated machine library generation technologies for SMT, assembly, test and inspection and stencil creation. This release brings Mentor’s engineering processes to industry alignment of Industry 4.0.

Figure P-1: Top 5 Major PCB Vendors - 2014



(Source: Gary Smith EDA, November 2015)

PCB DESIGN: REDEFINING THE SUPPLY CHAIN

Year to year the number of designs produced each year remained steady. North America remains the largest region for PCB designers. Dow Electronic Materials is one of the largest suppliers of materials to the PCB, packaging and semiconductor industries. During the past 3 years they introduced new dielectric materials for flip chip and 2.5D/3D packaging applications, new materials for copper pillar and TSV plating. Dow engineers are correct in that the semiconductor industry is at an inflection point of transformation that affects every sector of the supply chain. Legacy technologies continue to capture 65% of product designs, driving consolidation and intense pricing among competitors at all levels of design. At the same time, EDA vendors and customers will face explosive costs of scaling at 20nm/10nm down to 5nm, increased costs from SEC regulations over “Conflict Materials” and increased competition from IP companies. The next forecast period through 2020 would see an increased need for more engineering skills and/or new EDA companies/solutions industry to fuel the growth of new applications such as:

2015 CHALLENGES AND LANDMINES

Driving applications	Driver	Opportunity
Smartphones	Apple	IoT/Watches Smartphones
Ultramobile/PCs	Intel	Integration of subsystems driving emulation
Large SOCs	Qualcomm/Broadcom	Verification
Automotive	Mentor/Solid Works	MCAD/ECAD
Industrial	GE,Dassault/Infineon	MCAD/ECAD
IoT	Semiconductor/Systems	IoT integration
Biomedical	GE/Medtronics/Intel	Embedded mobile systems
Security/Power	Cisco/Intel/Military	Embedded

IoT “Internet of Things” by definition connects not only many devices (MEMs, sensors and RFs) but also calls for taking other elements into consideration such as battery life, size and services, but most importantly addresses/requires cyber security. The majority of architectures in IoT are embedded systems. IoT applications vary by complexity, flexibility and models. Investment from Home network, Industrial and Automotive industry has been strong. EDA opportunities are strong as part of the flexible framework required. As noted by ThingWorx, flexibility implies moving features and functions between devices, gateways, and the cloud. The latest growth estimates for IoT by systems applications companies are forecasting a 24% CAGR through 2020.

A potential landmine for EDA vendors is “Conflict Materials”. EDA companies are not included in the SEC requirements for “Conflict Materials” compliance. However, they may face pricing pressures during contract and license negotiations as the majority of their client base in the supply chain is directly affected. The first annual Conflict Materials filing with the SEC for public companies was due on May 31, 2014. This was for the Compliance Year beginning January 1, 2013, and ending December 31, 2013. According to Ron Jones CEO of N-Able Group, Conflict Materials consist of gold, tin, tantalum and tungsten, regardless of their origin. Public companies (IDMs and fabless semiconductor companies, foundries, OSATs and direct material providers) that manufacture products that require these metals must make an annual filing with the SEC. There are several lawsuits pending that may delay or over rule compliance to these requirements.

As Ron Jones recently noted, the ability to ship conflict free product to customers is a much more serious situation that can directly impact revenue, profit and customer satisfaction. Beyond SEC filings, both private and public semiconductor companies are being increasingly impacted by customer requirements for IC shipments to be conflict free. This is being driven, not directly by the SEC, but by large companies like Intel, Apple, HP, and Dell that want to be able to declare they are conflict free. They can only do this, however, by refusing to use materials or IC’s that are not conflict free.

If your products are conflict free and your competitor’s are not, you gain revenue. If the opposite is true, you may lose revenue. For the last year, N-Able Group and ProCM have partnered to offer semiconductor industry focused services in support of Conflict Minerals, RoHS and REACH Compliance. ProCM has a cloud based software application that provides the structure and functionality to manage compliance data down to the product level. This software is coupled with N-Able operations professionals that understand the semiconductor supply chain and regulatory requirements. The ProCM/N-Able combination allows semiconductor companies to totally outsource their compliance tasks, thus enabling their employees to focus on value added responsibilities.

PCB LAYOUT

Figures P-2 and P-3 show the supplier’s share of the PCB Layout market revenue in 2014, and the forecast out to 2019. This segment revenue increased 4.4 % in 2014 to \$431.3 millions of dollars. Mentor Graphics maintained the largest revenue share growing 1.7 percent to \$152.6 millions of dollars. The top 3 suppliers after Mentor were Cadence Design Systems, Zuken and Altium.

