PCB007 PRESENTS

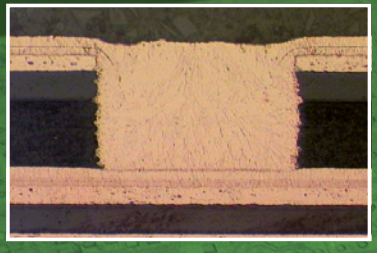
October 2011

the pcb magazine

AN I-CONNECT007 PUBLICATION

NO SPEED LIMIT FOR AUTOMOTIVE ELECTRONICS

Panel / Pattern Plating
InPulse 2HF – The Low Cost Solution for Blind Micro Via Filling



Diameter 170 µm /
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Plating thickness 15 µm !!!
Plating time approx. 30 min
Dimple < 10 µm

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AUTOMOTIVE ELECTRONICS

The October issue of The PCB Magazine is here!

Automotive Electronics—Waaaay Beyond Bones and Boulders

Who can forget the image of Fred Flintstone jumping into his car, beating his square little feet into the ground to get the thing going and slamming his heels down to brake? For a lighthearted look at how far we've come, take a quick stroll down memory lane with Fred.

Today, increasingly complex electronic systems require PCBs to accommodate functionality and space issues, as well as performance, reliability and infotainment demands. What does this mean for designers, suppliers and manufacturers? Find out this month in The PCB Magazine.

Not yet a subscriber? There's no better time than right now to make sure The PCB Magazine is parked in your inbox every month.

October Features

Jump-starting our features this month is EIPC's Michael Weinhold, explaining how industry expectations of 15 years of service life from automotive electronics can be achieved, in ***Embedded Component Technology—Can the Designs Meet Service Life Expectations?***

In ***Printed Circuits for Automotive Electronics***, Viasystems' Dr. Craig Davidson presents a thorough analysis of the rapidly increasing integration of electronics in automotive systems and what this means for PCB technology.

In one of two market reports, Freedonia weighs in with ***Automotive Electronics OEM Market: an Overview,*** which explains why telematics (electronics communication and entertainment systems) may soon have an easier time of finding an audience.

Zuken's Humair Mandavia lends his perspective on the increasingly expanding role of PCBs in automotive design process and the complexities—and opportunities for growth—they bring, in ***Impact of Electronics in the Automotive Industry.***

For yet another view, ***A Look at Printed Circuits in Automotive Electronics*** by Delphi's Christopher Brandon helps us understand how even in the face of design process changes, the foundation of the heavy copper, multi-layer, lead-free PCBs aren't going anywhere.

In our second market report, ***Growth Opportunities in Automotive Electronics,*** Databeans' Brice Esplin explains why the semiconductor market for automotive applications is on the rise.

What automotive issue would be complete without a look at electric cars? In ***Key Barriers to the Widespread Acceptance of E-vehicles,*** TÜV SÜD Group's Ishan Palit provides data on electric hybrid cars accounting for nine percent of total U.S. auto sales by 2020 and 22 percent by 2030.

Columns

Our columnists don't disappoint this month. In addition to John Coonrod's feature column ***High-Frequency Laminates Help Avoid Car Accidents,*** plenty of industry heavyweights are along for the ride, including Karl Dietz *(Tech Talk),* Barry Olney *(Beyond Design),* Steve Williams *(POV),* Mike Carano *(Trouble in Your Tank)* and Gray McQuarrie *(Solving DAM Problems).* New this month is I-Connect's very own Marcy LaRont, who also has something to say on the controversial topic of unions. In her piece, ***Boeing, Boeing… Gone!,*** LaRont references a recent column on the same topic by Steve Williams, but also lends her personal experience with unions that spans several decades.

Under the Hood

There's still plenty to come: Marcy LaRont's ***Conversations With…Fastprint,*** a high-tech, quick-turn company in Shenzhen, China, two feature videos from IPC Midwest and plenty of highlights from design, milaero, flex and more.

Finally, no road trip would be complete without a word (or two) from our publishers. In *The Way I See It,* Ray Rasmussen recalls Apple's defining moments, and ponders what's in store for the innovative giant. Barry Matties' *The Sales Cycle* provides a look into the how-to's, and how not-to's with regard to using your company website as a powerful marketing tool.

Enjoy this month's issue of The PCB Magazine and be sure to tell us what you think by taking a minute to fill out our feedback form. Yabba dabba doo!

PCB007 PRESENTS

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THE DEFINITIVE
INTERACTIVE MAGAZINE
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AUTOMOTIVE ELECTRONICS

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THE WAY I SEE IT

Apple Changed the World

SUMMARY

If you aren't reinventing your products and your business every few years, which is expensive, risky and not very comfortable, you're vulnerable. What would an Apple-esque PCB and assembly industry look like?

Editor's Note: The I-Connect007 team would like to express our heartfelt sadness at the passing of Steve Jobs. This column was composed at the time of, and in response to, Jobs' departure from Apple. The column originally appeared in the October 2011 issue of SMT Magazine.

by Ray Rasmussen
I-CONNECT007

I had mixed emotions when I heard that Steve Jobs had stepped down as CEO of Apple. It's the end of an era; it had to happen someday. However, with change, things can move in new, exciting directions or stagnate and decline. It's going to be interesting to see what happens over the next few years. Tim Cook and his team will likely have a few more tricks up their sleeves. With all that cash and all those markets waiting to be conquered, they'll be busy for a while.

The Game-Changer

It certainly has been fun watching Apple over the last decade as they've reinvented one market after another. The day they announced the iPhone, I was watching the press conference live. I was stunned. I had always wanted something like this. I needed something like this. Honestly, I had been waiting for over 20 years. Finally, a company knew what I wanted. They took all these disparate parts and made them all work, seamlessly, in concert. It was beautiful. Not only that, it was so far ahead of the competition that most didn't understand the implications. Recently, Sprint Nextel's Chief Executive Dan Hesse, who was on Nokia's board of directors at the time he made the following comments, said this about Apple and the iPhone:

Everyone underestimated how incredibly successful the iPhone would be. We took the iPhone seriously, but Nokia management underestimated it, certainly. We were much more concerned at the time with RIM. It's not easy to make complicated things simple. The value of simplicity is something that so many businesses don't understand, but boy did Steve Jobs.

As lines stretched around city blocks and people camped out for the chance to get their hands on this revolutionary new personal tool/smartphone, their competitors were bewildered. First, they went into denial mode, then into reactionary mode, then crisis management mode, then into capitulation mode.

I don't know if a post-Jobs Apple will be able to see things as clearly, but what I've always loved about Apple products in the last decade, especially, is that they just work. They do what they're supposed to do. Companies like RIM and Palm, Nokia and Motorola had this entire market in their hands and were content to "me, too" it with incremental changes, but not willing to take the technology where it could go. When you do that, when you're content with the status quo, you're vulnerable.

As Apple demonstrated, if you aren't constantly willing to reinvent your business, you'll be subject to a similar fate as RIM (struggling for survival), Palm (sold to HP), Motorola (sold to Google) and now HP (exiting the PC market). Apple did all of this to these guys; or, more accurately, they did it to themselves. What is sad is that Apple came in and completely changed the rules and these guys decided to "me, too" it again by offering

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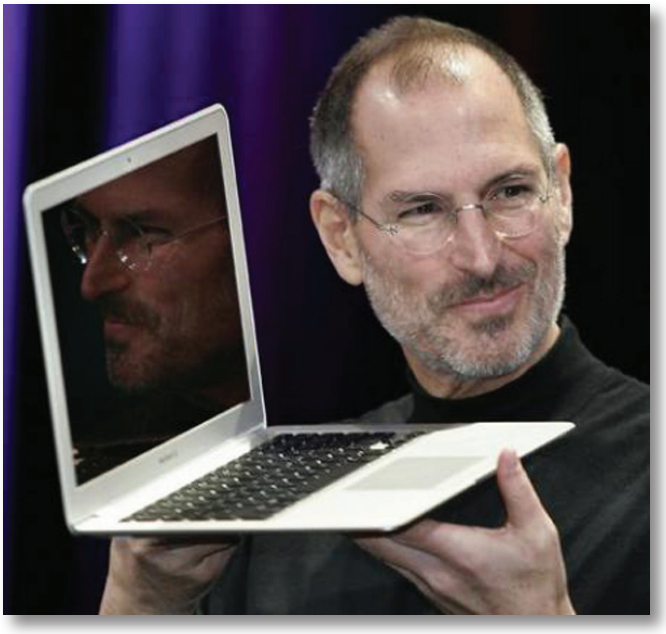
similar products, trying to save some market share instead of going for the gold—the brass ring—and reinventing their businesses. That's lazy business. Those CEOs were content with their annual income and golden parachutes, I guess.

Back to the point of this column—to talk about what's happened. Apple has changed the world. Apple said, to those who were established players, "The game has changed." Actually, they didn't say it at all; they just did it. It's easy for a guy like Steve Jobs, who can see what needs to be done and has the resources to do it. Of course, he's not perfect, but he and his team do get a lot of things right.

It seems like just plain old common sense to me. Apple is changing the world by taking all the different pieces marketers and engineers conceive and saying, "What if?". Then, they build very smart products to bring them all together.

Here's something you rarely see a company do. In this process of reinventing their business and entire market segments, Apple is destroying a market for a whole line of products they make: PCs. In fact, they invented the PC. It's not just HP, Dell and others who will lose market share to the iPad, but it will be Apple, as well. That takes vision and courage.



Before I go on, some fun.

As with politics, Dan Feinberg and I don't see eye-to-eye on our choice of PCs either. Dan believes Windows PCs are better than Macs. He is a staunch fan of Windows PCs, and, as with his politics, he isn't easily swayed (he must own Microsoft stock; that's the only thing I can figure, because he's a smart guy). He's certainly a hardware guy whose passion is to add continually more power to his PC. Dan teaches classes on the ins and outs of Windows software, and he writes a column on this topic for I-Connect007. What's interesting here is that he has to teach a class on *how to run* Windows software. That should tell you something, Dan. Go figure.

For my part, I've been the only Apple guy in the company until of late. Apple products just work for me. They save me time and, therefore, save the company money. Recently, things have started to change here at 007. iPhones have started to become the norm and the company owns a couple of iPads, too. And, my guess is that Dan probably has an iPhone by now, or an iPad, which he keeps hidden in his closet when his PC friends come over to try to figure out how to run the latest and greatest Windows application. Hell, Dan, Apple doesn't even give you a manual on how to run their stuff. You don't need one! I'm sure at night, when no one's around, he pulls out his iPad and learns what it's like to be a Mac enthusiast. (He also may be a closet liberal, but I doubt it.) Sorry, Dan. It was fun writing this, I must admit. By the way, if you think I should have given Dan a chance to defend himself before I went to press with this, forget it.

What's now good for all of us is if anyone wants to compete with the iPhone, iPad or iPod, they don't just have to be as good as Apple, but a whole lot better. A serious competitor will have to change the game again, or forget it. That's the only thing that makes sense. Apple was stuck with low personal computer market share for decades until the iPad. They had to reinvent the market for PCs to win that battle. I doubt that they were thinking this way strategically, since they likely didn't know how things would

play out. However, as they learned from the iPod and iTunes, if they put all the pieces together, and put them out there for all to see (digital music formats, the Internet, low-cost music players and storage in small formats), they could change the world.

The iPhone strategy was the same as the iPod's and the iPad's. Just watch: the next product they pour their resources into will follow a similar model. I do have an Apple TV, which I now use more than my cable box. Maybe that's the next big play, to take over the world of TV. The promise of having everything integrated into the TV (shows, movies, calls, video calls, Internet, gaming, apps, etc.) has been around for the last couple of decades and there are pieces of it everywhere, but no one has put it all together yet. Sure seems like a job for Jobs, or now, Cook (wonder what he's *cooking* up?).

So, where am I going with all this? There are lessons here for all of us. If you're content with incremental improvements, you're vulnerable. It may never happen that some competitor arrives on the scene and wipes your business out in a few short years, but it's much less likely to happen if you're the one changing the rules. This probably doesn't sound attractive, but if you aren't reinventing your products and your business every few years, which is expensive, risky and not very comfortable, you're vulnerable. At least internally, you have to try to figure out, realistically, how to put yourself out of business. That exercise will certainly open your eyes to the possibilities.

Think about where we're headed as an industry. Because of companies like Apple, we have to build continually denser products. Manufacturing is getting harder and more complex. That comment by Hesse regarding the value of simplicity has to start resonating with our technologists. I love Joe Fjelstad's response to the insanity of lead-free, which was to reinvent the way we assemble and connect components; don't just get rid of lead, but simplify the entire system. That's the kind of thinking we need as an industry. We have to reinvent what we're doing and not be content to continue

down the same incremental path, which, by the way, leads nowhere, ultimately. There's no future for the industry in that.

What would an Apple-esque PCB and assembly industry look like? For sure, the PCBs and assemblies would be complex, but elegant. The components would easily come together in a simplified structure (like Occam) with the whole being much greater than the sum of the parts.

There are many industries and markets waiting for an innovative company like Apple to step in and rock their world. They could do it to us. They could decide they're going to reinvent the way electronics are packaged. They will likely have to, in order to keep pace with the products they want to build. When they do, it will change us all forever. **PCB**

Ray Rasmussen is the publisher and chief editor for I-Connect007 publications. He has worked in the industry since 1978 and is the former publisher and chief editor of *CircuiTree Magazine*. Ray can be contacted at: ray@iconnect007.com

EMBEDDED COMPONENT TECHNOLOGY—
Can the Designs Meet Service Life Expectations?

by Michael Weinhold
EIPC TECHNICAL DIRECTOR

SUMMARY

The automobile has evolved into a complex electro-mechanical system, with electronics working in unison with complicated mechanical components to increase levels of performance, comfort and safety. The industry expects 15 years service life from automotive electronics, and embedded component technology offers a means of achieving this.

The printed circuit board market in Germany is dominated by two sectors, industrial electronics and automotive electronics, which together, represent 65% of the demand.

The automotive industry is the largest industry sector in Germany, with an annual turnover of approximately 300 billion Euros—around 20% of total German industry revenue. Approximately 4.9 million passenger cars, and more than 245,000 trucks and buses, were manufactured in German factories in 2009, and German automobile manufacturers produced the equivalent of 17% of worldwide production. Technology-driven, the German automotive industry spends more than 20 billion Euros annually on R&D, with a very strong focus on reliability.

Automotive electronic systems are increasingly complex, and now affect almost every operating aspect of the vehicle: engine, transmission and chassis electronics, active safety, driver assistance, passenger comfort and infotainment systems. The comparative value share of electronics in automobiles, which in 2005 was estimated to be between 20% and 25% of total vehicle cost, has risen dramatically in the last few years. Interviewed at electronica 2010, Dr.-Ing. Rainer Kallenbach of Robert Bosch GmbH believed that electric and electronic components already represented around 40% of the value of the vehicle and would naturally increase substantially in the future. Developments in the powertrain solutions market will promote microelectronics development, hybrid cars and related technologies, together with advances in information systems and car body electronics will speed up the trend. Safety technologies will grow strongly in response to governmental regulations.

Time-to-market and market penetration periods are becoming ever shorter. For example, ABS technology needed 20 years to

“ There needs to be a major re-think of design principles to establish a meaningful balance between functionality, cost and reliability. ”

enter mass production after it was introduced in the 1970s, whereas market penetration periods are now typically between two to seven years.

Modern automobiles are increasingly reliable mechanically. With good maintenance, a car will continue to give good service over at least 150,000 miles and fashion, rather than functionality, tends to determine its ultimate life span. However, in practical terms the economic life of a vehicle is often limited by the failure of a major electronic component. Manufacturers' warranty periods are now typically between three and five years, but if a major electronic component fails outside that period, the replacement cost can easily exceed the residual value of the vehicle, and the reality is that the life expectancy of automotive electronics is not much more than five years.

So how can 15-year reliability be achieved in automotive electronics if they are only designed for a five-year life? There needs to be a major rethink of design principles to establish a meaningful balance between functionality, cost and reliability. The automotive industry operates under extreme cost pressure—recalls and warranty-related repairs can place a heavy financial burden on the manufacturer and the suppliers of his electronic systems—but on the other hand, if components are over-engineered, the end product can be too costly to manufacture.

Printed circuit boards have evolved to survive the harsh operating environments of automotive systems, and materials currently available are capable of withstanding extremes in temperature, humidity and vibration. However, the circuit board is only part of the electronic device, albeit a fundamentally important part—the interconnecting substrate. In a conventional electronic assembly, the functional components are placed external to the substrate and connected by solder joints. They are subject to thermal and mechanical stress and may be exposed to air, dust, lubricants and fuel. Devices are also at risk from electrostatic effects, electromigration effects and may potentially experience signal integrity issues such as excessive noise and crosstalk.

The operating temperature of automotive electronics is a function of location, power dissipation and thermal design, and can easily exceed 125°C. Current trends in automotive electronics, such as placing engine control units on the engine and transmission control units in the transmission, will push ambient temperatures even higher, and power dissipation from the device may result in operating temperatures considerably higher than 150°C.

So how can the industry move forward cost-effectively? High-performance PCB base materials can enable maximum operating temperatures around 200°C, with low z-axis expansion and resistance to delamination and chemical attack. If the electronics were incorporated into the substrate instead of mounted on the outside, benefits of environmental protection against contamination from dust, humidity, chemicals and human impact as well as an improved EMC shielding could be achieved, together with higher miniaturization and improved reliability through advanced thermal management.

Embedded component technology has evolved over many years. As early as 1993, Hofmann Leiterplatten GmbH in Regensburg, Germany, responded to the demands of key customers seeking these attributes and developed a patented procedure for embedding devices in printed circuit boards.

Hofmann's technique is to use special cavities in the prepreg as a separator between the layers of a multilayer PCB, which enables the fabrication process to use standard PCB manufacturing technologies and equipment without damaging sensitive components during multilayer lamination and pressing. In the fabrication process, the components are placed on an inner layer of the multilayer, and connection between the components and the inner layer can be made by soldering, gluing with conductive adhesive, welding, riveting, bonding, sintering or plating. The attachment and interconnection techniques are chosen to suit the type of components and the requirement for electrical and/or thermal conductivity. Windows in the prepreg allow for

stress-free embedding of different components in one pressing operation, and the resin flow is sufficient to encapsulate the components completely. Specialist knowledge is needed to define the dimensions of the window, the correct resin content, the resin type and the press cycle to avoid stress at the component packages.

These techniques offer a cost-effective method for manufacturing electronic devices that provide outstanding protection against moisture, water, dust, gases and chemicals and provide a reliable electrical insulation. Components are positioned accurately and securely and are well protected against vibration, shock, stress and strain, or pressure. If necessary, EMC shielding can be achieved at low cost by plating the completed module.

Embedding devices within the PCB offers a route to superior thermal management of assemblies, resulting in lower thermal stress on the components and improved life expectancy. In a typical example, embedding of components reduced the temperature at the component level from 98°C to 90°C after 10 minutes of operation at 6 watts, and the outside temperature of the test sample was reduced from 188.5°C to 82.5°C.

The automotive industry has seen the potential of embedding technology for future developments, and a number of new products have been designed and manufactured which exhibit improved reliability, as well as opportunities for miniaturisation and potential cost reduction in the future.

From a manufacturing point of view, the PCB fabrication processes are suitable for large panel production. Lead-free reflow soldering technology can be used, with solder paste applied by stencil printing or dispensing, and components placed by standard equipment provided it is capable of handling thin materials. After soldering, cleaning of the assembled inner layer removes any ionic contamination that could lead to long-term defects based on migration, electrical conductivity or e-corrosion. The inner layer assemblies are compatible with AOI inspection and can be electrically tested so that the positions of components and solder fillets can be determined and electrical functionality can be verified. Handling of thin inner layers needs some training and experience, but such skills are well established in the routine assembly of flexible circuits.

The cost-effective fabrication and testing of semi-finished products results in high yields in final testing of the finished assembled device, and the option for repair in the semi-finished state allow identification, replacement or repair of defective components, and allow for repair of replacement of the defect parts before the multilayer PCB is pressed.

The technology has already been used in racing cars and in automotive applications such as dashboard instrumentation and lighting, which are critical for safety, visibility and durability, and is being evaluated for other functions.

The automobile is no longer simply a machine to transport people from place to place. It has evolved into a complex electro-mechanical system, in which electronics must work in unison with complicated mechanical components to increase levels of performance, comfort and safety. The industry expects a 15-year service life from automotive electronics. The concept of embedded component technology offers a means of achieving this. **PCB**

Footnote: A paper entitled "Practical experience manufacturing PCBs with embedded active and passive devices" will be presented by Thomas Hofmann at the 12th Electronic Circuit World Convention in Taiwan on November 9–12, 2011.

Michael Weinhold is the technical director and a member of the Board of Directors of the European Institute of Printed Circuits (EIPC). He represents Switzerland at the IEC-TC 91 committees, writing standards for the PCB fabrication and assembly industry. Weinhold has worked in the printed circuit industry since 1964, including 31 years for DuPont. He received the "Award IEC 1906" from the Swiss National Committee in 2010.

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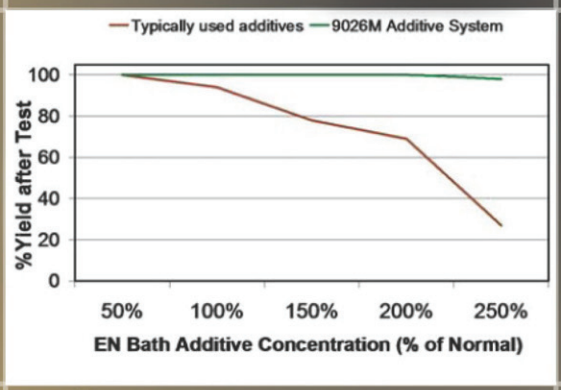

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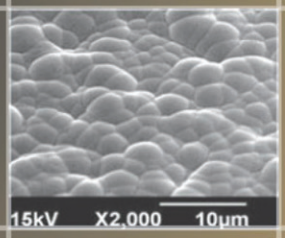

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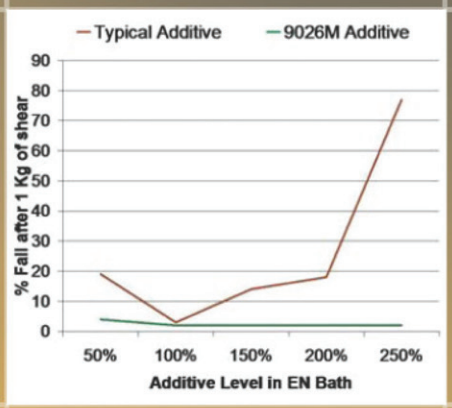

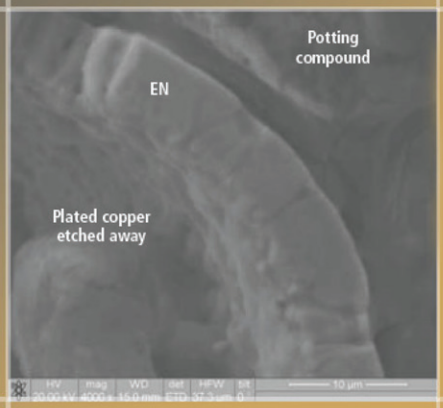

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SUMMARY

Advanced PCB technology enables much of the automotive-based sensing systems that facilitate adaptive cruise control, active brake assist and blind spot detection. The proper choice of the high-frequency laminate to be used in these PCBs can be critical.

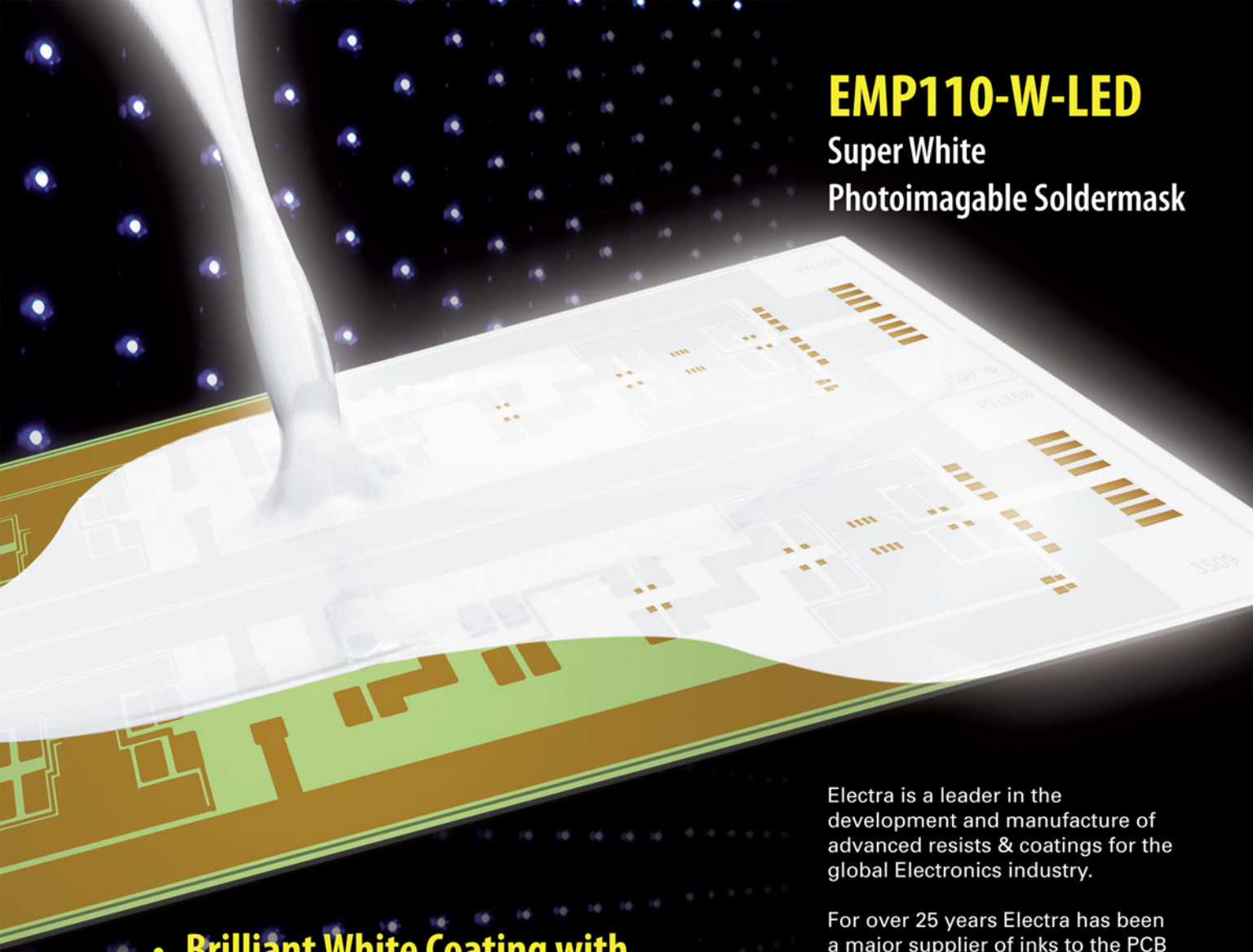
by John Coonrod
ROGERS CORP.

The automotive industry continues to make many advances each year and some of these require advanced PCB technology, which enable much of the sensing systems that facilitate adaptive cruise control, active brake assist and blind-spot detection. The technology is based on radar theory and has been well known for many decades.

Some of the advances in PCB technology enabling the automotive radar applications are due to attributes of high-frequency circuit materials. These PCB materials are specialized and have unique properties allowing them to perform at the high frequencies required by these applications. The blind spot and other near-car detection systems operate around 24 GHz. Most standard PCB materials are unstable at these frequencies; however, there are several high-frequency circuit materials being used at these frequencies without issue. Rogers Corporation supplies their RO4350B™ high-frequency laminate in many of the automotive near-car detection systems. The material has proven its high-frequency capabilities and it offers the circuit fabricator a process that is more aligned to standard PCB materials. Many of these PCBs are cost sensitive and often the RO4350B material will be used in conjunction with standard PCB circuit materials in order to have a "hybrid PCB" that is more cost effective, yet still meets the demanding electrical requirements. The RO4350B laminate is compatible with standard PCB circuit materials and, in most cases, even non-standard materials.

Multiple issues can be critical for an automotive sensor application as it relates to the PCB and, more specifically, to the high-frequency material that is used. One issue is the ability for multiple circuits to be manufactured with the same controlled impedance; having a laminate with a tight control of the dielectric constant (Dk) is important. The RO4350B laminate is specified to have the Dk value controlled to a tolerance ± 0.05, which is better than ± 1.5%.

