

FEBRUARY 2021

IConnect007

# PCB007

M A G A Z I N E

*GET SMART ABOUT YOUR PROCESSES*

*The  
VIRTUAL  
ZONE*

**APEX  
EXPO**  
IPC 2021

I-007eBooks

# Distinctly different.

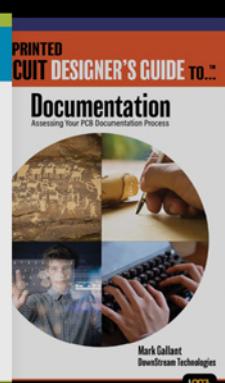
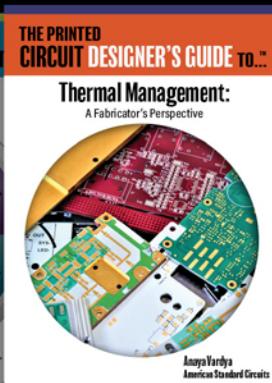
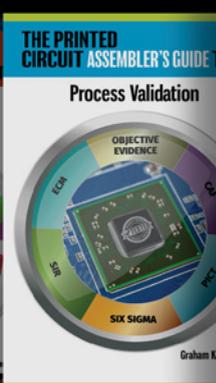
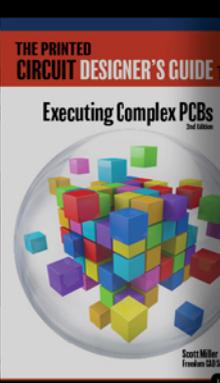
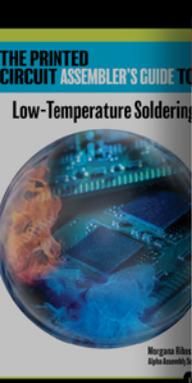
Our books are written by recognized industry experts. At around 8,000 words, they are unique in that they are able to be incredibly focused on a specific slice of technology.

“I-007ebooks are like water in the desert  
...it’s up to you to drink it in order to survive!”



**Stephen V. Chavez**  
PCEA Chairman, MIT, CID+

**VISIT OUR LIBRARY**



# I-Connect007e

## ROUNDTABLES

Lively and insightful discussions from industry experts. **Watch now!**



**App Notes  
and Fab Notes**



**Process Ionic Contamination  
Test (PICT) Standard**



**Achieving Operational Excellence  
in Electronics Manufacturing**



**Use of IMS Thermal Materials  
in Multilayer Stackups**

# PCB007

M A G A Z I N E

## Get Smart About Your Process

In this issue, we preview the program and schedules for the upcoming virtual IPC APEX EXPO, as well as continue our exploration of “ $X = X_c - 1$ ” continuous improvement by getting smart about process efficiencies.

### IPC APEX EXPO 2021 FEATURES

22

#### Tech Program Preview

Interview with Matt Kelly and Chris Jorgensen



32

#### Schedule at a Glance

Full Schedule of Events at the Show

34

#### Managers Forum

Interview with Gene Weiner



38

#### Managers Forum Schedule

Full Schedule of the Day’s Events

44

#### Membership Has Its Benefits

Interview with Brian Knier



12

### IPC APEX EXPO 2021 FEATURE COLUMNS

#### Join Us for IPC APEX EXPO: Virtually

by Dr. John Mitchell

16

#### Ebullient Trade Events Going Virtual

by Dr. Jennie S. Hwang

40

#### Here We Go (Virtual) Again

by Eric Camden



48

#### IPC Education Foundation Update and Looking Ahead

by Charlene Gunter du Plessis

---

### REAL TIME WITH... THE TOP 5 THINGS YOU NEED TO KNOW ABOUT

54

#### Solder Masks

by Taiyo America

56

#### Direct Imaging

by Burkle North America

58

#### Moisture Management

by Super Dry Totech EU

60

#### Manufacturing Training

by Blackfox Training



22

# Focused on Solutions

We are setting new standards for PCB laser manufacturing.

The Schmoll Maschinen CombiDrill UV/CO<sub>2</sub> dual-laser drilling platform is a high-volume and stable processing solution for manufacturers looking to perform at the highest level.

schmoll  optronics



- + **Micro-via drilling 50-300µm diameter**  
Cutting and structuring with UV and/or CO<sub>2</sub>
- + **Space saving compact design**  
Integrated loader / inline version also available
- + **Best power/size ratio in market**  
10-20W UV-Power = Increased process speed in thicker materials  
3kW CO<sub>2</sub> peak power = Less number of pulses required  
Efficient optical train = No AOM required  
Less downtime, gas refills on site
- + **Pulse stabilizer**  
Pulse-for-pulse energy and peak power control = pulse repeatability  
Large process window and stability
- + **North American technology and support center**  
Online and on-site first level service  
OEM Software

1991  
2021  
**BURKLE**  
NORTH AMERICA, INC.

For more information call us: +1 (336) 660-2701

[burkleamerica.com](http://burkleamerica.com)

# PCB007

M A G A Z I N E



74

## SHORTS

- 10 Turning Streetwear Into Solar Concentrators
- 20 IPC APEX EXPO 2021 Is the Place to Be... From Wherever You Are! 
- 97 Benchmarking to Make Processes Smarter—Our Survey 
- 106 Kitchen-Temperature Supercurrents from Stacked 2D Materials

## HIGHLIGHTS

- 52 EIN007 Industry News
- 69 MilAero007
- 101 PCB007 Suppliers
- 112 Top 10 from PCB007



## DEPARTMENTS

- 115 Career Opportunities
- 124 Educational Resource Center
- 125 Advertiser Index & Masthead



## CONTINUOUS IMPROVEMENT FEATURES

- 70 Do You Have a CPIM?  
by Barry Matties
- 74 Process Management and Control—  
Benchmarking Best Practices  
by Michael Carano
- 86 Quality and Continuous Improvement  
by Patrick Valentine
- 98 Benchmarking With Your Suppliers:  
What to Know About Solder Mask  
by Bob MacRae
- 108 The Benefits of Statistical Process Control  
by Kurt Palmer

## COLUMNS

- 8 IPC APEX EXPO 2021—  
Something That Makes Sense  
by Nolan Johnson 
- 82 Attacking the Loophole That Does Not Exist  
by Jan Pedersen
- 94 Owning Your Processes  
by Todd Kolmodin 
- 102 Leadership 101: The Law of the Lid  
by Steve Williams

## INTERVIEW

- 62 Functional Inkjet Printing  
in PCB Manufacture  
by Pete Starkey 

## WORLD-CLASS SUPPLIERS

Insulectro, the largest distributor in North America of materials used in the manufacture of printed circuit boards and printed electronics, salutes our premier suppliers.

**CALL 949.587.3200 FOR MORE INFORMATION**



### Because Reliability Matters

## THE NEW IS550H

#### FEATURES



#### MARKETS



The Material for e-mobility that is suitable to use for those applications requiring high voltage, high power and high thermal stability.

✉ info@isola-group.com

☎ 800-537-7656

🌐 isola-group.com

# isola®

## EMD PERFORMANCE MATERIALS

### Ormet® Sintering Paste: Fewer Multiple Lamination Cycles

Ormet® Transient Liquid Phase Sintering (TLPS) via fill pastes enable anywhere and any-layer vias in high-performance complex printed circuit boards without any need for copper plating. TLPS-filled z-axis interconnect layers can be fabricated in parallel with individual x-y trace layers, or PCB sub-constructions of multiple layers with installed PTH and laminated in a single cycle.



# IPC APEX EXPO 2021— Something That **Makes Sense**

## Nolan's Notes

by Nolan Johnson, I-CONNECT007

The news is bustling with financial results and economic insights. While this is the predictable norm in January, what isn't so predictable is what these news items contain under these global pandemic circumstances. For example, as I write this, here's just a snapshot from this week's industry news:

- IPC reported the North American PCB industry sales are up 4.5% in December 2020
- Rockwell Automation reported fiscal first quarter 2021 results, saying, “The recovery in manufacturing is happening at a much faster pace than we were anticipating, with our orders exceeding pre-pandemic levels”
- While OSI Systems saw a downturn in sales revenue overall for 2020, its health-care division contributed a 31% increase in second quarter revenue
- Amphenol closed 2020 with record fourth quarter sales (13% increase for the quarter), exceeding the high end of their guidance
- Plexus expanded its “funnel of qualified manufacturing opportunities by nearly \$600 million from the prior quarter to a record \$3.3 billion”
- The U.S. Department of Commerce reported on January 28, 2021, that the U.S. economy surged in the third and fourth quarters of 2020, but that rebound still left the U.S. with a negative 3.5% growth for the year



The pandemic effect is something we all feel, in some part of our life or another. It's a sense of randomness in a world that thrives on structure and order. However, I'm also reminded of how natural disasters often play out. In the U.S., the center of the 48 contiguous states is "tornado territory." These huge twisters are notorious for cutting broad paths of destruction wherever they touch down. But within that path are bits of randomness—one house left standing amongst destroyed neighbors, for example. In the western states of the U.S., the signature disaster situation is a wild-fire. While tens, or hundreds, of thousands of acres might be consumed by fire, still there are places, homes, and businesses spared amongst the damage. The study of chaos theory, in fact, puts mathematical structure to what otherwise can look like chaotic, random behavior. So, while there is an element of random chance to natural disasters, there is also a calculated, proactive planning element that can reduce or even eliminate our risk.

The pandemic is an occurrence of nature as well, and it affects us with that same chaotic pattern. It's well established in other news reporting how certain sectors in the economy have been hurt (decimated, even) by the pandemic. My personal circle of friends includes professionals who work as:

- A flight attendant (furloughed)
- Executive administrative assistant (furloughed)
- Outside sales in lumber (travel restrictions, temporary reassignment)
- High school educator (tele-teacher, he calls himself)
- Professional musician (pivoted to lessons full time)
- Restaurant owner (forced temporary closure)
- Hotel and hospitality (forced closure)

These folks have all felt the negatives of the pandemic.

Meanwhile, other friends who work in similar roles, but in slightly different parts of the market, are thriving:

- A college friend, who works in outside sales in windows and treatments, is thriving as people continue to refresh their homes
- A key executive for a company providing psychological care for elderly dementia patients finds the company overstretched to provide enough care to meet demand (and manage the near-constant COVID-related testing and patient positives)
- Hosts for hotel alternatives, such as AirBNB, are reporting high demand for their lodging options for guests who otherwise might use a hotel

Listening to major news reports based on government data, we hear about entire industries and how they're faring. But look more closely, and we see that not every individual or company has that exact same experience. Some thrive, some struggle. We try to make sense of the randomness we feel, to put some kind of order to our universe.

Hopefully you're feeling the lift in your business, and that you see this as a good problem to have. Over the past 12 months, our coverage has tracked many of the challenges facing PCB fabrication in these unusual circumstances. Just as we're being called upon to innovate and—dare I say—revolutionize PCBs for new and emerging customer requirements, we are also faced with social distancing restrictions that test our traditional methods for production, collaboration, innovation and research.

To help, I-Connect007's theme for 2021, as readers have already been made aware, is continuous improvement. Our tagline, by the way, is " $X = X_c - 1$ ," our way to crisply define the cyclical process of continuous improvement. These recent challenges have likely spurred you and your team to find new ways to do traditional tasks. I don't need to belabor the point by listing, once again, all the well-known new

technologies helping us work remotely and still maintain some form of team dynamics. But now certainly is a good time to embrace a continuous improvement culture to take full advantage. With so much uncertainty surrounding us, it's a way to exert some control and find a way to thrive.

This month in particular, the continuous improvement discussion turns pragmatic. This month's issue of *PCB007 Magazine* is the much-anticipated annual IPC APEX EXPO 2021 preview issue. IPC has adjusted to its own pandemic-related challenges by reinventing the conference and exhibition as a virtual event. In this issue, we bring you preview information, schedules, and tips on how to get the most out of the virtual show.

For readers who would like to participate in the IPC APEX EXPO program, but who might not have the opportunity under normal, on-

site-only circumstances, this is the year to dive in, register, and participate. IPC has made it so very easy (and in some scenarios, free-of-charge) to gain access to the expo as well as the technical programs. The staff at I-Connect007 encourages you to consider attending. Read about it here, then make your plans. There may be plenty of randomness in our marketplace currently, but time spent at IPC APEX EXPO 2021 is one of the ways to improve our ability to make informed decisions that minimize the randomness of our business in the current world environment. **PCB007**



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

---

## Turning Streetwear Into Solar Concentrators

Researchers at Empa and ETH Zurich succeeded in developing a material that works like a luminescent solar concentrator and can even be applied to textiles. This opens up numerous possibilities for producing energy directly in everyday electronics. A new polymer, applied on textile fibers, jackets, T-shirts and the like, could soon function as solar collectors and thus as a mobile energy supply.

Materials capable of using ambient light for energy generation are already used in the solar industry.



*The newly developed solar concentrator when irradiated with blue LED light: The polymer material is so flexible that it can be bent with tweezers. Image: Empa*

These materials contain “Luminescent Solar Concentrators,” or LSC for short. The LSC captures diffuse ambient light, transmitting energy to the actual solar cell, which converts light into electrical energy. LSCs are neither flexible nor permeable. A research team has succeeded in incorporating several of these luminescent materials into a polymer that provides flexibility and air permeability.

This new material is based on Amphiphilic Polymer Co-Networks, or APCN for short, a polymer already available on the market as silicone-hydrogel contact lenses. The team added two different luminescent materials to the gel tissue, turning it into a flexible solar concentrator. Just as on large-scale (rigid) collectors, the luminescent materials capture a much wider spectrum of light than is possible with conventional photovoltaics. The novel solar concentrators can be applied to textile fibers without the textile becoming brittle and susceptible to cracking or accumulating water vapor in the form of sweat. Solar concentrators worn on the body offer an immense benefit for the ever-increasing demand for energy, especially for portable devices. (Source: Empa)



**pluritec**

INTERNATIONAL SUPPLIES



powered by Occleppo

# Surface Preparation Machines for Printed Circuit Boards

## PUMEX/PUMIFLEX

Mechanical cleaning (Brush - Pumice or Aluminum Oxide)



## MECETCHBOND

Chemical cleaning, supports all industry supplied or in-house created blends.



**Don't settle for less – make IS your trusted partner. 40 years of experience with mechanical and chemical surface preparation ...and counting!**



[www.pluritec.com](http://www.pluritec.com) | [info@pluritec.com](mailto:info@pluritec.com)

# Join Us for IPC APEX EXPO: *Virtually*

## One World, One Industry

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

As many of you know, IPC APEX EXPO will be held virtually March 8–12, 2021. We look forward to producing APEX EXPO every year, and 2021 will be no different. It is our signature event, and we are committed to providing the cutting-edge content and networking opportunities that attendees have come to expect over the past 20-plus years. This year, we will just do it from a digital platform.

In person or online, our goal is to maintain IPC APEX EXPO's position as the premier event for the electronics industry by providing far-reaching insights and ideas. The challenge we face to provide a premier networking event is also an opportunity for growth. While we pride ourselves on the networking experience our in-person event provides to our attendees, we believe that the virtual setting allows us to achieve that same goal: to offer connections, new knowledge, and important opportunities to our audience.

Because companies will not have to pay for employee travel, we hope to increase our global audience by going deeper into organizations, offering our cutting-edge content to more people. This gives us the unique opportunity to meet and connect with a broader audience while increasing our reach in the industry.

IPC APEX EXPO will still be the place to connect and collaborate as the digital platform will allow attendees to easily navigate more than 100 technical conference sessions and application-focused professional development courses as well as view product demonstrations, schedule one-on-one meetings with exhibitors, and experience other offerings within the online exhibition.

This year, IPC will bring experts together to help companies transform and modernize as we look toward the future of electronics manufacturing. Our Technical Conference reflects

“TECHNICALLY SPEAKING:  
IT'S THE PLACE TO **thrive**

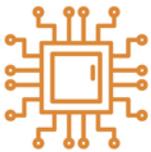
**REGISTER NOW!**



# COPPER FOIL

North America's only electrodeposited copper foil manufacture is beginning a new era as part of the Nippon Denkai, Ltd. family.

**DENKAI AMERICA IS THE LEADER** in the manufacture of high-quality electrodeposited copper foils for printed circuit board (PCB), industrial, and energy storage applications. With the strength of domestic manufacturing, and backed by a global presence, Denkai America delivers both conventional cladding and application specific copper foils required by technology leading companies. We are committed to:



Continued dedication to the PCB industry



American made ED copper foil



Unparalleled domestic support



New access to technology and innovation

 803-425-7900

 [denkaiamerica.com](http://denkaiamerica.com)

 [sales@denkaiamerica.com](mailto:sales@denkaiamerica.com)

that transformation by offering a three-track educational event, featuring:

- **Factory of the Future Implementation:**

This is complete with brand new technical sessions to help you modernize your facility on such topics as cybersecurity, data analytics, connected factory and digital twin.

- **PCB Fabrication and Materials:**

Sessions on microvia reliability, PCB design, PCB reliability and PCB advancements.

- **Quality, Reliability, Test, and Inspection:**

Covering automotive electronics, electronics materials, assembly, coating, and assembly design.

- **Technical Sessions:** Will include opportunities to ask questions live at the scheduled time, and content from the sessions will be available on demand for 90 days following the event.

---

## This year's virtual professional development program includes something for everyone.

---

This year's virtual professional development program includes something for everyone. Whether it's advanced classes exploring the details and depth of specific topics, or informative classes catering to engineers ready to improve their careers, we've got courses for every role and experience level.

In terms of a virtual exhibition experience, GoExpo's virtual event space and setup allows you to learn, connect, and collaborate as if you were there in person. Thanks to this year's all-virtual format, it's easier than ever to attend IPC APEX EXPO, which means incredible opportunities to meet with and learn from industry insiders across the globe.

Within GoExpo, you can:

- Create your personal profile
- Log into the event
- Search for friends, peers, and exhibitors
- Request to connect one-on-one

As IPC APEX EXPO 2021 goes virtual, face-to-face standards development meetings scheduled for March 2021 will also be moving to a virtual environment. Each IPC staff liaison will work with committee leaders to select a time for their meeting. Following the Summer-Com 2020 model, the meetings will be spread over a few weeks, so as not to conflict with the technical conference sessions. We will start posting meetings this month.

While we won't be able to meet each other in-person this year, I hope you will take advantage of the opportunities to network virtually and participate in live Q&As with speakers and instructors during professional development courses and the Technical Conference. I hope you'll spend some time talking to IPC Hall of Famers and Emerging Engineers and interact with new and experienced managers at the Managers Forum. I encourage you to test your knowledge at our virtual trivia event.

Your involvement in IPC APEX EXPO is directly responsible for the show's success. We appreciate your flexibility, dedication, and input as we move from an in-person event to one that offers a vibrant virtual program.

I hope that you'll join us March 8-12 for what promises to be an exciting virtual event. For information on how to take advantage of all that IPC APEX EXPO has to offer, visit [www.ipc-apexexpo.org](http://www.ipc-apexexpo.org). **PCB007**



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

Courses & Conference  
Online Exhibition

**March 8–12, 2021**



**TECHNICALLY  
SPEAKING:**

**IT'S THE  
PLACE TO**

**learn**

IPC is the go-to association helping companies transform and modernize. IPC APEX EXPO 2021 is the place to plan for advancing and implementing **FACTORY OF THE FUTURE.**

**Kevin Kusiak**

Electronics Engineering  
Senior Staff,  
Lockheed Martin

Registration is Now Open at  
**IPCAPEXEXPO.ORG**

# Ebullient Trade Events Going Virtual

## SMT Prospects & Perspectives

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

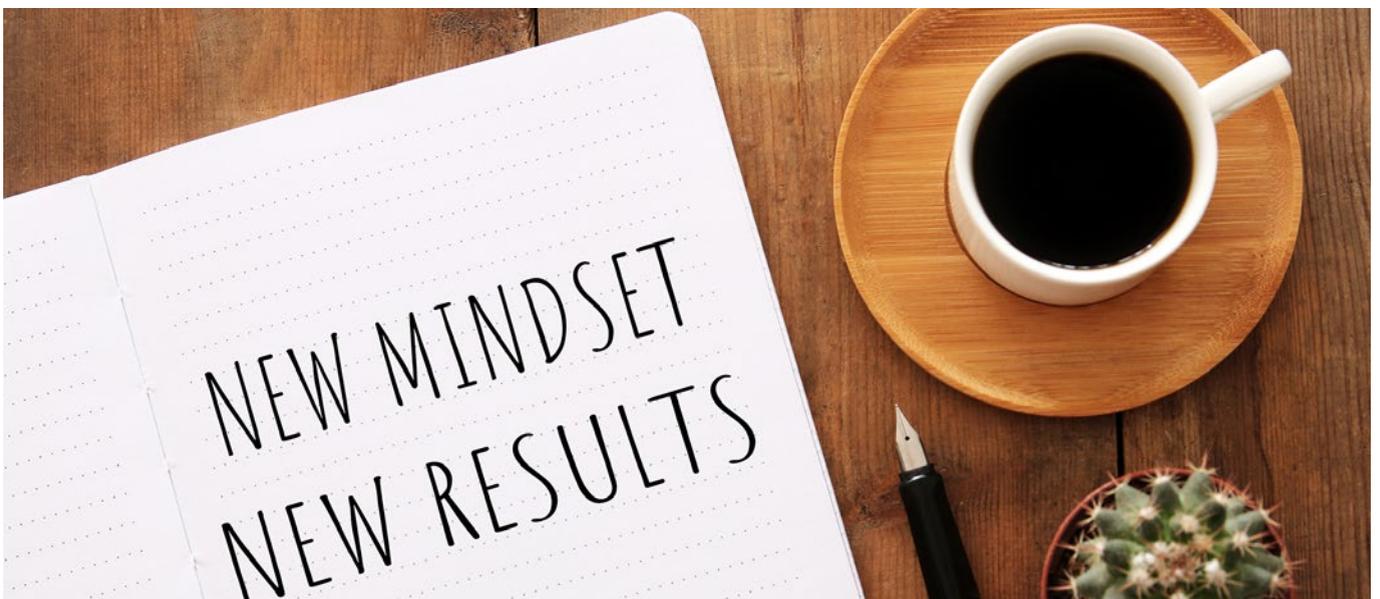
In the first quarter of recent years, we have looked to two information-rich events in the electronics industry arena—IPC APEX EXPO and CES (formerly Consumer Electronics Show)—to learn, observe, contribute, and enjoy. I have attended and participated in both events for several years, something I have relished.

This year, both events will be unprecedentedly different as they go virtual. We have been on this virtual platform for the past 10 months, and by now, perhaps we are all “trained” to conduct business virtually. IPC officials have indicated that IPC is committed to providing a digital platform that will allow the attendees to easily navigate more than 100 technical conference sessions and to view product demonstrations, as well as to advance by attending professional development courses.

As stated in the CES official site, CES is owned and produced by the Consumer Technology Association (CTA), and is the most influential tech event in the world. It is the proving ground for breakthrough technologies and global innovators. This is where the world’s biggest brands do business and meet new partners, and the sharpest innovators hit the stage. CES features every aspect of the tech sector.

Indeed, CES has been the venue for leading electronics companies to showcase their cutting-edge products and services, as well as a platform for business leaders and innovators to share their vision and views on prevailing issues.

Certainly, there is nothing short of innovation in products and of inspiring and informative presentations and speeches. I recall that



**We offer a wide range of process equipment,  
service, spare parts and specialty consumables**

**all4-PCB<sup>®</sup>**

**WORLDWIDE**

**Via Fill  
Process**

Via fill equipment  
Planarization  
Ovens and vacuum chambers  
Conductive and non-conductive pastes



**Imaging**

Direct image, photoplotter, inkjet printing  
Contact exposure  
Dryfilm lamination  
Line & space measurement



**Lamination  
Area**

Vacuum presses with and without automation  
Lay-up & breakdown, press plate cleaner  
Press pads for high and regular temperature  
Release films and other lamination aids



**Fabrication**

Flash cutting, v-score  
Drilling & routing, laser processing  
Deburring, plasma, hole-checking  
Cross section equipment



**Automation**

Loaders & unloaders, robot solutions  
Accumulators, buffers



**Wet Process**

Etchers, strippers & developers (DES & SES)  
Chemical pre-clean, pumice and alum oxide jet spray  
Direct metallization, horizontal and vertical de-smear  
Electroless & Electrolytic plating



**Final  
Processes**

Solder mask coaters spray and screen print  
Developers, ovens  
Final finish: HASL, ENIG, immersion silver, OSP,  
electrolytic Au  
Electrical test flying probe and grid



my very first in-person speech by Bill Gates (then CEO of Microsoft) was at CES. Without exception, I have been dazzled every year by the extent and the breadth of new products and lively demonstrations. The exciting products displayed at the show are mind-boggling in terms of the ingenuity, creativity, innovation, and the phenomenal functionalities of end-use products.

---

**Without exception, I have been dazzled every year by the extent and the breadth of new products and lively demonstrations.**

---

IPC APEX EXPO, on the other hand, focuses on the packaging and assembly of the electronic circuit board that is the critical “brain” behind the electronic products that are used across all industry sectors, be it consumer, industrial, commercial, military, telecommunication, computing, or medical and health care sectors. The IPC APEX EXPO conference and exposition address real-world problems related to printed circuit boards.

According to the IPC APEX EXPO 2021 website:

- Attendees at all career stages can expect to access new material- and process-related research and best practices
- Learn more about trending materials, applications and processes to prepare for the Factory of the Future
- Interface with the collection of top suppliers
- Learn from new product demos
- Learn technical advances in technical sessions and professional development courses
- Network with colleagues

Over the years, countless professionals, engineers, managers and business-decision makers have unequivocally benefited by attending and participating in the IPC APEX EXPO. At IPC APEX EXPO 2021, there will be a comprehensive slate of professional development course offerings, ranging from circuit design and component technologies to PCB fabrication/materials and assembly processes to quality/test/inspection and reliability. Here, I would like to introduce two professional development courses I will be presenting that focus on preventing production defects and enhancing product reliability.

### **First Course: Preventing Manufacturing Defects and Product Failure**

This course focuses on preventing the most prevailing production defects and product reliability issues that affect yield, cost and performance through an understanding of potential causes and plausible solutions. I will provide a holistic overview of product reliability, including the roles of materials, processes, testing/service conditions, and crucial principles behind the product reliability.

I will discuss two selected areas related to product failure:

- Intermetallics
- Tin whiskers

and five selected defects:

- PCB pad cratering vs. pad lifting
- BGA head-on-pillow
- Open or insufficient solder joints
- Copper dissolution issue
- Lead-free through-hole barrel filling

Specific defects associated with the reliability of BTC, PoP and BGA assembly will be highlighted. The role of intermetallics at-interface and in-bulk, and the difference between SnPb and Pb-free solder joint in terms of intermetallic compounds, will be concisely summarized.

From practical perspectives, tin whiskers with emphasis on risk mitigation through un-

derstanding the factors that affect tin whisker growth and its testing challenges will be outlined. The practical tin whisker criteria for reliability implications in the lead-free environment and the relative effectiveness of mitigating measures will be ranked.

## **Second Course: Reliability of Electronics— Role of Intermetallic Compounds**

As intermetallic compounds (IMCs) play an increasingly critical role in the performance and reliability of solder interconnections in the chip level, package level and board level of lead-free electronics, the second course expands the content coverage on the role of intermetallic compounds in the reliability of electronic products.

This course covers the relevant and important aspects of intermetallic compounds ranging from scientific fundamentals to practical application scenarios. I will examine IMCs before solder joint formation, during solder joint formation and after solder joint formation in storage and during service. Intermetallics at interface and in-bulk, as well as the role of PCB surface finish/component coating in relation to intermetallics, in turn, to reliability will be discussed. The difference between SnPb and Pb-free solder joints in terms of intermetallic compounds, which affects production-floor phenomena and the actual field failure, will be outlined. The course will also address the relevant aspects of newer lead-free alloys that were recently introduced to the market.

The virtual setting of the APEX EXPO 2021 will be unique. However, it is the intent to make my courses interactive and lively. More importantly, attendees are encouraged to bring their own issues relevant to the topics for deliberation; questions and comments are warmly welcomed.

On a lighter note, in this virtual environment, one unintended “fringe benefit” is that the sore feet caused by walking for many hours a day on the expansive and enticing show floor will be spared, while we still can see, learn,

observe the exhibits, and interact with the exhibitors on the show floor through the virtual platform.

As I sifted through my previous writings related to IPC APEX EXPO, I want to share what I wrote in March 2001:

*“Reflections from APEX 2001, “... As I strolled on the exhibit floor, Siemens proudly and confidently demonstrated their newest equipment that offers the capability and precision in handling 0201 components. With the robust market demand in wireless products, this is indeed the year to actually implement the ‘tiny’ 0201s—be prepared... Another real progress is the keen interest in the alloy selection, technology and applications of lead-free systems as vividly demonstrated across the industry. Actual operation of lead-free assembly production finally extends to the U.S. from the foreign market. A slow yet steady progress in this area is expected... There were many other examples on the show floor that are evidence of the continued technology advancement. At APEX my time ran out unnoticeably and I wish I could have spent more time on the floor...”*

It’s been 20 years since that column, and the “tiny” passive components such as 0201 and 01005 have been implemented successfully and continue the path on miniaturization, integration and embedded system. Lead-free alloys, having gone through converging to SAC alloy and then diverging to application-specific alloys, continue to advance and evolve.

This year, without reservation, I expect a variety of new products and frontier technologies to be exhibited; and I look forward to an exuberant, invigorating and enriching experience at IPC APEX EXPO and CES. (Note: This column was written just before CES, scheduled for Jan. 11–14.)

## IPC APEX EXPO Presentations

- “*Preventing Manufacturing Defects and Product Failure*,” by Dr. Jennie S. Hwang, 9 a.m.-noon CST March 8.
- “*Reliability of Electronics—Role of Inter metallic Compounds*,” by Dr. Jennie S. Hwang, 2-5 p.m. CST March 8. **PCB007**



**Dr. Jennie S. Hwang**—an international businesswoman and speaker and a business and technology advisor—is a pioneer and long-standing leader to SMT manufacturing since its inception as well as to the development and implementation of lead-free electronics technology. 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, named an R&D Star to Watch, and received a YWCA Achievement

Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., and SCM Corp., she was the CEO of International Electronic Materials Corp. and is currently CEO of H-Technologies Group, providing business, technology, and manufacturing solutions. She has served on the board of Fortune-500 NYSE companies and civic and university boards; the Commerce Department’s Export Council; the National Materials and Manufacturing Board; the NIST Assessment Board; as the chairman of the Assessment Board of DoD Army Research Laboratory and the chairman of the Assessment Board of Army Engineering Centers; and various national panels/committees and international leadership positions. She is the author of 600+ publications and several books and is 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, visit [JennieHwang.com](http://JennieHwang.com). To read past columns or contact Hwang, [click here](#).

## IPC APEX EXPO 2021 Is the Place to Be... From Wherever You Are!

Although the setting will be unique, we are committed to providing you with the cutting-edge content you have come to expect from IPC APEX EXPO. The event’s digital platform will allow you to easily navigate more than 100 technical conference sessions and application-focused professional development courses as well as view product demonstrations, schedule one-on-one meetings with exhibitors and experience other offerings within the online exhibition.

The graphic features the IPC APEX EXPO 2021 logo in the top left corner. In the center, a man with glasses and a blue shirt is pointing towards the text. The text reads: "TECHNICALLY SPEAKING IT'S THE PLACE TO learn". A red play button icon is positioned next to the word "Video" in the bottom left corner.

