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I-Connect007

# PCB007 MAGAZINE

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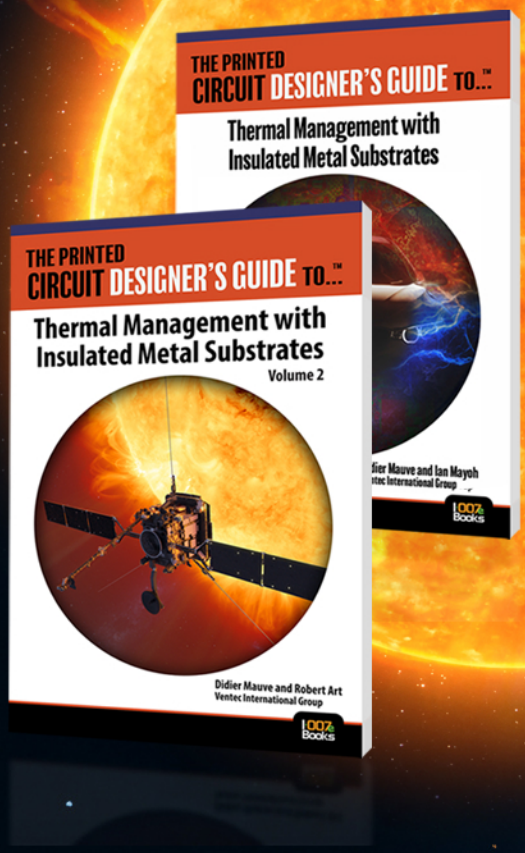


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# The Fabricator's Guide to IPC APEX EXPO

Like any great tech industry event, IPC APEX EXPO pushes us outside our busy 24/7 manufacturing bubbles. It forces us to pay attention to things that are important but not always present in our day-to-day lives. This issue previews many of the important events taking place at the show and highlights some changes and opportunities. So, buckle up. We are counting down to IPC APEX EXPO 2024.

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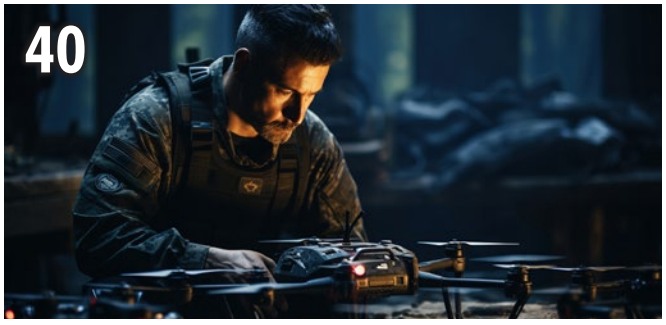




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# COUNTDOWN: The Fabricator's Guide to IPC APEX EXPO

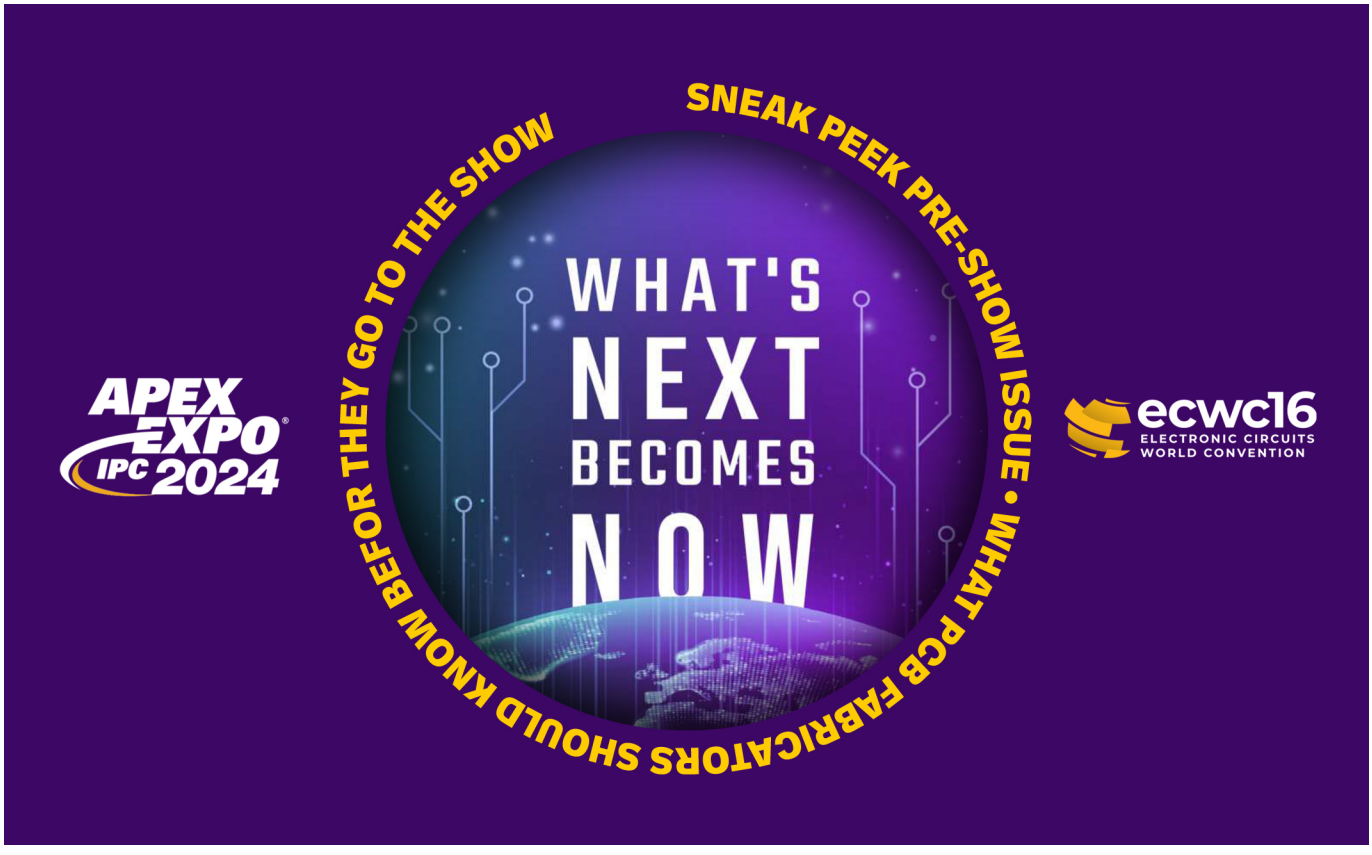
## Marcy's Musings

by Marcy LaRont, I-CONNECT007

Like any great tech industry event, IPC APEX EXPO pushes us outside our busy 24/7 manufacturing bubbles. It forces us to pay attention to things that are important but not always present in our day-to-day lives. But there is so much to see and do.

This issue of *PCB007 Magazine* previews many of the important events taking place at the show this year and highlights some changes and opportunities. Let us help you map out your show plan. This issue is focused on the PCB fabricator's show experience and how you can get the most from your valuable time and investment in attending the show. So, buckle up. We are counting down to IPC APEX EXPO 2024.

Most of us likely shared a sigh of relief that this year's show, April 6–11, would not happen immediately after the Christmas and New Year holidays. Though many will miss their beloved venue in San Diego, this move back to Anaheim is only 90 minutes north,



ensuring visitors can still bask in the sunny skies and moderate temperatures of Southern California.

The Anaheim Convention Center is a well-established and appointed venue conveniently located in the center of the greater Los Angeles area, near two large airports—LAX and John Wayne (Anaheim)—which makes it easier if you're traveling long distances. It's also strategically located across the street from Disneyland and Downtown Disney, which definitely adds appeal. In fact, IPC exhibitors can get discounted tickets to the overpriced Magic Kingdom with their registration packets. So, if you like to make the most of opportunities, a day in Walt's Wonderland might be just right for some epic team-building or memorable moments with customers.

This year, IPC will host Electronic Circuit World Convention (ECWC16), a global gathering of the World Electronic Circuits Council that happens every three years. Significantly, because of this year's confluence with ECWC, the Technical Conference promises to deliver higher-level content, in addition to robust Professional Development Courses for PCB designers, fabricators, and EMS professionals. Of course, a massive exposition with more than 4,700 exhibitors will be there on the show floor as well.

For this issue, we conducted an expert panel interview with IPC staff and chairs of the Technical Conference Committee, who talked about the technical prowess of the 2024 show from every angle: technical conference, special sessions, professional development, and standards. Make no mistake, technical topics for PCB fabricators have factored heavily into the paper presentations. The experts want PCB fabricators to get the most from their time and investment in attending this important industry event.

I've also included previews of other activities and networking opportunities at IPC APEX EXPO, from the Women in Electronics reception to the special technical sessions. Columnists John Mitchell, Hannah Grace, and Don Ball provide a welcome and their own tips on making the most of the show. And just for fun, we have some history of both IPC APEX EXPO and ECWC.

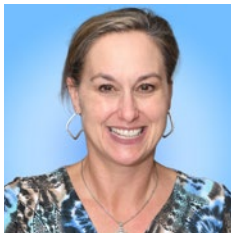
In addition to technical topics from our other columnists, I want to mention an important interview highlighting IPC's efforts to improve workforce development through an accredited apprenticeship model. These programs have recognition from the U.S. Department of Labor and are now gaining acceptance within individual state programs that will directly boost your hiring and training programs.

As I prepared for this month's issue, I was continually reminded of what impresses me most about IPC APEX EXPO: An unparalleled networking opportunity, communing with friends and colleagues (some of whom we only see one time each year), a ripe environment for impromptu technical discussions and business meetings, and deepening of the customer/supplier relationship.

Whether you are considering attending IPC APEX EXPO 2024 for the technical program, professional development, or to check out new equipment and technology toward improving your throughput, quality, or sustainability, it's most definitely worth your time and investment.

If you or your management team is still on the fence about your attending, please visit IPC's Justification Toolkit, which will help you better communicate the value of this investment for you and your company.

It will be my first time back at IPC APEX EXPO after returning to the industry. I look forward to seeing you all in April. **PCB007**



**Marcy LaRont** is the editor of *PCB007 Magazine*. Marcy started her career in PCBs in 1993 and brings a wide array of business experience and perspective to I-Connect007. To contact Marcy, click here.

# What PCB Fabricators Should Know

Feature Interview with the I-Connect007 Editorial Team

On the cusp of another IPC APEX EXPO, we focus on how bare board fabricators can maximize their time and investment at the show. We visited with Matt Kelly, IPC chief technologist, and Julia Gumminger, IPC professional development and events manager, as well as Udo Welzel and Stanton Rak, the chairs of the technical program committee, to discuss the technical depth and breadth that the 2024 show will bring to fabricators and professionals all along the supply chain. With IPC hosting the Electronic Circuit World Convention (ECWC16), this show presents an opportunity to highlight the most cutting-edge and relevant technical expertise available from across the globe.

***Barry Matties: IPC is hosting ECWC16 at APEX EXPO 2024. How will this year's technical conference be different from IPC APEX EXPO 2023?***

*Julia Gumminger:* The conference's Technical Program Committee has grown to a 35-person advisory group of subject matter experts from around the globe—about half of them with PhDs—working in various sectors of our industry with different areas of expertise. Stan Rak and Udo Welzel, the co-chairs, have done a fantastic job welcoming the new members representing the World Electronic Circuits Council (WECC) countries' organizations. The committee membership, made of WECC and IPC reps, have solicited technical papers

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Julia Gumminger

from their powerful, international professional networks. Last year, about 90% of the conference papers were due to direct outreach from a committee member to a colleague.

The ECWC16 conference will feature technical presentations from companies spanning the global supply chain. The committee acts as peer reviewers for the abstracts and the papers. They are always looking for new information, technical innovation, and data. Committee members attend conferences worldwide, sit on standards development committees, and are generally very active in the industry. They know whether something is new, the premise is false, or the data doesn't make sense. They have high standards for technology, that it must be innovative, make sense, and be relevant and useful in the industry.

*Matt Kelly:* My number one goal is to drive the quality level of our technical content. This show has been a great opportunity for that. The Technical Program Committee is not afraid to turn authors away if their papers do not feature new and innovative work. We focus on new topics and challenges, discoveries in materials and processes, and information that could transform our industry. Our team, namely Stan, Udo, and Julia, have done an amazing job modernizing the conference planning processes over the past three years. The printed circuit board tracks have traditionally been a strong focus at the show, but we are even stronger now with the breadth and depth of topics covered this year thanks to the global WECC member contributions.

*Stanton Rak:* I've been involved with the Technical Program Committee for over 10 years, and because of ECWC this year, we will have the greatest number of PCB-related submissions in the recent history of the conference. We expanded our committee by joining forces with several PCB associations in Asia and Europe; we nearly doubled in size for this event. We are integrating the contributions from both organizations—ECWC16 and IPC APEX EXPO 2024—and combining our technical conferences into one program. That was a big step for the Technical Program Committee.

*Kelly:* The printed circuit board industry in the United States deteriorated heavily over the last 20 years. Because of that, there is not as much printed circuit board technology leadership in this country as in some other global areas, certainly in areas like advanced packaging and EV. This leadership team and the technology committee spent a tremendous amount of time focused on the technology elements driving our industry, regardless of where the information is coming from, to bring the very best information to everyone attending the show. By bringing in global speakers on important topics that push our manufacturing limits, we can get that leading edge. This is driving the quality of our technology content higher.

***Matties: This seems to be a shift from past years when you simply asked for technical papers.***

*Gumminger:* Yes, and to be clear, IPC APEX EXPO is not an invitation-only conference, but this year is different because of the global reach of ECWC. Each year the technical conference puts out a Call for Participation that can be answered by anyone in the industry. With the participation of the WECC member countries, there was a concerted effort to recruit authors from those representing countries. It is also important to distinguish that there are two parts of the Technical Conference. In 2023, for the first time ever, we created the Thursday Special Sessions, which were curated by IPC and featured invited speakers. This year, IPC leadership, in consultation with the co-chairs of this committee, have designated two technical topics—advanced packaging and EV/automotive—to be highlighted in the two Special Sessions. Those presentations are by invitation only and feature highly curated content. This is separate from the peer-reviewed technical conference of papers. The special sessions are very much complementary but in a different style. It's a nice way to close out the week.

*Kelly:* The challenges and needs in printed circuit boards and ultra HDI will be discussed in the Thursday morning advanced packaging special session. Hannes Voraberger of AT&S will be speaking about the advances and challenges in fabricating UHDI PCBs and substrates. We want PCB fabricators to be aware of the state-of-the-art and how to push the limits in terms of miniaturization, materials, and changes. Udo and Stan, is there some synergy with that and the EV session as well?

*Udo Welzel:* There is always synergy with EV in automotive. EV applications are exposed to very harsh environments, and the functional requirements typically require a very high voltage. This unique combination of harsh environments and very high-voltage applications presents critical challenges to the PCB manufacturer. Overcoming these issues is crucial to achieving a wide distribution of EVs.

Also, it's worth highlighting that IPC's Technical Program Committee has always put a strong focus on PCBs. For this conference, due to combining forces with ECWC, we have a global outreach and representation of broader expertise through contributions that no other regional event can achieve. That's very attractive to attendees.

Udo Welzel

***Matties: From the bare board fabricator's perspective, what stood out in the conference paper submissions as most important?***

*Welzel:* HDI and substrates. Related to that are issues within advanced packaging around emerging technologies like additive manufacturing, printed electronics, and sustainability. Of course, some of these technologies provide an opportunity to make much greener electronics compared to what we are doing now.

***LaRont: Are these topics specifically covered within the Technical Conference?***

*Gumminger:* We have 100 paper submissions in peer review right now. We believe we will have about 80 presentations delivered during Tues-

day and Wednesday of the conference, covering every topic that has just been discussed here, some of which will overlap into advanced packaging and/or EV.

***Matties: Do you review the papers as they are received, or are they batched at the end?***

*Rak:* We follow a process. As Julia mentioned, we begin by reviewing the abstracts, and if the abstract seems to be the right fit for the conference, we invite the authors to submit their papers. After the papers are reviewed, we provide feedback to the contributors. In most cases, it's minor and easily addressed, but if substantial effort is required to address questions and feedback, the author must decide whether to invest additional time in pursuing paper presentation. It's usually pretty clear how things are going along the way. There generally aren't surprises.

> "There are multiple opportunities for anyone to get the information they seek at the conference."

***Matties: Another big issue for fabricators has been finding and maintaining a qualified workforce. Can a fabricator expect to find solutions to these types of business challenges at IPC APEX EXPO?***

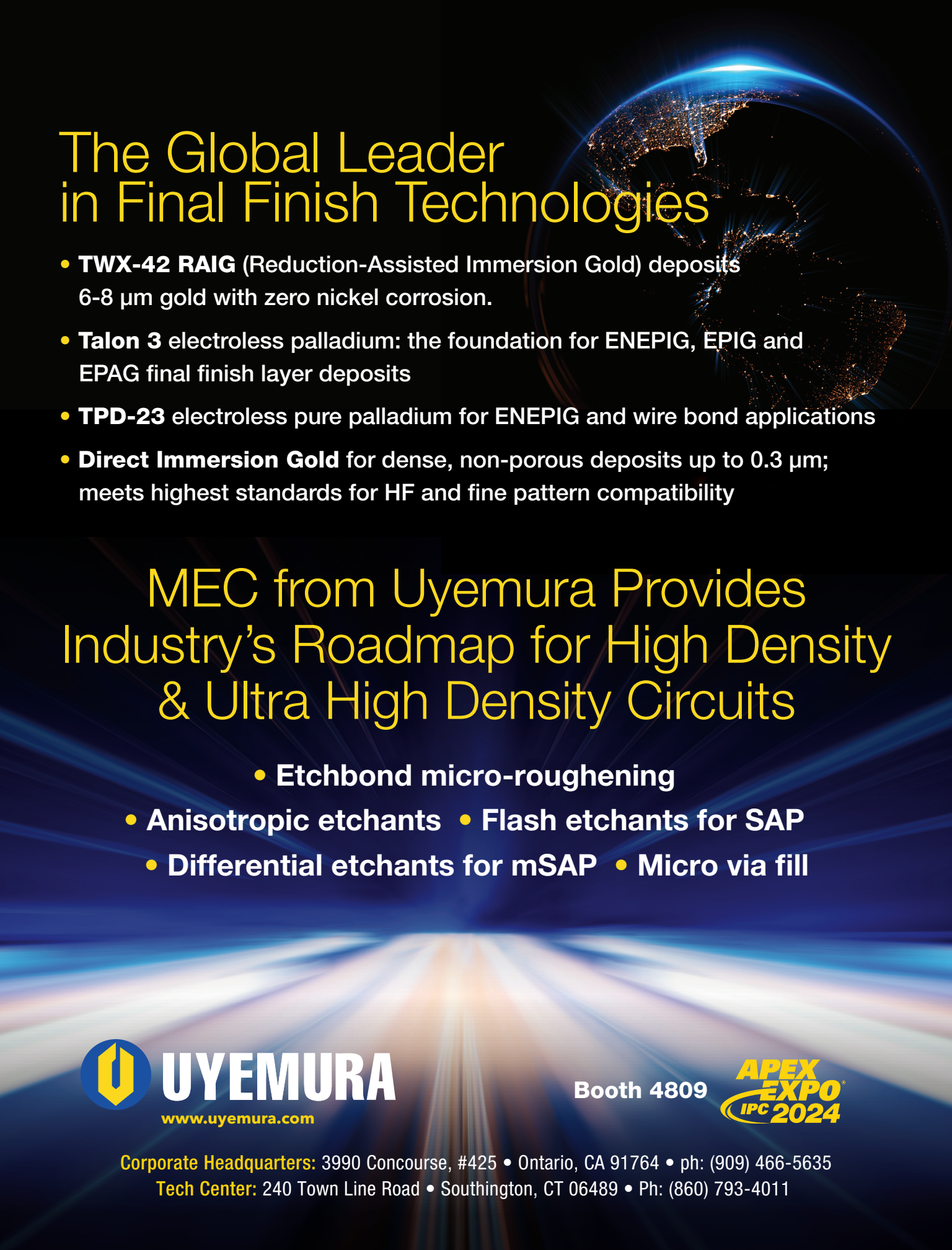
*Gumminger:* This would be something more likely to be addressed within the Professional Development Courses, but maybe not overtly. We try to ensure that the courses represent the diversity of topics attendees might be interested in to build their technical and professional skills. David Bergman and I work to ensure a balance of different topics and experience levels, whether the participant is a beginner or advanced in their part of the industry. We try to be conscious of filling technical knowledge gaps across the supply chain, offer opportunities for attendees to up-skill, and feature timely topics, such as sustainability.

*Rak:* There are four approaches a fabricator should consider when coming to the show to get access to the information they may need. First, there are the Professional Development Courses. Second, there are technical conference talks on pretty much all aspects of the PCB fabrication process, from material selection to surface finishes to the etching of copper and the creation of vias. I strongly encourage attendees to approach authors afterward to ask questions, get further information, or set up a meeting for future discussion. Third, we have exhibits with experts in all areas of the PCB manufacturing process who are answering questions and providing information at their booths. Finally, there are the standards committee meetings with a collection of experts and good opportunities for networking. The networking opportunities and potential for information on tangential topics that may not be covered specifically in the formal program are very important as well.

So, there are multiple opportunities for anyone to get the information they seek at the conference. I recommend fabricators utilize all of them to maximize their time and investment in the show.

*Gumminger:* It is important to note that the standards development committees look at the papers from the conference and sometimes use them as reference materials in developing updates or creating new standards.

*Rak:* This is certainly the case. A high-quality technical paper presented at the conference could end up being referenced to or serve as a basis for a future standard. If you want to aid the industry in making the right choices about standards, you could present a technical paper



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Matt Kelly

on a particular subject where you have expertise. Since it is peer-reviewed, the data can be trusted, which is needed as a foundation for developing standards.

*Gumminger:* We actually even spent several days as we built the conference agenda, comparing the standards development committee meetings and conference schedules to mitigate time conflicts on the same topics so that someone who is a leader in standards and very active in the conference could attend as many events as possible.

***LaRont: Does some of IPC's advocacy work, particularly around legislation in the U.S. and Europe, support more global participation in paper submissions? It's not just about Asia anymore with some of these technologies. Did that influence this process for the entire industry?***

*Welzel:* It is too early to tell if IPC advocacy has yet had an influence in this way. What we know is that we need more participation. For example, in the EV special session, as of today, we don't have a test coupon standardized for PCBs for high voltage-related testing requirements. That is something we must work on. We are on the inside and at the forefront of technology. To accelerate innovation, we must harmonize requirements along the supply chain. If every stakeholder in the supply chain is working with different requirements, then there's much attrition and friction. It is when the requirements are clearly defined and standardized across the supply chain that we can accelerate innovation.

