

iConnect007

JANUARY 2018

PCB007

M A G A Z I N E



THINKING
About **NEW**
EQUIPMENT?

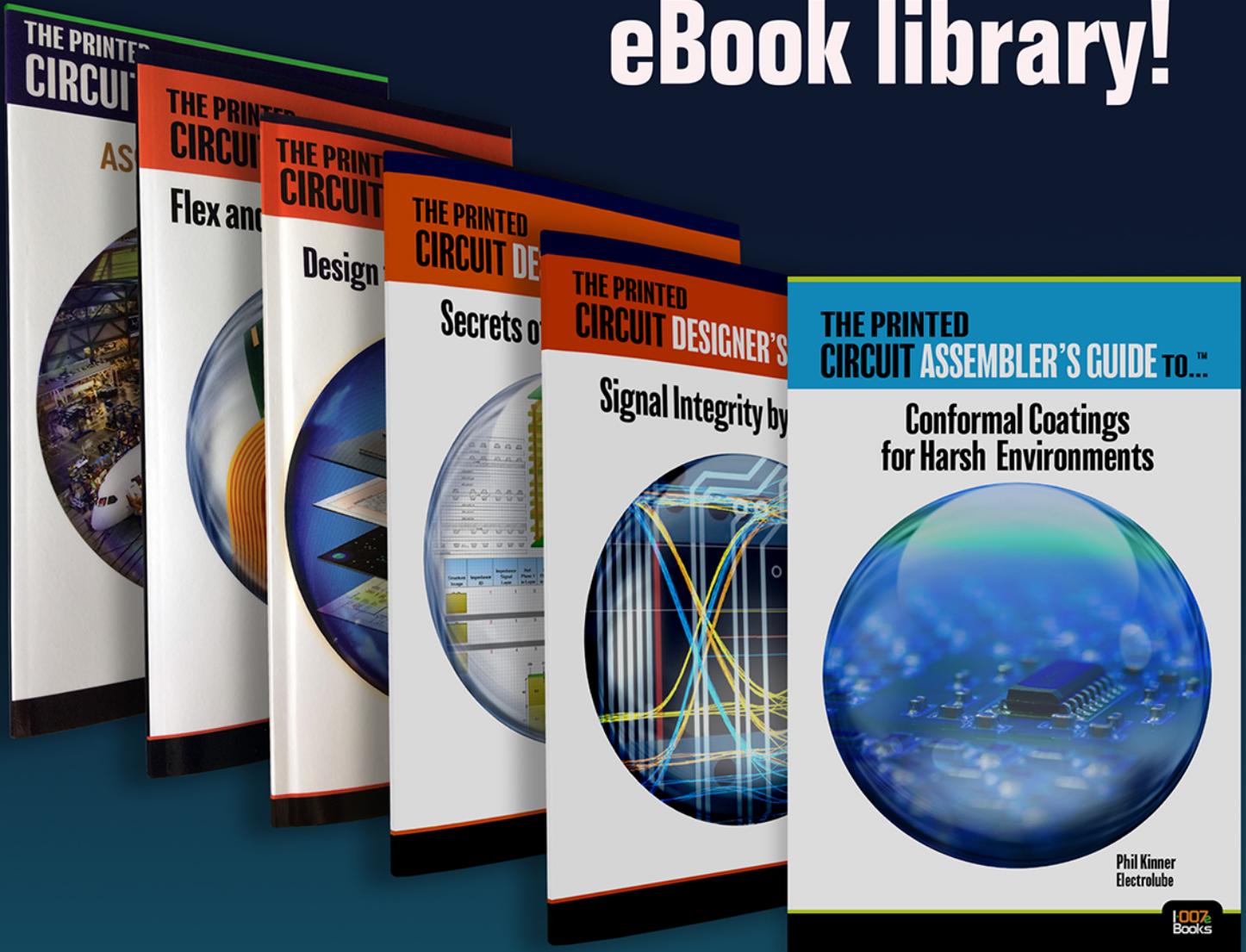
SPECIAL SECTION IN THIS ISSUE!

**APEX
EXPO**
IPC 2018

PRE-SHOW COVERAGE



Download free books from our micro eBook library!



Written by industry experts,
these free micro eBooks each contain
valuable information on relevant topics in
an easy-to-read format.

Log in or register to access all of our
premium content at: myconnect007.com

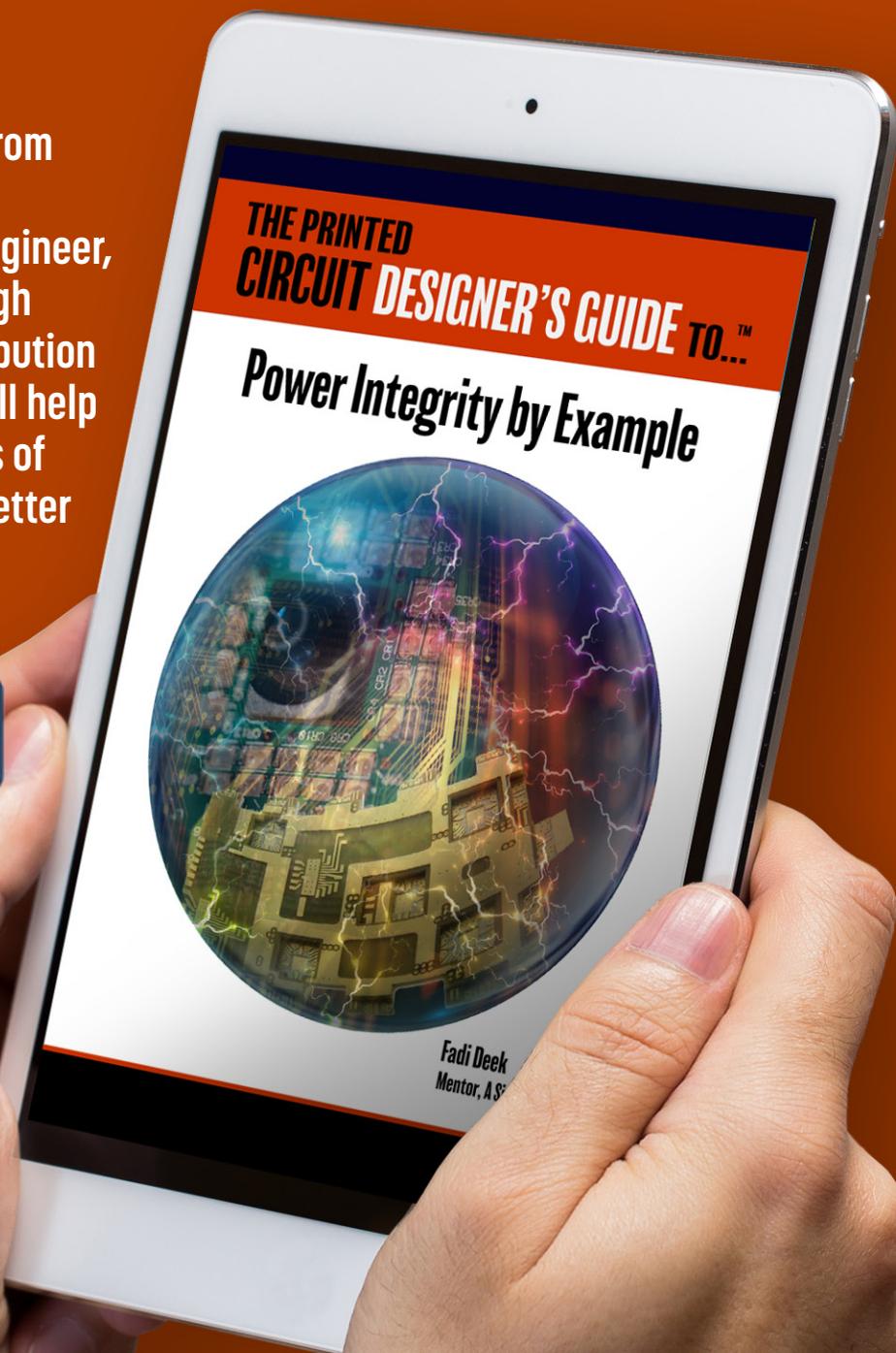


“This micro eBook should be required reading for every PCB designer or design engineer, whether novice or veteran.”



Andy Shaughnessy
Managing Editor, The PCB Design Magazine

In this second micro eBook from Mentor, A Siemens Business, written by signal integrity engineer, Fadi Deek, provides a thorough investigation of power distribution network performance and will help PCB designers and engineers of all experience levels make better design decisions.



PCB007

M A G A Z I N E

New Equipment

As equipment gets more sophisticated and costly, determining equipment needs has become far more complicated. Choosing wisely—and correctly anticipating your and the market’s needs—has never been more critical. Our experts are well equipped to give us their professional perspectives on just what to consider when evaluating new equipment.



12 Making the Right Equipment Selection
by Stephen Las Marias and Patty Goldman



24 Equipment/Process Selection: Case Study of a DMADV Approach to PCB FAB Process Design
by Alex Stepinski



31 Whelen Engineering and AWP Explain their Unique Collaboration
Interview with Alex Stepinski, Jochen Zeller and Henk Van der Meij



36 The Selection of Chemical Etching Equipment for PCB Production
by James Hall

SPECIAL SECTION:
43 IPC APEX EXPO 2018 Pre-Show Coverage

1000-HOUR
PASSED
CAF

Tachyon® 100G laminate materials have superior fill and flow compared to competitive products that require very high pressure (500psi) with proven sequential lamination and HDI structure performance.

Tachyon® 100G

Ultra-Low Loss Laminate & Prepreg

Tg: 200°C Td: 380°C

Ultra-low loss material with
Dk: 3.02 and Df: 0.0021

Stable Dk over temperature range: -55 to 125°C
and up to 100 GHz

Scalable solution for next generation designs of
backplanes and daughter cards, enabling 10x
improvements from 10 Gb/s data rates

1000-Hours CAF Tested

Low moisture absorption

0.8 mm pitch capable

6x 260°C reflow capable

6x 288°C solder float capable

RoHS Compliant

Multiple lamination cycles

HDI technology compatible

Tachyon® 100G
**HIGH SPEED
DIGITAL**

Designed for Very High Speed
Digital Applications (>100 Gb/s)

© 2017 ISOLA GROUP. ALL RIGHTS RESERVED.

AEROSPACE & DEFENSE • COMPUTING • STORAGE • NETWORKS • COMMUNICATIONS

isola

FOR MORE INFORMATION, CONTACT YOUR LOCAL SALES REPRESENTATIVE.

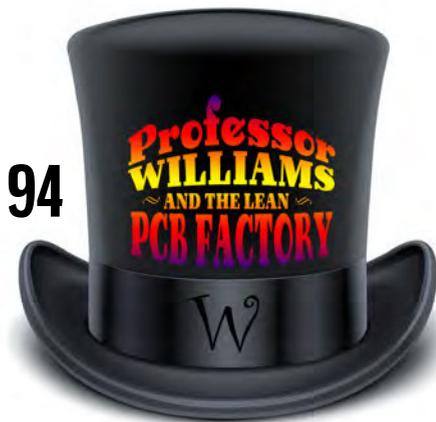
Isola Group
3100 West Ray Road
Suite 301
Chandler, AZ 85226
Phone: 480-893-6527
info@isola-group.com

Isola Asia Pacific (Hong Kong) Ltd.
Unit 3512 - 3522, 35/F
No. 1 Hung To Road, Kwun Tong,
Kowloon, Hong Kong
Phone: 852-2418-1318
info.hkg@isola-group.com

Isola GmbH
Isola Strasse 2
D-52348 Düren, Germany
Phone: 49-2421-8080
info-dur@isola-group.com
Website: isola-group.com

PCB007

M A G A Z I N E



SHORTS:

- 21** Maximization of IIoT Technologies in Test & Measurement to Enable Smart Testing
- 48** Philip Carmichael IPC President, Asia on the Changes in PCB Value Chain
- 98** Micro-Spectrometer Opens Door to a Wealth of New Smartphone Functions
- 104** Unattended Ground Sensors Market to be Worth \$458M by 2022

COLUMNS:

- 8** New Year, New Equipment—Right?
by Patty Goldman
- 84** All the Fun of the Fair: Behind the Scenes at productronica 2017
by Mark Ladle
- 90** Case Study: Pits and Mouse Bite Issues, Part 2
by Michael Carano
- 94** Willy Wonka: The Lean Case Study
by Steve Williams
- 100** Electronics Industry Advocacy is More Important in 2018 than Ever
by John Mitchell

HIGHLIGHTS:

- 22** Supply Line
- 34** Markets
- 83** MilAero
- 106** Top 10 from PCB007

DEPARTMENTS:

- 110** Career Opportunities
- 120** Events Calendar
- 121** Advertiser Index & Masthead



Productive Fabrication Equipment



MDI-DT



WorkCell²



CombiDrill



MDI Micromirror-Digital-Imaging

- Cost-efficient & high-quality DDI
- High-power UV-LEDs & DMD-technology
- Operator-friendly concept w/compact footprint
- Modular machine concept & field upgradable
- Flexible number of heads and head distances for shortest exposure times
- Multiple wavelength concept

Vacuum Lamination System

- Even pressure across the platen surface
- State-of-the-art heating system
- All-steel construction
- Modular machine concept & field upgradable
- User-friendly visualization system
- Affordable initial investment

Hybrid Laser Drilling/Cutting System

- Microvia drilling 50-300 μ m diameter
- Space saving compact design
- Best power/size ratio in market
- Pulse Stabilizer
- European technology center and USA support center

Bürkle North America supplies a full complement of productive equipment for fabricating printed wiring boards. From imaging through metrology inspection, Bürkle North America's equipment offering sets the standard in the industry for Imaging, Registration, Lamination, Mechanical or Laser Drill/Routing and Feature Metrology Inspection.

BURKLE
NORTH AMERICA, INC.
11105 Knott Ave., Cypress, CA 90630



Contact **Dave Howard**
for more details.

Visit us at **APEX EXPO**
IPC 2018
Booth 801

www.burkleamerica.com

Phone: 714-379-5090

New Year, New Equipment—Right?

Patty's Perspective, a column by Patty Goldman
I-CONNECT007

Happy New Year and welcome to 2018! To bring in the new year, we've made a few changes to our magazines. You may have noticed that our name has changed from *The PCB Magazine* to *PCB007 Magazine*. Not only did we update our magazine's name, we refreshed the interior pages of the publication, as well. As an I-Connect007 publication, *PCB007 Magazine* fits nicely with our other publications, which also carry through with the naming convention starting this month: *SMT007 Magazine* and *Design007 Magazine*. We hope you enjoy this fresh new look.

This month, we will discuss the equipment purchasing decision-making process. How many of you can recall the earliest “dippy dunk” PCB shops, so-called because that's exactly how it was done? There were no conveyORIZED lines, no automatic hoists, no load/unload stations, maybe not even a lab for analyzing the plating baths. Plating or etch resist was screen-printed onto the boards, or in some cases sprayed or dip-coated, imaged and de-



veloped in a small vertical spray developing tank. A few shops had small conveyORIZED etchers.