# Need help finding the right people for your team?

DB Management knows that finding the right people can be like looking for a needle in a haystack. We can streamline your hiring process with pre-qualified candidates.

Engineering • Management • Sales & Marketing



[Click here to get started](#)

 207-649-0879  danbbeaulieu@aol.com

# Tech Program Preview

## Feature Interview by Nolan Johnson

I-CONNECT007

Nolan Johnson speaks with IPC's Matt Kelly and Chris Jorgensen about what can be expected from the IPC APEX EXPO 2021 technical conference, which is centered around smart manufacturing, Factory of the Future, emerging technologies, and driving the electronics manufacturing industry forward.

**Nolan Johnson:** Gentlemen, thanks for joining me to discuss IPC APEX EXPO 2021. I've heard that this is arguably the best technical program ever at APEX EXPO. Why would that be?

**Matt Kelly:** One of the main reasons we're really excited about this year's conference is the fact that we're doing something that is pushing the envelope and driving the industry forward, and we're talking about a lot of new subjects. We're moving beyond our core technolo-

gies well known to the industry. Not that we're not interested in them, we're absolutely interested and they're very important to our industry, but much of it is quite mature. This year's conference is building upon that core technology—PCB fabrication, for example, quality, reliability, assembly, and test—but we're really focusing in on new "Factory of the Future" type of topics.

**Johnson:** It seems like there is quite an extensive lineup of papers and presentations that talk to core technologies but others that add some new capabilities for some new conversations as well.

**Chris Jorgensen:** I think we have a great mix of topics, including some things we've talked about at past events, but what's really exciting, especially about the Factory of the Future track, is that the attendees are going to see real-world examples of what's happening. These



# THE NEXT BIG THING IS HERE

Introducing Inkjetable Solder Mask for rigid and flex printed circuit boards.



BY TAIYO

- 🕒 IJSR-4000 JM Series JM02DG & JM03G
- 🕒 Superior adhesion to laminate with dual cure (UV/Thermal) Process
- 🕒 Precision additive process. ZERO waste!

## Clean. Coat. Cure.

Contact your local sales representative today!

Visit [www.taiyo-america.com](http://www.taiyo-america.com) for more information.



Follow us on social media



aren't presentations about pie-in-the-sky or what-if sorts of concepts.

Our speakers will show attendees the capabilities that are available to them now so the electronics industry can begin to prepare for moving into Factory of the Future implementation.

**Johnson:** For the prospective attendee, what are some of the key topics that I can expect to find in the technical papers and presentations?

**Kelly:** We have three different tracks. We have Factory of the Future, which is our primary showcase track. Next, we have our PCB fabrication and materials track, and third is our quality, reliability, assembly, and test track. Within Factory of the Future, you're going to see topics that span actual implementation on the shop floor. There are presentations, for example, from the Manufacturing Technology Center, or MTC, out of England. They'll be talking about their vision, their journey to enabling smart factory for electronics manufacturing, with topics like augmented and mixed reality within electronics manufacturing, and the role of automation and robotics. The content just from MTC alone is very strong.

We also have PSMA, the Power Sources Manufacturers Association, which we have partnered with in 2020, talking about powering the Internet of Things, mobile smart technologies within the industry, and, my favorite, energy storage and energy harvesting within sensors.

We then move into data analytics, which is very close to the work we've been doing with our CFX initiative. Here, we're focused on collecting data and making sense of it, so we have folks from Arch Systems, ASM, and Flex, for example, talking about predictive features of



Matt Kelly

data for placement feeder maintenance. We have a second data analytics and mining session where we've invited different OEMs and an MES provider. We have presentations from Honeywell FM&T, IBM, and Critical Manufacturing, an MES provider. In this session, we'll be talking about mining and refining dark data, modern MES solutions, and building the case for an electronics supply chain blockchain. It goes on and on and on; there's a lot of new content here. I'm not even halfway

through the list. Chris, could you talk a little bit about cybersecurity and traceability?

**Jorgensen:** Cybersecurity is of major importance right now to our industry. We have built two very solid sessions on cybersecurity that will provide an understanding of cybersecurity risks, how to assess cybersecurity preparedness, as well as regulatory issues that affect our industry, such as CMMC. These speakers bring decades of knowledge about cybersecurity for electronics manufacture, so all of these talks will be direct fits for our attendees.

We'll also have a session on best practices for traceability, which will be led by the chairs of an IPC task group that oversees IPC-1782, our traceability standard. This session will provide a framework for how any company in the supply chain can assess their existing traceability capabilities and make plans to improve them to meet internal and external expectations, as well as the immediate and long-term benefits of adopting the traceability best practices.

We also have a session on digital twin, which is based on IPC-2551, the first industry standard we know of on digital twin for the electronics manufacturing industry. This session will provide an overview of the IPC Digital Twin and how to assess your company's dig-

ital twin readiness, followed by deeper dives into the use of digital twin data to enhance and improve design and manufacture, as well as how to utilize data in the field from digital twin products.

We're excited about all three of these sessions.

**Johnson:** Right. You have standards like CFX, IPC-2591, etc., and this begs the question for a virtual IPC APEX EXPO 2021: How are you handling the committee meetings?

**Jorgensen:** The standards committee meetings are a key element of every IPC APEX EXPO, so we will have meetings again this year—with a twist.

Being apart for this year's event is not ideal, but it gave us the opportunity to think outside the box a little bit when scheduling our meetings. Our committee meetings always run concurrent with the technical program at the event. This means committee members often must miss technical programming and our technical program attendees often will miss committee meetings they would want to attend.

This year, we will hold our IPC APEX EXPO committee meetings before and after the week of the technical conference. As with past in-person APEX EXPO meetings, they will be open to anyone who wants to listen in on what a specific group or groups are working on and, if interested, get involved with those groups. We're already hearing positive responses to this approach from our committee chairs and members, so we anticipate event attendees will also be happy with this move.

We will post the full meeting schedule and a mechanism for getting meeting invitations on the IPC APEX EXPO [website](#) very soon. Check out the list of meetings. If you see topics



Chris Jorgensen

of interest, request the meeting invitations, and help to shape our industry standards.

**Johnson:** Matt, IPC has been collaborating even more closely than in the past with several industry organizations. Can you tell us about this?

**Kelly:** One thing that IPC has done in 2020 is to reconnect in some cases—and then strengthen in others—our collaboration with other industry groups.

This is so that IPC can make

sure that we're working directly with these groups to ensure that new information, new research, and new development efforts reflect state-of-the-art advancements and critical issues as best as possible. We've recently engaged with MTC, PSMA, and AIAG and continue our longstanding relationships with iNEMI, HDP, and Navy Defense Base as well.

iNEMI, for example, will be discussing 5G high-frequency challenges and opportunities. HDP is reporting on latest 2019 and 2020 project updates. Topics include evaluating solder joint fatigue performance as a function of PCB thickness, accelerated thermal cycling, and photonic soldering rework. From the Navy DoD workgroup, we've got a session on the defense PCB industrial base and their technology roadmap—things like quilted circuit board assemblies and high-density interconnect development. When you look at the IPC APEX EXPO program, we have a very nice collection of other industry groups presenting their work.

**Jorgensen:** Another group we have partnered with for the last couple of years is the Advanced Functional Fabrics of America—or AFFOA. They and their members have been engaged in our e-textiles standards activities for the past several years, and as that relationship has grown, so has our work together. We

approached AFFOA last year to gage their interest in putting together a technical session on e-textiles. The interest in this among their members was so high, we wound up with two technical sessions out of it.

These two e-textiles sessions provide a solid opportunity to learn about e-textiles technologies and applications. There will be presentations on textile capacitive touch sensing, power harvesting for e-textiles, wireless wearables, and then functional fibers and fabrics that are used to construct these products.

You wouldn't expect to see two technology tracks on e-textiles during IPC APEX EXPO, but because this is a growing technology area and deals with electronics manufacture, we feel these sessions are a perfect fit within the technical conference. This is a way for anybody in the industry, whether you work in automotive, aerospace, consumer products, soft or stretchable electronics, to learn about these technologies.

**Johnson:** What do you have planned for the other two technical conference tracks?

**Kelly:** As we mentioned earlier, the core of our technology focus remains very strong, and we've compiled really good content within the PCB Fabrication and Materials track and the Quality, Reliability, Assembly, Test and Inspection track.

We have a variety of topics included in the PCB Fabrication track such as microvia design and material reliability improvements, 3D embedded modules, additive build-up processing, mixed VIPPO structures, and measuring high speed/high frequency signal integrity characteristics, to name a few.

For the Quality, Reliability, Assembly, Test and Inspection track we have a nice mix of content including topics such as AI-assisted quality inspection using edge computing, thermal interface material advancements, flex PCBA design, conformal coating evaluation, and RF plasma cleaning.

Automotive electronics is obviously a very important area now with rapidly emerging requirements to operate in extreme conditions. As such, we've built a dedicated session on automotive electronics advancements resulting from our engagement with AIAG and with IPC members working in the automotive sector. In this session, we'll be addressing topics like improvement of automotive designs through proper material choices, technology verification for reliable smart surfaces, and reliability of solder alloys for harsh environments.

One thing that I think readers will note is there's less content being offered on conventional assembly process technologies. The main reason is we had overwhelming demand for new technology content. We turned away over a third of abstracts this year for the technical conference. This stat alone shows the strong demand for new Factory of the Future topics and PCB board fabrication advancements—specifically, microvia and other HDI technologies.

**Johnson:** That seems to be the focus for those in assembly and EMS, for sure.

**Kelly:** Again, I want to stress, as a reader looks at this program, it's not that we're not interested in assembly processes, it was just the overwhelming demand for these new technologies and that's very exciting.

**Johnson:** Let's circle back to the Factory of the Future. You have quite a lot going on there. There's the ongoing work with IPC-2591, Connected Factory Exchange, which is the backbone for Factory of the Future, plus you'll be showcasing the Factory of the Future. What can I expect to see when I visit the showcase during APEX EXPO?

**Kelly:** What you can expect for IPC APEX EXPO 2021 Factory of the Future is a solid and well-rounded grouping of topics that we've explained. We put so much emphasis

# CAN YOU PLAN FOR THE FUTURE IF YOUR SYSTEMS KEEP YOU IN THE PAST?

See why the top flex PCB fabricators rely on ESI to help them innovate and stay ahead.

Leverage CapStone's unique technologies to deliver breakthrough productivity.

- Cut per-panel processing costs by up to 30%
- Double your flex PCB production throughput
- Lower total cost of ownership



**Learn More Here**

*"Stepping Up To Laser Processing for Flex"*

**CapStone™**





on Factory of the Future because, strategically for IPC, it is the framework that defines our overall roadmap moving forward. It has been designed to drive the industry forward, to modernize, and to help build electronics better. Everything that we're doing now within IPC is wrapped around this concept of advancing the industry.

We're structuring our program to foster industry-wide awareness, collaboration, and implementation. What better way to do this than at an industry conference like IPC APEX EXPO? We're building upon 20+ years of mature conventional technologies and now we're adding in a very strong focus on emerging and disruptive technologies; IPC's Factory of the Future vision and mission.

**Johnson:** Be a bit of a futurist for me for a moment. What do you want Factory of the Future to look like in 2022 and beyond? What's out there in the planning stages for our shared readers and participants?

**Kelly:** If I'm peering into my crystal ball, and Chris has heard me talk about this for a long time now, it is really all about implementation. The concepts, the ideas, the promise of these technologies and ways of working, they've been out there for quite some time

but what's different is we're at the cusp of a lot of these maturing to a point where we can actually use them to deliver real business value. Looking past this year, 2021, and into 2022 and '23, what I would like to see is more actual implementation across IPC's membership and across the electronics industry, so that in 2022, we have even more companies reporting back, "These are the types of problems that were out there in my factory and my supply chain and here's how I was able to solve them using this new way of working."

If you think about what has been done for the last 20 years, there's been so much content published on solder joint metallurgy, interconnect failure mechanisms, electronic assembly materials, and SMT assembly processes—all of these studies using different techniques (like design of experiments, statistical analysis, and gap analysis, for example) to solve problems and make improvements. I'd like to see the industry take those concepts and methods and apply them now to modern business needs and applications like electrical-mechanical co-design, real-time statistical process control, supply chain data mining and insights, high-mix low-volume optimization, NPI cycle time reduction, six sigma quality delivery, high product mix yield improvements, all of these types of things. That's what I hope for in the next couple of years: more implementation and more case study examples of all of this technology and new ways of work at play.

**Johnson:** I get to talk to a lot of people in the industry, and I run into the occasional cynic who will say that all of this is just about convincing industry participants to buy new equipment. But if someone really listens to what we're talking about here today, that's not the case at all.

**Kelly:** No. I'm an engineer; first and foremost, we go back to basics. These things have to create value. In engineering and in the production

world, that means agile supply chain management, faster NPI cycles, highest quality, product reliability, first pass yields, maximum productivity, lower costs, faster response time, ability to debug problems faster, crisis management, and reduction of scrap. I could go on and on; there's a very long list. What I see different is problems still exist today, and they will exist tomorrow, but IPC's Factory of the Future approach will allow us to solve those problems faster, more accurately, timelier, provide better business insights, and make better decisions. I think the challenge with Factory of the Future overall is that it is not just one thing. If this is going to work, a whole bunch of things must come together all at the same time. We need the industry to collaboratively move forward together.

**Johnson:** Is there an opportunity for IPC members to get involved in furthering this program, and how can they do that?

**Kelly:** Absolutely. First and foremost, they can contact me directly as IPC's chief technologist. We have an open-door policy. There are a lot of committees where we're forming new standards and guidelines. If there are new tracks and new areas of technology that we are not looking at, let us know. There's no shortage of ways to get involved. I'll also bring in our IPC Emerging Engineers program. A lot of youth coming into this industry have new skills from school, new aspects of what's important to them in design, materials, and process, and we are working to ensure next generation talent is a part of this transformation as well.

**Jorgensen:** One of the most fantastic things about IPC is that we're a solutions organization. When industry comes to IPC with a problem or with a question, we work together with industry to resolve it. I have a couple of good examples of that.

About a year and a half ago, Dave Bergman was approached at a conference by someone

who said we need a standard on digital twin. There seems to be a lot of confusion in industry about digital twin, what it is, its importance to industry and how to implement it. We took that problem to some of our committee members, and within a month, we had a task group; a year later, we have a published international standard for digital twin.

Another example would be when NEC approached us at IPC APEX EXPO last year with a need for an industry standard for cybersecurity for electronics manufacturers. Much like the digital twin standard, we went from concept to a formed task group in a few months, and that group is now working on the standard, with a goal to publish later this year.

These ideas don't just lead to standards which sit on a shelf somewhere. IPC works with industry to develop full-scale solutions for implementation of these standards.

Just look at where IPC-CFX is now. The need for that standard came during IPC APEX EXPO in Las Vegas in 2016 to address concerns with multiple messaging platforms for assembly line equipment. From that meeting, industry not only solved the issue with equipment messaging, but we now have a tangible solution for EMS and OEM companies of any size to meet their Factory of the Future objectives.

In fact, we're seeing so much activity in this area, we have developed support services for industry, ranging from on-demand education and engineering support to an online equipment self-validation system and an IPC-CFX Qualified Products List (QPL) for EMS and OEM companies to use for making equipment purchases for their IPC-CFX lines.

**Johnson:** What is the one thing you want to ensure happens with the virtual format of IPC APEX EXPO 2021 to measure your success?

**Jorgensen:** I think the measurement of success is going to be in the content. We have been left



with a situation, as many other organizations have over the last year in dealing with COVID-19, but that hasn't stopped us in any way from putting together a really strong technical program. In fact, hearing early comments from people who have viewed the program—that this is one of the strongest that we have had in some time—is really positive.

The event is obviously going to be different from the standpoint that people won't be in person. We won't have the handshakes and the hellos in the hallway. But if you want to get a really strong sense of what's happening in the industry across all the topic areas that Matt and I discussed, you'll have it with the technical conference.

An added benefit compared with in-person events is that if you have to decide between two presentations or sessions that are running simultaneously during the conference, you won't miss out on any of the content. Registrants will be able to access their technical sessions on-demand following the conference.

**Kelly:** Well said, Chris. I fully agree, and it's why we spent so much time on the content. We realized that people are going to be sitting at their desks, probably at home, and the measure's going to be whether they are interested in tuning into that particular topic. If it's good and new and relevant to them, then they're going to tune in. In person, we'd have everyone's

time sequestered for the week in San Diego where we get their full attention; now, there's going to be a lot of distractions. We ultimately have to draw them into the content, so I fully agree with Chris.

Also, as IPC's new chief technologist and new to IPC, I'm really excited about how much IPC is investing in the future. I want people to walk away from this conference realizing that we're very serious about IPC being the go-to association to help companies transform and modernize. This goes beyond the conference and this is not going to stop. The programming that we have at IPC APEX EXPO will be an example of that, but it will also come through in the work that Chris and the team does with the standards organization as well.

**Jorgensen:** There's definitely more to come.

**Kelly:** This is the beginning.

**Jorgensen:** This is not a "Factory of the Future buzz word thing" that we wanted to do just this year for IPC APEX EXPO. As Matt said, Factory of the Future thinking and modernization is going to shape pretty much everything IPC does moving forward.

**Johnson:** Extremely informative and insightful. Thank you. The technical conference looks to be living up to its hype! **PCB007**

## WORLD-CLASS SUPPLIERS

Insulectro, the largest distributor in North America of materials used in the manufacture of printed circuit boards and printed electronics, salutes our premier suppliers.

**CALL 949.587.3200 FOR MORE INFORMATION**



## Denkai America



Denkai America is a leader in the manufacture of high-quality electrodeposited copper foils for printed circuit board (PCB), industrial, and energy storage

With the strength of domestic manufacturing, and backed by a global presence, Denkai America delivers both conventional cladding and application specific copper foils required by technology leading companies.



### **PACO-CLUTCH** ALL-IN-ONE CONFORMABLE RELEASE FILM PACKAGE

### Conformal Release Film

Pacothane provides innovative lamination

processing solutions including revolutionary PACO•CLUTCH™: decouples PCB panel from lamination separators, simplifies layout, improves scaling predictability, and improves yield for cap lamination, thin core multilayer, and sub laminations.

### **LCOA**

DON'T WAIT FOR BACKUP MATERIALS!

LCOA® can stock your shelves today!

**PolarBack**  
HIGHER PRODUCTIVITY AT A COOL PRICE

**SLICKBACK**  
Lubricated Drill Backup

SlickBack®, BEST hole wall  
Bullseye®, BEST hole location  
PolarBack™, BEST melamine

Available at all stocking locations in North America!

### **FOCUS TECH PROCESS CHEMICALS**

A Complete Line of Chemistry & Controllers used in PCB Manufacture & Metal Finishing

Products and Services to be Distributed by Insulectro

ADHESION PROMOTERS	ETCHANTS
ANTI-FOAM	IMMERSION TIN
ANTI-TARNISH	HAL & REFLOW
COPPER CLEANERS	HAND SANITIZER
COPPER CLEANING/ HALF DEVELOPERS	MICRO-ETCH
DRYFILM DEVELOPERS	OXIDE ALTERNATIVE PUMICE
DRYFILM STRIPPERS	SCREENING PRODUCTS
ETCH	SOLDER/TIN STRIPPERS
CUPRIC ETCH	WASTE TREATMENT PROCESS CONTROL SYSTEMS

**Great Teams have Great Chemistry**

Remember!  
All events are  
US Central time  
GMT-6

# Schedule at a Glance

## As of January 2021:

---

### Monday, March 8

- 8:45–8:50 a.m. Welcome Message
- 9 a.m. –Noon EMS Management Meeting
- 9 a.m. –Noon Managers Forum: Managing Challenges in Periods of Transition—*Presented by the Raymond E. Pritchard Hall of Fame Council*
- 9 a.m. –Noon Professional Development Courses
- 12:30–1:30 p.m. Keynote Presentation by *John Mitchell, President and CEO, IPC*
- 1:30–5 p.m. EMS Management Meeting
- 1:30–5 p.m. Managers Forum: Managing Challenges in Periods of Transition—*Presented by the Raymond E. Pritchard Hall of Fame Council*
- 2–5 p.m. Professional Development Courses

### Tuesday, March 9

- 8:45–8:50 a.m. Welcome Message
- 9 a.m. –Noon Professional Development Courses
- 9 a.m. –Noon Exhibitor New Product Presentations
- 12:30–1:30 p.m. IPC Annual Meeting and Awards Ceremony
- 12:30–1:30 p.m. A Virtual Escape Experience
- 2–5 p.m. Professional Development Courses
- 2–5 p.m. Exhibitor New Product Presentations

### Wednesday, March 10

- 7:55–8 a.m. Welcome Message
- 8–8:45 a.m. Keynote Presentation by *Travis Hessman, Editor-in-Chief, IndustryWeek*

- 10 a.m. –Noon Technical Conference Sessions
- 11 a.m. –Noon Forgotten Tribal Knowledge with IPC Hall of Fame and Emerging Engineers
- 12:30–1:30 p.m. IPC Emerging Engineers Roundtable
- 12:30 –1:30 p.m. Exhibitor New Product Presentations
- 12:30–1:30 p.m. Live Q&A with *Travis Hessman, Editor-in-Chief, IndustryWeek*
- 1:30–3 p.m. Technical Conference Sessions
- 1:30–5 p.m. Exhibitor New Product Presentations
- 3:30–5 p.m. Technical Conference Sessions

### Thursday, March 11

- 8:10–8:15 a.m. Welcome Message
- 8:15–9 a.m. Keynote Presentation by *Shawn DuBravac, Chief Economist, IPC*
- 9 a.m. –Noon Professional Development Courses
- 9 a.m. –Noon Exhibitor New Products Presentations
- 10–11:30 a.m. Technical Conference Sessions
- 12:30–1:15 p.m. IPC Education Foundation: Looking Ahead
- 12:30–1:30 p.m. Trivia Networking and Name That Tune
- 1:30–3 p.m. Technical Conference Sessions
- 1:30–5 p.m. Exhibitor New Product Presentations
- 2–5 p.m. Professional Development Courses
- 3:30–5 p.m. Technical Conference Sessions

### Friday, March 12

- 9–9:45 a.m. IPC at a Glance (Standards, Education, Advocacy, Solutions and Industry Intelligence)
- 10–10:30 a.m. Exhibitor New Product Presentations
- 10:30 a.m. –Noon Technical Conference Sessions
- Noon–12:15 p.m. Closing Remarks

# Excellon

*Manufacturers of precision Micro-Machining  
Solutions for over 50 Years*



## **COBRA II Hybrid Laser**

*UV and CO2 lasers  
Blind via, flex cutting, cavities*



## **HS-4L**

*Low-cost, 4-station precision drilling  
or routing system with large panel option*



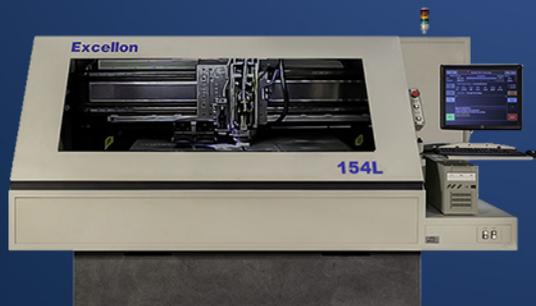
## **HS-1L DS**

*Single-station, dual spindle high-speed  
drilling/routing with Intelli-Drill Vision*



## **136L**

*High-Speed, precise accuracy  
drilling/routing with Intelli-Drill Vision*



## **154L**

*Large panel size precision drilling/routing  
Single station with vision options*



## **HS-2L**

*High-speed, 2-station drill or router  
w/populated board routing option*

**Move into the future with the latest innovations  
in Fabrication Technology from the Industry Leader!**

[www.excellon.com](http://www.excellon.com)

# Managers Forum

## Feature Interview by Nolan Johnson I-CONNECT007

Nolan Johnson gets a preview from Gene Weiner about what he has planned for the Hall of Fame Council's biggest IPC APEX EXPO Managers Forum in years. With a lineup of speakers from throughout the supply chain, and spanning many different-sized companies, it is set to be an insightful and beneficial discussion for those in attendance.

**Nolan Johnson:** Gene, let's talk about the Managers Forum.

**Gene Weiner:** I've done an executive level every few years. This is the biggest, and probably the broadest, one that I've done since we had the meeting in Los Angeles in 2007.

**Johnson:** Tell me more!

**Weiner:** The intent this year is to cover the entire market based on the crisis we've had: the shortages, the COVID-19 complexities, the smaller companies not having the staff or the wherewithal to know where to go or how to react to what's next. How do they build their own factory of the future while they're trying to get the supply chains filled and deal with the shortages? How do they work with their customers who were also scrambling and changing supply chains? So, I thought we'd start at the top and work down, starting with the OEMs who have managed the crisis: General Dynamics or Northrup Grumman. Everyone knows they're legitimate, good, wonderful companies. We asked them to talk on these points:

- How did you deal with this?
- What can we expect from you?
- What can you teach your supply chain?



# WE HAVE YOUR SOLUTIONS.

## Leading Direct Metallization Technologies with Application Expertise

A complete line of lower costs and environmentally friendly processes for alternatives to conventional electroless copper processing.

87% REDUCTION  
IN CYCLE TIME



### **BLACKHOLE AND ECLIPSE**

#### **Industry Leading Carbon Black Metallization**

Consistent, high reliability with reduced operation costs compared to conventional metallization.

90% WASTE  
REDUCTION



### **SHADOW**

#### **Graphite Based Advanced Direct Metallization**

Easy to control process that has no chelating agents, formaldehyde or heavy metals.

60% LESS  
WATER USAGE



### **ENVISION HDI**

#### **High Performance Conductive Polymer**

Three-step process for high productivity that meets or exceeds performance and reliability standards.





Gene Weiner

Then we go down to the next step. And I kept hearing, “We’re small. What can we do?” Our goal became aiming it at companies under \$100 million in sales. After the IPC introduced its education programs, I ran into Norman Weiss, who founded a small EMS company, connected with German Robotics, and founded the German Ondustry 4.0 Campus for upskilling workers in our industry.

We said, “That takes care of the EMS guys. Now, what do they do?” Well, they’ve got to work with their fabricators. How are they going to do that? That led us to the presidents of two fabricators: Anaya Vardya [American Standard Circuits] and Brad Bourne [FTG]. Anaya is the author of all of these online books and does a great job working with new suppliers, testing new stuff, educating their customers. When you educate your customer, you’re doing a service and you create value. At the same time, Brad agreed to sit on the panel comprised of companies representing the entire supply chain.

Then we asked, “What about your suppliers?” Well, who is one of the largest suppliers in the world—supplying larger and smaller companies—and doing leading edge stuff? Atotech. They do over \$1.1 billion from metal finishing, semiconductors, and printed circuits—everything from equipment to specialty chemicals. How venturesome are they? Just look at Whelen Engineering and GreenSource Fabrication, and we see what they’ve done. Then he [Alex Stepinski, GreenSource] actually bought the company that supplied his wet processing equipment, improved it and took it international.

**Johnson:** Right, AWP.

**Weiner:** Yes, AWP. Then Alex came up with this waste treatment process which eliminates hazardous waste, among other things. His customers started asking for help designing a green-field factory for re-shoring. Alex made that a business. Next thing you know, he’s got SEL and Vicor as customers—and all three parties agreed to present. They’ll talk about why they’re doing it, how they’re doing it, and what they expect from it. They’ll discuss the planning process and how they choose their location, which will be Andover, Massachusetts, and Moscow, Idaho.

Then, we needed a materials expert on the panel. I contacted Jonathan Rowntree, group vice president of Rogers. He said, “Sure, I’d be happy to sit on the panel.”

I think we’ve put together the most complete program covering education, materials, specialty chemicals, fabrication, new re-shoring facilities, and so on. We’ve got EMS for the small guy, AI, factory of the future, and the OEM view. What more can you do in a day?

**Johnson:** That many topics requires two hands worth of fingers to count them off (laughs). That’s very comprehensive and the topics are very timely. I’m curious, is this year’s program intentionally put together

to draw a wider audience to the forum than would be typical?

**Weiner:** Absolutely. Printed circuit fabrication is what, 8% or 9% of the IPC now? The IPC has grown, I've grown, the industry has grown. I hope I've grown, but not just here (points to his stomach and laughs).

**Johnson:** Who should attend, Gene?

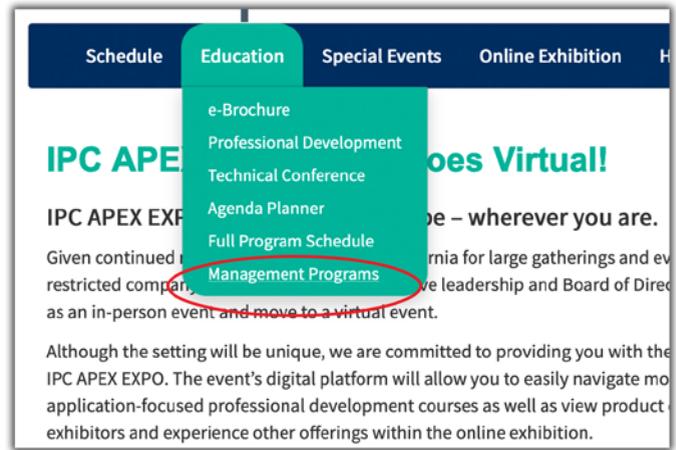
**Weiner:** Every new manager or manager dealing with the issues and crises of the day, just trying to move forward. I would say middle- to upper-level management, and those aspiring to become managers who want to know how to solve problems. It's a broad range.

**Johnson:** Equally EMS, fabrication, and suppliers.

**Weiner:** Yes, equipment and material suppliers both. It's a connected chain. If you're going to benefit the industry, you have to go top to bottom, or bottom to top. If you miss a link, you break the chain and you really don't accomplish the goal.

**Johnson:** This certainly covers the whole chain.

**Weiner:** I have fun doing this. I like dealing with people. The terrible part of this is I've had to



do it all by computer, phone and internet instead of over a beer or a lunch and a factory tour. Hopefully, that will end soon.

**Johnson:** Despite all the obstacles you've faced, this certainly is a very topical, strong program. Gene, for those who are following along here and realize that they can take advantage of the managers forum this year, where should they go to register or sign up? How do they do that?

**Weiner:** Go to [ipcapexexpo.org](http://ipcapexexpo.org) and select "Management Programs" under the "Education" tab, or just type "IPC APEX EXPO 2021" in the search bar.

**Johnson:** There you are. Anything else that we should know?

**Weiner:** I hope that all those involved in electronics manufacturing and packaging including government officials that are concerned about the industry's viability, take advantage of this. They should because it supports the program and training the millions of workers that the IPC promised to Washington, and the only way it can succeed is if people take advantage of it by signing up for the event and participating in it.

