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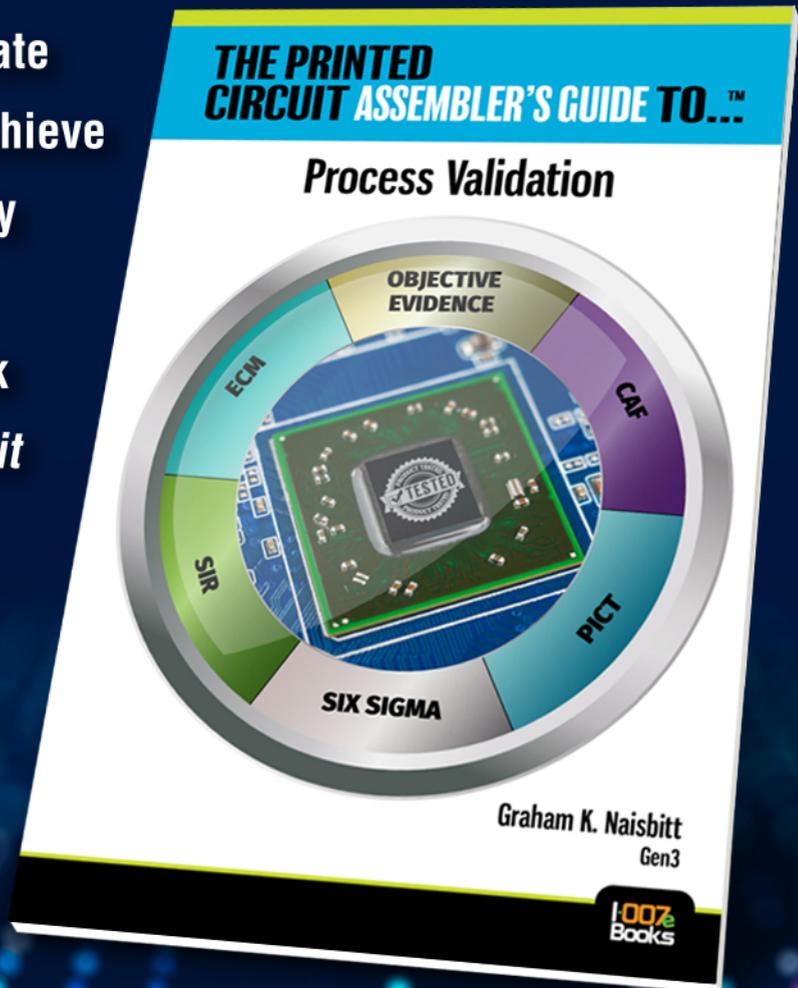


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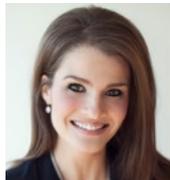
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M A G A Z I N E

IPC APEX EXPO 2020 Preview

IPC APEX EXPO is here again. I-Connect007 has been previewing IPC APEX EXPO all month, and we're excited to bring the highlights you can expect to see while in San Diego.

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Don't miss these sessions at the show

Martin Franke

Siemens AG, Corporate Technology - Industry 4.0.

How we transform a Buzzword into Manufacturing Excellence in Electronics:

Case Study for Improving the PCB Print Process Using Factory Data.

Wednesday, February 5th, 10:30 am to 12:00 pm.

Jay Gorajia

Director, Global Services, Siemens Digital Industries Software.

Optimizing Throughput and Cost with Manufacturing Simulation.

Thursday, February 6th, 1:30 pm to 3:00 pm

Visit
website



IPC APEX EXPO 2020

Preview

Nolan's Notes

by Nolan Johnson, I-CONNECT007

IPC APEX EXPO is here again. If you have followed our coverage in *SMT007* and *Design007*, then you're probably laser-focused on the upcoming show. We have been previewing IPC APEX EXPO all month, and we're excited to pass that information along to you within these pages. Here's what we learned.

Twenty years of IPC APEX EXPO: This is the 20th event, and IPC will be commemorating this milestone throughout the week. IPC compiled a list of every company that has exhibited at IPC APEX EXPO from the beginning. The list is quite long, which speaks to the ongoing value that this event provides the industry.

Technical Conference: Brook Sandy-Smith, IPC technical conference program manager, gives a detailed overview of what attendees can expect in the technical sessions, as well as some new and reconfigured events and resources on the technical conference side.

Sessions @ the Intersection: Growing out of the venerable Buzz Sessions, this year, you'll be sure to enjoy Sessions @ the Intersection. Brook and her team have been gathering presenters and striving to bring you the most informative, most up-to-date information available.

IPC Validation Services: Randy Cherry, director of Validation Series at IPC, discusses the latest in the Validation Services program and what attendees can expect to see at IPC APEX.

Trusted Supplier Program: Randy Cherry also introduces us to IPC's new Trusted Supplier Program and shares some member company testimonials.

STEM Student Outreach Program: IPC continues its work to engage high school youth in our industry. This effort expanded in 2019 and this year will be both larger and more detailed than ever before.



The Fundamentals Program: This new technical session targets attendees who are new to the industry or looking to gain a solid understanding of the technologies, processes, and terms in use all across the industry.

The Newcomers' Lounge: This gathering place for folks who are new to IPC APEX EXPO can be a valuable resource.

Further, published in *SMT007 Magazine*, we provided updates on CFX, the IPC-published digital factory data interchange protocol. Find our [interview](#) with Chris Jorgensen and an article titled “[True or False: CFX Edition](#)” by Dave Bergman in that publication. We also shine a spotlight on IPC’s Government Relations team.

There will be so much more at IPC APEX EXPO; this is just a taste! Expect a wide range of technical papers, training sessions, networking events, awards to present, and industry standards to advance.

In this issue, we also feature walking tours and videos from Mycronic and Viking Test Ltd. Alex Stepinski updates us on GreenSource Fabrication, and Vladi Kaplan from CIMS addresses streamlining inspection and verification.

But don’t think for a minute that we’ve left out our columnists! Dr. John Mitchell, Jan Pedersen, Tara Dunn, Mike Hill, Michael Carano, George Milad, and Steve Williams share their thoughtful perspectives this month as well.

See you in San Diego! **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](#).

Top Reasons to Attend IPC APEX EXPO 2020

Brook Sandy-Smith, IPC’s technical conference program manager, discusses the top reasons to attend IPC APEX EXPO 2020, from connecting with other members of the industry to planning for the future by being up to date on the latest industry advancements and new technologies. Click the image to watch the video. (Source: IPC)



IPC APEX EXPO 2020: A Special Anniversary Year

One World, One Industry

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

This year marks the 20th anniversary of IPC APEX EXPO, and IPC is thrilled to celebrate this event milestone with attendees, exhibitors, and presenters. Their dedication to and involvement in IPC APEX EXPO is directly responsible for its success, and their efforts clearly illustrate how the entire electronics manufacturing industry comes together to “Elevate the Excellence of Electronics”—this year’s theme. This is the place to be to create new business relationships and opportunities and enjoy this vibrant, ever-evolving industry.

Not only are we celebrating 20 years of a successful trade show, but for the past 19 years, the Trade Show News Network (TSNN) has recognized IPC APEX EXPO as a top U.S. trade show. It’s a tremendous accomplishment for IPC, and we are very proud of the recognition. For the past

several years, IPC APEX EXPO has experienced both attendance and net-square-footage growth. Last year, the show welcomed more than 9,000 professionals from 45 countries. We’re looking forward to an even larger crowd this year.

Here’s What’s New in 2020

1. The Fundamentals Program

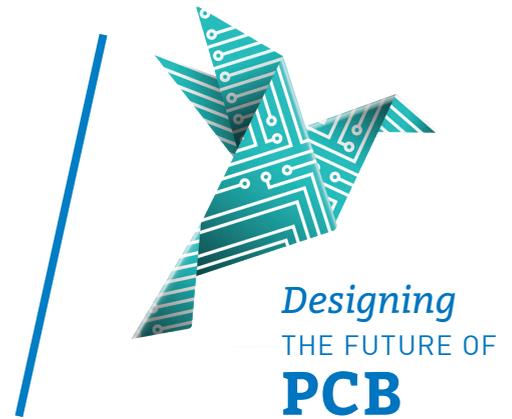
The Fundamentals Program is a new option for those attending the technical conference. Geared toward adding value to the attendee experience, the program provides curated content covering the many facets of the electronics industry. Attendees will gain a broader view of the industry and will learn important terminology and background as preparation for content on new studies and technologies pre-



In this video, Brook Sandy-Smith, IPC’s technical conference program manager, emphasizes the new Fundamentals Program, as well as the Intersection sessions, which are designed for people who are new to the industry or specialized attendees who want to gain a broader view of the industry through cultivated content.



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sented at the technical conference. Sessions will include topics presented by subject matter industry experts, interactive panel sessions, and opportunities for attendees to learn the secrets of success from our valued presenters. Program topics include introduction to IPC and standards basics, soldering processes, testing, circuit board design and fabrication, surface reliability considerations, and more.

2. Technical Conference Single-Session Pass

The technical conference single-session pass offers admission to one technical conference session. It's perfect for seeing a friend's presentation, getting the latest information on a favorite topic, or meeting subject-matter experts on a specific issue.

3. Sessions at the Intersection

Whether at the intersection of business and engineering or the intersection of two industry organizations, these sessions are free to all attendees and will address the hottest industry topics you need to know about today. Here are some of the topics: semi-additive processes for building circuits, e-textiles developments, supply chain diversity, PCB challenges, needs for emerging applications, weak microvia interfaces, best practices for strategic board procurement, and conscientious engineering.

Additional Highlights

Here are a few additional highlights of the IPC APEX EXPO 2020 experience:

- Listen to aerospace legend Burt Rutan speak on the new era in commercial space travel and race for space in his **keynote** presentation
- View cutting-edge products and services in the **new products corridor** and get a sneak preview of tomorrow's equipment, materials, and services that are breaking new ground in our industry
- Find out what nearly 500 of the industry's top innovators and suppliers have to offer on the **show floor**

- Participate in our **technical conference** to discover the latest research and studies in the areas of design, board fabrication, and electronics assembly
- Attend **standards development committee meetings**. Your input is critical to the development of IPC standards
- Visit the **IPC CFX Industry 4.0 digital factory** and participate in live demonstrations on the show floor to see how two industry standards—IPC CFX (IPC-2591) and Hermes (IPC-HERMES-9852)—work together for any manufacturer to achieve Industry 4.0. The factory line will feature equipment from different vendors all speaking the same language for machine-to-machine and machine-to-factory exchange communication, creating a simple-to-operate, practical, smart, and fully connected manufacturing environment
- Offering something for everyone, from informative classes for engineers ready to level-up in their careers to advanced classes, this year's **professional development courses** will help you build your knowledge and enrich your career
- Take in a multitude of **networking activities**, from the newcomers' reception and ribbon-cutting ceremony to the ice cream social on the show floor

This year, you'll be inspired to take the ideas and innovations you encounter onsite and turn them into real-world solutions and business opportunities. We hope you will join us. If you're on social media and would like to share your IPC APEX EXPO experience and/or post photos, we encourage you to do so. Use the hashtag #IPCAPEXEXPO on your Twitter, Facebook, LinkedIn, or Instagram to continue the conversation. **PCB007**



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

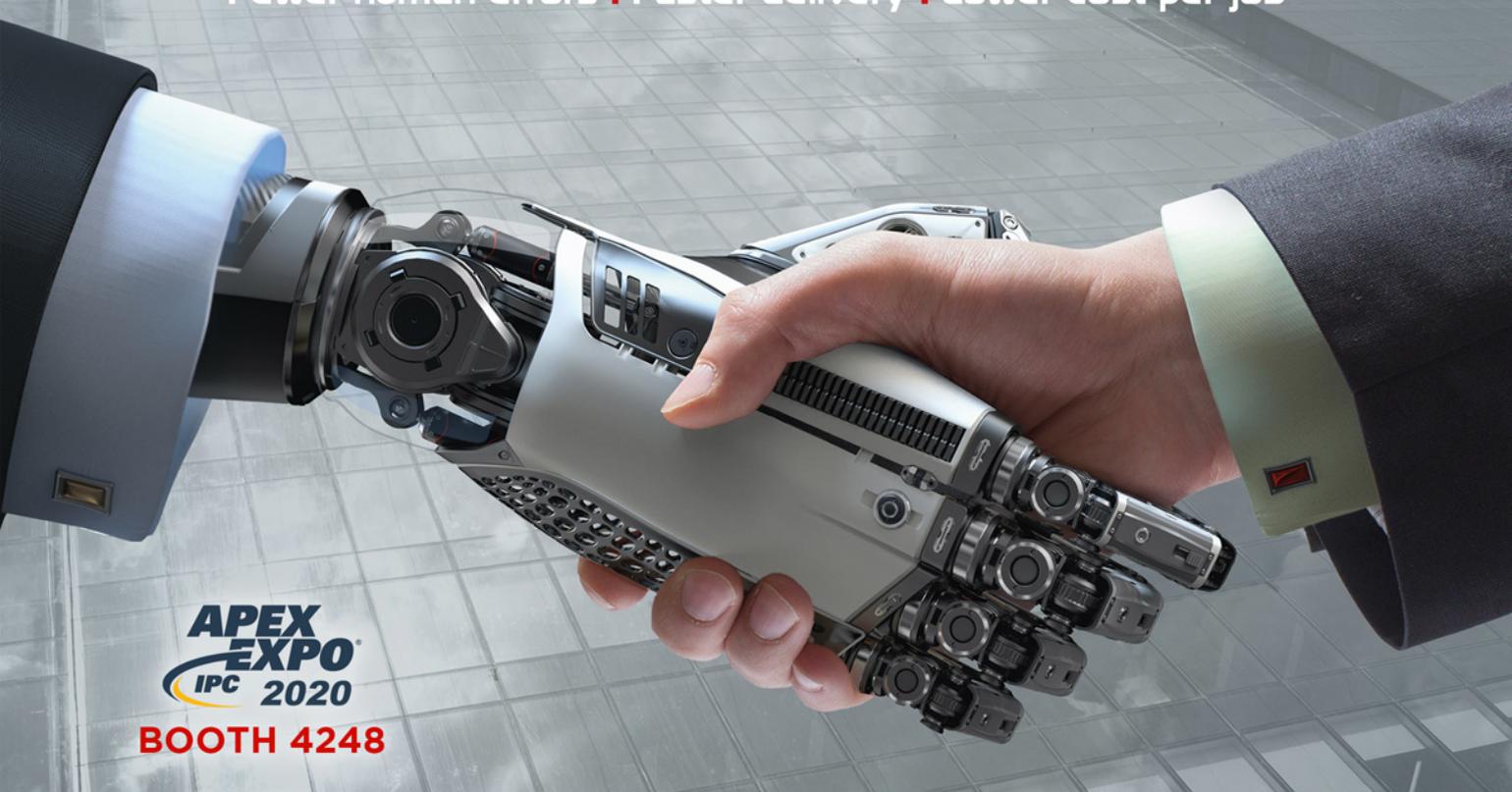


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Charlene Gunter du Plessis



Corey Lynn

Engaging STEM Students at IPC APEX EXPO 2020

Feature by Nolan Johnson
I-CONNECT007

At this year's IPC APEX EXPO, you're likely to see quite a few high school students moving amongst all the normal show activities thanks to the IPC APEX EXPO STEM Outreach Program. Launched two years ago at IPC APEX EXPO 2018, the 2020 version of the STEM Outreach Program will be larger and more immersive than ever before.

Charlene Gunter du Plessis, director of strategic partnerships and programs at IPC, shares: "The IPC APEX EXPO STEM Outreach Program has grown on an annual basis. This will be the third year hosting high school students at IPC APEX EXPO, and the program has evolved ever since." She adds, "200 high school students

and educators from the San Diego region will join us during an interactive day of hands-on technical activities, career exploration, and industry engagement."

The STEM Outreach Program will take place on February 6, 2020. The organized activities will start at 8:00 a.m. and conclude at about 3:00 p.m. After a kickoff breakfast, students will move to the show floor, where they will rotate through four different education tracks throughout the morning. The tracks will provide students with real-world technical skills training in soldering, coding, design, and assembly of PCBs as well as an IPC APEX EXPO show floor tour. After a career panel luncheon, students will complete their day with one more education track before returning to their staging area for closing remarks and dismissal.



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The soldering stations are a regular highlight on STEM Outreach days.

Corey Lynn, education marketing manager at IPC, adds, “We’re excited that we are doubling the number of students who joined us last year and we’re doing more activities. Last year was mainly a tour of the show floor and some light soldering. This year, we’re adding to the fun.” Lynn continues, “There will be a session on PCB design, including evaluating the design of the pin, by Professor Kris Moyer from Sacramento State. We’ll also have a session creating circuits using a breadboard and components with Padre Rudolph from North Country Trade Tech High School in Vista, California.” Further, Lynn points out, “And we’re still going to solder. I just received the shipment of the IPC Education Foundation pin we’ll be soldering. It has two leads and two resistors and was designed by Kevin Pintong from Oregon Tech.”

Of course, the soldering portion seems to be a student favorite. Nichola, a high school sophomore who attended the STEM Outreach Program in 2019, shared, “The hands-on experience with all of the soldering was useful because if/when I get a job as an engineer, I can use the tips they gave us on how to solder better and make higher-quality products.” Diego,

a high school freshman, wrote, “The soldering was awesome. I never knew that it would be that easy. I thought that it would be super complicated, but the people there helped me out plenty.” Further, Catherine, a high school junior, reported, “I really enjoyed the hands-on experience in soldering and learning more about how different companies solder components on their circuit boards.”

Rudolph, who is also a high school teacher volunteer for the STEM Outreach Program, emphasizes, “Students get excited about the hands-on activities and gain new ideas about what they can do with their careers. Many have no idea about what electronics careers are available.” She continues, “If students are successful at school and know there are jobs available, then they are more excited about going to University.”

I asked Gunter du Plessis how teachers and students respond when reached about this program, and she said, “We’ve been receiving an overwhelming positive response from students and teachers, especially from the Career and Technical Education (CTE) front with a focus on the STEM and manufacturing tracks. Students enjoy learning from experts on how

to solder, and their faces light up when they complete the hands-on activity. Project-based learning is so important, and our hands-on soldering events have a strong focus on applications that support classroom teaching.”

When I asked Rudolph how she became involved with the program, she said, “I have been teaching high school robotics for the last 5.5 years. I was asked how I plan to add more electronics education to my course by IPC. I told them about what I have been doing with circuits and breadboarding and how excited I am about adding more electronics to my course. As a result, I took a course to get an IPC J-standard certification in soldering. I have been working with IPC with the goal of sharing with other teachers and expanding my program for the last 1.5 years.”

To that end, IPC has been reaching out beyond the San Diego local area as well. Gunter du Plessis elaborates, “We have expanded our community across the U.S. and established 26 IPC Student Chapters at local universities and community colleges.” Gunter du Plessis continues, “We’ve hosted six hands-on soldering STEM-focused events in Pennsylvania, North Carolina, Alabama, California, and Illinois that engaged nearly 400 students. We’ve engaged with hundreds of CTE teachers and instructors in over 16 states.”

Rudolph adds, “STEM projects take extra time to set up and figure out how to run in a classroom. They take money to buy the materials. And teachers have to learn to let students experiment and be willing not to know the answers all the time. It is a lot of fun, but it is something that takes experience that many teachers don’t get a chance to acquire.”

There are scholarship opportunities, as well. Gunter du Plessis shares, “We awarded \$30,000 in scholarships and impacted 23 students, one educator, and six schools.” She adds, “The IPC Education Foundation officially launched at the beginning of 2019 and has made excellent inroads. We have established a solid platform and will continue to create connections between individuals—such as students in high school and college, teachers, instructors, professionals—and IPC industry members.”



Dadre Rudolph

For industry insiders who want to get involved, Gunter du Plessis explains, “We are always seeking volunteers to join us during the STEM events, depending on the activity. Let us know if you want to provide supplemental technical instruction and/or guidance in one of the technical learning tracks; engage with students (informally) about your career, job, and/or company to help expand their understanding of careers in electronics; or help coordinate student activities.”

When I asked Rudolph about her biggest personal takeaway, she said, “Having students be proud of the projects they complete and be successful in school and gain more confidence in their future.”

A final note from IPC Education Foundation is that this event is free for participating students, and they are thankful for the support from their sponsors: TTM, Nordson, Panasonic, Weller, and I-Connect007. **PCB007**

Learn More

- [IPC Education Foundation Student Chapters](#)
- [IPC Education Foundation 2019 Scholarship Award Winners](#)

Automotive Standard Elevates the Excellence of Electronics

The PCB Norsemen
Feature Column by Jan Pedersen, ELMATICA

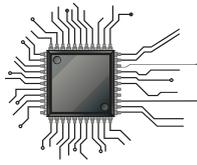
Soon, we will be heading to sunny San Diego and IPC APEX EXPO again to meet old friends, make new connections, indulge in interesting discussions, and, of course, talk for hours and hours about the importance and development of IPC standards, especially those related to automotive.

IPC-6012DA-WAM1, Automotive Applications Addendum to IPC-6012D, was the first document in IPC's Automotive Initiative. Further standards are in the pipeline and, more or less, challenge each other to be the next in line, such as the joint document IPC-A-610/IPC J-STD-001 Automotive Addendum that will cover both requirements and acceptability of electronic assemblies. Then, we have IPC-9797, which is a brand-new cold joining press-fit standard for harsh environments. Finally,

and also running the race to reach a release within IPC APEX EXPO 2020, we have IPC-1782A—the traceability standard, that, if you ask me, links all other standards seamlessly together.

IPC-6012DA (currently in WAM1) was the first automotive standard for printed boards; it also needs to expand to cover all types of rigid printed boards. To meet the PCB needs in the automotive industry of today and tomorrow, we have started to collect information and identify the types of printed boards not covered by the existing standard. One finding in the research is printed boards used for LED headlights and taillights, which have two requirements not covered; these are described as metal-core printed boards and high-power printed boards.



