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IPC APEX EXPO 2020 Preview

Our IPC APEX EXPO preview issue! IPC APEX EXPO celebrates 20 years, which makes the event's history a 21st century story. In this issue, you will find the history, the present, and the future of the electronics manufacturing industry. See you in San Diego!

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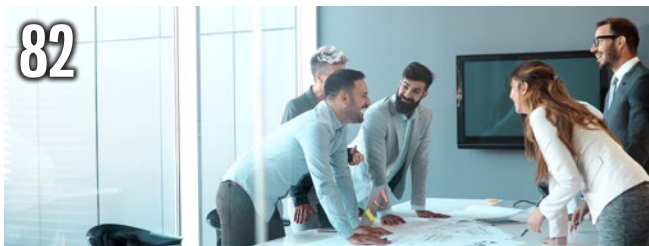
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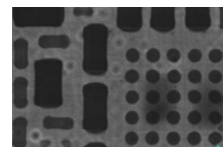
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IPC APEX EXPO 2020 Preview

Nolan's Notes

by Nolan Johnson, I-CONNECT007

Welcome to the start of 2020 and the launch of the third decade of the 21st century! For those of us senior enough to have been in this business at the change of the millennium, it's hard not to be amazed how deep we are into the next century. However, youngsters just joining the industry were born at the turn of the century. Emerging engineers and technicians see the 20th century as ancient history, as they should.

This is our IPC APEX EXPO preview issue. You will find both the history, the present, and the future of the electronics manufacturing industry today. IPC APEX EXPO is 20 years old this year, too, so the event's history is a 21st-century story.

This year, in addition to the extensive technical conference, networking opportunities and events, and the IPC APEX EXPO exhibition, IPC's ongoing work to involve high school youth in the industry will be even more apparent on the show floor through the IPC STEM Outreach Program. I-Connect007 is proud to be a sponsor of this program at IPC APEX EXPO 2020.

Kicking off this magazine is a series of video tours from Mycronic from productronica 2019. Next, we feature a piece covering details of how IPC is engaging STEM students, including

quotes from students, teachers, and members of IPC, as well as what the IPC Government Relations Team has planned for IPC APEX EXPO.

IPC's David Bergman unpacks myths about CFX in a game of "True or False: CFX Edition," and Barry Matties interviews Phil Carmichael to gain his perspective on IPC Asia's continued growth. Then, I share my conversation with Molex on connectors and successful manufacturing, followed by an interview with Graham Naisbitt, who offers an update of cleaning standards and committees. Chris Jorgensen also provides a preview of what attendees can expect regarding CFX at IPC APEX EXPO.

In addition, you will find columns from our regular contributors, including Dr. Jennie Hwang, Eric Camden, Alfred Macha, and Bob Wettermann.

We hope to see you in sunny San Diego for IPC APEX EXPO 2020! **SMT007**



Nolan Johnson is managing editor of *SMT007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing. To contact Johnson, [click here](#).



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Martin Franke, Siemens AG, Corporate Technology - Industry 4.0 - How we transform a Buzzword into Manufacturing Excellence in Electronics: Case Study for Improving the PCB Print Process Using Factory Data.

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

Jay Gorajia, Director, Global Services, Siemens Digital Industries Software - Optimizing Throughput and Cost with Manufacturing Simulation

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

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Joint Industry Standard IPC J-STD-006: Electronic Solder Alloys

SMT Prospects & Perspectives

by Dr. Jennie S. Hwang, CEO, H-TECHNOLOGIES GROUP

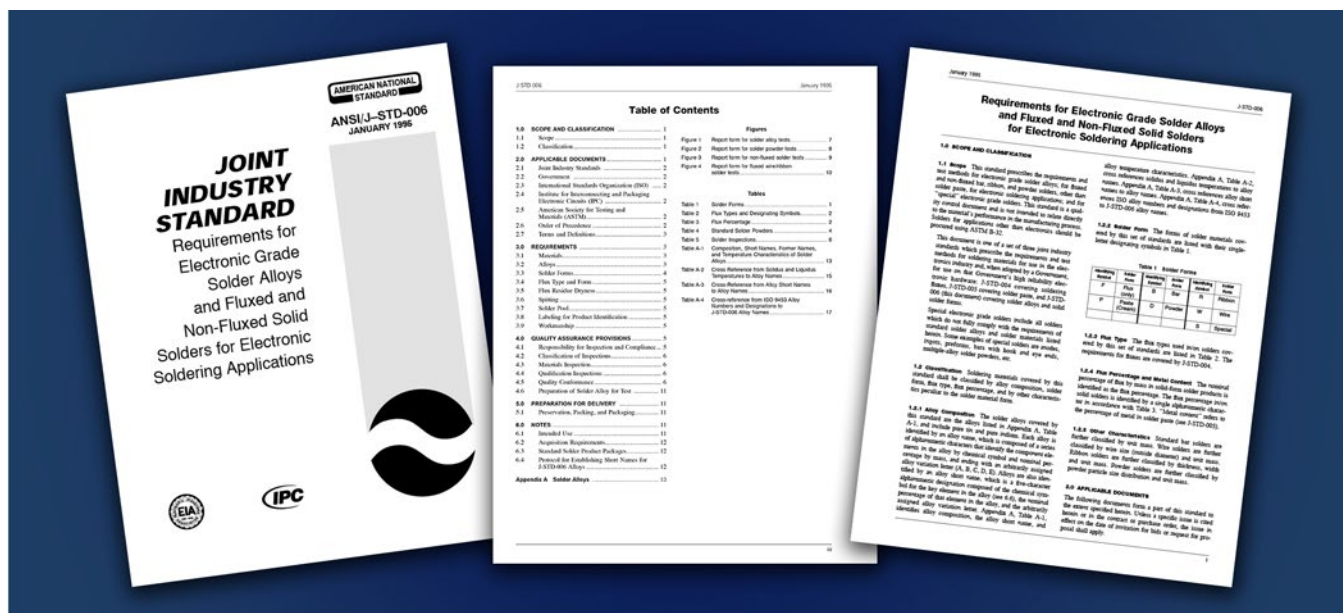
It has been nearly two decades since the global electronics industry adopted lead-free conversion from leaded electronics. Readers who have been in the industry during this period will recognize the changes and challenges the industry has faced and appreciate the fact that taking the element lead (Pb) out of electronics has not been a straightforward path. Right at the outset, in my view, four questions should have been addressed:

1. Which solder alloy could be widely accepted?
2. Which alloy(s) could be regarded as working alloys?
3. Which alloy(s) is (are) merited with high-reliability performance under harsh environments?
4. Could the former three questions necessarily be causing mutual exclusivity?

In this column, I will confine my comments to the milestones, key events/activities, and thought processes, to some extent, of IPC Joint Industry Standard J-STD-006: "Requirements for Electronic-Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications."

J-STD-006 primarily focuses on solder alloys and is generally deemed mundane—certainly not glamorous. However, solder alloy is critical to electronics, performing a critical function as the interconnecting material for electrical, thermal, and physical connections as well as other surface coating functions. To reiterate my two snippet statements over the years:

"Solder joint cannot perform better than the solder alloy is intrinsically able to deliver," summarizing the inseparability of a solder alloy and a solder joint that is made of a specific solder alloy.





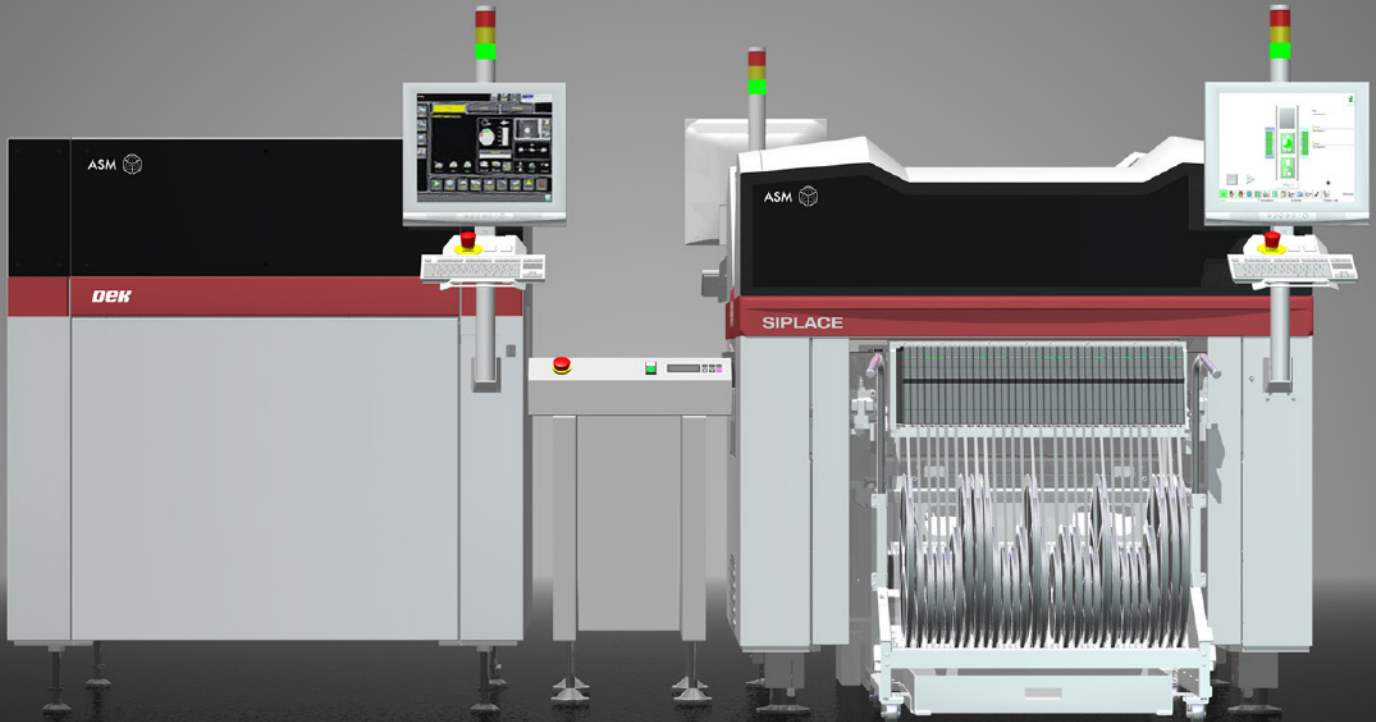
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“When/if one single solder joint in an electronic system fails, the whole electronic system, regardless of the level of design sophistication or functional complexity, fails,” summarizing the critical role of solder joint in electronics.

Accordingly, J-STD-006 has been playing a pivotal role in serving the industry’s needs and wants, particularly during the transitional period from the leaded world to lead-free and onward.

Serving as the chairman of the standard over the years, I have been privileged to personally work with both users and suppliers of solder alloys to enhance communication and facilitate solving prevalent issues in a timely manner. Our goal has always been to find the best solution when an issue arises and to reach consensus when different positions exist. Throughout the years, in our communications and discussions, whether in-person or via air waves, our task group always follows the principles of standardization from the American National Standard Institute (ANSI) and IPC.

Our goal has always been to find the best solution when an issue arises and to reach consensus when different positions exist.

These principles include how standards should show a relationship to design for manufacturability (DFM) and design for the environment (DFE), minimize time to market, contain simple language, focus on end-product performance, and include a feedback system on use and problems for future improvement. Principles also: include—rather than inhibit—innovation; do not keep people out, and; do not contain information that cannot be defended with data. The standard should include specification information—it should

not tell you how to make something. In a nutshell, it is worthwhile being reminded that the standard is a specification—not a know-how document.

With these items in mind—for the benefit of readers who have not been participants in our task group, and for the interest of paving the future path of current and future participants—I share a few highlights of J-STD-006, in both retrospective and prospective perspectives, that might be helpful.

What Has Been Accomplished

First and foremost, we thank our task group members who have worked patiently and relentlessly to move the J-STD-006 forward and upward over the years. J-STD-006 has moved (improved) from J-STD-006 to J-STD-006A version (May 2001), and to J-STD-006 B (January 2006) and J-STD-006B with Amendments 1 and 2 (October 2009), further to J-STD-006C (July 2013) and J-STD 006C with Amendment 1 (October 2017). For the recent years since the lead-free transition period, key milestones include:

- J-STD-006A was revised to J-STD-006B. The Revision J-STD-006B, published in January 2006, essentially was to “introduce” lead-free alloys (i.e., Table A-1)
- In October 2009, Amendments 1 and 2 to J-STD-006B were introduced to include proper notes for tables
- In 2011, our task group’s focus was to harmonize the alloy designation or naming system. Efforts were directed to elect a logical system that is also practical to our industry’s use. Several options have been considered. For instance, the order of the metallic elements in an alloy designation can be predicated on the rules of academic/metallurgy (e.g., AgAuBiCuInNiSbSn) or custom and convenience (e.g., SnAgAuBiCuInNiSb)
- J-STD-006C was born in July 2013 to adopt the naming system of our choice and the conversion of all alloy designations in accordance with the naming system of choice

- Amendment 1 to J-STD 006C was published in October 2017 to incorporate new alloy listings, the statements regarding rare earth elements, and the expansion of control ranges of nominal compositions

Solder Alloy Inclusion in the Standard

Requirements to list a solder alloy in the J-STD-006 include:

- All elements, including dopants, shall be disclosed
- All elemental dosages, including dopants, shall be provided
- Analytical methods to identify and confirm the presence and quantity shall be provided

It should be noted that all elements herein refer to all intentionally introduced elements or included in the manufacturing process of an alloy composition for a purpose, use or expected function, rare earth or otherwise (e.g., La, Ce, Nd, Mn, Ge, etc.) regardless of dosage (e.g., 88 wt% or 0.01 wt%); that is, elements in an alloy composition that are not introduced by design are impurities.

Upcoming Challenges

In our recent past meetings, I have challenged the task group to address four questions:

1. How can we make J-STD-006 document more useful, more complete, more informative, and more practical to the industry (i.e., suppliers, users, or any interested party)?
2. Which area(s) should be added?
3. Which area(s) should be expanded?
4. What are the priorities?

To this end, one of the recurring issues that was brought up in our task group meetings is dopant vs. impurities. As more new alloys are being developed with intentionally added dopant(s)



in a small weight percentage, J-STD-006 bears the responsibility to provide a guide.

Framework Efforts on Dopants vs. Impurities

Updating solder alloy impurities remains a challenge. Differentiating dopants from impurities drives another level of effort. I have laid out the skeletal framework that is to be considered in three distinct categories of elements.

1. Current impurities elements (Table 3-2).
 - E.g., Ag, Cd, Pb, Al, Cu, Sn, As, Fe, Zn, Au, In, Sb, Bi, Ni
2. Additional elements to be considered.
 - E.g., Phosphorus (P), sulfur (S), others
 - It is worth noting that QQ-S-571F (Federal specification: solder, electronic) limits P at 0.010 wt% and S at 0.005 wt%, but J-STD-006 makes no call on these two elements, which could potentially affect the properties and behavior of a solder alloy
3. Dopants being used in alloys that are listed in the current impurity table.
 - E.g., Ni, others

To move forward to the next stage of development of J-STD-006, the issue is requested to be addressed. This will be a daunting task, demanding substantial efforts and affecting suppliers, users, and the industry overall.

Invitation to Attend Task Group Meetings

Our next in-person meeting will be held in the afternoon of Tuesday, February 4, 2020, at IPC APEX EXPO 2020 in San Diego, California. I keenly extend my invitation to all of you to attend and participate in the meeting. You are always welcome regardless of your main interest as a supplier, user, or researcher; you are also always welcome no matter whether you are more inclined to share or just to observe. SMT007

Upcoming Presentation

Dr. Hwang will present a lecture on “Reliability of Electronics: The Role of Intermetallic Compounds” in February 2020 at IPC APEX EXPO 2020 in San Diego, California.