The adaptive cruise control (ACC) applications are typically more demanding. The operating frequency is usually about 77 GHz and this frequency is even outside of the range of many high-frequency circuit materials' capabilities. The RO3003™ high-frequency laminate is being used in many of these applications with great success. There are several reasons and, obviously, Dk tolerance would be one of them. The RO3003 laminate has an excellent Dk tolerance of ± 0.04 and at this high frequency, concerns with insertion loss are paramount. The RO3003 laminate offers an extremely low dissipation factor of 0.0011, which ensures the dielectric loss component of insertion loss will be very low.



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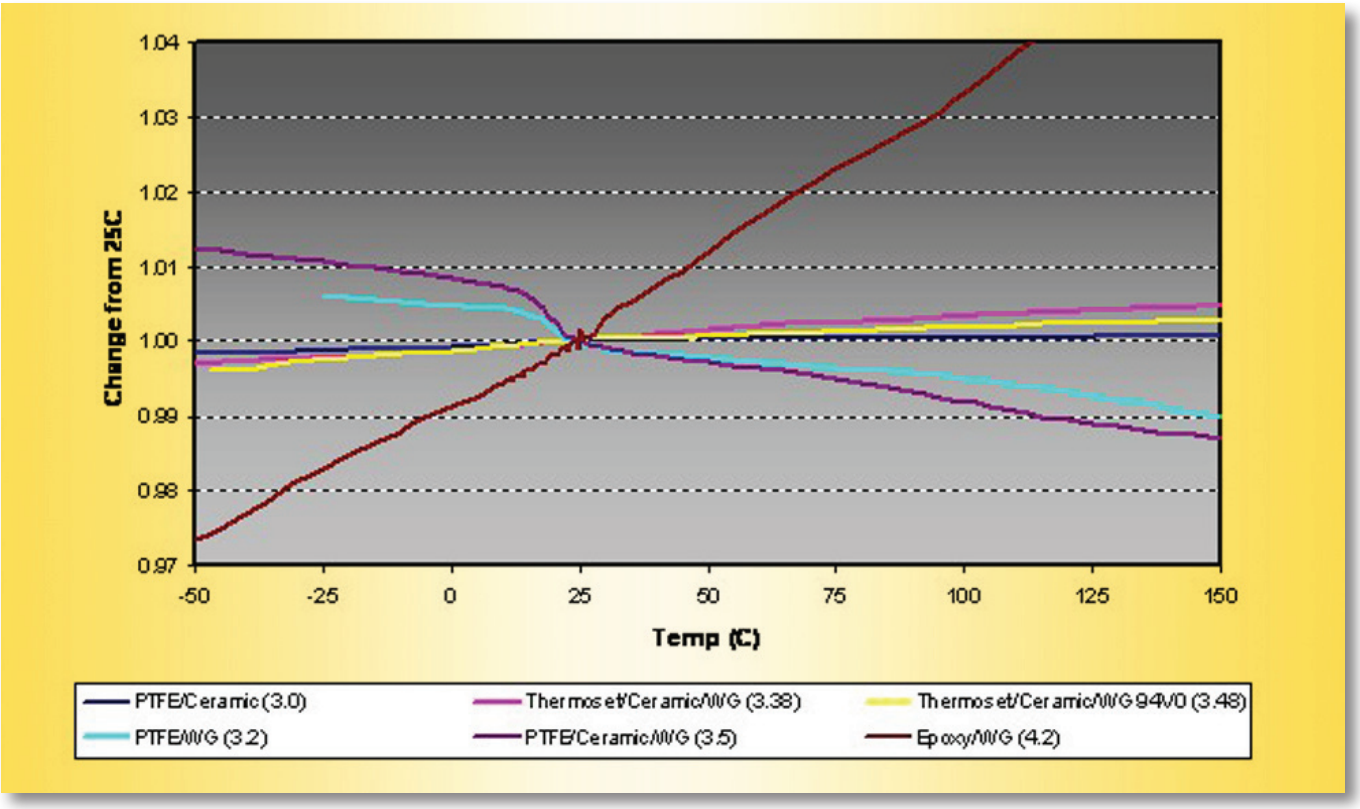

Figure 1: TCDk chart showing the results of several PCB circuit materials.

Another topic of interest would be the effects of temperature on the performance of automotive sensing circuits. The circuits are not generally exposed to very high temperatures, although there is an attribute of PCB laminates which can be concerning with moderate temperature changes. The temperature coefficient of Dk (TCDk) is the property where the laminate will change Dk value with a change in temperature. It is common for some laminates to have a TCDk of +200 ppm/°C or more. With an application that is very sensitive to a change in impedance, which can be directly related to a change in Dk, the TCDk property can be a concern.

In Figure 1, a graph of the TCDk property is shown for several common laminates used in the PCB industry. The curve which is labeled PTFE Ceramic (3.0) is the most linear on the chart, representing the least change in TCDk across the temperature range. This material is Rogers RO3003 circuit material.

The previously mentioned concerns with Dk tolerance and losses are typically well considered, however, sometimes designers may overlook the TCDk value and that potential effect will not be obvious in laboratory environment testing.

Many things should be considered for the concerns of automotive sensing applications, and the proper choice of the high-frequency laminate to be used in the PCB can be critical. **PCB**

John Coonrod is a Market Development Engineer for Rogers Corporation, Advanced Circuit Materials Division. He has more than 24 years experience in the PCB industry, about half of which in the flexible PCB industry doing circuit design, applications, processing and materials engineering. Coonrod has also supported the high frequency rigid PCB materials made by Rogers for the past 10 years. Reach Coonrod at john.coonrod@rogerscorporation.com.

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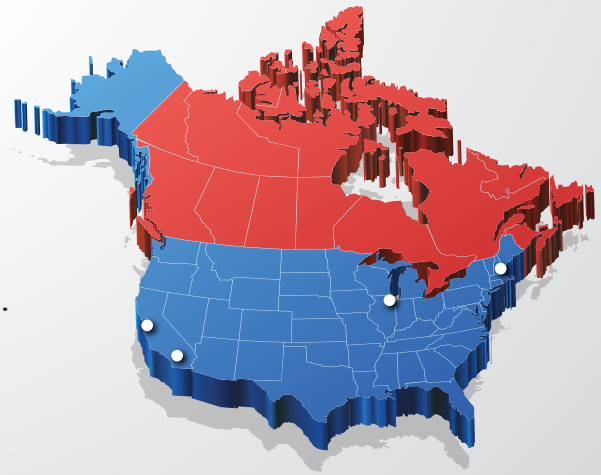

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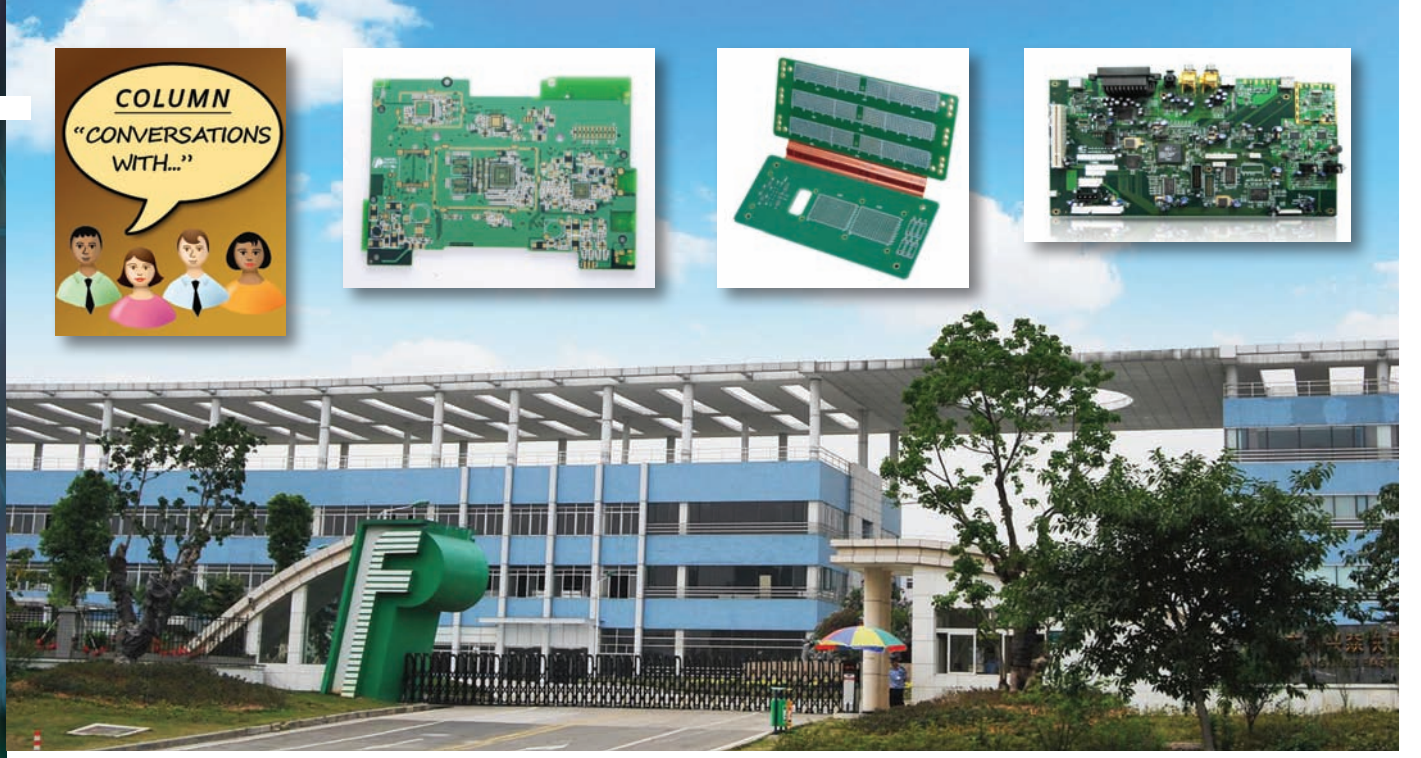


Conversations with... **Fastprint**

by Marcy LaRont
I-CONNECT007

SUMMARY

Fastprint rode on the tip of the offshoring spear, opening its doors in 1999 in Shenzhen, China. Today, boasting a roster of 4,000 customers, 2,500 employees and several offices worldwide, Fastprint is a high-tech, quick-turn company that embraces Lean.

In 1999, just as North America began to see a significant shift to offshore manufacturing, Fastprint rose up in Shenzhen, China, as a promising low-cost PCB manufacturer.

Just a dozen years later, Fastrprint has grown to boast a roster of 4,000 customers, 2,500 employees and several offices worldwide. Not only that, Fastprint is a high-tech, quick-turn company that has embraced the principles of Lean manufacturing.

Sunny Lao, Overseas Sales Manager for Fastprint, met recently with Marcy LaRont to discuss Fastprint's accomplishments as well as the risks and benefits of serving customers globally.

Marcy LaRont: ***Hi Sunny. Thanks for sitting down with me today to talk about Fastprint. Your company has grown significantly since 1999. Can you give us a brief history of Fastprint?***

Sunny Lao: Shenzhen Fastprint is the largest high-tech, quick-turn prototype (high mix, small and medium volume) PCB design and manufacturing service provider in Asia. We were founded when Fastprint created a manufacturing facility in Shenzhen's High-Tech Industry Park, which today continues to serve as our headquarters. In 2008, we broke ground on an 8,000 square-foot state-of-the-art facility in Guangzhou's Science City, also in South China. This new facility combines administrative offices, a research area, and prototype and production scale manufacturing spaces. We can now provide a full array of manufacturing and engineering services for our customers, including hardware design solutions through our partners. All of this has given Fastprint a market advantage in drawing a broad range of customers. Our 2010 annual

“ We can now provide a full array of manufacturing and engineering services for our customers, including hardware design solutions through our partners. ”

sales reached 800 million RMB, which was a 60% increase year-on-year.

Marcy: ***Of the many things Fastprint has achieved over the past dozen years, is there any particular achievement that stands out above the others?***

Sunny: There are really several things. Our new facility in Guangzhou is certainly a significant milestone for us. However, on June 18, 2010, our company was listed on the Shenzhen Stock Exchange (symbol code 002436), becoming the first listed PCB prototype manufacturing company on that exchange. That is a crowning achievement for Fastprint, and one of which we are extremely proud. It is something that makes us unique among our competitors, giving us a competitive edge globally. We also believe it underscores the quality and breadth of our capabilities and confirms our business prowess.

Marcy: ***Sunny, what do you find to be the biggest challenge doing business today? Being an offshore company for the North American and European markets, you may have a very different perspective than many of your global competitors.***

Sunny: I would say the challenges brought on by macroeconomics are most challenging for us.

Marcy: ***Will you elaborate?***

Sunny: With the current state of the global economy, the interplay and interdependence of most countries’ financial and market systems underscores the pervasive nature of the electronics industry in total. From the second half of 2008 through the first half of 2009, the United States’ financial crisis broke out and continued to spread to other countries and regions. World economic growth slowed down, and some countries and regions experienced negative growth. The downstream application areas of the PCB industry—the full PCB supply chain—were affected to varying degrees, and all negatively. The market risks for many PCB manufacturers increased significantly as large orders shrank. We saw several manufacturers bankrupted or liquidated. In the second half of 2010, the global economy began a gradual recovery, but global macroeconomic uncertainties still resisted this recovery.

Marcy: ***How did this affect Fastprint specifically, and how did you react?***

Sunny: Fastprint is the biggest prototype PCB enterprise in Asia. We are on a run rate to have 4,000 customers this year. The industries affected in the down economy are obviously very broad, including network communications, industrial controls, medical electronics, military and the semiconductor industry. The current market demand has a kind of rigidity, with very strong anti-risk requirements for their vendors.

This has required us to face the financial crisis and the larger economics uncertainties proactively by implementing programs to increase our quality metrics, our QTA abilities and further upgrade our facility for technology. This we have done, to the greatest extent, in the Guangzhou facility. We are also currently putting a great effort into further exploration of the global PCB market, specifically the U.S. and European markets. All of these things have allowed Fastprint to grow our top and bottom line sales and revenue as we have seen the recovery of 2011.

Marcy: ***What about raw materials and precious metals pricing? How much has that affected your business?***

Sunny: The challenge brought by the rising price of raw materials is significant in this business. With rising copper prices and oil price instability, these factors will continue to affect the price of copper-clad laminates, copper foil, copper anodes for plating baths, etc. In reaction to these business variables which we can do nothing to affect, we continue to enhance the management of our business through programs such as Lean, working to improve and advance our manufacturing methods and techniques, and thereby improving manufacturing

yields and efficiencies to reduce our production costs. We also work to enhance our supply chain management, strengthening strategic partnerships with key suppliers, which further reduces material and procurement costs.

Marcy: ***You touched on this previously, but can you discuss more broadly the global business landscape and how this has affected Fastprint? As a Chinese company, you have reaped the benefit of the mass movement of manufacturing away from North America and Europe.***

Sunny: The importance of the global trade environment in today's global business climate brings us a golden opportunity to increase our brand recognition and influence in overseas markets. Overseas sales currently account for as much as 40% of our total sales. We will continue to focus on the North American market in next few years. We have just opened a branch office in California in order to better serve our American customers and to help us fully understand their needs and requirements. How we are able to meld into the business cultures, and adjust to the needs of our international customers in this global trade environment, has become more and more important.

Marcy: ***As you look into the next few years, what are Fastprint's goals?***

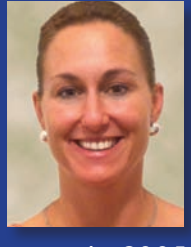
Sunny: Within the next two years, we plan to complete a capacity expansion with regard to our PCB prototype and small-volume capacity, which we expect to help us achieve North American market development and a significant sales increase to maintain a compound annual growth rate (CAGR) of 30% or more. We are also working to optimize and increase our technology offering, and to develop our high-layer-count manufacturing abilities rapidly, as well as rigid-flex and HDI PCBs in key markets.

We are putting much energy and resources into further developing our "one-stop shop" service advantage for customers, offering a complete PCB design, manufacturing and assembly solution. Finally, we are initiating an even stronger effort to give full attention to our V.I.P. customers, to reinforce and strengthen Fastprint's historically strong business areas and advantage industries, like the telecommunications equipment industry. We do this even as we focus on the huge potential demand industries, like national defense science and education, and medical electronics, as well as regional markets such as the USA and Eastern China.

Marcy: ***As we close this discussion, do you have any concluding thoughts you would like to leave with our readers?***

Sunny: I'd just like to reiterate our core values here at Fastprint: Our customers come first. We strive to be fast and efficient in our business, always. We work toward continuous innovation. We want to grow together with our customers.

Marcy: ***Thank you, Sunny. I wish you and Fastprint continued success. I look forward to seeing you at Nepcon China and CPCA soon.*** **PCB**



Marcy McAllister LaRont has worked in the PCB industry for more than twenty years, and has held positions in EH&S, purchasing, production control, customer service and sales. Prior to joining the I-Connect007 team in 2005, she worked for Data Circuits (Merix), Trend Circuits/Praegitzer Industries, and Hadco/Sanmina-SCI. LaRont currently resides in Hong Kong. Contact LaRont at marcy@iconnect007.com.

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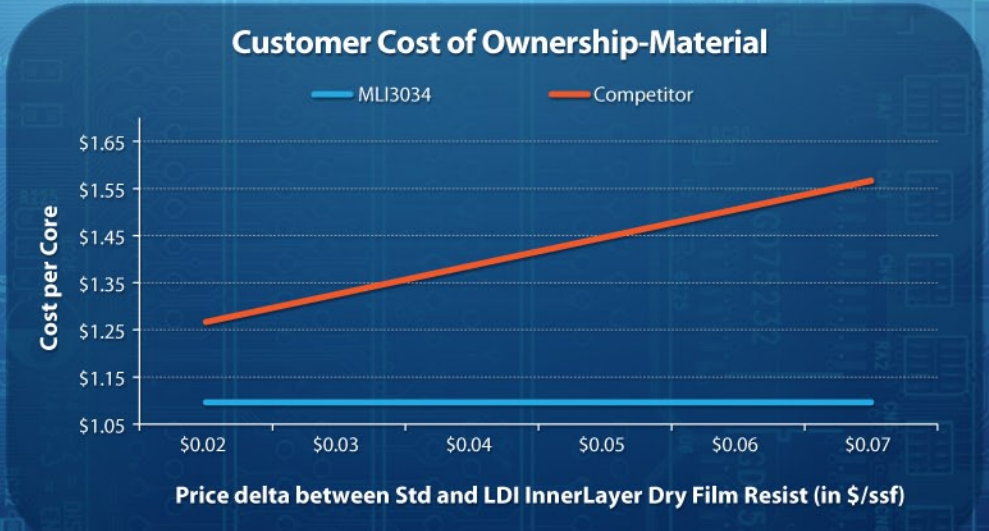

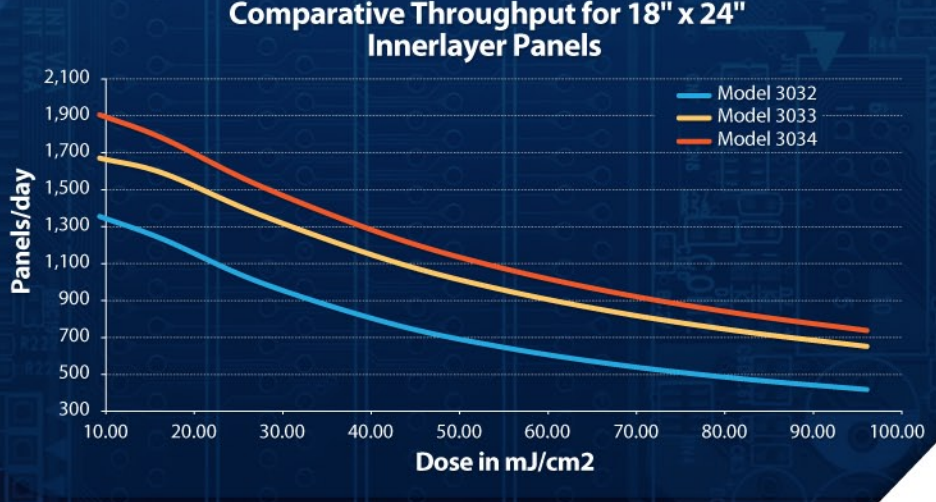

Automotive Electronics OEM Market: *AN OVERVIEW*

by Anand Mehta
FREEDONIA GROUP, INC.

SUMMARY

While worldwide demand for OEM automotive electronics is expanding, especially for powertrain and emissions systems, telematics (electronics communication and entertainment systems) struggles to find an audience. This may change as automakers begin collaborating with third-party application developers like Microsoft.

World demand for OEM automotive electronics is forecast to expand 12.4% per year through 2014 to $177 billion. This strong showing includes the effect of a significant rebound from recessionary 2009 levels, when production in developed countries—the U.S. in particular—plunged dramatically.

Gains in electronics revenues will grow faster than light vehicle production through 2014 as new electronic features and technologies continue to enter the vehicle platform. Above-average gains will be recorded for electronically controlled transmissions and transfer cases, airbag systems, security systems, navigation systems and collision avoidance technologies such as antilock brakes (ABS), traction control systems (TCS) and electronic stability programs (ESP). Backup monitors will also experience strong growth, especially in the U.S. where they are expected to be mandated, as will communication and navigation electronics in general.

Powertrain and emissions electronic systems represent the largest and most mature segment of the industry, including such established systems as engine management, cruise control, electronic transmissions and fuel injection. Certain safety and security products (antilock brake systems, car alarms and keyless entry systems), entertainment products (radios and tape and CD players) and dashboard instrumentation products are also rapidly maturing. In fact, cassette tape decks are essentially obsolete in developed markets, while CD players are on their way to extinction over the next ten years, as that technology will be replaced by MP3 and similar digital music players.

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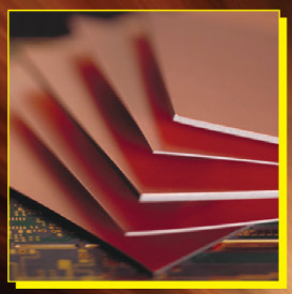

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AUTOMOTIVE ELECTRONICS OEM MARKET: AN OVERVIEW *continues*

sound systems, there is significant price competition from aftermarket products, which inhibits OEM demand. Likewise, consumer electronics devices such as mobile phones and add-on navigation systems have significantly co-opted market segments that automakers originally assumed would be their own. The greatest potential for growth lies in communication and navigation systems and safety and security technologies. Light vehicles will continue to advance from being primarily mechanical machines—evolving into platforms that seamlessly integrate mechanical and electronic components and systems to create machines move beyond their traditional function as utilitarian transportation devices—to become an extension of the consumer's lifestyle. Other areas of strong continued demand include electronic stability control systems, and diesel engine control systems (in Europe currently, but projected to start growing rapidly in the U.S. and other large markets).

In some respects, this revolution in vehicle design has been about making driving safer, and more environmentally friendly and efficient, as evidenced by the proliferation of electronic safety features, engine management systems and emission control systems. However, some of the innovations are less about practical matters than they are comfort, convenience and information access, such as MP3 and satellite radio audio systems and video/DVD, gaming and computer systems.

A segment of the OEM automotive electronics industry initially thought to exhibit great growth prospects focused on telematics systems, defined as a combination of electronic communications and entertainment systems that allow vehicles to receive wireless mobile services, including navigation and entertainment (radio, television and computer). The majority of these products would be included in the comfort, convenience and entertainment product grouping, although there is a certain amount of overlap, particularly with safety and security products and navigation and instrumentation products.

Telematics, originally introduced in the 1990s, has experienced much slower than anticipated market growth across the Triad countries. In part, the issue is one of consumers indicating unwillingness to pay monthly subscriptions for the service. Perhaps a more significant inhibitor has been the latent nature of telematics offerings: a clear "killer application" has not emerged for telematics. Unlike personal computers, which businesses and consumers originally valued for spreadsheet and writing/publishing applications, or the Internet, which became valued due to email capabilities, telematics has so far not found the application that will stimulate demand.

Automakers originally envisioned a wide range of telematics products and services as a means of adding value to their vehicles and differentiating themselves from their competitors. Traditional market acceptance of these products has been much lower than expected, causing U.S. telematics leader General Motors to fit telematics systems as standard equipment in many of its product lines, and to offer one year's free service. This has caused telematics providers to move beyond the automobile platform, offering smartphone applications that enable the system to link with consumer mobile devices.

World OEM Automotive Electronics Demand by Product Class (million dollars)

Item	1999	2004	2009	2014	2019
World OEM Auto Electronics Demand	66000	88500	98600	177000	258000
Powertrain & Emissions	32610	41850	44645	77235	108230
Safety & Security	17710	25015	29615	56415	86875
Comfort, Convenience & Entertainment	9265	12045	12835	21570	29980
Instrumentation	6200	8010	8790	14975	20450
Communication & Navigation	215	1580	2715	6805	12465

Source: The Freedonia Group Inc.

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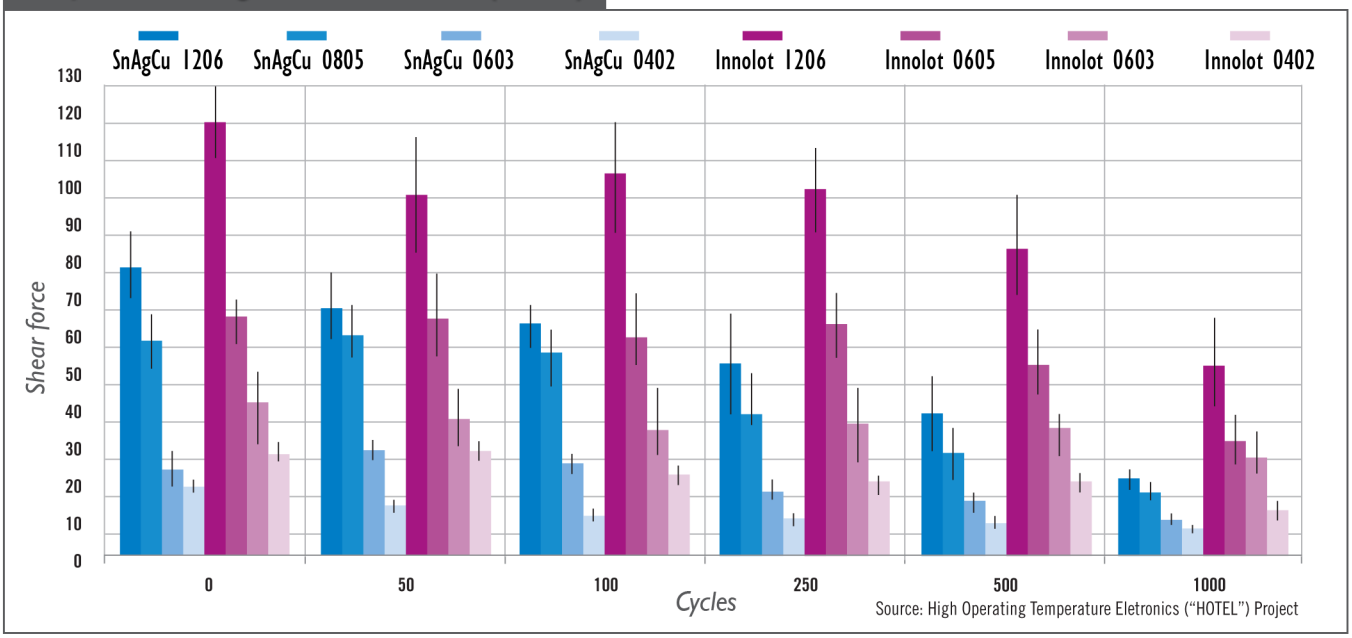

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Ultimately, telematics could become more and more common as OEMs continue to "seed" the market and as man/machine interfaces become more accessible. However, several challenges beyond market acceptance are on the horizon, including the unresolved driver distraction issues reportedly caused by these systems.

While companies have ceded, to an extent, key communications technologies to the aftermarket, some automakers have begun to fight back. Ford, for example, introduced its SYNC in-vehicle communication and entertainment system in a dozen 2008 light vehicle models in North America. Designed in conjunction with third-party application developers using Microsoft's Windows-embedded automotive operating system, SYNC enables users to connect virtually any mobile phone and some digital media players with Bluetooth capabilities to make use of SYNC's voice or manual controls. Sold as a standalone option for under $400, SYNC enables Ford to capture some of the value lost to mobile phone carriers and consumer entertainment and communication device manufacturers. **PCB**

Anand Mehta is an industry analyst for The Freedonia Group, Inc., where he writes global industry studies. Some of his most recent titles include World Turbines, World Machine Tools and World Flat Glass. Mehta holds a B.S. in Mathematics and Economics from the College of Wooster, and an M.B.A. from Cleveland State University.

