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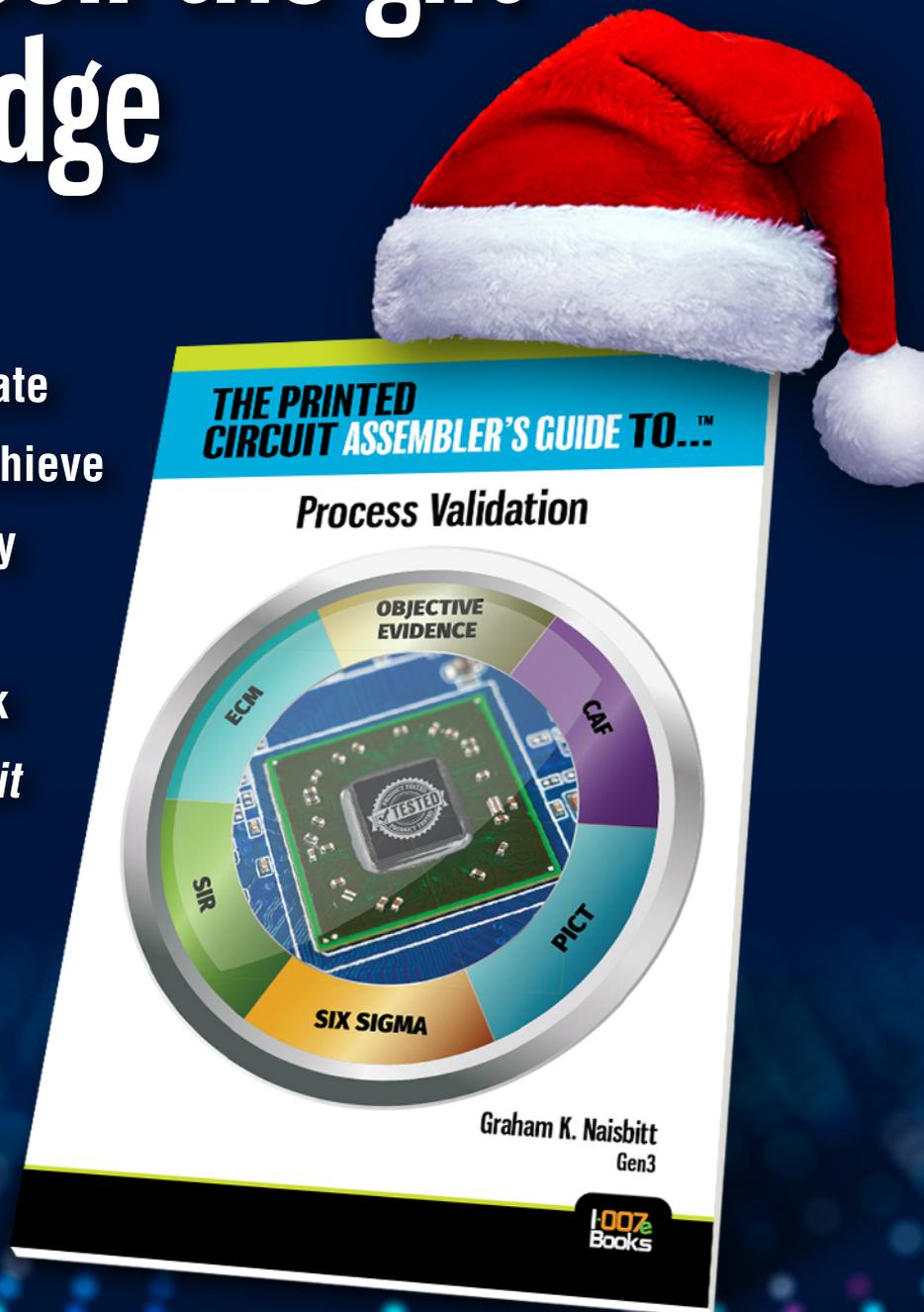


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What You Need to Know

Our theme this month is “What You Need to Know,” and what we learned as we put this issue together is that there is a lot you need to know as a printed circuit fabrication professional. We bring you some selected categories of critical PCB fabrication expertise, plus some bonus coverage from productronica 2019 in Munich.



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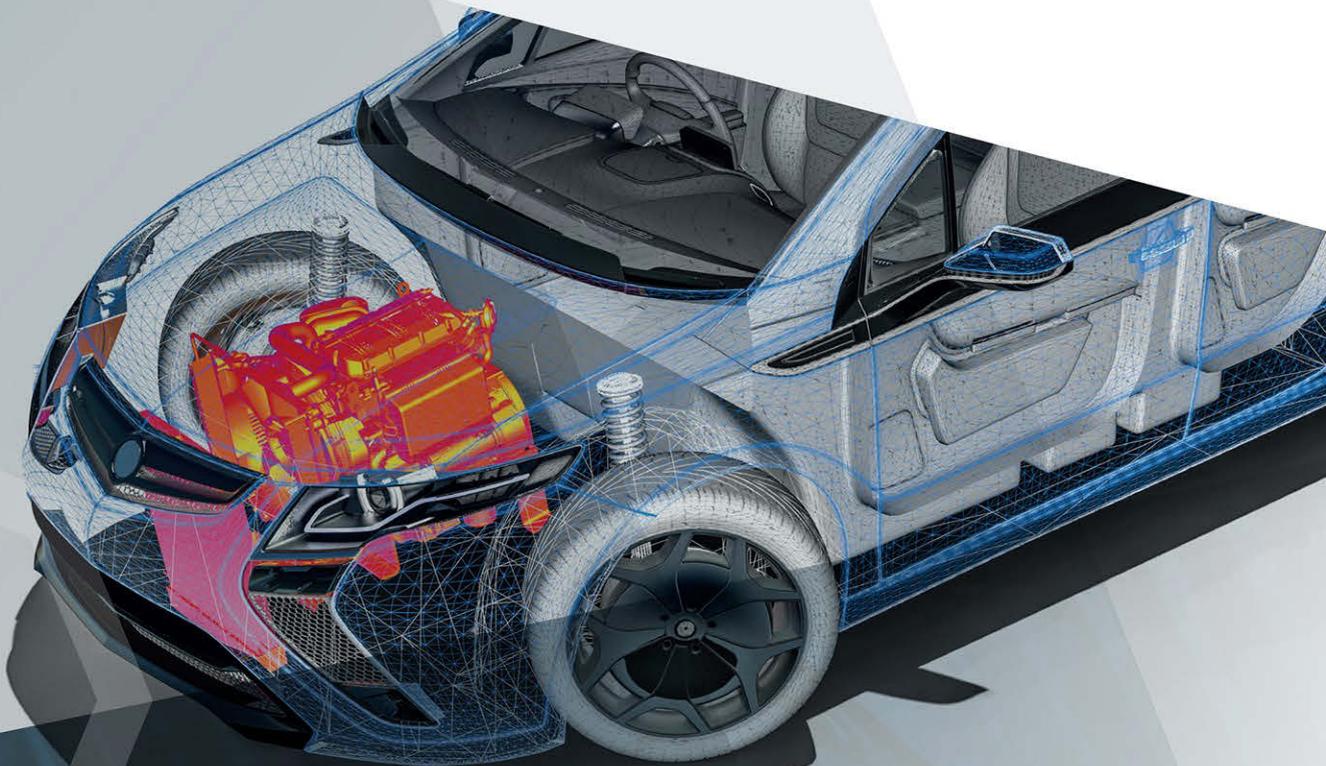
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What You Need to Know

Nolan's Notes

by Nolan Johnson, I-CONNECT007

Our theme this month is “What You Need to Know,” and what we learned as we put this issue together is that there is a lot you need to know as a printed circuit fabrication professional. Admittedly, we already knew that, but here is a partial list of the topics we found that you needed to know more about.

We speak with the Molex team about connectors and design services. Dr. John Mitchell discusses tariffs, and Mike Carano argues that it's never too late to learn. We learn the latest in lamination from DIS, Jan Pedersen reports from *productronica*, and Todd Kolmodin reminds us to stay in our lane.

Further, NCAB talks about the European perspective, George Milad discusses ENIG, and we all learn how to host a successful technical conference from DINEvents' CEO Amanda Lange. We also hear from Kurt Palmer on his new role as president of Burkle America. Rich Nichols from AWP weighs in on copper plating, and Chris Minard details CML's positioning to be more than a mere manufacturer. I-Connect007 Technical Editor Dan Feinberg reports on Wi-Fi 6.

If you've read the December issue of *SMT007 Magazine*, you're already well aware of our coverage from *productronica* 2019, which was recently held in Munich.

The *productronica* show is a biennial event, and the I-Connect007 team was on-site in force. In *PCB007 Magazine* this month, we continue that coverage, bringing you a taste of the latest industry news from the show. We also produced a variety of *productronica* video interviews, which you can find online in our RealTime with... series. Read

and watch the interviews to get even more detail from *productronica* for yourself. Enjoy! **PCB007**



Nolan Johnson is managing editor of *PCB007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing. To contact Johnson, [click here](#).

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New Trends in the PCB Industry at productronica 2019

The PCB Norsemen
Feature Column by Jan Pedersen, ELMATICA

Working with PCB technology and standardization as I do, it is always interesting to see the new trends and where the PCB industry is moving. Changes tend to happen at a slow pace; still, I visited productronica this year for dedicated meetings and expected to learn about new processes and production equipment. What hit me was the different manufacturing focus between Asia and Europe. 5G applications and smartphones—both making

an impact in the news as a high focus in Asia, where most of the production is placed—were hardly mentioned at productronica 2019. However, I picked up on other new trends in the PCB industry.

A Crystal-clear Focus for Europe

It's crystal clear that the European manufacturers have another focus, including the technologies they do best, where high reliability is in focus, with complex build-up, advanced rigid-flex boards, or printed circuits where there are specific demands for the material. The focus is more toward what the customer requests within technology and demands and less on new processes and equipment for extremely fine-line applications, like 5G applications and smartphones, which are already established in Asia.

However, it's no secret there have been struggles for European PCB manufacturers lately. I recently learned that seven German factories had shut down this summer. Still, it seems the course is set in the right direction, at least that's my impression after visiting productronica 2019 and talking to several industry colleagues.

Walking through hall B3 for PCB and EMS production equipment, talking to people, and looking for new trends and changes, I realized almost no stands had groundbreak-



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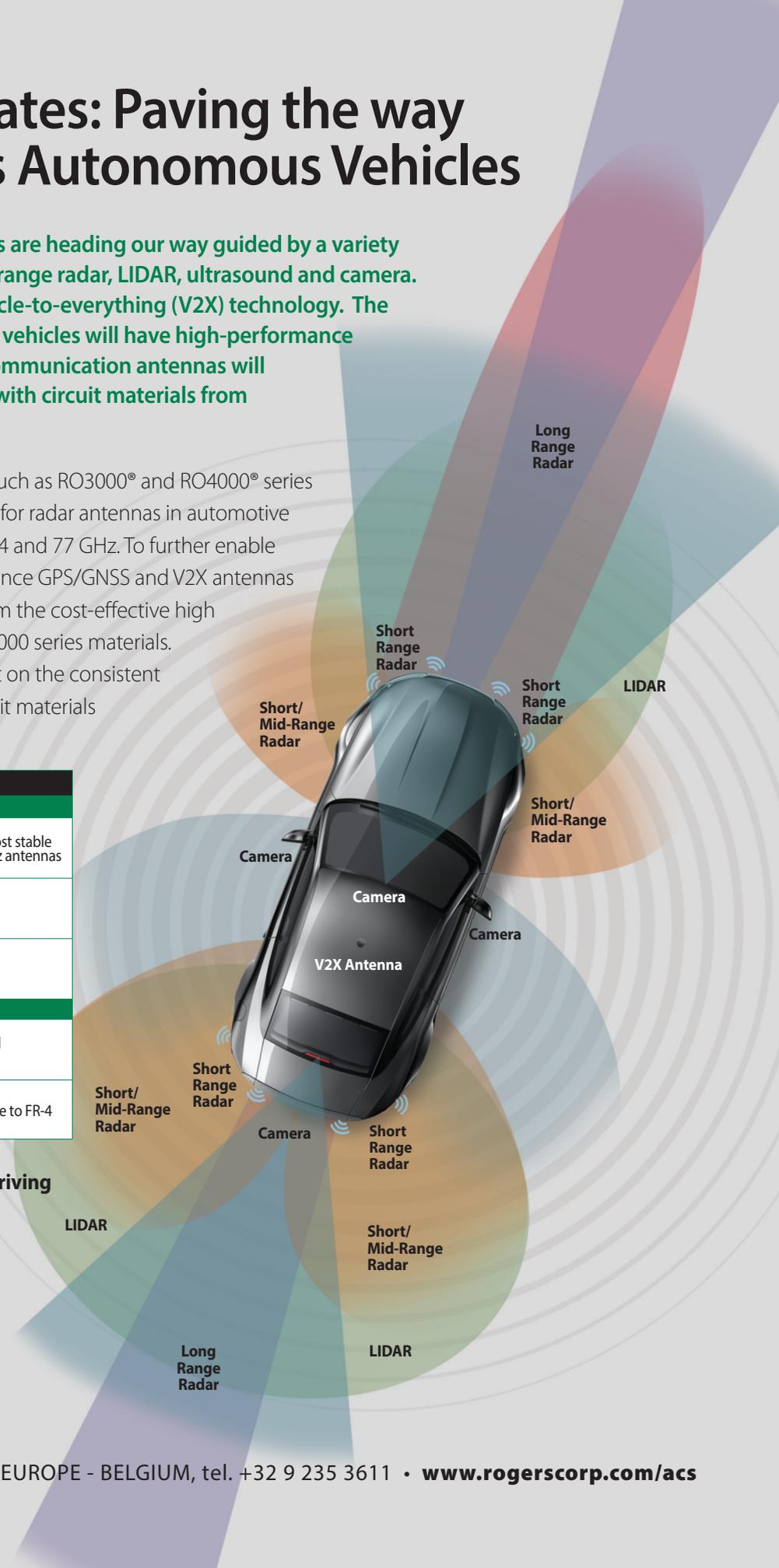
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ing news, processes, materials, or equipment, going one step further in manufacturing solutions, precision, or processes. What I found was a focus on what I call panel-by-panel engineering or adapted processing.

Processes Engineered to Secure Every Panel Meets Specification

In my daily job, consulting with customers for PCB manufacturing, I have experienced an increased need for serialization and traceability. At the EIPC stand, I talked to Alun Morgan about this. He confirmed that if there is a trend today, it goes toward processes engineered to secure every panel meets specification: etching and plating equipment that can adapt to small differences panel by panel; inkjet printers that can print etching resist and plate resist and solder mask and legend adapted to exactly what is needed for that panel, or that design.

If you pair this with the drive toward the connected factory—IPC-CFX—you find a trend that fits more than one purpose. The keywords and phrases are traceability, impedance tolerances, changes made on-the-run, and multiple variations of the same design. We also see tighter mechanical tolerances as a result of miniaturization.

Tighter Etching and High-speed Materials

The demand for tighter etching and plating tolerances, combined with high-speed materials, comes not only from 5G, but also other high-frequency and high-speed applications, where 10% impedance tolerances no longer are acceptable. To meet tolerances down to 5%, and probably even lower in the future, not only materials but also processes must be more accurate and adapted.

These 5G requirements toward PCB manufacturers are impossible without major in-

vestments. Modified semi-additive processes (mSAP) are on everyone's lips when we talk about the ability to create copper lines down below 30 microns, which is needed in smartphones and other products within the 5G sphere.

Upgraded Equipment: An Unavoidable Result

This also means plating and etching equipment needs to be upgraded to meet new impedance requirements in volumes, and sometimes engineered panel by panel. I believe we will see changes in the image transfer process as well, going from film lamination and ink resist to inkjet or other 3D printing methods.

Some equipment was shown at productronica that can print etching resist, the plating resist, and solder mask and legend, in the same machine. And with both jet printing and imaging, we need speed and individual adap-

tation to each production panel. Today, this equipment has a relatively low-volume capability but with flexibility, which could help European manufacturers to meet some of the requirements with a reasonable investment. Last week, Taiyo America and Würt Elektronik CBT announced successful cooperation on producing inkjet solder mask and they are not the only ones.

The same goes for imaging, but here, manufacturing speed is not the challenge. I asked Øyvind Tafjord from the Norwegian imaging company Visitech, a company that delivers the imaging equipment for major AOI and LDI manufacturers, what the speed and resolution are for their equipment. The answer was that a panel of 500 by 610 mm could be imaged in a few seconds, and with resolution down to 2 µm, Visitech can meet demands from 5G and beyond. If a factory sticks with their five-year-



old AOI, LDI, and AVI, the resolution will be an issue going down the track width ladder.

The Impact of Change

Each time we see generation changes—or a big jump down the miniaturization ladder—the massive investments end up challenging the smaller factories. It is unavoidable to mention that government-supported companies have been able to invest at a much higher rate than their competitors based in less supportive countries, and that is exactly what we see today—the gap between the strong ones with extra financial power, and the ones without. Playing a central part in the PCB industry, we monitor all manufacturing changes closely, and this development is for sure a topic to return to in another column.

My impression is that the future will demand volumes, individually adapted. Adapted applications will require adapted PCBs manufactured almost like individuals, often with several versions of the same printed circuit. But why? Because the speed of technology runs fast and allows it. As always, hang on to the tech express, and if you don't feel assured you are, involve a partner that is. **PCB007**



Jan Pedersen is a senior technical advisor at Elmatica. To read past columns or contact The PCB Norsemen, [click here](#).

productronica 2019: Benefits of Automation in Horizontal and Vertical Plating and Wet Processing Systems

Pete Starkey and Andreas Schatz, global manager product equipment for Atotech, discuss automation, consistency, quality, safety, yield, and sustainability in the company's systems and their progress toward full Industry 4.0 capability.



Rising Tariffs Put a Painful Squeeze on Electronics Manufacturers

One World, One Industry

by Dr. John Mitchell, IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

IPC recognizes that you—our members and customers—are greatly affected by the ongoing tariff dispute between China and the United States. To date, the two countries have imposed tariffs on hundreds of billions of dollars in imports in a tit for tat that was poised to escalate further if an agreement was not reached soon.

On Friday, December 13, the United States and China announced they had struck a “phase one” deal that effectively pauses the trade war that has flared between the countries over the last two years.

IPC welcomed news of the “phase one” deal. The Trump administration says the deal

“requires structural reforms and other changes to China’s economic and trade regime in the areas of intellectual property, technology transfer, agriculture, financial services, and currency and foreign exchange.” It also obligates China to make substantial purchases of U.S. goods and services and establishes a stronger dispute resolution process. In response, the U.S. has postponed new tariffs that were scheduled to go into effect on December 15 and cut the tariff rates on the most recent previous round.

To determine the effects tariffs on U.S. electronics manufacturers, IPC conducted a survey of its U.S. members. The results reflect how difficult it is for a global industry to navigate this uncertainty. Here’s what we learned:

- Almost 90% of U.S. electronics manufacturers are troubled by higher tariffs imposed by the United States and China on each other’s imports
- Companies are choosing to invest less in the United States, laying off staff, or slowing the hiring process
- On average, companies are seeing tariff increases on 31% of the total dollar value of the products they import
- 25% of companies report over half of the dollar value of the products they import are facing higher tariffs
- More than one-third of companies cannot increase their prices to cover the cost of higher import tariffs due to various factors
- 51% of responding companies report they are now sourcing from countries other than China as a result of increased tariffs on Chinese imports



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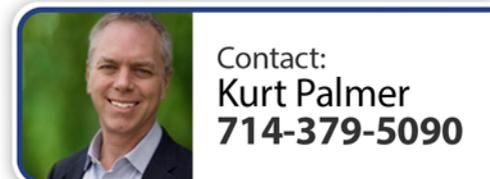
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TARIFF WAR FALLOUT



While some manufacturers are not affected by the trade war, the overall response shows that rising tariffs are putting a painful squeeze on many electronics manufacturers in the United States, China, and even Europe—and on their business partners and customers as well. IPC members tell us they are facing supply-chain disruptions, steeper costs, and market-access problems from the tariffs that have been imposed to date, and the impacts are likely to grow as the trade war drags on.

Tariffs are taxes, and they distort global competition, create an uneven playing field for businesses, and force companies to choose sub-optimal, second-best alternatives when it comes to their global operations. More importantly, the uncertainty of tariffs damage workers' job security. Consumers and businesses on both sides of the ocean now face the burden of higher annual costs in the tens of billions of dollars.

IPC's position on this issue is rooted in the fact that electronics manufacturing facilities are located throughout the world, including the United States and China, and they are engaged in a complex web of supply-chain relationships that cross multiple borders. Imposing tariffs on goods from a single country like China gives the false notion that we are creating a steeper hill only for Chinese goods. More accurately, a great many goods coming from

China are made by American companies, support American jobs, and are sold to American consumers as American goods.

IPC supports the right of all countries to address unfair trade practices, and we have long-standing concerns about some of China's industrial policies, including government subsidies and intellectual property violations. But addressing unfair trade practices by ratcheting up tariffs is like using a sledgehammer to make orange juice; in both cases, it's the wrong tool and makes a mess of the job.

We were warned of the harm to manufacturers and consum-

ers when the idea of tariffs was first discussed, and we have been watching the situation like a hawk since the trade war began. We are committed to advocating for our members as this trade war takes a toll on our industry. To begin to fix this situation, IPC is calling on the governments of the United States and China to de-escalate the tariffs and focus on concluding meaningful agreements that address the long-standing concerns of both sides. Moreover, the U.S., China, and other major trading partners need to recommit themselves to strong multilateral mechanisms to enforce existing and future trade agreements.

