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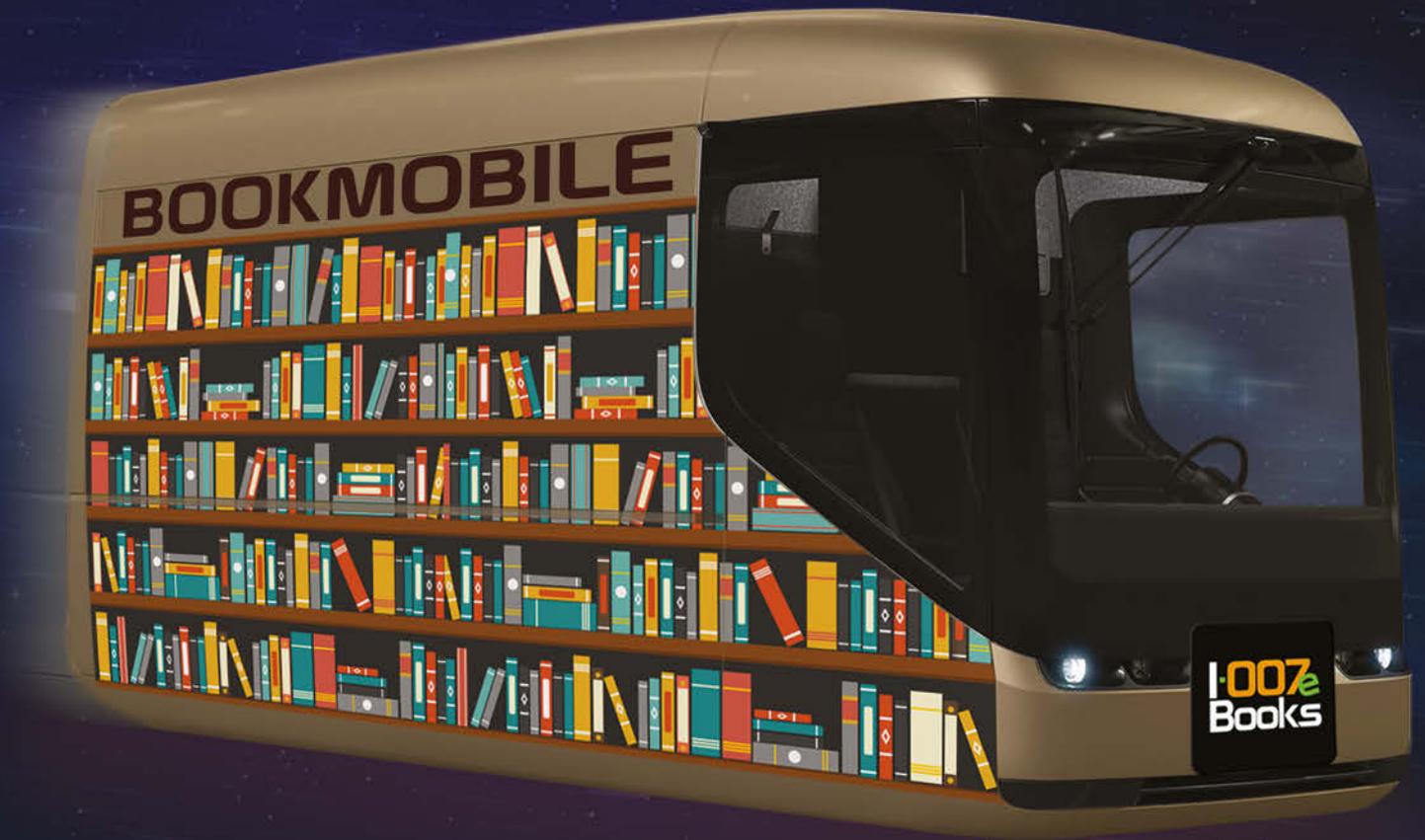
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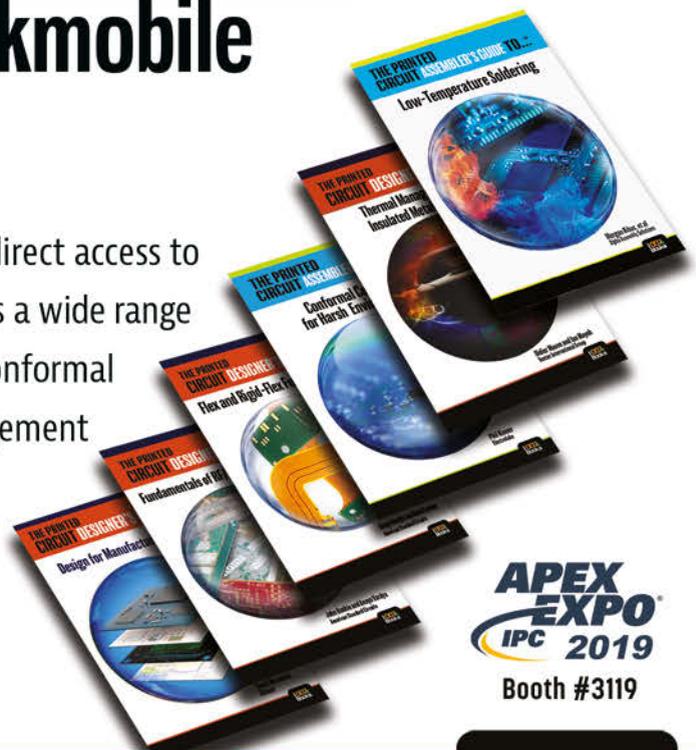
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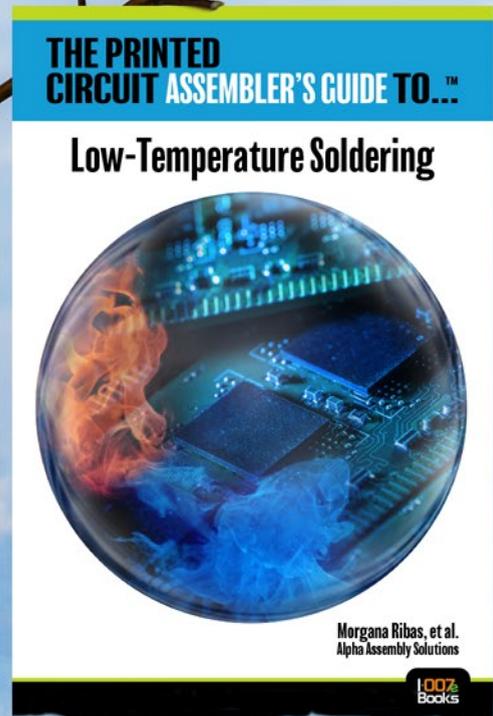
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IPC APEX EXPO 2019 PREVIEW

There's no better place to participate in the excitement and innovation of the printed circuit industry than at IPC APEX EXPO 2019. We preview the show, events, exhibitions, new technologies, awards, competitions, and standards work. Experience the magic that is our industry with IPC APEX EXPO. So, relax and make your travel plans as we give you the big reveal!



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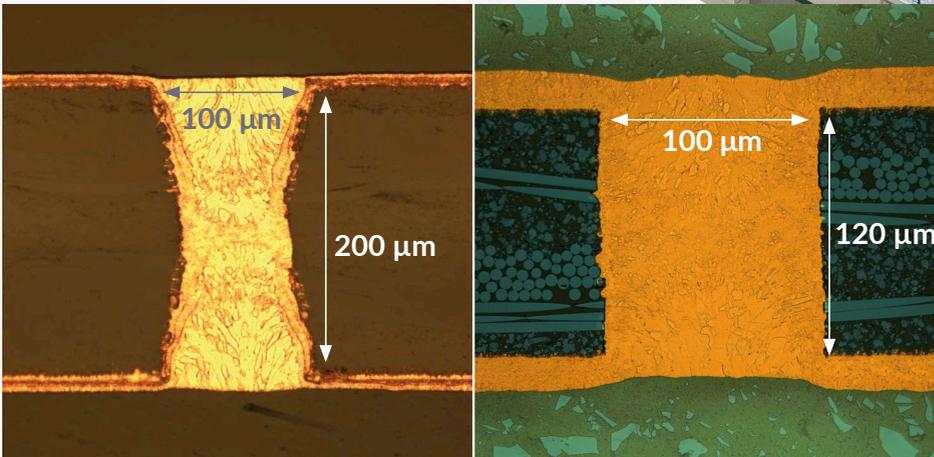
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in

Get Ready for the Unveiling!

Nolan's Notes

by Nolan Johnson, I-CONNECT007

The term “magic” has many definitions. While the word can be used to describe illusions and deceptions deemed entertaining, it can also be used to describe something that is touching, enchanting, or captivating. IPC APEX EXPO is much more of the latter and very little of the former.

This month's cover image is a tip of the hat to the primary subject of this issue: IPC APEX EXPO 2019! The magician's table, draped in a red cloth, seems appropriate for IPC APEX EXPO on a number of levels: there's the stage that is the show floor; the equipment all set up before the show, draped and covered; and the emotional response that the show triggers in its attendees and exhibitors.

I did a little research on the performance of magic, and I found this interesting quote in a forum for magicians. The question asked was, “What do you do when a trick goes wrong in your act?” In the thread of very insightful responses, I found a post from a magician named JT who had a LOT to say about how to recover from a botched trick. I tried to connect with JT about this quote, but he seems to keep his identity hidden and hasn't responded to my request. Normally, that would be a warning sign, but we're talking about magicians here.

In the middle of his larger contribution, JT answers the forum question this way:

“Have a large vocabulary. No, I don't mean knowing what ‘epiglottis’ means. What I mean is... know a bunch of effects and learn as many ways

as you can to do things—different techniques to get to the same place. Card palm? There are a dozen ways I can do it (most magicians know two, and one of them doesn't work reliably). Do I need to vanish a coin? I know about two dozen individual techniques. Do I need to control a card's position in the deck? I know a dozen ways to do that too. I know a lot of tricks, and this helps me because I can keep a running list in my head of what tricks can save my buns from this step. If I botch a particular step, I am already thinking about the way I can rewrite the ending on the spot and finish on a different road.”

Interesting, right? JT shares that he always has a backup plan or an escape plan. I don't know about you, but I found this passage particularly appropriate for PCB fabricators. How often do we find ourselves looking for a way to improvise a fix to an otherwise botched batch of boards? Is it possible to step outside the normal procedure and recover so that we can return to the proper process? Of course, we prefer to follow the process unerringly, but sometimes it just happens. It always helps to have the right trick at your disposal. Just like JT, “How can I save my buns from this step?”

That's really what IPC APEX EXPO is all about, isn't it? Helping you, the PCB fabricator, do the difficult work of delivering PCBs to your customer in a way that leaves that customer happy, delighted, and enchanted in some fashion or other and makes you



The Unveiling

look, well, magical. So, let's take a look at the show card for this month.

Dr. John Mitchell, IPC president and CEO, serves as the master-of-ceremonies and warms us up with an introduction to this year's show themed "Technology's Future Comes Together."

Then, we pull back the curtain with your back-pocket overview of the show including facts, schedules, events, locations, and details on the keynote presenter.

New products are a key at any show, and IPC APEX EXPO delivers on that expectation. In "Shopping at IPC APEX EXPO: Evolutionary or Revolutionary Products?" Andy Shaughnessy looks at the new technologies, products, and announcements you should expect to see at the show. Plus, he steers you to the complete list of new products.

Dan Beaulieu talks effective strategies for trade shows in the interview "Making the Most of a Trade Show"—a must-read to help you finalize your rehearsals for IPC APEX EXPO.

CFX and Hermes look to play an emerging critical role in PCB fabrication and will be a key highlight at this year's show. We spoke to Michael Ford and Dave Bergman about the live demonstration planned for the IPC APEX EXPO floor, and we tell you how to access the live data, so you can fully experience CFX and Hermes in action.

Jan Pedersen of the PCB Norsemen gets in the spirit with a discussion of IPC APEX EXPO, but that's just the set-up for his act. Jan discusses his experiences in writing standards for IPC, especially for automotive applications. Given that standards are one of IPC's core functions, this column makes for a great read.

Turning more serious, Philip Carmichael, president of IPC Asia, provides guidance for managing the turbulence currently stirring up business relationships between the U.S. and Asia.

Tara Dunn, president of Omni PCB (and I-Connect007 columnist!), talks with Barry Matties about staying competitive through the ongoing generational shift in fabrication, communication, and building trust.

Membership in IPC is growing, and Mark Friedman, IPC member success advocate, tells Barry Matties what's new in membership, how

industry members can get involved, and why they should.

Going deep into the technical details, Andrew McManus, general manager at Gannon & Scott, discusses the question "Can E-waste and Metals Recovery Efforts Lower Environmental Risks and Liability?"

And, for our next trick, Andy Shaughnessy showcases the Real Time with... coverage that I-Connect007 provides on the show floor. Stop by booth #3119 to share news with the I-Connect007 team, catch our interviews, or even cut one of your own.

Tara Dunn's "Flex Talk" column dives into two papers to be presented by Averatek at IPC APEX EXPO. She talks semi-additive processes (SAPs) and surface treatments for soldering to aluminum with Averatek's president, Mike Vinson.

An army of volunteers delivers much of IPC's functionality; thus, awards are a crucial part of the IPC APEX EXPO agenda. Patty Goldman shines the spotlight on these magical moments.

Automotive technologies are at the forefront during the executive development sessions this year. Patty Goldman and IPC staff provide an overview of the itinerary for this key strategic session.

Taking "The Right Approach," Steve Williams considers Industry 5.0 in his column. From 3D printing to IoT and technologies beyond, Williams updates us on some of the technical magic we can expect.

Michael Carano's column, "Trouble in Your Tank," continues the series on surface preparation and cleaning. This installment looks at cleaning and surface preparation to optimize adhesion.

Just like the magician, practice and mastery are key. Keep up the rehearsals, and we'll see you on the show floor! **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](#).

IPC APEX EXPO 2019: Where **Technology's Future** Comes Together

One World, One Industry

by John Mitchell, IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

The electronics manufacturing industry continues to grow and change, and there's no better place to participate in the excitement than at IPC APEX EXPO 2019. We've built a strong community of enthusiastic individuals passionate about electronics manufacturing, and I'm eager to work with exhibitors, speakers, standards committee leaders, members, and attendees alike to ensure that "Technology's Future Comes Together" at the 2019 event.

While at the show, attendees will have the opportunity to experience and compare equipment from nearly 500 of the industry's top innovators and suppliers, discover new processes to gain greater efficiency, and find new suppliers while uncovering new solutions that will prepare them for tomorrow's opportunities.

Educational program offerings will help keep attendees and their companies productive in 2019. Here are my top eight reasons to take part in IPC's technical conference sessions and professional development courses:

- 1 All IPC APEX EXPO 2019 programming is designed to help address current and future industry challenges such as the expanding importance of automation and data exchange, the increasing miniaturization of assemblies, the need for low-temperature soldering to lower energy consumption, and the growing complexity of design.
- 2 The education is not theoretical—it's grounded in and driven by real-world applications that are happening right now.
- 3 All submitted abstracts are a snapshot of what the industry is interested in, and the education program committee is comprised of people working in the industry. Selected submissions are always based on how they will truly offer value to the attendee.
- 4 The content that participants experience during our technical conference is presented here first and is completely unique to IPC APEX EXPO.



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5. IPC APEX EXPO is a multidisciplinary event. This is an opportunity to learn while interacting with others who represent different functionalities within the supply chain. The conference also provides a greater, more well-rounded picture of the industry when compared to other events available.
6. Attendees will have the opportunity to connect with equipment and solution providers on the show floor to discuss how current or future technology may impact what they learned in the classroom.
7. Learn how updated IPC standards around reliability, assembly, and other concerns address changes in both traditional areas such as PCBs and emerging technologies like printed electronics.
8. 83% of IPC APEX EXPO attendees say the training and education delivered met or exceeded their learning objectives.

Further, part of the fun of attending IPC APEX EXPO is learning from individuals who are influential in the industry. IPC APEX EXPO 2019 will feature JB Straubel, chief technical officer (CTO) and co-founder of electric vehicle maker Tesla Inc. Straubel will present “Accelerating and Disrupting Innovation: The Tesla Story” on January 29. In his presentation, Straubel will draw on his extensive experience and share the history of Tesla, detailing that



Attendees connecting with exhibitors on the show floor.

innovation was not an add-on to its operations but woven into every element of the business. He will also answer the perennial question, “How can my organization re-engineer itself to create products and ideas that answer 21st-century needs?”

From the show floor to the classroom and all points in between, IPC APEX EXPO 2019 is the place to be to learn, network, conduct business, and create new relationships while building on established ones.

Every year, IPC APEX EXPO provides me with unique ways of learning things I didn’t realize that I needed to know. I look forward to seeing you and learning along with you in sunny San Diego in just a few short weeks!

A few noteworthy happenings:

• Show Floor Reception: January 29

You’re invited to the industry’s largest networking event—the IPC APEX EXPO show floor reception. This is your opportunity to network with industry colleagues, make new connections, and interact with nearly 500 exhibitors in a dynamic environment.

• New Products Corridor

View cutting-edge products and services in the New Products Corridor located in the Sails Pavilion (upper-level exhibit hall). Get a sneak preview of tomorrow’s equipment, materials, and services that are breaking new ground in our industry.



An attendee participating in a buzz session.

• **Connected Factory Exchange (CFX)**

IPC-CFX is an electronics manufacturing industry developed standard forming the foundation and backbone of Industry 4.0 applications. Participate in a live demonstration of IPC CFX on the show floor with a larger presence of supporting exhibitors for 2019.

• **IPC Hand Soldering World Championship and Rework Competition: January 29-30**

Competitors will be presented with a soldered assembly that will be partially populated with components. Contestants will be required to remove six specific components, remove the old solder, and clean the area of removed components. This will take place in the Sails Pavilion (upper-level exhibit hall).

• **Ice Cream Social on the Show Floor: January 30**

Satisfy your sweet tooth while networking with the innovators and suppliers of the electronics industry. Check the IPC APEX EXPO mobile app for the specific time, so you don't miss out on the fun!

• **Passport to Prizes: January 31**

Travel around the show floor collecting stickers from participating exhibitors and enter for



Attendees networking with industry professionals.

a chance to win an exciting prize including an Apple Watch, GoPro, VR Headset, Ring Doorbell, and Star Wars Hero Droid BB-8. Submit your completed card to the IPC Bookstore on or before Thursday, and attend the drawing giveaway at 12:30 p.m. PCB007

For more information on IPC APEX EXPO 2019, visit ipcapexexpo.org.



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

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FUTURE COMES
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SAN DIEGO CONVENTION CENTER, CA, USA

IPC APEX EXPO 2019

Schedules, Stats, and Programs

Feature by Nolan Johnson
I-CONNECT007

IPC APEX EXPO 2019 will open its doors at the San Diego Convention Center in late January. IPC APEX EXPO is regarded as the largest event for electronics manufacturing in North America, attracting more than 9,000 professionals from 45 countries.

Attendees at all career stages can expect to access new research and best practices; learn about trending materials, applications, and processes such as Industry 4.0 and wearables; address real-world problems to help with job success; experience the largest electronics industry collection of top suppliers, live demonstrations, and extreme innovations; and make connections in educational sessions on the show floor and during networking events.

Read on to find schedules, stats, and programs in preparation for IPC APEX EXPO 2019.

Event Information

- Meetings: January 26–31
- Courses: January 26–31
- Conference: January 29–31
- Exhibition: January 29–31
- IPC CID/CID+: January 31–February 3



EXPO by the Numbers

- | | | |
|---|--|---|
| <ul style="list-style-type: none"> • 8 Buzz sessions • 16 Special events <ul style="list-style-type: none"> - Chairman's reception - Event awards luncheon - Hall-of-fame breakfast - IPC first-timers welcome - IPC annual meeting - Opening keynote • 5 Management sessions • 30 Professional development sessions | <ul style="list-style-type: none"> • 36 Technical conference sessions • 105 New product announcements • 117 Standards committee meetings <ul style="list-style-type: none"> - 23 Assembly and joining - 17 Base materials - 11 Cleaning and coating - 10 Electronic product data description - 4 Flexible and rigid-flex printed boards - 6 High-speed/high-frequency interconnections | <ul style="list-style-type: none"> - 4 Management - 6 Packaged electronic components - 4 Printed board design technology - 13 Product assurance - 6 Rigid printed boards - 3 Testing - 10 Other topics |
|---|--|---|

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Activities

Innovation Awards

The IPC APEX EXPO 2019 Innovation Awards are a celebration of the innovators and forward thinkers who are changing the technological landscape of the electronics industry.

Buzz Sessions

Buzz sessions are free, educational, and informational and are meant to bring participants up to speed on the topic. They are usually moderated and may include one presenter or multiple depending on subject matter. Questions from participants are encouraged; for some sessions, questions can even be submitted ahead of time. Here is a list of the current [buzz sessions](#):

Export Control

- January 28, 10:30 a.m.–12:00 p.m.

E-textiles—The Fourth Industrial Revolution

- January 29, 1:30–3:30 p.m.
- Send your electronic textile integration questions in advance to etextiles@ipc.org

IPC-2581

- January 29, 3:30–5:00 p.m.

Perm Buzz Session

- January 30, 9:00–10:00 a.m.



Impacts of Warpage on SMT Processes

- January 30, 10:30 a.m.–12:00 p.m.

Shoring Up the U.S. Defense Electronics Industrial Base

- January 30, 1:30–3:30 p.m.

Findings from IPC's PCB Technology Trends

- January 30, 3:30–4:30 p.m.

iNemi Next-Generation Solder Materials

- January 31, 8:00 a.m.–2:00 p.m.

Management Programs

EMS Executive Management Meeting

- January 28, 7:30 a.m.–5:00 p.m.

Executive Forum on Advancing Automotive Electronics

- January 28, 7:30 a.m.–5:00 p.m.
- A must-attend event brought to you by the IPC Hall of Fame Council

Technical Information for Designers

Ray Prasad, Ray Prasad Consultancy Group

- Design and assembly process challenges for bottom-termination components such as QFN, DFN, and MLF in tin-lead and the lead-free world

Dale Lee, Plexus

- Design for excellence: DFM, DFR, DFA, and more—Parts 1 and 2

Martin Goetz, Northrup Grumman Corporation

- Designing additive manufacturing/3D printing to PCB fabrication and assembly
- High-speed/high-frequency laminate materials used in design
- Electrical and thermomechanical design constraints affecting system and component performance

IPC Designer Certification (CID and CID+)

- Tutorials January 31–February 2
- Exams February 3



Professional Development Program Highlights

Topics include reliability, reflow soldering, troubleshooting PCB related defects, Lean practices, design for testing (DFT), thermal management, high reliability for lead-free solder joints, electrostatic discharge, design for manufacturing (DFM), contracting with the customer, PCB fabrication basics, and process and specification.

Show Floor Highlights

January 29

You're invited to the industry's largest networking event—the IPC APEX EXPO show floor reception. This is your opportunity to network with industry colleagues, make new connections, and interact with nearly 500 exhibitors in a dynamic environment.

January 29-30

The IPC World Championship Hand Soldering and Rework Competition will require steady hands, nerves of steel, and a will of iron—only at IPC APEX EXPO 2019.

January 29-31

Participate in the live show floor demonstration of the IPC CFX Industry 4.0 protocol. Look for CFX supporting booths to answer all your questions.

January 29-31

The New Products Corridor will be the place to find cutting-edge products and services. This showcase of innovation will be located in the Sails Pavilion (upper-level exhibit hall).

January 30

Satisfy your sweet tooth at the ice cream social while networking with the innovators and suppliers of the electronics industry. Check the IPC APEX EXPO app for the specific time. You don't want to miss out on the fun!

How to Connect

Available mid-December on Google Play and the Apple Store, the IPC APEX EXPO smartphone app allows you to plan for sessions and events at the expo, review the show floor exhibitors, stay informed on schedule updates, and receive event alerts as they happen. You can also use the schedule at a glance from the IPC APEX EXPO conference guide. **PCB007**

For more information, visit the
IPC APEX EXPO 2019 website: ipcapexexpo.org
email: registration@ipc.org

or call the attendee hotline:
Toll-free: 877-472-4724
Outside of the U.S. and Canada: +1 847-597-2861



Shopping at IPC APEX EXPO: Evolutionary or Revolutionary Products?

Feature by Andy Shaughnessy
I-CONNECT007

Every year, managers and technologists descend upon IPC APEX EXPO, shopping list in hand, scouring the aisles in search of deals on capital equipment, software, alloys, chemistry, and whatever else they can find. Sure, many of the big pieces of equipment on display are already sold. On the flip side, there are plenty of deals to be made at IPC APEX EXPO because no company wants to pay to ship a machine twice.

As you're finalizing your shopping list, take a second to consider this: Are you in the market for products that are evolutionary or revolutionary? And what do those terms even mean for someone looking for new DFM software or a new pick-and-place machine?

Evolutionary vs. Revolutionary

The term "revolutionary" gets thrown around pretty often in the electronics world. But most new products—even the most expensive—fall into the evolutionary category; they feature logical updates and improvements over the last revision of that particular product. You could see these updates coming, and they make a good product a better product.

If you look back on a product's life cycle, you can track the new func-

tionalties as they were incorporated each year or so, much like parents chart their children's growth by marking the kids' height on the wall on their birthday. Evolutionary change is slow and gradual, and fairly predictable. I imagine that most of the equipment and software in your facility contain evolutionary improvement and upgrades over the previous models.

But revolutionary change is disruptive to the status quo. Revolutionary change is unpredictable, an upset applecart that can't be set right until the full effects of the shift are quantified and understood. Sometimes the reverberations from revolutionary change make it almost impossible to measure its long-term effects for years.

You know your product is revolutionary if it forces other companies to change the way they operate. I liken revolutionary change to a quantum leap; it's not exactly an apples-to-apples comparison, but it's close.

The Model T was clearly revolutionary, putting the average Joe into an automobile and blacksmiths and wagon builders out of work almost overnight. EDA software and the SMT process were likewise revolutionary, changing the way PCBs were designed and assembled, and



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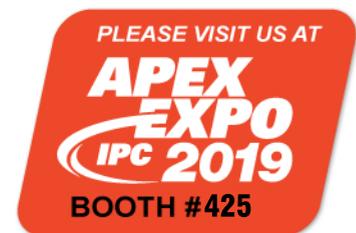
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Then again, some products are “leaners” that are tough to categorize.

The Wright brothers’ first airplane was revolutionary, but there is some debate about whether the first jet plane was too since it’s really just an airplane with a more powerful engine. Similarly, the Tesla seems revolutionary to most of us, but electric vehicles (EVs) have been around since the 1800s, and one EV held the world land speed record until 1900. Is a new type of fastener or squeegee capable of being revolutionary? Undoubtedly, some companies will say so, especially if they increase their profit margin.