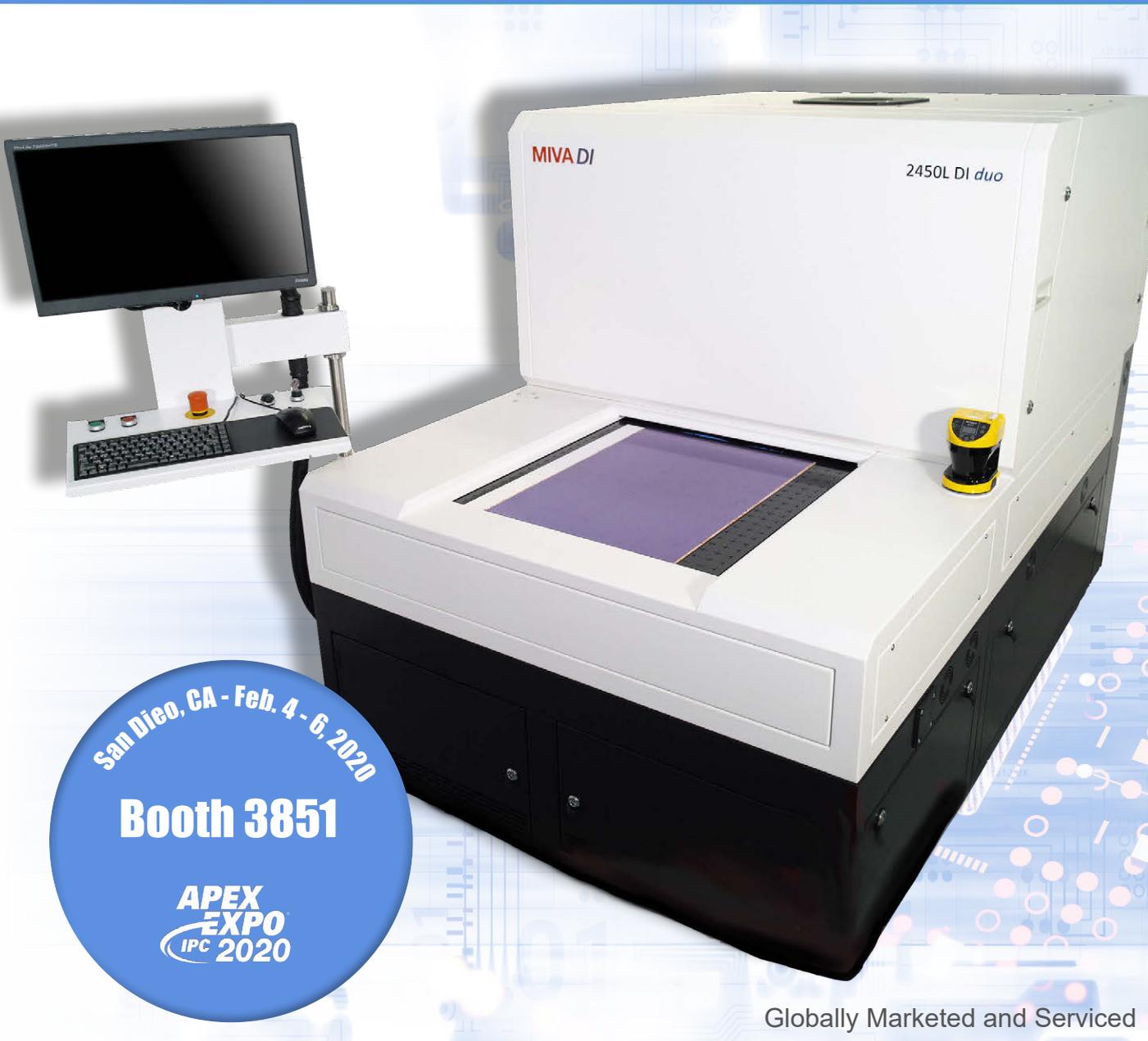


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Metal-core Printed Boards

IPC started to develop a standard 4–5 years ago, but the work to develop this standard was stopped halfway. The result is that it's a jungle out there, especially the specification and standardization of aluminum used as a base material and heat distributor. The situation today is that the major players in the market develop their own materials without a material standard. That does not mean the materials are of low quality. The challenge comes when you try to compare materials from two competitive vendors.

The situation today is that the major players in the market develop their own materials without a material standard.

You can sort on thermal conductivity and other parameters for the insulation material, but if you try to specify the aluminum carrier, you soon get stuck. If you ask the big vendors, you surely get figures, but how to compare if you don't have a standard for reference? A good example is to know how to select the correct material if you have a long, slim printed board and want to avoid bow and twist.

High-voltage Printed Boards

Along with the metal-core printed boards comes the requirements for high voltage for LED headlights and taillights. We see voltage of 1000 volts or more with all the requirements that follow this level. For printed boards used in such applications, test and qualification will be discussed along with material and electrical requirements.

Traceability

IPC-1782A is currently in the ballot stage, and we have finally managed to include traceability for printed boards in addition to the electronic production. Traceability is a critical tool to limit the cost when a problem occurs, and

with the volumes of automotive applications, it is vital to keep the cost down. The new revision of Automotive Applications Addendum to IPC-6012 will be linked to IPC-1782A with a requirement to traceability levels related to reliability requirements.

Press-fit Technology

IPC-6012DA WAM1 already has requirements related to press-fit, but with the new cold-joining press-fit standard IPC-9797, we will have a much better tool to set requirements using a well-defined standard. These are some of the issues that will be discussed when we start developing the new revision of the Automotive Applications Addendum to IPC-6012. Again, some of the issues have up to now not been sufficiently discussed. I think we are overdue but, hopefully, not too late.

Join the Group and Raise Your Voice

The first open discussion will be at IPC APEX EXPO on February 4. The task group is open for new members, and with this agenda, I expect an increased interest in this standard. We need members from the whole supply chain to join the discussion, from automotive application designers to all parts of electronics production and carmakers. Printed boards for electric vehicles will also be a part of the whole discussion.

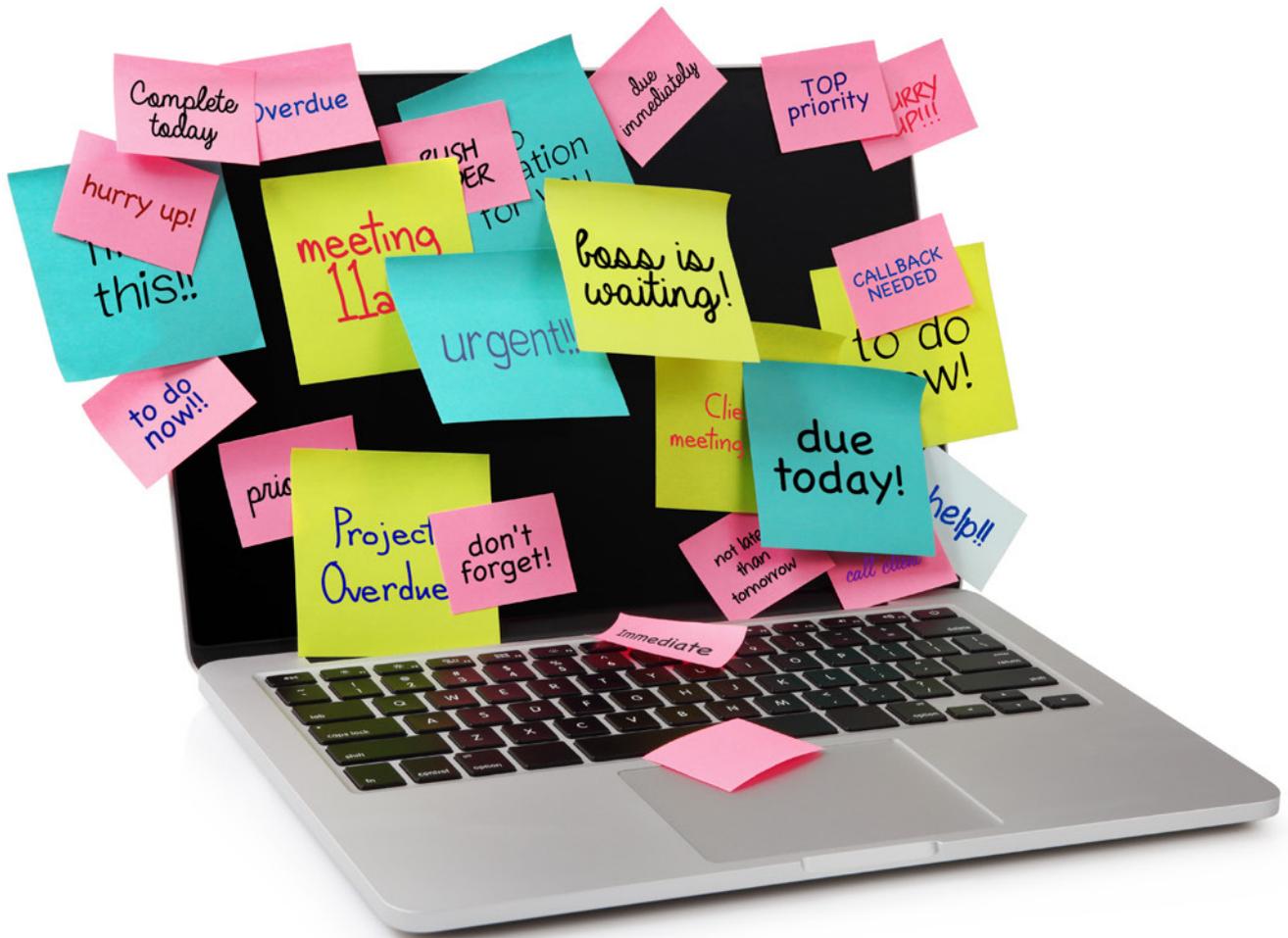
Be a Cheerleader

Since six PCB manufacturers came together to create the Institute of Printed Circuits (IPC) in the fall of 1957, hundreds of standards have been developed, obstacles removed, and the advancement of the PCB industry has been cheered forward. I am looking forward and hoping to see lots of cheering and enthusiasm at this year's grand event in San Diego as well. We all need the standards and to be involved in making them function optimally. **PCB007**

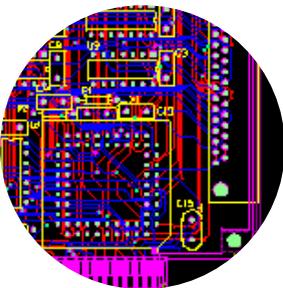


Jan Pedersen is a senior technical advisor at Elmatica. To read past columns or contact The PCB Norsemen, [click here](#).

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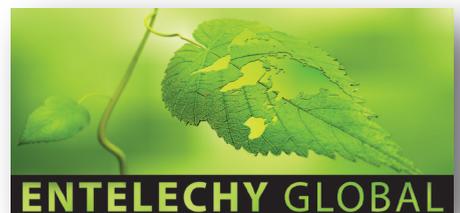
Here are six ways that outsourcing CAM and related front-end work can help manufacturers not only stay in business but also help them thrive:



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IPC Government Relations Team Offering Education and Fun at IPC APEX EXPO



Feature by Chris Mitchell

IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

This year's IPC APEX EXPO is going to be especially interesting for anyone interested in government policies that affect the electronics industry and what IPC is doing to influence them. Your IPC Government Relations team is preparing a variety of activities to educate and engage you on these issues.

IPC places a high priority on government relations because there are so many public policy debates that have huge impacts on our members, from trade and tariffs to environmental regulations, research and development, minerals sourcing, and workforce skills.

Our "GR" team educates government officials on these issues from our members' perspective, advocating for policies that will help our members prosper and grow. We also serve as an information resource for you, answering your questions about what to expect and how to comply with new laws.

Here are the highlights of what IPC will be doing in San Diego from a GR perspective. We hope you will join us.

Calls to Action

At the highest level, IPC will be emphasizing several key themes.

Elevating the Industry's Excellence Through Government Policy

Our overall theme this year is "Elevating the Excellence of Electronics," and one of the ways IPC does that is through our government relations work. Because the electronics supply chain is so important to so many other industries and national economies, IPC is calling on governments worldwide to enact policies that enable a thriving, innovative electronics supply chain. Some nations and blocs, led by China and the European Union, are pursuing ambitious industrial policy programs with a view toward dominating 21st-century technologies. Others, led by the United States, are taking a more market-driven approach. While we can debate which approach works best, there is no doubt that all nations have an interest in staying ahead of the megatrends that are shaping tomorrow's economy, including Industry 4.0, automation, cyber threats, 3D printing, and the



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- 2011 Mach 630UP Cut-Sheet Laminator & Pre Heater
- 2011 Pal Galvanic Copper-Tin Auto Electroplating Line
- 2008 Schmid Black Hole Line
- 2014 UCE Strip-Etch-Strip Line
- Probimer-Burkle LPI Curtain Coating Line
- 2015 Votsch Walk-In Oven
- 2011 Penta 550 Pb Free HASL
- Occleppo Chem Clean Line
- (6) Hydra Semi-Auto Screen Printers
- Orbotech Discovery AOI
- 2017 Profitech Opticheck 3D Video CMM
- (6) Schmolli CNC Routers
- (4) HML Multilayer Platen Presses
- 2011 HML RM 652 CNC Scoring Machine
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- Mania Silverwriter Plotter
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Workforce Champions

The electronics industry has a responsibility to train the workers of tomorrow, recognizing that many of those job descriptions haven't even been thought of yet. Over the last two years, IPC has doubled down on its longstanding commitment to addressing the skills gaps affecting the electronics industry (see my [August column](#)). At IPC APEX EXPO 2020, we will be unveiling new worker credentialing programs that will further drive excellence. We'll also renew our call for government policies and initiatives that more effectively link workforce education programs with job opportunities.

Industry Intelligence

Consistent with IPC's role as the eyes and ears of the electronics industry, we will be announcing several initiatives to expand our research and insight programs, including a landmark study by IPC's new Chief Economist Shawn DuBravac on the many economic contributions of our industry. Many of the deliverables of our expanded research program will be useful in planning your business strategies and educating policymakers as well.

Opportunities to Engage and Learn

Throughout the show, we will have numerous opportunities to learn from and engage with each other.

For example, the IPC GR team will be participating in many of the industry standards discussions that are relevant to government policies, such as the groups that are developing materials declaration standards, halogen-free materials guidance documents, and the trusted electronic designer, fabricator, and assemblers standards. Please [contact me](#) if you have thoughts or questions on any standards-related issue.

Members of the IPC North American Government Relations Committee, who provide essential input for our advocacy work, will gath-

er for their next meeting on February 3. The meeting is by invitation only, but anyone interested in the work of the GR Committee is invited to [contact Ken Schramko](#), IPC senior director of North American government relations, for more details.

The electronics industry has a responsibility to train the workers of tomorrow...

The IPC Environment, Health, and Safety (EHS) Committee will gather on February 5 to discuss EHS policies, research priorities, and upcoming happenings that are applicable to electronics manufacturers. This meeting is also by invitation only, but anyone interested is invited to [contact Kelly Scanlon](#), IPC director of EHS policy and research, for more details.

Speaking of EHS issues, on February 4, Kelly will lead an open session on California's environmental regulations, with expert contributions from Michael Easter, principal of EN-SIGHT—a California-based consulting firm—and Carol Monahan Cummings, chief counsel of the California Office of Environmental Health Hazard Assessment (OEHHA).

And it wouldn't be a complete business conference without a networking reception! On February 4 from 4:00–5:00 p.m., all IPC APEX EXPO attendees are invited to join us for a GR-team-sponsored reception titled, "From D.C. to Brussels, Beijing, and Beyond: How IPC Advocates for Your Company and How You Can Get Involved." We'll have an open bar, light snacks, and a few tips and tools for you to make your voice heard by your government officials.

See you in San Diego! **PCB007**



Chris Mitchell is IPC's VP of global government affairs. Contact him at ChrisMitchell@ipc.org, and view his columnist page [here](#).

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IPC Validation Services: What to Expect at IPC APEX EXPO 2020



Randy Cherry

Feature Interview by Nolan Johnson I-CONNECT007

IPC's Randy Cherry previews what to expect from IPC APEX EXPO 2020, including a full line on display demonstrating CFX/Hermes, further development of the Validation Services program, as well as testimonials from member companies that have been participating in IPC's new trusted supplier program to the Department of Defense (DoD).

Nolan Johnson: Randy, you work with IPC's Validation Services programs. Let's start with an overview of those programs.

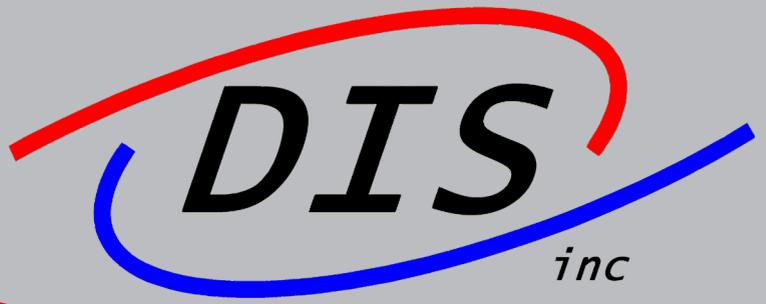
Randy Cherry: IPC Validation Services is comprised of three programs. We have the certification program based around the qualified manufacturers list (QML) and the qualified products list (QPL) where we certify the company's manufacturing process to the IPC standard. We also do gap analysis with companies that aren't interested in auditing but would like to get a snapshot of how their manufacturing processes stack up to the IPC standards.

The third program is our Technology Solutions program, which is more of a problem-solving, troubleshooting program where we work on very specific issues that the IPC member company would come up with. We're constantly developing new programs as time goes on. One program I'd like to highlight is our new Trusted Supplier program based on the IPC-1791 standard.

This was a project that IPC worked on with the Executive Agent team, including folks from SAIC and the Naval Surface Warfare Center (NSWC) Crane Division in Crane, Indiana. Together, we developed this program focused on PCB manufacturing, from the designer to the fabricator that makes the raw PCB, and of course, the assembler that assembles the PCB. This program is based around companies who supply to the DoD and their contractors. There are four basic parts of this program.

First, you must have a good quality system in place, but we build from the quality systems that the IPC member companies already have like AS9100, Nadcap, and IPC's QML, so nothing new has to be done. Second, there's also the supply chain risk management policy; we

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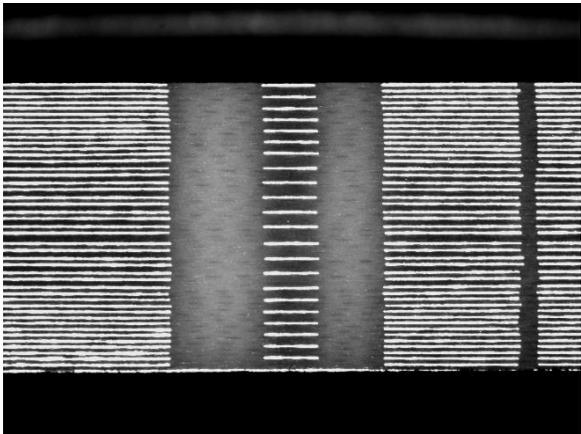
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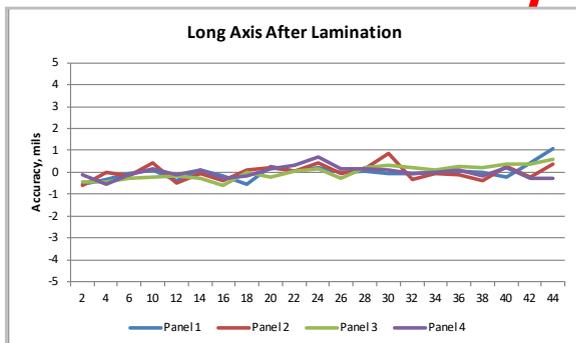
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make sure that's in place and that it protects the supply chain from certain threats or counterfeit disruption. As you know, counterfeiting is a big problem in our industry. The third part is security and compliance with NIST SP 800-171. We also look at your export controls and make sure that your ITAR and EAR compliance registrations are all up to par; we review all that documentation.

Finally, there's the chain of custody, which is the fourth piece of this program that focuses on how you handle your product traceability, deal with scrap, protection of CAD/electronic data, and how you ship your products or finished goods. That's looked at under the chain of custody. The main driver for this is the Defense Federal Acquisition Regulation Supplement or DFARS 252.204.7012; that's what's prompted IPC to get involved with this program.

Johnson: This is something you launched at IPC APEX EXPO 2019 and have been working on solidly ever since. Will that be more of a focus in 2020?

Cherry: Yes.

Johnson: What can we expect to see at IPC APEX EXPO 2020?

Cherry: We're going to share some more testimonials and stories from some of the IPC member companies who have already joined this program. We currently have ten IPC member companies on the QML. Then, we're going to continue to let them be our voice and help them promote the program. It's always better to have your customers talk about how well the program has gone. We also have a few more going through the certification process. By IPC APEX EXPO, we should have a nice group of companies.

Johnson: Will this be presented at IPC APEX EXPO, and how does a company get involved?

Cherry: The easiest way for IPC member companies to get more information on this would be to come to the IPC booth. We're going to

have a campus there where you can come to one place and not only learn about the Validation Service programs, but the bookstore will be there as well if you want to purchase a document, and you can learn about membership and certification. It will all be in one place.

Johnson: If this touches a hot button for someone, then they're not going to find things in the program directory; they need to see you at the booth to talk to you about it.

Cherry: That is correct. Once they connect with me at the booth, I can walk them through the program at a high level and give them some of the benefits. We're going to have a video board in the booth where we are going to be talking a lot about this program, and people can watch the video and pick up some information from that too. But we'll always have someone at the booth to answer questions about this program. As the DoD continues to work on this mandate, early adopters will get ahead of the curve by learning about this now instead of waiting until they have a certain deadline that they have to be certified by.