Mentor's Xpedition® xPCB Layout is an essential part of the tightly integrated Xpedition Enterprise product family. With its highly automated functionality, it offers designers and engineers an advanced technology to build today's complex designs. Mentor expanded Xpedition's layout products to collaborate and offer:

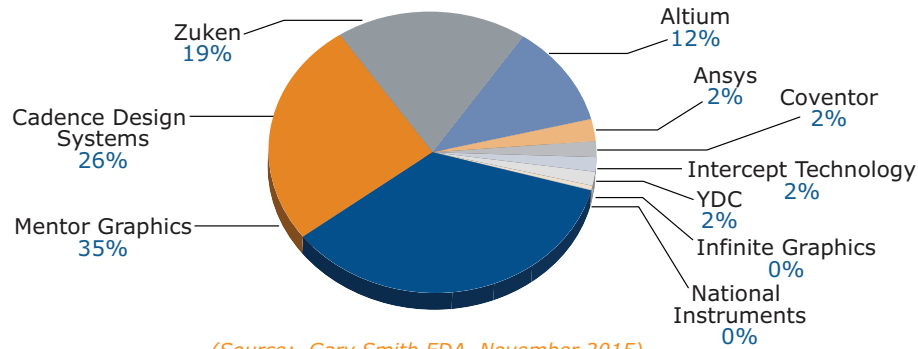
- Concurrent team layout with multiple designers and sites
- 3D layout and MCAD
- Automated placement, planning and management
- Auto-assisted interactive sketch routing
- RF/analog/digital/embedded passive/active co-design
- Advanced integrated, planning, place and route editing environment

Mentor Graphics acquisition of Valor Corporation enhanced and strengthened Mentor's position in the EDA PCB industry. Mentor recently released the latest version of the Valor® Process Preparation software, with a focus on addressing engineering requirements of Industry 4.0 (a European standard). The Mentor Graphics solution provides "digital manufacturing mastery" that is the ability to orchestrate product allocation to multiple production configurations, as well as the ability to quickly transition products between them, bringing the flexibility that Industry 4.0 requires. This flexibility is achieved by consolidating the full product model and any number of related manufacturing process definitions into a single efficient container. The Valor® Process Preparation software applies advanced process simulation and automated machine library generation techniques to create complete "ready to go" machine programs, operational data and work instructions for processes such as SMT, assembly, test & inspection, and stencil creation. This ensures minimal changeover downtime and start-up risk when executing manufacturing changes.

This release of the Valor Process Preparation product includes enhanced support for rapid test programming, including the ability to intelligently link schematic, PCB layout and Bill of Materials (BOM) data. Simply selecting a track on the PCB layout immediately shows the node in the corresponding schematic diagram from design, and vice-versa. This helps ensure the highest level of testability and rapid debug time when investigating test failures at shop-floor repair stations. In addition, this provides for the first time, a simple way to directly compare electrical component data between the schematic and the production BOM, ensuring correct output for test and SMT machines.

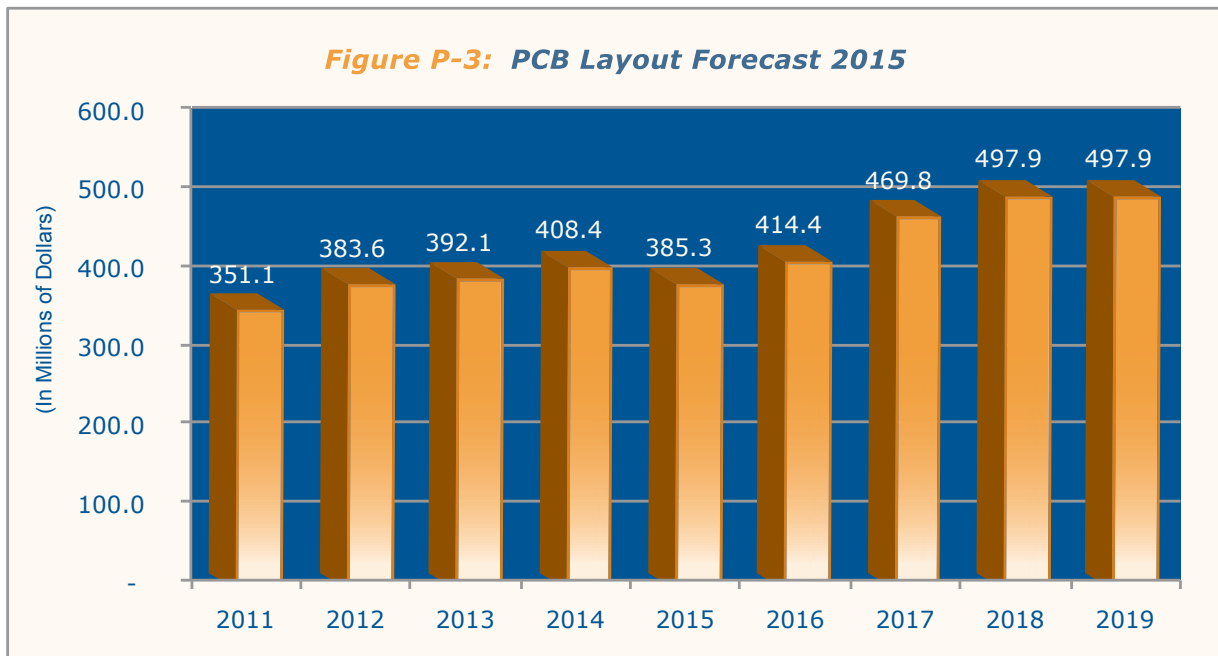
Ansys continues to maintain a stronger presence in this segment with its RedHawk product that offers full chip power integrity analysis and simultaneous switching noise. Cadence is expected to maintain its strength in this arena as it builds its relationships with foundry. Its Voltus solutions offer transistor-level noise and power signoff with Virtuoso. Altium's new strategic plan with its updates to Designer is to unify PCB layout data, schematic data and supply chain data into one platform creating a unified design environment. Altium made two strategic acquisitions in 2015 for the data management space. Octopart (spans design to supply chain data) and Ciiva (design and manufacturing cloud based BOM data management).