Products at IPC APEX EXPO

Keep all of this in mind as you roam the aisles at IPC APEX EXPO. You’ll probably see

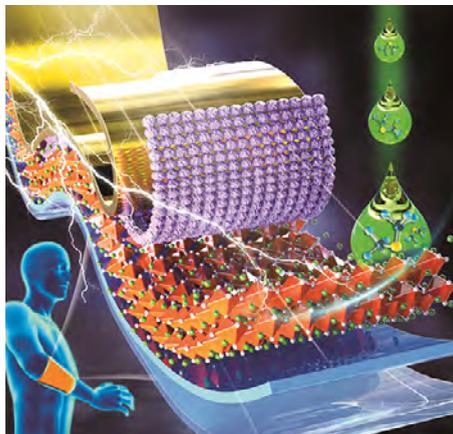
some “leaners,” somewhere between evolutionary and revolutionary. IPC’s Connected Factory Initiative (CFX) comes to mind. The open-source CFX standardizes machine-to-machine communications, allowing one person to monitor all of the machines on a line through a smartphone. But is CFX a truly revolutionary? You be the judge. Try it out in San Diego next month and see.

To help you craft the ultimate trade show shopping list, IPC has created this [handy listing](#) of all 311 new products on display at IPC APEX EXPO. It’s not too late to thumb through these pages and start making a list of new products that could put your company light years ahead. Whether your company needs the latest cutting-edge tools or not, you can find what you need at IPC APEX EXPO 2019. **PCB007**

Scientists Release Review Article on Recent Advances in Flexible Perovskite Solar Cell

With the rapid development of advanced technologies in the electronics industry, the demand for portable electronics, shaped display devices, and wearable electronic textiles is ever increasing. Flexible solar cells are thereby receiving more and more attention for their favorable traits including being lightweight, flexible, portable, and compatible with curved surfaces.

A research group led by Professor Liu Shengzhong from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences achieved a series of innovations in perovskite solar cells, and repetitiously created an efficiency of world records for flexible, rigid planar-type and two-dimensional perovskite solar cells. Recently, Liu’s group in collaboration with Professor Yang Dong’s group from Shaanxi Normal University published a review article on providing a comprehensive summary of the previous article with a perspective discussion on application costs, potential opportunities, and challenges in flexible perovskite solar cells.



“We introduced and discussed the low-temperature fabrication technology for perovskite films as well as their advantages and disadvantages, and described the low-temperature interface materials applied in flexible perovskite solar cells in this review,” said Liu.

The review summarized the important development of various flexible electrodes in flexible perovskite solar cells, concluded the environmental and mechanical stability of flexible perovskite solar cells, and analyzed how to employ flexible encapsulation to improve environmental stability. It also estimated the cost of flexible perovskite solar cells fabricated by vacuum roll-to-roll technology.

The project was supported by the National Key Research and Development Program of China, National Natural Science Foundation of China, National University Research Fund, and the 111 Project.

The review was published in *Angewandte Chemie International Edition*.

(Source: Chinese Academy of Sciences)

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Dan Beaulieu on Making the Most of a Trade Show



Feature Interview by Barry Matties I-CONNECT007

Dan Beaulieu, president of D.B. Management Group, has over 30 years of experience in the PCB industry. In this interview, Beaulieu provides his expert knowledge on selling strategies for companies as well as getting the most from your trade show experience as an exhibitor.

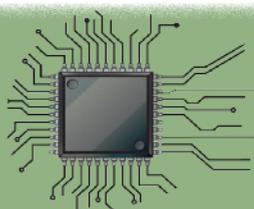
Barry Matties: Dan, IPC APEX EXPO 2019 is coming up fast. This industry has been going to trade shows forever, and we've seen the exhibitors grow and contract through good and bad times. Right now, we have a good extended period in our economy, which means a lot of people are going to be at the trade show. What advice would you give your customers in terms of preparing for a trade show and making it as successful as possible?

Beaulieu: The key is preparation. Barry, so often we hear, "I went to that trade show for years and got nothing out of it." Like everything else, it's what you put into it. I like to set clients up with a schedule. The first question to ask is, "Why are you going to this trade show? Why did you pick this event? What are you hoping to get out of it?"

Set your goals, whether that's introducing a new product or going to meet potential customers. You just want to know what's going on in the industry. Some people say a trade show is basically a branding tool. I think it is, but I like to be much more effectual. Start with establishing why you're going to this show. It's just like marketing—it's getting the story for the show, and showing off your marketing and sales abilities.

I like to work backward as well. At the end of the show, do a debrief. What happened? What worked well? What didn't work well? Even look at what you brought. Did you forget anything? Do you want to attend that show again?

The other thing is, as you start preparing for the show, put together a schedule 14 weeks out. At week 14, you should start talking about what your graphics will be and what you want to share at the show. At week 13, you're down to basic stuff like solidifying hotel and travel details, who's coming to the show, and what you want to talk about? Many times, it drives me crazy when people spend \$8,000–9,000 on a show, and you walk by, they're sitting in the back of the booth reading a magazine or something. That's not what you should be doing. There are so many other valuable things you could do.



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It's all in the preparation and deciding what you're going to get at the show, right down to the core of who are you going to meet. Set up those appointments. Send invitations and email blasts announcing what you're going to do. It's always great if you have a white paper to work around. Do things with intention. Make sure that every minute of that expensive show is worthwhile for you and your company's resources even down to who you invite to breakfast, lunch, or dinner.

Another important thing is don't load the booth with all of your employees so that there are 20 people wearing the same outfit and you feel like you're crashing a party if you try to go in and talk to somebody. If you have a big company, work in shifts to ensure there are two or three individuals in the booth at once. Always be thinking of that person who's coming to see your product. Try to load the deck. You don't just say, "Well, they'll walk by, and we'll bump into them." No, you should reach out to the kind of person or company who wants your service, and you make sure that they're going to come to the booth.

Also, if you're giving something away, give away something you do. Don't give away golf balls—you're not selling golf balls.

In summary, plan, prepare, organize, have a system, and be intentional.

Matties: That's really good advice. Further, one thing we would suggest people look at is the flow of your booth. Some companies have a booth that's 10 x 10 feet. Do you want them to step into that booth, or do you want them in the hallway behind a counter?

Beaulieu: That's right. Don't block the way in; instead, let people come in. Try to have a table and a couple of chairs in the corner of it to have a place where you can have a conversation. If that's not possible in the booth, then stake out a place where you can have individual conversations.

Matties: Great advice, Dan. Thank you very much for your time.

Beaulieu: Thank you. It's my pleasure. **PCB007**

Dan Beaulieu is president of D.B. Management Group and an I-Connect007 columnist. To read past columns or contact Beaulieu, [click here](#).

ANU Researchers Make Big Strides in Noise Cancellation

Researchers at Australian National University (ANU)—including Professor Thushara Abhayapala from the Research School of Physics and Engineering, Ph.D. Scholar Fei Ma, and Dr. Wen Zhang—have found a way to cancel out noise produced by things like motors and AC units, providing much-needed relief to anyone working or living in a noisy environment. Their research was published in the *Journal of the Acoustical Society of America*.

"We've come up with a technique to separate the sound going out from the sound coming in, and actually cancel the sound going out. No matter where you are around it, you get the reduced noise level," said Professor Abhayapala.

Ma, the lead author, was the first one to get the demon-

stration working. It involves using multiple microphones and loudspeakers to override the original noise source with a second sound effectively. It works on any noise with a lower frequency, but high-frequency noises present a bigger challenge. When the frequency is high, the wavelength is very small, so canceling them would require multiple microphones and loudspeakers, which isn't always practical.

The technique—which can reduce the noise level by around 10 dB—could be important when it comes to protecting our hearing because prolonged exposure to noises above 80 dB can cause long-lasting damage.

The Australian Research Council funded the research. (Source: Australian National University)

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IPC APEX EXPO 2019 Offers a Full Operating CFX Demo Line

Feature by the I-Connect007 Editorial Team

A year on from their first demonstration, IPC's Connected Factory Exchange (CFX) now nears the release of version 1.0 at this year's upcoming IPC APEX EXPO. The I-Connect007 team spoke with CFX specialists Michael Ford and Dave Bergman about how far the program has come from the first initial public demo all the way through now becoming a published standard, and what users can expect from the demonstrations planned for the 2019 show.

Barry Matties: Gentlemen, can you please tell people about the CFX program at IPC APEX EXPO 2019—what should they know?

Dave Bergman: I am the current staff liaison for the CFX committee for IPC. Michael serves as a working chairman. We have three chairmen, but Michael is a vital industry volunteer. He is the glue for all the pieces, answering tons

of questions, and giving presentations everywhere. He has a crucial role in this effort and works very hard on this, including staying up late to do interviews like this one. I am happy he is joining.

From IPC's perspective and what we have going, I think it's important to note that IPC-2591 CFX is marching forward continuously and getting nearer to publication. CFX is in a 30-day final draft for industry review cycle per our standardization rules. Then, it will be followed by a 30-day vote cycle where companies need to give a vote of approval—a thumbs up, thumbs down, or technical comments.

We're doing this circulation slightly differently: IPC-2591 explains everything about CFX and provides examples and explanations. The nuts and bolts of CFX, which are the messages that machines both publish and consume, are on the open-source software development site called GitHub. We pushed both the standard and the GitHub link out a week or so ago to have people starting to look at. I am happy to announce that we are getting closer to the release of version 1.0 of CFX.

At the same time that we're doing that, Michael and the committee decided we had to draw a line in the sand somewhere. We looked at this and said, "Does CFX have enough content that the industry can start implementing it and getting excited about it?" We drew the line in the sand and said, "Okay, this is enough for now. Let's stop here, get this approved and published, and then we'll turn our focus on





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additional messages.” At IPC APEX EXPO, we will start to discuss messaging for the 1.1 version of CFX, which will be part of the activity that takes place in San Diego this year.

In addition, we will highlight several things at IPC APEX EXPO 2019, including the collaboration between IPC and the HERMES Consortium. The HERMES standard should also be approved as an IPC standard IPC-9852 because that is undergoing a consensus vote very soon. The HERMES Consortium will also meet at IPC APEX EXPO 2019, so they will be talking about any potential upgrades for that standard format.

Then, the most exciting thing will be the show floor demonstration. We plan to have two manufacturing lines. We needed to go with two because there are more and more companies interested in showcasing their capability. We will have one manufacturing line, which is a combination of both the HERMES format, which will be IPC-9852, and CFX, which is IPC-2591. We’ll run messages in both of those standards and an assembly operation on the show floor.

We will have a second line, which will be all CFX. Some companies don’t do both formats. Some companies have said, “I can only have so many manufacturing pieces of equipment within the line.” So, the second line gives more companies the ability to participate outside of the combined HERMES/CFX line. I think people are going to get to see some very exciting activities. We’ve been building on this. We did the first CFX manufacturing line in Birmingham, England, in the U.K. in September. Then, we did one at the LEAP Expo with MMI in Shenzhen, China, in October. This will be the next step—adding in collaboration with HERMES—and then expanding from our virtual demonstrations when we have that at this year’s IPC APEX EXPO.



Michael Ford

Michael Ford: Yeah, it’s easy to forget that it was not even a year ago at IPC APEX EXPO 2018 when people saw CFX working for the first time. The people there could not believe that they could just go to a QR code with their mobile phone and look at data with value and meaning from so many different machine vendors all in one platform—no installation or configuration, it was just there. That was the point where started to chart the history of what’s happened over

the last year in terms of people getting really excited about it. Whenever we talk about CFX, you would think that people would be into all of the messaging, protocol, and technical stuff, which people do have an interest in. But for me, most of the questions surround, “How is CFX going to solve Industry 4.0 and how is going to bring me that value?” People are talking about the value that is brought for manufacturers as well as that for machine vendors.

For example, in the beginning, we had a number of machine vendors who were interested in taking part in that very first demo. What you will see coming up is that so many more machine vendors have come along. Even those who had kind of been holding out, hedging their bets, and waiting to see what the industry was going to do have heard from customers who had specific issues in manufacturing related to Industry 4.0, and suddenly related to making machine processes smarter than they used to be.

They’re being faced with the idea of having to develop something again, worrying it’s going to cost too much money, and it will all be spoke for this customer. But now CFX is in their minds, and they’re thinking, “Well, with that CFX demo we saw, we could use the messages in that to achieve what we want to do.” They start to really understand the business process that this represents for the whole industry. It’s

not just one or two companies or certain of companies—absolutely everyone that is involved is going to benefit from this.

As we've been talking about CFX, the business processes have been put into place as well. That is what drives the achievement of that critical mass of adoption for the standard, which I believe is happening behind the scenes right now. A lot of companies have taken on board their own demonstrations. They've set it up in their own workshops and are starting to go out and explain it to customers proactively. We've had people come along recently and say, "The software development kit (SDK) that we have is completely free of charge from IPC and it is so easy for people to adopt CFX, but what about smaller pieces of equipment?" We had one company with soldering irons. How do you embed a whole infrastructure of an industrial internet of things (IIoT) standard within a soldering iron? They came up with a solution. It's a five-millimeter square chip, and they're running a Linux-based software development kit and producing CFX messages directly and natively from their soldering irons.

This is something I hope we are going to see at IPC APEX EXPO 2019—the fact that it's not just the big expensive machines now. The majority of the machines that actually exist in the factory are smaller, bespoke, niche, specialist, and even homemade for the functional testers. We're even talking about a method to integrate all of that within CFX as well. It means that the excitement is reaching areas that, from what we've seen in the past in terms of communication, it has never even gone to. It's never even been able to get kind of close to these areas.

But CFX, even now that we are imminently close to publication, has already started to reach these kinds of people. It's really excit-



Dave Bergman

ing to see it coming together because that marks the sustainability for CFX in the future. We've had an incredible year with so many people providing contributions and ideas, and getting together and talking. Even direct competitors are willing to talk to each other and help each other out in certain areas. It's been an amazing ride.

The milestone of getting this first revision, as Dave said, has everything in there that we need to establish this as a

real, usable, and valuable industry standard, and we will have further messages to come. On this publication date, we're going to find a lot of people who already have embedded CFX into their machines. We have around 40–50 different machine types that already have CFX. Many people are already developing and close to having full support for their machines. This was an amazing year from the first initial public demo all the way through now to a published standard, and not only that, but the actual implementation being supported as well.

Matties: When you look at a visitor at the show, how will they tour the CFX demonstration? Is it a booth-by-booth tour, or what's it going to look like?

Bergman: Barry, we're physically planning to build assemblies at the show, so we will have two manufacturing lines—one with CFX only, and one with both CFX and Hermes. The plan is to put a bare board on, have an assembled board come out at the other end, and show users a variety of flat panel displays and the related the data, or they can monitor that on their phones.

I can tell you that when the Birmingham event took place, you could monitor what was going on with one of the reflow ovens including what the temperature was in each zone of

the oven on your phone as it went through. The data was being pushed live, and you could see what was going on in manufacturing. In addition to physically seeing what's going on, we expect that they'll be able to view it on a web browser on their phone as well.

Ford: It's really important that people come to the demo. A normal demo is kind of like smoke and mirrors—the people have fantastic claims and wonderful messages. However, with the CFX demo like the one we did last year, you can actually see the data, as Dave said. It's human-readable data. You can go to your phone and see that it's there. Nobody is hiding anything or pretending that something is working; it's right in front of people. That's when they get the thought, "Well, there's my traceability. I didn't have to pay for anything. It's right there." That is really amazing for them.

Matties: Visitors can come to the show, see the process, and experience the data. Whether they are an equipment supplier or a fabricator, they're going to want more information. What will be available to them to look at in the next step? Will you direct them to the website, or is there any collateral material that you'll have to hand out? What's the takeaway?

Bergman: The thing I would like them to take away is a complete appreciation that Industry



4.0 is many steps closer to reality and is within reach of more companies—even small—and medium-sized companies.

It has been very gratifying to see IPC CFX being born. A year ago before IPC APEX EXPO when we were talking about CFX at production, we said maybe we should do a demonstration line. The questions we got from people were, "What the heck is this CFX thing? Who is supporting it?" The equipment guys said, "I won't support it unless my customer asks," and the customer said, "My equipment guys won't support it, so I'm not really interested." That has changed significantly over the last year and many more companies are on board. We have a [CFX website](#) where people can see who supports it now or where they can commit to join the movement.

It's challenging to try and do manufacturing demonstrations when you're writing the standard that you're using for delivering the messages, which is kind of scary in itself, but it's important because so many more people have heard about it. People are now asking more questions to consider than ever before. That tells us they're excited about it, and now they're visualizing what this can now do stuff for them, so how soon can we get to the really cool stuff? When Michael mentioned the different formats with Linux where we have a group, we were ready to form some sub-groups to target these areas or allow companies to work together and say, "Okay, how about you guys focus on this. Build an SDK so that more companies using Linux can start to implement CFX."

LabVIEW came up at the meeting on Industry 4.0 just this week in Fremont, California. There were a number of people interested in LabVIEW, and Python also came up. There are these formats where companies have software programming capability or things that they've been working on. This is what they're comfortable working with, but they really want to communicate with CFX, so how can IPC help do that? I guess the way IPC can help, like we do with anything else, is to try and get people

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with common interests together and work on it. We certainly want as many companies as possible to be able to use the format because that's the way that everyone will benefit.

Matties: Is there anything that we haven't talked about that you feel like visitors should know?

Ford: One of the most important beneficiaries of CFX is manufacturers. In the committee so far, and we have a few actually, the most vocal people have been machine vendors and solution providers because we understand the pain that's been gone through. When I say to people, "Guys, this will last interface that you will ever have to develop." They know that they're supporting 30–40 bespoke interfaces for customers that can now be just replaced by one. They get it, but I think we need to talk to manufacturers as well because it's the chicken and the egg scenario in terms of, "Do manufacturers want to use it, and will equipment vendors support it?"

We're making headway with the machine vendors and manufacturers. A very large manufacturer in China has already come out and said they expect all of their equipment vendors to support CFX in the future. We need more people to do that. We need people to see the demonstration, ask questions, and come to us with their challenges: "Can CFX do this for me? Can CFX provide the data that I need here? Can I get the level of control?" Come along and see what those answers are. We can start to talk about the real benefits for manufacturing, and that pays for the whole thing. Manufacturers will get the benefit from the data, the machine vendors will see the demand from the customer, and everything starts to work. It's really important that we start to get the actual manufacturing customers involved in seeing this demo.

Bergman: There are a couple things I would like people to take away with from the show. We have a core group out of hundreds of people

on the CFX committee. In our current committee that we're managing from headquarters, there are over 250. Our IPC China team has a local committee also working on it at the same time, and there are around 100 people there. We have 350–400 individuals who are interested in working on IPC CFX. There were a lot of messages written, and some individuals carried the lion's share of the work to get it to the point where it could start to take on a life of its own.

The CFX messaging is done in an open-source software-development mode. We have proven that this can work. I'd like to see that catch fire. What I am trying to do is plant seeds that say, "Don't expect me to write all of this stuff for you. You want CFX to do cooler stuff, so you can help by writing a message." We had companies come in with a whole section of messages on sensors that we weren't expecting or it wasn't on our list. A guy came in and said, "This makes sense to me. I understand this. It doesn't look so hard. I'm going to write all these messages," and when he was done, everybody thought it was pretty darn good. We were able to add a new section with minimal modification.

What I am starting to hear—particularly from some people that I've known for many years that are now in different job functions—is, "Dave, what's going on with CFX? Can it do this, this, and this?" I say, "Well, I don't know that I'm smart enough to know all of the answers to those questions, but I can point to where the messages are, and you can tell. If it doesn't, it means the message hasn't been written yet, so why don't you look at that if this is important for you and draft a message. You won't break anything."

The development process is not going to allow something to come in without some vetting. We have experts in the committee that spend a lot of time debating whether things make sense. They edit them, and we get comments on them. They won't be pulled in until they've gone through a vetting process. I would like this to get to the point where we

spread the writing, and more people submit messages because then CFX could grow even faster.

Matties: Do you have a classroom or session talking about CFX for people to attend as an overview?

Bergman: We give a lot of presentations. I honestly don't think we will for IPC APEX EXPO this year. I'm not sure we'd be able to do that with all the demonstration lines and the committee meetings. Michael travels the world giving these presentations. I don't know how many presentations you've made, Michael, but I'm sure it's a lot at the various PCB conferences and different assembly shows. We get a lot of visibility; I just don't know that we'll do a tutorial. I can tell you from a messaging-writing standpoint that we recorded a great webinar that's available on the [CFX website](#). I've been pointing to people there who are interested in trying to look at this. Watch the video, and you'll find it's not as hard as you think.

Ford: At the show, there will be times where we'll start to produce actual PCBs, which I think is a good demonstration to do as an introductory presentation. We could probably do a very short presentation where we let people know the basics while at the line and see the actual boards being made. We could explain what's happening and give some background on CFX so they can understand the context of what's been shown. It would probably be five or six slides to get people to understand the technical side and the value. Then, each individual vendor could explain what they see as people walk down the line.

Bergman: I think it's important to highlight the fact that we're going to be demonstrating two standards. We have managed to pull together



er two open industry standards, which will be two approved IPC standards. We've found a way to demonstrate how they can work together to benefit the industry. Both HERMES and CFX will be showcased. That could've just as easily been perceived as a competitive thing and had them go in different directions, but that's not the case. They're going to be working in lockstep with each of their strengths, and we'll be able to show that.

Michael, one of the things that came up at the conference and when we toured Nuremberg a little bit was the retrofit for pieces of equipment that may not be the newest. There's certainly of interest from some of the big EMS companies with a huge install base looking for opportunities: "How can I get this manufacturing line? I can't afford to replace everything? How can I get these things to play in the CFX world?" We saw some of that starting to happen at one of the booths in Nuremberg, and I'm hoping that will continue.

Ford: Yes, that's one of the key things. Look at Industry 4.0. Everybody is thinking, "Wow, do I have to buy all new equipment? Do I have to replace everything in my factory even though it works?" With CFX, we provide a solution

for that. I would expect current machines will be fitted with CFX. Even those under support should be very easy to extend the support back. But some old machines are 10–20 years old and had no idea there was going to be this kind of revolution. If we look beyond electronics to even robot and mechanical assembly, again, the interfaces are nowhere near as developed as the modern surface mount area. So, we have to have a strategy to expand CFX to those machines.

Now, when any factory becomes smart, people will try to look for solutions that they can apply off the shelf. To get a 100% solution, no matter what anybody may claim, it's not going to happen. You'll always end up with a load of machines that are kind of in blackout as far as visibility is concerned. The nice thing about CFX is that customers themselves can take that software development—the IT people who are the ones wanting to take responsibility for the factory but don't want to develop everything themselves. They can take CFX and apply it to the machines that they created within the factory. They can equip them with a CFX interface.

Now, there may be some very old machines where you might think, “How on earth do we

get information out of these?” It's going to be necessary to put in some sensors to interrupt some lines of communication within the machine to try and get out some status. We see that at least three or four hardware vendors are coming along and saying they can retrofit some kind of hardware interface onto these machines, which is not a real expensive thing. This is like a Raspberry Pi computer that costs \$30 or this system-on-a-chip that we see in soldering irons that costs \$14, and you have a CFX client on that. You connect through sensors into the machines. They may not be the cleverest machines in the world, but they are machines that work adequately and are part of this digital factory.

Let's not forget people who are at their manual workstations accepting products in and out—doing, recording, and noticing things, and acting. Their activities have to be recorded as well. CFX extends into user interfaces that may be present in the factory. There's something here for everybody to do. It means getting to 100% visibility without resorting to a customization that is going to be very, very difficult to sustain. It's all going to be based on this one standard and work together seamlessly. That's what CFX is all about.

Matties: You're giving an opportunity for DIYers all the way to buying new equipment that's ready to go.

Ford: Absolutely.

Nolan Johnson: Gentlemen, I just wanted to circle back to what you're doing at the demo at IPC APEX EXPO 2019. I heard you say that you will be able to monitor some of the parameters from the machinery in real time on the show floor with a smartphone. Did I hear that correctly?

Bergman: Correct.

Johnson: Is that something where that application can be downloadable by visitors at the





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show so they can actually watch that happening on their own phone?

Bergman: Yes, they can visit the website, which we used at last year's show and in Germany. We've used that quite a few times this year, but basically, they visit the website where it's running. If you want to see it, the website is live and being used as a test bed for equipment manufacturers that are working on their CFX interface. Visit connectedfactoryexchange.com. Companies have found it's a helpful tool. It's also been really helpful for the equipment guys who are playing around with trying to build some interfaces. We think IPC APEX EXPO 2018 was the first time that it was ever done—very exciting.

Ford: Yes, we use QR codes to make it easy for people to do it; they can simply visit the URL. There's no app to install or configuration—nothing at all. They go there and the data is there waiting for them. It's updated live. You can look at it right now. There are actually four people who are currently testing this CFX interface online right now as we speak.

You just reminded me of something. Throughout this whole year of trying out and developing CFX for the various shows and demonstrations that we've been doing, there has not been a single business trip taken by anybody—not the engineers. We have not had any problems with people arguing with each other, exchanging non-disclosure agreements (NDAs), or talking about how interfaces work. All of the normal pain associated with any two pieces of equipment talking to each other has been completely eliminated with CFX. What you see with CFX is how that happened. People can see the data from their machine, know that it adhered to the specification of the standard, and the job's done; that's all they needed to do. As long as what they produce matches what is in the standard, then they are confident that their machine can talk to anybody else's machine and any customer's systems. It's a revolution in the way that the interface has been developed.

Matties: Sounds like we can use this in our politics (laughs).

Ford: Save the environment, reduce business trips and lawyers, and all kinds of stuff. A bunch of things make a difference.

Matties: You keep it simple, and simplicity is elegant.

Ford: Absolutely.

Matties: This is going to be exciting. We look forward to the show, and while we're there, we'll be sure to cover this extensively with our editorial crew, get user feedback, and interview people on their takeaways with their experience with this demonstration.

Ford: That's very cool. Thanks.

Matties: Thank you guys very much.

Bergman: Thank you. PCB007





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Alun Morgan, EIPC President

Given that the PCB industry nowadays is what might be called a "close-knit community" in which everyone knows everyone else, and hears all the local news and gossip, it is always good to know that EIPC has organised another family "get-together". This year we have arranged for this to take place in the romantic Italian retail resort city, Milan—on Valentine's Day!

Program highlights include presentations and panel discussions on a wide variety of subjects. On the afternoon of Day 1 we have arranged for transportation to tour the Elga Europe Factory followed by a networking dinner at the Milan Centre.

[Click here for detailed conference information.](#)



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Technology's **Future** Comes Together: A Great Slogan for Us All!