Johnson: That's their call to action: To gain preventative awareness and to know this information before it becomes a requirement. This seems like a crisp program, and I'm sure there will be an ongoing discussion about preparation issues going forward. What else is in store, Randy?

Cherry: I've been involved with the CFX/Hermes standards that IPC has been developing, and I've been working with the committee chairs. At IPC APEX EXPO 2019, we installed two working SMT lines: one dedicated to CFX, and another one for CFX/Hermes. At IPC APEX EXPO 2020, we're going to have one line on the first floor with all the exhibitors, and it will be a dedicated line for CFX and Hermes.

We'll have more CFX messaging than we had last year. We're also going to be working with the IPC-2581 committee, which is the standard for the XML format for intelligent data. Along

with CFX and Hermes, this is all part of Industry 4.0, and we'll be assembling boards, which will be very exciting.

Johnson: Last year, that was very well-received and helped everyone understand that Industry 4.0, CFX, and data interchange was viable. Anything else on your docket?

Cherry: There will be a full schedule at IPC APEX EXPO 2020. And the IPC Validation Services booth will be associated with this IPC campus, where we have everything all in one spot. It's going to be a fantastic show, and I

encourage everyone to attend. The IPC Validation Services program is still fairly unknown to the industry and a lot of our IPC member companies. It's a global program that's continuing to grow. We've had a lot of interest in Europe, and we have solid development in Asia going on with this program. The basic goal of Validation Services is to improve manufacturing processes and products, along with helping our member companies succeed.

Johnson: Thanks, Randy.

Cherry: Thank you. PCB007

The Newcomers' Lounge

We've all had the experience of being new to an event, especially at large events like IPC APEX EXPO. Whether you're attending for the first time, or even if you have previously attended once or twice, IPC APEX EXPO can be a bit overwhelming. There's so much to do and see. If you're attending without a friend or colleague, you might feel a bit like the new kid in school, trying to find a seat at a friendly table in a cafeteria full of strangers.

IPC is ensuring that all new attendees have the opportunity to meet others in the same situation. The newcomers' reception (formerly the first-timer's reception), of course, continues as a great opportunity for newcomers to network with each other. And yet, IPC is taking this idea a step further by providing an opportunity throughout the entire event for newcomers.

The Newcomers' Lounge will open on February 2, will remain open through February 6, and is conveniently

located near the technical conference and meetings area, where it will serve as a dedicated resource center for newcomers to get their questions answered and meet other newcomers. Use the lounge to take a break from the hustle and bustle of a busy day, catch up on emails, or grab a quick snack or refreshment.

In addition, newcomers will have an opportunity to meet key leaders and influencers in our industry during scheduled sessions in the lounge. Here are just two of the meet-and-greets planned for the Newcomer's Lounge.

- Meet IPC's **Teresa Rowe** (senior director, assembly and standards technology, IPC) and **Leo Lambert** (VP and technical director, EPTAC Corporation, and 2019 recipient of the IPC Raymond E. Pritchard Hall of Fame Award), along with IPC's **Emerging Engineers**, and listen in on the **Tribal Knowledge Cultivation Project**
–February 3, 1:30-2:30 p.m.
- Meet IPC's president and CEO, **Dr. John Mitchell**
–February 4 at 4:00 p.m. and February 5 at 9:30 a.m. and 3:30 p.m.

Stop by the Newcomers' Lounge to see the full schedule of meet-and-greets throughout the week, including an opportunity to meet Brook Sandy-Smith, IPC technical conference program manager, additional IPC Hall of Fame Award recipients, standards committee chairs, and several other subject-matter experts. (Source: IPC)





THOMAS STETTER

VP OF ASSEMBLY SOLUTIONS, MYCRONIC

Video



Thomas Stetter, VP of assembly solutions at Mycronic, discusses the positive effects of recent acquisitions, the MYPro line, and the benefits of the company's technology.



OLIVIER PIROU

VP GLOBAL INSPECTION, MYCRONIC

Video



Olivier Pirou, VP of global inspection, addresses the company's new AOI offering, which adds testing results analysis and feedback into the Industry 4.0 solution set.

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Alex Stepinski:

GreenSource Fabrication Update

Feature Interview by Barry Matties I-CONNECT007

Alex Stepinski gives an update on GreenSource, their acquisition of AWP, and their move to full production after some delays. Barry Matties and Alex also discuss automation and the difficulties in hiring in the U.S. and announces the decision to go to market with their recycling equipment in 2020.

Barry Matties: It's nice to see you at production, Alex. Let's start with an update on GreenSource Fabrication.

Alex Stepinski: We experienced some significant delays in the past year from the equipment supply perspective. It was mostly associated with non-direct process equipment. We have all of our core processes in place with the automation from AWP and a couple of other suppliers. To mitigate this, we recently purchased AWP. We reorganized and got our equipment out of there, as well as finished up

machines from other suppliers that were struggling. Everything is going to be on-site within one month. In Q1, we believe we're going to be in full production.

Matties: The story on the street, as you're building this factory, is that it's a hands-off operation from start to finish.

Stepinski: Nobody has to touch anything. We have all different types of automation and applications. We have buffers that reprioritize the work for single-piece flow in a very compact space. We have vertical and horizontal loaders and unloaders and robots that load and unload special machines. The integration of automation into the factory is the key to our being successful.

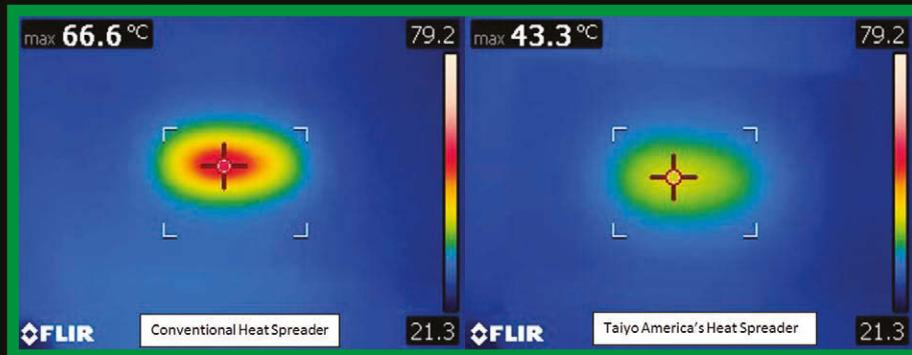
Matties: When people talk about automation, this is one of the areas that you can help clarify. What you're talking about is process automation and controlling the processes digitally.

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Stepinski: Automation has many potential benefits. You can use automation to more efficiently move product through your factory by removing human error or the human component in general. Machines don't take breaks, so that's one benefit of automation. Another benefit is, when you have automation, you can think, "What are the possibilities that I didn't have before?" For instance, on a plating line, can I come out in the middle of the cycle and have a robot arm turn the panel upside down and front and back and get a better distribution profile than I ever could if I let it sit in the tank? Because you can't trust a person to do this repeatedly all the time, but the robot can.

There are other aspects of automation, such as hold times, that are not well-controlled in our industry. You can put a buffer at the end of your line, where you have a hold time specification, and say, "This product cannot proceed to the next step until this much hold time has elapsed." You could also say, "I will not process this product to the next step until it reaches a certain temperature," because registration is going to be influenced. What happens with automation is you get much more consistent. You get much better registration and plating results. There's a value-added by-product—not eliminating people; it's eliminating all of the challenges related to people in general. However, it's not just labor costs; it's all the indirect costs of people.

What happens with automation is you get much more consistent.

Matties: Again, it's the process control automation. You're talking about a software-driven, recipe-driven digital factory.

Stepinski: Exactly. It's improving your process control.

Matties: Why is there so much uncertainty about this approach and bringing it down to a lot size of one, as you've done?

Stepinski: Europeans are more open to it. We've had more Europeans come to our factory than people from the U.S. We recently became ITAR-certified, so things are somewhat locked down now. But, in general, there aren't many people that are open to new things. It's one thing to not be open; it's another thing to not even be interested in visiting when they're invited to get some ideas to improve. A few companies are benefiting from what we've done, directly and indirectly. There's a lot of investment going on in the Northeast with our equipment company and other companies that are here based on stuff we've done in GreenSource.

Matties: You've created the model of the captive shop. Again, that makes sense for large OEMs, such as big electric car companies that would be interested in this sort of thing. My guess is they're spending billions of dollars a year on electronics.

Stepinski: I think it's the quality and cycle time issues.

Matties: All of the benefits that go along with it.

Stepinski: For companies that are very innovative and want to leverage circuit board technology to improve their end product, or make a new end product, this is a very attractive thing for a lot of OEMs. When you work with a board shop, it's very challenging, and because board shops are job shops, they build to a specification. And to do R&D and help a customer make a new product line, the customer has to be in your factory, or they have to have their own factory working and moving things fast down the field.

Matties: Is your shop now a job shop, and are you bringing in outside work?

Stepinski: Yes, and no. At first, we planned to be a job shop, but then we took a turn when



we had some of these equipment delays, so we made the best out of it. We took the equipment division and made it an integral part of Green-Source. Based on our initial experience with customers, there's a tremendous need for a real solutions provider, not just a PCB job shop.

If you're an OEM, we can leverage our network all over the world because we have a very strong network technically. I flew 1.2 million air miles in a very short amount of time to research our facility. Nobody else has done this worldwide since I did it. I've been maintaining my network and staying on top of what's coming out. It's a real partnership with our customers, so we're only looking for partners right now. We're not the one-off job shop company, nor are we interested in customers like that; we're interested in relationships.

Matties: My guess is you had customers lining up at the door, at least with a lot of interest.

Stepinski: And because of that, we've been able to make some decisions on what's the best-fit customer for us.

Matties: The other point that I've been talking about in the industry is, in traditional board shops, the profit has been stomped down to minimal, and you're showing that there was still profit on the table. We have to approach manufacturing differently.

Stepinski: Yes, there's a tremendous amount of waste in a traditional circuit board shop that

people have not addressed. It has become the standard that this is what they have to deal with, and I can't explain it, to be honest.

Matties: The profit is there. Is the problem that there aren't more Alex Stepinskis out in the industry driving this thing?

Stepinski: The brain drain in our industry has been bad over the past 20 years. I used to know a lot of people who were top-notch in the industry, but I don't know many anymore. Most people retired. For every five people that retired, there was maybe one to replace them. That's the way it is. In general, there's also a lack of capital investment. It's not a place for young people to come in. Factories stink, and the job-shop environment is quite cutthroat. Students coming out of school find that this is not a very interesting industry for them for many of these reasons.

Matties: But you changed the type of employees in this factory. You've set it up to be more about computer operators than machine operators. Granted, you have the technicians to maintain equipment, but it's the front-end work that you have to do to get the jobs through your factory.

Stepinski: Yes. The front-end portion of the process is our big focus for 2020. We have some experience doing tooling for this facility, and we're planning a lot of investments. We're adding a new office in Poland for the mechani-

cal design of equipment and for augmenting our tooling capacity for non-ITAR work. At the same time, we're adding in the U.S. a little more slowly. We're ramping up in Poland a lot faster than the U.S. because it's easier to find people in Poland than it is in the U.S. We're not a manufacturing economy anymore.

Thus, you have to train people, even when they come out of school. They need a lot of training to make circuit boards the way we want, whereas Poland has a manufacturing economy. Schools are more integrated with industry, so we've been fortunate to find good people very quickly over there. We are adding at both locations, but it's easier to grow Poland faster.

Matties: Last time, we chatted about typical cycle time for producing an HDI.

Stepinski: It's one to two days per sequential lamination.

Matties: Versus a traditional HDI fabricator.

Stepinski: We look at it in a few different ways. That's the theoretical time. If you have weird requirements or materials that aren't on the shelf, then everything changes. Typically, that's what we've been achieving. We have some pauses, as we're in startup mode because we have to analyze everything to finalize our recipes, but this is going to be our standard beginning in Q1.

Matties: We see embedded technology more and more. Are you incorporating that into yours?

Stepinski: We're doing passives right now.

Matties: Are actives coming?

Stepinski: For the actives, we understand the process of integration, but it's not the top item on our list. We have one customer who was interested in this and had the potential for some government funding of this project, but it hasn't been moving that quickly. Most of the customers have been focusing on realizing the

benefits from our plating and wet processes. Some customers like the signal integrity aspects, while others look at the stacked microvia reliability aspect. We're getting extremely reliable stacked microvias with our process.

Signal integrity was a big issue in the U.S. market because we have a SAP process. This allows us to hold much tighter tolerances than people doing pattern plating or people doing subtractive etching, etc. And this has been very interesting to a lot of people. The registration is a single-digit, micron-scale registration. We have 10-micron tolerances layer-to-layer, so it's a different level. Everybody's looking at it in a different way. We have 20 differentiating competitive advantages, and not all of them hit with everybody, but a few do.

Matties: What are your achievements right now with the plating process?

Stepinski: We've demonstrated up to 40:1. We're planning up to 60:1 aspect ratios, and we have 6:1 through-hole fill that we've demonstrated already.

Matties: These are record-setting numbers!

Stepinski: Yes, for the industry, and we're in the process of continuing to develop this capability and make it more repeatable. We recently acquired all of the key copper plating folks from the old i3 IBM company. They joined us, so we added close to 100 years of experience to our team in the past two months. It has been fantastic, as they've helped us develop recipes, and we're continuing to invest in this area to differentiate ourselves more.

Also, AWP in 2020 will be making vertical equipment based on all the innovations in vertical that we came up with already. Specifically, our first project is for internal use as a surface finish process, where there's a lot of interest in VeCS technology and RF cavities. It's challenging to get the surface finish down there to be clean.

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Rick Nichols, process engineering director at AWP.

ic gold, and silver—and electrolytic that will go up to 15:1 blind aspect ratio. This is way past anybody else. We have already done some testing and demonstrated the capabilities, and we hired Rick Nichols at AWP. He has been at Atotech for 15 years, and he's working with our design department to make this machine right now.

Matties: You're making a tremendous investment. What do you expect the ROI time to be?

Stepinski: With AWP, we've changed the company a bit. We got it ISO-certified this year, and have three ISO certifications. We put in an SAP ERP system, and we're continuing to invest in what we've deemed to be the bottlenecks there and to get more capacity because there's a high amount of demand for this equipment.

Matties: Is it a Stepinski signature series?

Stepinski: No (laughs). The way we look at AWP, we had two big suppliers for our project: Schmoll and Atotech. AWP was also a key supplier, and we had a lot of other suppliers too.

Matties: But those were your primaries.

Stepinski: In the course of things, we had two suppliers that totally gave up on things financially in the middle of it. AWP was one. This is

also in our whole Pareto of risk, and for long-term risk, we came to the conclusion that it makes sense to have our own captive equipment company.

Matties: Because people wondered if you were crazy, trying to run an equipment company.

Stepinski: Companies at productronica are offering one year plus lead times on things, maybe. There are a lot of financial problems out there if you're not the first two companies I mentioned. Some people do okay, but it's a hard life in the equipment business. R&D investment is very low, and it's more of a job-shop type thing. What we determined was, "We may not have an equipment supplier to make a smart factory, but when we expand, what are we going to do?" This company was our hope to implement that. We bought them, improved it, and we'll continue to grow it. This company, for us internally, is going to make whatever equipment we can get.

Number one, it's going to continue to lead the market in automation and smart factory development. We're going to add these new capabilities for vertical wet processing. We have some interesting new machines that aren't on the market for problems that I've known about for 20 years, and we're building solutions for those. Our plan is to develop the solutions for GreenSource first. Then, once we debug it and are satisfied, we can decide if we want to sell it, and if so, where and how we're going to sell it. Right now, we're partnering with a few clients in Europe for the equipment that we deem to be non-competitors to us, and we're also going to be having a few partners in the U.S. that are not competitors. We'll still offer some products even to direct competition, but not all.

Matties: In the U.S., there are a few big companies, but most are small. Are you scaling this down to help smaller companies?

Stepinski: The machine in front of you is a buffer. Even our unloader after it, you'll see examples of this equipment from three or four

suppliers here in Munich. Our stuff is 20–25% of the size, and we're still working to make it smaller. This is the kind of equipment that you can fit in existing facilities. If you look everywhere else, these machines are massive, so it's a problem everywhere. Everybody wants it to be smaller, and we take this to heart, so we have minimized it.

Matties: GreenSource is a unique situation because you had a blank canvas. Other shops have island manufacturing with processes set up in different rooms and sometimes different buildings.

Stepinski: When we started at Whelen, the original captive facility, we had a buffer that did something similar for three times the size of the AWP unit in front of you now. Now, we have a much more compact version that is about the same footprint as a human, which is the goal. We want to make all the machines the footprint of a human.

Matties: On the chemical side, are you relying on partners, or are you looking at your own juices as well?

Stepinski: We do both. We decided to go to market with our recycling equipment in 2020.

Matties: That's your zero-waste solution.

Stepinski: We are commercializing the solution. We have a bunch of IP that's being managed legally right now, and we're here looking for our first clients, and most likely it's going to be in Japan. The challenge with doing it in China is IP control, so we haven't gotten around this yet. This is a new product line for AWP, and we're going to grow this equipment division to be a strong equipment company worldwide and then leverage it to make sure GreenSource always has that advantage of getting the new tools first, or even exclusively, in some cases.

Matties: It's smart. The Whelen family believes in what you've done and continues to invest

smartly in you, and the ROI is going to be very good.

Stepinski: The Whelen family has been awesome; they have supported us from the beginning and continue to do so. It's a great situation.

Matties: The other great thing about the zero waste is you're creating a footprint that you can plant anywhere in the world.

Stepinski: That's another aspect. Our central recycling system is less than 100 square meters in size. It's tiny. It's a fraction of the size of what most people have for recycling systems, so it's quite simple to implement in an existing facility. We have been working the past year on making a commercial version of this so that you can drop it in anywhere and it works.

Matties: In your factory, you've incorporated other strategies to minimize the impact on that system. Is that something that the current users are also going to have to adopt?

Stepinski: They have the option.

Matties: Depending on how much they want to spend or how fast they want to achieve zero waste.

Stepinski: What we offer is a system that will economically deliver zero waste. If you don't want to make any changes in your process and take advantage of those technologies, it's still economical. It's not as economical as what we have. There are other benefits too. We believe recycling is a significant part of our reliability performance because when you recycle the water, you have unlimited water. It's going in circles, so it's about how big your pumps are. You can have the cleanest rinses imaginable and run 1,000 liters an hour through a cascade rinse and have it be ultra-pure clean. If it's that kind of an application where you want that, then you set it up, put a controller on the rinse, and configure it this way. That's how you take advantage. It's going to take a little time for

people to understand this change because everybody's incredulous that you have a system that's tiny and recycles everything in the factory.

Matties: It has only improved.

Stepinski: We constantly improve. We're always focusing on that. Don't sit still. If you sit still, then you die.

Matties: One of the big concerns is there's not a stream of young engineers coming in with the mindset that you have. What should the industry do to help resolve that? Because we're going to need them, even with all this great equipment. We're all growing older.

Stepinski: I don't have a solution for the industry. All I have is our case study, which is data-driven, and we know students coming out of school in the U.S. have a long lead time to get them to function at the level that we need. In Poland, it's a little bit easier, but we don't have a factory in Poland for PCBs; we have a factory for equipment. It seems to work out well. We're trying to leverage that as best we

can and partner with schools in the local area. Whelen made a donation of an advanced manufacturing facility to the University of New Hampshire a few years ago in the name of our former CEO.

We had a lot of young grads out of the University of New Hampshire and Keene State. We have a few other schools in the area; again, we're constantly partnering with them to move things forward. We even have a "little league" of manufacturing. We have school buses locally come in, and kids are learning about manufacturing. We're doing a lot, but it's still quite challenging.

Matties: You keyed in on it. The appeal of manufacturing isn't there compared to technology companies.

Stepinski: We're a service economy now, so it's quite a challenge.

Matties: Thank you, Alex. It has been great catching up with you.

Stepinski: You too, Barry. PCB007

Make the Most Out of IPC APEX EXPO 2020

Brook Sandy-Smith, IPC's technical conference program manager, shares a few tips on getting the most out of IPC APEX EXPO 2020, such as attending two key speaker presentations, downloading the app, and taking advantage of the new single-session pass. Click the image to watch the video. (Source: IPC)



5G: Higher Frequencies!