Figure P-2: PCB Layout Market Share 2014



(Source: Gary Smith EDA, November 2015)

Figure P-3: PCB Layout Forecast 2015



(Source: Gary Smith EDA, November 2015)

PCB CAM

The vendors listed in Figure P-4 are providers of current PCB CAM tools and solutions used to automate the entire process (design, fabrication, assembly and testing) of PCB manufacturing. The PCB CAM data in Figure P-4 covers the market share of major suppliers for 2013. Frontline JV and Mentor now control the largest share of PCB CAM.

Frontline is a Mentor Graphics - Orbotech Company. Frontline leads the PCB CAM industry and has over 7,500 seats worldwide. Orbotech distributes Frontline products. Frontline’s CAM & Engineering products are part of Mentor Graphics’ PCB Systems Design-through-Manufacturing.

FRONTLINE CAM Products include:

InCAM is a comprehensive CAM system for HDI boards that performs fast, high-precision CAM tooling. InCAM offers improved CAM productivity and advanced data integrity and fault indication in a collaborative work environment.

Genesis 2000 is the leading PCB pre-production CAM system, integrating design analysis with automatic data optimization to deliver precise PCB tooling data with accuracy and speed.

GenFlex is a dedicated CAM system for flex and rigid-flex PCB manufacturers, compensating for material bending and possible distortion. Take advantage of CAD editing tools and fast revision through dedicated flex DFMs to improve yield and cut cycle time.

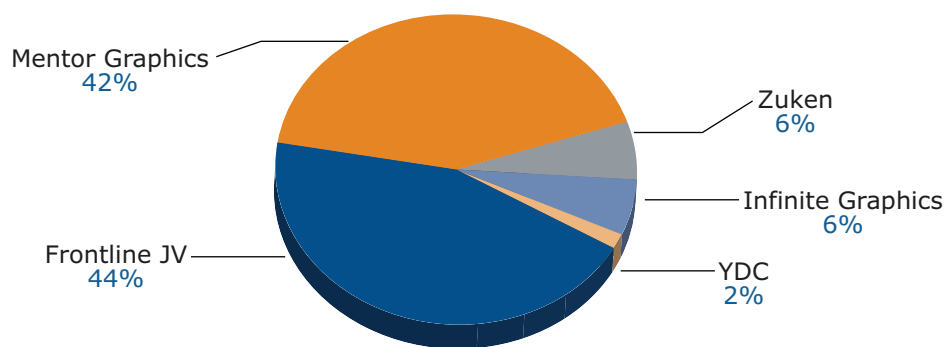
InPlan is a comprehensive PCB Engineering system that combines sophisticated engineering know-how with state-of-the-art pre-production planning tools to design the optimal manufacturing process for PCB jobs in a rapidly changing manufacturing environment.

InStack is an automatic stackup designer dedicated to generating the best possible stackups for quality, manufacturability and price. Fully integrated with industry-leading impedance modelers, InStack keeps designs within manufacturing tolerances while dramatically cutting cycle times.

InSolver powered by Mentor Graphics HyperLynx® technology, is a cost-effective impedance solution that enables fast and accurate stackup and impedance modeling for a wide range of PCB geometries. InSolver is available both as a standalone application for engineers, QA and sales, and as an embedded impedance solver in Frontline’s industry-leading engineering solutions.

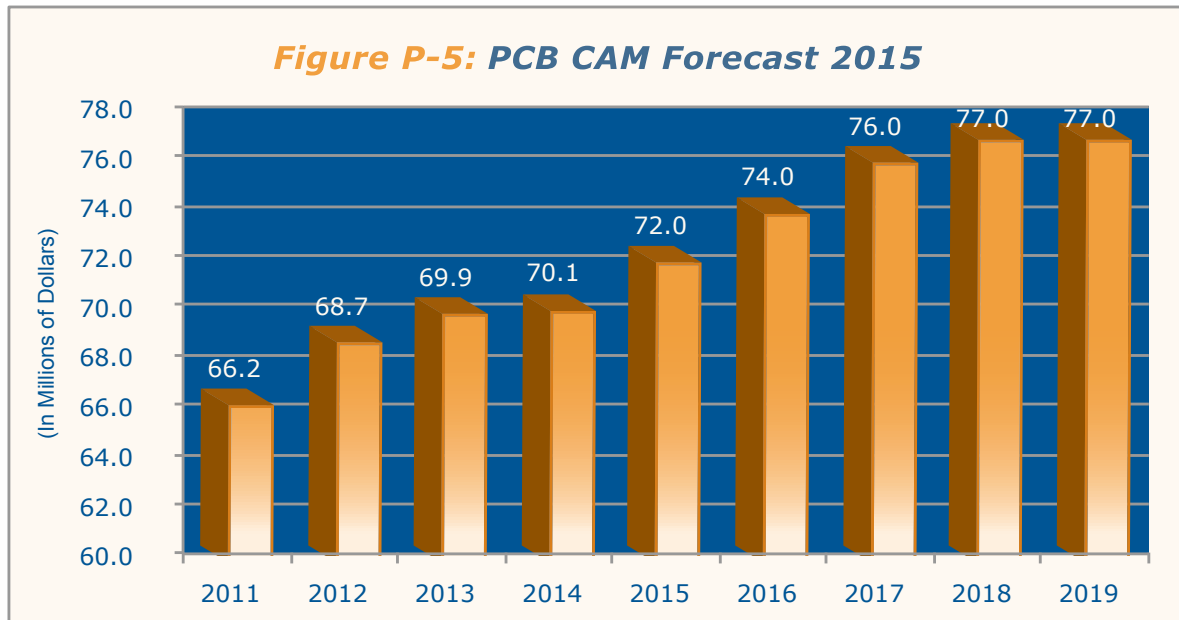
InSight PCB is a web-based tool for managing and assessing incoming customer PCB data for non-CAM experts. From automatically retrieving comprehensive product information to generating precise summary reports, InSight PCB empowers Sales and Engineering people to work more independently, efficiently and profitably. The result: faster and more accurate quoting and product engineering, complete CAM data in minutes, early detection of manufacturing problems and increased throughput.