The PCB Norsemen
by Jan Pedersen, ELMATICA

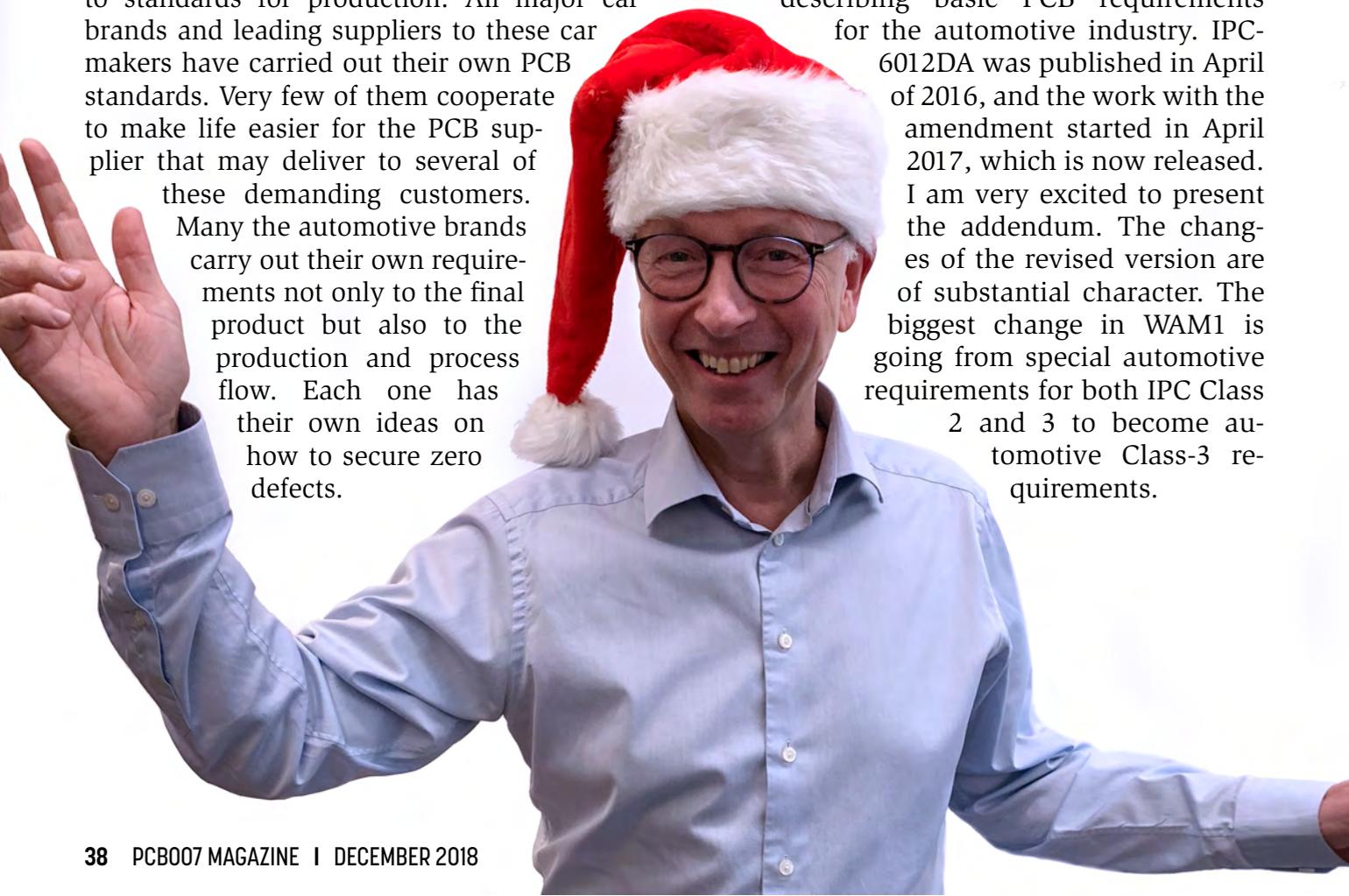
It's that time of the year again. Yes, the holidays—such as Christmas and New Year's—are coming up, but I am not thinking about the joy of this wonderful time of year. My mind is preparing for IPC APEX EXPO 2019, including all of the exciting meetings, discussions, and teachings.

“Technology's Future Comes Together” is the theme, which is quite suitable during these changing times. I guess we all need to come together, especially the automotive industry. The automotive industry has been characterized by individualism for years when it comes to standards for production. All major car brands and leading suppliers to these car makers have carried out their own PCB standards. Very few of them cooperate to make life easier for the PCB supplier that may deliver to several of these demanding customers. Many the automotive brands carry out their own requirements not only to the final product but also to the production and process flow. Each one has their own ideas on how to secure zero defects.

The reason why my focus is targeted on the automotive industry is due to the newly released and revised IPC-6012DA-WAM1: Automotive Applications Addendum to IPC-6012D, Qualification and Performance Specification for Rigid Printed Boards. As chair of the task group, it would be an understatement to say that this standard is close to my heart.

A Never-ending Task

The idea behind the automotive addendum was to find a consensus in the jungle of corporate specifications—a common document describing basic PCB requirements for the automotive industry. IPC-6012DA was published in April of 2016, and the work with the amendment started in April 2017, which is now released. I am very excited to present the addendum. The changes of the revised version are of substantial character. The biggest change in WAM1 is going from special automotive requirements for both IPC Class 2 and 3 to become automotive Class-3 requirements.



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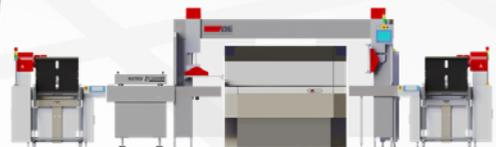
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Among the enhanced features and requirements in IPC-6012DA WAM1, you find a recommendation to use automated optical inspection (AOI), a requirement to use AOI on all layers, a measurable requirement for lifted land after thermal stress, and strengthened requirements to wicking. However, working on standards is a never-ending task. As soon as the New Year's turkey is digested, the task group starts its preparations, and right after takeoff to San Diego, we all meet for new discussions, revisions, and further developments of the IPC-6012-DA standard.

Standards Need to Go Hand-in-hand

So, what does the theme of IPC APEX EXPO 2019 mean? For me, "Technology's Future Comes Together" when standards are in line with new technology, and go hand-in-hand into the future. Still, to obtain this, we need some changes—or rather, additions—from IPC. Creating, improving, and voting standards forward has no effect at all if they are left in the bottom of the drawer. They need to be used, implemented, and embraced by the industry.

Creating, improving, and voting standards forward has no effect at all if they are left in the bottom of the drawer.

Still, several standards working on their own is no solution either. What we really need is for IPC to develop a parent standard or a work manual supplying the correct guidelines for usage of all standards in the automotive industry, which should provide the automotive industry the opportunity to contribute to further development and make the standards functional.

Today, there are three standards for the automotive industry: one balloted through and released—the IPC 6012-DA—while the Automotive Addendum Task Group 7-31BV and the

5-21M Cold Joining/Press Fit Task Group are still a work in progress, and work there will be. This is my third time attending IPC APEX EXPO, so not feeling like a rookie anymore, I am looking forward to meeting old and new friends, working in the task groups, and widening my knowledge. The Executive Forum on Advancing Automotive Electronics brought to you by the IPC Hall of Fame Council is definitely on my to-do list.

IPC: Goliath vs. David?

However, some seem to look upon IPC as an unreachable organization with a Goliath versus David feeling. Personally, I do not recognize these opinions. I find Goliath to be the friendly and welcoming giant towards new opinions and suggestions. Running your cases through the IPC system and using the advantages of it will eventually lead to improvements and constructive innovation.

A good example is how we in the medical task group faced the challenge with micro PCBs—a designation not working for these devices. We had constructive discussions within the group, but in the end, found a more suitable designation that suits both IPC and the medical device applications industry better. If you gather the right people together, utilize the strength of IPC, and dare challenge the industry, you will get results.

Shout Out!

We all know that change comes by action; sitting still and keeping your mouth shut creates no action. IPC APEX EXPO is the perfect spot to network and raise your opinions and concerns in the various forums arranged. For example, several technical conference sessions with interesting topics have made it into my calendar.

The luncheons awards are also always a pleasure to participate in. We all benefit from networking in the industry. I cannot emphasize the value of networking enough; after all, several voices are stronger than one. Further, I was amazed by the energy from the main keynote speech by Jared Cohen last year talking about big technology disruptions. Jared gave a

very engaging speech focusing on how the digital revolution is a game changer.

I am looking forward to this year's keynote speaker as well. I will be prepped and ready for "Accelerating and Disrupting Innovation: The Tesla Story" presented by JB Straubel, chief technical officer (CTO) and co-founder of electric vehicle maker Tesla Inc. The future is definitely electric, innovative, and moving fast. Since he's responsible for new technology evaluations, R&D efforts, and technical diligence reviews of key vendors at Tesla, I am sure we are in for an exciting lesson.

Tesla, Turkey, and Jolly Wishes!

Similar to Tesla and JB Straubel, we at Elmatica strive to be ahead of the digital revolution. We try to lead in the right direction and

make the digitalization an advantage instead of a weakness. Innovation is key, and you must dare embrace challenges. We have some interesting projects going on, but first, Christmas and New Years with all of its treats and joys, and then IPC APEX EXPO 2019. I wish you all a very Merry Christmas and an exciting PCB New Year. The PCB Norsemen will be back in January with new thoughts. We hope you will follow us! **PCB007**



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

Virginia Tech Researchers Use Brain-inspired Methods to Improve Wireless Communications

Virginia Tech researchers Lingjia Liu and Yang (Cindy) Yi are using brain-inspired machine learning techniques to increase the energy efficiency of wireless receivers. Their published findings, "Realizing Green Symbol Detection Via Reservoir Computing: An Energy-Efficiency Perspective," received the best paper award from the IEEE Transmission, Access, and Optical Systems Technical Committee.

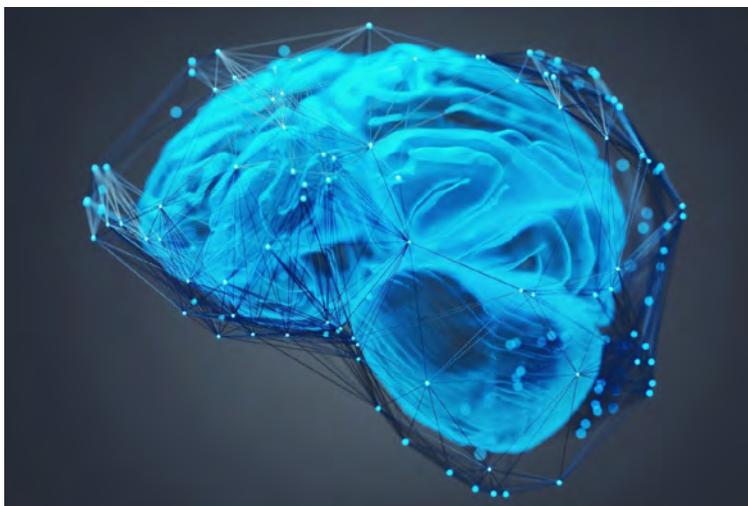
Liu and Yi, associate and assistant professors respectively in the Bradley Department of Electrical and Computer Engineering, along with Liu's Ph.D. student Rubayet Shafin are collaborating with researchers from the Infor-

mation Directorate of the U.S. Air Force Research Laboratory—Jonathan Ashdown, John Matyjas, Michael Medley, and Bryant Wysocki.

This combination of techniques allows signals to travel from transmitter to receiver using multiple paths at the same time. The technique offers minimal interference and provides an inherent advantage over simpler paths for avoiding multipath fading, which noticeably distorts what you see when watching over-the-air television on a stormy day, for example. To minimize the inefficiency, the researchers are using artificial neural networks—computing systems inspired by the inner workings of the brains.

"Using artificial neural networks, we can create a completely new framework by detecting transmitted signals directly at the receiver," said Yi. "This approach can significantly improve system performance when it is difficult to model the channel, or when it may not be possible to establish a straightforward relation between the input and output," said Matyjas, the technical advisor of AFRL's Computing and Communications Division and an Air Force Research Laboratory Fellow.

(Source: Virginia Polytechnic Institute and State University)





Strategies to Manage Your China Business Through Turbulence

Article by Philip Carmichael

IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

Twenty years ago, you could gauge the political climate in China by observing what cars officials were driving. If the economic climate was opening up and trending towards reform, officials could be seen driving Mercedes. During times of stress, tightened access, and political meetings, officials would be seen only in domestically-made cars, like the ubiquitous Red Flag or the Shanghai-made Santana; during these times, the Mercedes were quietly garaged. Today's China is a lot more complex, which means the "official's auto" metric no longer applies since nearly all automotive manufacturers worldwide now have local production in the world's largest car market.

While the United States may be the world's most open market, China remains the most competitive. It is also the second largest economy in the world and is still viewed by most U.S. and EU companies as the "last great opportunity for growth." Many companies want to gain entry to the Chinese market share for their products or services. Thus, the competition for sales of products or services is corre-

spondingly intense, which causes foreign companies to offer low prices, reducing normal or worldwide margins to gain a foothold. It also creates significant volatility for those engaged in sales forecasting.

Recently added to this complexity are turbulent trade tensions between the world's number one economy (U.S.) and the number two (China), so how can you navigate your business successfully through this landscape?

Strategies

One of the first strategies is to be low key. Now is not the time to hold a global board meeting in China with a lot of fanfare, nor is it a good time to translate and publish locally your company's commitment to the "make America great again" initiative. While that might seem relatively obvious, I have seen examples of this in the last three months. Quietly keeping focused on your core business is a key consideration.

Foreign participation in this current marketplace is under an increased level of open scrutiny. All foreign companies are facing this attention—not just Americans. Recently, for example, I received a notice from the bureau that approves work permits for foreign work-

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ers. The notice openly stated that “...going forward, it will be more difficult for you to receive a work permit.” However, a different agency still includes the following on the Chinese equivalent of a W2 form in English stating that the bureau “...thanks you for your contribution to building China’s economy.” Complex indeed.

Along with keeping a low profile, your People’s Republic of China (PRC) entity and operations will need to be “squeaky clean” and in full accordance with “all relevant rules, laws, regulations, and customs of the PRC.” While this has always been the case, this lever is increasingly being used against foreign players, like Apple (excessive profits tax) and Google (content management and censorship).

Payment terms by Chinese companies have always been slow. Few adhere to a net-30 policy even when they have signed a contract to do so. Situations are considered fluid, and payment streams are affected. Plan for this eventuality. It’s not that Chinese customers won’t pay, it’s just that cash flow might be affected. This is especially true when payments are in U.S. dollars because there has been an 11% decline in the RMB(CNY)/USD value in the second half of 2018 alone. This means Chinese companies need to spend 11% more to buy the same thing in dollars. Volatility touches everything.

In this turbulence, it is important to position yourself as a global player wherever applicable. When your company can emphasize operations in the EU, factories in China (and the rest of Asia), R&D teams in Germany, etc., you can better avoid pulled into a bilateral dispute in your external-facing Chinese language statements. Position your business as global.

New projects and undertakings will be easier outside the central business districts (CBDs) of big cities like Beijing, Shanghai, and Guangzhou/Shenzhen. Foreign businesses need an approved China business license to operate. While these licenses often define a narrow scope of permissible activities, services, and businesses, what isn’t widely known is that business licenses are locally approved but nationally applicable. Also, differences between

locations can work to your company’s advantage.

Even in today’s complex and turbulent marketplace, second- and third-tier cities can offer and are offering incentives for new foreign investments in nearly all categories. Tax rebates, no-cost office spaces, or business license scopes similar to your company’s business model can all be negotiated in places like Chengdu, Zhengzhou, and Qingdao. These locations offer new airports with direct international flights and are connected to the 10,000-km domestic high-speed rail network. By population, these “smaller” cities are still larger than New York City and Chicago combined!

A crucial final strategy is to maintain cordial, strong relationships with the local government where you operate. Regular meetings with officials are a great use of your time and will bring long-term benefits, such as gaining an early notice of new infrastructure projects. Showing officials what you and your company are doing regarding corporate social responsibility may help them fulfill requirements from central government. Similar to the Hawthorne effect where subjects alter their behavior in a study due to an awareness that they’re being observed, such contacts will provide a face and recognition to key players and factors in your business’s success.

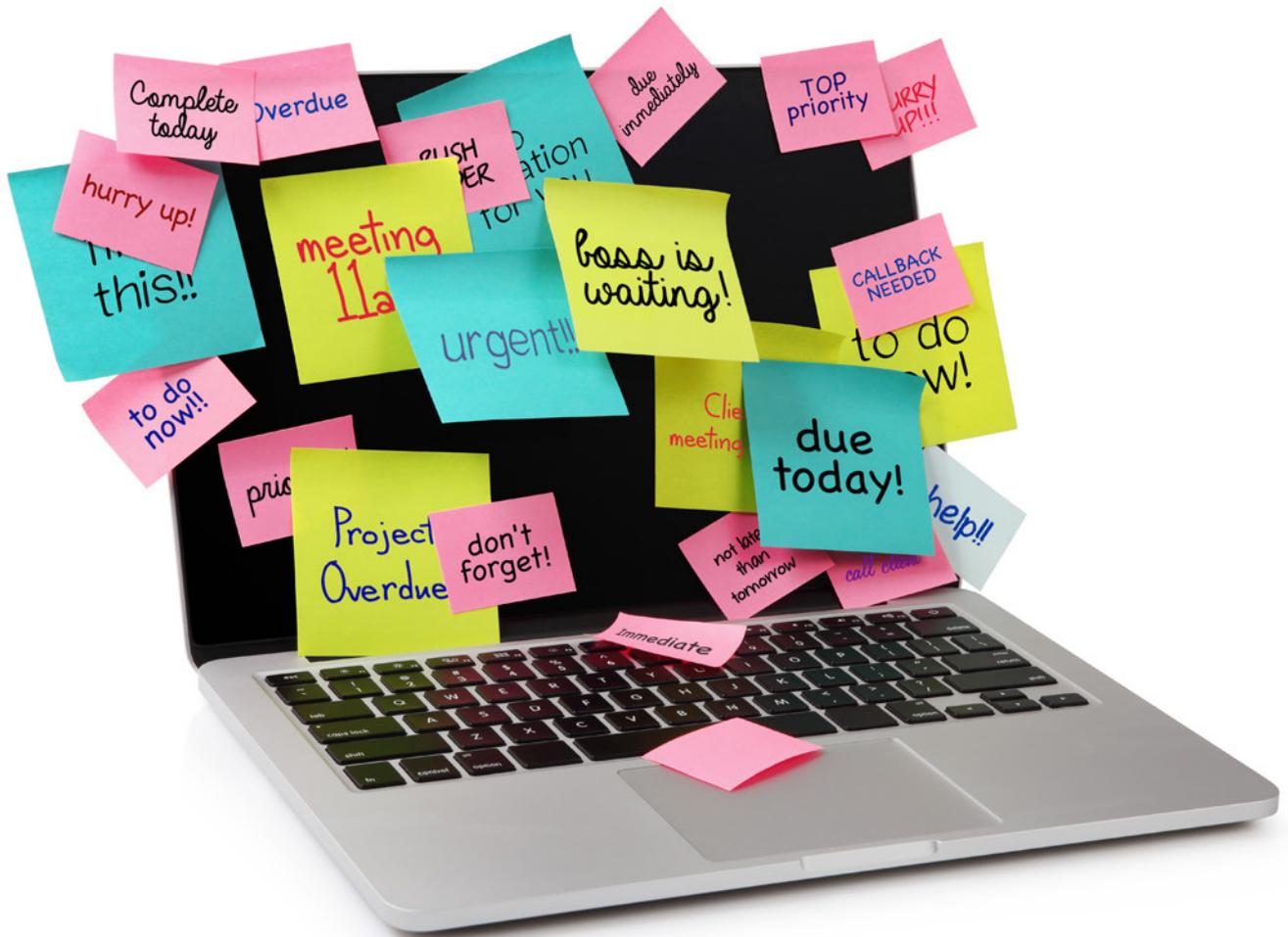
Conclusion

Even a turbulent China still offers great opportunities if you understand how to operate. China is the second largest economy worldwide and is now at the table on a global basis. The Chinese approach to business is unique; China will still be volatile and very competitive for the next few years. Being a bit low key, focusing on local-level relationships, and displaying cultural sensitivity will make this journey smoother and more successful. **PCB007**

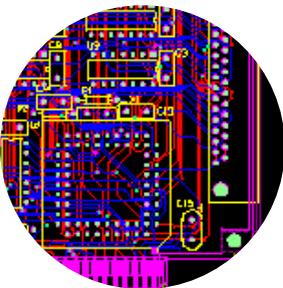


Philip Carmichael is president of IPC—Association Connecting Electronics Industries Asia.

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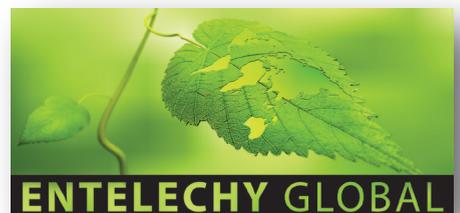
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Supplier Highlights



Jeff Waters: Isola Updates ▶

During PCB West 2018, Nolan Johnson and Barry Matties sat down with Jeff Waters, Isola CEO, to catch up on company activities, including the recent sale of the factory in Chandler, Arizona, the plan to build a new facility, product developments, current market dynamics, a new CFO, and much more.

Trouble in Your Tank: The Art and Science of Photoresist Stripping, Part 1 ▶

Photoresist stripping has become a complicated process due to many unique resist formulations on the market. The first part of this column series looks at some of the most common problems in photoresist stripping and offers strategies on how to address them.

GreenSource: The Future ▶

This issue is a special one. We devote the entire magazine to a detailed look at GreenSource Fabrication (a division of Whelen Engineering) and its brand new, fully automated HDI facility in New Hampshire. GreenSource is arguably the most advanced and automated fabrication facility in North America today.

All Flex Expands Rigid-Flex Capabilities with Pluritec X-Ray Drill/Rout Optimizer ▶

All Flex purchases a new Pluritec Inspecta HPL X-ray drill/rout optimizer and two EVO-2S automated drill/rout systems to expand rigid-flex capabilities.

EIPC SpeedNews: News from the European PCB Industry ▶

In this week's EIPC SpeedNews: Technolam appoints Roland Schönholz as technical marketing manager; Atotech's Rick Nichols to present and become a panelist at SMTA International 2018; Seica publishes video on new Compact

Slim Next > series; Dyconex to exhibit at electronica 2018 and expoAIR; and Ventec International Group's Martin Cotton retires.

Nano Dimension Shows Strong Growth with Expanding Partner Network ▶

The year isn't yet over, but Nano Dimension Ltd. has racked up a variety of accomplishments as it continues blazing its pioneering path for precision additive manufacturing of printed electronics around the globe.

Ventec Expands ThinFlex Inventory in Europe ▶

Ventec International Group Co. Ltd. is expanding its ThinFlex inventory to multiple European locations with full cutting capability in both Germany and the U.K.

Insulectro Leverages One Source Distribution for Printed Electronic Materials at IDTechEx Show ▶

Insulectro exhibited at IDTechEx's Printed Electronics World 2018 conference held November 14-15, in Santa Clara, California, at the Convention Center.

IPC APEX EXPO Executive Forum Focuses on Auto Electronics ▶

Senior-level executives from across the global electronics industry supply chain will gather to discuss challenges and opportunities of the burgeoning and rapidly changing automotive electronics industry during the IPC Executive Forum on Advancing Automotive Electronics at IPC APEX EXPO 2019.

Eltek Adds New Members to Its Management Team ▶

Eltek Ltd. names Gil Riff as its VP quality assurance and continuous improvement, and Shmuel Wider as its VP of sales.

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Tara Dunn Shares Strategies for Today's PCB Business

Feature Interview by Barry Matties I-CONNECT007

At the recent AltiumLive event, Barry Matties met with PCB sales expert Tara Dunn of Omni PCB to discuss selling strategies for selling PCBs in the North American market. The conversation also covers strategies for staying competitive through a generational shift in the ownership of PCB shops, and the importance of supply chain communication and building relationships.

Barry Matties: First, talk a little bit about your company for our readers.

Tara Dunn: My company is Omni PCB. We are a manufacturer's rep company focused exclusively on the PCB industry, so we provide sales and engineering support for our customers ranging from standard FR-4 designs through high-end HDI. We also specialize in flex, rigid-flex, and advanced manufacturing that enables line width and space below one mil.

Matties: How many years have you been doing this?

Dunn: Over 20 years, and I always hate to admit it and age myself!

Matties: In those 20 years, what comes to mind for significant changes or milestones?

Dunn: Technology is definitely advancing, and I'd say particularly the last five years I've seen it advancing at an even faster rate. Over those 20 years, we also went to a lot of offshore manufacturing. When I first started, that wasn't common. Also, there are changes in how we do business. We used to use fax and mail to send purchase orders and files, and use the telephone as the primary communication method. Now, we heavily depend on email. There is a much faster response time, but I think we have also lost the benefit of communicating with each other on a more personal level.

Matties: That's interesting because at one point, ordering your circuit boards on a website was becoming popular with the prototype and hobbyist market. Is that as popular these days?

Dunn: I think that there's still a significant portion of the market that can utilize web-based

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ordering and it works very well. When you move into needing high-reliability products or preproduction runs, then it becomes a little more difficult to do the web-based ordering. You miss out on some of that collaboration, design rule checks, and things like that.

Matties: I think people from the fabricator side had an electronic and not a personal relationship. They knew their numbers and had their accounts and specifications, but perhaps they didn't really know the customers. I think that left a lot of people at a disadvantage.

Dunn: Yes. I think that's a common issue across fabrication in North America. For example, in the spirit of trying to respond very quickly to all customers, many fabricators use a general mailbox that anyone in customer service has access to. For example, sales@ whatever the URL may be, but then you never build a relationship. You can't even say "Hello, Judy." You just have to say hello because you don't know who is going to pick it up.

Matties: Exactly, and you're in the sales business. This is what you do. When I look at selling, I always say it's not selling but building relationships. The same holds true with PCBs. What sort of relationships do you have to build with the customer to get them to do business with you?

Dunn: I think one of the key things for Omni PCB is that we really work at connecting our customers to technical knowledge. We work at having the information out there and available whenever they need it, so they have a place to find what they are looking for. From there, you can start a conversation around that and build the relationship.

Matties: It's always great when you can help somebody solve a technical problem because you become the hero, and that really cements a relationship, doesn't it?

Dunn: Yes, and it's a lot of fun.

Matties: Is your background technical?

Dunn: It is not. I graduated college with an economics degree and took my first job at a flex-circuit manufacturer. At that time, I was going to do accounting, and some human resources work. Before they would let me have the checkbook, they had me work on the production floor to understand all the processes and materials.

Matties: Smart move.