***Matties: Automation and Factory of the Future are still popular topics. We're seeing investments in captive facilities with an increased focus on capability, and IPC has been involved in helping make that happen in the United States.***

*Kelly:* Yes, and we have seen quite a bit of interest from the U.S. Department of Defense. They are very interested in these technologies. In the presidential determination in early 2023, IPC was instrumental in putting in language to include printed circuit board technologies and IC substrates. We don't have a lot of action behind it yet, but at least we have the awareness and the attention that these are important technologies. We are making sure they get included.

Also, the design of printed circuit boards and how they are made is lacking from a reliability standpoint. As you know, whenever there is a change or standardization in EV markets or advanced packaging, commercially or for defense, the material sets called out in the design are at the very beginning of the process. As we continue working on the design side, we're also focusing on microvia technologies and overcoming some of the reliability failure mechanisms. And as we get into these new devices and chipsets, those determine design aspects as well. IPC launched a new initiative in 2023 to bolster our PCB design support, working with Peter Tranitz, senior director of technology solutions.

***Matties: Regarding design, we always hear about the need for more collaboration between designers and manufacturers from the engineering phase all the way through the assembly process. Is IPC APEX EXPO helping to foster that collaboration?***

*Kelly:* Of course, everything starts with design so you can't get too far down the product segment without having that defined. This is an area where we have asked for more participation from OEMs and are hopeful to see those partnerships develop.

***LaRont: Are you seeing papers from OEMs themselves?***

*Rak:* Not as much as we would like. We have some collaboration, though, and I know of at least one paper where the work was a collaboration between a technical organization and the OEMs.

*Kelly:* Julia, did you want to mention the OEMs who are involved?

*Gumminger:* So far, they include Intel, Samsung, IBM, Panasonic, Lockheed Martin, NASA, the U.S. Army, and more.

*Welzel:* This early involvement is reflected in the Professional Development design track where we have both design for excellence (DFX) and design for manufacturing (DFM) explicitly highlighted.

*Gumminger:* We currently have three or four papers in peer review in the design track, and we have design information being covered in the UHDI special session.

***Andy Shaughnessy: As the editor of Design007 Magazine, I'm happy to see IPC expanding its design offerings every year at IPC APEX EXPO. The Professional Development Courses have about 10 classes, and about half are DFM. It gets designers to consider talking to their fabricator. Is that an IPC goal?***

Stanton Rak

*Kelly:* Yes. This goes back to the core of our technology solutions mission where we have our key initiatives: advanced packaging, design, Factory of the Future, and e-mobility. Those pour into an event like this and the efforts behind it. We selected those very deliberately. They're slightly different, but they all have synergy, and they overlap.

***Matties: IPC has received some high praise around standards committees and meetings at IPC events from some of those who previously had been harsh critics. That change in attitude shows both acknowledgment and appreciation for how IPC's approach to the technical program and standards development has changed over the last couple of years, and how information is being developed and presented. Well done.***

*Kelly:* Thank you. That is good to hear.

***Matties: What else would be important for the PCB fabricators to know who are attending IPC APEX EXPO 2024?***

*Rak:* Let's do a quick overview of the session tracks related to PCB fabrication. We mentioned the design session for bare board fabrication, and HDI and microvias will have three session tracks. It has been an area of very high interest for the past three years. We have a session track planned on general via design, formation, construction, stacking, plating, and plugging. These sorts of topics should be of interest to PCB fabricators. There is a session track planned on laminate materials, with a greater interest in things like high-speed applications. We have two session tracks planned on PCB plating and surface finishes. Additive manufacturing is typically covered under Factory of the Future. Finally, there is one session track planned and about four separate papers on flexible and hybrid circuits. There is a lot of content in the program related to PCB fabrication.


***Matties: What has been the most fulfilling part of planning this year's show? What are you particularly proud of?***

*Rak:* For me, the integration and collaboration with ECWC colleagues was a special aspect of this conference.

*Welzel:* I agree with Stan. I think it worked very nicely, even considering the scheduling challenges between all the time zones. It was very efficient and really enriched the program for the upcoming conference.

*Gumminger:* We have modernized our processes as a team and as a committee. Logistically, we have delineated and defined the tools we are using. They are much more modern and that has been helpful when working with people from around the globe, allowing the 35 reviewers better access to the papers and information they need. It's a different way of doing business.

*Rak:* It is a sustainable group and process; it doesn't depend on any one person.

*Kelly:* I am most proud of this leadership team. What these three people do is unbelievable. I'm also most proud of the technical horsepower that IPC is delivering to the industry.

***Matties: You have provided a lot of great information, helping our fabricator readers plan to maximize their time at IPC APEX EXPO 2024. Are there any closing thoughts?***

*Gumminger:* I would like to encourage your readers to submit proposals/papers in the future. There is something very special happening this year with the wider global participation, particularly in Asia thanks to the efforts of the WECC representatives who recruited papers from their member countries. We won't have that level of attention and involvement next year, and the technical program committee will be much smaller, which means smaller networks of professionals from which to recruit papers. This is not an invitation-only conference. Anyone working on research or innovation should consider submitting their work. It is important for the whole industry to have more participation. It propels us all forward.

***Matties: Thank you all for spending this time with us. It was a pleasure. We're all really looking forward to IPC APEX EXPO 2024.*** PCB007

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# What's Next Becomes Now

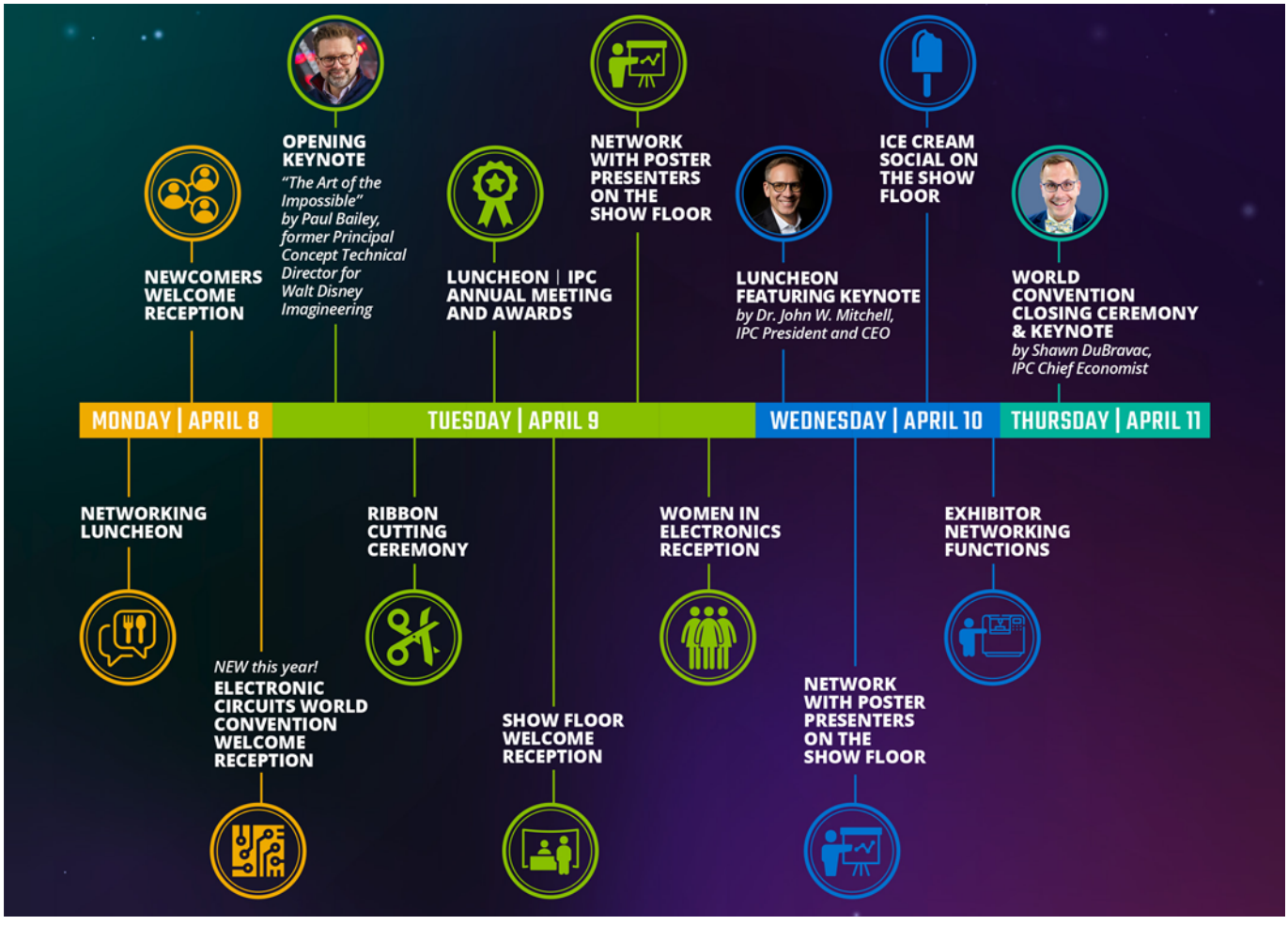
## One World, One Industry

Feature Column by Dr. John W. Mitchell, IPC PRESIDENT AND CEO

An extraordinary experience awaits attendees in Anaheim, California, when IPC APEX EXPO 2024 hosts the 16th Electronic Circuits World Convention (ECWC), an international PCB symposium held every three years in different cities worldwide. Combined, IPC APEX EXPO 2024 and ECWC16 will bring over 9,000 professionals from 60+ countries together in one location. The opportunity to gain perspectives from peers and industry leaders, manufacturing innovators, and subject matter experts from all corners of the world is a valuable opportunity for all attendees.

### What can you enjoy at IPC APEX EXPO this year?

The IPC APEX EXPO 2024 show floor will feature more than 300 exhibitors from every step in the electronics manufacturing supply chain. Walk the show floor to meet the indus-



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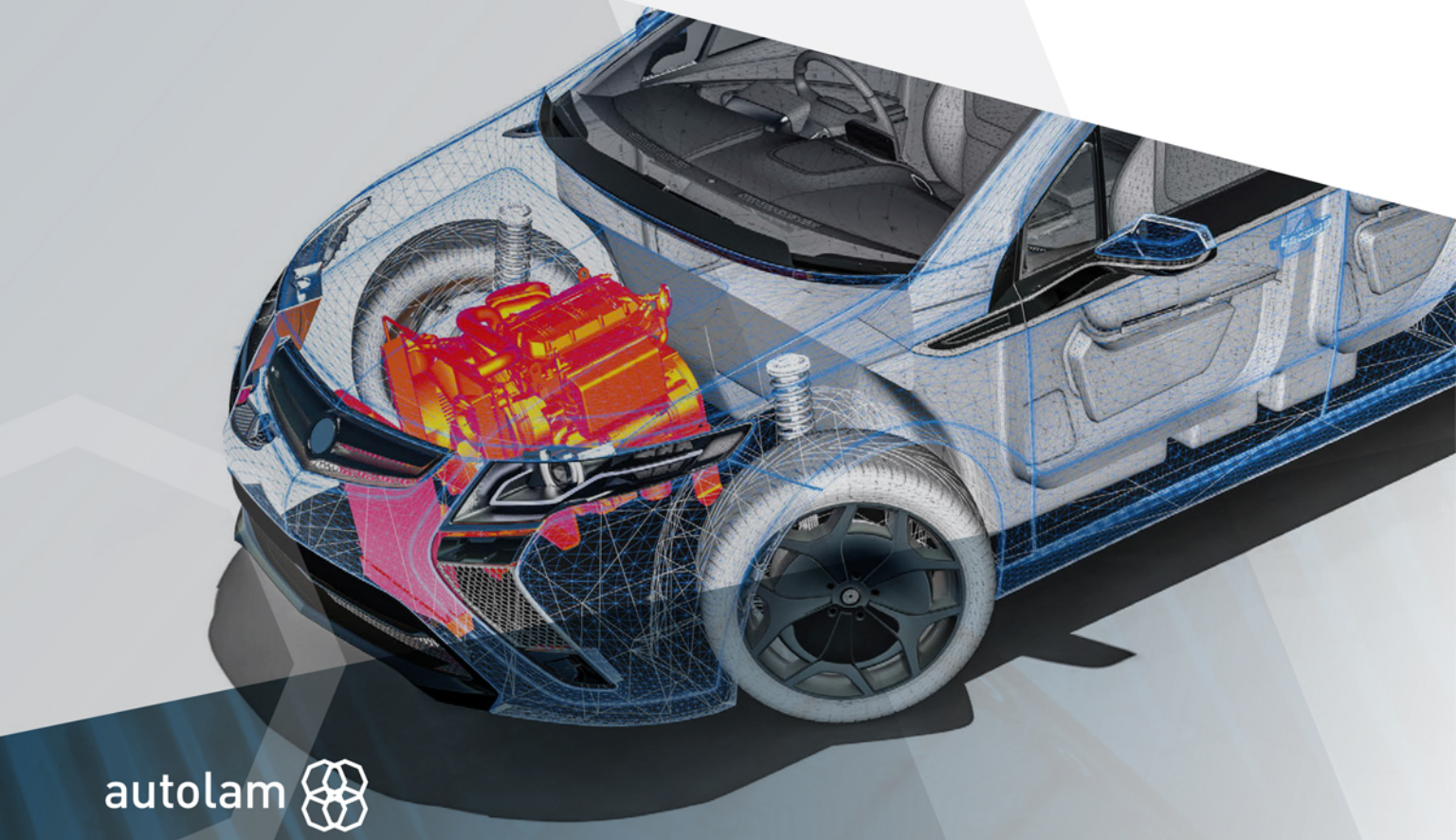

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We're excited to present three keynotes this year with a new twist: an opening keynote, one luncheon keynote, and for the first in a long time, a closing keynote. Former Principal Concept Technical Director for Walt Disney Imagineering Paul Bailey will provide anecdotes in his opening keynote about the creation of "Star Wars: Rise of the Resistance" and other "moonshot" projects while discussing the "why" and deep purpose behind the decisions made, as well as the human side of leading a team while attempting projects of such magnitude. Closing keynote speaker and IPC Chief Economist Shawn DuBravac will cover the dynamic changes paving the way for a new era of innovation and growth. And yours truly will explore the transformative impact of automation, artificial intelligence, and responsive technology, and hopefully dispel any doubts you may have about the role humans play in this changing landscape.

The EMS Leadership Summit on April 8 will bring together current and future industry leaders to solve problems, build business networks, and share insights into doing business better. Focused on high-level topics that drive business growth and financial success, leaders will gather insights from experts and discuss their own and potential new best practices during panel discussions and roundtables. This meeting of minds inspires action and builds resources for participants, future leaders, and the greater EMS industry.

Educational offerings at IPC APEX EXPO are unique, and 2024 will heighten the learner experience through the ECWC16 Technical Conference. IPC's Technical Program Committee (TPC) has convened an expert lineup of speakers and instructors in technical education and professional development, delivering

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the latest data and trends in materials, manufacturing, and electronics design. Attendees can select from nine topic tracks: Design; PCB Fabrication and Materials; Assembly Materials; Assembly Processes; HDI, UHDI, and Substrates; Sustainability for Electronics; High Reliability; and Factory of the Future. Two special sections within the technical conference will cover advanced packaging and EV electronics. Professional Development Courses will include something for everyone, from advanced classes exploring the details and depth of specific topics to informative classes catering to engineers just beginning their careers.

If you're interested in actively participating in the development, review, and update of the electronics industry's critical standards and guidelines, attend one of more than 100 standards development committee meetings. Standards committee meetings are the perfect place to meet and collaborate with new peers, industry leaders, and innovators.

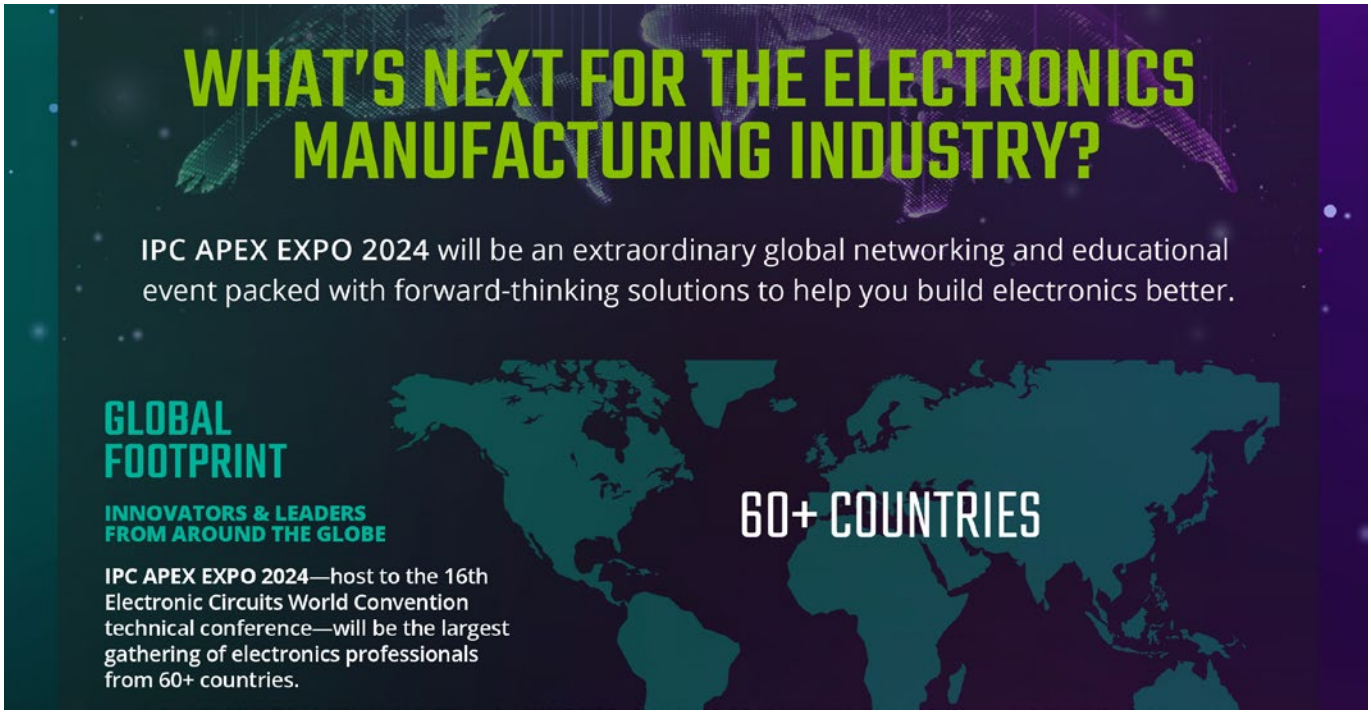
For those visiting IPC APEX EXPO for the first time, we'll welcome you to the largest gathering of electronics professionals in North America. We are happy that you've chosen to spend your time with us. Be sure to take advantage of the many networking opportunities offered by signing up for educational sessions directly applicable to your work. You will meet manufacturing industry professionals from around the world facing (and solving) challenges like yours.

For returning attendees, we are thrilled to welcome you back. One of the best things about IPC APEX EXPO is the community we've built over the years, and we look forward to reconnecting with you again.

We at IPC are profoundly grateful to an industry that has encouraged and supported us in producing this event. We never lose sight of the fact that we could not host IPC APEX EXPO without the dedicated volunteers and industry leaders who share their time, expertise, and enthusiasm with us all.

I, for one, am so looking forward to IPC APEX EXPO 2024 and looking forward to seeing you. **PCB007**

**Dr. John W. Mitchell** is president and CEO of IPC. To read past columns, click here.




# IPC Global Insight Newsletter: It's Happening Now, for You

## AN INTERVIEW WITH BRIAN KNIER

Information is knowledge, and IPC's weekly Global Insight newsletter provides curated, highly relevant content on what's happening within IPC and on a broader scale to help you make better business decisions and stay on trend in today's world of electronics manufacturing.

In this interview, Brian Knier, vice president and chief marketing officer at IPC, discusses the compelling reasons this newsletter is a must-read for a worldwide audience that wants to compete in this global marketplace.

***Nolan Johnson: Brian, what is the importance of Global Insight? What content are you striving to deliver to the readership through this newsletter?***

*Brian Knier:* We're in a very dynamic industry. Global Insight is an opportunity to provide curated content that is relevant and timely for our readers—IPC members and our nonmembers alike—so they know about the activities we're pursuing, outcomes we've learned, industry news headlines, what's coming up, benefits of IPC membership, and other things we're doing on their behalf. We keep it very streamlined and focused on the things that they need to know. It's easy to read and digest.

***There is so much in the news to sort through; I'm sure a focused perspective is valuable.***

An area where we get a lot of readership is in compliance and regulatory affairs. Those are ever-changing landscapes, and with the help of our advocacy team, we provide timely information for your business. The format of Global Insight allows you to easily scan the headlines and summaries and then choose the articles that are most relevant to you. The articles are short and easy to read. We are cutting through the clutter to bring our readers what we know will be most relevant and timely. These are the things you want to know right now.

***Access to IPC Global Insight comes with IPC membership, but can nonmembers access the newsletter as well?***

Yes, it's designed with the entire industry in mind, but with a nod toward our members. We want them to be aware of the advantages of being an IPC member. There are unique benefits for members; it's always good for us to keep that in front of them, especially as new benefits become available.

For nonmembers, we feel that as they read the newsletter and learn more about what we do for the industry, they'll consider joining us as a member company.

***Is there anything else you'd like to share about IPC Global Insight?***

There is some new energy around our newsletter; we've recently moved production and support into IPC Publishing Group, which includes the I-Connect007 family of publications. We feel there is a much stronger partnership in developing the content and supporting our advertisers who want to reach that same audience. We've got some new energy, and that's pretty exciting for us.

**Learn more here about subscribing to IPC Global Insight.**


# A Brief History of IPC APEX EXPO

**Feature Article by Alicia Balonek**
IPC

Although IPC APEX EXPO was launched in 2000, the story began in 1994 with the opening of the IPC Printed Circuits Expo in Boston, where more than 1,700 people attended the event, which hosted 158 exhibitors.

In 1998, the Surface Mount Equipment Manufacturers Association (SMEMA) approached IPC for help. Because of IPC's success with the Printed Circuits Expo and recognizing the need to establish control of its own event, the discussions between SMEMA and IPC ensued. This led to a merger between the two organizations and provided SMEMA with IPC member benefits. To further meet the needs of equipment manufacturers as well as other suppliers to the assembly industry, a new conference and exhibition was born. The goal of IPC and SMEMA councils was to produce the premier event for the electronics assembly industry, providing a cost-effective forum for user/supplier dialogue with the guiding principles of reduced costs, focus, and fairness. Named APEX, this new event focused on the full electronics manufacturing process and associated technologies.