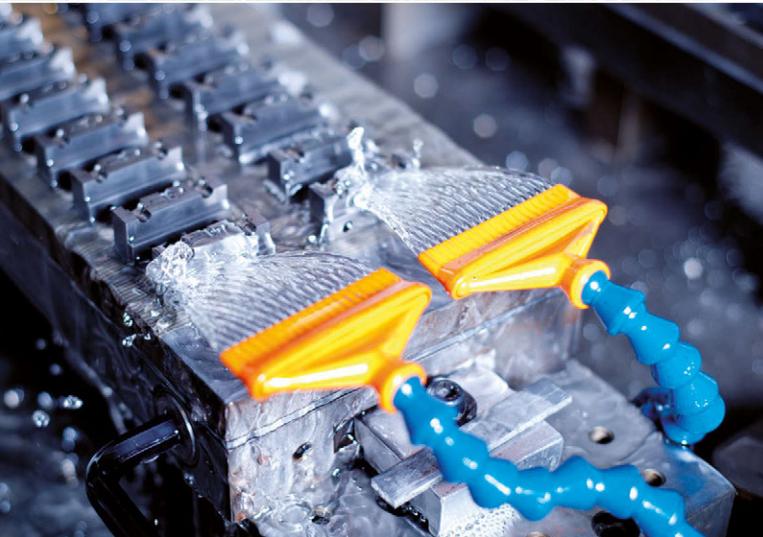
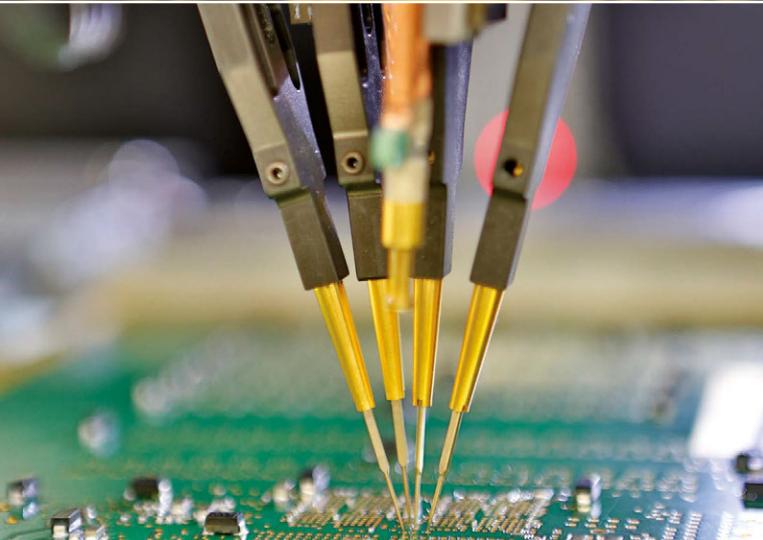
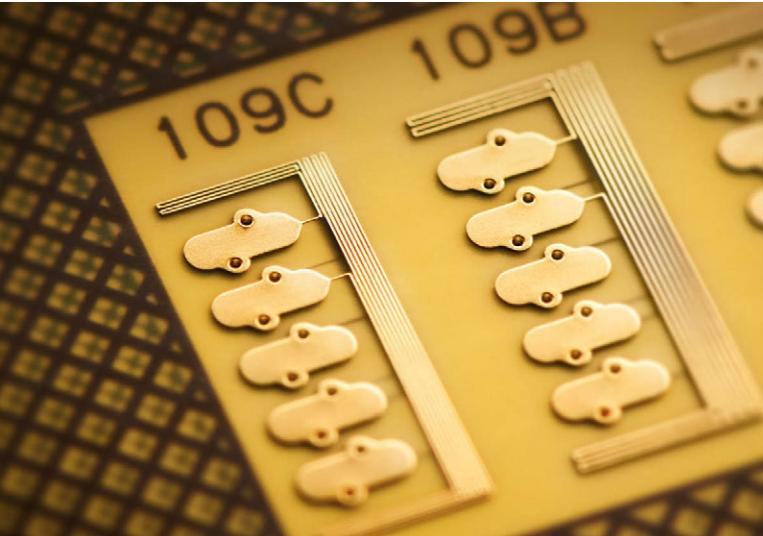
We have come so far and become so sophisticated! Equipment for making a PCB is many orders of magnitude more involved and far, far more capable than those ancient days—and many orders of magnitude more expensive.

But as equipment has become more sophisticated and costly, determining what equipment you need has become far more complicated, too. Choosing wisely—and correctly anticipating your and the market's needs—has never been more critical, and can involve hundreds of thousands and indeed millions of dollars. Being wrong is not only costly but could put your whole operation in jeopardy. Yikes.

As usual, we conducted a survey on this month's topic to see what was most important to our readers. Interestingly, the most common two reasons for buying new equipment were to improve an existing capability and to increase capacity; adding a new capability placed third.

cicor

Your technology partner



Cicor is a global engineering and manufacturing partner with innovative technology solutions for the electronics industry. With about 1900 employees at ten production sites, Cicor manufactures highly complex printed circuit boards, hybrid circuits and 3D-MID solutions and offers complete electronic assembly and plastic injection molding.

The Group supplies customized solutions from design to finished product for international customers.

www.cicor.com

info@cicor.com

Apparently, we neglected to include “to improve quality” as an option because this was mentioned repeatedly in the comment section.

Additionally, you are researching your equipment needs and purchases through many venues like publications, tradeshow and, most notably, by benchmarking with other companies (Figure 2).

Let’s move on to our line-up for the month, starting with our discussion on the decision-making process for choosing the right equipment. We invited a couple of veteran industry people, Matt Turpin, president and CEO of Zentech Manufacturing, and Kathy Nargi-Toth, president of Eltek-USA. They provide some sane advice on evaluating your equipment needs in line with your customer-partners, the value of creating a roadmap and having a plan, and, as always, open communication lines with your supply chain.

As I mentioned last month, the buzz around is all about Whelen Engineering, certainly a top equipment purchaser in our industry. Naturally, we’ve got an article by Alex Stepinski, pres-

ident of Whelen Engineering’s newly formed division, Greensource Fabrication. Alex’s vision is clear as he delineates the steps he has followed to build a new PCB manufacturing plant here in the USA. Considering the magnitude of this undertaking, it was imperative that a strict evaluation process be followed.

A sidebar interview with Jochen Zeller and Henk Van der Meij, VPs at AWP Group, one of Alex’s major equipment suppliers, is also included—which may or may not be illuminating. As Alex says, they are doers and thinkers, not talkers. But one can clearly see they extent of the partnership that has been formed.

Taking a slightly different tack is Chemcut’s Jim Hall, who carries us through the thought process for choosing conveyerized equipment, from physical parameters and construction material choices to the less obvious requirements like ease of maintenance, expansion capability and IoT extras.

Here in the middle of the magazine is our IPC APEX EXPO 2018 pre-show special, including a series of interviews with the people at

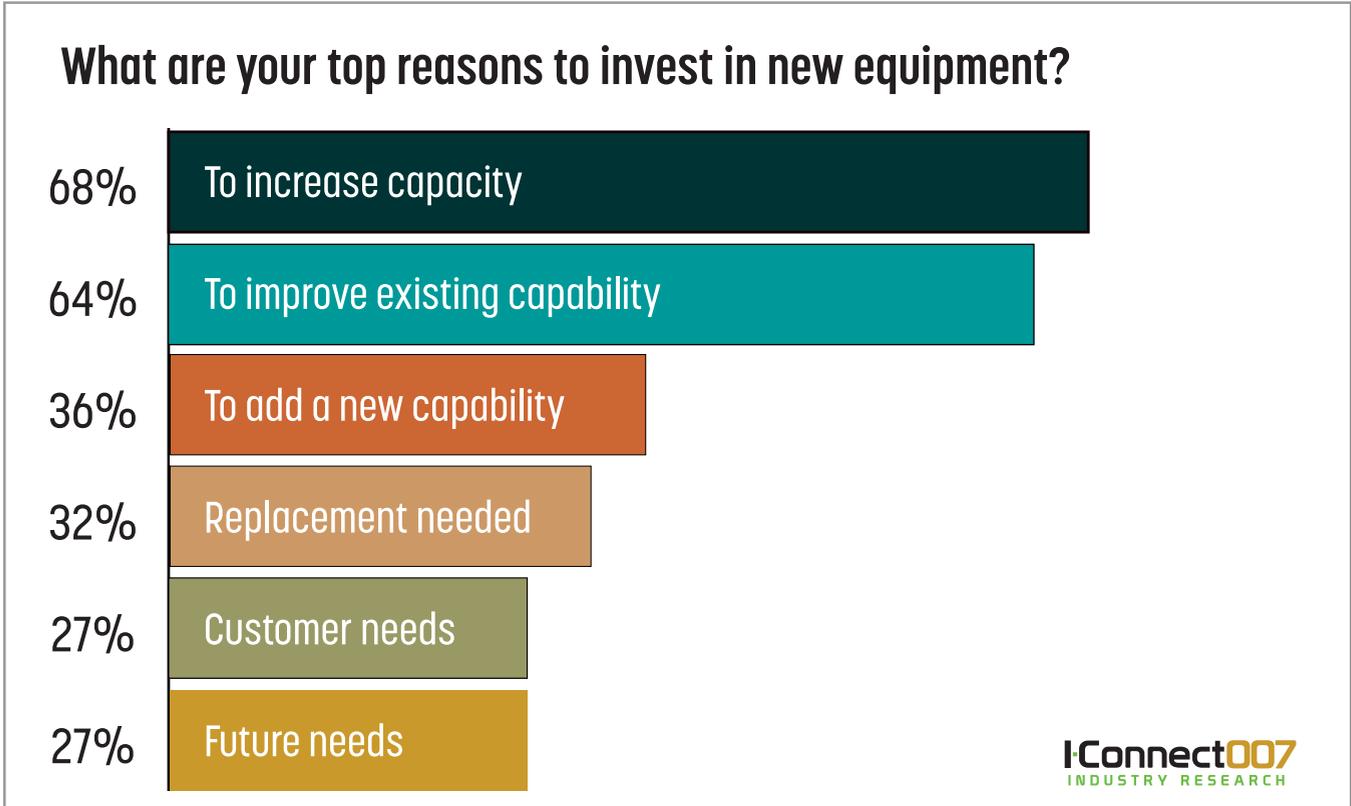


Figure 1: Reasons for investing in new equipment.

When doing research, what are your sources of information?

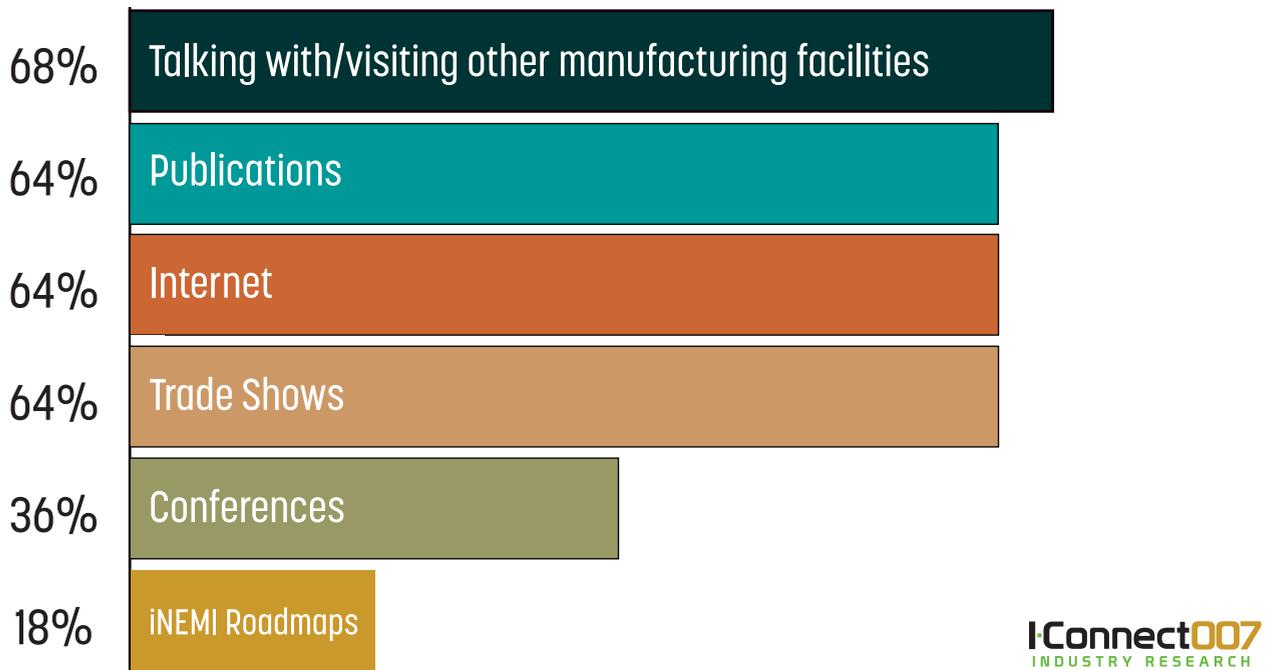


Figure 2: Types of research when investigating new equipment.

IPC who make it happen. Besides the show, we include details on the conference, CFX (check it out to learn more), and IPC’s Emerging Engineers program. The last interview is about the IPC app for the show and conference.

Getting back to our regular content, columnist Mark Ladle from Viking gives us a behind-the-scenes look at what it takes for equipment suppliers to show off their wares at an industry show. I’ve witnessed some of that before-the-show mess and it is always a wonder how everything is perfectly together and neat when the show opens.

Next, we have columnist Mike Carano, RBP Chemical Technology, with the second part of his case study on pits and mouse bites (don’t you love our industry-specific terminology!). Mike’s columns often deal with troubleshooting and his advice is always practical.

Steve Williams of Right Approach Consulting gives us a clever analogy on lean manufacturing using “Willy Wonka and the Chocolate Factory.” His comparisons are most interesting and entertaining, a pleasant way to learn.

(Steve, how many times have you watched that movie?)

IPC’s John Mitchell wraps up this month with a column on advocacy. Once upon a time, we simply built our factories and companies and ran them without giving politics, legislation or regulation a second thought. Those days are long gone across the globe, and we have learned the importance of having a say in things by speaking with and educating our legislators on the importance of manufacturing and to insist that science be part of legislative decisions.

Enjoy this opening issue of 2018 and we will see you next month! **PCB007**



Patricia Goldman is managing editor of *The PCB Magazine*. To contact Goldman, [click here](#).

Making the Right Equipment Selection

Feature Article by Stephen Las Marias and Patty Goldman
I-CONNECT007

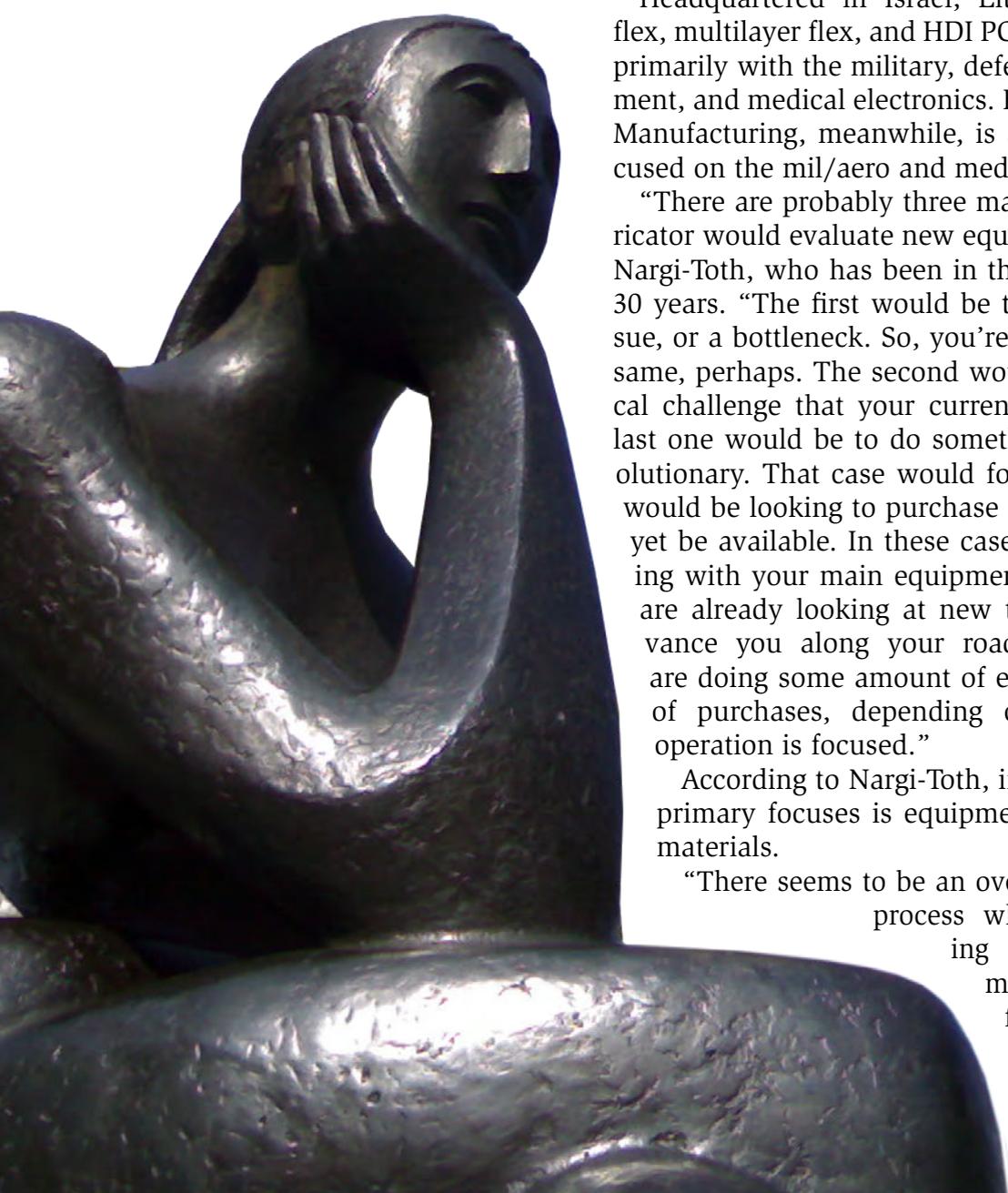
For this month's issue of *PCB007 Magazine*, our focus is on equipment—not just on who's got the latest and the greatest, but on how people decide what to buy, when to buy it, and how those decisions are made. In preparation for this issue, we invited Kathy Nargi-Toth, president of Eltek USA, and Matt Turpin, president and CEO of Zentech Manufacturing to a discussion on the decision-making process for new equipment, and the key considerations for choosing the best machine solution for a process.