Dunn: It was. And little did I know at the time the value of the education I was getting by running the equipment, and it was a small company, so it was easy to ask a lot of questions.

Matties: We are here at a design conference, and one of the things that we hear so frequently—almost to the point of it being a broken record—is there is not enough communication between designers, fabricators, and assemblers. When you're selling, you're selling to designers a lot. At least they influence or actually make the final purchase decision in many cases. How important is it to have that relationship or firsthand knowledge of the manufacturing?

Dunn: I think it's extremely important for a designer to understand the manufacturing process and also for the manufacturer to understand what the designer is going through as they try to fit all these different things into one board. It definitely helps to know the manu-





facturing side and what your design will go through, particularly in the wet process area where you create the trace, space, and plated through-holes.

Matties: We all agree it helps, but we still know that there's a deficiency in that communication. How do we change that? Is their pain not high enough yet?

Dunn: That's a great question. I have been thinking about it a lot while at this conference. Not to date myself, but 10–15 years ago, it was very common to have site visits. Designers would come into the manufacturing facility, tour the plant, sit down, talk, and have lunch. We all got to understand each other's problems, viewpoints, and processes a little bit better. Over time, everybody got busy, and we became more narrowly focused.

Matties: Digital.

Dunn: Exactly. We don't have to have conversations. We don't send you out to see your board shop because you can go online, search "PCBs," and look at sites, but it's not the same thing.

Matties: Not to just cast millennials into one basket, but I talked to a fabricator who invited a millennial to tour their facility, and the millennial's response was, "Why would I waste my time doing that when I can see it online?" Is that a generational thing, or is that just the data or internet world that we live in?

Dunn: I think it's probably both. It's not just millennials who have that response, but it's certainly not people in my generation. That gap in between is where I think it started. Maybe it goes back to digital, that's when email started and ordering online.

Matties: When you look back 20 years ago, where were we then? We were still in relationships. We didn't have webcams inside of factories or virtual reality tours and things like that. I'm trying to think back 20 years ago and remember what life was like.

Dunn: It's hard to remember. I feel bad because if you never tour a fabricator or see a wet process, how do you even understand that smell—the PCB smell?

Matties: Quite truthfully, you might be better off not knowing it ever existed (laughs). When we look at tours, the tour is not really about understanding manufacturing because a lot of what people say is that they need to manufacture boards to actually understand it. At AltiumLive, they're introducing 365 and say the feedback that you are going to get and the real-time collaborative environment that they are creating with their new tool is a partial replacement—maybe not 100%—but certainly a replacement to accelerate that knowledge that a designer needs.

Dunn: I'm really excited about what they rolled out today. I think that's going to have a big impact on the industry.

Matties: It will be interesting to see what improvements come out of a tool like that. What advice would you give somebody buying a board today?

Dunn: Pay attention to more than just the price of the board you're going to purchase. Look at capabilities and make sure that you fit the fabricator that you're looking at with your long-range technology plans.

Matties: North America is where you focus on your sales with low-volume, high-mix sorts of shops. When it goes to production, how many of your customers go to high volume or are these R&D type companies that you deal with?

Dunn: I'd say both. I have customers that do prototypes and preproduction work in the U.S. and then transfer high volume offshore, and then I have some that are just strictly based in North America.

Matties: Is the advice different for those that are transferring offshore? Now, it's a two-step process.

Dunn: Yes, if your intention is to go offshore, you want to make sure you are with somebody that understands the material sets that are being used offshore when you do your North American prototypes. They should also understand the technical capabilities of the supplier that you are going to be working with offshore, so you can do your testing on the same materials.

Matties: Is it important to have a supplier in America that has a partner offshore?

Dunn: I think there is a lot of benefit to that for a lot of reasons. Number one, you keep your North American contact. They work with you on your tooling packages and prototypes and are going to understand what you need for the long term. Build up a lot of that relationship. A lot of the North American suppliers that will help you transition offshore will also come back and offer stocking programs and a lot of added value.

Matties: What sort of trends do you see in designs?

Dunn: I'm seeing a trend to smaller line and space requirements—smaller vias.

Matties: It's always been the case, right? It just seems smaller and smaller.

Dunn: Yes, and we're going to hit that point now where the three- or even two-mil line/space if you have sophisticated equipment that isn't quite meeting all those needs. I see people moving to a semi-additive process or are at least investigating that technology.

Matties: One of the things that I see in America is that as the market moves, there's an aging ownership structure in circuit board fabrication companies. What I mean is they're not starting a business, they are in the sunset of their careers, and perhaps it's hard for them to be energized to come in and change to the shifting demands of what the modern buyers are looking for. Do you run into that?

Dunn: Absolutely.

Matties: What advice do you give to those people? Sell?

Dunn: Or find somebody now who you want to sell to in 10 years that is energized and excited.

Matties: Part of the problem is who wants to buy a PCB shop today, right?

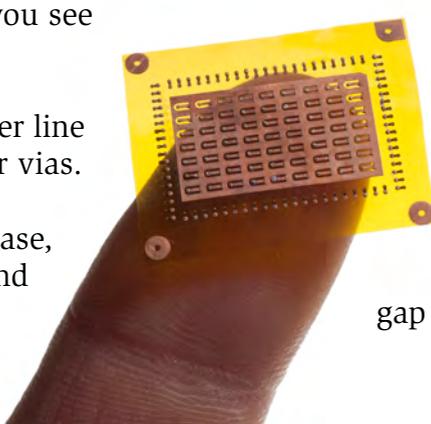
Dunn: That's very true.

Matties: The point of the question is what has happened to that supply chain then? As you point out, the requirements are to invest in new processes, laser drills, etc., which takes a lot of energy to come in and retool a factory.

Dunn: And the industry in North America is so segmented—the bulk of which are shops that are five million dollars or less, and it's a tough capital expenditure on that annual revenue.

Matties: Even if you are a young person.

Dunn: Exactly, so I think that gap will probably widen.



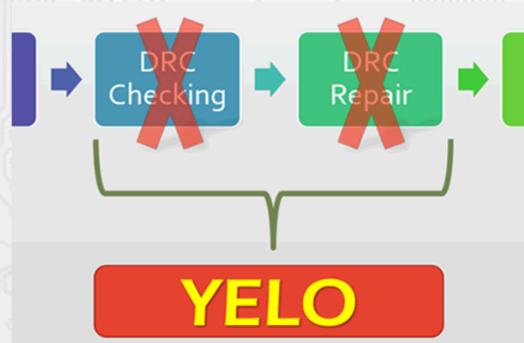
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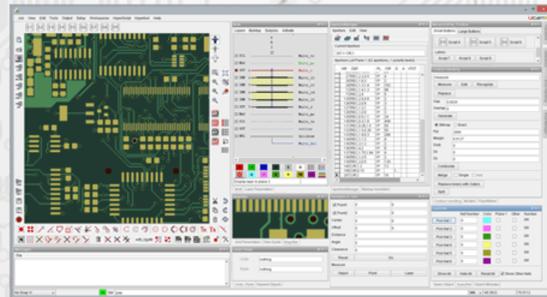
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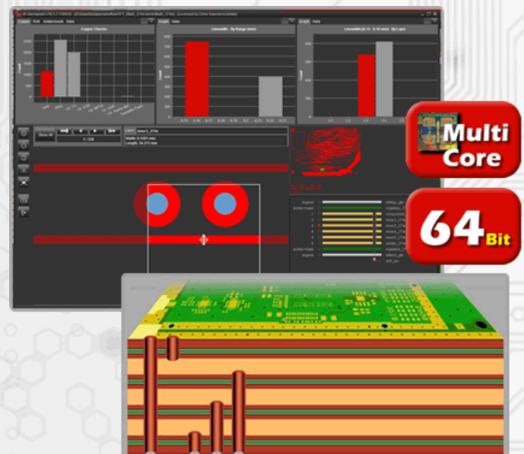
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Matties: What effect do you think that will have on the market?

Dunn: We already see so much consolidation, but as you get bigger, you lose some of the relationship side of things. The one thing that the smaller companies are much better at, in my opinion, is the relationships and the depth of knowledge they have regarding their customers.

Matties: We saw consolidation back in the late '80s and early '90s where we had 3,000 shops, and now we have about 270. How much more consolidation can we have?

Dunn: When you think about the shops that you assume will consolidate—either sell or retire altogether—that's a big number.

Matties: We always talk about aging designers, so it's nice to see some young energy here at AltiumLive. I don't know that there is enough to fill the supply chain of the need, but we are seeing this trend. I look at the supply chain of the fabricators, and we see GreenSource Fab-

rication building a new fully automated facility. It's a factory of the future. It's the model of what factories have to be. I don't know what they invested, but let's assume it's \$40–50 million to build a new factory. There's not a lot of people coming into this market saying they want to invest that amount of money.

Dunn: Into a market where generally—even though it's all custom electronics—we're treated as a commodity, that's a big investment.

Matties: In my mind, it's kind of an uncertain future for meeting demand, or we're going to see the level of prototypes being built offshore in other areas. I think we are already starting to see some of that.

Dunn: I think we are, yes. The old adage used to be that the lead time offshore is long; it's 20–25 days plus shipping. Now, it's not uncommon to find offshore suppliers turning boards in five days, which is no different than North America.

Matties: I'm hearing about close to fully automated factories in China that are moving to zero waste and building HDI in mass quantity. When you look at the GreenSource Fabrication approach, it's lot size of one. Alex Stepinski [VP of GreenSource Fabrication] goes further to say it's not just a lot size of one—it's any panel, lot size of one. It could be thin or thick because the process is flexible to handle this. When you're building lot size of one, it doesn't matter if you have a mass quantity factory or not. If I need one, I can put one in and get one out. Even with the way prototypes are built, it may not be challenging or difficult for a person to do it all—one to many.

Dunn: It's exciting.

Matties: It will be interesting to see what happens. I know there is a lot of conversation around tariffs. Have you felt any impact from those conversations yet?



Participants in the robotics challenge at AltiumLive.

Dunn: Yes, particularly in the last couple of weeks. Before that, a lot of people were aware of it and thinking about it, but maybe hoping it wasn't going to be put into place for PCBs. Since then, there's been a lot of conversations on what it will impact. For example, maybe I need to do my prototypes domestically for now, or what other options are there for low-cost countries? I know that there's been some kind of hold back on ordering if there's time to be able to do that, to see how this shakes out.

Matties: And maybe that goes to. You mentioned that while the shops still have work in their queues, it seems like some of the quoting activity has stalled a bit.

Dunn: There's definitely been a slowdown the last few weeks in quoting. It could be extremely long component lead times, the boards are not quite as urgent, or just fiscal year end. There are a lot of variables here.

Matties: It has been nice to catch up with you. Is there anything that we haven't talked about that you think we should share with the industry?

Dunn: Going along the line of what's being presented at AltiumLive today, we should break down barriers and be more engaged in working with the next step—both before you and after you—in the process to really understand each other's needs. As we've said throughout this conversation, there is a lot of uncertainty and potential change coming up in the industry. The more we work together and put our heads together to solve some of these problems, the better. It's kind of like having apple pie and ice cream—both are good apart, but if you work together or put them together, it's even better.

Matties: It's interesting because a lot of the onus of the communication is being placed on the designer. How does the fabricator get more

involved in communicating with the supply chain?

Dunn: We see that about 98% of jobs that come into a fabricator go on hold for a tooling question. A lot of those questions are very repetitive, so I think it's taking the time to figure out how to teach each other. Both sides are frustrated by that. Nobody wants it to happen, and yet we just don't take the time to stop long enough to be thoughtful.

Matties: Prototron Circuits recently published an eBook in our *The Printed Circuit Designer's Guide to...* series on producing the perfect data package.

Dunn: Yes, I just downloaded that.

Matties: Have you read it? What did you think?

Dunn: I skimmed through it today. I think it's very well done. Mark Thompson is great at what he does.

Matties: Absolutely. I think this goes to exactly what you are talking about, right? Unless we start communicating, why are we making the same mistakes over and over? The mistakes are seemingly simple to resolve. It gets resolved at some point, so why not resolve it before we send it, cause stress, and delay the systems for everybody?

Dunn: Exactly.

Matties: Thank you so much, Tara.

Dunn: Thank you, Barry. PCB007

Tara Dunn is the president of Omni PCB, a manufacturer's rep firm specializing in the printed circuit board industry. To read past columns or contact Dunn, [click here](#).

To download your copy of Prototron Circuits' eBook, *The Printed Circuit Designer's Guide to... Producing the Perfect Data Package*, [click here](#).

Mark Friedman on IPC Membership

Feature Interview by Barry Matties I-CONNECT007

I recently spoke with Mark Friedman, a member success advocate at IPC, about the current status of IPC's membership programs, the recent growth they've seen, and some hidden benefits of IPC membership that potential members might not be considering.

Barry Matties: Mark, you're a member success advocate at IPC, and your function surrounds membership. Tell me a little bit about what that title means.

Mark Friedman: I support IPC's membership, so if they have any issues or inquiries, I make

sure that they get the responses they deserve. We have several programs that members might not be aware of, and I guide them to the appropriate individual who can help them out with their inquiries.

Matties: How long has this position been at the IPC?

Friedman: It's been there for about three and a half years.

Matties: So, it's a newer position.

Friedman: That's correct. Management realized that a lot of our members weren't getting the attention and support that they needed from a personal standpoint, so they created this position to enhance the member experience.

Matties: Is this a global function?

Friedman: Yes, we support members globally.

Matties: Great. Can you tell us about your background?

Friedman: I'm an electrical engineer with more than 30 years of sales experience in the semiconductor industry.

Matties: How did you find your way to the IPC?

Friedman: I had a colleague who worked with me in the semiconductor industry and



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he mentioned that there was a position open, so I applied and was offered the position.

Matties: Nice. Congratulations.

Friedman: Thank you.

Matties: In your role, what kinds of issues do members have that you can help them with?

Friedman: The interesting thing is a lot of members aren't aware of all the services and programs that IPC offers. We expose them to different areas. For instance, they'll have questions about certification, so we support them from our certification quality initiative (CQI) program. They'll have questions on standards, so we support them with technical liaisons and experts who sit on committees and explain and interpret the standards from a practical standpoint.

Matties: How do you measure your success, and is there a metric of retention?

Friedman: Yes, renewal, retention, and new member acquisition are all metrics we track.

Matties: Let's talk about renewals. Since this position has been established, have you experienced an increase in renewals?

Friedman: By supporting our members, we build relationships with them, gain their trust, and they realize that there's someone internally to help them. They appreciate that and extend their membership.

Matties: Now, you mentioned oftentimes it's just an education process to help them understand all of the value that the association brings. Why do you think they don't know this up front?

Friedman: Members are singularly focused when they join IPC. The main thrust has been either standards or certification. We have other programs as well, such as market research,

validation services, global advocacy efforts, and transportation solutions. We also have various membership initiatives that they're not aware of.

Matties: You were talking about existing members, but certainly in your role, you're also looking at increasing membership.

Friedman: We have about 4,800 member locations globally and growing that span the globe from China to Brazil and all points in between.

Matties: When you say locations, are you talking about factories or people?

Friedman: Facilities. We have two options when it comes to membership: conventional membership, which is based on location, and revenue-driven membership (Enterprise membership), which you can picture as a corporate membership based on global revenue. While conventional membership is site specific, revenue membership will incorporate all global locations of the member company.

The advantages are that, from an administrative standpoint, you're dealing with a single invoice. Also, the duration of the membership is uniform throughout all locations. You don't have to worry about one site expiring in February and another expiring in August. Additionally, now that all global locations are members, you have a uniform approach to standards and procedures that are governed by IPC standards.

Matties: Everything's synchronized, and everybody has full access.

Friedman: That's correct.

Matties: That definitely makes it a lot easier for your member. With IPC APEX EXPO 2019 just around the corner, what efforts do you have for membership during the show?

Friedman: IPC APEX EXPO is the biggest mo-

tivator for nonmembers to join IPC. Attending one of the largest exhibitions of its kind in North America—coupled with all the activities such as technical sessions, professional development courses, standards committee meetings, and the number of exhibitors and attendees—generates so much energy that you want to be a part of it and become a participating member rather than a spectator on the sidelines.

In addition, we always have a booth with management ready and available to answer all questions. We also have various programs that we announce at IP APEX EXPO to enhance membership. Typically, if it's a first-time member, we offer an introductory rate for membership. Those are some of the various programs that we have.

Matties: You talked about 4,800 locations. What sort of growth have you experienced in the last three years?

Friedman: Growth has been phenomenal: 20% over where we were three years ago.

Matties: What do you expect for the coming year?

Friedman: With enterprise memberships being offered—which is only a year old now—the growth rate will be maintained.

Matties: What do you think is the most hidden value that an IPC member needs to know about?

Friedman: We're focusing a lot on education, especially with the labor shortage and retirement of experienced engineers. This will fill a niche to provide continuity for both us and corporations and from a relevancy standpoint, bringing added value to the IPC relationship.

Matties: I was talking to a couple of training facilities, and they mentioned there's an unex-



pected increase in the demand for training. Is that part of the awareness that you're driving as well as market conditions?

Friedman: Plus, we're enhancing our online ability to train up-and-coming engineers. We're planning more courses online that will be instructor led. You can get real certification as a member of the team going through various projects, which is something that is not available today.

Matties: Do member companies request training, and if so, do you build curriculums specifically for that? For example, maybe a large OEM says, "We need this type of training."

Friedman: Licensed third-party training centers provide most of our training and certification, and we offer precertification-level training, online training, and some certification through IPC EDGE. If we do receive requests that seem to be an industry groundswell, then yes, we'll go ahead and develop training for that demand.

Currently, we're asking our members to volunteer to join the IPC JTAC (Job Task Analysis Committee) to help document the core knowledge, skills, and abilities required to succeed in key roles in our industry. The outcome of this project will shape IPC's future certification and education programs for years to come.

Matties: What if a singular large OEM says, “We’d like to train our workforce on this.” Would that be possible?

Friedman: That’s something we would take under consideration.

Matties: It seems like there’s a dynamic shift in the marketplace, and the needs for training are shifting as well. You mentioned earlier that there’s a shortage of entry-level workers. Do you see a groundswell there?

Friedman: Absolutely. In fact, we’ve hired industry experts to focus specifically on that issue. The other thing that companies have not taken advantage of in the past, which was your original question, is our global government relations group—especially today with tariff and trade issues. Members have an actual voice in Washington D.C. and other halls of government to channel their feedback and make it relevant so that the government pays attention to our industry as they’ve never done before.

Matties: It looks like you’re having some success there.

Friedman: That’s true. We’ve gotten some legislation passed that incorporates language from some of IPC’s positions that we’ve submitted to the government specifically in the areas of defense electronics and workforce education.

Matties: Is there anything we haven’t talked about that you feel we should share with the industry?

Friedman: If any issues require addressing and you feel strongly about it, we’re here to listen, and if it’s something that we see should be industry driven, then we’ll certainly take up the banner.

Matties: Thank you so much for your time today, Mark.

Friedman: Thank you. PCB007

Automotive Electronics: Past/Present/Future

In this video, IPC president and CEO John Mitchell discusses technological advancements in automotive electronics and IPC’s standards development activities that support the automotive industry.



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Can E-waste and Metals Recovery Efforts Lower Environmental Risks and Liability?

Article by Andrew McManus

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Gold, palladium, silver, and other precious metals (PMs) in manufacturing wastes represent high value, but how PMs are recovered can pose environmental and liability issues. Aerospace and electronics manufacturers and suppliers, in particular, produce volumes of manufacturing wastes that contain varying levels of PMs. With U.S. growth projected at around 2% in 2019^[1,2], there may be an opportunity for more manufacturers and suppliers to review current methods and move to higher ground.

This would include printed circuit board (PCB) manufacturers. Although bookings for PCBs have fallen from recent peaks, shipments have been up about 10% through the third quarter of 2018^[3]. There are two waste streams for recycling and recovery for manufacturers to consider—the electronic waste (e-waste) from manufacturing operations and end-of-life (EOL) product recycling.

On the manufacturing side, a waste audit can identify areas where more PMs might be

captured for recovery. This includes both high-level PM residuals from manufacturing operations—such as precious metals plating solutions, conductive pastes, filters, and sludges—and lower-level PM residual materials—such as syringes, wipes, rags, gloves, solder waste, and floor sweepings. Manufacturing wastes also include damaged parts and returns, as well as finished electronic components and PCBs that are outdated or obsolete. These items may also need to be handled according to industry and government standards.

Security is often a paramount concern. The design of PCBs may be proprietary, classified, or under International Traffic in Arms Regulations (ITAR) restrictions and sensitive components may need to be destroyed or obliterated to render information “irretrievable by any means.” The environmental impact of recycling and recovery efforts is also a key consideration especially for government entities, consumer product companies, and other public corporations.

Beyond e-waste from manufacturing, EOL recycling is a growing concern for OEMs since it can impact operating costs as well as brands. As environmental issues grow, it also can im-



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pact PCB suppliers both directly through new quality or compliance requirements, or indirectly through a change in customer or public perceptions. Whether that is a threat or an opportunity depends on a variety of factors and how companies including recyclers choose to respond. Environmental considerations can often be downplayed, ignored, or simply overshadowed by the drive for maximizing returns, and smaller operations may be more vulnerable.

Of course, manufacturers, suppliers, and recyclers must comply with regulatory requirements and operate profitably in a competitive marketplace to remain in business, yet how companies respond can have long-term consequences. Environmental liabilities can surface years later from improper management and challenge a company's reputation or very existence. Liability can also lurk closer to home. When any recycler goes out of business and leaves a mound of hazardous waste behind, there can be finger pointing and a search for deep pockets ^[4]. For these reasons, it is important for manufacturers and suppliers to develop close, trusted downstream relationships and understand recycling and recovery processes and the ultimate fate of their products.

Baseline Value

The value of recycled e-waste can vary widely. Recent bans from China and Thailand on e-waste emanating from the U.S. further devalues recycled e-scrap in the U.S. and puts pressure on collection facilities, landfills, and tipping fees. At the same time, the value of recovered precious metals can gyrate, making planning difficult. The profitability of recovery and refining operations is often closely tied to metals commodity prices, and foremost among those is gold. Over the last 10 years, gold has swung from below \$750/oz. in 2009 to a high of nearly \$1,900/oz. in 2011 before settling into a range around \$1,250/oz. \pm \$200 ^[5]. Palladium has seen even wilder swings with prices jumping over \$1,100/oz. in the last month from \$175/oz. a decade ago.

Manufacturers should seek waste recyclers that are financially stable. Those in a better po-

sition to withstand market fluctuations are also more likely to value their reputation and environmental responsibility and have programs in place to ensure environmental compliance and traceability.

There is also variability at the part level for electronic scrap. The amount of gold in a dynamic random access memory (DRAM) can easily vary by a factor of three or more depending on the exact part and manufacturer. Counterfeit parts in EOL waste streams can also confound expectations about returns. Fair pricing for e-scrap is often a matter of experience with a supplier and trust that builds over time. Speculators can acquire parts and either hold them for years hoping for market conditions to change for resale, or seek an immediate premium on the precious metals content, but may generate ill will.

Looking ahead, miniaturization, substitution, and advanced electronics manufacturing techniques will likely further reduce the already low levels of precious metals in key components, putting a further squeeze on the recycling industry. This means that while there are a variety of advanced recovery processes available or under development for precious, base, and rare earth metals—proven methods of recovery—and refining will likely continue to predominate for the foreseeable future.

Recycling Overview

Whatever the prevailing value of the underlying metals, electronic manufacturers often want to reduce the volume or bundle their scrap. Some recyclers offer one-stop services and may shred e-scrap on site before hauling it to another downstream vendor. On-site shredding can be advantageous for volume reduction to lower transportation costs and destroy intellectual property. However, it can make recovery of targeted PM components more difficult if not impossible. Closed-box services can offer an alternative with shipments directly to a PM recovery operation. Locked-box services go a step further with the secure shipment of high-value items. Secure transit can be accomplished through the use of seals, evidence tape, or lockable containers.

From the recycler’s perspective, one of the biggest differences between manufacturing scrap and EOL scrap is that EOL scrap involves more plastic and base metals and typically more sorting. With either waste stream, for components that cannot be directly recycled or reused, the goal is to transform heterogeneous materials into one or more marketable commodities. PCBs are comprised of a complex mix of materials that includes fiberglass and epoxy resins, solder, and electronic components. They contain copper, and to a lesser extent gold, silver, palladium, steel, stainless steel, aluminum, and other base metals.

From the refiner’s perspective, the best way

to gauge how much PM there is any e-scrap stream or batch is by sampling and assaying. Due to the variability inherent in e-scrap, the more concentrated the level of PM in waste, the more important accurate sampling is and the higher the return. Of course, the value of the batch should cover the cost of sampling and assaying. It does not make sense to refine e-scrap worth \$1 per pound in a process designed for \$8–10 per pound PM residuals.

Primary E-scrap Recycling

Chart 1 shows a generalized flow diagram for metals recovery from e-scrap [6]. E-scrap recyclers may voluntarily certify to R2 or other in-

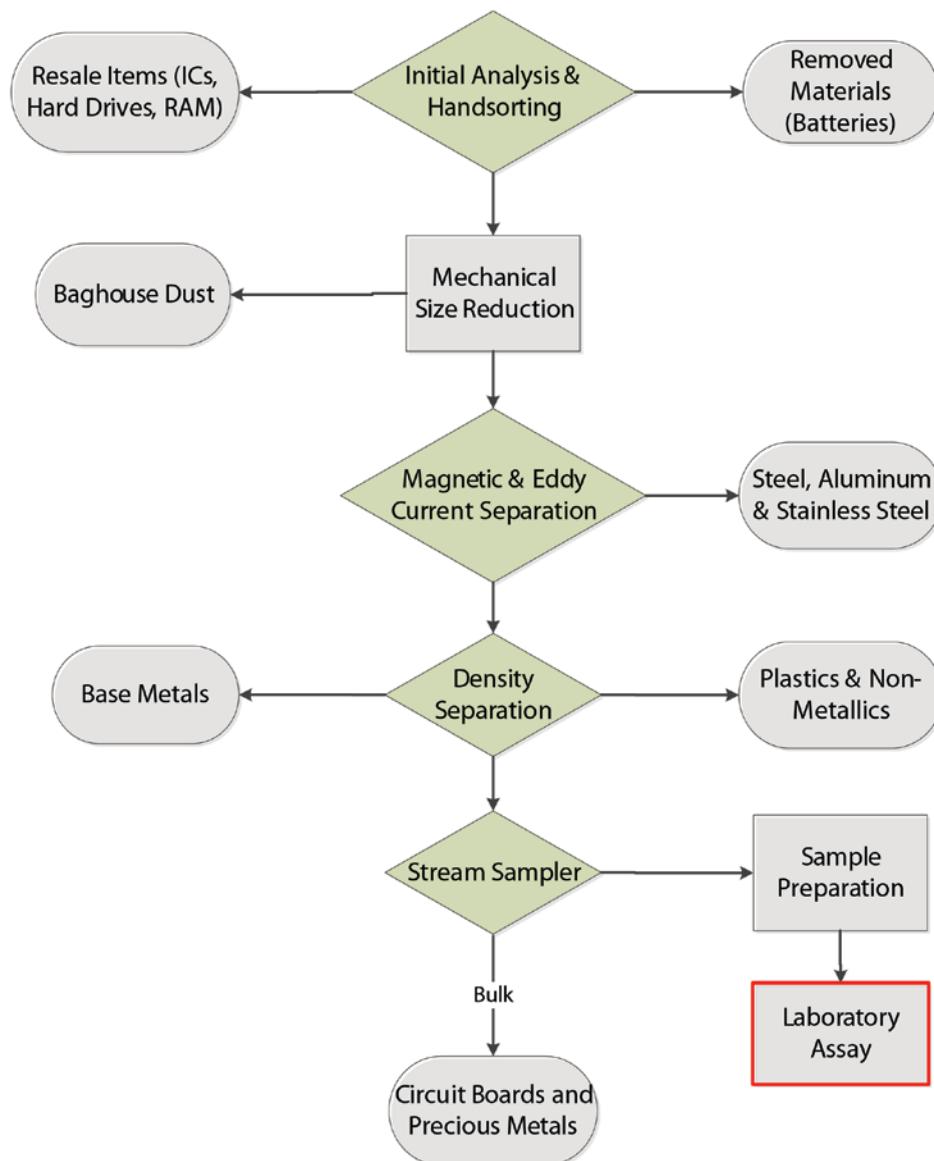


Chart 1: Primary e-scrap recycling.