**Johnson:** Great, Gene. I think that's a great way to wrap it up. Thanks so much!

**Weiner:** You're welcome, Nolan. PCB007



# Managers Forum Schedule

Presented by the Raymond E. Pritchard Hall of Fame Council

**March 8, 2021 – Central Time (–6 GMT)**

*Theme: Managing Challenges in Periods of Transition*

*Delegates: Members of Management in Electronic Manufacturing*

TIME	MIN	SPEAKER	SESSION
8:45–9 a.m.	15	<b>John Mitchell</b> , IPC President and CEO	Welcome to all IPC Monday meeting attendees
9:03 a.m.	2	<b>Gene Weiner</b> , IPC Ambassador	Call to Order
9:05 a.m.	30	<b>Chris Mitchell</b> , IPC VP Government Relations	Seizing the Moment: Catalyzing Government Support for Industrial Base Resiliency, Security, and Innovation
9:35 a.m.	30	<i>Joint Keynote</i> <b>Jeanie Wade</b> , Vice President Operations, Northrop Grumman—Joint Meeting Keynote	Lessons Learned in Times of Crisis (OEM View)
10:05 a.m.	75	<b>Mark Wolfe</b> , EMS Chairman, moderator Panel of 5 composed of EMS, component, fabricator, material, and OEM executives  <b>Brad Bourne</b> , CEO/president of FTG (Firan Tech): Fabricator <b>Jonathan Roundtree</b> , Group VP Rogers Corp.: Material Supplier <b>David Patterson</b> , Cirtronics <b>Jeanie Wade</b> , Northrop Grumman: OEM	EMS/HoF joint panel: Lessons Learned in Times of Crisis
11:20 a.m.	10	Break	
11:30 a.m.	40	<b>Harald Ahnert</b> , president, Atotech Group	Technical Support and Product Development in the Post-pandemic World

TIME	MIN	SPEAKER	SESSION
12:10 p.m.		Lunch	
12:30 p.m.	60	<b>John Mitchell</b> , IPC President and CEO	Regular IPC APEX EXPO programming: Keynote
1:30 p.m.	40	<b>Anaya Vardya</b> , president/CEO, American Standard Circuits	Going Forward: Evaluating and Validating New Products, Processes and Equipment for PCB Fabrication
2:10 p.m.	40	<b>Norman Weiss</b> , CEO, GermanRobotics, and <b>Sebastian Schaal</b> , founder, Luminovo GmbH	Transitioning to Factory 4.0—How AI Can Help Small EMS and Fabricator Companies Make the Move Affordably
2:50 p.m.	40	<b>Katherine Ducharme</b> , director of Procurement Management, General Dynamics Mission Systems; <b>Cheryl Van Dyke</b> , senior manager Supply Chain Management, General Dynamics Mission Systems	Managing the Supply Chain During Periods of Uncertainty
3:30 p.m.		Break	
3:45 p.m.	10	<b>Alex Stepinski</b> , founder/VP, GreenSource Fabrication, founder/managing director GreenSource Engineering	A Case Study: From Inventor to Contractor Through Several Steps of Vertical integration
	15	<b>Diane Donnermeyer</b> , supply chain manager, and <b>Jessi Hall</b> , senior director for Vertical Integration, Schweitzer Engineering Laboratories (SEL)	Vertical Integration: Why and How We Decided to Build a New PCB Factory in Moscow (Idaho)
4:15 p.m.	15	<b>Jeff LeBlanc</b> , director of Plating Fabrication, Vicor Corporation	Vertical Integration From Boards to Chips
4:30 p.m.	30	<b>Joe O'Neil</b> , CEO, Green Circuits, IPC Board of Directors (12+ years)	The Uncertainties We Can Expect From the Unexpected and the Resulting Challenges and Changes
5 p.m.		<b>Gene Weiner</b>	Wrap-up

# Here We Go (Virtual) Again

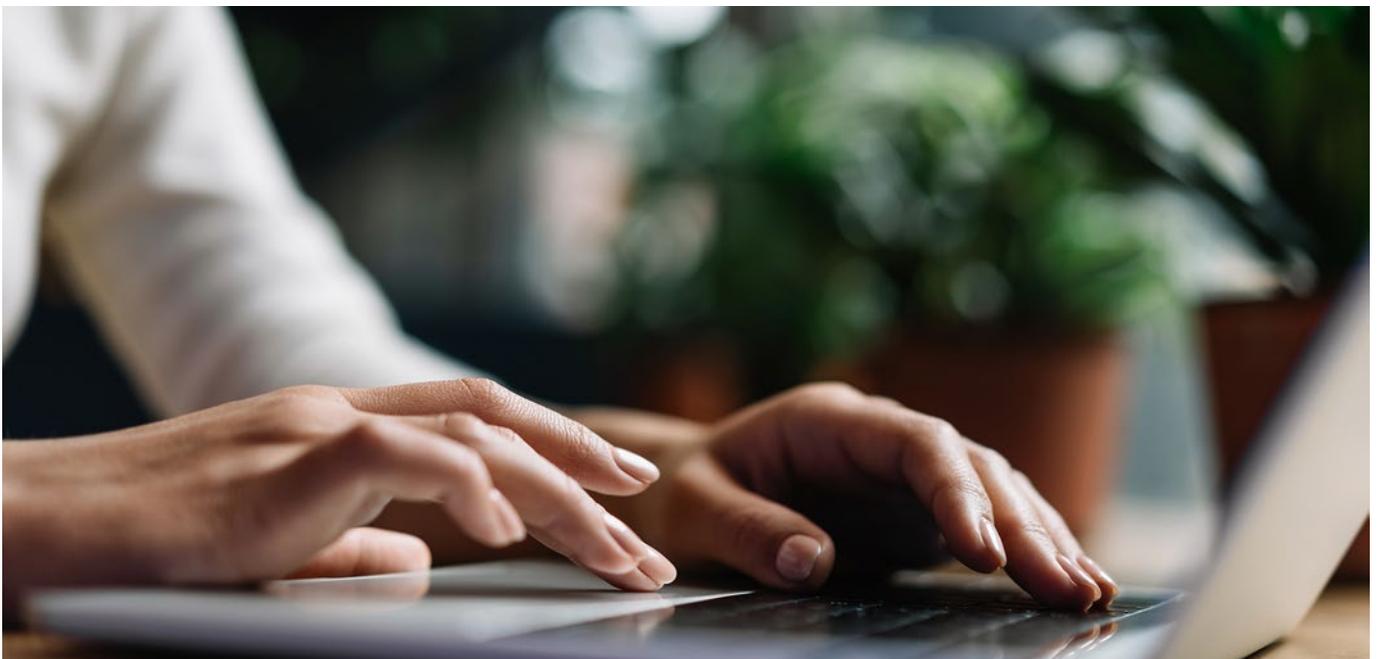
**Quest for Reliability**  
Feature Column by Eric Camden, FORESITE INC.

It seems Santa was unable to bring me the one thing I asked for this Christmas: in-person conferences. Maybe what I really wanted was just for safe travels again, but the conference thing kind of rolls up under that umbrella. IPC APEX EXPO was the last conference I attended in person in 2020. I know asking to have it in person again is a lot to ask for (and we will get there), but for now, IPC APEX EXPO 2021 is going virtual.

For some reason, during most of 2020 I wasn't the least bit interested in virtual conferences. I've sat in on many webinars over the years and didn't think twice about the format, but conferences seem a lot different. How can I see the latest and greatest equipment? I remember, years ago, being in awe as I watched

a pick-and-place machine placing 01005s by the thousands; sitting in meeting rooms discussing acceptance criteria; and learning about other companies' test results looking into failure analysis. How can all of that be recreated over a Zoom call? As you well know by now, it can't; but we can work with it this time around and hopefully we will all be back together for SMTAI in the fall. I'm buying the first round up in Minnesota come November.

So how does the virtual IPC APEX EXPO tie in with reliability? It does by recommending we all get registered and sign up for the same technical sessions and professional development courses that you would if we were meeting in-person. One good thing about data is it stays the same no matter how it is presented.

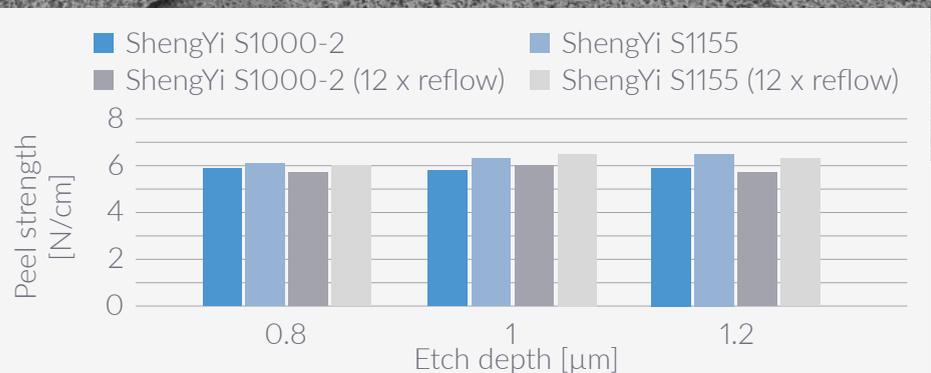


# BondFilm® HP

Low sludge requirement



Next generation of bonding enhancement  
with optimum process cleanliness  
for I/L bonding



Pic. 1: BondFilm® HP

Pic. 2: Peel strength results with BondFilm® HP

> 35

g/L high copper loading

A key benefit of the new BondFilm® HP is a high copper capacity and low sludge over the market-standard oxide replacement processes. It is higher than a 40% increase in copper content compared to conventional oxide replacement systems. Sufficient adhesion for I/L bonding on different Tg materials can already be obtained with an etch depth of only 0.8 μm, while still assuring excellent thermal reliability. The low sludge characteristic of the BondFilm® HP process shows great operational benefits, and significantly reduces equipment maintenance and downtime frequency.

Atotech Group  
+49 30 349850  
info@atotech.com



Look at the IPC APEX EXPO 2021 website and you will see every aspect of PCBA manufacturing being covered by an industry expert. Review your process and see where you could make improvements, and then sign up for a related class. Everyone knows that it is quicker and cheaper to learn from someone else's experience, and a conference like this is full of people who have experience with failure. That is a very valuable resource because they tend to write papers about what happened and how they fixed it.

---

**One good thing about data is it stays the same no matter how it is presented.**

---

There is no shortage of material combinations when you consider all the options, but in general, I would say the vast majority are pulling from a smaller pool. That increases the likelihood that someone will be discussing some way to improve your current process and quite possibly without adding any cost (outside the registration fee). This all speaks to the topic of reliability because with all the transferrable knowledge available you can take something you learn, apply it to your process, and see immediate results. It might not be some gigantic revelation that saves the product, but even minor tweaks to a process that is currently acceptable can further improve reliability—even for your product that “hasn't ever had a problem,” but especially for those that “have always done it this way” and don't see the failure coming.

At the risk of sounding like a commercial for IPC, I just wanted to highlight some of the seminars I see as having tremendous potential for value. Keep in mind the differences between Professional Development courses and Technical Conference Sessions, and how each are beneficial.

## Professional Development

These courses are very in-depth, and last three to six hours. They are presented by well-known experts on the topic at hand and offer experience you never had an opportunity with. There are also options within the PD courses based on your level of experience. Some of these range from a thorough explanation of some of the basics of manufacturing up to the advanced level with detailed content and high-level discussion.

## Technical Sessions

The tech sessions will normally have three speakers addressing the same topic from different angles. They don't always go in depth, like the PD courses do, but there is almost always an opportunity after the sessions to communicate directly with the author for more information. In fact, this year there will still be live Q&A for all tech sessions. This gives you the chance to ask questions in real time with the presenter instead of trying to remember everything and follow up from an on-demand webinar situation. The schedule is packed so you will need to schedule your time wisely to take in everything you would like to. The “hallways” between session rooms are a lot shorter this year so it will be easier to go from one to the next. Based on what we see here in the lab, I would suggest PD courses that look at assembly challenges with bottom-terminated components, or BTCs. Even after about a decade we see many assembly issues related to BTCs. If you look for presentations on these components you're likely to find just about as many as you would have found on transitioning to lead-free a week before July 2006.

On the other side of the assembly coin is a class on the topic of design for reliability. I have often thought that every designer should have hands on experience with assembling the hardware. When designers and assemblers work together with shared experience there should be fewer assembly challenges, which

in turn, creates a more reliable product. I recommend the course on creating objective evidence related to J-STD-001 Section 8. This relatively new section of J-STD-001 is a hot topic within the industry because it essentially removes the acceptance criteria of ROSE testing for any new product. We get a lot of questions about this here as cleanliness testing is a big part of what we do. The course instructor is Doug Pauls, who, along with the help of an experienced and knowledgeable group of experts, wrote the section. If you have any questions, this course is a great opportunity to better explain the why and how related to those changes within the J-STD-001.

There is simply no shortage of topics when it comes to the tech sessions. You can learn about everything from raw components, printed circuit boards, and solder paste/flux all the way up to final packaging. With these being 90 minutes in length you have a chance to take in many topics and speakers in a short period of time.

## IPC Task Group

There will still be IPC Task Group meetings but instead of packing 25 meetings into three days they will all take place virtually during March. While I would still prefer to take breaks from the meetings on that big veranda overlooking the San Diego Bay, the format this year

will allow you more time to get involved in different types of groups. I have discussed these in the past as a great way to get involved with shaping guidance documents from the IPC that may directly impact your business. Group members have extensive experience with the document subject material and with each revision there is discussion about requirements, and a determination on whether the revision needs to be adjusted to reflect changes in the industry. If you are interested in joining one of these task groups simply reach out to the IPC and they can get you added.

My point is that while going virtual won't be the same as being in San Diego this year, there are still so many opportunities to learn information that can increase reliability in your assembly. The internet will never replace seeing everyone in person, shaking hands, drinking adequate coffee for six hours, and hoping the next class has a cookie break, but we will just have to double up in Minnesota. Remember, I'm buying the first round. **PCB007**



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

A dark blue textured background with a large magnifying glass icon on the right side. The text 'jobCONNECT007' is prominently displayed in white and yellow. Below it, the text 'Companies seeking talent with circuit board industry experience post their jobs with us.' is written in white. The website 'jobconnect007.com' is at the bottom right.

**jobCONNECT007**  
Companies seeking talent with circuit board industry  
experience post their jobs with us.  
jobconnect007.com

# Membership Has Its Benefits

**Feature Interview by Nolan Johnson**  
 I-CONNECT007

Brian Knier, IPC vice president of marketing, sales and membership, took time out from preparing for IPC APEX EXPO to discuss the value of becoming an IPC member. IPC recently announced [changes to the membership pricing structure](#), which made this conversation quite timely.

**Nolan Johnson:** Why become a member?

**Brian Knier:** IPC is a member-driven organization going back to our beginning in 1957. We currently serve more than 3,000 member companies worldwide representing the entire electronics manufacturing supply chain. Our mission is dedicated to furthering the competitive excellence and financial success of our members. Membership dues also support the work IPC pursues on behalf of its members and the industry.



Brian Knier

As an IPC member, companies receive numerous benefits and savings on IPC products and services. But, more importantly, an IPC membership helps companies manufacture their products at the highest level of quality and have a noticeable impact on their bottom line. In fact, 72% of current members say IPC has increased their quality, and 60% of companies who use IPC products and services estimate that they've experienced an annual economic impact of savings from tens to hundreds of thousands of dollars. \*

We updated our membership structure in 2021 to a company-based model. Member dues are now based on annual company revenue or type of organization. The new structure provides a single dues payment to cover all locations and employees.

**Johnson:** What are some of the key benefits of membership?

**Knier:** Key member benefits include:

- Complimentary copies of all new and updated versions of IPC standards within 90 days of release
- Discounts on products and services including IPC standards, education, training, events, certification, industry intelligence, and sponsorships
- Access to hundreds of technical papers, industry reports and documents, and webinars via the IPC website
- A complimentary listing on IPC Global Marketplace to advertise your business

IPC also has an affiliation with the Wiring Harness Manufacturers Association (WHMA) and companies receive membership to both associations with their dues payment. Visit [ipc.org/membership](http://ipc.org/membership) for more information on IPC member benefits.

**Johnson:** How does being a member help the industry?

**Knier:** Membership dues help support strategic activities IPC pursues on behalf of our members and the industry. The IPC Board of Directors and strategic committees, comprised of industry supply chain executives and representatives, identify important issues to advance

## iamcam

### Intelligence Aided Manufacturing

Artificial intelligence | Next level of automation | Global web access  
Fewer human errors | Faster delivery | Lower cost per job

AI automation shortens  
delivery times

Free your brain resources  
for complex jobs

[iamcam.ucamco.com](http://iamcam.ucamco.com)

the industry. IPC also actively gathers feedback from members on key industry issues and priorities.

Further, IPC membership drives quality, reliability, and consistency through:

- **Standards:** Company operations benefit from the widespread adoption and implementation of IPC's extensive collection of industry standards and guidelines.
- **Education and training:** IPC has invested heavily in training and education to position the industry for future growth and to address the global electronics manufacturing skills gap. An IPC membership increases a company's ability to build and support a high-performing workforce.
- **Advocacy:** IPC membership provides critical support to IPC's advocacy initiatives around the world. An investment in an IPC membership is an investment in providing a strong and unified voice for the global electronics industry.
- **Solutions:** As an electronics manufacturing industry innovator for more than 60 years, IPC (through membership and staff) supports and provides research on, and solutions to, many industry challenges and opportunities. Companies should view it as the consulting partner they need to stay on top of trends, solve process issues, and keep an eye on the future.
- **Industry intelligence:** IPC is the industry's trusted source for industry intelligence and comprehensive market data in areas such as workforce development, environmental concerns, health, safety, technology and innovation, and economics. With unique data sources from around the world, IPC's research reports, studies and analyses provide insights that cannot be obtained anywhere else.

**Johnson:** What are some examples of resources available to members?

**Knier:** IPC's website is a great place to find special resources that are available to members. A few examples include access to hundreds of technical papers and documents, recordings of past webinars, support from our technical staff on questions related to IPC standards, support from our government relations team on policy and regulatory issues, and industry special reports and updates.

**Johnson:** Does membership enhance my participation in standards and committee activities?

**Knier:** We encourage our members to participate in IPC standards committees in areas relevant to their business segment and provide input on these critical industry publications. Committee participation takes place in meetings, by teleconference, or by email. Distance shouldn't deter those interested in IPC standards development from joining a committee. IPC welcomes global input.

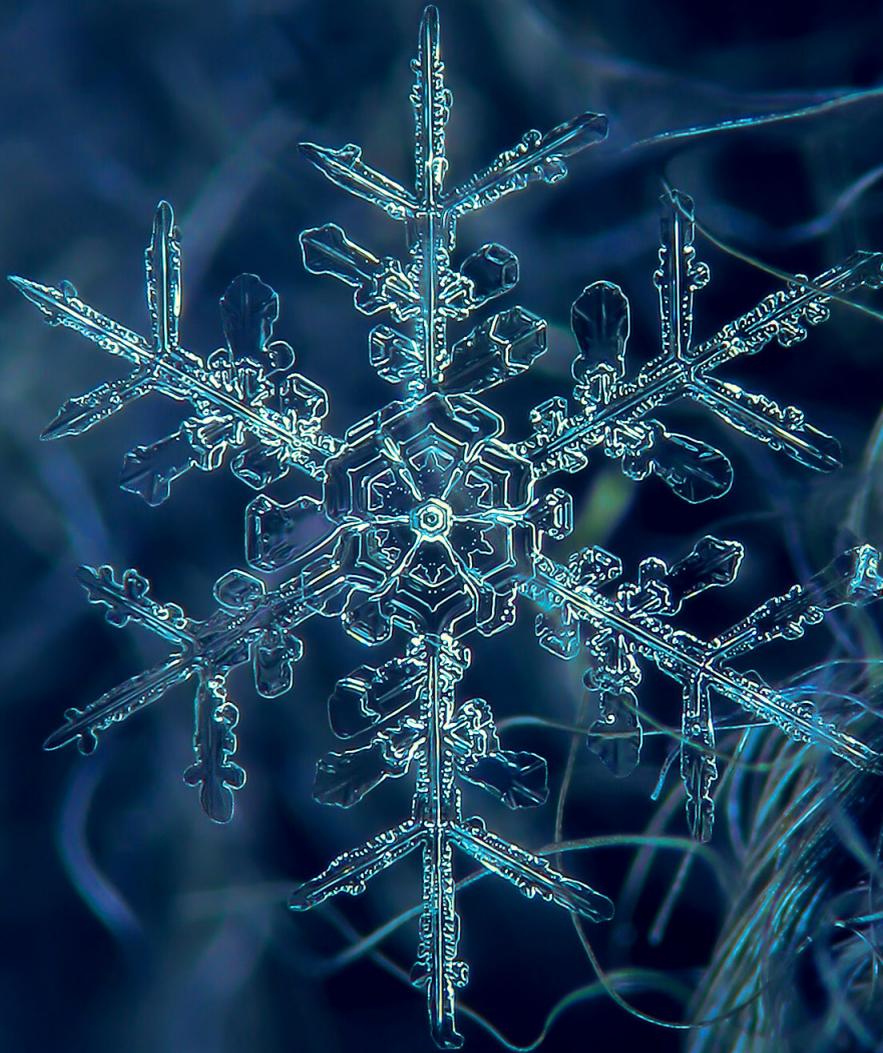
Committee members sharpen their presentation and negotiation skills by participating in the committee process. Individuals personally benefit from developing a network of industry peers. As an added benefit, IPC members are also eligible to serve as committee chairs.

**Johnson:** Does membership enhance my experience at conferences and shows such as IPC APEX EXPO?

**Knier:** Yes. IPC members receive discounts on IPC events and the opportunity to participate in members-only events or activities. In addition, IPC members who sponsor or exhibit at IPC APEX EXPO as well as IPC conferences throughout the year receive discounted rates. **PCB007**

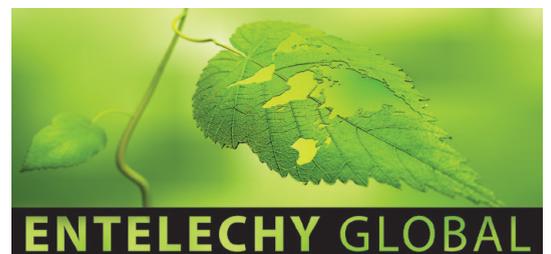
*\*Source: TechValidate survey of 303 users of IPC. Sample comprises Large Enterprise, Medium Enterprise, S&P 500, Global 500, Fortune 500, and Small Business electronics industry organizations.*

# Uniquely suited solutions for an increasingly demanding world.



Outsourcing can help you remove your CAM bottleneck. We deliver the highest quality PCB CAM engineering services to customers around the world.

[Find out how we can help you >](#)



[www.entelechyglobal.com](http://www.entelechyglobal.com)

# IPC Education Foundation Update and **Looking Ahead**

## Foundations of the Future

by Charlene Gunter du Plessis, IPC EDUCATION FOUNDATION

The IPC Education Foundation (IPCEF) takes pride in the accomplishments of its second year. The foundation focused on a variety of digital/virtual exposure and engagement activities to share information about the electronics manufacturing industry. The foundation held 10 webinars covering a wide range of industry-specific topics and conducted 28 interviews with IPC student members, IPC emerging engineers, industry representatives, and IPC leadership, to share knowledge about career paths into the industry that led to blog posts, articles and social media campaigns. The foundation successfully reached more

than 110,000 individuals and engaged with more than 5,500 individuals through these activities.



An IPC student member, Paige Fiet, president of the IPC Student Chapter at Michigan Technological University and graduating in December 2021 with an Electrical Engineering degree/BioMed application, was appointed in February 2020 as student member board liaison representative to the IPC Board of Directors. Elections will open in the fall to identify the next candidate.



Paige Fiet

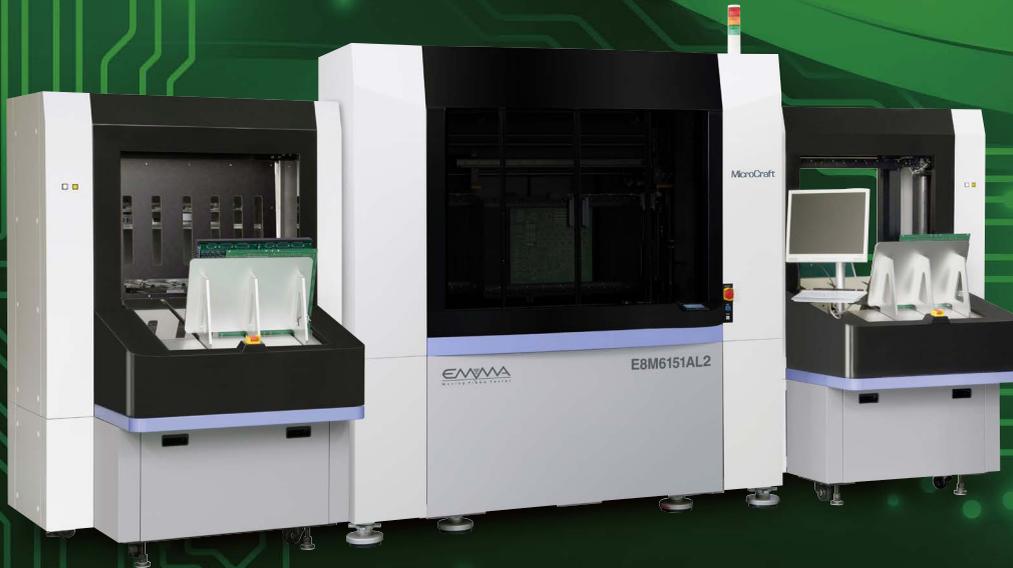
The IPCEF will continue to create awareness of the careers the electronics manufacturing industry has to offer students in high school and college by providing them with opportunities to access people, courses, and knowledge in 2021.



# Fully Automated Unattended Operation

Over 1,900  
Machines Installed  
Worldwide  
(as of March 2020)

EMMA Series



EMMA  
Moving Probe Tester

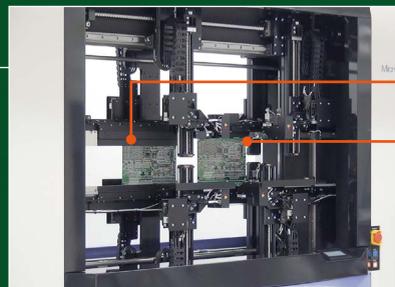
10,000  
Test Points/mins.

Load up to  
200 pcs

## E8M6151AL2

### Increased Throughput

Transfer speed reduced by **37%**

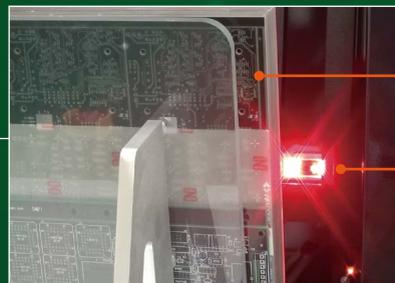


Ready for next test

Being tested

### Built-in Scanner for Seamless Job Changeover

Improved Efficiency for  
high-mix boards



Boards stacked  
vertically for easy  
operator access

Bar & QR  
Code Reader



USA MicroCraft, Inc.

1247 N Tustin Ave, Anaheim, CA 92807  
TEL (714) 482-2550

[www.usamicrocraft.com](http://www.usamicrocraft.com)  
[sales@usamicrocraft.com](mailto:sales@usamicrocraft.com)

Visit Our Website

Watch Video

## IPC Student Chapters

The IPC Education Foundation's Student Chapter Program focuses on providing scholarships, offering relevant industry content, and assisting with career readiness for its student members. 2020 was another year of growth. IPCEF chartered 15 new IPC Student Chapters bringing the total to 38 student chapters across 19 states in the U.S., engaging 517 student members. Twenty-five chapters exist at four-year universities while 14 chapters exist at two-year community/technical colleges.

To be eligible for membership, student members must be pursuing degrees in the following disciplines: electrical, electronics, mechanical, computer, technology, chemical, aerospace, and/or broad engineering. IPCEF has student members in certificate programs, two-year degrees, four-year degrees, master's and doctoral students.

The foundation will continue to expand the reach of the program by growing the number of chapters in the United States with plans to expand internationally in 2021 and beyond. The IPC Student Chapter program provides scholarships, industry-standard education, industry connections, and access to hands-on competitions, especially with the support of industry experts and professionals like yourself.

Learn more information about the 2020 scholarship winners [here](#).

## High School Student Engagement

The IPC Education Foundation (IPCEF) hosted its STEM Outreach event on February 6, 2020 at IPC APEX EXPO in San Diego, California. Twice as many students were able to participate and the day was packed with several hands-on technical activities, career exploration, and industry engagement. Nine local high schools attended bringing 193 students and 30 educators from: Mission Hills High School, Morse High School, North County Trade Tech High School, San Marcos High School, E3 Civic High School, Point Loma High School,

Otay Ranch High School, Mount Miguel High School, and Otay Ranch High School—Girls in STEM. Each participating high school received a \$1,000 award to support electronics education in their classrooms.

We are truly grateful to our event sponsors who supported and participated in the day's activities. The student participation, awards, and giveaways were made possible through the generous support of Foxconn Interconnect Industries, I-Connect007, Nordson, Panasonic, TTM Technologies, and Weller Apex Tools.

Because of the pandemic, the 2021 STEM Outreach Event will take place during the fall and delivered virtually, allowing more schools, students, and teachers to participate in learning about the careers and skills the electronics manufacturing industry has to offer.

## Exciting New Opportunity

By equipping students with valuable industry-related knowledge through specific online IPC resources and content, the foundation may be able to address some of the industry's needs:

- Lack of awareness of the careers and skills needed
- Shortage of qualified technical candidates due to not enough skilled younger workers entering the electronics industry
- An aging workforce
- Lack of job preparedness as many schools are not teaching the students the right curriculum related to industry and career readiness

We will be reaching out to high schools, preferably vocational high schools, as well as technical community colleges and universities to participate in this new program. The goal is to share relevant industry content with students that will not only create awareness but also allow them to better understand the skills needed to pursue and access viable career opportunities.



The foundation needs company representatives to volunteer their time to host virtual information sessions, facility tours, provide mentorship and guidance, assist with projects, and showcase opportunities in the electronics industry. The students across our IPC Student Chapters and the participating high schools are full of optimism, and ready to join the industry. Please let us know how you wish to support the foundation by answering a three-question survey [here](#). Thank you for your support! PCB007

## Interested in Participating and Supporting These Efforts?

The foundation will continue to create awareness of the careers the electronics manufacturing industry has to offer students in high school and college by providing them with opportunities to access people, courses, and knowledge in 2021.



Charlene Gunter du Plessis is the senior director of the IPC Education Foundation. To read past columns or contact Charlene, [click here](#).

IConnect007  
ROAD FOR THE INDUSTRY

**REALTIME** with... **IPC APEX EXPO 2021** *Virtual*

TO OUR PREMIUM SPONSORS...



*Thank You!*

# **ein** Electronics Industry News and Market Highlights



## **CES 2021: Just How Different Will It Be? ▶**

At CES this year there is no need for an overpriced hotel room in Vegas, no long lines to get a taxi or board a bus, and no crowded exhibit halls (one good thing this year). On the other hand, you must decide ahead of time what you want to see and make a reservation or appointment if you wish to have time and access assured.

## **CES 2021 Coverage: A Virtual Show Floor ▶**

I write this on the final day of CES 2021, and I expect CES will never be the same. It will not revert back to what it once was. I also cannot imagine it stays a totally virtual show; in doing so, I feel it would fail. Does that mean I think the 2021 show was a failure? No, not at all. In fact, it was a very good event, particularly in light of the medical and political pandemic that we have been enduring.

## **Appear Inc. to Launch First Lightest 5G Smartphone with Graphene Battery ▶**

Appear Inc. announced the launch of the world's lightest and first graphene battery-powered smartphone with innovative water-resistant technology.