Dr. Jennie S. Hwang—an international businesswoman and speaker, and business and technology advisor—is a pioneer and long-standing contributor to electronics hardware manufacturing as well as to the environment-

friendly lead-free electronics implementation. Among her many awards and honors, she was inducted to the International Hall of Fame—Women in Technology, elected to the National Academy of Engineering, an R&D-Stars-to-Watch, and YWCA Achievement Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and CEO of International Electronic Materials Corp., she is currently CEO of H-Tech-nologies Group providing business, technology, and manufacturing solutions. She is the Chairman of Assessment Board of DoD Army Research Laboratory, serving on Commerce Department’s Export Council, National Materials and Manufacturing Board, NIST Assessment Board, Army Science and Technology Board, various national panels/committees, international leadership positions, and the board of Fortune-500 NYSE companies and civic and university boards. She is the author of 500+ publications and several books, and a speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as the Harvard Business School Executive Program and Columbia University Corporate Governance Program. For more information, please visit www.JennieHwang.com. To read past columns or contact Hwang, [click here](#).

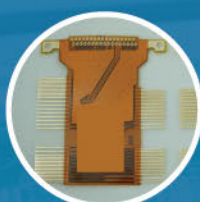
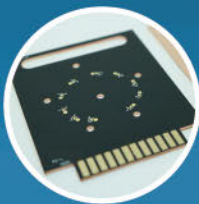
Top Reasons to Attend IPC APEX EXPO 2020

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



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Mycronic AB Demonstrates Expanded Portfolio at productronica 2019

At productronica 2019, Mycronic AB demonstrated a full portfolio of electronics assembly solutions. In addition to the latest integrated SMT line, jet printing, dispensing, 3D inspection, and material handling solutions, the company highlighted its industry-leading automotive camera module assembly and high-precision die bonding solutions.

Enhancing Quality, Flexibility, and Productivity

As electronics assembly continues to grow more complex, Mycronic has more ways than ever before to improve quality, flexibility, and productivity in a range of electronics manufacturing applications. “All of the state-of-the-art solutions that we offer are part of our vision to enable zero-defect assembly with the highest utilization for any product mix,” says Thomas Stetter, senior VP, assembly solutions. “From integrated SMT production lines to advanced packaging and automotive sensors, our aim is to enhance our customers’ control over the data, processes, and material flows that matter most to their success.”

New Production Insights With Enhanced M2M Communication

As an active member of the Hermes Standard Initiative, the majority of Mycronic’s machine models will now be Hermes-compliant. This standardized machine-to-machine (M2M) communication protocol represents an important step in enabling customers to look beyond discrete manufacturing process steps and gain holistic insights into factory-wide productivity. It will also allow greater vendor-independent capabilities, enabling customer processes and programming to become increasingly driven by board requirements.

Full SMT Line Solution With Expanded Capabilities

The recently launched MYPro Line—the company’s latest full SMT line solution—provides a number of new software and automation capabilities. The SIGMA Link software, which correlates data between solder paste inspection (SPI) and automated optical inspection (AOI), now features more intuitive process controls to further improve inspection efficiency and first-pass yield. A new AOI platform with 2x faster programming and a new SPI and jet printing repair system closes several data feedback loops to automatically increase yield and product quality over time. New dashboard and analysis software will simplify production scheduling and enhance overall equipment effectiveness.

New Advances in Conformal Coating and Plasma Treatment

As part of Mycronic’s rapidly evolving MYSmart series of dispensing and conformal coating robots, a number of new hardware and software innovations were on display at the show. The industry-leading MYC50 conformal coating system—with its new intuitive user interface, precision spray valve, and



Jeff Leal, head of product management, MYSmart assembly solutions, describes Mycronic’s family of precision dispensing solutions, from simple to complex and prototyping to mass production. Leal also demonstrates the versatile MYC50 platform integrated with in-line flash-off and UV curing.

flow monitoring system—promises to deliver even higher levels of precision, repeatability, and yield. In addition, a new series of MYS plasma offers all the benefits of traditional vacuum plasma systems at atmospheric pressure with safer and cleaner operations and up to 50x faster cleaning speeds.

Added Versatility, Speed, and Precision

The MY700JX jet printer and jet dispenser is unbelievably fast, precise, and allows you to produce complex boards with a speed of more than one million dots per hour. This printer can be integrated with a closed-loop with the Mycronic PI 3D SPI system to predict and prevent solder paste defects. The MY700 handles flexible substrates, LED boards, cavities, and package-on-package applications with no hassle.

Collaborative Robotics for Autonomous Material Handling

In a significant step towards improving labor utilization, Mycronic also demonstrated a next-generation collaborative robotics system. Developed in collaboration with industry-leading partners, the solution shows the potential for entirely operator-



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

independent retrieval, kitting, and distribution of component reels..

High-performance Automotive Camera Module Assembly

In addition to these new SMT capabilities, Mycronic also presented the manufacturing solutions and experts behind the industry-leading CMAT system. The millions of sensor modules assembled every year by manufacturers using this system are enabling enhanced automotive safety and, ultimately, autonomous driving. Mycronic's process experts are able to answer questions regarding design for manufacturing, rapid prototyping, application enhancement, and full-scale manufacturing optimization.

Advanced Die-bonding Systems

Finally, visitors to productronica had the opportunity to learn about the industry's leading high-precision die bonding systems for flexible high-speed assembly of optoelectronics and microelectronics.

For more information, contact Mycronic at mycronic.com.



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



Charlene Gunter du Plessis



Corey Lynn

Engaging **STEM** Students at IPC APEX EXPO 2020

Feature by Nolan Johnson
I-CONNECT007

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

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

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

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

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

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

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

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

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

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

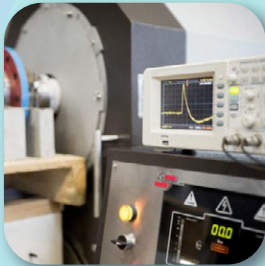


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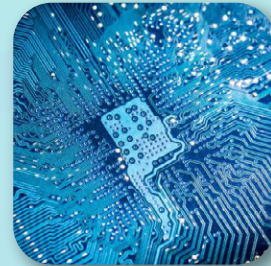
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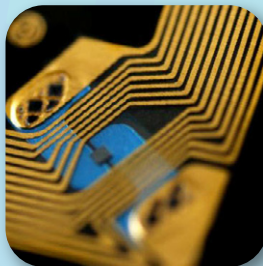
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to solder, and their faces light up when they complete the hands-on activity. Project-based learning is so important, and our hands-on soldering events have a strong focus on applications that support classroom teaching.”

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

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

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

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



Dadre Rudolph

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

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

A final note from IPC Education Foundation is that this event is free for participating students, and they are thankful for the support from their sponsors: TTM, Nordson, Panasonic, Weller, and I-Connect007. SMT007

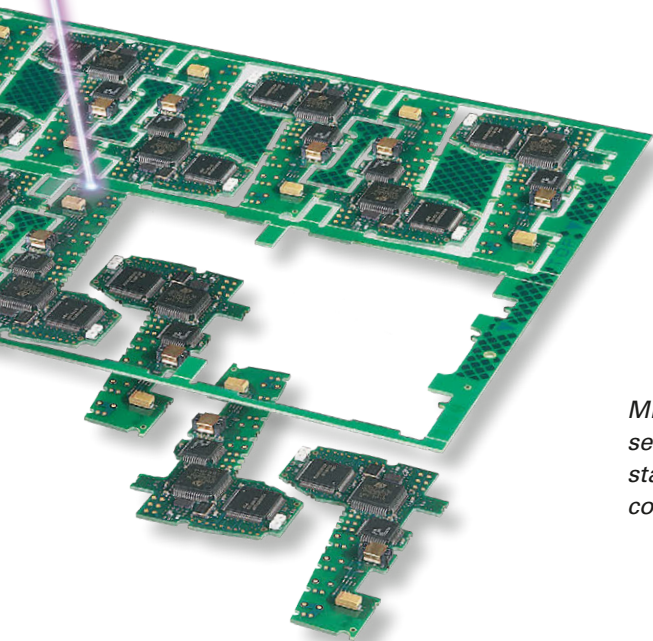
Learn More

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



Feature by Chris Mitchell

IPC-ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

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

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

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

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

Calls to Action

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

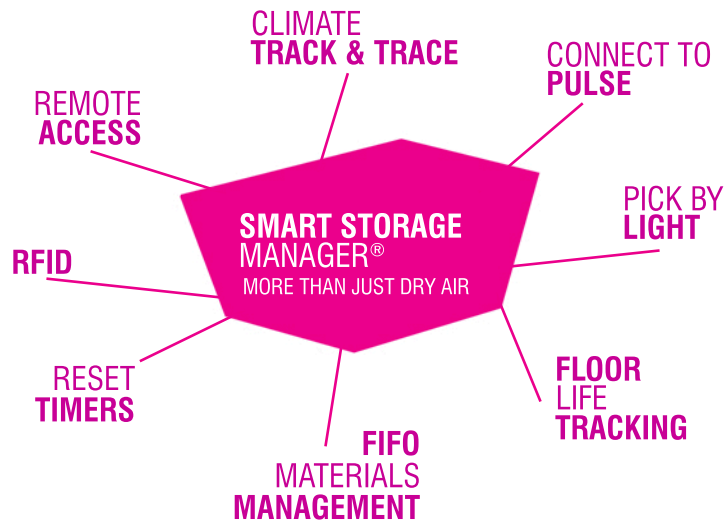
Elevating the Industry's Excellence Through Government Policy

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



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shortage of technically skilled workers, to name a few.

Workforce Champions

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

Industry Intelligence

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

Opportunities to Engage and Learn

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

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

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

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

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

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

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

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

See you in San Diego! SMT007



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

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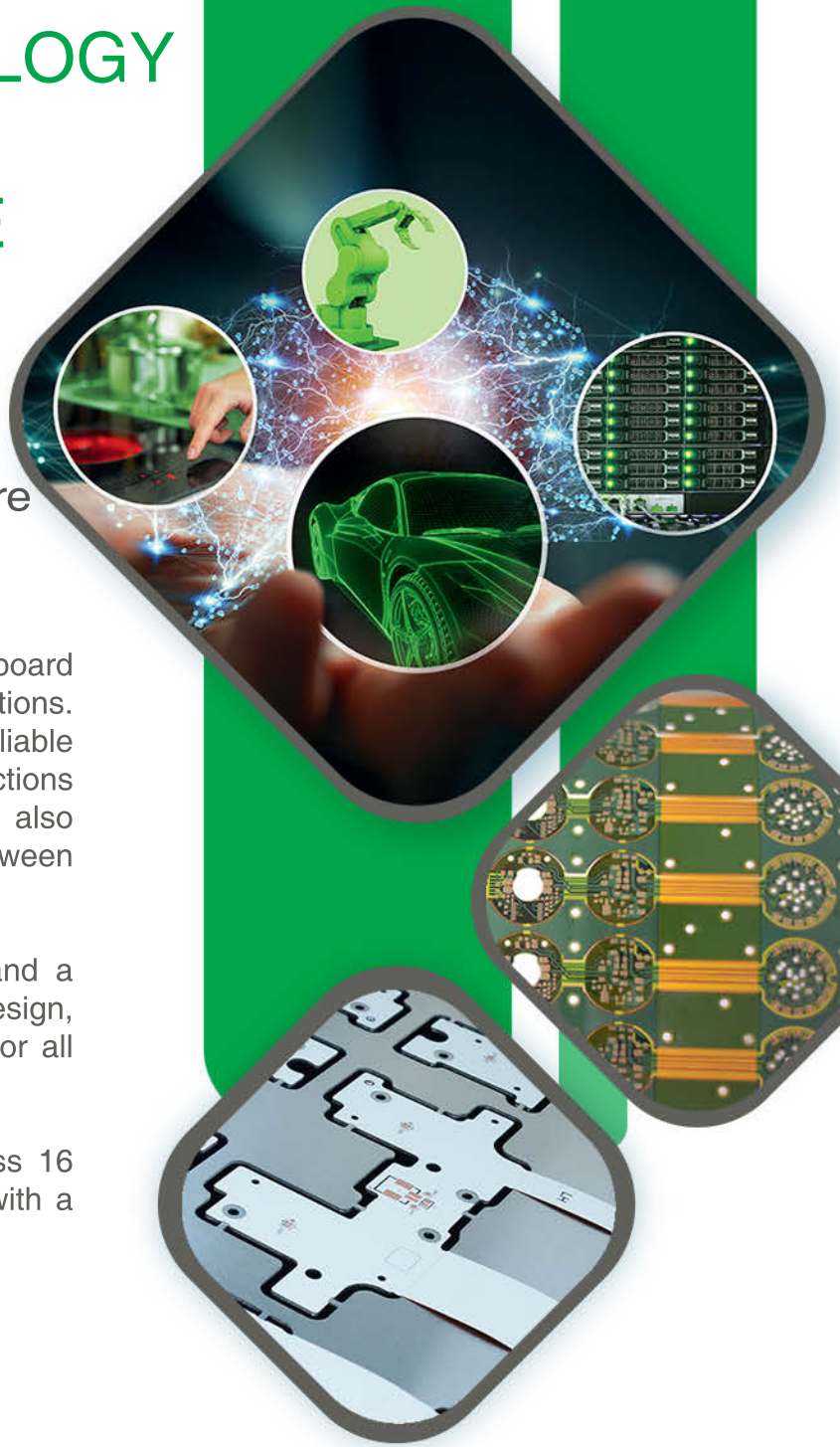


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True or False: **CFX** Edition

Feature by David Bergman

IPC-ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

Earlier this year, IPC published IPC-2591—Connected Factory Exchange (CFX), Version 1.0. This standard was developed by the IPC Connected Factory Initiative Subcommittee over a two-year period to address issues with machine-to-machine communication and provide the electronics manufacturing industry with a true plug-and-play system for any company to achieve Industry 4.0.

Since the release of the standard, there has been a lot of buzz regarding CFX within the industry from all segments, including EMS companies, equipment manufacturers, and software solution providers. The Subcommittee has grown to 275 members, with an additional 63 members on the 2-17-CN Connected Factory Initiative Subcommittee in China, and 94 companies have declared their support on the CFX website. Additionally, 24 companies have shared their CFX implementation roadmaps on the CFX website, with more roadmaps coming in on a regular basis. You can view the supporters, roadmaps, and a library of helpful CFX resources at ipc-cfx.org.

Still, with all of the buzz, there are also some misconceptions floating around the industry

regarding CFX, how it is used, the need for middleware, and how it stacks up against other standards for Industry 4.0. Thus, I thought it would be fun to take some of those statements, using feedback from Subcommittee members, and play a little game of “True or False: CFX Edition.”

“Middleware is needed to implement and utilize CFX.”

Answer: *False*

No middleware is required. Middleware, once an essential part of the factory data triangle, is a barrier to efficient standard implementation. Middleware provides two additional interfaces that can break, which can cause third-party finger-pointing. One of the primary goals of the Subcommittee, when it developed CFX, was to eliminate that triangle and need for middleware or other programming to enable machines to communicate with one another on a line. CFX is implemented natively within each machine and system.

This holds true for mixed-vendor lines or lines with both legacy and new equipment. The Subcommittee developed standardized equipment messaging to enable any piece of equip-



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ment in a CFX line—new or legacy—to perform omnidirectional, point-to-point, request/response (command/response) communications with any other piece of equipment in the network without the need for extensive programming or messaging modification.

“CFX is a plug-and-play standard for Industry 4.0.”