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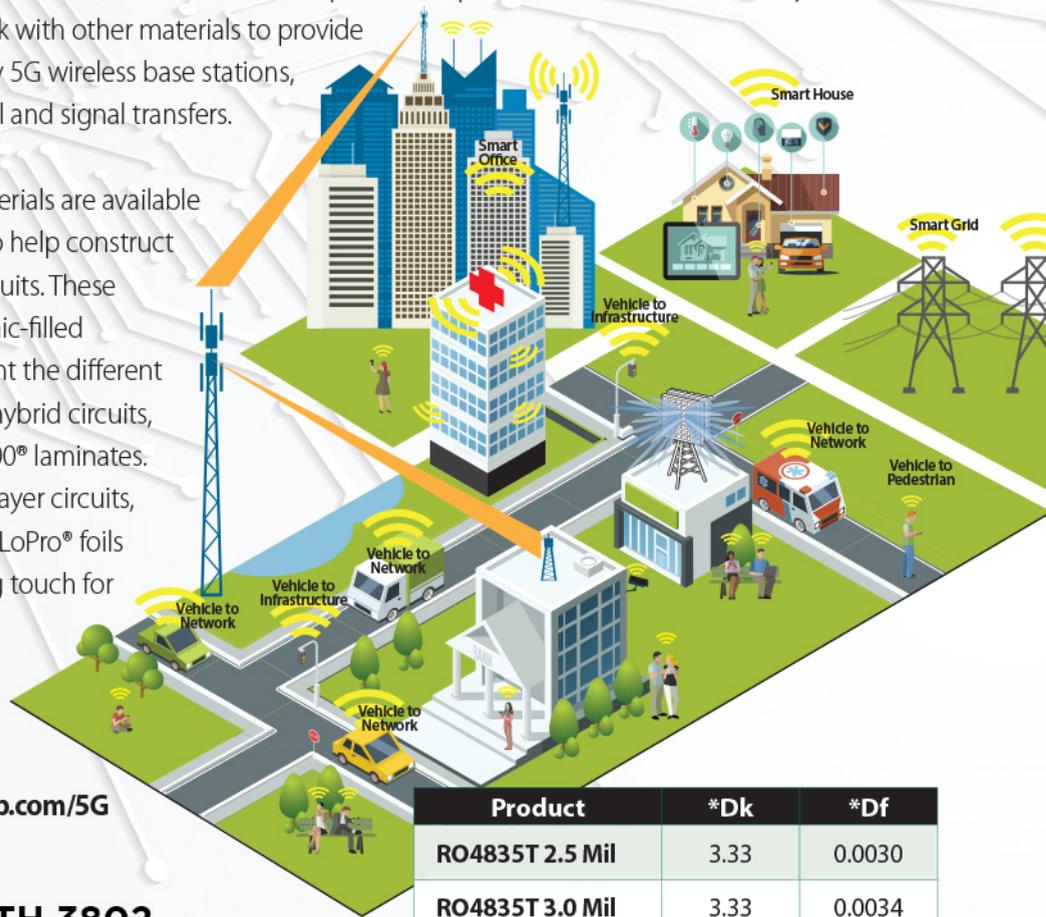
Frequencies at 28 GHz and higher are being used in Fifth Generation (5G) wireless communications networks. 5G infrastructure depends on low-loss circuit materials engineered for high frequencies, materials such as RO4835T™ laminates and RO4450T™ bonding materials from Rogers Corporation!

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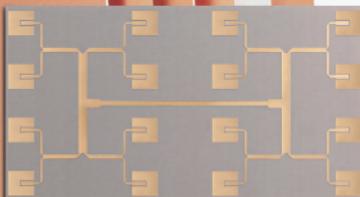


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IPC APEX EXPO Technical Conference, Featuring **Fundamentals** and **the Intersection**

Feature by Brook Sandy-Smith

IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

In addition to the Sessions @ the Intersection and the Technical Conference, Fundamentals Program is new at IPC APEX EXPO 2020. The program provides curated content for industry newcomers and anyone interested in a broader view through the many facets of electronics manufacturing. Attendees will learn important concepts, terminology, and background as preparation for the detailed content on new studies and technologies presented at the technical conference. Sessions will include topics presented by the need-to-know industry experts, interactive panel sessions, and opportunities to learn the secrets to success in this industry from our valued presenters (included with registration for the Technical Conference, plus \$25 for lunch).



Please note that the schedule is subject to changes. For the most updated information and details, consult the app or the agenda planner online.

The Fundamentals Program

The following is the schedule for the Fundamentals Program on February 3.

10:00 a.m.	Introduction to IPC
10:15 a.m.	Standards Basics
10:45 a.m.	Tribal Knowledge
11:15 a.m.	Circuit Board Design
12:00 p.m.	PCB Fabrication
12:30 p.m.	Lunch: Life Skills Panel
1:15 p.m.	Components and Terminology
1:45 p.m.	Soldering Materials/Reliability
2:15 p.m.	Soldering Process: Reflow
2:45 p.m.	Test Strategies
3:30 p.m.	Cleaning Processes
3:45 p.m.	Surface Reliability
4:15 p.m.	Long-Term Reliability
5:00 p.m.	Hot Topics Panel

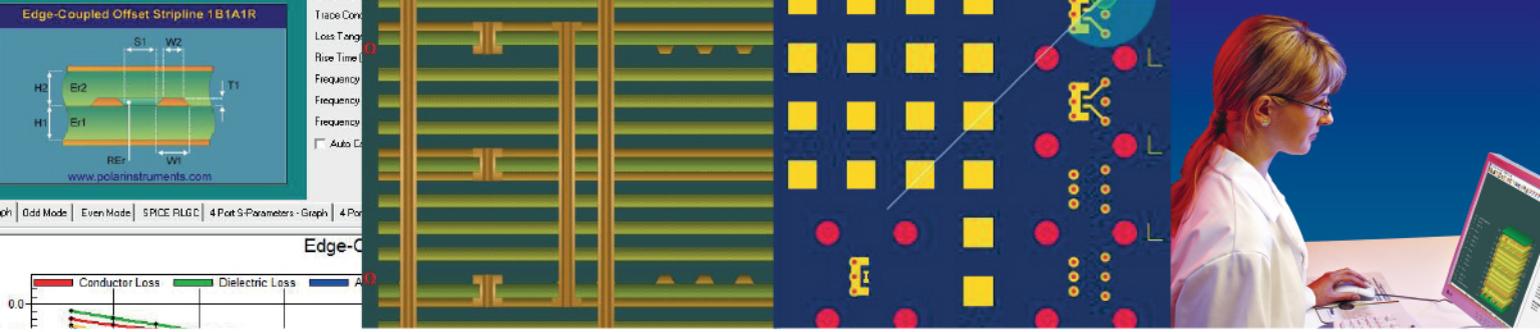
Technical Conference

The technical conference sessions will address a variety of topics, including assembly processes; cleaning, coating, and contamination; Industry 4.0, CFX, and smart factories; environmental issues and compliance; design and PCB fabrication and materials; and quality, reliability, and test.

Sessions @ the Intersection

Please note that some of the Sessions @ the Intersection are labeled interACTION sessions, which encourage participation and two-way communication. Topics covered will include business and technology, current techniques and future technology, methodology and reliability, standards development and IPC APEX EXPO, and more. **PCB007**

[Click here for more information.](#)

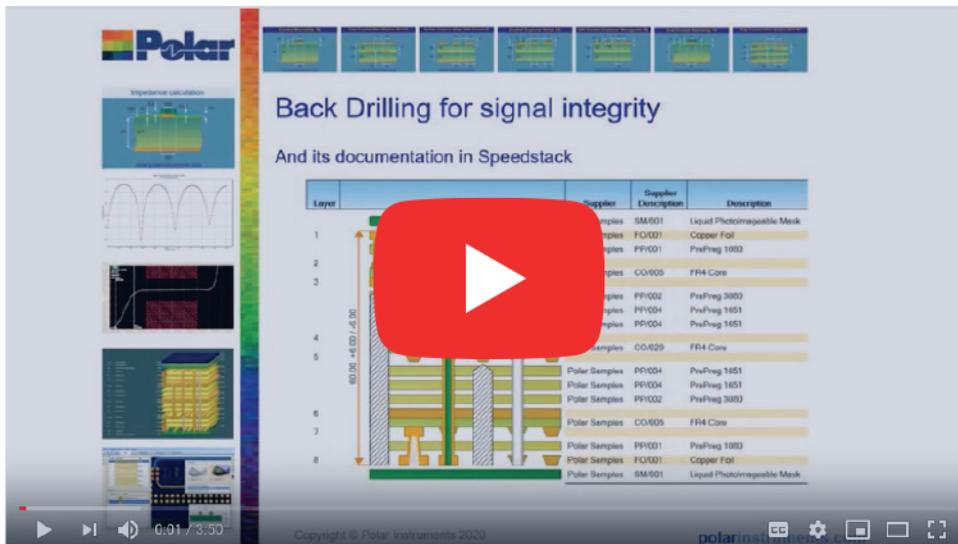


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Additive PCB Technology for Next-generation Electronics

Flex Talk

Feature Column by Tara Dunn, OMNI PCB

Semi-additive PCB processes help to enable very fine features, with trace and space down to 25 microns and below, significantly reducing space and weight for next-generation electronics. Tara Dunn speaks with Todd Brassard and Meredith LaBeau from Calumet Electronics about how the company is the first domestic PCB manufacturer to license Averatek's A-SAP™ process and will be presenting information on the industrialization of this process at this year's IPC APEX EXPO.

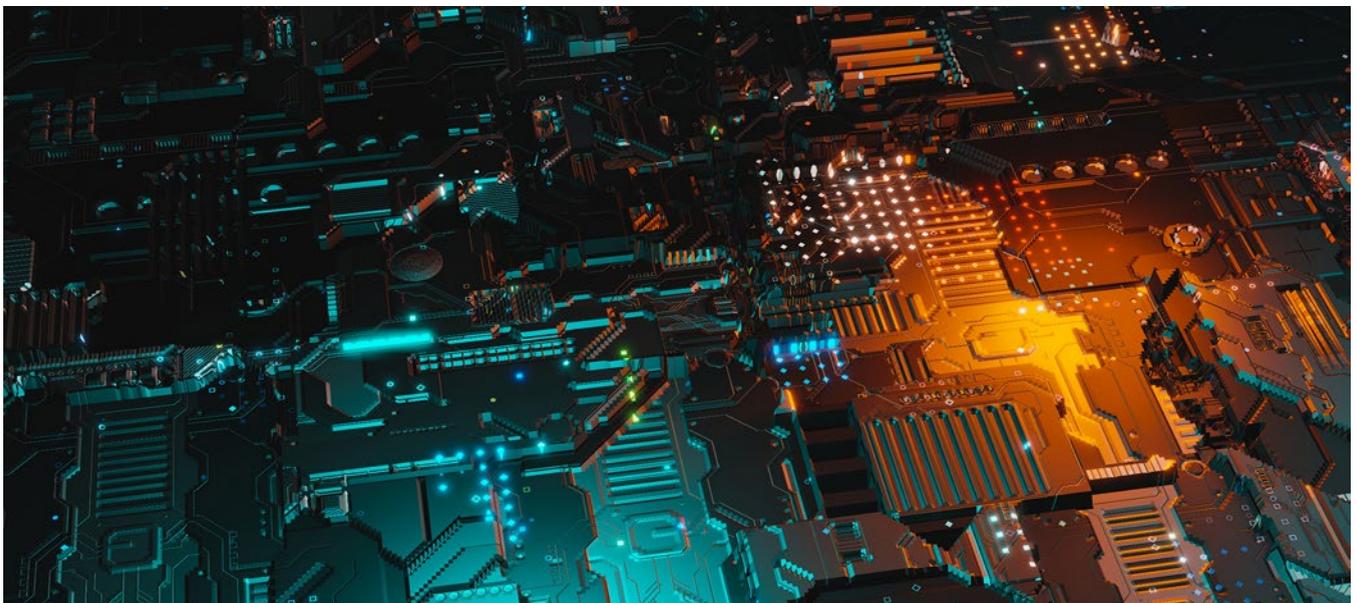
Tara Dunn: Thank you for taking the time to talk with me about Calumet Electronics and some of the exciting things you have going on at IPC APEX EXPO this year. Can you provide a little bit of background about Calumet Electronics and your roles there?

Todd Brassard: Thanks, Tara. I serve as the VP and COO at Calumet Electronics.

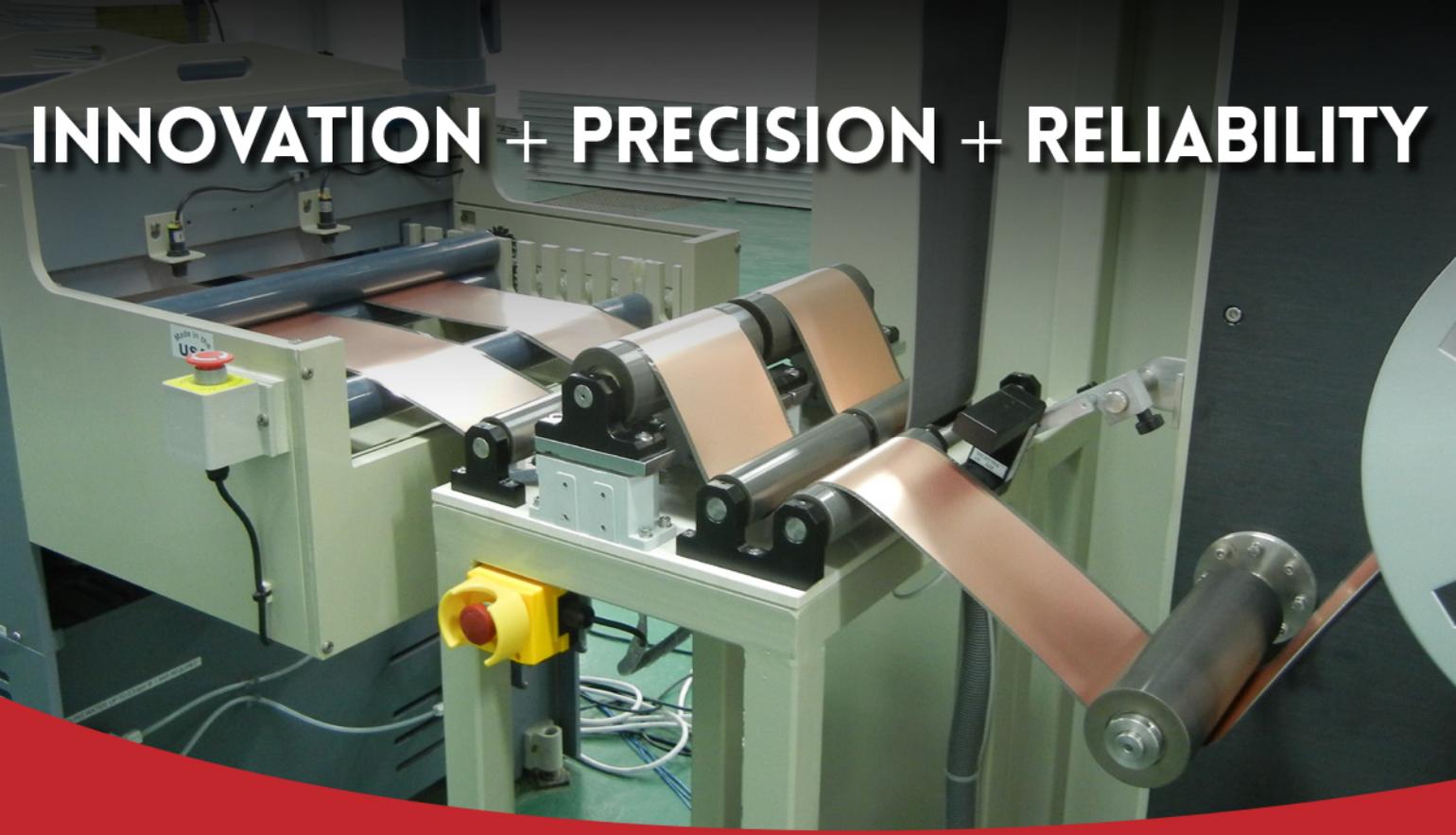
Meredith LaBeau: And I am the director of process engineering and one of the chief strategic planners.

Brassard: Calumet Electronics has a great story dating back to 1968, preceded by 100 years of copper mining. Our company's founding mission was to provide jobs to the region as the copper mines closed. This remains a strong component of our mission still, which is to provide careers for good people. Today, Calumet Electronics has grown and evolved to be among the healthiest and strongest PCB manufacturers in the country. Calumet is fiercely focused on strengthening the domestic electronics industry and solving problems for our North American customers.

LaBeau: In 2013, Calumet Electronics restructured to modernize the management team to meet the needs of the technology and job



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market. Calumet transitioned its focus from the head down to growing technological capabilities side by side with OEMs and other customers. Our technology has significantly evolved over the past six years, positioning Calumet to compete at the highest levels for all customers, but especially the aerospace and defense market. Calumet is also developing technologies that could reset the technology curve and bring semi-additive processing in volume to the United States.



Todd Brassard

Dunn: It is great to see a domestic PCB manufacturer investing in leading-edge, forward-looking technology. I understand that two technologies you currently have in development are flexible circuits and the Averatek A-SAP™ process. Can you explain a little more about your corporate philosophy, and what is driving this focus on investment in the future?

LaBeau: Calumet's corporate philosophy is to meet the needs of the domestic market through the advancement of a full-scale holistic solution for PCB design and fabrication, from rigid to flex and 15–25-micron space and trace. Calumet's engineering and manufacturing strives to provide world-class quality, technology, and service to continue to position the North American market as reliable and robust. We are focused on employees, customers, and technologies as driven by our internal strategic plan and the voices of the market. The market demands a robust workforce to meet the current and future demands as driven by componentry and size/weight restrictions.

Brassard: Exactly. There is where America is and where America should be, with respect to the types of technology U.S. companies can design, engineer, manufacture, and deploy. I'm fine with a global supply chain, but it's very important that American companies manufacture cutting-edge technologies on U.S. soil. Calumet Electronics is flying the compa-

ny toward the holes that need to be plugged in the U.S., in some cases, by providing advanced technologies securely sourced within the U.S. with short lead-times, and in other cases, industrializing industry-changing technologies, such as Averatek's A-SAP™. We can't be everything to everyone, but we drive hard to provide solid solutions that are 100% engineered and manufactured in

the United States.

Dunn: This year's IPC APEX EXPO is going to have several different opportunities for attendees to learn more about semi-additive processes for PCB manufacturing, and you are an integral part of that education. Can you give us a sneak peek? What are some of the benefits of this process for end-users?

Brassard: The potential applications for Averatek's A-SAP™ technology boggles the mind, or more realistically, solves real engineering and manufacturing problems in aerospace, defense, medical, and just about every industry where size matters, weight, reliability, or cost matters. The A-SAP™ process resets manufacturing complexity on technologies that cannot be produced at volume currently within the U.S. Imagine your design going from nine parts up on a 18x21 panel to 70 parts up, while reducing layer count, eliminating lamination cycles, and increasing reliability due to stronger chemical bonds. These capabilities are on the horizon for the domestic electronics industry.

LaBeau: Calumet is excited to be presenting on the initial results from the industrialization of the A-SAP™ process. Over the past seven months, Calumet has developed equipment, processing guidelines, and prototype products, realizing space and trace down to 20 microns. We will be presenting these early results at IPC APEX EXPO. Although results are what folks want to see, the bigger question and engagement we hope to draw forth is

the conversation on the design considerations with customers and supply chain representatives. The major question is, “How do we as a domestic supply base utilize this technology to reset the technology curve by reducing lamination cycles and the need for stacked and or staggered microvias for the development of a robust PCB with fewer opportunities for quality and lead-time issues?” Calumet with Averatek will be engaging a community of interest in the pursuit of answering this question, without immediate development of standards, which could stifle the innovation present with the A-SAP™ process.



Meredith LaBeau

Dunn: What do you think is driving the electronics market to need this technology?

LaBeau: The domestic electronics market is driven by the Asian and European markets, which is mostly the complexity of consumer products and cellphones. The component manufacturers have continued to reduce sizes to increase profitability. This has driven the North American market to design for smaller components, driving a decrease in BGAs, spaces, and traces. The domestic market is now seeking solutions to utilize the component supply chain. One solution is A-SAP™ technology.

In addition, as the technological demand increases, there is a greater need for more advanced PCBs. A-SAP™ technology provides the technological market with a manufacturing-ready solution to bring cutting edge componentry and design for high speed and high-frequency applications.

Brassard: I have attended high-level meetings at conferences where the U.S. was described as an “afterthought” in the global electronics industry and that American manufacturing technology is so far behind Asia and Europe that we’ll never catch up. I’ve also learned that the American warfighter requires the most advanced cutting-edge technologies to maintain

supremacy and that we cannot produce those technologies in the United States. If this is true, we need to get to work—not just Calumet, but at every PCB manufacturer in the United States.

Dunn: Calumet Electronics is the first licensee of the A-SAP™ process, and you will soon be providing production capacity for this type of technology. As you have undertaken this process development, what has surprised you?

Brassard: My education may be electrical engineering, but keep in mind that I’m just an operations person these days. In very non-technical terms, I have been amazed by the simple elegance of the A-SAP™ manufacturing process and how neatly it has folded into our traditional manufacturing process. Averatek’s technology is truly a wonder, and I don’t understand how Calumet can be the first company to be industrializing the technology. Trust us, we are going to have all the same problems and solutions manufacturing additive features as traditional, but the difference is we’ll have problems at 20 microns instead of 100 microns. This is great because we already know how to solve these types of problems.

LaBeau: As we have been industrializing the process, our team has been shocked by the ease of incorporating this process into the standard subtractive process that is currently driving the domestic PCB market. Our team has also been able to quickly adopt the process to form sub 25-micron inner layers. In addition, we have also been surprised about the growing interest in this technology. The prototype adoption of the A-SAP™ process has brought significant new customer communication to Calumet and our solutions team.

Dunn: It must be exciting to be leading the domestic market in the adoption of semi-additive processes and to realize the ability to provide

25-micron trace and space. I imagine that this technology, like any that is new to our market, will require a very collaborative approach with designers as the full potential of this capability is developed. What does Calumet Electronics have planned to help users through this learning curve?

LaBeau: Yes, the A-SAP™ process will require a unique collaborative process between design engineers, process engineers, manufacturing engineers, and product managers. Calumet is working on assembling these teams to develop design tolerances that will feed back to our engineering services team and, ultimately, our partner—the customer. In addition, this technological development also offers a unique opportunity to engage with design software services to develop top-notch tools that will streamline the process through fabrication. Calumet is going to drive to provide the solutions through continual teaching of our customers and suppliers.

Brassard: I also want to add that the Averatek A-SAP™ process requires wide-spread adoption if the technology is going to thrive and allow America to regain a competitive advantage in PCB manufacturing. With this in mind, Calumet is not only working through science, technology, and advancing toward full production capabilities, but we are also committed to teaching others. Let's face it—Calumet Elec-

tronics is strong when the domestic electronics industry is strong.

Dunn: What sessions will you be presenting and educating at during the IPC APEX EXPO show? When and where can people learn more?

LaBeau: We will be presenting in two different formats on February 4. Please attend the semi-additive process technical session from 1:30–3:00 p.m. and the “Emerging Technology: Semi-Additive Process” panel discussion from 3:30–5:00 p.m. at the “Intersection.” We will also be participating in a community of interest meeting on Wednesday morning.