Headquartered in Israel, Eltek manufactures rigid-flex, multilayer flex, and HDI PCBs. The company works primarily with the military, defense, and aerospace segment, and medical electronics. Baltimore-based Zentech Manufacturing, meanwhile, is an EMS firm mainly focused on the mil/aero and medical electronics markets.

“There are probably three main ways that a PCB fabricator would evaluate new equipment purchases,” says Nargi-Toth, who has been in the PCB industry for over 30 years. “The first would be to address a capacity issue, or a bottleneck. So, you're looking for more of the same, perhaps. The second would be to meet a technical challenge that your current equipment can't. The last one would be to do something that is new or revolutionary. That case would follow your roadmap and would be looking to purchase equipment that may not yet be available. In these cases, it is best to be working with your main equipment suppliers. Often, they are already looking at new techniques that can advance you along your roadmap. Most fabricators are doing some amount of each of these three types of purchases, depending on how the particular operation is focused.”

According to Nargi-Toth, in Eltek's case one of the primary focuses is equipment that can handle thin materials.

“There seems to be an overriding decision-making process when we go about buying a new piece of equipment. How does it handle flex material? How does it handle the sequential lamination, sub-composite layers or plated through-hole innerlayers? This mate-



IT-170GRA1

COME SEE
US AT
DESIGNCON
**BOOTH
#1338**

IT-170GRA1 Value Proposition

- Halogen Free
- Best in class performance in its space
- Best in class CAF performance
- Very attractive price to performance ratio
- Pass MRT-6 requirements
- CAF > 1000 hours
- 0.65mm pitch equivalent, no thermal issue
- Available with RTF and 2μ copper which provides additional performance on a very solid platform
- Df = 0.0075 @10GHz

Intel Purley Mid-Loss Solution – IT-170GRA1

Futures
Halogen free mid loss, Df < 0.01
Tg 180°C by DSC, low CTE

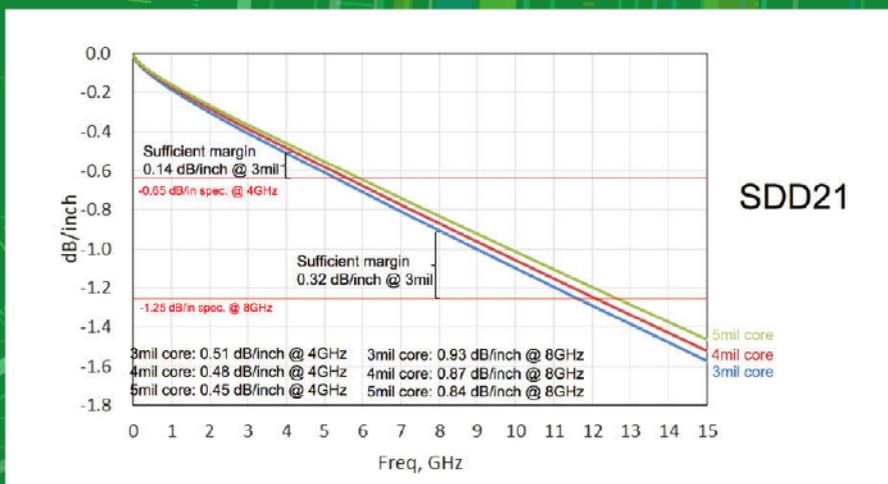
Applications
Server/Storage/Switch (10G, 40G)
Backplane, Telecom
Base station



Feature *Purley Platform Mid-Loss Solution – Hi Tg*

General Properties	Items	Methods	IT-170GRA1
	Tg (°C)	DSC	180
	T-288 (w/ 1 Oz Cu, min)	TMA	60+
	Td-5%(°C)	TGA 5% loss	380
	CTE (%), 50-260°C	TMA	2.4
	Peel strength (lb/inch)	1 oz	7.0
	Water absorption	D-24/23	0.1
	Dk: 2-10 GHz	Bereskin	3.96 – 3.99
	Df: 2-10 GHz	Bereskin	0.0073 - 0.0075

IT-170GRA1 Insertion Loss



ITEQ



Kathy Nargi-Toth, Eltek USA

rial handling focus helps us concentrate on equipment that meets our overarching requirement, because we need to have equipment with 1-10 mil handling capabilities,” said Nargi-Toth. “As an example, we do a lot of hole filling, and we have been using one type of equipment for many years. But it wasn’t as adept at handling the thin materials. So, when

we looked to add more capacity we evaluated a different machine and found that gave us better fill, especially with those small holes, and was also better for handling thin material. The process, basically, is we have a need, we put together a proposal of what type of equipment we want to look at, we gather some samples, we run samples, we evaluate them versus what we have, and then decide. We’ve done that for our etching line, and we have done that for laser drilling. Basically, benchmarking new equipment against existing and looking at two or three different types of equipment from different suppliers in the same category. We just purchased another laser drill, and in that case, we did a survey of what was out there, and we ended up buying another machine like the one we had, because it best met our needs.”

Being in the EMS business for about 35 years now, Turpin has already seen a lot of changes. According to him, in the old days—around 15 years or so back—an EMS firm could buy a set of equipment, and use the same set of equipment 10 years later. “Because technology just did not change that fast,” he says. “Back in the old days, you had a lot more mom-and-pop shops. A lot of Tier 4s and Tier 3s, because it wasn’t as capital intensive back then. It was great for an EMS business, selling from the equipment standpoint. I wouldn’t neces-

sarily say ‘the good old days,’ but there’d be times where you bought the equipment, you could run the equipment, and things didn’t change that much. And then we entered a period where there was a rate of change, and we were like this until relatively recently, where you knew that there was new technology out there, but you could wait for a program, a customer, or an opportunity to come along before you buy. It’s like, ‘Okay, I know that there are longer ovens out there. But if I get a 30-core layer board and it’s a big enough program, I’ll bite off and I’ll buy a new oven.’”

Over the past five years, Turpin says, you just don’t need to wait for a program because there was enough research to figure out what you needed. “You had to become fast with the technology to even know how you’d end up quoting, because you can’t just buy the equipment and start using it the next day. You have to develop a process around it. You’ve got to learn how to do it. You’ve got to hire people. In the EMS world, we are driven more towards having a technology roadmap, where we do need to plot out emerging technologies. Not just on the process side, but on the component side. Component suppliers are coming out with some crazy stuff that influences the equipment you need to process it. It is just creeping more into the EMS side.”

As an example, Turpin said you cannot just get an oven only when you get a 34-layer board program. “You can’t just have one oven, you need to have three ovens that can do heavy layer boards and highly integrated BGA technology on those boards. You need more than one rework machine to be able to rework BGAs that are on that. You have to get out in front of that,” Turpin says.

One of the technologies that Zentech started looking at a year ago was cleaning technology. “We spent six months just looking at all the different versions. It used to be you’d see a couple of LGAs, a QFN, on a board. We’ve got some with hundreds of LGAs on a board now, and it forces you to a completely different cleaning paradigm where you can sort of clean it with the old stuff, but not really. So, you really need to look at new technologies all the time.

It's the same thing with 3D AXI. You can't use a manual X-ray system when you have a Class 3 board with 400 bottom-terminating components. There's no way any human being is going to accurately look at all those without glazing over. You need automated technology to do the heavy inspection on that type of work. You still have a human to do a sample to make sure you have compliant joints, but there's no way you can screen all those bottom-terminated joints manually," says Turpin.



Figure 1: When investing in new equipment for the factory, manufacturers should follow a proven evaluation procedure. (Photo Courtesy: Eltek Ltd)

Challenging Equipment Suppliers

Do they ever make demands on their equipment suppliers to come up with something better for their processes? What happens when they run into equipment limitations?

Nargi-Toth says some of their equipment is "machine #1," which is when they have challenged their suppliers to give the industry something better. "I think many of the #1 machines that Orbotech has introduced have spent some time in Eltek," she says. "We had one of the first laser direct imaging machines they made, and the first direct imaging solder mask machine they made. It is very important for our industry that these types of relationships exist between fabricators and the supply base. We are constantly challenging our suppliers to give us something better than the equipment we just bought from them."

But sometimes, current technologies have notable limitations. "We've tried to get better handling, say, in a DES line, and there are some limitations in available equipment. It may handle a 1-mil dielectric layer, but it doesn't necessarily handle that 1-mil film when we remove 75% of the copper from it. So, I would say, from our perspective as a panel flex

supplier, there are some limits in what's currently available to meet our requirements," says Nargi-Toth.

Automation Vision

How is automation, or the drive towards it, affecting the decision process in acquiring new equipment?

"In the EMS world and certainly in the military/aero and the medical side, your raw material expense is going to be around 60-70% of your revenue," says Turpin. "The number one expense, in our world, is raw materials. From an automation standpoint, you certainly want to be automated in terms of how you buy, plan and process your raw materials."

While direct labor is always important, Turpin says it's even more important to have a robust process that can make sure you have virtually no scrap. "You've got these \$25,000-\$40,000-dollar-a-piece PCBAs running through your facility at relatively low profit, low contribution margin. You really can't afford to have any scrap. Your focus is less on labor and more on quality, reliability, and taking scrap down to zero. And, pretty much, rework down to zero, too, because you can't afford to hold onto these components for very long. You're more looking for velocity than you are efficiency on the

labor side. Having said that, you're always concerned about efficiency, but it's not like it was in the old days because labor, as each year goes by, is increasingly a smaller percentage of your spend. At least, in my world."

On the PCB side, especially in the flex area, Nargi-Toth says they look at automation as a way of removing the typical handling issues and increasing product yield and production efficiency. "As Matt said, handling can sometimes lead to scrap. And while automation has its own set of problems, it is more controlled and predictable," she explains. "At the end of the day, handling is critical throughout the manufacturing operations. Removing handling-related scrap improves yields and in turn that improves efficiencies and the overall competitive position for the company."

"And just to amplify what Kathy just said,

Removing handling-related scrap improves yields and in-turn that improves efficiencies and the overall competitive position for the company.

anytime that we introduce automation, it's more about reducing variability, and increasing quality, reliability, reducing scrap, than it has anything to do with reducing labor content," says Turpin. "So that would probably be the main message I can suggest. It's automation for reducing variability and increasing reliability, not reducing labor."

No Longer Customer-Driven

The decision to acquire new equipment was once driven by customer requirements, but not anymore. At least not as much as it used to be, according to Turpin.

"Take the three periods of an EMS: First is what I call the good old days, when you could just chug along with the same set of capital for

a decade or more. The second phase after that was when it wasn't, 'Build it, and they will come' but 'if you get a program, you get a customer, then you go out and you buy the capital equipment to support it.' Now we've moved away from that to where you really have to get out in front of it. Generally, you have to get out in front of it with a technology roadmap, with some level of R&D. Because by the time a customer comes in with an opportunity, even though the equipment lead time may be four or six weeks, to do a thoughtful evaluation process takes a lot more than that. The capex is around automating a process—you can't just introduce a new piece of capital equipment to your process without doing a thoughtful process development, and analyzing it, training, making sure that you followed your due diligence to introducing that new process. By the time you stack up all those activities, the customer generally is going to wait if you're doing it on a wait-and-buy basis.

"Having said that, we have one customer relationship where we do share our technology roadmap. We do have visibility into their engineering groups, and we do get to see where their head is at in terms of what the next thing may be, so we can pull from that. So, it's not wetting your finger and sticking it up in the air to see where the industry is heading. We can be a little bit targeted from a customer-needs standpoint, but we don't always have that luxury."

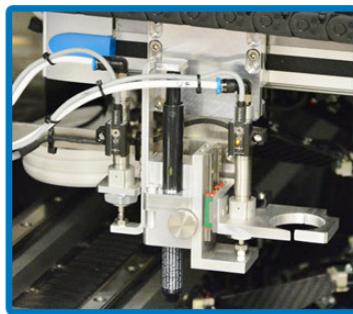
Advice for Designers

For Nargi-Toth, the best thing designers can do is start working with fabricators early in the design process. "They need to engage early with the manufacturer. We can help designers best when we are brought on early and become part of the project team. It is important because the designer together with the board fabricator and assembler should be assessing the manufacturing trade-offs associated with new designs. Many times, the designers do not fully understand manufacturing constraints and if they wait to address them after a design is completed it will lead to delays. Designers often use simple DFM analysis as a first pass, but this

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
sales@atg-lm.com • www.atg-lm.com





Matt Turpin,
Zentech Manufacturing

approach is not going to fully address more complex products like rigid-flex and HDI constructions. In these types of products, the material set is going to play a key role in how the boards are going to process and yield for tight tolerance items such as Class 3 annular ring or wrap plating requirements. For more complex designs you need to understand and select materials correctly, and design appropriately. Designers don't necessarily understand the myriad of manufacturing challenges the PCB producer must navigate when they are evaluating materials based primarily on electrical properties."

Turpin agrees. "That would be my number one: Engage with a PCB fabricator. And, at a minimum, understand their pain and their process, and, in general, what they can and can't do. Because the problem nowadays with PCB design is that the barriers to entry for somebody to call themselves a PCB designer are so low. There are so many people out there as contractors. More and more, even large companies are moving toward a contractor model. There are some bad designers out there that don't know anything about PCB fabrication, they don't know anything about what the EMS company has to do, and they come out with some really, really bad layouts that are almost unproducible," he notes. "And the problem is, with a lot of the ways the contracting worlds work, by the time it comes to Kathy and myself, the design has been bought and paid for, and you've got a customer that really doesn't even know what it is they're dealing with. Then we've got to be the bad guy to tell them that, 'No, this really isn't going to work, and you've got to do this, this, and this.' And it slows things down. Or worse, they just don't have the time

and they just try to build it as is. Or they go to some other bare board supplier that isn't going to ask the right questions, and just produce something that isn't manufacturable."

One of the issues that challenges manufacturers like Eltek is how we as an industry approach prototypes, according to Nargi-Toth. "If we look at the North American model today, we see a high number of prototypes that are being built in relatively small domestic factories. The fact is that even if they are not in the best facility in the world, they can make one or two of anything and the design has been manufactured and is vetted as manufacturable. However, when you bring it to the production manufacturer they may say, 'We can't build this in production.' And by this they usually mean, the tolerances are too tight, the yield will be negatively impacted and the material utilization on a standard panel is wasteful. Net result is the cost is going higher than predicted, or the board needs design modification and ultimately the customers' end target for time to market, price or both is missed. It's an important factor that can get missed when dealing with the prototype. It's best to work with a factory that can help you bring the product from design to market right from the start," she says.

Turpin notes that the problem in the PCB fabrication side is that when you're building prototype quantities, the manufacturability sometimes gets lost in the equation. "Because when you're buying one board or three boards, it's either going to cost you a lot or it's going to cost you a whole lot. If it's going to have a high repeatable cost, a lot of times it won't get caught until later," says Turpin.

"Right, and then when it goes into production, nobody wants to carry that poor design forward," says Nargi-Toth. "In the prototype model, you don't care what your yield is. You never track it because you're never going to see the part again. You make it one time and you're on to the next one. When it comes to production and you're going to be seeing the same part number every month, you can't live with a poor yielding design. That is what we try to avoid by early engagement with our customers."