## **My View from CES 2021: Day 1 ▶**

What a difference a year makes. One year ago, those of us who cover and attend CES were going from one press conference to the next; this year, we are at home going from link to link. Confusing and challenging, yes, but there are some advantages: no masks, only five steps to get to a restroom, being able to have three of

four events or more displaying on your screens at the same time and being able to download press kits as needed. So far, many new devices are being introduced, but of course, they are all online, so you wonder if some of them really exist or are truly operational as yet.

## **ElectroNeek, a Robotic Process Automation Company, Posts Significant Revenue Growth in 2020 ▶**

ElectroNeek reported its 2020 business results posting a 400% increase in its annual software license revenue compared to 2019. The growth has been powered by an increased demand for business process automation and digital transformation by American mid-market companies and by increasing ElectroNeek's presence outside of the United States, including into areas such as India and the LATAM region.

## **Geek+, Universal Logic Team Up to Explore New Depths of Flexible Automation, Elevate Industry 4.0 ▶**

Geek+, a global leader in autonomous mobile robots and warehouse automation, and Universal Logic, a world-leading pioneer of an AI/sensor/machine-control software "brain" for robots, announce the beginning of a new partnership.

## **Onto Innovation Acquires Inspectrology, Adds Overlay Metrology Capability ▶**

Onto Innovation Inc. has acquired Inspectrology, LLC. Headquartered in Sudbury, Massachusetts, USA, Inspectrology is a leading supplier of overlay metrology for controlling lithography and etch processes in the compound semiconductor market.

# REALTIME with... IPC APEX EXPO 2021 *Virtual*

*The top 5 things  
you need to know about...*

- ▶ *Solder Masks*
- ▶ *Direct Imaging*
- ▶ *Moisture Management*
- ▶ *Manufacturing Training*



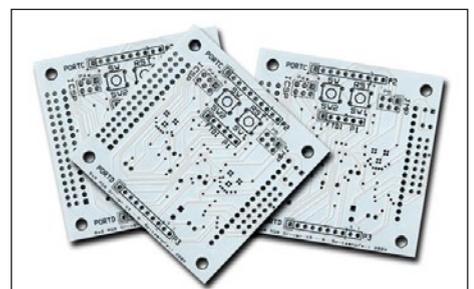
## The Top Five Things You Need to Know About

**SOLDER MASKS**

by Taiyo America

The main function of solder mask is to insulate and prevent the copper surface from oxidizing/corroding and prevent solder bridging. While these are the main objectives for solder mask, in the electronics industry there is a misconception that all solder masks are alike.

- 1 Selecting the Right Solder Mask**
- 2 Solder Mask Applications Evolve**
- 3 Advances in Solder Mask Imaging**
- 4 To Flex or Not to Flex**
- 5 Solder Masks Are Not Only Green**



## 1 Selecting the Right Solder Mask

In the world of electronics there are multiple industries each with their own requirements when it comes to solder mask. For the automotive sector, solder masks are required to withstand harsh environments. In the aerospace industry, solder masks must meet out-gassing requirements. Over the years, white solder masks have been developed that provide a high degree of reflectivity for the LED market.

## 2 Solder Mask Applications Evolve

Solder mask and the methods by which they were applied have evolved over the years. When non-photoimageable solder resists were introduced to the printed circuit board (PCB) industry, silk screen printing was the common method of application. As the demand for real estate on PCB designs increased, photoimageable solder masks were developed. The popularity of photoimageable solder masks introduced new application systems such as double-sided screen printing, curtain coating and spray systems. These methods of application have been around for many years and are still being used today. In the past five years, several other application processes have been reintroduced to the market including ink jet and photoimageable dry film.

## 3 Advances in Solder Mask Imaging

As technologies advance and offer more functions, PCBs have become more populated with the miniaturization of key components. The advancements have pushed the boundaries on image registration using conventional exposing units. Over the years, direct imaging (DI) systems were introduced to the PCB industry to help alleviate the challenge. The DI systems provide different wavelengths in comparison to conventional exposing units. Solder mask manufacturers, working side-by-side with equipment manufacturers, developed DI solder masks that are better suited for these types of imaging systems.

## 4 To Flex or Not to Flex

Solder masks have some degree of pliability. Thinner PCBs that are not categorized as a flex build can sometimes encounter a degree of bending due to handling or manufacturing processes. Depending on the amount the substrates are bent, they can exhibit a degree of fracturing. Fracturing of the solder mask is not the same as corner cracking caused by exposure to harsh environments. In cases such as this, PCB manufacturers and contract electronics manufacturers (CEM) should consider the use of a flexible solder mask.

## 5 Solder Masks Are Not Only Green

Solder masks have evolved from green to several other colors over the years. The most common colors besides green are black, blue, red, white, and yellow—all of which fall in the family of primary colors. Colors were developed and brought to market at the request of original equipment manufacturers (OEMs). Colored solder mask can be used for identifying prototypes, revision changes, manufacturing facilities, or for cosmetic reasons. Colored solder masks can also be combined in measured amounts to create a vast number of other colors such as orange, purple and brown. Solder masks can also have various surface finishes such as matte, glossy, or somewhere in between, depending on customers' requirements.



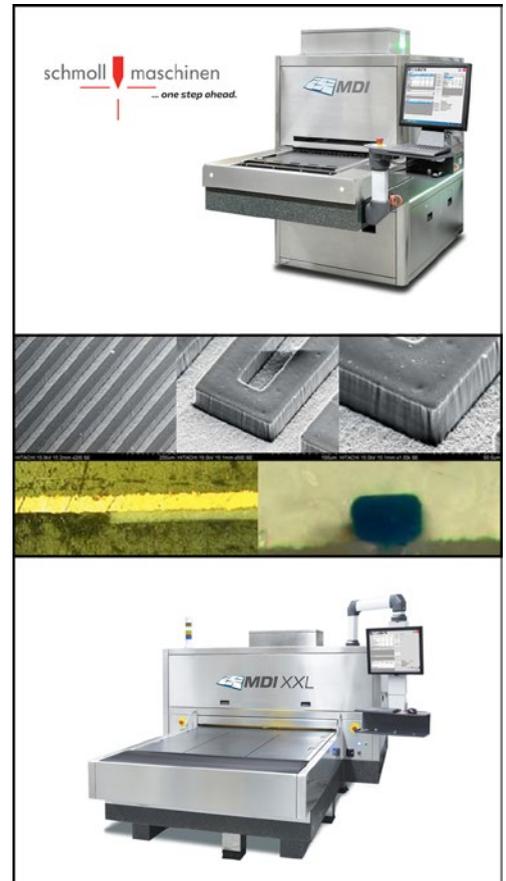
Established 30 years ago, Taiyo America Inc. is a subsidiary of Taiyo Holdings Co. Ltd., the world's leading manufacturer of specialty inks and solder masks for printed circuit boards. Taiyo offers conductive inks for manufacturing printed electronics. Visit us online at: [Taiyo-america.com](http://Taiyo-america.com).

# The Top Five Things You Need to Know About DIRECT IMAGING

by Burkle North America

Digital direct imaging (DI) was first introduced in the early 1980s and is now an industry-accepted technology for fine line circuit boards. Here are five things to consider when selecting a direct imaging system.

- 1 Resolution/Capacity Trade-off**
- 2 Choosing a New DI Machine?  
Test It on Your Work First!**
- 3 Will More Light Engines Increase  
Productivity?**
- 4 Floor Space and System Platform**
- 5 Environment, Data Collection  
and Support**



## 1 Resolution/Capacity Trade-off

The machines of today are capable of fine line resolutions that were unfathomable just a few years ago. But it's important to understand the trade-off between fine line capability and high production. A direct imaging machine with two types of light engines—a “hybrid” machine—can offer the best of both worlds.

## 2 Choosing a New DI Machine? Test It On Your Work First!

Every design is different. Dry films and solder masks are different. And claims made by equipment manufacturers vary wildly. Don't just look at a spec sheet and assume you'll get the same results. Test your work on the machine before you commit. Be aware that production processes greatly influence the outcome and could even potentially limit the capabilities of a new DI machine.

## 3 Will More Light Engines Increase Productivity?

A common myth about laser direct imaging is that more light engines increase productivity proportionately. It is important to understand that the exposed area (or image field) needs to be distributed well over the width of your panel size to give optimum exposure speed. When

adding further light engines on a multiple head system, it should be considered that these still cover the area of your panel, as you wouldn't see any gain in capacity if one light engine exposes in the “empty” areas.

## 4 Floor Space and System Platform

Cleanrooms may allow only a limited amount of space for the integration of new DI equipment. Ideally, it should replace older contact exposure units or LDI equipment from the previous generation. However, it is unlikely that the old equipment will be removed before installation of the new; therefore, a space-saving machine design which still offers all capabilities is a good choice as it won't require high infrastructure costs on your side.

## 5 Environment, Data Collection and Support

Controlling the environment in your direct imaging area is key to optimum machine performance. Since this digital technology provides the ability to log all relevant machine and production data, it makes direct support and preventive maintenance easier and plannable. Don't just look for a good equipment manufacturer; look for a partner that can guarantee good, long-term support for the equipment while supporting the progress of your process capabilities.



Celebrating 30 years in business, Bürkle North America distributes and services Bürkle GmbH and Schmolz Maschinen equipment which includes IMPEX and LHMT. BNA distributes equipment lines for multilayer lamination, drilling, cutting, routing, imaging, registration, automation and measuring. Visit us online at [BurkleAmerica.com](http://BurkleAmerica.com).

## The Top Five Things You Need to Know About

# MOISTURE MANAGEMENT

by Super Dry Totech EU

Moisture and surface mount components do not mix. This includes PCBs. The risks fall into two categories: solderability and encapsulant damage. How best to meet this continuously growing challenge? Here are five suggestions:

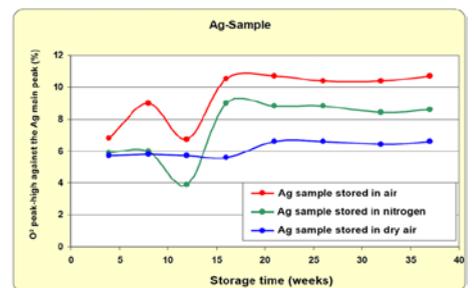
**1** When Component Moisture Levels Become Critical, Encapsulant Damage Can Occur During Reflow

**2** Components are Rated With a Moisture Sensitivity Level (MSL) Which Dictates Available Floor Life

**3** Oxidation Will Occur When Components Are Improperly Stored, Compromising Solderability

**4** If the Floor Life is Exceeded, it is Possible to Restore it Under Carefully Controlled Conditions

**5** Dry Air Atmospheres Stop Oxidation Better Than Nitrogen



## **1** When component moisture levels become critical, encapsulant damage can occur during reflow.

Plastic/epoxy resin packaging material is permeable to moisture (as are PCBs). Components should be delivered in properly prepared moisture barrier bags. Once the bag is opened, components absorb moisture from the atmosphere. If moisture levels become critical (0.1% water weight), damage occurs during reflow as the moisture attempts to escape too quickly, exceeding the elastic limit of the encapsulant.

## **2** Components are rated with a moisture sensitivity level (MSL) which dictates available floor life.

The moisture sensitivity level (MSL) of components is identified by the manufacturer in one of six levels as defined in J-STD-020, displayed in J-STD-033D. This identifies the available safe floor life of components (time out of MBB). For instance, MSL 3 components have a floor life of 168 hours. Tracking the exposure time is critical to preventing defects.

## **3** Oxidation will occur when components are improperly stored, compromising solderability.

Oxidation will also occur on components stored in ambient RH. This negatively affects solderability. The same safe storage conditions

(<5%RH) that will stop moisture absorption by encapsulants will also stop oxidation. A level of <5% RH provides unlimited safe storage time, thus “stopping the clock” on the MSL floor life. This is particularly significant for low-volume high-mix operations.

## **4** If the floor life is exceeded, it is possible to restore it under carefully controlled conditions.

Expired floor life can be restored by reducing absorbed moisture to safe levels. Traditional high temperature (125°C) baking reduces moisture but induces oxidation and intermetallic growth, increases wetting times, and compromises solderability. Lower baking temperatures (40–60°C) combined with ultra-low RH (1%) will rapidly restore floor life without reducing solderability, and unlike high temperature, this process can be safely repeated.

## **5** Dry air atmospheres stop oxidation better than nitrogen.

Nitrogen was a traditional method for safe storage. However, dry air is much less expensive and provides lower RH%. X-ray data of numerous alloys proves low %RH air stops oxidation better than N<sub>2</sub>. This is because water is the more aggressive bearer of oxygen than tightly bonded O<sub>2</sub> molecules. Removing the moisture removes the catalyst and prevents the corrosion process.



Super Dry Totech EU® [www.superdry-totech.com](http://www.superdry-totech.com) is a moisture management specialist, providing hardware and process control software for safe storage, floor life reset and automated tracking of moisture sensitive components and materials.

# The Top Five Things You Need to Know About MANUFACTURING TRAINING

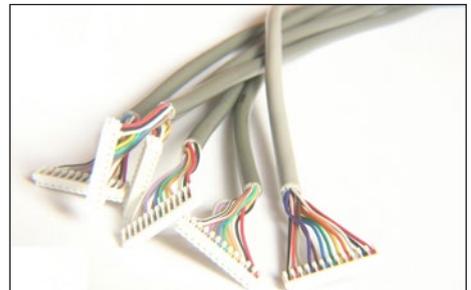
by Blackfox Training

Electronics manufacturing companies need skilled and certified workers to perform the intricate and important tasks required to build modern electronic equipment. Here, we explain five ways to gain these workers:

**1 Train and Certify Manufacturing Employees and Support Staff to the IPC Standards**



**2 Fill Training Gaps with Customized Courses that Focus on Basic Knowledge and Skills**



**3 Access Tools and Resources to Assess Your Workforce and Maintain Skill Levels**

**4 Offer Self-Paced Learning for Soft and Technical Skills (Available 24/7)**



**5 Hire U.S. Military Veterans Who Have Already Completed Immense Training**

## **1 Train and certify manufacturing employees and support staff to the IPC standards**

IPC certification is an internationally recognized credential that proves an employee's knowledge and skill level. IPC training and certification is industry developed and covers electronic manufacturing quality concerns, including PCB assembly and soldering, rework and repair, wire and cable harness production, and bare PCB fabrication. Having an IPC-certified workforce demonstrates an attention to detail and commitment to quality.

## **2 Fill training gaps with customized courses that focus on basic knowledge and skills**

IPC training and other standardized courses don't cover every aspect of electronics manufacturing. Therefore, it is important to have customized courses that fill those missed gaps. Basic soldering, ESD, and electronic component identification are just a few examples of the many courses that complement IPC certification and ensure that your workforce is prepared for any challenges that may come their way.

## **3 Access tools and resources to assess your workforce and maintain skill levels**

Assessing your workforce before and after training is an essential part of a proper manufacturing training program. The effectiveness

of training and the retention of knowledge gained can be gauged through assessments that are computer-based, interview-based, or audit-based. In addition to assessments, both students and trainers need to have complete access to resource documents and training materials after training has been completed.

## **4 Offer self-paced learning for soft and technical skills available anytime**

Self-paced learning that is delivered in consistent, small snippets will have a higher retention level than content delivered through other methods. When employees can convert non-productive time into learning time, that employee becomes more valuable to the company, and in turn, the company benefits. Self-paced learning for your workforce will increase engagement, productivity, and positive morale.

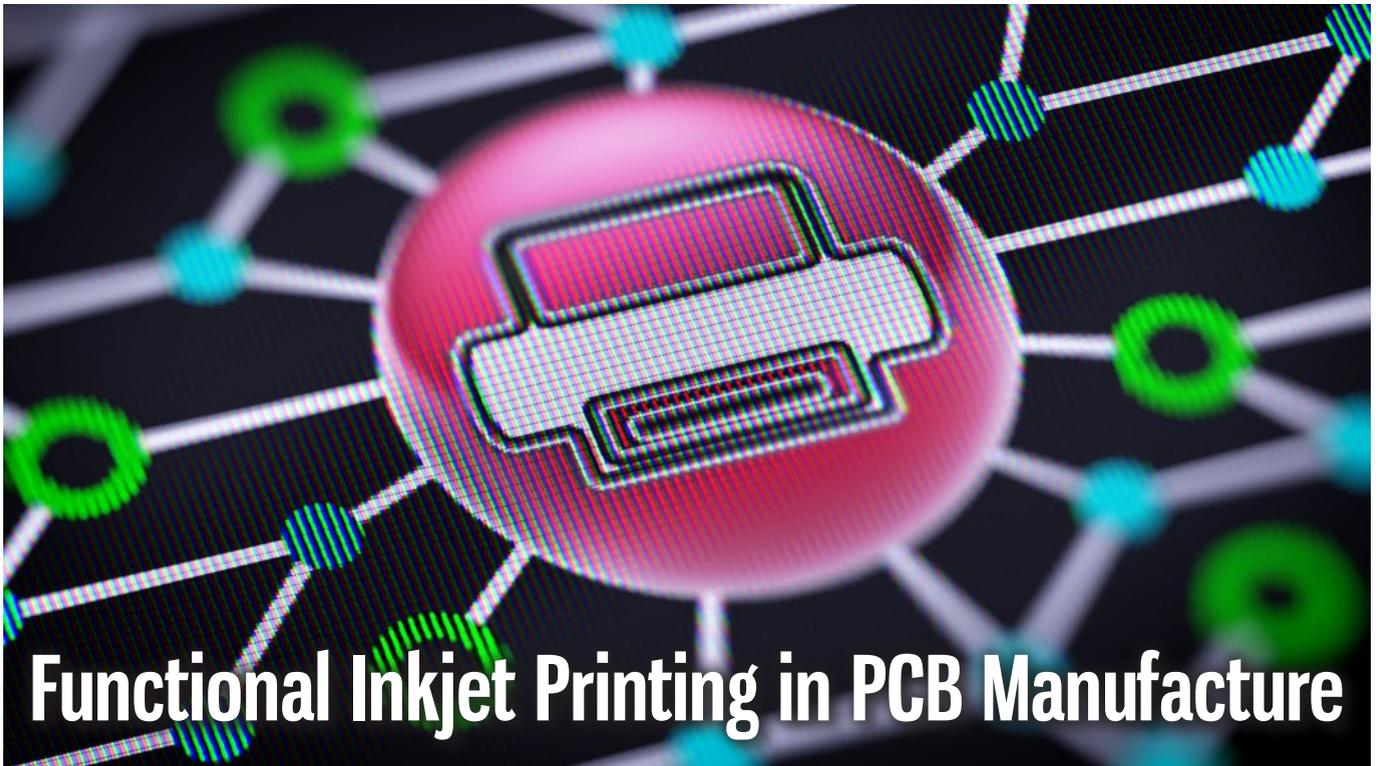
## **5 Hire U.S. military veterans who have already completed immense training**

Now more than ever, highly skilled and efficient employees are needed in manufacturing. The U.S. military invests an enormous amount of training in our soldiers. They are equipped with a framework of skills and attributes such as loyalty, integrity, leadership, and excellent work ethic. They know how to learn new skills quickly and adapt to changing environments, which are highly desirable qualities for manufacturing.



Blackfox is the worldwide leader in providing IPC certification and custom training systems to the manufacturing industry's top companies. Blackfox provides solutions for the manufacturing industry and for veterans seeking employment.

Visit us online at [Blackfox.com](https://www.blackfox.com).



**Interview by Pete Starkey**  
I-CONNECT007

Pete Starkey speaks with Dr. Luca Gautero, product manager at SUSS MicroTec Netherlands B.V., about advances in inkjet printing, even outside the lab.

**Pete Starkey:** I'm delighted to speak with Dr. Luca Gautero, product manager at SUSS MicroTec Netherlands, in Eindhoven, who has responsibility for functional inkjet as an additive process in PCB manufacture, with particular emphasis on digital solder mask.

Luca, it's good to meet with you. I've heard a lot about you and read some of your published work on functional inkjet printing.

**Luca Gautero:** Likewise, Pete, nice to meet you. Your voice and your interviews have been very inspiring for many. I somewhat think that you almost single-handedly created the market need for inkjet printing, didn't you?

**Starkey:** I don't think so, Luca, but I have certainly followed the progress of the technolo-

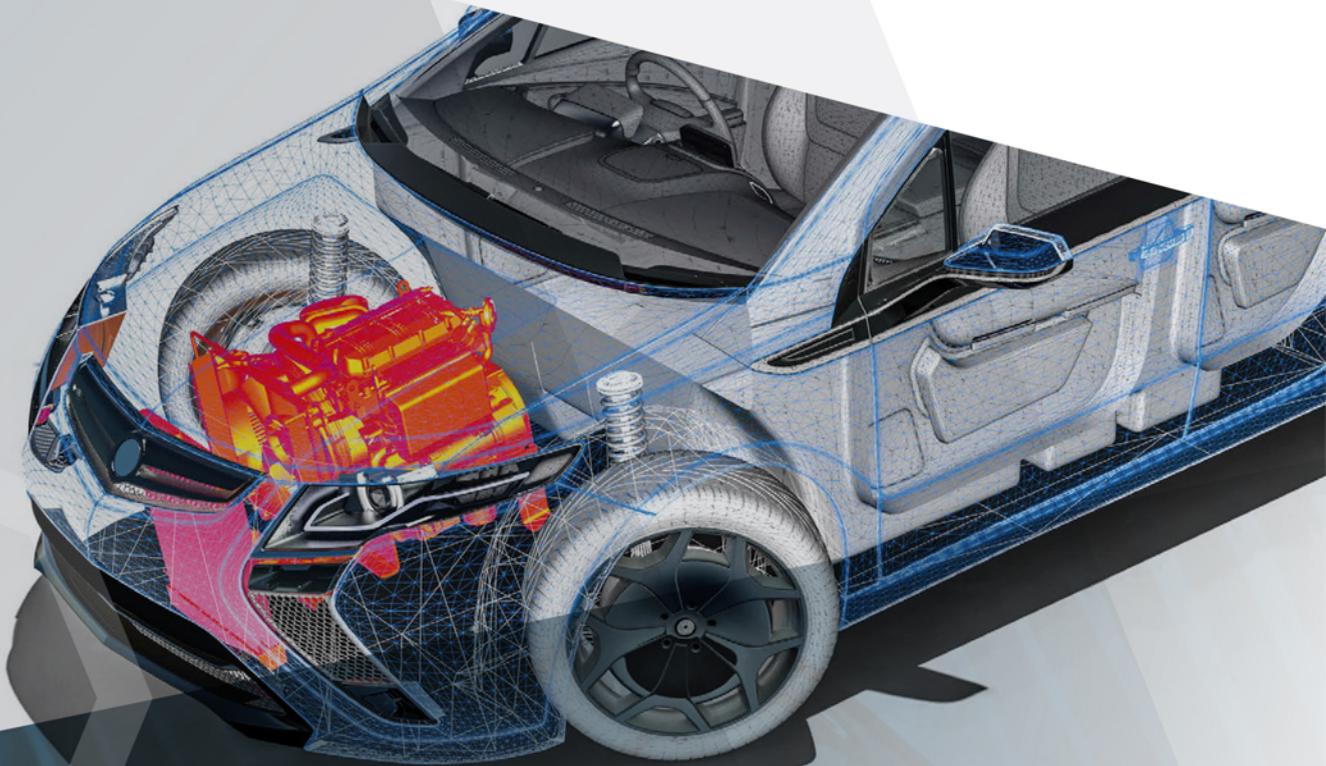
gy for more than 20 years since I recognised the potential opportunities for inkjet printing in PCB manufacture. During that time, I have been closely involved with several development groups, both in the equipment and the materials areas, and I have attended and reported on numerous conferences and symposia, as well as speaking with many exhibitors at the trade shows. Solder mask has always been an ultimate objective, but realistically unattainable until recently, for a variety of reasons. It has to do, partly, with printer capability, and partly with ink printability. The formulators have had a difficult job because solder mask becomes a permanent material feature of the PCB and is subject to critical qualification and approval. Generally, if an ink would jet, it wouldn't pass qualification; and if it would pass qualification, it wouldn't jet! But because of equipment developers like yourselves working closely with ink formulators, it appears that the ultimate objective has been realised.

So, Luca, please tell us a little about your experience in equipment design and development in the electronics and semiconductor industry.



**ventec**  
INTERNATIONAL GROUP  
騰輝電子

## **autolam:** Base-Material Solutions for Automotive Electronics



**autolam** 

Automotive electronics technologies are evolving at an increasing rate. Paying attention to the properties of materials at the substrate level is the first step towards achieving the most stringent performance targets of today's automotive manufacturers. autolam offers the solutions demanded by the diverse and unique requirements of automotive applications today and in the future.



[ventecclaminates.com](http://ventecclaminates.com)

**Gautero:** I'll do my best to keep it short. My experience throughout time and market is best described as someone who improves the given equipment toward a cheaper, faster, or enhanced production. This started during my academic time at Fraunhofer ISE, where a complete photovoltaic pilot line gave the possibility for PhD candidates like me to make the most of each tool installed. Once in the private sector, this approach has continued on several kinds of coatings: anti-reflective, passivation, moisture barrier, semicon packaging, and now, solder mask coating. All of these need a cheaper manufacturing on a larger surface area.



Luca Gautero

**Starkey:** You have certainly had broad process engineering experience. How does this help you in your role now?

**Gautero:** My contributions to the company's effort were different for each application; sometimes the whole equipment was non-existing, sometimes the tool needed additional parts, and sometimes the game was to squeeze higher performances from "what's on the floor." These look like different situations, though there is a common line: how the equipment manufacturer brings expectations into the tool. Plenty of literature explains why specifications (in the larger sense this includes MRS, FDS, RI, FMEAs, safety, etc.) and acceptance documents exist, and what they contain—as well as how these interact during the tool lifetime as a product. Still, seeing their positive and negative interactions firsthand shows the fluidity of such concepts. Now as a product manager for inkjet solder mask, my role is to orchestrate, not manage, this fluidity.

A successful tool fits the market needs at the right time and with the right cost of ownership. This match and its coming of age are in front of everyone. It is a challenge we share

with few other excellent companies—which, by the way, makes it even more fun.

**Starkey:** Luca, we're familiar with the PiXDRO family of inkjet printers. I understand that PiXDRO is now part of the SUSS MicroTec organisation. Could you briefly describe how this came about, and how PiXDRO fits into the SUSS MicroTec portfolio?

**Gautero:** PiXDRO is a vision and a brand that existed well before I joined the team. Throughout the years we have applied inkjet printing across many applications in the electronics industry. SUSS MicroTec, as a leading supplier of process equipment for microstructuring in the semiconductor industry, recognized the importance of patterning and the role that inkjet can play in this. It recognised the potential of inkjet printing in the semiconductor industry and acquired PiXDRO for this reason. The idea is to create a future in which the focus of SUSS MicroTec, namely high yield for backend and packaging aspects of the semiconductor industry, can benefit from precise additive technology. This calls upon all the knowledge that PiXDRO has in house. Inkjet solder mask is very relevant and already commercially successful.

**Starkey:** What's your installed base of inkjet printers, and what typical applications are they employed in?

**Gautero:** The PiXDRO team disseminated the inkjet capabilities very well. There are hundreds of R&D printers (the PiXDRO LP50, under the care of Dennis Kuppens) all over the world, most of them in printed electronics, from conductive lines to solder mask; tens of production printers in several business areas (such as semicon, photovoltaic, printed electronics); and, coming back to today's topic, two installed PiXDRO JETx-Ms for solder mask printing in Europe currently running production.



Figure 1: The PrintLab while action is taking place.

PiXDRO, therefore, has a lot of experience to share; the in-house laboratory, called the PrintLab (Figure 1), hosts a number of our tools in several configurations. These enable demonstration and consultancy work all through the year. This is where the team of Wouter Brok, innovation manager, often astonishes us by bridging inkjet printing to unexplored markets. We welcome interested customers to personally experience what is behind the scenes of an inkjet printing process development; by necessity, we recently became better at doing this remotely.

**Starkey:** Thanks for filling in the background, Luca. Could we talk about some recent developments in inkjet printing technology? I've heard the saying "Keep calm and keep on printing." How is that possible?

**Gautero:** When explaining the capabilities of inkjet for manufacturing, I often can see the doubt in the minds of the receiving partner. Everybody has had experience with a cheap inkjet printer at home, with high maintenance costs (expensive ink) and missing features, such as color.

The answer starts by moving the attention from an A4 toward ceramic tiles, billboards, and other large surfaces. Industrial graphical inkjet printers create these products. This graphical sector and its machinery are actually the right comparison term. In fact, the growth of this industry enabled the quick development of high quality printheads during the last decade. The inkjet tools on the market for solder mask have all made their decision based on these, now available, advanced technologies. At SUSS MicroTec Netherlands, we target low operation and maintenance costs. This keeps the business meaningful for the customer.

**Starkey:** Indeed, the bridge between the graphical industry and printed electronics explains the recent history. However, it is still not clear how you can create an inkjet printer that always works.

**Gautero:** When the PiXDRO team formulated the solder mask requirements a few years back, knowledge of several types of printheads was essential. The modularity of the in-house R&D printer and our PrintLab provided the neces-

sary data for the decision. A tool to “Keep calm and keep on printing” has four requirements:

1. MEMS printheads for its great precision, its high density of nozzles and its reproducibility and reliability.
2. A recirculation system to zero on the starting time, decrease maintenance and reduce clogging.
3. A small drop size able to pattern tiny features.
4. Make use of high-tech solutions from the graphics industry to spread the contribution of each nozzle to a larger area to homogenize the print result.

In conclusion, these requirements gave the PiXDRO JETx-M system a Fujifilm Dimatix SAMBA® G3L as printhead (Figure 2), which has the whole package. In simple terms, it's like thousands of reliable teaspoons for millions of espresso cups, instead of a few ladles.



Figure 2: The heart of the JETx-M printer, the Fujifilm Dimatix Samba® G3L printhead.

**Starkey:** I understand what you mean, and it's clear that PiXDRO has established a resilient and reliable core technology. PCB fabrication also has its challenges. What, in your view, makes inkjet such a logical technique for solder mask coating?

**Gautero:** There are three important things about inkjet printing: digital, digital and digital.

The CAM station is creating a description of the whole board manufacturing. This is a digital information understandable directly from an inkjet printer. It is still possible to go one

step further and fully integrate PCB CAM workflow with a specific software. This happens on our platform: the JETx-M. This seamlessly integrates into the customer current workflow. Aside from simplicity and obtaining the famous “what you see is what you get” (WYSIWYG), it enables all new possibilities by inkjet in a user-friendly way. The incoming description becomes a printing strategy: a set of digital instructions for the printer to create multiple layers of print.

The alignment operation, either ex-situ or in-situ, provides a set of coordinates for each single board that are used “on-the-fly” to deform the digital file to match reality. This goes beyond “finding the board” by compensating offsets or finding the subpanels, by applying some X-Y fixed scaling. The target is to maximize panel yield, so “finding the pads” by applying linear scaling or “finding the last micrometer of accuracy” by multi-point linear scaling for local deformations. All options are available in this digital procedure.

Finally, and this is where the inkjet printing will start to outshine the traditional technology, digital solder mask overlays can be digitally defined: local definition of thicknesses, critical regions where solder mask cannot be present, matte and shiny areas within the same pattern and serialization. Even legend functionalities can be integrated as required. This enables material savings, local functionalities, better and easier further assembly of the board, and several other advantages that smart OEMs can find out when these overlays come to their attention (Figure 3).