In 2004, IPC took the next logical step by co-locating the Printed Circuits Expo and the Designers Summit with APEX to create one event for the entire electronics interconnection industry. The intent of the APEX event was to concentrate solely on the electronics

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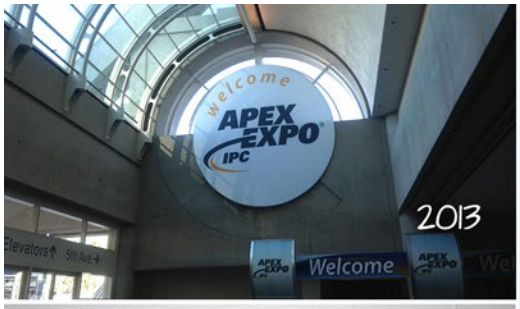





assembly industry. EXPO, the trade show floor exhibition, was designed to ensure that each exhibitor, regardless of booth size, is provided an equal opportunity to select exhibit space and that all show rules are fairly and uniformly applied to all exhibitors.

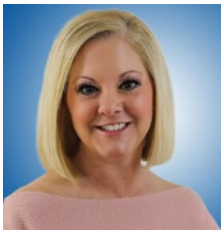
To that end, the exhibitor lottery drawing has remained the best way to guarantee each exhibitor has an equal opportunity to choose the best exhibit space. In keeping with IPC's 40-year policy and to support the integrity of this important industry event for all paid exhibitors, no one who is not a part of the event's official program can conduct or sponsor a function of any kind from the opening to the closing of the event. In short, any function that is not part of the event's official program is prohibited.

In 2009, the trade show name was changed to IPC APEX EXPO and is now viewed as a single trade show event consisting of many different elements and serving the full electronics supply chain. In keeping with IPC's original intention of seeking a new and independent trade show event that would better serve industry members—IPC APEX EXPO—IPC remains committed to keeping this a cost-effective show as it pertains to exhibit space while promoting the philosophy of competition based on the merits of the company products and services, not only the size of their booth or hospitality events.

Today, the show's technical conference, paper and poster presentations, professional development, and robust business networking opportunities make for a full week for all levels of participants and a show that seems to get better every year.

A year after its inception and to this day, IPC APEX EXPO has been recognized as one of the top 250 trade shows in the U.S. and has received many accolades since. In 2012, 2013, and 2018, IPC APEX EXPO was awarded one of the 25 fastest-growing shows for attendance by Trade Show News Network (TSNN). In 2017, IPC APEX EXPO was awarded one of the 50 fastest-growing shows for attendance and exhibiting companies by Trade Show Executive Magazine. Most notably, in 2019, IPC APEX EXPO was recognized as the fastest-growing association show for attendance in the United States for 2016–18 by the Trade Show News Network (TSNN).

As we inch closer to the 25th anniversary of IPC APEX EXPO in 2025, it's nice to share how it all began and I'm proud to say I've been here every step of the way. **PCB007**



**Alicia Balonek, CEM,** is senior director of trade shows and events at IPC.

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*Source: IPC*

# Dip Your Hand in the IPC APEX EXPO Candy Jar

## The New Chapter

Feature Column by Hannah Grace, TEXAS INSTRUMENTS

As IPC APEX EXPO quickly approaches, aligning your agenda with personal and professional development goals is necessary to get the most out of your show week. If 2024 is planned for growth opportunities, whether presenting, expanding your technical repertoire, or learning something new, this show and conference is for you. I see several opportunities that can easily align with those goals.

### Keynote Presentations

To kick off the show, the keynote speaker is Paul Bailey, former principal concept director for Walt Disney Imagineering, who will be discussing some of his former projects, including Disneyland rides Star Wars: Rise of the Resistance, and Millennium Falcon: Smugglers Run. We will learn what goes on behind the brain of an Imagineer and see the depth of managing blockbuster projects.

Artificial intelligence (AI) has been the rave in the industry. Almost every day, I hear someone talking about how AI will take over our jobs. IPC President and CEO Dr. John W. Mitchell, and IPC Chief Economist Shawn DuBravac will be highlighting AI implementation in their keynote presentations. Mitchell will be discussing the future of the workforce and how AI and automation may be incorporated into jobs we see every day. He will also teach us how to embrace the ever-changing work environment we live in. DuBravac will highlight emerging technologies gaining interest, which of course, includes AI. The 2024 conference is looking bright with this set of incredible speakers.

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## Technical Conference

After attending IPC APEX EXPO the past two years, one of my favorite parts is attending a variety of presentations in the Technical Conference and the Professional Development Courses. They have enough to satisfy anyone's career development needs. My favorite course from last year was on RF antenna design. The presenter gave real-life examples and theory to help design and use your very own antenna. I left the presentation inspired to do some independent study, and I designed several of my own antennas based on the theory I learned from this professional course.

Attending the technical paper reviews has helped broaden my awareness of the electronics industry and helped me grasp where the industry is focused concerning new technology. This year, you can expect to see tracks from design to manufacturability, and I'm really excited to learn from the technical track about emerging technologies.

> "IPC sets the standards for all things PCB, and your company's voice needs to be heard."

## Networking Opportunities

Did you know IPC APEX EXPO is more than just grasping technical knowledge? It may be the place where you find your company's next technical expert or maybe you'll meet a mentor to help propel your professional career forward. Networking is one of the biggest opportunities you'll have there. To help with networking, IPC hosts several events that bring together companies, technical presenters, and experts in their specified fields. Other opportunities include a newcomers networking reception, women in electronics reception, and chatting with poster presenters and people on the show floor. After all that hard work, you will definitely want to cool down at the ice cream social. Companies from all over the world, even Lockheed Martin, NASA, and Apple, will be in attendance. Whether you're looking to grow in technical knowledge or build out another area of interest, be sure to have your business cards in hand and get ready to mingle.

## Standards Development

Last but not least, I think the most important part about attending the conference is participating in standards committee meetings. IPC sets the standards for all things PCB, and your company's voice needs to be heard. From IPC-J-STD-001 to IPC-610, participating in standards committee meetings will set the tone for the latest technologies and help grow the development of technologies that may not even be on the market yet. Participating in committees, even those that my work does not directly align with, have been incredibly useful in expanding my technical expertise. I can learn about topics from manufacturing tolerances to chemical bare boards. Meanwhile, I can also contribute my thoughts and ideas on changing documents, even while being a first-year engineer.

## Conclusion

For a young engineer like me, IPC APEX EXPO is a candy factory full of powerful networking opportunities and a vast technical repertoire. It is a place that encourages technical and professional growth. The experiences I have gained there have helped in my own decisions about my career. So, if 2024 is a year of growth for you, attending IPC APEX EXPO 2024 should be number one on your bucket list. **PCB007**

**Hannah Grace** is a process engineer at Texas Instruments and in the IPC Emerging Engineer Program. To read past columns, click here.

# Women in Electronics Reception

**Feature Article by Alicia Balonek**
IPC

Women comprise about 47% of the workforce and are statistically underrepresented in STEM fields, yet the number of women in STEM positions has steadily increased. In 1970, women comprised 8% of STEM roles. Today, they represent 27%. This jump is an encouraging sign for aspiring women in tech, but it shows there's still a long way to go in ensuring the tech and STEM industries reflect the general workforce.

In the early years of this event, we introduced the Women in Electronics reception to allow the very few females at this event to meet and network with each other. Since the launch of IPC APEX EXPO in 2000, we've seen an increasing number of females attend the event each year.

Thankfully, through the years, we have had plenty of female trailblazers paving a path for the younger women entering this industry. Each year, we look forward to helping these women build their network so they can share their journey, learn from each other's experiences, and support each other well beyond IPC APEX EXPO.

This year's Women in Electronics Reception is scheduled from 6 to 7:30 p.m. Tuesday, April 9. It will feature a panel discussion led by IPC Hall of Famer Karen McConnell, Northrop Grumman, on work-life balance. Panelists include:

- Debie Vorwald, Collins Aerospace
- Despina Davis, Ph.D., Boeing Defense, Space & Security
- Paige Fiet, TTM Technologies
- Christina (Tina) Landon, Naval Surface Warfare Center, Crane Division (NSWC Crane)

They will discuss and highlight success stories and lessons learned on managing a successful career and family and how it's possible for women to do it all.

Anyone attending IPC APEX EXPO is invited to this event, and we look forward to seeing you there. **PCB007**

**Alicia Balonek** is the senior director of trade shows and events at IPC.

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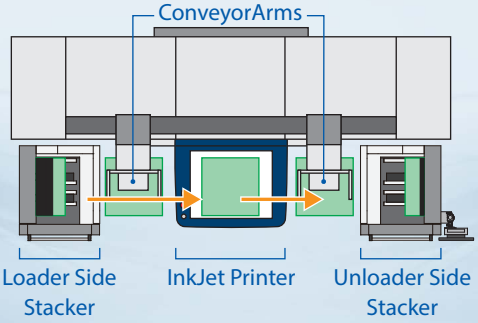


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# Electronics Circuit World Convention: A Brief History

Article by David Bergman
IPC

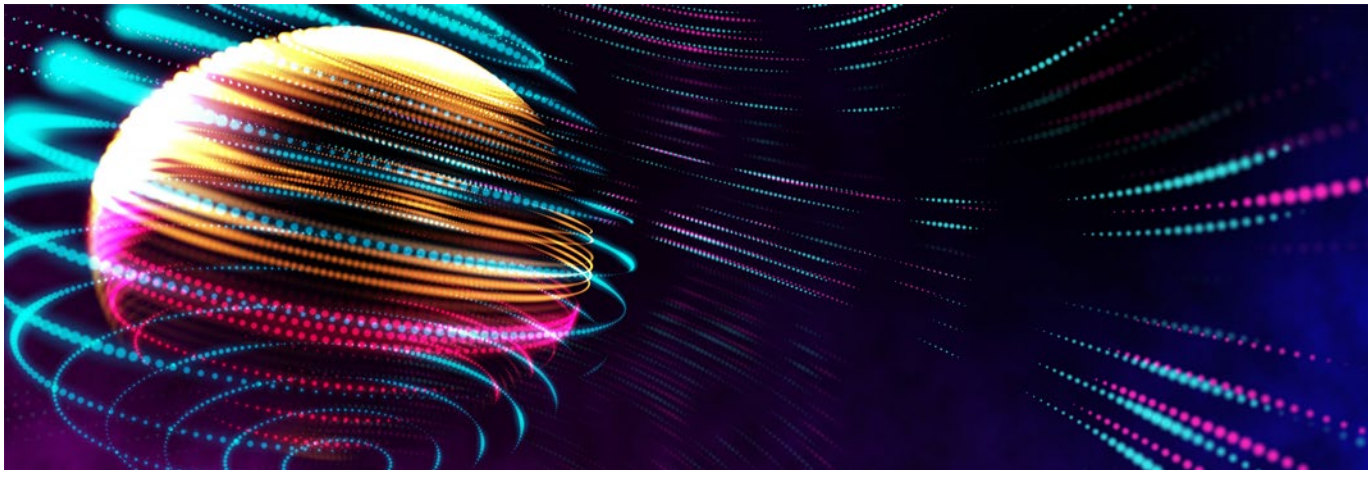
In 1978, a new event called the Printed Circuit World Convention (PCWC) was born.

It brought together printed wiring board (PWB) associations from around the world to focus on advancing technology, growing the market, and providing insight into the management of the manufacture of printed boards. It was the first major international event of its kind for the industry. The first event, PCWC I, was hosted by the Institute of Circuit Technology (ICT–UK) and the Institute of Metal Finishing (IMF–UK) was supported/sponsored by IPC USA, EIPC Europe, and JPCA Japan.

It was decided that the convention would be held every three years, rotating between the various associations and countries. In 1998, having had nearly 20 years to work together, the globally-located PCB associations agreed to form a global association, and the World Electronics Circuits Council (WECC) was formed. It comprised the following associations:

- IPC volunteered to serve as the first Secretariat of WECC
- Japan Printed Circuit Association (JPCA)
- China Printed Circuits Association (CPCA)
- India Printed Circuits Association (IPCA)
- Taiwan Printed Circuits Association (TPCA)
- European Federation of Interconnection and Packaging (EFIP), representing the following:
  - Verband Der Leiterplattenindustrie (VDL)
  - European Institute of Printed Circuits (EIPC)
  - Printed Circuit Interconnect Federation (PCIF)

ECWC8 in 1999 changed a few things. First, the scope of the world convention was expanded to include electronics assembly, and PCWC became ECWC. Then, the naming



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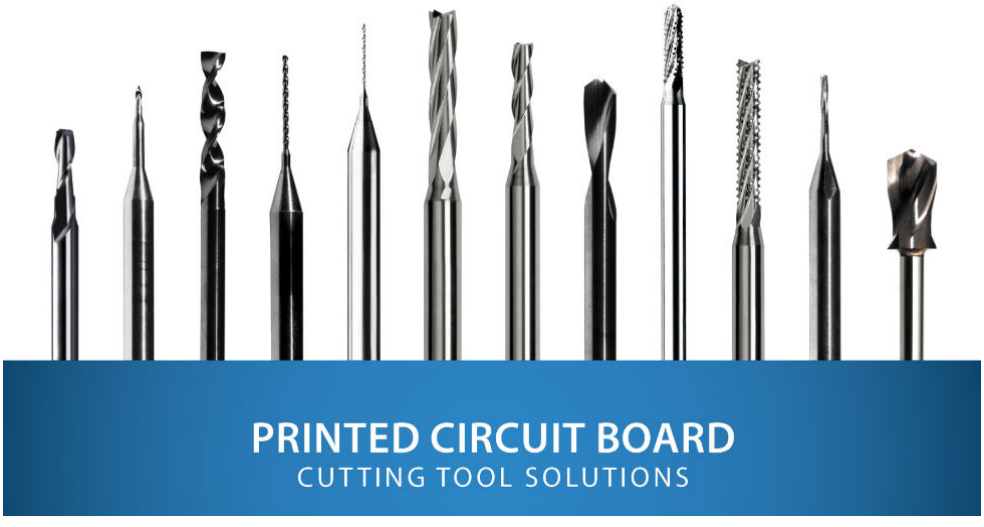


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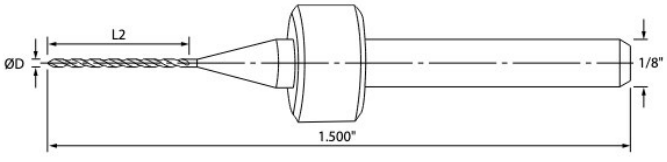
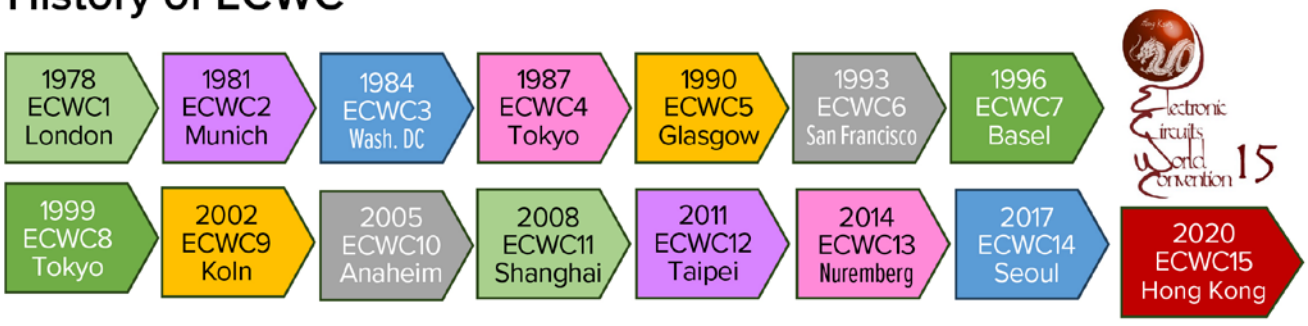



4 Facet Point Geometry

**REPOINTING** will be a new service offered by Insulectro through Kyocera. The company has recently invested in automated, state-of-the-art equipment and all repointing will be done in Southern California.




convention for the year of the event was changed from Roman numerals to numbers. In addition, many of the WECC members were starting trade shows for their members in their regions. The WECC decided in the future that a stand-alone event was no longer required and decided to have events in conjunction with the host organization's trade show. ECWC8 was the last stand-alone world convention.

In 2001, the Hong Kong Printed Circuit Association (HKPCA) joined WECC. The Korean Printed Circuits Association (KPCA) joined in 2003. The Electronic Industries Association of India (ELCINA) joined in 2017, and the Thailand Printed Circuit Association (THPCA) joined WECC in 2019.

The Electronic Circuits World Convention (ECWC) is the most notable and recognized international PCB symposium. It takes place every three years and is hosted by different members of the World Electronic Circuits Council (WECC). Thousands of presentations have been made to tens of thousands of delegates. Relationships have started, friendships have grown, and the world is a better place because of the collaboration that started in 1978. We hope you will join us at the 16th meeting of ECWC in April in Anaheim, California.

## PCWC/ECWC

- **PCWC I:** 1978, London England, hosted by ICT and IMF
- **PCWC II:** 1981, Munich Germany, hosted by EIPC
- **PCWC III:** 1984, Washington, D.C., hosted by IPC (for the first time)
- **PCWC IV:** 1987, Tokyo Japan, hosted by JPCA
- **PCWC V:** 1990, Glasgow Scotland, hosted by European Federation of Interconnection and Packaging (EFIP)
- **PCWC VI:** 1993, San Francisco, USA, hosted by IPC
- **PCWC VII:** 1996, Basel Switzerland, hosted by EIPC
- **ECWC8:** 1999, Tokyo Japan, hosted by JPCA
- **ECWC9:** Cologne, Germany, hosted by EFIP
- **ECWC10:** 2005, Anaheim, California, hosted by IPC
- **ECWC11:** 2008, Shanghai, China, hosted by CPCA
- **ECWC12:** 2011, Taipei, Taiwan, hosted by TPCA
- **ECWC13:** 2014 Nuremberg, Germany, hosted by EIPC
- **ECWC14:** 2017, Seoul, South Korea, hosted by Korean Printed Circuit Association (KPCA)
- **ECWC15:** 2020, Hong Kong, hosted by HKPCA
- **ECWC16:** 2024, Anaheim, California, hosted by IPC (for the fourth time) **PCB007**

**Resources**

1. "Happy Holden: ECWC15 Virtual Event a Success," I-Connect007, Dec. 15, 2020.

**David Bergman** is IPC vice president of standards.

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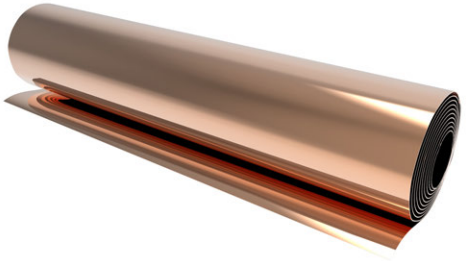

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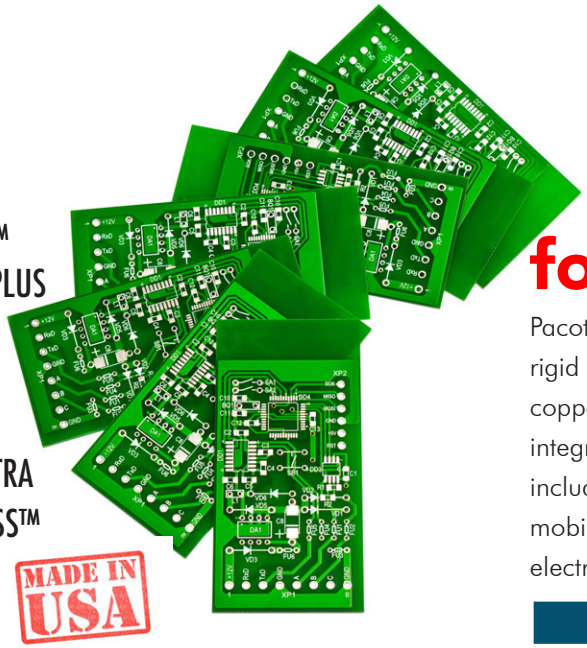

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# Congress Must Handle Supply Chain Challenges in 2024

## American Made Advocacy

by Travis Kelly, PCBAA

It's easy to get distracted in an election year. A constant stream of polls, primaries, and political prognostications will surely dominate the media cycle. Elections are important, but they should not distract the 118th Congress from the important work of securing our fragile supply chains and rebuilding microelectronics manufacturing capacity on our own shores.

A recent Department of Defense report demonstrates why this is so important. The first-ever National Defense Industrial Strategy focuses on creating resilient supply chains including microelectronics. The Pentagon sees the risks of foreign sourcing and has identified the need to expand domestic production and invest in a skilled workforce.

World events further underscore these conclusions. Recent shipping disruptions in the Red Sea are being felt all over the world, and are a reminder that total dependence on foreign sourcing is risky—and avoidable.

Understanding these stakes, here are three things Congress should do in 2024:

### ONE

### Fund and deploy the DPAI

Last year's invocation of the Defense Production Act was a win for American-made printed circuit boards and IC substrates. After years of offshoring and contraction, the government recognized that these technologies are critical to U.S. national security and economic via-

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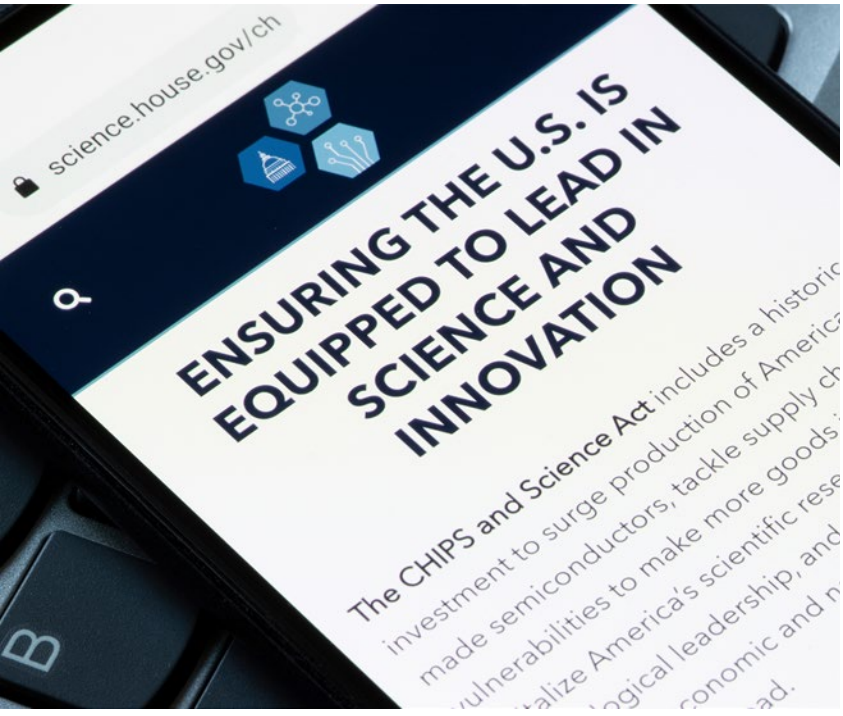



bility. The Defense Production Act Investment Program (DPAI) is how this support is made real. Congress has obligated approximately $150 million for investments in microelectronics using the Defense Production Act. Two recent awards include:

- $46.2 million to GreenSource Fabrication LLC via the DPAI. The award will enhance production capabilities at a manufacturing facility of state-of-the-art IC substrates, high-density and ultra high-density interconnect, and advanced packaging.
- $39.9 million via the DPAI to Calumet Electronics Corporation to enhance capabilities to produce high-density build-up (HDBU) substrates, which include high-density interconnect printed circuit board cores and HDBU layers.