ROGERS NAMES HOECHNER PRESIDENT AND CEO

Rogers Corporation announced that its Board of Directors has elected a new President and Chief Executive Officer, Bruce D. Hoechner, effective October 3, 2011. Hoechner has also become a member of the company's Board of Directors, succeeding Robert D. Wachob, who will now serve as Chairman of the Board of Directors.

Hoechner has many years of broad leadership experience across numerous geographies, businesses and functions in the specialty chemicals industry with particularly strong international business expertise. For the past five years, Hoechner was based in Shanghai, China, first with Rohm and Haas Company, for whom he worked for 28 years, and then moving to Dow Chemical upon its acquisition of Rohm and Haas in 2009. While in Shanghai, Hoechner was responsible for a variety of businesses, most recently as President, Asia Pacific Region, Dow Advanced Materials Division with regional revenues of more than $2 billion.

"I am very pleased to be joining Rogers, a company that clearly has done an excellent job of positioning itself for success in the fast growing megatrends markets related to the Internet, Mass Transit and Clean Technology. I look forward to working with the Rogers team to build on this solid foundation and to continue to grow the company," said Hoechner.

Lead Director of the Rogers Corporation Board of Directors, William E. Mitchell, said, "The entire Board of Directors would like to thank Bob for his many years of dedicated service, for setting the strategic direction of the company and for positioning Rogers to continue growing. We are pleased to have Bruce join the company. He is exceptionally well qualified to succeed Bob and assume the role of President and CEO of Rogers."

Hoechner holds a Bachelor of Science degree in Chemical Engineering from Penn State University and is a graduate of the Wharton Management Certificate Program at the University of Pennsylvania.

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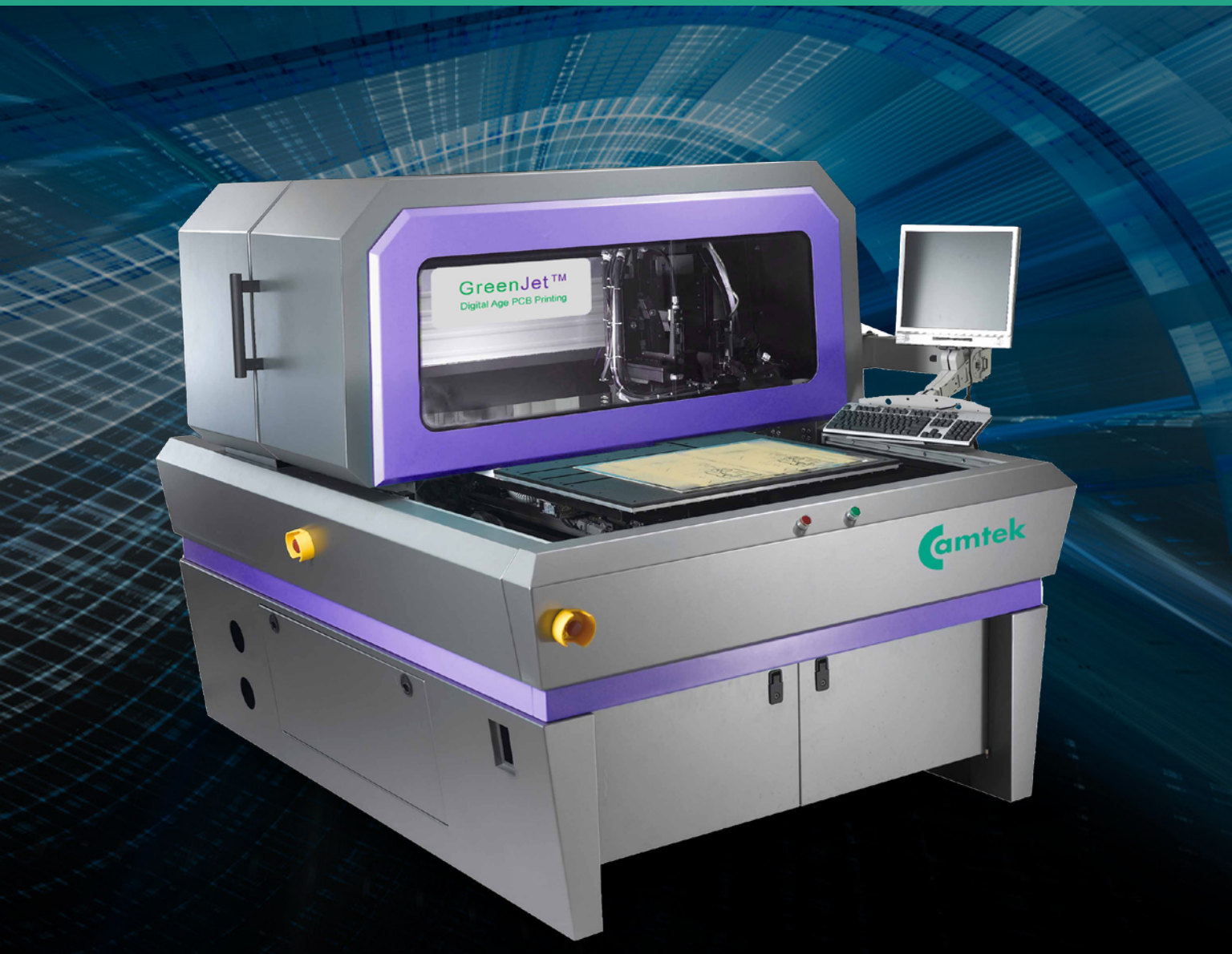

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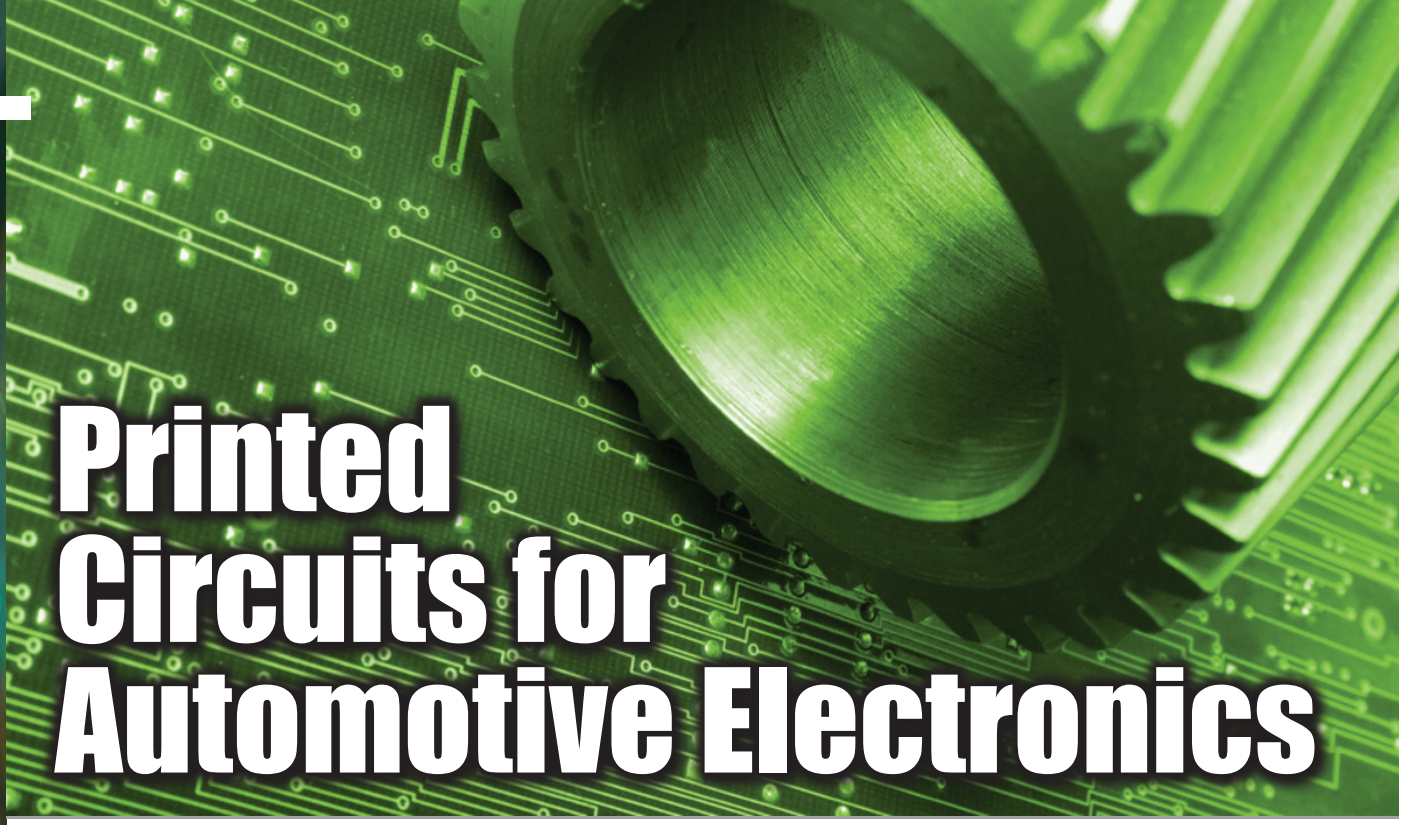

Printed Circuits for Automotive Electronics

by Craig Davidson, Ph.D.
VIASYSTEMS GROUP, INC.

SUMMARY

Rapidly increasing integration of electronics into automotive powertrains, safety systems and other advanced features has accelerated the technology content of automotive PCBs to accommodate functionality, space limitations, heat dissipation and higher requirements for performance and reliability.

Background

For at least the last ten years, the automotive industry has been a very significant end-user electronics market. It should be obvious to anyone purchasing a car today that its electronics content has increased dramatically in the last decade. It is apparent in the transition from simple analog radios to today's infotainment systems; from analog instrumentation to digital LED displays; from maps in the glove box to satellite-enabled GPS systems; and from rear view mirrors to video monitors, displaying what is behind you. What might not be as obvious is the rapidly increasing integration of electronics into powertrain and safety systems such as engine control units, chassis stabilization, powertrain distribution, interior environment control and air bag control. Add to that today's most advanced automobile features such as self-parking, collision avoidance, communication and night vision. It is clear that automotive electronics continues to grow with the industry and will become an ever-increasing component of the value of a car, while at the same time providing greater safety, better control and more comfort and convenience.

In 2011, the electronics industry will be over $1.4 trillion worldwide with the automotive end-user market accounting for approximately 10%. Except for 2008-09, this 10% market share has been relatively stable and is projected to remain so for at least the next five years (Figure 1). As the overall electronics industry recovers from the lingering effects of the financial crisis of 2009, it is expected to resume historical growth rates of 5-6% with automotive electronics maintaining its 10% share.

In 2015, automotive electronics are expected to be a $200 billion market. Using historical ratios for the content of PCBs, automotive PCBs will be worth almost $4 billion (Figure 2). Half of all automotive PCBs are used in the extremely high reliability applications of pow-

“ Like most other electronics end-user markets, the automotive industry pursues fabricators that can supply product with high cost/performance benefits. ”

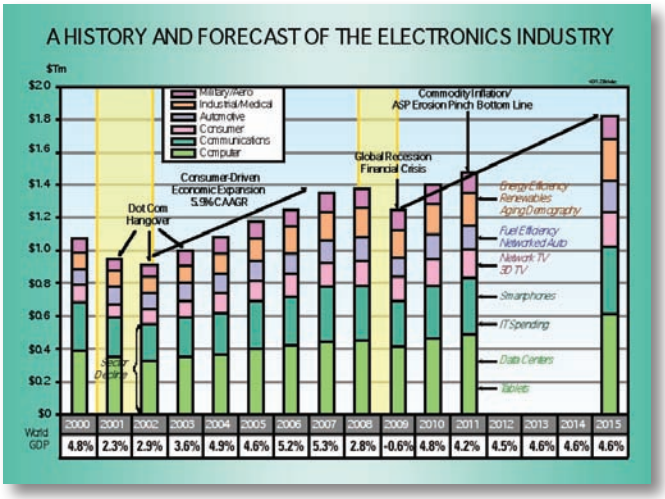

Figure 1: Total electronics industry. (Courtesy of Prismark Partners)

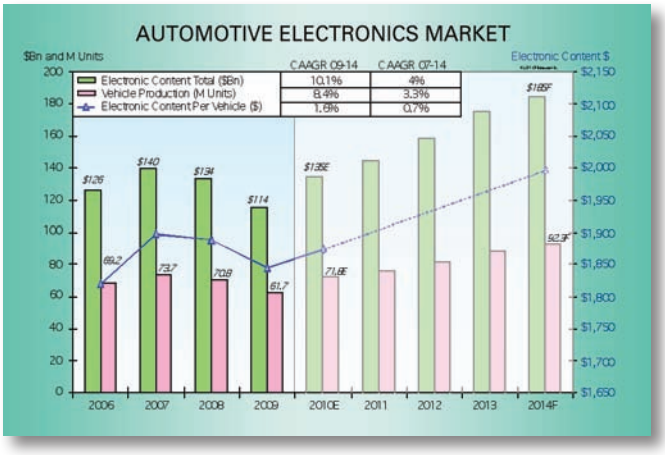

Figure 2: Automotive electronics. (Courtesy of Prismark Partners)

ertrain and safety systems. Other automotive applications include instrumentation, infotainment, lighting and interior controls.

Another consideration for automotive electronics is the migration of production from the U.S. and Europe to Asia. Like most other electronics end-user markets, the automotive industry pursues fabricators that can supply product with high cost/performance benefits. Today, only 10% of automotive electronics are produced in Europe and 85% in Asia, including 15% in Japan. Asia has become an important supplier in a relatively short period, even in the face of inexorably increasing complexity, higher reliability requirements and cost pressures. In addition, Asia itself—and China in particular—has become an important end market of automobiles in its own right. This certainly argues for local content and suppliers that are positioned close to their end customers. In December 2008, for the first time, there were more cars sold in China than in the country who had always previously led in car sales—the United States. China continues to lead the world in automobile sales, automotive electronics production and automotive PCBs.

Current and Future Requirements

In the recent past, automotive PCBs were characterized by low complexity and low layer counts (2-8 layers). Given the market developments noted above, there has been acceleration in the technology content of automotive PCBs to accommodate the increasing demands of functionality, space limitations, heat dissipation, high-current designs, higher electrical performance and higher reliability requirements.

Because of the automotive industry’s demand for high reliability, high quality and high cost-effectiveness, particularly in the powertrain and safety systems, the qualification process emphasizes strong collaborating between the system manufacturer and the PCB supplier. Qualifications are rigorous and can take as much as two years. They are governed by many industry specifications such as ISO/TS 16949 certification and AIAG (Automotive Industry Action Group) specifications, in addition to detailed individual company purchase specifications and requirements. It is typical for qualifications to be required for new products, materials, processes, equipment and fabrication sites. In addition, automotive life cycles are long—typically three to six years. Any change in material, process or equipment during the lifetime of the product usually is also subject to requalification. Moreover, there is always heavy involvement of customers in ongoing process and quality monitoring through their active quality programs and frequent on-site audits.

New requirements result not only from specific product physical features and performance enhancements, but also from a

more sophisticated view of product life-cycle management. Examples of the latter include traceability at the component/board level, in-process monitoring, supply chain management and reliability modelling—not just pass/fail testing. Automotive electronics have been transitioning to lead-free assembly for several years, and this will continue into the future, placing additional requirements on materials and processing on both the fabricator and the assembler to ensure reliability in the field.

The introduction of plug-in hybrid electric vehicles and all-electric vehicles brings its own demands on PCBs including high current, power distribution and high heat dissipation. The increasing use of RF (radio frequency) circuits for collision avoidance, lane change assist and self-parking is driving the demand for materials with higher electrical performance. Ceramic-based power circuits will transition to lower cost organic laminates. The introduction of high-efficiency lighting systems will require high heat dissipation, better power distribution and high-density controls. These new requirements have to be met with qualified and truly high-volume processes that tolerate no room for error.

It is expected that requirements of automotive PCBs will increase substantially over the next several years, including dramatic increases in operating temperatures, higher currents, higher power distribution with better efficiencies and higher circuit density accompanied by integration of power and control circuits. In short, automotive printed circuits are following the path of semiconductor substrates, high-end computer, telecom and datacom applications in that the PCB is transiting from a component carrier to an integral part of the overall electronic system.

Some specific parameter values and targets, which will need to be accommodated by next generation automotive PCBs, include:

- Increased operating temperatures to 150°C with even up to 200°C contemplated
- Circuits with 2 – 5 kV operating voltages
- Circuits with up to 1,000 amps
- Increased temperature cycling resistance—up to several thousand cycles (-40°C to +150°C)
- High heat dissipation
- Improved CAF (cathodic/anodic filament growth) resistance—high voltage (200-500 V) passing up to 3000 hours or more of standard CAF test protocol
- Higher density circuits requiring HDI microvia constructions
- Improved materials to support high-temperature, high-voltage, and high current-environments
- Movement to 20+ year product life requirements
- Total board-level traceability through fabrication processes carried through to packaging and shipping
- Movement from simple pass/fail reliability testing to lifetime models that incorporate field performance and integrate physics of failure and detailed understanding of process effects

Advanced Technologies for Automotive Applications

Heavy Copper for High-Current Applications

It is possible to process PCBs with extremely heavy copper, up to 12 oz. copper on inner layers. Figure 3 shows some current production parts, and Figures 4 and 5 show cross sections of two such configurations. This technology

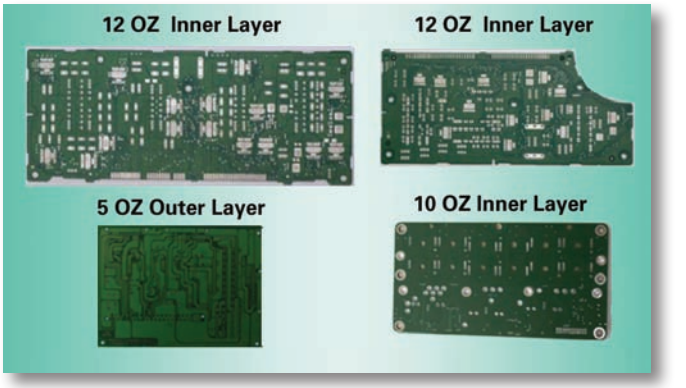

Figure 3: Heavy copper applications in production.

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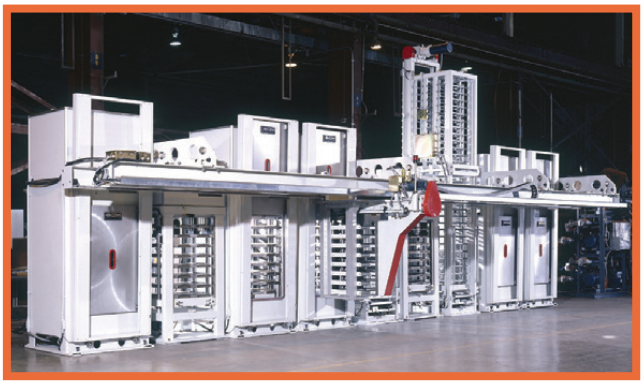

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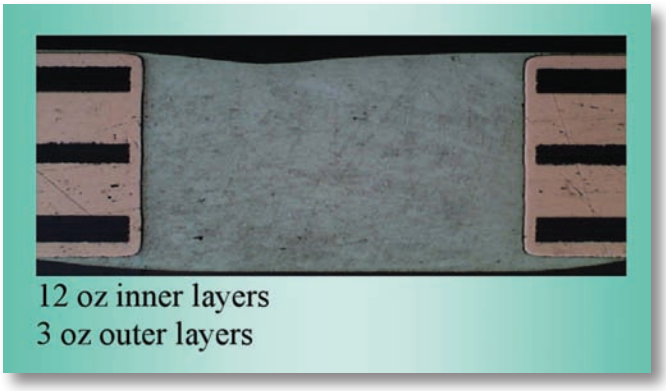

Figure 4: Heavy copper applications.

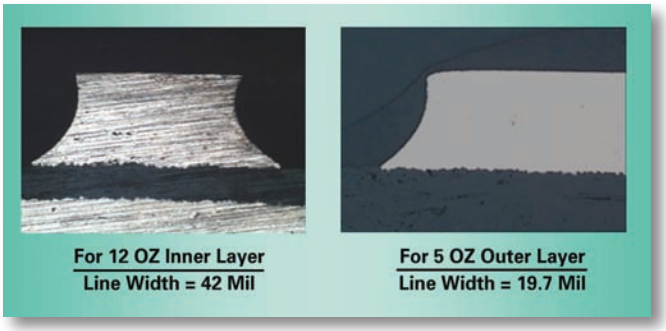

Figure 5: Heavy copper applications (cross-sections).

has been developed over the years and requires particular attention to critical processing parameters to be successful. In particular, lamination has to be carefully controlled to assure void-free product. Special stress relief is employed to eliminate dielectric cracking and delamination. This becomes even more important as products transition to higher Tg materials, which are more brittle.

Of course, these products must be lead-free compatible and remain reliable in the field even after high-temperature assembly operations. Ultra-heavy copper makes this a significant challenge, and careful process optimization is required for each dielectric system employed.

Thermal Management Technologies

There is a wide range of thermal management solutions available today that have many applications in the automotive industry. They include:

- Thermal via farms
- PCBs with integral heat sinks
  - — External post bonded
    - Thermally conductive pressure sensitive bond sheets (cold lamination) attach
    - Thermally conductive adhesive (hot lamination) attach
    - Sweat-soldering attach
  - — Embedded heat sinks
    - Copper inlay
    - Copper press fit

Via Farms

Via farms make use of plated through-holes arranged in a pattern that ultimately contributes to heat transfer. A big advantage is that it makes use of standard processing and is therefore a low-cost thermal solution. It is most useful for surface mount devices. However, it has the least heat spreading and transfer of the thermal solutions described here. Figure 6 shows a standard via farm application.

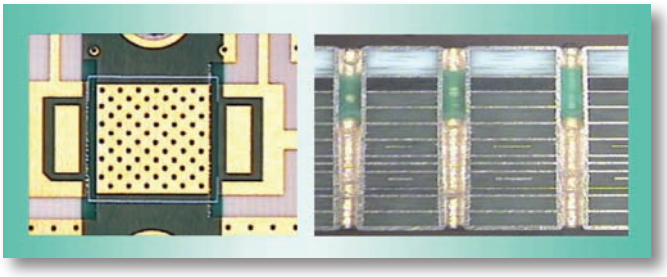

Figure 6: Via farm thermal management.

Heat Sinks

Heat sinks are metal plates and/or blocks of any designed shape. They can be attached to the printed circuit using a variety of approaches, or they can be embedded into the PCB either by lamination or by press-fit techniques.

Post-Bonded Heat Sink

A post-bonded, adhesively attached heat sink is shown in Figure 7, and the associated process flow is depicted in Figure 8. A pressure sensitive, thermally conducting adhesive film attaches an aluminium or copper plate or pal-

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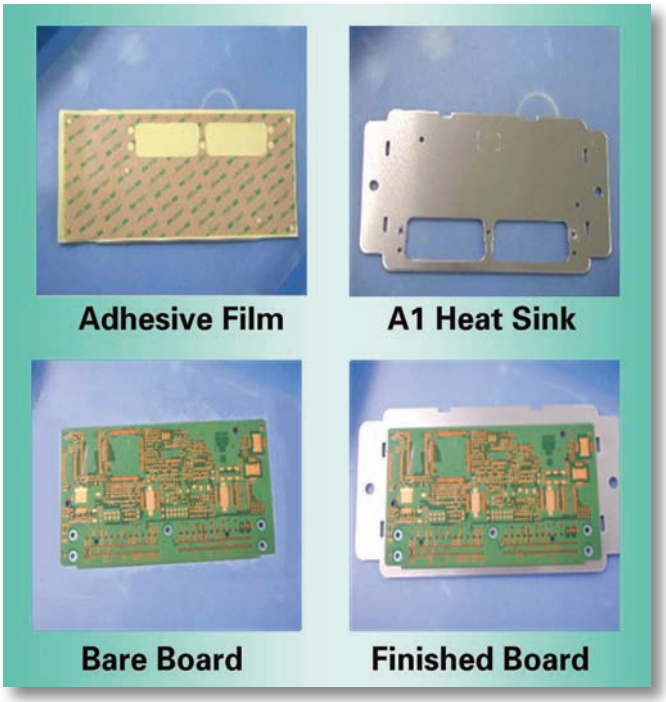

Figure 7: Adhesive-attached heat sink.

let to the board. Cold lamination techniques are used for the attachment process. The aluminium can serve as both heat spreader and heat sink.

In addition, a high-temperature solder pre-form can be used to attach a copper heat spreader/sink to the board (Figure 9). An eight-zone reflow oven is used to perform the soldering operation. Scanning acoustical microscopy is used for final inspection to ensure void-free processes.

Embedded Heat Sink

Embedded copper technology contains discrete solid copper inserts that are embedded into the PCB during lamination. These copper inserts can have any shape and they conduct heat through the PCB directly to a chassis or other heat sink. They can also be electrically grounded. This configuration provides ten times the thermal transfer capacity of through-hole via farms. It reduces the complexity of surface mount assembly associated with vias and solder wicking. Fabrication costs are reduced over post-bonded coins and pallets by eliminating the associated post-fabrication attachment processes. The high-temperature

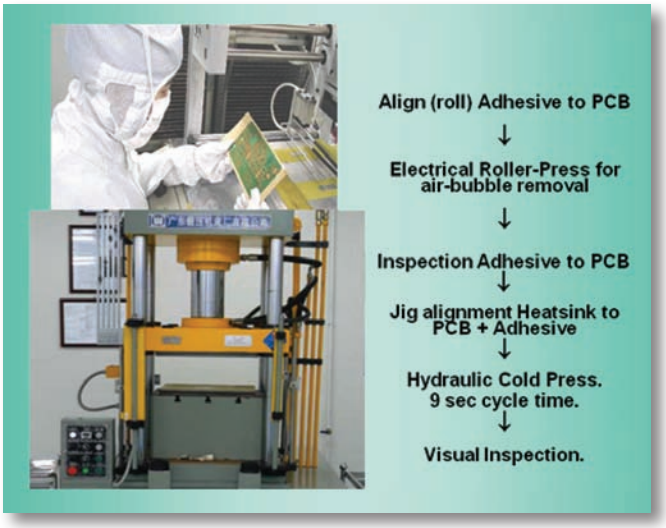

Figure 8: Adhesive attach process.

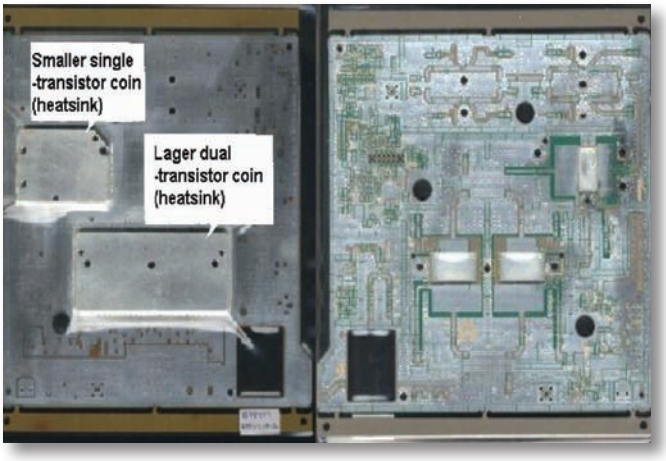

Figure 9: Sweat solder heat sink attach.

attach processes are also eliminated resulting in one less thermal excursion for the PCB.

An alternative to E-coin embedded copper technology uses a press-fit approach for the discreet copper inserts. It has all the advantages of the E-coin technology mentioned above with a relatively simple press-fit insertion process. The copper inserts have cleats designed onto the edges, which mate with a plated edge route in the board that matches design of the insert.

E-coin technology and the press-fit alternative are shown in Figures 10 and 11.