Figure P-4: PCB CAM Market Share 2014



(Source: Gary Smith EDA, November 2015)

There are numerous companies in this PCB CAM category. Many standouts that could have a disruptive impact on SDA rankings in PCB EDA and drive the forecast (see Figure P-5) higher than the estimated rate for 2018, are companies like Infinite Graphics, PTC, Dassault Systemes (3D Solidworks), and Intercept Technology.

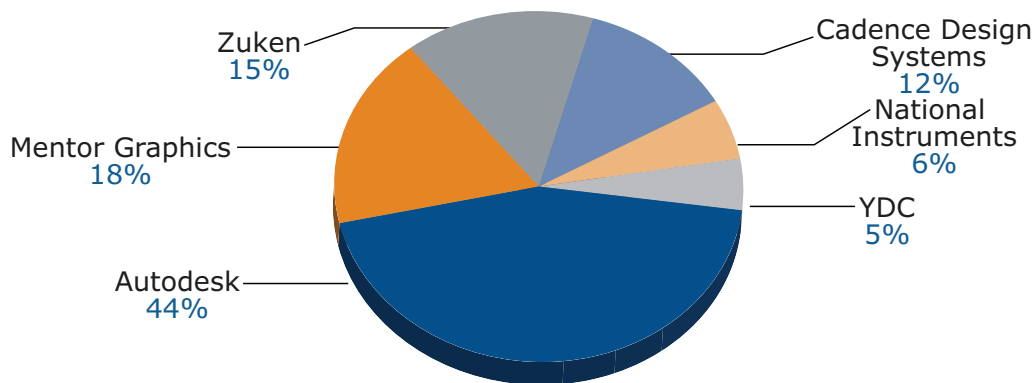


(Source: Gary Smith EDA, November 2015)

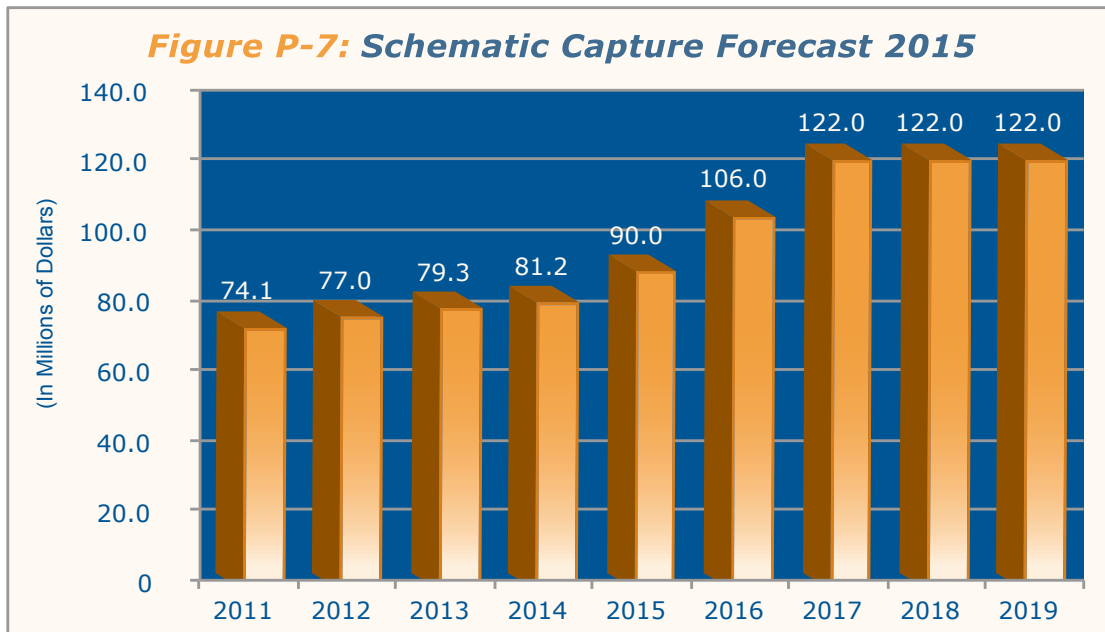
Schematic Capture

Schematic capture is a design process that consists of graphical schematic entry and netlist extraction. Autodesk leads the market with 44 percent share of the 2014 market in schematic capture, followed by Mentor and Zuken as shown in *Figure P-6*. The long range forecast is shown in *Figure P-7*.