Figure 1: High-value electronic scrap containing precious metals.

dustry standards, which are intended as an indicator of regulatory compliance and commitment to environmental procedures that follow a reuse-recover hierarchy and seek to reduce wastes to landfills and monitor transboundary movement. Resale of components typically offers the highest value and does not generate any new waste. After the initial sort, potentially hazardous components such as batteries must be removed. Components likely to contain recoverable levels of precious metals should also be targeted such as high-density PCBs, integrated circuits (ICs), memory chips, and PM connectors and pins (Figure 1).

Most recyclers serve primarily as collection points and include some type of sorting or shredding operations. They may shred or pulverize materials before sending them to further processing operations. A few are vertically integrated and incorporate chemical recovery and/or thermal reduction methods to prepare marketable metals for recovery.

Tight labor markets and rising wages put pressure on e-scrap recyclers to limit disassembly and/or rely more on automated methods. Along these lines, Phase II of a trial on a new method for disassembling PCBs is underway with the U.S. Environmental Protection Agency (EPA) and due for completion at the end of February. The equipment uses infrared (IR) to melt solder connections as PCBs travel on a conveyor and are then vibrated to loosen com-

ponents [7]. This may improve recovery of reusable board-level components such as ICs, as well as improve returns by segregating devices containing precious metals for refining or further processing or refining. However, significant copper remains in the substrate with a requirement to process. Downstream charges are the same, or in some cases, more since both the per-pound value and attractiveness as a smelter feedstock are reduced.

Chemical Methods of Metals Recovery from PCBs

Chart 2 shows a generalized method of recovering metals from recycled PCBs via hydrometallurgy [6]. This wet chemical recovery process involves leaching followed by a concentration and purification step and may include further metal recovery. Leaching solutions may vary in their oxidation-reduction potential depending on the reaction. They may also require additional energy for heating to speed or extend the reaction, and may use chelating agents to extract certain metals selectively.

Recovery may proceed in sequence from the top, or leaching processes may be used for targeted materials. Leaching agents include nitric acid and hydrochloric acid (aqua regia). They also include salts such as sodium cyanide that form a strong base when dissolved in water. These are all hazardous chemicals and pose health and environmental risks if not properly stored and handled. Sodium cyanide solution reacts violently with acid and can produce highly toxic and flammable hydrogen cyanide gas.

Electrowinning selectively separates metals from an ionic solution using electrolysis. For example, with direct current, copper or gold can be electroplated from the solution. Electrowinning can be used in the solder leaching step to remove trace hazardous chemicals such as selenium and lead.

In the PM recovery process, chloride leaching may be used to recover palladium or potassium iodide used to recover platinum. Gold and silver are recovered by acid leaching, and the solution is then filtered. Activated carbon adsorption can also be used in a separate step

to separate residual heavy metals such as nickel and zinc.

It should be noted that milder leaching chemistries such as glycine-peroxide solutions are being investigated [8] and have the potential to reduce environmental impact. Even mild acids such as white vinegar can be used for leaching gold [9]. However, a stronger acid and oxidant are still needed along with additional time or energy, and results are not suitable for commercial scale. When it comes to recovering precious metals, the goal is always 100% recovery. Some progress is also being reported on improving extraction from hydro-

metallurgical leaching solutions through the use of electroactive polymers. This requires additional active-bed processing but avoids the need for extraction reagents or additional energy [10].

In addition to hazardous wastes, hydro-metallurgical processes generate non-metallic waste, which is typically a mix of different plastic compounds that are not recyclable. A fraction may find its way to waste-to-energy facilities, but the vast majority is trucked to landfills. More advanced chemistries may also generate waste that requires additional treatment for environmental disposal.

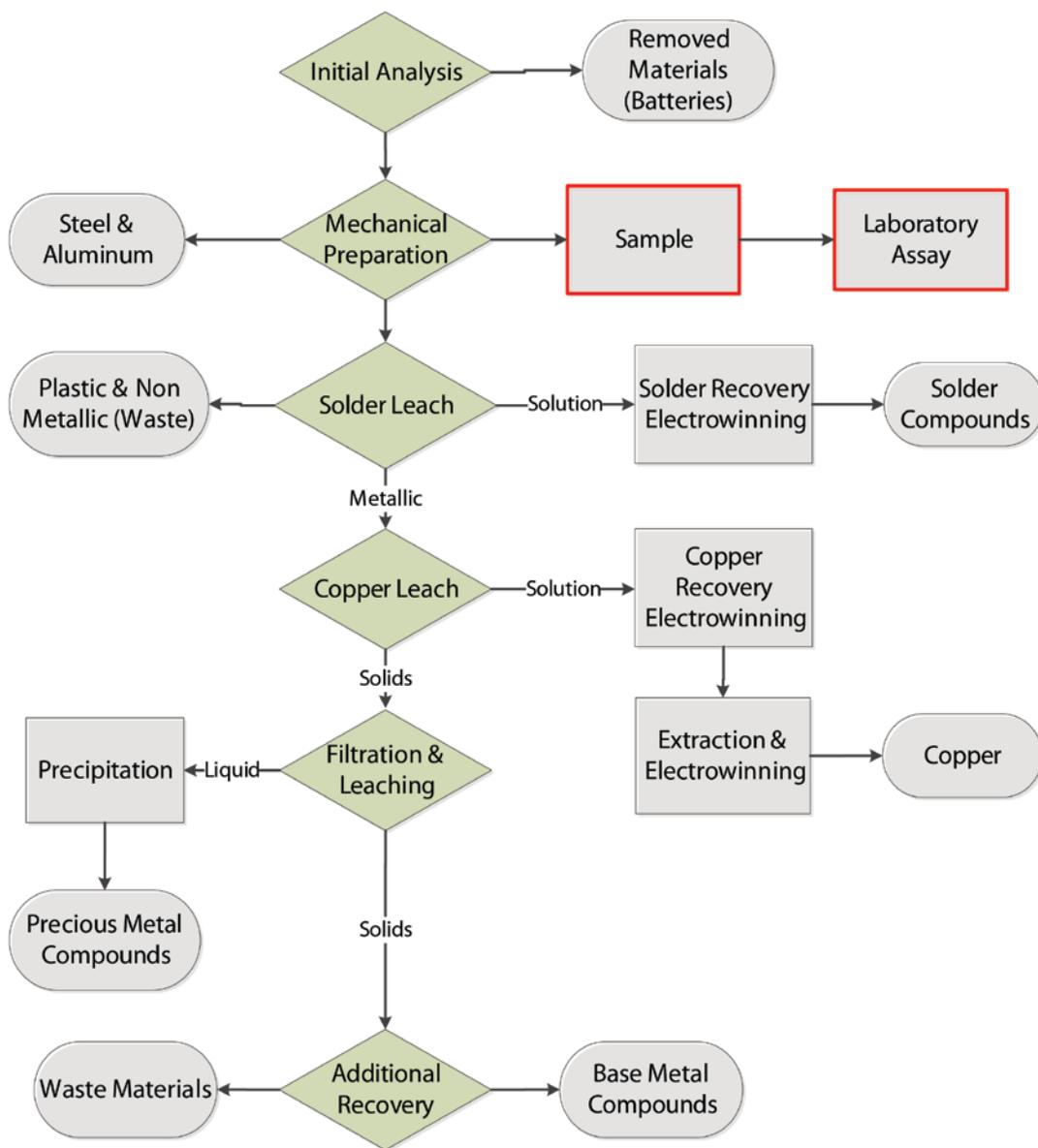


Chart 2: Chemical recovery of PMs.

Pyrometallurgical Recovery and Refining of PMs

Chart 3 shows a generalized diagram of the pyrometallurgical process for PM recovery. This method is ideal for e-scrap with high-levels of precious metals, such as the recurring wastes as noted from electronic manufacturing operations. It can also be valuable for recycled electronic components that have been segregated for potential residual value such as high chip density circuit boards.

Newer combustion processes typically use natural gas, which is cleaner and more cost-effective than other fuels. Pyrolysis greatly reduces the volume of non-metallic residue [11] but

generates combustion byproducts which must be controlled. Newly constructed facilities and process upgrades typically incorporate more stringent pollution controls to meet government standards and permitting requirement.

Traditional incineration furnaces may operate at temperatures in excess of 2,500°F. These high temperatures contribute to the formation of toxic compounds when processing plastics and other organic compounds. Older furnaces may include a secondary afterburner to achieve more thorough burning of exhaust, but often lack other environmental controls or even basic filtration.

Controlled temperature processing and advanced controls can greatly reduce emissions

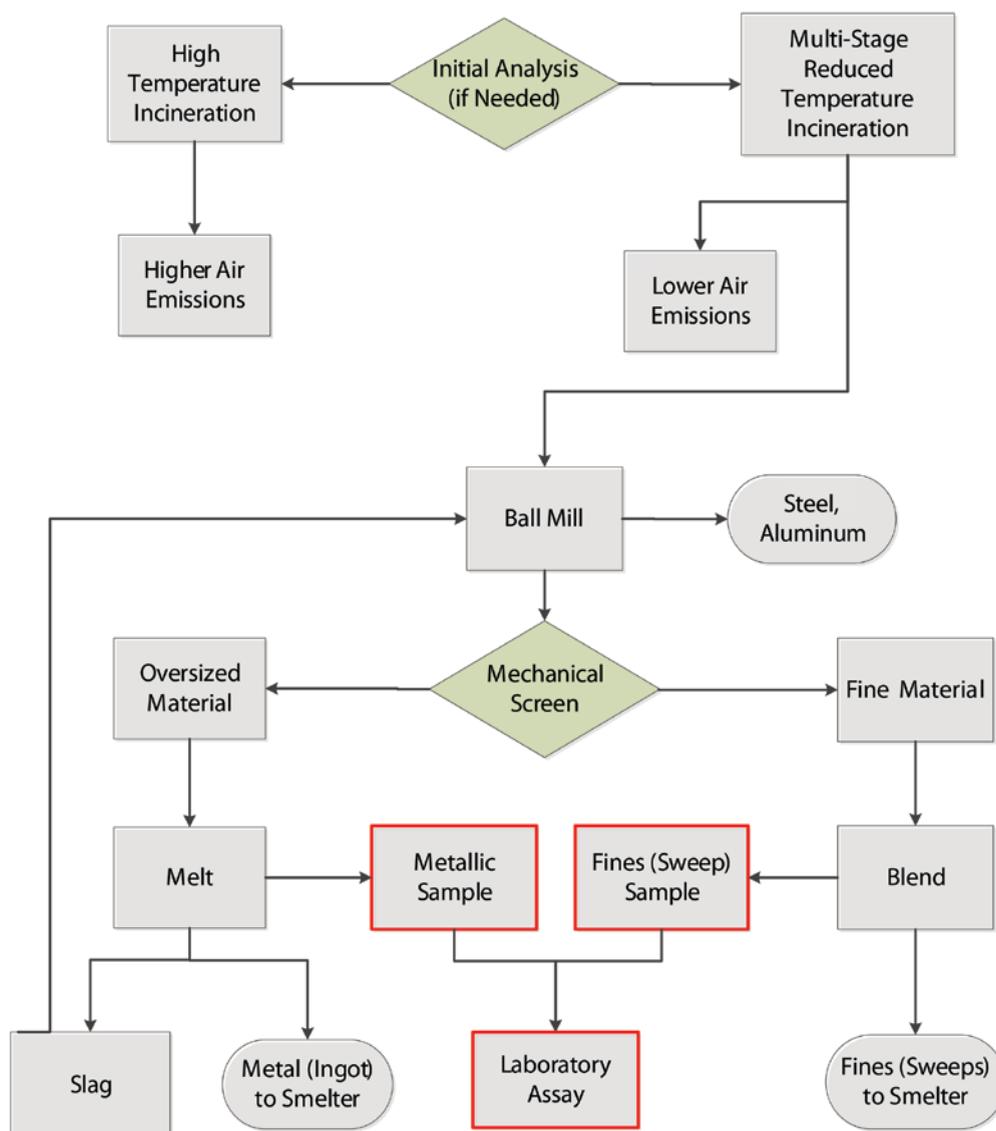


Chart 3: Thermal recovery of PMs.

while increasing the efficiency of subsequent milling or leaching operations. Recognizing the emerging needs in the electronics industry, Gannon & Scott designed a multistage thermal reduction system that essentially roasts combustible materials at temperatures around 1400°F. The company operates the TRu3Tec® thermal reduction system at processing plants on the West and East Coast—both of which are zero-discharge facilities (Figure 2).

Following combustion, gross metallics and primarily steel are removed before sending out for base metal recovery. The process also yields organic ash entrained with a combination of base and precious metals. The volume of organic content is much higher than high-temperature pyrolysis, which is evidence of much lower air emissions. The resulting ash is reduced to a powder by heavy ball milling, and the residue is screened by particle size. These two simple mechanical processes separate organic ash fines (also called sweeps) from the metallic (oversize), typically copper and precious metal alloys. Precious metals are also contained in the ash fines, which are then blended, sampled, assayed, and sold as a commodity. Metallics are melted, sampled, and poured into ingots.

The TRu3Tec system features advanced pollution controls including quenching, cyclonic separation, wet scrubbing of exhaust gases, and dust collection [12]. Quenching reduces exhaust temperatures to decrease the formation of hazardous byproducts. Cyclonic separation then knocks down carbons and other heavy particulate matter. Next, wet scrubbing removes acidic compounds, and the liquids are neutralized and air-dried in a separate process. Before exhaust is released to the air, it passes through a final series of filters which remove fine particles. All scrubber-solution entrapped solid salts from the air purification process and filtered dry particles are captured and converted on-site into sweeps. No hazardous waste is created.

There are other advanced electronic recycling technologies on the horizon including electromechanical and supercritical gas technologies, and even biometallurgical methods [13]. However, what may work in the laboratory

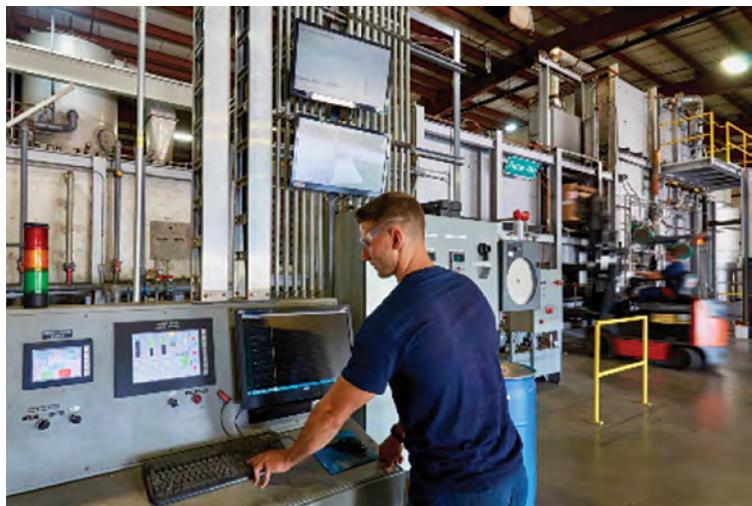


Figure 2: Lower temperature thermal reduction in combination with advanced environmental controls greatly reduces emissions. (Source: TRu3Tec system, Gannon & Scott Inc.)

must also be tested at a commercial scale, and be economically viable, profitable, and ideally, sustainable.

In the final analysis, the two current paths for PM recovery following primary recycling operations remain chemical (hydrometallurgy) and thermal (pyrometallurgy). Both are proven methods that exist today. Nevertheless, there can be wide variation in process equipment and efficiencies, and residual waste byproducts. In addition, market pressures can negatively impact recycling channels. For this reason, electronic manufacturers and suppliers concerned about data security or environmental liability should carefully evaluate downstream processes and relationships. Those who do will likely discover fresh opportunities for growth. **PCB007**

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Andrew McManus joined Gannon & Scott as general manager in 2016. Previously, he spent 15 years at a recycling company that processed electronic waste and precious metal scrap. Early in his career, McManus worked in environmental and operations

positions at manufacturing facilities involving precious metals at metal-finishing shops and a flexible-circuit operation. Andrew also served over 30 years in the U.S. Army and Reserve retiring as a lieutenant colonel. He earned an MBA in operations management from Bryant University and a B.S. in chemical engineering from the University of Rhode Island.

Gannon & Scott has been a precious metal processor since 1919.

Researchers Unveil Breakthrough in Human-machine Cooperation

Researchers at KTH Royal Institute of Technology reported new progress working within the framework of the Horizon 2020 European research project, Co4Robots. The project has developed functionality that enables real-time robots to move in a dynamic situation while collaborating with other robots and people.

The new functionality the project has developed has since been assigned to the TIAGo robot from PAL Robotics in Spain. TIAGo has gained a sense of observation that it can use to navigate in a changing landscape such as an office. As the robot steers itself around a workplace, it can identify things that must be moved. When a human co-worker wants the robot



to help them pick up an object, the worker gives the robot a hand signal. Another signal tells the robot to release the object so it can be set down.

Professor Dimos Dimarogonas, coordinator of the project at KTH's Department of Automatic Control, says that the functionality is not platform-specific, so it can be transferred to other robots during the next phase when tests continue with Bosch.

"The robots will be in a larger dynamic office environment and collaborate with more robots and people. They will get more advanced tasks, and with different types of agents," Dimarogonas says. Other uses for the technology will eventually include healthcare facilities.

(Source: KTH Royal Institute of Technology)



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In the Studio: *Real Time with...IPC*

Article by Andy Shaughnessy

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It's almost time for IPC APEX EXPO 2019 at the San Diego Convention Center, and that means another *Real Time with...IPC* video program bringing you interviews with the electronics industry's top movers and shakers, engineers, and managers. It's hard to believe that *Real Time with...IPC* has been a staple of IPC APEX EXPO since 2007.

I still remember my first *Real Time with...IPC* at IPC APEX EXPO 2008 in Las Vegas quite well. I had just begun doing video interviews, and to say I was a little rough is an understatement. Publisher Barry Matties had given me some training beforehand, but I was still trying to find my groove.

My first interview went along pretty well; so far, so good. Then, the engineer I was interviewing stopped talking and I couldn't think of a good follow-up question to ask. I looked around, trying to find inspiration for another

question, and saw Barry raise one eyebrow at me and start smiling. We all started laughing. Finally, he said, "Don't look at me, focus on who you're interviewing."

That turned out to be good advice because an interviewer has to tune out everything except the person being interviewed, no matter where you are, and I'm usually surrounded by distractions at IPC APEX EXPO. Pick-and-place machines and vacuums always seem to be running. If we're doing a show wrap-up interview as the event is breaking down, a forklift driver will usually pull up next to us and drop a half dozen pallets. Once I tuned out the distractions, I could focus on the interview like a hunter's gun-proofed retriever.

Then and Now

Things have certainly changed since 2008. For one thing, I've gotten much better at doing

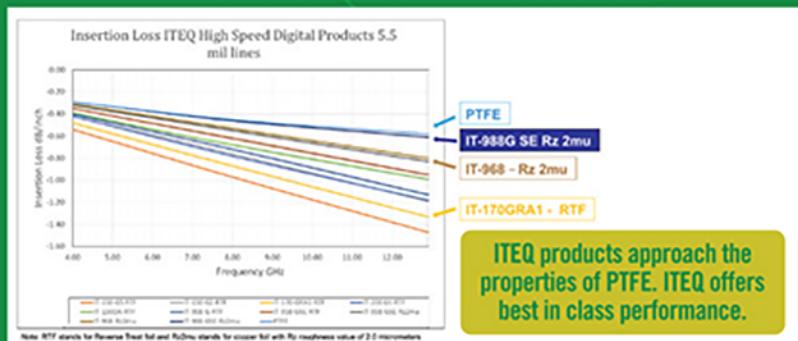


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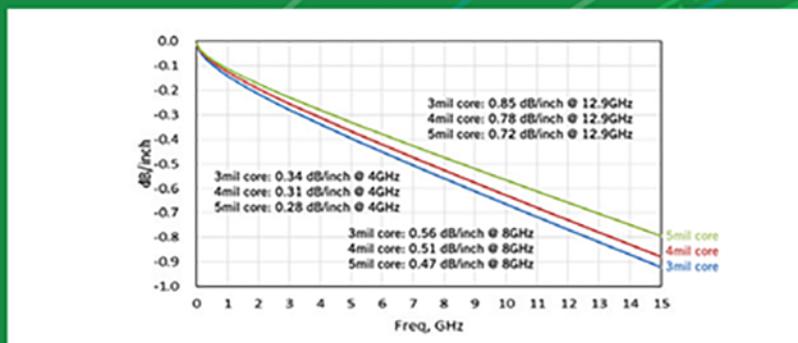
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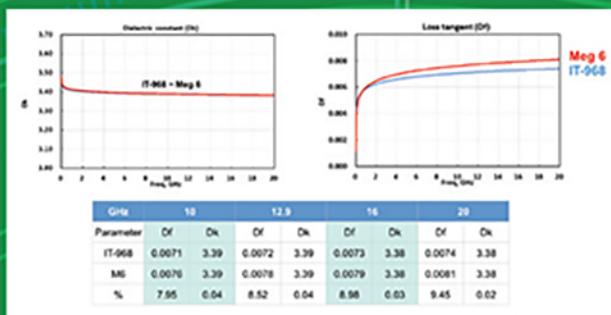


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IT-968 SPP Comparison



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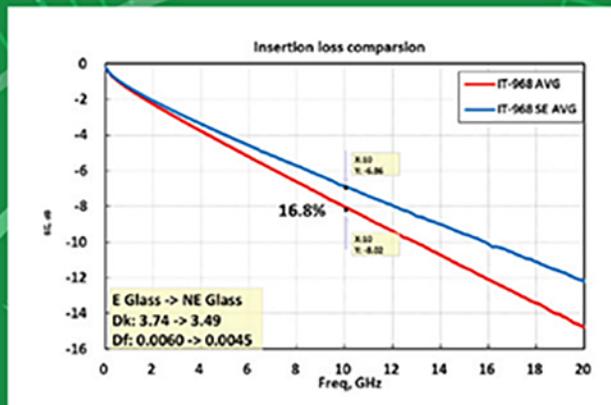
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Td-5% (°C)	TGA 5% loss	300+	300+
CTE (NL 50-200°C)	TMA	2.2	2.2
Peel strength (lb/inch)	1 oz	6	6
Water Absorption (D-2423)		< 6.1	< 6.1
Dk, 1 GHz	IPC TM-410 2.5.5.9	3.8	3.4
Dk, 2-18 GHz	IPC TM-410 2.5.5.13	3.8-3.7	3.4-3.3
Df, 1 GHz	IPC TM-410 2.5.5.9	0.0032	0.0028
Df, 2-18 GHz	IPC TM-410 2.5.5.13	0.0028-0.305	0.0021-0.004

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on-camera interviews; of course, after those first attempts, there was really nowhere to go but up.

We've also added a whole range of guest editors—many of them are people just like you—who conduct fantastic interviews with individuals in their segment of the industry. No matter what topic the interviewee wants to discuss, we probably have a guest editor who is familiar with that topic. Some of our guest editors have been doing *Real Time with...IPC* interviews for a decade, and we couldn't do it without them.

The technology we use today is also light years ahead. In 2008, we used our big old-school camcorders that still ran on tape, and our video editing operations sometimes took well into the night. Now, we shoot interviews with digital recorders; editing is finished before the show closes each day, and most of that day's interviews are posted on the *Real Time with...* site on the same day.

Another thing that I've noticed is that people in this industry are much more open to doing on-camera interviews than they were 10 years

ago. It used to be tough finding someone to sit in front of the camera. Back then, a company might have had one person—perhaps in marketing communications—who was accustomed to doing video interviews. Now, forward-thinking companies consider video interviews to be another part of the marketing process, and they come to IPC APEX EXPO with a handful of camera-ready technologists.

Each year, we set up a studio at IPC APEX EXPO that allows us to conduct two video interviews at the same time. Jo Ann Sotelo is the conductor in the middle of this synchronized madness, rapping her baton on the dais, making sure that interviewers and interviewees are ready to go when the time comes. I still don't understand exactly how she makes all these interviews work out; I just do what she tells me to do!

So, stop by our *Real Time with...IPC* studio at IPC APEX EXPO 2019 and say hi. You just might meet some of the biggest names in the industry. And if you'd like to be a guest editor, all you have to do is ask. **PCB007**

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MilAero007 Highlights



Rick Hartley is Bullish on PCB Design, 3D Printing ▶

At the recent PCB West in Silicon Valley, Consulting Technical Editor Tim Haag met with long-time design industry veteran Rick Hartley to discuss the changing landscape of circuit board design, the layout designers of the future, and how designers can benefit from 3D printing of circuit boards.

Substrates for Advanced PCB Technologies: What Will the Future Hold? ▶

The UK chapter of the global IMAPS community of electronics and microelectronic packaging engineers shared a wealth of knowledge and wisdom about PCB substrate technology trends, developments, and future requirements in a webinar on the first of November.

Standard of Excellence: Forging Partnerships Through Adversity and Problem Solving ▶

For the past few months, this column has discussed how to find and work with a great PCB vendor, and most importantly, how to form a strong, productive partnership. This month, Anaya Vardya will address how adversity can forge a great partnership between you and your PCB vendor that will last for life.