HDI

The density requirements of most automotive products historically have not pushed

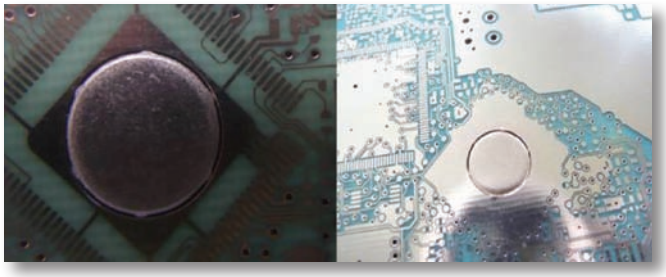

Figure 10: Press-fit /copper inlay coin attach.

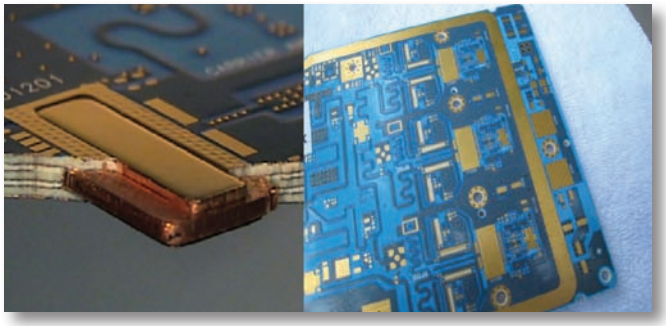

Figure 11: E-coin embedded copper technology.

the limits of PCB capabilities. However, as discussed above, the use and performance of automobile electronics is growing rapidly and driving interconnect density requirements. Designing with more advanced semiconductor devices brings the same pressures experienced in computer and telecom products with respect to accommodating I/O count, power distribution, signal integrity and miniaturization. To meet the latest demands, automotive electronics are beginning to make use of HDI, which brings the same advantages to automobiles that it has for computers and mobile phones. HDI utilizes laser-drilled microvias in build-up interconnect layers with the primary advantage of increasing wiring density. In addition, microvias are robust and have demonstrated high-field reliability, easing their adoption into automotive electronics (Figure 12).

Currently, automotive products and advanced designs utilize one or two build up

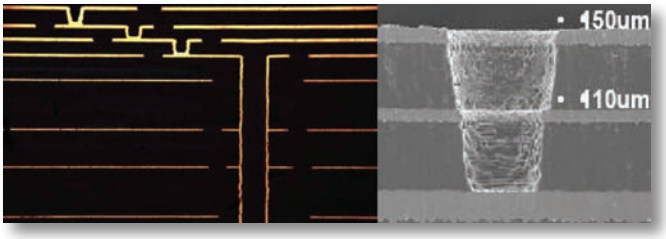

Figure 12: High-density interconnect.

layers. As HDI designs are adopted in automotive electronics, volume considerations will come to the forefront. Automotive applications are associated with very high volumes and, of course, very high reliability. This places high expectations on the fabricator for these more advanced fabrication techniques.

Conclusion

The use and performance of automotive electronics are accelerating rapidly. They already play major roles in control, safety and comfort. The introduction of new features and capabilities ensure the continued drive to advanced semiconductors, controllers, power electronics and RF circuits. Demands for better thermal performance and reliability are also placing further requirements on materials and process integrity. **PCB**

Dr. Craig Davidson is vice president of engineering and technology for Viasystems Group, Inc. With a background in printed circuit fabrication, card level electronics assembly, and semiconductor packaging, his responsibilities at Viasystems include engineering and technology development, customer application support and environmental compliance for RoHS/WEES. Davidson has over 20 publications and is inventor of seven patents.

KARL'S TECH TALK

Wafer Bumping Technology Choices

SUMMARY

Dominant bumping technologies include ball-drop, stencil printing and plating. Given these choices, how does one select the best and most cost-effective process for a given flip-chip type package?

by Karl Dietz
KARL DIETZ CONSULTING

Tech Talk introduced the topic of wafer bumping some time ago (Tech Talk #170, CircuiTree Magazine, November 2009) with a short reflection on the history of wafer bumping, going back to IBM's introduction of the C4 process (controlled-collapse chip connection). Bumping is done at the wafer-level, before chip singulation. As I/O count increased, wire-bonding of chips with peripheral array I/O patterns became more difficult and drove the technology of bumped area array I/Os.

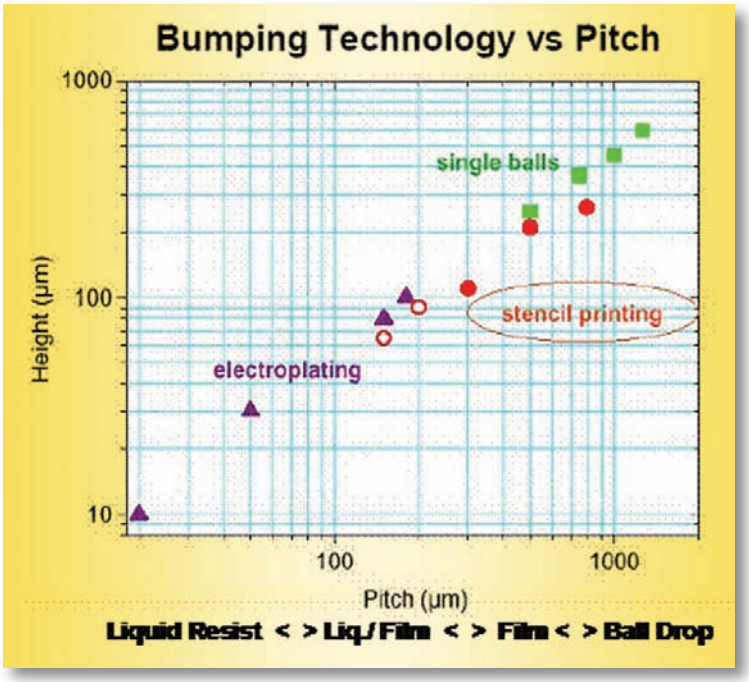

Figure 1: Bumping technologies and options by bump height and pitch. (courtesy: Dr. M. Toepper, IZM Fraunhofer Institut, Berlin, Germany)

The dominant bumping technologies are ball-drop, stencil printing and plating. Given these choices: How does one select the best and most cost-effective process for a given flip-chip type package? There are several considerations, most importantly pitch and desired stand-off height (i.e., the gap between the chip and the package top surface).

Figure 1 shows an overview of different bumping technologies options in relationship to bump pitch and bump height.

As pitch becomes smaller, the technology moves from ball placement (which does not require photolithography) to stencil printing, which may employ a metal stencil or thick dry film photoresist, to electroplating which uses dry film photoresist, single-coating liquid photoresist or multiple coatings of liquid photoresist, depending on bump height requirements. As Figure 1 illustrates, there are pitch ranges where these technologies overlap.

When plated solder bumps are reflowed, the shape of the bump approaches that of a sphere. Thus, the volume of the plated solder will determine the bump height as well as the achievable pitch. As pitch goes down, so does stand-off height, a fact that may not be welcome because under-filling becomes more difficult and co-planarity requirements become more stringent. In case there is no reflow operation such as with gold bump plating for tape automated bonding (TAB) or chip-on-glass (COG) applications, very fine low-profile bumps are achieved (see Figure 1, lower left-hand corner). An interesting new technology is the formation of bumps with copper pillars, capped with solder or tin (see Figure 2). The copper pillar is plated

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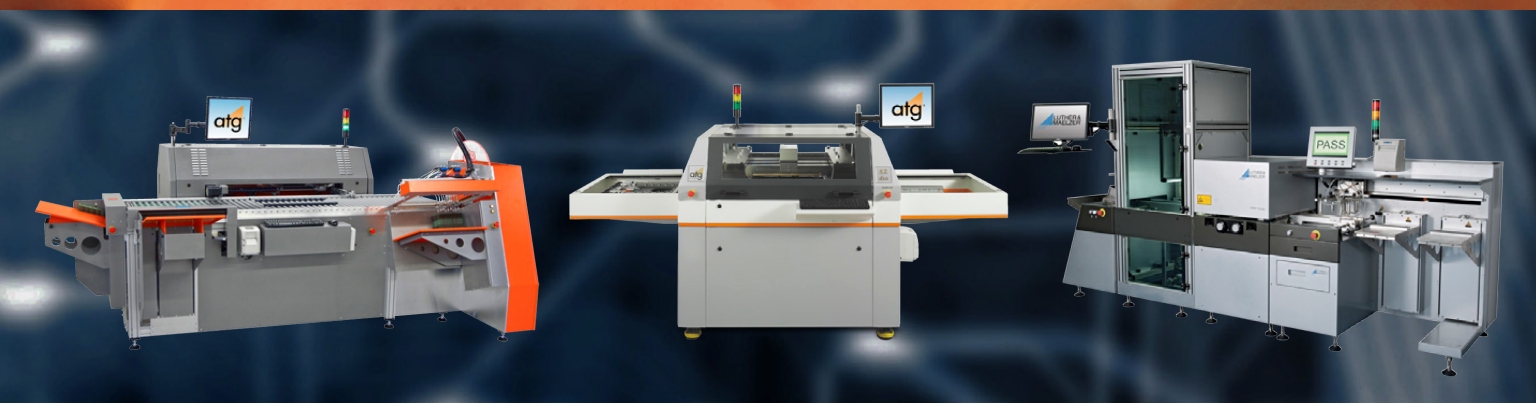

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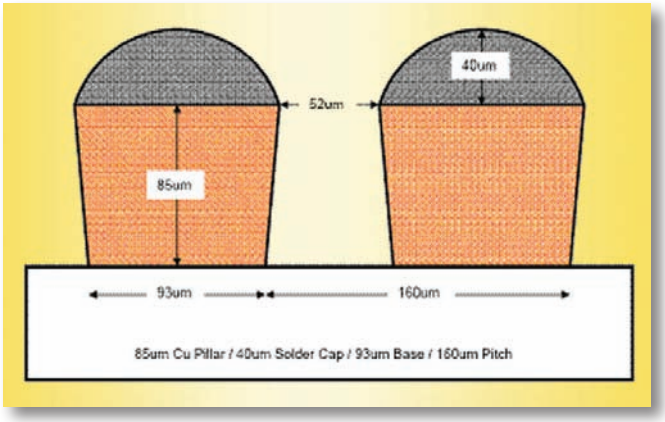

Figure 2: Copper pillar with solder cap. (source: Amkor Technology®)

first, followed by solder plating. After resist stripping, the solder is reflowed whereby the shape of the plated solder changes from a flat disc to dome-shaped cap. Since the copper does not reflow, it retains its original pillar shape, allowing the formation of fine-pitch, high stand-off bumps. These copper columns give the package interconnection higher reliability because of the good compliance of copper under stress.

Figure 3 shows an array of plated copper pillars with tin caps before resist stripping.

As shown in Figure 1, there are overlapping technologies in wafer bumping. This also applies to the use of liquid versus dry film photoresist, and the use of a single coat of liquid resist versus multiple coatings. A curious process has developed that stretches the ability of thin resist coatings to form relatively high solder bumps. The solder is deliberately over-plated, forming solder mushroom heads over the resist ("mushroom plating," see Figure 4). After resist stripping and solder reflow, the mushroom reshapes into a solder sphere whose position on the UBM is defined by the developed resist pattern.

It should be noted that for this technology, compatible photoresists and strippers have to be selected so that the stripped resist is in liquid form or very fine suspended particles to allow clean stripping under the over-plated metal.

As mentioned above, if solder paste is stenciled, one can use a metal stencil or a

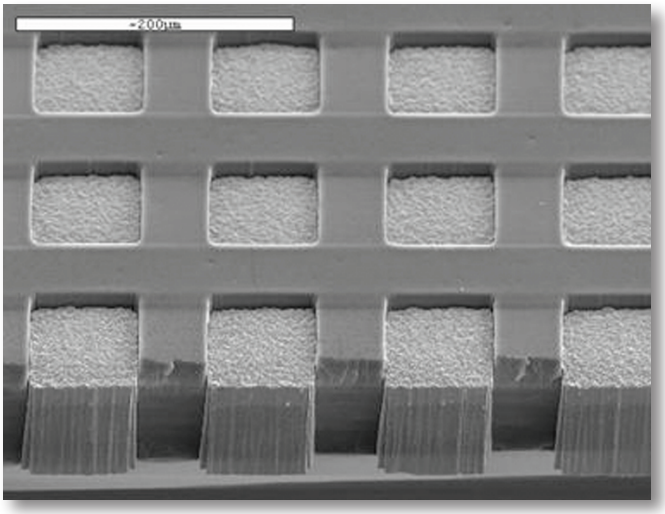

Figure 3: Copper pillars with tin caps before resist stripping. (Source: DuPont Electronics & Communication)

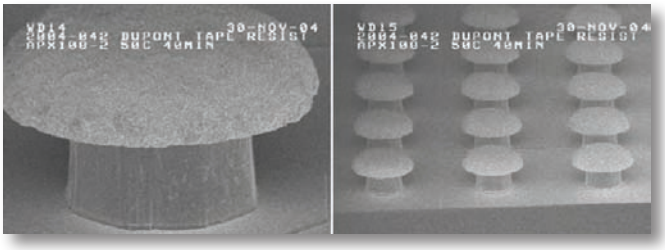

Figure 4: Mushroom plating of solder bumps. (Source: DuPont Electronics & Communication)

suitable dry film photoresist that is exposed and developed to form the openings that define the location of the stenciled solder paste. Since the solder paste needs to be partially reflowed before resist stripping to keep the stenciled paste in place during and after stripping, the resist needs to be rather thermally stable. **PCB**

Karl Dietz is President of Karl Dietz Consulting, LLC. He is offering consulting services and tutorials in the field of circuit board & substrate fabrication technology. Karl can be reached by e-mail at karldietz@earthlink.net or phone (001) 919 870 6230.

Printed Electronics Picks Up Speed at IPC

by Real Time with...IPC Midwest 2011

Dan Gamota is driving IPC's standardization efforts. With several standards in the works, Gamota updates us on their progress and provides additional perspective on the PE industry drivers.

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VIDEO INTERVIEW

EPTE FROM JAPAN: PRINTABLE ELECTRONICS OR PRINTED ELECTRONICS?

Dominique K. Numakura, *DKN Research*

Media groups and researchers affiliated with the electronic packaging industry use the phrase "printed electronics" instead of "printable electronics." They explain that the word "printable" is a future tense adjective that refers to the possibility of printed electronics. Since the technology now exists, they can refer to these products as printed electronics. I disagree with their timeline because the basic process and materials were established more than 30 years ago, along with the creation of a printed electronics industry.

I can understand using the word printable for certain electronic devices. For example, researchers and R&D engineers created prototype models for TFT transistor arrays, flexible displays and flexible photovoltaic cells used in printing processes. They claim the devices are printed electronics; however, none of them were used in commercial applications.

Things are a little clearer for process engineers. This group is responsible for developing new products and they always consider alternative methods when designing a manufacturing process for new electronic devices. They first look at the functions of the new devices and feel lucky if these structures are printable because they can expect a simple, low-cost manufacturing process. Only a few processes use printable technologies, while the rest use methods that are more traditional. In this case, the term printed is not accurate to describe the entire process.

Today, silver paste suppliers and screen-print manufacturers are enjoying a boom in business due to global demands from the mobile electronics segment and solar energy plants. The screen-printing process plays a small, but necessary, role in manufacturing. The basic constructions for most devices cannot be completed without screen-printable materials.

It is no big deal for some manufacturers—they don't care what you call it as long as they're making money.

SHORT

FLEX007 Highlights

BPA Report: Bare Flex Market to Hit $12.7 Billion by 2016

Between 2002 and 2007, the worldwide market for flex and rigid-flex printed circuits doubled from a little less than $4 billion to just over $8 billion. The market then slowed in 2008 and recovered to exceed 2007 levels in 2010. Thanks to smartphones and tablets, BPA predicts that by 2016 the bareboard flex market will reach $12.7 billion and flex assemblies will top $40 billion.

N.A. Flex Shipments Drop 28.3% On-Year in July

Flexible circuit shipments in July 2011 were down 28.3% and bookings declined 4.5% compared to July 2010. Year to date, flexible circuit shipments increased 3.2% and bookings also increased 8%. Compared to the previous month, flexible circuit shipments decreased 17.8% and flex bookings fell 34.9%.

Free Online Flex Design Course Released

"Designing Flexible Circuits" is an online course for engineers, product managers and "anyone who wants to design a flexible circuit," said course instructor John Michael Pierobon, who holds an advanced engineering degree from Purdue University. This free course comprises six online chapters and features an extensive glossary.

Printed Electronics: What have we learned so far?

IDTechEx has tracked printed electronics since 2002 and, being impartial, are careful to state the good and the bad. There is enormous opportunity for the current capability of printed electronics devices, but not enough effort to make needed product. So, what has been learned in the past decade about this technology, which could be worth over $2 billion in 2011 alone?

Career Tech Plans to Acquire Sunflex

Flexible PCB maker Career Technology reportedly plans to acquire fellow maker Sunflex Tech through a share swap, in which one Sunflex share will be exchanged for 0.9 Career Tech shares.

Teknoflex Updates Designers Guide to Flex Technologies

Teknoflex has released "Designers Guide to Flexible Circuit Technologies" Version 3. This valuable guide to flexible and flex-rigid circuit technologies, which Teknoflex first created and published in 1995, is free via the company's Web site.

Workshop to Focus on Flex, Stretchable Electronics

The third Flexible & Stretchable Electronics Workshop, November 16 - 17, 2011, in Berlin, Germany, will bring the latest developments in the area of flexible and stretchable electronics.

Dyconex Boosts Capability with New SEM

Dyconex has announced the addition of scanning electron microscopy (SEM) to its service offerings.

The Evolving World of Flex

Flex circuitry is on a continuous path of growth and evolution. Costs have come down and the materials have changed for this extremely versatile application. Verdant's Joe Fjelstad explains why to Guest Editor Kelly Dack as they explore "Joe's World of Flex."

FPCB Makers Optimistic about Q3

Flexible PCB makers Career Technology, Ichia Technologies and Flexium Interconnect have posted mixed results for July 2011, but the three companies are positive about the outlook for the third quarter thanks to steady demand from the handset and smartphone sectors.

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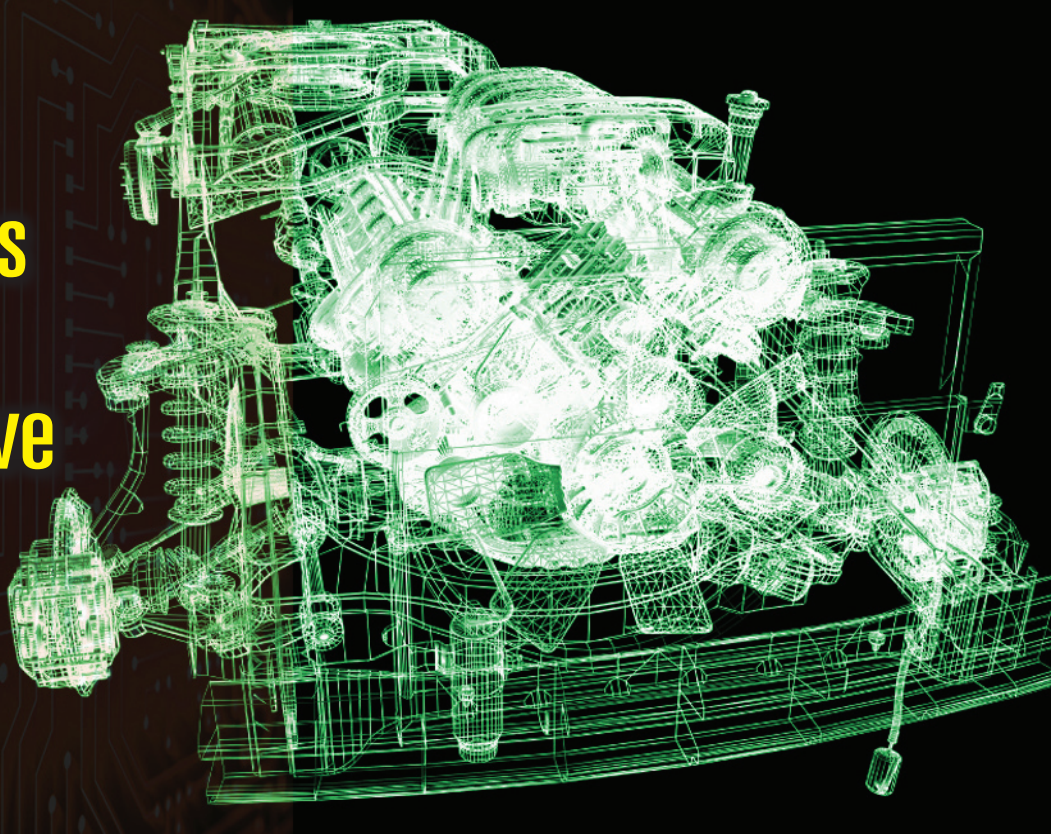
Impact of Electronics in the Automotive Industry



by Humair Mandavia
ZUKEN

SUMMARY

For the automotive industry, the increasingly expanding role of PCBs in the electrical and electronic system adds new complexities to the already challenging design process. However, with these complexities come new opportunities for process improvement.

The automotive industry continues to experience the influence of today's rapidly changing world economy. In a market primarily dominated by mechanical and electrical design, over the past few decades there has been exponential growth in the number of electronic components incorporated into the design of motor vehicles. The increase in electronic modules adds a new complexity to the overall product design of a car, while at the same time introduces many new factors that have to be considered to allow the industry to be viable and competitive in the long term. Factors such as reliability, modular design and data management are a few examples. As we steer into an era of alternative fuel cars and trucks, we need to take into account that the inclusion of electronics in vehicles will only increase. Therefore, it is vital to understand how electronic design matures alongside the other disciplines in the overall product design cycle, and how it affects the bottom line in vehicle production.

Maintaining Reliability

Reliability is one of the key issues that designers face when creating a PCB for a transportation product. Cars and trucks are expected to withstand extreme temperatures and rigorous conditions throughout their lifecycle; this includes the printed circuited boards and components used in the design. It is no secret that the automotive industry has faced this challenge for many years; by adding more electronic modules, selecting the right materials and components becomes even more important. Choosing between a low-temperature, co-fired ceramic and a high-temperature FR-4 could mean the difference of a few cents or more for each PCB in the system. Taking into account the number of cars one company manufactures in a year, those few pennies can have a significant impact on the overall margin of each vehicle.

Reliability is also tied to the issue of the

“ Engineers have to work together to consider how to optimize the addition of all the new features while still maintaining the physical space reservation designated for each section of an automobile. ”

wide array of the latest features and interfaces that come with cars today. Most cars have optional navigation systems, portable music interfaces and Bluetooth hands-free systems to choose from, and all of these options introduce a new set of concerns during product development: signal integrity, analog simulation, RF analysis and EMC studies are becoming an integral part of the design process. What makes the problems unique for automotive engineers is that in addition to dealing with the range of power supplies introduced into the PCB that is typically seen in consumer products, they are also working with other large voltage and current supplies throughout the system of the car to make it operational. With these elements in mind, ensuring that signal quality and crosstalk interference are maintained within specifications is essential. Throw in the fact that some cars include memory and SuperSpeed USB, and engineers are now dealing with constraint management issues along with the need to conduct early analysis. This makes a case for designing right the first time and adds to the pressure of improving savings from iteration reduction.

Importance of Modular Design

As formerly optional items such as automatic window and door locks become standard features, and new features such as navigation and Bluetooth become today’s options, modularized design is now a key factor in the design process. Engineers have to work together to consider how to optimize the addition of all the new features while still maintaining the physical space reservation designated for each section of an automobile. Think of a stereo and speaker unit that may come standard with a car, and the elective upgrade package that may include a rear camera or color display that manages your MP3 and voice control functions. Both the base feature and elective option must be considered in the same space reservation allocated in the car. Designers taking advantage of modular design must be cautious of this early in the design process to avoid costly mistakes. See Figure 1 below.

Figure 1: 3D visualization assists with space reservation for modular design.

Modular design also requires that other important factors such as power distribution be taken into consideration. Since the power supply systems in a vehicle are already complex, ensuring that the electronics function is not the only concern—the car still needs to start every time and use the battery in the most efficient way. That is why some car models have the option to upgrade to specific features and others do not. If you try to add an aftermarket device to your car, the warranty may become null because manufacturers cannot guarantee that the existing power distribution can support the power consumption of new devices. As engineers address these types of issues during the design process, identifying the proper specifications of acceptable modules becomes vital to ensure the automobile operates correctly. In addition, it is important to understand which options, modules or after-market parts will violate operation specifications to protect manufacturers from warranty disputes.

> *"With the use of modular design, design teams can leverage design reuse from one model to another."*

With the use of modular design, design teams can leverage design reuse from one model to another. As long as space reservation and reliability concerns are addressed, most modules can be reused effectively to allow manufacturers to deliver new products to the market on time. The automotive industry comprises a vast network of suppliers and partners who work together during all facets of product development, from engineering to production. As each player in the process leverages reuse, the cost savings benefits quickly mount up—helping auto manufacturers retain a competitive edge, and allowing suppliers to hold their ground as partners by providing cost-efficient solutions to the overall vehicle production process.

Aligning Data Management to the Design Process

Along with the other integral pieces in the automotive design process, data management is a crucial element. Consider all the steps in the process and all the contributors involved with production; data management is a necessity and is the major element that ties the whole process together. Of particular concern in this area is the supply chain. Most manufacturers have adopted "just-in-time" methodologies and Lean Six Sigma processes, ensuring that you have access to the correct, qualified component and information about its availability, meaning that parts can be shipped at a specified time. Therefore, linking your domain data management system and the procurement system tightly with the supply chain has key benefits when making design decisions during product development.

Data management also plays an important role when interacting with the suppliers and partners that are part of the product design cycle. Many times, design data is shared between several companies and worked on concurrently by multiple design engineers, so keeping track of your work in progress (WIP) and securing your data when needed is vital. This is also a key concern in the automotive industry because of the competitive and sensitive nature of the business. Most automotive manufacturers have become truly global companies in the past 20 years or more. Having the proper data management system in place affords companies the flexibility to securely design and manufacture anywhere while maintaining the required delivery to market.