Figure 2: Investing in equipment is essential to keep pace with the driving forces of ever-evolving technology. (Photo Courtesy: Zentech Manufacturing)

Communication

Nargi-Toth says that now, more OEMs and designers get in touch with her company early on. “I would say we engage with the OEM in about 50% of our relationships. We do a lot of work directly with the OEM, especially on the medical side, because we work together with them through the FDA process. We help them to lock down materials and processes. For these types of projects, we are involved with the designers at the beginning,” she says. “With flex and rigid-flex projects, the designer wants you to be involved early because they have a concept and often they need our help to figure out how best to get what they need on the board and get the board folded into the final package. It becomes a mechanical as well as electrical design project from the beginning, so we certainly can add value by our early involvement.”

Turpin prefers to get involved from the beginning. “Last year we acquired a design service bureau, so we could have the scale and the toolsets to be able to do the layout on pretty much any platform. And that has worked, so

the extent that we can get involved in the beginning, do the layout up front, and take care of all those issues and make the bare board fabricator’s life easier, make our life easier, and generally make it up. We’re reliable, cost-effective, with quicker time to market,” says Turpin. “In some cases, the OEM will have their own engineers. And, generally, when they’re doing their own layout—which is probably half the time if we’re not doing the layout—our customer has a dedicated designer who knows what they’re doing, and they will almost always look for input before they release the final package.”

“In other words, to do one final look through a DFM and DFA to bring out any things that may have been missed or, particularly with the new package types, we always get calls from designers in our customer base when they are using a new package, in terms of talking about what footprint to put in a design. Because most of them are smart enough not to use the footprint that the manufacturer gives. They’ll use that as a basis, but they’ll always tweak it based on something. But it’s not enough. I

wish it was 100% of the time we or somebody else could get involved. I would say 25–30% of the time we just get what we get, and we try to make it work.”

There is a difference depending on if it is a commercial or military/medical application. “On the commercial side, it is more transactional. You may never meet the designer unless they have a problem and they may already be on Rev B or C. Unfortunately, the manufacturer is now coming in after the fact and trying to make changes, which is more difficult and wasteful,” says Nargi-Toth. “But for sure, in some of the new programs in mil/aero, or in medical, we often find that the OEM already knows they need assistance, and they want to reach across the table and engage early. They have a history of positive experiences with collaborative efforts that have produced successful projects that were on-time and met the commercial targets and they want to build on this positive experience.”

Conclusion

When it comes to making decisions on investing in new equipment, manufacturers should have some sort of an evaluation procedure, according to Nargi-Toth.

I think most companies do have a procedure when they evaluate new materials and new equipment. Obviously, they need to know what the end goal is for the equipment.

“I think most companies do have a procedure when they evaluate new materials and new equipment. Obviously, they need to know what the end goal is for the equipment,” says Nargi-Toth. “If it’s a bottleneck fix, the leadership should come from operations and engineering.

The decision is based on what is needed to improve productivity for one process or another. If it is technical development, advancing the process based on a current need that has already been identified, then engineering and product development are tasked with developing the evaluation criteria. And if it is something that is needed for a next generation product following a roadmap such as what Matt talked about, the company needs to do some research to better understand what’s out there today and what is being worked on and may be available in 12–24 months.”

First, manufacturers must define what type of equipment they need and what they are trying to accomplish. Once that’s done, it’s time for a project plan to evaluate what’s available.

“Even if we’re talking about some of the simplest equipment in fabrication, we’re talking \$250,000. If I want to go out and buy a new automatic plater, we’re talking about \$5 million. It’s a lot of money to invest, and you’re not going to do it by just running a few samples,” says Nargi-Toth. “It all needs to begin with a project plan and a solid understanding of what the goals are for the new equipment. Once that has been established you can determine how you’re going to evaluate the available technologies to make sure that you’re making the correct decision and purchasing the right piece of equipment for your particular needs.”

Turpin agrees. “Everything that Kathy said would apply to not just the EMS business, but, I would say, to any problem that anybody is trying to solve. Don’t buy a piece of capital equipment unless you know what problem you’re trying to solve, whether it’s a technology problem, whether it’s a process problem. Maybe it is an efficiency problem. Know what you’re trying to solve, and then, whether it’s your evaluation requirements with the capex supplier, share those goals with them and how you’re going to evaluate it,” says Turpin. “Certainly, for a project plan, make sure that you’re checking for that, and in your turn-up of the process, that the problems you’re trying to solve are the processes you’re developing, and

documenting, and rolling out during the roll-out of the new piece of capex. But, that said, from a high level, start with a problem in mind. Don't just start with, 'Hey, I need to buy a piece of equipment X, Y, Z.' Start with, 'I've got a problem, A, B, C. How am I going to solve it?'"

Finally, Turpin noted that, inasmuch as they want to be tightly integrated with their customers, he hopes that component manufacturers were as integrated with the automation suppliers. "They should make sure that the things they're doing are integrated with the way of properly placing components, cleaning components, inspecting components, things like that."

Nargi-Toth says having an open dialogue with customers and sharing road-mapping activities is beneficial to both parties. "Because in doing that, we can use the information we gather from them to help direct our research efforts and it benefits the customers because we are better able to meet their future requirements," she explains. "So, if we do know that sub-1 mil lines and spaces will be a reality in implantable medical devices in the coming years, that's the direction we have to move in. And how we get there becomes an actual research effort on our part before we can even begin to go out and evaluate equipment. First, we must understand how we're going to get there. What's going to be the best way to get there? Can it be done subtractively or do we need to move into additive processing? That's the kind of thinking that keeps us always forward looking."

Every company should have a road-map, perhaps, a five-year plan. This underscores the need for communication in the industry, throughout the supply chain. Working closely with both customers and suppliers can provide vision and help determine when and what new equipment will be needed for a company's long-term success. **PCB007**

Maximization of IIoT Technologies in Test & Measurement to Enable Smart Testing

The emergence of Industrial Internet of Things (IIoT) and its implementation in test and measurement (T&M) is expected to transform the industry. Through digital connectivity, the use of test equipment can be maximized, improving the quality of testing and opening a host of future opportunities. In a highly competitive environment, vendors must develop product differentiation and branding strategies to penetrate smart testing opportunities.

Frost & Sullivan's latest analysis, "Adoption of Industrial IoT in the Global Test and Measurement Market Forecast to 2022," finds that the value of the IIoT in test and measurement market is expected to reach \$104.8 million by 2022 growing at a compound annual growth rate of 6.7% from 2016. The research assesses market dynamics including trends, drivers, restraints, forecasts, mega trends and industry convergence implications, and opportunities in end-user verticals. Profiles of key competitors such as National Instruments, Fluke Corporation, Keysight Technologies, and Rohde and Schwarz are also provided.

"Currently, original equipment manufacturers are cautious when it comes to IIoT technology adoption with significant concern toward security issues and limited entrants in the market," said Frost & Sullivan Measurement & Instrumentation Research Analyst Anisha Nikash Dumbre."



Supply Line Highlights

Orbotech Inks Order from Career Technology for Pattern and Solder Mask DI Solutions ▶

Orbotech Ltd. has announced a multi-million-dollar order from Taipei-based Career Technology (Mfg.) Co., Ltd. a worldwide manufacturer of flexible printed circuits, for Orbotech's industry-leading Nuvogo for Patterning DI and Orbotech Diamond 8 for Solder Mask DI solutions.

Pluritec Wants to Remove Human Factor from Solder Mask ▶

Solder mask remains a relatively hands-on task, which can result in human error. But equipment manufacturer Pluritec wants to change that. At PCB West, I spoke with Pluritec Vice President of Sales Lino Sousa about the company's new spray technology that can turn solder mask application into what is essentially a push-button operation.

Ventec: Eye on the Future, with Automotive and Lighting Front and Center ▶

Ventec's Thomas Michels and Didier Mauve sat down with I-Connect007 Editors Patty Goldman and Pete Starkey and enjoyed an upbeat and enlightening conversation. Topics covered were the importance of maintaining supply chain continu-

ity, market drivers for thermally conductive materials, and development of enabling technologies to support the automotive electronics revolution.

Viking: Covering the Globe with Value-Added Services ▶

In the final hours of productronica 2017, Barry Matties met with Jake Kelly of Viking to discuss the company's value-added services, their growth in the India and America markets, and the UCE manufactured line they displayed.

AGFA: From Film to Inkjet Solder Mask ▶

The productronica show was filled with new technology, and it was great to meet with people and learn about it. This was how I met AGFA's Frank Louwet, who filled me in on the Dipamat inkjet solder mask they have been developing.

Nordson MARCH Launches New-Gen RollVIA Plasma System for R2R PCB Manufacturing ▶

Nordson MARCH, a Nordson company, has launched its new-generation RollVIA plasma system, a self-contained vacuum plasma system with production-proven, roll-to-roll material handling for flexible PCB manufacturing.

Panasonic and Matrix Complete Outgassing Tests for Flex Materials ▶

Panasonic Flex materials and Matrix Flex Coverlay materials have passed the ASTM E595-15 outgassing test.

Trouble in Your Tank: Moving into Microvias—The Interaction of Materials and Processes, Part 2 ▶

For the fabricator to successfully implement an HDI strategy, several new competencies must be acquired.



VISION



MULTIPLE PLATFORMS



Drill/Rout/Optimizer
X-Ray Vision

[MORE INFO](#)



Drill/Rout Multi-Spindle
CCD/RGB Vision

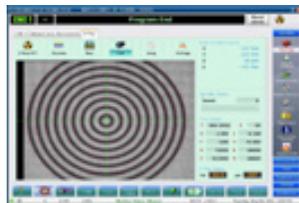
[MORE INFO](#)



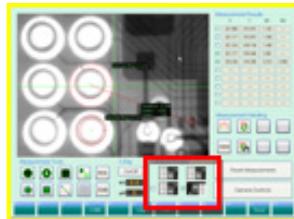
Dual Spindle All in One
Vision System

[MORE INFO](#)

SEEING IS BELIEVING



X-Ray - 8X Faster!
with NEW concentric target



See inside your PCB
measure your results!



Drill/Rout/Optimize
Entry level "Smart Drill"

[MORE INFO](#)

TIME-TESTED FEATURES

Vision Simplifies

Post Etch Slot/Drill

X-Ray Optimization

CCD Camera Optimization
"Smart Drill"

BarCode Job
Data Management

Panel Marking/Serialization

1700 Tool Library per spindle

Control Depth Drilling and
Routing to 15 μ m

Lights out Automation

Up to 6 Spindle
Configurations

Automated Panel Prep
(Flash Routing, Edge
Beveling, Corner Chamfer,
Panel Thickness Measuring)



pluritec

www.pluritec.com | info@pluritec.com



AWP Group/Sigma-Mecer
acid etch recycling system
under construction in Poland.

Equipment/Process Selection:

Case Study of a DMADV Approach to PCB FAB Process Design

Feature Article by Alex Stepinski
WHELEN ENGINEERING COMPANY

Background

In 2014, Whelen Engineering Company, the OEM market leader in the emergency warning industry, developed the world's first green smart PCB fab factory as a captive operation servicing internal demand. Due to the success of this venture, in 2016, a decision was made to explore building an upgraded factory which would serve the merchant market. This article outlines the approach we took to designing this new phase of our commercial existence, which has now been spun off as a separate business unit known as Greensource Fabrication. This new business unit is expected to go live in 2018.

Summary Approach

In our experience, a holistic DMADV approach to complex process design is not commonly used in the PCB industry. This approach requires a commitment to dedicated R&D resources, extensive travel by the technical team, a great deal of hands-on experience, as well as significant investment capital. Since very few PCB fabs perform R&D, we believe that there is a currently a very high ROI to this approach with low risk, since it is easy to design and secure strong competitive advantages when everyone else is just copying each other.

Stage 1: Define

When designing any factory or process, the first step is to define the market needs. In our case, since we were just coming to the market

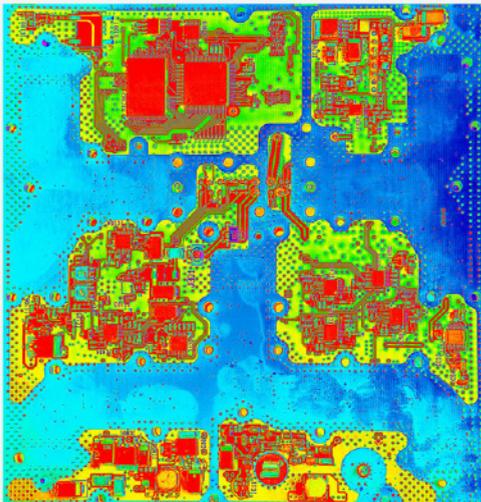
Technology leader for high performance thermal management materials



ventec
INTERNATIONAL GROUP
騰輝電子

Ventec VT-5A2 - Designed for the world's most thermally demanding PCB applications

VT-5A2 is designed for the world's most thermally demanding PCB applications such as power converters, hybrid multilayers and high power electronics with heavy copper designs providing enhanced signal stability in harsh environments. With VT-5A2, Ventec has created its highest performance thermally conductive laminate material so far, with a polymer matrix that is fully compatible with other Ventec laminates, epoxy- or polyimide based materials including our IMS tec-thermal® range & tec-speed®. With VT-5A2 total compatibility in the manufacture of hybrid multilayer boards is guaranteed.



VT-5A2 best-in-class performance:

- thermal conductivity of 2.2 W/m.K (8 times that of FR4)
- in plane thermal conductivity of 3.4 W/m.K
- high Tg of 190°C
- best in class thermal performance (T260 >60 Minutes, T288 >30 Minutes and T300 >15 Minutes)
- M.O.T. up to 150°C
- lead-free assembly compatible
- fulfills RoHS and WEEE requirements
- UL94 V0 compliant
- IMS materials compatibility in hybrid constructions
- choice of thin core and prepreg variants

The VT-5A2 thermally conductive laminate is manufactured by Ventec using strict quality controlled processes that are certified to AS9100 Revision C, ISO/TS16949 and ISO 9001:2015, and, like all Ventec products, is backed by a fully controlled and managed global supply chain, sales- and support-network.

**Ventec - Your strategic partner
for safety-critical supply chains**

DESIGNCON[®] 2018
WHERE THE CHIP MEETS THE BOARD

**VISIT US IN
BOOTH 118**

Ventec International Group
21 Water Street, Amesbury
Massachusetts, MA 01913, US
T: 978-521-9700
E: saleseast@ventec-usa.com
🐦 @VentecLaminates

www.ventec laminates.com

DMADV APPROACH HIGH LEVEL OUTLINE

Define	Define the goals of the design activity.
Measure	Measure customer input and compare roadmaps with your suppliers. Your suppliers often have great ideas on how to achieve your customer goals. What problems can/should we try to solve to develop advantages?
Analyze	Analyze innovative concepts for products and services to create value for the customer. Determine performance of similar best-in-class designs.
Design	Design new processes, products, and services to deliver customer value. Use predictive models, simulation, prototypes, pilot runs, etc., to validate the design concept's effectiveness in meeting goals.
Verify	Verify the new systems perform as expected. Create mechanisms to ensure continued optional performance.

for the first time, we spent six months traveling the world, and visited scores of PCB shops and equipment suppliers in 20 different countries. We also researched customer roadmaps and had conversations with key OEM technologists. What we quickly found was that most of the best equipment/processes in the world were not even available in North America. We also found that our potential customers had to often procure PCBs offshore to meet their advanced technical needs. In the cases where offshore manufacturing was not an option due to IP export restrictions/legal constraints, design limits had often been restricted by our regional capability limits. This should come as no surprise since North America has not been a major center for PCB fab for almost 20 years now.

We also found that if, as a board shop, you rely on local reps for guidance, then you may be significantly limiting your capabilities. If you work directly with overseas principals, you often find that there are much better solutions available than what your local reps tell you. This is especially true in North America due to its small share of worldwide PCB production, and even smaller share of PCB fab capex investment, resulting in it not being a focus market for the major equipment suppliers.