The bottom line is we're in a "wait-and-see" situation, and until we see some solutions, the tariffs will continue to take a toll on the electronics industry and our workers and customers. We are aware of the issues you are facing, and we are doing our best to help. Please feel free to reach out to me with any concerns you have. Let's continue the conversation and work on solving this critical issue together. **PCB007**



Dr. John Mitchell is president and CEO of IPC-Association Connecting Electronics Industries. To read past columns or contact Mitchell, [click here](#).

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Never Stop Learning

Trouble in Your Tank

Feature Column by Michael Carano, RBP CHEMICAL TECHNOLOGY

Introduction

My father always told me, even when I was 40 years old, that I should never stop learning. Of course, he was a teacher and an administrator, so he made it his mission to make sure others had great learning opportunities. And my dad never stopped trying to learn new things, either.

This lesson applies to the PCB manufacturing industry, as well. I have spent my life trying to get better at my job and, in turn, help others too. This is where constant learning and new skills development come into play. Let me introduce a few if you haven't heard these already.

How to Troubleshoot a Technical Issue

This should come as no surprise to those of you who read my monthly columns or have met me in your circuit board facility; remember that time is money. And the longer

a problem goes unresolved, the more money and certainly future customer goodwill can be lost. When being called on to solve technical issues—whether it is a delamination situation, copper plating failures, or solderability defects—I stress a few simple rules:

1. Walk the line and watch the operators in action.
2. Review documented work procedures.
3. Check rinse water quality and dwell times. Are you rinsing away the contaminants or simply dragging them along with the boards to the next critical process?
4. And the biggest sin, “Yes, everything in the chemistry is being controlled per the datasheet.”

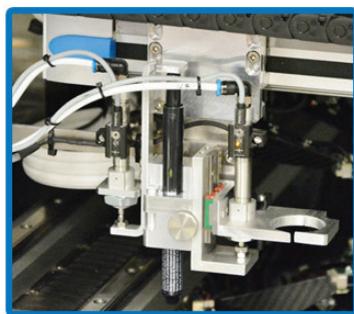
What I'm saying here is quite simple: develop the troubleshooting skills necessary to solve process problems efficiently. The rule of thumb is to keep the troubleshooting project as



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manageable as possible. Begin to brainstorm on the linkages in the up- and downstream processes and potential effects of process variation in these process steps. Gather all pertinent information, including SPC charts, temperature logs, analysis records (including a record of calibration and analytical standards), etc. Then, develop a cause-and-effect diagram. Fish-bone diagrams serve this purpose well.

At the risk of having hundreds of factors to investigate, only the most likely causes should be investigated first. This will serve to weed out those processes that are not contributing to the defect. A process audit is a must in this situation. Hopefully, you have a reliable supplier or suppliers who work with your company in close partnership. Ongoing process audits jointly and separately performed by your supplier and designated individuals in the fabricator's facility should be the standard operating procedure. Process audits alert the manufacturer if a process is "drifting" out of the control window.

At the risk of having hundreds of factors to investigate, only the most likely causes should be investigated first.

Once the team has set up its test plan based on a narrowing of potential causes, the divide-and-conquer approach will aid in the efforts. For example, if one suspects that thin plating of copper in the hole is caused by problems associated with the electrodeposition process, simply processing the pwb in the acid copper plating solution for the required time and current density should yield whether or not the copper plating process or the equipment (copper plating anodes, rectifier, electrical connections, etc.) are the cause. If not, then one must examine the previous steps. Are there discontinuities in the electroless copper deposit or

direct metalization process causing thin plating? Are there voids one cannot see? These are just some of the questions to be asked. Only a systematic approach will help solve problems expeditiously.

Soft Skills

There are a few other soft skills that I see as being absent in many of the facilities I visit. Here are a few of these critical soft skills that you should know.

Design of Experiments (DOE)

Understand how to design an experiment. This requires brainstorming and certainly a team approach to solving the problem. DOE methods are for engineers to employ during experimentations. Whether it is problem-solving or process development, the DOE experimental method provides the most efficient means of determining the correct answers and is critical for troubleshooting. It helps you understand those variables that are weighing more heavily on the issue and those that are of little consequence.

Start with a brainstorming session and construct a fish-bone diagram or something similar. This will help put into perspective the possible causes of the problem you are seeing. Then select from there and focus on the most likely causes of the defect based on everyone's input. Then, design the experiment to investigate the most likely causes.

Total Quality Control (TQC), Six Sigma, Statistics, and Curve Fitting

TQC and Six Sigma is the philosophy of continuous improvement through statistical techniques and a commitment to excellence. The plan-do-check-act (PCDA) process is a central theme using the nine basic tools: cause-effect, process flow, Pareto, scatter, histograms, process capability index, control charts, time series, and check sheets. A useful book is the *Statistical Engineering Handbook* available from NIST and free to everyone to download. A fundamental place to start is how to "Select The Right Statistical Tools" (measurement system analysis, SPC, comparative methods, DOE).

Process Steps	Failure Mode	Effects of Failure	Severity	Potential Cause(s) of Failure	Occurrence	Current Controls in Place	Detection	RPN
Lack of Uniformity of Appearance (A) Skip Etch	Resist stripper spent	Skip etch	6	Poor solution maintenance	5		3	90
			6	Faulty controller	3		5	90
	Poor rinsing after resist stripping	Skip etch	6	Clogged nozzles	6		5	180
			6	Low rinse pressure	3		4	72
	Oxidation on cores	Skip etch	6	Poor resist stripping	5		2	60
	High acid in pre-dip	Skip etch	7	Bath contamination	4		3	84
	Spent pre-dip	Skip etch	7	Old bath	5		3	105
	High sulfuric in oxide alternative solution	Skip etch	7	Wrong adds	3		2	42

Table 1: Failure mode example.

FMEA

FMEA stands for failure mode effect analysis and is critical for problem-solving. An example of just one failure mode related to the use of an inner layer bonding process is shown in Table 1. Of course, there are multiple process steps to consider. For purposes of illustration, I only show issues related to a lack of uniformity of the coating appearance.

Conclusion

Certainly, there are additional skills I would recommend, including improving one's techni-

cal writing skills. However, if you can acquire or improve on the skills we outlined here, you will achieve a much deeper understanding of critical aspects of the PCB fabrication process and ensure the end product is of the highest reliability. **PCB007**



Michael Carano is VP of technology and business development for RBP Chemical Technology. To read past columns or contact Carano, [click here](#).

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Jesse Ziomek



Tony Faraci

What You Need to Know About **Reducing** Lamination Time

Feature Interview by Barry Matties

I-CONNECT007

Barry Matties recently interviewed Jesse Ziomek and Tony Faraci of DIS Technology. They discussed pinless registration—a new process that can reduce lamination cycle time, improve quality, and eliminate a lot of the guesswork usually involved in the lamination procedure.

Barry Matties: I understand that you are based in New York. You've been doing pinless tooling for quite some time on the rigid side, correct?

Jesse Ziomek: We have, for about 15 years in the market globally. As a reference point, we've had 152 installs in 18 different countries. But yes, our focus has been the rigid side until recently.

Matties: And now you are eliminating the hard tooling—the pins to do the layout of a rigid-flex PCB and reduce those tolerances.

Ziomek: Yes. About two years ago, we were asked by a rigid-flex customer, “Can you de-

sign something for this?” Because of the cut-outs and the prepreg, the PTFE fillers and the overall design was completely different. We used a lot of the same technology, but we had to make some different configurations, so we did. Now, the operator manually loads each inner layer and prepreg into the system. Two fixed cameras read the fiducial targets that are on the centerline on the core, and there are also four different bond pads on the outer perimeter.

The platen then comes down, picks up that inner layer, and gets it into the right position; there's also a clamp on the north and south ends of the panel, which clamps that into position. The platen then releases and repeats that process with the prepreg and the next layers. As that build-up takes place, it then has one final clamp that feeds into the system, where the induction heads then clamp down, turn on the induction, and the copper on the copper bond pads on the perimeter heat up, causing a tack bond between the prepreg and the inner layers.

Matties: And then it's ready for lamination.

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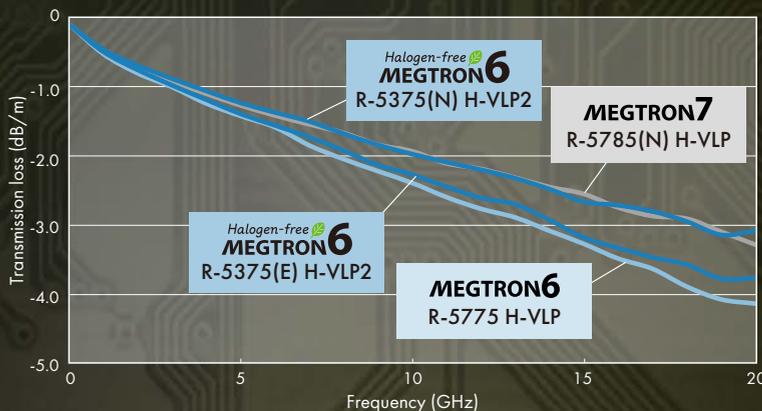
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- Low transmission loss

@10GHz	Dk	Df
R-5375(N)	3.3	0.003
R-5375(E)	3.8	0.005
R-5775	3.8	0.005

Applications

- ICT infrastructure equipment, High speed networking(High-end server/ router, Optical network, switch), High layer count PCB, etc.

Transmission Loss



Construction



Line length	200mm , 100mm
Line width	125µm
Impedance	50Ω
Inner Cu treatment	No-surface treatment
Core	0.13mm
Prepreg	#2116 56% x 1ply



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Ziomek: It's packaged and ready to go. And there's a whole other handling process because you have a pinless panel that's going into the lamination. We have corner blocks and some other unique tools that our customers are using that are very successful in that as well.

Matties: You're talking about tight tolerances, and you're using optical registration here to align. You're also saying it's repeatable. But a lot of people are steeped in pin technology; it's what they know, do, and rely on. What's the critical point for them? What's the driving factor for them to make this change?

Ziomek: The first thing is we understand that when you leapfrog technologies and go from hard tooling to pinless, it's a complete change in everything. And many layup operators have dedicated 20–30 years of their career to dial in that process; now, we are bringing in this automated system that can eliminate all that. Right off the bat, the DIS systems align up to 40 layers with ease and 17-micron layer-to-layer registration. Again, we understand it's kind of hard to grasp at first hearing.

For this technology to be successful, just like any other new technology that you integrate into a process, you have to have complete buy-in.

It is not a difficult technology—just new learning processes—but there is another very important part that I want to talk about. For this technology to be successful, just like any other new technology that you integrate into a process, you have to have complete buy-in. This means that the other side of the team needs to let go of all of those old ways and be eager to learn something new; let us educate you on the new way. And if you dedicate

yourself to that, in about two or three days, you can figure this system out and be running production.

Matties: Regarding your rigid-flex layup system, throughput might be an issue because in a traditional post-etch punch layup situation, I can bring additional people in and set up layup stations, if you will. What's the advantage of time here for a fabricator?

Ziomek: In fact, we just got some fresh throughput numbers on the rigid-flex system at our first install location in Pennsylvania. I recall running some 20-layer and 30-layer panels. Tony, maybe you can talk a little bit about what you saw on the cycle times with that.

Tony Faraci: Typically, for each element on this machine, we can align inner layers as well as prepreg because we can position the prepreg as well. Each one of those takes about 15–18 seconds per core. And the tack bond is at the end. Depending on how many layers and elements you have, each one takes about 17–20 seconds.

Matties: I'm curious about how this compares and contrasts with a traditional system.

Faraci: In a traditional system, you take all the inner layers and have to go through a punching process and punch them all, so that's the first one. And if this customer does some internal pinning, you also have to punch or drill each one of those holes. For example, if they have 20 extra holes in the center because they do the internal tooling, each one of those must be singularly punched; now, those hole locations are not going to be perfect because they're based on the image. If the image moved, those holes have moved, so all of that has to happen.

With this process, that whole step goes away. And if you do this internal tooling, that goes away too, such as routing the prepreg on the inside for the pinning holes. The lam plates and separator plates are usually made out of FR-4 and polyimide, which is eliminated; you don't need that. You can use stainless steel separator plates. There are big savings right there.

Matties: That's a huge savings in time and cost. In a quick-turn situation, this would give you some cycle time back.

Faraci: Of course. Because with that new cycle time, you're eliminating making all those special lam and separator plates, putting in all those pins, and de-pinning. If you ask a customer who does internal tooling, "If you were to eliminate the internal tooling and do it a different way, how much would that save you?" They'll tell you that the cost savings is enormous.

Matties: So, the ROI is pretty quick. With this one machine, I could set up multiple layup stations, but you're describing the process steps before you even get to the layup stations, and that has to be taken into consideration.

Faraci: Exactly. And what normally happens, they only compare any of our machines to a layup station, but it's not just the layup station because we're doing the registration. Therefore, the hole punching and pre-processing of the panels goes away. There is no pre-handling or punching the layers before drilling all the backer boards or drilling all of the prepregs.

Ziomek: And one of the big advantages for the new DIS user is their layer-count capabilities beyond throughput. We see customers that maybe were only capable of building up to 10-layer PCBs. But with the DIS system, they have repeatability and accuracy and can build up to 20 layers, and maybe even a little bit higher. They're able to take on new jobs that they couldn't before, which is a huge benefit.

Matties: How many installs do you have of this?

Ziomek: We had serial numbers 1 and 2 installed at a top U.S. DoD PCB fabricator—Flexible Circuits Inc.

Matties: That's quite good.

Ziomek: It went under rigorous testing, as you can imagine, considering the type of panels

being built and for whom. It was very successful due to the teamwork involved, and it went into production last year. At the same time, we made adjustments and modifications because it was serial number 1. Again, it was so successful that they purchased the second system and took order of it. Flexible Circuits also tested our automated DIS internal bonder to eliminate internal pinning for rigid-flex PCBs. We have five manual systems installed in North America, but they also went ahead and bought serial number 1 for the automated version.

**“If you were to eliminate the internal tooling and do it a different way, how much would that save you?”
They'll tell you that the cost saving is enormous.**

Matties: Are you saying this one is automated?

Faraci: This is automated, and by automated we mean it is optically aligning the layers. For the manual system that we're talking about, we have two versions for the internal pinning.

Matties: But what about bringing the material in?

Faraci: The future plan is to do something with that. That's part of the reason why you see the machine has some headroom.

Matties: Because that's a big growth area, right?

Faraci: It is.

Matties: And with digital manufacturing, you're going to have to be able to take in barcode information and adjust on the fly.

Faraci: We're doing that now, as you can see.

Ziomek: There is another interesting thing. On our rigid side, with the way that the customers are utilizing the tool, they always bring us back new information too. And one of the great things about using this system, especially on the rigid side when they're bonding that package, is they're able to take that internal package and put it on an X-ray drill. Before, the traditional process was to do it after it was pressed, which is too late because you still can't identify where it came from.

Some of the customers are taking that bonded package off the DIS system and putting it on the X-ray to make sure that the machine is doing what it's supposed to be doing. Then, it goes through the press, and they put it back on the X-ray after it has been baked. They can also compare the results and find out if it came from the press. They're able to have a baseline reference.

Matties: Are you also providing a process improvement tool with this?

Ziomek: Absolutely.

Faraci: Right now, when they pin up on pin lam, there's no way to check if the operator made a mistake, or if it's the core. You can't say. The

only thing you know is that, from after the layers were punched until you came out of lamination, something happened, but you don't know where. In this process, we're laying up the panel, and it will be tack bonded. They can measure with the X-ray machine and know if the machine did its job. And you have the data set just before lamination. Now, you laminate, come out, and remeasure the same panel; you have what happened in the press. And most of our customers have done that, where they will go in and tweak their press cycle based on the data—not on if they think they have to play with the pressure or add more papering.

Matties: It's not guesswork anymore.

Faraci: Correct. You take the black magic out.

Matties: Congratulations, and thanks for sharing this today. I think this is fantastic. As you know, I'm a big fan of the systems that you produce and look forward to seeing some more of these in the U.S.

Faraci: Exactly.

Matties: Thanks for your time. This is great.

Faraci: Thank you. PCB007

CML's Tribute to Hubert van Rennings

On August 23, we had to say goodbye to our dear colleague, Hubert van Rennings. His unexpected death at 64 years of age caused great grief and left a gap in our hearts.

Hubert entered the PCB world at a young age, starting at Ruwel (Unimicron Germany GmbH). There, he made his way from manufacturing to technical roles and became a CAD/CAM expert. After 30+ years in Germany, Hubert went to China and worked for several big PCB manufacturers.

In 2011, Hubert joined CML as technical director located in our Shenzhen office in China. Shenzhen and CML became his sec-

ond home and family. A big portion of his work further enabled CML to establish its position in Asia.

Hubert was a knowledgeable PCB expert, and we could

rely on his solutions, whether for standard or advanced technology PCB challenges. With more than 40 years of experience in the PCB business, he was a mentor and passed on his knowledge to the younger generation in our team.

Once more, we express our gratitude and appreciation of his work and friendship at CML. Hubert, you will always remain in our memories.

(Source: CML)



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Kurt Palmer Takes on **New Role** as Burkle America President

Interview by Barry Matties
I-CONNECT007

During productronica 2019, Barry Matties chatted with Kurt Palmer about his new role as president of Burkle America, the work they do with Schmolli Maschinen, and why customers in North America must continue to invest to keep up with the technology and be profitable.

Barry Matties: Welcome. First, can you talk a little bit about your position at Burkle now?

Kurt Palmer: I joined Burkle North America in January of 2019, so I have been with the company for 11 months. I initially joined as a person that was going to manage the PCB sales for the North American market, including both the Burkle press equipment and all the Schmolli equipment we provide to the PCB market. But fairly quickly after accepting the sales role, I was offered a different position as

Burkle North America president. It was a rapid change of positions after accepting the initial role. Now I'm responsible for overseeing a team of 24 employees as well as the sales and direction of the company for the future.

Matties: And in North America, Burkle does not just do PCB electronics, but you also do solar, photovoltaics, woodworking, and plastic cards. You have a pretty broad portfolio of products.

Palmer: Especially with the Burkle side of things, those are all part of our portfolio.

Matties: What was your background before Burkle?

Palmer: It's all been in the PCB industry, including consumable and equipment sales, so I'm not going to let that go; I will continue to stay involved in that business because I grew

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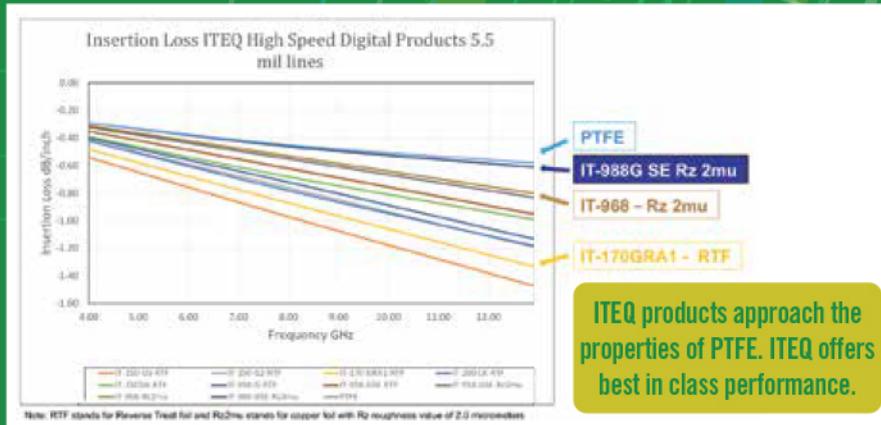
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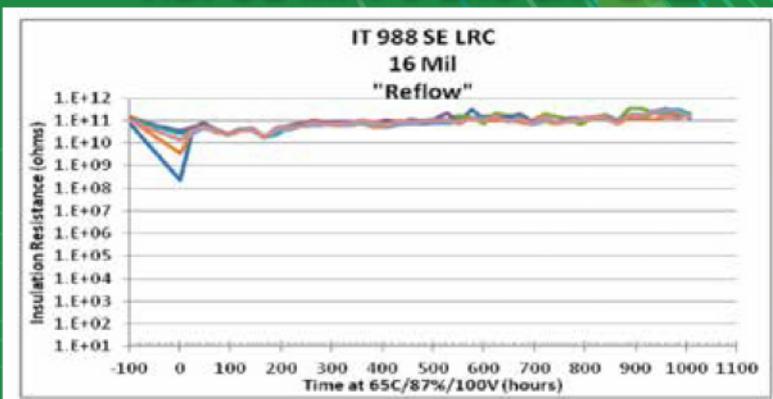
Sequential Lamination

7 Lamination cycle data

Lamination	DMA	DSC	TMA	T200 with CU	Solder Dip PCT: 1h @ 121°C	Td 2wt% / 5wt%
1	213	187 / 187	182	> 60	> 60	408 / 435
2	216	194 / 199	193	> 60	> 60	417 / 438
3	214	186 / 192	185	> 60	> 60	417 / 442
4	216	193 / 194	184	> 60	> 60	424 / 443
5	217	194 / 199	190	> 60	> 60	418 / 442
6	218	191 / 197	188	> 60	> 60	405 / 436
7	218	190 / 197	194	> 60	> 60	425 / 444

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Schmolz single-spindle drilling machines in tandem.

Schmolz group of products. Schmolz is an extremely important part of Burkle North America.

Matties: As I travel to different shops, I see a lot of the Schmolz equipment in Asia, Europe, and the U.S. I have seen a lot of the single-spindle models. What trends do you see around that equipment?