Answer: *True*

Because CFX defines the specific data content for all fields and topics, any endpoint in the CFX network can understand the content from all other endpoints, no matter what type of equipment or software they are, or from which vendor they originate. This sets CFX apart from other solutions that recognize themselves as Industry 4.0 for electronics manufacture. CFX is the solid foundation that will help put the “smart” into smart factories.

“CFX may be machine-readable, but it is not human-readable.”

Answer: *False*

The Subcommittee spent a considerable amount of time deliberating the data format to use for CFX messages and came to consensus on JavaScript Object Notation (JSON). They did so because JSON is an open-standard data format that uses both machine- and human-readable text to transfer data messages. JSON-encoded CFX messages are easy for people to read and write and for any machine to parse and generate data, as well as easily transferred and read by any device or ERP system.

“CFX is not a secure data transfer protocol.”

Answer: *False*

Hacking concerns got you down, Bunky? CFX can help! Data security was at the fore-

front with the Subcommittee. AMQP, which was developed by the financial industry, guarantees delivery of messages from one device in a CFX network to another device in the CFX network; provides security to prevent unwanted, uninvited, and/or malicious participants in a CFX network; and provides encryption to protect the information shared within a CFX network.

The Subcommittee selected AMQP as the data transfer protocol because it eases the burden of equipment manufacturers and factory-level system providers as they implement their CFX support and eliminates most of the development effort needed to send and receive CFX messages. It can also support billions of messages per day on a basic server.

“CFX is costly and time-consuming to implement.”

Answer: *False*

The Subcommittee developed CFX to allow for any internal IT team to be able to quickly and easily implement it on the factory floor or in equipment being shipped to customers. Using the SDK and supporting IPC-2591 standard, the Subcommittee has reported that the total time to implement a CFX line on a factory floor is a matter of days, and because no middleware is needed, there is no need for days or even weeks of on-site support from software and equipment vendors to set up a line.

The Subcommittee has proven this out with live factory lines at IPC APEX EXPO, the LEAP Show in China, and productronica in Germany, where we have gone from equipment delivered to the booth to a functioning line a few days. Without CFX, the process would take weeks.

This pales in comparison to estimates for the implementation of other systems as observed by the Subcommittee. For example:

- SEMI ELS: Eight months plus at least four paid systems support visits

- OPC-UA: Four months plus at least two paid systems support visits
- MTConnect: Four months plus at least two paid systems support visits

“CFX is limited to large pieces of equipment only.”

Answer: *False*

CFX was developed to be flexible enough so that it can be implemented on or adapted through version upgrades to apply to any piece of manufacturing equipment. This was demonstrated at IPC APEX EXPO 2019 when a vendor installed CFX on a soldering iron for the factory demonstration.

“CFX is an open standard, meaning any equipment vendor, software supplier, or user can influence it.”

Answer: *True*

As with any other IPC standard, IPC-2591 is an open industry standard. In fact, the Subcommittee wants your involvement because comments from industry only serve to strengthen the standard. Additionally, there is no cost to participate in the ongoing management of the standard, and your level of participation is up to you. You can be an active participant, attending all the meetings, or you can submit comments on drafts or published releases. The only thing that matters is your involvement.

This is counter to other similar standards, such as SEMI ELS—a standard that is developed by a committee, behind closed doors, and once you sign an NDA.

“SEMI ELS is the IPC SMEMA standard replacement.”

Answer: *False*

This is a “five Pinocchios” level of false. SMEMA has been part of IPC since 1999 and

is the appropriate body to determine what constitutes replacement. SMEMA, through IPC, updated the interface standard through IPC-9851 and now further through IPC-HERMES-9852. The Hermes Standard, IPC-HERMES-9852, which was developed by The Hermes Initiative and adopted as a joint standard by IPC, is a full replacement for the SMEMA standard replacement and provides significant benefits over the SEMI standard.

With IPC-HERMES-9852, data is passed along a shop floor as a digital twin, with clear board statuses communicated to and from each piece of equipment. The SEMI ELS standard uses an archaic approach to board handling, which results in hardware costs and software problems.

IPC-HERMES-9852 and IPC CFX, used together, provide a clear cut between vertical and horizontal tasks, making these standards together far more powerful than SEMI ELS. IPC-HERMES-9852 provides full-line coverage, whereas SEMI ELS misses coverage for many parts of a factory line.

“SECS-GEM is an Industry 4.0 solution.”

Answer: *False*

SECS-GEM transmits messages in a binary format between devices and a host control system, or server, which communicates decisions back to the machines. This is why the Subcommittee decided this standard was not an Industry 4.0 solution when it began work on CFX.

CFX is a single-source Industry 4.0 system because it transmits messages between machines, and between machines and EPR systems, and enables direct interaction between those machines and systems, without having to route through another system. This is the basis for smart factories, the industrial internet of things (IIoT), and Industry 4.0.

Additionally, SECS-GEM can be complicated for today’s IT teams because its origins date back to the 1980s, whereas CFX is JSON, which just about any IT developer is familiar with.

“OPC-UA and/or MTConnect can be used instead of CFX.”

Answer: *False*

OPC-UA is a machine-to-machine communication protocol for industrial automation. Because OPC-UA focuses on the communication only and not on the data architecture or machine-to-machine messaging that IPC CFX provides, it is not a replacement for IPC CFX, nor is it a plug-and-play Industry 4.0 standard for the electronics industry like CFX. Additionally, OPC-UA will require middleware for any level of electronics manufacture shop floor communication.

MTConnect is a protocol designed for the exchange of data between shop floor equipment and systems used for monitoring and data analysis. MTConnect is a read-only standard. It defines the extraction of data from control devices but does not write data to a control device.

CFX differs from MTConnect because it provides a constant flow of data between pieces of equipment as well as between equipment and ERP systems to enable a fully automated shop floor. MTConnect is not a plug-and-play Industry 4.0 standard for electronics manufacture and will require middleware to implement it on a shop floor.

“I don’t need to invest in additional systems to use CFX in my shop.”

Answer: *True*

CFX enables manufacturing facilities of any size to be able to easily implement CFX with minimal hardware requirements. If your facility has one or two servers operating on a standard 100 Mbps Ethernet network, you are CFX-ready.

How did you score? Even if you didn’t score 100% on this first try, I hope you learned a lot and can challenge your colleagues to your own game. Between now and then, there are some other upcoming CFX activities that will be of interest to you.

IPC-2591, Version 1.1

The Subcommittee has set a goal to publish version updates to the standard twice per year. The first version upgrade is expected to pass ballot at the time of writing this article and should be available by IPC APEX EXPO 2020. This version and all subsequent ones will include a summary of updates, so it will be easy for new and existing CFX users to identify the changes for implementation in their equipment.

IPC/Hermes Digital Factory and CFX Virtual Demonstrations at IPC APEX EXPO 2020

IPC will once again host the IPC/Hermes Digital Factory—a live factory line that demonstrates the power and simplicity of CFX and Hermes working together. Now that industry has seen how easy CFX is to implement in a mixed-vendor line, and in a short period of time, the planning committee is focusing its efforts on demonstrating the true power of CFX as it pertains to Industry 4.0.

Be sure to visit the digital factory on the show floor and talk with the vendors about why they have chosen CFX. Drop by at the top of the hour each day for a guided tour of the line. And in addition to the digital factory, dozens of exhibitors will once again push CFX messages from equipment at their booths to the cloud server. You will be able to monitor all the messaging from the digital factory and virtual demonstrations live and on-demand from your laptop or mobile device at connect-edfactoryexchange.com.

Rolling Out Industry Support Solutions

Beginning in early 2020, IPC will begin rolling out educational, validation and self-qualification solutions to support the industry in its successful implementation of CFX, which will include:

- On-demand education webinars and training videos that enable any manufacturing facility, IT team, and equipment supplier to quickly, easily and successfully understand, implement, and utilize CFX

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- A portal for the electronics industry to verify if equipment has been third-party validated to CFX message sets
- A cloud-based application for equipment vendors and manufacturing facilities to self-evaluate their equipment to CFX
- Technical support services to assist manufacturing operations looking to implement CFX-based solutions

As IPC releases these solutions, we will announce them to the CFX Subcommittee members. To be sure you get the information as soon as it becomes available, sign up for the Subcommittee and demonstrate your support for CFX by visiting cfx.ipc.org/join.

Now, one final true or false statement.

"I plan to implement CFX."

Answer: *True*

IPC, led by the Subcommittee, will help to make that happen. **SMT007**



David Bergman is IPC's VP of standards and technology.

IPC APEX EXPO 2020 Networking Events

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



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Phil Carmichael

IPC Asia Continues Solid Growth

Feature Interview by Barry Matties I-CONNECT007

Phil Carmichael, IPC president of Asia Pacific, talks with Barry Matties at the HKPCA show about the continued growth and increased engagement by Asian member companies with IPC, with over 320 members in standards committees now working on the development of the next-generation standards.

Barry Matties: Can you give a brief update on the status of IPC and the accomplishments in Asia over the last year?

Phil Carmichael: Financially, IPC has had a good year, and we continue to grow our membership. We've had a very strong year in South-east Asia and Japan. China continues to grow, even though the economy has been a little bit slower this year than in previous years. But overall, we're growing, and we've had a good year. I started almost eight years ago. And when I joined at the beginning of 2013, we had around 300 members; we're going to end the year at about 1,500.

Matties: That's substantial growth.

Carmichael: And revenue, a sign of industry engagement, has grown even faster than that.

Matties: What was the impetus behind your growth?

Carmichael: We developed an entire management infrastructure in the AP region. We brought in a finance team and strengthened the sales organization. One of the critical issues was that we were able to make decisions to support a member customer in China on the same day without having to go somewhere else to get information. That is one of the big reasons that we've been able to sustain growth. It's tough to have seven years in a row where you're growing, and that's what we've had.

Also, the engagement that we have with our member customers in China has been huge. We're a standards organization, so that's the core of our business; it all starts with the standards. IPC developed standards with committees from the industry. Our interest is to have



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strong member companies to participate in standards committees globally. In 2015, we had no members in China on standards development committees. We had about 200 people in China working only on translations.

Forward to this year, and we continued to grow our translation capability up until last year. But then we started to develop a strong cadre of development participants on IPC standards. We now have over 320 company members on standards development committees from China, helping to develop the next generation of standards. And translations are driven by special customized software.

We now have over 320 company members on standards development committees from China, helping to develop the next generation of standards.

Matties: That makes a big difference.

Carmichael: That is a huge engagement, and it's a commitment by member companies to allow one of their employees to spend their time working on the next-generation standard. Over that period of time, we also helped educate Chinese companies about standards. Before, many people originally thought that if you went with one standard, you were supporting one company (think beta/VHS); now, they understand that standards are a common language to communicate to your supply chain.

And the supply chain has become more global, even across China. Maybe you make components in Shenzhen, they get sent to Chongqing for partial assembly, and then they get final assembled somewhere else. That supply chain needs to have a common language, and IPC provides that for our industry. The standards development in China has had continued success because companies are coming

deeper into the IPC process. As I said, we're probably now closing in on 10% of the development personnel writing the next generation of global IPC standards.

Talking about translation, it used to take us almost a year from the beginning of writing a new standard to when we translated training material for it. You release a new version of 610, and a year later we could have that in Chinese with training material. We felt that was way too slow, so we started doing translation ourselves. That sped things up and took about six months out of the process. At the same time, two years ago, we started using a software tool to develop a database for IPC language in Chinese. That's a very intensive and expensive upfront process. We invested in that for our member companies. When the next generation of 610 comes out, which is next year, we'll be able to go from the release of the standard to Chinese training material in under/about three weeks. That's a huge improvement and a matter of supporting the people.

We've also talked before about 1401, which was the first standard that was initiated in China a couple of years ago. It's about how to meet the EU standards for corporate social responsibility for mid-size companies. As of today, in the development process in IPC, globally, there are now six standards in the process that have originated in China, including a social responsibility and green manufacturing program in addition to some more traditional manufacturing standards. We've made a lot of progress, and China is playing a much stronger role, as they should, in the next generation of standards development. Being local and engaging further with people in the standards development side have been the two things that have helped maintain our growth.

Matties: There has been a big shift in China around environmental impacts, and you've had a firsthand view of that attitude shifting. What can you share about that?

Carmichael: The fact that the government is fully supportive of this is why it's working

well. It's a big change. The government has said, "You will do this." I was in Beijing at the largest state enterprise company on Monday last week, and they have a whole new department on environmental protection, green manufacturing, recycling, etc. They're asking us, "We understand 1401, which is good for us to export to Europe. That's great, but what else do you have?" If you think of it from a company standpoint, it's one of their KPIs that they have to show the government on what they're doing to support the environment, and that's a positive thing. I don't see that strong of a government input in some other parts of the world. It certainly will serve China well.

Matties: I think they recognize that not only is it good for the environment, but it's good for business. There's a lot of global pressure to clean up, and they took it seriously because they have a long vision.

Carmichael: I think the Chinese government does take a much longer view of things than most countries. They still do a five-year plan that has money behind it, which is unique in the world today. They say, "We want to focus on these five areas over the next five years. We're going to put money aside for R&D, and people that are working in those areas." That's what makes it happen. If you put investment against it, it's going to happen.

Matties: The other thing that I hear a lot about is factories moving to expand, and they're only allowed to do that if they're doing it without operators. It has to be an automated/AI situation.

Carmichael: If you're expanding a factory, in addition to your local government approvals, you need approvals of your neighbors on all sides, regardless. Even if it's a restaurant or a hotel, they have to approve your expansion. Increasingly, neighbors are very concerned about how you dispose of certain waste products. Are you recycling? What about the wastewater from cleaning operations? You need to convince not only the government but also

your neighbors that you're a good citizen, and that's how it operates. Again, I see that as a real positive.

Matties: My understanding is if you're looking to expand, they don't want to hire or create operator jobs; they want to create automated factories.

Carmichael: They're more interested in knowledge-based workers. That's a natural evolution in China. Because I travel the region, I see that touch labor assembly work moving to lower-cost countries, but it's not decimating the industry. The industry is migrating into knowledge-based or automation/CFX-type products where you can run a factory and have machines talk to each other by themselves. But you still need somebody to do programming and oversee that. It's a different type of person than somebody who's populating a board by hand.

The industry is migrating into knowledge-based or automation/CFX-type products where you can run a factory and have machines talk to each other by themselves.

Matties: The interesting thing for me is that the cost of labor has to go down to compete in the world because, as AI is coming, that 30% or so advantage that they enjoyed for many years is starting going away. Thus, they have to look to be competitive on different levels.

Carmichael: Yes, and part of the good year we had was based on the fact that we grew very strongly in Southeast Asia. As we support their growth in touch labor production that's moving from China to Vietnam, Thailand, Indone-

sia, and the Philippines, it's a natural evolution. We saw movement from North America come to China back in the '90s. Now, we see that same sort of products being built elsewhere. For instance, Vietnam has a number of investors from China, Japan, and Korea who have moved some very large manufacturing operations. I went to one three years ago, and they had 3,000 people who each worked one shift; I was there this year, and they have 9,000 people who work 24/7. That's a sign of how their development is going.

I see China moving into design as well. And we're looking beyond CFX to machines talking in a common language and the digital factory. How do we put in standards for both communication and security when everything is running around on the airwaves? We have some meetings this week to kick off this project in China.

Matties: The digital factory is happening. Now, it's a question of finding the standards and getting the investment to go with it.

Carmichael: And as CPCA's board chairman said this morning in his opening remarks, 5G will further push production in China as well. There will be more factories producing things that support that technology. I still see that this industry will be fairly robust going forward for the next period.

Matties: We're starting to see manufacturing come back to America for a variety of reasons, such as labor and costs. As we look in North America, we see companies like GreenSource Fabrication setting up digital factories; GreenSource provided a blueprint for a lot of others. Their facility is zero waste and has continuous flow, a lot size of one, and digital fabrication. It lends itself well to becoming a model for captive facilities. Do you see any desire for captive facilities, or is it still going to be drop shops?