Figure P-6: Schematic Capture Market Share 2014



(Source: Gary Smith EDA, November 2015)

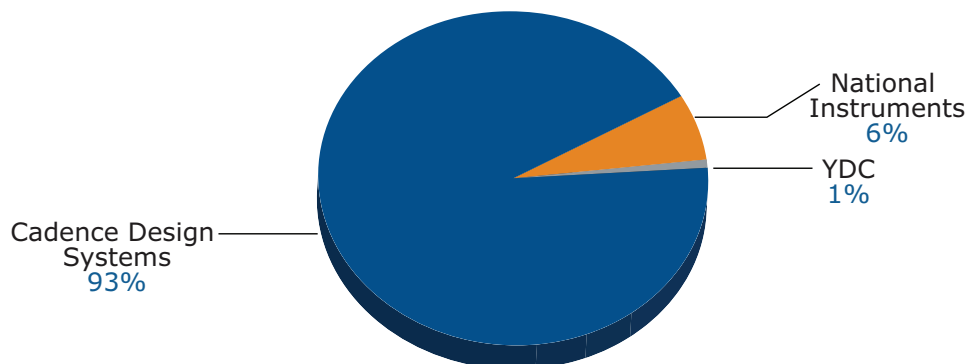


(Source: Gary Smith EDA, November 2015)

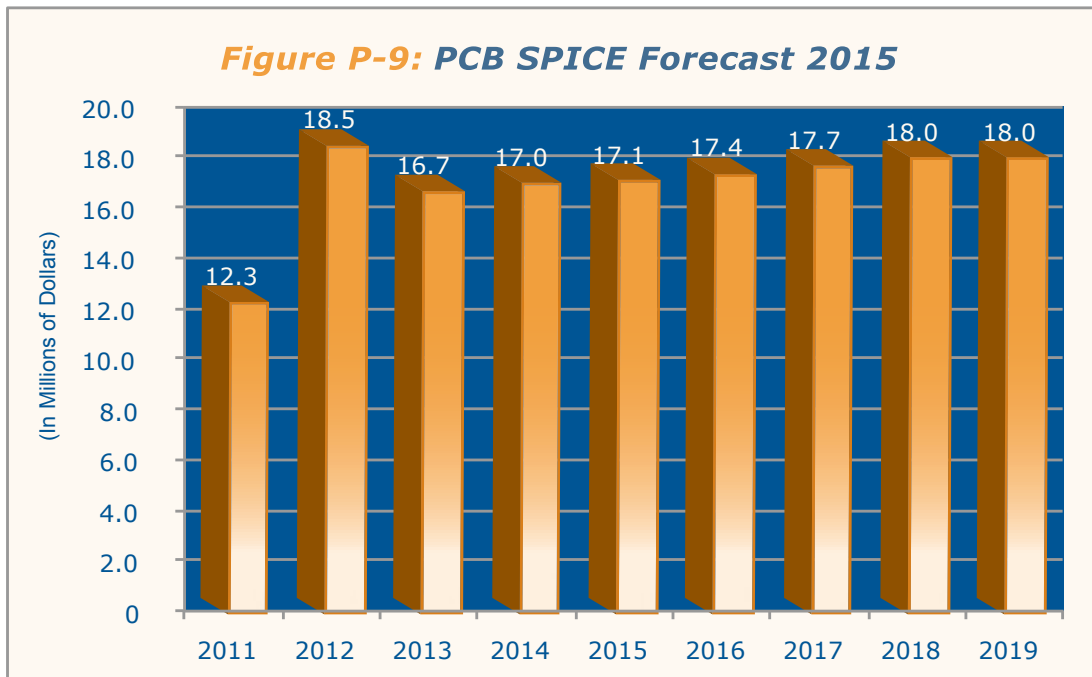
PCB SPICE

Cadence continues to control the SPICE market segments. PCB SPICE revenue remained flat in 2014. Cadence still maintains the major share as shown in Figure P-8. SPICE (Simulator Program for Integrated Circuits) simulator revenue growth will remain steady through the forecast period as shown in Figure P-9, as SPICE simulation is an important part of any design process. By simulating circuits, designers can predict circuit behavior, detect errors early in the process, and avoid costly and time-consuming prototype reworking. Designers at the chip-board-package levels can easily swap components to evaluate designs with varying BOMs (bills of materials).