Palmer: With the Schmolz equipment in North America, it's all about flexibility and the single-spindle equipment that allows customers to drill smaller lots efficiently. The nice thing about the Schmolz product line, in particular, is

up in the industry. I graduated in the late '80s from college and started working for the family business, selling copper-clad laminates, drill bits, etc. After 30 years, we made the bittersweet decision to sell the business to one of our supplier partners. I stayed on for three years through the integration and then decided to join Burkle earlier this year.

Matties: It's nice that you're moving into a management role, though, because you're managing the health of the business now.

Palmer: That's true, but in my role, I'll always be in sales. I've enjoyed working with all the PCB accounts that we have in North America. I've met several of our accounts in solar and woodworking industries as well, and I plan to continue to maintain and develop those relationships in my current role. I still travel and stay involved in the business that way.

Matties: Because the technology is one thing, but it comes down to relationships that you have with the marketplace.

Palmer: I can take things I learned out in the field and apply it to our business as well, internally. Burkle America is owned by Burkle Germany but operated independently. As an extension of Burkle Germany, we represent the Burkle product line, but then we also have our

these single unit drill machines can be added in-line and automated so that you can have what might look like a six spindle drill with six individual units all drilling different jobs at the same time.

We also sell many MXY-type machines in North America. An MXY machine may have six tables with two spindles each, but each table is independent so that each of the six panels on the machine can be drilled with different scaling; it's highly accurate, productive drilling.

Matties: It drives the yields up. As we move into the era of digital manufacturing, we see it on the assembly side. It's happening quicker than on the PCB side. On the PCB side, we see companies like GreenSource Fabrication that are creating a digital factory. You build a digital recipe, and they come out without human intervention. What trends do you see or conversations do you hear from those who are already in brownfield sites regarding this?

Palmer: The biggest challenge is that they're already in the brownfield sites. They don't have the capability to flip the switch and start new. The customers have said, "If we had the ability to start brand new, we could automate like GreenSource. Otherwise, it's one step at a time." And that is a little bit of a challenge because if you can buy all of the equipment at once, you can design it, lay it out, and add

automation equipment to make it all work well together. When you're replacing older equipment, one piece at a time, it provides more of a challenge. While people want to automate, the reasons we don't see it happening so fast is because they have existing equipment to work with.

Matties: Right, and for North America, in particular. Years ago, the big six-spindle machines made a lot of sense. Now, single spindles probably make the most sense, in the majority of applications.

Palmer: That's true. We see a lot of the old six-spindle punch and crunch-type machines coming out and being replaced by faster, more accurate, and more productive, higher-technology single- or two-spindle machines.

Matties: The return on investment is justifiable.

Palmer: It's very quick.

Matties: That looks like one of the areas that they would start with the digital factory. Is that something that you see, where they come in and don't just want to bring in the single-spindle machine but want to automate this area?

Palmer: Yes, and they'll pull out two big machines with a large footprint and say, "In this area, we want to put in four single-spindle machines. What are our options for automation?" They can manually load a loader that will have, for example, 12 stacks in it and run all weekend. Or they can have an AGV machine, which runs behind the drill machines to keep feeding the machines.

Matties: That's one of the trends. It runs all weekend without people there. That's the key.

Palmer: Yes, you don't have people there. Of course, if there is an issue, the person who gets alerted at home can run in, see what the problem is, and get the machine going again. As long as there's communication with the operator, that works well.



Matties: But all the machines have drill bit detection, measuring, and safety precautions to make sure that the right holes are in the right spot at the right time.

Palmer: They're all there, so you'll be notified if something goes awry.

Matties: It seems like it would be an easy decision for somebody who has legacy equipment and it's time to upgrade.

Palmer: We just did a presentation of one of our MDI direct imaging machines for solder mask exposure, and the customer is insisting on automation. This customer cannot find operators in their area, so it's not as much of an ROI decision; it's a practicality decision. If they don't have people available to run those machines, they must have automation, even if the ROI is longer.

Matties: The digital factory makes sense. The lack of employees adds to that along with the flexibility of a lights-out factory. I was recently at an Austrian PCB facility, and they said they turn on their single-spindle machines at night, everybody goes home, and in the morning, the work is ready to go, and it's all automated.

Palmer: Yes, and they run 24/7 without the labor.

Matties: The other thing we have heard sometimes is that there's not much profit left in circuit boards. But what we find is people keep throwing that money at waste, which Alex at GreenSource Fabrication has proven quite well. The longer we continue to use old and inflexible technology that's not digital and doesn't eliminate human costs, we're throwing money away.

Palmer: Right, and that's why customers have to invest. We've had some strong recent years because customers in North America continue to invest to keep up with the technology and be profitable. As you said, with the old equipment, there is so much waste, and they can't afford to keep making products with them.

Matties: And it's not just about selling; it's about relationships and educating the marketplace to help them realize these benefits that you're talking about. When you talk to companies about this, what do you point out to them?

Palmer: When you talk to people at production, for example, everybody's already there in their mindset, so it seems easy. You forget about the fact that there are people who don't think they can afford to come to the show, so they don't. That's more than half of our market. When you see those customers, they say, "I don't have the funding, and I can't afford to do it. I'm going to milk this equipment," so to speak. It's a tough sell, but you have to talk about the ROI and talk about if you want to be around for years to come, you have to make some investments. It doesn't have to be with us; there are a lot of great equipment manu-

facturers out there, but you have to invest in technology.

Matties: What we've described is island manufacturing, which is what we have in North America: drilling in this room, imaging in another, and plating in a different building, for instance. You have to be able to start somewhere, as you're pointing out. Any incremental changes that we make are important, but there are areas that are going to reward you a lot faster, and those are the areas we should focus on.

Palmer: And the challenge for our customers is trying to figure out which areas those are and where your biggest ROI is going to be. We try to help there, but we're selling our own equipment, so that's where we start.

Matties: In the lamination cycle, there's a lot of sequential lamination going on; what innovations or considerations should someone have right now in the lamination sector?

Palmer: With multiple lamination cycles, process control is more important than ever. Many of the old presses still in operation today open and close and heat up just fine, but controlling the pressure and temperature inside the board is a challenge. With new systems today, the operator can program precise lamination recipes. In addition, once the cycle begins, it's monitored and can be adjusted as necessary. And we are also seeing a migration towards high-temperature lamination. Specific materials that need to be laminated at 750°F push the envelope in terms of the materials and the heating systems used. It's a whole different game once you get to these temperatures.

Matties: We've talked about the Schmoll lines of Burkle. What other product offerings do they have in the PCB sector?

Palmer: Besides Schmoll, we also offer Impex high-precision and scanning machines. Impex is a sister company of Schmoll located in Austria. The machines quickly scan your boards

and provide accurate hole locations and tell you if they're in the right spot. The machines also have the capability of putting a probe down into the hole for inner layer depth measuring.

Matties: What demand do you see for lasers coming into North America?

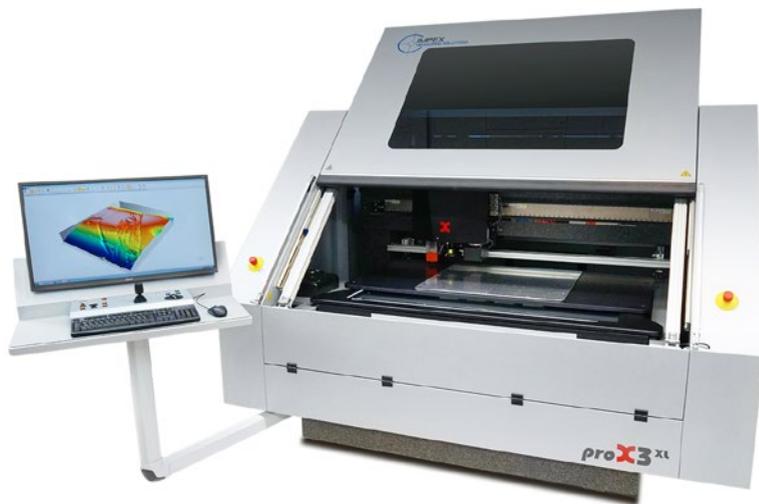
Palmer: Lasers represent our fastest growing business segment. Lasers are used for high-speed microvia drilling, depth drilling, cavity processing, and customers are looking at laser vs. mechanical processing. Laser technology has come a long way, and Schmolz has invested heavily in laser machine development, as you can see when you visit the Schmolz booth.

Matties: When they introduced their laser, it was a smart move, and it was perfect market timing, as the HDI sector was demanding laser drilling.

Palmer: Absolutely, and our first laser was placed four years ago in the Bay Area. Now, we have dozens of machines placed in North America, and we've already sold three at this show. It's an exciting part of our business.

Matties: Let's talk about Schmolz for a moment, which is run by Thomas Kunz and his brother, Stephan. They have been doing this for years.

Palmer: Yes, Thomas bought the company several years ago when it was much smaller. Thomas is the technology driver behind the business. As a whole, the company is equally smart, innovative, and they focus on customer intimacy. Some people think that because Schmolz sold 1,200 machines last year, they did it all in China and only the largest U.S. manufacturers. But Stephan, who manages sales, gets just as involved in a one-machine sale as a multi-machine sale. Schmolz will bend over backward to satisfy the customer, so they're an exciting company to work with.



IMPEX measuring system proX3.

Matties: It's interesting you mentioned China. I went to visit Victory Giant Technology and saw a lot of the Schmolz machines there.

Palmer: It's true; many of the largest manufacturers in the world prefer Schmolz.

Matties: We've been doing business with Burkle for quite a while, and you've found a great place.

Palmer: I really like working with Dick Crowe. As you know, he has tried to retire a handful of times, but now I've asked him to stick around for a while. I can certainly use his wisdom and support, so he's going to do that.

Matties: He's great, and I know he has threatened to retire. Every time, I think, What are you going to do, just sit around and play your guitar?

Palmer: He still does that, but he likes his two hours in the office and his cup of coffee every day, and it's great having him around.

Matties: Kurt, I'm so happy for you. Congratulations on your new position.

Palmer: Thanks, Barry. I'm excited to be in this position and working for a great company. **PCB007**



MilAero007 Highlights



BAE Systems to Innovate Electronic Warfare Jamming Technology for U.S. Army ▶

BAE Systems will create advanced radar jamming technology that will improve air survivability and mission effectiveness for U.S. Army rotary-wing aircraft and unmanned aerial systems.

Communication, Part 6: The Importance of Technology Fit ▶

In the final installment of this series on how PCB fabricators and designers can better communicate, Bob Chandler from CA Design and Mark Thompson from Prototron Circuits discuss the importance of “technology fit” and how this concept impacts the synergy of the two parties involved.

Lockheed Martin GPS Spatial Temporal Anti-jam Receiver System to Be Integrated in F-35 Modernization ▶

Lockheed Martin (NYSE: LMT) received a \$25 million initial contract award for engineering and manufacturing development for the GPS Spatial Temporal Anti-Jam Receiver (GSTAR) system that will be integrated into the F-35 as part of its modernization phase, also known as Block 4.

How NASA Is Helping Humans Reach the Red Planet, Using GPUs ▶

A group of NASA scientists and engineers is working with colleagues from Old Dominion University and NVIDIA to simulate with unprecedented accuracy the physics needed to land the first manned Mars mission. To do so, they’re using the fastest supercomputer in the world, the NVIDIA GPU-powered Summit system at Oak Ridge National Laboratory.

U.S. Chamber of Commerce Foundation Announces Finalists for 9th Annual Hiring Our Heroes Awards ▶

U.S. Chamber of Commerce Foundation recognizes employers and individuals that have gone above and beyond to hire, retain, and empower our nation’s veterans and military spouses.

Cirrus Aircraft Introduces Autonomous Flight With Safe Return Emergency Autoland ▶

Cirrus Aircraft, the global leader in personal aviation, has ushered in a new era of innovation with the introduction of Safe Return™—a revolutionary emergency autoland system that enables passengers to land the Vision Jet™ with just the touch of a single button.

From the Hill: Technology and Reliability Demands Drive Designers and MIL-PRF-31032 Specification ▶

With the future demand for more and more military electronics, certification to the PCB MIL-PRF-31032 specification becomes a business decision for many fabricators. Fluency in the MIL-PRF-31032 language is a key first step to understand the requirements and communicate with the DoD. Mike Hill defines many terms related to this military specification that you should review before informing the DoD of your intent to certify.

Aquatic Rover Goes for a Drive Under the Ice ▶

BRUIE, or the Buoyant Rover for Under-Ice Exploration, is being developed for underwater exploration in extraterrestrial, icy waters by engineers at NASA’s Jet Propulsion Laboratory in Pasadena, California.

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Staying in Your Lane

Testing Todd

Feature Column by Todd Kolmodin, GARDIEN SERVICES USA

Happy holidays! As 2019 comes to a close, I thought I would take a moment and talk about the importance of standardization. When we talk about the standardization of processes, it doesn't necessarily mean that you have to do something the same as the people next door. Sure, there may be some industry guidelines that we all must follow, but there still is a great deal of latitude that allows us to perfect our way of doing things.

Some people may rise in the morning and put their right sock on first, while others may begin with the left. Is that a problem? No, the end result is the same—socks on! It doesn't have to be any different in larger-scale processes. Standardization comes down to an agreement that we are to perform a task or set of tasks the same way every time. Putting your engineering hat on, this provides predictability. If we all agree on how the task(s) should be

performed, we can predict the outcome with a high degree of accuracy.

Now, to begin with, the word “standardization” strikes fear into the hearts and minds of many who think about rules, regulations, problems. Not true! All that it means is that we review a task or set of tasks that we routinely perform and roadmap it. How we perform the task, and which steps are involved and in what order, results in the standardization of that task or process. Standardizing a process is nothing more than mapping the steps involved and repeating them each time to achieve the predicted result. Unfortunately, this is where many attempts at standardization fail.

I've written many processes and standardized numerous activities in the workplace over the years, and I have found areas of concern that usually result in a process failure or standardization breakdown.

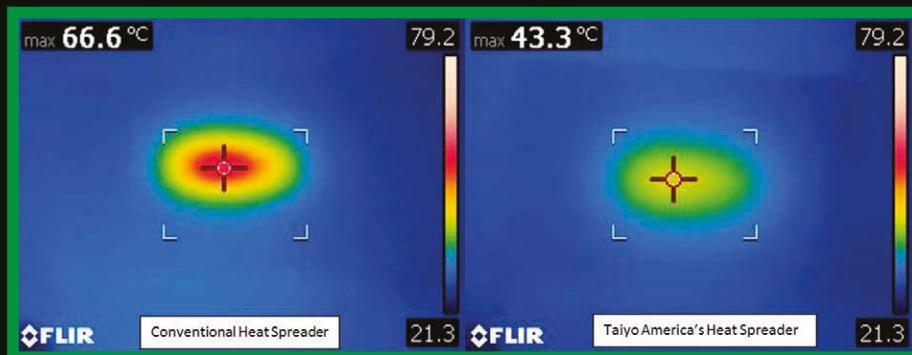


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Let's explore some simple steps in building a process and standardizing it. Here are my 10 steps to building a process and standardizing:

1. Identify the task that requires standardization or process creation.
2. Map the process from a high altitude (i.e., block diagram, flow chart).
3. Zoom in to the individual blocks and expand into macro steps.
4. Zoom in again and expand into micro-steps.
5. Rebuild the pyramid from micro-steps back to the master flow chart.
6. Test your process.
7. Review the continuity of the process.
8. Edit/revise.
9. Retest your process.
10. Release and standardize.

Let's break down these steps even more so that I don't leave you all in a December Nor'Easter.

In step 1, we want to identify what we are trying to accomplish. This may sound easy, but it may be the most difficult task of all. This is where many failures occur and can result in wasted labor, increased cost, and reduced productivity. For those of you involved in the world of ISO, this is an area where the term "risk analysis" becomes very apparent.

For those of you involved in the world of ISO, this is an area where the term "risk analysis" becomes very apparent.

Step 1 identifies a candidate for a process build or standardization. However, just because it has been identified does not necessarily mean it should be committed. What is the benefit of creating the process or standardization? What is the risk of not committing to building or standardizing this process or task?

Some ideas to think about here are whether the task is mission critical or is it a menial task that has no significant impact on the overall end result. Performing a solid analysis here can save time and money in the long run but combatting "over-standardization," or as I put it, "painting oneself into a corner."

In step 2, we have decided that we need to proceed and build this process or standardization. A big mistake here is that many try to throw something together; "Write down how you do that task and bring it back." Sound familiar? Send two people out on that same task, and I guarantee you that you will have two different versions of that same task from each of them. What needs to be done here is a map of the task, including where it starts and what we want the end result to be. Depending on the process, this can be a rather simple map, or with more complex operations, it could look like the Dallas 635 freeway at 5 p.m. Make general diagrams or flow steps. I use the term "high altitude" here, as we want a global view of the process requiring standardization.

Step 3 takes us down to a low altitude and breaks down the blocks. In a simple process, this may not require too much effort. In larger tasks, this is where a team approach works very well. Instead of just one person writing steps how they perform them, there is a collective approach to the task which optimizes it for the best flow. This is where we identify sub-processes that may affect the success of this step. This lower altitude pass is a necessary step to prevent missed opportunities for success.

In step 4, we are now on the ground or in the trench. We expand the tasks within our blocks and really turn the wrenches. This is the fine print of the task down to dial settings, colors to use, where to place what, use what tools, etc. Don't forget safety concerns, as well. We don't need an unexpected OSHA visit!

We start building our pyramid in step 5. We combine steps 4 through in reverse order to bring our process or standard to maturity. Work instruction notes from the micro and macro levels are combined to validate the process map. This is where we find whether we are in our lane or experiencing a train wreck.

In step 6, we have a written process or standardization candidate. Again, this is another area where failure can occur. If the process or standard is released at this point, you may find that the result may not even be close to what you outlined in step 1. Unfortunately, for many, this is the case and can lead to unpredictable results, loss of time or materials, and ultimately, failure. The process needs to be tested. This should not be done by any person writing the micro and macro levels of the process or standard. This should be an independent third party. This provides an unbiased view of the task and will quickly identify inconsistencies. The result of this step is really a “go or no go” on whether the process or standardization is functional.

With step 7, we want to know the continuity of the process or standardization with respect to ergonomics, movements, tool accessibility, repetition, lighting, etc. If the steps of the task are correct from the testing done in step 6, are they being done efficiently? Just having the steps for repeatability doesn’t mean it is efficient. Here is where efficiency is taken into consideration and applied.

In step 8, we review the actions of steps 6 and 7. Adjustments are made to correct inconsistent results and to improve efficiency. I cannot state enough how important steps 6 and 7 are when building a process or standardizing. Omitting those steps and going right to a mature process is almost a guaranteed failure.

After the corrections and optimizations are done in step 8, we move to step 9: test it again. This time, use another third party candidate to perform the tasks. Use a fresh pair of eyes and abilities to perform the tasks. We may identify yet another anomaly that was not detected previously. This also adds to the continuity of the process or standard. We want it capable of being performed by anyone qualified to perform the task or set of tasks outlined with the same predicted results.

Step 10 is the home stretch. We have a final working process or standard. It’s ready for release, right? Not so fast. Here is another pitfall that many fall into; release the document, post it to the databases for online reference, and it’s done. Here, we must remember that we need

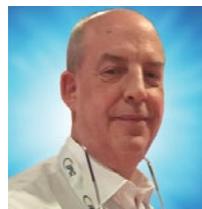
to educate those who are in this department, area, or team that will be responsible for the results. That means training and review of the process or standard. We can write standards all day long, but if our teams are not educated or aware of the standard, how can we hold them to it?

We can write standards all day long, but if our teams are not educated or aware of the standard, how can we hold them to a standard?

Conclusion

Hopefully, I’ve given you some solid building blocks for creating your processes or standards within your circle of the world. Of course, there are other guidelines and building techniques out there, but I’ve found a very high degree of success with the tools I’ve outlined above. In my time doing process audits and standard reviews, there is an overall design which can be characterized by “staying in your lane.” We’ve all seen it; we may all be driving in the same direction to the same destination, but there is always that “one guy” who is drifting over the lines, looking at his cellphone, eating a burger, or who knows what. Sure, he is probably going to get there, but with reduced efficiency, more steps and unnecessary corrections (and maybe a ticket too!).

Thanks for reading this year. I appreciate your readership! I hope you all have a great holiday season as we look forward to a prosperous 2020. **PCB007**



Todd Kolmodin is VP of quality for Gardien Services USA and an expert in electrical test and reliability issues. To read past columns or contact Kolmodin, [click here](#).

PCB Manufacturing From a European Perspective

Feature Interview by the I-Connect007 Editorial Team

The I-Connect007 Editorial Team recently spoke with Stephan von Barga and Hüseyin Anac, both of NCAB Group's Munich office, during AltiumLive in Frankfurt. They discussed the European market, as well as how they support their customer base in Europe and determine when it's the right time for moving production to Asia.

Andy Shaughnessy: Nice to meet you both. Stephan, can you give us a quick background of the company and the Munich office?

Stephan von Barga: We are an integrated PCB producer, which, in practice, means that we work closely with both our customers and our factories. We do not own our factories, but we "own" what is most important: the relationship and process with both customer and factory. We have a big team in China, where most of our PCBs are produced, and

we are on-site at the factories to secure high-quality factory performance and delivery precision. Our Munich office is one of many local offices worldwide. By being local, we can support our customers with service and technical expertise in their local language on their terms.

Barry Matties: When you deal with the customers here in Europe, what requirements or trends do you see in this market?