While these actions are helpful, America needs to make a sustained, robust investment in manufacturing the microelectronics that power all aspects of modern life. That's why PCBAA and IPC have jointly called on Congressional appropriators to increase DPAI funding for microelectronics in 2024 and beyond.

## TWO
## Support the PCBS Act

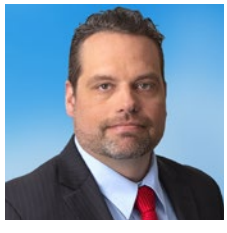
Thanks to Reps. Anna Eshoo (D-CA-16) and Blake Moore (R-UT-1), the House is now considering the "Protecting Circuit Boards & Substrates Act," legislation that would provide $3 billion for R&D, facilities, and workforce development along with a 25% tax incentive for companies buying American-made PCBs and substrates. This bill continues to gain co-sponsors and the attention of policymakers. More support is needed.

## THREE
## Bring the Senate Into the Conversation

For several years, senators from both sides of the aisle who understand the synergy of national security and industrial policy have led the fight to bring high-tech manufacturing back to the United States. The PCBS Act needs a Senate companion bill, and the same champions who led the CHIPS fight should step up and help industry secure the rest of the microelectronics ecosystem.

There are plenty of issues for our elected representatives to disagree on, but rebuilding industrial capacity and securing our supply chains should be a bipartisan priority. This is the year to act.

The PCBAA believes in and fights for market fairness and a level playing field on which U.S. PCB and substrate manufacturers can compete and win. This is the year to join our effort by visiting us online or contacting me directly. **PCB007**



**Travis Kelly** is CEO of Isola and chair of the Printed Circuit Board Association of America. To read past columns, click here.

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# MilAero007 Highlights

## Northrop Grumman Completes First Production Delivery for the US Army's Integrated Battle Command System ▸

Northrop Grumman Corporation delivered the first production Integrated Battle Command System (IBCS) major end item, an Integrated Collaborative Environment (ICE), to the U.S. Army on December 19, 2023. Working at an accelerated pace, the Northrop Grumman team will deliver additional major end items in early 2024 to support the Army's aggressive modernization schedule.

## NASA Puts Next-Gen Exoplanet-Imaging Technology to the Test ▸

A cutting-edge tool to view planets outside our solar system has passed two key tests ahead of its launch as part of the agency's Roman Space Telescope by 2027. The Coronagraph Instrument on NASA's Nancy Grace Roman Space Telescope will demonstrate new technologies that could vastly increase the number of planets outside our solar system (exoplanets) that scientists can directly observe.

## BAE Systems' Enhanced M-Code Global Navigation Satellite System Technology Reaches Major Development Milestone ▸

BAE Systems' program to design and manufacture an advanced military GPS receiver and next-generation semiconductor has completed Critical Design Review (CDR). The Military GPS User Equipment (MGUE) Increment 2 Miniature Serial Interface (MSI) program is part of a $247 million contract received in 2020 from the U.S. Space Force.

## Lockheed Martin, NVIDIA Demonstrate AI-Driven Digital Twin With Potential To Advance Predictive Forecasting ▸

In a year where the National Oceanic and Atmospheric Administration (NOAA) has reported record ocean temperatures, an innovative project from Lockheed Martin, built in collaboration with NVIDIA, is showing how artificial intelligence can be used to fuse data and detect anomalies in current environmental conditions.

## RTX Completes Milestones on DARPA Blackjack Program with Four Blue Canyon Technologies Satellites ▸

RTX's small-satellite manufacturer and mission services provider, Blue Canyon Technologies (BCT), announced the satellites supporting the Defense Advanced Research Projects Agency (DARPA) Blackjack program have completed critical milestones activities. National security space assets, critical to U.S. warfighting capabilities, traditionally reside in a geosynchronous orbit to deliver persistent overhead access to any point on the globe.

## NASA Space Tech Spinoffs Benefit Earth Medicine, Moon to Mars Tools ▸

JPL-developed technologies featured include several used by Curiosity and ECOSTRESS, plus new data visualization methods, imager miniaturization, and DNA-identification techniques. As NASA innovates for the benefit of all, what the agency develops for exploration has the potential to evolve into other technologies with broader use here on Earth.

# DESIGN TIPS #124:

## ETCH COMPENSATION

What is minimum space and trace? The answer depends on the starting copper weight.

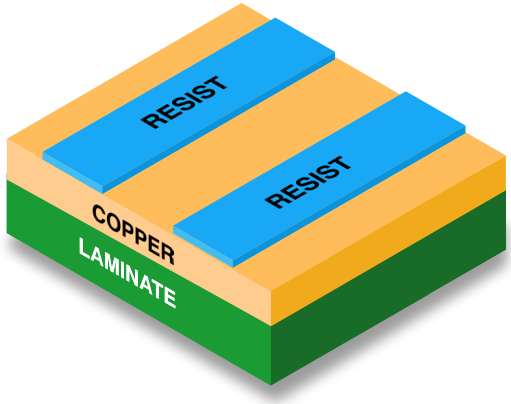
This is because we must do an etch comp on the traces in CAM to compensate for known etch loss. The space between traces after compensation will play a role in whether a board can be manufactured.

The lower the spacing width, the higher the cost. Designers don't always account for the proper starting copper weight after edge compensation.

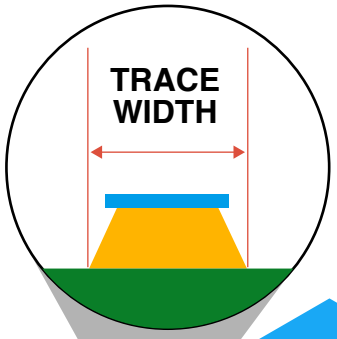
### Design tips:

- For accurate starting copper weight, **add a half mil (.0005″) to all copper features**.
- **Start with 3/8 or 1/4 oz. foil**, reducing etch comp and less likely to cause a spacing issue.
- **Boards that call for full body electrolytic gold are not comped** to avoid gold slivers occurring during the etching process.

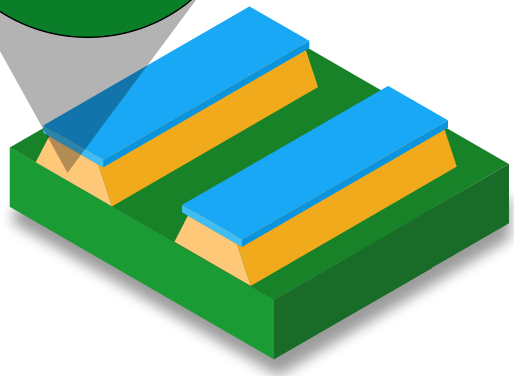
### Before etching




### After etching




*During etching, trace width expands beyond the width of the resist.*



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# Real Progress Toward Solving U.S. Workforce Problems

Interview by the I-Connect007 Editorial Team

IPC achieved a landmark in 2023 by creating an apprenticeship program approved by the U.S. Department of Labor. With such a registered framework in place, industry can work through IPC to secure local, state, and federal dollars for workforce development in a way they've never been able to do before. Cory Blaylock, director of workforce partnerships at IPC, has been instrumental in developing and moving this program toward adoption and outlines what companies need to know to get involved.

***Michelle Te: IPC is not just embracing a change in the revolution of workforce development but driving it as well. What is behind IPC's efforts?***

*Cory Blaylock:* There has been a solution in the industry for developing talent that offers career pathways, giving employers what they want as well as catering to developing employees. IPC wants to be the one owning it because we're representing everybody in electronics manufacturing.

Apprenticeships, and workforce development, in general, are not user-friendly in their current state. There's a lot of nuance and things that people don't know or understand unless they work in it every day. They may not understand what's required for a registered apprenticeship concerning the rules and regulations of the Department of Labor. We've worked through all the red tape so it could be utilized without having to go through all the rigamarole.

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*Te: Can you define an apprenticeship?*

An apprenticeship is an earn-while-you-learn model. Traditionally, we think of apprentices in jobs like plumbing and HVAC. IPC is joining that space to expand and diversify pathways into good jobs and careers in advanced manufacturing. In an apprenticeship, there are three components. You have an apprentice learning a skill, a journey worker who is already proficient in a skill, and you have related technical instruction to get the theoretical background and the technical information you need to be successful. The mentor teaches the apprentice all the skills they need to be fully competent by the time their apprenticeship is over through the on-the-job learning aspect.

There's also a behavioral competency portion, which considers the soft skills that everybody always complains that people don't have. Are you able to show up on time to work? Are you trustworthy? In the electronics industry, are you making sure you're recording the date and batch codes and serial numbers appropriately so that there is traceability for parts and components that could be recalled later? Do you have attention to detail? It's things like that which are often established in a company culture.

*Marcy LaRont: Explain the importance of the mentor/mentee relationship and how the apprenticeship manages or highlights it. That seems key.*

The mentor/mentee relationship is a crucial component of IPC's National Program Standards of Apprenticeship. This relationship plays a significant role in the successful development and progression of apprentices within the program. When looking at the importance of these relationships during an apprenticeship, it's important to consider the structured transfer of knowledge through hands-on training and on-the-job experience facilitated by mentors. Throughout the apprenticeship, there are mechanisms for regular performance assessments and feedback discussions


Cory Blaylock

between mentors and apprentices. We recognize the mentor/mentee relationship as a cornerstone for apprentice development. Mentors play a key role in providing constructive feedback on an apprentice's performance, which aids their professional development. The standards outline clear expectations, responsibilities, and mechanisms for managing the importance of this relationship to ensure a successful and well-rounded apprenticeship experience.

*Te: What is the financial incentive to the apprentice?*

Participating in IPC's apprenticeship programs offers several financial incentives for apprentices. These incentives are designed to attract individuals to apprenticeships, support them during their training, and enhance the overall attractiveness of apprenticeship as a career pathway.

***Earn while you learn:*** Apprentices receive wages for the work they perform during the on-the-job training component of their apprenticeship. This model allows apprentices to start earning a paycheck from day one, making apprenticeships financially viable for individuals entering the workforce.

***Wage progression:*** Apprenticeship programs follow a structured wage progression, where apprentices receive incremental pay increases as they advance through the program. It provides a clear path for income growth, incentivizing apprentices to continue and complete their training.

***Competitive salaries:*** Apprenticeships often lead to careers with competitive salaries. As apprentices acquire valuable skills and experience, they become more qualified for higher-paying positions within their chosen industry. Completing an apprenticeship enhances long-term earning potential.

***Industry-recognized credentials:*** Completing IPC's apprenticeship program results in the attainment of industry-recognized credentials and certifications, as well as a nationally recognized credential from the U.S. Department of Labor, upon completion of the program. These credentials enhance an apprentice's marketability, making them more attractive to employers and potentially leading to higher-paying job opportunities.

*Te: What was involved in creating the IPC apprenticeship program?*

Creating the IPC Apprenticeship National Program Standards was a comprehensive and collaborative effort aimed at bridging the gap between industry needs and workforce development. Our program is designed to cultivate skilled professionals in the electronics assembly, aligning with the dynamic demands of the industry.

*LaRont: What was the process for getting to the adoption stage? Which apprenticeships are currently launched and which are still in the works? What are the timelines?*

The process to make our national standards applicable across the industry involved the following steps. We are working on steps five to seven with our currently registered occupations, but as we register additional occupations with the Department of Labor to meet the needs of industry, this becomes an iterative process. One of our goals is to have these apprenticeship programs be a "plug and play" workforce training option that employers can adopt, which is beneficial to them and their employees.

## The Seven Steps

1. **Needs assessment:** Conducted thorough research to identify key skills required in electronics manufacturing.
2. **Stakeholder collaboration:** Engaging with industry, education, and apprenticeship experts for a holistic perspective.
3. **Curriculum alignment:** Developing a curriculum aligning theoretical knowledge with IPC standards for practical skills.
4. **Registered apprenticeship structure:** Formally structuring the program as a registered apprenticeship, meeting Department of Labor criteria.
5. **Educational partnerships:** Forging partnerships with high school CTE programs, technical colleges, and universities to ensure high-quality program delivery.
6. **Continuous improvement:** Establishing feedback mechanisms for ongoing program refinement.
7. **Outreach and promotion:** Conducting extensive awareness campaigns targeting potential apprentices and employers.


Our current occupations are Electronics Assembler and PCB Fabricator. We plan on having additional occupations registered in 2024 to include PCB Design Engineer, Wire Harness Assembler, and even a Program Management role.

***Te: Why is it important to have an apprenticeship program approved by the Department of Labor?***

It allows the approved apprenticeship from the Department of Labor to be registered with each state. Since we have employers in all 50 states, we wanted to have a plug-and-play type apprenticeship so that all employers, whether they are small mom-and-pop shops, medium-size employers, or large PCB and EMS companies, can utilize a registered apprenticeship model to help standardize training across the industry.

***Te: What feedback was IPC getting from industry? Did you see companies needed more help with training, and that companies would be open to this type of model?***

Yes, and the other benefit for employers is there are many funding opportunities available to help offset training costs because it's a model that has already been vetted by the Department of Labor. There are local and state workforce dollars, and sometimes federal funding is available for employers to utilize for registered apprenticeship programs. It also offers career pathways for the employees so they're able to have a career instead of just a job.

***Te: What are the costs involved in a company having an apprenticeship program?***

Employers must bring in employees regardless, so they're incurring the cost of recruitment, interviewing, and training all on their own time. We want them to be able to partner with entities in their region, like workforce boards, community colleges, high schools, universities, and manufacturing associations so they can have a workforce ecosystem in place. This way, they're better able to utilize those dollars that might be available for recruitment and training. One option is through the federal government's Workforce Innovation and Opportunity Act, which funnels federal dollars down to states to help offset training costs through registered apprenticeships. Because it is a structured framework and a national program standard, that means that employers in any state can utilize it.

***LaRont: Federal (and state) grant money seems to be a huge opportunity, but it also seems that our companies are just not aware that this may be for them. How does IPC help companies access these funds?***

Accessing federal and state grant opportunities is indeed a valuable avenue for companies, and IPC is committed to supporting our industry partners in navigating and capitalizing on these funding resources. IPC is dedicated to provide education, guidance, advocacy, and resources to help empower companies to leverage these opportunities for growth, innovation, and workforce development.

Victoria Hawkins, IPC's director of education grants and proposals, recently joined the U.S. Education Department and she and I are working very closely to provide education and

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awareness, grant navigation assistance, grant writing support and technical assistance, and advocacy for industry inclusion in the grant landscape. As employers are adopting IPC's apprenticeship standards, we are working hand in hand with their leadership teams to identify funding sources that can help offset the training costs available to them in individual states as well as making them aware of federal opportunities as we become aware of newly available grants, changes in eligibility criteria, and deadlines, ensuring that companies remain informed and can take timely action.

***LaRont: So, these are DOL-approved apprenticeship programs, but you still must get approval in each individual state?***

A federally approved national program standards of apprenticeship provides a consistent framework and set of guidelines that serve as a foundation for apprenticeship programs across the country. While the standards are established at the federal level, their implementation and oversight occur at the individual state level. Reciprocity agreements, facilitated by the Office of Apprenticeship state designation, further enhance coordination and standardization across state lines, fostering a more seamless and efficient apprenticeship system. There are also some states that operate State Apprenticeship Agencies (SAA), which are responsible for overseeing apprenticeship programs within their jurisdiction. SAAs work in partnership with the federal DOL to implement and enforce national standards while tailoring them to meet the specific needs and regulations of their state.


***LaRont: How many states are currently registered or have adopted this apprenticeship program and which states are they? Who looks to be next?***

National Program Standards of Apprenticeship provide a standardized framework applicable across all U.S. states and territories and can be implemented "as is." However, including apprenticeships on a state's Eligible Training Provider List (ETPL) offers additional benefits, particularly in utilizing Workforce Innovation and Opportunity Act (WIOA) funds. Apprentices and employers can tap into WIOA funding to cover various costs associated with apprenticeship programs. This may include tuition, books, and other related expenses, providing a valuable financial resource for both apprentices and employers.

IPC is currently included on the following state's ETPL: Texas, Colorado, Utah, Georgia, Illinois, Indiana, New York, New Hampshire, and Florida. We are actively coordinating the addition of IPC's registered apprenticeships in California, Arizona, North Dakota, Kansas, Iowa, Arkansas, Mississippi, Alabama, South Carolina, Michigan, New Jersey, Connecticut, Maryland, and Massachusetts. The list is growing weekly as companies in various states contact us about apprenticeship opportunities in their state.

***Te: I understand that IPC is working with three high schools in the United States, hoping to find 200 students to become apprentices.***

We have three schools—one in Texas, one in Colorado and one in Massachusetts—that offer workforce training courses to high school stu-

dents that align with the technical instruction piece of our registered apprenticeship. We want those high school students to already have some industry-related knowledge, certification, and even credentials when they graduate. They will get their IPC-J-STD-001 and IPC-610 certifications so they can join an employer partner as a registered apprentice and get credit for prior learning that they completed while they were in high school. This is another benefit to employers because they're not providing all the training. High school can open the students' eyes to manufacturing career opportunities, and do the training themselves.

For the past 20 years, the U.S. has fallen far behind in offering manufacturing jobs as a career, and now we're dealing with the setbacks. We've asked kids what they wanted to be when they grew up, and they all said they wanted to be a lawyer, doctor, or teacher. Manufacturing wasn't sexy, and nobody wanted those jobs, so they didn't even know it was an option. We now have high school students not only exploring those options but also getting training in things like soldering. So, if college is not their path—and only about 36% of high school graduates continue on to college—training can be offered that gives them industry-based credentials and a career path.

For example, in Texas, there is the "60 by 30" initiative, which means that 60% of high school graduates will have an industry-recognized credential by the year 2030. Their goal is for every high school graduate to have a credential recognized by an industry. Some high schools are offering OSHA and Cisco certifications so graduates will be employable as soon as they graduate high school. Why can't the electronics manufacturing industry join in with that? Why don't we get our training out there for high school students so that we're just adding another vein in the talent pipeline? Let employers start establishing relationships and building that workforce ecosystem to include high school and CTE programs.

When the high schools offer the training and the state pays for it, the employer reaps the benefits.

***Te: What has been the level of interest from high school students?***

We are conducting surveys before and after their workforce training so we can judge their reaction. I don't have that data yet, but the teachers at the schools have been very excited. They love the curriculum. They like that the students can work self-paced, but then they can support the instruction in class. It's been very positive from the teacher and instructor standpoint and we're waiting on more data from the students.

> **Some high schools are offering certifications so graduates will be employable as soon as they graduate.**

***Te: With the DOL approval in place, what has been the reaction from industry?***

Companies are enthusiastic about it. Zentech Manufacturing, headquartered in Baltimore, Maryland, with production facilities in Bloomington, Illinois, and Richardson, Texas, is the first employer partner to adopt IPC's national program standards of apprenticeship. We're working on helping them secure grant funding dollars available through those states that will help offset their costs incurred with training. We are also working with national apprenticeship intermediaries that have incentive funding available for employers who are new to adopting apprenticeship as well as federal grantors with funding allocated for reimbursement for the related technical instruction component of apprenticeship in advanced manufacturing occupations.

Like I said, they're having to bring these people in regardless, and so they might as well take advantage of the registered apprenticeship model. The training, being asynchronous and computer-based, is an investment in their employees.

Across the industry, we have several letters of support from companies that have committed to supporting our apprenticeship programs and implementing them in their U.S. facilities.

***Te: How does this align with the CHIPS Act?***

The CHIPS Act has a big focus on workforce development. IPC's National Program Standards of Apprenticeship aligns seamlessly with the goals of the CHIPS Act to bolster semiconductor manufacturing in the U.S., by providing a supportive framework for workforce development within the electronics manufacturing industry. Because we're focusing on a PCB fabricator occupation, we're able to further support the CHIPS Act by having a trained workforce that can allow PCBs to be fabricated here in the U.S., so we're increasing PCB fabrication that supports the chip production. We have to support that onshoring effort in the PCB world, as only 4% of PCBs are currently manufactured in the U.S.

***Te: Cory, what are you most enjoying about your work in this program?***

I most enjoy getting to work with companies of various sizes in different states and navigating the workforce system for them in their state, figuring out the intricacies because every state is different and every grant is different. I really enjoy establishing those relationships and helping the employer solve the problem they have.

***Te: You came to IPC after teaching in a classroom, and then doing instruction at Lockheed. Now you get to work with so many different companies.***

Yes, I get to have an impact on shaping what the workforce will look like in the future. This may be the single most important thing that has been done to address the workforce issue for our industry in the United States.

***Te: Cory, thank you for sharing about the IPC apprenticeship program, and congratulations on all your hard work. We look forward to seeing how it expands and progresses as you move forward.***

Thank you. **PCB007**

# Make the Most of Your Marketing and Trade Show Investment

Trade shows are an investment of valuable resources: time, money, labor, travel, and time away from the office. In fact, the average trade show investment in the United States is between $40,000–$60,000 (inkwellusa.com) simply for a booth. Trade shows take tremendous effort, and every exhibitor's goal is to get the greatest return on investment, which translates into closing sales.


Being at the show and having products ready to present is just part of the ROI equation. It is also critical to make your booth a destination so magnetic that prospects arrive at the event with a plan to seek you out, ready to do business. To really maximize your investment and success, the work begins long before the show doors open. Pre-show marketing is a critical part of any successful trade show strategy.