Carmichael: It's a matter of when and how it fits into the economics. It's going to come, but it's a matter of when. The other attractive aspect of that type of facility is no pollution. Having a green footprint makes it very important and attractive.

Matties: It seems like there's still a lot of investment going on in Chinese manufacturing, trying to become true smart factories.

Carmichael: I've always been a big advocate of following the money if you want to be successful. In China, money is being spent on R&D and development in certain areas: clean manufacturing is one, and green manufacturing is another. If you want to get through tighter economic times, follow where the investment's going, and you will have a better chance for success.

Matties: At one point, one of your product offerings was to help train the employees on work ethics and the end process. Is that still popular?

Carmichael: Now, they're interested in learning how to be more green. How can

they meet high levels of requirement for both green and ethical manufacturing that European companies put on suppliers? Again, it's a sign of the maturity of the Chinese industry that they're asking for these sorts of things. China has come a long way from green tunics and bicycles. I could never have predicted how much a part of the global economy that Chinese manufacturing is today. I had some inkling that there was a good opportunity, but I didn't think it would be on this scale. For example, there are so many people at this show making business connections. It's extremely busy and well-attended.

Matties: This is the first year with IPC is not a co-organizer of this event, but you're supporting the event. That was always your intent.



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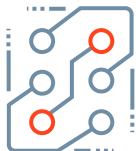
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Carmichael: Our job is to support the industry and our member companies in the industry. We have more members in this show this year than we did last year when we were a co-sponsor. Part of my job is to make sure all of our member participants are happy and getting the treatment that they want. So far, everybody is pretty happy, so that's good.

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Matties: Recently, the Hand Soldering World Championship was held at productronica.

Carmichael: Yes, there were 11 competitors from Asia Pacific and seven other competitors, primarily from Europe and Asia. The champion was from Indonesia, where I'm headed tomorrow to visit. We have a custom that the winning HSC company gets a visit from one of the IPC senior executives. We bring along the local government and some other people as well to help give them good PR. That has helped support their continued involvement in what we're doing.

Matties: It's great to see how the hand soldering competition has been elevated in the world, and in this region in particular.

Carmichael: We will have an event at the Shanghai productronica show too. Again, we are no longer a co-partner with the HKPCA show, but we are partnered with MMI and the productronica show both in Shanghai and in Shenzhen, so you will see more of our activities in March. The day before the

show opens, we'll have a very in-depth technical seminar. It's the China Electronic Manufacturing Annual Conference, which is an IPC-sponsored event. It's similar to maybe SummerCom in the U.S. and will have technical speakers and some standards activities on March 17.

Matties: Is this open to members and non-members alike?

Carmichael: Yes, our goal is participation from the industry. We'd like to see as many people attend as possible.

Matties: Is there anything we haven't talked about that you feel we should still share with the industry about what's going on in this region?

Carmichael: We had a CFX demo last year in Shenzhen and another one this year that made a product on 20 pieces of interconnected equipment. It started with a bare board and ended with a finished board with no human intervention. Our next goal is to have several members working on converting their existing facilities into CFX lines. You need to bridge from the standard to your equipment. Some software writing is required, but we're assisting a couple of companies in doing that. I expect that early next year, we'll be able to announce at least a couple of factories who are going to be fully CFX integrated. That's almost a science fiction approach to things, where you have a factory running and machines talking to each other and resupplying components and materials. Nobody is involved on the floor; it's only the machines, and that's a huge change.

Matties: And over 300 companies are participating in CFX. IPC has done a good job getting it into the industry and making it a reality.

Carmichael: Work always has to be done to go from a standard language to executing it into a factory, but that's where we're at right now. We're working on that.

Matties: Having a couple of case studies will be beneficial. How important is a show like IPC APEX EXPO to this region? A lot of people say it's not a necessary show for them to come to and everything they need is at shows like this or productronica.

Carmichael: IPC APEX EXPO is a unique show because a big part of it is the committee meetings that start the Sunday before and run through the show period. There are both committee and continuing education meetings. We have a number of our active member companies who mainly go to committee meetings, and that's an attraction to North American compa-

nies as well. Nowadays, SG&A and travel budgets are tight. If you can say, "I'm going to go IPC APEX EXPO because there are 10 committee meetings I want to attend as well as continuing education opportunities," that's easier to pitch to management because it's more efficient. That's why that show continues to grow; it's not as big as this show, but it is very important since it's the main show in the industry in the U.S.

Matties: That's a big attraction. Thank you very much, Phil.

Carmichael: Thank you. SMT007

Professional Development at IPC APEX EXPO 2020

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



Molex on Connectors and Successful Manufacturing

Interview by Nolan Johnson
I-CONNECT007

As a components supplier turned electronic solutions provider, Molex has a great perspective on the challenges of getting from design to successful manufacturing. Nolan Johnson spoke with the Molex team, including Jim Hines, Frank Ruffino, and Brett Rickett, about what the industry needs to know.

Nolan Johnson: Let's start with a quick overview of Molex.

Jim Hines: As both a components supplier and electronic solutions provider, we have visibility into the challenges faced by both the OEM design team in selecting the correct component for an application and the CM responsible for attaching the component to the PCB.

Frank Ruffino: For many different markets, like automotive, medical, industrial, consumer goods, etc.

Johnson: That puts you in a unique position. You have a chance to talk about the connector side of the business as well as the design side.

Hines: Correct. Design engineers, OEMs, and CMs need to know that they can rely on and count on their manufacturing provider. A lot of times, customers will have projects, and their designer engineers may not be aware of all the



industry-established specifications or testing requirements. And with us having visibility and experience as both a component supplier as well as a complete PCBA electronic solutions provider, we understand a lot of those industry PCBA manufacturing and testing requirements and specifications.

At times, customers—let's take an automotive application—will get an RFQ or a new project request, and we conduct an internal review of the project and manufacturing and testing requirements. During that review, we may see a customer requirement on conformal coating coverage or thickness. At times, the customer may have specified a PCBA manufacturing requirement or test procedure that is either less stringent than typical industry standards or, at times, even more stringent. It's often up to us to help explain why a customer specification is not typical of industry requirements, to inform them about the typical requirements and testing, discuss how their specified requirements could impact the product reliability or manufacturing costs, and finally offer options to the customer that they may not have been aware of previously.

Johnson: That's a great point. Over-specifying your design and creating a cost that is then passed along to the end price for your product is not what anybody wants. How do you communicate that message?

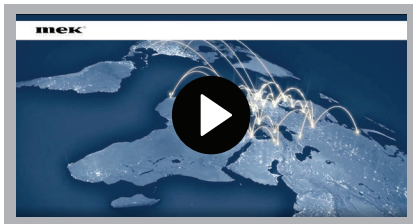
Hines: It can be challenging, but it's a matter of sitting down with the customer and explaining

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our point of view and why we see it a certain way. During these customer reviews we rely on our experience and history to explain to the customer that, although they may think they are making a product more reliable or higher quality by specifying tighter requirements, it could be increasing manufacturing costs by requiring extra testing/inspection or by causing more defects or more rejects due to the manufacturing or testing requirement while not increasing the reliability of the final application.

Here's one example. A customer may have multiple field returns for a particular application from PCB shorts caused by liquid spills or something shorting out the circuit board, so the design engineer may have a focus on exploring opportunities to prevent that type of failure. In an effort to prevent this failure type, the design engineer may specify thicker conformal coating coverage or a specific conformal coating material that they believe is going to help to solve that challenge without understanding that the new material requirement could require special processes or equipment in the manufacturing line or additional fixturing or inspection and testing that increase manufacturing costs. It's a matter of providing an understanding and a comfort level to the customer on why we suggest testing a certain way; this is where Molex benefits from having experience as both a component supplier and an electronic solutions provider by being able to offer insight from multiple points of view.

It's a matter of providing an understanding and a comfort level to the customer on why we suggest testing a certain way.

Johnson: How does a specifying engineer become aware ahead of time? Are they getting the feedback not when their design is essentially finished, but while they're actively making the design decisions?

Hines: At Molex, we follow our product development process (PDP), and there are multiple stages within that process. In the early stages of the PDP, when evaluating a new project or opportunity, we highlight any manufacturing or testing requirements and specifications that appear to be outside of established industry practices and provide feedback early in the PDP process to the design engineer or customer before the application or the final design is done. We definitely make a point to engage with the customers as often and early as we can.

Johnson: And that requires you to have an existing relationship with the customer.

Hines: Exactly. And that feeds back to the advantage we have of being both traditionally a component supplier as well as moving into being a full electronic solutions provider. We already have a lot of those long-developed relationships with our customers that we can leverage.

Johnson: As you work with customers, how do you engage them?

Hines: Sometimes, there are multiple business units or teams within a company. One of our customers can have multiple groups with each having different project requirements, expectations, and goals, and we may have an established relationship with specific business units or groups within a customer's company who may have already had the same challenge that the new project faces. Often, we will leverage our experience and relationship with other units or groups within the customer's company to support our suggestion or recommendation.

Johnson: How does this connect back to the connector business?

Hines: Most applications have connectors. A lot of times, connectors are thought of in a generic way, but there's a lot of technology involved with them now. Not only do we work a lot with our external customers, but we work

with our internal customers and peers, as well those who are designing new connectors to help explain how design features could impact the PCBA manufacturing process. Taking that knowledge and sharing it both internally and externally has been a good benefit.

Going back to your comment about how a design engineer, or anyone for that matter, finds out how to engage with us. One of the things that we do globally is we affectionately refer to them as “tech days.” We work with a customer, and they will invite us in and sequester a conference room or a foyer; we’ll bring in subject-matter experts, like Jim and the team, with various skill sets and knowledge domains and have an open house/knowledge share. We often go on-site to our customer locations or do this at trade shows, either on the show floor or privately. The tech days have provided an intimate environment where the customer doesn’t leave their location, and anyone who wants to come down to have a conversation with Molex is welcome and encouraged to do so.

Johnson: For customers who are going to engage with Molex—either as a connector supplier or to plug into your services—what are the most important things that customers need to know after the tech days presentation?

Hines: In terms of trending in the data center space, everything needs to be faster. The speed of circuitry, connectivity, and design is paramount. The hyperscalers, edge computing, and traditional service providers are all looking for faster, so speed is one important factor; signal integrity would be another one. The last one that I will highlight is everything needs to be smaller, lighter, and lower cost, and have less of a footprint. When you combine all of those, it makes for a very challenging design process.

Ruffino: My lens is in the reliability and performance of a product, and I think it’s important for users to understand their use-case of the product, whether it’s a connector or a solution. Reliability testing could be designed and focused on that use case because if you overspecify, which is generally what’s done, you

end up running the costs up because you’re testing it in much more severe environments than it’s going to be used in. You add cost to balance testing of the product and reduce the likelihood of a product to survive those tests if it’s being used in a new application. Often, we see those test requirements overspecified; they need to be sized correctly. Even more importantly, we need to incorporate all significant application physics-of-failure modes in a reliability test regimen. This includes SMT processing; not addressing degradation mechanisms or under testing could result in under-performance in the field.

Hines: And as you said, Frank, that could drive costs, but then we’ve also seen that the application space is truly getting more severe, depending on the market, whether it be automotive or mobile products.

Ruffino: They are, but we need to understand the severity of the application, the physics of failure, and a right-sized testing regimen. The application and environment should be categorized to a point where we can simulate that use-case in modeling and empirical testing. Understanding the application environment and developing a test plan that’s the correct fit or evaluating existing product data supports this goal.

Rickett: That translates back into the SMT space where people start looking at more robust conformal coating materials, and then it drives the processes for depth-depositing those and so forth.

Johnson: How do these dynamics influence the design considerations for connectors themselves?

Hines: When we meet with our internal design engineers, one of the things we try to stress is that there’s more to a PCBA than the connector. Let’s consider things like coplanarity, package miniaturization, more pin counts, and reduced terminal pitches on the board. For example, with a BGA component, if we make a connec-

tor that has a coplanarity of 0.15 mm, and we recommend a 6-mm stencil, the customer may not be able to use our component due to other component requirements on the PCBA. We try to stress to our internal design engineers that there's a bigger world than connectors. And when we're designing connectors, we have to account for other components on the board and how our connector design impacts that.

Ruffino: And being a user of our own products gives us a good feedback loop on those critical characteristics.

Hines: A design engineer might make a connector, you have a coplanarity of 0.15 mm, and one of the things that we like to emphasize to our design engineers is that coplanarity matters not only as it leaves our manufacturing plant or as it's received at the customer, but coplanarity during reflow is even more important. How does the connector react as temperatures peak during reflow oven soldering?

That's one of the major advantages of having a complete SMT process line in the Molex Corporate Reliability Lab is that you can evaluate.

Ruffino: It's warpage, and, at times, the coplanarity, degrades during the reflow process itself versus the as-received product. This could impact solder joint yield and reliability. That's one of the major advantages of having a complete SMT process line in the Molex Corporate Reliability Lab is that you can evaluate. That SMT process is not only here to help us evaluate, tweak, and help our manufacturing organizations with their problems with building PCBAs, but it also gives us the ability to run our connectors through a true manufacturing process and run our reliability testing after they've been

exposed to what our customers will expose our products to. If typical SMT processing impacts the performance of a new connector under development, we will measure and address its effects early in the development cycle.

Hines: It even gives us the ability to translate that back into design guidelines while putting controls and limits on things that we might not have in the past because we have insights we didn't have before.

Johnson: What sort of design team, product, customer, company is a good fit for you to do design services with?

Hines: It's pretty broad, but Frank mentioned our industry segments earlier. I'll highlight the ones that we're focused on, Nolan. We categorize a 5G data center network. So, when you think about providers of data center servers and equipment that is critical to running the network and the design engineers that are designing the next generation of data center hardware, those are folks that we would want to engage as early as possible in the design process. Automotive and medical are also big areas for us.

In terms of what we call "big bets" in the industrial space, we call it industrial automation. As you look at the industrial internet of things (IIoT) where you have manufacturing for equipment, robotics, and AI that are connected to the manufacturing process and data systems, all of those require connectivity. All of those would be very good customers and prospects for us to engage in.

Rickett: Which we get with Phillips-Medisize's long history in drug delivery; the synergy between its long history in that space and Molex's history in connectors and electronics helps to deliver more value to the medical consumer in terms of even networking your drug delivery device to the internet. And that includes wearables and monitoring devices.

Johnson: What are the challenges in getting from design to getting something successfully manufactured and out the door?

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Hines: My response to that would be nobody knows everything, nor can they do everything; we want our customers to understand that. We focus not only on component design or connector design but also on the complete application. We don't expect our customers or the design engineers to know exactly what solder paste they want to use or what material they want to use for conformal coating; we want them to know that's our focus.

And to add on about the automotive market, Molex has the capability to design the connectors that communicate at mega gigahertz speed. We can also provide the completed assembly, which takes one step away from them having a contract manufacturer or somebody else assembling the Molex connector onto their application. If something goes wrong, it's one less person to point the finger at.

To add on about the automotive market, Molex has the capability to design the connectors that communicate at mega gigahertz speed.

Rickett: And Jim always tells me that the connectors usually are the hardest things to get through the line successfully.

Hines: Unfortunately, that's true, at times.

Johnson: There's wisdom to that. That's the part that connects the PCB—the mostly digital, slightly analog, device connection—to the very analog world. There seems to be a strong concern that to meet the changing demands for those categories means new materials, interactions between the components and how you bond them to these new materials, and changes in connectors, etc. Right behind that is a concern that when you start getting to the very high-speed things and low-profile appli-

cations, there needs to be innovation in everything, from how you attach the active components in the chips to the board to how you connect the board to the rest of your system.