Hüseyin Anac: Designers often ask for prototypes and if we can provide quick turnaround PCBs from our factories in the U.K. and in Southern Europe. Designers want to have the board in two or three days. This is possible, depending on the technology of the board. It's not possible in three or five days if the factory is in the Far East. The huge advantage of working with us is that you get the boards from the beginning out of the serial fabrication plant; the material, stackup, and panelization will be the same as the prototypes.



Stephan von Barga



Hüseyin Anac



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NCAB's China facility.

That means on the front end, you have to wait a few days more for your prototype board, but time to market is way shorter. You may have five days longer lead time for your prototypes, but your time to market is shorter. This gives our customers a competitive advantage to place their products earlier into the market.

Shaughnessy: You'll have consistency.

Anac: Exactly, and directly from the start of a project through to volume production.

Shaughnessy: What segments do you serve primarily?

Anac: Primarily, we serve the industrial sector. We are also doing medical and railway solutions. In automotive, we're doing trucks and transportation, but not Tier One automotive.

Matties: We're here listening to the designers, and one of the core messages from the instructors is to talk to the fabricators as early as possible in the design cycle. Where they're using a service like yours, they're not talking to the manufacturer. How do we get around that?

Anac: That's why we are here with our local engineers to support. Many times, you get the

data package, the whole setup, and all things are qualified, and the layout is done. But the hot topics, like cost drivers and reliability improvement as well as design for manufacturing, start with the design. At this stage, we can help designers to improve their projects.

Matties: But the instructors are talking about when designers are starting their designs, and they need to pick their fabricator. And you use multiple fabricators in China or in Asia. Are all the factories that you use located in China or in Taiwan and other areas?

Anac: Currently, most of our factories are based in China. The whole infrastructure is there, from chemical suppliers for copper plating or surface finish to all global players of laminate producers. They all have their plants in China, and the best PCB factories are also there.

Matties: If they want to talk to the fabricator, how would they do that working through your organization? Is that a possibility?

von Bargaen: It's not necessary to talk directly to the factories because that's our job. That's why we have local companies with local teams, including engineering departments, working closely together with the customer. Our factory management team in China is in full control of the factories' performance. We provide this service to our customers so that they can focus on their business. But if a customer would like to visit a factory, it's no problem. It's possible because we are very open about what we do and we have a very strong relationship with our factories.

Matties: That makes sense. If they want collaborative engineering, they're going to come to you as the engineering representation of the factory for their DFM and all of the other considerations.

Anac: Exactly. And that is also what makes us different from other suppliers. We have our own NCAB people in the factories—our factory management. We are in direct contact with the

factory. This way, it's easier to implement requirements of safety, special requirements for final quality checks, or general specifications from customers. If a customer has an idea, we can support it from the start. This already starts with choosing the right factory with the capability to produce the boards as required.

Shaughnessy: They can talk to you instead of having to deal with the time difference in China.

Anac: Yes. And we are PCB experts. What we see in Europe is that the global markets are shifting. If you compare it to 25 years ago, there were about 400 PCB manufacturers in Germany, and now, there are about 45. The experts from German PCB productions are retiring, and we see that even the bigger companies have some lack of knowledge about PCBs. We are now providing this expertise to our customers. We do not own factories or have any shares in our partner factories. However, we own what is most important when it comes to delivering the best quality at the lowest sustainable cost; we own the relationship with the factory, which is crucial.

Matties: What are the trends in terms of orders? When you look at your forecast, what are you projecting?

Anac: The forecast is that it's slowing down a bit, like all global markets, but it's not as critical as the crisis in 2008. We are still growing.

Matties: How would you say the general economy is in Germany?

Anac: The same condition. It's slowing down a bit, but still strong.

von Bargaen: I don't see a big problem for us because we are in a good financial situation. And from my side, the more the market is going down, the bigger is our chance to win more market share because we have a solid foundation and a great team to provide support and quality to our customers.



NCAB's Illinois facility.

Matties: There are some pretty sophisticated and automated facilities within an hour or so of where we are. What impact would that have for the German customer? Are they first looking to produce in Germany, or are they determined on being in Asia? Is the cost differential that much?

Anac: It's different and depends on their application, of course. We have examples from the same customer producing one part of his products in Germany and the other part in the Far East. Another example is military PCBs; these boards are only allowed to be produced in Germany or the European Union.

Matties: Is there a line of separation where you decide to do something more high-tech here in Germany versus something in China?

Anac: That's a good question. We see that the investments in the PCB factories in China are huge. They are world-leading and have the newest PCB plants. All of the machinery, including drilling machines and plating lines, are all state of the art. Your iPhone is produced in China, for example. They are leading and high-tech.

Shaughnessy: Do you do HDI boards?



NCAB's New Hampshire facility.

Anac: Yes. We do almost everything, such as HDI boards, blind vias, buried vias (stacked and multiple steps), flex-rigid, etc. We have some examples in our booth here at AltiumLive.

Matties: You have spent three days here at AltiumLive. What have you learned that you will apply to your business?

Anac: We are a hotspot for people who are creating designs, and you will get first-hand information about what is important to them. We have received many questions about our design guidelines; we have them available for standard multilayer, HDI, rigid-flex, and semi-flex. They can be downloaded from our website. We are also looking forward to implementing all our guidelines into the Altium layout software. It's easier for designers. It means one click, and all DRCs are loaded. And, in general, we have found this to be a great and very well-organized event.

Matties: What do you think are the greatest challenges that a designer faces today?

Anac: Miniaturization on the boards, and the requirements of the application. Overall, you can say PCB designers face or consider so many topics because the spectrum of PCB is very wide. It starts at electrical engineering, and then you need knowledge about PCB materials, capabilities, applications, production,

assembly, and much more. For example, if you have an optical board, it's totally different from a board that is designed for high-power applications. We are going to customers to ask the right person—the designer—"What is the background? What do you need?" With those answers, we can provide solutions or improve existing projects.

Shaughnessy: Do you see more optical boards?

Anac: It was one example. If you have a high-speed optical board, there are some other rules for design, as for a high-power board. That also means you have other requirements for production, and we have to choose the right factory. We know which factory is best suited for each application. Our variety of applications is wide and includes almost all classes.

Shaughnessy: I guess that's where you come in, right? Because you speak the designer's language.

Anac: Exactly.

Matties: What advice would you have for a designer today?

Anac: Talk to your PCB supplier as early as possible. We have some very interesting speakers here, and that is also their advice. Talk to your manufacturers. Communication and a close relationship is the key.

Matties: And to be clear, NCAB only does bare board production, correct?

Anac: Producing PCBs is challenging, and yes, we only do one thing and want to do it 100%—no assembling, stencils, laminates, etc. We produce PCBs sustainably, on time, with zero defects and at the lowest total cost.

Matties: Thank you both for your time.

Anac: Thanks.

von Bargaen: Thank you. PCB007

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New Developments in ENIG

The Plating Forum
by George Milad, UYEMURA

Electroless nickel immersion gold (ENIG) has been around the printed circuit industry for more than 25 years. The first version of the IPC-4552 ENIG specification was issued in 2002. Initially, the specification only addressed tin/lead solder; now, lead-free solder, like SAC 305 and its variants, dominate soldering in electronics. Although the occurrence of corrosion was recognized, a better understanding of the defect has led to a series of improvements over time.

Today, it is well established that Ni corrosion occurs in the immersion gold step, and the most important method for eliminating the defect is through process control. ENIG is a complex chemical process with multiple process steps, and each step must be completed successfully before proceeding forward. ENIG remains a very popular surface finish and offers a series of benefits at assembly: it is easy to inspect, has an extended shelf life, and is suitable for a wide range of assembly applications.

The IPC-4552 Rev A, issued in 2017, specifies the deposit thickness: nickel from 3–6 μm (120–240 μnis) and gold from 0.04–0.1

μm (1.6–4.0 μins). The upper limit for gold at 0.1 μm (4.0 μins) would require an extended dwell time in the immersion gold bath. The extended dwell time makes the deposit susceptible to nickel corrosion. The recommended immersion gold deposit thickness is 0.04–0.07 μm (1.6–2.8 μins). If a higher gold thickness is a design requirement, an alternative to immersion gold should be used for deposition. Two available alternatives are reduction-assisted immersion (RAI)

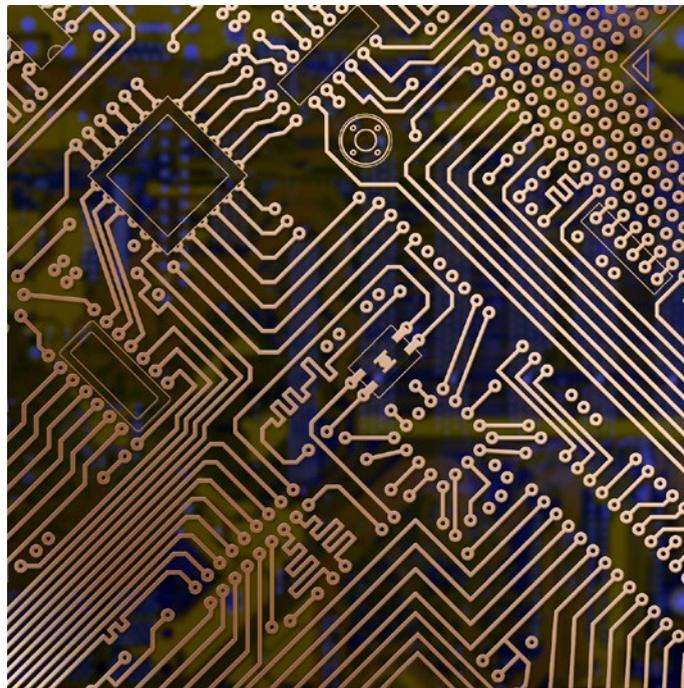
gold and electroless gold.

ENIG Pre-plate: Tin Stripping and Solder Mask Preparation

Controlling the outcome of ENIG plating starts with the parts coming to the line; parts must be free of tin and organic residues. Tin is used as an etch resist during the circuitization of the board. Tin must be

completely stripped to allow for uniform catalyzation of the copper surface. Residual tin interferes with the deposition of the palladium catalyst or activator.

The copper surface coming to the ENIG line, in most cases, follows the application of sol-



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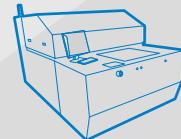
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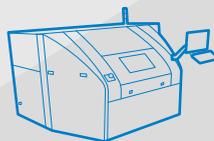
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der mask. This involves cleaning and roughening the copper surface, the application of a photoimageable mask, tack drying, imaging, developing, and curing. Attention to the details of processing solder mask is paramount to achieve the desired ENIG deposit. The prop-

The copper surface coming to the ENIG line, in most cases, follows the application of solder mask. This involves cleaning and roughening the copper surface, the application of a photo-imageable mask, tack drying, imaging, developing, and curing.

er adhesion between the mask and the copper surface has to be achieved. After development, the sidewall should be straight, with no signs of negative or positive foot, and there should be no organic residues left on the copper pad surfaces. This is particularly important if the design includes solder mask-defined pads. Organic residues, like tin residues, contribute to the non-uniformity of the Ni deposit. In addition, monomers from partially cured solder mask leach out in the electroless nickel bath and contribute to instability, reduced deposition rate, and shorter life of the bath.

ENIG Pretreatment

The objective of pretreatment is to ensure a pristine copper surface to ensure an even/uniform catalyst deposit. Pretreatment involves a series of steps, namely cleaner, microetch, and acid predip. The cleaner serves a series of functions: the detergent component removes soils and organic residues (fingerprints), and the acidic component removes oxidation and the surfactant present wets the surface. The new development in cleaners is the use of low

surface tension surfactants. A properly wetted surface will help dislodge any entrapped air in the narrower vias. Vibrating the parts in the cleaner bath is recommended for high aspect ratio holes and small vias. Good rinsing should follow the cleaner.

The microetch removes a layer of surface copper and modifies the surface topography. The proper choice of microetch can effectively reduce the profile of the copper surface that was previously roughened to ensure proper solder mask adhesion. Peroxide/sulfuric based micro-etch is the preferred choice here. Usually, 30–50 μm of copper are removed. This should be monitored and maintained. Good rinsing should follow the micro-etch as well.

Failure to rinse off all microetch residues, particularly from small holes, will interfere with the immersion (charge transfer) based palladium catalyst deposition. A heated sulfuric post-dip is recommended here. This step helps in removing any traces of oxidant trapped in small holes. Again, this followed by rinsing.

If all the aforementioned items adhered to, the copper surface now has a low profile, is organic residue-free, oxidation-free, and, more importantly, charge neutral.

The Catalyst/Activator

The catalyst bath lays down the foundation on which the nickel, and eventually the gold, will deposit. The bath is, in most cases, composed of palladium sulfate in a sulfuric acid low-pH medium. Here, the Pd ion in solution will be reduced to Pd metal at the expense of copper metal (the substrate) that is oxidized to the Cu ion. This is an immersion reaction and is based on electron transfer, where a metal ion higher up in the electromotive series will displace a substrate metal lower in the series. Nickel will not plate on a non-catalyzed copper surface. Proper rinsing is important after the catalyst bath to ensure no drag-in of Pd into the electroless nickel bath. The catalyst is a very thin layer applied to the copper surface to initiate the Ni deposition and is not a significant part of the ENIG finish.

The Electroless Nickel Bath

Electroless nickel (EN) baths are formulated to give a specific range of incorporated phosphorus, expressed as a percentage range, in the deposit. A low-phos deposit would range from 4–6%, a mid-phos deposit would range from 6–8%, and a high-phos deposit would range from 8–10%. Mid-phos nickel is widely used for ENIG application, where soldering and corrosion control are required. With the emphasis on eliminating nickel corrosion, newer formulations now favor a higher phos content (> 8%) to further expand the corrosion control window.

EN is a well understood multi-component bath. The primary constituents are nickel sulfate as the source of nickel and sodium hypophosphite (hypo) as the reducing agent. The latter supplies the electrons needed to reduce the nickel ion to the nickel metal. The hypo reaction also produces phosphorus and the byproduct orthophosphate. The phosphorus is incorporated in the electroless nickel deposit. The buildup of the orthophosphate byproduct in the bath determines the life of the bath.

The nickel deposition reaction requires a specified temperature (ranging from 175–185°F) and a weak acidic pH medium. In addition, there are a series of other important proprietary constituents that have a direct impact on the quality of the nickel deposit, including stabilizers, surfactants, complexing agents, accelerators, and buffers. Different vendors or suppliers may use various ingredients to achieve the goal of a uniform deposit with an optimized deposition rate and achievable/reproducible operating conditions.

The nickel bath requires good management as it is a dynamic, ever-changing bath. The nickel and the hypo are consumed during the deposition; in addition, there is a buildup of the byproduct orthophosphate. The pH of the bath must be controlled within a narrow range. It is necessary to replenish those ingredients that are being used up. This is best achieved by a controller that will automatically replenish the desired components as well as maintain the pH. To compensate for byproduct buildup, newer, more sophisticated controllers increase the nickel concentration and the pH operating

ranges, as the bath ages to maintain a consistent rate of deposition.

The Immersion Gold Bath

To minimize corrosion, new developments include:

- Neutral pH formulations for reduced corrosion
- Reduced gold concentration for cost control
- RAI gold for corrosion elimination

RAI gold is a mixed reaction bath that initiates as an immersion bath and continues as an electroless bath. It is capable of depositing 4–6 μins of gold with no corrosion. RAI gold is ideally suited to deposit thicker gold if it is a design requirement.

The nickel bath requires good management as it is a dynamic, ever-changing bath.

Conclusion

The ENIG line is one of the most complex chemical lines in a board shop. It requires a good understanding of how the process works and the critical parameters that must be maintained. The ENIG line has little tolerance to deviations, particularly to extending the bath life of any of the process steps. Shops that have good engineering and documentation of the manufacturing process, coupled with a dedicated, experienced ENIG operator and backed by a capable analytical laboratory, run defect-free ENIG day in and day out, producing a consistent product that meets customer requirements. **PCB007**



George Milad is the national accounts manager for technology at Uyemura. To read past columns or contact Milad, [click here](#).



Supplier Highlights



Technica USA Announces New Equity Investment to Fund Growth Plans ▶

Technica USA, located in San Jose, California, announced that they reached an agreement on an equity investment that will be used to expand the company's already successful business model.

Meet George Milad, I-Connect007 Columnist ▶

Meet George Milad, one of I-Connect007's newest columnists! George's columns will cover PCB plating, IPC specifications, and more. George is the recipient of the 2009 IPC President's Award, chairs the IPC Plating Committee, and is a permanent member of the IPC Technical Activities Executive Committee.

SCHMID Group Installs PlasmaLine at Hofstetter PCB AG ▶

SCHMID Group installed the first PlasmaLine comprising ICP etch and sputter deposition of its Korean JV SCHMID AVACO at Hofstetter PCB AG in Switzerland.

Four Key Developments From the TPCA Show ▶

The recent TPCA Show 2019 attracted 31,926 attendees who had the chance to visit 1,432 booths erected by enterprises from 420 countries. In addition, the topics brought forth by the 57 seminars and keynote forums held at the recent IMPACT 2019 have directed the future trends of the PCB industry.

It's Only Common Sense: The Right Way to Brand Your Company ▶

Columnist Dan Beaulieu has helped a lot of companies develop their brand, and believes the best way to get started is to find their story. It's always

there; you just have to find it. Like the Michelangelo anecdote that claims he was fond of essentially saying, when faced with a huge block of marble, "There is a beautiful statue in there; it's just my job to find it." The same applies to a company's story. Here are some of the questions Dan asks the companies he works with.

Chris Hrusovsky Joins IEC ▶

Chris Hrusovsky has recently joined IEC (International Electronic Components). Chris will be building IEC's Central, Midwestern, and Eastern region sales and service capabilities.

Multilayer Press Technology Using Magnetism to Produce Lamination Heat ▶

A revolutionary concept in multilayer press technology has been developed that uses electromagnetic energy to heat the existing stainless-steel separator plates with a never-before dreamed-of accuracy and precision. The heating and cooling systems—embedded within a robust hydraulic press inside a vacuum chamber design—are controlled using a temperature feedback loop that guarantees perfect fidelity between the press recipe and the press result.

Miniaturization Continues: Day 3 productronica Coverage ▶

The conversations on day 3 of productronica continued, including topics such as flexibility, 5G capabilities, and increased data and intelligence. The theme from test and inspection equipment providers included increased capabilities in sensing, material handling, and visual inspection technologies. And through it all, one common perspective emerged time and time again: PCB manufacturing is now approaching the levels of line, trace, and component density that were once limited to the surface of a silicon wafer.



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Planning a Successful Technical Conference

Feature Interview by Nolan Johnson
I-CONNECT007

Amanda Lange founded DINEvent and has evolved her company into an active events planner and management company with a global client base. In this interview, Nolan Johnson asks Amanda to share how a technology company should get started with a technical conference for customers.

Nolan Johnson: Can you tell me a little bit about who you are, what your company does, and why you're at AltiumLive?

Amanda Lange: Sure. Thanks, Nolan. We have been working with Altium since 2012, but have been partnering with them on AltiumLive since 2017 for their first conference. I'm the founder and CEO of DINEvent based in Phoenix, Arizona. We work with companies from the banking, e-commerce, and technology industries, so we have a wide perspective of trends within the event space.

With Altium, in particular—and a lot of our more technical clients when they put on events like AltiumLive—one of our most critical missions is to ensure that the client is focusing on content. Attendees, especially in highly tech-



nical industries, are there primarily to gain knowledge and information. Of course, there's the fun aspect of the conference too, like the robot challenges, something that the attendees look forward to year after year.

Johnson: DINEvent is the name of your company; it seems you might have started in a niche that's a little bit different.

Lange: Yes, we did (laughs).

Johnson: Tell me about that.

Lange: I founded the company in 2010 in Minnesota. I basically started as a concierge. I was working for a local restaurant group, running their private dining program for approximately 10 restaurants, when a client said, "I need 50 people in St. Paul." And I would say, "I don't have private dining for 50 people, but this restaurant across the street can help you." I found myself sending business down the street, and I realized this was ridiculous; I worked hard to cultivate those relationships, and then I sent them to my competitor.

Ultimately, I quit my job and built a book of business where clients would come to me, and I could place them at any restaurant; then, that restaurant was required to pay a commission. My company was first founded on a referral-based commission model. As time went on, my clients started asking for additional services, saying, “Thanks so much for booking us at this restaurant, but can you help us with the program/event itself?”

Johnson: That was a pivot moment for your business. What does your portfolio look like now?

Lange: We work with a lot of Fortune 500 companies. We’re going to do another pivot within the next 18 months by adding a third service to our organization. Our book of business includes big companies like Amazon and Google all the way down to local law firms in many states. We’re a global company now, so we work with restaurants, hotels, and especially event venues all across the world.

Johnson: If a technical company is looking to create a user group event, or to bring together customers, and that company creates a program or mini-conference, when do they need to book with an event manager such as yourself?

Lange: The answer to that question is twofold. We would love the opportunity to work with a

client like that. The advice that I would have for someone wanting to host an event is it’s so important for super technical companies to host those conferences, not in a stale hotel space or your typical board room. That’s one thing I admire that Altium does so well: They select a venue with a beautiful backdrop and scenery at the Loews Coronado Bay, which is a draw in and of itself. Now, you’re pairing what a non-industry person would consider dry content—something that is highly technical—with a beautiful experience, which softens the overall content.

Johnson: If I’ve been asked by my employer to run a program or launch a new annual conference for my customers, you’re going to want a checklist of things that you need to know. Walk me through that.