**Starkey:** I can appreciate the benefits of a digital printing strategy, and understand some of the options that it offers, but what else can you tell me? Is it sufficient to have high quality printheads driven by some clever computer software?

**Gautero:** No, there is more than meets the eye. Another point of attention is the tool interac-



Figure 3: Example of serialization of panels in clear sight, hidden or absent.

tion with the ink. Our customers benefit from our expertise with a recommended ink. However, being able to choose between multiple ink suppliers is an attractive feature of our system. In principle, the PiXDRO JETx-M is ink independent thanks to its highly chemically passive materials and components along the ink path. Therefore, if jetting and curing are correct, the machine can print it. However, as you can imagine, the inks on the market today and in the future will contain the most disparate components. This introduces unknowns and, for what you do not know, you cannot prepare. Luckily, we learned early in the development about such challenges. From that time on, to remain on the safe side and still enable robust processing, we created a material compatibility kit to run stress tests on future alternative inks. This will avoid bad situations like a chemically attacked gasket resulting in litres of ink spilling out, more subtle situations like inexplicable shifts in performances, or sudden increases of maintenance time “to get it working.” Negative results from stress tests enact specific changes in the ink path that will hence ensure a robust process. Thanks to agreements with our components suppliers and the modularity of the system, these data-driven changes are quick and effective.

**Starkey:** Luca, I understand you have developed the in-house capability to characterise

and qualify inks. Could you tell us something about how it works?

**Gautero:** At first, a few years back, there were just a couple of available printable, curable inks. So, qualification was only about results repeatability. In the last couple of years, however, a wealth of companies stepped up their game and prepared interesting formulations for solder mask. Since we are technicians at heart, we started trying some of them. However, after a first, goofing test, we adopted a rigorous structure of milestones to qualify all these incoming ink alternatives. Three milestones keep it small and simple: Each milestone is the gateway to the next one. The first gateway is information; written documentation needs to cover safety, rheology, wetting behaviour on PCB surfaces, standard operating procedures for printing and maintenance operation (i.e., filling and draining the system as well as the results of the material compatibility kit), and the ink suitability as solder mask. For the latter, we refer to tests stated in IPC-SM-840. We know that it is only part of the story, though it’s a minimum requirement.

The second is the real deal: An R&D printer in our PrintLab becomes the test vehicle for the ink. Our printing strategies, together with the candidate ink’s curing and post-treat instructions, are applied. The resulting panels (Figure 4) are then characterized, either manually or automatically, to define the ink process suitability.

The last phase involves the PiXDRO JETx-M in our PrintLab and a commercial aspect. The ink reaching this level is good enough to print, though we ask the material supplier to introduce a willing, independent PCB manufacturer as supplier of half-fabricated large substrates and judge of the final inkjet coated solder mask. This third party will then, independently from us or from the material supplier, validate the effort performed so far.

**Starkey:** What parameters determine how an ink will perform in practice?

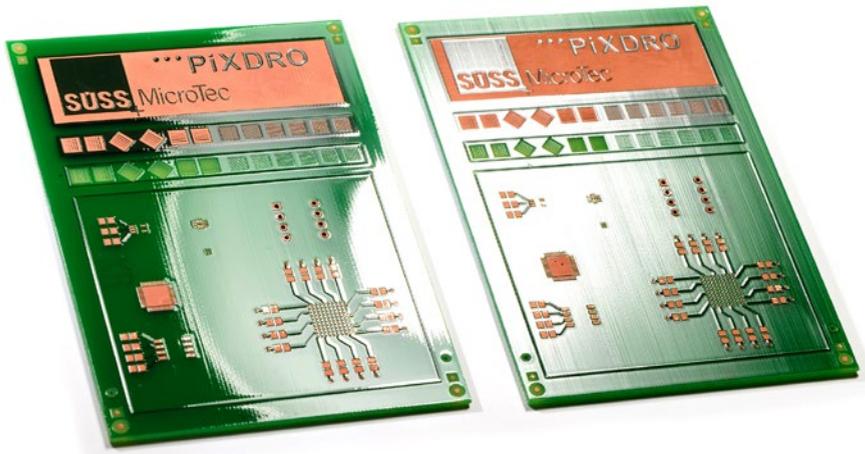


Figure 4: Example of “SUSS demo” panels where the typical challenging features are printed and characterized. Two appearances are presented in the picture: From the same ink, a change of printing strategy delivers a shiny or a matte appearance (see the lamp reflection).

**Gautero:** The ink is fluid when it lands, so all the theory on the liquid-solid-gas interaction holds. Here, the required information on surface wetting comes in hand. Printing strategies are flexible and can compensate for a wide range of wetting behaviour. However, a lot of compensation means that something has to give; an underperforming ink might therefore affect the feature size or the throughput or both.

**Starkey:** Luca, you have presented a very well-reasoned explanation of the science behind your developments, but much of it relates to the laboratory. How can you convince our audience that your inkjet technology is ready for production?

**Gautero:** Good question, Pete. First, we can show the performance with a demonstration on our mass production tool, the PiXDRO JETx-M, which is installed in permanence in our lab. Moreover, demonstrations of the tools installed at our customers can be arranged; our distributors around the world—Adeon for EU, Technica for North America, and TKK for Asia—would be very happy to support here. On the other hand, I can give extensive quan-

titative answers on demonstrated feature size and throughput, though this would relate the discussion to our tools, and we want this interview just to present the technology. Hence, since the reader can easily retrieve this information, I will take a different angle. PiXDRO is not alone in the market, we have a number of valuable competitors on the solder mask market. Both your hands are no longer enough to count the number of tools out

there printing full size boards. Then again, everybody is claiming perfection. While not all of these tools are running productions, still, the tool supplier experience is common: A tool is at a PCB manufacturer, and it has a large table with thousands of nozzles and precise alignment, and available (and straightforward) integration to automation. This is what the market wants. I would even go further and say that this is what the market is starting to like and appreciate, especially when care goes into simplifying the CAM-to-production workflow with WYSIWYG concepts. The green factor—the digital nature—will become more and more evident and justify further deployment of the inkjet technology.

**Starkey:** Luca, I’ve really enjoyed this discussion, and I’m grateful for you taking the time to answer my questions and to give such clear explanations of how the challenges have been addressed and overcome. I certainly believe that inkjet printing of solder mask is now a practical reality, and I wish you every success in promoting the technology. Thank you.

**Gautero:** Thank you, Pete, for your involvement and interest in inkjet printing. **PCB007**



# MilAero007 Highlights



## Elbit Systems Awarded \$24M Contract to Supply Tactical Computers for Royal Netherlands Army ▶

Elbit Systems Ltd. was awarded an approximately \$24 million contract from the Dutch Ministry of Defence to supply the Royal Netherlands Army with new vehicular tactical computers. The contract will be performed over a 30-month period.

## L3Harris Technologies Demonstrates Antenna Technology for U.S. Space Force Satellite Communications ▶

L3Harris Technologies has successfully completed a technology demonstration, under a Defense Innovation Unit prototype contract, for the U.S. Space Force satellite communication system to improve communications with the agency's growing number of satellites.

## Defense Speak Interpreted: Your Best Friend is a Skyborg? ▶

Suddenly the term "Skyborg" is popping up in Air Force publications, and if you are an Air Force pilot, your future best friend may be a Skyborg. To understand the concept behind the term Skyborg, we need a bit of weapons strategy for the Air Force.

## Book Excerpt: Thermal Management with Insulated Metal Substrates, Part 5 ▶

The following is an excerpt from Chapter 5 of *The Printed Circuit Designer's Guide to... Thermal Management With Insulated Metal Substrates*, written by Ventec International Group's Didier Mauve and Ian Mayoh. In this free

eBook, the authors provide PCB designers with the essential information required to understand the thermal, electrical, and mechanical characteristics of insulated metal substrate laminates.

## Tales from a Trailblazer: An Interview with Christine Davis ▶

Columnist Steve Williams recorded a series of interviews with new I-Connect007 columnist Christine Davis, president and founder of contract manufacturer CAMtek, who recently joined Zentech Bloomington. As a female business owner in a male-dominated industry, Christine has a unique perspective on what it takes to thrive in the electronics industry, and shares some of her stories and lessons learned along the journey.

## The Government Circuit: IPC is Ready for the Year of Advocacy Ahead ▶

As anticipated, it was a busy close to 2020 in Washington, and we saw resolutions on several major legislative priorities, including coronavirus recovery, spending bills, and the National Defense Authorization Act. IPC was able to secure some policy victories for the electronics manufacturing industry and keep our agenda moving forward into the new year. Read on for some of the recent highlights.

## IPC Applauds U.S. Defense Department for Establishing New Defense Electronics Consortium ▶

IPC, the global association of electronics manufacturers, is applauding the U.S. Department of Defense for establishing a new Defense Electronics Consortium.

# Do You Have a CPIM?

Feature by Barry Matties

I-CONNECT007

Process improvement is a never-ending endeavor for all companies; however, the difference is the pace at which a company pursues this idea. Some make it a proactive culture, others take a reactive approach, and there's a group somewhere in the middle. When you compare the types, the proactive culture typically outperforms the others in all key metrics in the long run.

Continuous improvement drives out waste in your processes, streamlines workflow, and gives you a competitive advantage. So why do some live and breathe it—and some don't? That has to be answered individually. As a customer, when you deal with a supplier that is dedicated to continuous improvement, you feel the benefits; when you deal with a supplier that doesn't have that mindset, you feel that as well. One is smooth and pleasant and the other can result in disappointment.

## A Designated Role

Because continuous improvement is a daily task, the question is: Who is responsible for it? Look at the list of titles in your company and

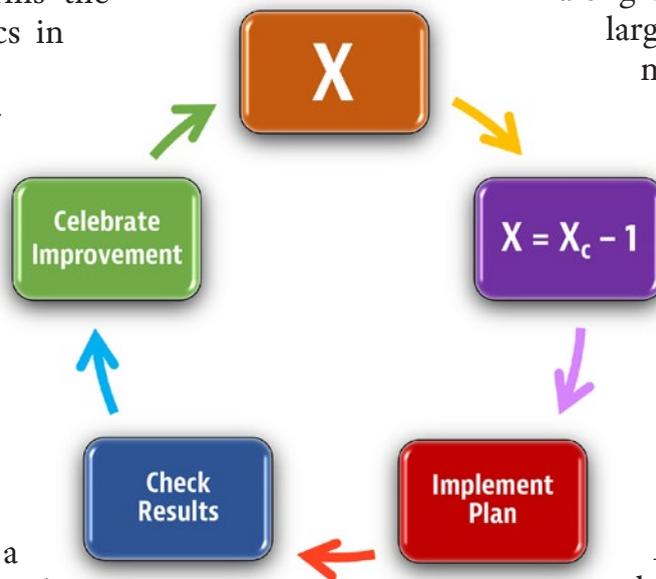
you will typically see CEO, VP, sales, accounting, manufacturing, and so on. The one that you rarely see is chief process improvement manager (CPIM), yet this may be the most essential position in your company. It may be hard for some to justify the added expense, but once you realize improvements, you will see the CPIM could be worth their weight in gold. Often in smaller organizations, you will see the

leadership take on the role of CPIM, along with their other tasks. In large companies, this role may expand into a process improvement department.

Overall, the role of your CPIM is to examine, document, and work to improve all your processes. This includes your business processes as well as your manufacturing processes.

As they do this, they will then begin to challenge the current processes by asking,

“Why do we do it the way we do it?” Often, the answer is, “Because we've always done that way.” *Why* is one of the most important questions they can ask: Why are deliveries late? Why do we have scrap? Why do we do this step? Why do we use this tool? Why do we have a bottleneck? Why is work in progress at a standstill in the hallway? By asking why, the status quo is challenged, and improvement begins.



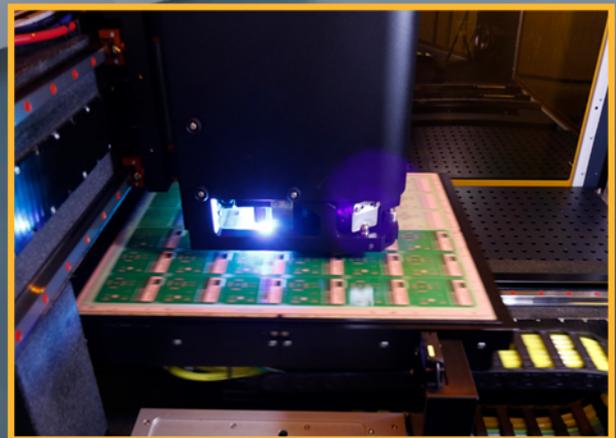


**TECHNICA, U.S.A.**

Fulfilling Manufacturing Needs Throughout the Electronics Industry



# ●●● PiXDRO JETx-M



**BEST IN CLASS  
SOLDER MASK INKJET PRINTER**

Available through Technica, USA in Assigned Territories

**1-800-909-8697 • [www.technica.com](http://www.technica.com)**

Some people may feel threatened by the “why” question, feeling like it’s a personal attack on their work. It is not, and an experienced CPIM will work with and train your team to realize that they are attacking process and not people. By doing so, they will be facilitating a continuous improvement culture and fostering teamwork.

Keep in mind that your CPIM does not need to be an expert on what you’re doing; they need to be an expert on how to make systems more efficient and facilitate change within your team. The process owners will work with your CPIM and together they will drive out waste and optimize your company.

I found a good example of this in 2020 when I had a chance to visit Ventec International Group in Germany. That’s where I first met Frank Lorentz, who was brought in as the general manager even though he did not have any previous laminate or PCB industry experience. Frank’s expertise is logistics, and he is definitely a systems thinker. In a very short period, not only did Frank optimize key processes, but he created a culture of continuous improvement. Even though his official title is general manager, I would say that he’s also their CPIM. A link to the interview I conducted with Frank can be found at the end of this article <sup>[1]</sup>.

Unless you have a dedicated effort to continuous improvement you may be missing some real opportunities to have a competitive advantage. I am not talking about the big improve-

ment plans, though they are a part of it. It’s the small things that can add up in a big way. Here at I-Connect007, we have a focused commitment to continuous improvement. Here’s one example of how a small change can have a big impact.

In this case, we examined workflow and discovered that if we just reordered one step in our process, we would save 40 labor hours per month and improve the product. Of course, we made the change, saved the labor hours, and found that other benefits rippled through our entire process. If we did not challenge the process with our *why* question, we would have just done it the way we had always done it. Having those hours back added extra capacity to our team and reduced our overall cost of producing our product. This is a prime good example of how  $X = X_c - 1$  works. If you would like to learn more about  $X = X_c - 1$ , our January issue of *SMT007 Magazine* is dedicated to this topic.

Process improvement can provide a huge return on investment. But like anything, if you are not committed to it, and you do not have a CPIM in your organization along with the resources needed, then you could really be missing out on removing waste in your processes and optimizing your organization. PCB007

## References

1. *Logistics Are Frank Lorentz’s Passion*, Ventec International Group interview with Barry Matties and Frank Lorentz, PCB007.com, January 2020.

The banner features a portrait of Joe Fjelstad, a man with short grey hair wearing a dark leather jacket over a red shirt. To the left of the portrait is the 'I.007e WORKSHOP' logo in green and white, and below it is the 'American Standard Circuits' logo with a stylized 'A.C.' and a lightning bolt. To the right of the portrait, the text reads 'On Demand: Free Training Video Series' in white, followed by 'FLEXIBLE CIRCUIT TECHNOLOGY' in large white capital letters, and 'with Expert Joe Fjelstad' in smaller white text. A green button with the text 'WATCH NOW' is located in the bottom right corner.

# Why Choose Fein-Line?

Because there is a fine line between winning and the alternative.

**Fein-Line Associates** is a consulting group serving the global interconnect and EMS industries, as well as those needing contact with and/or information regarding the manufacture and assembly of PCBs. Dan (Baer) Feinberg is a 50+ year veteran of the printed circuit and electronic materials industries. Dan is a member of the IPC Hall of Fame; has authored over 150 columns, articles, interviews, and features that have appeared in a variety of magazines; and has spoken at numerous industry events. As a technical editor for I-Connect007, Dan covers major events, trade shows, and technology introductions and trends.

Fein-Line Associates specializes in:

- Management consulting
- Technology transfer
- New product market entry
- Merger and acquisition due diligence
- Market information and market research
- Expert witness assistance and seminars regarding all aspects of printed circuits
- Electronic assembly manufacturing and marketing

**Fein-Line Associates**  
P.O. Box 73355  
San Clemente, CA 92673

Telephone: (949) 498-7866  
Email: [baer@feinline.com](mailto:baer@feinline.com)



Dan (Baer) Feinberg



[www.feinline.com](http://www.feinline.com)



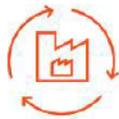
# Suffering from Test Anxiety?

We have two proven frameworks to eliminate all your anxiety!



## OnDemand Solutions

Global service where and when you need it



## Integrate Solutions

End-to-end support that is fully integrated with your infrastructure

## Our testing solutions will:

- Improve overall quality
- Increase customer retention
- Reduce your costs
- Yield higher throughput
- Streamline your processes
- Add capacity

[Get Relief NOW](#)



There are multiple variations within the printed circuit board manufacturing process. That is a fact. Having a deep understanding of these possible variables and their ultimate effect on quality is the cornerstone of process control and management. This understanding becomes the basis for complex troubleshooting activities.

## Approaches to Process Control

I strongly suggest that operators and engineers monitor all aspects of the processes for each unit operation. This includes walking the line, taking measurements, recognizing what is not in control (and getting it back within range). Quality and yields must come first—not pushing out production and cutting process costs! Indeed, SPC charts are often seen dotting the walls of the company's laboratory, theoretically giving the impression that crucial unit operations within the manufacturing facility are in control. That is not always accurate. For example, several processes can be set up for automated analysis and replenishment of critical chemical additives. However, this often only covers the basic additives in the electroplating or electroless plating processes (copper concentration, acid levels, etc.). What about the organic additives (leveling agents, throwing power enhancers, stabilizers) that profoundly affect the overall quality and reliability of the plated deposit? How does one know with any confidence that these critical additives (special additives that influence ductility, grain structure, resistance to thermal excursions) are in the proper range?

The fabricator can rely somewhat on the chemical and material supplier for the analysis of key organic additives. In general terms, these critical additives are packaged so that they are replenished as the essential inorganic additives are added. Yet, TGW—there is potential for additive decomposition and the potential of over-adding these materials. This is precisely why different approaches to process control are needed. This means that additional

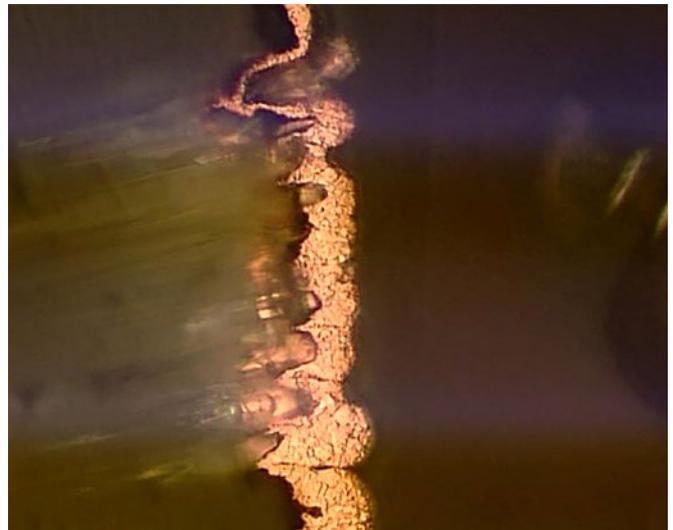


Figure 1: Extreme rough hole wall due to poor drilling practices.

analytical methods, coupled with quantitative measurements of rinse water cleanliness and temperature, are critical to success, along with the basics described above. In addition, operators should regularly inspect nozzles in various spray modules for wear and tear, then replace those nozzles as needed. Finally, methods to prevent the drag-in of harmful chemicals and enhanced filtration of all solutions are just several of the best practices that must be implemented.

Figure 1 shows the significant hole wall roughness. Analysis of this situation told the tale of too many hits from the drill bits. The fabricator looking to cut costs increased the hit rate from the recommended 2,000–2,500 hits to 4,500–5,000 hits, with deleterious consequences! Best practices were not being followed here. When best practice procedures were implemented—all drill bits were limited to 1,700–2,000 hits, resharpened once, and then discarded after another 1,500 hits—the drilled quality drastically improved, as did the subsequent plating quality (Figure 2).

## Benchmarking Best Practices

The above example aside, let's review what this author considers critical performance enhancers that often are not considered important by many fabricators. This is only a partial

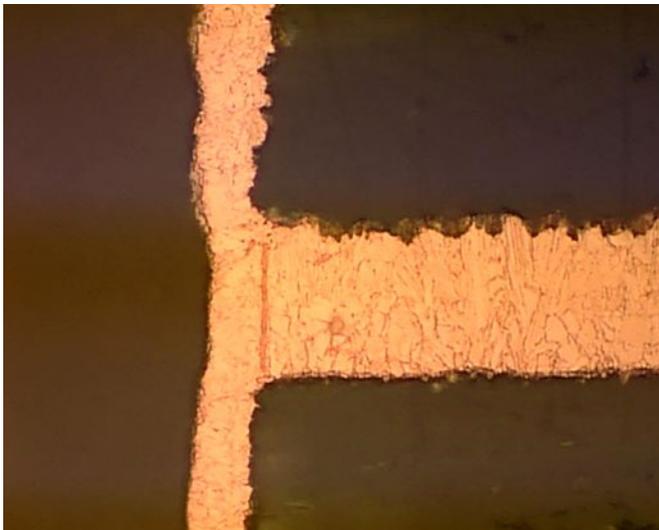


Figure 2: Via quality after implementation of best practice.

list, however, there are several deemed worthy of benchmarking and implementing best practices.

### **Rinsing**

The PCB fabrication wet processes require good quality rinse water and best practice regarding proper rinsing design. Here again is the quest to reduce cost by cutting back on rinsing. This is not an ideal situation. Yes, it is a hard fact that processing printed circuit boards consumes large volumes of a precious resource. However, there are ways to remove contaminants from the printed circuit board and still conserve water.

At first thought, rinsing is often defined as removing process solutions from work, or in the case of the PCB industry, a panel. This is true, if not absolutely true. In general, rinsing is not the complete removal of the contaminants but rather a dilution of a process solution from work (panel) down to “manageable” concentrations. With this definition in mind, rinsing systems can be designed to minimize harmful contaminants on a printed circuit board and reduce water consumption. I’m often asked if some “standard” can be applied to the rinsing process. Are all types of contaminants the same? Is there a hard and fast rule for rinsing? The short answer is, not really. What consti-

tutes a “manageable” concentration is dependent upon three conditions:

- The type of contaminant
- The tolerance of the following process step for the particular contaminant in question
- The effect the residual contaminants have on the work

The bottom line is to use tempered water rinses, along with sufficient dwell times required to remove the majority of these harmful contaminants. Counterflow rinses are particularly effective. When rinsing is ineffective (Figure 3), the stark reality of contaminant drag-in to subsequent process steps is certain.

Consider issues related to the electroless copper metallization process. Inadequate rinsing after the micro-etch step will lead to copper ion drag-in to the palladium-based catalyst. And it is well documented that high copper



Figure 3: Poor rinsing leading to cleaner drag-in to another key process tank: Significant foam from residual cleaner drag-in.

levels in this process will act as a catalytic poison, which then leads to the possibility of voids in the copper deposit.

### Conductivity Probes

One of the least expensive things one can purchase for process control is a conductivity probe. This little unit (looks like a ballpoint pen) costs about \$200. This is a great way to monitor the rinse water cleanliness and the rinsing operation's overall effectiveness. The use of these probes is also an excellent method to measure contaminant build-up in certain chemical processes. An example of a conductivity probe is shown in Figure 4.

### CVS (Cyclic Voltammetric Stripping)

While most fabricators rely on Hull cell plating analysis to gain some control of the additives in the electrolytic copper plating solutions, one must resort to a more quantifiable means to measure and control for today's technology organic addition agents. Cyclic voltammetric stripping is an electrochemical technique used for the measurement of organic additives in plating baths. It is based on the effect that the additives have on the rate of electroplating. Regardless of the specific type of organic additive (brightener, leveler, grain refiner, etc.), its activity is reflected in a change in the plating rate.

The analysis is performed in an electrochemical cell using a three-electrode system, one of which is a platinum rotating disk electrode. During measurement, the potential of the platinum electrode is controlled by the instrument. The potential is scanned at a constant rate back and forth between negative and positive voltage limits. A small amount of metal from the plating bath is alternatively plated onto and stripped off the working electrode



Figure 4: Conductivity probe, courtesy of Myron L Company.

as the potential is changed. During the scan, the current at the working electrode is measured as a function of potential.

The activity of the additive will affect the plating rate of the metal onto the electrode. The plating rate is determined by calculating the charge required to strip the metal of the working electrode. The relationship between the stripping charge and the additives' activity is used to measure the additives and their components quantitatively.

A typical CVS scan for acid copper analysis may proceed from 1.5V to -0.225V and back again to 1.5V (Figure 5). During this potential sweep, the copper metal will be plated onto the platinum electrode and then again stripped off. The area of the curve under the

stripping peak is measured in millicoulombs (mC). Each scan is performed equivalently, and multiple scans are committed to both condition the disk and allow for averaging the results from each potential sweep.

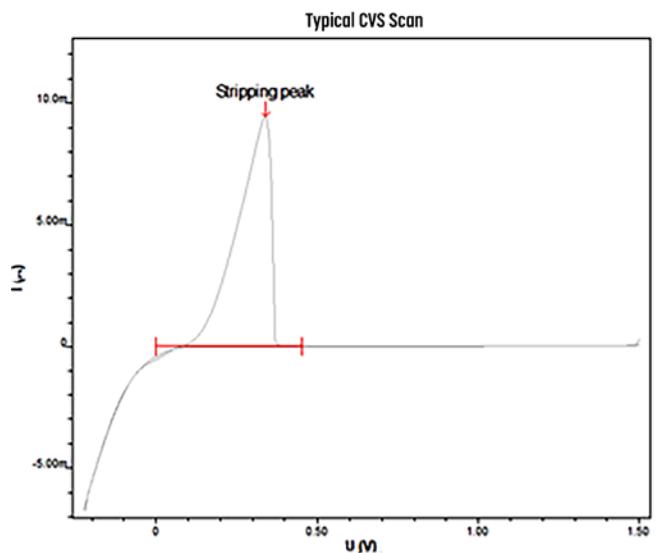
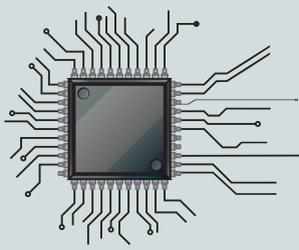


Figure 5: Typical CVS scan showing the stripping peak. The area under the stripping peak curve is the millicoulomb reading obtained for the scan.



# MivaTek

## Global

### 2000 Series Small Footprint



### 2400 Series High Throughput



### Features

- Quad-wave LED DLP: 360, 375, 390, and 405nm
- Worldwide LED DLP Patent Holder
- Panel Sizes: 24" x 30" (up to 30"x60")
- Up to 6 Light Engines, High Throughput
- Compact Footprint, Low Cost of Operation
- Low Maintenance Costs, No Contract Required
- Automation compatible with third party sources

### Applications

- PCB - IL OL, SM, Diazo
- Chemical Milling
- Electroforming
- Micro Electronics
- Interposer
- Chrome-Glass Emulsion

### Configuration Options

Feature	2000 Series	3000 Series	2400 Series	12000 Series
50/25/10 micron features	●	●	●	●
Sub-10 micron available	●			●
Mixed Resolution Available	●	●	●	●
Max Panel : 12 x 16	●	●	●	●
Max Panel : 24 x 24	●	●	●	
Max Panel : 24 x 30	●	●	●	
Max Panel : 30 x 60 or 42 x 60		●		
Panel Index Capable	●	●		
Dry film resist	●	●	●	●
Soldermask	●	●	●	●
Silver / Chrome Phototools	●	●	●	●
Reel to reel	●	●		
Automation available	●		●	
MivaMeasure available	●	●	●	●
Lifetime Software Upgrade	OPT	OPT	OPT	OPT
2 year light source warranty	STD	STD	STD	STD
Local Technical support	STD	STD	STD	STD
Local Applications support	STD	STD	STD	STD
TekFlex Support Plans	OPT	OPT	OPT	OPT

CVS analysis is used to measure the organic addition agents' concentration present in the copper plating solution. This method is adaptable to quantifying both suppressors and the grain refiner/brightener in the working solution. This allows the fabricator to make required additions of critical components properly without the risk of over-adding or allowing the key components in the plating solution to fall out of balance.

### **Filtration**

The need for filtration cannot be overemphasized, mainly when plating in through-holes and blind vias. Any void in the plating in the hole caused by small contaminants causes a reduction in the area available to carry the electric current. Rejects would also be caused when insoluble debris is co-deposited on the surface of the hole.

Flow rates are the only means of carrying solids to a filter or bringing a new solution into contact with the particulate matter. The flow rate is referred to as the turnover—total gallons pumped per hour concerning the size of the tank (for example, 200 gal/h on a 100-gallon tank is two turnovers per hour). Dirt-holding capacity is essential and can be attained with throw-away paper cartridges of different porosities, or filter surfaces coated with filter aid. Porosities of 100 microns down to less than 1 micron are typical. In practice, the average plating solution is turned over once per hour. The recommended flow rates should provide at least two complete tank volume turnovers per hour. However, to achieve the ultimate clarity, turnovers of up to 10 times per hour may be necessary. Keep in mind that the initial flow rate is not the average flow rate. In other words, if one started at 1000 gal/h, and cleaned or replaced the filter when the flow was reduced to 200 gal/h, the actual average flow would probably be about 600 gal/h, depending upon the type of filter media used.

Ineffective filtration leaves debris in the rinse and process tanks (Figure 6).



Figure 6: Sediment remaining in a process tank that used no filtration.

### **Temperature Control**

All too often, while process engineers and technicians focus on wet analysis, the operating temperature checks often go overlooked. Rinsing and developing are typical processes that are more effective with tempered rinses. All too often, when rinsing uses incoming water (during the winter months in very cold climates), the water temperature is quite cold unless heaters are in place.

An increase of 10°K at temperatures not far from room temperature will increase the reaction rate by a factor of 2 to 3 (see chart below).

°F	°C	°K	Rate Increase
72	22	295	—
90	32	305	2-3X (200-300%)
108	42	315	1 ½X (150%)
126	52	325	1X (100%)

At some point, the reaction rate increase starts to level off. What's the point to this?

The temperature has a significant influence on chemical reactions and rinsing.