Hines: That makes sense. For us, beyond production PCBA and NPI PCBA, we are developing practices around more of an R&D focus on PCBA-related technologies and challenges. And we have a lot of history in the SI area, so we're leveraging that experience from a connector side and incorporating that more and more into our PCB design.

Johnson: At a practical level, one of the things that my readers need to know about working with Molex, and connectors in general, is to get you involved in the conversation very early.

Hines: Absolutely. The earlier, the better. And there are multiple ways to engage us, such as face-to-face with any representative at a field-level. And with the digital age that we live in, designers can pretty quickly identify their needs, and we have the ability to facilitate that request or inquiry to the right people and start that process. That knowledge share is the challenge, such as the timing. Early engagement increases our probability of finding the right solution and helping the customer move along.

And with our lab capability in Lisle, we have a PCBA line used for R&D and prototype builds. Early on, if a customer has a concern, such as wanting to try using a certain component or material, rather than having them try to break into their CM production line to run a test or experiment, we have that capability. We're set up and equipped to do that, and in our lab here in Lisle, we use the same type of platform equipment that we have in our global manufacturing plant.

Johnson: This has been quite informative. Thank you.

Ruffino: Thank you for the time. SMT007

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Supplier Highlights



Mek to Showcase Latest Range of AOI Technology at IPC APEX EXPO ►

Mek (Marantz Electronics) will be showcasing the ISO-Spector M1 Full 3D AOI system with artificial intelligence at this year's IPC APEX EXPO in San Diego in Booth 3029.

Nordson Advanced Technology K.K. Japan Moves to New Office and Demonstration Center ►

Nordson Corporation announces that Nordson Advanced Technology K.K. Japan has relocated to new, larger office and demonstration facilities in central Tokyo to deliver superior sales, service, technical training, and support to its customers and sales network in Japan.

Rehm Thermal Systems' Three-mode Oven ►

Editor Nolan Johnson and Michael Hanke discuss the company's new three-mode oven at productronica 2019. In addition, Nolan and Michael address data analysis and reporting advances in Rehm's products.

Indium Corporation to Feature Innovative New Alloy at IPC APEX EXPO 2020 ►

Indium Corporation will feature its new high-performance, high-reliability alloy technology at IPC APEX EXPO, February 4–6, in San Diego, California.

Mirtec's Approach to Raw Data: The 'Sushi Principle' ►

Editor Pete Starkey and Brian D'Amico discuss the company's new Alpha system, designed for the automotive market. D'Amico explains why Mirtec is focusing on providing customers with raw data instead of "cooked" data, what he terms the "sushi principle"; he says that the system is able to pick up tiny defects that would otherwise be filtered away if the

system were not using raw data. D'Amico also discusses their use of artificial intelligence and some of the possible benefits of using AI going forward.

ifm Relies on Automated Component Storage From Totech ►

Totech today announced another strong partnership with ifm electronic GmbH—a global progressive sensor and automation company—headquartered in Germany. The Totech Dry Tower, a fully automated SMD warehouse, will be installed at the ifm electronic Bechlingen location in Tett nang at the beginning of next year.

A Walking Tour of Mycronic Equipment at productronica ►

I-Connect007 pays a visit to the Mycronic booth at productronica 2019 in Munich, and Jeff Leal, product manager for Mysmart, takes us on a walking tour of just one of the lines on display at the show. Jeff discusses a series of dispensing and conformal coating machines.

Murray Percival's Longest Tenured Employee to Retire After 22 Years ►

The Murray Percival Company, the leading supplier to the Midwest's electronics industry, announces the retirement of Mr. Fred Binggeli, a highly valued team member, and the company's longest tenured employee.

Indium Discusses New Materials and Plans for 2020 ►

Nolan Johnson sits down with Chris Nash and Andy Mackie to discuss Indium's focus on creating innovative products for the 5G, automotive, semiconductor, and high-reliability segments. Mackie also offers a preview of Indium's plans for 2020 and beyond.



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Graham Naisbitt

Updates on Cleaning Standards and Committees

Feature Interview by Nolan Johnson I-CONNECT007

Graham Naisbitt of Gen3 talks about changes he sees in cleaning, including how the WP-019 white paper has caused a closer look at electrochemical reliability. As a long-time head of committees, Graham also breaks down many of the topics he hopes are addressed at this year's IPC APEX EXPO.

Nolan Johnson: Graham, even though so many members of this industry know who you are, I'm going to have you introduce yourself again.

Graham Naisbitt: On behalf of IPC and IEC, I am the vice-chair of the IPC 5-30 Committee, which embraces many different topics. I'm also vice-chair or chair of both the SIR and the CAF test groups, and some major changes have taken place with the document that is used by the industry on how to assemble electronic circuits.

In October of 2018, J-STD-001 was changed with respect to Section 8 relating to cleaning, where we dropped the number that everyone has been relying on: 1.56 micrograms per centimeter squared of sodium chloride equivalent.

The reasons for dropping that are covered comprehensively in the WP-019 white paper, which sets out the rationale for making these changes. It's having a profound effect on the industry because with new products moving forward, we now have to look more closely at electrochemical reliability. Electrochemical reliability has become more and more relevant as the consequence of miniaturization in circuitry and circuit designs and working effectively in an increasingly hostile operating environment.

One of the challenges that the industry faces is that most process chemistries produced today have non-ionic additives that are used to aid wetting or de-wetting, as the case may be. These are not detectable by the existing or prevailing techniques. Insulation resistance testing, however, is something that has been used and embraced widely for at least the last 15-20 years, and I've been directly involved in most of the scientific research that originally kicked off around 1987 when we were dealing with the Montreal Protocol and the removal of CFCs, and that coincided with the introduction of no-clean processes. No-clean presents some kind of tough challenges because if it's not going



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to be cleaned, why would you use a cleaning technique, which is what the ROSE test does to establish whether or not? From an ionic contamination point of view, it's acceptable.

What we found is that using insulation resistance techniques, we effectively have no interest in whether or not it's ionic or non-ionic; it simply measures changes to resistance. And that makes a huge amount of sense. You should only embrace techniques, such as ion chromatography and FTIR, when you find a problem. Some customers are even going to the range of spectroscopy, so this is a far bigger subject than people realize.

What we found is that using insulation resistance techniques, we effectively have no interest in whether or not it's ionic or non-ionic; it simply measures changes to resistance. And that makes a huge amount of sense.

The world of standards is broken down from the World Trade Organization (WTO) to two bodies, the International Electrotechnical Commission (IEC) or the International Standards Organization (ISO). Beneath those, there are a host of national standards bodies. In the U.K., we have the British Standards Institute. Further, in France, there is the AFNOR; in Germany, there is DIN, there's the American National Standards Institute (ANSI) in the U.S.

Beneath ANSI—subcontracted, if you wish—IPC has taken up that role, and I've worked for more than 20 years in both groups. It has been my experience that the work done at IPC has some advantages to IEC because it embraces a huge number of professional people that attend the committee meetings; meanwhile, in IEC and

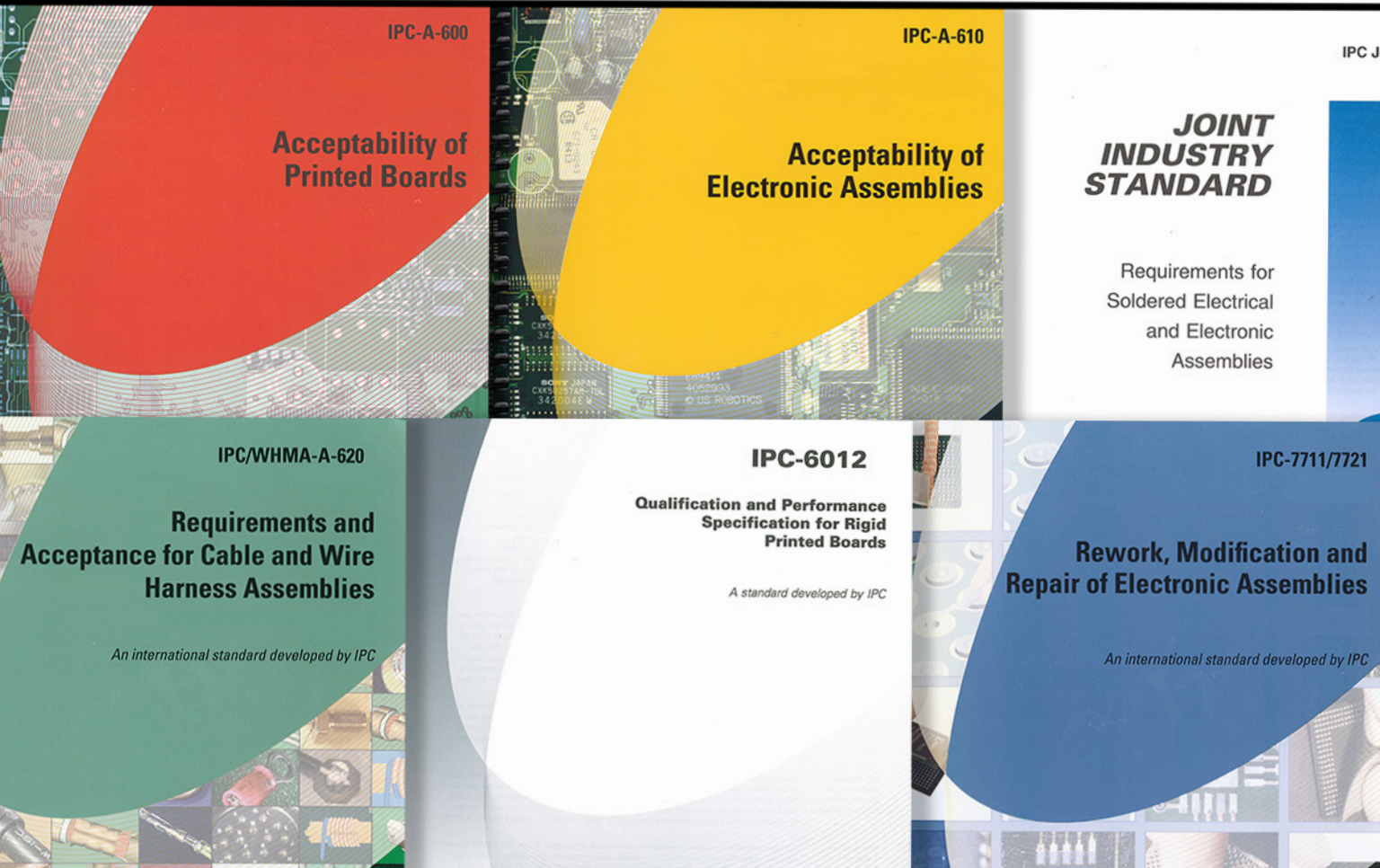
ISO, it tends to be the selected leaders coming together. Every country has its own shadowing committee, so it's a cast of thousands, but most of them never get to meet one another. Having that exchange of ideas and concepts in preparing IPC documents is a great benefit.

Now, through this change to J-STD-001, users have to produce objective evidence and not rely on a simple cleanliness number, which is a grossly misleading term. It shouldn't be applicable to anybody because how do you define cleanliness? Twenty years ago, I would say, "How clean is clean?" when we were involved deeply in the subject of conformal coating. Trying to help people understand the extent of that question is a difficult problem, coupled with the fact that we have an increasingly transient workforce in the industry pretty much globally, certainly in Europe and America. As a consequence, the need to reeducate people becomes of huge importance, and finding and keeping good people is hard to do.

Historically, what I have seen—and I've been in business for 50 years—is that, generally speaking, companies no longer provide good career opportunities. Companies bring someone in, have them do a job, and get rid of them because it's all about numbers, but people are not numbers. Having that depth of knowledge, experience, and expertise is diminishing because people of my generation, immediately behind me, are already retired. Many of my colleagues say I should, too, but why would I want to retire? I enjoy what I'm doing. It's very rewarding to help educate people going forward with a background of understanding that enables that to be communicated effectively.

Barry [Matties] and I recently did an interview on "[The Long Road to a New Standard](#)," and that is so true. The industry leaders, for the benefit of their numbers, want to have standards up to date at the absolute maximum period of a couple of years. It is nearly impossible to do that because by the time you've written the document, drafted it, circulated it, received everybody's feedback, addressed various comments, and discussed and debated whether or not it needs to be modified, you present it for a re-ballot and may be pleased

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with it. But then, in the case of IEC, it has to be translated into French, for instance.

By the time you've gone through that procedure and had the document printed, published, and submitted to the committee, you cannot produce that in less than five years based on my experience. The demand is to do it faster; the requirement thrust on the committee is to do it in three years. But don't lose sight of the fact that everybody on the committees is doing this work voluntarily, and pushing them to do it as a matter of priority to the day job isn't going to happen.

It's not a simple exercise, but every standard has a five-year breakpoint at which it has to be at least considered for revision, and if the committee controlling it believes that it is still extant, leave it alone. If it isn't broke, don't fix it. The committee meetings, both with IEC and IPC, are only twice a year—one in the early part of the year, and the other at the back end of the year; one of the difficulties we have is trying to find the appropriate locations to conduct those, which enables people to do more than talk about standards. They want to be able to talk about day job problems, so having an exhibition attached to the conference and the committee meetings is important.

Johnson: You can get double duty out of one trip.

Naisbitt: Exactly. When there are discussions—especially in the U.S. with IPC, and I've been involved as a chair of committees for quite a few years—one of the biggest challenges is, "Let's do the meetings in Las Vegas." But when most engineers go to their boss and say, "I'd like to attend these committee meetings to help develop standards going forward," they are asked where it's being held, and once the engineer tells their boss it's in Las Vegas, the answer is usually, "No."

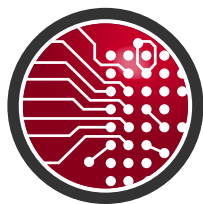
Johnson: That's a good point for why there is an exposition to accompany the IPC meeting. IPC APEX EXPO puts the two together so that you have maximum value out of that one trip. You're quite involved in what's going on with

multiple standards committees. What do you see coming up for us at IPC APEX EXPO 2020 in February?

Naisbitt: I love coming to San Diego in the winter from the U.K. We'll be looking at helping companies determine acceptable objective evidence of what they are doing in their process control—that process evolution. We have ever-increasing miniaturization, which is a double entendre, and the drive to miniaturization goes hand in hand with two extreme conditions. If you're talking about space and medical applications, it needs to operate at ultra-low voltage. But when you think about the drive to reduce the impact of CO₂ for environmental reasons, everybody's talking about electric vehicles.

Now, I'm not even going to attempt to get on my soapbox and say anything about environmental challenges, except that you still have to have electric power no matter where you are, and that electric power is going to consume a huge amount of fossil fuel right now. There's no escape. The alternative is to go nuclear, and everybody I know is working frantically to develop and approve nuclear fusion. When we get to nuclear fusion, the world will be a far better place, but in the meantime, governments around the world want and encourage people to have electric cars. When you're talking about electric cars, the demands on energy for those are rather extreme, to put it mildly.

The two routes being followed are either to go low-voltage, high-current, or high-voltage, low-current. If you go down the route of low-voltage, high-current, once an electric vehicle is delivered to the customer, it is switched on for the rest of its life. Thus, with those electric vehicles, if they're low-voltage, high-current, they may have a residual current of around 1200 amps. If emergency services attending you in an accident don't handle the car properly, with 1200 amps, there will not be much left apart from a pair of smoldering boots. Do they know whether it's a high-current or a low-current application? These challenges are enormous. And when you're dealing with high-current loadings, it means that when you're manufacturing the circuit boards,



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the inter-copper layer needs to be much more heavy-duty; it's thicker, heavier, and more expensive.