Lange: First and foremost, who are you? Who is your client, and what is the profile of the attendee? Know your customer; that will drive the geography. Once you identify where your clients are coming from, then you’ll have to choose a site. Are a lot of individuals that are coming from the East Coast or West Coast? I know people can travel easily, but a place that’s central and easily accessed is a critical component to ensuring that people attend your conference. It should be easy to get to and have accessible international flights. We would obviously need to know your budget—“the big B”—and the number of guests and speakers.

Johnson: Let’s start to put together the program. I’m guessing your team is not going to be the ones who create the program from scratch.

Lange: No, that’s pretty technical. But like this year, we assisted in managing speaker deliverables, for example. There are a lot of assets that go into every speaker from biographies to abstracts, headshots, and the presentation itself, we help manage those relationships, ensure hotel rooms are booked, etc. So we get involved with that piece. DINEvent is especially strong at helping with the logistics.



Johnson: Your client hands over those parts so that the technical can focus on the “meat” of the program and make sure they have the right subject-matter experts. What else do you find useful from your clients to help move things forward and make it faster?

Lange: With Altium, we’re involved in a lot of the food and beverage selections, so we make sure that we create the most value with your budget. We’ll go through the menu and negotiate pricing and beverages packages to maximize the use of every dollar that you spend. It’s easy to look at menus and want certain things, but what is the perceived value of mini donuts, for example?

Johnson: And you have a lot of experience and can give some expert advice on what does and doesn’t work.

Lange: Right, and what sounds good but isn’t in actuality.

Johnson: At AltiumLive, for example, they also include some evening activities to create some team building and entertainment. Part of the reason why, I suspect, is because this is a destination resort and spa. We’re across the bay from downtown San Diego, so leaving the site takes time and thought.

Lange: That’s intentional. The reason that this property is selected is not just because it’s beautiful, but it’s also to ensure that you cultivate a networking culture and keep a cohesiveness with the attendees. Because Altium and I agree with the mentality that networking is where an event prospers. Relationships and ideas are cultivated at events like this; if you go offsite with your buddy that you came here with, that’s not going to happen. Another thing that we do, which is smart, is that for the robot challenge, as well as dinner on the second night of the summit, when individuals enter the ballroom for dinner, they draw a number from a fishbowl. This ensures that people sit at random because we want to cultivate a networking and idea-sharing culture.



Johnson: Networking is such a valuable result of that. As the evening program initially developed between you and Altium, who drove that?

Lange: Altium came to us with the whole robot challenge, and it works. It has become this tournament-style mentality where attendees remember their teams and the places they got every year. During planning, I asked if we should change it up. I met so much resistance and rightfully so because, as an event planner, we have to keep things new and fresh, but the robot challenge is a staple of the event.

Johnson: You’re spot on. What keeps it fresh is the intentional creation of different teams and the history from previous years. Having been there, I could easily imagine somebody saying, “I was on your team last year. I know your weaknesses. I am taking you down.”

Lange: Totally. And it’s cool that we see a lot of familiar faces. A lot of alumni come year after year. I’ve been doing this event since 2017, and I see probably a third of the attendees each year.

Johnson: Can you talk to us about how the robot challenge works?

Lange: After the dinner, every table, which has 10 people, receives a package with all the parts of the robot disassembled. The instructions and a remote control are in the box, and the group of likely strangers works together as a team to build the robot with 30–40 parts. The first round of winners is the first to complete



Johnson: What's the hidden secret to putting on an event like this?

Lange: You can have fantastic content, but unless people leave feeling some sort of connection to the conference or magical experience, I don't know that it holds the same gravity.

Johnson: How many people do you have in your company?

the robot assembly. Once the next team has their robot assembled, then they start battling. The robot has a scorpion-like tail with a point at the end of it. Everyone has two balloons on the robot, and then you use the robot's tail to pop your opponent's balloon. Once your balloons are popped, then you're out, and the successor continues their challenge to the next robot.

It's so fun for us to watch the whole thing unfold. It's like kids in a candy store; everyone has a blast. They get so into the instructions, and the creativity that happens is amazing. One time, an attendee put a beer bottle on a robot to weight it down. And as an event planner and a type-A person, I lose it a little bit because it's controlled chaos, but from the user experience, no one else is the wiser, and they have a blast.

Johnson: There's jousting through the whole ballroom, and things happen very quickly as everybody assembles their robots in the first rounds, and then the tables are moved to make the arena and start the battles. It's pretty cool.

Lange: It's hardcore.

Johnson: And that creates a huge amount of camaraderie and connection in this community. Friendships are being made, which is huge. You don't get that when people disperse.

Lange: It's critical to keep the focus on the property, especially for events like this.

Lange: I have three full-time employees.

Johnson: And then you hire for events as well.

Lange: We have a great network of friends, colleagues, and folks in the industry that we'll pull into our organization. It's nice to have the ability to expand and contract, as the demand of business is seasonal.

Johnson: When is your busy season?

Lange: We're busiest in the spring and fall. We're not as busy around the holidays because people don't meet, nor are conferences held as much in the summertime. For example, in August, most people are on vacation, and in December, everyone's on holiday. Our busiest months are March and April, and then September and October.

Johnson: You're in a place to see some technical conferences in both similar and diverse industries. How does this model stack up?

Lange: It's strong, and the nice thing about this event is that the team is adaptable; they invite feedback from surveys, listen, and adapt to the needs of the attendees by making changes.

Johnson: Thank you, Amanda. This has been insightful.

Lange: Thanks for asking me to join you in conversation. **PCB007**

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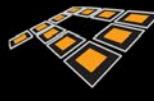
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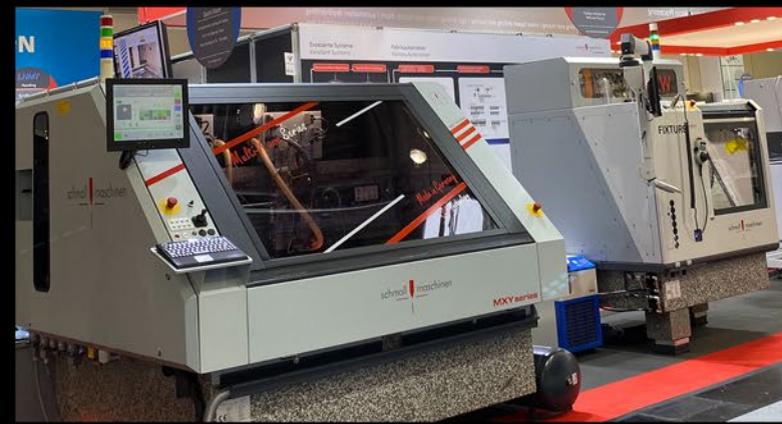




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The Founding Fathers of Quality: W. Edwards Deming

The Right Approach

by Steve Williams, THE RIGHT APPROACH CONSULTING

This column begins a series of seven installments, each highlighting one of the seven founding fathers of quality (as selected by the author). It is important to understand and acknowledge their revolutionary contributions that still form the foundation of modern quality practices.

The Founding Fathers of Quality

Companies like Toyota are often touted (with good reason) as the gold standard for quality system models. Toyota's production system (TPS) has been highly publicized and gained increasing acceptance in American manufacturing operations over the last decade or so. What has not been highly publicized is the fact that many of these concepts originated in America, and quality pioneers like Dr. W. Ed-

wards Deming had to take their show on the road to Japan only after being rejected by the leaders of American industry. The contributions of such legends as Dr. Deming, Dr. Juran, Philip Crosby, Dr. Ishikawa, Dr. Shewhart, and Shigeo Shingo had such an impact on the world that they truly are the founding fathers of modern quality.

Dr. W. Edwards Deming (1900-1993)

Dr. Deming is perhaps best known for his theory that most problems are systemic and his not-so-subtle reminder that management owns the system. In emphasizing management's responsibility for systems, Dr. Deming noted that workers are responsible for only 10-20% of the quality problems in a factory and that the remaining 80-90% is under man-

**It is not enough to do
your best; you must
know what to do, and
then do your best.**

— W. Edwards Deming

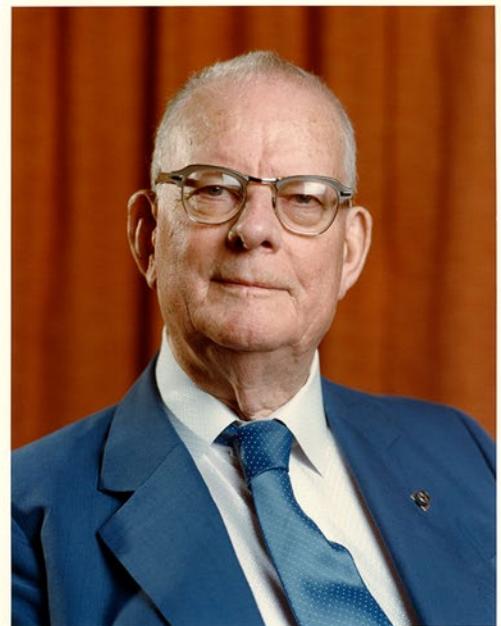
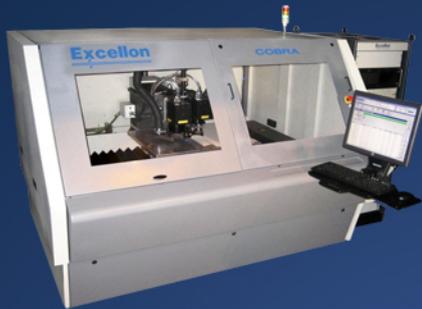


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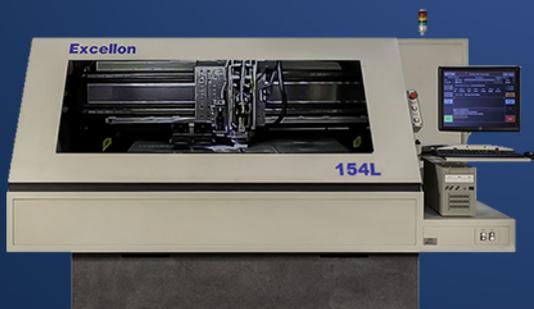
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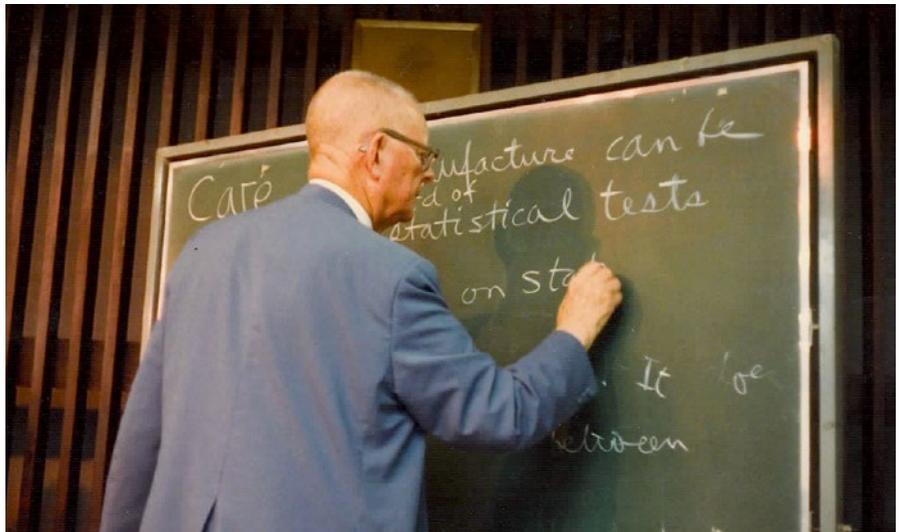
154L
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HS-2L
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agement’s control—the systems. This position was a bit revolutionary for America in the 1950s and was a major reason his philosophy was not well-received when originally introduced. Dr. Deming had many influential quotes over his illustrious career, but as a personal note, it was his famous quote—“It is not necessary to change. Survival is not mandatory.”—that was the inspiration for the title of my book *Survival Is Not Mandatory: 10 Things Every CEO Should Know About Lean*.



Deming writing about statistical testing—1980s.
(Photo courtesy of The W. Edwards Deming Institute®)

Core Attributes of the Deming Philosophy

The framework for Dr. Deming’s philosophy is his famous 14 points for management, which focus on process improvement through statistical analysis instead of relying on inspection. These 14 points stemmed from Deming’s obsession with variation. Deming saw variation as a “disease” that threatened American manufacturing; the more variation, the more waste. Dr. Deming is credited with turning around Japan’s product quality and helping to rebuild the country into the automotive and electronics manufacturing power it has become. In 1951, The Deming Prize was established as one of the highest awards on TQM in the world.

Deming’s 14 Points for Management

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business and provide jobs.
2. Adopt the new philosophy. We are in a new economic age. Western management must awaken to the challenge, learn their responsibilities, and take on leadership for change.
3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag (lowest bid mentality). Instead, focus on the total cost. Move toward a single supplier for any one item, building a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service to improve quality and productivity, and thus constantly decrease costs.
6. Institute training on the job. Employees need to know not only how to do a job right, but why they are doing the job.
7. Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of an overhaul, as well as supervision of production workers.
8. Drive out fear so that everyone may work effectively for the company. Eliminate finger-pointing and foster an environment of empowerment and trust.
9. Break down barriers between departments. People in research, design, sales, and production must work as a team to foresee problems of production and in use that may be encountered with the product or service.
10. Eliminate slogans, exhortations, and targets for the workforce asking for zero

defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the workforce.

11. Change the focus from sheer numbers to quality. Eliminate management by numbers and numerical goals. Substitute leadership.
12. Remove barriers that rob people of their right to pride of workmanship. This means, among other things, the abolishment of the annual or merit rating and management by objective.
13. Institute a vigorous program of education and self-improvement. Skills and job knowledge should be a lifetime activity.

14. Put everybody in the company to work to accomplish the transformation. The quality transformation is everybody's job.

Conclusion

Dr. Deming's focus on statistical control and variation reduction have stood the test of time and are still fundamental aspects of any good quality management system. His contributions show just the beginning of how influential and ahead of their time the founding fathers of quality were. **PCB007**



Steve Williams is the president of The Right Approach Consulting. To read past columns or contact Williams, [click here](#).

productronica 2019: Innovative Multilayer Press Technology

Pete Starkey and Víctor Lázaro, R&D manager/technical director at InduBond, discuss the operating principles of the InduBond X-Press and explain how it achieves enormous energy savings and improvements in lamination uniformity.





Process Control **Essentials** in the Plating Line

Interview by Barry Matties
I-CONNECT007

Barry Matties and Rick Nichols, process engineering director at AWP, discuss process control, including why it's important to establish a baseline and embrace new technology.

Barry Matties: From a process control engineering point of view, what do you think people need to know about their process?

Rick Nichols: The most important thing they need to know about the process is the baseline. They need to achieve a baseline from which they can make adjustments to keep and dial into. If you start without a baseline, you just get lost. You have to alter to get the result you need, but as little as possible. You need a baseline from which you can deviate, but try not to deviate too much.

Matties: You have to have an intention to capture a baseline rather than just process data, so there's a difference.

Nichols: Absolutely, because with typical chemistry, you usually have temperature and concentration of multiple parts, like processing time.

Matties: There are environmental aspects.

Nichols: Correct. There are tactics. If you do a wide range of products, you have lots of possibilities to change stuff, but it's much better to change the dwell time and temperature and keep everything else the same. In an electroless process, for example, you may wish to increase or decrease your deposit thickness, and that is best achieved by extending or decreasing dwell time rather than changing the chemical aspects of the bath.

Matties: A lot of these now are still manually controlled processes. In the U.S. and Germany, we're going to start seeing more and more IoT, digital factories, and Industry 4.0 movement. We see more of that right now on the assembly side than we do on the bare board side. From a process point-of-view, what do you need to know to become a digital factory?



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Nichols: People need to know that there's intelligent equipment that can adjust and/or monitor their processes. But they have to be serviced, or they can make slight adjustments to the online dosing system to keep it correct. You need to embrace the technology.

Matties: And you've seen this firsthand and know what someone should expect for ROI. If they're embracing technology, that means they're going to be investing some money.

Nichols: For a fairly complicated system, the top end is currently around \$215,000–250,000. I'm talking electroless copper analysis in real terms for scrapping panels. Let's say your panel is \$10,000, depending on military aerospace.

Matties: And with the digital process control, the yields would go up.

Nichols: Even if you don't increase the yields, you will prolong good yields. You don't get the fallouts.

Matties: The fallouts are the problem.

Nichols: Exactly. At GreenSource, for example, in their lab, they have the ability to monitor every line from the lab. I hadn't seen that before.

Matties: I think that's where people need to head.

Nichols: In populating assembly houses or wafer shops, where they are automated, the difference is that it's not a process, while PCBs still involve a process. You still have a solution that can last months or years, so it fluctuates. Things are changing. Whereas in wafer fabrication, they do three, four, or five wafers, and throw it away. Can you make them? It's not a process, so that's the difficulty with PCBs and why you need process control.

Matties: I appreciate that information. That's very helpful. Thank you very much.

Nichols: Thank you. PCB007

productronica 2019: Pluritec Takes Industry 4.0 to the Next Level

Editor Pete Starkey and Nicola Doria discuss some of the changes that have taken place at Pluritec over the past few years.





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ein Electronics Industry News and Market Highlights



Helping Autonomous Vehicles See Around Corners ▶

To improve the safety of autonomous systems, MIT engineers have developed a system that can sense tiny changes in shadows on the ground to determine if there's a moving object coming around the corner. In a paper presented at the recent International Conference on Intelligent Robots and Systems (IROS), researchers describe successful experiments with an autonomous car driving around a parking garage and an autonomous wheelchair navigating hallways.

Samsung Unveils 5G NR Integrated Radio at MWC LA 2019 ▶

Samsung Electronics has announced at MWC Los Angeles 2019 its new 5G New Radio (NR) Access Unit (AU) supporting the 28-GHz spectrum. This new AU brings together a radio, an antenna, and a digital unit into one compact box, making it the industry's first integrated radio for mmWave spectrum, compliant to the 3GPP NR standard.

The Buck Starts Here: NVIDIA's Ian Buck on What's Next in AI Revolution ▶

AI is still young, but software is available to help even relatively unsophisticated users harness it. That's according to Ian Buck, general manager of NVIDIA's accelerated computing group, who shared his views in the latest AI Podcast.

Heilind Electronics Adds Molex Robust Contrinex Inductive and Photoelectric Sensors ▶

Heilind Electronics, a leading global distributor of electronic components and authorized distributor for Molex products, has expanded its

portfolio of Molex industrial automation solutions to include Contrinex inductive and photoelectric sensors.

Fast Flash Programming for Microsemi FPGAs ▶

Newly released support for Microsemi FPGAs and SoCs on ASSET InterTech's ScanWorks can dramatically decrease programming times for SPI flash memory devices to the point where inline programming on the assembly line will not disrupt the manufacturing beat rate. ASSET InterTech is a leading supplier of JTAG-based software and hardware debug, validation, and test tools. ScanWorks, one of the company's flagship product lines, is a fast test and programming platform.

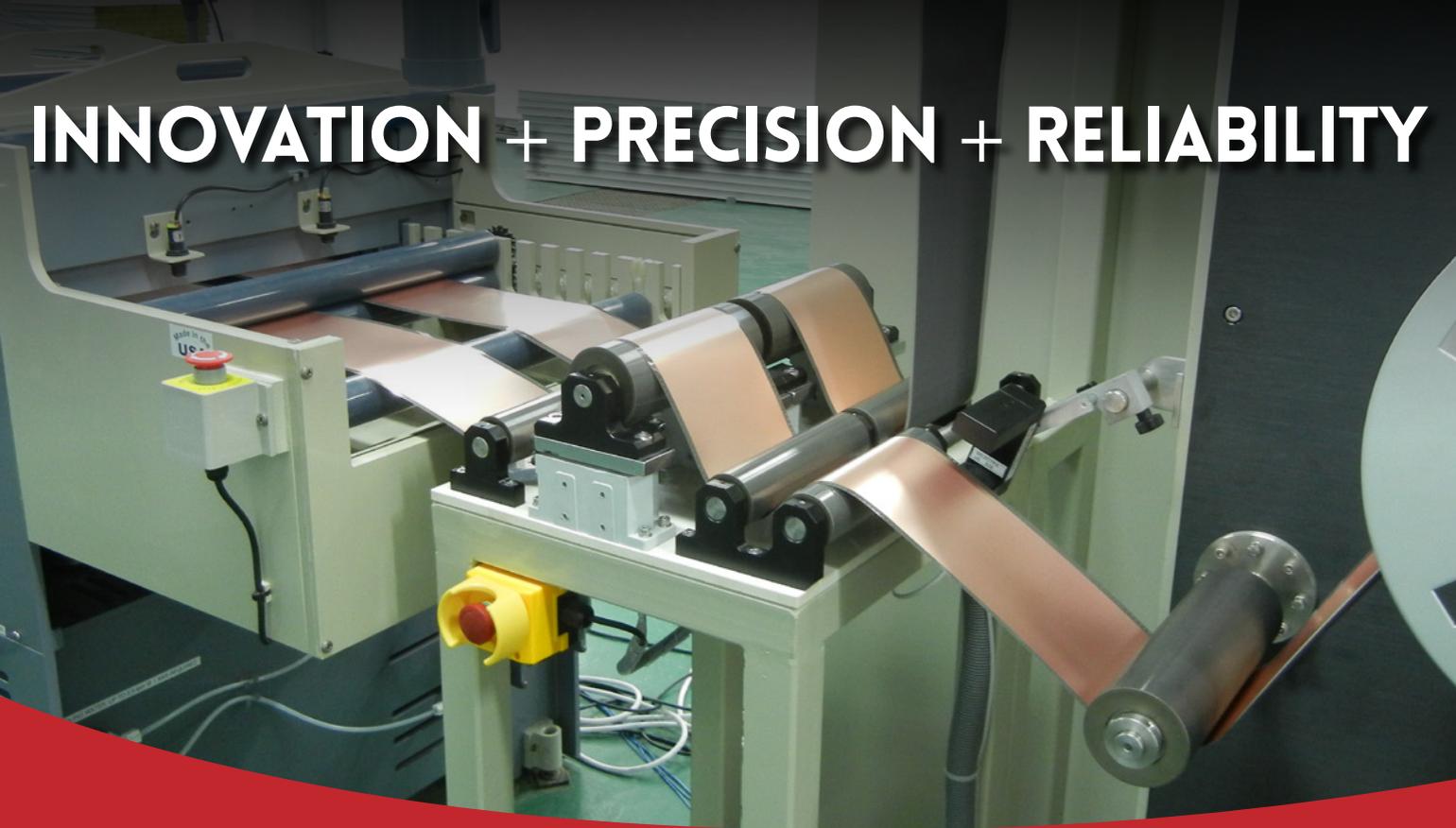
Innovation and Investment Are Growth Drivers for Asia's Transition to Clean Energy ▶

Over 180 thought leaders shed light on current and future developments for minimizing the impact and implications of climate change at the recently concluded Asia Clean Energy Summit (ACES), hosted by the Sustainable Energy Association of Singapore (SEAS).