NASA Looking to Tiny Technology for Big Payoffs ▶

NASA is advancing technology that could use large amounts of nanoscale materials to launch lighter rockets and spacecraft than ever before. The super-lightweight aerospace composites (SAC) project seeks to scale up the manufacturing and use of high-strength carbon nanotube composite materials.

Increasing Productivity for Flex Fabricators ▶

Barry Matties and Nolan Johnson of I-Connect007 met with Shane Noel and industry veteran Mike Jennings of ESI to discuss the introduction of their CapStone laser tool, a product aimed at doubling their flex circuit fabricators' throughput. Mike also shares advice for fabricators who are looking to move into the ever-growing flex market.

Ventec at electronica 2018: No Compromises for High-frequency Materials ▶

Ventec's IMS material families, thermally conductive and standard laminates and prepregs for multilayer PCB's, Ventec has teamed up with EMI Thermal to provide a range of thermal interface materials (TIM) to the European market.

ERAPSCO Inks \$40M in Navy Sonobuoy Contracts ▶

Ultra Electronics Holdings plc (ULE) and Sparton Corporation announce the award of sub-contracts valued at \$39.6 million to their ERAPSCO joint venture, for the manufacture of sonobuoys for the United States Navy.

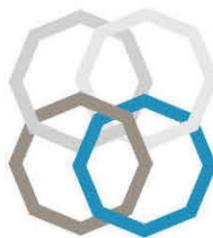
Nano Dimension Partners with Productivity Inc., Expands Reseller Network ▶

Nano Dimension announced a new reseller agreement with Productivity Inc., significantly expanding the company's North American channel partner ecosystem.

Sparton Receives 2018 Asia Pacific Entrepreneurship Award ▶

Dung Tran, managing director of Spartonics Viet Nam Co. Ltd, has been presented with the 2018 Asia Pacific Entrepreneurship Award for exemplary leadership and innovation in the electrical and electronics industry.

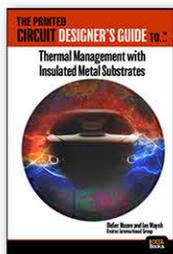
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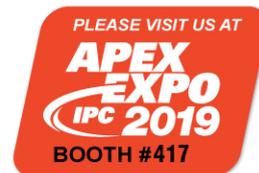
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Averatek to Present **Two Papers** at IPC APEX EXPO 2019

Flex Talk

Column by Tara Dunn, OMNI PCB

Averatek is going to be presenting two papers at IPC APEX EXPO 2019. One paper discusses semi-additive processing (SAP), and the second addresses a surface treatment that enables low-volume soldering to aluminum. I sat down with Mike Vinson, Averatek president, to learn more about what the company does.

Tara Dunn: Mike, as we get started, can you give me a brief history of Averatek and what you do?

Mike Vinson: Of course. Averatek is a small business located in Santa Clara, California, with extensive expertise in very high-density interconnect (HDI). Averatek develops the key chemical products that enable very small fea-

ture sizes—down to five microns and below—in PCBs, integrated-circuit (IC) packaging, and interposers. The chemistry was initially developed at SRI International in Menlo Park and was transferred to Averatek when the company was spun out of SRI. Since then, Averatek has done additional development on this fundamental chemistry as well as proprietary fabrication processes that leverage this chemistry.

Dunn: Your team is going to be presenting two papers at IPC APEX EXPO 2019. Can you tell us a little bit about the topics you will be presenting?

Vinson: One topic that will be presented is “Sub-10-Micron Semi-Additive Process (SAP) Utiliz-

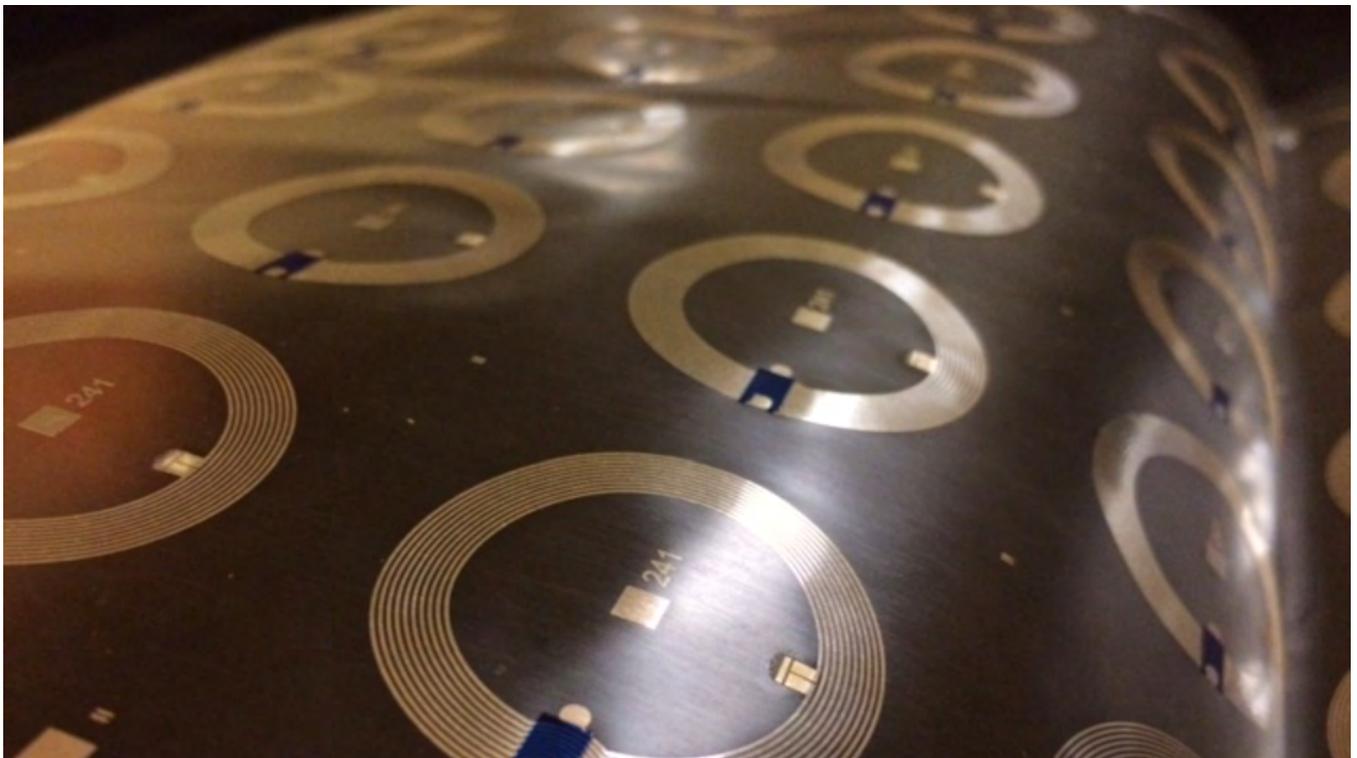
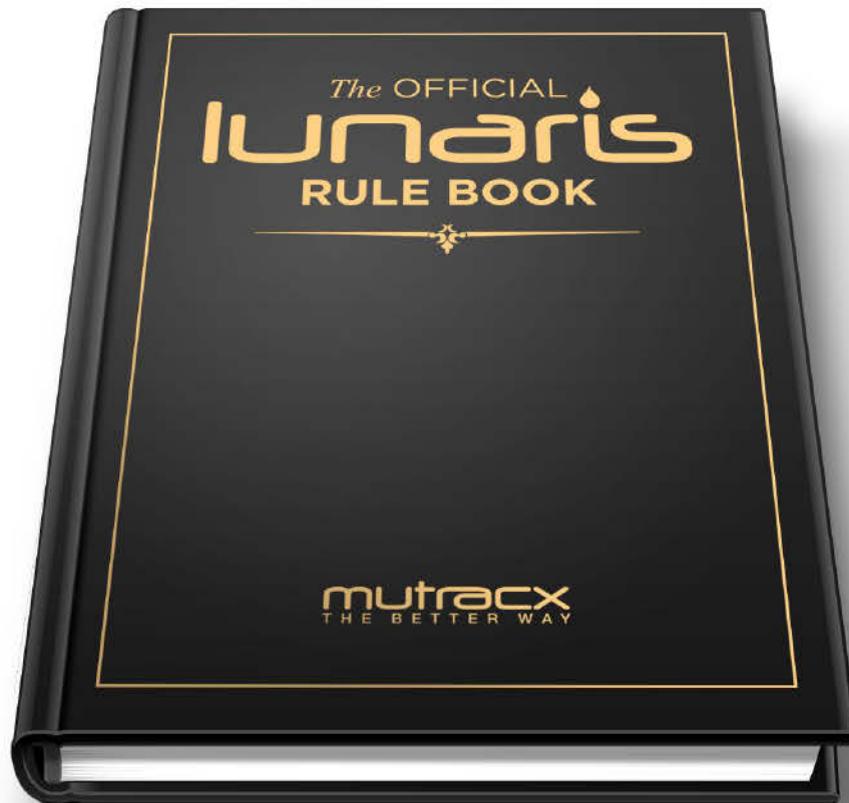


Figure 1: A 25-micron trace and space with SAP.

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ing Very Uniform and Ultrathin Copper by a Novel Catalyst System.” This topic will explore a catalyst system that promotes very controlled copper thickness over the substrate targeting next-generation HDI to wafer-level packaging substrates. The paper discusses this new catalyst process, proposes a typical SAP process using the new catalyst, and demonstrates the reliability improvements through a comparison between a new SAP PCB process and the conventional process.

The second topic that will be presented is “Surface Treatment Enabling Low-Temperature Soldering to Aluminum.” This surface treatment provides an alternative to anisotropic silver pastes and is an easy-to-use stencil printable. The presentation will discuss the process used to make functional aluminum circuits, study the resultant solder-aluminum bond, and shear results and reliability data.

Dunn: Mike, there seems to be more and more discussion in the PCB market about SAP, modified SAP (mSAP), and substrate-like PCBs (SLPs). What is unique about Averatek’s approach to SAP?



Mike Vinson

Vinson: Averatek has a true semi-additive process enabling industry-leading sub-micron base copper thicknesses. These processes also support the simultaneous formation of traces and vias. It is possible to omit electroless, and the process supports other metals such as gold and palladium for copperless applications.

Dunn: What factors do you see contributing to the drive to SAP technology?

Vinson: I think that one of the primary things contributing to the drive to SAP technology is the feature-size limitations of subtractive technology. Today’s electronics push the envelope of what is possible, and more sophisticated electronics are driving the trace, space, and via sizes even smaller. SAP enables these finer features, can reduce layer count and the required

lamination cycles, and allows a higher aspect ratio on traces and vias.

Dunn: SAP in PCB manufacturing is an exciting topic. What do you see as the biggest challenges in SLP and SAP technology adoption?

Vinson: I think this is a developing technology that is going to require the industry to reevaluate a number of things. From a designer’s perspective, there are no established design rules at this point; it takes a collaborative approach between design, fabrication, and assembly to achieve the required end product. From a fabrication perspective, I think fabricators will want to continue with their larger panel sizes, and there will be new equipment requirements as this technology is adopted. In general, the industry is used to being able to have very short lead-times for very complex PCBs. Because this

is an emerging technology operating in a collaborative environment, lead-times are going to be longer than some may be used to.

Dunn: What advice do you have for designers and companies interested in exploring and implementing this technology?

Vinson: One of the first pieces of advice I have is don’t get hung up with the current design rules. Design rules are developing, and some of the rules for a subtractive etch process either are not applicable or will be significantly different than what we are used to. I would also like to mention that this technology does not have to be an all-or-nothing approach. It is possible to implement solutions with SAP being used on selective layers and incorporated into a stackup that is also utilizing subtractive etch layers where these feature sizes are not required. This can result in a layer-count reduction and a more cost-effective product.

Dunn: Mike, you are working in somewhat uncharted waters for PCB fabrication. I am sure that can be both exciting and challenging.

What are your favorite and least favorite aspects of working with an emerging and developing technology?

Vinson: You're right, Tara (laughs). Working with an emerging and developing technology can be both exciting and challenging at the same time. I think my favorite part of working in this environment is the ability to create new solutions and product categories that would not have existed otherwise. One of my least favorite aspects is the long transition times from prototype to production. An emerging technology can have a long cycle time from concept to prototype, and a long cycle from prototype to production.

Dunn: One thing that is very interesting to me is the fact that Averatek's SAP process applies to materials outside of just PCB materials. What are other application areas for this technology?

Vinson: Yes, we have been more focused on the PCB fabrication process while discussing what we are presenting at IPC APEX EXPO in January, but Averatek's chemistry applies to other functional areas as well. We can put metal on 3D-printed objects for wear, conductive, and aesthetic properties. We enable the efficient use of precious metals for industrial catalysis operations such as catalytic converters, food processing, refineries, etc. One of the other applications receiving a lot of attention and interest is the ability to metalize industrial fabrics, fibers, and films.

Dunn: Speaking of other applications that you are involved with, let's switch gears to the second topic Averatek will be presenting on at IPC



Figure 2: Averatek's Mina product, a surface treatment enabling low-temperature soldering to aluminum.

APEX EXPO 2019. You will be speaking about a surface finish treatment that enables low-temperature soldering to aluminum. What markets do you see as early adopters of this surface finish treatment?

Vinson: We have seen early adopters include both the radio-frequency identification (RFID) and light-emitting diode (LED) lighting panels. Each engagement with new customers provides us with new applications for our "Mina" product.

Dunn: What are the benefits of Mina in terms of both cost and performance?

Vinson: One of the benefits of a simple surface treatment enabling low-temperature soldering to aluminum is that it allows for the use of aluminum in place of more expensive and heavier alternatives like copper. Options such as aluminum-polyethylene-terephthalate (PET) circuitry become much more attractive. Another benefit is the reduction in the thermal resistance between high power components and aluminum heat sinks. Expensive anisotropic conductive paste (ACP) and conductive silver-filled epoxies can be replaced with high-per-

formance, low-cost options, and reliable solder connections.

Dunn: When looking at the LED market, I can see the benefit of combining both the SAP and Mina technology. Can you describe how these technologies could work together and what the potential benefits are?

Vinson: Yes, these two technologies can work together. In high-power electronics—including LEDs, metal-oxide semiconductor field-effect transistors (MOSFETs), gallium-nitrate-based (GaN) electronics, insulated-gate bipolar transistors (IGBTs), and driver and MOSFET modules (DrMOSs)—the combination allows the use of an anodized aluminum circuit board with an improved thermal design. This is possible be-

cause the SAP process allows direct copper plating to the anodized areas while Mina allows direct soldering to the bare aluminum areas.

Dunn: Mike, thank you for taking the time to talk with me. I am always interested in new and emerging technologies in our industry. I look forward to attending both of these presentations at IPC APEX EXPO 2019.

Vinson: Thank you, Tara. PCB007



Tara Dunn is the president of Omni PCB, a manufacturer's rep firm specializing in the printed circuit board industry. To read past columns or contact Dunn, [click here](#).

Best Hope Yet for Aluminum-ion Batteries

In a study completed at Northwestern University in Illinois and published in *Nature Energy*, Dr. Dong Jun Kim, now of the University of New South Wales School of Chemistry, led a team of researchers including Nobel Laureate Sir Fraser Stoddart to demonstrate a strategy for designing active materials for rechargeable aluminum batteries.

"We found a novel way to design rechargeable aluminum batteries by employing a redox-active macrocyclic compound as the active material," Dr. Kim said. His team managed to use a large organic chemical compound as

the part of the battery that stores energy—something that previously stumped researchers.

What makes this is a big deal is that while lithium-ion batteries have enjoyed remarkable success powering mobile electronic devices in renewable energy applications they are fraught by limited cycle life, safety concerns, and relatively high costs. Aluminum-ion batteries, on the other hand, have been seen as ideal contenders for this space given aluminum is the third most abundant element in the Earth's crust behind oxygen and silicon. It also has one of the highest theoretical volumetric capacities due to its multiple redox states.

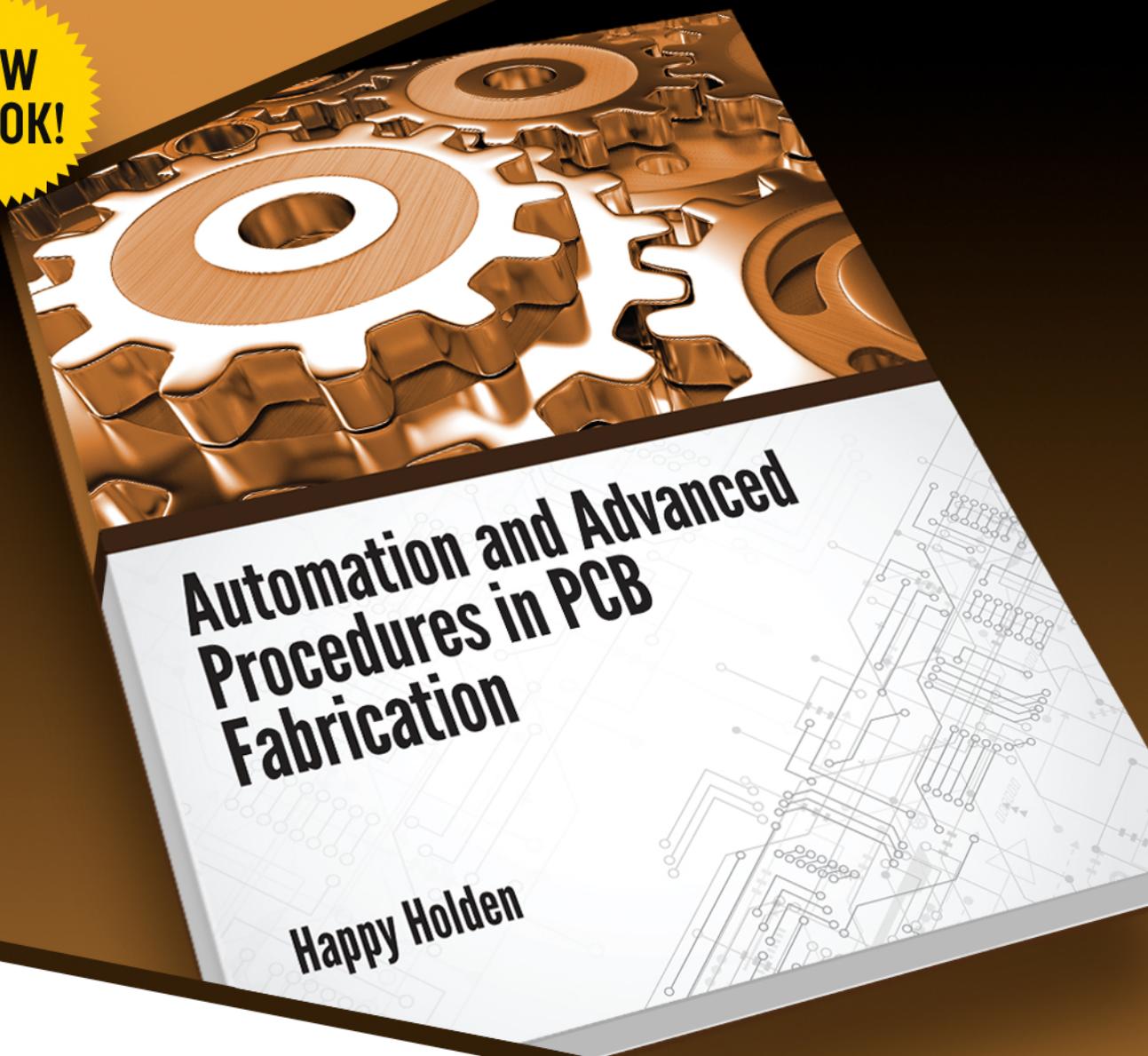
"Our results showed promising battery performances; however, it is early days, and we stress that there is a need to improve even more in every aspect. So, it does not make much sense to compare against the well-established lithium-ion battery system," Dr. Kim said. He said he will continue to research aluminum-ion batteries while examining the potential of using other elements.

(Source: UNSW Sydney)



Aluminum-ion batteries could offer improved renewable energy storage.

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Vice president, PCB
GreenSource Fabrication

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IPC Recognizes Volunteers at Awards Luncheons

Feature by Patty Goldman
I-CONNECT007

Those not involved in the committee activities may wonder what the awards luncheons at IPC APEX EXPO are all about. If nothing else, IPC—Association Connecting Electronics Industries—is an organization of volunteers. Every document issued—whether specification, standard, guideline, or training program or webinar—is generated entirely by volunteers. The IPC staff facilitates the creation of those documents by organizing and scheduling meetings, keeping the documents moving through the actual creation and approval process, and disseminating the results to the electronics world.

Today, IPC has more than 100 standards committees (including subcommittees and task groups) working on over 300 active documents that cover every aspect of electronics manufacturing from design through assembly, including addressing specific needs of the various market segments such as automotive, military, and medical.

This translates into many volunteers discussing, writing, and editing a lot of documents (including revisions and updates) for our industry, which also represents a lot of time—endless hours—spent on these efforts. Whether it is company time or one’s personal time (which, believe me, much of it is), the individuals who put forth this effort are to be commended. And, I might add, those individuals



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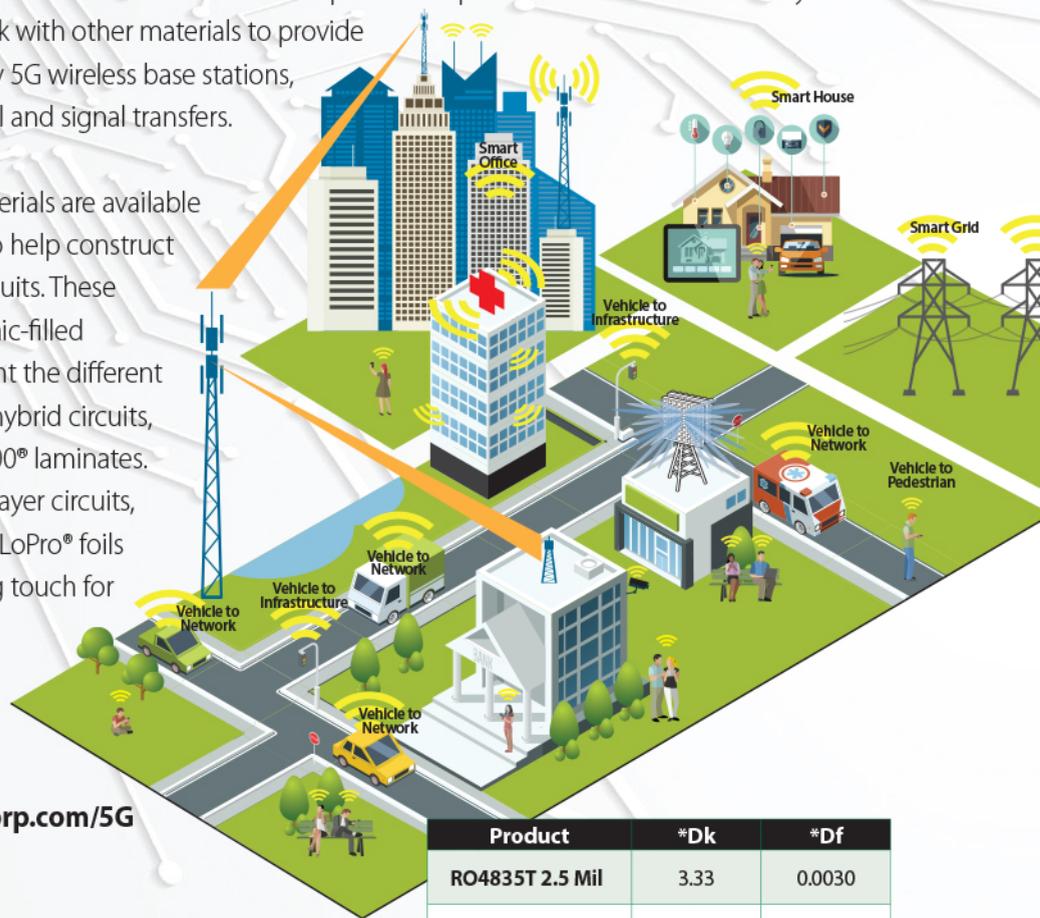
Frequencies at 28 GHz and higher will soon be used in Fifth Generation (5G) wireless communications networks. 5G infrastructure will depend on low-loss circuit materials engineered for high frequencies, materials such as RO4835T™ laminates and RO4450T™ bonding materials from Rogers Corporation!

Rogers RO4835T spread-glass-reinforced, ceramic-filled laminates are low-loss materials in 2.5, 3.0, and 4.0 mil thicknesses. They are well suited for millimeter-wave frequencies as part of the inner cores of 5G hybrid multilayer PCBs. They can work with other materials to provide the many functions needed by 5G wireless base stations, including power, signal control and signal transfers.

Rogers RO4450T bonding materials are available in 3, 4, and 5 mil thicknesses to help construct those 5G hybrid multilayer circuits. These spread-glass-reinforced, ceramic-filled bonding materials complement the different materials that will form these hybrid circuits, including RO4835T and RO4000® laminates. And for many 5G hybrid multilayer circuits, Rogers CU4000™ and CU4000 LoPro® foils will provide a suitable finishing touch for many hybrid multilayer circuit foil lamination designs.

5G is coming! Do you have the right circuit materials?

Learn more at www.rogerscorp.com/5G

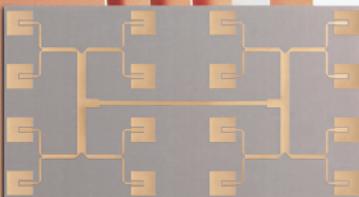


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should be especially appreciated by those who use the finished documents.

Each year, a number of these documents comes to fruition and is published—often after several years of work. The completion of a document is a momentous occasion for those who have been working on it (“We’re finally done!”). IPC has made a practice of recognizing committee leaders and volunteers for their work completing standards and specifications—and for other activities within the organization—at the committee luncheons during IPC’s spring and fall meetings. According to IPC, the two categories include ^[1]:

1. Committee Leadership Awards are presented to committee chairs upon the completion of a standard or specific program. Any chair is eligible. This award can be given more than once and can also be presented to an outgoing chairman who has made contributions over a period of time.

2. Distinguished Committee Service (DCS) Awards are presented to IPC committee members who have made an exceptional contribution to a specific standard or program. Any person who is actively involved on an IPC committee is eligible, except members of the board of directors. This award can be given more than once. Exceptional contributions include consistent participation through attendance or regular contributions, ballot submission, and having a significant impact on a document or project.