Figure P-8: PCB SPICE Market Share 2014



(Source: Gary Smith EDA, November 2015)



(Source: Gary Smith EDA, November 2015)

PCB Analysis Tools

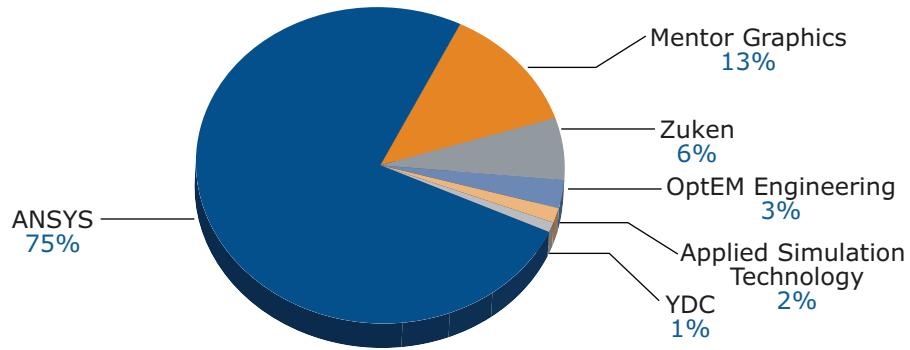
This segment of PCB is made up of five fast growing sub-applications.

- EMI (Electro Magnetic Interference)
- Power
- Signal-Integrity
- Thermal
- Timing

Together these categories have captured the second largest share of the entire PCB market for PCB design tools. These have become mainstream tools by market leaders Mentor Graphics, Cadence and Ansys. Mentor's Xpedition product addresses EMI, signal integrity and timing issues throughout the design process. By incorporating its HyperLynx PI (Power Integrity) Mentor now provides the engineer and designer with pre- and post-layout analysis of complex power distribution networks to insure proper operation and high reliability of the PCB. As many new applications get smaller with high performance features and functions, the thermal management issues increase. As such, Mentor now also incorporates HyperLynx Thermal, FloTHERM and FloFED solutions as part of Xpedition to provide thermal analysis capabilities for the PCB as well as the PCBs complete product/system layout (enclosure, fans, heat sink, etc.).

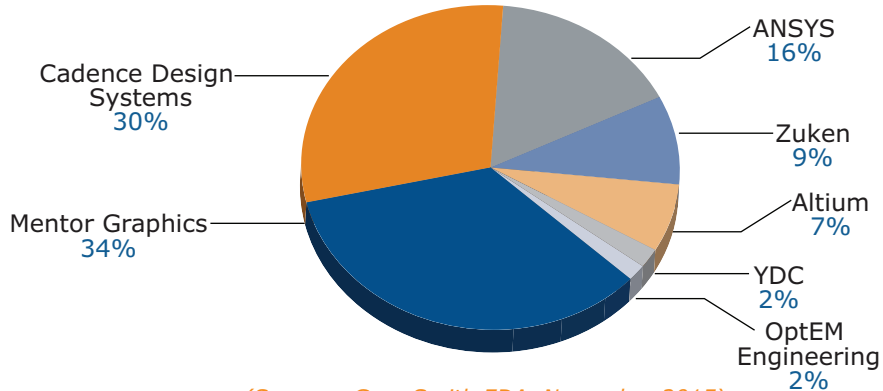
The available market share for the PCB Physical Analysis segments is reported in Figures P-10 through P-13. Figure P-14 shows the long range forecast for all of the PCB Physical Analysis segments.

Figure P-10: PCB EMI Market Share 2014



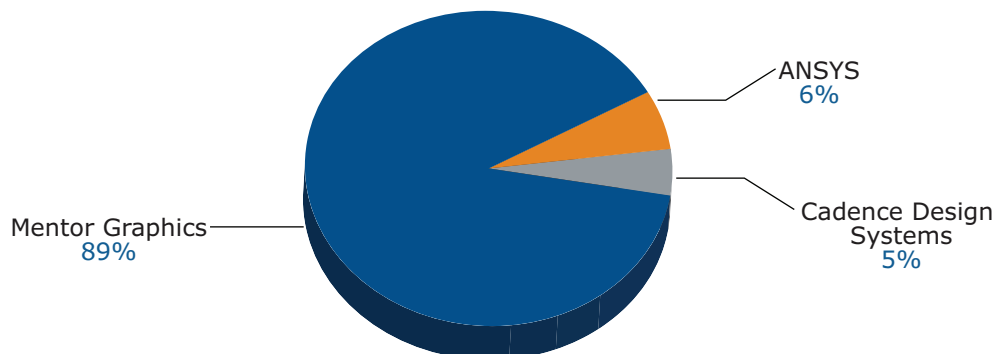
(Source: Gary Smith EDA, November 2015)

Figure P-11: PCB Signal Integrity Market Share 2014



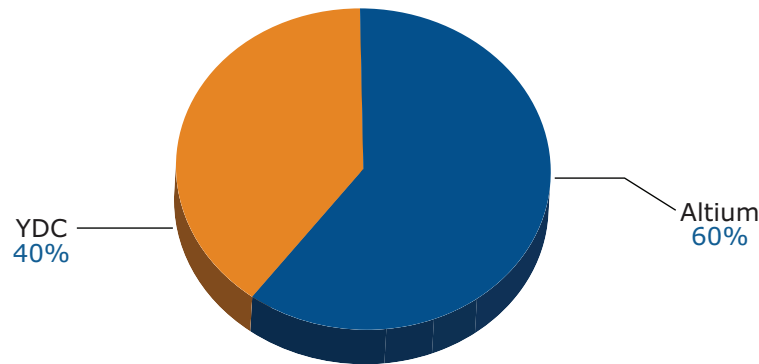
(Source: Gary Smith EDA, November 2015)