Future of Laser Innovations Discussed at Revamped ICALEO Conference ▶

The Laser Institute of America's (LIA's) 38th International Congress on Applications of Lasers and Electro-Optics (ICALEO) was recently held in Orlando, Florida, and featured the conference's many firsts. A meeting of laser industry experts and decision-makers from around the world, the event hosted dialogue with a deeper industry focus, more expansive technical sessions, and a new business conference that addressed laser end-users while highlighting solutions from the manufacturing community.

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CML Poised to Be ‘More Than a Manufacturer’

Interview by the I-Connect007 Editorial Team

The I-Connect007 Editorial Team recently spoke with Chris Minard, director of business development at CML, about how CML’s business model has evolved and some of his insights about manufacturing trends around the globe right now.

Andy Shaughnessy: Chris, CML is more than a PCB solutions provider. Tell us about that.

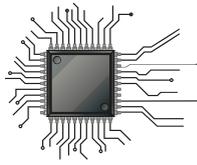
Chris Minard: Yes. Our new slogan, “More Than a Manufacturer,” plays off how we’ve changed very significantly over the past few years. When we were founded in Germany in 2001, we were a PCB sourcing company and were very much an automotive market supplier. We’ve been able to grow over the last 18 years and have evolved into manufacturing to provide even more comprehensive PCB solutions for our customers. Now, we’re in 16 different locations worldwide and 12 different countries with more expansion planned for 2020. All of our growth is organic, so we move into a market, hire local people located in the country, speak the native language, and, of course, operate on the local time zones.

Our expansion over the years has been very methodical and measured. We want to be sure that, as we keep moving forward and developing as a company, nothing falls between the cracks and that service levels are not affected. Customer satisfaction is our number one priority.

A lot of companies try to grow too quickly, and there are pitfalls that we acknowledged that go along with that; from our managing directors down, we are extremely careful not to do that. We want all of our customers to get the same level of support and service regardless of where in the world they’re located. Some of our core customers are headquartered in Germany but are also doing manufacturing in Asia and Mexico. Their expectation, and our goal, is that all of their locations will get the same level of services from our local CML branch, regardless of where they are located.

Shaughnessy: Are you planning more global expansion?

Minard: We are looking to expand further through vertical integration, which includes production facilities in Sichuan province. We chose Sichuan because it’s extremely acces-

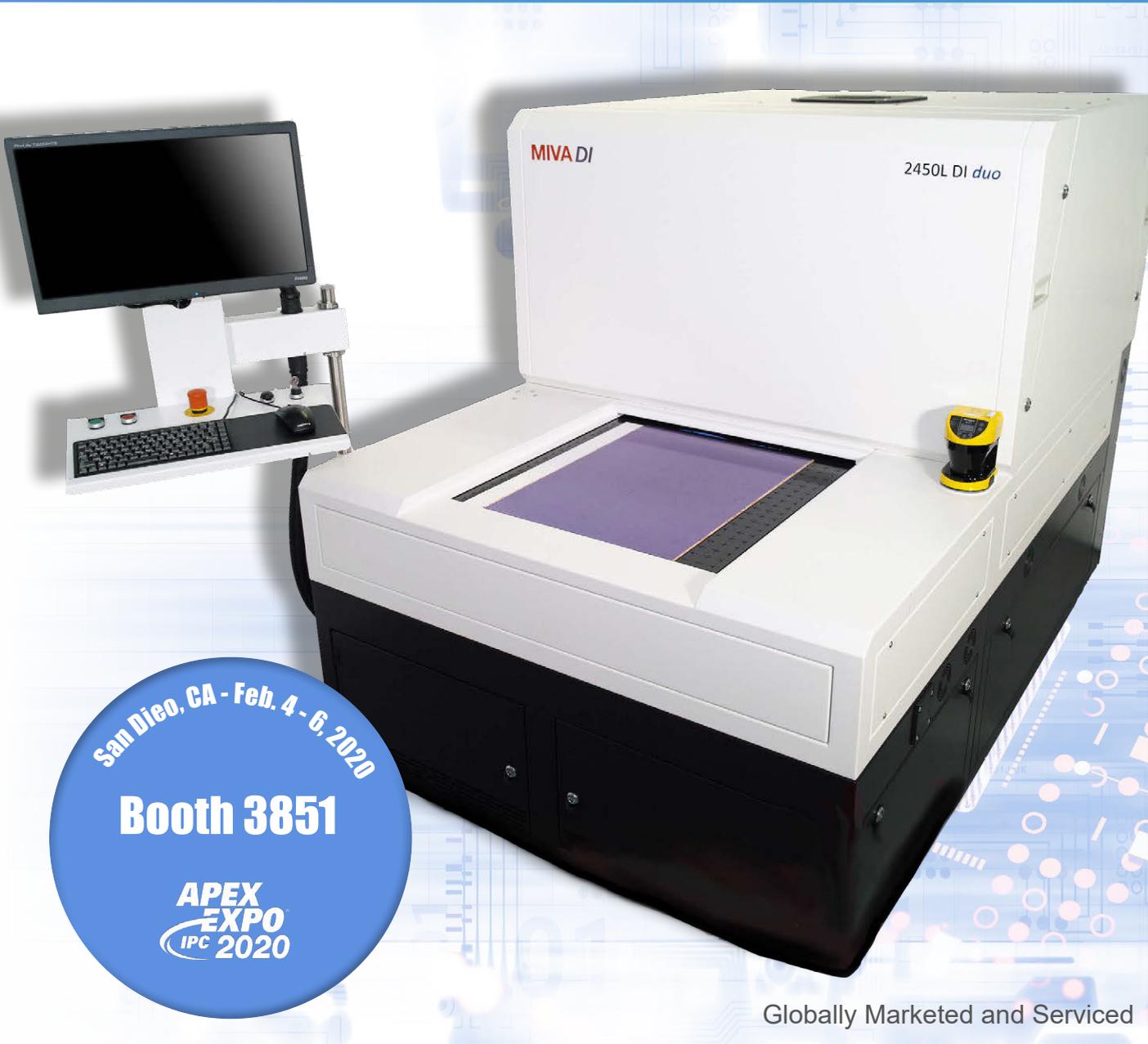


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sible with international flights and the high-speed train. We're also looking into some key areas in Asia-Pacific and potentially in South America down the road.

Nolan Johnson: What sort of capacity does the new manufacturing facility add, Chris?

Minard: Currently, it's at about 500,000 square feet per month. It was able growing that capacity already this year, with plans to significantly grow over the next five years with further investments and expansion. There are already measures taken that would allow us to grow the capacity by multiples. The current production area is about 15,000 square meters. Of course, it's ISO-qualified for 9001 and 14001 and with the automotive space, as well as certified for IATF-16949. We have VDA 6.3 6.5 auditors that conduct onsite trainings and audits on-site and with all of our partner suppliers. We also have certified IPC-600 and IPC-6012 inspectors as part of our outgoing quality inspection.

Being from Germany, and with many of our customers in the automotive space, quality is always a critical deliverable. We're steeped in almost 20 years of making sure that all of our factory partners, suppliers, and teams are fully qualified, inspected, and audited to maintain very high levels of quality. The company has won the Mianyang City Technology Award

in 2019, which was an acknowledgment of what has been achieved since investing in the production equipment, infrastructure, and headcount.

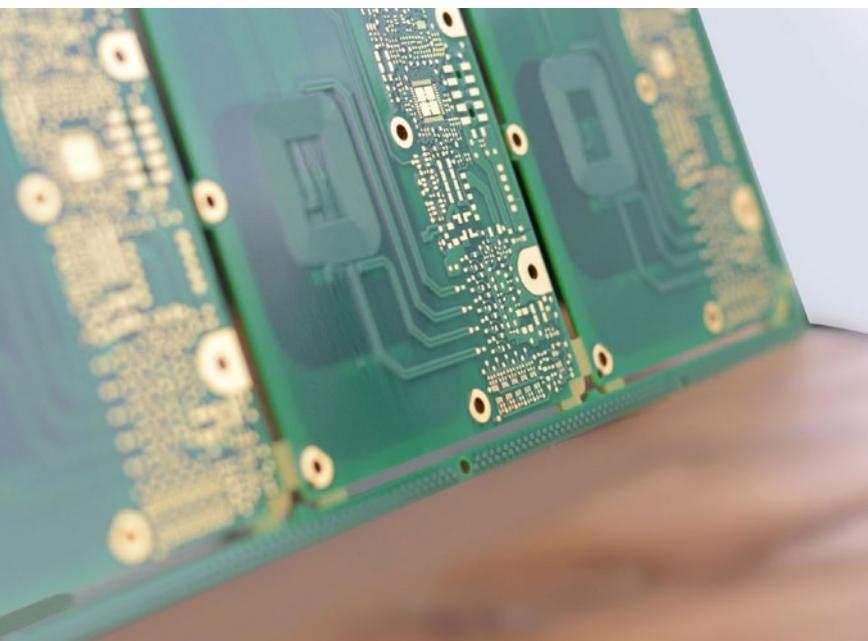
We've also launched a new venture called CML Chemistry, which is a partnership with Innotech; they are an immersion tin surface finish company. We partnered with them to bring more immersion tin solutions for our customers, and we found ourselves being engaged with Innotech hand-in-hand over time. It seemed to make sense to do something a little bit different that would benefit our customers, so why not do a joint venture with them? It allows us to have R&D and product innovations based on-site and pass these benefits onto our customers directly.

Johnson: Does CML offer design and engineering services as well?

Minard: We do. We recently took a step to expand our global engineering resources by adding head counts in both our German and Shenzhen offices. Our goal is to have the availability of our engineering teams to our customers at the very early stages of the design launch. We can provide DFM and DFX inputs in the NPI stage, and we hope to drive our customers to a commercially and technically sound solution; that's a value-add.

We also want to engage more robustly at this early stage of the design so that we don't get in after the fact when boards are in production status. We're hoping to remove costly re-spins and re-qualifications and offer a more complete solution to our customers, so we've put some resources into that. And we've had customers, both in Canada and the U.S., collaborate with our engineering teams in Germany and Asia to review their designs; therefore, we can help make recommendations on materials and surface finishes, etc.

Hand-in-hand with the expanding of our global engineering resources, we have further been actively sourc-

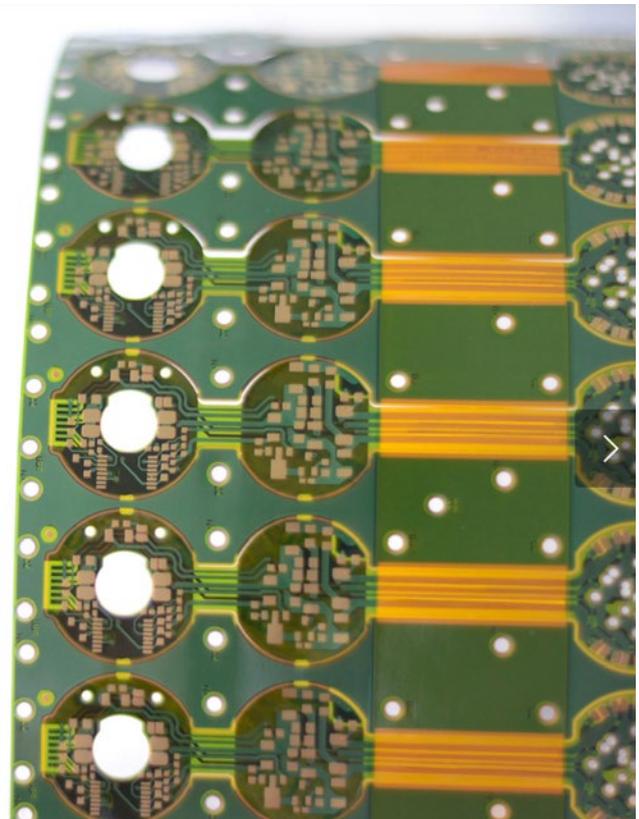


ing some new supplier partners that are more focused on advanced technologies, such as higher layer counts, high-frequency laminates, backdrill, bendables, pure flex, rigid-flex, thermal management solutions, and heavy copper. We see more of these designs from our customers, and it's important to us that we have the supplier partners in place that can service them.

If you're going to engage in these sorts of higher-technology boards, you must have your engineering backbone behind it first. In the U.S. and Canada, when you start to talk with the network and the storage spaces, you need to have a supplier partner who can engage and has years of experience and dedicated capacity in like technologies. These two things have become very strong building blocks for our team as we expand our businesses in the U.S. and Canada. Especially in Silicon Valley, where there are some of the largest and highest growth network and storage companies in the world located in one small region. I'm excited that I have the engineering and the supply base backing to confidently go into these customers with a strong technology offering.

Johnson: What do you see as your sales revenue trajectory at CML? This all speaks to the expectation of significant growth.

Minard: Like anything, it's a moving target. Our managing directors have a very long view of where they want the company to go and what we want to be in as far out as 12 years. I can't comment specifically on anything that's going to happen in 2020, but this does make a good segue into the impact of tariffs. The China-U.S. tariff situation has impacted our PCB suppliers and us in selling into the U.S. market. There were several projects that we were working on with certain customers that were going to be serviced out of China, especially Sichuan. When the tariffs didn't get lifted by March, as everyone thought at the beginning, everybody thought, "This isn't temporary or something that's going to go away quickly. What do we do?" Wisely, In the early part of 2019, we began scouting in territories like South Korea and



Thailand, where we'd had supplier partners in the past and had great relationships with. We got an early start on finding a solution for our customers.

Shaughnessy: We hear companies talk about what a nightmare the tariffs are now.

Minard: A lot of customers said it wasn't the tariffs themselves that were the biggest factor; instead, many talk about the red tape and paperwork required to pay the tariffs. If they happen to ship PCBAs out of the U.S., there was a secondary process to refile paperwork to get the tariff money back. They said it became an overwhelming dedication of resources to manage the tariff situation internally.

I think we're all looking cautiously to 2020 to see if the U.S. and China resolve their issues related to trade, whether the confidence comes back into the marketplace or whether the spending rebounds. Things have slowed on a global basis. Anything that changes the Chinese economy creates an impact for anybody located in China, as we are. But the good news is we moved ahead with well-thought-out



processes, so it didn't have an impact on all of our expansion plans and investments. All of those things were already well into play for 2019.

Johnson: What are your ideal customer profiles?

Minard: In Europe, and especially in Germany, the automotive space is where it's at; it's still where all of the major automotive projects are being both designed and purchased. For us, moving into the U.S., there is a significant tier of up-and-coming networking and storage customers in Silicon Valley that we'd love to engage with. We have aligned ourselves with a couple of supplier partners that are perfectly positioned to support that sector of the market. I know that market well. Beyond that, on the commercial side, having dealt with a few IoT home automation customers and all of the big consumer players, we have three or four factories that are perfectly aligned with those technologies.

What CML's model allows me to do for my customers is to find them the best technology and commercial fit. If the two-layer board goes to one factory, rigid-flex to another, and HDI goes to a third factory, we can get them the best factory technology fit and the best price, and the boards come out with the CML proudly displayed on the boards.

Shaughnessy: It sounds like a lot of what you do involves educating the customer.

Minard: Correct. And I've had an opportunity to chat with a few of my good contacts in the EMS world, especially onshore in the U.S., where their commodity managers manage not only PCBs but perhaps enclosures and maybe some mechanical stuff. Their time is extremely valuable to them. When you get a company like CML that can come in with eight different factories at their disposal that can do anything from a single layer IMS for LED lighting all the way up to the 24-layer board in a high-tech space, the customer doesn't have to send it out to six companies to get quotes back anymore; CML can handle it all. That is a great time saver for them and helps streamline the supply base. Beyond that, we can offer a common engineering resource that can support all our factories.

Shaughnessy: That's cool. Is Jurgen Kaulich a big part of this?

Minard: Yes. Juergen is our engineering director and, while he's based in Germany, he spends a lot of time in Asia. He manages his teams in Germany and Shenzhen and has made their role more proactive; their goal is to be engaged as early as possible with our customers.

For example, I was talking to a customer out of Canada that said, "I don't need another PCB

shop. I've been dealing with a variety of companies, and they all give me similar pricing. But in the last six years, I haven't had anyone look at my board and tell me what I could change to make them more manufacturable. What can I change to create some cost savings?" That was a perfect opportunity for me to organize a conference call with Juergen and his team in Germany. We looked at a few of their designs. We offered some alternative solutions as far as materials and solder mask went.

On one of the boards, we saved them a fairly significant amount of money, which they were extremely happy with; that opened the door for them to say, "This is worth something to me." Juergen and his team played a critical role in that. It's huge to have someone on the other side of the phone to share ideas back and forth and ask questions and get answers in real-time. Adding human interaction goes a long way in our service model.

Customers begin to think, "Maybe I'm not only going to be a price-first guy, but there might also be a lot of value in the fact that I have somebody who I can reach out to on any given day to collaborate with." A certain segment of the market seems to have a need for that, and our model and teams can offer great solutions. I had always seen that as a distinct advantage in CML's setup because we could service those personal service level needs.

Johnson: You mentioned that strategically, your management team is planning even as far out as 2030, and we talked about tariffs; let's bring those two things together. Am I correct to read between the lines that your management team and your projections don't see the tariffs as being a long-standing, long-term issue?

Minard: The plans moving out to 2030 or beyond are more about infrastructure and our global footprint. Since CML only entered the U.S. market in 2018, the amount of business we're doing in the U.S. as a portion of the overall company revenue was not that significant. Now that we have tariff mitigating solutions in place, we don't believe they will impact our long term growth plans for the U.S.

The U.S. market is going to be a major market for CML; we're already working on a three- and five-year plan. So, you could say that the tariffs were not factored in what we're looking at, but the reality of this situation is our long-term plans as a company have a lot of walls in place that we're building around. The tariff wasn't something we all foresaw in early 2018. But we did our due diligence, took the action plan early in 2019, and put into play a couple of new plant options in South Korea and Thailand, which was a solution that worked out great for our customers.

We don't have any barriers in front of us now. If the tariffs stick for the next five years, then we have solutions in place. If the tariffs go away, then we're back to having dual regional source options for our customers. In the long-term, I hope that the U.S. and China can come to an agreement, as the tariffs have global impacts.

In the long-term, I hope that the U.S. and China can come to an agreement, as the tariffs have global impacts.

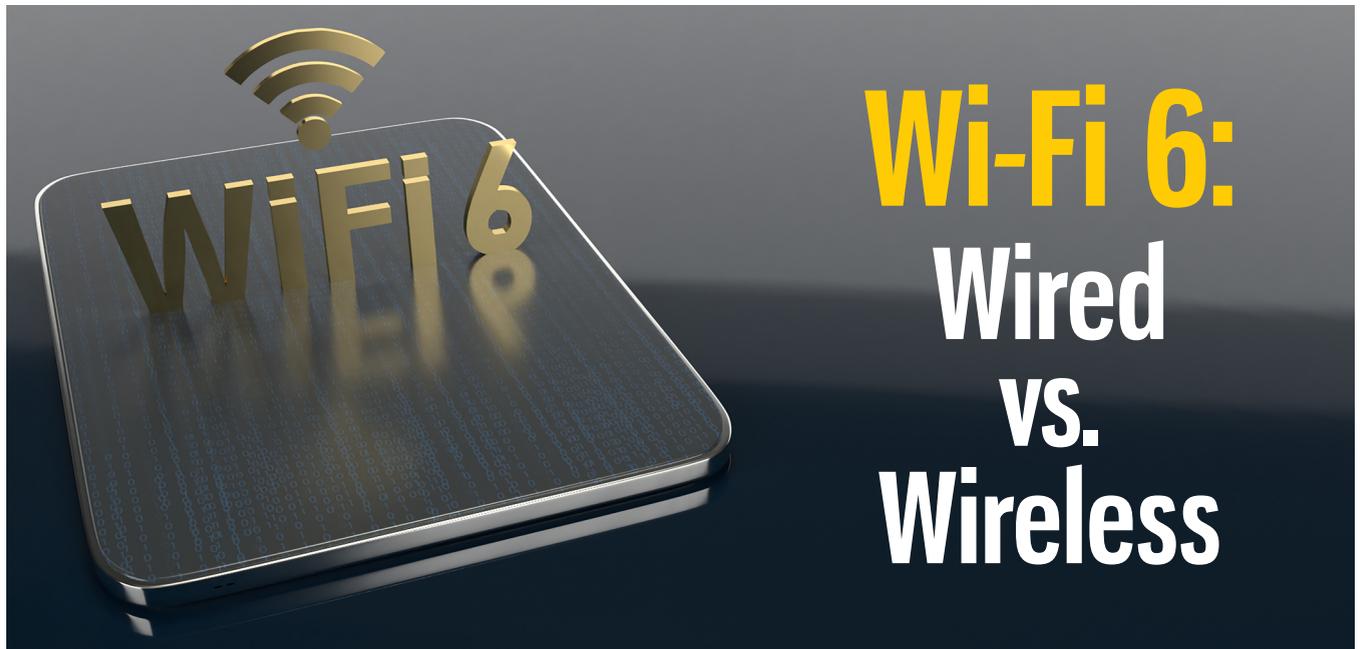
CML is 600+ strong today, and we don't know if that will double, triple, or quadruple in the future. We need to strive to keep our business cost-efficient and service-oriented for our customers. There's confidence when you work for a company, such as CML, that is engaged in the long-term journey and want their employees to be a big part of that.