Johnson: And a bigger load on the mineral resources.

Naisbitt: Absolutely. As a consequence, what is happening in Germany is that they are opting to go for the high-voltage, low-current route, where you'll still have high amperage ratings, but nothing as high as the high current. But they will still be up around 50 amps, so they're inherently dangerous. If you have a conventional petrol or diesel vehicle, the warranty level that the manufacturers of the vehicle impose on the supply chain; it is 15 years, which for petrol or diesel vehicles, is around 12,000 hours in operation. With an electric vehicle that is always on, to achieve that same 15-year period, it goes out to 130,000 hours.

Part of the problem that the industry is trying to address is, of course, there are a big number of automotive manufacturers, and don't think purely of cars. There are trucks, vans, buses, and all manner of other vehicles, such as aircraft and drones. Those circumstances are driving a huge reliability problem because the test duration to get the evidence to support the reliability that you need to meet that warranty, we have users in test labs around the world that are testing for anything up to 2,000–3,000 hours at anything up to 1,500, 2,000, or 2,500 volts. If you run a chamber and a test for 2,500 hours, you have 93 days where you cannot have power disruption.

In the U.K., of which I'm ashamed politically, by way of illustration, our government has said, "We want to go carbon-neutral by 2030, and we want everybody in electric cars by 2030. And just to make it interesting, we're closing down all the power stations." Joined-up thinking is a requirement in the world of tomorrow.

Johnson: There are two separate pools of thought.

Naisbitt: It's crazy. At IPC APEX EXPO, a lot of questions are going to be asked, and we have

to address the need to provide greater education. We have to address a huge variety of different application parameters that satisfy ultra-low voltage to ultra-high voltage, ultra-high current, and low current. There's a lot of work to be done in that area, and I only talk about the electrochemical performance. There are so many other parameters that still have to be addressed, but I don't get involved with those; after all, there are only so many hours in a day, and I have Gen3 and a home life, not necessarily in that order!

Johnson: You used automotive as one example. Now, we're looking at what happens with wearable technology because that's being driven so strongly by the medical field. And then you have IoT, delivering connection requirements and data sharing in so many different ways. Industry 4.0 is an example within manufacturing of the overall global technology trend. There are so many competing forces on what we do, all at the same time. The IPC standards activity at IPC APEX EXPO, etc., is where all of that comes together. It may seem like a dry process to put standards together, but so much hinges on these documents being up to date, accurate, workable, measurable, and meaningful.

Naisbitt: Exactly, and trying to get the raw materials to match the demands of a cataclysmic change in the way in which we go about things is an overwhelming amount of work to be done on people who are already overstretched. Where are you going to find more people? Where are you going to get the necessary knowledge?

Johnson: If that isn't a call to action to industry professionals to get more involved, then there it is. Thank you for your time. I appreciate it.

Naisbitt: You're very welcome. SMT007

Graham Naisbitt is the author of *The Printed Circuit Assembler's Guide to... Process Validation*. Visit I-007eBooks.com to download this and other free, educational titles.



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Integrating FirstNet into training exercises is not only helping agencies improve their communications, but it's also another way that public safety's network platform is working to continuously meet first responders' needs.

Nano Dimension Appoints New President and CEO ▶

Seasoned turnaround executive Yoav Stern takes the helm as Nano Dimension's incoming president and CEO, succeeding co-founder Amit Dror, who is taking the role of customer success officer.

Sikorsky and United Rotorcraft Deliver Three Firehawk Helicopters to CA Firefighters ▶

Sikorsky, a Lockheed Martin company, and United Rotorcraft, a division of Air Methods Corporation, announced today deliveries of three new S-70i™ FIREHAWK® helicopters to California fire agencies: one each to the Department of Forestry and Fire Protection (CAL FIRE), the Los Angeles County Fire Department (LACoFD), and the City of San Diego Fire-Rescue Department.

Lockheed Martin Partners With The Common Mission Project to Support Hacking for Defense (H4D) ▶

Lockheed Martin announced a corporate donation to The Common Mission Project to support the adoption of innovative solutions that solve critical national security challenges through the National Security Innovation Network (NSIN) program Hacking for Defense® (H4D), a nationwide academic course.

Echodyne Radars Anchor DARPA's Urban Drone Testing ▶

The DARPA testing involved radar sensors on two large tethered aerostat balloons flying at up to 400 feet above ground level (AGL) over San Diego and National City, as well as fixed building-top and tower-mounted locations providing large-area coverage. The sensors were tuned to detect and track small drones and distinguish them from background objects such as buildings, vehicles, and birds. The testing assessed how well the system could detect, track and identify over 150 sorties of drones.

New Sandia Labs Director Named ▶

Dr. James S. Peery has been named the next director of Sandia National Laboratories, the country's largest National Laboratory. Peery, who began his career at the Labs in 1990, succeeds Dr. Stephen Younger, who is retiring at the end of 2019.

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

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

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

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AIM Solder	2447	Kulicke & Soffa Industries Inc.	2421
AIRTECH International Inc.	3819	Kurtz Ersu Inc.	844
AIR-VAC Engineering Company	2829	KYZEN Corporation	1637
Arlon EMD	4043	M+B Plating Racks	4326
ASC International Inc.	1537	MacDermid Alpha Electronics Solutions	1824
ASM	3036	Machine Vison Products Inc.	1800
Asys Group Americas Inc.	1601	MYCRONIC Inc.	1336
Atotech USA LLC	4215	National Technical Systems	1004
Austin American Technology Corporation	2352	Nordson ASYMTEK	1611
BlueRing Stencils	2044	Oak Mitsui Inc.	4034
BPM Microsystems	1604	Omron Inspection System	2837
BTU International Inc.	3119	Orbotech Inc.	3834
Burkle North America Inc.	3827	P. Kay Metal, Inc.	3316
Chemcut Corporation	3809	PACE Worldwide	530
Count On Tools Inc.	1528	Panasonic	1301
Crystal Mark Inc.	2718	Pillarhouse USA Inc.	3413
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Hanwha Techwin Automation Americas Inc.	1645	Taiyo America Inc.	3951
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Henkel Corporation	3603	Topline	2842
HEPCO Inc.	3323	Uyemura International Corporation	3745
Heraeus Electronics	1806	Via Mechanics (USA) Inc.	4008
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CFX Preview at IPC APEX EXPO 2020



Chris Jorgensen

Feature Interview by the I-Connect007 Editorial Team

The I-Connect007 Editorial Team chats with IPC's Chris Jorgensen about the advances CFX has made in the past year and where the standard is in the standardization process. Chris also previews the CFX line that will be on display at the upcoming IPC APEX EXPO and shares IPC's plans on educating and providing support solutions to potential users of CFX to implement it more easily.

Dan Feinberg: Chris, I knew absolutely nothing about CFX until about 18 months ago. I became involved in it by listening to some talks at IPC APEX EXPO 2018, and I was fascinated by it. And last year's exhibit was quite good; I went upstairs to the demo room and had a chance to look at it. What CFX progress are we going to see at IPC APEX EXPO 2020 this year?

Chris Jorgensen: At last year's IPC APEX EXPO, the IPC-2591 standard was not even pub-

lished yet. Since that time, the subcommittee approved the first edition in spring and has put the standard on a twice-yearly version update schedule to support CFX for additional equipment or other needs communicated by the industry. The subcommittee chose to have the standard follow a version approach rather than the typical revision letters or amendments of other IPC standards because this is what IT professionals or software solutions providers understand. Once the subcommittee approved IPC-2591, version 1.0, they began work on version 1.1, which is currently under ballot. We expect to have that published in time for IPC APEX EXPO 2020.

Aside from the standard, we have also continued to bring real-world views of CFX to the industry through virtual demonstrations and live factory lines at trade shows in the U.S., Europe, and China. These demonstrations enable the industry to see the power and simplicity of CFX in mixed-vendor factory lines, as well as how CFX can enable Industry 4.0. IPC has also started collecting CFX implementation



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roadmaps from the industry so that EMS and OEM companies can see CFX plans for their equipment and software suppliers. IPC publishes these roadmaps to the CFX website.

In addition to that, IPC also published a joint standard with a Hermes initiative, IPC-HERMES-9852, which is the SMEMA standard replacement. This joint standard is a positive and exciting step in the work IPC and The Hermes Standard Initiative are doing together to support industry. We have been working together on the live factory lines and taking steps to ensure the two standards work together seemed like a very natural next step.

Feinberg: As I understand it, the main thing with Hermes is that it tracks the transfer of each circuit board from machine to machine when you're using CFX. Is that correct?

Jorgensen: Yes. Hermes can work on its own, but it also can work with CFX. If you look at what we demonstrated at IPC APEX EXPO earlier this year, the Hermes part of it was with the line control and the multiple board sizes that we used. We're able to do a transfer between board sizes without human interaction and without having to stop equipment. It tells the machine when a different board size is coming through.

Feinberg: One thing you commented on was that this is software that has been updated a couple of times. That's normal because software is going to be updated much more often

than a standard of metal thickness or all the other IPC standards that we have had for decades.

Jorgensen: Right, and we have the software development kit (SDK) that goes with CFX and is available on GitHub as a free download. We also have a way for industry professionals to submit messages that need to be added or comments on existing messages on GitHub. Those comments and suggestions that come in through GitHub form the basis of looking at how the subcommittee wants to make any changes to the standard. Again, some of the changes might be to a message or an update in the SDK that doesn't have any change in the standard, but sometimes it will reflect changes in the standard.

Feinberg: Can they see your comments through GitHub, and then other people that are using the CFX can see them and comment back?

Jorgensen: There is a way to view the comments because they're within the GitHub community. Additionally, any changes that need to be reflected in the standard are tracked through comments submitted through the IPC standards process as well as tracking changes in the standard.

Feinberg: How often do you see the software and these standards being updated?

Jorgensen: The SDK can be updated regularly free of the version updates to the standard, but the subcommittee has indicated that it will publish version upgrades to the standard twice per year. This keeps the flow of messages to the SDK moving and also provides the industry with a regularly updated consensus standard to match the relevant SDK changes.

Feinberg: Looking at the new standard that has been out since last year, what do you think the next major changes will be?

Jorgensen: For version 1.1 that should be published after January 1, the changes are primar-

ily additions to support messages for working with Hermes and many new messages for materials management, test and inspection, and assembly process. To help the industry understand the updates for version 1.1 and future versions, the subcommittee has created an appendix of change updates. This way, when somebody gets version 1.1 of the standard, they will be able to see what changed from one version to the next.

Feinberg: When are you expecting the next standard change?

Jorgensen: I don't want to hold the committee to six months, but the goal is twice a year.

Johnson: Let's talk about what the update request process looks like.

Jorgensen: The update request process can go one of a couple of ways. One way is the GitHub direction as I was talking about, where somebody posts a message request to the GitHub community. Any message requests or comments that come through GitHub are reviewed by a triage team from within the subcommittee, or what we call an A-Team. The second way is when comments come directly to the subcommittee. With either approach to submitting comments, the committee will review those comments and figure out if and how the standard needs to be changed.

Johnson: Walk us through the line that you'll have at IPC APEX EXPO 2020. What can we expect to see in the line, and what's going to be engaging about it?

Jorgensen: Last year, we had two lines in the sales pavilion, which was disconnected from the show floor. We had feedback from the committee and the line participants that we need to be on the main floor. So, we found a spot on the main floor, and we're going to have one line with 10 pieces of equipment. Like last year,

we are going to do live soldering, but to demonstrate the power of Hermes for line control, we will run two-component placement variations on the same process sequence. The committee is also planning to show more about the Industry 4.0 connection for CFX.

Johnson: That suggests that there's a bit of a scope change to the application of the data.

Jorgensen: I'd say it's more of a scope expansion. The focus of the lines that we had at IPC APEX EXPO earlier this year was to demonstrate CFX. The power of CFX is that you have a multi-vendor or a mixed-vendor line and can load CFX across all of them; everything runs through fine. This year, the committee wants to demonstrate not only the equipment messaging and line control but also what any manufacturer can do with CFX in just a few days to take their company to Industry 4.0.

Johnson: There's no argument that the equipment manufacturers are responding to CFX and Hermes and implementing them. How are customers responding to this?

Jorgensen: We are aware of some companies that are implementing CFX or have plans to soon, but we can't share the company names. We expect some of them to make announcements soon. We have heard from several equipment vendors that customers are asking for



CFX, and that's why you see so many equipment vendors that have their roadmaps on the CFX website.

IPC has also recognized that as more EMS companies decide to start implementing CFX on their factory floors, they will need validation that equipment they are buying meets their CFX needs, as well as educational programming for their IT staff to successfully implement CFX in their facilities. IPC is going to provide a service where we'll have third-party validation for equipment, as well as a self-evaluation service for any equipment vendor to test their equipment for CFX before shipping to the customer.

Feinberg: The number of exhibitors at IPC APEX EXPO last year showing support for CFX was impressive. What do you expect this year?

Jorgensen: The factory line was confirmed weeks ago, but we are still gathering volunteers for the virtual CFX demonstrations from exhibitor booths, and we can accept new equipment for the demos pretty much up to the date of the show. Last year, we had a company or two that decided last minute that they wanted to participate, and they were able to get CFX loaded on their machine to be up and running in a few hours. The goal is to have more virtual demonstration participants than what we

had the last year because it's good marketing for those equipment vendors, and it's a way to push CFX across the show floor.

Feinberg: If you wanted to get a message through to those who have heard about CFX, but don't understand what it is, or to those who haven't heard about it, what are some of the messages that you'd like our readers to know?

Jorgensen: The three words that always pop to mind for me with CFX are that it's standardized, free, and easy. CFX was developed by the subcommittee for the industry to provide a true plug-and-play Industry 4.0 solution that is based on a standard set of message sets which are available via a free SDK which was developed to allow any IT department to set up a CFX line with no or very minimal hardware requirements. The subcommittee has delivered.

Happy Holden: With the demo line for IPC APEX EXPO, does the product information come over from IPC-2581 seamlessly, or is there an interim step in between?

Jorgensen: That's a good question. For the CFX line for this year, the committee is planning on using IPC-2581 data for the boards and for the assemblies.

Holden: Are there any handouts or data available?

Jorgensen: We're in the early stages of planning. We just had our first meeting with the vendor/line participants. They're all aware that we're using IPC-2581, so there's going to be a guided tour to walk people through each step of the process and show the messaging. I would guarantee that there will be a discussion of IPC-2581 as part of that, but I still think it would be a good idea to have a takeaway for people. We have members of the CFX committee that are also involved with DPMX, IPC-2581, as well as the traceability standard for IPC.



Holden: There is also going to be other software that people will want to tout related to why their equipment should be selected because of how it uses the CFX data for Industry 4.0 for higher profits or better equipment utilization, etc.

Jorgensen: Those are some of the metrics that would be great to have. As we get more utilization of CFX through the EMS community, we hope they will share what they have experienced as well as their improvements in productivity and reliability, reduced costs, lack of downtime, being able to get their fingers on data for their customers for the status of projects, etc. Those are going to be great stories to tell, and they're going to come over time. One of the reasons IPC is working with the industry to develop the three programs I discussed for self-evaluation, validation, and education is to support this. It's important to have these support solutions because the committee and industry put a lot of time and effort into developing CFX, so IPC will provide as much support as necessary for the industry to implement CFX.

Holden: And will someone be available to answer questions on CFX as an expert?

Jorgensen: As part of the solutions IPC will provide to support CFX implementation, we will make available on-site engineering expertise for a fee. Even though there could be a cost for this, our hope is that it will be insignificant or significantly lower than if you were trying to have a mixed vendor line with middleware connecting all of the devices together, etc. Ideally, the company's IT and equipment techs will pick up enough knowledge from the on-demand web-based CFX education that IPC will provide.