Corporate and Individual Awards

IPC has also created several special awards over the years. These awards are presented for extraordinary efforts and long-time commitments to both IPC and the electronics industry. There are six of these award categories: four go to outstanding individuals, and two recognize companies whose IPC involvement has been extensive. As described by IPC, the awards are ^[1]:

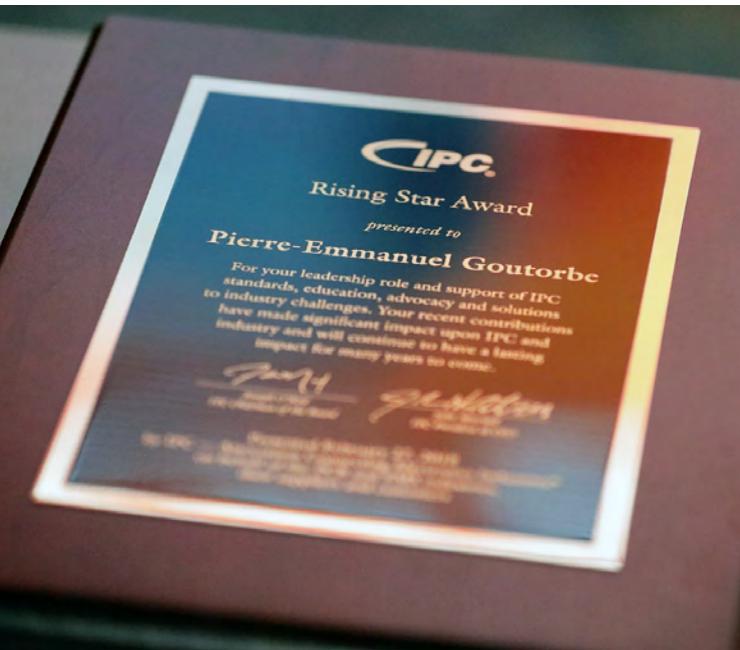
- **The IPC Raymond E. Pritchard Hall of Fame Award** is given to individuals in recognition of extraordinary contributions and distinguished service to IPC and in the advancement of the industry, including the creation of a spirit of mutual esteem, respect, and recognition among members consistent with the goals and mission of IPC. This is the highest level of recognition and achievement that IPC can give to an individual, and it is based on exceptional merit over a long-term basis—the operative imperative being “long-term.”

- **The Dieter Bergman IPC Fellowship Award** is given to individuals who have fostered a collaborative spirit, made significant contributions to standards development, and have consistently demonstrated a commitment to global standardization efforts and the electronics industry. Each recipient will be eligible to bestow the Dieter Bergman Memorial Scholarship upon the university or college of their choice.



- **The President’s Award** is given to IPC members who have exhibited ongoing leadership and have made significant contributions of their time and talent to the association and the electronics interconnect industry. Individuals can receive this award only once.

- **The IPC Rising Star Award** is given to IPC members who have taken leadership roles and provided support to standards, education, advocacy, and solutions to industry challenges. Their contributions have made a significant impact on IPC and industry within the past five years and will continue to have a lasting impact for many years to come.



- **The IPC Peter Sarmanian Corporate Recognition Award** honors and recognizes an IPC member corporation (or appropriate division) in the PCB industry (supplier, board manufacturer, or OEM) that has made contributions to the industry while demonstrating support of IPC through participation in technical and/or management programs. While it is individuals who volunteer their time and talent, corporate support can be critical to any individual (or group of individuals) continuing to participate. This award recognizes companies who have not been content to “let the other guy

do it,” but who have actively made our industry better. The award is named for former IPC Board Chairman Peter Sarmanian, former president of Printed Circuit Corporation. Companies may receive this award more than once.

- **The IPC Stan Plzak Corporate Recognition Award** honors and recognizes an IPC member corporation (or appropriate division) in the electronics assembly industry (supplier, EMS company, or OEM) that has made contributions to the industry while demonstrating support of IPC through participation in technical and/or management programs. While it is individuals who volunteer their time and talent, corporate support can be critical to any individual (or group of individuals) continuing to contribute. This award recognizes companies who have not been content to “let the other guy do it,” but who have actively made our industry better. The award is named for former IPC Board Chairman Stanley Plzak, former president of Pensar Corporation, and a founding member of the IPC Electronics Manufacturing Services Industry Management Council. Companies may receive this award more than once.

While none of the recipients has been named yet, we have learned that three individuals will receive the President’s Award, the Rising Star Award will be presented to four recipients, and three people will be honored with the Dieter Bergman IPC Fellowship Award. The other awards will have one recipient each. All of the awards will be announced at IPC APEX EXPO 2019 in San Diego, California, from January 26–31. We will also explore these awards further in our I-Connect007 post-show “Show & Tell” publication to be published in February. **PCB007**

Images courtesy of IPC Flickr album.

Reference

1. [IPC Corporate and Individual Awards.](#)



Executive Forum at IPC APEX EXPO 2019 Focuses on Advancing Automotive Electronics

Feature by Patty Goldman
I-CONNECT007

This year at the IPC APEX EXPO, the Hall of Fame Council has put together an executive forum on “Advancing Automotive Electronics.” This not-to-be-missed forum is designed for executives in the entire automotive electronics system supply chain. Reserve this date: January 28 at 7:30 a.m.

The program includes a special overview of the IPC’s growing role in automotive electronics by IPC President and CEO, Dr. John Mitchell, as well as important presentations by Tier-1 providers Robert Bosch in Germany and AP-TIV (formerly Delphi) in the U.S.

To quote a recent press release from IPC:

Senior-level executives from across the global electronics industry supply chain will

gather to discuss challenges and opportunities of the burgeoning and rapidly changing automotive electronics industry during the IPC Executive Forum on Advancing Automotive Electronics at IPC APEX EXPO 2019. Presented by IPC’s Hall of Fame Council on January 28, the forum will focus on automotive electronics costs, reliability, and programs from concept to production.

With a global repertoire of speakers—including ones from the United States, Asia, and Europe—forum topics will include materials in automotive electronic packaging, PCB reliability testing for automotive electronics, developing dry-film photoresist to meet automotive fine-line circuit needs, cost models with suppliers and understanding costs of new technology, and developing and getting approval of new material for automotive electronics.



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The keynote speaker is Alex Stepinski, VP of GreenSource Fabrication, who will discuss recent innovations that enabled the construction of circuit production lines with the capability for single-piece flow, autonomous work cells, and extreme traceability capabilities that can yield higher quality levels and shorter cycle times than ever before while eliminating the traditional environmental footprint of a PCB manufacturer at the same time. Examples of these key innovations and how they relate to the future of the automotive industry supply chain will be presented.

Additional presentations will include:

- Alun Morgan, Ventec International Group ambassador, and Giorgio Favini, a founder of Elga Europe. Ventec and Elga are substrate and specialty chemical companies, respectively, both located in Europe and have developed materials specifically for automotive applications.

- The Senior Global VP of MacDermid Alpha Electronics Solutions, Joe D'Ambrisi, along with Director of Marketing Communications Don Cullen will present their global outlook for specialty chemicals and materials in automotive electronic packaging.

- Larry Wilson III, the leader of Nexteer Automotive's Global Electronics Costing Team, will provide a cost history and forecast of automotive electronics by following the history of a particular motor vehicle.

- CTO of MicoteK Labs China, Bob Neves, will present "PCB Reliability Testing for Automotive Electronics—The China Story." Neves is a member of the HoF Council and the IPC Board of Directors.

- Randy Hierbaum, VP of OptimalPlus, will present "Striving for Zero DPPM." He is working with Tier-1 automotive supplier Continental in Guadalajara on this topic.

- Gene Weiner, IPC Executive Forum program chair, had this to say: "As the automotive industry increasingly incorporates electronics into its manufacturing, this provides a unique opportunity for IPC and our members to participate in this continually evolving field. This forum provides us with a chance to hear from subject-matter experts about the many ways for the involvement of our industry in automotive electronics."

According to IPC's VP of Solutions, Sanjay Huprikar, this forum at IPC APEX EXPO 2019 is a great follow-up to IPC's June Automotive Electronics Forum held in Nuremberg, as well as the September launch of a new Reliability Council in Frankfurt. "It directly supports IPC's efforts to engage heavily with the transportation vertical," said Huprikar.



2018 IPC Automotive Electronics Reliability Forum attendees, L-R: David Bergman, Lars-Olof Wallin, and Sanjay Huprikar.

Early registration is highly recommended to ensure participation in this event as it could be limited to 100 delegates. Information and registration for the IPC Executive Forum on Advancing Automotive Electronics is available online at www.ipcapexexpo.org. Along with breakfast, lunch and the VIP networking dinner are included, although the dinner is for IPC members only. Judging from past events, the networking alone is worth the registration price. **PCB007**



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ein Electronics Industry News and Market Highlights



Nine Top-15 2018 Semiconductor Suppliers Forecast to Post Double-Digit Gains ▶

The expected top-15 worldwide semiconductor (IC and O-S-D—optoelectronic, sensor, and discrete) sales ranking for 2018 is shown in the figure. It includes seven suppliers headquartered in the U.S., three in Europe, two each in South Korea and Japan, and one in Taiwan.

Global Biometrics Technology Market to Reach \$59.31 Billion by 2025 ▶

The global biometrics technology market size is likely to reach \$59.31 billion by 2025, experiencing a CAGR of 19.5% during the forecast period.

NASA Looking to Tiny Technology for Big Payoffs ▶

NASA is advancing technology that could use large amounts of nanoscale materials to launch lighter rockets and spacecraft than ever before. The super-lightweight aerospace composites (SAC) project seeks to scale up the manufacturing and use of high-strength carbon nanotube composite materials.

Seven of Top 10 Smartphone Markets Down in Q3 2018 ▶

Worldwide smartphone shipments fell by 7% in Q3 2018, a fourth consecutive quarter of decline. This was also the worst third quarter performance since 2015.

Gold 'Micro Jewels' from 3D Printer Printing Pure Metal Microparts ▶

Thanks to a laser technique that ejects ultra-tiny droplets of metal, it is now possible to print 3D metal structures, not only simple 'piles' of droplets, but complex overhanging structures as well: like a helix of some microns in size, made of pure gold.

Is an 'Internet of Ears' the Next Big Thing for Smart Homes? ▶

Next generation of connected buildings environments using changes in vibrations, sound and electrical field to improve energy consumption, monitor occupants' movements.

Global Semiconductor Sales Up 14% YoY in September ▶

According to SIA, worldwide sales of semiconductors reached \$122.7 billion during the third quarter of 2018, an increase of 4.1% over the previous quarter and 13.8% more than the third quarter of 2017.

Fleets of Drones Could Aid Searches for Lost Hikers ▶

Finding lost hikers in forests can be a difficult and lengthy process, as helicopters and drones can't get a glimpse through the thick tree canopy. Recently, it's been proposed that autonomous drones, which can bob and weave through trees, could aid these searches. But the GPS signals used to guide the aircraft can be unreliable or nonexistent in forest environments.

IDC Reveals Worldwide CIO Agenda 2019 Predictions ▶

In the multiplied innovation economy, enterprises are racing to reinvent themselves as the pace of digital transformation (DX) becomes exponential.

Solution for Next Generation Nanochips Comes Out of Thin Air ▶

Researchers at RMIT University have engineered a new type of transistor, the building block for all electronics. Instead of sending electrical currents through silicon, these transistors send electrons through narrow air gaps, where they can travel unimpeded as if in space.

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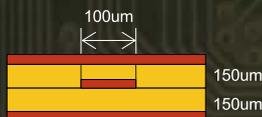
	Dk	Df
R-5785(N) + H-VLP2 Cu and Low Dk glass-cloth	3.4	0.002 @ 12GHz
R-5775	3.6	0.004 @ 12GHz

Applications

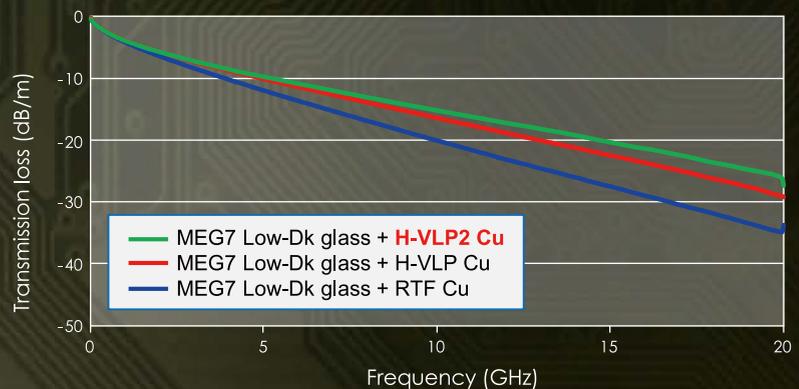
- High-end servers, High-end routers, Supercomputers, and other ICT infrastructure equipment, Antenna (Base station, Automotive millimeter-wave radar), etc.

Transmission Loss

- Construction



Line Length	1000 mm
Impedance	50 Ω
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Inner Cu Treatment	No-surface Treatment
Core	#1078 (RC67%) x 2ply
Prepreg	#1078 x 2ply



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Industry 5.0: Can We Learn From Other Industries?

The Right Approach

by Steve Williams, THE RIGHT APPROACH CONSULTING

The last few IPC APEX EXPO events have focused heavily on Industry 4.0, which is all about the Internet of Things (IoT), automation, and data exchange between machines. Where do we go from here? Perhaps we can learn some lessons from the sheet metal and plastic industries.

Integration of 3D Printing

I first wrote about this burgeoning technology back in the September 2012 issue of *The PCB Magazine* with a column titled “Will ‘Old’ PCB Technology Save American Manufacturing?” which compared 3D printing to the original additive process of manufacturing PCBs. Many of us old-school, pre-1980s technology board guys remember actually running the additive PCB process back in the day well before the subtractive process became the preferred methodology. The additive process was quite simple and had far fewer process steps than the complicated travelers seen in today’s PCB shops. There was neither a need for copper clad raw laminate nor current selective electroplating technologies. A negative image was defined on a resin substrate, and metal was selectively added, or built up, to form the circuitry and interconnects.

This was followed up in the October 2013 issue of *The PCB Magazine* with

“Point of View: 3D Printing—Tales from the Road,”

which highlighted the successful utilization of 3D printing from my travels in a variety of industries, none of which were PCB manufacturing:

Medical

Peking University’s Dr. Liu Zhongjun has been using EBM 3D printing for the past nine years to develop new spinal implants (Figure 1). During that time, he has created hundreds of orthopedic implants that have been custom engineered to fit each specific patient’s body. He explains, “In the past, we used clinical titanium mesh, but with the growth of bone, titanium mesh could easily stick into the bone and cause collapse. 3D-printed implants fit the bone completely and allow the bone to grow into the implants.” Zhongjun continued, “In this aspect, 3D-printed implants are more reliable than traditional ones.”



Figure 1: 3D-printed spinal implant. (Source: Spinal Surgery News)

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Consumer Electronics

Stratasys has been working to combine its 3D printing solutions with Optomec's Aerosol Jet thin-film conformal printing process for electronics. Optomec has utilized this process to develop a method of printing 3D antennas on the standard plastic enclosures and inserts of smartphones and other mobile devices. This process will allow different placements of the antennas, thereby reducing mobile device thickness.

Aerospace

NASA has been using this technology for over five years with a 3D printer built to make replacement parts in real time in space. According to Astronaut Timothy Creamer, "3D printing provides us the ability to do our own Star Trek replication right there on the spot to help us replace things we've lost, replace things we've broken, or maybe make things that we've thought of that could be useful."

Wow, what a difference six short years can make! 3D printing is now mainstream in industries such as sheet metal fabrication, injection molded plastic, machining, and die-cast. I have worked with companies in these industries for over 15 years and can personally attest that they have embraced this technology and opened up new revenue streams in the meantime. There has long been talk of utilizing this technology for PCB manufacturing, but it has

never seemed to get out of the science project phase.

Let's take a look at how other industries are utilizing 3D printing and see if there is a lesson to take for PCB manufacturing.

Sheet Metal Fabrication

These engineers have probably integrated 3D printing into manufacturing better than any industry, continuously developing new applications that directly improve operations and the bottom line. The first innovation was to print 3D press brake custom tooling (Figure 2). The concern about the durability and strength of plastic 3D-printed parts is quickly dispelled while watching metal being formed in plastic tooling under the stress of a 150-ton brake press. Another breakthrough application was the ability to create part-specific welding fixtures to hold geometrically complex parts or orientations (Figure 3). Inspection benefits from similar tooling to hold these challenging parts in place on the coordinate measuring machine (CMM) for quick a setup for first article and in-process inspections.

Plastic Injection Molding

Plastic engineers have developed hybrid tooling combining traditional steel with 3D-printed plastics (Figures 4 and 5). Some tools are mostly plastic, but the biggest innovation is to use 3D-printed plastic inserts—internal mod-

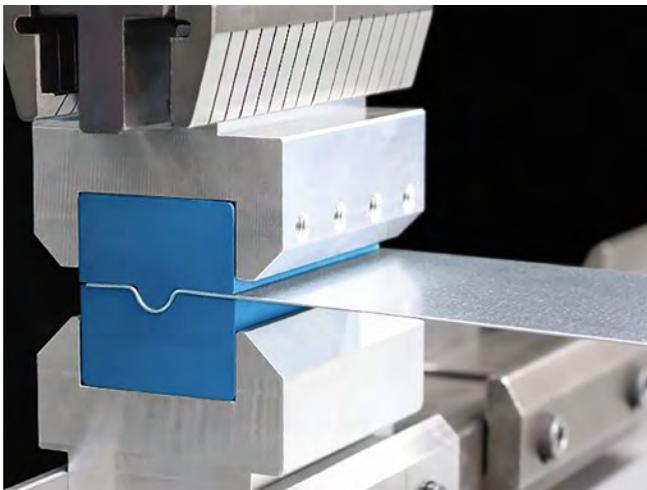


Figure 2: 3D-printed press brake tooling. (Source: *The FABRICATOR*, September 2018)



Figure 3: 3D-printed welding fixture. (Source: *The FABRICATOR*, September 2018)



Figure 4: 3D-printed injection molding hybrid tool. (Source: [Javelin Technologies](#))

ules that may change or need to be replaced frequently due to wear. The ability to tweak and print inserts immediately without having to send the tool back to the tool maker is a game changer.

Of course, jigs and inspection tools are as prevalent in plastic manufacturing as sheet metal, but what has added another dimension is the ability to produce fully functional prototypes, proof of design, and small run products. Injection molding tooling can cost anywhere from about \$20,000 to well over \$500,000 depending on size and complexity, which is extremely cost prohibitive for prototypes and very small production runs. Being able to additive-

ly manufacture a few parts through 3D printing with zero tooling has opened up a whole new market for plastics companies (Figure 5).

Aerospace

Heat exchangers are used extensively in the aerospace industry for thermal management and come in all shapes, sizes, and complexities. There are two legacy methods of manufacturing these heat exchangers. First, drill cross channels in a thin structure and use screws to block channels and direct the flow of coolant. This process is greatly limited in design flexibility. Second, milling channels in multiple parts, as much as six to seven, to create the flow path, and then the parts are brazed together to complete the exchanger. Companies like Fabrisonic have developed a hybrid machine that combines 3D printing, ultrasonic surface smoothing, and 3-axis machining, which makes it possible to produce deep slots, hollows, lattices, and honeycombs with ultra-smooth channel surfaces (Figure 6).

PCB Applications

The ability to print custom engineered parts is especially beneficial to industries such as PCB manufacturing where everything is custom and specific to part numbers. Shops have occasionally outsourced custom-machined inspection guides for a specific part number, but these are usually very high-volume programs

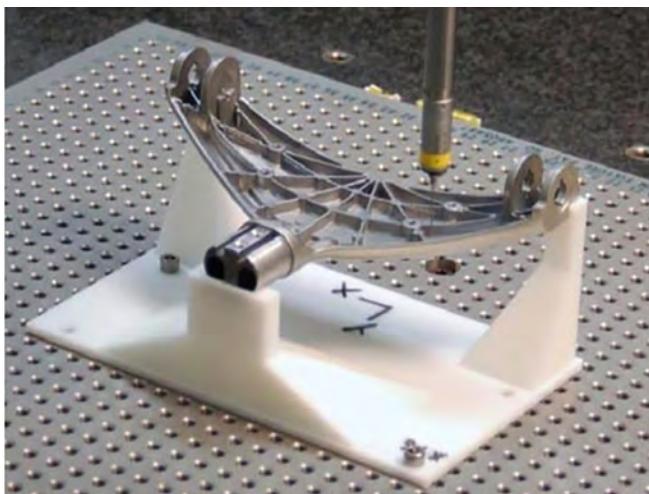


Figure 5: 3D-printed inspection gauge. (Source: [Prove3D](#))

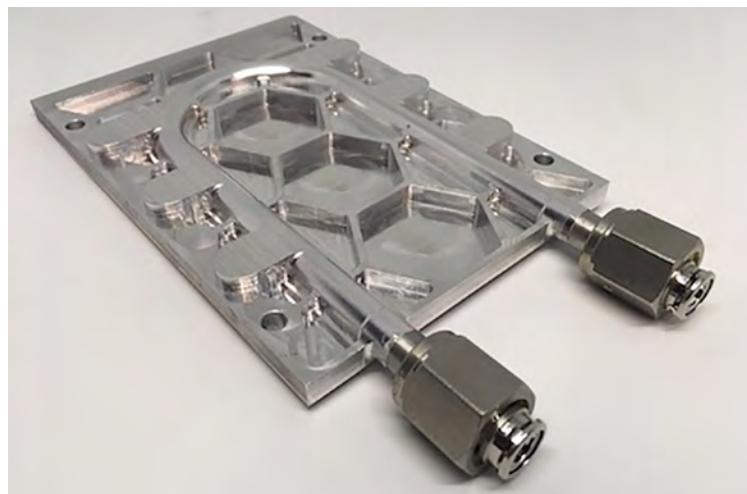


Figure 6: SonicLayer 3D-printed heat exchanger. (Source: [Fabrisonic](#))

due to cost. Think about the implications if custom jigs, fixtures, and inspection guides could be quickly and inexpensively produced for every job regardless of quantity.

Flex and rigid-flex products often require intense internal tooling pins with exact diameters and overall length. Imagine being able to quickly produce your own pins in infinite diameters and lengths without having to purchase a 1,000-piece minimum order when you only need 50. A custom inspection fixture for the CMM may be needed to hold a complicated 3D board to be able to measure some dimensions while in the final application state.

External heat sinks are another application for 3D printing, again, especially for prototypes or small-run orders (think of the heat exchanger example previously mentioned). A metal heat sink with a very complicated profile may challenge the capabilities of tra-

ditional machining or be cost prohibitive for small runs.

Conclusion

I would stack up our PCB engineers against engineers from any of the above industries and challenge them to find creative applications in our industry to use 3D printing to move us forward. While a 3D-printed advanced technology PCB is certainly nirvana with all the hybrid substrates, complex via structures, and differing electrical performances, this technology is just not there yet. But let's check back in again in another six years! **PCB007**



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

Ventec's Marketing Strategy and Their Newly Appointed Technology Ambassador

At electronica 2018, Mark Goodwin, chief operating officer at Ventec International Group, discusses the company's marketing strategy along with their newly appointed technology ambassador, Alun Morgan, and how he sees the world.

"Ventec is heading in the direction of increasingly becoming a technology company," says Goodwin. "All of the new products we're bringing to the market have

a technology driver, not primarily a cost driver. Cost, price, and supply chain are always important, but we don't want to be a me-too FR-4 laminator forever. We aren't anymore. We're a very strong market leader in thermal management and have ambitions to be leaders in other interesting high-technology niche markets too—I use the word 'niche,' but those niches are quite big today."

Of Morgan's appointment, Goodwin notes that his role is to help the management team at Ventec to bring their message of technology and technical know-how to a wider audience at the PCB level, and more importantly, at the OEM level.

"We know all of our customers in Europe, but we don't know all our customers' customers—we don't know all of the OEMs. Our materials are becoming more integral parts of their products with functionality, not just real estate or a mechanical structure for holding components. We have to talk to these individuals directly," says Goodwin.

[Read the full article here.](#)

(Source: Pete Starkey, I-CONNECT007)



Pete Starkey, Mark Goodwin and Alun Morgan.

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Surface Preparation and Cleaning, Part 3

Trouble in Your Tank

by Michael Carano, RBP CHEMICAL TECHNOLOGY

Surface preparation and cleaning are essential aspects of metal finishing and PCB fabrication. The PCB fabricator has several processes that fit the broad category of cleaning and surface preparation. However, the organization needs additional studies to enhance the broad portfolio of products for their respective fitness for use in today's technology. In addition, this exercise will assess gaps in the RBP cleaning and surface preparation segment and make necessary process improvements through bench scale and field application trials.

Overview

In general, surface preparation is done to ensure good adhesion of metal, dielectric, photoresist, or solder mask to the prepared surface, although avoiding excessive adhesion could also be the objective. Take the example of surface preparation before dry photoresist lamination, such as failure to:

- Achieve good adhesion in a print-and-etch process, which will cause etchant attack under the resist and ultimately an open defect
- Achieve good adhesion in a plating process, which will cause tin and lead underplating, ultimately leading to shorting defects (shorts)
- Achieve a good release of unexposed resist during development, which can cause etch retardation in a print-and-etch process, ultimately leading to shorts

- Achieve a good release of unexposed resist during development in a plating process, which can cause poor adhesion of the plated copper to the copper base (copper-copper peelers)
- Achieve a good release of exposed resist in a print-and-etch process on inner layers, which can inhibit the formation of a multilayer bond on such a copper surface
- Achieve a good release of exposed resist in a plating process, which can cause etch retardation
- Remove residues including chromates and organic soils (including resin spots), which will adversely affect inner layer bonding and plating quality

Figure 1 depicts an example of both an open and a short due to improper surface preparation leading to poor adhesion.

To fully grasp some of the surface preparation issues, a primer on the copper foil manufacturing process will enhance the reader's understanding with the composition and topography of standard electrodeposited (ED) and reverse-treated foils (drum-side-treated foils).

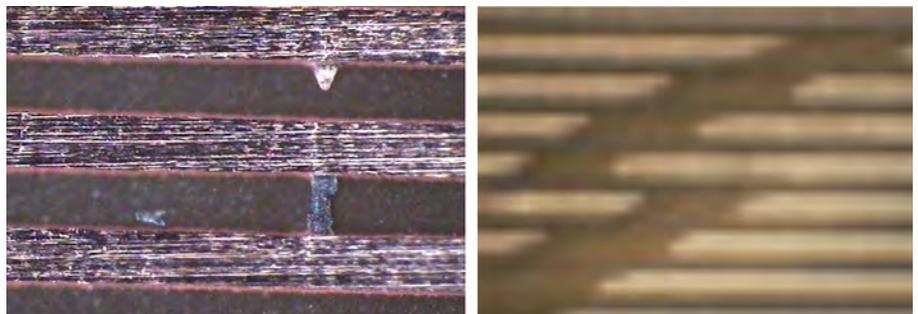


Figure 1: Short circuit (L) and open circuit (R) due to insufficient resist adhesion.