### ***Solution Agitation***

Proper agitation and solution movement improves the efficiency of rinsing as well as improves plating distribution and uniformity. For best practices, the following rules apply:

#### ***Mechanical agitation for PTH processing:***

##### **1. Baskets/Racks**

- Should be ridged to withstand the vibration energy
- Needs to hold the panels tightly so they don't move

##### **2. Spacing**

- < 0.059" @ 0.5"
- 0.060–0.125" @ 0.5–1.0"
- 0.125–0.250" @ 1–2"
- >0.250" @ 2"

##### **3. Agitation (Rack)**

- 2- to 4-inch stroke on center
- 14–16 revolutions/minute

#### ***For Electroplating Processes:***

This will depend on the electrolyte. Electrolytic copper responds very well to eductor-type agitation. Eductor agitation is based on the Venturi Principle, whereby one volume is pumped, and up to four volumes are drawn-in by the pressure drop, making it a highly efficient jetting system. When fully submerged, no air is introduced into the plating solution. Several manufacturers market eductors. Eductor agitation overcomes several of the disadvantages associated with air agitation. Air bubbles and misting are eliminated. In addition, eductor agitation provides a more uniform mixing of the plating solution. This minimizes potential "dead spots" in the cell where the air agitation is lacking. It is well known that educators provide more uniform agitation, better known as laminar flow.

In contrast, air agitation provides turbulent flow and may only promote the mixing of the solution. For quality plating results, it is pref-

erable to have interface agitation. That is, one interface agitation is directed more at the cathode diffusion layer. This reduces the diffusion layer thickness, thus permitting the efficient delivery of additives and ions to the cathode surface.

Concerning tin plating solutions (etch resist), metal deposit uniformity is critical. This is especially critical on the pads and the knee of the via. Thin deposits often occur in these areas on the circuit board. As a consequence of thin plating, the etching process's opportunity to cut through the tin is easily realized. This then may lead to the etching of the plated copper.

This issue is mitigated with best practice agitation. While air and eductor agitation are contraindicated for electrolytic tin plating, mechanical agitation is a must. Tin plating best practice is to set up through-hole mechanical agitation. This action ensures optimal delivery of process chemistry to the surface of the board and through the vias.

### **Summary**

Certainly, most operators and engineers worry about controlling the wet chemistry of the printed circuit board fabrication's various processes. Yet, they are often surprised and disappointed that the finished product's quality is not meeting stringent requirements and key workmanship standards. Further examination will find that other aspects of the process often overlooked were not controlled and maintained. Thus, it only makes sense that in addition to wet chemistry, other non-chemical factors be monitored and controlled. These include rinsing, filtration, agitation, and temperature controls. Ignore these best practices at one's peril. **PCB007**



**Michael Carano** is VP of technology and business development for RBP Chemical Technology. He is also a long-time *PCB007 Magazine* columnist. To read Mike's columns or contact him, [click here](#).

# Attacking the Loophole That **Does Not Exist**

The PCB Norsemen  
by Jan Pedersen, ELMATICA

When producing PCBs, we follow IPC standards for Qualification Performance and Acceptance from design, through production, to customer incoming inspection and acceptance. However, there is often one way of writing a standard and a different way of interpreting it.

Today I will attack a loophole that does not exist, yet is still used by many. Let's dig into the term "workmanship" as written in IPC-6012E 3.3.10, which represents the Qualification and Performance Specification for Rigid Printed Boards. You find the same section in IPC-6013 and IPC-6018. The requirement says:

## **IPC-6012E 3.3.10: Workmanship**

*Printed boards shall be processed in such a manner as to be uniform in quality and show no visual evidence of dirt, foreign matter, oil, fingerprints, tin/lead or solder smear transfer*

*to the dielectric surface, flux residue and other contaminants that affect life, ability to assemble and serviceability. Visually dark appearances in non-plated holes, which are seen when a metallic or non-metallic semi-conductive coating is used, are not foreign material and do not affect life or function. **Printed boards shall be free of non-conformances in excess of those allowed in this specification.** There shall be no evidence of any lifting or separation of platings from the surface of the conductive pattern, or of the conductor from the base laminate in excess of that allowed. There shall be no loose plating slivers on the surface of the printed board.*

## **Are We Misinterpreting the Standards?**

A typical understanding of this requirement is often limited to "no visual evidence of dirt, foreign matter, oil, fingerprints, tin/lead or



# INNOVATION + PRECISION + RELIABILITY



## IN-HOUSE CUSTOMER LAB

Available to assist every Chemcut customer with:

- R&D process development
- Producing an initial prototype
- Small pilot production runs
- Feasibility studies
- Producing scale-up data
- Operator training and education



Contact Matt



To learn more about our lab, contact Matt Erlichman at [merlichman@chemcut.net](mailto:merlichman@chemcut.net)

[www.chemcut.net](http://www.chemcut.net)



**CHEMCUT**  
BOUNDLESS INNOVATION | UNBEATABLE PRECISION

solder smear transfer to the dielectric surface, flux residue and other contaminants that affect life, ability to assemble and serviceability.”

Also note: “There shall be no evidence of any lifting or separation of platings from the surface of the conductive pattern, or of the conductor from the base laminate in excess of that allowed. There shall be no loose plating slivers on the surface of the printed board.”

As written, there is a requirement here; not measureable, but it’s still quite clear. But are we missing something here?

In my daily work with suppliers, we often discuss what is acceptable. We read the related standards, explain, and give examples. We try to agree on how to understand the specific requirement or a combination of several requirements. Then we inspect the related boards and agree on what we observe. Some years ago, the defects we found were functional, such as open circuit, short circuit, and via hole, that will cause functional problems.

## The Difference Between Cosmetic Issues and Cosmetic Failure

Today’s factories have better process control and improved functional testing, meaning that most of the claims are what can be called cosmetic. The challenge is knowing what is cosmetic, and what is purely a cosmetic issue that could lead to a failure in the application. This leads me back to the standard, and the sentence that many PCB suppliers often overlook: “Printed boards shall be free of non-conformances in excess of those allowed in this specification.”

The last revision of the standard, and still written in IPC-6013 and IPC-6018, says: “Printed boards shall be free of defects in excess of those allowed in this specification.”

The word defect has then, if we are kind to the reader, been understood as functional:

- What is a defect?
- Is a cosmetic imperfection a defect?

The next revision uses the term non-conformance, and we hope that helps. Here, it must

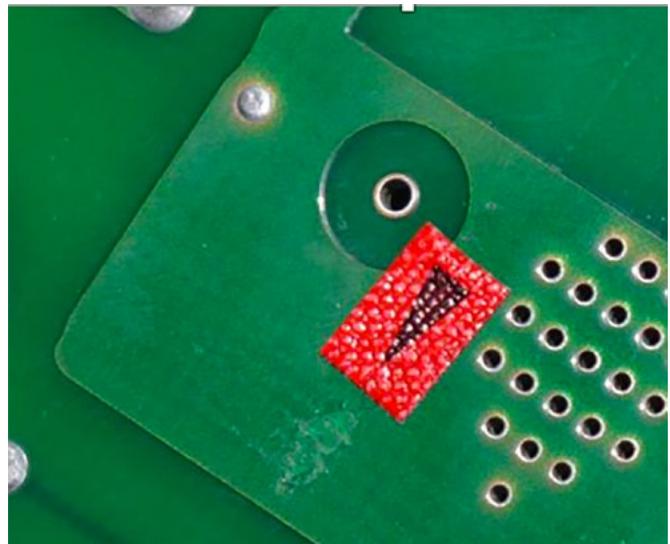


Figure 1: A cosmetic defect in the solder mask highlighted by the customer. A typical example of a defect not specified in the standard, but still covered by the workmanship rule.

be understood as *any imperfection* to the PCB design.

Before we discuss this further, it is important to understand that even an up-to-date PCB factory will have some handling, and smaller cosmetic issues will occur. It is very important that the user understands and does not reject fully functional products.

For further understanding I suggest reading my [April 2020 column](#), keeping in mind what I discussed last year that it is still important for the PCB supplier to understand the standard and have a goal to reduce such cosmetic issues.

## Workmanship: What Does the Standard Really Say?

What the standard says about workmanship is, in reality, that the PCB shall be free of any imperfection not allowed in this specification. But what are we talking about? I would say that more than 60% of customer claims are related to solder mask in one way or the other. Let me give some examples:

### 1. Scratches in the solder mask

All of us producing and using PCBs know that handling in production will lead to scratches in



Figure 2: An unwanted particle in solder mask not violating general rules but still not allowed by the workmanship requirement.

the solder mask. But what is the criteria to accept a scratch? How many scratches, and how deep? The immediate answer is that IPC does not specify what is acceptable or not. The only requirement we have is the workmanship rule that says a scratch is an imperfection that is not allowed.

So, what is the solution? We need to talk together and agree upon reasonable inspection criteria.

## 2. Foreign particles in solder mask

The processing of solder mask today is in a much cleaner environment than before. The clue is cleanroom areas that enable the factory to deliver a clean solder mask, free from unwanted particles that mostly come from the application room condition and workers' clothes. Still, we are not yet at a level where we can guarantee the solder mask will be 100% clean from unwanted particles. Such room conditions are costly and many factories trade between a defect free solder mask and the cost of such conditions.

But what are the requirements? Even though not written specifically in IPC-6012 series, an unwanted particle can, in a worst case, lead to a defect in the application. And, with the min-

iaturisation of PCB designs, existing clearance rules may not be sufficient. Again, the rule is such that unwanted particles are not allowed. We know it happens, so we need an inspection criterion just like the solder mask scratch issue.

## Discuss and Accept Acceptability Criteria for Both Parties

Both of these issues represent a condition not allowed according to the workmanship specification. These issues happen daily, and in most cases, the PCB supplier will handle it as a cosmetic issue and therefore the customer shall accept it. But that is not what IPC says. It is important to know the standard and understand the requirements; even then, you will have a grey zone situation where the only solution is to talk together and discuss acceptability criteria that is satisfactory to both parties. The user should also understand that the workmanship standard may have different effects on different base materials, and between a prototype or small volume order compared to volume manufacturing.

## Conclusion

What can we learn from this? The most important thing to know is the standard and how to use it. Most people read the measurable requirements, while a requirement like the workmanship rule is left out. It is hard to deal with because it requires at least two parties to find a solution that works for both. This, however, leads to my next article, which will focus on the term AABUS (as agreed between user and supplier), meaning these open requirements shall be discussed with the supplier, be part of the article specification, or agreed in a general procurement requirement.

Until next time... PCB007



This installment of The PCB Norsemen was written by **Jan Pedersen**, senior technical advisor at Elmatica. To read past columns or contact The PCB Norsemen, [click here](#).



# Quality and Continuous Improvement

**Article by Patrick Valentine**  
TECHNICAL AND LEAN SIX SIGMA MANAGER, UYEMURA USA

## Introduction

Quality and continuous improvement are an integral part of the electronics industry. Poor quality is costly. Remediation costs of poor quality can cost a company 25% of its annual sales. Poor quality and the need for high reliability are the catalysts driving continuous improvement today. An in-depth review of quality and continuous improvement is presented.

## The History of Quality

The concern for quality control and reduced product variation can be traced back centuries. Archaic quality control methods were used by the Xia Dynasty in 2100 BC in ancient China <sup>[1]</sup>. During the late 1290s in medieval Europe, guilds—the pre-cursor to unions—were responsible for product and service quality <sup>[2]</sup>. From 1700 to 1900, product quality was determined by the individual craftsman's efforts <sup>[3]</sup>. At the close of the 19th century, Eli Whitney introduced standardized, interchangeable parts to simplify assembly <sup>[3]</sup>. In

1875, Frederick W. Taylor introduced the scientific management principles, which divided work into smaller, more easily accomplished tasks <sup>[3]</sup>. Taylor believed the key to productivity and improved quality was knowledge, organization, and leadership. In 1903, Karol Adamiecki developed the harmonograph, a chart depicting workers' movements and actions indicating the causes of low productivity and potential quality issues <sup>[4]</sup>. Quality principles were accelerating at the beginning of the 20th century as manufacturers began to shift from purely focusing on their production economy to balancing the number of products produced while meeting increased consumer demands for quality.

In 1901, the Engineering Standards Committee was formed in Great Britain to establish imperial standards in all fields <sup>[3]</sup>. In 1906, the International Electro-Technical Committee was created to prepare and publish international standards for all electrical, electronic, and related technologies. By 1930, most industrialized countries had established national standards organizations. Most of these national standards organizations were linked to the International Federation of the National Stan-

# Unrivaled Test Speed with Full Automation



**Introducing the newly designed atg A8a with 8 test probes and a new high speed “lights out” automation for unrivaled throughput.**



## Highlights:

- Small footprint (6 square meters)
- Dual shuttle pick & place automation
- High accuracy combined with high test speed
- Pen or label marking option

[Watch video](#)

[Get more info](#)

**atg Luther & Maelzer GmbH**

Zum Schlag 3 • 97877 Wertheim • Germany  
Phone +49-9342-291-0 • Fax +49-9342-395 10  
klaus.koziol@cohu.com • www.atg-lm.com



standardization Association, formed between 1926 and 1928. Global standard settings were stifled during the Great Depression of the 1930s and were further hampered in 1939 with the beginning of World War II.

In 1941, the United States entered World War II. The U.S. government enacted legislation to switch the civilian economy to military production. During this time, military contracts were typically awarded to the lowest bidding manufacturer. Product quality was determined by inspection after delivery. This quality inspection method consumed copious amounts of human resources and led to recruiting and retaining problems. With the help of Bell Labs and Dr. Walter Shewhart, the military adopted sampling inspection techniques to save time and resources <sup>[2,3]</sup>.

When World War II ended in 1945, global quality standards entered a renaissance period that would accelerate over the next 70+ years. The years 1946-1947 were significant because of the formation of the American Society for Quality Control (ASQC) and the International Organization for Standardization (ISO). Quality management standards began focusing on a product's value for customers, increasing product quality, increasing production speeds, and understanding the ramifications of stakeholders' economic activity.

During the 1960s, a paradigm shift occurred in quality thinking to that of identifying potential risks and problems before they surfaced. The paradigm shifted again in the 1980s with the concept of focusing on customer quality requirements during product development. Designed experiments and other statistical quality methods became popular across many industries. Lean manufacturing gained recognition outside of Japan. During the 1980s, Motorola initiated its Six Sigma program, the U.S. Congress established the Malcolm Baldrige National Quality Award, and the ISO published its first quality systems standard. During the 1990s, Lean principles spread from manufacturing entities to service organizations. In

1998, the American Society for Quality Control changed its name to the American Society for Quality (ASQ) in order to serve diverse industries better. During the 2000s, the ISO issued its global quality standards: ISO 9001:2000 and ISO 9001:2008. In 2015, ISO published the fifth edition of ISO 9001:2015 Quality Management System. The ISO released documents ISO 13053-1:2011, ISO 18404:2015, and several other standards covering Lean Six Sigma. The cost of poor quality, the need for reliable products, product safety, and world goods globalization, is driving the uniform quality standards movement.

## The Cost of Poor Quality

The costs of poor quality include all costs incurred for not making or providing a perfect product or service the first time, and includes scrap, rework, re-purchasing raw materials, labor, and inventory <sup>[5]</sup>. Companies operating at three sigma quality levels can spend about 25% of their annual sales remediating poor quality costs <sup>[6]</sup>. Other estimates put the costs of poor quality in the range of 25-40% <sup>[7]</sup>. Poor quality can destroy a company.

Unexpected product failures (poor reliability) significantly increase selling, general, and administrative (SG&A) costs, and lead to increases in inventories and fixed assets required to support operations. These indirect costs erode profitability more than the amount directly attributable to warranty claims processes. Product recalls negatively impact businesses financially and result in adverse publicity.

Printed circuit board assemblies (PCBA) are becoming more complex, resulting in an increased need for quality and reliability to reduce "no-fault-found" failures (NFF). No-fault-found failures occur during a product's use, but the fault is not found during subsequent post-mortem evaluation. As PCBA complexity increases, there is a related increase in multiple failure modes. As multiple failure modes increase, so does the NFF paradigm. Every failure mode may have dozens of



Figure 1: Leadership and management.

possible causes resulting from latent manufacturing defects.

The need for high quality and reliability in aerospace applications is paramount. The aerospace industry is just one of many sectors requiring the need for high quality. Similar quality and reliability needs abound in the medical industry. The FDA lists numerous examples of medical product recalls and quality issues related to faulty PCBAs. There are hundreds of defects that impact the quality of printed circuit boards and printed circuit board assemblies [8,9]. Many continuous improvement activities are undertaken to improve the quality and reliability of PCBAs.

## Continuous Improvement

Continuous improvement = continuous change. For an organization to improve, it must have a culture that embraces change. The difficulty is determining and measuring culture within an organization. Organizational culture can be ambiguous and formidable to quantify.

Organizational culture is a shared belief system consisting of an organization's philosophy, traditions, shared expectations, work ethics, and values that hold it together.

Given any improvement situation, one must define the problem in a process; design and manage a series of simple, efficient data collections; analyze data; determine what to do; present to management; and maintain the improvements over time. An optimized continuous improvement culture leverages leadership/management, innovation, 3S thinking, and human resources.

Both leadership and management are crucial for success. Leadership and management have specific individual responsibilities and shared organizational commonalities (Figure 1). Management's focus is on operational excellence. Management does this by influencing the motion of human resources. Methods include meeting short-term goals, improving reliability and efficiency, mitigating risk, and continuous improvement. Leadership's focus is on in-

novation. Leadership does this by influencing the direction of the organization. Methods include visionary leadership, rethinking, re-engineering, and change management. An organization needs both leadership and management. Leadership without management is mediocracy; management without leadership is disastrous.

Innovation requires abrasion, agility, and resolution<sup>[10]</sup>. Abrasion is about creating ideas through discussion—sometimes very passionate discussions. Abrasion blends team diversity and conflict to get the best ideas to the forefront. Agility allows the team to test ideas through discovery-learning. Agility blends structured scientific thinking with the unstructured artistic process. Resolution takes the team from divergent to convergent thinking. Resolution allows the team to combine different ideas and approaches into the best possible solution.

The 3S thinking encompasses three areas that fall under the umbrella of critical thinking: systems, statistical, and scientific thinking.

1. Systems thinking breaks down the value stream into three parts. The system is a collection of interrelated processes. Systemic thinking is a holistic look at the collection of all processes. Systematic thinking is an approach that is organized, step-by-step, scientific, and logical.
2. Statistical thinking views all work as a function process,  $f(x_1...x_n)$ , acknowledges variation,  $\sigma$ , exists in all processes, and recognizes that knowledge and management of variation are critical for success.
3. Scientific thinking is a five-step process. These five steps require the researcher to make observations, propose a hypothesis, design and conduct an experiment, analyze the data, accept or reject the hypothesis, and, if necessary, propose and test a new hypothesis. Scientific thinking promotes logical, not emotional thinking.

Human resource practices include employee recruitment, job duties training, employment security, career advancement paths, teamwork opportunities, performance-related pay, and communication. Critical human resource practices boil down to communication and training. Communication includes establishing an open dialog and developing a culture of trust and collaboration. Training includes teaching employees to use new tools and processes and establish an environment conducive to learning and continuous improvement. Ultimately, every employee's job, from the janitor to the president, is to "add value and solve problems."

Humans are hardwired to solve problems. Teams and teamwork are crucial for continuous improvement. Team members, and therefore each team, have three problem-solving resources from which they can draw from. These problem-solving resources are technical skills or knowledge (What do I know?), intellectual capacity (What "horsepower" do I bring?), and cognitive style (How do I prefer to solve problems?).

Team members gain knowledge by working with experienced colleagues on various continuous improvement projects. Intellectual capacity is an individual's ability to think critically, see connections between disciplines, and problem solve in changing situations. Cognitive style can be measured, enabling diversification of continuous improvement teams.

The Kirton Adaption-Innovation inventory (KAI) measures cognitive style. When one applies their skills and intellectual horsepower to a problem, do they prefer creative adaption (Edison) or creative innovation (Einstein)? Dr. M.J. Kirton developed the adaption-innovation theory in 1976. KAI score distribution range is from 40 (adaption) to 150 (innovation) (Figure 2). An individual's KAI score is unaffected by their age, IQ, job level, culture, or educational level. There is a paradox of structure: We need it to solve problems, but



Figure 2: KAI distribution of scores.

too much limits us. Cognitive team diversity maximizes continuous improvement efforts and solutions. If they are developed, diversified teams can resolve a wide range of strategic and tactical problems. Cognitive diversity must be coached and challenged if it is to be exploited.

All quality management systems (QMS) contain an element of continuous improvement. For example, the ISO has seven quality management principles, with principle five focusing on continuous improvement. The aerospace (AS) 9100 quality management system is an extension of the ISO 9001 quality management system platform. AS9100 uses the process approach, incorporating the plan-do-check-act (PDCA) cycle and risk-based thinking. Total Quality Management (TQM) is a fact-based philosophy that defines quality as customer fulfillment and satisfaction. TQM puts the cus-

tomers as the central focus and implements continuous improvement efforts to fulfill customers' needs. In the late 1990s and early 2000s, Lean Manufacturing and Six Sigma began amalgamating into a single quality management system known as Lean Six Sigma. Lean Six Sigma strives to achieve increased process speeds, eliminate waste, and reduce defects and variation using Lean Manufacturing principles and Six Sigma tools. No matter what QMS is used, they typically share standard continuous improvement tools (Figure 3).

In addition to the nine standard continuous improvement tools shown in Figure 3, there are four common continuous improvement activities. Combining continuous improvement tools with continuous improvement activities produces a synergistic effect. The continuous improvement activities are gemba walks, Six-S (6S), kaizen events, and benchmarking.

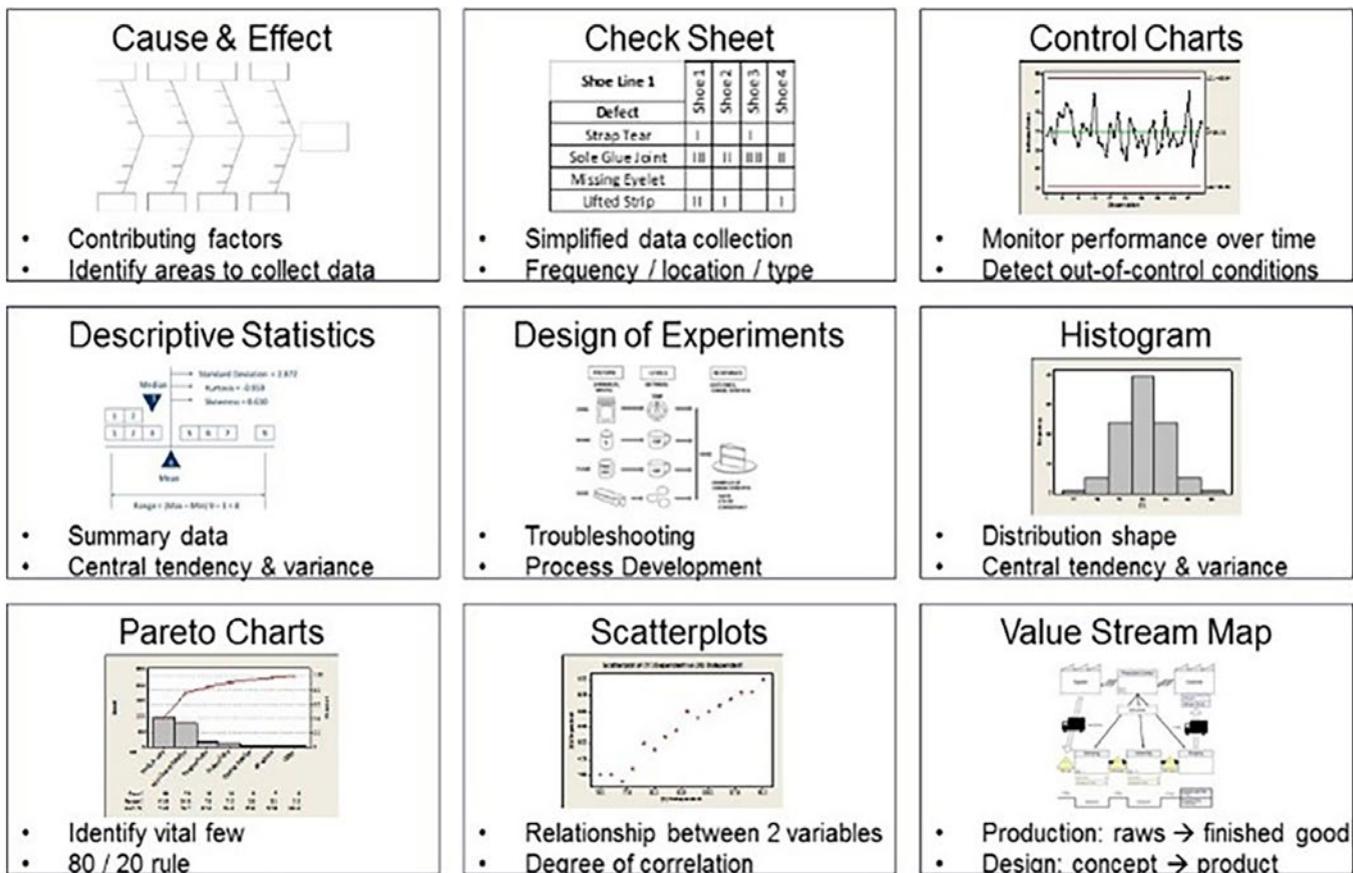


Figure 3: Continuous improvement tools.

Gemba walks are activities in which one goes to and sees the place where the work is happening. Is the process designed to achieve its purpose? Are operators engaged to accomplish this purpose? Continuous improvement teams discover wastes to eliminate by searching for symptoms rather than prescribing solutions. These teams rely on operators to provide valuable information.

Five S (5S) is a workplace environmental hygiene technique that originated in Japan. In modern applications, safety is segregated out for heightened awareness. The six S's are: sort, straighten, shine, standardize, sustain, and safety. Six-S (6S) enables anyone to distinguish between normal and abnormal conditions at a glance. Six-S is the foundation for continuous improvement, zero defects, cost reduction, and a safe work area.

Kaizen events are changes for the good that impact continuous improvement activities.

Kaizen development is credited to Toyota Motor Company. Kaizen events have a simple tactical focus, employ intellectual capital before money, look for “no brainer” fixes, and are short (2–5 days).

Benchmarking is a systematic process of searching for best practices, innovative ideas, and highly effective operating procedures that lead to superior performance. Benchmarking activities focus on either process, performance, or strategy.

- **Process:** Seeks to identify the most effective operational practices
- **Performance:** Price, technical quality, ancillary product or service features, speed, reliability, and other performance characteristics
- **Strategic:** Longer-term competitive patterns

Unlike traditional internal continuous improvement tools and activities, benchmarking is unique and occurs within the organization, within the industry, or entirely outside the industry.

Continuous improvement projects culminate with either adopting, adapting, or abandoning the proposed solution:

- Adopting accepts and implements the entire solution
- Adapting cherry-picks select attributes of the solution
- Abandoning rejects the solution in its entirety

Ideally, continuous improvement solutions are simple, quick, and effective. Lastly, knowledge management comes into play. The team must formally document the project and knowledge learned. An A3 report format or equivalent should be used.

## Conclusion

Quality and continuous improvement activities share a long and impressive history. The cost of poor quality and the need for high reliability are the catalysts driving continuous improvement today. Continuous improvement requires continuous change. It is paramount that organizational leaders and managers develop a culture of continuous improvement. Leadership without management is mediocracy; management without leadership is disastrous. All employees must realize their primary function is to “add value and solve problems.” Quality management systems (QMS) contain an element of continuous improvement and share common tools and activities. Having an excellent foundational understanding and application knowledge of these tools and activities is crucial. Human resources are the most important resources of all, and priority needs to be set to develop their talents. **PCB007**

## References

1. “Theory C: The Near Future of Quality Management,” Kernenade, E. (2014), *The TQM Journal*, 26(6), 650-657.
2. American Society for Quality (n.d.). History of Quality [Quality topics A to Z]. Retrieved from <http://asq.org/learn-about-quality/history-of-quality/overview/overview.html>.
3. *Introduction to Statistical Quality Control* (7<sup>th</sup> ed.), Montgomery, D. (2013). Hoboken, NJ: John Wiley & Sons.
4. “Forgotten Contributions to Scientific Management: Work and Ideas of Karol Adamiecki,” Debicki, B. (2015), *Journal of Management History*, 21(1), 40-67.
5. *The Handbook for Quality Management* 2nd Ed., Pyzdek, T. & Keller, P. (2013). United States: McGraw-Hill Companies.
6. *Get it Right. A Strategic Guide to Quality Systems*, Imler, K. (2006). Milwaukee, WI: ASQ Press.
7. “Cost of Quality: Not Only Failure Costs,” Buthmann A. (2017). Retrieved from <https://www.isixsigma.com/implementation/financial-analysis/cost-quality-not-only-failure-costs>.
8. *Acceptability of Printed Boards* (Standard No. IPC-A-600J), Association for Connecting Electronics (2016), Bannockburn, IL: IPC.
9. *Acceptability of Electronic Assemblies* (Standard No. IPC-A-610F), Association for Connecting Electronics (2014), Bannockburn, IL: IPC.
10. *Collective Genius: The Art and Practice of Leading Innovation*, Hill, L., Brandeau, G., Truelove E. and Lineback, K. (2014). Boston, MA: Harvard Business Review Press.



**Patrick Valentine** is the Technical and Lean Six Sigma Manager for Uyemura USA. As part of his responsibilities, he teaches Lean Six Sigma green belt and black belt courses. He has a PhD in Quality Systems Management

from New England College of Business, Six Sigma Master Black Belt certification from Arizona State University, and ASQ certifications as a Six Sigma Black Belt and Reliability Engineer.

# Owning Your Processes

## Testing Todd

Feature Column by Todd Kolmodin, GARDIEN SERVICES USA

I hope everyone is getting through this pandemic as best as possible. Keep hanging in there. Things will improve. Speaking of improvement, how are your processes and work instructions holding up? I'm sure current times have caused modifications in how we do things now. Have you audited them lately? That's what I figured. Don't feel bad. It's extremely common to write a process or work instruction and let it loose in the wild to thrive. The problem is, if there is a problem or a glitch it may never get noticed. Why, you ask? It's simple. Humans have an extraordinary ability to adapt.

A perfect scenario is a process that was written to operate the Acme 1000 widget maker in 1983. Millions of widgets have been made since

1983. However, in 2007 the Acme 1000 was replaced by the Acme 5000. The new machine quadrupled output, everyone was extremely happy, and all was well with the world. That was until John abruptly left the company. He had operated that machine and process since 1983. The company adjusted, of course, and Susan took over. There was a work instruction for the process, so everything should've been fine, right? Unfortunately, output dropped, and the widgets were being rejected at quality control at a much higher rate than what was acceptable. What was Susan doing wrong? Was the machine broken? Neither. Remember we replaced the machine back in 2007? What happened? Well, we didn't review the process when we updated the machine and John adapted. He adapted to the new environment—in this case the updated machine—and life went on. The pitfall was that, like an embezzler, the problems will not surface until the criminal is removed from the environment. By no means



# Electronics Coatings for the Digital Era



**ELECTRA**

## **ELECTRAJET® EMJ110** **Inkjet Soldermask**

- SM840 and UL V-0 approved
- High resistance to ENIG, Tin and lead-free processes
- Suitable for rigid & flexible substrates
- Optimised ink characteristics for sharp printing and excellent cosmetics
- Wide jetting window to maximise print strategy options
- Universal product suitable for a range of print heads including Konica Minolta 1024i Series and Dimatix Samba™
- Fully additive process with substantial environmental improvements in energy usage and VOC emissions

**EMJ110 is a high performance, high reliability soldermask specifically designed for application by inkjet. Using over 35 years' experience in developing and supporting soldermask products, Electra has rigorously formulated EMJ110 to meet or exceed industrial standards and PCB manufacturing process demands.**



T +44 (0)1732 811118  
[info@electrapolymers.com](mailto:info@electrapolymers.com)  
[www.electrapolymers.com](http://www.electrapolymers.com)

am I calling John a criminal but the oversight of reviewing the process or work instruction after the machine was upgraded led to unavoidable future problems.