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# An Exhibitor's View of IPC APEX EXPO

## The Chemical Connection

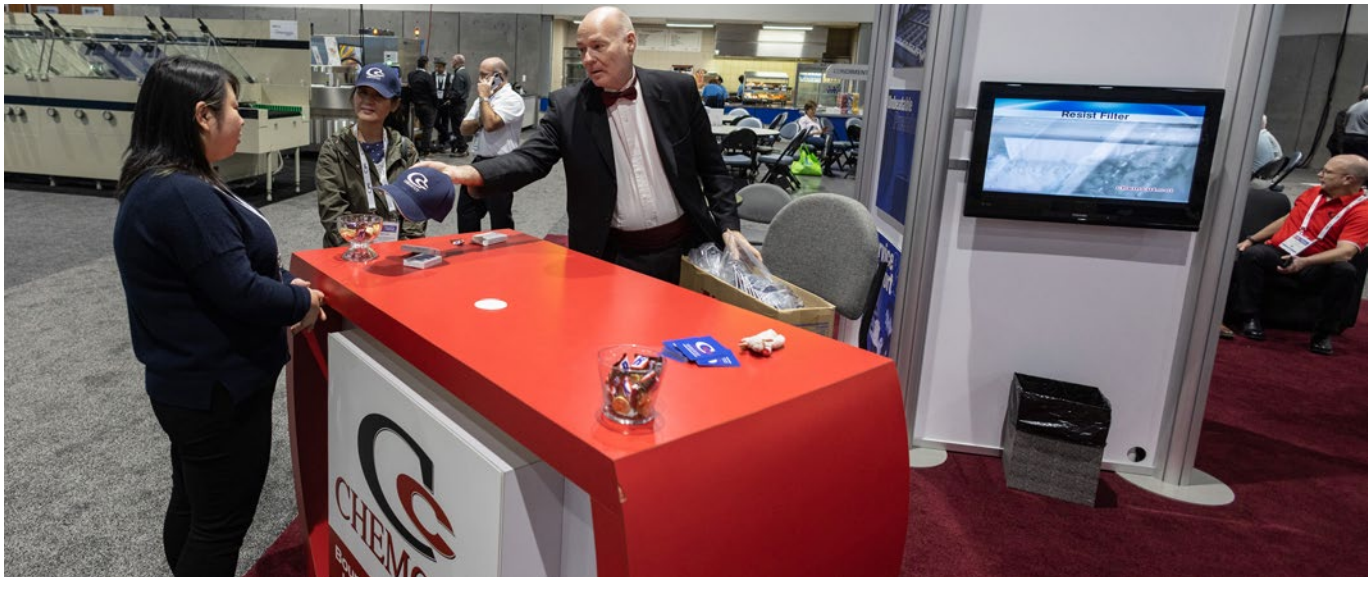
Feature Column by Don Ball, CHEMCUT

When I learned this issue would be dedicated to optimizing the bare board fabricator's experience at the IPC APEX EXPO 2024, I thought it would be an easy column to write. With more than 40 of these shows under my belt, I didn't think it would be too difficult to come up with a list of dos and don'ts to make your visit to an exhibitor's booth worthwhile.

However, after giving it some thought and then consulting with some of my colleagues, I found that from an exhibitor's point of view, there are an awful lot of dos, and not many don'ts. The whole point of being at the show in the first place is to introduce new products, meet and talk with old customers, and introduce yourself and your product to potential new customers. Therefore, your welcome at any vendor's booth is all but assured. So, what can you do to make your visit even more useful?

### Say Hello

Don't be afraid to stop at a booth just to chat. It never hurts to find out what's new and trending with that vendor; it just might give you some ideas for future projects or improvements for your own company. It's always good to renew acquaintances, put faces to names you may have only spoken to on the phone, and introduce new staff or hires that may be interfacing with that vendor. This is especially important with capital equipment suppliers where long stretches of time may pass between contacts. A personal touch always makes communication easier.



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## Get Into the Details

An exhibitor will always be happy to enter any discussion that could possibly lead to a purchase order. If you wish to discuss a new project, it is helpful to be as detailed and concise as possible. Sometimes, we take security and confidentiality a little too far, and that can interfere with clear communication. The more detail you supply on what the goals for your project are and what the specifications are for the final project, the easier and faster the vendor can determine which, if any, of his products or processes can help meet your goals. From there, serious discussion can begin on possible configurations and price estimates. Future negotiations to finalize products and prices will be easier and quicker if a solid start is made at the show.

## Give Feedback

Believe it or not, constructive criticism is appreciated, if not always received enthusiastically. Don't be afraid to point out what you consider deficiencies in the vendor's product (in a professional and friendly way, of course). If the vendor is unaware of a problem, he can't fix it. For example, just last week we met with a customer who had purchased five identical pieces of equipment over the past four years for a special project. The project took off, and they are currently building a new plant to double their capacity. They will have to order at least five more pieces of equipment to put in the new building and are concerned about downtime based on the equipment they already have. They listed all the downtime from the past two years of operation and the reasons for that downtime.

Our teams from engineering, process, and sales met with them at their facility, and we went over each reason for downtime. A frank and honest discussion ensued (as the politicians say), and within two hours we had come up with fixes and possible solutions for any new equipment to be purchased for the new plant. This was a win/win situation for both of us. We learned how to make more reliable equipment for their process, and they will benefit from less downtime and more productivity. Any vendor should be willing to talk about problems encountered using their product and ways to avoid or eliminate them, so don't hesitate to ask about them. If they are unwilling, perhaps it's time to find a new vendor.

It should be obvious that approaching any criticism with anger and belligerence is likely to be counterproductive. No one likes having their deficiencies screamed in their face, which makes them more likely to dig in their heels and temporize rather than look for solutions. Express your concerns, but try to keep your frustrations in check, and it is more likely that a mutually agreed-upon solution to the problem will be found in good time.

## Be Prepared

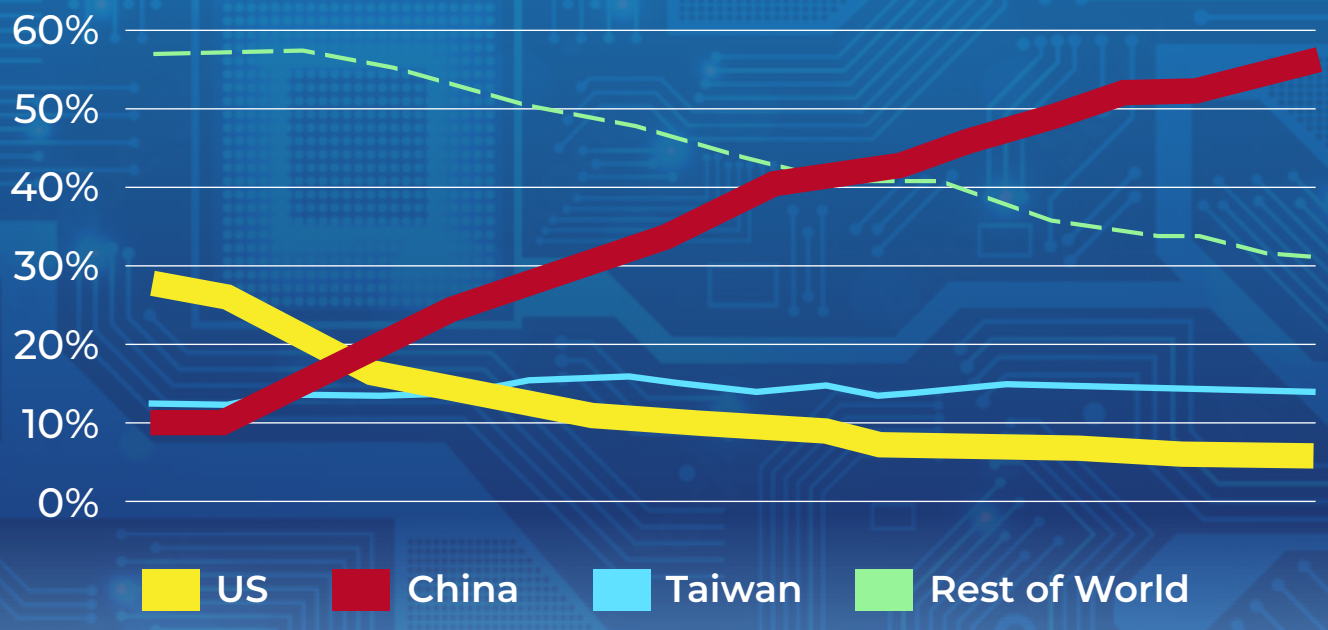
In short, the best way to optimize your time at the show is to be organized before you go. Make a list of the exhibitors you want to visit and what you want to talk about. If you need time for a serious talk, visit the booth as early as possible and set a time to meet later, avoiding time wasted while waiting for the person to disengage from their previous contacts. Sometimes visiting a booth later in the show (Wednesday afternoon or Thursday morning) might not be a good idea as some people are getting tired or cranky from trying to look alert and interested after 16 hours in the booth (not me, of course). On the other hand, in the later hours of the show, some people are happy to have someone to talk to after the traffic dies down. You take your chances.

Have a good show. **PCB007**

**Don Ball** is a process engineer at Chemcut. To read past columns or contact Ball, click here.

# CONGRESS MUST ACT TO RESTORE AMERICAN LEADERSHIP

## Global Production of PCBs

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# Professional Development: From AI to DFM

**Feature Article by Julia Gumminger**
IPC

The Professional Development Course program at IPC APEX EXPO 2024 will offer attendees a diversity of topics taught by new and returning instructors. Electronics industry professionals at any stage of their career will benefit. Thirty-two courses covering all aspects of the electronics manufacturing supply chain will be offered on Sunday, April 7, and Monday, April 8.

Participants in these courses will gain new knowledge and real-world skills that will equip them to rapidly respond to changing demands for new technologies, materials, and processes. Attendees will find updated content from veteran instructors and innovative courses from new instructors.

The diversity of educational content includes courses about chiplets and heterogenous integration, soldering, AI and machine learning, design for manufacturing principles, and designing for harsh environments. We highlight just a few of the courses you can expect to see.

Paul Cooke of Ventec International will address design and fabrication for high reliability. "Designing printed circuit boards and assemblies is more difficult than ever due to complexity, component availability, thermal requirements, signal integrity, material selection, layer counts, harsh environments, and increased functionality all required in smaller form factors," Cooke says. "We will look at all the elements to successfully design a PCB that can meet all the designers' requirements and perform to the customer and industry standards as well as survive in today's harsh environments. We will look at everything from materials to surface finishes and testing to ensure the product is robust as possible with a high level

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of confidence that it has been designed for extended life in the field."

Dr. Tim Burke, chief technology officer at Arch Systems, will provide an introduction to machine data analytics in the EMS industry. "As EMS manufacturers advance toward Industry 4.0 and the Factory of the Future, there are massive opportunities to leverage the large-scale capture and analysis of machine data to improve almost all aspects of factory operations," he says. In this course, Burke will cover domain-specific forms of data analysis appropriate for the EMS industry on top of machine data such as what is produced by SMT machines inside an EMS factory. The course assumes familiarity with SMT equipment such as PnP machines, SPI/AOI machines, and solder paste printers. He covers topics ranging from what kind of data is produced by these machines, how to visualize time series of parameters from machines, examples of identifying specific machine problems in the data, and freely available open-source tools that are appropriate for analyzing EMS machine data.

Cecelia Rios, rework and repair technician at Hi-Tek Electronics, will discuss solder techniques. Students will leave with an ability to identify parts and know how to solder in accordance with classes 1, 2, or 3.

Dr. John Lau, senior project assistant at Unimicron, will present a course titled, "Chiplet Design and Heterogenous Integration (SiP)." Chiplet is a chip design method, and heterogeneous integration is a chip packaging method. "Chiplet design and heterogeneous integration packaging have been generating a lot of traction lately," Lau says. "For the next few years, we will see more implementations of a higher level of chiplet designs and heterogeneous integration packaging, whether for cost, time-to-market, performance, form factor, or power consumption. His lecture will cover the reasons behind chiplet design, how it relates to heterogenous integration packaging, lateral communication between chiplets, and multiple systems in various scenarios.

Design engineer Vern Solberg will teach two courses. This first tutorial will furnish the design for manufacturing principles established for flexible and rigid-flex circuit fabrication. Additionally, guidance will be presented in developing surface mount component land pattern geometry and methods for providing the physical reinforcement criteria that will contribute to ensuring quality, reliability, and manufacturing efficiency.

The second course "will furnish PCB design engineer guidance for developing and implementing the new generations of advanced multiple function semiconductor packaging technology, high-density circuit boards, as well as ultra-high-density interposers," Solberg says. "Driven by the need to maintain a competitive edge and technical advantage, product developers are relying heavily on more innovative IC package solutions. Although integrating several semiconductor functions onto a single die element (system-on-chip) appears to provide a viable solution for some, development cost and time have often proved excessive. On the other hand, semiconductor companies, working together with other companies, are establishing the universal chiplet interconnect express (UCIe) standard as a high-bandwidth, low-latency connector for those computing blocks to communicate inside a chip and lead the ecosystem to create the UCIe Consortium.

Frank Richter, CEO of Greenectra will provide a comprehensive introduction to Li-ion battery technology. "We cover the main topics needed to understand how Li-ion batteries work as well as the challenges for the implementation within battery systems," Richter says.

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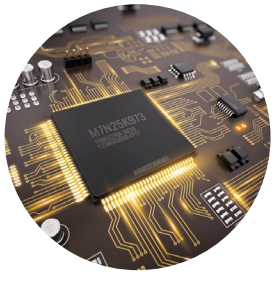

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Rita Mohanty, senior scientific principal at Henkel, presents a course on the fundamentals of thermal interface material. "The cooling of electronics is critical to the safety, performance, and reliability of contemporary electronic systems," Mohanty says. "Electronics industries continue to move toward highly integrated devices with smaller feature sizes and higher currents with smaller footprint devices. Higher functionality comes with the price of high heat generation due to higher power dissipation. In general, heat from a system can be removed by conduction, forced convection, and radiation. For most electronic applications, heat is primarily removed by transferring heat by conduction through a solid medium. Polymer-based thermal interface material (TIM) is one of the most effective solid media used in thermal management today."



Mark Finstad, director of engineering at Flexible Circuit Technologies, and Nick Koop, director of flex technology at TTM Technologies, will give a joint "ask the flexperts" course about lessons learned in design through test. There will be two sessions. Mark is the IPC-2233 committee chair, and Nick is the IPC-6013 committee chair. They will cover the following topics: mechanical design/material selection, cost drivers, bending and forming concerns, testing, and issues unique to rigid-flex. This course also includes a complete virtual plant tour of a flexible circuit manufacturing facility to help attendees understand the manufacturing processes. Throughout the presentation, the instructors will share many real-life stories of flexible circuit applications gained over 35+ years in the industry. Some of these are success stories and others not so much, but all provide excellent lessons learned. The instructors also welcome and encourage questions, and enjoy "wandering off course" with lively interactive discussions on specific topics from the class.

Gerjan Diepstraten, manager of advanced technology at ITWEAE, will discuss how to develop a robust selective soldering process. "Boards can be soldered in different ways," he says. "What is the best method and how can we define this in the design phase?"

Dr. Jennie Hwang, CEO of H-Technologies Group, will present a course on the opportunities, challenges, and possibilities of artificial intelligence. "As we move into an artificial intelligence (AI) era, the new AI tools and platforms are remaking our daily lives and every aspect of workplace, including design, research, engineering, manufacturing, and management across all industries, from semiconductor and printed circuit board design to life sciences and new material design," Hwang says. "Even not being an AI technologist, staying in the core knowledge zone is a viable strategy to remain proficient and competitive in the workplace."

Fil Arzola, senior PCB design engineer at Raytheon, will teach a course on how to set up, organize, and engineer a mixed-signal wire-bonded board design. This course will instruct technical professionals to understand the basic guidelines. This course is intended for PCB designers at all levels of design experience. Arzola will present material on improved design methodologies, how to define a well-defined stackup to engineer to the ideals of packaging complexity, and the need to understand basic structures of wire-bond design. **PCB007**

**Julia Gumminger** is manager of professional development and events at IPC.

# Supporting IC Substrates and Advanced Packaging, Part 5

## Trouble in Your Tank

by Michael Carano, IPC CONSULTANT

Direct metallization systems based on conductive graphite or carbon dispersion are quickly gaining acceptance worldwide. Indeed, the environmental and productivity gains one can achieve with these processes are outstanding. In today's highly competitive and litigious environment, direct metallization reduces costs associated with compliance, waste treatment, and legal issues related to chemical exposure. What makes these processes leaders in the direct metallization space?

### The Carbon-based Systems (Graphite and Carbon Black)

While both are carbon-based materials, graphite and carbon black have a few differences. The graphite process is based on a very fine and stable aqueous dispersion of synthetic crystalline graphite. The graphite particle, by virtue of its crystalline structure, is highly conductive. Carbon black is an amorphous material with the ability to conduct current. Both materials are well represented in the global market for printed circuit board fabrication. So, what makes these two carbon-based processes ideal for thin material metallization and plated through-holes?

Both processes are quite versatile in depositing carbon or graphite on non-conductive materials. This fact is especially important today as the industry's materials suppliers push the envelope to produce higher-performance resins and laminate composites. With each incremental enhancement in materials' properties, such as coefficient of thermal expansion (CTE), temperature of decomposition (Td), signal integrity (SI), and glass transition temperature (Tg), these materials become more difficult to process.

These higher-performance materials are highly cross-linked and are more chemically resistant to processes such as alkaline perman-

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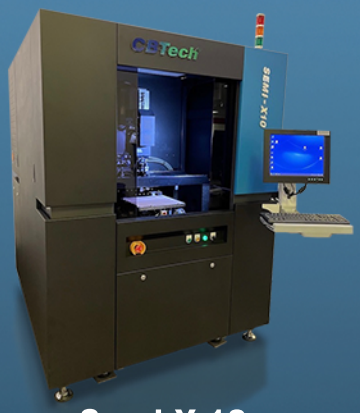


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ganate desmear. Conventional electroless copper requires a micro-roughened resin surface to effect sufficient adhesion of the copper to the resin. In contrast, the carbon-based systems are likened to a coating technology. Surface topography is not an issue for these carbon-based systems to adhere to the resin materials.

With respect to electroless copper, a precious metal catalyst (palladium is most common) is required to bring about the oxidation of formaldehyde (the reducing agent most commonly used in electroless copper formulations). Essentially, electroless copper comprises two half-cell reactions, with several process steps required to provide a void-free copper deposit.

In addition, during the copper plating process, hydrogen gas is evolved. Hydrogen gas produces bubbles that can lodge in small diameter through-holes and blind vias. If the hydrogen gas bubbles are not efficiently evacuated from the vias, plating voids will result. The overall electroless copper reaction is shown below:

**Overall reaction:**

$$Cu(EDTA)^{2-} + 2HCHO + 4OH^{-} \rightarrow Cu + H_2 + H_2O + 2CHOO^{-} + EDTA^{4+}$$

In addition, the manufacturing cycle time to metalize a printed circuit board through a conventional electroless copper process is 45–55 minutes. CapEx requirements aside, direct metallization offers faster throughput and, in turn, reduces energy costs as well as greenhouse gas emissions. Certainly, sustainability should be on everyone's list going forward. If one simply calculates the amount of energy required to heat process tanks and the time it takes to process a circuit board through any one process, it can be shown that processes that reduce production time and use less energy will reduce the carbon footprint and thus greenhouse emissions. More on this in a future column.

## Ideal Applications for Direct Metallization

With more emphasis on HDI and ultra HDI, ease of use and speed are critical operational must-haves. Advanced packaging is driving higher densities for IC substrates, interposers, and product boards. This necessitates the increased complexity of these boards and substrates with ever finer lines and spaces, multiple sequential laminations, and smaller diameter blind vias. The carbon- and graphite-based

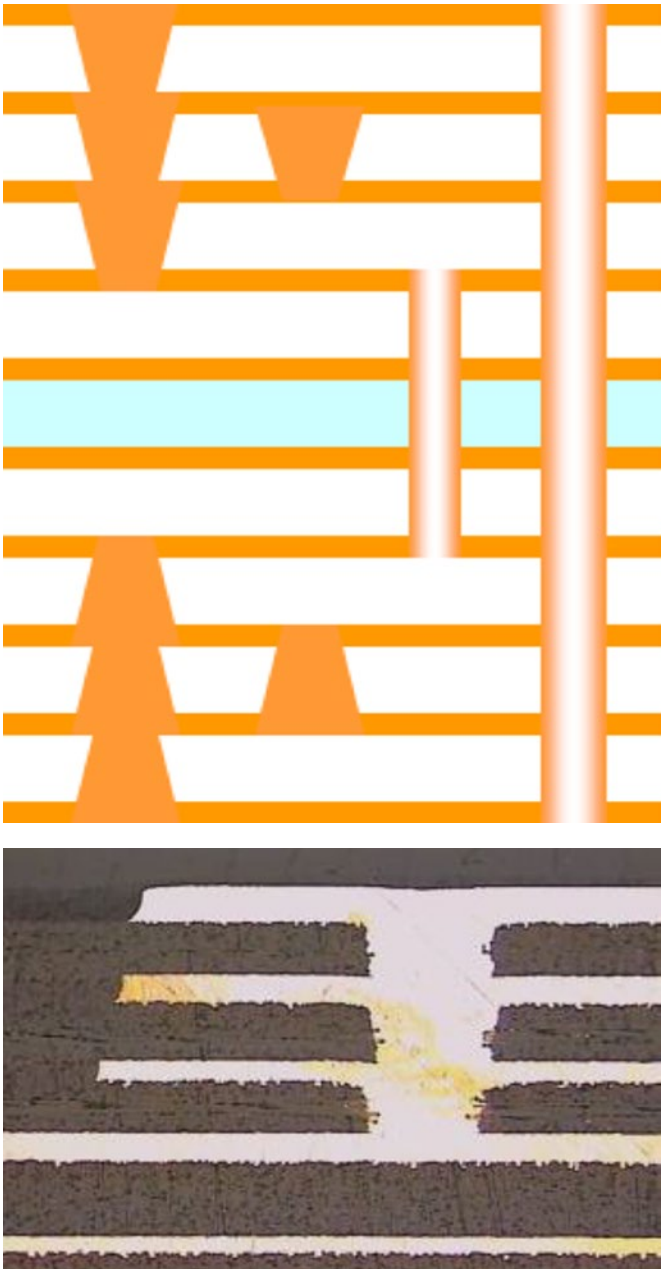

Figure 1: Examples of stacked vias.