Dunn: And that session is by invitation, so if you are interested, please contact me. Thank you both for your time, and I look forward to seeing you at IPC APEX EXPO.

Brassard: Thank you for talking with us today.

LaBeau: It has been a pleasure to discuss the upcoming events at Calumet Electronics and IPC APEX EXPO. PCB007



Tara Dunn is the president of Omni PCB, a manufacturer's rep firm specializing in the PCB industry. To read past columns or contact Dunn, click here.



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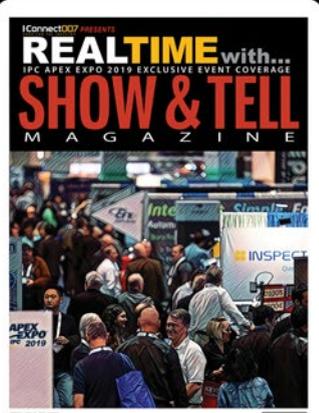
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MilAero007 Highlights



Lockheed Martin Paints Helicopter for Capt. Kimberly Hampton Memorial ▶

Lockheed Martin (NYSE: LMT) completed painting the OH-58D Kiowa Warrior helicopter that will be a part of the memorial honoring Capt. Kimberly Hampton in Easley, South Carolina.

Space History Is Made in This NASA Robot Factory ▶

Built in 1961, the Spacecraft Assembly Facility at Jet Propulsion Laboratory in Pasadena, California, is the cradle of robotic space exploration.

Aerojet Rocketdyne Highlights Successful Year Supporting DoD and NASA Missions ▶

Aerojet Rocketdyne continued to power critical defense and space missions in 2019, while also making significant investments aimed at reducing costs and increasing its operational efficiency.

NASA's X-59 Quiet Supersonic Research Aircraft Cleared for Final Assembly ▶

NASA's first large-scale, piloted X-plane in more than three decades is cleared for final assembly and integration of its systems following a major project review by senior managers held recently at NASA Headquarters in Washington.

U.S. Congress to Approve Funds for R&D on Lead-Free Electronics in Aerospace, Defense, and High-performance Applications ▶

In a win for U.S. taxpayers, defense readiness, and the electronics industry supply chain, the

U.S. House and Senate were poised to approve a defense spending bill that includes \$5 million for research and development on the issues surrounding lead-free electronics in mission-critical applications.

U.S. Navy Awards Contract for Thousands of APKWS Laser-guided Rockets ▶

Following a U.S. Department of Defense announcement in September 2019, BAE Systems announced that the U.S. Navy has signed a \$2.68 billion indefinite delivery/indefinite quantity contract for the purchase of thousands of additional APKWS® Laser-Guided Rockets, the company's combat-proven, low-cost precision munition.

Strategic Partner: Rolls-Royce, Reaching for the Skies ▶

Researchers at Cambridge are working with Rolls-Royce to make aeroengines greener.

Lockheed Martin's Precision Strike Missile Successful in First Flight Test ▶

Lockheed Martin successfully tested its next-generation long-range missile designed for the U.S. Army's Precision Strike Missile (PrSM) program at White Sands Missile Range, New Mexico. All test objectives were achieved.

NASA's Moon to Mars Plans, Artemis Lunar Program Gets Fast-tracked in 2019 ▶

In 2019, NASA celebrated the 50th anniversary of the agency's Apollo 11 Moon landing, the most historic moment in space exploration, while also making significant progress toward putting the first woman and next man on the Moon by 2024 under the Artemis program.

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IPC APEX EXPO Technical Session Preview

Feature Interview by Nolan Johnson I-CONNECT007

Brook Sandy-Smith, IPC technical conference program manager, previews the technical side of IPC APEX EXPO 2020, which includes the customary technical sessions, but also some new wrinkles like the fundamentals program and “sessions @ the intersection” to encourage more interaction.

Nolan Johnson: Brook, welcome back! We’re talking about IPC APEX EXPO, which is coming up in the early part of February 2020. You have a lot of your part of the program already figured out.

Brook Sandy-Smith: IPC APEX EXPO is planned far in advance so that we can get everything on the website in time for people to plan their travel. I’m overseeing the technical conference and professional development courses.

Johnson: Let’s start with what’s new this year at IPC APEX EXPO.

Sandy-Smith: It’s the 20th anniversary of the show, so that’s exciting. We’re trying to cele-

brate in some cool ways. We want people to share pictures from the past 20 years of being at the show and recognize exhibitors that have been around the whole time. I’m also trying to put together more ways to let people know all the cool things that we’re planning because sometimes people don’t know about some of the other things that are going on. We’re trying to have more networking and interactive events.

Another cool thing is that we’re on the other side of the convention center this year, so it will feel fresh and different because we’ve been in the same space for several years. It might throw people off balance a little bit. We definitely want to mention this ahead of time, so as people visualize the future and what they’re going to do at IPC APEX EXPO, they realize it’s going to be in a different space. And one of my favorite things about that is that the conference sessions are near the windows, looking out onto the terrace and bay, so you can easily walk out and see the ocean, which is what I always wanted.

Johnson: That changes the whole experience.

Sandy-Smith: It makes it feel a lot different. It’s sad when you’re at IPC APEX EXPO for a few

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days but never see the ocean. This year, I'll see it every day, so that's new. I also decided to do something different regarding the buzz sessions, which were free to expo attendees and people that come to the technical conference, but they were a bit outside of the technical conference because they were unconventional topics.

I still wanted there to be free content that people who come to the expo floor can take part in because there are a lot of big ideas in our industry that we want to discuss with everyone. So, I'm calling the area near the outdoor terrace and where you would come into the technical conference "the intersection." It's a meeting place. We're going to have couches so that you can have a conference call while looking at the ocean in a comfy seat.

Then, we're going to have sessions nearby there that we'll call "sessions at the intersection." This could be at the intersection of two different organizations, between what's happening on the show floor and what's happening in the technical conference, or of engineering and business. Those sessions will focus on bringing two worlds together and talking about the challenges that we face and some solutions for them. Again, I want to respin it and make it feel new and encourage more interaction. Technical conferences are awesome, but when the conversation is only going in one direction from the speaker to the audience, engagement is limited. The goal is to have more interactive sessions.

Johnson: You're going to have speakers act as a subject-matter expert on a topic. Do you want attendees to come prepared? If so, how?

Sandy-Smith: Yes. With the panel discussions that I've done in the past, the most compelling moments were questions from the audience that maybe the person who asked them thought it was a simple question or something that you already know. But someone with new eyes to the industry often brings a fresh take on what we're doing. Those questions are so insightful and get the conversation started, especially when half of the rest of the room was thinking the same thing. Those engagements are where you get to the heart of the matter. That's where you find the solution when someone says, "You said this, but it doesn't make sense because I'm doing this in my real life."

Johnson: Those are the great moments.

Sandy-Smith: And it's not just about the experts' opinions or having people who've been in the industry for 30 years share their expertise. I want new engineers to have a place to let those thoughts out, have conversations, and get them the information they need right up-front without waiting; I want to increase interaction so that they can get more information.

Johnson: It could cause somebody to decide to go hear about those topics. There's an element of initial engagement.

Sessions @ the Intersection

In this short video, Brook Sandy-Smith, IPC's technical conference program manager, explains how "the Intersection" will be a new meeting place in between the show floor and the technical conference available to attendees and the free sessions that are open to any registration type. (Source: IPC)



Sandy-Smith: Exactly.

Johnson: How many of those sessions are you planning?

Sandy-Smith: We have 10 sessions. They'll be paired up, two at the same time. We have six presentation blocks, and within each block, there are six presentations that are for the technical conference. You'd have to buy the technical conference pass to go to those sessions, and then one or two other sessions at the intersection. The people who sign up for the expo show for attendance can take part in the intersection sessions, too. I'm not making any changes to the traditional technical conference. We still have all the great papers that you expect to see and the cutting-edge research that people wait all year to present at IPC APEX EXPO. I am, however, trying to add something extra to start the conversation.

Johnson: And what with the changes to the IPC APEX EXPO location, I can understand why you're so excited about this.

Sandy-Smith: Everything is coming together, and I'm excited. I love panel discussions, but in the future, I want to explore some different formats for sessions.

Johnson: How we interact is changing based on demographics, expectations, technologies, etc., so moving away from panel discussions to something else may be appropriate.

Sandy-Smith: And if we're bringing a whole new generation into the industry, we have to be efficient about communicating all the history that's there and the tribal knowledge that these experts carry. The younger generation also wants to level up faster; they want the information to be conveyed in a different way, which leads to another program that's new at IPC APEX EXPO next year. I'm calling it "the fundamentals program."

This program will be available as part of the technical conference, and it takes place on Monday. The technical conference is tradition-

ally Tuesday through Thursday, but I am adding a session on Monday where I'm cultivating the content and reaching out to the experts on each of these facets of the industry. Having these experts in one place will provide a comprehensive overview of electronics manufacturing, terminology that you need to know to make the most out of the technical conference, and opportunities for learning and career success. It will cover the fundamentals.

Johnson: Afterburners for newbies.

Sandy-Smith: But it's not just for newcomers to the industry; it could be anyone from the industry that has been in one niche and wants a broader understanding of all of the things that happen in the industry. For instance, if you focus on cleaning systems and chemistries and different kinds of contamination on boards, but you want to know more about how a circuit board is made and what kind of process residues could be in that part, this would help broaden your perspective as far as the whole industry.

Johnson: Monday is usually reserved for executive forums. Is the program running alongside the professional forums?

Sandy-Smith: Yes. There will also be professional development courses on Monday, both intermediate and advanced levels, most of the level training will take place in this fundamentals track. If, for example, someone buys an all-access pass, the fundamentals track could count as two of your professional development courses for Monday. Or if you sign up for the technical conference pass, you can come to those fundamentals sessions on Monday to prepare for the technical conference. There's a small fee for lunch, but we'll have a panel discussion on hot topics or strategies for success.

Johnson: I know I'm going to want to drop in and see how it's going.

Sandy-Smith: We don't want to overwhelm anyone, but we think it will be helpful to hear

about each step of the process in the logical order that it happens. We'll cover the history of IPC, how to use standards, how PCBs are designed and made, solderability, cleaning, conformal coating, reliability, and failure analysis. Even if it's not a comprehensive, deep dive into each topic, it will get you started. If it's your first time at the conference, and you walk into a technical session, it can be tough because speakers often use a lot of acronyms and don't have time to explain them; this is a terminology-heavy industry. I want to encourage people to get involved and make the most of their conference experience.

Johnson: When I think of people who are designing PCBs, for example, who may not know the manufacturing process, they can sometimes make design decisions that are not manufacturable because they don't know how it works from tank to tank and process to process. They don't have an awareness that the process is imprecise compared to what the CAD tool is going to tell them. I've had conversations in the past where someone says, "What do you mean you can't give me the six decimal points of accuracy? The CAD tool did." That was their perspective. Understanding the whole process is a critical part of being successful in the whole process.

Sandy-Smith: Exactly. I still remember when I went to a board fabrication facility with some new PCB designers; they were surprised and said, "Oh, each layer is manufactured separately and then stacked up!" That's a critical thing to know when you're jumping into an industry where everyone is so experienced; those simple intricacies may be overlooked. I can't tell you how many times in my previous life as a solder expert where it was a revelation to someone that you heat up solder, and it melts; you don't put it there, and it's not like glue. It seems like something that's so basic if you already know it, but if you were never taught that, it's not a logical jump.

It's something that I've been dreaming about ever since I've been in the industry because I know for the first few years when I attended conferences, terms and things being talked about would go over my head. You don't think about those things as much when they're happening, but if I could have taken advantage of those learning experiences early on, that would have been so valuable and helped me understand better. Think about how much more anyone's employees would get from having all of the building blocks that you need for success.

And when people come to these new sessions at the intersection, if they do want to dig deeper into a topic, they can go into the technical conference, so I've introduced the single-session pass, so you can pay a session ticket to get into one session for \$99 as a member. That way, if you want to go see your friend present, or you're super interested in a specific topic, like materials for space applications, you can sign up for that single-session pass. You don't have to go all in and buy the full conference pass; instead, you can come, test it out, and attend a presentation on a topic that floats your boat.



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Johnson: For a junior engineer, attending IPC APEX EXPO on my company's dime, that \$99 pass to go see one session should be an easy sell.

Sandy-Smith: If you're thinking, "I want to know about the latest conformal coating. It's almost a nominal fee. It's less than dinner or a night stay at a hotel. And people that participate in the standards committee meetings get a single-session pass for free, so they can use it to attend the technical conference in their free time after back-to-back committee meetings. A lot of times, people wouldn't go to the technical conference because you'd have to buy the full pass even though you wouldn't be there the whole time. We want to thank our members for contributing to the standards committees. What they do is impactful, and we want to show our gratitude with the single-session pass.

Johnson: You have to get fed, as well as do the feeding, as an IPC volunteer.

Sandy-Smith: I have so much appreciation for the speakers, volunteers, and conference attendees. A lot of these people are going outside of the bounds of what their job requires to give back to the industry. That was one of my favorite things when I was attending these

conferences was to bring back the knowledge that I was gaining in my lab to the industry so that other people might not have to toil as hard. IPC is very appreciative of that. We're finding new ways to show it.

On the show floor, we're also keeping the ice cream social because everyone loved it, and bringing back the expo show floor reception. We appreciate our attendees, and we want them to have the best experience possible and exceed expectations because IPC APEX EXPO is still the biggest and most attended electronics manufacturing conference in the U.S.

ference in the U.S.

Johnson: Can people register to attend now?

Sandy-Smith: Yes. The website is live, and our app shows everything. It makes for a much better experience. It figures out what you're looking for and makes recommendations, and you can connect with people and set up meetings. You can have your whole schedule laid out on your phone with reminders if you need them, so you know where to be and at what time. Instead of carrying around a show brochure, you can put it on your phone.

Johnson: It was very helpful when I put together an itinerary for myself last year.

Sandy-Smith: With all the effort you're expending at these conferences, the app helps streamline your schedule. Arrange your schedule on the app ahead of time, and then execute your plan when you're there. Another thing that's interesting about this year is that IPC APEX EXPO will be over Super Bowl Sunday, but we've anticipated that. For professional development that usually takes place on Sunday, we've shifted the schedule earlier to make sure that we're done by 3:00 p.m. so that you can get to the nearest bar and watch the game. We don't want to take away from anyone's fun, as

far as the Super Bowl is concerned. But don't let it deter you from still coming to professional development and the standards meetings.

Johnson: How many papers do you expect?

Sandy-Smith: There are about 80 papers, and then all of the special sessions.

Johnson: Do you see any general trends or things standing out in the papers?

Sandy-Smith: There are a lot of cool papers about board fabrication with topics such as copper treatments, making the copper smoother and better for RF and signal integrity, etc. There are also some special sessions on semi-additive processes, starting with a very thin copper layer and essentially 3D printing and building up the circuit instead of starting with the copper and etching it away to get your circuit. This technology could be revolutionary for microelectronics and HDI; I haven't yet seen it work, personally, but it's amazing, and I want to hear more about it.

We also have several sessions that interface between organizations. AIEG is an automo-

tive organization that we partnered with to represent some content, and they will be at IPC APEX EXPO to do a two-part professional development course on the fundamentals of problem-solving. That may sound simple and broad, but knowing that it's coming from AIEG, it's going to be good content, and you'll want to be there. And then we have a couple of sessions from iNEMI, talking about new technology drivers and materials, etc.

Something different is that we're partnering with an organization called the Women's Business Enterprise National Council (WBEMC), which is an organization that advocates for women-owned businesses. We're going to have a whole session with them about why building diversity into your supply chain and having lots of different kinds of companies into services are so important. We're broadening the horizons into social responsibility in the electronics industry and how we can make more robust supply chains as well as how we can support diverse companies.

Johnson: Thanks, Brook.

Sandy-Smith: Thank you. PCB007

IPC APEX EXPO 2020 Networking Events

Brook Sandy-Smith, IPC's technical conference program manager, provides an overview of networking opportunities, including the Newcomers' Networking Reception, the Women in Electronics Reception, and the Trivia Networking Night. Click the image to watch the video.

(Source: IPC)



This year, IPC APEX EXPO celebrates 20 consecutive years as one of the largest technical conferences and industry expositions in the North American electronics manufacturing industry. IPC would like to recognize and thank all 82 exhibitor companies who have participated in the expo each of these 20 years.

Exhibitor	Booth	Exhibitor	Booth
Advanced West Inc.	3803	ITW EAE, a division of Illinois Tool Works Inc.	813
Aegis Software	2119	JUKI Automation Systems	2819
AGC Nelco	3721	KIC	1126
AIM Solder	2447	Kulicke & Soffa Industries Inc.	2421
AIRTECH International Inc.	3819	Kurtz Ersä Inc.	844
AIR-VAC Engineering Company	2829	KYZEN Corporation	1637
Arlon EMD	4043	M+B Plating Racks	4326
ASC International Inc.	1537	MacDermid Alpha Electronics Solutions	1824
ASM	3036	Machine Vison Products Inc.	1800
Asys Group Americas Inc.	1601	MYCRONIC Inc.	1336
Atotech USA LLC	4215	National Technical Systems	1004
Austin American Technology Corporation	2352	Nordson ASYMTEK	1611
BlueRing Stencils	2044	Oak Mitsui Inc.	4034
BPM Microsystems	1604	Omron Inspection System	2837
BTU International Inc.	3119	Orbotech Inc.	3834
Burkle North America Inc.	3827	P. Kay Metal, Inc.	3316
Chemcut Corporation	3809	PACE Worldwide	530
Count On Tools Inc.	1528	Panasonic	1301
Crystal Mark Inc.	2718	Pillarhouse USA Inc.	3413
CTI Systems	2523	Plasma Etch Inc.	3523
Custer Consulting Group	3703	PVA	1201
DDM Novastar Inc.	2412	Qualitek International Inc.	729
Eastman Kodak Company	3821	RBP Chemical Technology	4204
ECD	1541	Rogers Corporation	3802
Equipment Technologies Inc.	4209	ScanCAD International Inc.	2719
Europlacer Americas	1910	Sciencscope International Corporation	2536
Excellon Automation	3845	SEHO North America Inc.	1451
FASTechnologies	4328	Seica Inc.	1922
FCT Solder	1945	Seika Machinery Inc.	3645
Fuji America	2221	Simplimatic Automation	1137
Glenbrook Technologies Inc.	529	Smart Sonic	3554
GPD Global Inc.	3609	Sono-Tek	928
Hanwha Techwin Automation Americas Inc.	1645	Taiyo America Inc.	3951
Heller Industries	2137	Technical Devices Company	2047
Henkel Corporation	3603	Topline	2842
HEPCO Inc.	3323	Uyemura International Corporation	3745
Heraeus Electronics	1806	Via Mechanics (USA) Inc.	4008
Indium Corporation	1037	Viscom Inc.	3336
Integrated Process Systems Inc.	4319	Vision Engineering Inc.	628
Isola	4025	VJ Electronix Inc.	3627
ITC Intercircuit NA	3715	ZESTRON Corporation	1319

Thursday, February 6, 8:30 am–3:00 pm. Activities include hands-on, project-based learning, including soldering, PCB assembly and design.



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Streamlining Inspection and Verification

Interview by Barry Matties I-CONNECT007

Barry Matties speaks with Vladi Kaplan, VP of marketing for CIMS, about the company's newest verification station, the benefits operators will see from its colorized real-time video, and how it makes verification much faster and much more efficient for companies pushing 100% inspection.

Barry Matties: Congratulations on some new equipment you're showing at the International Electronics Circuit Exhibition in Shenzhen, China. First, can you give us a quick overview of CIMS?

Vladi Kaplan: We are an AOI equipment manufacturer and used to be known as Camtek. A little over two years ago, we were spun off of Camtek. For two years already, we have been a completely independent company, but the basis of our technology and the types of equipment that we are selling are the same. Of course, we have improved quite a lot, came up with a lot of new models, and are doing well.

Matties: And you're introducing some new technology at this show.

Kaplan: Everything that we are showing this time is all about drill inspection. We have families of models for laser via inspection, which is a very hot topic right now, mainly driven by new demands from end-users for 100% inspection of laser vias. On top of that, there are various types of laser vias requiring inspection. Most recently, we see a new process of a direct laser via that drills all the way through the panels. It is similar to a mechanical drill, but with a laser, so our customers are looking for an inspection solution for that as well. Therefore, we have launched a dedicated model for the inspection of these type of products.

For this particular solution, we are using LED-based illumination called ViaLight™ that is built inside the table. It works in combination with our traditional illumination called Microlight™ illuminating the PCB surface from the top. With this dual illumination setup, we are able to see the entire full image of the drill, both from the inside and outside.

Matties: There must be a big need for it for you to invest in producing a machine like this.

Kaplan: We believe that we are right at the beginning of that kind of demand. We anticipate growth, and there's a lot of interest, so we de-

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* Low Dk glass cloth type

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- Low transmission loss

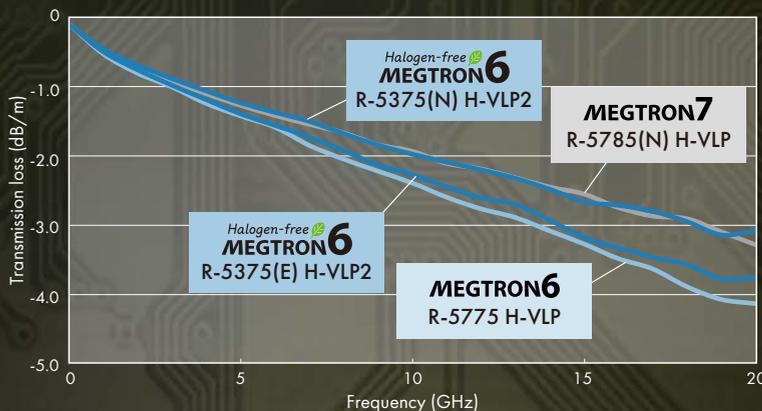
@10GHz

	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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CIMS' Virtual Verification and Repair (VVR) system combines verification of AOI post-processed images with live video mode.