Now, before management goes after Susan with torches and pitchforks, we need to understand what happened: we didn't own the process. So often what happens is that a clinical process is written by engineering when the machine is placed, and then forgotten. As we all know, evolution is unavoidable and better techniques are found. We need to keep our thumbs on the pulse of processes and allow them to evolve. Therefore, we need to control them. I don't know about you, but I have seen many times that the best way to develop a process or work instruction is to find the people that operate the machine or perform the task on a daily basis. You can have a fleet of engineers, which is fine, but I can tell you from experience that the best way to fine tune a process or work instruction is to gather valuable input from the operators who perform the task.

---

## We need to keep our thumbs on the pulse of processes and allow them to evolve.

---

Since this is the year of continuous improvement, let's look at a good foundation to own that process or work instruction. Although some what I'm going to outline may seem obvious, you would be surprised how many times it can be overlooked and cause unnecessary rework and corrective action.

The best way to start this activity is with both engineering and operators involved. The team approach works very well even if the team is only two participants.

**Phase 1:** Look at the task or process from the 10,000-foot level, meaning you should look at the task you wish to document as it may affect

other activities related to it. Look at space requirements, labor burden, tools required, facilities, and ergonomics.

**Phase 2:** Clinically create the task or process. This can be anything from factory installation to operating instructions. Place necessary tools and supplies as needed. Once documented, perform a dry run through the process to make sure critical steps are captured.

**Phase 3:** Train your operators to the new document or process. Have them walk through it more than once. Now, this is normally where the process creation task ends and what causes the most problems. The operators are trained and off we go. The work instruction goes to the training library and the engineers move off to another new project.

But wait, there's more! Now the control mechanisms need to be in place. This is what determines whether a process will thrive and evolve or whether it will eventually fail when minor attributes change.

**Phase 4:** Develop KPIs (key performance indicators) or control attributes. One can create many processes or instructions and never know whether they are a benefit or a distraction. A process or work instruction is created to standardize or create repeatability of a task. Without monitoring, the process or task can get out of control without any restraints which causes waste or scrap. Keeping a thumb on the pulse can quickly identify an anomaly before it affects down line processes or quality of the product.

**Phase 5:** Review the process. This is the game changer. A process or task should be reviewed at least once a year or whenever any significant change happens. (See Phase 1 objectives for a hint.) If something changes, what effects will it have on surrounding tasks or environment? Review your KPIs daily, weekly, or monthly depending on the importance of the task. Consult with the operators who perform the task and gauge repeatability between operators. If there is a difference, find out why. Did

an operator evolve and find a better way to perform the task? Or are they cheating and jeopardizing the process? This is where adjustments can be made before control is lost. Using a 5S concept, look to see if the task or process can be improved. Look to eliminate waste, such as time, movements, or other factors. If corrections are found, go back to Phase 2, make the corrections and continue the loop.

This outline gives continuous control of tasks or processes and will not allow out-of-control scenarios to develop. If they do, depending on

KPI review frequency, they can be captured and corrected expediently. It also keeps a standardization from operator to operator or shift to shift.

Stay safe! PCB007



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

## Benchmarking to Make Processes Smarter—Our Survey

by the I-Connect007 Research Team

In a recent survey conducted by I-Connect007's research team, we asked readers about benchmarking processes. A critical step to continuous process improvement is to measure a process to determine if/how it can be improved. Benchmarking, therefore, is a key step to effective continuous improvement. We summarize the survey results here.

We kicked off by asking about the most important things to benchmark. Responses were grouped into a number of categories. Among them, process parameters, including operating windows and implementations, are high on the list. Speed, quality, quantity, and repeatability made up the list of benchmark-worthy throughputs on the manufacturing floor. Equipment selection and line configuration were common responses, which also aligned with floor efficiencies. But costs, price, lead times and returns were also mentioned, reminding us that processes across the company eventually bubble up to the accounting reports in one way or another.

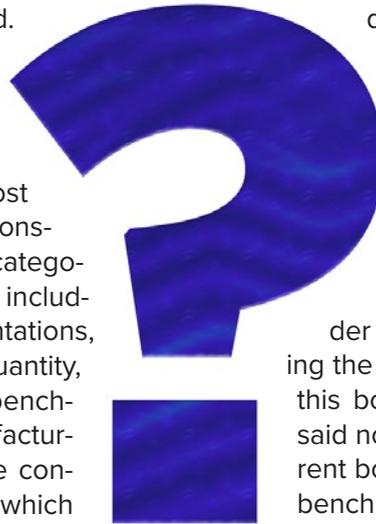
Scrap rates, as reported in the survey, ranged from 0.5–15%, with respondents generally bunched together at each end of the range. Likewise, quick-turn delivery times were separated into two groups: three days or less, and 10 days. In our survey data, we did find a correlation between a higher scrap rate and a longer lead time. But this does not necessarily suggest a cause-and-effect relationship between the

two, as it is equally feasible that these survey respondents specialize in complex or cutting-edge manufacturing processes. Standard services, as reported, ranged from one week to three weeks, with the majority of responses in the three-week range. Furthermore, longer lead times on standard services did not correlate to either the quick-turn lead times or the scrap rate.

We asked about current process bottlenecks. Understandably, some individuals were hesitant to share, but of those who did, bottlenecks were (surprisingly) evenly distributed across the fabrication process: from plating and drill, to coating and solder mask printing. We followed up by asking the respondents if they were benchmarking this bottleneck. Sixty percent of respondents said no, they were not benchmarking their current bottleneck. When asked why they weren't benchmarking, the replies fell into three general categories: staffing shortages, difficulty in measuring, and process automation.

When we asked about ISO 9001 certification, 80% of the surveys indicate that they are certified.

While the survey results are not necessarily a strong correlation of cause and effect, there are some general conclusions we can derive. For example, respondents identified process improvement opportunities throughout their organization, yet knowing of a process bottleneck doesn't mean that the process will automatically be addressed. Staffing shortages, as well as uncertainty in how to measure the process for benchmarking purposes, are key factors.





# Benchmarking With Your Suppliers: What to Know About **Solder Mask**

**Feature by Bob MacRae**

EASTERN REGIONAL SALES MANAGER, TAIYO AMERICA, INC.

Everyone wants a smooth-running solder mask process with high productivity and minimal rejects, but to achieve this you really need a firm understanding of what your current process is capable of, what its limitations are, and what you want to improve. Process capability benchmarking is a great way to identify and implement improvements within your process.

There are six primary process steps involved with a typical LPI solder mask process:

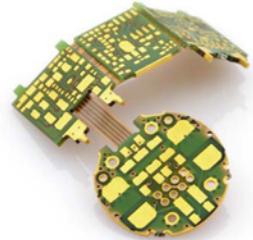
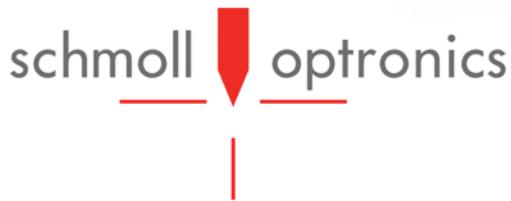
- Surface prep
- Solder mask coat
- Tack dry
- Exposure
- Development
- Cure

But, within each of these segments of the process, there are a vast number of sub-process steps and variables that will influence your suc-

cess; their impact on the entire process needs to be completely understood before the process can be fully optimized. For example, if you increase the tack dry temperature, examine how it will impact exposure, hole clearing, and sidewall definition.

Others include variables such as the type of surface you are applying the solder mask to (Cu vs. Au), panel design, circuit trace height, mixed solder mask pot life, solder mask coating application method, the associated coating parameters, the type of equipment used to expose the solder mask, and the exposing parameters used. Even the type and color of solder mask (and many, many more) can have a major impact on each individual process, as well as the overall solder mask end results. There are also many external process steps before and after solder mask, such as copper pattern plating, resist strip, solder strip, and final finish; these can all impact the capabilities of your solder mask process. A thorough understanding on how each variable impacts your

# Focused on Flex



## Laser $\mu$ Flex series

The versatility and precision of laser processing makes it the ideal tool for machining a wide range of materials.

Typical applications:

- Polymer cover foil
- Covered polymer laminates
- Thin, rigid-flex materials
- Inner layers and prepregs
- Separation or decap from tracks
- Structuring cavities
- Micro-via and through-hole drilling



For more information call us: +1 (336) 660-2701

[burkleamerica.com](http://burkleamerica.com)

overall process is vital when making improvements.

You need to start by establishing what the current capabilities of your solder mask process are. A helpful way to do this is to create one or more test panel designs, incorporating as many of the performance characteristics you want to benchmark as possible, and including as many of the possible variables that you suspect will have an impact on the results. Your test panel needs to be designed to push the limits of what you believe your current solder mask capabilities are. This way you can see a clear, measurable cutoff point in your current process so that when you make changes later, you can effectively tell what the impact is.

---

## Your test panel needs to be designed to push the limits of what you believe your current solder mask capabilities are.

---

For example, if you can only reliably clear holes down to 8 mil finished, you want to make sure your test panel design has finished hole sizes above and below that. Remember, for this example, panel thickness also plays a role so you will want to make panels of different overall thickness as well as with plated and non-plated holes.

In another example, if you are looking to improve the minimum solder mask web that you can maintain, you would want to include a pattern with decreasing web widths and various configurations across the panel to see what your current process can do consistently. Where there are many additional variables influencing web retention, your test panels should also include different diameter holes so you can correlate hole clearing with web

retention, because being able to reproduce small webs is useless if you can't clear the holes. You should also use the same test pattern with multiple Cu trace heights and spacing, because you will likely see a correlation of circuit heights and solder mask thickness to the minimum web retained. Your results will also differ by type and color of solder mask used. Again, the same test vehicle can be designed to incorporate coating uniformity, solder mask coverage over different circuit configurations, solder mask registration, etc.

Once you have identified the areas you want to improve, and established the baseline of what your current process is capable of, you can then alter individual variables within your process to evaluate what impact they have on your final results. Remember, a change you make to one step of the process can impact several later process steps. An example of this effect might be a simple change in squeegee angle at solder mask coat. Such a change may impact how much solder mask is deposited into the holes, which can then increase phototool sticking, increase exposure times, and increase solder mask residue on the phototool as well as create solder mask hole clearing issues at developing, resulting in increased developer dwell times and solder mask web retention difficulties.

So, before you start down the path of process improvement, it is best to have a good, measurable system in place to understand what your process can do before making modifications. Otherwise, you will not be able to tell if the changes are improving the process or just fixing one issue while creating another issue down the line. **PCB007**



**Bob MacRae** is the Eastern Regional Sales Manager for Taiyo America, Inc.



# Supplier Highlights



## **Nano Dimension Strengthening its Leadership Position in 3D Printed Electronics with AME Design Methodology ▶**

Nano Dimension Ltd., a leading Additively Manufactured Electronics (AME)/PE provider, offers quick solutions and easy access to complex PCBs and 3D printed electronics. Its unique and novel technology allows for rapid prototyping and production of high-performance electronic devices (Hi-PEDs™).

## **Ventec Strengthens Canada OEM Activities with Appointment of Sigma Component Design ▶**

Ventec International Group Co., Ltd. has announced the appointment of Sigma Component Design (Sigma) to provide sales and support to OEM customers in Canada. The two companies have signed a contractual agreement under which Sigma will help drive new OEM business for Ventec in Canada and represent all product lines from January 1, 2021.

## **Zero Defects International Enhances PCB CAM Services ▶**

Zero Defects International (ZDI) and its strategic partner Skyla Technologies have announced measures to further increase their printed circuit board front-end engineering CAM service capabilities.

## **CCI Eurolam Group Signs Agreement to Acquire Adeon Technologies BV ▶**

CCI Eurolam Group, a leading distributor and industrial service provider to the EMEA electronics manufacturing industry, announced the signature of an agreement to acquire Adeon

Technologies BV, a major full-service provider of equipment for the European PCB Industry.

## **Technica USA, TFE Canada to Promote Elite Materials Company Ltd. Laminate Materials ▶**

On January 19, 2021, Technica USA, located in San Jose, California, announced it had reached an agreement at the end of 2020 with TFE to act as a sales representative of EMC products in Eastern Canada. The cooperation includes stocking of EMC materials in their Toronto, Ontario facility.

## **Rogers' Advanced Connectivity Solutions Business Adds EMEA Distribution Channel ▶**

Rogers Corporation's Advanced Connectivity Solutions (ACS) business unit announced the introduction of a new distribution channel with the addition of CCI Eurolam (CCI) to their sales and service team in the EMEA effective January 1, 2021.

## **Atotech Commences Initial Public Offering ▶**

Atotech Limited, a leading specialty chemicals technology company and a market leader in advanced electroplating solutions, has commenced an initial public offering of 34,146,000 of its common shares.

## **High Density Packaging User Group Announces Nippon Denkai Membership ▶**

High Density Packaging (HDP) User Group is pleased to announce that Nippon Denkai has become its newest member.

# Leadership 101: The Law of the Lid

## The Right Approach

Feature Column by Steve Williams, THE RIGHT APPROACH CONSULTING

### Introduction

As we continue with the second installment of Leadership 101, it is wise to review the premise of this series: *Good leadership always makes a difference; unfortunately, so does bad leadership.* Today we will be talking about the first of the 21 Irrefutable Laws of Leadership: The Law of the Lid <sup>[1]</sup>.

### The Law of the Lid

Last time, I stated that the biggest mistake most companies make is to promote someone to a leadership position based on their technical skills. This makes some sense, on the surface. But the thing is, leadership requires a completely different skill set and what happens more times than not is that you lose a good technical person and gain a bad manager.

The Law of the Lid states that your success as a leader is dependent on your leadership ability, or your *leadership lid*. You can never rise above your lid (Figure 1) and neither can your organization. Take your left hand and hold it out in front of you with your palm parallel to the ground (this is your lid). Now make a fist with your right and hold it under your palm (this is your business). Your business success may rise up to your lid but cannot rise above it. In fact, for many people success falls a bit short of their lid.

So, your leadership lid in this context is your ability to realize your vision for the business: Create a highly effective team, motivate those people in a common purpose behind that vi-

sion, and inspire them to see how their own goals are in alignment with the team goals. In other words, to quote my friend Jim Collins, to get the right people on the bus, get the right people in the right seats, and get the wrong people off the bus. Only then can we get the bus going in the right direction.



Figure 1: Leaders can get stuck “under the lid” and not have the ability to raise themselves or their organizations.

Your circuit boards delivered...

**1**  
**DAY**  
**LATE**

**2**  
**DAYS**  
**LATE**

**3**  
**DAYS**  
**LATE**

# WHAT'S THE COST TO YOU WHEN YOUR BOARDS ARE DELIVERED LATE?

With Prototron, you don't have to ask that question. Serving customers for over three decades with a 98% on-time delivery record, we understand that providing you with high-quality PCBs on time, and right the first time, is critical.



**Prototron Circuits**  
*America's Board Source*

[www.prototron.com](http://www.prototron.com)

## The McDonald Brothers

One of the most illustrative examples of The Law of the Lid is to compare the leadership ability of the McDonald brothers with that of Ray Kroc. In the 1930s, Mac and Dick McDonald moved from New Hampshire to California to pursue the American Dream, and after a couple of failed businesses decided to open a small drive-in restaurant that served hot dogs, fries and shakes. The business was quite successful, and in 1937 they moved to San Bernardino and opened a much larger facility, adding barbecue and hamburgers to the menu. Business exploded, and the brothers McDonald decided to turn the industry on its ear by focusing on walk-up customers and serving them in 30 seconds or less.

To do this, they focused on hamburgers and engineered a process that streamlined the operations, cut costs, and lowered the price to their customers. They called their new process the Speedee Service System, which truly revolutionized this market and created the “fast food” industry. The business was so successful that they decided to start franchising their restaurant in 1952, which ended in abject failure. Why? The McDonald brothers’ true genius was in customer service and kitchen organization. They were good single-restaurant owners; they were efficient managers, but they were not leaders. Their leadership ability had clamped down a lid on what they could and couldn’t do.

---

**The McDonald brothers’ true genius was in customer service and kitchen organization.**

---

In 1954, the brothers partnered with Ray Kroc, the founder of the company that made the milkshake equipment used by most drive-up restaurants, including the McDonald brothers. Kroc formed McDonald’s Systems, Inc., which later became McDonald’s Corporation.

Ray immediately assembled a team of the sharpest people he could find to fulfill his vision of making McDonald’s a nationwide company. In 1961, Kroc bought the exclusive rights to McDonald’s for \$2.7 million (\$23 million in today’s dollars). During the earlier failed franchise attempt by the brothers, one franchisee wanted to open a McDonald’s in Phoenix, to which Dick replied “What %\$@ #&\* for? The McDonald name means nothing in Phoenix.” Contrast the McDonald brothers’ “lid” with that of Ray Kroc, which was sky high. Between 1955 and 1959, Kroc opened 100 restaurants; four years later there were over 500. Today there are more than 31,000 McDonald’s restaurants in 119 countries!

Ray Kroc’s *lid* was obviously much higher than that of the McDonald brothers.

## Raise Your Lid

The first step is to recognize the importance of leadership, see it as a learnable skill, and to set about developing that skill. Many organizations spend fortunes recruiting the best, most talented, and most in-demand people; then, they put them on poorly performing teams with terrible leadership. This happens not through malice or indifference; it is simply because they don’t understand the importance of leadership. Unfortunately, at most companies, leadership training is either ignored completely or limited to training on how to fill out the annual review form.

But if we can agree that a leader’s role is delivering results through others, having a low leadership lid is not going to work very well; it’s as simple as that. And the more people they’re leading, the bigger the problem. Like most things, raising your lid is a process, you’ve got to grow; to grow you have to get in the growth zone; and unfortunately, the growth zone is not the comfort zone. Growth takes place outside the comfort zone, not in it. It’s an active pursuit and it’s intentional. It’s a contract you make with yourself; really, it’s an internal thing, not somewhere you necessarily



STRIVE FOR **EXCELLENCE**

www.emctw.com | EMC.INFS@mail.emctw.com

# Enable 800GbE Ethernet Speed with EM-892K and EM-892K2 Materials

## Industry's First Halogen-free Extreme Low Loss (ELL) Laminates



 World's largest producer of environmentally-friendly advanced laminate materials



**Key Material Features:**  
EM-892K @70%RC:  
Dk: 2.84/ Df: 0.0017 @10GHz  
EM-892K2 @70%RC:  
Dk: 2.76/ Df: 0.0013 @10GHz  
with Cavity Resonator Method



**Lead-Free Soldering Test:**  
PASS LF-260°C/ 10X  
with 32L 0.6mm hole pitch



**Anti-CAF Test:**  
Pass 100V/ 85°C/ 85% RH  
with 32L 0.6mm hole pitch  
for 1K Hours



**IST Test:**  
Pass Room temperature  
to 150°C for 3K Cycles  
with 32L 0.6mm hole pitch



go to grow. We have to choose growth over comfort, and that means getting out of the comfort zone regularly. It's a great way to raise your leadership lid. Getting around people who think differently is another great way to raise your lid. And it's the same in anything, isn't it? If you want to play a better golf game, stop playing with your friends and seek out better players. If you want to be a better leader, get around better leaders.

## Leadership is a Learnable Skill

But it takes effort, focus and perseverance. I learned the hard way, over a long period of time, that if you don't have influence you will never be able to lead others. If you're going to be successful in life the first thing you work on is to grow and raise your leadership lid. And the Pareto principle really does apply here: a little goes a long way. The minute that you begin to grow and raise your leadership lid, suddenly, your results will begin to change. Leadership really is that important: Everything rises and falls with leadership. **PCB007**

## References

1. "21 Irrefutable Laws of Leadership" by John C. Maxwell.



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

---

## Kitchen-Temperature Supercurrents from Stacked 2D Materials

Could a stack of 2D materials allow for supercurrents at warm temperatures? A study published last year opens a new route to high-temperature supercurrents at temperatures as "warm" as inside a kitchen fridge.

Previously, superconductivity has only been possible at temperatures less than 170°C below zero. For this reason, the cooling costs of superconductors have been high.

This new semiconductor superlattice device could form a new class of ultra-low energy electronics with vastly lower energy consumption than conventional, silicon-based (CMOS) electronics. Such is the aim of the FLEET Centre of Excellence.

Oppositely charged electrons and holes can form tightly bound pairs, called excitons. Excitons can in principle form a quantum, "superfluid" state. With such tightly bound excitons, superfluidity should exist even as high as room temperature.

But in practice excitons have extremely short lifetimes—just a few

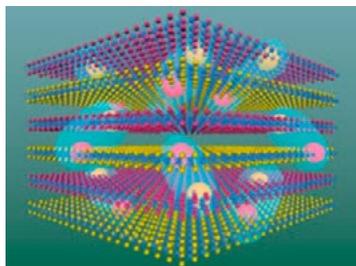
nanoseconds, not enough time to form a superfluid. As a workaround, the electron and hole can be separated by atomically-thin conducting layers, creating so-called "spatially indirect" excitons. The electrons and holes move along separate but very close conducting layers. This makes the excitons long-lived, and superfluidity has been observed.

Sara Conti, co-author on the study, notes a problem: atomically-thin conducting layers are two-dimensional, and 2D systems have rigid restrictions that eliminate the superfluidity at temperatures above  $-170^{\circ}\text{C}$ . The new proposed system of stacked atomically-thin layers of transition metal dichalcogenide (TMD) semiconducting materials is three dimensional. Alternate layers are doped with excess electrons (n-doped) and excess

holes (p-doped) and these form the 3D excitons.

The study predicts exciton supercurrents will flow in this system at temperatures as warm as  $-3^{\circ}\text{C}$ .

(Source: Arc Centre of Excellence in Future Low-Energy Electronics Technologies)



THE INDUSTRY LEADER IN SOLDER MASK PRODUCTION

# THERMO

# COOL

BY TAIYO

The electronics industry continues to innovate. Innovation means more functionality to the consumer in smaller packages. Because the PCB industry is evolving, PCBs are getting smaller, more functional, and in some cases, thicker with copper.

To combat this added heat, Taiyo America has introduced Thermo Cool (Patent Pending). Thermo Cool is a revolutionary product that can dissipate heat at over 10 W/m K. If you need thermal management for your PCB designs, you need to add Thermo Cool.

### Thermal Conductive/Heat Dissipating Product Features:

- ⊕ High Tg (169°C)
- ⊕ Application for Gap Filling, Via Filling and as an Adhesive
- ⊕ Extremely Low CTE  
α1-14 ppm / α2-45 ppm
- ⊕ Thermal Conductivity - 10 W/mK
- ⊕ Thermally Cured
- ⊕ Screen Print or Via Fill



**Kate Han**

Western Technical  
Sales Engineer

(949) 910-2028 (cell)  
KateH@taiyo-america.com



**Don Monn**

Midwestern Regional  
Sales Manager

(651)491-4199 (cell)  
DonM@taiyo-america.com



**Bob MacRae**

Eastern Regional  
Sales Manager

(508) 380-5475 (cell)  
BobM@taiyo-america.com

 **TAIYO  
AMERICA**  
UNMATCHED INNOVATION



Follow us on social media

Contact your local Taiyo Sales Representative  
for your FREE SAMPLE (1KG) ▶



# The Benefits of Statistical Process Control

Feature by Kurt Palmer  
BURKLE NORTH AMERICA

Statistical process control (SPC) is a method of quality control which employs statistical methods to monitor and control a process. This helps to ensure that the process operates efficiently, producing more specification-conforming products with less waste <sup>[1]</sup>.

The concepts of statistical process control were initially developed by Dr. Walter Shewhart of Bell Laboratories in the 1920s, and were expanded upon by Dr. W. Edwards Deming, who introduced SPC to Japanese industry after WWII. After early successful adoption by Japanese firms, SPC has now been incorporated by organizations around the world as a primary tool to improve product quality by reducing process variation <sup>[2]</sup>.

The use of statistical process control (SPC) was initially ignored in North America for quite some time, but in the 1960s and moving forward, SPC—using control charts to control every step of a process—became an integral part of any manufacturing process. Dr.

Robert Deming was the evangelist who advocated the concept of eliminating final inspection requirements if every step in the process was monitored. At the beginning, this program met management headwinds, but over time, the concept, when adopted from senior management down through an organization, has proven to reduce costs and improve quality.

From our experience, and with the development of a host of modern electronic innovations, we have witnessed this program successfully interfaced directly from the machine to an engineer's computer and stored as history to the cloud.

The Bürkle LFC roller coating machine is another example of how a coating process can be monitored in “real time.” The variables for coating include:

- Transport speed
- Roller coating speed
- Viscosity of the liquid material
- Groove depth and geometry
- Doctor roll pressure
- Application roll pressure

# Rogers' Laminates: Paving the way for tomorrow's Autonomous Vehicles

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

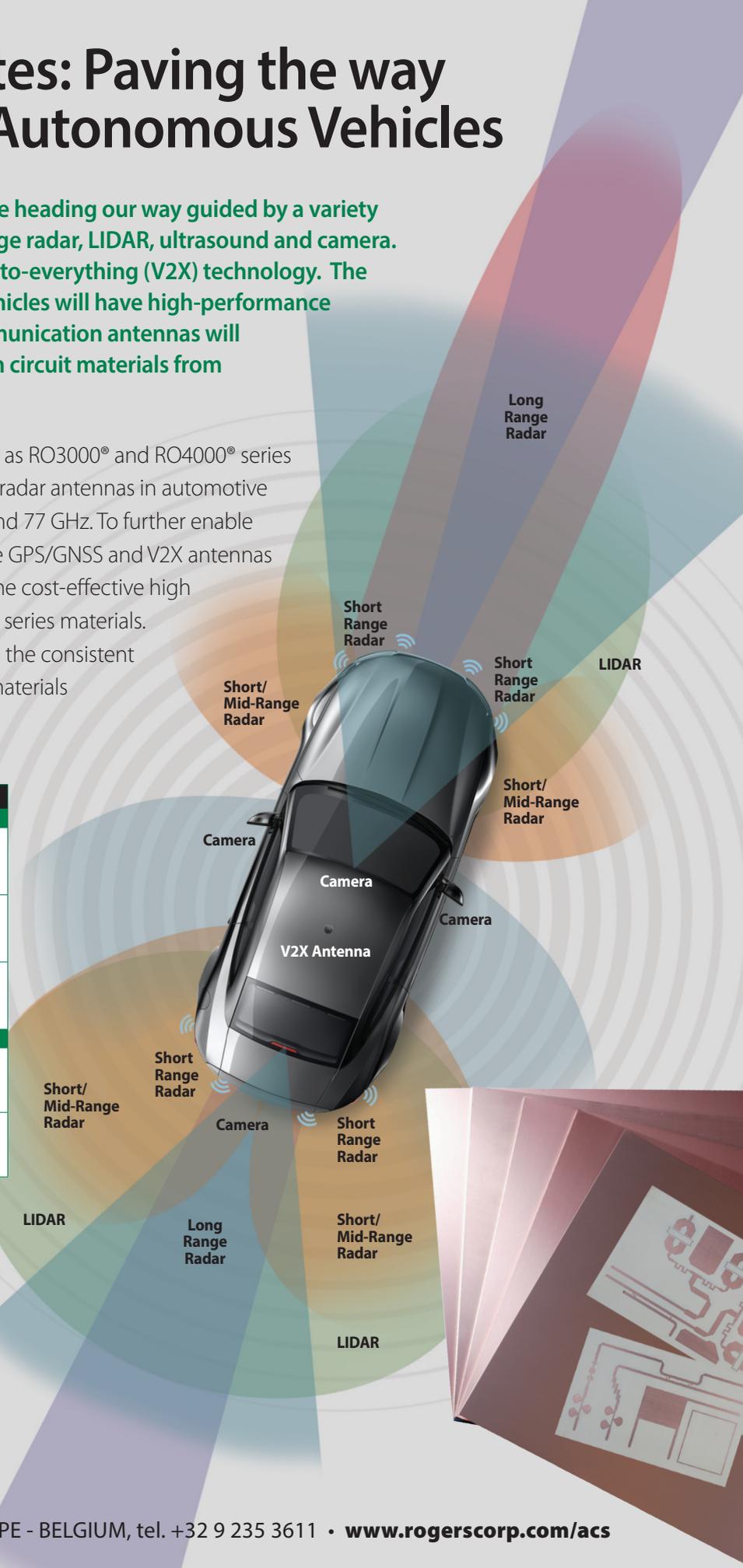
High-performance circuit laminates, such as RO3000® and RO4000® series materials, are already well established for radar antennas in automotive collision-avoidance radar systems at 24 and 77 GHz. To further enable autonomous driving, higher performance GPS/GNSS and V2X antennas will be needed, which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

Material	Features
<b>RADAR</b>	
<b>RO3003G2™ Laminates</b>	Lowest insertion loss and most stable electrical properties for 77 GHz antennas
<b>RO4830™ Laminates</b>	Cost-effective performance for 77 GHz antennas
<b>RO4835™ Laminates</b>	Stable RF performance for multi-layer 24 GHz antennas
<b>ANTENNA</b>	
<b>RO4000 Series Circuit Materials</b>	Low loss, FR-4 processable and UL 94 V-0 rated materials
<b>Kappa™ 438 Laminates</b>	Higher performance alternative to FR-4

To learn more visit:  
[www.rogerscorp.com/autonomousdriving](http://www.rogerscorp.com/autonomousdriving)



Advanced Connectivity Solutions



Each of these variables can be measured and maintained.

Industry 4.0, also known as the Fourth Industrial Revolution, takes advantage of the interconnected machine to computers (M2M) concept.

Industry 4.0 is the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. Large-scale machine-to-machine communication (M2M) and the internet of things (IoT) are integrated for increased automation, improved communication, and self-monitoring, as well as production of smart machines that can analyze and diagnose issues without the need for human intervention [3].

All Bürkle machine systems and many others today utilize modern programmable controllers and menu-driven computers. Connection to manufacturing computers requires interconnections and dedicated real-time software such as Manufacturing Execution Systems (MES) that provide a host of tools for management, including the ability to monitor machine variables (Figure 1). It also includes other important tools such as shop floor loading, resource planning, etc. All of these benefits are beyond the scope of this article, but suffice it to say that Factory 4.0 does a great deal more than just process monitoring.