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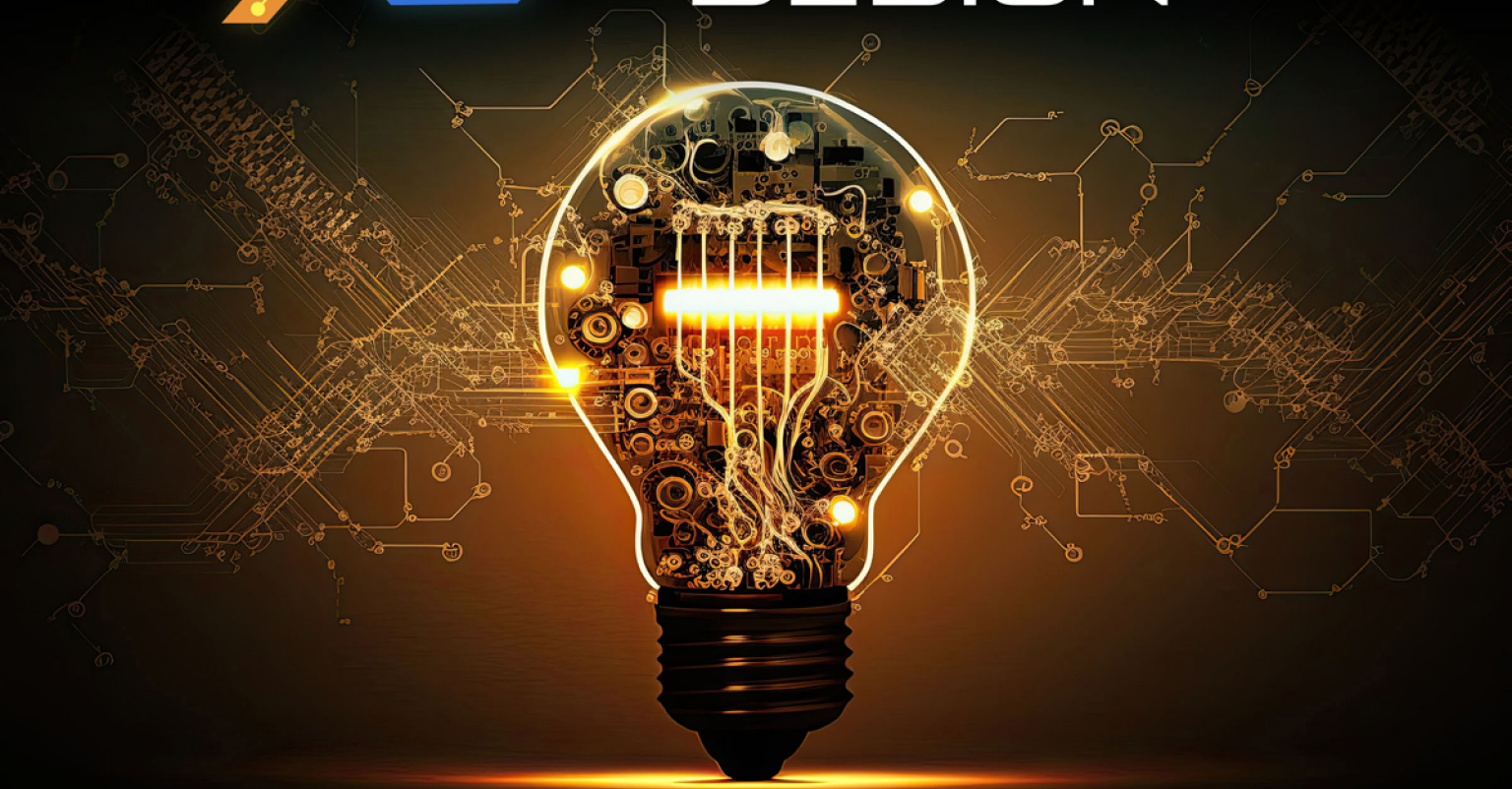

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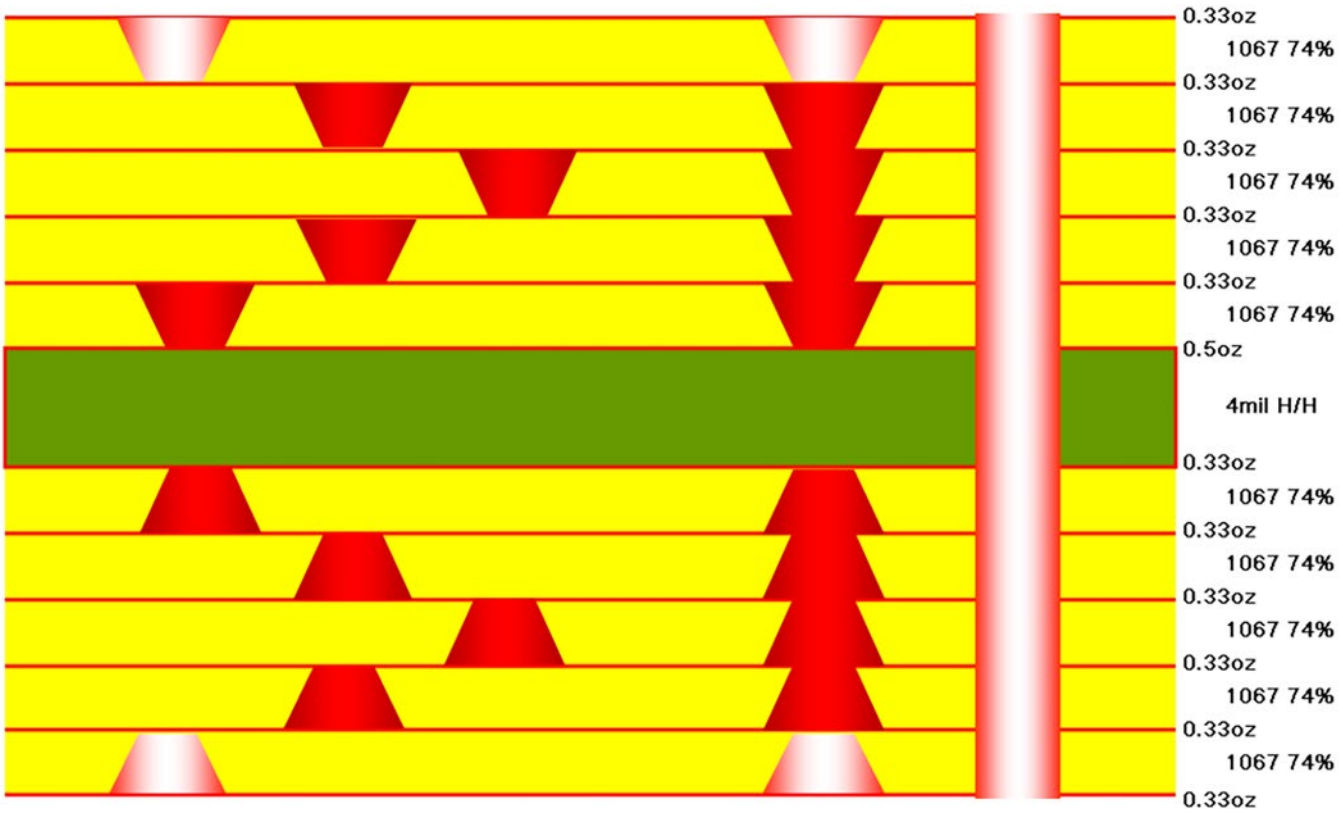


Figure 2: ELIC process.

direct metallization systems are ideally suited for these challenges. The level of complexity is depicted in Figure 1.

In addition, the ELIC process (every layer interconnect) is also practiced in the industry (Figure 2).

With proper material selection, the constructions shown in Figures 1 and 2 will improve long-term reliability and withstand the multiple laminations required. The key here is to select materials with low CTE and higher temperatures of decomposition.

The direct metallization process I've described will enable faster productivity through primary metallization in contrast with conventional electroless copper. **PCB007**

**Michael Carano** brings over 40 years of electronics industry experience with special expertise in manufacturing, performance chemicals, metals, semiconductors, medical devices, and advanced packaging. To read past columns, click here.

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# ECWC16 Technical Conference Special Sessions

**Feature Article by Julia Gumminger**
IPC

The ECWC16 Technical Conference at IPC APEX EXPO 2024 will feature two curated Special Technical Sessions on Thursday, April 11. Building on the success of similar sessions last year, these sessions will feature leaders in the advanced packaging and e-mobility segments, focusing on technological challenges and innovations. Both sessions were curated by the Technical Program Committee (TPC), consisting of subject matter experts in their fields.

## Session 1: Advanced Packaging

From 8:30 to 11 a.m., IPC Chief Technology Officer Matt Kelly will provide the latest insights from industry experts on next-generation IC substrate and UHDI needs for next-generation advanced packages. Application workloads (including AI), high-performance computing, and 5G/6G wireless communications, among others, drive the need for faster, higher bandwidth, more powerful processors, and more memory. Significant changes in semiconductor architectures and designs using chiplet-based, heterogeneous integration approaches are well underway. These changes directly impact IC substrates that interconnect directly with semiconductor chips and UHDI-printed circuit boards needed to connect the electronic package to the rest of the system.

Please join us for this important session that will provide a big picture of the needs for next-generation substrates, insights on the challenges of fabricating UHDI PCBs vs. IC substrates, discussion on next-generation organic build-up substrate advancements, and future substrate R&D needs and challenges. Additional speakers representing companies such as Intel, AT&S, Resonac, AMKOR, and Dia Nippon Printing will dive deeper into these important issues.

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## Session 2: EV Electronics/E-mobility

From 11:30 a.m. to 2 p.m., the topic is "EV Electronics: Design, Manufacturing, and Reliability Challenges." It will include two topical sessions selected by a Technical Program Committee of EV industry experts chaired by Dr. Stanton Rak.

The first session, "PCBA Reliability and Test for EV Applications," will be moderated by Lenora Clark, director of autonomous driving and safety technology at MacDermid Alpha Electronics Solutions. Topics will include high-voltage test and reliability, solder and Ag-sintering material reliability, high-voltage PCB failure mechanisms, and testing protection materials.

Dr. Udo Welzel, senior expert at Robert Bosch GmbH, will moderate the second topical session, "EV Power Electronics Design and Manufacturability." Speakers representing companies such as Semikron Danfoss, Robert Bosch, Zestron, Indium Corporation, MiroTek, and TRUMPF will deliver brief technical presentations followed by a panel discussion with audience participation. Topics include high current and high voltage connections with PCB, laser welding for busbars, power electronics, and more. The e-mobility session is supported by IPC's e-Mobility Quality & Reliability Advisory Council, and closely aligns with the council's mission to help deliver e-mobility quality, reliability and safety while protecting the drive for innovation.

"On behalf of the TPC, I invite you to attend Thursday's Special Sessions, built for conference attendees to learn from and network with industry leaders," Kelly says. "Amazing things are happening in electronic packaging and eMobility applications. We are delighted to bring you strong, high-quality technical insights shaping the future of electronics manufacturing."

Plan your travel accordingly to attend these exciting Thursday morning sessions. Flexible registration options allow attendees to attend these Thursday sessions by selecting the option that works best with their schedules: These Special Sessions will be included in the following registration packages: "All-Access," "World Convention," "Committee Meetings Plus Conference," and the "Full Technical Conference." Other attendees may wish to register for one or both Special Sessions using the "Technical Conference Single Session Pass" option. **PCB007**

**Julia Gumminger** is the manager of professional development and events for IPC.

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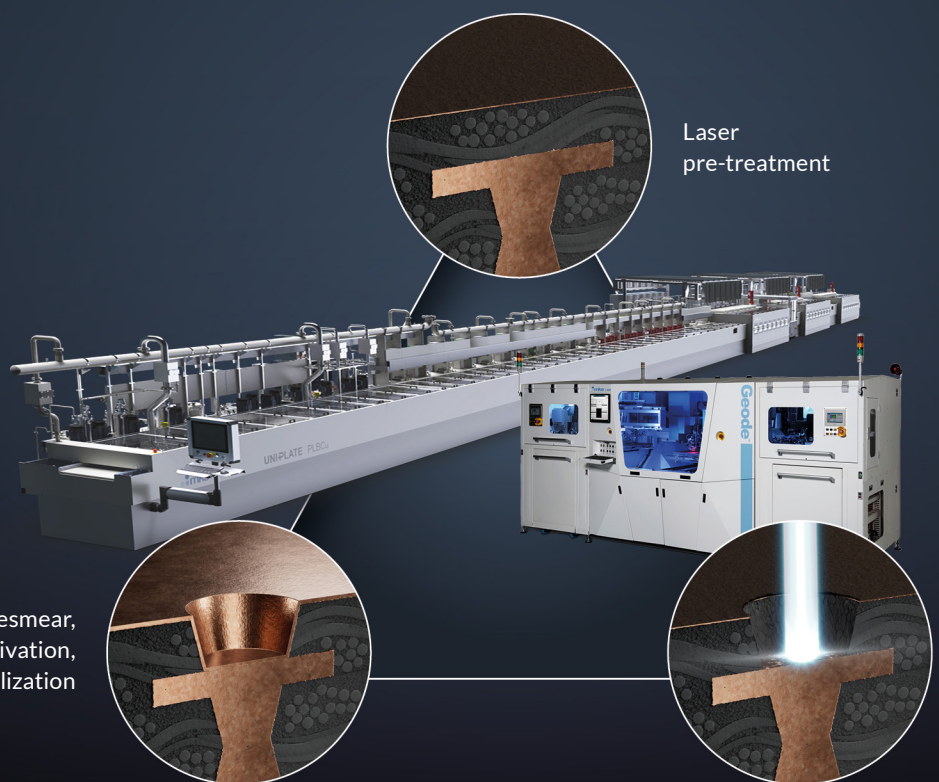


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# Why 4-wire Kelvin?

## Testing Todd

by Todd Kolmodin, GARDIEN SERVICES USA

As William Thomson (Lord Kelvin) once said, "If you cannot measure it, it cannot be improved." This is truer today than ever before. With the advances in microelectronics and nanoelectronics, HDI, and buried active/passive components, the signature of the printed circuit is critical. High-speed substrates rely on signal transmission to be as pristine as possible. Minor changes can cause impedance changes in standing wave ratio (SWR) elevation, which leads to degraded performance.

As we know, there is a difference between low resistance threshold continuity testing and 4-wire Kelvin. Wait, maybe we don't. Let's take a look.

Continuity resistance in the standard electrical test (ET) theater relates to the end-to-end resistance of a single circuit. This is outlined in IPC-9252 for testing printed wiring boards. In this specification, referenced in many others as the standard for ET, Table 4-1 outlines continuity and isolation parameters for Class 1, 2, and 3 builds. These are referenced to Test Levels A, B, and C, accordingly. Here, continuity resistance for Class 3/Test Level C is 10 ohms, meaning point-to-point resistance in the circuit cannot exceed 10 ohms to be compliant. However, this just means that if the resistance is ≤ 10 ohms, all is well with the world.

However, with via plating, microwave circuits, and critical timing circuits, this can be a problem. This is where the high-resolution measuring of the 4-wire Kelvin bridge is recommended. Historically, 4-wire Kelvin has been used to identify plating anomalies where sight resistance changes may indicate taper plate or insufficient bonding in the microvias.


Figure 1: Lord Kelvin.

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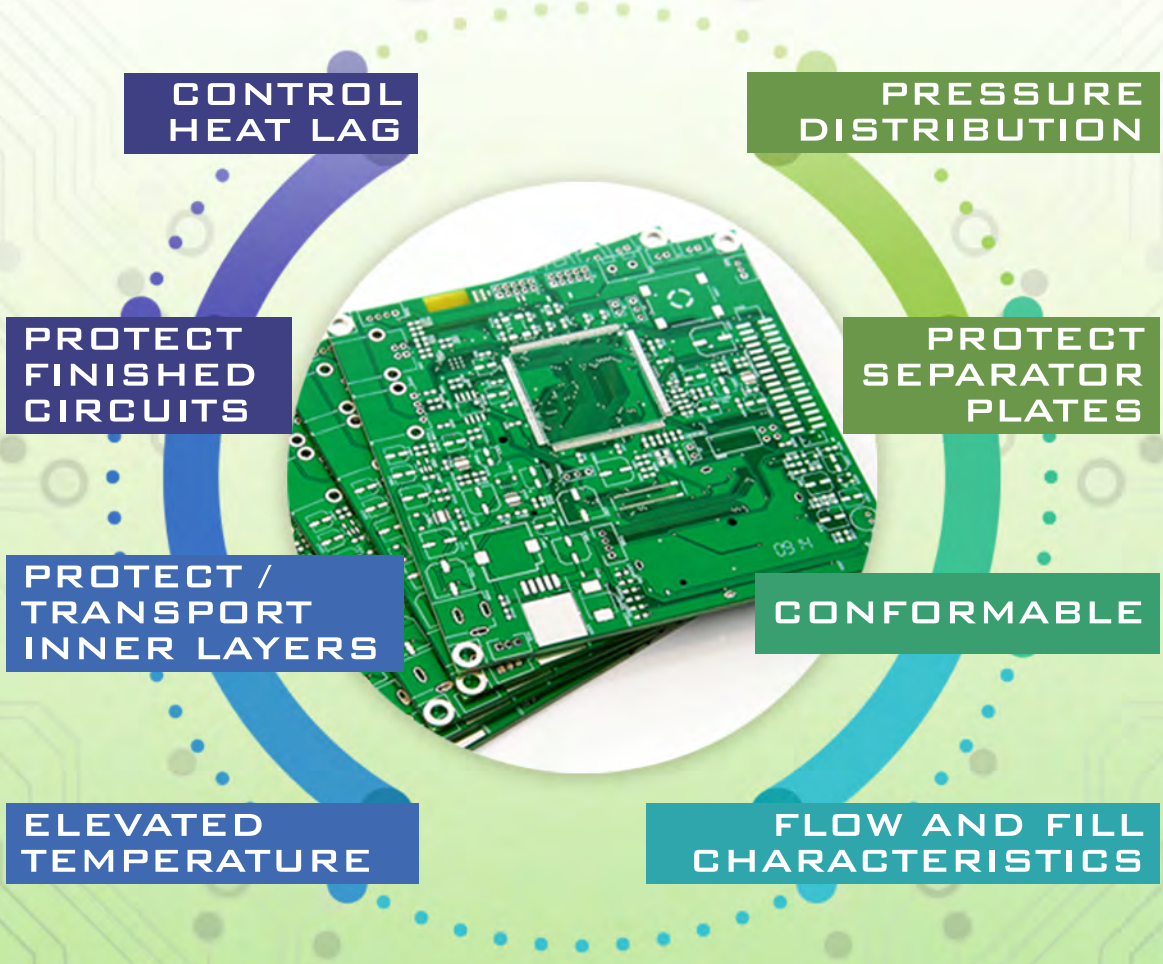


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Today, resistance values play into the overall performance of the circuit and, further, the performance of the final product.

We must remember that 4-wire Kelvin is different from standard continuity testing and enhanced equipment is required. We must also remember that fixture testers are not a good solution either. The main reason is the continuity threshold capability. Honestly, most 1980s and '90s fixture testers will struggle to perform under a 5-ohm continuity threshold requirement unless they are in a strict maintenance program that refurbishes the cassettes and machine interfaces. Otherwise, contamination and oxidation will hamper the ability to test to the lower continuity requirement. Second, most fixture testers cannot perform a 4-wire Kelvin test due to the lack of system metering technology. The solutions are bench tests or flying probes.

Technology exists now where passive components can be tested to a known value. This is common with resistors, capacitors, and inductors. These values can be learned on machines and compared, or a predetermined value can be programmed. However, this is used in lower resolution requirements of usually 3 ohms and above. This is still a 2-wire measurement with better accuracy obtained by less wiring and wire resistance nulling on the machine. This is usually unavailable on fixture testers.

To realize the full potential of the high-resolution measurement requires the 4-wire Kelvin bridge. The theory is that as the stimulus is applied to the unit under test (UUT), the stray/contact resistance is shunted, leaving only true resistance. This allows for very fine measurements in the milli- and micro-ohm ranges. Using this methodology, the very fine changes in resistance can be measured. Here is where it has been very beneficial identifying plating anomalies. Thin copper in the via barrels will have a change in resistance that can be detected using 4-wire Kelvin and thus removed from the supply chain and stopping the latent field failure.

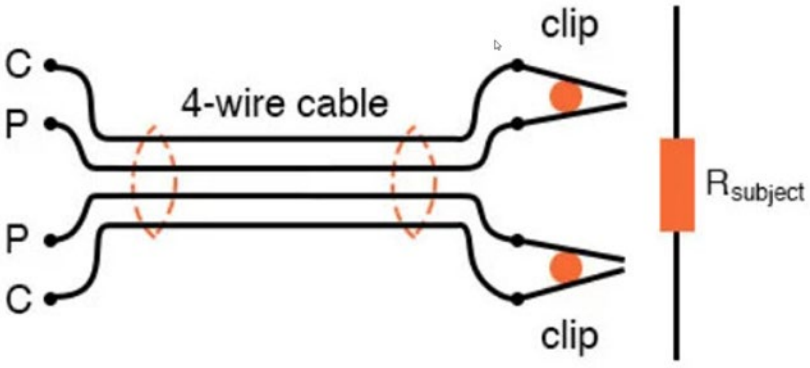
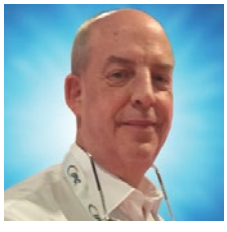



Figure 2: Kelvin clips.

Build technology is advancing rapidly and 4-wire Kelvin has found a new niche in the high-speed substrate, HDI, and microwave markets. High-speed transmission and wave propagation are affected by resistance changes. These changes can cause changes in the reactance of circuits. In this arena, it is bad news; 5 ohms continuity in a circuit may be way too much. Designers are now adding predictability to their designs, which includes circuit resistance. We also see this in ceramic substrates where circuit resistance must be predictable in the 300 mohm to 1.2 ohm range. This requires measuring with 4-wire Kelvin hardware. This can be pre-programmed so that the test is invisible to the operator. Reports can be generated so that predictability can be reviewed.

This is why 4-wire Kelvin has emerged as an even more important tool in the ET arena. Standard testing, buried passive interrogation, and 4-wire Kelvin should be in the manufacturer's toolkit. If not, seek a reputable test supplier to help you along the way. **PCB007**



**Todd Kolmodin** is VP of quality for Gardien Services USA and an expert in electrical test and reliability issues. To read past columns, click here.

# Electronics Industry Mourns Loss of Colleague and Visionary Michael Ford


Sadly, longtime I-Connect007 columnist, industry visionary, and friend Michael Ford passed away Saturday, Jan. 27, 2024. "In this time of sorrow, we can take solace in the knowledge that Michael leaves a great legacy of contribution to the electronics industry," according to a statement from Aegis Software.

Michael was senior director of emerging industry strategy at Aegis. He was a prolific writer and speaker whose work and ideas put him at the forefront of electronics manufacturing. Working for Aegis gave him the opportunity to apply his software for electronics manufacturing experience to further drive technology solution innovation.

In the statement from Aegis, Michael was described as "always envisioning what was needed to achieve an improved manufacturing future before others could see it. What new system, standard, or concept could help move things forward for the better? Michael could move those ideas to the forefront and was always seeking the views and ideas of others in the process. He had a singular gift in helping everyone he encountered see the future with him in his articulate and compelling way that brought everyone into the process, whether an individual or a full conference hall."

He started his career with Sony, including eight years working in Japan. He was instrumental in creating and evolving software solutions for assembly manufacturing that meet the most demanding expectations. He was an established thought leader for Industry 4.0 and digital Smart factories, and an active contributor to industry standards.