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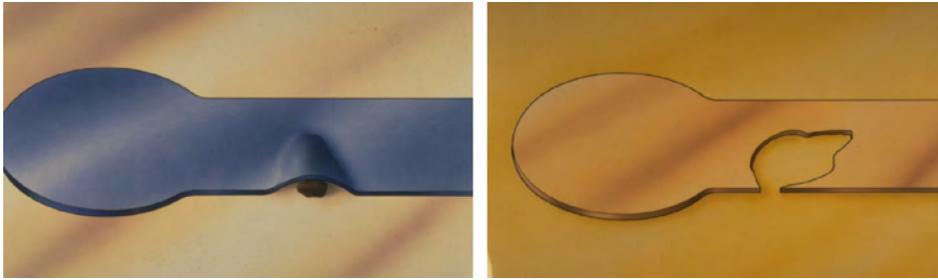


Figure 2: Inner layer showing poor resist adhesion (L) and result after etching (R).

Figure 2 shows a schematic of poor adhesion leading to resist lifting. As a result, the poor adhesion leads to the etching away of copper.

Figure 3 illustrates a typical process for treating the rough and smooth sides of the ED foil. In a continuous reel-to-reel process, the foil unwinds and passes through several treatments in a treater line. Copper dendrites are first grown on the rough side. These dendrites are brittle and need to be encapsulated in a second step with more ductile copper. This sequence is repeated, creating dendrites on top of dendrites. A zinc coating—or a brass coating, alternatively—is then deposited, followed by the encapsulation with silane coupling agent, which forms strong bonds with the resin.

On the smooth (drum) side, a very thin zinc (nickel) barrier is deposited, followed by a chromate and zinc coating. The nickel barrier prevents the formation of copper and chrome intermetallics that are difficult to remove with acid cleaners.

In the past, thickness and chemical composition of chromium layers were not well controlled and could lead to poor resist adhesion and low yields. Great progress has been made in controlling the conversion coating. The desirable stain-proofing properties are balanced against the ability to remove a fair portion of the chromium layer with a simple process step such as treatment with 10% sulfuric acid.

One should note that chromate levels may vary for any number of reasons. There is no correct chromate thickness or amount on the surface of the copper foil. Regardless, removing the chromate from the foil surface is the first step to enhancing photoresist adhesion. The chromate conversion coating serves as

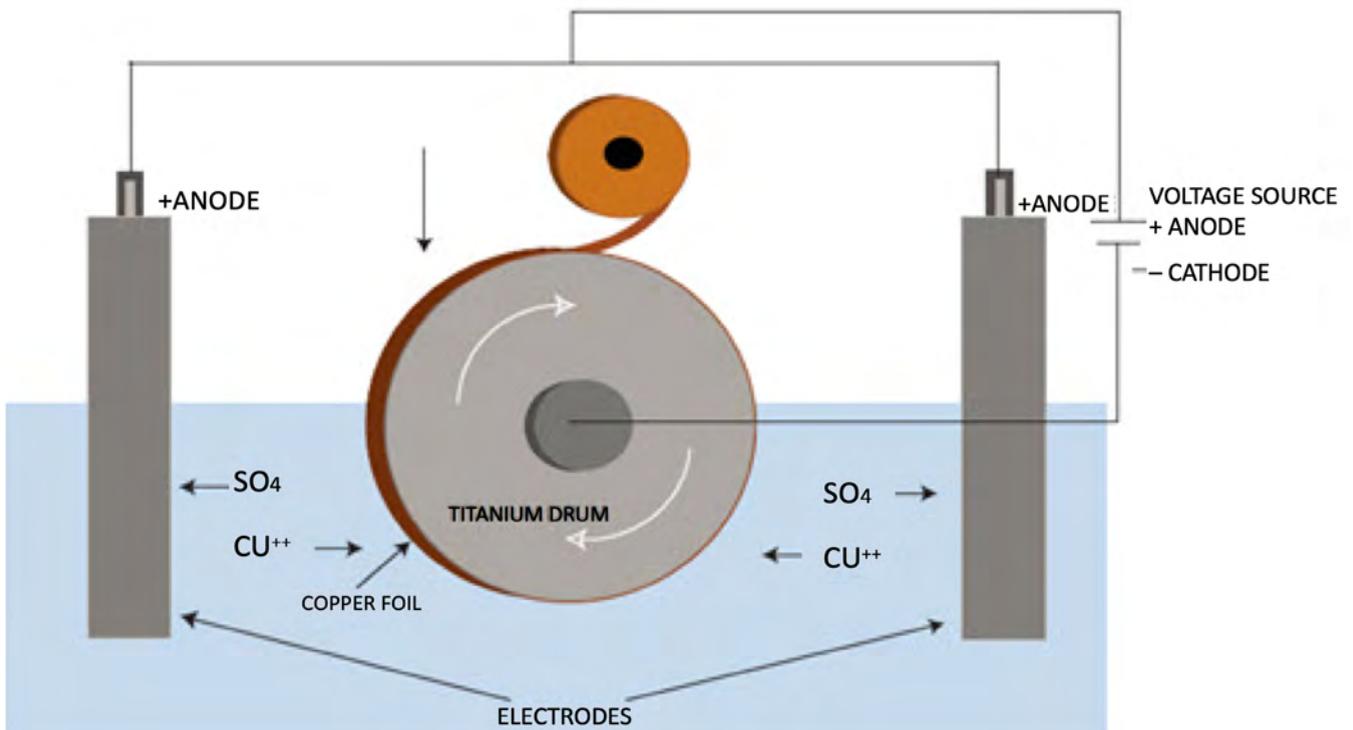


Figure 3: Manufacturing of ED copper foil. (Source: Oak-Mitsui Inc.)

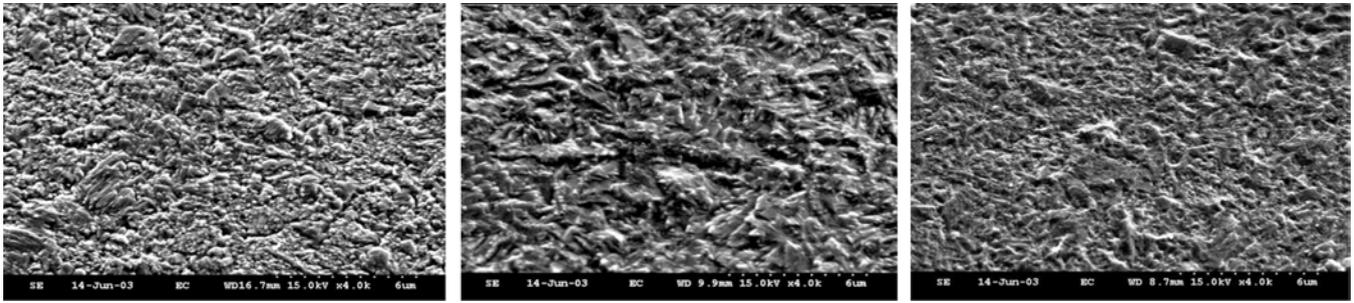


Figure 4: Hydrogen peroxide-sulfuric (L), oxone (middle), and sodium persulphate (R).

an anti-tarnish to preserve it and slow down the copper oxidation process. The chromium phase is a contiguous, hydrated $\text{Cr}(\text{OH})_3$ phase with chromium predominantly at the oxidation state Cr^{+++} with interspersed zinc. The degree of hydration is critical to the removal of this layer in acid. Typical chromium coverage would be about 5 mg/m².

Occasionally, suppliers also apply organic anti-tarnishes such as benzotriazole. It is debatable why and to what extent these conversion coatings should be removed before lamination. In the case of chromate conversion coatings, there is ample evidence that most dry films do not adhere well to such a surface. Also, in most inner layer production processes, prelamination cleaning serves a dual purpose: to remove chromate to help film adhesion and ensure good oxide formation for multilayer bonding.

In addition, failure to remove chromates and other soils effectively will lead to differential etching. This means that during the surface roughening step (after chromate and soil removal), by employing a microetch formulation, the roughening will be less than optimum due to incomplete chromate and other soil removal. This negatively impacts the adhesion of resists. In areas where organic soils and chromates remain, the microetchant will have a compromised ability to provide a uniformly structured surface.

In-house Evaluation and Data Gathering

Due to the importance of surface preparation in PCB manufacturing, the fabricator should embark on an evaluation of current chemical and mechanical processes available. Some of

the evaluations will require working closely with the dry film and chemical suppliers.

When evaluating the effectiveness of surface preparation for primary imaging, at a minimum, the following data points must be measured:

1. Surface profilometry with different microetchants
2. Effect of chromate removing chemistry on surface cleanliness and topography
3. SEM analysis of treated copper surface utilizing different microetch chemistries
4. Film and mask peel tests after chemical treatment
5. Sidewall SEM analysis after development comparing differing chemical preparation methods

Examples of generic chemistry performance on copper surfaces are shown in Figure 4. The different generic microetches impart stark differences in topography. One must consider these differences when evaluating chemical clean processes and adhesion.

In a future column, I will explore solder mask adhesion issues. This is critical due to the aggressive nature of several final finishes including ENIG and immersion tin.

Desired Outcomes

The overarching task for the fabricator is to optimize the cleaning and surface preparation processes of the copper surfaces. The engineer will also need to finalize data including supporting documentation as to differences in grain structures of different microetch formulations and their effect on the copper foils.

Recognizing these differences, the engineer will provide recommendations as to which combination of cleaners and microetchants provide optimal surface profiles to meet current industry criteria including but not limited to:

1. Adhesion performance for sub-5-mil lines and spaces for primary resist (Figure 4)
2. Ability to hold solder mask dams
3. Improve solder mask adhesion under various conditions including the ability to withstand lifting when exposed to ENIG and immersion tin plating
4. Documented yield improvements from customers willing to share data
5. Expand RBP chemical clean and surface preparation process platform with new and improved processes and formulations (i.e., separate project—phase 2)

In the end, lines and spaces are only getting finer (Figure 5). **PCB007**

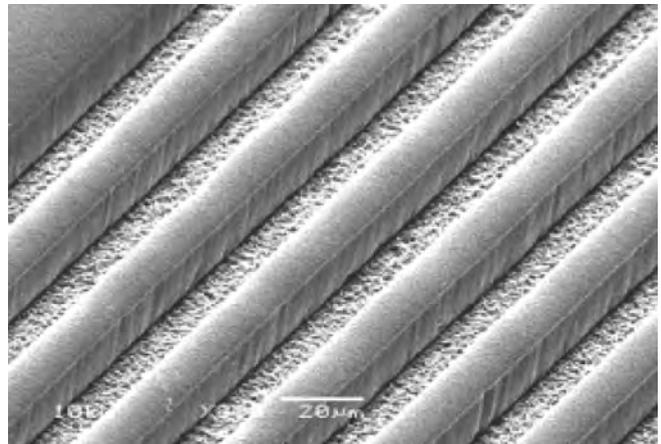


Figure 5: Sidewall of developed photoresist (20-micron line, 0.8 mils).



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

Electrolube on Managing Thermal Interfaces and Conformal Coatings

In an interview with I-Connect007 during the recent electronica 2018 show in Munich, Germany, Jade Bridges, Electrolube's global technical support manager, discusses how to manage thermal management interfaces for maximum heat transfer efficiency. She addresses new applications in the market, and how they are addressing the increasing need for thermal management solutions.

"The LED industry is one we've focused on a lot where efficiency is key, and the automotive industry is another important area," says Bridges. "We've looked at the requirements of these industries and how they differ from what we were doing 10, 15, and 20 years ago. It's a growing market, and the range of applications is expanding, so we decided to invest in a thermal management specialist team that solely concentrates on that area. We have chemists developing new technologies and making our



Jade Bridges

current technologies even better. That's the basis of what that team does, which has resulted in a massive expansion of our range over the past four years not just in current product technology, but in new technology like our phase-change materials (PCMs), for example."

Bridges also provides an update on their conformal coatings. "It's another fast-growing market with an increasing variety of applications. Different industries are realizing that they need some level of protection because of warranties on electrical products and the importance that electronics continue to have in our everyday lives. As a result, that means harsher conditions, a longer working life, more thermal cycles or thermal shock conditions, and with conformal coatings—as in many other industries—high throughput."

[Read the full article here.](#)

(Source: Pete Starkey, I-CONNECT007)

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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 Substrates for Advanced PCB Technologies: What Will the Future Hold? ▶

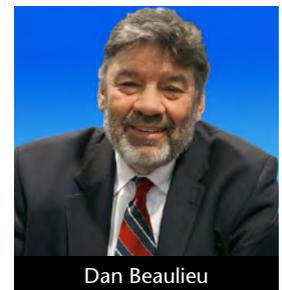
The UK chapter of the global IMAPS community of electronics and microelectronic packaging engineers shared a wealth of knowledge and wisdom about PCB substrate technology trends, developments, and future requirements in a webinar on the first of November.



Pete Starkey

3 It's Only Common Sense: What the Customer Really Means ▶

As salespeople, one of the things that we spend a great deal of time doing is trying to interpret what the customer is telling us. We all can hear the customer and what they are saying, but so often, we don't know what they mean.



Dan Beaulieu

2 Increasing Productivity for Flex Fabricators ▶

Barry Matties and Nolan Johnson of I-Connect007 met with Shane Noel and industry veteran Mike Jennings of ESI to discuss the introduction of their CapStone laser tool, a product aimed at doubling their flex circuit fabricators' throughput. Mike also shares advice for fabricators who are looking to move into the ever-growing flex market.



Shane Noel

4 Jeff Waters: Isola Updates ▶

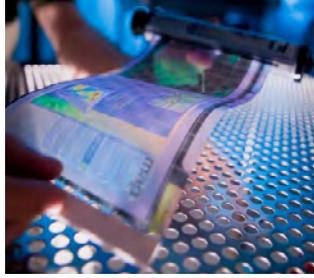
During PCB West 2018, Nolan Johnson and Barry Matties sat down with Jeff Waters, Isola CEO, to catch up on company activities, including the recent sale of the factory in Chandler, Arizona, the plan to build a new facility, product developments, current market dynamics, a new CFO, and much more.



Jeff Waters

5 Powering the Flexible World ▶

From 2019 we will come to a world with flexible electronics and batteries to power these devices have attracted tremendous attention. These devices may require batteries with special mechanical properties or form factors.



6 IDTechEx Highlights World Firsts in Printed Electronics in 2018 ▶

With the end of the year in sight, it's interesting to look back and review what has been new in the world of printed electronics in the last 12 months. This analysis is taken from the new IDTechEx Research report, "Flexible, Printed and Organic Electronics 2019–2029" covering the entire sector in great detail based on analyzing the industry for over 15 years.



7 IPC Signs White House Pledge to the American Worker ▶

IPC has signed the President's Pledge to the American Worker and committed to creating at least one million new training and workforce development opportunities in the electronics industry over the next five years.



8 Punching Out! Avoid Surprises During the M&A Process ▶

No one likes surprises, especially in merger and acquisitions (M&A) deals; there are enough unknown variables to start with.



Tom Kastner

9 150+ Years of Experience: Reflections with Three Industry Icons ▶

You would be hard-pressed to find a more knowledgeable and experienced group than that of Gary Ferrari, Gene Weiner, and Happy Holden. In a brief interview with Barry Matties, these three industry icons consider the past, present, and future state of electronics manufacturing while also offering advice to the newest generation of manufacturers.



Weiner, Holden & Ferrari

10 Trouble in Your Tank: The Art and Science of Photoresist Stripping, Part 1 ▶

Photoresist stripping has become a complicated process due to many unique resist formulations on the market. The first part of this column series looks at some of the most common problems in photoresist stripping and offers strategies on how to address them.



Michael Carano

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- communication and organization skills
- Sales attitude

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- Ensure that the quality management system is fully implemented
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- Liaison with customers and technical staff to resolve in-process problems
- Responsible for effective and successful management of staff and personnel matters (e.g., employee training and awareness is continuously maintained and updated)

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- Build and maintain positive relationships with customers
- Produce service reports
- Cooperate with the technical team and share information across the organization
- Assist with the crating and uncrating of equipment

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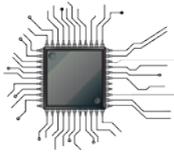
- Three to five years of experience with SMT equipment or an equivalent technical degree
- Proven strong mechanical and electrical troubleshooting skills
- Proficient in reading and verifying electrical, pneumatic, and mechanical schematics/drawings
- Organized, detail orientated, and capable of multitasking
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- Excellent team player that can lead projects and mentor others
- Self-motivated, with 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, PADS, Xpedition)

Primary Responsibilities

- Design project leader
- Lead highly complex layouts while ensuring quality, efficiency and manufacturability
- Handle multiple tasks and provide work leadership to other designers through the distribution, coordination, and management of the assigned work load
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Product Group Field Manager Waterbury, CT

The Product Group Field Manager is responsible for creating and driving the regional product line strategic plan in coordination with the global product line managers, strategic account manager and regional business managers. The successful candidate must balance commercial obligations to assist the sales teams in closing new business, perpetuating technical expertise throughout the field and develop best practices for the region.

Education: Bachelor's degree; 5 years of related experience; or equivalent combination of both.

Responsibilities

- Thorough understanding of the PCB business; specifics in wet processing areas.
- Facilitate developing commercial and technical strategy for customers.
- Create and deliver customer facing presentations.
- Training.
- Create and execute a product rationalization program aligning with global product managers.
- Develop roll-out packages for new product introductions, including operating guides.
- Excellent written and oral communication skills.
- Expert in chemistry and chemical interaction within PCB manufacturing.
- Willingness to travel globally.

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Responsibilities

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- Recommend product, process, and analytical method improvements; including changing composition of compounds.
- Develop final finish product line. Install products at beta sites; collect data.
- Lead technical teams during beta site installations of new products and problem-solving groups at customer locations.
- Train personnel.
- Set up tests of final finish chemistries and products for laboratory personnel to identify customer problems, analyze result to resolve customer issues, and communicate results to customers.
- Oversee laboratory analysis and processing of customer samples through our global technical centers; summarize data, make recommendations and write reports.
- Document technical bulletins.

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Career Opportunities



Director of Final Finishes Waterbury, CT

Education: Advanced practical knowledge—formal education and experience in chemistry or related sciences. Knows all technology within the business area and has knowledge of end use processes and OEMs.

Responsibilities

- Collects and analyzes market information, understands the competitive landscape, identifies potential gaps in product portfolio and effectively communicates needs to the product development group.
- Oversees product development activities, and reviews projects as they reach PDP milestones.
- Responsible for customer presentations and participation in trade organizations and other industry activities.
- Constructs release package information for the introduction of new products and sets pricing guidance for the commercial teams.
- Responsible for customer presentations and participation in trade organizations and other industry activities. High-level customer interaction required.
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- Develops and responsible for budgets and goals of the group.

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Gardien is the world's largest international provider of independent testing and QA solutions to the PCB industry with a global footprint across 24 service centres in 5 countries and we cater to a whole range of customers, from small, family-owned PCB shops to large international fabricators, and everything in-between. Gardien's quality solutions and process standards are trusted by leading high-tech manufacturers and important industries including aerospace, defense and medical technology.

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- Modify customer supplied data files and interface with customers and engineers
- Responsible for releasing manufacturing tooling to the production floor
- Prepare NC tooling for machine drilling, routing, imaging, soldermask, silkscreen
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- Suggestions on continual improvements for engineering and processing.
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A fantastic opportunity has arisen within Electrolube, a progressive global electrochemicals manufacturer. This prestigious new role is for a sales development manager with a strong technical sales background (electro-chemicals industry desirable) and great commercial awareness. The key focus of this role is to increase profitable sales of the Electrolube brand within the Midwest area of the United States; this is to be achieved via a strategic program of major account development and progression of new accounts/projects. Monitoring of competitor activity and recognition of new opportunities are also integral to this challenging role. Full product training to be provided.

The successful candidate will benefit from a generous package and report directly to the U.S. general manager.

Applicants should apply with their CV to
melanie.latham@hkw.co.uk
(agencies welcome)

[apply now](#)

Career Opportunities



International Field Service Engineer located in ITALY

The successful candidate will:

- Install and service our plotters and direct imaging machines at customer sites Europe-wide
- Carry out maintenance in the field
- Frequent travel: 4 to 5 days a week, 3 to 4 weeks a month
- Assist product manager

We are looking for a team player who is:

- Strongly customer-oriented and experienced in on-site support
- Accustomed to travel, and willing to travel frequently
- Motivated, independent and enterprising
- Technically-minded with training/background in electromechanics/electronics
- Experienced with software (setup, configuration, and usage of Windows-based CAM front-end software and Linux-based RIP software)
- Fluent in Italian and English (German and/or French is a plus)
- An analytical thinker
- Capable of problem solving

The right candidate will be a valued member of a friendly, team-oriented, growing international company that is a leader in its field, dedicated to excellence in all it does. Dynamic and fun, the company offers a great working atmosphere, and this new position is forward-looking and open, with plenty of opportunities for enterprising individuals whose results could be rewarded with prospects for progression in technical development.

Apply to Anja Ingels after clicking below.

[apply now](#)



Role: Vice President Gardien Taiwan TAOYUAN COUNTY, TAIWAN

Gardien Taiwan is a service provider of circuit board (PCB) quality solutions, including electrical testing, AOI optical inspection, engineering (CAM), fixture making, repair and rework. Gardien Taiwan operates service centers in Taoyuan and employs about 100 employees and is currently seeking a vice president to manage and oversee the entity.

Candidate Profile:

- Proficiency in Chinese and English (written and spoken)
- Excellent communication and organization skills
- Experience in change management
- PCB background appreciated, but not mandatory
- Management experience in internationally operating companies
- Savvy in standard office software (Word, Excel and Power Point)

If this sounds like you, please [click here](#) to send us an email with your attached CV.

About Gardien Group - Gardien is the world's largest international provider of independent testing and QA solutions to the PCB industry with a global footprint across 24 service centres in five countries and we cater to a whole range of customers, from small family owned PCB shops to large international fabricators. Gardien's quality solutions and process standards are trusted by leading high-tech manufacturers and important industries including aerospace, defense, and medical technology.

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Career Opportunities



ZENTECH

Zentech Manufacturing: Hiring Multiple Positions

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

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

Zentech is an IPC Trusted Source QML and ITAR registered. U.S. citizens only need apply.

Please email resume below.

[apply now](#)



Sales Associate - Mexico

Manncorp, a leader in the electronics assembly industry for over 50 years, is looking for an additional sales associate to cover all of Mexico and to be part of a collaborative, tight-knit team. We offer on-the-job training and years of industry experience in order to set up our sales associate for success. This individual will be a key part of the sales cycle and be heavily involved with the customers and the sales manager.

Job responsibilities:

- Acquire new customers by reaching out to leads
- Ascertain customer's purchase needs
- Assist in resolving customer complaints and queries
- Meet deadlines and financial goal minimums
- Make recommendations to the customer
- Maintain documentation of customer communication, contact and account updates

Job requirements:

- Located in Mexico
- Knowledge of pick-and-place and electronics assembly in general
- 3+ years of sales experience
- Customer service skills
- Positive attitude
- Self-starter with ability to work with little supervision
- Phone, email, and chat communication skills
- Persuasion, negotiation, and closing skills

We offer:

- Competitive salary
- Generous commission structure

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Career Opportunities

Mentor[®]

A Siemens Business

PCB Manufacturing, Marketing Engineer

Use your knowledge of PCB assembly and process engineering to promote Mentor's Valor digital manufacturing solutions via industry articles, industry events, blogs, and relevant social networking sites. The Valor division is seeking a seasoned professional who has operated within the PCB manufacturing industry to be a leading voice in advocating our solutions through a variety of marketing platforms including digital, media, trade show, conferences, and forums.

The successful candidate is expected to have solid experience within the PCB assembly industry and the ability to represent the Valor solutions with authority and credibility. A solid background in PCB Process Engineering or Quality management to leverage in day-to-day activities is preferred. The candidate should be a good "storyteller" who can develop relatable content in an interesting and compelling manner, and who is comfortable in presenting in public as well as engaging in on-line forums; should have solid experience with professional social platforms such as LinkedIn.

Success will be measured quantitatively in terms of number of interactions, increase in digital engagements, measurement of sentiment, article placements, presentations delivered. Qualitatively, success will be measured by feedback from colleagues and relevant industry players.

This is an excellent opportunity for an industry professional who has a passion for marketing and public presentation.

Location flexible: Israel, UK or US

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BLACKFOX

Premier Training & Certification

IPC Master Instructor

This position is responsible for IPC and skill-based instruction and certification at the training center as well as training events as assigned by company's sales/operations VP. This position may be part-time, full-time, and/or an independent contractor, depending upon the demand and the individual's situation. Must have the ability to work with little or no supervision and make appropriate and professional decisions. Candidate must have the ability to collaborate with the client managers to continually enhance the training program. Position is responsible for validating the program value and its overall success. Candidate will be trained/certified and recognized by IPC as a Master Instructor. Position requires the input and management of the training records. Will require some travel to client's facilities and other training centers.

For more information, click below.

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*With original content dedicated specifically to flex system and PCB designers, electrical engineers and those responsible for integrating flex into their products at the OEM/CEM level, you won't want to miss a single issue of **Flex007 Magazine!***

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Events Calendar

48th NEPCON JAPAN ▶

January 16–18, 2019
Tokyo, Japan

IPC APEX EXPO 2019 Conference and Exhibition ▶

January 26–31, 2019
San Diego, California, U.S.

DesignCon 2019 ▶

January 29–31, 2019
Santa Clara, California, U.S.

SMTA Pan Pacific Microelectronics Symposium ▶

February 11–14, 2019
Kauai, Hawaii, U.S.

EIPC 2019 Winter Conference ▶

February 14–15, 2019
Milan, Italy

China International PCB & Assembly Show (CPCA Show 2019) ▶

March 19–21, 2019
Shanghai, China

MicroTech 2019 ▶

April 4, 2019
Cambridge, U.K.

Medical Electronics Symposium 2019 ▶

May 21–22, 2019
Elyria, Ohio, U.S.

Additional Event Calendars



Coming to *PCB007 Magazine* in 2019:

January: SUPPLY CHAIN

We look into the effects of the supply chain crisis on fabrication.

February: SELLING YOUR SERVICES

The dynamics of the marketplace have shifted. What sales strategies are working for PCB companies.

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INNOVATIVE TECHNOLOGY: **BRYSON MATTIES**

COVER: **SHELLY STEIN**

COVER IMAGE: **ADOBE STOCK © sveta**

PCB007
MAGAZINE

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

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December 2018, Volume 8, Number 12
PCB007 MAGAZINE is published monthly,
by BR Publishing, Inc.

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