Our conclusion from this stage was that, if we were to procure world class processes and place them together in a North American shop, we would have a good likelihood of developing a strong competitive advantage with

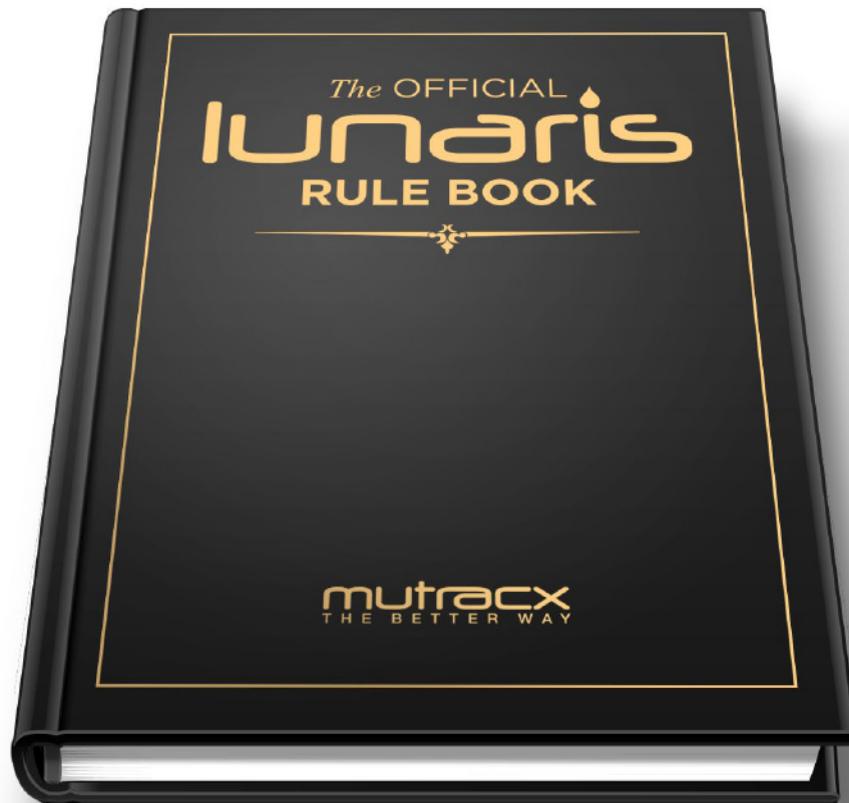
a good ROI. It was subsequently decided that we would design the factory to focus on advanced HDI, tight registration tolerances (X, Y, and Z axis), high aspect ratios, and thin dielectrics (including flex, ABF, etc.) across a wide overall thickness range of 0.050 - 6.20mm; we would do this with no significant environmental footprint, and with the highest level of automation possible.

Stage 2: Measure

Once we identified the key equipment suppliers, we began having meetings to benchmark individual companies to determine their technical and commercial capabilities as potential partners. We then vetted their prior project performance by auditing multiple installations, and contacting our industry contacts to sift through the marketing pitch and hearsay. The more reference data points collected, the closer to the truth of the matter we came. We quickly found that there was a high ROI for this research, and we had some surprises with what were previously perceived as top worldwide suppliers failing to qualify, and smaller regional suppliers excelling.

After completing the measurement stage, we found that 80% of the suppliers we selected as partners were from Europe and Japan, with the balance from the U.S., Taiwan, and PRC. This regional distribution was driven in large part by the need for highly reliable processes, and a low total cost of quality, given our highly automated/low-labor approach.

A new set of rules for PCB production



Less process steps. CAM to etch in minutes instead of hours. Maximum yield. Minimal environmental impact. These are just a few of the PCB production rules that Lunaris has redefined.

We've put together a complete set of all the new rules made possible by Lunaris ...get yours today!

Download all the new rules:
The Official Lunaris Rulebook

CLICK HERE TO DOWNLOAD



mutracx
THE BETTER WAY

www.mutracx.com



Atotech thin core flex electroless and flash plate line under construction in Germany.

Stage 3: Analyze

Once we had our key supplier partners selected, we sat down with them and began discussing the specifics of the project. Only at this point did we begin to discuss details and introduce our own IP to the project under controlled conditions. Our IP was associated with having already developed the world's first green smart factory^[1] for captive work. The challenge now was to do the same thing economically in a shop that would service the merchant market with more conventional processes (i.e., dry film, electroless copper, OSP, etc.) compared to our previous captive operation.

The good news was that

our chosen suppliers were very excited by our project approach and had a tremendous amount of good ideas to both automate and make green even the most high-tech processes in the world market.

Stage 4: Design

The design phase was the most time-consuming part of the project and required hundreds of hours of face-to-face discussions—mostly at supplier sites overseas—between our own engineering team, and our suppliers' technical departments. This was done to sort out the details of the tool designs we would procure, to ensure that we engineered out any risk, and to maximize the design performance.

This phase yielded the greatest number of positive surprises since we spent so much time together with our partners, and could combine the experience of some of the most talented engineers in our industry on a worldwide scale. For instance, the automation level we have now targeted is at half the labor level we originally estimated, and the wastewater balancing we did within the wet process equipment has resulted in no waste rinse-water ever leaving the actual wet process lines, while reducing chemical cost by over 50% through engineering of balanced systems with full drag-out recovery built in.

We were also able to design the world's first full traceability system for PCB fab production,



AWP Group's zero-liquid discharge, single-piece flow DES line under construction in Poland.

Mentor[®]

A Siemens Business

EXPLORE HYPERLYNX[®]

Industry-leading PCB simulation for
high-performance SerDes Designs
mentor.com/designcon

DESIGNCON[®] 2018
WHERE THE CHIP MEETS THE BOARD

BOOTH
943

Jan 30th - Feb 1st, 2018
Santa Clara Convention Center



Ludy's zero liquid discharge specialized SAP and high aspect ratio plating line under construction in Germany.

with embedded 2D codes and RFID tracking down to every individual CCL, allowing for true single piece flow and elimination of paper and manual traveler transactions, along with the use of some AGV transport. These are just a few of the initial design innovations achieved with our partners.

Stage 5: Verify

We are currently in the process of start-up and verification with 50% of the equipment set already installed and qualified. To date, we have met all our milestone targets, and the ownership has been pleased with our progress. We attribute the performance to date to our diligent supplier selection, coupled with a tremendous amount of hard work and travel by both ourselves and our supplier partners, and we believe it gives some credence to our chosen DMADV approach.

We hope that the market will agree, and that smart green factories with zero discharge/emissions and high levels of automation and consistency become the industry norm in the not-too-distant future. Based on our experiences, we feel that this transformation is long overdue in our industry, and it is truly time to proceed to the 21st century in this regard, especially given the high ROI for the change-over. **PCB007**

Reference

1. "Whelen Engineering Reduces Cycle Time by Building a New Automated PCB Factory," *The PCB Magazine*, October 2015.



Alex Stepinski is VP and GM of Greensource Fabrication.

Whelen Engineering and AWP Explain their Unique Collaboration

by **Patty Goldman**
I-CONNECT007

If there was a buzz word in the PCB hall at productronica this year, it was probably Whelen, as in Whelen Engineering and Alex Stepinski, VP of Whelen's circuit board division. Numerous pieces of equipment bore "Sold to Whelen" signs, including a few machines in the AWP booth. I had the opportunity to spend a few minutes with Alex and the fellows at AWP, including VP Jochen Zeller, who focuses on wet processing and VP Henk Van der Meij, whose focus is automation.

Patty Goldman: Alex, let's start with you telling me how AWP came to be working with Whelen Engineering.

Alex Stepinski: We selected AWP to do a turn-key project for us in Charlestown, New Hampshire.

Goldman: Henk, can you tell me a little bit more about AWP, and what you do, specifically?

Van der Meij: AWP is a German company, with our headquarters of engineering in Germany. We have the manufacturing side in Poland, where we manufacture all kinds of handling units, recycling units, and horizontal wet process machines. In addition to the factory in Poland, we also have a sales and service office in Suzhou, China, to cover the Asian market, and we work together with an agent network in North America for all our products.

Goldman: Alex, you say you selected them to work with you?

Stepinski: The first phase of our project at Whelen Engineering was a great success for



Alex Stepinski flanked by Jochen Zeller (left) and Henk Van der Meij (right).

our company, so our ownership decided to do a new investment focused on advanced HDI, thin substrates, fine line and space, as well as very dense designs on a thicker scale. We can take very dense features and put them up to 6.2 millimeters thick, for instance. We are putting together an ecological factory, a green factory, for the advanced HDI MSAP/SAP market in the same kind of a way we did our first phase. We are taking the spirit of the first phase to the highest level of technology currently around the world.

To do this, we searched the world. I spent six months traveling overseas. I went to over 50 board shops in 20 countries to learn the best practices, and less than best practices, as to how people make PCBs. We took all the pluses that we found and some of the minuses, and then I went and sat with some key suppliers around the world, including AWP, to develop a next-generation process that incorporated all this cumulative learning and gave us some nice competitive advantages.

Zeller: All the equipment that we are going to supply to Whelen is fully integrated to meet



Equipment in the AWP booth at productronica sold to Whelen.

the challenges on the technology side. There are some nice features in there, but some of it is confidential. We had a couple of new developments in this whole project, but what we can say is that the whole system is integrated with panel tracking. We have all kinds of data transfers, syncing the servers.

Stepinski: We will have true single piece flow. Every substrate, every circuit board, every core has a unique 2D code. There are no batches. It's a batch of one across the whole factory. This is a unique thing that these guys helped with.

Zeller: And that's what we incorporated in this whole setup with all kinds of camera systems, data connections throughout the handling machines as well as the wet process machines to make this happen. Alex was good to work with; he knows what he wants, and I think we helped him a bit and he has a lot of good ideas.

Goldman: Alex, what else can you tell us about this collaboration?

Stepinski: AWP, for us, fills a great niche. They're automating all the equipment in the factory and they're doing a lot of the wet process equipment specifically the etching and the subtractive processes. They did this in a single-piece-flow way. It's a new development that is very special and unique. You don't have to run out the whole etch line to switch between jobs. Most etchers in North America are extremely inefficient because of the switchover [to a different] copper weight, so they've gotten past all this. Even our warehouse is au-

tomated. One of the key features of the inner-layer side is we can take a core from an automated warehouse, check it all along the way, pull the recipes automatically, provide the metrology back to the database and it's finished in about an hour and 20 minutes through AOI.

Goldman: Is this equipment installed now?

Stepinski: The whole factory is about 30-35% installed right now. We've only just started with the AWP equipment. We're in the process of buying off our finished wet process equipment now while we're here in Europe. We have some automation on-site and our last purchase orders just came in recently, so it's going to be going on for another six months. However, we'll be in production in the spring before every piece is here from AWP because some of it is replacing something we already have. Everything that is really unique and critical with the operation we'll have sooner.

Zeller: It was a very challenging project, but it was also nice to do a project like this again after so many years in the industry and having seen something like this, somebody with so much knowledge. To do a project like this was quite exciting for us, because we appreciate very much that we could also add more knowledge to this project and help put all this together. At this table we probably have 70+ years of PCB experience, so it's a good project.

Stepinski: We honestly have very complementary skillsets here. Jochen was in the automation side; he was in a board shop, CTO of Schmid, and now he has his own company. Henk has been all over the place—including managing director and chief engineer at Kuttler. All these skills have come together to make this happen.

Goldman: Gentlemen, I appreciate your time and filling our readers in on this interesting collaboration. Let us know when it's time for an update.

Alex: Thank you, Patty. We do appreciate it. **PCB007**

Electronic Industry News and Market Highlights

Laser-Boron Fusion Now 'Leading Contender' for Energy ▶

A laser-driven technique for creating fusion that dispenses with the need for radioactive fuel elements and leaves no toxic radioactive waste is now within reach, says a UNSW physicist.

Worldwide Spending on the Internet of Things to Reach \$772 Billion in 2018 ▶

Worldwide spending on the Internet of Things (IoT) is forecast to reach \$772.5 billion in 2018, an increase of 14.6% over the \$674 billion that will be spent in 2017.

U.S. Cellular Operators Success in M2M Markets May be Jeopardized by Distraction and IoT Hype ▶

A new report by ABI Research forecasts that the U.S. cellular M2M market will grow beyond 300 million connections by 2022. As U.S. network operators rush to deploy the latest LTE technologies, new competition is emerging.

IDC Canada Releases Its 2018 ICT Predictions ▶

International Data Corporation (IDC) Canada just released its top information and communication technology predictions for 2018.

Smart Hospitals to Invest over \$11 billion in Cloud Computing and Data Analytics ▶

By 2025, 10% of hospitals across the globe will become or will have started implementations to become smart hospitals.

Stable Quantum Bits ▶

Milestone achieved on the path to the quantum computer: Scientists of the University of Konstanz, Princeton University, and the University of Maryland develop a stable quantum gate for two-quantum bit systems made of silicon.

GDPR will Cause Challenges for Connected Care Developers ▶

According to a new research report from the IoT analyst firm Berg Insight, the upcoming implementation of the General Data Protection Regulation (GDPR) in 2018 will cause challenges for companies in the telecare industry.

Intelligent Transportation Systems Enable Growth and Innovation in Mobility Infrastructures ▶

With increasing pressure on cities' mobility infrastructures due to rising urbanisation, city governments all over the world are constructing new roads, bridges and tunnels, and using intelligent transportation systems (ITS), to mitigate transportation-related challenges and requirements.



Innovation: it's what leaders do.

For over a decade, the world's top flex PCB processors have relied on ESI's advanced laser processing solutions to drive innovation and stay ahead.

Can you afford to make the wrong decision? Future-proof your investment in flex PCB with ESI's family of laser processing solutions, and maintain your innovation advantage.

Align yourself with the industry leader and let ESI take care of your flex PCB drilling needs.

A man with a beard and short hair, wearing a dark blue suit jacket over a light blue button-down shirt, stands with his arms crossed, smiling slightly. He is positioned on the right side of the advertisement, partially overlapping the text.

esi®

ESI's family of FPC laser processing solutions.

5335
GemStone

Flex5335
LodeStone

5335xi
RedStone



For more information, visit us at www.esi.com



time to
BUY

The Selection of **Chemical Etching** Equipment for PCB Production

Feature Article by James Hall
CHEMCUT CORPORATION

Introduction

Congratulations! Your process development team has completed its DOEs and is convinced they are ready to scale up. The facilities crew has found space for your new operation or, even better, your manufacturing team will have a newly-built building in which to locate the project. Marketing has prepared pro forma projections on demand and even lined up the first customers. Top management has given the green light for the project. Now it is time to determine what you will be using to manufacture your product. In short, it is time to make an equipment purchase.

First Steps

What do you need right now to get started? And of equal importance, what will you need two, five, or 10 years from now to continue

making the quality product in the quantities you plan to sell? Will you be running primarily prototypes for another manufacturer (or yourself)? Your products might be a mix of different sizes or on rigid or flexible substrates. Maybe you've landed a contract to produce 100,000 identical units monthly.

The more accurately you can gauge this question, the better idea you will have on equipment sizing. It will also help you to know at which point or points in the process you will be performing quality checks on your product. You may be able to spec out an all-in-one system where only the finished product is checked; alternatively, if it is necessary to closely evaluate the effects of each process step, if for example the develop-etch-strip (DES) process is new to you, having a separate processing line for each process may be a better choice initially.

In general, a system with multiple process steps combined will have a smaller overall footprint than separate process lines; if space

Visit our booth
654

MEGTRON7

Laminate **R-5785(N)** | H-VLP2 Cu and Low Dk
Prepreg **R-5680(N)** | Glass-Cloth Specifications

Features

- H-VLP2 copper foil and Low Dk glass-cloth allows for 30% loss improvement than MEGTRON 6
- Glass transition temperature (T_g): 200°C (DSC)
- Reduce process cost (Improve drill processability and ENIG (Electro-Nickel Immersion Gold))

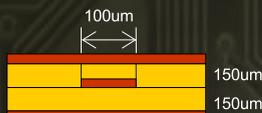
	Dk	Df
R-5785(N) + H-VLP2 Cu	3.4	0.002 @ 12GHz
R-5775	3.6	0.004 @ 12GHz

Applications

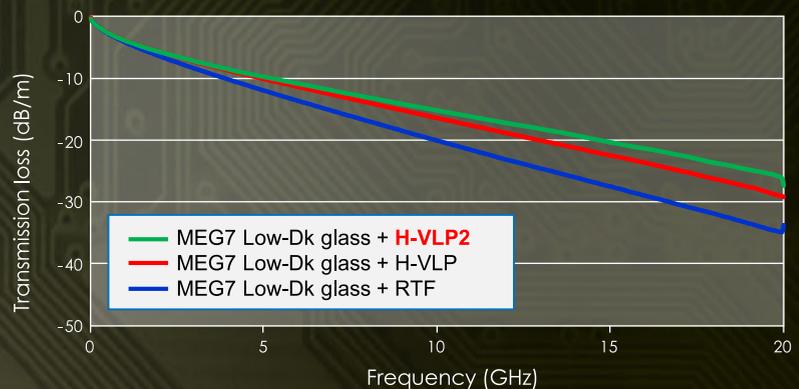
- High-end servers, High-end routers, Supercomputers, and other ICT infrastructure equipment, Antenna (Base station, Automotive millimeter-wave radar), etc.