Johnson: Thanks for speaking with us, Chris.

Minard: Thank you for the opportunity. **PCB007**

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Article by Dan Feinberg
I-CONNECT007

We all know that it makes no sense to get the latest device just because they come out with a new one every year. Sure, post-millennials tend to want a new phone every year, but most of us are well past that. However, as the competitive nature of the consumer tech industry continues to increase, the rate of change is also accelerating, as is the peer pressure to upgrade. Non-techies get new phones every year, techies get new CPU and GPUs every two years, average consumers get bigger and higher-res TVs every three years, and on it goes.

Sometimes, it does make sense to upgrade. However, a few years back, upgrading to a new modem/router using the new (at that time) DOCSIS 3.1 standard made sense, as it allowed high-speed cable data to potentially reach download speeds of up to 10 Gbps; this would greatly improve a wide variety of online experiences and abilities that have become a part of our lives, such as 4K video streaming, high-resolution multi-channel video conferencing, and multi-player online gaming. With the advent of 5G and all that it will enable, faster internet transfer speeds will become more than a want; for many 5G-enabled activities, those speeds will become necessary.

Before we discuss what you can expect from the next generation of internet connection, let's first consider wired vs. wireless. As someone who usually uses wireless for net connection for notebooks, tablets, and phones and wired for my main rigs, let me categorically state that using wired is always better than wireless. I use large desktop computers as our main workstations because I want the high-speed, rapid ability to transform and transfer files (e.g., copying over a 45-minute 4K HiFi sound video from my NVME SSD PCIe4 workstation took under four minutes, while doing the same thing on my standard notebook takes just under an hour) and extreme multitasking. On these workstations/desktops, I use wired internet. Here are three main reasons why.

- Higher data rates
- Increased capacity
- Improved power efficiency
- Performance in environments with many connected devices

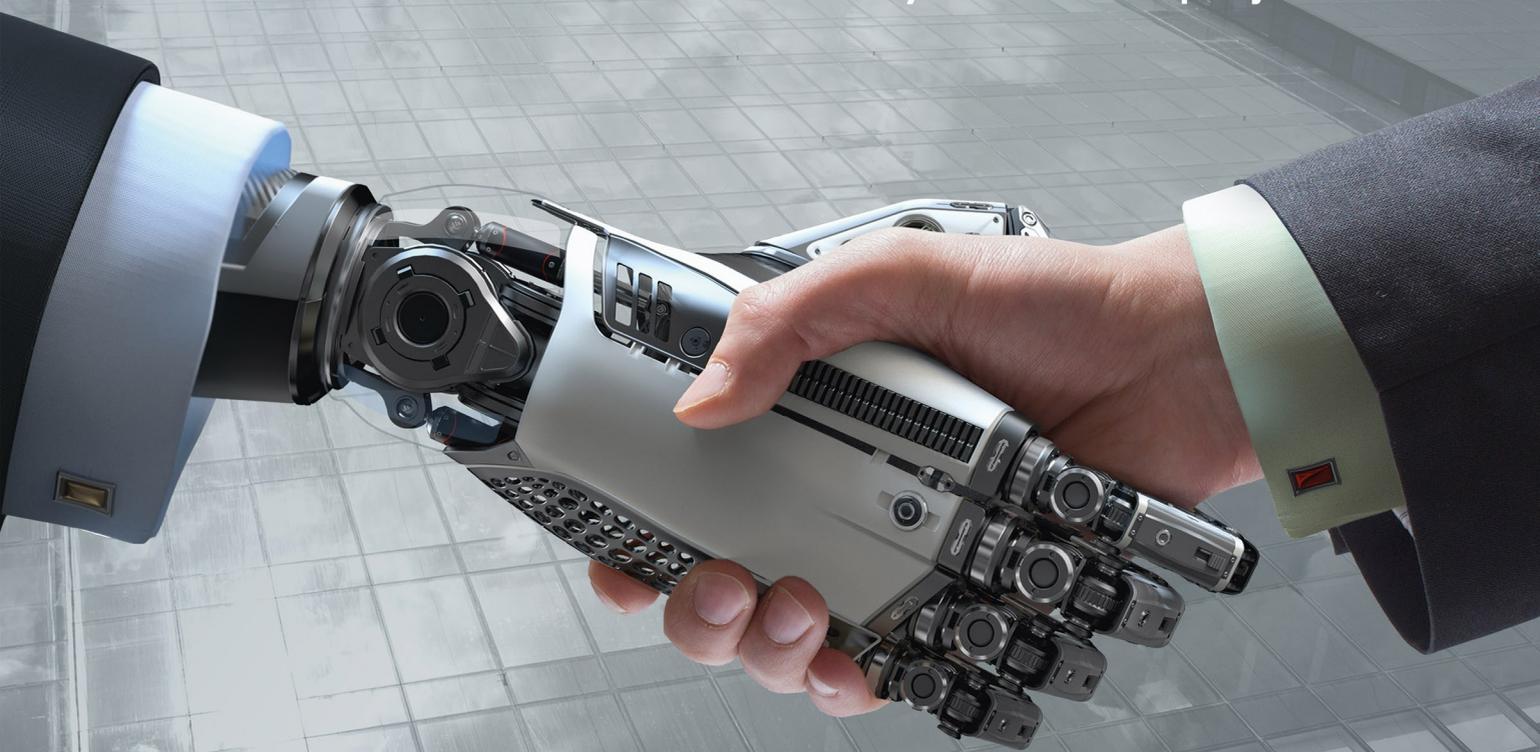


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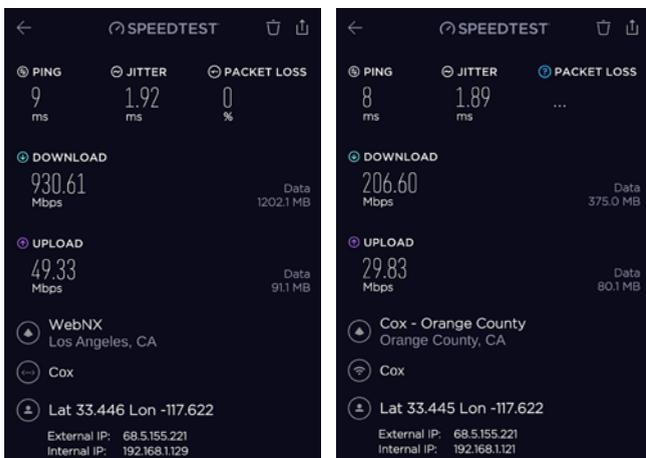
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Notebook and new DIY workstation.

1. Faster Speed and Lower Latency

My main net connection is through Cox cable, and enabling it to max out requires a DOCSIS 3.1 modem and compatible router. In addition, I only use Cox for net—no sharing of data transfer abilities with TV or VOIP phone; I do this to max out speed and reliability. In addition, I use maxed-out Cat7 cables. All of that improves both my wired as well as my wireless; however, my wired goes directly to



Wired vs. wireless (same network, same location, and same test).

my desktop computers (or if I chose, I could connect wired to notebooks, but that is inconvenient).

Take a look at these two-speed tests run on the same network using a wired desktop and wireless notebook. Note the extreme differences in speed and the amount of data transferred.

When it comes to the speed you get, and the quality and reliability of your internet connection, it is very important for you to understand that wired internet provides significantly more speed and reliability than wireless internet. The reason for this is very simple. Wired internet is direct to your computer; therefore, there will be no loss of data or packets when you are surfing the internet, but as far as wireless internet is concerned, there are many factors that can influence your data speed, reliability, lag, and overall usage.

By going for wired internet instead of wireless internet, you will be able to increase the chances of you getting better speeds, more reliable connections, and lower latency significantly.

2. Better Security

No matter what you are doing online, your privacy should be of concern. Yes, you may be just on Google or Facebook, but while doing so, do you want someone getting access to your files, pictures, and browsing history? Of course not. If you are doing business or investing online, a hack could damage you more than you might realize. Security is a lengthy discussion, so for this article, if you are using wireless, just be aware that you have less security than if you were using a wired connection and take whatever precautions you feel are necessary to decrease your chances of being hacked and having files or photos stolen, etc.

3. Possible Health Issues

We all use more and more wireless devices that generate radio-frequency (RF) radiation. Phones, Wi-Fi, non-IR remote controls, and even wireless earbuds all of these generate RF—in some cases, with the transmitter right up against our head. We use these

devices more every day, and they can have a lasting impact on our health; this can also be the case with wireless internet. While there isn't any significant data yet that shows this, mostly because there has not been much focused testing that shows that wireless signals can be harmful to health, it is something to consider, and we will all be hearing more about as we construct thousands of 5G transmission sites in the coming years. This is not something that I would be overly concerned about yet, but just be aware. It is not a bad idea if you are going to be on your phone talking, listening to music, watching videos, etc. to consider using a quality wired headset or earbuds. It can't hurt, and the sound quality is usually better.

Installation: Time and Difficulty Considerations

As a brief synopsis, wired is faster, more stable, easier to connect and maintain, and more secure. Meanwhile, wireless is more conve-

nient and location-flexible and still relatively easy to set up.

Wired

- Every device must be hard-wired
- Time-consuming process
- Easy to configure

Wireless

- Quick installation
- More layout options
- Usually two configuration options
- Must be wireless capable
- Sometimes must be reset up or reconnected
- Possible health concerns/long-term awareness

There is no doubt that we all use wireless for at least some, and probably most, of our device communications, so improvements in wireless that will enable or improve the next few generations of useful and neat stuff are of great interest to all of us.

Wireless Standards 802.11ac, 802.11n, and 802.11g

	✓ PROS	✗ CONS
802.11ac	Fastest maximum speed and best signal range; on par with standard wired connections	Most expensive to implement; performance improvements only noticeable in high-bandwidth applications
802.11n	Significant bandwidth improvement from previous standards; wide support across devices and network gear	More expensive to implement than 802.11g; use of multiple signals may interfere with nearby 802.11b/g based networks
802.11g	Supported by essentially all wireless devices and network equipment in use today; least expensive option	Entire network slows to match any 802.11b devices on the network; slowest/oldest standard still in use

Lifewire

Wireless standards.

History and Background

For most of the last two decades, we have used an evolving series of wireless devices based on the first IEEE WLAN standard developed in 1997; they called it 802.11, which was the name of the group formed to develop it. The original 802.11 only allowed for a maximum of 2-Mbps bandwidth, which is way too slow for most applications, even back then. For this reason, ordinary 802.11 wireless products are no longer manufactured. However, things have evolved, and they continue to do so.

802.11b was the first widely used standard. I am sure you already feel that the 802.11 naming protocol is confusing, so it is time to simplify the naming protocol. Certainly, if you were asked if you were using 802.11ac, which is the latest most commonly used version, many of you would not know, and if you were asked if you were going to 802.11ax soon, you would probably have no idea. But if you were asked if you were using Wi-Fi 5, and if so, were you soon going to Wi-Fi 6, while you still might not know, you would understand the question. Using Wi-Fi and then a version number from now on will greatly decrease the confusion, and when you hear that Wi-Fi 7 will be announced at some point in the future instead of 802.11btx, you will probably know what they are talking about. Here's an overview.

- 802.11b was the first standard to be widely used in wireless LANs
- The 802.11a standard is faster but more expensive required than 802.11b
- 802.11a is more commonly found in business networks
- A common standard, 802.11g, attempts to combine the best of both 802.11a and 802.11b, though it too is more expensive especially for a home networking option
- The newest standard, 802.11ac, operates on the 5 GHz band and offers speeds of more than 3 Gbps

By now, you must agree that Wi-Fi 5, Wi-Fi 6, etc., would be so much easier to understand. Further, both wired and wireless networks accommodate broadband modems or

all in one modem-routers, which allow easy sharing of a cable modem or slower/older DSL internet connection, and virtually all include firewall support. The best way to look at these standards is to consider 802.11 as the foundation, and all other iterations as building blocks upon that foundation that focus on improving both small and large aspects of the technology. Some building blocks are minor touch-ups, while others are quite significant.

The largest changes to wireless standards come when the standards are “rolled up” to include most or all small updates. For example, the most recent roll-up occurred in December 2016 with 802.11-2016. Since then, however, minor updates are still occurring; eventually, another large roll-up will encompass them. The following is a brief look at the most recently approved iterations, outlined from newest to oldest. Other iterations—802.11ax, 802.11ay, and 802.11az—are still in the approval process.

- **802.11aj:** Known as millimeter-wave and used in China, this standard is basically 802.11ad for use in some areas. The goal is to maintain backward compatibility with 802.11ad
- **802.11ah:** Approved in 2017, this standard is designed for lower energy consumption and enables longer range Wi-Fi that can increase the range and use less power than a typical 2.4-GHz or 5-GHz network
- **802.11ad:** Approved in December 2012, this standard is fast; however, the client device must be located close to the access point
- **802.11ac:** The generation of Wi-Fi that first became popular, this standard uses dual-band wireless technology, supporting simultaneous connections on both the 2.4-GHz and 5-GHz Wi-Fi bands while still allowing backward compatibility to the older 802.11b/g/n standards and with reported bandwidth rated up to 1300 Mbps on the 5 GHz band plus up to 450 Mbps on 2.4 GHz band; most home wireless routers in use today are compliant with this standard

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The pros of 802.11ac are that it has the fastest maximum speed and best signal range and can be on par with some slower wired connections. Meanwhile, the cons of 802.11ac include that it's the most expensive to implement, and performance improvements are only noticeable in high-bandwidth applications.

Again, 802.11 ac is now being referred to Wi-Fi 5, so if you have a router using this standard, you know that you are presently using Wi-Fi 5. There is also 802.11n, which was implemented to improve supported bandwidth by using multiple signals and antennas and is now being referred to as Wi-Fi 4. What is now referred to as Wi-Fi 3 is much older, and while still in use, it barely used any longer; it was called standard 802.11g, and before that, there was 802.11a and b (Wi-Fi 1 and 2).

In addition to the general-purpose Wi-Fi standards, there are other wireless network technologies, such as Bluetooth. Bluetooth is a low-bandwidth, short-range connection standard that is very different but extremely applicable for wireless device-to-device connections, such as smartphones to automobiles or headsets to phones, etc. One advantage of Bluetooth is its low manufacturing cost.

Wi-Fi 6

Now that we have the basic comparisons and background out of the way, let's focus on the upcoming and greatly improved Wi-Fi 6 standard. With Wi-Fi 6, we get huge improvements in coverage and data transfer speeds, up to 4X presently available. This comes just in time for 5G, so getting more data, faster into your network, and then getting it faster and more reliability to your wirelessly networked devices seems to be perfectly in sync. Lionel Paris, director of product marketing for Netgear, recently stated, "...the new [Wi-Fi 6] standard is much better equipped to deal with the modern home full of connected devices. The average home predicted to have as many as 50 connected devices by 2023, so it's crucial to bring in a standard has the capacity to deliver great performance under increasing demand."

As of the last month, all the major router brands have Wi-Fi 6 units announced, and



TP-Link Wi-Fi-6 router.

some are now available. Netgear seems to be going all out for Wi-Fi 6 with their new Night-hawk AX8, offering eight wireless streams and 6,000 Mb/s throughput. It is not cheap at \$400 and seems to already be overshadowed by their AX12, which is just available for the same price.

Some of the mesh network systems are now being updated to the new standard and are reported to be capable of gigabit speeds across the network. Others who are offering very promising Wi-Fi 6 devices include TP-Link and D-Link. D-Link was one of the first to offer Wi-Fi 6 routers almost a year ago. If you use your smartphone over your Wi-Fi, you may often be aware that very few existing smartphones support Wi-Fi 6 yet. Samsung seems to be the first to go all-in for Wi-Fi 6 and 5G. With smartphones being the most Wi-Fi connected device, this gives them a significant advantage; however, that advantage is limited to their higher tier phones for now.

The new iPhone 11 is also Wi-Fi 6 capable, but not 5G-capable, but we can be sure that next year's model will be. Even though my smartphone is now almost three years old, I will wait for another year. While having one more lens on my phone camera is not that important to me, having both Wi-Fi 6 and 5G support is something that I feel will be useful, and with most phones having both available in the next year, prices for the then-outdated models will start to come down. If you are thinking about a new phone, you just may want to wait. If you are not interested in Wi-Fi

6, you may still want to consider waiting, as today's Wi-Fi 5 phones will certainly drop in price about the time the new ones are about to be announced.

Finally, here are a few more Wi-Fi 6 points of interest. Wi-Fi is one of the largest power users on your phones and laptops and has a target wake time capability that determines when devices wake, send, and receive data wirelessly. Phones and other IoT devices using this will have noticeably longer battery life. In addition, your coverage will be better, as it uses the next generation of beam-forming. It will also provide wider coverage and greater connection stability as you move around your home or office, and the ability to connect to more devices

at the same time will, I am sure, be welcomed by most of us. Channel sharing and more efficient data delivery will also increase speed and stability.

Conclusion

As we all increase the number of connected devices in the coming years, Wi-Fi 6 will initially be greatly welcomed by those that initially use it; then, it will become commonplace with higher speeds, greater coverage, and improved stability appreciated, then expected, and within a few years, demanded.

Wi-Fi 6 capable devices are something that we will be looking for at the upcoming 2020 CES. Stay tuned. **PCB007**

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- IPC-7711/7721 Certified IPC Trainer (CIT) Rework of

Electronic Assemblies and Repair and Modification of Printed Boards and Assemblies

- IPC-A-600 Certified IPC Trainer (CIT) Acceptability of Printed Circuit Boards
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(Source: Blackfox)

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American Standard Circuits

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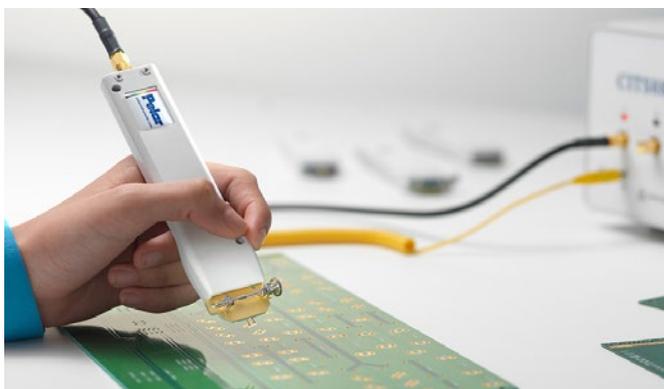
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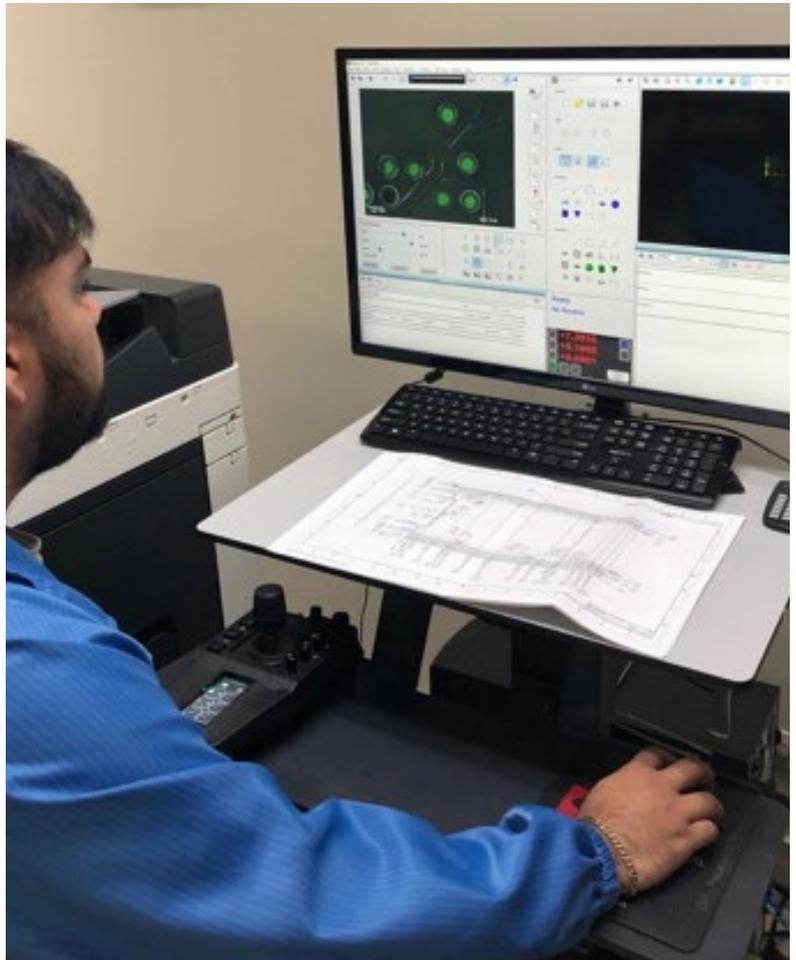
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- Three-fold exchangeable primary filter
- Four-fold exchangeable apertures
- Options for different semiconductor detectors (silicon PIN detector, SDD 20 mm^2 , SDD 50 mm^2)

Ram Optical Sprint MVP 600

Coordinate measurement machines (CMMs) are becoming a more integral component of PCB shops' inspection and verification capability given the increasing complexity of today's designs. Add in the 3D measurement requirements common with high-tech products, like rigid-flex and external heat sinks with complex milling and cavities, and advanced measurement equipment is a must-have. The 600 in

than $0.05 \mu\text{m}$ thick. For example, mapping mode makes it easy to scan surfaces, and during production or incoming goods inspection, the testing of different components in large quantities.





the Ram Optical Sprint MVP 600 stands for 600 mm, or 23.6” in the X-axis, so full panel inspection is now a reality. The full specifications for the size are X-axis 600 mm (23.6”), Y-axis (17.7”), and Z-axis (5.9”), which is quite impressive and can handle most any measurement a shop would need.