For example, an IT person or equipment tech may only need a handful of 30-minute or one-hour web education courses to help guide them through one specific area of utilizing CFX. This alone would be a tremendous cost saving to manufacturers who have to pay time and travel for software vendors and equipment vendors to set up a line or make adjustments to it. The reality is that there will be some cases where a company needs some added assistance for implementation or ongoing support. That's where the on-site engineering assistance would kick in.

Johnson: Is there anything you'd like to add that we haven't talked about yet?

Jorgensen: We covered the revision of the standard coming out, but I would say that also in addition to the CFX Hermes line and the virtual demonstrations, there is a CFX subcommittee meeting on Monday from 8:00 a.m. to 12:00 p.m. at IPC APEX EXPO that's open to anybody to attend. It would be great to have anybody who is interested in learning more or wants to join the subcommittee to drop by because you can get involved right away.

Johnson: Chris, this has been great. Thank you for your time.

Jorgensen: Thanks for the opportunity. SMT007

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Sunshine and Circuit Boards

Quest for Reliability
Feature Column by Eric Camden, FORESITE INC.

As we approach IPC APEX EXPO 2020 in sunny San Diego, now is the time to look at the schedule to mark down a few of the highlights not to be missed. The first one that caught my eye is a technical conference session that is all about the fundamentals of IPC. This session includes a lot of basic information on a broad range of topics, including soldering, testing, reliability, etc. But the part I think is of most interest is the introduction into IPC and standards basics.

I have said it many times before, and will say it again: If you are new to the industry, it is important to understand how IPC standards are structured for each part of the assembly process from raw parts to final packaging. The reason this is so important is the number of companies that rely on IPC standards for assembly criteria is already substantial and ever-growing. There is a very real issue with

veteran employees retiring and not passing on their tribal knowledge, which impacts new recruits.

We have worked with the same companies on the same reliability issues over the years, and the only thing that is different is the engineering contact. And whenever a question pops up at a company, and there is no clear answer, you can reach for one of these standards and find the answer, or get you pointed in the right direction, at a minimum. These standards are written and reviewed by some of the most experienced people in our industry who have been there, done that, and use that knowledge to help shape the standards.

After you have gained at least a basic understanding of how the standards work, then you can take the next step and get involved with the task groups. This allows you to get deeper in the weeds of setting the standards, which



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gives you a much better understanding of how and why certain decisions were made. If you disagree with something currently in a standard, you are always open to bring your supporting data and make your case for a change in the next revision.

If you disagree with something currently in a standard, you are always open to bring your supporting data and make your case for a change in the next revision.

The second thing to highlight is the opportunity to attend the keynotes. There are two good keynotes this year, with the first on Tuesday morning featuring Burt Rutan, and another Tuesday evening that has Elaine Larsen speaking at the Women in Electronics reception. Burt Rutan is an aerospace engineer and entrepreneur who was instrumental in the design of Voyager and SpaceShipOne. Both of those vehicles are engineering feats in their own rights. Affordable space travel is closer than we might think, and Burt is at the forefront of that effort. Elaine Larsen is a two-time IHRA Jet Dragster World Champ in a male-dominated sport. She also launched a STEM initiative that works with students to get them interested in racing and all the engineering required to get a car going 280+ mph. I am sure both will be well worth your time to attend.

From there, we get into the real meat of the conference: the professional development courses and tech sessions. This is where I think the greatest value of IPC APEX EXPO resides. Within the many wide corridors of the San Diego Convention Center, among the random water and coffee stations—and the stray baked good if you're lucky—you will find some of the greatest minds in the industry sharing findings

from their own research studies or real-world experience that normally started with a failure of some sort but was remedied.

Shameless plug: I will be joining Mike Konrad of Aqueous Technologies on Sunday, February 2, in PD11 to talk about electrochemical migration and the new IPC J-STD amendment on qualifying cleanliness. I'll be expounding on the real-world effects of "contamination gone wild" while Mike goes through what will certainly be an informative and good-looking presentation; he's really good at those.

You may also find a few sessions that feel more like a sales pitch than a learning opportunity. When you find yourself in that position, be sure to leave a comment for the session Chair, which will be passed on to the powers that be in IPC. I have walked out of a few myself—no shame there. There is a concerted effort to be sure that the sessions are not sales pitches and are technical in nature, but a few will get by the goalie, and those are the worst.

Inevitably, when you sit in a session like that, the person giving the talk isn't all that technical but more on the sales side of things. Most people giving presentations work for a company that has something to offer, so there will always be a sales aspect to it, but some are simply more blatant than others. You will see this most often when product/material A vastly outperforms product/material B (shocker), and the only details to be given during the session are "come see me at my booth." But I digress. Basically, if you have a question about anything related to the assembly process—all the way from raw components and bare boards through assembly, testing, and final packaging—you will be able to find a session or personal development course that is focused on that.

The last thing to look forward to is all the opportunities to mix and mingle with everyone previously mentioned. All the speakers are there for the same reasons attendees are, so they are also roaming those wide hallways. More likely than not, they will be happy to discuss the presentation they delivered in more detail. They can often be found in their company booth or roaming the expo floor,



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checking out new technologies the same as we all do. I have yet to have anyone I approach not want to discuss their work with me and allow me to squeeze out another drop of information.

The expo floor is a fantastic place to learn about existing and emerging technology from the companies making the equipment. This is where the sales pitch belongs, and there is no shortage. But this is where you want to see that pitch since these companies have working experience with a process you may be currently using or considering. There are plenty of squeeze balls, candy and pens to collect as well, and there are plenty of social events on the floor itself, including free ice cream, beverages, and snacks. Outside the walls of the convention center, you can find events, like the trivia networking night, where you and your team of geniuses compete against oth-

ers. Put some of that useless knowledge to use for once!

Overall, I always look forward to IPC APEX EXPO for the learning and networking opportunities (and the escape from the Indiana winter). If you take time before you go to thoroughly review the schedule, you can maximize every minute of your time while you are there because every minute holds a valuable opportunity. Oh, and San Diego is conveniently located on the Pacific Ocean, so you might want to pack your flip-flops and sunscreen too. **SMT007**



Eric Camden is a lead investigator at Foresite Inc. To read past columns or contact Camden, [click here](#).

Getting the Most Out of IPC APEX EXPO 2020

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





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Global Unichip Corporation Uses Cadence Digital Implementation and Signoff Flow to Deliver Advanced-Node Designs for AI and HPC Applications ▶

Cadence Innovus Implementation System and Voltus IC Power Integrity Solution enable GUC to achieve first-pass silicon success and meet GHz performance target for multibillion gate designs.

STEM: Girl Scouts Learn to ‘Think Like an Engineer’ ▶

Girl Scouts of the USA has launched a new program of exciting activities to peak girls’ interests in STEM (science, technology, engineering, and mathematics) career fields.

Bell Autonomous Pod Transport 70 Wins Popular Science ‘Best of What’s New in Aerospace’ Award ▶

Bell Textron Inc., a Textron Inc. company, announces that Popular Science recognized the Bell Autonomous Pod Transport (APT) 70 with a Best of What’s New Award in the Aerospace category for 2019. In 2018, Bell received a Best of What’s New Award in the Aerospace category for its Bell V-280 Valor Joint Multi-Role Technology Demonstrator. This continued recognition validates Bell’s commitment to technology advancement and innovation in the aerospace industry.

Lascar Electronics Introduces New EasyLog Data Logger ▶

From discovering new species of frogs in South America to monitoring water flow in caves in New Mexico, clients from all over the world have used the EasyLog range of data loggers for various applications. As technology evolves

and application requirements change, it is more important than ever for researchers, engineers, technicians, and even hobbyists to have a reliable and robust data logging system for recording and measuring data.

Paul McEuen Delivers Inaugural Dresselhaus Lecture on Cell-sized Robots ▶

Cornell University professor and physicist uses nanoscale parts to create smart, active microbots.

Pit Boss Brings Autonomous Mission Management to Space ▶

Raytheon (NYSE: RTN) is designing Pit Boss—an autonomous mission management system for DARPA’s Blackjack satellite constellation—with prime Scientific Systems Company, Incorporated.

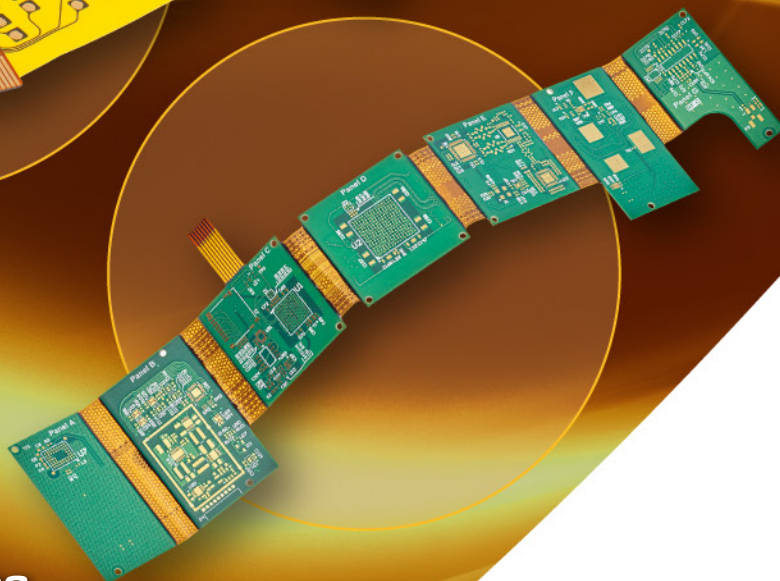
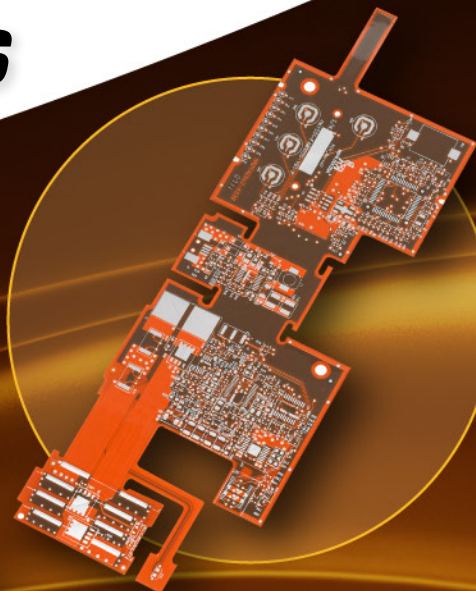
Giga-tronics Names Daniel S. Kirby Vice President of Business Development ▶

Giga-tronics Inc. announced the appointment of Daniel S. Kirby as the vice president of business development. Mr. Kirby was originally with Giga-tronics from 2013–2017. He then owned and operated a consultant firm and provided technical services and account management for Giga-tronics, supporting their ongoing government business.

California ISO and Siemens Go Live With New EMS Platform Based on Spectrum Power 7 ▶

Siemens announced that the California Independent System Operator (ISO) has launched its Spectrum Power 7 Energy Management System (EMS) platform, offering a highly sophisticated system that will enhance grid reliability for much of California and a portion of Nevada.

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Hiring and Retaining Top Employees

Operational Excellence
by Alfred Macha, AMT PARTNERS

The economy is booming, and this presents challenges for manufacturing organizations. Your top-performing employees are prime targets for competitors that are not only willing to offer a higher wage but can also offer a more attractive work environment and career growth path.

Before I dive into a strategic approach to hire top talent and retain your best employees, we need to understand the dynamics of manufacturing and labor statistics. The unemployment rate in the manufacturing industry is at its lowest in the last 15 years (Figure 1). This presents a challenge for companies to find qualified employees to fill job openings. Highly skilled employees with a strong work history are in high demand.

The Big Challenge for the Next Decade

As we look forward, economists expect a slow-down in the next few years, but the demand for skilled employees will continue to be strong. One of the expected challenges is the skill gap being created. According to one study^[2], the gap between available jobs and the number of skilled workers is growing. The study estimates that there may be up to 2.4 million jobs unfilled in the next decade in the United States, with the possibility that certain skilled and managerial positions will become almost three times harder to fill than they are now. In preparation for this challenge, leading companies are taking mitigation steps to retain their top employees and creating a company culture that is attractive to draw prospective employees into the organization.

Hire the Right Talent, Not the Best Talent

The natural inclination is to always hire the best available talent for a given role. This



UNEMPLOYMENT % RATE IN MANUFACTURING,
PRIVATE SECTOR IN THE UNITED STATES

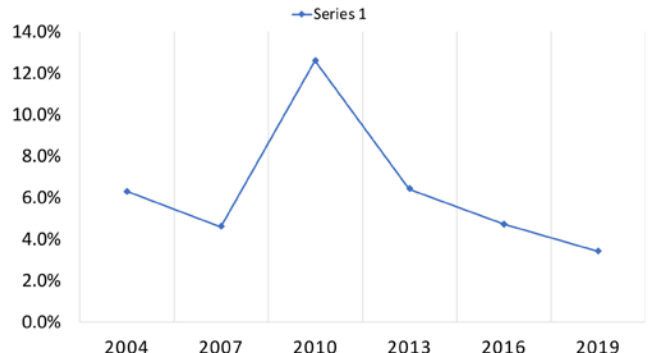


Figure 1: Unemployment rate ^[1].

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approach makes the most sense in theory but may not yield the expected results in practice. Before making a decision to hire a candidate for an open position in your organization, consider using Table 1, which describes the CEV-EQ method (competence, experience, values, and emotional intelligence). Table 1 will also allow you to evaluate and compare candidates to make sure you hire the right candidate for the job requirements and your company culture.

Create an Exceptional Company Culture to Retain Top Employees

The fundamental key is establishing an exceptional company culture. An exceptional culture can make the critical difference between organizational success and dismal failure. It impacts just about every business metric, from customer service to productivity to profitability. It is the key to retention

because employees don't want to leave an exceptional culture.

Establishing an exceptional culture does not mean creating a happy work environment. You certainly need to create an enjoyable work environment, but more importantly, you need to establish a culture where there is trust, communication, accountability, and motivation to achieve goals. There needs to be a factor of flexibility; top performers place higher value on organizations that provide challenges and recognize those employees that make it happen. Review the effectiveness of your business and management policies by evaluating your organization's culture with Table 2.

The X Factor: Great Leadership

Once you have a strong culture, you need to make sure it is sustainable so that you can achieve results consistently and create an organization that top performers want to be associ-

	Requirements	Evaluation Index	Evaluation Score
Competence	Demonstrate subject-matter expertise with specific examples of accomplishments	0: Inadequate 5: Adequate 10: Ideal	
Experience	Prior work experience in the industry, product, and/or processes required for the job	0: Inadequate 5: Adequate 10: Ideal	
Key Values	Value 1: Transparency. Does the candidate demonstrate openness during the interview?	0: No 5: Yes	
	Value 2: Integrity. Does the candidate come across as a person of integrity?	0: No 5: Yes	
	Value 3: Commitment. Does the candidate have an all-in mentality to take on difficult assignments?	0: No 5: Yes	
Emotional Intelligence	Quality 1: Self-awareness. Does the candidate demonstrate awareness of emotions, strengths, limitations, and actions, and understand how these affect others around them?	0: Inadequate 3: Adequate 5: Ideal	
	Quality 2: Social skills. Does the candidate demonstrate the ability to engage with people and make people feel comfortable?	0: Inadequate 3: Adequate 5: Ideal	
	Quality 3: Empathy. Does the candidate care for the wellbeing and success of others?	0: Inadequate 3: Adequate 5: Ideal	

Table 1: Example of how CEV-EQ is used in evaluating candidates (this method was created by AMT-Partners).