Kaplan: It's a big component of it, and there's a lot of anticipation. China is moving ahead of the rest of the world in 5G. There is a lot of government encouragement and investment in this area, so it's going to help all of us.

Matties: Absolutely. One of the other pieces of equipment you have is for inspection, and another is a verification system.

Kaplan: This is a new type of verification system called VVR, which stands for virtual verification and repair. The idea is to make verification more efficient than it used to be. This system is a combination of virtual and physical verification.

By virtual verification, I mean grabbing defects' images from the AOI machine and feeding them to our verification station. The first step is to go through those images to quickly filter out obvious false calls. The defects' pictures that VVR operator sees are post-processed grey-level images from AOI, but you can't tell that they are. Those images look just like a video with very natural color. We can achieve that natural look by using our unique post-processing technology that runs on every image grabbed by AOI. This way, VVR operators can see all the defects in a matrix, and in 90% of cases, can easily tell which are false calls and which are true defects.

The idea is to give an operator the opportunity to look at all of those images at once. They can set up as many as they want on one screen and choose those that they want to have a closer look at. For example, if they see a potential defect, such as something that could be either dust or a pinhole, they simply click to move the live video to that area. Then, they make a final judgment on whether it's a defect or not. This sequence makes verification much faster and more efficient.

In the past, we had to use multiple verification stations, but now, we can replace several of them with just one such system. In addition, we can upgrade our existing verification station called CVR that is used as just

developed this solution based on emerging market demand. Since we have a reputation of a company that can develop a complex AOI solution quickly, we have customers coming to us and asking us to meet that specific demand. We have big hopes for this system.

Matties: More and more HDI work is taking place. Is that what you see as driving the anticipation for this?

Kaplan: Yes. As far as inspection goes, as I mentioned before, laser via inspection is a big part of it. Years ago, it used to be sampling purely for some calibration purposes. Right now, companies are pushing 100% inspection, which is why we focus on that, so there is a big, new inspection market for us out there.

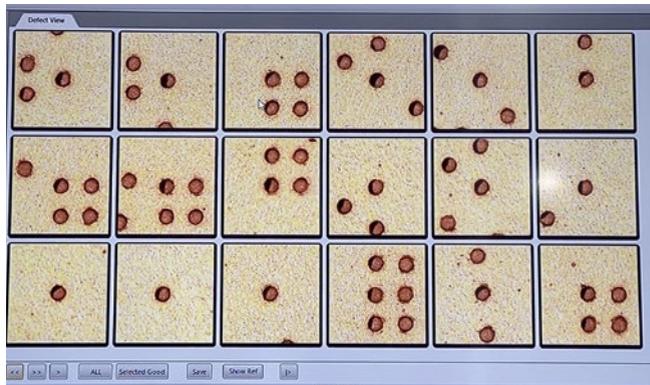
physical verification with this kind of system. That takes some hardware and software upgrade but can potentially be done for the entire existing CVR install base. We have hundreds of systems in the market that can be upgraded.

Matties: The process flow begins with the board in the AOI system. When it's detected as questionable, the board is moved to the verification system, where all the imaging is communicated, and the operator can make determinations. Then, it moves from one machine to the next. What you're talking about is key to the digital factory. How are you plugging this information—and your Industry 4.0 strategy—into the marketplace?

Kaplan: By doing this, we can save all the images of the defects and feed them into the database in real time. We can also store them and analyze them in the future. If AI becomes a reality, it can be fed directly to some kind of AI module that does all the judgment instead of humans doing it. Whether you can replace 100% of human verification with some sort of AI is still an open question, so VVR can serve as a stepping-stone towards this goal. Keep in mind that we can store those images and give access not only to customers but even to a third party that the customer may hire for building AI or other apps on top of it. This would fit very nicely into the whole concept of the digital factory, where we store data that is traceable. You can go back, look at it again, and figure out trends in quality issues in real time.

Matties: With the images that they see on the verification system, is that something that's going to improve the group or yields because they're making better decisions?

Kaplan: There is some component of that, but mainly, the system improves the entire efficiency of an AOI cycle, so you can get multiple benefits. One is that you don't need that many verification stations. Customers can pass boards much faster out of the AOI room because they're going to verify them faster. Veri-



Close up of live video verification screen.

fication usually is a bottleneck of an AOI cycle. Plus, you can store all the data as an added benefit. In the past, once you did verification, all this data was gone because it was a live video that you could only look at once. Now, we can store all that data and feed it to the next process.

Matties: This is the system that's well-suited for anywhere in the world, and a quickturn fabricator would benefit from a system like this.

Kaplan: Absolutely.

Matties: AOI is typically a batch process. Is this something that you see moving into inline processing? For example, is there a demand for a lot size of one when where the board comes out of a DES line, and we see inline AOI inspection for continuous flow manufacturing?

Kaplan: There's a demand for inline AOI, but we see this demand mainly in the lower end of the market. Of course, everybody would like to have faster AOI and be able to connect directly to the DES line; a lot of companies are doing that. We don't see it happening in the higher end, and that's our focus—IC substrates and HDI. The type of inline AOI that we see from AOI vendors focusing on the lower end of the PCB market has a lot of limitations. The truth is that you can't really connect it directly to the DES line because you would be putting a sensitive optical system in a very acidic environment. The AOI machine has a lot of very fine components, optics, and mechanics that

are going to get corroded pretty quickly, so you can't just connect it directly. It's sort of wishful thinking, but nobody does that in practice. Therefore, I believe that the term "inline AOI" could be misleading.

Matties: As we move into a digital factory, it seems to me that if we're moving into a lot size of one, that is going to become something that might turn into a demand. You're also a key supplier at GreenSource Fabrication.

Kaplan: That's true. GreenSource is a unique case, at least for now, where all the systems are connected in one production line. All of our AOI machines work in the same line, but the panel doesn't go directly through the scanner like in the pure "inline AOI" concept I mentioned earlier. That would be very hard to achieve given synchronization challenges between different types of equipment and processes. We have a smart automation setup that allows GreenSource to achieve smooth flow using traditional table-based AOI. Basically, automation takes a panel, loads it directly on AOI or in some type of buffer, and then puts it back on the conveyor after the scan is completed.

We have a smart automation setup that allows GreenSource to achieve smooth flow using traditional table-based AOI.

Matties: It's still a continuous flow inspection process.

Kaplan: Exactly.

Matties: You don't have to wait for a panel of boards to show up because I believe your whole system is fully automated there. Let's talk a little bit about the GreenSource install. What did you learn from that, and what are you taking to the marketplace from the action?

Kaplan: We've learned a lot based on the demand. One of the key points is that they use our metrology to feed back and improve their process for quality control. This is something that we have been offering to the market for a few years now. It's a built-in option that comes with our high-end systems. We have 2D and 3D metrology. As far as I know, GreenSource uses both, and it's all inline.

Matties: What's the advantage of having that option in the system?

Kaplan: My understanding is that by taking those kinds of measurements in real time, they can feed it back to the previous process and adjust some process upstream. I'm not sure how they use the data exactly.

Matties: I understand, but it's an option. Are any other companies taking advantage of that option?

Kaplan: Absolutely. It's another hot topic, and we've been ahead of the market in this area. We launched our metrology options already a few years ago. At the very beginning, nobody cared that much about measurements; right now, it's becoming almost a must, and we already have it for a few years now. Since we've been refining those capabilities way before the real market demand has materialized, those capabilities are now very mature. We're running them in many companies, and they love it.

Matties: Is this an upgrade option that somebody can add to the existing equipment?

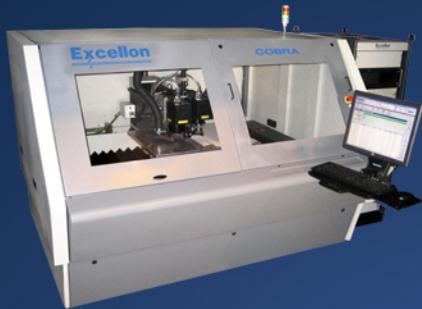
Kaplan: Yes, they're called add-on options.

Matties: It sounds like you have brought in some flexible thinking in the way that you're presenting your equipment to the marketplace, where they can upgrade the verification system and these systems along the way.

Kaplan: That's our philosophy. All our systems are upgradable. We realize that sometimes

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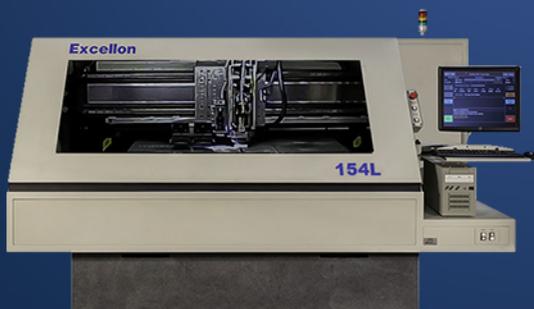
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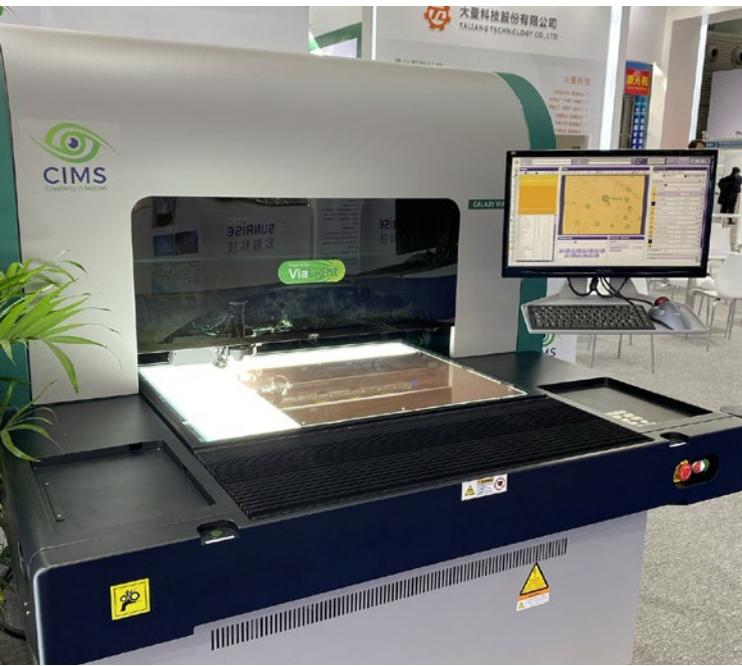


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companies don't want to buy new equipment for multiple reasons, so we always have the option of an upgrade.

Matties: If someone wants to bring the verification system in, but they have another brand of AOI, is it compatible with somebody who's not using your AOI system?

Kaplan: Right now, we don't do that. It only works with our AOI. From a business standpoint, we don't see a lot of benefits to us doing it.

Matties: Because your verification system seems like it has a lot of benefits.

Kaplan: Yes, but the truth is that our main source of revenue is AOI. After all, we are in the business of selling AOI, not verification stations. Some companies offer verification stations that are usually quite cheap and can be connected to different types of AOIs. I can see why some customers could be interested in this kind of setup. However, with such solutions, customers would not be able to take advantage of all the advanced capabilities that can only come with deep integration between inspection and verification cycles. You

don't have those kinds of capabilities, such as grabbing grey-level pictures, colorizing them, showing them all at once to the operator, combining virtual and physical verification, updating database in real-time, automatically generating e-map of scrapped units, etc. The bottom line is if a customer needs a solid performance on the verification side, combined with all the advanced capabilities, there is no substitute for our solution.

Matties: Earlier, you also mentioned AI. Is that an area that you are working on?

Kaplan: Definitely. We are working on multiple, ongoing projects right now with companies that specialize in AI development, and different customers are at various stages. It's too early to tell how it is going to play out, but we decided to work with a partner that specializes in this field rather than developing it in-house.

Matties: In China, eliminating operator expenses is a priority, so that makes perfect sense.

Kaplan: The priority eventually is going to be avoiding missing any real defects and overall quality. It would be great if AI could reach that level, but that's an ideal world. Even with autonomous driving today, no vehicles are completely autonomous. If you drive a Tesla, you have to put your hands on the steering wheel. There still must be some kind of human element.

Matties: I understand what you're saying, but the goal is to minimize the operator level, and if AI can augment that and you can eliminate 80–90%, that's perfect.

Kaplan: That is a good goal because 100% isn't realistic. Human involvement is still needed.

Matties: Human judgment is still valuable.

Kaplan: I agree.

Matties: You're doing great, innovative things. It's nice to see this new verification station.

Kaplan: Thank you. That's what CIMS is all about.

Matties: You're obviously a global player. How do you see the business climate around the world?

Kaplan: Our main focus is still Asia, so we're very optimistic about China despite all the negative news. We see a lot of growth in China and Taiwan. As far as other markets go, we see some optimism in the U.S. We don't expect a lot in Europe, but we still have a solid presence in all of those countries because of the fact that a lot of new technologies are coming out of there. Many companies manufacturing in Asia are still headquartered in the U.S. or Europe. We're working with them directly in those countries. As far as installations go, it's mostly going to be in China and Taiwan. There was a significant slowdown in Korea this year. Hopefully, they will recover because Korea is a very important market for us as well.

Matties: Do you see a shift to Thailand and India?

Kaplan: There's always potential there, but we don't see it as a big contributor to our sales in the next year. India, Vietnam, or Thailand are not going to replace China any time soon. Ten years ago, everybody was talking about emerging PCB markets in Southeast Asia, but it didn't happen as we hoped. Vietnam is an interesting case; we see a lot of ongoing investment there by Korean companies, and some big Japanese PCB makers continue expansion in that part of the world. By working with those companies in their home countries, like Korea or Japan, we are covering that market as well. In addition, we have had a presence in both Vietnam and Thailand for years already, and we're still hoping that we're going to see some more business there in the future.

Matties: I appreciate your time today. It's always good to catch up. Thank you so much.

Kaplan: No problem. PCB007

Professional Development at IPC APEX EXPO 2020

Brook Sandy-Smith, IPC's technical conference program manager, describes the wide selection of professional development courses that attendees can partake in to level up their careers, understand changes in standards, hone their leadership skills, and more. Click the image to watch the video. (Source: IPC)





JAKE KELLY

MANAGING DIRECTOR, VIKING TEST LTD.

Video



A Walking Tour of Viking Test With Jake Kelly

In this video tour, Viking Test Managing Director Jake Kelly walks us down the line of Viking’s universal film stripper.



MARC LADLE

DIRECTOR, VIKING TEST LTD.

Video



Viking Test Services on UV Curing With LEDs

In this video, Pete Starkey and Marc Ladle, Viking Test engineer, discuss how Viking Test Services developed a conveyerized UV Curing machine with LED light sources to satisfy the industry requirement for UV bumping of solder mask.

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Sampling Plan Language in MIL-PRF-31032

From the Hill

by Mike Hill, MIL-Q-CONSULTING LLC

What's the Sample?

Conformance to military standards is all about using the correct sample specimen and testing the proper quantity. That, of course, sounds too simple to warrant an entire column. However, military specifications have numerous tests with various sample specimen types that all require different quantities for test or inspection. The complexity greatly increases by the fact these specifications contain 35–40 pages and cross-references to many more documents.

Specifically, the MIL-PRF-31032 series of specifications is composed of 12 Department of Defense (DoD) documents. In addition, within the main documents, there are at least 20 more commercial specifications related to board testing, inspection, and design. Therefore, listing every sampling combination in every document is not possible in this summary

column. Therefore, the focus will be limited to MIL-PRF-31032/1C WAM 2 dated July 11, 2018, for rigid multilayer boards. This information is not meant to be a replacement for reading the specification but a learning guide that should make understanding the key parts of compliance straightforward.

To start, here is some sample terminology specific to MIL-PRF-31032:

- B/P or B: A production board from the lot
- T: Test coupon (A, B, AB, D, S, G, E, C, M, N, P, etc.)
- SMT: Surface-mount test coupon
- THM: Through-hole test coupon
- MIX: Boards with through-holes and surface-mount features
- Sample Plan Frequency Series Table E-I Options: H, J, and N (most frequently used)



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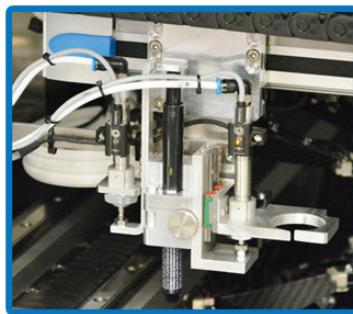
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Sample Plans

All sample series plans follow Table E-I from MIL-PRF-31032 C WAM 1, page 49 (Table 1). The sample size is determined from the lot size and the required sample plan series. Note: The lot size is determined by the number of layers/panels and changes to the number of boards after routing. There are seven sample series in the table. They are labeled B, D, F, H, J, L, and N. For each test or inspection in MIL-PRF-31032, the sample size will be defined either as an exact number or by specifying the test vehicle and a sample plan series from Table E-I.

For example, if BL is the required sample plan, B defines the test vehicle as a board, and L defines the sample plan series from Table E-I. Similarly, if the “TN” sample size is required, “T” requires the proper test coupon for the test vehicle, and “N” is the sample plan series. And the use of Table E-I is straightforward. For example, if the sample series is specified as “TJ” and the lot size is 24, the sample type “T” is a test coupon, and the sample plan series “J” requires three test coupons (red items in Table 1).

Required testing/inspection can be divided into five main groups:

1. Each lot
2. Each month
3. Each year
4. Every two years
5. Initial qualification (once only)

Note: The first four groups are required for continued compliance year after year.

1. Each Lot: Lot Conformance Inspection (LCI)

The Inspection points and test performed for samples are listed here:

Inner Layer

- Develop-etch-strip inspection (DES): “BH” sample plan using the number of layers for lot size (minimum line width and spacing)

External Layers

- Strip-etch-strip (SES): “BH” sample plan (minimum line width and spacing and plating adhesion)

Ionic Contamination Before Solder Mask

- One panel per lot

Microsection

- Structural integrity (per panel, A and B coupons; X and Y direction A coupons plus X and Y direction of B for each hole type [X and Y from opposite corners])
- Solderability (surface): “TJ” sample plan using coupons
- Solder mask adhesion: “TJ” sample plan per side using coupons
- Marking adhesion: “TJ” sample plan per side using coupons

Lot Size	Series B	Series D	Series F	Series H	Series J	Series L	Series N
1 to 8	All	All	All	5	3	2	1
9 to 15	All	All	13	5	3	2	1
16 to 25	All	All	13	5	3	2	1
26 to 50	All	32	13	5	5	3	2
51 to 90	50	32	13	7	6	4	2
91 to 150	50	32	13	11	7	5	2
151 to 280	50	32	20	13	10	6	4
281 to 500	50	48	29	16	11	7	4
501 to 1,200	75	73	34	19	15	8	4
1,201 to 3,200	116	73	42	23	18	9	4

Table 1: Table E-I from MIL-PRF-31032 ^[1].

Electrical Testing

- 100% sampling (point to point, impedance, hipot test)

Final Inspection

- Visual, dimensional, bow and twist: “BN” sample plan

2. Month to Month: Periodic Performance Testing (PCI)

- Elongation of plated copper (per copper tank: five samples horizontal and five vertical)
- Tensile strength of plated copper (per copper tank: five samples horizontal and five vertical)
- Purity of plated copper (per copper tank: one sample)
- Surface peel strength for foil construction only: (eight samples per material type, four each from two different lots, P coupons)
- Rework simulation (two B coupons per material type qualified)
- Moisture and insulation resistance (two E coupons per material type qualified)

3. Year to Year: No Additional Testing Required

- Summary report of the past 12 months required to verify all testing was completed.

4. Every Two Years: Capability Verification Inspection (CVI)

- Thermal Shock: Two D coupons for 100 cycles per material type qualified
- Two-Year Summary Report of each material type qualified: Within the two-year

window, there must be test reports for each material verifying all the DLA approved attributes were compliant

5. Initial Qualification

- For each material type to be qualified, all lot, monthly, and yearly tests must be completed.

Summary

In general, understanding the tests and the quantity to test for PWB military specification is 90% of compliance. Having learned the sample language in MIL-PRF-31032 makes certification much easier.

One Last Point

Remember, regardless of the sample plan size or the test/inspection, when any sample fails, the sample size always defaults to 100%. In addition, when the determined sample plan size is more than the lot size, the sample is also 100%. Of course, testing/inspecting more samples than required is always allowed. **PCB007**

Reference

1. DLA MIL-PRF-31032C WAM1, page 49.



Mike Hill is president of MIL-Q Consulting LLC. He has been in the PWB fabrication industry for over 40 years. During that time, he participated in specification writing for both IPC and the military. Past employers include ViaSystems, Colonial Circuits, and DDi. To read past columns or contact Hill, [click here](#) or email Milqconsulting@outlook.com.

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Supplier Highlights



EPTE Newsletter: Taiwan's Circuit Board Industry—Red or Black for 2019? ▶

The circuit board industry in Taiwan released its shipping data for November. The revenue declined by 5.61% compared with the previous month and declined by 0.29% for the same month last year. Year-to-date revenue increased by 0.29% comparing year over year. Dominique Numakura unpacks the details of Taiwan's PCB industry for 2019.

Ventec Invests in Key Equipment to Support Expansion of PTFE Laminates Manufacturing ▶

Ventec International Group Co. Ltd. has significantly increased its PTFE laminate manufacturing capabilities following a strategic investment in a new state-of-the-art high-temperature press and lay-up/break-down line at its Suzhou (China) manufacturing plant.

Toray Creates Revolutionary PPS Film for 5G Circuit Boards ▶

Toray Industries Inc. announced that it has created a polyphenylene sulfide film that maintains the outstanding dielectric characteristics—or low dielectric losses of electrical energy—flame retardancy, and chemical robustness of that polymer while remaining thermally resistant at 40°C higher than conventional counterparts.