Transmission Loss

- Evaluation Sample



Line Length	1000 mm
Impedance	50 Ω
Copper Thickness	18 µm
Inner Cu Treatment	No-surface Treatment
Core Type	#1078 (RC67%) x 2ply
Prepreg Type	#1078 x 2ply



Contact us



More information



is an issue it could make this decision easier. It may also result in a cost savings over a separate equipment purchase for each process.

Physical Parameters

As part of the equipment selection process you will need to know the physical dimensions of your product line. For PCB manufacturing, the copper weight is a primary consideration, as is the panel size. The weight refers

to copper thickness on the substrate and typically is expressed in ounces (per square foot), mils, or micrometers. One-ounce thickness = 1.39 mil = 35 micrometers.

Generally, in this industry most production occurs on horizontal conveyorized equipment, with the product traveling through each process chemistry followed by rinsing before the next process chemistry. After the final rinse, some type of air blow-off, forced air dryer, or combination is used to deliver a dry product, ready for inspection, packaging, or movement to the next process.



Figure 1: Example of a single-process line with etch (or other process), rinse and dry modules.

Most manufacturing in this type of system is of panels or sheets, with the product being immersed or sprayed on one or both sides with the process chemistry, so another important consideration will be the panel footprint, e.g. 18" X 24" (or in millimeters X millimeters). Conveyor widths are offered as narrow as 15 inches and as wide as 80 inches, with 20-inch and 30-inch widths the most

common. The overall length of your multi-stage process line is largely determined by the amount of contact time needed in the most critical process, and by the volume of production per shift needed. The etching step is typically the crux of this decision for most applications. Once the etching time and work volume requirements are known, determination of the line length is straightforward.

This type of horizontal conveyor also works quite well with reel-to-reel (or roll-to-roll) processing, where product to be treated spools off a supply spindle at the start of the process

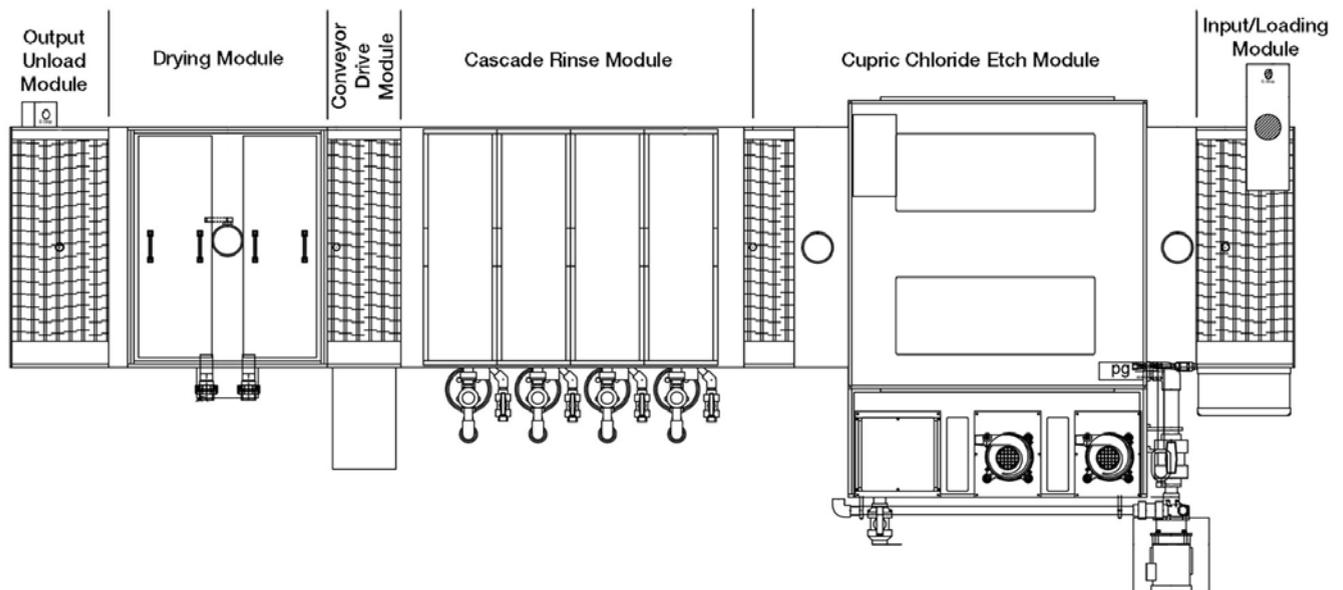


Figure 2: Schematic of a cupric chloride etch equipment complete with rinse and dry modules.

and re-spools on a take-up spindle at the exit. The type and complexity of the product determines the needs of the supply and rewinding equipment.

Type of Chemistry and Equipment Compatibility

Obviously, your equipment must be made to last for years of continuous use. The first consideration is chemical compatibility with the materials of construction. Many of these materials are already well-known to equipment builders. For example, if you are etching with a chloride-based etchant, stainless steel is a poor choice—chlorides will immediately degrade the surface and slowly (or quickly) destroy all your fasteners! For this reason, titanium fasteners are generally used, and sumps and other contact surfaces must be of non-reactive materials such as polyvinyl chloride (PVC) or polypropylene (PP). Other materials can be used as well.

Conversely, stainless steel is a good choice for most resist stripping chemistries. PP can also be used for stripping; its heat limit is lower than stainless, but it has other advantages. These include extreme chemical resistance (a very good property if used adjacent to a chloride etcher), low density with high rigidity (so less weight), lower material and assembly costs, and it is available in different colors.

The important consideration here is if you plan on using a chemical process that is not well-known in the industry, for example a proprietary product with unknown organics or other “secret ingredients” or an unusual acid combination, it is critical to understand chemical compatibility when specifying materials of construction. Rather than guess, it is best to test construction materials being considered for chemical contact with some type of immersion testing. One month of testing in a test bed at the expected operating temperature using the exact process chemistry is a good starting point.

Again, most commonly used etchants, cleaners, and strippers and their compatibility with construction materials are well-known; with something unusual it is best to consult with

both your chemical and equipment suppliers to prevent a potentially costly (or dangerous) mistake. Taking this a step further and finalizing a process while testing different equipment configurations on-site at your supplier’s process development lab will likely lead to a better purchase decision.

It is also certainly worth determining what your supplier’s support will encompass, both before and after the sale. Access to and use of their lab, as well as the willingness to process samples, is an indicator of their commitment to your success.

Reliability and Maintainability

No one likes unexpected shutdowns. Cleaning and preventative maintenance are an unavoidable necessity if you want your new equipment investment to last as long as possible and produce excellent results every hour that it is in service. So it pays to consider where in your production schedule you will be doing monthly and annual maintenance.

It should not be necessary to hire a mechanical engineer to service your production line.

Equipment design will play a big role in how much time must be set aside to do this. It should not be necessary to hire a mechanical engineer to service your production line. In fact, many of the most commonly cleaned or replaced items should be serviceable without the use of tools, or at most a wrench or screwdriver. If it is too difficult to remove a part for cleaning, or to replace a high-wear item, it will tend to not get done until that dreaded unexpected shutdown occurs.

Your selected supplier should be able to show you just how easy it is to clean and maintain your capital purchase. In addition, a supplier that can provide same-day shipping of replacement parts, as well as schedule their own

professional service technicians into your facility (wherever in the world it is located) is an attribute you should strongly consider.

Facilities

While a smaller single process line (as shown in Figure 1) might not put an undue strain on your plant's utilities, a large line will require planning for electrical demand, cooling water capacity, compressed air needs, city water (possibly deionized water) needs for rinses, and exhaust venting. An experienced supplier starts with a good idea of what these requirements will be once the layout of the equipment is determined. However, the responsibility for making sure all necessary utilities are proximate to the installation point of the equipment typically lies with the end user.

Larger organizations will generally have internal facilities personnel to install or extend necessary lines, but if you do not have your own people it will be necessary to utilize a reliable electrical and mechanical contractor. As one example where things can go wrong, consider just the possibility of differing voltages: 208V, 220V, 240V, 460V, 480V, and single- or three-phase, and these are just in the U.S. Internationally, it is common to encounter both different voltages and frequency: 50 Hz vs. 60 Hz, for example. While three-phase is most common in industrial settings, not everyone has it.

Before the equipment is built, electrical voltage, frequency, and phase must be known. Finally, you need to know your local, state, and federal environmental requirements. If your facility is adding a new process or substantively changing current processes, a wastewater treatment system may be not

optional but required. Your equipment supplier should be able to help guide you with discharge compliance.

What about next year?

It's been a year since you started up your new line, and you can barely keep up with demand. You've added shifts, your operators have found ways to optimize throughput, and the market shows no sign of slackening. Upper management is ready to approve more capital investment. If the company stakeholders are happy with the results you have been getting, your purchase decision may be as easy as ordering a second line that is fundamentally the same as what you are already operating.

Perhaps, however, you have found a bottleneck at one point, where work in process tends to back up prior to completion. In many instances, it is possible to reconfigure an existing production line if it was originally purchased as a modular type of construction.

Modular construction allows an equipment purchaser to build around the requirements of one process step, or to maintain a specified line speed or throughput requirement. As an example, the equipment previously purchased can maintain your target production with an etching time of 75 to 90 seconds. Now, however, your end customer is requesting you use a thicker material, or a deeper etch is required in the same material. You find that the time required in the etcher will now be 120 to 135 seconds. You could slow down your conveyor line speed, but this might adversely affect an upstream process (such as developing) or a downstream process (such as resist stripping). Even if the other processes on this com-



Figure 3: Front and side-panel view of ion exchange system.

Software

Multi Job Panelizer

High-yield multi-job panel generation made easy ...

- Combines different PCBs into a production panel
- Optimizes material utilization
- Reduces material costs
- Interactive or 24/7 automated operation
- Hotlinkable to ERP or Planning systems

[Read more](#) →



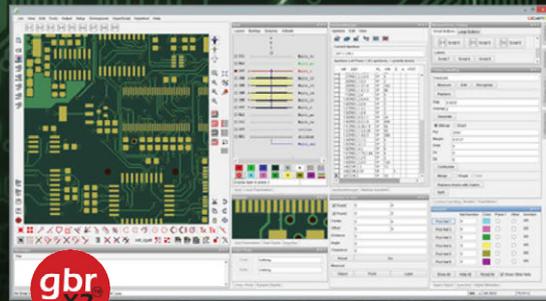
Software

UcamX

New ground-breaking CAM Software

- For Rigid, Flex and HDI PCBs
- New Graphical User Interface with Workspaces
- Optimal performance using Parallel Processing
- Multi Job Processing via load balanced Sessions
- Support for Gerber version 2 (X2) format

[Read more](#) →



64 Bit

Multi Core

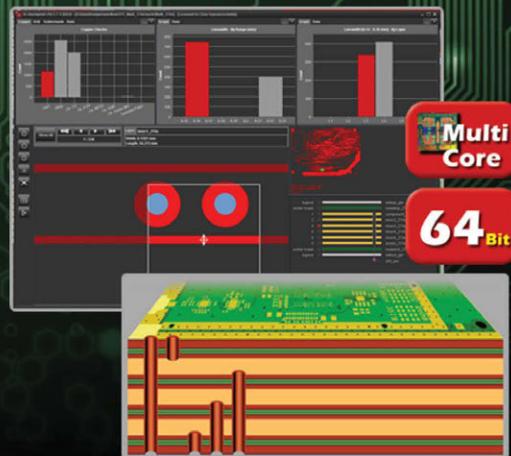
Software

Integr8tor

Automated data entry and design analysis

- Ucamco's 9th Generation Sales & Engineering Tool
- Field proven with more than 250 installations in daily production
- Seamless integration into any environment

[Read more](#) →



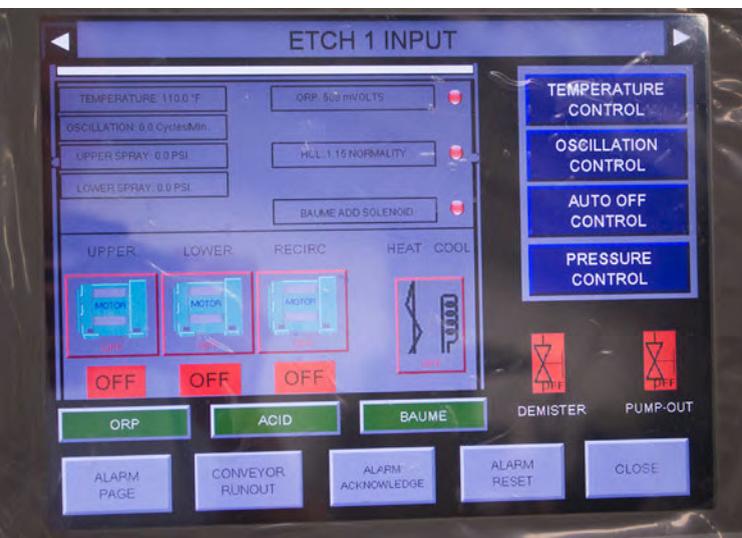


Figure 4: Example of user interface panel with display for PLC control.

bination line are not impacted to the point of unacceptability, your total production will decrease.

In a modular system another etch module can be built and placed right next to the existing etch module. While less expensive than an entirely new system, this approach has some caveats. First, there must be sufficient plant space available to lengthen the system. Second, there must be sufficient electrical capacity to run more process pumps and possibly another conveyor drive motor. Finally, the line must be taken out of production and cleaned out prior to retrofit work being performed. A shutdown over a two-week period may be necessary to complete integration and testing of the new module.

Extras

One final consideration is process control. A number of methods have been developed to help automate your process and keep it running properly. Depending on your needs, dosing tanks and pumps, regeneration systems for chloride etchers, Programmable Logic Control (PLC), wastewater treatment and ion exchange systems are all available.

PLC control is especially adaptable to processing a mix of products, as an engineer or lead operator can program process parameters such as conveyor speed (or contact time),

temperature, dosing or regeneration parameters, even spray pressures on auto—adjusting sprays for each unique product and assigning a recipe number to that product. Once this recipe is loaded into memory, any operator can easily change from one product to the next and know that it will run at the specified conditions.

Using bar coding apps and a bar code reader, each product can be matched to a specific recipe, removing further chances for mistakes. Data coding, which applies a time and date stamp to each panel, allows you to track individual panels through the entire process. If a non-conforming product is found during inspection, the time stamp makes it easier to determine if other product run during the same time frame is also defective.

Furthermore, in our brave new world of 24-hour connectivity, with the right set-up, all of this can be monitored on a smartphone or device from anywhere there is Wi-Fi connectivity. Depending on your product mix and volume, adding in some form of automatic process control is well worth the up-front cost.

Conclusion

Whether it is your first process equipment purchase, you've outgrown your current system, you just want to improve your yield or increase throughput, or you have decided on a completely new product or product mix, your supplier should be able to help guide you through this purchase using their own expertise. The purchase decision will be with your company for years to come, but it does not have to be a terrible experience. Working with a supplier that has built many different systems to customer specifications and has a proven record of efficient, long-lasting designs can take much of the worry and uncertainty out of the decision process. **PCB007**



James Hall is R&D process technician at Chemcut Corporation.

I-Connect007

EXCLUSIVE IPC APEX EXPO 2018
PRE-SHOW COVERAGE



SAN DIEGO
OR BUST!

**APEX
EXPO**
IPC 2018

February 24th
thru March 1st



A Sneak-Peek at IPC APEX EXPO 2018

IPC President and CEO John Mitchell gave I-Connect007 a sneak-peek at the upcoming IPC APEX EXPO, happening in February in San Diego. Mitchell provides a description of this year's keynote, as well as a few new additions and areas of emphasis. It looks like it will be another packed house, with plenty to see, do, and learn about.



John Mitchell

insights into the complex world of technology. In addition to this opening keynote on February 27, I will give a keynote on 'Educating a 21st Century Workforce,' and cover how understanding the challenges and solutions in educating a 21st century workforce, is critical to businesses and leaders around the globe.

Patty Goldman: John, what can you tell us about the upcoming show, and keynote speaker, which I understand is expected to be quite a draw?

John Mitchell: Jared Cohen is our Tuesday keynote. He is now the CEO of Jigsaw, which is a part of Google. He's the former advisor to two U.S. Secretaries of State and the author and member of the Council on Foreign Relations. The title of his speech is, "Game changers, Technology, and the Next Big Disruptions." He travels a lot, so he'll be drawing on his travel and first-hand accounts of some of the various important and emerging trends in technology, and then reveal how some of those will matter to the electronics industry.