Beyond the new things benefiting industry is the “health” of the tool being used. Standardized process and maintenance procedures are critical tools enabling predictable processes. Bürkle provides measurement tools as part of its service program that calibrates machine variables. Consumable machine parts, such as the rubber rollers used in roller coating systems, are exchanged and reconditioned on a defined periodic basis before wear impacts quality. Applied machine pressure and temperature are re-calibrated using instruments traceable to the National Institute of Standards of Technology (NIST). Parallelism and

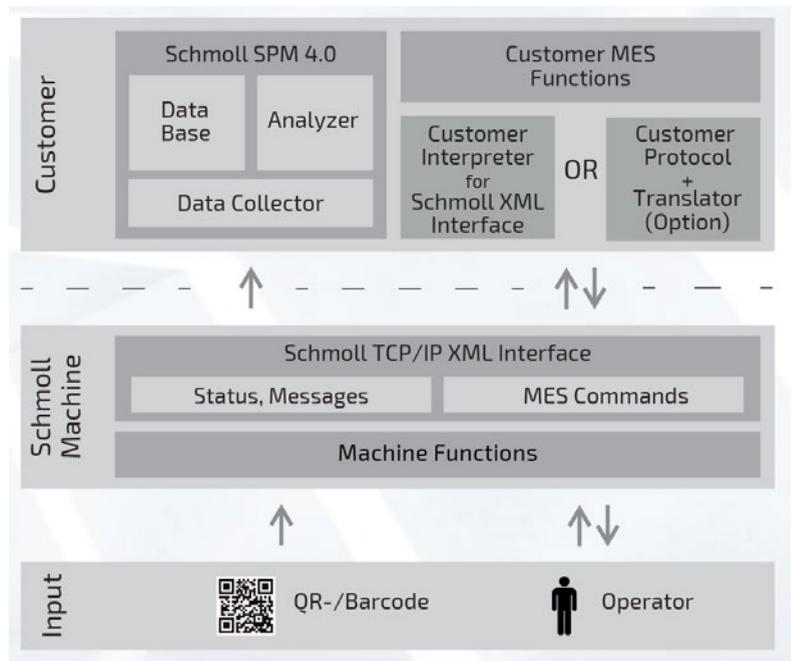


Figure 1: Schmolli interface for network integration.

flatness of platens are checked using solder bar testing.

During process development, internal temperatures of a “book” are measured and used as part of the lamination recipe. Layup procedures and material uniformity are important in the lamination of precision circuit boards.

This is all considered a definable process for the entire manufacturing process from order entry, work orders, and all other facets of the operation. SPC impacts office procedures and internal company tracking. Again, the SPC process needs to be embraced by senior management and continue throughout the organization, otherwise the program will fail. **PCB007**

## References

1. Statistical process control, Wikipedia.
2. [moresteam.com/toolbox/statistical-process-control-spc.cfm](http://moresteam.com/toolbox/statistical-process-control-spc.cfm)
3. Fourth Industrial Revolution, Wikipedia.



**Kurt Palmer** is president and CEO of Bürkle North America.



TECHNICALLY  
SPEAKING:

IT'S THE  
PLACE TO

**connect**

from wherever  
you are!

**IPC APEX EXPO 2021** will be virtual for the first time ever. Safely connect and collaborate with industry innovators and peers, through various technical conference sessions, professional development courses, unique networking opportunities, product demonstrations, and one-on-one meetings with exhibitors and attendees.

**Access more than 100 educational offerings for 90 days post-event with the All-Access Package.**

**Maria Colon**  
Senior Process Engineer,  
Raytheon

Register for our virtual event at  
**[IPCAPEXEXPO.ORG](https://www.ipcapelexpo.org)**



## Editor Picks from PCB007

### 1 Whiteside's View from the Summit: An Industry Perspective ▶

Nolan Johnson spoke with Shane Whiteside to get his unique perspective on the industry as president and CEO of Summit Interconnect, as well as his position on the board of directors for the IPC. Whiteside discusses the business challenges he sees overall.



Shane Whiteside

### 3 Futurist, Writer and Manufacturing Tech Expert Travis Hessman to Keynote IPC APEX EXPO 2021 ▶

Each year, IPC APEX EXPO features the industry's most dynamic, innovative minds to deliver keynote presentations that are both educational and entertaining.



Travis Hessman

### 2 CES Dispatches: Opening Day at Pepcom ▶

On Monday, January 11, Nolan Johnson attended the launch of the CES 2021. Well, more precisely, the Pepcom program, one of the multitude of ways to connect with CES in the virtual environment. Pepcom is a regular at CES, functioning a bit like a show-within-a-show.



### 4 Bruce Mahler Discusses Ohmega Technologies' Acquisition by Arcline Investment Management ▶

I-Connect007's Nolan Johnson catches up with Bruce Mahler, vice president and general manager at Ohmega Technologies, about the recent announcement that Ohmega Technologies has been acquired by Arcline Investment Management. Mahler outlines the new opportunities this presents for Ohmega Technologies and discusses how this change in ownership will benefit existing customers and markets as well.



Bruce Mahler

## 5 Your Greatest Competition is Yourself ▶

It really doesn't matter who you think your external competitors are, because the only competitor that really matters is you. Of course, you will look externally to stay on top of latest trends, but when it comes to competition, just competing with yourself is a win. When you look at yourself as your greatest competitor, you will start with a huge advantage: you already have great intel on how "your competition" thinks. Ask yourself, "What can I do to displace my 'competitor' and create something much better?"

## 6 IPC CEO and President John Mitchell Discusses New Membership and Dues Structure ▶

In this video, IPC CEO and President Dr. John Mitchell discusses the organization's move from a site-based and enterprise membership dues structure to a company revenue-based model. Mitchell explains that this change will go into effect upon each member company's renewal in 2021, and he points out that many of the existing member discounts will remain unchanged.



## 7 Aismalibar, American Standard Circuits Confirm IST Thermal Testing of HTC 3.2w High Tg Multilayer Thermal Conductive Material ▶

Aismalibar and American Standard Circuits confirm successful IST thermal testing of HTC 3.2w High Tg Multilayer Thermal Conductive Material.

## 8 What's Driving Price Increases for CCL and Prepreg? ▶

Demand for copper foil is increasing from both PCB and battery production for e-mobility, leading to an upward price pressure for copper foils as post-lockdown, pent-up demand starts to exceed capacity. Lead times are stretching and prices increasing, particularly for heavy copper foils (2 oz./70 micron and above) as capacity is repurposed to maximize square-meter output for lightweight foils to increase capacity for lithium battery production.

## 9 IPC Praises U.S. Government Actions to Bolster Security and Resiliency of Defense Electronics Supply Chain ▶

The following is a statement by Chris Mitchell, vice president of global government relations at IPC, the global electronics manufacturing association, on recent actions by the U.S. government to bolster the security and resiliency of the U.S. defense electronics supply chain.



## 10 DPO&Co Partners with Charles Anderson to Acquire Circuits West ▶

Daniel P. O'Reilly & Company (DPO&Co), a Chicago-based Strategy and Operations consulting firm, has partnered with Charles Anderson to acquire Circuits West, Inc. Circuits West is a designer and manufacturer of printed circuit boards, with more than 30 years of experience, headquartered in Longmont, Colo.



For the Latest PCB News and Information, Visit: [PCB007.com](http://PCB007.com)

# Career Opportunities



## How Do Your Team Members Stack Up?

### Find industry-experienced candidates at I-Connect007.

For just \$750, your 200-word, full-column ad will appear in the "career opportunities" section of all three of our monthly magazines, reaching circuit board designers, fabricators, assemblers, OEMs, and suppliers.

In addition, your ad will be featured in at least one of our newsletters, and your posting will appear on our [jobConnect007.com](http://jobConnect007.com) board, which is also promoted in every newsletter.

Potential candidates can click on your ad and submit a resume directly to the email address you provide or be directed to the URL of your choice. If you wish to continue beyond the first month, the price is the same per month.

**No contract required. We even include your logo in the ad, which is great branding!**

To get your ad into the next issue, contact:

Barb Hockaday at [barb@iconnect007.com](mailto:barb@iconnect007.com) or +1 916.365.1727 (-8 GMT PST)

**I-Connect007**  
GOOD FOR THE INDUSTRY



# Career Opportunities



## Circuit Engineering Planning Engineer

### Experience

- Minimum of 5 years' working within printed circuit board manufacturing industry

### Responsibilities

- Review Gerber data and talk with the customer when necessary
- Create production traveler based on Gerber data to release the order
- Improve process capability, yields and cost while maintaining safety and improving quality standards
- Work with customers in developing cost-effective production processes

---

## Quality Engineer/Manager

### Experience

- Minimum of 2 years' working within printed circuit board industry
- Possess working knowledge of the IPC requirements and submitting PPAP reports
- Should have knowledge of working with the A16949 certification

### Responsibilities

- Perform defect reduction analysis and activities
- Participate in the evaluation of processes, new equipment, facility improvements and procedures

---

## Sales Associate/Customer Service

- Should have a minimum of 2 years' experience
- Salary plus commission

All positions will be on location at Circuit Engineering, 1390 Lunt Ave., Elk Grove Village, Illinois, not remote!

Contact: Felix Simon: +1 847 867-7942

[apply now](#)



MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

## Pre-CAM Engineer

Illinois-based PCB fabricator Eagle Electronics is seeking a pre-CAM engineer specific to the printed circuit board manufacturing industry. The pre-CAM Engineer will facilitate creation of the job shop travelers used in the manufacturing process. Candidate will have a minimum of two years of pre-CAM experience and have a minimum education level of an associate degree. This is a first-shift position at our Schaumburg, Illinois, facility. This is not a remote or offsite position.

If interested, please submit your resume to [HR@eagle-elec.com](mailto:HR@eagle-elec.com) indicating 'Pre-CAM Engineer' in the subject line.

[apply now](#)

---

## Process Engineer

We are also seeking a process engineer with experience specific to the printed circuit board manufacturing industry. The process engineer will be assigned to specific processes within the manufacturing plant and be given ownership of those processes. The expectation is to make improvements, track and quantify process data, and add new capabilities where applicable. The right candidate will have a minimum of two years of process engineering experience, and a minimum education of bachelor's degree in an engineering field (chemical engineering preferred but not required). This is a first shift position at our Schaumburg, Illinois, facility. This is not a remote or offsite position.

If interested, please submit your resume to [HR@eagle-elec.com](mailto:HR@eagle-elec.com) indicating 'Process Engineer' in the subject line.

[apply now](#)

# Career Opportunities



**ventec**  
INTERNATIONAL GROUP  
騰輝電子

## Operations Manager, Elk Grove Village IL, USA

Want to advance your career by joining a globally successful and growing world class CCL manufacturing company and help drive that success? As operations manager at Ventec USA LLC, a wholly owned subsidiary of Ventec International Group, you will coordinate and oversee our organization's operations in Elk Grove Village, IL, and Fullerton, CA. Your tasks will include formulating strategy, implementing performance improvement measures, procuring materials and resources and assuring compliance. You will be a mentor to your team members, find ways to maintain and improve the highest quality of customer service and implement best practices across all levels.

### Skills and abilities required for the role:

- Proven commercial experience as operations manager or similar role for minimum 5 years
- Knowledge of organizational effectiveness and operations management
- Experience with ISO9001 or similar QMS required
- Experience in budgeting and forecasting & familiarity with business and financial principles
- Excellent leadership ability and communication skills (English)
- Outstanding organizational skills
- Degree in Business, Operations Management, or related field preferred but not required

### What's on offer:

- Excellent salary and benefits commensurate with experience

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](mailto:jpattie@ventec-usa.com) and mention "Operations Manager—Elk Grove Village" in the subject line.

apply now



## Our Summit Anaheim, CA, division currently has multiple open positions for planning engineers.

The planner is responsible for creating and verifying manufacturing documentation, including work instructions and shop floor travelers. Review lay-ups, details, and designs according to engineering and customer specifications through the use of computer and applications software. May specify required manufacturing machinery and test equipment based on manufacturing and/or customer requirements. Guides manufacturing process development for all products.

### Responsibilities:

1. Accurately plan jobs and create shop floor travelers.
2. Create documentation packages.
3. Use company software for planning and issuing jobs.
4. Contact customers to resolve open issues.
5. Create TDR calculations.
6. Assist in the training of new planning engineers.
7. Review prints and purchase orders.
8. Create stackups and order materials per print/spec.
9. Plan jobs manufacturing process.
10. Institute new manufacturing processes and or changes.

### Education/Experience:

1. High school diploma or equivalent
2. Minimum five (5) years' experience in the printed circuit board industry with three (3) years as a planning engineer.
3. Must be able to cooperate and communicate effectively with customers, management, and supervisory staff.
4. Must be proficient in rigid, flex, rigid/flex, and sequential lam designs.

apply now

# Career Opportunities

## Now Hiring

### Director of Process Engineering

A successful and growing printed circuit board manufacturer in Orange County, CA, has an opening for a director of process engineering.

#### Job Summary:

The director of process engineering leads all engineering activities to produce quality products and meet cost objectives. Responsible for the overall management, direction, and coordination of the engineering processes within the plant.

#### Duties and Responsibilities:

- Ensures that process engineering meets the business needs of the company as they relate to capabilities, processes, technologies, and capacity.
- Stays current with related manufacturing trends. Develops and enforces a culture of strong engineering discipline, including robust process definition, testing prior to production implementation, change management processes, clear manufacturing instructions, statistical process monitoring and control, proactive error proofing, etc.
- Provides guidance to process engineers in the development of process control plans and the application of advanced quality tools.
- Ensures metrics are in place to monitor performance against the goals and takes appropriate corrective actions as required. Ensures that structured problem-solving techniques are used and that adequate validation is performed for any issues being address or changes being made. Develops and validates new processes prior to incorporating them into the manufacturing operations.
- Strong communication skills to establish priorities, work schedules, allocate resources, complete required information to customers, support quality system, enforce company policies and procedures, and utilize resources to provide the greatest efficiency to meet production objectives.

#### Education and Experience:

- Master's degree in chemical engineering or engineering is preferred.
- 10+ years process engineering experience in an electronics manufacturing environment, including 5 years in the PCB or similar manufacturing environment.
- 7+ years of process engineering management experience, including 5 years of experience with direct responsibility for meeting production throughput and quality goals.

apply now

## Now Hiring

### Process Engineering Manager

A successful and growing printed circuit board manufacturer in Orange County, CA, has an opening for a process engineering manager.

#### Job Summary:

The process engineering manager coordinates all engineering activities to produce quality products and meet cost objectives. Responsible for the overall management, direction, and coordination of the engineering team and leading this team to meet product requirements in support of the production plan.

#### Duties and Responsibilities:

- Ensures that process engineering meets the business needs of the company as they relate to capabilities, processes, technologies, and capacity.
- Stays current with related manufacturing trends. Develops and enforces a culture of strong engineering discipline, including robust process definition, testing prior to production implementation, change management processes, clear manufacturing instructions, statistical process monitoring and control, proactive error proofing, etc.
- Ensures metrics are in place to monitor performance against the goals and takes appropriate corrective actions as required. Ensures that structured problem-solving techniques are used and that adequate validation is performed for any issues being address or changes being made. Develops and validates new processes prior to incorporating into the manufacturing operations

#### Education and Experience:

- Bachelor's degree in chemical engineering or engineering is preferred.
- 7+ years process engineering experience in an electronics manufacturing environment, including 3 years in the PCB or similar manufacturing environment.
- 5+ years of process engineering management experience, including 3 years of experience with direct responsibility for meeting production throughput and quality goals.

apply now

# Career Opportunities



## We're Hiring! Connecticut Locations

### Senior Research Chemist: Waterbury, CT, USA

Research, develop, and formulate new surface treatment products for the printed circuit board, molded interconnect, IC substrate, and LED manufacturing industries. Identify, develop, and execute strategic research project activities as delegated to them by the senior research projects manager. Observe, analyze, and interpret the results from these activities and make recommendations for the direction and preferred route forward for research projects.

### Quality Engineer: West Haven, CT, USA

Support the West Haven facility in ensuring that the quality management system is properly utilized and maintained while working to fulfill customer-specific requirements and fostering continuous improvement.

For a complete listing of career opportunities or to apply for one of the positions listed above, please visit us here.

[apply now](#)



## We're Hiring! Illinois / New Jersey

### Technical Service Rep: Chicago, IL, USA

The technical service rep will be responsible for day-to-day engineering support for fabricators using our chemical products. The successful candidate will help our customer base take full advantage of the benefits that are available through the proper application of our chemistries.

### Applications Engineer: South Plainfield, NJ, USA

As a key member of the Flexible, Formable, and Printed Electronics (FFPE) Team, the applications engineer will be responsible for developing applications know-how for product evaluation, material testing and characterization, and prototyping. In addition, this applications engineer will provide applications and technical support to global customers for the FFPE Segment.

For a complete listing of career opportunities or to apply for one of the positions listed above, please visit us here.

[apply now](#)

# Career Opportunities



## SMT Operator Hatboro, PA

Manncorp, a leader in the electronics assembly industry, is looking for a **surface-mount technology (SMT) operator** to join their growing team in Hatboro, PA!

The **SMT operator** will be part of a collaborative team and operate the latest Manncorp equipment in our brand-new demonstration center.

### Duties and Responsibilities:

- Set up and operate automated SMT assembly equipment
- Prepare component kits for manufacturing
- Perform visual inspection of SMT assembly
- Participate in directing the expansion and further development of our SMT capabilities
- Some mechanical assembly of lighting fixtures
- Assist Manncorp sales with customer demos

### Requirements and Qualifications:

- Prior experience with SMT equipment or equivalent technical degree preferred; will consider recent graduates or those new to the industry
- Windows computer knowledge required
- Strong mechanical and electrical troubleshooting skills
- Experience programming machinery or demonstrated willingness to learn
- Positive self-starter attitude with a good work ethic
- Ability to work with minimal supervision
- Ability to lift up to 50 lbs. repetitively

### We Offer:

- Competitive pay
- Medical and dental insurance
- Retirement fund matching
- Continued training as the industry develops

[apply now](#)



## SMT Field Technician Hatboro, 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

[apply now](#)

# Career Opportunities



## Sales Account Manager

Sales Account Management at Lenthor Engineering is a direct sales position responsible for creating and growing a base of customers that purchase flexible and rigid flexible printed circuits. The account manager is in charge of finding customers, qualifying the customer to Lenthor Engineering and promoting Lenthor Engineering's capabilities to the customer. Leads are sometimes referred to the account manager from marketing resources including trade shows, advertising, industry referrals and website hits. Experience with military printed circuit boards (PCBs) is a definite plus.

### Responsibilities

- Marketing research to identify target customers
- Identifying the person(s) responsible for purchasing flexible circuits
- Exploring the customer's needs that fit our capabilities in terms of:
  - Market and product
  - Circuit types used
  - Competitive influences
  - Philosophies and finance
  - Quoting and closing orders
  - Providing ongoing service to the customer
  - Develop long-term customer strategies to increase business

### Qualifications

- 5-10 years of proven work experience
- Excellent technical skills

Salary negotiable and dependent on experience. Full range of benefits.

Lenthor Engineering, Inc. is a leader in flex and rigid-flex PWB design, fabrication and assembly with over 30 years of experience meeting and exceeding our customers' expectations.

Contact Oscar Akbar at: [hr@lenthor.com](mailto:hr@lenthor.com)

[apply now](#)



## Senior Process Engineer

### Job Description

Responsible for developing and optimizing Lenthor's manufacturing processes from start up to implementation, reducing cost, improving sustainability and continuous improvement.

### Position Duties

- Senior process engineer's role is to monitor process performance through tracking and enhance through continuous improvement initiatives. Process engineer implements continuous improvement programs to drive up yields.
- Participate in the evaluation of processes, new equipment, facility improvements and procedures.
- Improve process capability, yields, costs and production volume while maintaining safety and improving quality standards.
- Work with customers in developing cost-effective production processes.
- Engage suppliers in quality improvements and process control issues as required.
- Generate process control plan for manufacturing processes, and identify opportunities for capability or process improvement.
- Participate in FMEA activities as required.
- Create detailed plans for IQ, OQ, PQ and maintain validated status as required.
- Participate in existing change control mechanisms such as ECOs and PCRs.
- Perform defect reduction analysis and activities.

### Qualifications

- BS degree in engineering
- 5-10 years of proven work experience
- Excellent technical skills

Salary negotiable and dependent on experience. Full range of benefits.

Lenthor Engineering, Inc. is the leader in Flex and Rigid-Flex PWB design, fabrication and assembly with over 30 years of experience meeting and exceeding our customers' expectations.

Contact Oscar Akbar at: [hr@lenthor.com](mailto:hr@lenthor.com)

[apply now](#)

# Career Opportunities



**BLACKFOX**

Premier Training & Certification

## IPC Instructor

Longmont, CO; Phoenix, AZ;  
U.S.-based remote

*Independent contractor,  
possible full-time employment*

### Job Description

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

IPC instructors will conduct training at one of our public training centers or will travel directly to the customer's facility. A candidate's close proximity to Longmont, CO, or Phoenix, AZ, is a plus. Several IPC Certification Courses can be taught remotely and require no travel.

### Qualifications

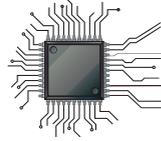
Candidates must have a minimum of five years of electronics manufacturing experience. This experience can include printed circuit board fabrication, circuit board assembly, and/or wire and cable harness assembly. Soldering experience of through-hole and/or surface-mount components is highly preferred.

Candidate must have IPC training experience, either currently or in the past. A current and valid certified IPC trainer certificate holder is highly preferred.

Applicants must have the ability to work with little to no supervision and make appropriate and professional decisions.

Send resumes to Sharon Montana-Beard at  
[sharonm@blackfox.com](mailto:sharonm@blackfox.com).

apply now



**MivaTek**

Global

## MivaTek Global: We Are Growing!

MivaTek Global is adding sales, technical support and application engineers.

Join a team that brings new imaging technologies to circuit fabrication and microelectronics. Applicants should have direct experience in direct imaging applications, complex machine repair and/or customer support for the printed circuit board or microelectronic markets.

Positions typically require regional and/or air travel. Full time and/or contractor positions are available.

Contact [HR@MivaTek.Global](mailto:HR@MivaTek.Global)  
for additional information.

apply now

# Career Opportunities



**eptac**  
TRAIN. WORK SMARTER. SUCCEED.

## Become a Certified IPC Master Instructor

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

### Qualifications and skills

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

### Benefits

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

[apply now](#)



**APCT**  
Passion | Commitment | Trust

## 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](http://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.

[apply now](#)

# Career Opportunities



**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](mailto:mfariba@uscircuit.com)

[apply now](#)



YOUR  
JOB  
AD  
HERE

For information, please contact:  
BARB HOCKADAY  
[barb@iconnect007.com](mailto:barb@iconnect007.com)  
+1 916.365.1727 (PACIFIC)

**I-Connect007**  
GOOD FOR THE INDUSTRY



Webinar: For more information about the iamcam concept, please request the iamcam webinar video via [presales@ucamco.com](mailto:presales@ucamco.com).

## REALTIME with... IConnect007

ROUNDTABLE DISCUSSION FEATURING:



Chris Hanson  
Ventec International Group



Rax Ribadia  
Excello Circuits



Denis McCarthy  
Ventec International Group



Pete Starkey  
I-Connect007

Video  An IMS Thermal Materials Discussion

Roundtable: "Use of IMS Thermal Materials in Multilayer Stackups for Power Applications" with Ventec International Group and Excello Circuits.

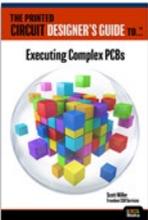
## I-007eBooks The Printed Circuit Designer's Guide to...



### **Thermal Management: A Fabricator's Perspective**

by Anaya Vardya, American Standard Circuits

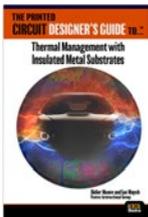
Beat the heat in your designs through thermal management design processes. This book serves as a desk reference on the most current techniques and methods from a PCB fabricator's perspective.



### **Executing Complex PCBs**

by Scott Miller, Freedom CAD Services

Readers will learn how to design complex boards correctly the first time, on time. This book is a must-read for anyone designing high-speed, sophisticated printed circuit boards.



### **Thermal Management with Insulated Metal Substrates**

by Didier Mauve and Ian Mayoh, Ventec International Group

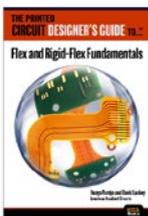
Considering thermal issues in the earliest stages of the design process is critical. This book highlights the need to dissipate heat from electronic devices.



### **Fundamentals of RF/Microwave PCBs**

by John Bushie and Anaya Vardya, American Standard Circuits

Today's designers are challenged more than ever with the task of finding the optimal balance between cost and performance when designing radio frequency/microwave PCBs. This micro eBook provides information needed to understand the unique challenges of RF PCBs.



### **Flex and Rigid-Flex Fundamentals**

by Anaya Vardya and David Lackey, American Standard Circuits

Flexible circuits are rapidly becoming a preferred interconnection technology for electronic products. By their intrinsic nature, FPCBs require a good deal more understanding and planning than their rigid PCB counterparts to be assured of first-pass success.

**Our library is open 24/7/365. Visit us at: [I-007eBooks.com](http://I-007eBooks.com)**

**PUBLISHER: BARRY MATTIES**  
barry@iconnect007.com

**MANAGING EDITOR: NOLAN JOHNSON**  
(503) 597-8037; nolan@iconnect007.com

**ASSOCIATE EDITOR: MICHELLE TE**  
michelle@iconnect007.com

**CONTRIBUTING EDITOR: PATRICIA GOLDMAN**  
(724) 299-8633; patty@iconnect007.com

**TECHNICAL EDITOR: PETE STARKEY**  
+44 (0) 1455 293333; pete@iconnect007.com

**CONTRIBUTING TECHNICAL EDITOR: DAN FEINBERG**  
baer@iconnect007.com

**CONTRIBUTING TECHNICAL EDITOR: HAPPY HOLDEN**  
(616) 741-9213; happy@iconnect007.com

**SALES MANAGER: BARB HOCKADAY**  
(916) 608-0660; barb@iconnect007.com

**SALES: ANGELA ALEXANDER**  
(408) 489-8389; angela@iconnect007.com

**MARKETING SERVICES: TOBEY MARSICOVETERE**  
(916) 266-9160; tobey@iconnect007.com

**PRODUCTION MANAGER: SHELLY STEIN**  
shelly@iconnect007.com

**MAGAZINE LAYOUT: RON MEOGROSSI**

**AD DESIGN: SHELLY STEIN, MIKE RADOGNA,  
TOBEY MARSICOVETERE**

**CREATIVE TECHNOLOGIST: BRYSON MATTIES**

**COVER: SHELLY STEIN**

**COVER IMAGE: ADOBE STOCK©KRAS99, ANTONIART**

# PCB007

MAGAZINE

PCB007 MAGAZINE®

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

© 2021 BR Publishing, Inc. does not assume and hereby disclaims any liability to any person for loss or damage caused by errors or omissions in the material contained within this publication, regardless of whether such errors or omissions are caused accidentally, from negligence or any other cause.

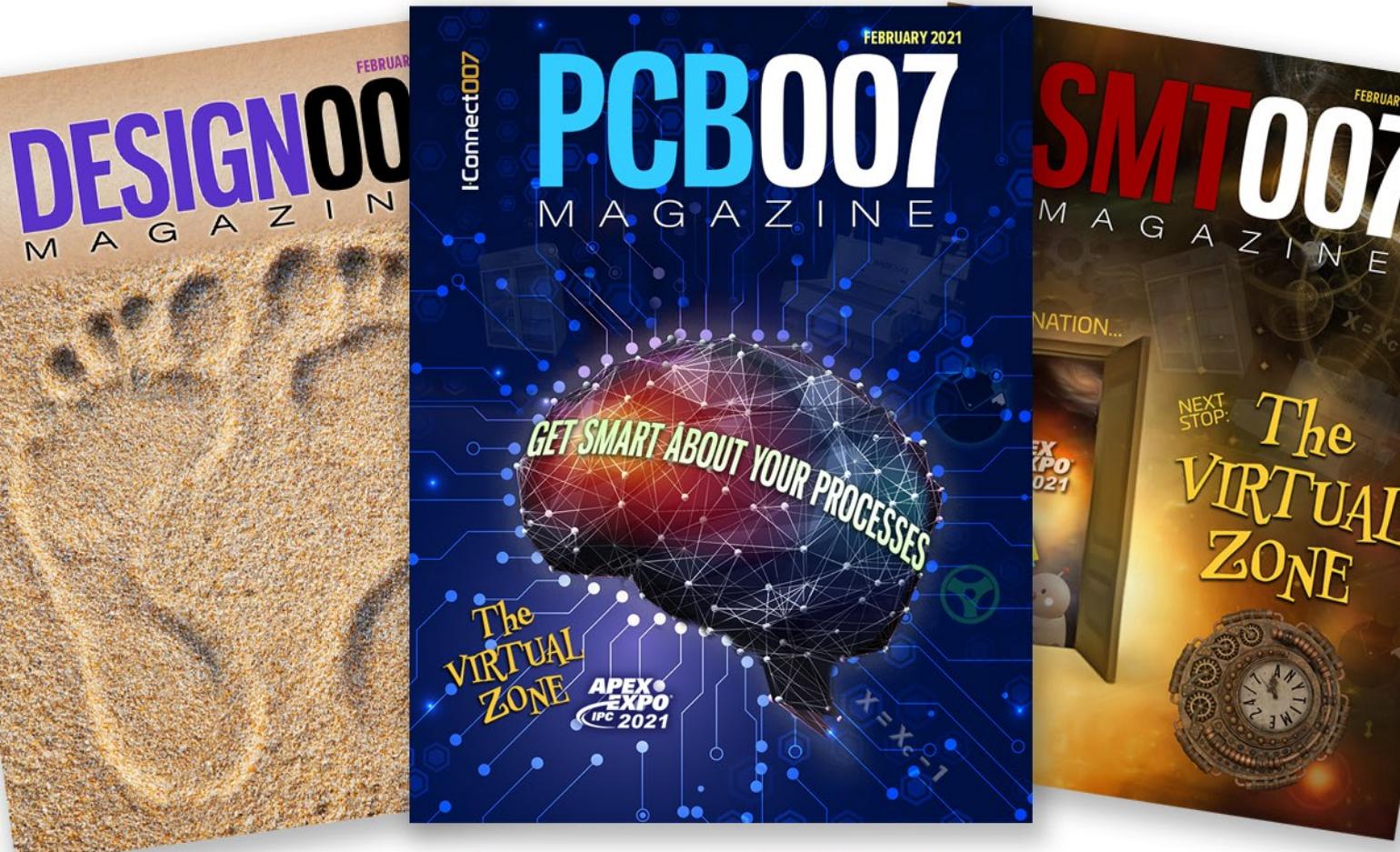
February 2021, Volume 11, Number 2  
PCB007 MAGAZINE is published monthly,  
by BR Publishing, Inc.

## ADVERTISER INDEX

all4-PCB.....	17
atg Luther & Maelzer GmbH.....	87
Atotech.....	41
Burkle North America.....	5, 99
Chemcut.....	83
DB Management.....	21
Denkai America.....	13
Electra Polymers.....	95
Elite Materials.....	105
Entelechy Global.....	47
Excellon.....	33
Fein-line Associates.....	73
Gardien.....	75
I-007 eBooks.....	2
I-007e Roundtables.....	3
IPC.....	15, 111
Insulectro.....	7, 31
MacDermid Alpha Electronic Solutions.....	35
MicroCraft.....	49
MivaTek Global.....	79
MKS   ESI.....	27
Pluritec.....	11
Prototron Circuits.....	103
Rogers Corporation.....	109
Taiyo America.....	23, 107
Technica USA.....	71
Ucamco.....	45
Ventec International Group.....	63

# I-Connect007

GOOD FOR THE INDUSTRY



FREE SUBSCRIPTION



[myconnect007.com](http://myconnect007.com)

**EDITORIAL CONTACT**

**Nolan Johnson**  
nolan@iconnect007.com  
+1 503.597-8037 GMT-7



[mediakit.iconnect007.com](http://mediakit.iconnect007.com)

**SALES CONTACT**

**Barb Hockaday**  
barb@iconnect007.com  
+1 916 365-1727 GMT-7



[www.iconnect007.com](http://www.iconnect007.com)