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Cybersecurity/John Vaughan
interview



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Key Culture Component	Why Is This important?	What Do Employees Perceive?
Quarterly Company Updates	Communication to ensure all employees are on the same page	Understand the direction the leadership team is taking the company
Well-Defined Business Metrics/ KPIs	Measure performance over time (measurements drive behaviors)	Understand what is important for the organization and is a result of everyone's efforts
Active Recognition of Good Work	Recognize efforts that achieve great results (sends the right message to the workforce)	The most important leadership behavior is empathy, which shows that management cares
Eliminate Bureaucracy	Red tape drives top performers away (don't create approval and review processes that freeze progress)	Efficient decision making and change happen quickly without bureaucracy
Consistent Accountability	Hold everyone accountable to the same standards	No double standards exist, and everyone is treated equally
Promote From Within	There's a career growth path for top employees	Do not have to look elsewhere to continue to develop and grow
Celebrate Key Milestones	Creates pride in the workforce	Creates a fun work environment that recognizes the whole team for long hours

Table 2: Key culture component assessment.

ated with. The key is to develop your managers at all levels to transform from good leaders to great leaders. A good leader can help people become better at what they're doing, while a great leader can do so much more; they can take a team and make each individual brilliant at what they do by inspiring them to learn and become the best version of themselves that they can.

What do great leaders do? They:

- Inspire and motivate those around them
- Think strategically, not just about next week or next year, but about what changes need to be instituted to bring about continual positive results years from now
- Create a space for interaction and reflective dialogue that encourages people and provides opportunities for others to learn and grow professionally
- Set a positive example in both their personal and professional lives for others to emulate

- Have great character, are selfless and modest, and have a clear vision of what is right, true, and ethical
- Accept responsibility for their actions, do not blame others, and are problem solvers **SMT007**

References

1. Federal Reserve Economic Data (FRED) St. Louis Fed, "Unemployment Rate: Manufacturing Industry, Private Wage, and Salary Workers," December 6, 2019.
2. Deloitte, "2018 Skills Gap in Manufacturing Study."



Alfred Macha is the president of AMT Partners. He can be reached at Alfred@amt-partners.com. To read past columns or contact Macha, [click here](#).

Industry 4.0: The Most Important Steps to Consider



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Underfill Rework and Solder ‘Squirt Out’

Knocking Down the Bone Pile
by Bob Wettermann, BEST INC.

One of the toughest rework challenges is removing and replacing components on PCBs with underfilled components. Many times, underfill is used to provide a shock barrier to component solder joints of handheld electronics, such as notebooks, tablets, and phones. This underfill is added post-test in the assembly process and is dispensed underneath components, such as BGAs, QFNs, and LGAs.

There are several aspects of reworking PCBs that have underfilled components that make them a real challenge when it comes to rework. The underfills’ softening or liquidus temperature is less than that of the reflow temperature of the solder on the PCB. This means that under the BGA, as well as any other underfilled devices, the material softens and expands (Figure 1) before the solder reaching a liquidus state. The pressure this creates then forces out the solder in neighboring solder joints, thereby

pushing out the solder when it reaches reflow temperature (Figure 2). The result is a mess of open solder joints, solder balls, and excessive solder in and around the rework area.

The second large challenge in reworking a PCB containing underfilled components lies in the removal of the underfill itself. Due to mechanical forces, either through prying with a removal tool or via a specialty vacuum nozzle removing the underfill, the board may end up with extensive pad and/or laminate damage. In addition, the prying of the component from the board during the removal process may damage pads and laminate underneath the underfilled component. The final challenge is in the tack adhesive strength of the underfill, as this may be of such a high value that the pads are pulled off of the board. This phenomenon may be most pronounced for pads that are no-connects underneath the device.

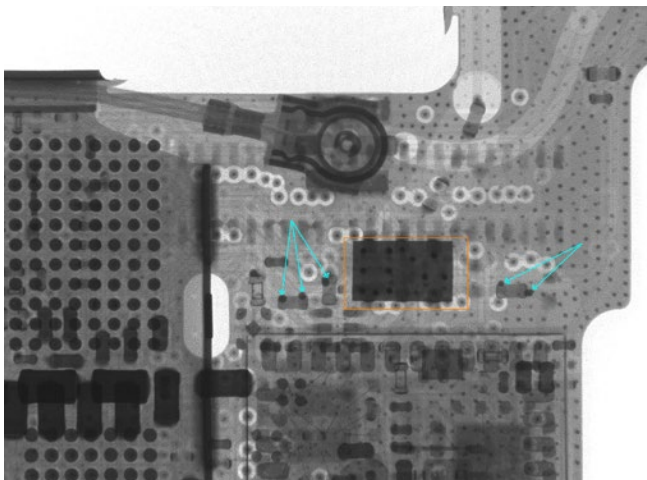


Figure 1: Disturbed solder balls in underfilled BGA.

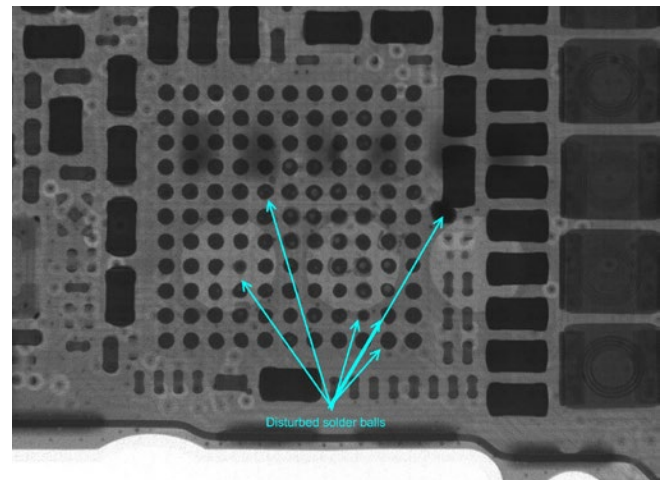


Figure 2: Disturbed solder balls in underfilled BGA.



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There are a couple of approaches that hold promise in preventing this solder “squirt out” during the BGA rework process. One of the methods is through the use of a mechanical mill to completely ablate the component from the PCB. No direct heat is applied, but the ensuing debris, mechanical stresses on the joint, and precision required does not make this rework method an option in every case. Another rework method being resurrected is the use of a highly focused laser as the heat source ^[1]. This method relies on bringing the temperature above liquidus on the solder joint very quickly, thereby not giving the opportunity to reflow neighboring devices while also not allowing the underfill to squirt out.

This phenomenon may be most pronounced for pads that are no-connects underneath the device.

The challenges of reworking these underfills can be mitigated to a great extent through:

1. More thorough training of the operators
2. Having the right tool for the right job
3. Having the right process and site preparation process
4. Controlling collateral heat damage
5. Proper reflow profile development

1. Operator Training

BGA rework technicians must be fully trained and must have their skills practiced and developed. These technicians need to be conversant in material selection, including underfill softening agents, fluxes, and solders. They also need to understand the inter-relationship of underfill softening and solder reflow temperatures. In addition, knowledge of how the softening agents may/may not interact with the materials on the PCB would prove helpful. Since X-ray analysis is many

times the process debugging tool, the BGA rework technician needs to be schooled in reading X-ray images.

2. The Right Tool for the Right Job

In order for the process to have a chance of success, the right tools—including the type of rework heat source, a profiling tool, X-ray equipment, and solder excavating tools—need to be used. This will help to have a controlled rework process with repeatable and predictable results.

3. Proper Site and Process Preparation

There are several processes, as well as site preparation steps, to consider once the component on a PCB with underfill has been removed. Proper moisture sensitivity control (per IPC/JEDEC J-STD-033) methods will help prevent both the board and the component from moisture-induced damage during the rework process. Proper bake-out heat cycles will drive out the moisture from both the component and the board to prevent component “popcorning” and board delamination. An accurate assessment of solder ball size, solder mask condition, and a search for missing or contaminated pads at the component rework as well as neighboring sites will help determine the effectiveness of the rework process.

4. Collateral Heat Damage

There are numerous problems that can arise from the reflow of neighboring underfilled component solder connections; for example, oxidation, de-wetting, pad and lead damage, solder ball formation, wicking, starved solder joints, and component damage are the biggest anomalies post-rework. Depending on the rework heating source, there can be a variety of heat shielding methods employed ^[2].

5. Proper Profile Development

The rework profile for underfilled PCBs mostly duplicates the original reflow profile. To protect neighboring underfilled components due to the below solder liquidus softening tem-



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perature of the underfill means that there will be a slight deviation for this rework profile.

Summary

By concentrating on these five factors, a more repeatable rework process for underfilled PCBs can be developed. **SMT007**

References

1. J. Burke and A.D. Chunsheng, "Laser Rework Process for BGA: A New Method for PCBA Rework Instead of Hot Air/Infrared Heating," October 2018, SMTAI.

2. A. Gaynor and B. Wettermann, "Shielding Effectiveness of Polyimide Tape During Rework," October 2014, *Circuits Assembly*.



Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. For more information, contact info@solder.net. To read past columns or contact Wettermann, [click here](#).

IPC APEX EXPO Show Floor

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



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



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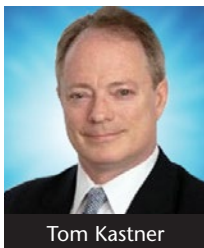
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Editor's Picks from SMT007.com

1 Punching Out! Lessons From Recent PCB/PCBA Buyers ▶

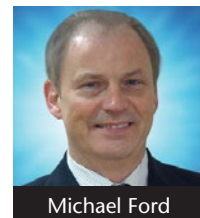
Tom Kastner reached out to several buy-side clients as well as others who have recently made acquisitions in the PCB and PCBA sectors. He shares some common themes and their thoughts on what went right, what went wrong, and what they would do differently next time.



Tom Kastner

3 Smart Factory Insights: Dromology—Time-space Compression in Manufacturing ▶

Dromology is a new word for many, including Microsoft Word. Dromology resonates as an interesting way to describe changes in the manufacturing process due to technical and business innovation over the last few years, leading us towards Industry 4.0.



Michael Ford

2 The Government Circuit: Europe Eyeing Changes in RoHS Environmental Regulations ▶

One of the world's most comprehensive and restrictive environmental regulations is undergoing a comprehensive regulatory review, and IPC is actively involved in the process, coordinating industry views and advocating on behalf of the electronics manufacturing industry. Chris Mitchell gives an update on activities related to the European Commission's Restriction of Hazardous Substances Directive (RoHS) Directive.

4 Operational Excellence: Are CMs Ready to Embrace Project Management? ▶

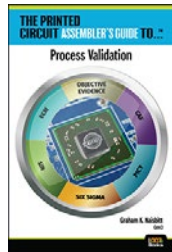
Project management does not have to be complex, nor costly; on the contrary, project management can help create a culture of operational efficiency, enhanced customer engagement, and employee self-accountability and enable data-driven decision-making.



Alfred Macha

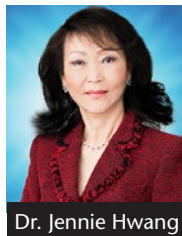
5 New Book Highlights Approaches to Ensure Reliability in Your Assembly Process ▶

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6 SMT Prospects & Perspectives—Revisiting Globalization: Technology, Jobs, Trade ▶

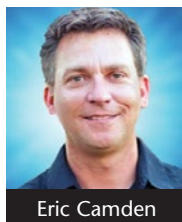
In 2004, Dr. Jennie Hwang wrote a column titled “Globalization: Technology, Jobs, Trade,” which was published in the July issue of SMT007 Magazine. Amid the protracted and roller-coaster trade uncertainty between the U.S. and China, and the renewed debate on globalization, she revisits the topic. What has changed over the last 15 years? Where do we stand today? Is globalization undergoing a retreat or reverse course?



Dr. Jennie Hwang

7 Quest for Reliability: Voices Carry ▶

The title of Eric Camden’s column this month is “Voices Carry,” so not only is it a great chance to revisit the wonderfully written, top-10 hit song by ‘Til Tuesday/Aimee Mann, but it is also a good opportunity to share the voices of modern electronics and electronic assembly processes.



Eric Camden

8 Zulki’s PCB Nuggets: Vital Details for Implantable Medical Devices ▶

In addition to smart pills and smart cameras, which Zulki Khan covered in a previous column, another segment of the medical electronics devices market is rapidly growing, as well: implantable medical devices, which medical personnel surgically or otherwise insert into various parts of the human body. Zulki explains the extra measures required for these devices.



Zulki Khan

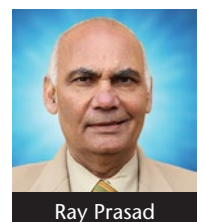
9 MacDermid Alpha Electronics Solutions Announces the Acquisition of Kester ▶

MacDermid Alpha Electronics Solutions—a leader in the production of innovative materials used in semiconductor, circuitry, and electronics assembly—announced that it has acquired Kester from Illinois Tool Works Inc.



10 SMT Solver: Today’s Soldering Options ▶

If you have to deal with mixed-assembly boards with both surface-mount and through-hole components—as is the case today for more than 95% of electronic products—the selection of a soldering process becomes more complex, especially if you use both tin-lead and lead-free components on the same board.



Ray Prasad

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Career Opportunities



Technical Support Engineer III

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

Requirements

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

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West Software Application Engineer

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

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

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Career Opportunities



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OEM Sales Manager Chicago/Home-Office-Based

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

Skills and abilities required for the role:

- Non-negotiable: Drive and tenacity!

Required:

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

Full product training will be provided.

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

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

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Sr. PCB Designer—Mentor Xpedition

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

Key Qualifications

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

Primary Responsibilities

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

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Career Opportunities



Advanced Connectivity Solutions

Senior Development Engineer

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

Essential Functions:

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

Required Education and Experience:

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

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

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Gardien Is Hiring!

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

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

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

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

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

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

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Career Opportunities



Assistant Department Manager, Operations, Carson City, NV

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

Required Experience/Education:

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

Preferred Skills/Experience:

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

Working Conditions:

- Occasional weekend or overtime work

See complete job listing for more information.

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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

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- Ability to operate from home. No required in-office schedule
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Career Opportunities



Technical Account Manager Chicago/Minneapolis

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

Qualifications:

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

We offer:

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

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APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

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Career Opportunities



Development Chemist Carson City, NV

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

Essential Duties:

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

Required Education/Experience:

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

Working Conditions:

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

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Multiple Positions Available

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

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

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

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

www.indium.com/jobs

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Career Opportunities



SMT Field Technician Huntingdon Valley, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

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

We Offer:

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

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U.S. CIRCUIT

Sales Representatives (Specific Territories)

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

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for
more information.

mfariba@uscircuit.com

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Career Opportunities



ZENTECH

Zentech Manufacturing: Hiring Multiple Positions

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

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

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

Please email resume below.

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

For more information, click below.

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Events Calendar

CES 2020 ▶

January 7–10, 2020
Las Vegas, Nevada, USA

NEPCON Japan ▶

January 15–17, 2020
Tokyo Big Site, Japan

DesignCon 2020 ▶

January 28–30, 2020
Santa Clara, California, USA

IPC APEX EXPO 2020 ▶

February 1–6, 2020
San Diego, California, USA

Pan Pacific Microelectronics ▶

February 10–13, 2020
Big Island, Hawaii, USA

The LED Show ▶

February 11–13, 2020
San Diego, California, USA

Embedded World ▶

February 25–27, 2020
Nuremberg, Germany

Electronica China ▶

March 18–20, 2020
Shanghai, China

Semicon China ▶

March 18–20, 2020
Shanghai, China

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

March 24–26, 2020
Munich, Germany

Additional Event Calendars



Coming Soon to *SMT007 Magazine*:

FEBRUARY 2020: Shrinking Pitches

The quest to deliver smaller and smaller end products is triggering innovation not only in component packages but also in fabrication techniques. We look at the latest.

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