Goldman: That should be very interesting and appropriate.

Mitchell: Yes, we're looking forward to Mr. Cohen's

Goldman: Sounds good. What else will be going on at APEX?

Mitchell: Our theme this year is "Succeed at the Velocity of Technology." We are more than 95% sold out for the show floor, which is great, and we're anticipating more than 450 suppliers to showcase their products and services. In addition to the exhibition, we of course have our educational offerings, the professional development courses, which include subjects like PCB fabrication troubleshooting, printing, dispensing, jetting, manufacturing yield, reliability, and DFX. We really try to provide things

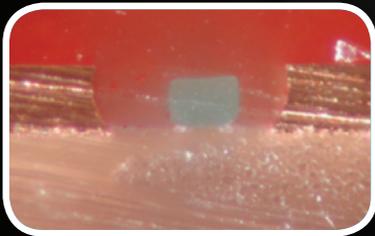
that are driven by real-world application of what's happening right now, so the attendees can apply it later. We're trying to help them access new research on materials and processes and learn about trending materials or applications and processes, such as Industry 4.0 and wearables. We'll address real-world problems and teach the practical way that people can be



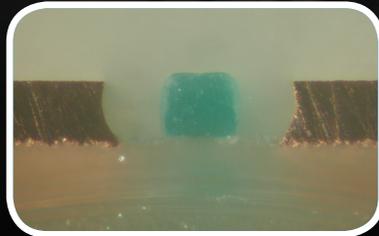
MOVE BEYOND YOUR
PROCESSING BOUNDARIES

*DIRECT
IMAGING*

B Y T A I Y O



PSR-4000 BW01 DI



PSR-4000 BN HF DI



PSR-4000 HFX DI



Phone [775] 885-9959 • www.taiyo-america.com • info@taiyo-america.com

in



successful at their jobs. So, flex circuit design, signal integrity issues, wearables, printed electronics, impedance and tools that merge electrical and physical design are just a few of the areas that the programming will cover.

Then, we have the technical conference, which offers the industry's most stringently-vetted program available. We have more than 80 papers this year, and they're measured against strict requirements by a panel of industry experts. We want to make sure we have the latest research and innovation available from the subject matter experts in the areas of board fabrication, design and electronics assembly.

The content that the attendees will be experiencing at this show is completely unique to IPC APEX EXPO. We've been careful to craft the conference so that similar topics don't overlap to help attendees maximize their time and effort. A few of the highlights include PCB fabrication reliability, assembly reliability, and then voiding and developments in the assembly of bottom termination components.

The Design Forum will be going on concurrently and will feature distinguished experts from the design community. They'll be delivering design-focused education on some topics, as well as sharing priceless and timeless lessons learned. They'll be presenting practices in Industry 4.0, including IPC-2581, emerging ECAD and MCAD, designing for flexible circuits, as well as circuit board design and mistakes you can avoid. Those are some of the topics that will be presented there. We will have

buzz sessions again, with a market outlook buzz session, as well as IPC standards updates and environmental legislation updates.

We're trying to make sure that people in every stage of their career can be successful by coming to IPC APEX EXPO. There will be sessions for early career that we would recommend, things like PCB fabrication, voiding, bottom termination components, PCB surface finish reliability, things like that. Then, for those in mid or later career, some of the sessions they might benefit from would be the wearables, printed electronics, emerging technology, SIR corrosion, and some of the reliability issues with dispensing jetting, etc.

The whole show continues to grow every year, which I'm very pleased with. Frankly, the industry's been doing very well this past year. We're excited about that because typically the show follows the viability of the industry. We expect the show to grow right along with it this year. One of the two annual IPC board of directors' meetings will be held right before APEX EXPO, so you should see the majority of the IPC board members in attendance.

Goldman: Will there also be award ceremonies?

Mitchell: Yes. At the Tuesday luncheon we will have the official IPC annual meeting, and then for the Monday and Wednesday luncheons we will have the industry awards ceremonies. We just can't get them all done in one lunch. When you have thousands of volunteers, it's a good problem to have, right?

Goldman: Exactly. At the Tuesday annual meeting, will we be electing any board members?

Mitchell: A new member of the executive committee—a new secretary/treasurer—will be put forward at that time. Actually, all of the executive positions will be renewed because Joe O'Neill will just have finished his two-year term as chairman. He would move to immediate past chair and there would be subsequent shifts in the other positions, if tradition fol-





lows. Those positions are being vetted by the board and we'll have that approved for general voting, as well, once the board approves. Also, there will be at least one board member renewal, and there may be one slot available, or not. We'll see. Right now, we're completely full at the maximum number of board members. If one of those people moves onto the executive committee, then there's a possibility that there may be another slot available, but it won't be a necessity to fill it. We have five on the executive committee, and then the elected board members range anywhere from seven to 14 members at any time. Right now, we're at 19, which is the max.

Goldman: Okay, what else? Anything more to add on the keynote speaker?

Mitchell: I think people will be very excited to hear from him. We've had really good fortune most of the years I've been here in having keynotes that people are pretty gung-ho about, so I expect this will be no exception.

And one other thing. In an effort to engage people earlier on understanding the industry and what IPC does for it, we're bringing in some high school groups that will be touring and will be privileged to hear some panels. I understand one of the schools, a San Diego school, has already accepted, and we've put the invitation out to a couple others.

Goldman: Any news on the standards front?

Mitchell: In addition to our standards, education, advocacy, and solutions areas, there are a few initiatives that we're going to focus on for the next two or three years. You'll see some of this coming out at the show. One of those initiatives is what we're calling the transportation initiative. As you've noticed, we've recently had a lot of standards in the automotive arena. We're going to be looking at the heavy trucking, rail, and shipping, etc. as well. Since electronics is proliferating into the transportation space, we want to make sure that we can

leverage the industry's expertise to those verticals, as well. You'll see a lot of effort on the transportation initiative.

On the education initiative, we're looking to do a lot more and that will be discussed at APEX EXPO as well as workforce development. There are still a lot of jobs that aren't being filled and we're trying to work with the industry to understand exactly what the skill sets are that we could help develop in individuals so there can be more people available to be hired, as well as reaching out to schools and doing some academic work there.



We'll continue to improve our systems to be better and more consistent with our offerings to the industry, on a global basis.

Andy Shaughnessy: You mentioned the design forum. My focus is design, so I'll be covering that. Sounds like you have a pretty good program.

Mitchell: There's the standard information that everybody's used to, that will of course, always be there, but the team just continues to reach out to the industry to understand the latest, newest, hottest issues that we need to be covering. They're striving to make sure that it's out there so people can get that information.

Goldman: John, how much interchange is there between the people out on the show floor and the people in the conferences and committee



meetings? Sometimes I feel like for the people on the show floor, all they know is the show, and they never see that other half, which is the conference and the committee meetings. Do you get that feeling?

Mitchell: I'm sure that happens for some people, but I know there are other people that are experiencing all the show has to offer. It just depends. For instance, if you're a sales person and you're there, guess what? You're not going to leave the show floor, and that's where you ought to be because I know people there last year who said, "Hey, in the first day I met my entire annual quota." That person really ought to be on the show floor, doing the selling. That's what their role is. That's where they're going to be the most effective they can be.

For other people, they're going to spend time at committee meetings, standards meetings, and learning events, etc., and the show floor. That will be the guy that gets caught Wednesday afternoon and buys something on the show floor from somebody else because they were

tied up all day Tuesday, and that's why people have three days to check out the exhibits.

Some instructors are going to be teaching the entire time and they may not even make it to the show floor. That's why we try to have the big food event one evening so people have a good motivation to go down to the show where we do the burgers, the dogs, and the brats and stuff. We pull everybody out on the show floor at 5 pm on Tuesday for the reception, then on Wednesday we're having the ice cream social from 2-4 pm on the show floor.

Goldman: One of the good parts about San Diego is the fact that the meeting rooms and the show floor are so close together, right?

Mitchell: Yes. Just down the escalator and you're right there. It's all a good thing.

Goldman: Yes, it is. Thank you so much, John. We'll see you soon.

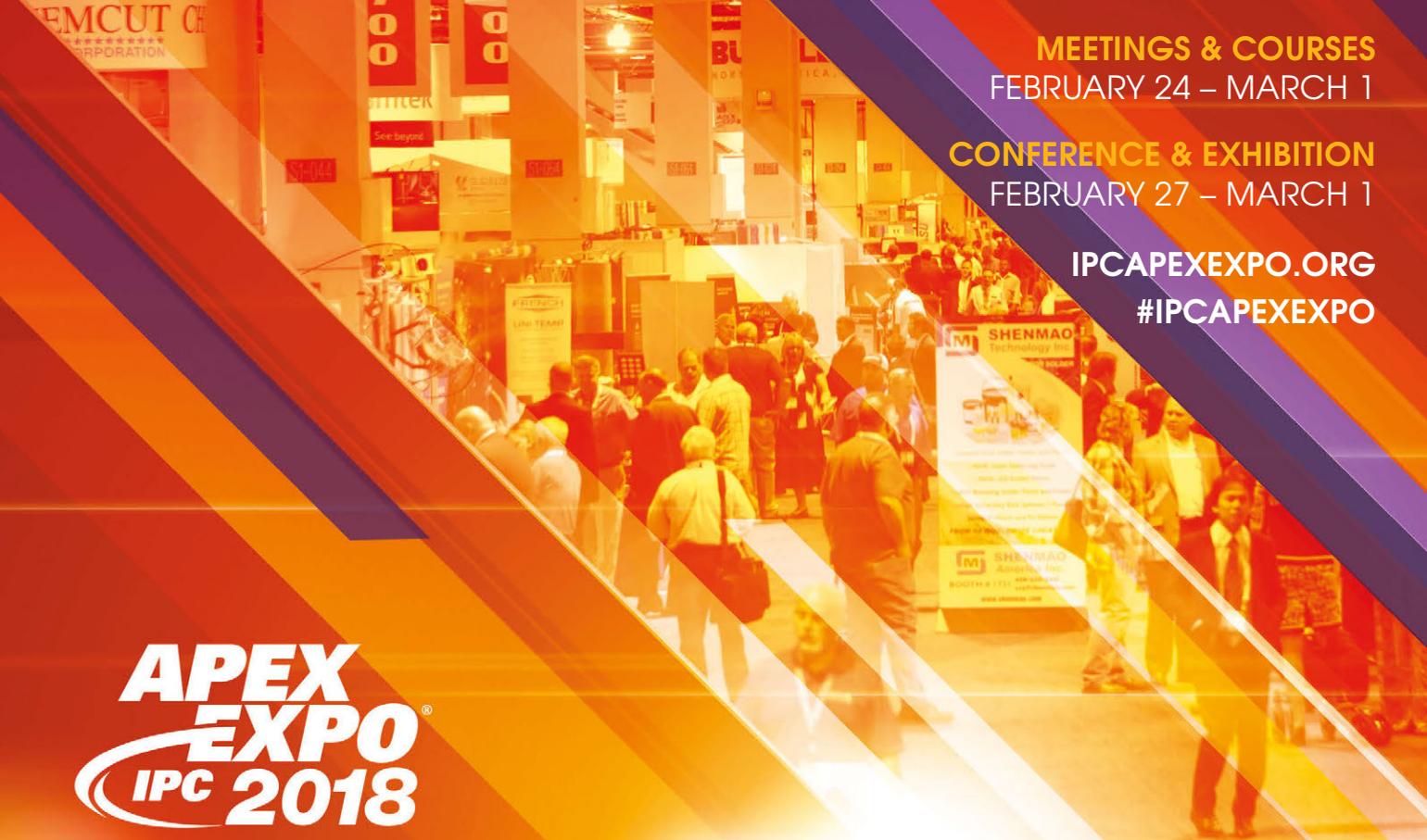
Mitchell: Thank you, Patty. **PCB007**

Philip Carmichael IPC President, Asia on the Changes in PCB Value Chain



During the 2017 International Printed Circuit & APEX South China Fair (HKPCA & IPC Show 2017) in Shenzhen, China, IPC Asia President Philip S. Carmichael speaks with I-Connect007 Managing Editor Stephen Las Marias about the move in the value chain that's driving the electronics manufacturing industry forward. He discusses the new market trends that will further the growth of the PCB industry, and how new manufacturing technologies will help bring the industry toward the vision of a lights-out factory. Carmichael also explains the need for knowledge transfer, education, and standards, in the industry.

[Watch the interview here](#) ►



MEETINGS & COURSES
FEBRUARY 24 – MARCH 1

CONFERENCE & EXHIBITION
FEBRUARY 27 – MARCH 1

IPCAPEXEXPO.ORG
#IPCAPEXEXPO

**APEX
EXPO[®]**
IPC 2018

**SUCCEED
AT THE VELOCITY
OF TECHNOLOGY**

THE SHOW FLOOR WILL ACCELERATE YOUR INNOVATION

In 2018, your leading opportunity to stay on top of electronics industry innovation is on the IPC APEX EXPO show floor. Join thousands of your industry peers as you uncover new solutions that will move you in the right direction to capitalize on tomorrow's opportunities!

- » Explore and compare equipment from more than 450 of the industry's top suppliers.
- » Discover new processes to gain greater efficiency.
- » Start your year with new suppliers that can save you both time and money.

VISIT IPCAPEXEXPO.ORG FOR MORE INFORMATION

NEW THIS YEAR!

WIN WITH OUR PASSPORT TO PRIZES GAME

Travel around the show floor collecting stickers from exhibitors, and enter for a chance to win an exciting prize!

**SAN DIEGO
CONVENTION CENTER
CALIFORNIA > USA**



Keeping it New, Current and Relevant: IPC Conference Director Jasbir Bath

Jasbir Bath, technical conference director for IPC APEX EXPO, has been coordinating IPC's technical program for several years now, but his interest and excitement for the event continues to expand. It's clear that Jasbir and his team take great pains to create a fresh, exciting menu of sessions, development courses and more, full of potential learning experiences, year after year. It looks like 2018 will be no exception.



Jasbir Bath

Patty Goldman: Hi Jasbir, please begin by telling me what your position at IPC entails.

Jasbir Bath: I'm the conference director for the IPC APEX EXPO conference. I've been doing it for the last four or five years. My responsibility is to help organize the conference, solicit papers, and then put together a technical program committee to solicit papers and review the abstracts coming in, and then select papers for the conference. We're at the stage now where we're putting papers into sessions. We're writing session descriptions and we're receiving papers and presentations for each of the sessions to review for the conference. That's the job that I'm responsible for. We may have some drops, we may have some additions, but we're in the middle of the review process for papers and presentations now.

Goldman: How many tracks should there be?

Bath: There should be 32 sessions. We're doing about five tracks in parallel from Tuesday afternoon, Wednesday all day, and then Thursday morning. We're trying to make sure that

the tracks have assembly, PCB fabrication, and reliability tracks, as well as some others. We're trying to keep the fabrication and the reliability in one track, the assembly in one track, etc., so that two fabrication sessions aren't going at the same time. It's always tricky. We try not to clash with the standards committee meetings. That gets interesting,

because some of the people who chair the paper sessions may also be involved in standards meetings. We want to make sure, for example, if there's a PCB assembly track that it doesn't overlap with a PCB assembly standards committee meeting. There has been feedback on that, so we're putting in a renewed effort to make sure we don't have any overlaps. At the same time, if there's a potential clash on Thursday morning with the professional development (PD) courses that are going on, we're also trying to make sure we don't have a PD course on one subject coinciding with a technical session in the same area.

Goldman: Do the professional development courses run on the weekend and during the week too?

Bath: They run on Sunday all day, Monday all day, and then Thursday morning. It's not a big overlap. There maybe last-minute changes that we can't account for, but generally we're in good shape.

Goldman: It's hard to make everyone happy.

Bath: Exactly. The chair of a standards committee session may also be chairing a technical



conference session we have, so we give priority in some ways to someone who's chairing a standards meeting and chairing a session. We'll give them the power to move things around.

Goldman: Continuing with the conference, are there any new tracks or hot topics this time around?

Bath: We have some that are generally considered hot topic sessions. There will be sessions on bottom termination components, which is a growing technology. We have the emerging technology session where we cover wearables, printed electronics, and emerging technologies like stretchable applications, wash-ability of materials for e-textiles, and an overview of XR virtual reality or augmented reality. That's a nice session. We have the traditional PCB fabrication and assembly sessions and component reliability. We have voiding sessions, which is a hot topic in terms of voiding areas for BGAs and components and how to minimize voids. We have a session on jetting, which is a newer technology where people are looking at non-contact dispensing for solder paste.