Ledia 6 Direct Imaging System Offers Enhanced Speed and Precision ▶

Technical Editor Pete Starkey recently met with Ucamco's Michel Van den heuvel, imaging product group director, to discuss the benefits of the Ledia 6 direct imaging system, which was introduced last summer and features scan-alignment and improvements in registration and positioning accuracy.

Nano Dimension Appoints a New Chairman ▶

Seasoned executive Ofir Baharav will replace Avi Reichental as Nano Dimension's chairman.

Rogers to Highlight High-speed Laminates at DesignCon ▶

Rogers Corporation will exhibit at DesignCon in Santa Clara, California, highlighting some of its high-performance circuit materials used in multilayer structures, which include a family of thin laminates, bonding materials, and sheeted copper foil options.

Technica USA to Distribute Meyer Burger's Inkjet Soldermask Technology in North America ▶

Technica USA has announced that they had reached a Master Distribution Agreement with Meyer Burger to promote and support Meyer Burger's inkjet solder mask technology based on PiXDRO JETx systems.

Ventec Builds Global Inventory of High-speed, Low-loss, High-frequency Materials ▶

In response to high demand and laminate material supply issues affecting some producers of low-transmission loss and high-frequency laminates and prepregs, Ventec International Group Co. Ltd. (6672 TT) has implemented material inventory and supply chain measures with favorable order requirements.

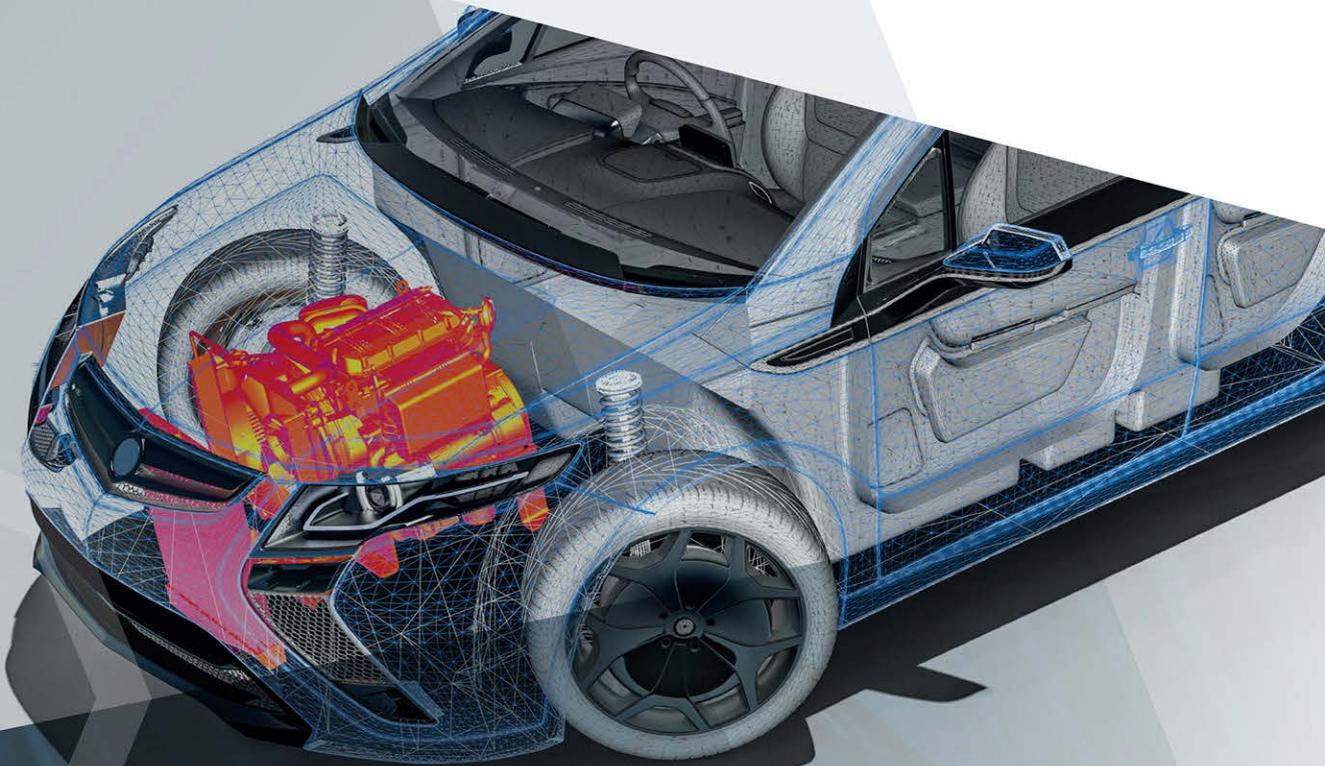
Uyemura Appoints Technology Director ▶

Uyemura Vice President and CTO Don Gudcauskas announced the appointment of Patrick Valentine as director of technology.



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Technology Trends and Direct Metallization

Trouble in Your Tank

by Michael Carano, RBP CHEMICAL TECHNOLOGY

In the recent IPC 2018 Technology Trends report, there are several very important trends that bare board fabricators should be aware of and plan for accordingly. These trends are moving quite fast, and for some, investment in equipment as well as adapting to new materials and processes will be needed.

High-density Interconnect (HDI)

HDI is not new as far as the trends go; however, HDI is now mainstream technology. Today, HDI is the fastest-growing segment of interconnect packaging used in portable products, IC, and ASIC packaging and large, complex multilayers for telecom and servers.

HDI provides the following:

- Reduction in layer count for thickness control and RoHS compliance (lead-free assembly)

- Method to integrate high-I/O and fine-pitch devices without adding layers
- Method to achieve higher component density and component I/Os without adding more layers

The use of blind vias provides opportunities to increase routing. As one can easily imagine, HDI is more than just miniaturization; it is an opportunity to adapt a technology to enable complex designs without compromising reliability and cost.

Let's properly frame the situation related to HDI and the current and future (projected) landscape. IPC recently published the results 2018 Technology Trends survey. A key finding of the survey showed that the majority of the OEMs surveyed anticipate that they will require blind vias on two or more layers by 2023. In addition, a high percentage of the participating



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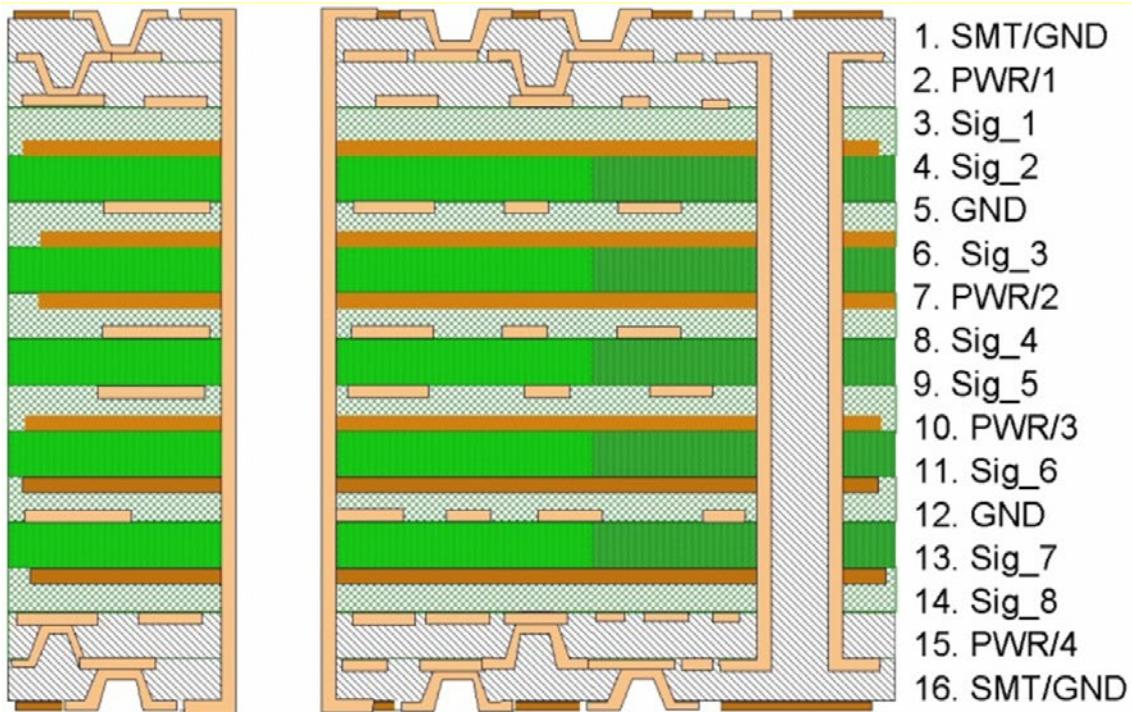


Figure 1: A 16-layer design incorporating blind and buried vias reduced from 26 layers.

OEMs specify buried vias today, and more expect to do so by 2023 ^[1].

As Happy Holden has pointed out in one of his many articles, designs with both multilayer blind via and buried vias allow designers to reduce layer counts while increasing wiring density ^[2]. Originally, the board shown in Figure 1 was a 26-layer through-hole-only board. By redesigning the structure to meet design rules and satisfy routing density, the 26-layer board was reduced to the design shown in Figure 1. This is significant both from the standpoint of cost reduction and routing density.

Of course, such a drastic change in design spurs changes as well as opportunities in processes. One such opportunity arises with the use of direct metallization as an alternative to conventional electroless copper.

Graphite-based Direct Metallization

Colloidal graphite direct metallization processes have proven their usefulness as a replacement for electroless copper. This is especially the case in high technology and quick-turn applications. The ability of the colloidal graphite to successfully enable the direct electroplating of difficult-to-metallize materi-

als—such as polyimide, PTFE, ceramic-filled resins, PPO, and PPE—is well documented.

Aiding this has been the improvement of the consistency of colloidal graphite direct metallization processes. This is accomplished through a better understanding of the influence of conditioning agents, the stability of the dispersion, and other process refinements that will be detailed in this column. The implementation of polyelectrolyte surface-active agents that enhance the adsorption of the graphite to the non-conductive surfaces without causing excessive film thickness is quite critical. And the introduction of post-process technology further enhances the uniformity and conductivity of the graphite coating. These improvements are necessary as the industry migrates to more complex designs.

The key takeaway here is quite simple: Direct metallization is an ideal process for HDI applications.

Application of Graphite Metallization for Flexible Circuits and HDI

While graphite-based direct metallization is a production-proven process for rigid PCBs, the

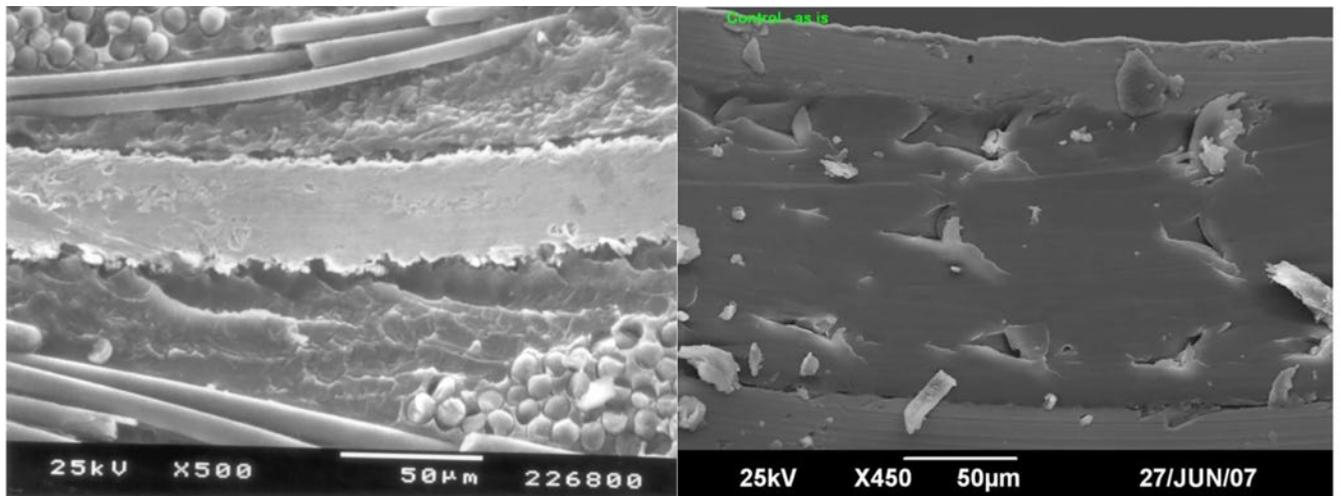


Figure 2: High-Tg FR-4 after permanganate desmear (L) and polyimide flex after plasma desmear.

process is also gaining a much larger share of the new capacity coming on line for HDI and flexible circuits. A major driver is the higher cost of equipment for electroless copper versus direct metallization. In addition, as has been described elsewhere in this column, the productivity of a graphite-based direct metallization process is much greater than conventional electroless copper. Most important, though, is the inherent ability of the graphite system to readily adhere to a wide variety of laminate substrates and materials, including polyimide, PTFE, ceramic filled materials, PPO, PPE, halogen-free, and many other materials. As laminate suppliers continue to reinvent themselves to stake out a position in higher technology, a versatile metallization process is critical to success.

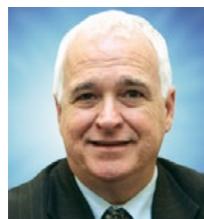
So, why be concerned with the different laminate materials? Aside from the obvious, successful metallization requires that excellent adhesion between the conductive coating (either electroless copper or conductive graphite) be achieved. It is well-documented that adhesion is favored when there is sufficient surface topography to promote the bond. This is especially true for electroless copper as the seeding of the palladium is required to initiate the copper deposition. However, as one views the SEM in Figure 2, the topography visible after permanganate desmear is rather smooth and unremarkable, further impacting the adhesion factor.

A critical advantage for the graphite-based system is that the colloidal graphite binds to resin and glass without the need for a high surface area. It is important to recognize that electroless copper is a plating process, whereby a series of reactions take place in order to effect a deposit. In the case of the graphite-based metallization system presented herein, the mechanism is primarily a coating process whereby the binder technology acts to promote adhesion of the graphite particles to even the smoothest of surfaces. Electroless copper lacks in this area.

Fabricators must embrace changes in the way printed wiring boards are processed. Direct metallization based on colloidal graphite is an enabling technology for HDI designs and flexible circuits. Stay tuned for future columns on direct metallization. **PCB007**

References

1. IPC, "IPC 2018 Technology Trends Survey," and "IPC APEX EXPO 2019 Buzz Session."
2. Holden, H., "How to Get Started in HDI With Microvias," CircuitTree (online article), November 2003.



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

ein Electronics Industry News and Market Highlights



Vahana Comes to an End; New Chapter at Airbus Begins ▶

Nearly four years after the Vahana concept was sketched on a napkin, the flagship program that launched the urban air mobility initiative at Airbus has come to a close. Vahana's key learnings are now providing Airbus Urban Mobility with invaluable insight on the design of its future urban air vehicle.

Taiwan's Most Innovative Companies Unveil Breakthrough Tech at CES 2020 ▶

On January 6, TAITRA hosted the press conference at the Mandalay Bay South Convention Center. The event provided early access to these innovative companies' spokespeople and their products.

AI Meets 5G at the Edge: The Innovation Center at MWC 2020 in Barcelona ▶

NVIDIA's AI Edge Innovation Center, a first for this year's Mobile World Congress (MWC) in Barcelona, will put attendees at the intersection of AI, 5G, and edge computing.

Czech Republic Acquires Mixed Fleet of AH-1Z and UH-1Y Helicopters ▶

Czech Republic becomes the first international customer to purchase a mixed fleet of H-1 aircraft.

'Tweezer Clock' May Help Tell Time More Precisely ▶

Atomic clocks are used around the world to precisely tell time. Each "tick" of the clock depends on atomic vibrations and their effects on surrounding electromagnetic fields. Standard atomic clocks in use today, based on the atom cesium, tell time by counting radio frequencies.

Pacific Design & Manufacturing 2020 Debuts Smart Manufacturing and 3D Printing Innovation Summits ▶

Pacific Design & Manufacturing, North America's largest advanced design and manufacturing event, announced two summits, the "Smart Manufacturing Innovation Summit" and the "3D Printing Innovation Summit," as part of the 2020 conference programming.

Submarine Cables to Offshore Wind Farms Transformed Into a Seismic Network ▶

An international team of geoscientists led by Caltech has used fiber optic communications cables stationed at the bottom of the North Sea as a giant seismic network, tracking both earthquakes and ocean waves.

Zero-emission Flight Is Taking a Giant Leap Forward ▶

Introducing the E-Fan X, a hybrid-electric aircraft demonstrator that is 30 times more powerful than its predecessor. The E-Fan X is the flagship hybrid-electric aircraft demonstrator at Airbus. But its predecessor, the all-electric twin-propeller aircraft E-Fan 1.0, can be credited for playing a key role in laying the groundwork for the next generation of zero-emission aircraft technology.

Rogers Communications and University of Waterloo Partner for 5G Tech ▶

Rogers Communications and the University of Waterloo joined in a three-year, multi-million dollar partnership agreement to advance 5G research in the Toronto-Waterloo tech corridor. Together they will create the first 5G smart campus in central Canada.

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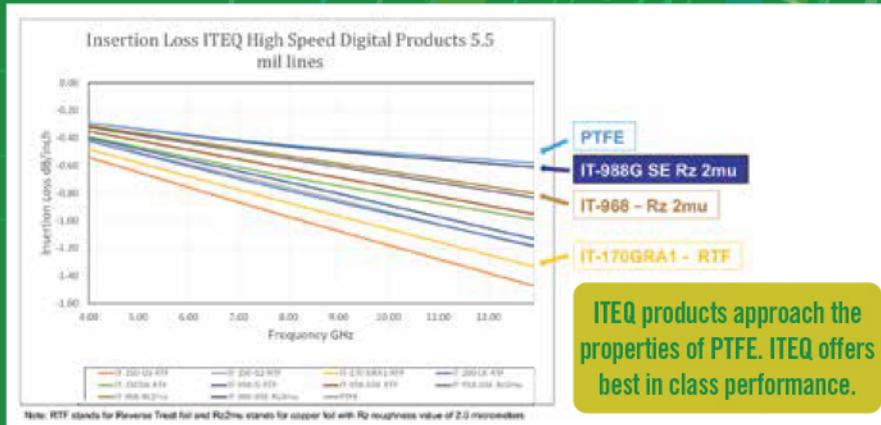
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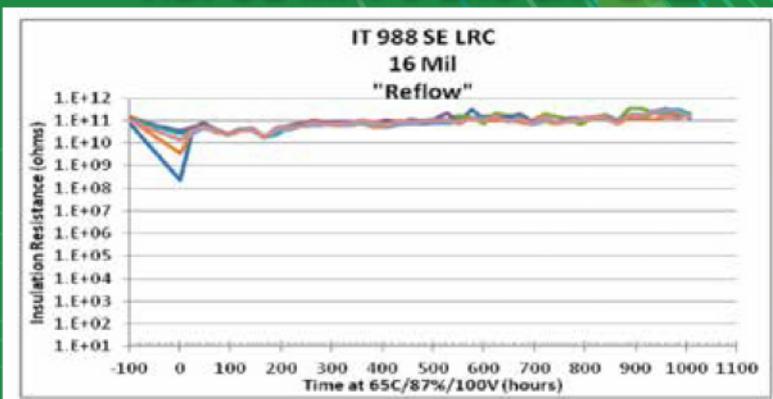
Sequential Lamination

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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EPIG: A Nickel-free Surface Finish for Next-generation Products

The Plating Forum
by George Milad, UYEMURA

In recent years, electronic devices, such as smartphones and tablet PCs, have been miniaturized. Chip-size package (CSP) used inside the electronic devices have been miniaturized as well, and the spacing between the lines continues to diminish every year. Some of the latest packages have spacing as little as 15 μm or less. If electroless nickel electroless palladium immersion gold (ENEPIG) is used with an EN thickness of 5–6 μm , only 5 μm of spacing would be left, increasing the risk of shorts between the traces.

Electroless palladium immersion gold (EPIG), an alternate surface finish, eliminates the use of EN and allows for greater spacing between the traces. EPIG is both solderable and wire-bondable. EPIG finished parts do not exhibit the skin effect of EN, making it ideally suited for high-frequency RF applications.

In addition, eliminating EN dramatically reduces processing time at the manufacturing site. The plating process for EPIG is similar to ENEPIG except for the EN step (the longest step in the process), which is eliminated.

For EPIG, electroless phosphorous-palladium (P-Pd) is the better choice for plating on copper. The use of reduction-assisted immersion (RAI) gold as the top layer gives a better rate of deposition on EP, as well as allowing for a thicker gold layer to be deposited. At present, no IPC specifications for

EPIG exist. For EP and IG thickness, refer to supplier recommendations for soldering and wire bonding applications.

Table 1 shows the plating process for EPIG on copper. Other variations of EPIG may be used for specific applications. These include EPIG on copper with a different activator; here, an immersion gold activator is used instead of the Pd activator. Another variation is to use a thin (0.15- μm) electroless nickel layer before applying EPIG. The latter variation will give a Ni/Sn intermetallic compound (IMC) while maintaining the advantages of EPIG like no signal loss due to excessive Ni thickness and does not interfere with the spacing for fine-line applications.