In 2020, Michael was given the IPC President's Award as recognition for contributions, including CFX, traceability, secure supply-chain and digital twin standards.

In 2021 Michael was awarded the Dieter Bergman IPC Fellowship Award and chose Villanova University's engineering department as the recipient of the grant which in turn awards a scholarship to benefit the promotion of opportunities for women in the industry.

His column for I-Connect007 was titled Smart Factory Insights, and he frequently took commonly-held ideas and pushed the boundaries of current thinking. He often found ways to improve business operations or create new business models that built off current frameworks.

"Michael has been such a generous and knowledgeable columnist for so long," says Pete Starkey, a technical editor for I-Connect007. "He was a genuinely lovely man and a worthy recipient of our 'Good for the Industry' award. I can't believe he's gone."

One time we asked him for his sage advice, and he said, "Always keep an open and progressive mind. Listen to and understand perspectives from all of those around you."

# IPS Engineers on AI and More

**Interview by Barry Matties**
I-CONNECT007

Over the past few months, we have met several of IPS's team members. IPS has been a manufacturer of wet process equipment for printed circuit board fabrication for over 30 years, working from its Cedar City, Utah, location. In this interview, you will meet IPS team members Travis Houchin, Larry Boehm, and Kaal Glazier. Travis has been in the industry for 15 years, Larry for 20 years, and Kaal, who studied manufacturing engineering in college and graduated in 2019, joined IPS last year. With this group of two seasoned industry experts and the voice of the next generation, we cover several topics, including AI, and some useful tips when considering equipment, especially in brownfield sites.

***Barry Matties: Larry, have you been in the industry for many years?***

*Larry Boehm:* Starting in high school, I worked for Viking Chemical, which did conformal coatings. We mixed resins, material, and hand-dunked PC boards. That was around 1986—and I wonder why I'm falling apart. I have been with IPS since last year.

***What changes or surprises stick out over your decades-long career?***

*Boehm:* First, the technology: everything from the laminates, signal integrity, I/O speeds, and the complexity of vias. You're now looking at things so complex from a basic double-sided board. Now you have Kapton® materials and other technology, for example, in missile programs, space, and satellite programs. It's never-ending, and it's such an advanced materials market.

***Kaal, you're fresh in the industry. What has caught your attention? What's been most interesting to you?***

*Kaal Glazier:* There is a lot to be considered. One thing is being at the manufacturing facilities and seeing how packed some manufacturers can be when it comes to real estate—trying to get a new process into such a small area. That challenge makes it a lot of fun for our engineering team. While looking at how we meet customers' demands in such a small space, I've asked a few times about going vertical, making a double-decker machine while keeping haz-

55
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ardous fluids contained in a very controlled way. It can be really difficult to always meet the demand from customers within the constraints they have. They understand the constraints, so is this just a challenge from them? I want to see where we can present solutions and value to the customer. It's not like everyone has an extra $500,000 to build a room for a new machine.

***I think you're keying in on something because it's a challenge when there's a need to up-grade at brownfield sites. Travis, overall, what should fabricators be paying attention to today?***

*Travis Houchin:* They should be paying attention to current trends in the market and knowing what's best for your customer's future. Also, look at how new technology and equipment can improve or add capabilities to your manufacturing. I think that's key. Specifically for fabricators, pay attention to manufacturing and future trends to ensure you're always up to date on any new technology and what's out there.

***I am curious how often AI comes up in your conversations with customers.***

*Houchin:* Maybe 20–30%. We're certainly going to be experiencing some fast-coming changes in technology. However, it's still unknown exactly how it will best be used. I've noticed it comes up more in conversations around our equipment, but it's still pretty new to be a focused topic of conversation. It will be a part of our lives. As we learn more about how it can help us, it will definitely be available and widely used. Right now, it can be a competitive advantage.

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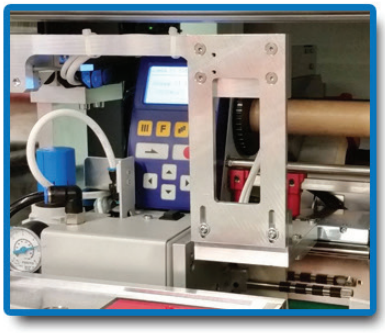

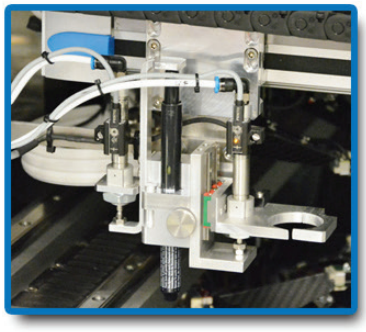

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Internal view of IPS automated ENIG line.

*Boehm:* We must remember that AI can be a scary area for many folks, especially regarding the data and information that can be collected and compiled statistically and physically. It's kind of overwhelming for a lot of people. How do you present the data? What about all the data AI is generating? That's the next level of all our statistical trends. It's accelerating so fast. Everything will have something to do with AI in the next year and a half.

***I agree. Kaal, what is your view of AI?***

*Glazier:* Maybe I just have a deeper sense of humor, but sometimes when I see those pictures purely generated by AI, I notice that somebody has six fingers or an extra leg. So, there is still that reliability concern. You don't want to be running too many experimental programs with live military-grade products; you don't risk your quality with that. That being said, there are proven AI tools that you can rely on, and they are getting much better. I know our machines provide the data so we can accurately track and supply the data to AI programs and help customers expand their AI programs.

***The AI is in the data collection and interpreting. We will be able to really tighten up the parameters of the manufacturing process. IPS is doing this sort of stuff already.***

*Houchin:* Yes. We are committed to helping our customers stay as competitive as they can be.

***Matties: That's great. It's an exciting future. Well, I certainly thank you for your time and insight.***

*Houchin:* Thank you. **PCB007**

*Look for part 2 in a future PCB007 Magazine.*




Side view of IPS automated ENIG line.

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| Certified Electronics Program Manager | Feb. 27–Apr. 4 | T/TH | 2:30 pm PT/5:30 pm ET | 6 |
| PCB Design II section 1 | Mar. 18–May 15 | M/W | 8 am PT/11 am ET/5 pm CET | 8 |
| PCB Advanced Design Concepts | Mar. 18–May 15 | M/W | 3:30 pm PT/6:30 pm ET | 8 |
| PCB Design II section 2 | Mar. 19–May 16 | T/TH | 3:30 pm PT/6:30 pm ET | 8 |
| PCB Design I (Brazil) | Apr. 22–May 29 | M/W | 7 pm BST/ 6 pm ET | 6 |
| Top Lead-free Production Defects & Issues – Causes, Remedies & Prevention | Apr. 23–May 2 | T/TH | 8 am PT/11 am ET/5 pm CET | 2 |

## WHAT STUDENTS ARE SAYING!

**"The live interaction facilitated asking questions that helped clarify the information."**

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**"The instructor explained the course in detail, in a way that can be understood by everyone."**

**"I liked the approach the instructor took for full participation of all students."**

**"The recorded lectures help me to review the training materials at my convenient time."**

# Standards Development Propels the Industry Forward

Feature Article
by Teresa Rowe, IPC

IPC standards are recognized around the world. As our industries delve more deeply into challenging areas, such as ultra high density and electric vehicles, standardization within and across the supply chain becomes even more pressing.

Standards development task groups will meet face-to-face at IPC APEX EXPO, April 6–11. The technical discussions provide an opportunity to share knowledge, learn from other subject matter experts, and network with others who have similar technical interests. You may remember the urgent need for coffee and the possibility of snagging a cookie or a granola bar to maintain the necessary energy level for these marathon sessions.

The schedule for this year's meetings looks as complicated and intense as years gone by. For 2024, we are adding several new projects, including IPC's Factory of the Future initiative and the IC Substrates Task Group, which meets in an international setting for the first time.

Staff liaisons for the task groups are busy preparing the documentation and hosting our technical community. Files are being prepared, comments gathered and logged, and drafts updated. This electronic documentation will be available in IPC Works for standards committee members prior to the meeting in Anaheim. Those who wish to download it can bring their individual copies to the meetings.

Industry leaders will be present at each meeting to guide the industry in decision-making; IPC staff will assist the leaders. In some groups, the leaders are new to their roles, and they, too, are excited to have the opportunity to lead discussions. No matter the size of the group meeting, everyone present will be encouraged to participate and contribute to the true spirit of standards development.

Several groups have presentations that will provide a foundation for recommended changes to existing content. These presentations may be made by A-Teams reporting on action items assigned at an earlier meeting. The A-Teams, known for their quirky names such as "The Inkpendables," "Testing, Testing, 1, 2, 3," and "Terminal Happiness," have continued to work diligently on technical content for task group consideration at this year's meeting. We expect spirited conversations on these topics.

If you have not attended a standards development meeting, we encourage you to stop by a task group meeting and see what's happening. From design to final products, there is something for everyone. Make sure to introduce yourself to the staff. We welcome all to IPC APEX EXPO 2024. **PCB007**

**Teresa Rowe** is IPC's senior director of assembly and standards technology.

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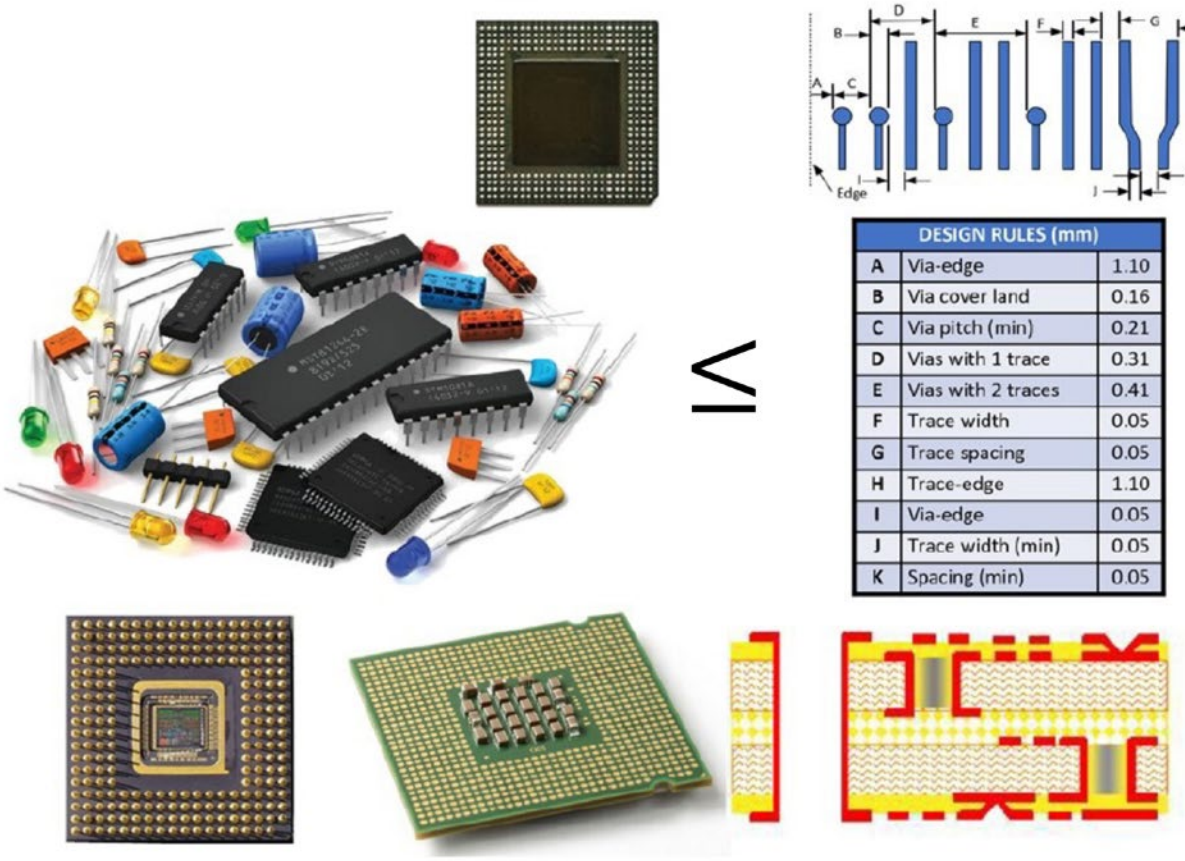
# Balancing the Density Equation

## Happy's Tech Talk #26

by Happy Holden, I-CONNECT007

Printed circuit design and layout is a creative process that has profound implications for electronic products. With the need for more parts on an assembly, or the trend to make things smaller to be portable or for faster speeds, the design process is a challenging one. The process is one of "balancing the density equation" (Figure 1) with considerations for certain boundary conditions like electrical and thermal performance. Unfortunately, many designers do not realize that there is a mathematical process to the layout of a printed circuit. The density equation has two parts: the component wiring demand (Wd) on the left, and the substrate wiring capacity (Wc) on the right.




| DESIGN RULES (mm) | | |
|---|---|---|
| A | Via-edge | 1.10 |
| B | Via cover land | 0.16 |
| C | Via pitch (min) | 0.21 |
| D | Vias with 1 trace | 0.31 |
| E | Vias with 2 traces | 0.41 |
| F | Trace width | 0.05 |
| G | Trace spacing | 0.05 |
| H | Trace-edge | 1.10 |
| I | Via-edge | 0.05 |
| J | Trace width (min) | 0.05 |
| K | Spacing (min) | 0.05 |

Figure 1: The component's PWB wiring demand is less than or equal to the PWB's design rules and construction capacity

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The four conditions are:

- Wd > Wc: There are not enough wires to complete the design
- Wd = Wc: Ideal, but nearly impossible to achieve in the time allotted
- Wd < Wc: About 20% is a good target to set, especially if autorouting
- Wd<< Wc: The normal situation where extra layers are used or tighter design rules than are required

1. Wiring demand > Substrate capacity: If the substrate capacity is not equal to the demand, the design can never be finished. There is not enough room for either traces or vias. To correct this, either the substrate has to be bigger, or components have to be removed.
2. Wiring demand = Substrate capacity: While optimum, there is no room for variability and to complete the design will take an unacceptable amount of time.
3. Wiring demand < Substrate capacity: This is the condition to shoot for. There should be enough extra capacity to complete the design on time and with only a minimum of overspecification and costs.
4. Wiring demand << Substrate capacity: This is the condition that usually prevails. By PC layout, the schedule is tight, and timing is all-important. Many choose tighter traces or extra layers to help shorten the layout time. The impact of this is to increase the manufacturing costs 15–50% higher than is necessary. This is sometimes called the "sandbag approach." It is unfortunate since the models above would help to create a more planned environment.

## Component Wiring Demand

Wiring demand is the total connection length required to connect all the parts in a circuit. When you specify an assembly size, then you create the wiring density in inches per square inch. Models early in the design planning process can estimate the wiring demand. Three cases can control the maximum wiring demand:

1. The wiring required to break out from a component like a flip chip or chip scale package.
2. The wiring created by two or more components tightly linked, say a CPU and cache or a DSP and its I/O control.
3. The wiring demanded by all integrated circuits and discretes collectively.

There are models available to calculate the component wiring demand for all three cases. Since it is not always easy to know which case controls a design, I usually must calculate all three cases to see which one is the most demanding and thus controls the layout. The model I find most useful for Case 3 is Coors and Anderson's "Statistical Wiring Requirement."[1]

The other widely used models are:

- D.P. Seraphim, R. Lasky, and C.Y. Li[2]
- H. Ohdaira, K. Yoshida, and K. Sassoka[3]
- W. Donath[4]
- S. Sutherland and D. Oestreicher[5]
- L. Moresco[6]

## Coors and Anderson's Density Model

In 1990, Drs. Paul Anderson, Grover Coors, and Lori Seward of the Colorado School of Mines proposed a statistical model for determining the total wiring requirements (Wd) for a modern digital PWB based on the stochastic model of wiring involving all terminals, their probability of length based on the distance of the second terminal (their probability distribution function), and the special geometry of the other terminals. By benchmarking existing successful PWB digital designs, the typical multilayer (Figure 3a) had the net length distributions seen in Figure 2a. This matches the probability distribution function (PDF) in mathematics, as seen in Figure 2b. Using a Gamma distribution function, the nets in the real board (Figure 2a) create the interconnect length histogram in Figure 3b. This model allows the cal-

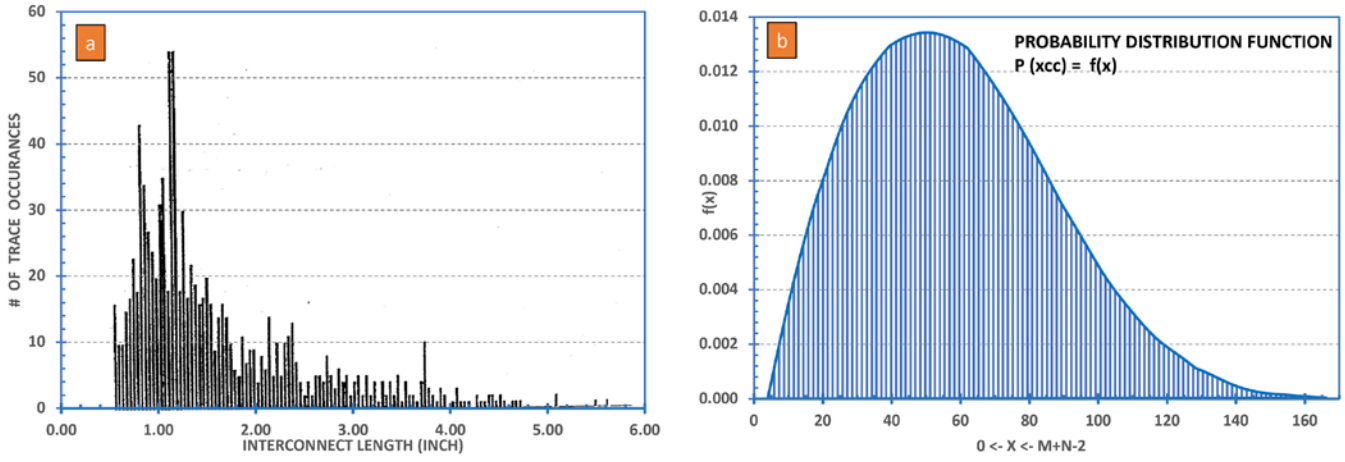


Figure 2: a) Interconnect length histogram for the PWB in Figure 3a; b) Probability distribution of trace length.[1]

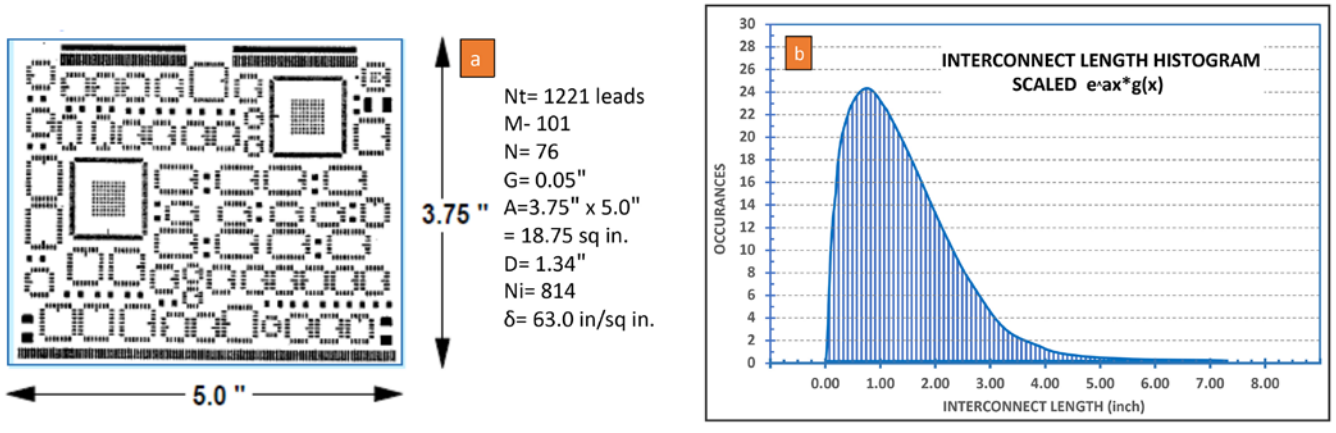


Figure 3: a) Multilayer example from Coor's paper; b) Interconnect length histogram for PWB 3a and 2a.[1]

culation of the Manhattan Predicted Interconnect Density, δ.

## Predicted Interconnected Density, δ

D = ave. interconnect distance (in.)
δ = D * Ni ÷ A (inch. per sq. inch)

where: N i= total number of interconnections (Ni = 2*Nt/3)

Nt = number of terminal leads
A = rout area (sq. inch)
D = E(x) * G

where: E(x) = expectation of occurrence
G = pad placement grid (in.)

where: α = empirically derived constant = 0.94

$$E(x) = \frac{1}{a}\left[\frac{\left((S-T)(S*a-2)\right)e^{aS}+S*(2-(S-T)*a)\,e^{a(S-T)}-2T}{(S-T)e^{aS}-Se^{a(S-T)}+T}\right]$$

$A = \ln\alpha \quad S = M + N \quad T = \sqrt{M^2 + N^2}$

M = board width of grid pts. = (width/G) + 1
N = board length of grid pts. = (length/G) + 1

## Substrate Capacity

Substrate capacity is the wiring length available to connect all the components. It is composed of three factors:

1. Design rules: The traces, spaces and via lands, keepouts, etc., that make up the geometries of the substrate.
2. Structure: The number of signal layers and the combination of through and buried vias that permit interconnection between layers and the complex blind, stacked, and variable depth vias available in HDI technologies.

3. Layout efficiency: The percentage of capacity from design rules and structure that a designer can deliver on the board.

These three factors determine how much wiring is available on the substrate to meet the wiring demand. The data is straightforward except for layout efficiency. Layout efficiency is a little used factor that expresses what percentage of wiring capacity can be used in the design. The equation for substrate capacity for each signal layer is below. The total substrate capacity is the sum of all the signal layers:

Wc (Wiring Capacity) = E * t/g
Where: E = Layout efficiency

t = number of traces per grid area or distance between two via pads
g = grid size or length between centers of via pads above

Table 1: Typical layout efficiency (best to replace with your own results)

| STACKUP | TYPICAL DENSITY | MAXIMUM DENSITY | EFFICIENCY |
|---|---|---|---|
| TH | 4.5–11 in./sq in. | 13 in./sq in. | 6–8% |
| BV/TH | 10–15 in./sq in. | 16 in./sq in. | 7–10% |
| BV/Buried Via | 12–20 in./sq in. | 22 in./sq in. | 8–14% |
| 2-BV/Buried Via | 15–28 in./sq in. | 30 in./sq in. | Up to 24% |
| 3-BV/Buried Via | 20–36 in./sq in. | 40 in./sq in. | Up to 30% |

## Wiring Demand Vs. Substrate Capacity

The key to meeting schedules and keeping manufacturing costs under control is layout performance metrics (substrate capacity/wiring demand). It's an understanding of an optimum design and keeping track of how close you get to it. Practice balancing the design equation and doing what-ifs. Try achieving a layout performance of from 1.05 to 1.15. Typical layout efficiencies are shown in Table 1.