Optimizing the Complete Electromechanical Design

Engineers, whether they are focused on the mechanical aspects of an automotive design, or the electrical or electronic aspect of product development, must always take into account the overall design of the complete system. Designing a vehicle requires a holistic view of the system at several levels. The operations of each system within the design discipline itself,

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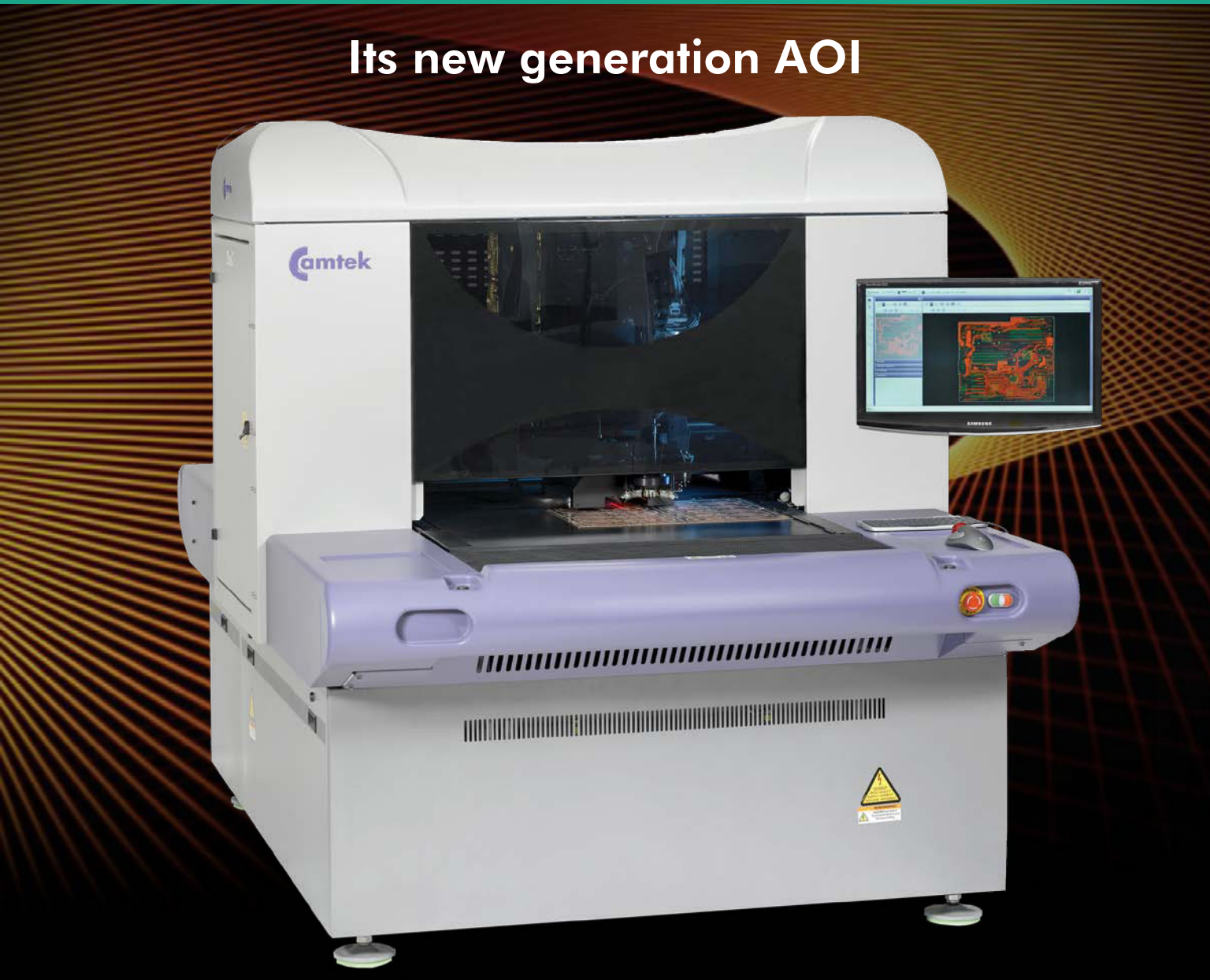

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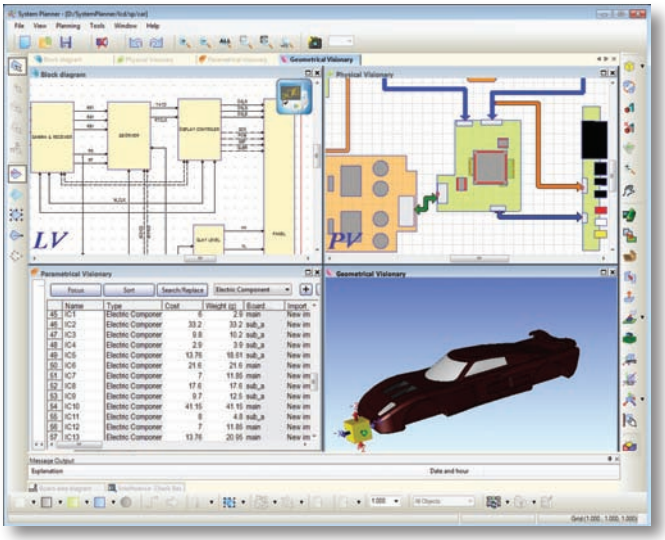


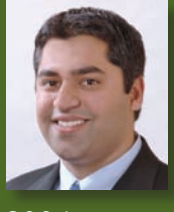
Figure 2: Upfront system planning in a single environment addresses multiple engineering disciplines.

and the operation of the system as a whole unit, have to be purposefully planned and examined early on in the design process. Being able to effectively design from concept to manufacturing is another area where engineers are looking for opportunities to improve. Many times, violation of space reservation and minding other factors such as cost, weight and power consumption are identified too late in the design process. System planning tasks—such as bill of material planning, functional diagrams and 2D and 3D space planning of the entire system or each sub-system—is an area where engineers can take advantage of working in a single environment. Linking the planning information to the electronic and mechanical design phase increases efficiency by saving time through using the planning data to initiate the detail design, and reduce errors by maintaining design intent. Integrating these tasks and reusing information, whether it is conceptual or for the detail design, adds benefits of cost reduction and improvement of overall quality to the product development cycle.

Because of the presence of more electronic components in automotive design, the complete behavior of the system requires attention, and simulation and analysis play vital roles at this stage. At this point, the concerns are beyond signal quality or EMI. Analysis areas such as thermal, hydraulic and even pneumatic studies have to be conducted early in the process to avoid costly mistakes that may normally be identified only after prototypes are produced. When system-level simulation is performed before the physical design takes place, the complete design process benefits.

Summary

With ever-increasing challenges faced by the automotive industry, and as more PCBs are now part of the complete electrical and electronic system, new complexities are added to the already challenging design process. With these complexities come new opportunities for process improvement. Designing a car or any other motor vehicle involves the more familiar issues of reliability and modular design reuse, while at the same time entails newer concerns such as data management and the conceptual planning and design of the complete electromechanical system. Many of the issues discussed can be addressed by modern EDA companies who specialize in electrical and electronic design, and understand how the importance of domain data management can provide value to the overall process. To remain profitable and competitive, it is imperative that both automotive manufacturers and their suppliers engage in partnerships with trusted vendors to help improve the existing design process and be ready for any future changes. By establishing these trusted relationships, many of the benefits and savings can be achieved through collaborative working practices. **PCB**



As Technical Marketing Manager at Zuken, Humair Mandavia focuses on System Level Design with emphasis on High-speed/SI and ECAD/MCAD collaborative solutions. He joined Zuken in 2004 as an applications engineer, and prior to that, worked as a hardware design engineer in the telecom industry. For more information, contact Humair.mandavia@zuken.com.

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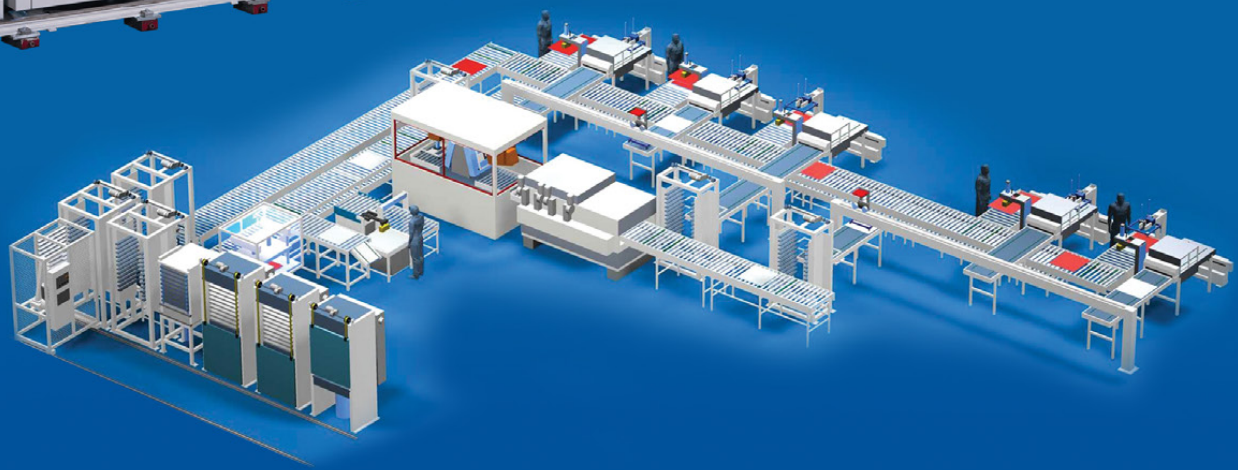

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COLUMN

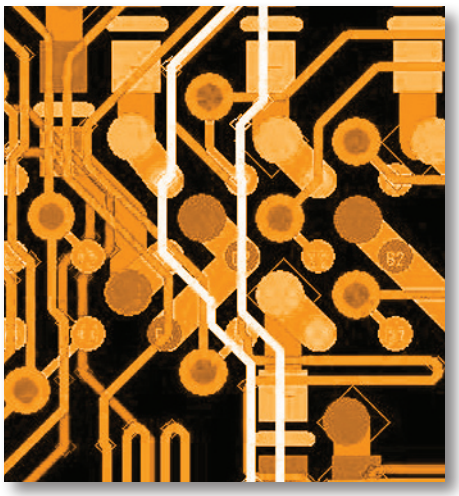
Differential Pair Routing

by Barry Olney
IN-CIRCUIT DESIGN PTY LTD, AUSTRALIA

SUMMARY

This application note discusses the selection and optimal settings of differential pair design rules. When it comes to successfully deploying differential signals in high-speed designs, symmetry is the key. Maintaining the equal and opposite amplitude and timing relationship is the principal concept when using differential pairs.

A differential pair is two complementary transmission lines that transfer equal and opposite signals down their length.



The debate rages as some argue that since the two halves of the pair carry equal and opposite signals, a good ground connection is not required as the return current flows in the opposite signal. In addition, tight coupling between the signals is better than loose coupling, as it reduces undesirable coupling from aggressor signals.

Others say that beyond the fact that differential pairs transfer equal and opposite signals, there are no special requirements that need to be considered when using differential pairs. They should be treated as two single-ended signals. The signals of a differential pair don't need to be routed together, should not be tightly coupled and are not required to be routed to the differential impedance.

Hmm…I am not getting into this argument, as I look at PCB design from a practical designer's point of view, the theory can be left to the experts to discuss.

However, most agree on the advantages of differential signaling:

1. The ground (reference) connection between the driver and load can be poor and the signal quality will not be compromised.
2. The signal can be attenuated significantly (20 dB) and still function properly.
3. Because of the high noise immunity, they can carry extremely high data rates (10 Gb/s) compared to single-ended transmission lines.
4. The equal and opposite nature of the differential pair means that demand on the power distribution network is less than for a similar single-ended data path.

Keeping both points of view in mind, I consider that symmetry is the key to successfully deploying differential signals in high-speed designs. Maintaining the equal and opposite amplitude and timing relationship is the principal concept when using differential pairs.

Differential pairs also require matched length traces. For instance, DDR2 clocks need to be matched to within 25 MIL. This ensures that there is no skew between the signals of the pair, and flight times will be identical, which is an important factor.

To control crosstalk, keep aggressor signals as far away as possible from differential pairs, especially in Microstrip (outer layers). A good rule of thumb: Clearance = 3 x trace width.

Additionally, reducing the signal layer to reference plane spacing (dielectric) improves crosstalk.

If the routing is dense then consider setting the clearance design rules to 2 x trace width to start. There is a good feature in Altium Designer that I use frequently: the "Parallel Segment" rule. This enables you to set a gap of 4 MIL (on the same layer or adjacent layer) for a maximum length of 500 MIL; then, the spacing must increase to 8 MIL.

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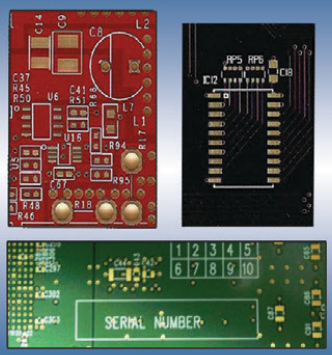

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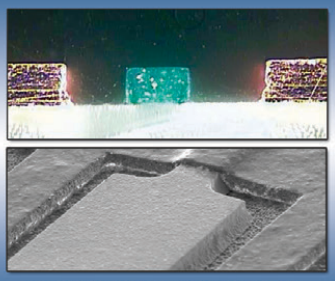

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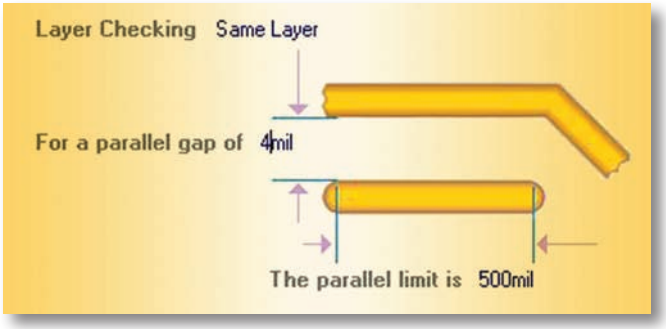


Figure 1: Parallel Segment rule.

In addition, placing copper pours next to one side of a pair isolates the two halves of the pair. This is another good reason not to pour copper ground planes on high-speed digital designs. Keep ground pours well away from differential pairs. If you must have them use a clearance of 3 x trace width.

The amount of real estate available is also to be considered. Typically, a DDR2 board will be routed with 4-MIL trace and 4-MIL clearance with vias 20-MIL pad and 8-MIL hole. This allows us to place the fanout vias under the BGA device and route out to open space. Generally, the 100-ohm differential clock will start at 4/4 (trace/clearance) and once clear of the BGA revert to 4/8.

Figure 2 below shows a DDR2 clock routed differentially from the processor with a 4-MIL trace and 8-MIL spacing. The signals come out of the BGA, fanout within 200 MIL and drop to an internal signal layer, and are then distributed to the memory chips.

In this case, I was fortunate not to have an obstacle in the path of this pair. It is typical however to have to split the pair around a via, pin or other obstacle to get to the load. This is where tightly coupled pairs come unstuck. That is, the gap, and hence, differential impedance cannot be maintained and the result is a much higher impedance in the diverted area, which creates reflections.

This brings us to another controversial point: whether to have close (tight) or loose coupling of the differential signals (where tight coupling is defined as 4/4; loose coupling is 4/12). Tight coupling is good for densely routed boards (aren't they all), but with tight coupling the clearance must be maintained along the entire length of the signal. As mention previously, this is not always possible because of the inevitable obstacle.

Leaving the theory of differential signaling aside, here's what works:

<u>The rule of thumb:</u> Gap = 2 x trace width.

Therefore, for a 4-MIL trace a gap or clearance (edge to edge) should be in the order of 8 MIL. If we expand the 8-MIL gap to 28 MIL around an obstacle (e.g., 20-MIL via) the differential impedance increases by 3.85 ohms (3.85%), but if we start with tight coupling of 4/4 and increase to 4/28 around an obstacle then the impedance does a massive jump of 25 ohms (25%). Clearly, this is way over the acceptable +/- 10% for controlled impedance boards (not considering the fabrication process variables).

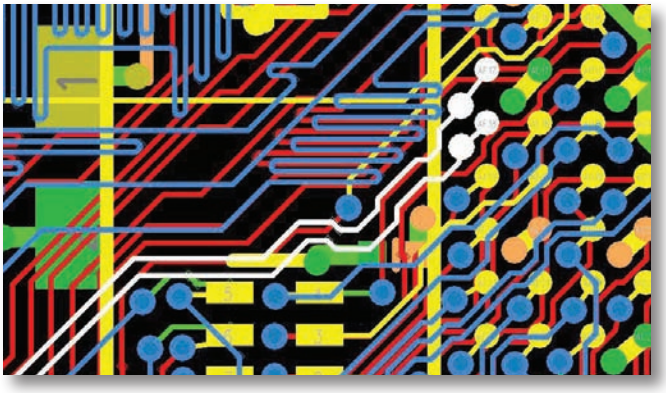


Figure 2: DDR2 clock at 4-MIL trace 8-MIL spacing.

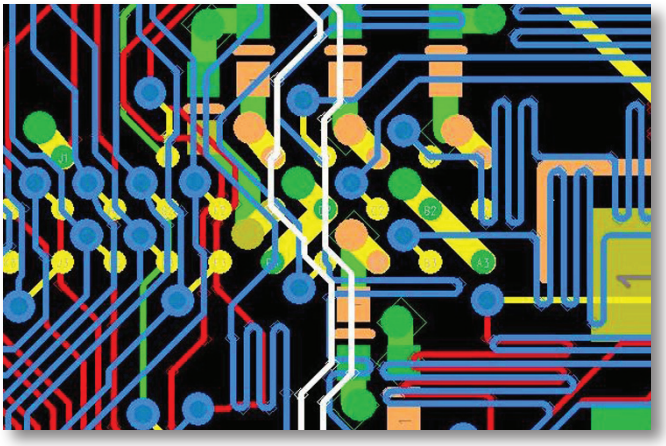


Figure 3: The gap increased from 8 MIL to 28 MIL around an obstacle then back to 8 MIL.

Trace Width (MIL)	Clearance (MIL)	Zdiff (ohms)	% increase
4	8	99.99	
4	28	103.84	3.85% ideal
4	4	100.99	
4	28	126.79	25% out of tolerance

UNITS: MIL — ICD STACKUP PLANNER – www.icd.com.au 9/1/2011 — Total Board Thickness: 61.8

Differential Pairs > DDR2 CLK | USB | SATA | ETHERNET

Layer		Material	Dielectric		Copper	Trace		Current	Impedance	Edge Coupled	Broadside Coupled	
Number	Name	Type	Constant	Thickness	Thickness	Clearance	Width	(Amps)	Characteristic(Zo)	Differential(Zdiff)	Differential(Zdbs)	Description
		Dielectric	3.3	0.5								Soldermask
1	Top	Conductive			1.4	8	4	0.31	53.53	99.99		Signal
		Dielectric	4.3	3								Prepreg
2	GND	Conductive			1.4							Plane
		Dielectric	4.3	10								Core
3	Inner 3	Conductive			1.4	8	4	0.31	62.39	99.59		Signal
		Dielectric	4.3	10								Prepreg
4	VDD	Conductive			0.7							Plane
		Dielectric	4.3	6								Core
5	GND	Conductive			0.7							Plane
		Dielectric	4.3	10								Prepreg
6	Inner 6	Conductive			1.4	8	4	0.31	62.39	99.59		Signal
		Dielectric	4.3	10								Core
7	VCC	Conductive			1.4							Plane
		Dielectric	4.3	3								Prepreg
8	Bottom	Conductive			1.4	8	4	0.31	53.53	99.99		Signal
		Dielectric	3.3	0.5								Soldermask

Figure 4: DDR2 clock differential pair of 100-ohms impedances.

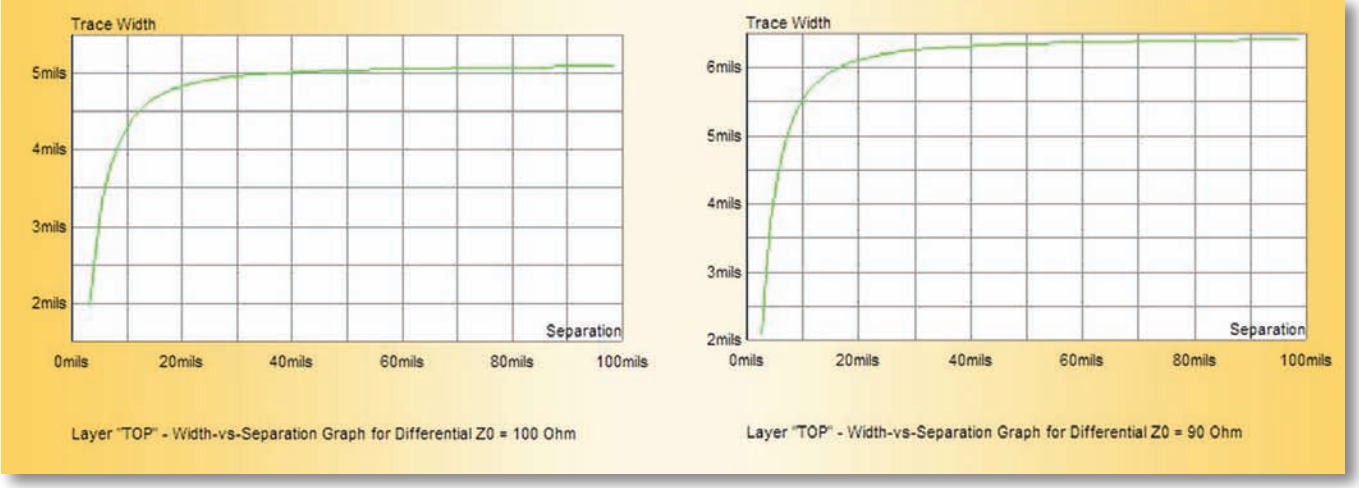


Figure 5: Graph of trace width vs. clearance for 100-ohm and 90-ohm differential impedance.

The above stackup was built with the ICD Stackup Planner (download from www.icd.com.au). The new HDI Designer Edition includes multiple differential pair definitions per layer.

These days it is quite common to have differential DDR2 clocks, USB pairs, PCI express pairs, etc., sharing the same layers on HDI boards. Until now, the designer had to calculate each impedance separately and somehow display the results meaningfully to fellow designers and the PCB fabricator. It is usually difficult enough to calculate one differential impedance, but the designer must now run both 100-ohm and 90-ohm impedances on the same layer.

As previously mentioned, the 4/8 differential pair works well for 100-ohm differential impedance on this particular substrate. However, the 90-ohm USB signal would be best routed at 5.5/11, as any increase in trace separation will have minimal effect on impedance.

The new HDI Designer Edition of the ICD Stackup Planner addresses these issues. Simply select the desired number of layers 2 to 16 (or create your own unlimited layer stackup) and start inserting differential pairs. As you insert a new differential pair, the ICD Stackup Planner automatically calculates both the single-ended (characteristic) and differential impedance of each layer. Simply adjust the variables to achieve the desired impedance of 100 or 90 ohms for a common substrate.

In Conclusion

1. Symmetry is the key to successfully deploying differential signals in high-speed designs. Maintaining the equal and opposite amplitude and timing relationship is the principal concept when using differential pairs.

2. Match the length of each signal of the pair. This ensures that there is no skew between the signals of the pair, and flight times will be identical.

3. Route the differential pairs to impedance and at the optimal spacing: Gap = 2 x trace width.

4. To control crosstalk, keep aggressors far away from differential pairs, especially on Microstrip (outer layers).

A good rule of thumb here is Gap = 3 x trace width. **PCB**

References

1. Advanced Design for SMT – Barry Olney
2. Design Techniques for DDR, DDR2 & DDR3 – Barry Olney
3. Embedded Signal Routing – Barry Olney
4. Copper Ground Pours – Barry Olney
5. Practical Differential Pair Design – Eric Bogatin
6. A treatment of Differential Signaling and its Design Requirements – Lee Ritchey
7. High Speed Digital Design – Howard Johnson
8. Routing Differential Pairs – Dennis Nagle, Cadence Design Systems
9. ICD Stackup Planner – www.icd.com.au

Barry Olney is Managing Director of In-Circuit Design Pty Ltd. (ICD), Australia, a PCB Design Service Bureau and Board Level Simulation Specialist. Among others through the years, ICD was awarded "Top 2005 Asian Distributor Marketing and "Top 2005 Worldwide Distributor Marketing by Mentor Graphics, Board System Division. For more information, contact Barry Olney at +61 4123 14441 or email at b.olney@icd.com.au.

SHORT

GERMAN PCB INDUSTRY GREW 18% IN FIRST HALF OF YEAR

Germany's PCB industry revenues grew by 18% for the first half of 2011, compared with the same period last year, according to the German Electrical and Electronic Manufacturers' Association, ZVEI. The organization represents the economic, technological and environmental policy interests of the German electrical and electronics industry at the national, European and international levels.

June revenues grew slightly year-on-year, albeit 12% lower compared to the previous month. Incoming orders, however, fell 26.8% in June compared to May.

Orders in the previous year, particularly in the period of May to July, were unusually high due to supply bottleneck fears. Compared to the 10-year average, incoming orders had grown in June by 0.2%, while that for the first half of the year grew 2.3%.

PCBDESIGN007 Highlights

Circuit Design ECOsystem Unveils eCommerce Web Site

The Circuit Design ECOsystem has announced a new collaborative eCommerce Web site that facilitates faster and smarter PCB prototyping and ordering for design engineers.

Zuken Supports IPC-2581; Joins Newly-Formed Consortium

Zuken has announced its support for the IPC-2581 electronic data transfer format. Zuken is a founding member of a new cross-industry consortium established to support the standard.

Mentor Graphics Launches Portuguese Language PADS Suite

Mentor Graphics launched a version of the PADS PCB design product suite in Portuguese targeted at the Brazil electronics industry to help Brazilian engineers and PCB designers become more productive by taking an unfamiliar language out of the equation.

Polar Launches Speedflex HDI

Polar has launched Speedflex HDI, a new flex-rigid and HDI stack-up design and documentation system that allows designers and fabricators to explore how combinations of materials, will affect the cost and performance of the finished PCB.

PCB Planet Increases North American Presence

PCB Planet is now providing engineering automation scripting services for its North American customers. PCB Planet's automation services are especially effective for companies that need to reduce CAM errors, thus freeing up their skilled engineering team from low-value tasks.

DownStream Technologies Releases DFMStream

DownStream Technologies has released DFMStream, a comprehensive, yet easy-to-use tool suite designed to help engineers and designers verify design and manufacturing rules on PCB design databases, Gerber and NC data during the PCB design cycle.

IPC Conference Tackles IP Security in PCB Designs

The IPC Conference on Securing Intellectual Property Through Physical Security, IT and Regulatory Compliance will examine an issue getting increased attention from OEMs and the U.S. DoD: The protection of intellectual property that is designed into PCBs.

Letter: Managing Outsourcing OK, But I MIss Design Work

"Having started my design career in 1970, I can identify with everything you wrote. In a strange sense, it made me long for those days to return," said Carrier's Susan James. "I don't get much of a chance to design any more - my job has changed to managing outsourcing of design…."

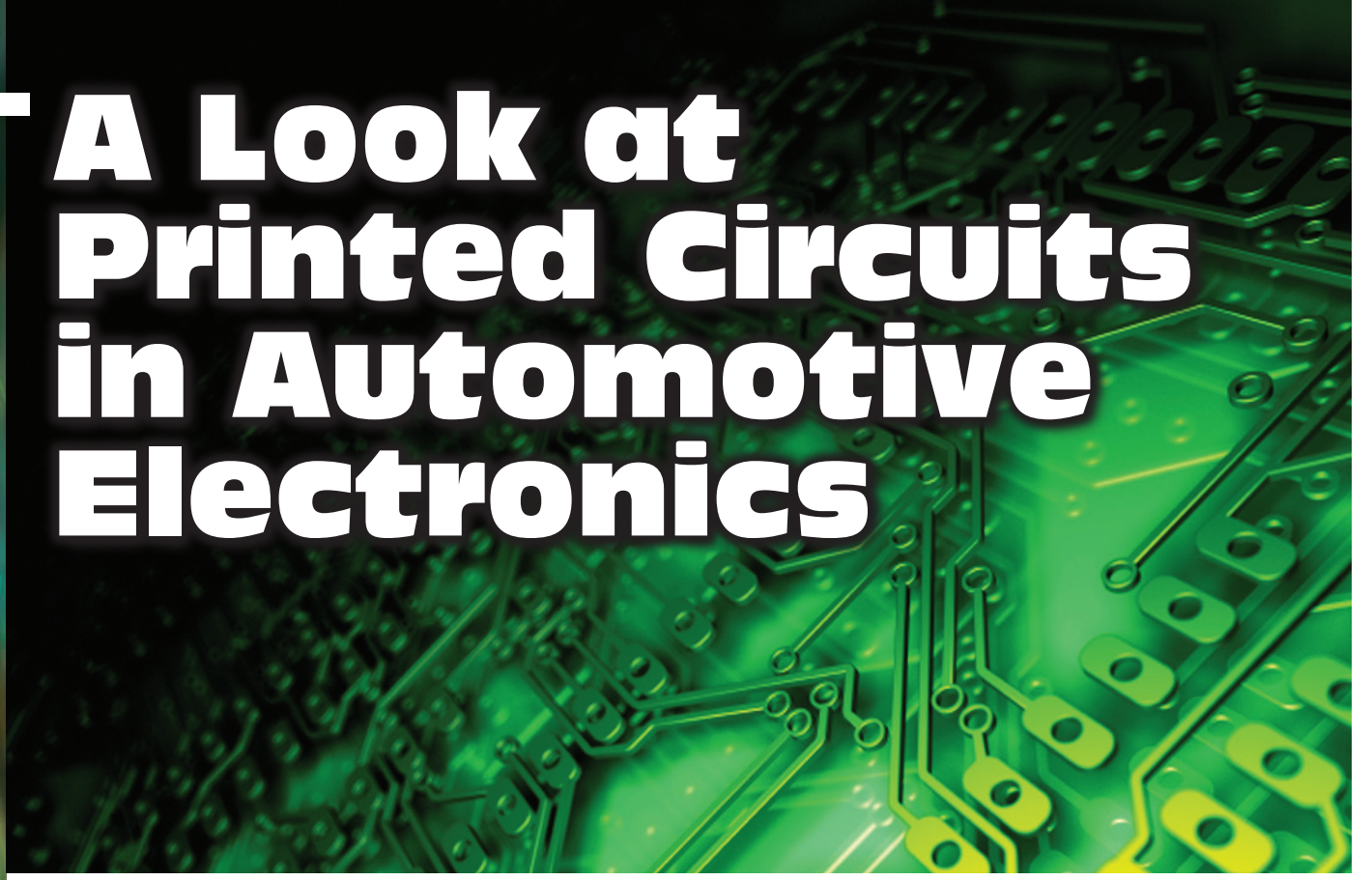
Laird Technologies Launches EMI Shielding Calculator

Parameters for the shielding computation are entered through a simple interface. They include material thickness, relative permeability, relative conductivity and a user-defined pattern of apertures.