Figure P-12: PCB Thermal Market Share 2014



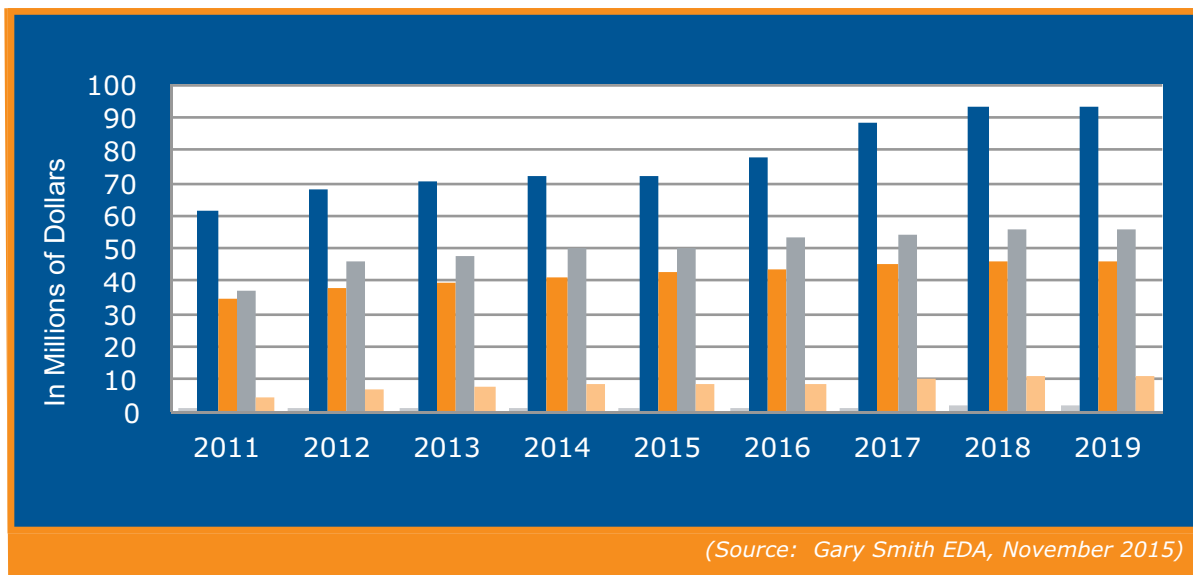
(Source: Gary Smith EDA, November 2015)

Figure P-13: PCB Timing Market Share 2014



(Source: Gary Smith EDA, November 2015)

Figure P-14: PCB Physical Analysis Tools Forecast 2015



(Source: Gary Smith EDA, November 2015)

3D Package Directions

GSEDA and several companies formerly in these categories shifted revenue into other categories within the PCB sector, while market emphasis on new package design tools for developing system design areas evolve. Virtual and vertical integration of outsourcing is occurring as the manufacturing processes of wafer fab, packaging and system integration converge. Wafer based packaging processes are now mainstream. According to the major SATs companies, this trend is expected to continue through 2020. 3D chip stacking, wafer level FC (Flip Chip) modules and platforms will continue to grow displacing other traditional QFN, SiP and CSP, and FCBGA may dominate the IoT and wearable devices market. Cadence, Mentor, and Synopsys, are working with Foundries (TSMC and Global Foundries) as well as OSATs companies, to find design solutions for 3D challenges coming into play at 20nm and 10nm technologies. The major challenges of 3D include:

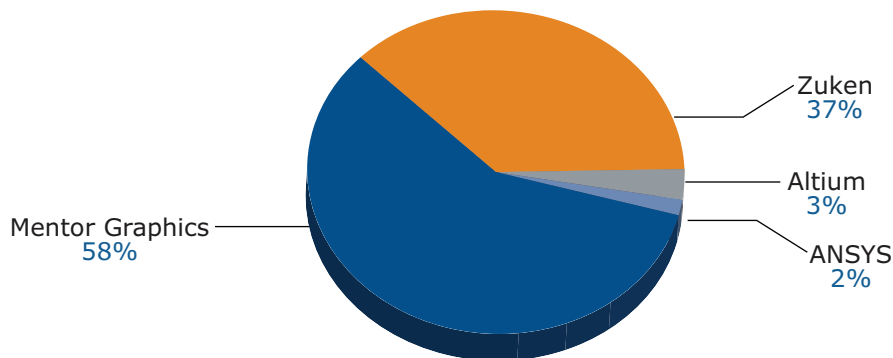
- TSV integration minimizes space – but Cu electroplating poses challenges

- Lead free SnAg plating compatible with CU pillars and Cu TSV
- Wafer stress and wafer warpage leads to cracking
- Si Interposer effects on yield/defects and C4 bumps
- Significant reliability challenges
- New process and materials costs
- TSV wafer supply to OSATS for backside integration
- Package level test – impacts stacked die