Soldering to EPIG

When soldering to EPIG (EP: 0.1–0.15 μm ; IG: 0.1–0.2 μm), a Cu/Sn IMC is formed as contrasted with ENEPIG where a Ni/Sn IMC is formed. The Pd and the gold are dissipated into the molten solder, and the solder joint is formed on the copper surface. From the re-

Process Step	Chemical	Temperature (°C)	Time (minutes)
Cleaner	Mild alkaline	50	5
Micro-etch	Persulfate type	30	2
Acid rinse	10% sulfuric acid	RT	1
Acid pre-dip	4% sulfuric acid	Rt	1
Activator	Pd type	30	1.5
Acid post-dip	Acid type	50	0.5
Electroless Pd	P-Pd	60	5, 10, 20
Immersion gold	RAI gold	78	6, 12, 24, 36

Table 1: EPIG plating process (target thickness, EP: 0.05, 0.1, 0.2 μm ; IG: 0.05, 0.1, 0.2, 0.3 μm).

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sults of EDS, when using EPIG surface finish, Cu_6Sn_5 was formed as layer 1, and Cu_3Sn was formed near Cu layer as layer 2. This solder joint is similar to immersion silver, immersion tin, and OSP solder joints, and is expected to demonstrate similar solder joint reliability.

Gold Wire Bonding

EPIG is a gold wire-bondable finish. Excellent bond strength and wire break location were easily achieved with the “as-plated” EPIG. However, after heat treatment for 16 hours at 175°C, there was a drop in pull strength and the corresponding wire break location. The drop is affected directly by the diffusion of copper and palladium to the bonding surface during heat treatment. The thickness of the palladium and gold layers have a direct impact on bond strength. To increase wire bond strength, the thickness of the EP and the IG layers have to be optimized.

Cu was detected after heat treatment when EP film was thinner; however, no peak of Cu was detected when the EP thickness increased. A thicker Pd deposit was effective in preventing copper diffusion to IG surface. Increasing the EP thickness to 0.15 μm will act as a diffusion barrier to copper from the substrate.

The diffusion of Pd to the surface of the IG layer after heat treatment was not dependent on the Pd thickness and was greatly dependent

on the Au thickness. A thicker IG layer will reduce the ratio of EP in the IG surface. The diffusion of EP to the top surface of the IG is mitigated by increasing the thickness of the IG to 0.2 μm .

In addition, there is a marked improvement in the strength and wire break location when performing a wire pull test after plasma treatment. It was confirmed by AES analysis that any Cu diffused to the surface was removed after plasma treatment.

Conclusion

EPIG is a solderable and gold wire bondable surface finish. EPIG was introduced around 2016 and is gaining popularity as circuit miniaturization continues with tighter spacing between the traces. The elimination of thick EN mitigates Ni corrosion, reduces processing time, and eliminates the skin effect signal loss associated with propagating high-frequency RF signals. The absence of thick nickel makes EPIG ideally suited for flex applications where bending may cause nickel fractures. **PCB007**



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

IPC APEX EXPO Show Floor Highlights

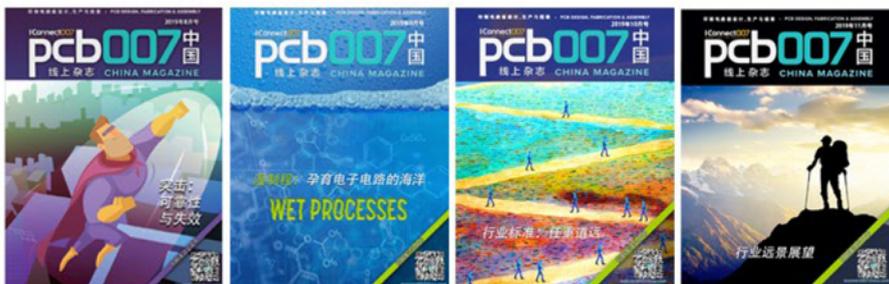
Brook Sandy-Smith, IPC’s technical conference program manager, highlights how attendees can learn about and test drive new equipment, materials, and solutions by visiting the nearly 500 exhibiting companies and enjoy the welcome reception and ice cream social on the show floor. Click the image to watch the video. (Source: IPC)



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The Founding Fathers of Quality: Juran and Crosby

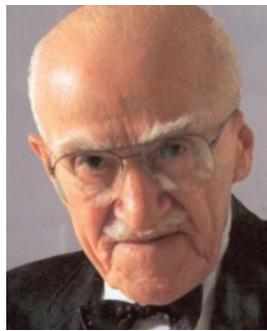
The Right Approach

by Steve Williams, THE RIGHT APPROACH CONSULTING

This column continues the series of 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.

Joseph M. Juran (1904-2008)

Dr. Juran's concepts can be used to establish a traditional quality system based around his famous quality trilogy of quality planning, quality control, and quality improvement (Figure 1). Dr. Juran was invited to Japan in 1952 by the Union of Japanese Scientists and Engineers to teach his principles of quality management as the country tried to rebuild its economy. Unfortunately, it



wasn't until the late '80s that Dr. Juran finally got the attention of American management when he declared, "In the U.S.A., about one-third of what we do consists of redoing work previously done."

Juran's Quality Trilogy

Quality Planning

Juran defined this first stage as providing operators with the tools to produce goods and services that can meet customers' needs. Juran's vision was perhaps the precursor to today's "voice of the customer" concept, as he believed an organization must determine who its customers are and what they need before any thought of process or product can be considered. Once this has been determined, the next step is to develop processes that will deliver products or services that meet these needs. Juran's premise was that if quality planning is poor, then chronic waste will occur in any process.

Quality Control

The second stage of the trilogy has nothing to do with influencing quality; it is merely the assessment (inspection) function that compares actual performance to a standard. This is the point where many companies allocate considerable resources in the hope of quality improvement. This premise is flawed because quality cannot be "inspected in;" it must be "built in." While quality control is not a value-add proposition, what it does do is identify chronic waste opportunities for the final stage of the trilogy.



Figure 1: Juran's quality trilogy.

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Autonomous "self-driving" vehicles are heading our way guided by a variety of sensors, such as short and long range radar, LIDAR, ultrasound and camera. Vehicles will be connected by vehicle-to-everything (V2X) technology. The electronic systems in autonomous vehicles will have high-performance RF antennas. Both radar and RF communication antennas will depend on performance possible with circuit materials from Rogers Corporation.

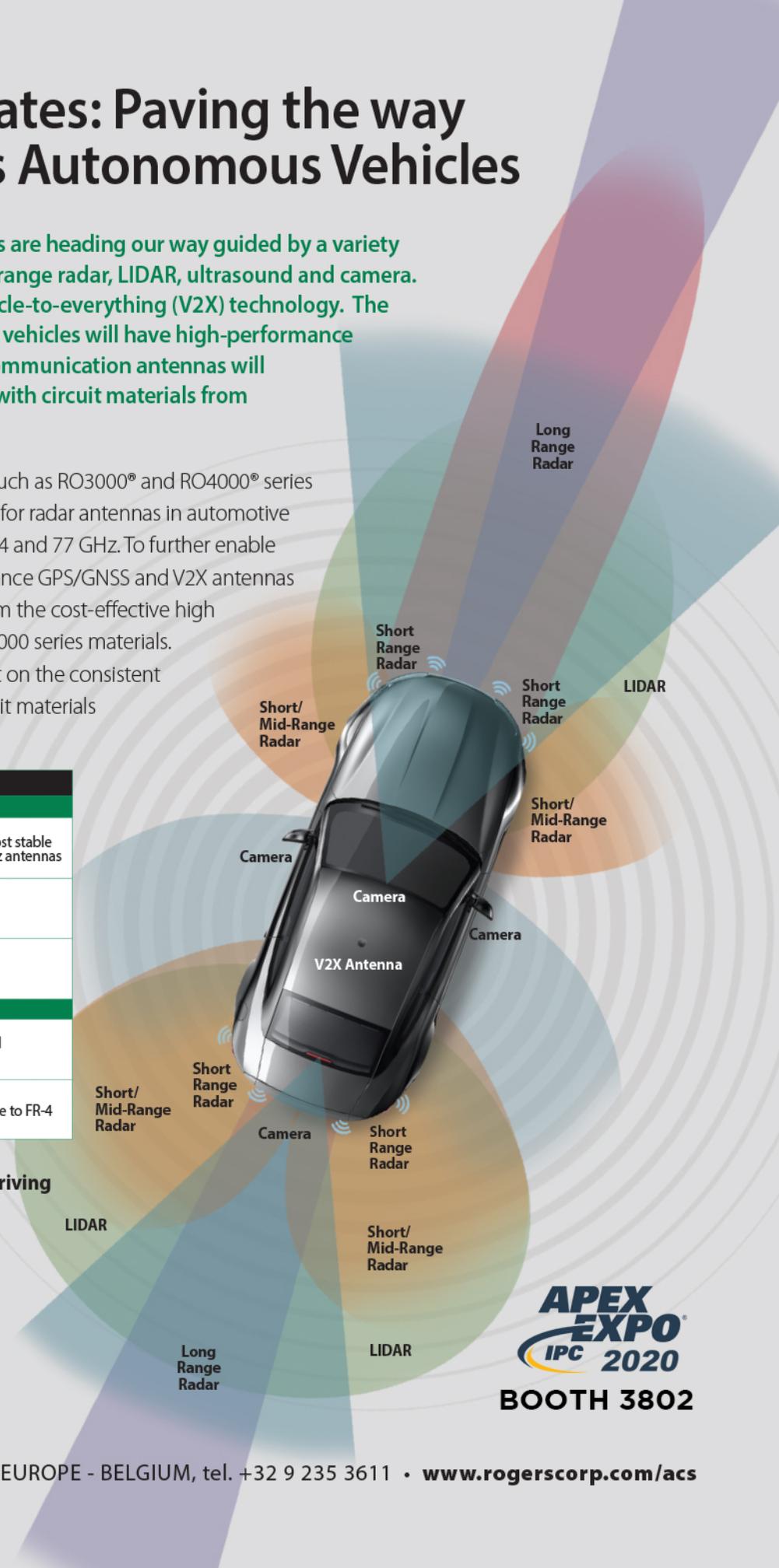
High-performance circuit laminates, such as RO3000® and RO4000® series materials, are already well established for radar antennas in automotive collision-avoidance radar systems at 24 and 77 GHz. To further enable autonomous driving, higher performance GPS/GNSS and V2X antennas will be needed, which can benefit from the cost-effective high performance of Kappa™ 438 and RO4000 series materials. These antennas and circuits will count on the consistent quality and high performance of circuit materials from Rogers.

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ANTENNA	
RO4000 Series Circuit Materials	Low loss, FR-4 processable and UL 94 V-0 rated materials
Kappa™ 438 Laminates	Higher performance alternative to FR-4

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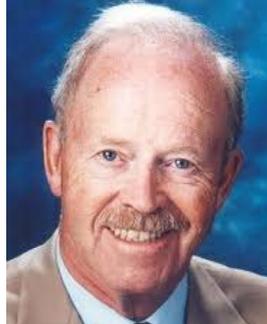
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Quality Improvement

This final stage of Juran's quality trilogy holds that the chronic waste identified by quality control should be considered an opportunity for quality improvement. Quality improvement is the systematic approach to the reduction or elimination of waste in a process. This can take many forms but should seek to continually establish a higher level of performance than previously achieved.

Philip B. Crosby (1926-2001)

Philip Crosby has been called "The fun uncle of the quality revolution" and had a talent for explaining a sometimes dry subject matter in terms that were simple and understandable to the average Joe. He coined the rally cry, "Do it right the first time," and was the first to introduce a "zero defects" mentality to manufacturing, which is not unlike today's Lean/Six Sigma movement. Like many of his colleagues, Crosby placed the responsibility with management for creating a culture of defect elimination without pointing blame at the operators.



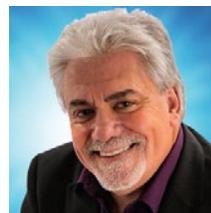
Another key attribute of this methodology was Crosby's definition of quality as conformance to a specification, not some ambiguous measure of goodness. As Crosby once famously stated, "Quality is conformance to requirements; non-quality is nonconformance." I would agree with this viewpoint but argue against the common misperception that there can be "good quality" or "bad quality;" there can only be quality. Crosby established the four absolutes of quality management as a foundation for his 14 steps to quality improvement (Figure 2).

Crosby's 14 Steps to Quality Improvement

1. Management commitment
2. Develop a quality improvement team
3. Quality measurement
4. Cost of quality evaluation
5. Quality awareness
6. Corrective action
7. Zero defects planning
8. Employee education
9. Zero defects day
10. Goal setting
11. Error-cause removal
12. Recognition
13. Quality councils
14. Do it over again

Conclusion

Juran's focus on quality planning as a primary tool for improvement and the proclamation that quality cannot be "inspected in" has stood the test of time. While I disagree with Uncle Phil's premise that "quality is free," his groundbreaking work to drive organizations to the goal of zero defects has resulted in tremendous quality improvement in U.S.-made products. Much can still be learned from these two founding fathers. **PCB007**



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



Figure 2: Crosby's four absolutes of quality management.

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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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Editor Picks from PCB007

1 The ICT 2019 Christmas Seminar ▶

Since 2016, the Institute of Circuit Technology (ICT) has held its northern area Christmas seminar at the Majestic Hotel in Harrogate—the elegant and historic English spa town in North Yorkshire. Pete Starkey provides an overview of this popular ICT event.



Pete Starkey

3 Heading Into 2020 With Isola ▶

Barry Matties recently spoke with Isola's Travis Kelly, who has moved from acting CEO into the position of president and CEO. Chief Sales and Marketing Officer Sean Mirshafiei also joins the conversation as they share an update on the progress on the company's new Arizona factory, as well as their views on the markets and technology trends.



Travis Kelly

2 It's Only Common Sense: Making 2020 the Best Year of Your Sales Career ▶

Even if you didn't do your homework last year, it's not too late to set yourself up for success—all you need are two days of planning and a lot of hard work to make 2020 the best year ever. Dan Beaulieu shares 10 surefire steps to help you be successful in 2020.



Dan Beaulieu

4 Punching Out! Why Buy a PCB/PCBA Shop? ▶

Overall, the U.S. economy is strong, and manufacturing has seen a resurgence over the past decade. Still, the overall trend for investors and small company buyers for 20 years has been in asset-light, tech-enabled services businesses, such as Uber, Amazon, Airbnb, etc. Given that background, why should someone buy or invest in a North American manufacturing business such as a PCB or PCBA company?

5 Trouble in Your Tank: Changes and Concerns Regarding HDI Technology ▶

One does not have to look too far back to point out some significant changes that have taken place in our industry over the past few years, including processes, materials, equipment, and board designs. Mike Carano explores what's driving these changes, what the supply chain needs going forward, and the impact on PCB fabricators with a focus on ever-increasing trends toward HDI.



Mike Carano

6 Ladle on Manufacturing: Sharing an Idea for Christmas ▶

In the spirit of giving for the traditional holiday season, Marc Ladle gifts us all with a long-pondered question and an idea: What if prepreg resins were used as a resist material?



Marc Ladle

7 Samsung Electro-Mechanics to Shut Down HDI Unit in China ▶

Samsung Electro-Mechanics' decision to shut down its HDI operations in China doesn't look doomy and gloomy. The overall demand for HDI PCBs may have slowed down because of the advancements brought forth by SLP, and Samsung Electro-Mechanics is one of the companies that are able to manufacture SLP boards. In other words—and while this wasn't officially confirmed—the company might feel like it needs to focus less on HDI and more on other, more modern solutions.

8 Register Now for the EIPC Winter Conference February 13-14 ▶

Attending an EIPC Conference in the middle of winter is becoming a tradition. Participants will learn how to meet and adapt to the changing needs of Europe and the global electronics market, and industry experts will explain the changes in the world-wide PCB supply chain for technologies, materials, and surface coatings of PCBs.



9 Atotech Announces Confidential Submission of Draft Registration Statement for Proposed IPO ▶

The Atotech Group recently announced that Atotech Limited, an entity that will be its indirect parent, has confidentially submitted a draft registration statement on Form F-1 with the Securities and Exchange Commission (SEC) relating to the proposed initial public offering of its common shares.



10 Elmatica Further Expands Technology Department With New Hire ▶

Printed circuit broker Elmatica announced a further expansion of their technology department with the hiring of Joseph Milsom in the position of IT developer. Elmatica has a dedicated focus on developing the best IT solutions for securing their customers' articles and data.



Joseph Milsom

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- 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)

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- 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
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- 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
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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.

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- Provide product and manufacturing support
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Events Calendar

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San Diego, California, 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*:

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Does investing in equipment to go digital on the fabrication floor pay off through increased profit? If so, how? PCB007 looks into the expectations and realities.

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COVER: **SHELLY STEIN**

COVER IMAGE: **ADOBE STOCK © SEANPAVONEPHOTO**

PCB007

MAGAZINE

PCB007 MAGAZINE®
is published by BR Publishing, Inc.,
942 Windemere Dr. NW, Salem, OR 97304

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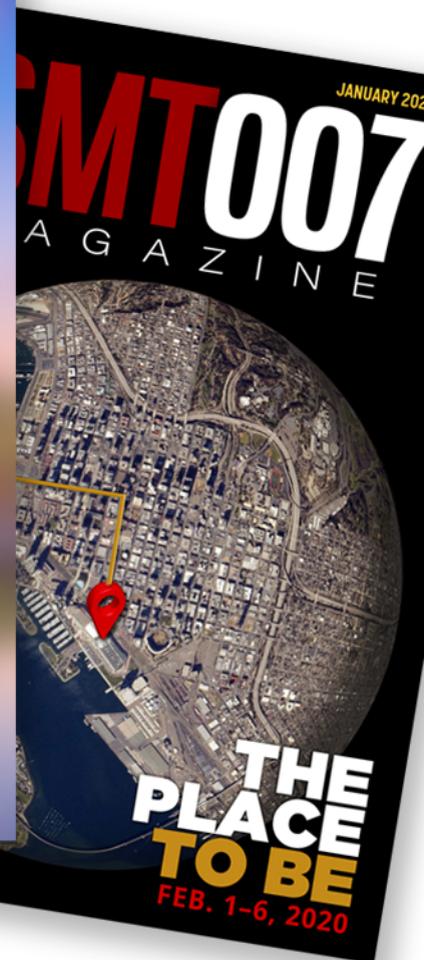
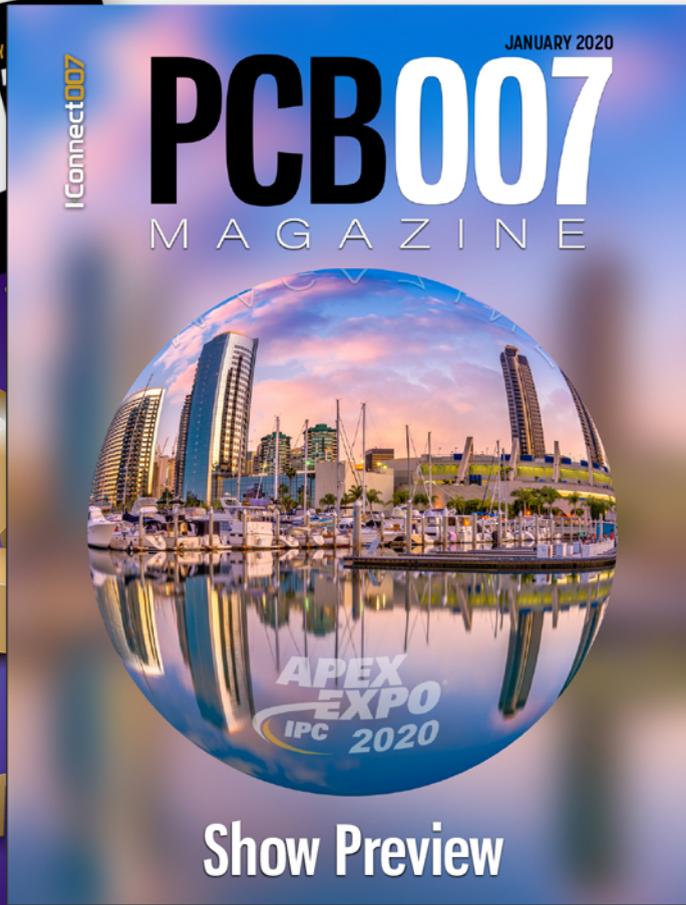
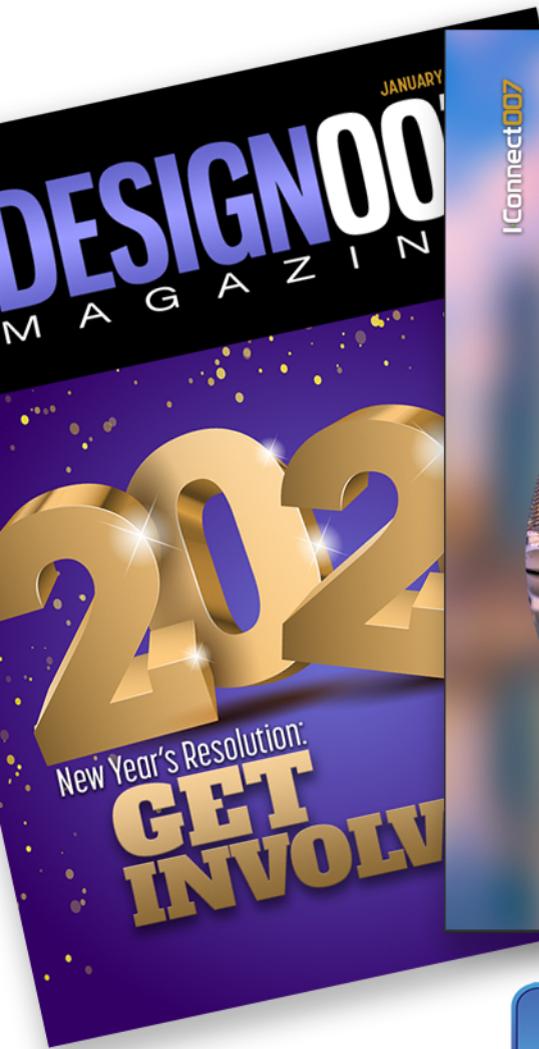
January 2020, Volume 10, Number 1
PCB007 MAGAZINE is published monthly,
by BR Publishing, Inc.

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