Free Online Flex Design Course Released

"Designing Flexible Circuits is intended for engineers, product managers and anyone who wants to design a flexible circuit," said course instructor, John Michael Pierobon, who holds an advanced engineering degree from Purdue University. This free course features six online chapters and an extensive glossary.

A Look at Printed Circuits in Automotive Electronics



by Christopher Brandon
DELPHI PACKARD ELECTRICAL/
ELECTRONIC ARCHITECTURE

SUMMARY

It isn't just your dad's old-school radio that has a PCB anymore. The sophisticated vehicle electrical systems of today can be totally dependent upon a printed circuit board. Designs will continue to evolve, but the foundation of the heavy copper, multi-layer, plated through-hole, lead-free PCBs will remain.

Printed circuit usage in cars has had a long and rich history. In 1957, some sedan instrument panels used a roll-die cut flexible copper foil, sandwiched between two layers of polyester film, to interconnect the bayonet twist-in dash light bulb and electrical instrument gauges to the instrument panel main electrical harness. This meant there was just one connection to be made at the vehicle assembly plant. Since then, printed circuit board usage in vehicles has increased alongside the growing popularity of radios and entertainment systems.

A Little Bit of History

In the early 1970s, there was a PCB-based electronics assembly associated with the short-lived seat belt interlock system. For you young readers, that was a government-mandated program that prevented someone from starting the car if the seat belts were not latched when the driver and passengers were present. Due to safety concerns, the production program lasted just one model year.

Later in the 1970s, electronics and PCB usage exploded with the advent of engine control computers. However, there were other, less glamorous applications. Multiple function tone generators began to appear that provided audible warnings to the driver that the headlights were on, the key was in the ignition, oil pressure was low or engine coolant was hot. In addition, some PCB-based electronic modules were being introduced as "specialty functions." These stand-alone modules were integrated directly into the wiring harness with special connectors that also served as the PCB assembly's housing.

“ Today, an estimated 40 percent of the value of the vehicle is electronic with new entertainment, environmental control, navigation systems and safety systems. ”

In the 1980s, as these specialty functions became more than just a low-option penetration gimmick and customers ordered more of them, they were then incorporated into larger multiple function modules call “body computers.” Examples of the specialty functions include automatic door locks with single door and delayed all-door lock functions, automatic head lamp dimmers and controls, exterior lamp monitoring and power sliding doors for vans. At the same time, radios were becoming more sophisticated with CD players and power amplifiers, and electronic climate control and anti-lock braking systems were being added in upscale vehicles.

Not all electronic features and functions caught on, though. I recall a system called “Rain-a-Tron” that would put the top up on a convertible and raise the windows when it started to rain. It was not very reliable and one of the first demo convertibles activated prematurely and tried to put its top up as the chief engineer was driving at 70 mph down the Ohio Turnpike on his way home from Detroit! To say the least, he ended up wet and not very happy, with the convertible top jammed halfway down into the back seat.

In the 1990s and 2000s, electronics continued to grow with everything from more complex engine control computers, audio and visual entertainment systems, instrument clusters, automatic headlamp systems, vehicle information systems, ABS, navigation systems and interior and exterior LED lighting. The growth of electronics, and thus PCB and flex circuit usage, in the automobile is not new. Today, an estimated 40% of the value of the vehicle is electronic with new entertainment, environmental control, navigation systems and safety systems.

The BEC PCB Makes Its Debut

On the not-so-obvious side, there is another growth path of PCBs used in the vehicle today that has brought with it design challenges. In 1992, a cross-functional engineering team from Delphi was tasked with analyzing a newly developed bussed electrical center, or BEC, to support a new vehicle power and signal distribution system at the lowest possible cost. The BEC provides significant wiring harness architecture advantages that lower total vehicle electrical system design and assembly complexity. The BEC, commonly known as the fuse and relay block, is a centralized, stand-alone unit that interconnects several separate wiring harnesses in the vehicle and provides primary and secondary circuit fuse protection and centralized relay control of major functions. The first bussed electrical center was a matrix of metal stamping (buss bars) arranged and placed in multiple layers of plastic spacers to interconnect the plugged-in devices (relays and fuse) and the wiring harness connections.

After reviewing dozens of interconnecting methods and technologies, the team’s ultimate recommendation was to use a PCB with copper thickness of greater than 60 micrometers on which terminals were soldered. At the time, the copper thicknesses required for an effective BEC design were not readily available from PCB suppliers. There were a few suppliers, but their pricing was at a premium and their capacity was limited. Over the course of the next several years, the “heavy” copper PCBs became available for production volumes at an acceptable cost.

PCBs Continue to Grow

Various methods and techniques from several automotive component suppliers are using PCB technology with copper thickness of 60 micrometers and greater. In conjunction

with buss bars and other techniques, the BECs connect, distribute, protect and control the battery and alternator electrical power source to the rest of the vehicle. A typical BEC can carry peak load currents of 200 amperes, more than a typical home electrical service load, at ambient temperatures that range from -40°C to 125°C.

The Delphi BEC is the heart of a very effective vehicle electrical/electronic architecture. This system design approach reduces the number of harness leads, effectively protects each lead from over current, interconnects multiple leads and harnesses and reduces difficult-to-manufacture splices. BECs facilitate the segmentation of the harness structure to improve assembly plant construction of the vehicle. The centralization of several isolated harnesses connections allows fast and effective interconnections, allows for building the vehicle as segments and, with the wire harnesses deeply and effectively embedded in each subsystem, allows interconnection among many subsystems, such as forward lamps, engine, body and instrument panel, and the addition of specific auxiliary harnesses. BECs are located under-hood, within the instrument panel and in the rear trunks of the vehicle, with distribution, localized protection and control of various loads.

PCB-based BECs are an OEM's panacea, boasting smaller size, lower weight, and lower cost. In addition to the power and signal distribution system architectural benefits of a BEC, the PCB design has several advantageous attributes. PCB design tools are readily available and well established. Tooling changes for a PCB-based BEC are drastically faster, simpler and much less costly. While changing a series of stamped metal buss bars in a stack of molded plastic layers can, and usually does result in a significant tooling change cost, and changing a trace or redirecting a fused circuit to another connector terminal is done in hours, not weeks, changes on a PCB-based BEC have been designed, fabricated, printed, assembled and tested in just three to four days.

Terminal designs for connector and device interconnects have changed, and are

done differently among the various suppliers of PCB-based BEC. Not only that, they continue to evolve. As material costs increase and connector cavity centerlines decrease, terminals are becoming smaller. With more power used in a vehicle today, the heavy copper trace and pad design guidelines are placing more demands on the PCB fabricator to control the printing and etching processes. PCB designers must become more aware of the fabrication process to help eliminate trouble spots before they are realized.

PCB assembly manufacturing is a commodity today. Surface mount placement, solder reflow, odd-form component pick and place, wave-soldering, lead-free process, and in-line electrical and optical verification are all common place and well-known processes. BEC printed circuit board designs allow for a cost-effective automated assembly process using the available off-the-shelf electronics assembly equipment, but with some unusual requirements.

Sizes of BEC PCBs range from 70 mm long by 50 mm wide, up to 300 mm by 300 mm. Warp, twist and bow can easily cause the terminal tips to misalign and the PCB assembly to not fit into the BEC's plastic housing, or mate to the harness connector terminals at vehicle assembly. Therefore, resin materials,

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glass weave type and counts and glass cloth layer counts are critical to our PCB designs.

Delphi ships nearly 26,000 PCB-based BECs per day from our two North American plants and another 10,000 per day from plants in China and Brazil for those local markets. In North America, we stamp and insert 1.8 million terminals per day. Each terminal is machine-vision inspected for key product characteristics at the stamping press, and our China operation supports its own terminal consumption at similar rates. Each location has multiple BEC PCB assembly lines, with multiple terminal insertion machines, inserting 18,000 terminals per hour. To handle the highest current loads and power distribution, the PCBs are augmented with copper stampings that are made in-house, placed, and pressed into the PCB by custom-designed machines.

Each BEC is electrically tested and machine vision inspected to ensure that the correct pluggable components are properly located. Ninety million post-solder reflow, automatic optical inspection images of the PCB assembly are taken and logged by the unique PCB assembly's serial number every day.

Conclusion

The evolution of the BEC into the printed circuit world has been good and will continue to evolve. Increased current, heavier copper, higher voltages and more content are the challenges we all face today. More dynamic controls and monitoring of the automotive electrical power and signal distribution system will place new demands on current and future PCB-based BEC designs. It is expected that more electronics will be placed in the BEC, which is both a challenge and an opportunity. New solutions, new materials and new designs will require innovation, hard work and very supportive suppliers that know how to make a heavy copper PCB and are willing and ready to understand how that board is going to be used.

It isn't just your dad's old-school radio that has a PCB anymore. The sophisticated vehicle electrical systems of today can be totally dependent upon a printed circuit board. Designs will continue to evolve, but the foundation of the heavy copper, multi-layer, plated through-hole, lead-free PCBs will remain. **PCB**

Christopher A. Brandon is Senior Technical Advisor, Electrical Centers, at Delphi Packard Electrical/Electronic Architecture. He has been involved with Delphi Packard E/EA's electrical center innovations as a product design engineer, manufacturing engineer, process engineer, and test engineer and supervisor. Brandon currently supports the Delphi Electrical Center design and manufacturing operations in China, Europe, South America and North America from the Delphi Mexico Technical Center in Juarez, Mexico.

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More Funky Plating Anomalies, *Part 2*

SUMMARY

Circuit boards covered with stringy nodules? Mushroom plating of copper on critical circuit features? This month, Trouble in Your Tank explores plating anomalies like this and more, along with some causes and remedies.

by Michael Carano
OMG ELECTRONIC CHEMICALS

Surface Roughness

In general, surface roughness is often attributed to particulate matter that is not being filtered from the plating solution. However, unfiltered particulate matter notwithstanding, roughness can be caused by a number of other factors. Some of the many examples of roughness will be shown below, with a brief discussion of its root cause or causes.

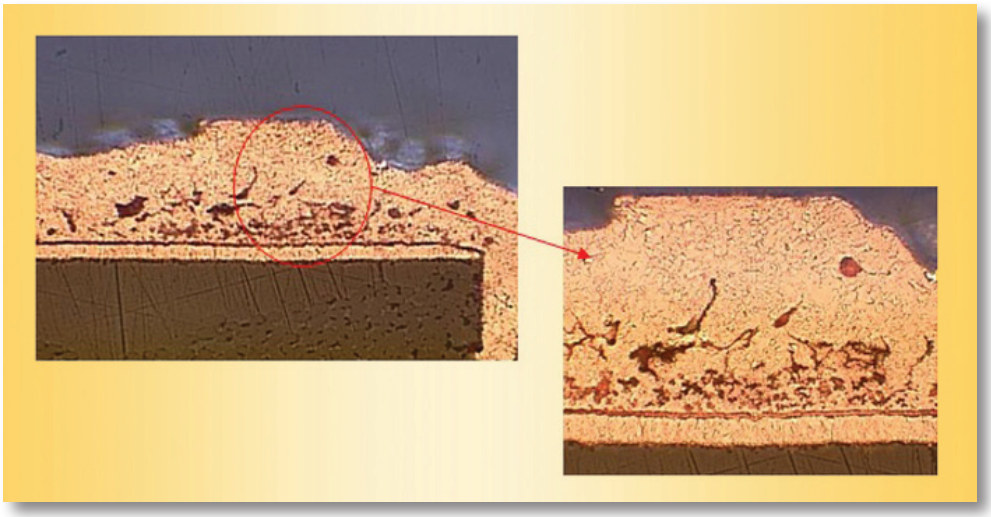

Figure 1: Plated surface of circuit trace showing excessive roughness. Note the residue left on the base copper prior to plating.

Some Examples

In Figure 1, the plated circuit trace is excessively roughened. Upon further examination, it is quite clear that the cause of the rough deposit is due to residues that remained on the surface of the base copper. Perhaps the team should look carefully at all rinsing and filtration steps leading out of the electrolytic copper process.

There is no question that I would be checking for rinse water contamination, a sure place for unfiltered residues. Consider also the quality of the rinsing after resist development. This check should include water cleanliness and temperature.

Figure 2 shows what looks like a raised portion of the electrodeposited copper. This of course should be considered a rough deposit. At first glance, the operators may assign the cause to a low concentration of the organic addition agent. Typically, when that assumption is made, the reaction is to add more organic addition agent to the plating solution. However, that will cause additional harm to the functioning of the plating solution. The key is finding out the origin of this raised portion of the circuit trace as displayed in Figure 2.

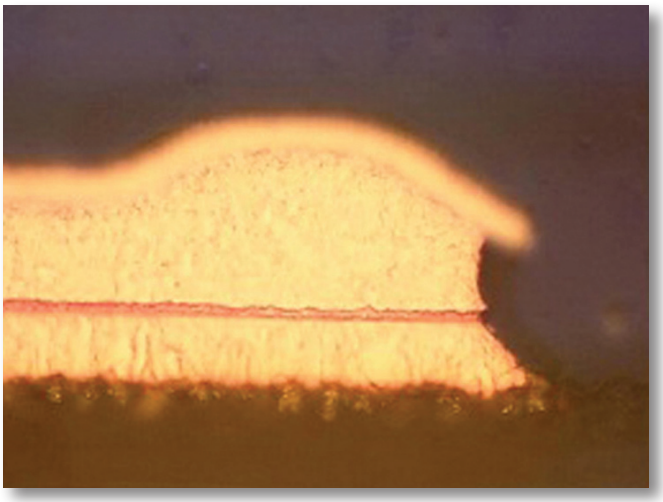

Figure 2: Mushroom plating.

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Figure 3: Close-up view of defect in Figure 2 shows the nucleus of the rough deposit.

Utilizing a finer microsectioning technique, the same section shown in Figure 2 now reveals a nucleus of some sort that leads to the rough plated circuit trace (Figure 3).

Now for something really weird!

On occasion, I get a call from a frantic PCB fabricator describing a situation that could be described as "stringy nodules" or "hairs." Obviously, without first seeing the actual defect, the image this conjures up in my mind can bring about a long brainstorming session as to the root cause of the anomaly. (Not to mention a picture of boxing promoter Don King!)

These stringy nodules usually have their origin in one of three areas:

- Organic contamination in the copper plating solution
- Improper brightener & carrier concentrations
- Improperly filmed anodes

It is unlikely that these stringy nodules are caused by particulate matter floating around in the plating solution unless the copper anodes are not filmed up properly. By that, I mean the success of acid copper plating depends in part on the uniform corrosion of the anodes during electrodeposition. In order to ensure this, the uniform black film must be present on the anodes. This film should not be disturbed once it is formed. If the film is not forming properly, one may expect to see these types of nodules as well as issues related to excessive consumption of the organic addition agents (brighteners, etc.). This will cause the various components of the additives to be out of balance, which will lead to plating anomalies such as stringy nodules and roughness. Figure 5 shows a sample of a copper anode that has the "ideal" anode film.

Again, do not let these plating anomalies go unchecked. If you start to experience anything described here, you have serious

Figure 4: Stringy nodules.

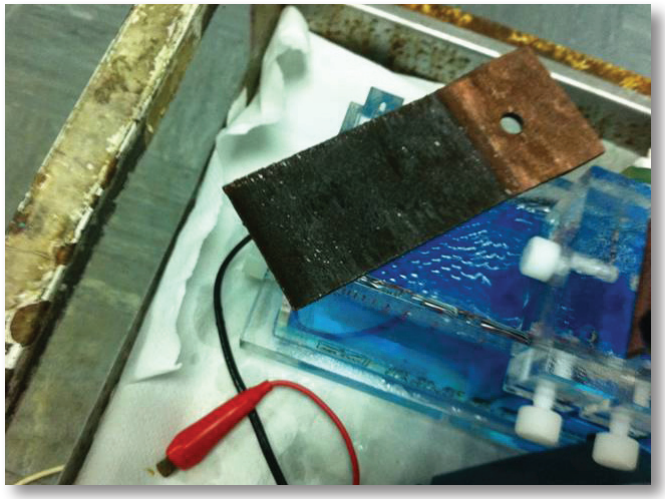

Figure 5: An ideal anode film.

issues in your plating operations. In addition, don't forget to use high-quality copper anodes designed for acid copper electroplating.

The chart below illustrates a summary of the causes of the various anomalies presented in this column.

Debris:
- Poor anode quality
- Poor filtration
- ASF, too low or high
- Particulate material on substrate prior to entering bath, and/or in bath

Residues/Cleaning Issues:
- Poor upstream processing
- Weak pre-cleaning

Strings:
- Organic contamination
- Improper brightener and carrier concentrations
- Improperly filmed anodes

Remember, surface roughness can originate from a number of sources, including organic additive imbalances and improper filming of the copper anodes. Certainly, good troubleshooting starts with a thorough investigation of the plated surfaces, pre-plate conditions and the potential for particulate matter that is for some reason not removed by filtration. **PCB**

Michael Carano is with OMG Electronic Chemicals (formerly Electrochemicals), a developer and provider of processes and materials for the electronics industry supply chain. He has been involved in the PWB, general metal finishing photovoltaic industries for over 29 years. Carano holds nine U.S. patents in topics including plating, metallization processes and PWB fabrication techniques.

SHORT

FINELINE GROUP OPENS FRENCH SUBSIDIARY

Fineline Group, established in 2007 following the merger between Aviv PCB & Technologies (Israel) and Fineline GmBH (Germany), has recently announced the establishment of a subsidiary, Fineline France. The company's growth and success in past years has demanded and resulted in a continuous improvement process aimed at satisfying customer requests.

Fineline Group specializes in PCB development, production and supply. It offers a wide range of products, from single-sided simple boards to 32-layer complex PCB boards and a variety of customized and standard electromechanical and cable parts. The group addresses all customer needs, from customized prototype and sample products to mass production solutions.

With the formation of the new subsidiary, Fineline France is now closer to the French market and is able to provide even better services, such as a French logistic hub, with French company invoicing, as well as quality and customer service support from an experienced technical and commercial French team. The company is led by the Managing Director Angel Fernandez.

The Fineline Group invests heavily in advanced technology and engineering capabilities, providing expert advice and support from the design stage and up to manufacturing. As technology leaders, the Fineline Group provides sophisticated boards for various advanced applications such as aerospace, military, communications and more.

Today, it operates eight subsidiaries and representatives in more than 10 European countries, in addition to Russia, Israel, Southeast Asia and China, where it closely works with its manufacturing partners. During 2010 Fineline Group supplied over US $40 million worth of PCB solutions and has moved more than 350 tons of goods to its customers in the medical, automotive, communication, industrial, aerospace, military and consumer sectors throughout the world.

MILAERO007 Highlights

IPC Conference Tackles IP Security in PCB Designs

The IPC Conference on Securing Intellectual Property Through Physical Security, IT and Regulatory Compliance will examine an issue that's getting increased attention from OEMs and the U.S. Department of Defense.

IPC to Hold ITAR/EAR Compliance Workshop

This two-day workshop focuses on ITAR/EAR Compliance for PCB manufacturers that gives an overview of Export Administration Regulations, the International Traffic in Arms Regulations, and how the export control system influences activities of both domestic and foreign companies.

Bay Area Circuits Completes ITAR Certification

Continually striving to meet the ever-changing demands of PCB manufacturing, Bay Area Circuits, Inc recently obtained ITAR certification as a part of their ongoing quality assurance program.

Cicor PCB Posts 10% Sales Growth in 1H

The net sales of Cicor's PCB division rose by 10.1% against the same period last year, to CHF 19.6 million (first half 2010: CHF 17.8 million). This growth is attributable largely to new orders in the areas of medical technology, aerospace and defense.

Multilayer Technology Completes Transitional Audit

Viny Mulani announced that his company has successfully completed their AS 9100C and ISO 9001:2008 audits. "There is nothing more important to us at Multilayer Technology than quality," said Mulani. "We want our customers to feel completely secure when they buy PCBs from us."

ITL Circuits Receives Nadcap Accreditation

Integrated Technology Ltd. (DBA) ITL Circuits is pleased to announce that it has received Nadcap Accreditation for Electronics for the second year running.

Career Technologies-USA Earns Mil-P-50884 Certification

Career Technologies-USA has earned the Department of Defense Performance Specification MIL-P-50884E, Amendment 1 for Type 4 Flexible Circuits.

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POINT OF VIEW

Delighting Your Customers

SUMMARY

A recent survey showed a vast majority of business owners believing they were fully meeting their customers' needs. However, a subsequent survey of those same customers painted a starkly different picture. Having an inflated perception of your organization's ability to meet customer's needs is common, but presents a problem that must be addressed.

by Steven Williams

Understanding your customers may seem like a no-brainer, but a recent survey reveals just how frequently this is not the case. Of the 350 companies surveyed, 80% believed they were fully meeting all of their customer's needs. However, when the customers of these firms were then surveyed, the results showed that the customers only rated 8% of their suppliers as truly delivering a superior value to them. Having an inflated perception of your own organization's ability to meet customer's needs is common, but a gap of this magnitude signals a very serious problem that needs to be fixed, and fixed quickly.

Delighting the Customer

I use this term frequently because, frankly, I firmly believe in it. *Delighting the customer* means exceeding their expectations, not just meeting them. Organizations spend a great deal of money in time and resources on strategic planning to develop the short and long-term goals that will guide the company going forward. It never ceases to amaze me how often these goals and plans are developed without any input from the customer base. The term customer service is quickly being replaced in today's business environment with customer excellence.

One could argue that all organizational activities revolve around satisfying the customer, and true world-class companies are no longer guessing what satisfies their customers; they are actively soliciting feedback and listening to their customer's expectations.

Talk to Your Customers

During a recent visit of a manufacturing company, the discussion turned to evolving technology, and what this company's plans were. The general manager, an ex-naval commander, said to me, "Anticipating what future needs our customers will have is the biggest challenge we face." When I asked what their process was for understanding this, the answer was, "We are very reactive; we develop new technologies, processes or products only after a customer, or customers, express a need for it."

Being on the technological "bleeding edge" and accepting the financial risk that comes along with it is not for everyone; however, you do not want to neglect customer needs and jeopardize the value proposition your company presents. Although the *if we build it they will come* philosophy can be financially prohibitive in the capital-intensive PCB manufacturing industry, there are proactive methods to understand future requirements that will prevent science projects and focus on real customer needs.

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I asked the commander if he had ever heard of Tom Peters, one of my favorite business consultants and author of the "Excellence" series of books. When he said no, I relayed a story that Mr. Peters told during a speaking engagement I happened to be attending. He was talking about interviewing the owner of a company that excelled in delighting the customer. When asked what his secret recipe was, the owner responded, "We have discovered a very rare and complicated method to fully understand the needs of our customers; we actually talk to them!"

Listen to Your Customers

This story has always stuck with me, and I could see from the commander's face that it resonated with him as well. Referring to the previously mentioned survey, clearly the question is not what is wrong with the 92% of those companies; the key question is what's right with the 8%? The answer is painfully simple: they listen to their customers.

As I have said many times before, you may in fact be a world-class organization, but if your customers don't perceive you that way, it doesn't really matter. As the survey shows, it's extremely easy for a company to assume they're keeping their customers happy. The challenge is in the ability to transform organizational culture into one that is driven by its customer's true needs. No level of performance is sustainable without an occasional adjustment, and the appropriate adjustment in strategy can only be developed after measuring your customers' perceptions. Customer satisfaction is like any other process, and as I am known to say frequently, you can't improve what you haven't measured. The key takeaway here is that, to quote Tom Peters again, "Perception is reality."

Take Action

Whatever *voice of the customer* (VoC) method is used for soliciting feedback (face-to-face, survey, quarterly business review, etc.), action needs to be taken on what is learned. This may sound simple, but many times a company will implement a VoC program, gather and review the data, and let the process

end there. The summary data needs to be presented to a senior-level management group, actions assigned and progress monitored throughout the year, tying out into subsequent customer feedback to assess effectiveness. The intent should be to capture your customer's perceptions of key areas of weaknesses (and strengths), and develop an action plan to improve (and capitalize) on them.

Although Tom Peters didn't coin this quote, he uses it frequently when he speaks to companies on delighting the customer, and it is just as appropriate today as it was 500 years ago:

"The greatest danger for most of us is not that our aim is too high and we miss it, but that it is too low and we reach it." —Michelangelo **PCB**

Steven Williams is a 35-year veteran in the electronics industry and an authority on manufacturing and management. He is currently the commodity manager for a large global EMS provider, a distinguished faculty member at several Universities and author of the book *Survival Is Not Mandatory: 10 Things Every CEO Should Know About Lean* (www.survivalisnotmandatory.com).

Dieter Bergman Talks Standards With Bob Neves

by Real Time with...IPC Midwest 2011

Bergman recaps the history that led to current IPC standards for data transfer technology, and interest in adopting generic standards in the future.

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VIDEO INTERVIEW

US CLOUD-BASED BUSINESS APPS MARKET TO TRIPLE BY 2015

Cloud-based business applications are garnering considerable attention from US small and medium businesses (SMBs). According to AMI-Partners' latest US SMB Cloud Services Study, the software-as-a-service customer relationship management (or, SaaS CRM) market, already representing 570,000 US SMB firms, is set to undergo double-digit year-over-year growth in the next five years. During this period, spending on SaaS CRM will outpace on-premise CRM by a margin of nearly four to one.

The advent of cloud services has changed the US SMB landscape tremendously and has allowed small and medium-size firms to acquire enterprise-class solutions such as CRM, at significantly less total cost of ownership (TCO). In the past, customer management has been a prime business concern for these SMBs—especially in light of the recent effects of the slow economy. Customer retention and acquisition have been a prioritized investment area for many SMBs who are still enduring business setbacks.

"Customer engagement on social networking sites," said Jacqueline Atkinson, research manager at AMI-Partners, "is driving SMBs to pay closer attention to their social communities. But it is the influence of the cloud that affects their decision to adopt more advanced customer solutions."

"Such market trends are creating the right conditions for the integration of social media with CRM applications for enhanced interactions with customers. In fact, US SMB CRM users are a third more likely to engage in social media activities for business than firms who do not use CRM," Atkinson continued.

Like traditional CRM applications, social CRM solutions are back-end processes that efficiently allow companies to analyze customer-related data extracted from social networking sites. Many social CRM solutions provide user-friendly tools to help businesses "listen" to online conversations and communicate more effectively with customers. Atkinson went on to say that more and more SMBs are attempting to attract and retain customers over social media channels.

SHORT

Growth Opportunities in Automotive Electronics

by Brice Esplin
DATABEANS, INC.

SUMMARY

Even in light of world economy fluctuations, the semiconductor market for automotive applications is expected to grow rapidly in the next five years, due to increased call for both electric and hybrid vehicles, as well as the demand for more complex electronics in traditional internal combustion vehicles.

Despite recessional fear, the automotive semiconductor market is growing almost twice as fast as the overall semiconductor market. Research firm Databeans Inc. forecasts that semiconductors in automotive applications will experience a nine percent compound annual growth rate over the next five years. This brings the current $25 billion market to about $40 billion in 2016 (Figure 1).

The regional update for automotive electronics has Europe finishing the year with 32% of the revenue, followed by Japan and the Asia-Pacific region. Like many other application markets, Asia-Pacific exhibits the highest growth numbers with a 14% average annual growth rate. Automotive Electronics are gaining share in the overall high-technology market thanks to consumer demand for added technology and features in new vehicles, the transition to hybrid and electric vehicles and government-mandated requirements that all new vehicles be equipped with the latest safety features and environmental controls.

Vehicle manufacturers are beginning to integrate infotainment devices, once only available in luxury cars, into most new vehicles. These devices combine many common car options into a single, more expensive unit that features audio integration, navigation and climate control. Currently, the technology leaders are Renesas with its R-Car E1 chip, Freescale with its i.MX application processors and STMicroelectronics with Cartesio.