More examples of wiring models can be found in Chapter 19 of the *Printed Circuits Handbook,* Sixth Edition, or Chapter 16 of the Seventh Edition. **PCB007**

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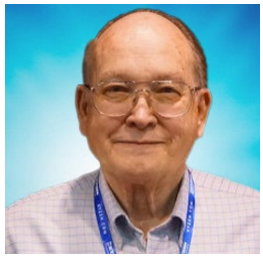


**Happy Holden** has worked in printed circuit technology since 1970 with Hewlett-Packard, NanYa Westwood, Merix, Foxconn, and Gentex. He is currently a contributing technical editor with I-Connect007, and the author of *Automation and Advanced Procedures in PCB Fabrication*, and *24 Essential Skills for Engineers*. To read past columns, click here.

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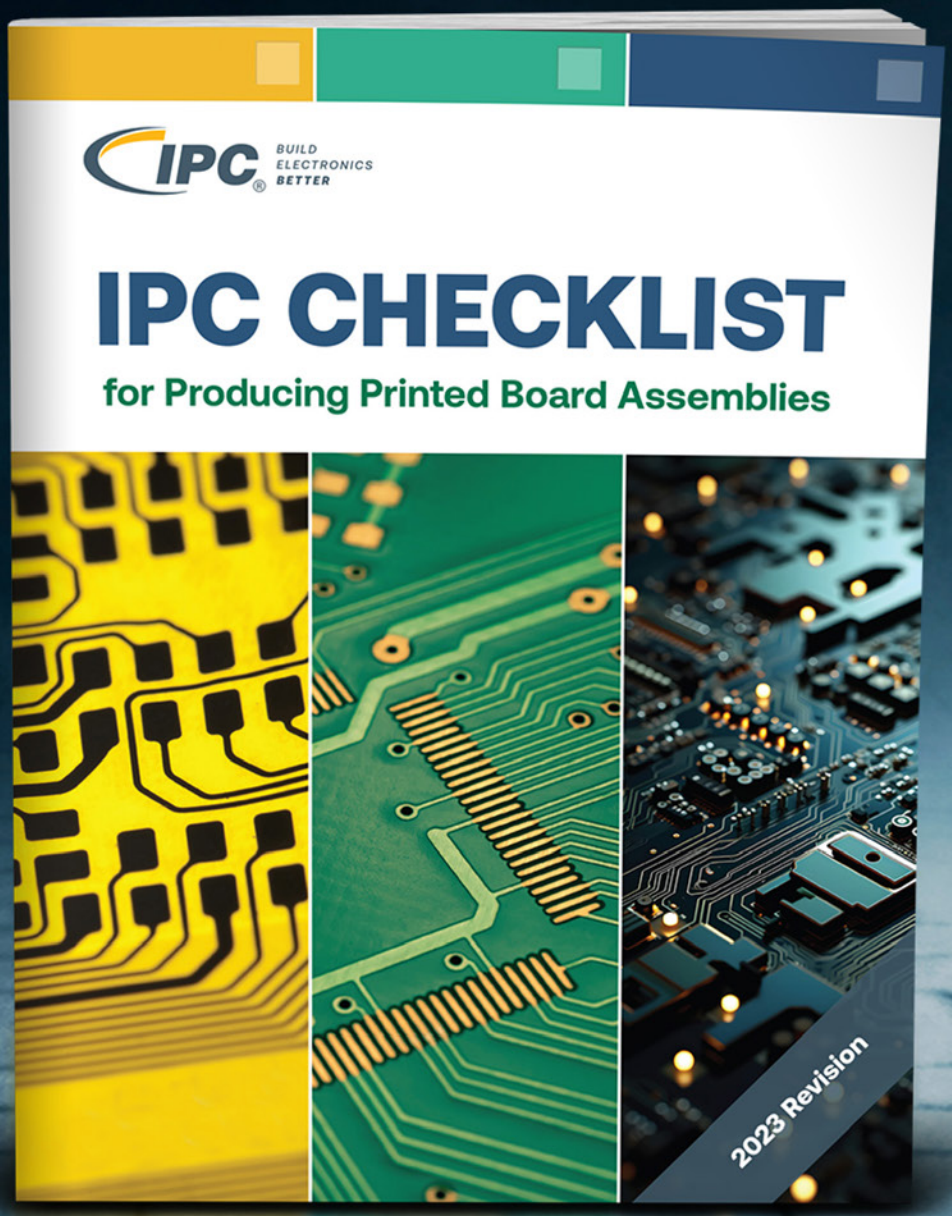


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# TOP TEN EDITOR'S PICKS

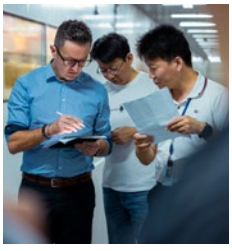
## The Designer and Manufacturer Must Be in Sync

It's no industry secret that most PCB data packages sent to fabricators from designers cannot be built as-is. Often, the finished boards seem to work okay despite a factory estimating what the designer wanted vs. what the documentation showed, then jointly rectifying issues through lengthy technical query (TQ) cycles. In general, everyone seems to be satisfied with this process, so why do we need to improve the designer/manufacturer relationship? Why is the best solution a strong designer/manufacturer relationship, and is it even possible?

## Nearshoring: Mexico Making Pivotal Move in Supply Chain Dynamics

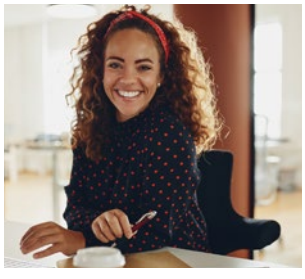
Amidst the turbulence of international trade wars, pandemic-induced supply chain disruptions, and the escalating demands for rapid delivery cycles, businesses are increasingly looking to relocate manufacturing and production operations to countries geographically closer to their core consumer markets. Nearshoring's potential promise is not only to mitigate the vulnerabilities of extended supply lines but also to offer agility in responding to consumer needs, fostering a more adaptable and resilient business model.

## Fostering Loyal Relationships with Design Engineers



Not to diminish the work of engineers from the past, but today's PCB design engineers have much more technology to learn about than engineers of the past. To make matters worse, technological advancements are moving faster than ever, which puts more strain on design engineers to stay updated. Additionally, PCB designers have more options than ever. In this landscape of new and complex challenges, nurturing a solid and enduring relationship with PCB design engineers becomes increasingly important and substantial.

## The New Chapter: Easing the Learning Curve for Young Professionals



My first semester of college included a course on engineering fundamentals that focused on teamwork, problem-solving, ethics, and, of course, coding. I had no experience in coding. In fact, downloading the program to my laptop alone almost required visiting the IT department. This class was my second course on my first day of school. Shortly after the introductory speeches, we were asked to write a "simple" code that output the phrase, "Hello World."

## American Made Advocacy: Five Things American Manufacturers Must Do in 2024

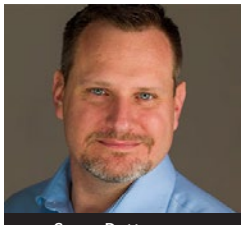
A new year always means new opportunities in Washington, D.C., but this election year presents special challenges. If you make, buy, or depend on printed circuit boards and substrates, here are five things our industry can do to make 2024 a winning year for our growing team. 1. Put circuit boards and substrates on the ballot.

## Ventec International: Growth, Changes, and a New Direction


Mark Goodwin

Barry Matties speaks with Ventec International COO Mark Goodwin about a new direction for Ventec. As a creative thinker and entrepreneur at his core, Mark explains that Ventec's move to add select equipment lines to their product lineup only adds value for their existing customers and complements existing product lines.

## Driving Operational Efficiencies at Summit Interconnect


Sean Patterson

As the largest privately held printed circuit board manufacturer in North America, with headquarters in Irvine, California, Summit Interconnect has eight facilities, including one assembly shop. Coming back into the industry after a career move that took him to Amazon, Summit COO Sean Patterson reflects on the issues of culture, the new workforce and PCB capacity issues in the United States, to name just a few.

## It's Only Common Sense: Involve Employees in Creating a Great Company Culture

We have come a long way from business executives like "Nuclear" Jack Welsh and Al "Chainsaw" Dunlap. Remember when old Milton Freidman declared that a business' only obligation was to its holders or when employees were disposables (practically consumables)? Oh, those were the days, my friend, we thought they'd never end. Well, they're over. AI is dead and buried both physically and in reputation.

## I-Connect007 Explores Designing for Reality With ASC Sunstone in Latest Podcast Series

*On the Line With...,* where industry experts share the latest insights and perspectives on the most relevant topics in the electronics industry. In this new season, host Nolan Johnson visited ASC Sunstone in Mulino, Oregon, for a series of in-depth conversations with VP, Manager, and published author Matt Stevenson about the specifics that can affect your circuit board during the manufacturing process.

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- Key technical contributor and ECAD/MCAD interface expert in the design of new or challenging PCB designs or projects bearing directly on organizational objectives
- Leverages thorough knowledge of Garmin processes and procedures through leadership of major research or product development projects consisting of multiple modules or sub-projects that align the team with Garmin and departmental mission and vision
- Leads the advancement of team capabilities through identification and testing of new PCB design technologies for ECAD software
- Connects engineering teams, communicating effectively with all project stakeholders (ex. Electrical, Process and Mechanical Engineering)
- Serves as an expert in PCB Design and Engineering processes including mentoring one or more PCB Designers

### Basic Qualifications

- Associate's Degree in Electronics Technology or related field AND a minimum of 10 years relevant experience performing similar consumer electronics industry duties OR an equivalent combination of education and experience
- Demonstrates expert proficiency using Garmin's ECAD tools (Cadence Allegro)

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GARMIN

## Lead eCAD Librarian

Garmin is seeking a full-time Lead eCAD Librarian in our Olathe, KS or Cary, NC location. Relocation allowance provided.

### Essential Functions

- Ability to define library solutions with a cross functional understanding of the overarching library impact
- Manages/delivers a global library database solution within established Garmin standards
- Develops reliable solutions for exceedingly complex eCad Library parts which require the regular use of individual thought and creativity
- Verifies/validates schematic symbols and physical footprints for parts created by other librarians for accuracy
- Leads advancement of team capabilities through identification and definition of eCAD Library technical strategy
- Expert in evaluation of new eCAD features and capabilities as they relate to the eCAD Library
- Ability to define eCAD Library process for new technologies and capabilities
- Ability to mentor one or more eCAD Librarians

### Basic Qualifications

- Possess a minimum of 15 years experience in an eCAD librarian position OR an equivalent combination of education and relevant experience
- Demonstrates expert proficiency of eCAD Library best practices and design standards for all PCB technologies used in current Garmin designs
- Demonstrates a working knowledge of all types of electronic components
- Demonstrates proficiency to interpret Manufacturer Data Sheets
- Demonstrates proficiency of PCB manufacturing processes

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# Career Opportunities

## Field Service Engineer (or) Field Service Technologist

SCHMID Group is currently in search of a Field Service Engineer or Field Service Technologist for its USA subsidiary SCHMID Systems, Inc. (SSI). This position acts as an advocate for the company providing worldwide customer service on-site or remotely.

General scope of duties includes machine installation, commissioning, maintenance, and repair of PLC and PC-controlled systems primarily in the company's proprietary industrial machines within the wet chemical processing industry as well as automation technology.

This is a full-time exempt position with limited supervision. SSI provides full-time employees different options for benefits including medical, dental, vision, flex, 401K, and more.

Contact Bob Ferguson:
Ferguson.ro@schmid-group.com

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pluritec®
MACHINES FOR PRINTED CIRCUIT BOARDS

## Sales Manager, Remote

**Location:** North America

**Experience:** Minimum of 4 years in the PCB industry

**Job Description:** We are looking for a highly motivated and experienced sales manager to join our team. The ideal candidate will have a minimum of 4 years of experience in the PCB industry and a proven track record of success in sales. The successful candidate will be responsible for developing new business and sales network, maintaining existing accounts, and achieving sales targets. The candidate must be able to work independently, have excellent communication and interpersonal skills, and be willing to travel.

**Qualifications:**
- Minimum of 4 years of experience in the PCB industry
- Proven track record of success in sales
- Excellent communication and interpersonal skills
- Strong technical process background
- Ability to work independently.
- Willingness to travel

**Education:** Technical or related field preferred

**Compensation:** Competitive salary and benefits package

Pluritec develops high end equipment for the printed circuit board (PCB & PCBA) manufacturing industry. We offer a wide range of equipment including drilling and routing, wet processing, spray coating and more. We are a global supplier with more than 3,000 systems installed worldwide.

**Contact Nicola Doria**
**nicola.doria@pluritec.org to apply.**

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# Career Opportunities

The Test Connection, Inc.

## Rewarding Careers

Take advantage of the opportunities we are offering for careers with a growing test engineering firm. We currently have several openings at every stage of our operation.

The Test Connection, Inc. is a test engineering firm. We are family owned and operated with solid growth goals and strategies. We have an established workforce with seasoned professionals who are committed to meeting the demands of high-quality, low-cost and fast delivery.

TTCI is an Equal Opportunity Employer. We offer careers that include skills-based compensation. We are always looking for talented, experienced test engineers, test technicians, quote technicians, electronics interns, and front office staff to further our customer-oriented mission.

## Associate Electronics Technician/ Engineer (ATE-MD)

TTCI is adding electronics technician/engineer to our team for production test support.

- Candidates would operate the test systems and inspect circuit card assemblies (CCA) and will work under the direction of engineering staff, following established procedures to accomplish assigned tasks.
- Test, troubleshoot, repair, and modify developmental and production electronics.
- Working knowledge of theories of electronics, electrical circuitry, engineering mathematics, electronic and electrical testing desired.
- Advancement opportunities available.
- Must be a US citizen or resident.

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TAIYO AMERICA

## Europe Technical Sales Engineer

Taiyo is the world leader in solder mask products and inkjet technology, offering specialty dielectric inks and via filling inks for use with microvia and build-up technologies, as well as thermal-cure and UV-cure solder masks and inkjet and packaging inks.

**PRIMARY FUNCTION:**

1. To promote, demonstrate, sell, and service Taiyo's products
2. Assist colleagues with quotes for new customers from a technical perspective
3. Serve as primary technical point of contact to customers providing both pre- and post-sales advice
4. Interact regularly with other Taiyo team members, such as: Product design, development, production, purchasing, quality, and senior company managers from Taiyo group of companies

**ESSENTIAL DUTIES:**

1. Maintain existing business and pursue new business to meet the sales goals
2. Build strong relationships with existing and new customers
3. Troubleshoot customer problems
4. Provide consultative sales solutions to customers technical issues
5. Write monthly reports
6. Conduct technical audits
7. Conduct product evaluations

**QUALIFICATIONS / SKILLS:**

1. College degree preferred, with solid knowledge of chemistry
2. Five years' technical sales experience, preferably in the PCB industry
3. Computer knowledge
4. Sales skills
5. Good interpersonal relationship skills
6. Bilingual (German/English) preferred

**To apply, email: BobW@Taiyo-america.com with a subject line of "Application for Technical Sales Engineer".**

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# Career Opportunities

BLACKFOX
Premier Training & Certification

## IPC Instructor
### Longmont, CO

This position is responsible for delivering effective electronics manufacturing training, including IPC certification, to adult students from the electronics manufacturing industry. IPC Instructors primarily train and certify operators, inspectors, engineers, and other trainers to one of six IPC certification programs: IPC-A-600, IPC-A-610, IPC/WHMA-A-620, IPC J-STD-001, IPC 7711/7721, and IPC-6012.

IPC instructors will primarily conduct training at our public training center in Longmont, Colo., or will travel directly to the customer's facility. It is highly preferred that the candidate be willing to travel 25–50% of the time. Several IPC certification courses can be taught remotely and require no travel or in-person training.

Required: A minimum of 5 years' experience in electronics manufacturing and familiarity with IPC standards. Candidate with current IPC CIS or CIT Trainer Specialist certifications are highly preferred.

**Salary:** Starting at $30 per hour depending on experience

**Benefits:**
- 401k and 401k matching
- Dental and Vision Insurance
- Employee Assistance Program
- Flexible Spending Account
- Health Insurance
- Health Savings Account
- Life Insurance
- Paid Time Off

**Schedule:** Monday thru Friday, 8–5

**Experience:** Electronics Manufacturing: 5+ years (Required)

**License/Certification:** IPC Certification–Preferred, Not Required

**Willingness to travel:** 25% (Required)

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Prototron Circuits

## Sales Representatives

Prototron Circuits, a market-leading, quick-turn PCB manufacturer located in Tucson, AZ, is looking for sales representatives for the Southeastern U.S. territory. With 35+ years of experience, our PCB manufacturing capabilities reach far beyond that of your typical fabricator.

**Reasons you should work with Prototron:**
- Solid reputation for on-time delivery (98+% on-time)
- Capacity for growth
- Excellent quality
- Production quality quick-turn services in as little as 24 hours
- 5-day standard lead time
- RF/microwave and special materials
- AS9100D
- MIL-PRF- 31032
- ITAR
- Global sourcing option (Taiwan)
- Engineering consultation, impedance modeling
- Completely customer focused team

Interested? Please contact
Russ Adams at (206) 351-0281
or russa@prototron.com.

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# Career Opportunities

EMA Design Automation®

## Technical Marketing Engineer

EMA Design Automation, a leader in product development solutions, is in search of a detail-oriented individual who can apply their knowledge of electrical design and CAD software to assist marketing in the creation of videos, training materials, blog posts, and more. This Technical Marketing Engineer role is ideal for analytical problem-solvers who enjoy educating and teaching others.

**Requirements:**

- Bachelor's degree in electrical engineering or related field with a basic understanding of engineering theories and terminology required
- Basic knowledge of schematic design, PCB design, and simulation with experience in OrCAD or Allegro preferred
- Candidates must possess excellent writing skills with an understanding of sentence structure and grammar
- Basic knowledge of video editing and experience using Camtasia or Adobe Premiere Pro is preferred but not required
- Must be able to collaborate well with others and have excellent written and verbal communication skills for this remote position

EMA Design Automation is a small, family-owned company that fosters a flexible, collaborative environment and promotes professional growth.

Send Resumes to: resumes@ema-eda.com

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ARLON ELECTRONIC MATERIALS

Arlon EMD, located in Rancho Cucamonga, California, is currently interviewing candidates for open positions in:

- **Engineering**
- **Quality**
- **Various Manufacturing**

All interested candidates should contact Arlon's HR department at 909-987-9533 or email resumes to careers.ranch@arlonemd.com.

Arlon is a major manufacturer of specialty high-performance laminate and prepreg materials for use in a wide variety of printed circuit board applications. Arlon specializes in thermoset resin technology, including polyimide, high Tg multifunctional epoxy, and low loss thermoset laminate and prepreg systems. These resin systems are available on a variety of substrates, including woven glass and non-woven aramid. Typical applications for these materials include advanced commercial and military electronics such as avionics, semiconductor testing, heat sink bonding, High Density Interconnect (HDI) and microvia PCBs (i.e., in mobile communication products).

Our facility employs state of the art production equipment engineered to provide cost-effective and flexible manufacturing capacity, allowing us to respond quickly to customer requirements while meeting the most stringent quality and tolerance demands. Our manufacturing site is ISO 9001: 2015 registered, and through rigorous quality control practices and commitment to continual improvement, we are dedicated to meeting and exceeding our customers' requirements.

For additional information, please visit our website at www.arlonemd.com

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# Career Opportunities

INSULECTRO

## Are You Our Next Superstar?!

Insulectro, the largest national distributor of printed circuit board materials, is looking to add superstars to our dynamic technical and sales teams. We are always looking for good talent to enhance our service level to our customers and drive our purpose to enable our customers to build better boards faster. Our nationwide network provides many opportunities for a rewarding career within our company.

We are looking for talent with solid background in the PCB or PE industry and proven sales experience with a drive and attitude that match our company culture. This is a great opportunity to join an industry leader in the PCB and PE world and work with a terrific team driven to be vital in the design and manufacture of future circuits.

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MivaTek Global

## Field Service Technician

MivaTek Global is focused on providing a quality customer service experience to our current and future customers in the printed circuit board and microelectronic industries. We are looking for bright and talented people who share that mindset and are energized by hard work who are looking to be part of our continued growth.

Do you enjoy diagnosing machines and processes to determine how to solve our customers' challenges? Your 5 years working with direct imaging machinery, capital equipment, or PCBs will be leveraged as you support our customers in the field and from your home office. Each day is different, you may be:

- Installing a direct imaging machine
- Diagnosing customer issues from both your home office and customer site
- Upgrading a used machine
- Performing preventive maintenance
- Providing virtual and on-site training
- Updating documentation

Do you have 3 years' experience working with direct imaging or capital equipment? Enjoy travel? Want to make a difference to our customers? Send your resume to N.Hogan@MivaTek.Global for consideration.

### More About Us

MivaTek Global is a distributor of Miva Technologies' imaging systems. We currently have 55 installations in the Americas and have machine installations in China, Singapore, Korea, and India.

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# Career Opportunities

eptac

TRAIN. WORK SMARTER. SUCCEED.

## Become a Certified IPC Master Instructor

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

### Qualifications and skills

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

### Benefits

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

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American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

## CAD/CAM Engineer

The CAD/CAM Engineer is responsible for reviewing customer supplied data and drawings, performing design rule checks and creation of manufacturing data, programs and tools required for the manufacture of PCB.

### ESSENTIAL DUTIES AND RESPONSIBILITIES

- Import Customer data into various CAM systems.
- Perform design rule checks and edit data to comply with manufacturing guidelines.
- Create array configurations, route, and test programs, penalization and output data for production use.
- Work with process engineers to evaluate and provide strategy for advanced processing as needed.
- Itemize and correspond to design Issues with customers.
- Other duties as assigned.

### ORGANIZATIONAL RELATIONSHIP

Reports to the engineering manager. Coordinates activities with all departments, especially manufacturing.

### QUALIFICATIONS

- A college degree or 5 years' experience is required.
- Good communication skills and the ability to work well with people is essential.
- Printed circuit board manufacturing knowledge.
- Experience using Orbotech/Genflex CAM tooling software.

### PHYSICAL DEMANDS

Ability to communicate orally with management and other co-workers is crucial. Regular use of the phone and e-mail for communication is essential. Sitting for extended periods is common. Hearing and vision within normal ranges is helpful for normal conversations, to receive ordinary information and to prepare documents.

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