Its features are as follows:

- Fully automatic, three-axis dimensional measuring system
- High-precision and capacity in a compact footprint
- Motorized zoom lens optics with high-resolution digital color camera
- Full function Measure-X® metrology software for fully automatic routines
 - Multi-step measurement routines
 - Automatic autofocus, edge detection, programmable lighting, laser scanning, and touch probing

Glenbrook XRA 113 Model RTX-113HV Micro 30

X-ray systems are another of the “price of admission” pieces of equipment if you are building advanced technology printed circuits with hybrid materials that push the registration limits of any shop. However, the advanced X-ray

capabilities of the Model RTX-113HV add another dimension; the ability to X-ray inspect drilled holes as small as 4 mils using geometric and optical magnification up to 225x. The X-Y drill offset can be measured extremely accurately using the GTI-3000 image processing software that comes with the system.

Features include:

- A motorized X-Y positioner travel: 19” X 15”
- Contrast resolution: Can resolve 0.001 gold wire
- Spatial resolution: 20 lp/mm up to 100 lp/mm
- Anode voltage: 40–80 Kv (PC controlled)
- Anode current: 20–150 microamps
- X-ray tube focal spot: 30 microns
- Machine dimensions: 43” X 36” X 52”
- Cabinet interior dimensions: 42” X 30”

Editor’s Note: Technical information provided by the OEMs.

Visit I-007eBooks.com to download *The Printed Circuit Designer’s Guide to... Fundamentals of RF/Microwave PCBs and Flex and Rigid-Flex Fundamentals* by American Standard Circuits and other free, educational titles.



Editor Picks from PCB007

1 Punching Out! Trust Is a Major Factor in M&A Transactions ▶

Trust is critical in M&A transactions. Both parties are naturally suspicious of each other, and tensions run high even in the smoothest of deals, so any small molehill can be magnified into Mt. Everest. To avoid bigger problems, Tom Kastner emphasizes the importance of establishing trust from the beginning and continuing to be trustworthy throughout the process.



Tom Kastner

3 Chinese Review: The 2018 NTI-100 Top Global PCB Fabricators ▶

Yonglin Gong, senior engineer, deputy secretary-general of the China Printed Circuit Association and editor-in-chief of CPCA Printed Circuit Information Magazine, takes a look at the NTI-100 data and provides his analysis from the Chinese perspective.



Yonglin Gong

2 Emerging Themes: Day 2 Coverage of productronica 2019 ▶

Day two at productronica, and the themes emerge: 5G, high-speed, low-loss, and new formulations. These were the catchphrases of the materials suppliers. It is clear from all the conversations that designers and board specifiers need to learn all they can about the new materials emerging on the market.



4 EPTE Newsletter: Monocoque Printed Circuits—An Update ▶

Wiring with flexible circuits could be a practical solution. Nowadays, most mobile device manufacturers are consuming huge amounts of thin, flexible circuits to attach on the surface of the housing in limited spaces. However, the cost of flexible circuits and assembling them is another headache for device manufacturers because they are not negligible in the whole cost of the devices.



D. Numakura

5 NCAB Group Acquires U.S. Fabricator Altus PCB ▶

NCAB Group, one of the world's largest suppliers of PCBs with headquarters in Sweden, signed an agreement to acquire 100% of the shares of Altus PCB. Altus PCB is based in Cresskill, New Jersey, and had a revenue of US\$4.8 million in 2018. The agreement was inked on November 14, 2019.



6 The Government Circuit: U.S.-China Tariff War Threatens American Jobs and Investments ▶

Fifty-five percent of companies report they are facing higher costs as a result of higher tariffs, which are affecting, on average, about one-third of the total dollar value of the products they import. Some companies say their costs have increased more than the direct costs of the tariffs due to higher administrative and operational burdens to sort it all out.



Chris Mitchell

7 Amitron Adds Checkpoint to Ucamco's Integr8tor Workflows ▶

USA-based PCB manufacturer Amitron has extended its Integr8tor software with the purchase of additional modules, including Checkpoint.



8 It's Only Common Sense: Sales Management—Focus on What Is Important ▶

A sales manager should do everything they can to focus on their sales team. They should perform at maximum proficiency at all times and ensure that they are focused on all the right things. It is recommended that good sales managers spend 90% of their time with their sales team doing three things: have one-on-one meetings with individual salespeople, lead team sales meetings, and take part in “ride-alongs.”



Dan Beaulieu

9 One World, One Industry: Opportunities Abound for Learning at IPC ▶

It's fall, and students are heading back to school. Will you be joining them? IPC offers many opportunities for continuous learning, enabling you to enrich your career and increase your value to your company.



John Mitchell

10 AT&S Posts Results for First Half of 2019/20 ▶

In an overall challenging environment, AT&S held its ground well in the first half-year. Revenue, at €490.3 million, declined slightly by 5.1% compared to the previous year: increases in sales volume in the IC substrates and medical and healthcare segments were offset by declining figures in the mobile devices and industrial segments.

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for Someone?



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Barb Hockaday at barb@iconnect007.com or +1.916.608.0660 (-7 GMT)

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Career Opportunities



Technical Support Engineer III

The technical support engineer III is responsible for providing leading-edge, high-level technical support to Indium Corporation's customers, potential customers, and sales staff. Due to their senior position and experience, their role also includes conceiving and devising projects, assisting with staff career development, marketing guidance, and more. The technical support engineer III has learned, mastered, and demonstrated unique and specific skills and information throughout their career. They are responsible for at least one sales territory and for leading other engineers. They train and evaluate colleagues on unique and general information. Continuing education/training is critical.

Requirements

- Technical undergraduate degree (B.S. in engineering, chemistry, physics, metallurgy, or materials science)
- 15 years of direct technical experience in applied materials science, electronics assembly techniques, and/or electronics assembly technical service
- Demonstrated technical competency
- Strong interpersonal, communication, and presentation skills
- Ability to work, with ease, with executive-level counterparts
- Strong alignment with the corporate and departmental missions
- Ability to work cooperatively and effectively in a cross-functional team environment
- Ability to travel with limited notice
- Proficient in Word, Excel, and PowerPoint
- Experience with JMP or Minitab preferred
- Special consideration is given to candidates with language skills in Spanish and/or Chinese

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West Software Application Engineer

This position reports directly to the Orbotech West software support manager and works with customers to support Orbotech's pre-production software products. Acts as a focal point for technical issues, manages product implementation projects, provides customer training, and supports the sales process. Advanced knowledge of Frontline PCB products, including InCam, InPlan, InStack, InSight, Genesis, and Genflex. Ability to travel and manage time to maximize results. Requires both written and oral technical communication skills. Skilled in the use of scripting languages, including C-Shell, Perl, or Python. Knowledge of relational databases and HTML/XML highly desirable. Knowledge of PCB manufacturing processes. Familiar with the processes used in front-end engineering departments at PCB fabrication sites. Requires use of project management skills to organize and complete projects that involve the implementation of sophisticated software tools used in printed circuit fabrication facilities.

An expected average of 35%+ travel. College degree or equivalent technical education, in addition to a minimum of five-plus years of related experience. Experience supporting sales and sales activities is a plus. U.S. citizen with the ability to work and travel within the U.S., Canada, and internationally.

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Career Opportunities



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OEM Sales Manager Chicago/Home-Office-Based

Want to advance your career by joining a globally successful and growing world-class CCL manufacturer and help drive that success? We are seeking to hire an OEM sales manager to grow and manage key customer accounts with OEM's and Tier 1 manufacturers in the USA, focusing on Ventec's core market segments: mil/aero, automotive, and medical, offering a full range of high-reliability materials, including polyimide, IMS, and thermal management products.

Skills and abilities required for the role:

- Non-negotiable: Drive and tenacity!

Required:

- 7 to 10 years' experience in the PCB industry in engineering and/or manufacturing
- Detail-oriented approach to tasks
- Ability to manage tasks and set goals independently as well as part of a team
- Knowledge of MS office products

Full product training will be provided.

This is a fantastic opportunity to become part of a successful brand and leading team with excellent benefits.

Please forward your resume to
jpattie@ventec-usa.com and mention
"Technical Sales Engineer—Chicago"
in the subject line.

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Sr. PCB Designer—Mentor Xpedition

Freedom CAD is a premier PCB design service bureau with a talented team of 30+ dedicated designers providing complex layouts for our enviable list of high-tech customers. Tired of the commute? This is a work-from-home, full-time position with an opportunity for additional compensation for overtime work at time and a half.

Key Qualifications

- EXPERT knowledge of Xpedition VX 2.x
- Passionate about your PCB design career
- Skilled at HDI technology
- Extensive experience with high-speed digital, RF, and flex and rigid-flex designs
- Experienced with signal integrity design constraints encompassing differential pairs, impedance control, high speed, EMI, and ESD
- Excellent team player who can lead projects and mentor others
- Self-motivated with the ability to work from home with minimal supervision
- Strong communication, interpersonal, analytical, and problem-solving skills
- Other design tool knowledge is considered a plus (Altium, Allegro, PADS)

Primary Responsibilities

- Design project leader
- Lead highly complex layouts while ensuring quality, efficiency, and manufacturability
- Handle multiple tasks and provide work leadership to other designers through the distribution, coordination, and management of the assigned workload
- Ability to create from engineering inputs, board mechanical profiles, board fabrication stackups, detailed board fabrication drawings and packages, assembly drawings, assembly notes, etc.

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Career Opportunities



Advanced Connectivity Solutions

Senior Development Engineer

Rogers Corporation is seeking a senior development engineer accountable for the development of more complex products and processes, the establishment of sound technical bases for these developments, and effective interaction with technology, process, and platform innovation; operations; sales and marketing; and process engineering personnel to commercialize these developments.

Essential Functions:

- Design and conduct experiments and interpret the results
- Report on projects in both written and verbal formats at all levels of the organization
- Perform technical troubleshooting of new products and processes; act as new product/concept incubator for new technologies and platforms, identifying opportunities for improvement and incorporation design for manufacturing requirements resulting in a viable, scalable product
- Provide ongoing process and manufacturing support to newly launched products as applicable
- Provide support in terms of analytical equipment maintenance, methods development, material analysis, and documentation of new process or products
- Manage capital projects for the purchase and installation of new process or support equipment; train employees in new processes

Required Education and Experience:

Ph.D., Ch.E., M.E., or material science, or B.S. or higher in a technical discipline with accomplishment in product development and project management.

Rogers Corporation provides equal employment opportunities to minorities, females, veterans, and disabled individuals as well as other protected groups.

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Gardien Is Hiring!

The Gardien Group, a leading solutions provider in the PCB industry, is looking to fill multiple openings in their China, Japan, Taiwan, and United States service centers.

We are looking for electrical engineers, operations managers, machine operators, and sales executives. Prior experience in the PCB industry is beneficial but not essential. Training will be provided along with excellent growth opportunities, a benefits package, and periodic bonuses.

Our global teams are from diverse cultures and work cohesively as a tight-knit unit. With performance and initiative, there are plenty of opportunities for professional growth.

Gardien is an equal opportunity employer. Employment decisions are made without any regard to race, color, religion, national or ethnic origin, gender, sexual orientation, age, disability, or other characteristics.

Interested candidates, please contact us with your resume and a cover letter. Kindly note that only shortlisted candidate will be contacted.

[Apply at careers@gardien.com.](mailto:careers@gardien.com)

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Career Opportunities



Assistant Department Manager, Operations, Carson City, NV

This is an entry-level professional management trainee position. Upon completion of a 1-2-year apprenticeship, this position will be elevated to facility/operations manager. Primary functions during training: shadow incumbent staff managers to learn and understand the operations and personnel of the operations department. This position will train and learn, develop, implement, and coordinate strategies related directly to the manufacture of Taiyo products. Additionally, this position will be learning all about the facility, environment, and health and safety functions. Eventually, this position will be responsible for the administration, security and maintenance of the facility and warehouse

Required Experience/Education:

- 4-year college degree in industrial engineering or another similar science discipline combined with work experience in ink or coatings manufacturing
- Ability to read, analyze, and interpret common scientific and technical journals, financial reports, and legal documents
- Ability to respond to inquiries or complaints from customers, regulatory agencies, or members of the business community
- Ability to develop and implement goals, objectives, and strategies
- Ability to effectively present information to top management, public groups, and/or boards of directors
- Ability to apply principles of logical or scientific thinking to a wide range of intellectual and practical problems
- Knowledge of governmental safety, environmental, transportation regulations/laws

Preferred Skills/Experience:

- Bilingual (Japanese/English)
- Toyota Production System (TPS)

Working Conditions:

- Occasional weekend or overtime work

See complete job listing for more information.

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Opportunities are available in Canada, New England, California, and Chicago. If you love teaching people, choosing the classes and times you want to work, and basically being your own boss, this may be the career for you. EPTAC Corporation is the leading provider of electronics training and IPC certification and we are looking for instructors that have a passion for working with people to develop their skills and knowledge. If you have a background in electronics manufacturing and enthusiasm for education, drop us a line or send us your resume. We would love to chat with you. Ability to travel required. IPC-7711/7721 or IPC-A-620 CIT certification a big plus.

Qualifications and skills

- A love of teaching and enthusiasm to help others learn
- Background in electronics manufacturing
- Soldering and/or electronics/cable assembly experience
- IPC certification a plus, but will certify the right candidate

Benefits

- Ability to operate from home. No required in-office schedule
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- IRA retirement matching contributions after one year of service
- Training and certifications provided and maintained by EPTAC

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Career Opportunities



Technical Account Manager Chicago/Minneapolis

Insulectro, the largest national distributor of printed circuit board materials, is seeking a talented sales superstar for a Technical Account Manager role based out of either our Chicago or Minneapolis office. This role will focus on maintaining the existing customer base and developing new business within the assigned territory in both the printed circuit board and printed electronics industries. We are looking for the perfect fit of education, experience, and attitude that matches our company culture and enhances the service level to our customers.

Qualifications:

- A self-motivated business professional who is driven to succeed with a minimum of 3 years outside sales experience in the PCB or PE industry
- Proven sales/business development record
- Excellent communication and interpersonal skills
- OEM and electronic assembly experience is a plus

We offer:

- Competitive salary and commission plan with a comprehensive benefits package
- A fun, high-energy company with an entrepreneurial spirit
- A great group of people to work with!

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APCT, Printed Circuit Board Solutions: Opportunities Await

APCT, a leading manufacturer of printed circuit boards, has experienced rapid growth over the past year and has multiple opportunities for highly skilled individuals looking to join a progressive and growing company. APCT is always eager to speak with professionals who understand the value of hard work, quality craftsmanship, and being part of a culture that not only serves the customer but one another.

APCT currently has opportunities in Santa Clara, CA; Orange County, CA; Anaheim, CA; Wallingford, CT; and Austin, TX. Positions available range from manufacturing to quality control, sales, and finance.

We invite you to read about APCT at APCT.com and encourage you to understand our core values of passion, commitment, and trust. If you can embrace these principles and what they entail, then you may be a great match to join our team! Peruse the opportunities by clicking the link below.

Thank you, and we look forward to hearing from you soon.

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Career Opportunities



Development Chemist Carson City, NV

Develop new products and modify existing products as identified by the sales staff and company management. Conduct laboratory evaluations and tests of the industry's products and processes. Prepare detailed written reports regarding chemical characteristics. The development chemist will also have supervisory responsibility for R&D technicians.

Essential Duties:

- Prepare design of experiments (DOE) to aid in the development of new products related to the solar energy industry, printed electronics, inkjet technologies, specialty coatings and additives, and nanotechnologies and applications
- Compile feasibility studies for bringing new products and emerging technologies through manufacturing to the marketplace
- Provide product and manufacturing support
- Provide product quality control and support
- Must comply with all OSHA and company workplace safety requirements at all times
- Participate in multifunctional teams

Required Education/Experience:

- Minimum 4-year college degree in engineering or chemistry
- Preferred: 5-10 years of work experience in designing 3D and inkjet materials, radiation cured chemical technologies, and polymer science
- Knowledge of advanced materials and emerging technologies, including nanotechnologies

Working Conditions:

- Chemical laboratory environment
- Occasional weekend or overtime work
- Travel may be required

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Multiple Positions Available

The Indium Corporation believes that materials science changes the world. As leaders in the electronics assembly industry we are seeking thought leaders that are well-qualified to join our dynamic global team.

Indium Corporation offers a diverse range of career opportunities, including:

- Maintenance and skilled trades
- Engineering
- Marketing and sales
- Finance and accounting
- Machine operators and production
- Research and development
- Operations

For full job description and other immediate openings in a number of departments:

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Career Opportunities



SMT Field Technician Huntingdon Valley, PA

Manncorp, a leader in the electronics assembly industry, is looking for an additional SMT Field Technician to join our existing East Coast team and install and support our wide array of SMT equipment.

Duties and Responsibilities:

- Manage on-site equipment installation and customer training
- Provide post-installation service and support, including troubleshooting and diagnosing technical problems by phone, email, or on-site visit
- Assist with demonstrations of equipment to potential customers
- Build and maintain positive relationships with customers
- Participate in the ongoing development and improvement of both our machines and the customer experience we offer

Requirements and Qualifications:

- Prior experience with SMT equipment, or equivalent technical degree
- Proven strong mechanical and electrical troubleshooting skills
- Proficiency in reading and verifying electrical, pneumatic, and mechanical schematics/drawings
- Travel and overnight stays
- Ability to arrange and schedule service trips

We Offer:

- Health and dental insurance
- Retirement fund matching
- Continuing training as the industry develops

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Sales Representatives (Specific Territories)

Escondido-based printed circuit fabricator U.S. Circuit is looking to hire sales representatives in the following territories:

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for
more information.

mfariba@uscircuit.com

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Career Opportunities



ZENTECH

Zentech Manufacturing: Hiring Multiple Positions

Are you looking to excel in your career and grow professionally in a thriving business? Zentech, established in Baltimore, Maryland, in 1998, has proven to be one of the premier electronics contract manufacturers in the U.S.

Zentech is rapidly growing and seeking to add Manufacturing Engineers, Program Managers, and Sr. Test Technicians. Offering an excellent benefit package including health/dental insurance and an employer-matched 401k program, Zentech holds the ultimate set of certifications relating to the manufacture of mission-critical printed circuit card assemblies, including: ISO:9001, AS9100, DD2345, and ISO 13485.

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Please email resume below.

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For more information, click below.

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Why Choose Fein-Line?

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Fein-Line Associates is a consulting group serving the global interconnect and EMS industries, as well as those needing contact with/information regarding the manufacture and assembly of Printed Circuit Boards. The principal of Fein-Line Associates, Dan (Baer) Feinberg, formally president of Morton Electronic Materials (Dynachem) is a 50+ year veteran of the printed circuit and electronic materials industries. Dan is a member of the IPC Hall of Fame; has authored over 150 columns, articles, interviews, and features that have appeared in a variety of magazines; and has spoken at numerous industry events. He covers major events, trade shows, and technology introductions and trends.

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- technology transfer
- new product market entry
- merger and acquisition due diligence
- market information and market research
- expert witness assistance and seminars regarding all aspects of printed circuits
- electronic assembly manufacturing and marketing



Dan (Baer) Feinberg

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Events Calendar

IPC APEX EXPO 2020 ▶

February 4–6, 2020
San Diego, CA, USA

Medical Design & Manufacturing ▶

February 11–13, 2020
Anaheim, California, USA

Embedded World ▶

February 25–27, 2020
Nuremberg, Germany

CPCA Show 2020 ▶

March 16–18, 2020
Shanghai, China

Electronica & Productronica China ▶

March 18–20, 2020
Shanghai, China

LOPEC Exhibition and Conference (Driving the Future of Printed Electronics) ▶

March 24–26, 2020
Munich, Germany

KPCA and KIEP Show ▶

April 22–24, 2020
Kintex, Korea

IMAPS High Temperature Electronics HiTEC ▶

April 22–24, 2020
Albuquerque, New Mexico, USA

IMAPS CICMT Ceramic Interconnect ▶

April 22–24, 2020
Albuquerque, New Mexico, USA

Additional Event Calendars



Coming Soon to *PCB007 Magazine*:

JANUARY 2020: IPC APEX EXPO Preview

Join us in the January issue as we share what to expect and what to look for in San Diego at IPC APEX EXPO 2020.

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PCB007

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