The entertainment systems are similar to what is found in portable devices. For example, Toyota and Hyundai are collaborating on a system that combines a wide variety of Internet services, including Internet radio, social networking sites, texting and e-mail programs, along with Google maps and a built-

“ Vehicle manufacturers are beginning to integrate infotainment devices, once only available in luxury cars, into most new vehicles. ”

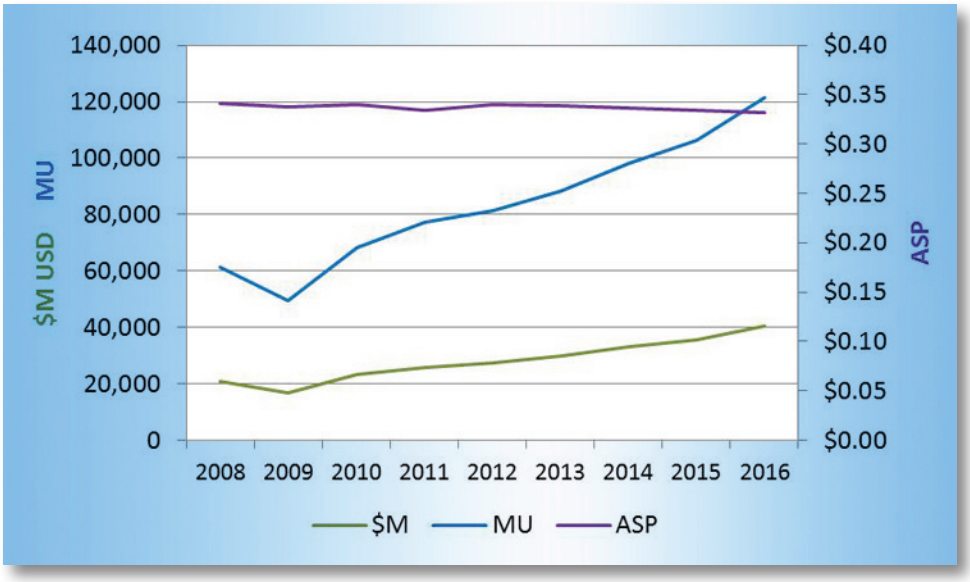

Figure 1: Worldwide automotive semiconductor market Forecast. (databeans Estimates)

in safety system that automatically notifies first responders in the case of an emergency.

Databeans also sees the demand for electric vehicles and hybrids growing rapidly in the near future. Currently, there are approximately two million electric vehicles and hybrids worldwide, compared to 64 million internal combustion vehicles. That equates to roughly three percent of the entire new automobile market consisting of electric and hybrid vehicles. That small percentage of EVs and HVs is expected to increase to more than 10 million, or about 14% of the total market, by the end of 2016 (Figure 2).

There is a large opportunity for suppliers with low-power consumption chips to be used in electric vehicles. Because EV vehicles do not possess an alternator to power the onboard electronics, low-power semiconductors will receive sockets in future EVs. NXP with their CAN partial networking system made a huge breakthrough recently. This system automatically diverts power when needed and increases power efficiency.

EVs also still have room for improved inverter/converter systems and charging stations. When all these pure electric vehicles hit the road, they will need charging stations in abundance. Suppliers will want to jump on board with the recharge station components, which will be focused on heat dissipation and fast charging times, among other things.

The automotive industry has also been favoring the sensors and MEMs segment due to new government regulations worldwide. Many of these regulations mandate safety systems to monitor different aspects of a vehicle. In Databeans newest automotive market tracker, revenue for the safety application segment of the automotive semiconductors is growing nine percent on average over the next five years. Airbags receive the largest revenue share in the sensors safety segment, with 40% and $429 million (Figure 3). There is also a growing focus on the development of electronic controls on doors, windows,

000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	CAGR%	11/10
North America	322	257	309	385	536	632	885	1,271	1,757	35%	25%
South America	62	58	70	92	114	145	193	296	501	40%	31%
ECU	402	344	420	549	689	892	1,166	1,680	2,588	36%	31%
Other Europe	102	83	104	135	171	210	273	391	604	35%	30%
Asia	518	520	687	878	1,274	1,664	2,251	3,375	5,144	42%	28%
ROW	9	8	10	11	16	18	31	47	56	38%	14%
Total	**1,415**	**1,270**	**1,600**	**2,050**	**2,800**	**3,560**	**4,800**	**7,060**	**10,650**	**39%**	**28%**

Figure 2.

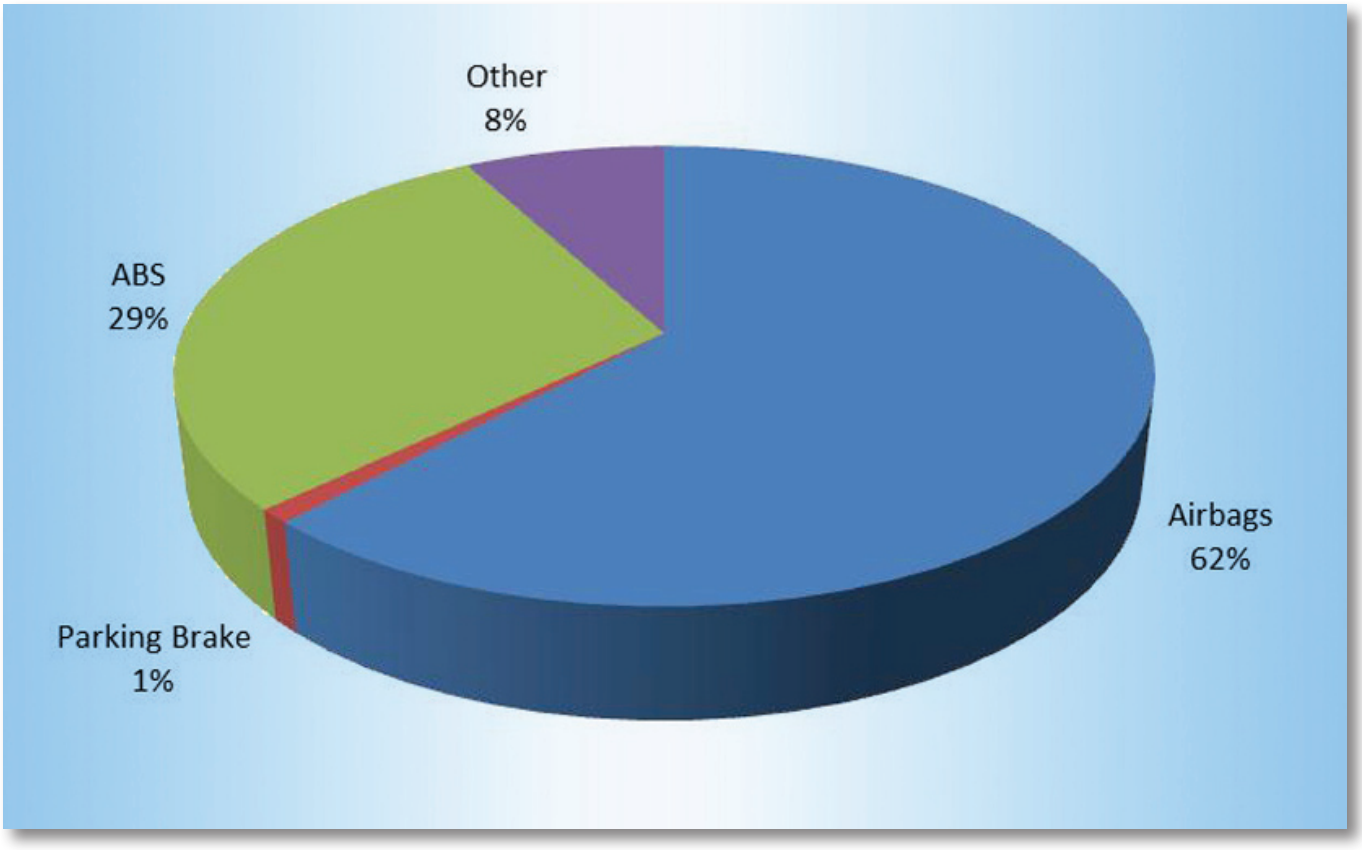

Figure 3: 2011 Worldwide Automotive Safety System Sensors Revenue Share by Application. (databeans Estimates)

wipers and roofs by way of more sophisticated electronic control units, and the use of sensors that provide data on changes to lighting conditions and the presence of precipitation.

Concerning supplier market share, the automotive semiconductors market is highly diverse, with not a single supplier capturing more than a nine percent revenue share. This high level of competition paired with strong governmental influence has been advancing the automotive electronics industry to new heights. Suppliers are focused on lowering cost and still maintaining pace with the next generation technologies. The most notable gains will benefit suppliers with low-power microcontrollers, SoCs, embedded processors and sensors or MEMs devices.

Far on the horizon, there may be some growth for networking ICs in the automotive industry. At the 2011 National Highway Traffic Safety Administration Conference there was some excitement regarding the latest safety technology that involves radar detection and wireless car-to-car communications. The test vehicles demonstrated a system developed by Ford that enables vehicles to avoid collisions by intelligently detecting potential hazards and then communicating that information both to a driver and to other vehicles. Technologies like this, which become backed by world government regulations, will be the moneymakers in automotive electronics. **PCB**

Brice Esplin is the marketing manager for Databeans Inc., a market research firm focused on the semiconductor and electronics industry, and a comprehensive source of information throughout semiconductor product categories and markets. For more information, contact Brice@databeans.net.

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GUEST COLUMN

Boeing, Boeing… Gone!

SUMMARY

"I don't like labor unions. I believe they are bad for business—period. Their time has come and gone in North America, at least for private sector, non-regulated business—which is most of us."

by Marcy LaRont
I-CONNECT007

I want to thank Steve Williams for his recent article, featured in MilAero007 and the August issue of The PCB Magazine: POV: The Beginning of the End for American Manufacturing. In it, he discusses Boeing's plans to open a new manufacturing facility in South Carolina—a "right-to-work" state, as well as the ridiculous lawsuit filed by the National Labor Relations Board (NLRB), which cites Boeing's decision to expand as unlawful due to its punitive nature for Boeing's Washington State employees (the location of their existing manufacturing facility).

I don't know if it was ever even on the table that Boeing might expand its Washington site, but it doesn't really matter. It is worth mentioning however, that, to my knowledge, there has been nothing said at this point to indicate that Washington stands to lose any existing Boeing jobs because of the new South Carolina facility. Of course, this remains to be seen.

Boeing employees in Washington have waged several strikes over the past few years, not the least of which was a lengthy debacle in 2008, during one of the worst economies on record. As a result, Boeing suffered significant losses. In a CNN Special Report by Chris Isidore dated September 12, 2008, he writes the following,

"A week ago, there was one sector of the battered U.S. economy that was performing particularly well—aerospace manufacturing. But, the strike at Boeing by the International Association of Machinists has changed that. With the dominant company in the field ground to a halt, the aerospace business has at least temporarily joined autos, home construction, airlines and financial services as industries acting as a drag on the overall economy."

I don't like labor unions. I believe they are bad for business—period. Their time has come and gone in North America, at least for private sector, non-regulated business—which is most of us. I come by my perspective on this controversial subject honestly. I grew up the daughter of a small business owner (a nine-man architectural firm, at its busiest) for whom it was always a struggle to meet all of the regulation, taxation and stipulations required of even the smallest of businesses—so much so that, finally, my father decided to go back to being a one-man shop. He stayed as such to retirement. Labor unions were, of course, not something my father had to contend with in his business. He opted for "no growth/low growth" business model, eventually letting all of his employees go, as this was his best chance at remaining profitable and making a good living for his family. That was his business decision and it was a good one.

Now, I realize that my father's small business and limited financial resources are a poor comparison to a corporation such as Boeing. However, at the end of the day, all businesses are equal in that they must

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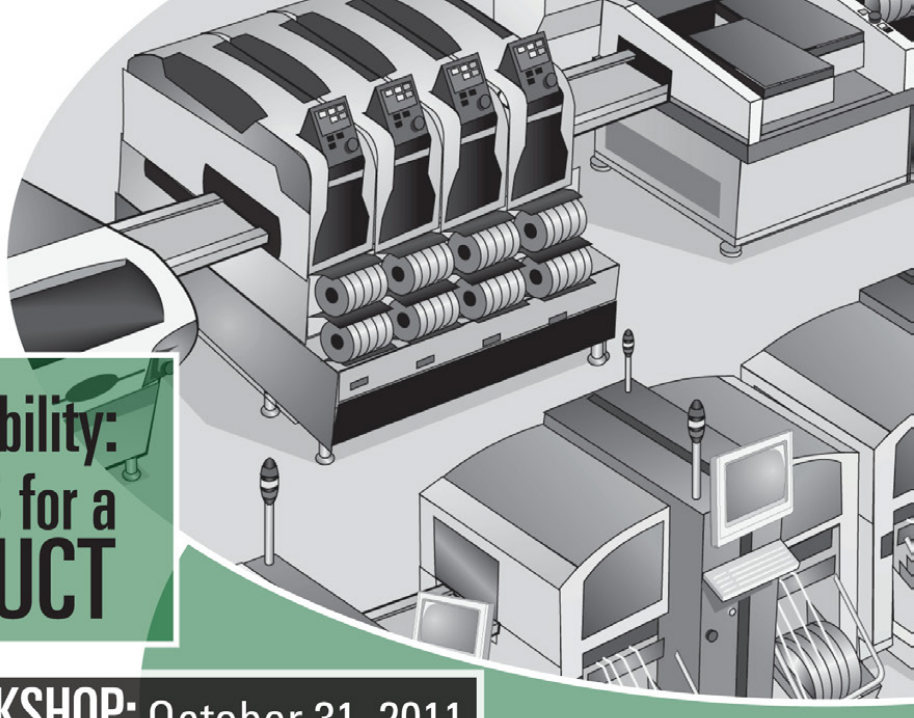

IPC Conference on Reliability: ASSEMBLY PROCESS for a RELIABLE PRODUCT

LEAD-FREE RELIABILITY WORKSHOP: October 31, 2011
CONFERENCE: November 1–2, 2011
Irvine, Calif.

LEAD-FREE RELIABILITY WORKSHOP

- Learn about issues that can arise during the transition to lead-free
- Hear the latest research on mitigating risk based on product's design, materials, complexity, volumes and customer expectations of reliability

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CONFERENCE

- Learn reliability issues at the assembly level
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eventually perform to profitability, or they will falter (unless, they are subsidized by the government, which is an entirely different discussion). What we have all experienced in our local, national and global economies these past four years has certainly underscored this business truth beyond all reasonable doubt. Because of this truth, businesses must make decisions about growth, logistics, hiring and lay-offs that create the best possible chance for that entity's profitability, growth and ultimately, their survival. These decisions are not always popular, but they are, most certainly, within the jurisdiction of the company making them—dare I say—for better or for worse. I absolutely believe Boeing's decision to expand into South Carolina is a completely sound and reasonable business decision for many reasons that include state provided incentives meant to draw businesses to South Carolina and a cheaper labor force.

Perhaps my simple-mindedness with regard to unions is due to never having worked for a company that didn't actually care what its employees thought or felt. Each of my employers over the past 20+ years in and around the PCB manufacturing industry truly did (and still does) want their employees to be happy working for them. (For the record, one of these companies could be considered a relatively large corporation, with $1B in sales before the crash of 2000—and they cared too.)

The majority of American companies—and I would even venture to broaden that statement to most companies, outside of America as well—want their employees to enjoy coming to work, to have a career growth path and longevity within the company, to achieve their personal and financial goals and to meet their family's needs. Perhaps I have been very fortunate in this regard; but that's the thing… I don't think so.

For instance, Endicott Interconnect in New York was just in the paper for recognizing the recipients of their annual employee college scholarship awards. Several Endicott employees' kids got college assistance through a very admirable and much appreciated scholarship program, which the company created to help families with the heavy burden of college tuition. I myself was the fortunate beneficiary of a similar program more than two decades ago, when my mom worked for Hewlett Packard. Most companies want to be great places to work. I don't just believe this is true. As Oprah would say, it is "something I know for sure." More to the point, they don't need outside groups telling them how they must go about making that happen.

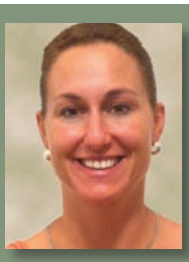
Another simple business and life truism is that most Americans will almost always choose working over not working, and most of us are more comfortable and confident relying on ourselves and our abilities to influence our own destinies, than we are having anyone else represent us. Quite simply, no one has my best interest at heart better than I do, and no one knows what is best for me better than I do. To suggest anything else is offensive. I don't want representation. I will represent myself, thank you very much.

The one thing I will give the labor unions is their collective bargaining power in regard to procuring the best, most affordable health insurance for their members. That is a great thing, to be sure. But with collective bargaining open to more of the private business sector, allowing groups of companies to band together in search of the best, most affordable health care options for their employees, even this serves to underscore my opinion that the time when labor unions were

"needed" in modern American society is over.

So what is to happen with a case like Boeing, with all of its frightening ramifications for business at large? My faith, and only slightly wavering belief in America and our imperfect capitalist system gives me hope that the right and just outcome will prevail—which is, in this humble business person's/employee's/offspring of a business owners' opinion, that the NLRB case will be thrown out of court for lack of grounds; Boeing will, in fact, open its manufacturing plant in South Carolina, thus providing 3,800 jobs to its economy. (Note: In July, the last reportable month by the Bureau of Labor Statistics at the time this article was written, North Carolina was among 10 states in the U.S. who showed a measurable increase in unemployment.)

Washington's loss is South Carolina's gain. And that, my friends, is capitalism at work—and working as it should, if you ask me. **PCB**



Marcy McAllister LaRont has worked in the PCB industry for more than twenty years, and has held positions in EH&S, purchasing, production control, customer service and sales. Prior to joining the I-Connect007 team in 2005, she worked for Data Circuits (Merix), Trend Circuits/Praegitzer Industries, and Hadco/Sanmina-SCI. LaRont currently resides in Hong Kong. Contact LaRont at marcy@iconnect007.com.

IPC SEEKS ABSTRACTS FOR PAPER COMPETITION

Association Connecting Electronics Industries® invites accredited U.S. and international colleges and universities with a strong focus on the electronics industry to submit paper abstracts for IPC's International Academic Paper Competition. The authors of the top three papers will be invited to present their research at a special session at IPC APEX Expo, the industry's premier conference on electronics manufacturing, February 28-March 1, 2012, in San Diego, California.

The International Academic Paper Competition presents an exceptional opportunity for international visibility and recognition and a unique opportunity for close interaction and communication between academic research programs and companies in electronics assembly and PCB manufacturing and design.

Paper submissions will be accepted on design, materials, processes and equipment, in the following areas, or related areas (see box at right).

Abstracts of 100 to 300 words that summarize technical and previously unpublished, non-commercial work covering case histories, research and discoveries must be submitted by one researcher on behalf of an accredited college or university and be received by December 15, 2011.

Abstracts will be judged by an IPC blue ribbon committee and the top three papers will be selected.

- Advanced Technology
- Area Array/Flip Chip/0201
- Assembly Processes
- BGA Packaging
- Black Pad
- Business & Supply Chain Issues
- Counterfeit Electronics
- Design
- Electromigration
- Electronics Manufacturing Services
- Embedded Passive & Active Devices
- Environmental Compliance
- Factory Automation
- Flexible Circuitry
- HDI Technologies
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IPC will provide the primary author/researcher of each of the top three papers with airfare allowance to present his/her paper at IPC APEX Expo, complimentary hotel accommodations and technical conference registration at no charge.

For complete details, visit www.IPCAPEXExpo.org/academic.

SHORT

How to Address the Key Barriers to the Widespread Acceptance of E-vehicles

by Ishan Palit, *CEO*
TÜV SÜD PRODUCT SERVICE DIVISION

SUMMARY

In the last five years, the popularity of e-vehicles has rapidly gathered pace, buoyed by the introduction of government incentives and concerns about the availability of oil and the world's burgeoning carbon footprint. Bloomberg New Energy Finance believes electric hybrid cars could account for nine percent of total U.S. auto sales by 2020 and 22 percent by 2030.

According to Pike Research, a trend toward awareness, manufacture and usage of e-vehicles will only intensify. A recent report[1] from the firm predicts 3.2 million electric vehicles and plug-in hybrid electric vehicles, such as Nissan Motor Co.'s Leaf model and General Motors Co.'s Volt, will be sold between 2010 and 2015 with a compound annual growth rate of 106%. Projections from Bloomberg New Energy Finance echo these sentiments. It believes plug-in electric hybrid cars could account for nine percent of total U.S. auto sales by 2020 and 22% by 2030.

These figures are unquestionably impressive and undeniably important, considering 19% of global energy use and 23 percent of energy-related carbon dioxide emissions are currently attributable to transportation[2]. However, with the world's automotive services geared towards supporting the 800 million fuel-powered vehicles that currently travel our roads, transportation needs set to increase and escalating concerns from consumers around their practicality, mass use of e-vehicles are still some way off from becoming a reality.

Growing Pains

I agree with Pike Research and Bloomberg New Energy Finance in that the potential for e-mobility is tremendous, bearing in mind demand and choice are rising, cost is falling and the target market is getting bigger by the day. However, as with all innovative new products destined for widespread use, this cocktail of ingredients is rarely enough for success. In the case of e-mobility, it requires an extra dose of education, affordability and

“ Reducing battery prices to levels of economic viability is therefore a primary goal for electric vehicle manufacturers—especially because the more prices fall while fuel prices rise, the more economical e-cars become. ”

transparency regarding performance. The current lack of an adequate battery-charging infrastructure, notably smart grids, is a cause for concern.

Education

The introduction of electric power for on-road vehicles brings a sea change in technology to the automotive sector. High-voltage components, for example, are required not only in engine and battery components but in all of the electronic controls. Unfortunately, such technologies come with potentially lethal risks. Education in high-voltage safety and handling of lithium-ion batteries is therefore imperative for anyone that encounters e-vehicles on a regular basis, including staff at manufacturing plants, consumers, service providers, workshop mechanics and the emergency services.

Proficient training courses in handling such issues are already available in the Asia Pacific region from accredited third-party providers. Adoption, however, is severely lagging behind the uptake in electric vehicles. In my view, this is due to a lack of awareness and/or shared responsibility from the industry’s major stakeholders. This must change quickly if manufacturers are to achieve growth targets and governments are to reach carbon emission goals. For example, if mechanics in garages or paramedics in ambulances are ill-equipped with the knowledge of how to handle, safely and effectively, high-voltage components in e-vehicles the consequences could be severe and the repercussions long-lived.

The issue lies in the fact that the majority of parties that come into contact with e-vehicles are often consumers, small businesses or small government departments with budgets that restrict their personal ability to take the appropriate action. Moving forward, I would like to see accountability for education tackled collectively by major stakeholders and ahead of the curve.

Cost

According to Bloomberg New Energy Finance, the price of electric cars is more than three-quarters that of their petrol/diesel counterparts[3]. This is primarily due to the high costs of production of efficient, effective and reliable batteries. Reducing battery prices to levels of economic viability is therefore a primary goal for electric vehicle manufacturers—especially because the more prices fall while fuel prices rise, the more economical e-cars become.

Manufacturing batteries at lower costs, however, has been a significant challenge for battery manufacturers for some time. In addition, while battery technology is slowly advancing it is unlikely that significant cost reductions will be realised for some years. Immediate solutions must therefore be sought in tandem, the most achievable of which is securing a second life for used batteries and extending their value.

At present, TÜV SÜD is developing the methodologies for the evaluation of retired batteries with the aim of establishing whether they could potentially be used as energy storage devices in green buildings. In theory, the added value this would bring to batteries would help manufacturers, or even consumers, recoup a significant proportion of their up-front costs.

Range

Aside from cost, one of the greatest concerns from consumers regarding e-vehicles is their range (i.e., the distance they can travel without needing to be recharged). A survey of motorists carried out by TÜV SÜD in 2009

revealed that while most people are open-minded and have a positive attitude towards e-mobility, 36% would only consider buying an electrically-powered car if a range of 300 km was guaranteed. This distance may be achievable by some e-vehicles, but they are few and far between, and the elephant in the room is consistency, especially during extreme internal and external conditions like low temperatures.

In December 2010, we introduced a new standard for determining the range of e-cars, named the TÜV SÜD E-Car Cycle (TSECC), which was the first to take into account such effects. Its first comparative test delivered dramatic results. One e-car that was tested was deemed to have a range of 133 kilometres when determined in accordance with the legal test cycle defined in ECE-R101 at 23°C and without additional power consumption. However, when based on the TSECC (carried out also at 23 degrees, but at a more realistic speed profile), the same car was revealed to have a range of just 113 kilometres. At the subzero temperatures, the situation for EVs seems to be more critical since, contrary to the internal combustion engine using the waste heat to warm up the passenger compartment, the EVs should be equipped with a separate heating system, often taking the energy from the traction batteries. At -7°C, and when the heating and additional power consumers were turned on, the range dropped to a meager 64 kilometres.

If consumers are going to not only buy, but also enjoy e-vehicles and increase sales through word of mouth, improved accuracy and transparency around range is imperative. It only takes a few customers to be left stranded tens of kilometres from home with no charging stations in the vicinity to spark outrage. The consequences of this should not be underestimated. In today's digital world, everyone has a voice. Moreover, one voice can quickly multiply into many.

To Conclude

I firmly believe that electric vehicles are our future—they have the potential to appease the world's appetite for green products and services and, more importantly, significantly reduce our carbon footprint and our dependence on energy imports. However, the key to their success will be dependent on the diligence and patience of the industry's major stakeholders. It is not about speed to market, it is about getting it right. **PCB**

Ishan Palit is CEO of TÜV SÜD Product Service Division and responsible for the corporate and strategic direction of the Division worldwide. He joined TÜV SÜD Group more than 15 years ago as General Manager for Indian Operations. TÜV SÜD is a global solution provider for product quality and safety testing & inspections, engineering support, management system certification and training solutions. More information is available at www.tuv-sud.com.

SUPPLIER/NEW PRODUCT Highlights

PCB Plasma System Integrates Two Key Technologies

Plasma Etch, Inc. has introduced a low-cost PCB plasma system utilizing two key technological patents developed by Plasma Etch, that when combined produce superior results, including the fastest etch rates and cycle times.

Polar Launches Speedflex HDI

Polar has launched Speedflex HDI, a new flex-rigid and HDI stackup design and documentation system. Now, designers and fabricators can fully explore how different combinations of materials, will affect the cost and performance of the finished PCB.

Wrekin Circuits Employs Taiyo Solder Mask, Inkjet Legend

Wrekin Circuits of Telford has converted their solder mask and inkjet legend ink to Taiyo. The West Midlands-based company has recently installed a new state of the art Orbotech Sprint 8 legend printer running Taiyo's IJR4000 MW300 inkjet ink.

Shocking Tech Raises Investment for ESD Solutions

Shocking Technologies, Inc. has raised $15.2 million in a strategic investment round. The backers include Littelfuse, Inc., Arch Ventures, ATA Ventures, Balch Hill Capital, Skylake Incuvest, Vista Ventures and a number of private investors.

Merlin Flex-Ability Installs New Laser Process

Further investment by the Falcon PCB group in its Merlin Flex-Ability Hartlepool facility continues with the installation of a LPKF MicroLine Laser Drill 600.

Atotech's EDEN & Tricotect Receive Award

The Total Ecosolutions Award was recently given to Atotech's EDEN - Electrodialysis System (Electroless Nickel), and Tricotect Regeneration System (Corrosion Resistant Coatings).

RBP Introduces E-cleanDF Acid Equipment Cleaner

RBP Chemical Technology has introduced E-cleanDF, a new acid equipment cleaner designed for use with photoresist developers and strippers.

ICD Releases HDI Designer Edition of Stackup Planner

It is common to have differential DDR2 clocks, USB pairs and PCI express pairs all sharing the same layers on HDI boards. Until now, the user had to calculate each impedance separately. In-Circuit Design Pty Ltd has released a new version of the ICD Stackup Planner—the HDI Designer Edition—that now addresses these issues.

FLEXcon Launches New THERMLfilm Product Line

FLEXcon, an innovator in adhesive coating and laminating, recently announced the launch of THERMLfilm HT, a new advanced line of high-temperature polyimide films able to withstand the fluctuating temperatures, abrasion and chemicals inherent in the PCB manufacturing process.

Don't Shoot the Messenger: Make Your Quality Meetings Fun!

by Gray McQuarrie

SUMMARY

Quality meetings are about hiding, fear and survival. Who wants to be the messenger that dares speak the truth, only to be shot? The truth is, in some way we all contribute to the problems in our company. Our work lives will improve dramatically when we accept this fact and stop shooting the messenger.

I don't know of a single person who enjoys quality meetings. Why? Because nobody wants to be shot! Quality meetings are about hiding, fear and survival. Want to be shot? Then be the messenger that dares speak the truth. Quality meetings are a witch-hunt to find bad people. Eliminate them, set the example and voilà, no more problems! But, where are they? Hiding behind their story. Who wants to stand up, just to then get shot? If you want to wipe out all problems, blow up the planet. No people, no problems.