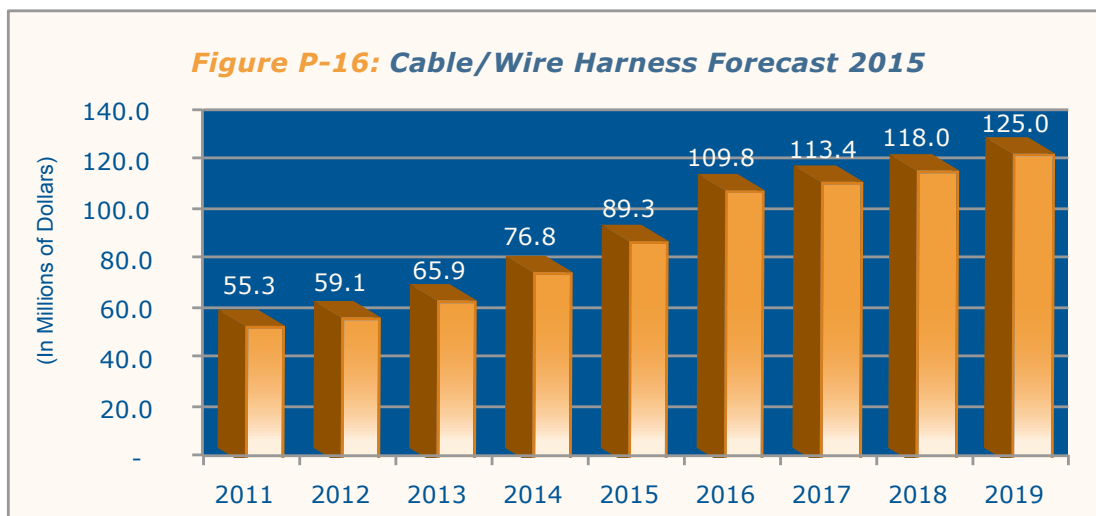
Cable Wire Harness

The Cable Wire Harness design category was added to the GSEDA PCB category in 2012. There are over ten companies that create cable wire harness design software. As shown in Figure P-15, Mentor Graphics and Zuken are the largest suppliers to this market. Zuken’s E3 series also provides direct integration for multi-domain design of cable and wire harnesses with the Synopsys Saber Simulator for mechatronics design. Multiple companies have developed tools for new multi-board systems (stacked, racks, servers) that may comprise up to hundreds of boards, all interconnected with cables and wiring harnesses. Other companies involved in the cable wire harness market include Dassault (3D Solidworks), PTC, Siemens, Aucotec, Comos, Eplan, and IGE/XAO.

Figure P-15: Cable Wire Harness Market Share 2014



(Source: Gary Smith EDA, November 2015)



(Source: Gary Smith EDA, November 2015)

Appendix A: PCB Worldwide Forecast 2015

	2013	2014	2015	2016	2017	2018	2019	CAGR 2014-2019
Software Product and Maintenance Revenue (\$M)								
Worldwide PCB Revenue (\$M's)	744.7	776.4	822.7	867.9	899.5	911.1	957.6	4.3%
PCB Layout-Design	413.0	431.2	448.0	460.0	471.5	477.3	492.0	2.7%
Schematic Capture	79.3	81.2	92.0	97.0	113.0	114.0	125.0	9.0%
Multichip	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-100.0%
Package Design	0.6	0.9	4.0	9.0	9.5	10.0	12.0	68.6%
PCB CAM	64.8	65.4	68.0	70.0	72.0	73.0	76.0	3.0%
PCB Spice	17.0	18.8	19.0	19.4	19.5	19.8	20.0	1.3%
PCB Physical Analysis	169.7	178.9	191.7	212.5	214.0	217.0	232.6	5.4%
PCB Timing	1.4	1.5	2.2	2.5	2.5	2.5	2.8	13.8%
PCB Signal-Integrity	72.6	76.8	80.0	88.0	90.8	92.0	99.0	5.2%
PCB EMI	39.7	43.1	45.0	48.0	48.5	49.0	51.3	3.5%
PCB Thermal	47.9	49.7	56.0	62.0	61.0	62.0	64.1	5.2%
PCB Power	8.2	7.8	8.5	12.0	11.2	11.5	15.4	14.6%
Cable Wire Harness	65.9	76.8	89.3	109.8	113.4	118.0	125.0	10.2%
Total Revenue*	810.6	853.1	912.0	977.7	1,012.9	1,029.1	1,082.6	4.9%
PCB Revenue Growth	3.2%	5.3%	6.9%	7.2%	3.6%	1.6%	5.2%	
EDA Total Revenue	7,241.4	7,799.1	8,559.9	9,524.5	10,111.7	10,461.2	11,452.9	8.0%
EDA Revenue Growth	29.4%	7.7%	9.8%	11.3%	6.2%	3.5%	9.5%	
	810.4	853.0	912.0	977.7	1012.9	1029.1	1082.6	

* PCB Total Revenue includes PCB Design Tools + Cable/Wire Harness Tools)

Note: All numbers shown are the best estimates of Gary Smith EDA analysts.