One choice only!		Problems Good or Bad?	
		Bad	Good
Your search?	The Truth	#2	#1
	Your Answer	#4	#3

Table 1.

The truth is, in some way we all contribute to the problems in our company. Our work lives will improve dramatically when we accept this truth and stop shooting the messenger. We need a new mindset. Wait; let me state this in a stronger way. We need a new culture in our industry in this country.

Louis Gerstner said, "I came to see, in my time at IBM, that culture isn't just one aspect of the game—it is the game." Table 1 shows the choices we have. Which box are you operating in? If it is Box 4, then you will have a culture where problems are bad and you want immediate answers. In this culture, fear will dominate and the truth is buried. Your company will be under a high degree of competitive pressure. You will lose customers.

Consider Box 1, where problems are good and people are on a quest to find the truth. In this culture, people will work together, learn and grow. People will find and deal with the truth with a high degree of emotional intelligence. Your customers will be happy because they will be the beneficiaries of your discovery and growth. Your business will thrive. Box 1 needs to be the goal for our industry in this country. In fact, at the end of the day, our quality meetings should be about success, not punishment. They should be (dare I say) fun!

Where do we start? Start with how we present data in our quality meetings. For example, average yield data is meaningless because averaging hides the truth! Let me explain. Consider Figure 1.

Figure 1 shows the average lot yield for Jobs A through O. You can pretty much tell any story you like with this data. If asked about Job E, just say, "it was a bad operator this month. We fired him." Or, "A press went down. We fixed it." Or, "There was a power outage. It was beyond our control." Just throw out the usual suspects. In other words, the story is important, not the truth. Since we want to change our culture and find the truth, then we need a better way to present our data. I have highlighted with red diamonds four jobs for us to consider. By focusing on these four jobs, we will discover that less is more.

Let's get started by developing a relative metric so we can compare the relative complexity of the different jobs. What's happened in our decades of being exposed to quality training like TQM and Six Sigma is that the emphasis on absolute precise metrics has

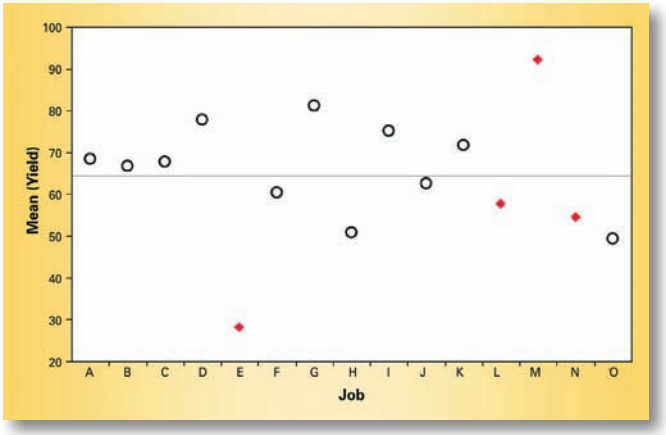

Figure 1.

robbed us of our most important innate skill: making relative comparisons and developing relative metrics. Our ability to detect slight differences in shades of color is an excellent example. Does it matter if we are accurate? No. Not only that, this ability to detect relative differences has been key to our survival. An example of an important relative metric is the Reynolds number in fluid mechanics. It is unitless. Accuracy and precision aren't important. It is all about comparisons. It is used to comparing how different solutions will flow through a given conduit design. What we need for our yield data is a similar unitless relative metric to compare the complexity of Jobs A through O.

Lets' start with board design. Suppose the range of lines we accept in the shop is from 1.5 mil to 5 mil. Let's assign the number 10 for the 1.5-mil line and the number 1 for the 5-mil line. Here, 10 is hard and 1 and easy. We can then interpolate to get a rating for different line widths. Consider the diameter of the hole. Let's say our smallest hole is a 2.5-mil diameter and our biggest hole is a 6-mil diameter. Anything above this is considered very easy to accomplish. So the range we choose for the scale has to be a within a range where we begin to have difficulty, all the way to where we are severely challenged, but still a part of normal production.

So again, a 2.5-mil diameter hole would be 10- and a 6-mil diameter or above would be 1. Let's say we have a board with a 1.5-mil line and 4.25-mil diameter hole. What would be the relative rating for the design complexity of this board? The 1.5-mil line would be a rating of 10 and the 4.25-mil diameter hole would be 5. Taking the average, we come up with 7.5. We can continue in this way for the other design parameters that include aspect ratios, total number of drilled holes, total number of blind vias, cavities, etc.

We can do the same thing with process parameters. Let's say our board can have as many as four sequential laminations, to having zero laminations. In this case, four laminations would be 10 and the zero lamination would be 1. In the same way with design you can include a number of process parameters, such as number of times the board needs to be imaged, the number of times it is routed through the drill room, whether special handling is involved through the etcher, etc.

The way you would combine the design with the process would be to multiply them. For example, if you had a relative rating of 7.5 for the design and a relative rating of 5 for the process, the overall combined rating, or the complexity rating design x process, would be 37.5.

Now for the fun part. Let's plot the data in Figure 1, not as an average of all of the lots, but use each of the individual lot yields and plot this data as a function of relative complexity. What do you think you will see? Figure 2 shows the plot.

In this figure, we have the jobs as before—E, L, M, N—which are shown by red diamonds. Often, a plant manager, operating

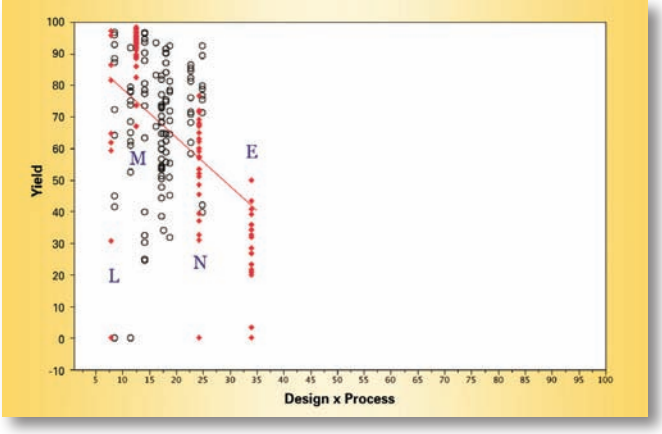

Figure 2.

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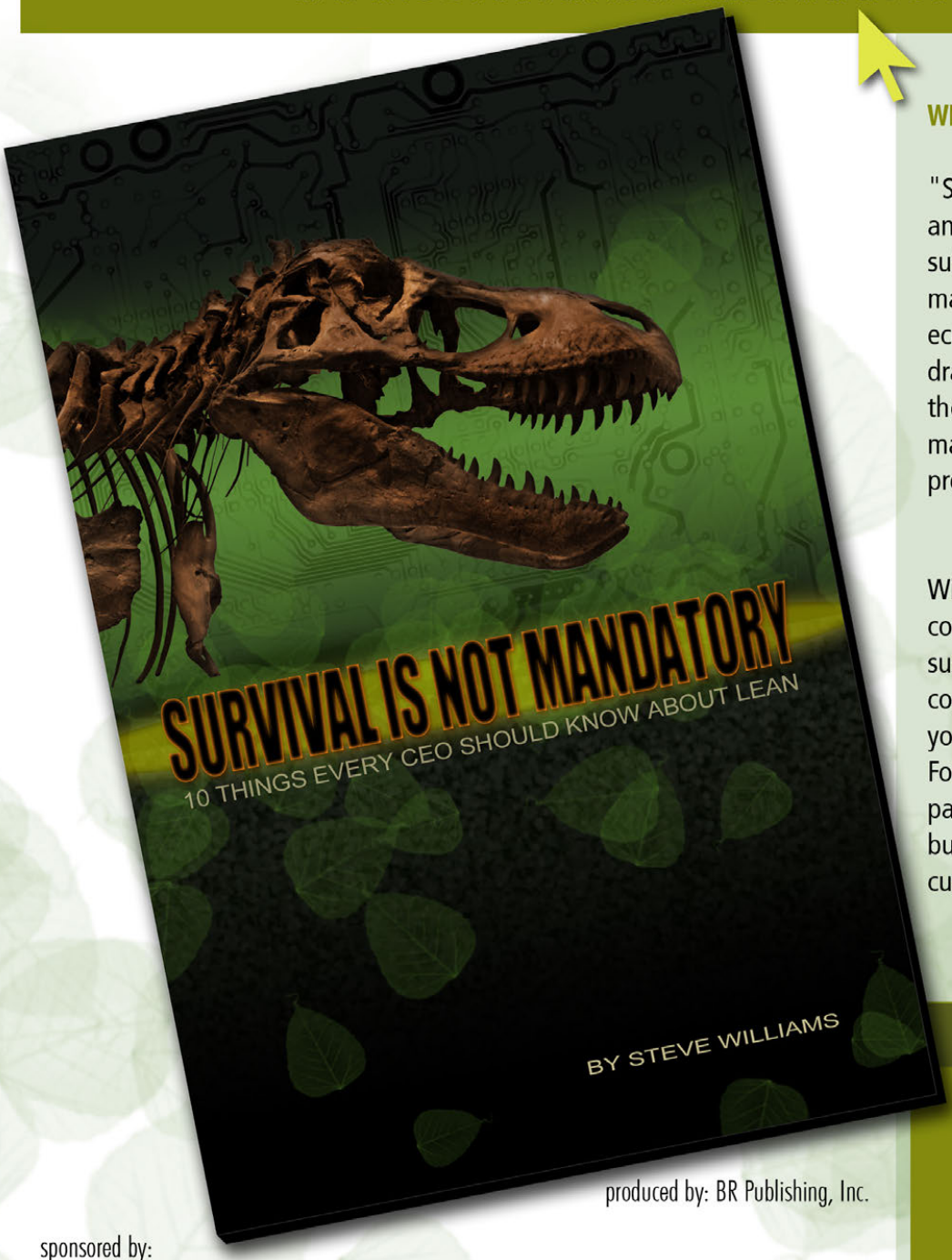

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WHAT BOOK REVIEWERS ARE SAYING:

"Survival is not mandatory" is another way of saying, "inadvertent suicide is an option." The subject may be your firm or your country's economy–does that sound overly dramatic? The evidence speaks to the peril if the exodus of U.S. manufacturing continues along its present trajectory.

–Harvey Miller

Williams' message is sobering–your company does not have the right to survive! Global, larger and lower cost competitors stand ready to steal your greatest asset–your customers. Fortunately, Williams lays out a clear path to success–transforming your business into a lean, efficient, customer-focused organization.

–Walt Custer

ABOUT THE AUTHOR

Steve Williams is the Printed Circuit Board Commodity Manager for Plexus Corporation (Neenah, WI), where he is responsible for strategic materials management and tactical support of the printed circuit board supply base. Prior to joining Plexus, Steven spent 22 years in senior management positions in the PCB fabrication industry. He holds a BA in Organizational Management from Concordia University and an MBA from Cardinal Stritch University.

in a fear-based culture, will not like a chart like this at all. The degrees of freedom she has with which to make up a story is very small. A chart like this forces the truth to be exposed. The manager has few options to protect herself. One option is to shoot the messenger and this chart, claiming, "I don't understand this chart, it is a lie," or my favorite, "You can make data say anything. This data is meaningless." This, by the way, is very true about Figure 1, but not so true about Figure 2. This reaction isn't the plant manager's fault. This behavior is a result of the company's fear-based culture perpetuated by the owner or CEO.

Since this chart is likely new to you, let me explain its most important feature, the slope of the regression (shown as a red line). Remember our relative metric? Well, it was based on what we would accept into the shop. That means jobs with a complexity rating of 100 would be quoted, and we would take the order. Should we? The answer is no. If we extrapolate the red line it would intersect the X-axis at about 70. Typically, when a chart like this is prepared for a client they are shocked about what they can't do and they are shocked that their hardest jobs have such a low complexity rating. Then the truth sets in. They aren't as good as they thought. However, now they have a target to shoot for and a means to measure their performance. The target? Change the slope of the line! Then go out and find more profitable work with higher complexity levels. Progress measured as the rate of change of this line becomes more horizontal. It takes substantial change in the factory and a big change in how the most challenging jobs are run through the factory to change this slope. Is this different from a TQM or SPC way of looking at yield? You bet. Is it powerful? Yes. By finding the jobs that need the most help instantly, it forces questions that get at the truth fast. A chart like this shows you exactly where you need to focus.

So often in our shops we think collecting more data will be better than looking at less data. The problem with looking at too much data is we can lose focus trying to do too much, which results in no improvement. In fact, more data provides us with a way to hide the truth if we live in a fear-based culture.

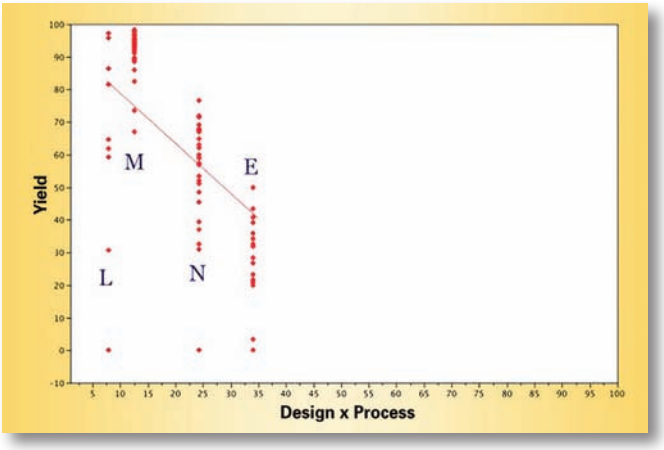


Figure 3.

Figure 3 shows the simplified graph where we focus on jobs L, M, N and E. The line still represents the fit of all of the data.

Each job is significantly different, which mean that not all jobs run through the shop in the same way. There are specific issues surrounding each job and when we address these issues we will make the shop better and become more profitable. To get at the truth it all starts with questions. For example:

1. What accounts for the 0% lots?
2. What accounts for the large variation and erratic yield in Lot L?
3. What accounts for the high average yield for Job M?
4. What accounts for the low yielding lots for Job M?
5. Why didn't Job M have a 0% yielding lot?
6. Why is the standard deviation on Lot M so much tighter than the standard deviation on Lot N?
7. What parameters specifically for Lot N, be it the design or in the process, accounts for the drop in yield?
8. The variation in lots N and E are very similar. Does this point to something similar about these two jobs that needs to be improved?

What I have found about working with similar data is the this: When I see something erratic like Job L, there is usually a process step or two that requires a high level of operator

skill. In the case of Job L it turned out to be an imaging operation. When presented with this, you can proceed in two ways. The first way is to make sure only highly skilled operators work on Job L at the step that counts. The second is to buy technology such that a high level of operator skill is no longer required. Variations found in lots N and E usually have to do with tight line and space jobs that require precision etching. If this is not done doing panel plate, and you have a high level of plating variation, then the yield problem will be compounded because the variation from both processes will add together. A job like M, which doesn't have these problems, will likely have variation that is half or a third of that of Job N or E.

There is something very important about Job M. It was the only job over the period where there wasn't a total yield loss. In fact, no lot came close to a low yield loss. Jobs that have total yield loss are usually caused by poor handling and operator mistakes. Job N is dialed in. Job N likely doesn't have critical handling steps. This means there are very specific areas within the shop that are contributing to 100% yield loss. Fix these and the economics of your plant will soar. However, you need to be willing to find the real causes (i.e., the truth). Job N shows what is possible for the plant. The 100% yield loss and the wide variation has nothing to do with job complexity. It has to do with how the shop is managed. And if you have a culture of fear, a chart like this will never see the light of day, because you will want to shoot the plant manager. In this case only the manager can deliver this message, so don't shoot the messenger. You must work with the manager so that operators care, are better trained, and help each other.

What about Job E? Despite all of the good reasons you can come up with, such as Job E is for a really important customer, you shouldn't be doing it. Job E is killing the economics of the plant and we described this in last month's article, "Are We Nothing More Than a Pair of Socks at Walmart?" The more jobs like Job E that you do, the less your plant will be able to produce per bag of money. Guess what? That means the cost of every single panel will go up, because cost is a function of overall plant throughput. Your production flow defines your plant economics. Until you invest in the technology to do Job E right (assuming the job is doable) and the customer allows you to do the job right, then you need to get it out of your factory immediately. Anything else is just wrong. It will sap your profitability and drive you out of business. If you continue to produce jobs like this then you choose to live in a fantasy world. Supporting this fantasy will drive a fear-based culture. You will reject the truth and look for the answer you want: Job E is good business. Anyone that tells you the truth and says, "Job E is bad business," will be shot.

The goal in our industry should be to develop a culture where quality meetings are fun. Our quality meetings need to be a time to celebrate our success, share our learnings, expose our weaknesses and mastermind new ideas in a culture of openness and trust. When the messenger comes to us, we should listen to his message, not shoot him. And in our quest to find the truth we need to work hard at collecting and displaying our data where problems are completely exposed, instead of abbreviating the data with conventional averaging that simply hides the truth. Edward Tufte wrote a series of famous books, one of which, Visual Explanations, said it best: "We shouldn't abbreviate the truth, but rather get a new method of presentation." Well said! **PCB**

Gray McQuarrie is the President of Grayrock & Associates, a team of experts dedicated to building collaborative team environments that make companies maximally effective. McQuarrie is the primary inventor of the patent Compensation Model and Registration Simulation Apparatus for Manufacturing Printed Circuit Boards. He has worked for AlliedSignal, Shipley, Photocircuits, Monsanto and many other companies and clients. For more information, visit www.grayrock.net, or email McQuarrie at gray@grayrock.net.

TOP TEN

Most-Read News Highlights from PCB007 this Month

① What is Your PCB IQ? — Cleaning

How deep is your knowledge of PCB cleaning? Take The Printed Circuit Girls and Geeks' 10-question pop quiz on the subject and find out—in just 10 simple questions, you'll discover where you stand in the PCB cleaning food chain.

② It's Only Common Sense: The Way It Is

IPC recently issued its annual PCB Production Report for the Year 2010, and it's full of interesting facts—some of them mind-boggling. For instance, Asia now builds 87% of the world's PCBs, but China's average salary has risen 350% since 2003. And, rigid-flex business doubled in Asia last year.

③ Gold Wire Bonding Performance & Reliability of ENEPIG Finishes

The aim of this paper, from authors at Atotech Deutschland and Fraunhofer IZM Berlin, is to review Au wire bonding and soldering performance based on an ENEPIG system of 4 to 6 µm Ni, 100 nm Pd and 50 nm Au. The reliability of this system is also investigated under defined ageing conditions.

④ Conversations with... Dynamic & Proto Circuits

Dynamic & Proto Circuits has been manufacturing PCBs for almost 40 years and the Canadian company continues to stay on, or even ahead of, the leading edge of technology. Dan Beaulieu sat down with North American Sales Manager Ken Moffat to get the low-down on DAPC.

5 ICT Welcomes PCB Industry to Hayling Island

Exercising creditable assertiveness against a babble of energetic conversation and a backdrop of loud rock music, ICT Technical Director Bill Wilkie called the gathering of industry professionals to order and introduced the ICT's Southern Area Evening Seminar. Editor Pete Starkey details the event.

6 It's Only Common Sense: Labor Day Thoughts

Have we forgotten the people who really make things happen and build the product? Those who are sweating it out in a 125° plating room tediously inspecting PCBs, or who crawl all over the facility keeping our equipment in full operation? How much time do we spend thinking about them?

7 IPC Report: World PCB Production Up 19% in 2010

Worldwide production of PCBs grew by 19% over 2009 to nearly $55 billion, according to the World PCB Production Report for the Year 2010, recently released by IPC. Approximately 2,600 PCB fabricators produced an estimated US $54.772 billion in 2010. PCB production grew in all regions in 2010 as the industry recovered from recession.

8 Conversations with... UniGlobal

The Taiwanese company UniGlobal is successfully doing what other Asian PCB manufacturers continue to struggle with: directly selling rigid, flex and rigid-flex board to North American customers, with no middlemen and no brokers. Dan Beaulieu recently sat down with John Holmberg, director of sales and marketing for North America, to discuss UniGlobal's unique business approach.

9 Report Reveals Industry-Wide Slowdown in Sales Growth

IPC has released the summer 2011 edition of its quarterly business report, "Electronics Industries Market Data Update," showing slower growth in most national economies, as well as in the worldwide electronics industry. U.S. economic growth in the second quarter was an annualized 1.3% while the Euro zone's growth was just 0.2%.

10 IPC: N.A. PCB Shipments, Bookings Down in July

"July is typically a slower month than June for the PCB industry," said IPC President and CEO Denny McGuirk. "Negative year-on-year growth rates in North American PCB sales and orders for July reflect slowing growth compared to the height of the recovery one year ago."

Your Competitive Advantage—Don't Waste it

SUMMARY

Your website is an incredibly powerful tool. In the hands of a master, it will perform as well or, most likely, better than any other tool you have. The question is: How do you determine the effectiveness of your site?

by Barry Matties
I-CONNECT007

It has been said that you never get a second chance to make a good first impression. For many of your prospects the first impression they form about your company is from your website. From the moment they land, the only thing they will see or hear (if you have audio) is who you are, what you stand for and the types of products or services you provide. You really have to control the message and make sure it is presented in a way that leads your prospect to the mindset you want them to have. A website is much more than a brochure; it is the voice—the ambassador, if you will—of your company. It really is the most powerful selling tool you have in your chest of selling tools.

Think about it: When a prospect lands on your website, they are giving you their focused attention. This is not the time to squander that opportunity. With this attention, you have to ask yourself: What do I really want the prospect to know first about us? (Just a tip: the "About Us" page is not necessarily what they are looking for first.) The next question to ask is: Where do I want them to navigate to within the site? As they go through each step, they should be getting the exact message, in the exact format and order you want them to have it. At the end of their visit, there should be a call to action: Contact us, download a white paper, receive free software, view an on-demand webinar, etc.

Remember, in the space of a website, the prospect is more relaxed than, say, if they were being called on by a salesperson. That's not to say the salesperson is not needed; rather, it's to say that a website can be tuned so that every prospect has a great experience and feels good about your company, leaving them wanting to take the next step, communicating with your team.

It seems to me that many are stuck in an old paradigm when it comes to websites. The website has transformed over the last few years to become an important part of your selling process. Would you send an untrained salesperson out to make a first impression and spread your message? Of course not. The trained sales-person follows a selling process—at least the good ones do. Think of your website as a salesperson. So many times we see bad sites that are not well thought out: When the prospect comes to the home page the message is convoluted and/or outdated, the navigation is confusing, or, in some cases, the links take the visitor away from the site! These examples are the exact opposite of what you want. Train your website the way you would a salesperson.

Here is a great example of not using the website tool properly. Recently, a customer placed an ad to promote their presence at a

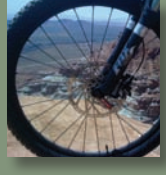
tradeshow where they would be exhibiting. In the ad, the only call to action was to visit the website for more information, a pretty typical call to action for banner ads. When the prospect clicked the link for more information, they went to the home page of a big corporate site. The home page did not mention the tradeshow event at all. Now if the prospect had the patience to hunt for information about the show the advertiser would be lucky. If the prospect did manage to find the "Events" section—the place on the advertiser's site where all upcoming events are listed—they would be further disappointed not to be able to find the specific event not even listed. What kind of impression does this one little item leave with your prospect? Why run the ad if you are not going to direct prospect to the right page with complete information? The best part is that the customer came back to say advertising does not work for them. Of course it doesn't, and it's clear that their website does not work for them either. This company is in trouble.

Business is about connecting all systems in a supportive way. If you are promoting an event, product or service, think it all the way through. Click the link in your ad to see where the prospect will land and what impression they will form about your company once they land at the link's destination. Keep in mind, everything today links to your site—business cards, ads and brochures. Your website is the e-lobby of your business. Imagine someone walking into your brick and mortar lobby and not being able to find a way to gain access to what they are looking for. It would be very frustrating.

Your website is an incredibly powerful tool. In the hands of a master, it will perform as well or, most likely, better than any other tool you have. The question is: How do you determine the effectiveness of your site? Well, here's some good news for you. We have been focused on e-marketing for years, and we provide in-depth website reviews. The key in our review is that we don't look at it as just a website; we look at it as a first impression and selling process. We compare the message that you really want to get out to what is currently

being conveyed. We look at the calls to action within the site. We make recommendations to tune your site to be a formidable selling tool to help you increase your business. My point here is not to make this column a commercial for our site review, as we do this as a courtesy service for our customers; rather it is to raise awareness that an independent review from a reliable source is an important part of site development and maintenance.

Please feel free to contact us if you would like to discuss your site. Remember: Your website is your competitive advantage. **SMT**



Barry Matties started in PCB manufacturing in the early 1980s. In 1987, he co-founded *CircuiTree Magazine.* Nearly 13 years later, *CircuiTree* was sold as the leading publication in the industry. In the early 2000s Barry and his former *CircuiTree* partner, Ray Rasmussen, joined forces again and acquired PCB007. Over the years, PCB007 has grown and continues to thrive. In July of last year, Barry and Ray acquired *SMT Magazine.* With his many years of business leadership skills, Barry now produces this column for anyone who has a desire for success. The column relates 25 years of successful business leadership, including marketing and selling strategies that really work. Read a few and decide for yourself.

EVENTS

- **IPC Complete Calendar of Events**
- **SMTA Calendar of Events**
- **iNEMI Calendar**
- **PCB007 Online Events**

EIPC Autumn Conference 2011
October 13 - 14, 2011
Basel, Switzerland

SMTA International Conference and Exhibition
October 16 - 20, 2011
Fort Worth Convention Center, Fort Worth, Texas

Aerospace & Defense Meetings Torino
October 26 - 27, 2011
Torino, Italy

Aerospace Industry Exhibition Tokyo (ASET) 2011
October 26 - 28, 2011
Tokya Big Sight, Tokyo, Japan

ISDEF 2011
October 31 - November 2, 2011
Israel Trade Fair & Convention Center, Tel Aviv, Israel

IPC Conference on Reliability: Assembly Process for a Reliable Product
November 1 - 2, 2011
Irvine, California, USA

LA/Orange County Expo & Tech Forum
November 2, 2011
The Grand Long Beach

IPC Conference on Securing Intellectual Property Through Physical Security, IT and Regulatory Compliance
November 3–4, 2011
Washington, D.C.

PCB Carolina 2011
November 8, 2011
Raleigh, North Carolina, USA

PCB Nickel Gold Surface Failures - Good, Bad and the Ugly Seminar
November 9, 2011
Online

12th Electronic Circuits World Convention
November 9 - 11, 2011
Taipei Nangang Exhibition Center, Taiwan

TPCA Show
November 9-11, 2011
Taipei Nangang Exhibition Center, Taipei, Taiwan

Known Good Die Conference
November 10, 2011
Biltmore Hotel in Santa Clara, California,

productronica 2011
November 15 - 18, 2011
Messe München, Germany

Flexible & Stretchable Electronics Workshop
November 16-17, 2011
Berlin, Germany

Silicon to Package incorporating the EU uBGA Project
November 17, 2011
Intel, Leixlip, Ireland

iMAPS UK
November 30, 2011
Cambridge, UK

HKPCA International Printed Circuit & Electronics Assembly
November 30 - December 2, 2011
Shenzhen Convention & Exhibition Centre, China

Printed Electronics & Photovoltaics USA 2011
November 30 - December 1, 2011
Santa Clara, California

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AD INDEX

It's all about Embedded Components in the November issue of The PCB Magazine!

You'll have plenty to be thankful for in November, including The PCB Magazine! Our ***embedded components*** issue is already stuffed with feature articles, columns, video, highlights and more, including contributions from industry leaders around the world, like Ohmega's Daniel Brandler, TE Connectivity's Stephen R. Kubes, Harvey Miller, Endicott Interconnect, Mentor Graphics and more. We'll provide a thorough look at what embedded components mean for the PCB industry, including new opportunities for designers. What applications are driving the demand for electronic functionality within the PCB? What technologies exist to embed these devices, and what new ones are emerging? How is the supply chain affected?

For technical discussions and industry chit-chat, our November columnists have it covered, including Karl Dietz *(Tech Talk),* Barry Olney *(Beyond Design),* Mike Carano *(Trouble in Your Tank)* and Gray McQuarrie *(Solving DAM Problems).* Don't forget our publishers Barry Matties and Ray Rasmussen, who will have plenty to cluck about (as usual!), lending their unique perspectives on the PCB industry, marketing and more.

If you aren't a subscriber yet, what are you waiting for? Just click here to have The PCB Magazine *embedded* in your inbox every month!