Then we have the traditional sessions, but some of those like surface insulation resistance (SIR) are still continuing issues. There are still challenges in terms of not just existing materials, but developing materials, masking materials, flux residue issues, etc. We'll have session(s) on reliability of plated through-hole materials, issues with reliability in terms of degradation and glass epoxy degradation. We're trying to cover things that are challenging, or issues that are coming up in the industry.

Goldman: Of course, all the papers are fresh and dealing with the latest technology.

Bath: Exactly. We also have a session on creep corrosion, where we have experts from IBM talking about the new developments in corrosion testing. Typically, you've got your alloy sessions, your high-speed/ high-frequency sessions, and where we're going on that. Then

surface finish reliability, where we'll talk about recommendations for increasing shelf life with PCB finishes. A paper we have for the cleaning session is looking at cleaning challenges when we get to very fine powder sizes for solder paste.

Goldman: How clean is clean, right?

Bath: How clean is clean, and how clean can you get it? What are the challenges of removing flux residue? We have solder paste testing development on where we are in terms of the test technologies and J-standard 005, what test vehicles you can use for solder paste evaluations, and paste development for laser soldering applications. It's the kind of things that discuss new applications coming up, like miniaturization. We're getting smaller and smaller paste deposits. Some of the components to assemble are temperature-sensitive so reflow ovens can't be used so you may have to use laser or other non-contact applications to reflow those locations.

We've got rework application sessions. Rework is still interesting and still coming up. Session speakers will talk about the challenges for big board rework and optimizing bottom heat for manual rework applications. Then there are the typical copper foil issues, alloy reliability, and test/X-ray inspection issues. For instance, the impact of X-ray on preprogrammed managed NAND devices and understanding if the X-ray is causing any radiation damage to the devices with best practices.





We have a design session looking at different redesigns and how to do it the right way, ECAD/MCAD tools, etc. We have a session on flex with areas covered including minimizing signal degradation for flex PCBs. We have sessions on conformal coatings covering issues on high temperature protective coatings, and nano coatings, etc. We are also looking at reliability modeling and reliability of adhesives. That pretty much covers the conference. We have some new sessions, some sessions on existing material developments, where we're going, and then test and papers to cover some of the challenges and development that we need for new technologies.

Goldman: How many papers total for the 32 sessions?

Bath: Approximately 75. The sessions are either two-or three-paper sessions running from Tuesday afternoon, Wednesday all day, and then Thursday morning.

Stephen Las Marias: Compared to last year, do you have more papers for 2018?

Bath: It's about the same. If the paper is being presented in another conference we don't accept it. Basically, we want what is new. We set a higher bar for our criteria for acceptance. Our philosophy is not quantity, but quality. If it doesn't add value we won't include it within the technical conference. Our review process is such that, when we're reviewing papers and presentations, we're reviewing for technical content, as well as grammatical issues, and making sure that the paper is a good read for the audience. We're reviewing papers to make sure they read well. That's something that I don't think other conferences do as well. Our process for review can take 2-6 weeks because of the back and forth with the authors. When we do reviews on the papers or presentations, we generally get good feedback. Some people

don't like some aspects when we ask them to update them. But, in general, we get a lot of feedback that says, "Thank you for helping me to provide a better paper and presentation." Because, at the end of the day, we're trying to enhance the information value to the audience. That's the idea.

Goldman: Do you also put together the buzz sessions?

Bath: The buzz sessions come in with industry challenges. Typically, we ask within IPC, "What sessions do you think would be of use to the industry?" The sessions typically are presented by IPC staff, but buzz sessions could be from somebody who comes to IPC and says, "We would like a session in this area." These are free sessions which are giving the status of some area of interest. For example, the first buzz session this year is a politics and policy roundtable. What's going on in government relations? What are the issues? Your typical technical conference session may not have this kind of discussion. These usually have two or three speakers, a panel, a short presentation, and then question and answer with the audience, and more interaction. The second buzz session will be a standards update. Three is on printed electronics. Where are we going? Where do we need to go to get to the next level? These are things that someone who is a chair of a standard committee, or an IPC staff standard committee liaison, has been talking within their committees, and is saying, "Couldn't we have a buzz session on this area?" Maybe it's not fully developed, but it's developing, and they can give a status of where they are at and say, "Here's where we need to go to." It should be of interest to the audience.

Goldman: I see there's also one called "Student Presentations," although there's nothing listed yet.

Bath: Yes. The suggestion came during the Technical Program





Committee discussions, “Should we just open up a buzz session to universities or students who have an area of interest?” Maybe they’re doing a six-month project or MS project and could come to the buzz session and present on this area. We’re asking around for students who do work in electronics manufacturing if they might be willing to come and present. We would look to get an IPC emerging engineer to chair that session because we’re trying to encourage students to participate in these kinds of events. That’s the idea. We haven’t got it dialed in, in terms of speakers yet, but we’re looking. And because it’s a presentation, it doesn’t need to have a paper with it. In terms of getting this session done, it wouldn’t be that hard. We’ve asked around a little bit and we’re just waiting. As of now, it’s just a place holder we have for student presentations.

Goldman: I hope that works out, because that could be very interesting.

Bath: It would be nice to have but if doesn’t happen in 2018, we’ll revisit that session for 2019. We’re trying to encourage the students who wouldn’t get the opportunity to present in a technical session to use this session, and get them involved a little bit more. That would be good for them and for the industry.

For other buzz sessions, you’ve got the typical ones: the pulse of the industry, China/environmental issues, and new areas such as e-textiles. This is a developing standards group; this is what we’re doing and some of the questions/areas around that. Where are we in terms of standards development? Buzz sessions can be kickoffs to discussions on where the industry should go.

Buzz session seven is on the the PCQR squared database. What are the updates? Then, the pulse of the electronics and the business outlook with roadmaps and things, and where we’re going. Buzz session 11 is something that we got from Brooke Sandy-Smith at Indium Corp. on IPC J-STD 001 standard and the ROSE testing requirements in the standard

being discontinued. What are we going to do? Let’s have a panel discussion on this. This was from a user. Someone out there saying, “We would like to have this.” Then we checked within IPC and there were people in the industry who were willing to be on the panel for this. We don’t have to go out and pull people. They want to be involved. We just ask them and they say, “Yes, sign me up.” This is an ongoing issue. This is something they’ve got to deal with, so you’ll get feedback in the in-



dustry on where we are and the status of the emerging methods to reach the level of industry standardization. What should we be doing? We’re trying to get these types of discussions moving in the industry.

Goldman: Let’s talk about the professional development courses, the PDs, of which I see there are 30 being offered. They’re usually about half a day, right?

Bath: Yes, there are 30 half-day sessions, with classes on things like non-contact/jet dispensing and other focused technologies. They can encompass what we currently know about a subject, and things on the horizon. As we get into more and more miniaturization, we learn about new technologies and people need to know where the state-of-the-art is. This is going to cater to that, which we hope will be of use. We believe it will be.

There are the regular courses too, like the design analysis courses. I think quite a lot of them have been around before, but there are updates from each of the authors on those. We’re trying to make sure we cover all the



bases. We cover the ESD program. It's not something that maybe has a massive audience, but it's something that we think could be of use. We've got design for testability and boundary scan.

There's something for everybody here. We've got the cleaning and coating. We have a couple of sessions on reliability from Dock Brown of DfR, discussing physics of failure. Let's give the audience something that they don't normally get when they come to the technical sessions with a more in-depth discussion on certain areas. We have Jean-Paul Clech at EPSI who is will be presenting on reliability as well. We also have new developments in selective soldering.

The rest of them cover areas including PCB fabrication, PCB assembly, and the issues in those areas. How do you troubleshoot? What are the defects? How do you do failure analysis? For engineers coming in, it covers people who maybe are developing engineers, trying to learn the ropes, and then some of the courses are more advanced for those who have been around in the industry and want to learn about developments in those areas. We're covering it in both ways as best we can. We're covering a wide range of topics from intermediate to advanced levels. We're saying, "Here's the booklet, pick and choose, however you want it." We think that these are the courses that would be of most interest to the audience.

Goldman: In the past, how well attended are the PD courses?

Bath: In recent years, we haven't had to cancel any PD course for lack of interest. I don't have the figures in front of me, but at minimum maybe 10-15 people, and at maximum maybe 100 attend a PD course. Typically, we're in the 20-40 range, but for some of these courses we're getting 60, 70, and more, which is a lot. We're not upset about the attendance whatsoever. These are the areas where there's a grow-

ing need, and we're happy to oblige.

Goldman: Any last thoughts from you, Jasbir?

Bath: If you look at the entire technical program, you'll see different pieces that cover different areas. I look at it in terms of new developments, but also new defects or failures that people are working on. It's a nice overlap between the technical conference sessions, which give you the details of where we're going, and the PD courses, which may give you more training, and cover those aspects in more detail. The technical conference session could be on printing, but the PD printing course will cover three hours where the conference would be a half an hour, or an hour and a half. It's more in-depth. The buzz sessions are where the pulse is, the biggest issues and the emerging trends. We've got a nice balance in terms of how we do this. We've got the PD courses on the front end and on the back end, with the conference and the buzz sessions in the middle. With the exhibits on top of this and the standard committee meetings, I think it's a nice balance. It gives everybody a chance to pick and choose.

Goldman: If somebody really wants to get immersed in it, they certainly can and come home with a boatload of knowledge.

Bath: Exactly. You come in, pick and choose what you want, and you come out and hopefully apply what you learned to your work. That's how we want people to come in on Saturday and Sunday all the way through to the end of week. You have every opportunity to learn something everywhere you turn.

Goldman: Thanks so much for your time, Jasbir. We appreciate it. See you in February.

Bath: No problem. Thank you. **PCB007**





Integrate QA Solution

Because everyone's QA needs are just a little bit different.

Integrate is a fully customized solution, and no two contracts are exactly the same. No matter what size customer you are, we can tailor AOI, testing, final inspection, or a combination of all three services to fit you. And you only pay for the product that actually passes quality assurance, not on panels produced or tested.

Find out if our Integrate solution is right for you!
www.gardien.com/why-integrate



GLOBAL FOOTPRINT
WITH A LOCAL PRESENCE



30 YEARS OF PCB
INDUSTRY EXPERIENCE



CFX: Updates and Developments

Nancy Jaster is the manager of design process at IPC—and she has every right to be. As part of the technical staff team, she works directly with many IPC standards committees to support the industry, particularly those related to DFM and DFX guidelines, as well as those involved in data transfer. With 28 years' experience in the industry—10 years in manufacturing and 18 years in design—she understands clearly what people need on the factory floor.



In an interview with I-Connect007, she discusses the latest developments in the Connected Factory Initiative (CFX), the machine data interface standard that would enable manufacturers, equipment, device and software suppliers to achieve Industry 4.0 benefits, and CFX demos at IPC APEX EXPO 2018.

Stephen Las Marias: Nancy, what's the rationale behind the Connected Factory Initiative?

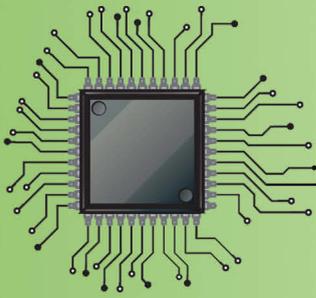
Nancy Jaster: I'm one of the fortunate ones in that I've got the experience in both design and manufacture. I already have the IPC-2581, which is the standard to get design data to manufacturers. The wonderful thing about 2581 is that it is intelligent data. It's no longer just a flat file. It's a model-based dataset where we can share much more information with the manufacturing floor than we ever have before because it's all bundled up in this one package.

IPC used to have CAMX, a standard for transmitting data on the shop floor. But it was tied to a message broker, which limited its usability.

After talking to some of the machine vendors, my original thought was how we could take CAMX to the next level, and how do we get CAMX working with 2581? I realized that we had an issue there, and that we really needed to look at the shop floor like we looked at getting design data into manufacturing as an intelligent data model.

Data is key not only to the design process but the manufacturing process. We really need this overall data backbone to support the industry, and we want this data backbone to be smart, intelligent data. We want it to be on a standards base, so that if we're calling, say a fiducial the same thing in every standard that we have, then we can easily pass that information back and forth. We standardize how we describe it, and what it makes up from a data perspective, and then you can reuse that piece of information anywhere within the product realization process. It's critical for us to get to the standard understanding, the standard way of using data. It's critical for the industry to be looking forward, thinking about it from an intelligent data perspective. When I started in this industry, we got flat files and we got drawings, and then we would have to take those and parse those out. I actually did some machine programming on the shop floor for a while. You'd have to take that unintelligent data and put all that intelligence in there. Now, we have the ability to do that within the data.

CFX is taking that shop floor data and taking it to the next level, coming up with standard terms and definitions, and has a standard transport definition so the information



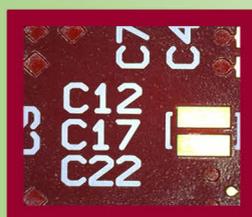
MivaTek

Global



LED Direct Imaging

We give a dam...2.0 mil solder dams



- > 2.0 mil solderdams
- > 4 mil mask defined pads
- > Colors: GRN, WHT, BLK, BLU, RED
- > Excellent camera registration
- > Legend printing using white SM
- > Inner and outerlayer imaging
- > Extensive North American support
- > 20 machines sold in North America

MivaTek Global, LLC formerly Kuper Technology, LLC

Now Hiring : Sales Engineers, Applications Engineers and Technical Support

MivaTek Global, LLC, PO Box 893, Concordville, PA 19331, Ph: (610) 620-3795

Eastern US: Brendan F. Hogan, M:(610) 620-3795, B.Hogan@MivaTek.Global

Western US: Kurt Weber, M:(714) 767-6367, Kurt@MivaTek.Global

MIVA: LED DIRECT IMAGING



can flow from machine to machine, no matter whose machine it is. When they get that data, they can then apply their internal algorithms, their secret sauce, shall we call it, so we're not infringing upon what the manufacturers are doing or what may make their piece of equipment special. It's just using that com-



mon framework so we can transmit the data from machine to machine. As we gather information, like if you have a part and you must alter the placement slightly, we can send that back upstream. You want this to be bidirectional data going back and forth, so we can learn from the shop floor and continually improve the manufacturing process.

Las Marias: Is CFX a replacement for the IPC-2541, or the CAMX, as you were mentioning earlier?

Jaster: It's kind of a replacement, but it's two-fold. One, the industry has moved ahead. When you think about how this industry started and how we used to do drawings on big drafting tables, and then photographing it down to the size we really wanted, to where we are today with data. The whole technology has changed and we're taking advantage of those advances. With the whole Internet of Things and Industry 4.0, people really want to start communicating more about the data. In the past, it's really been one way. You just keep it flowing through the factory. But we know there are so many things we can learn from the process, and we want to take that information and flow it back, not only in the manufacturing process but to design.

When I was in the development area, that was always a problem because we'd send it over to manufacturing and they may do something or tweak that data partially, not change the design, but they might adapt the data a little bit for their shop floor. Then that meant that information didn't necessarily get back into the design community. So, being able to have bi-directional data is going to move us forward. Not only can the shop floor understand what's going on in their machines and maybe tweak things a little here or there, or if they know this design in the past has had a problem, to change something to adapt to it. They can also feed information back to the design community as well because we've got this common set of terminology that we're using, so it'll be easy to transmit information back and forth.

Las Marias: How is CFX going to address all that?

Jaster: CFX is not related to any one tool. It is tool agnostic, so it is being done by the equipment manufacturers, the software vendors, and OEMs, all on the committee. We have a chair from each one of those areas to make sure that it's being looked at across the board, and that it's not one industry or one player trying to push their version of things. It is definitely a balanced committee with balanced leadership who are looking at this for the entire electronics industry.

We have already agreed to a transport mechanism, and it's the AMQP 1.0 message queuing protocol. The team looked at a number of transport mechanisms, and the team decided that was the one that really had the most versatility and would serve us in the long run for this committee. Now, the next thing we're working on is standardizing the bits of information we need to share back and forth.

But instead of doing it machine by machine, like if you're a surface mount machine or an oven, we're instead doing it by function. We know that with pretty much every machine,



they've got an eye on that machine to make sure that they're looking at the fiducial. So, this is from 00, and everything is determined from this point. We know everybody has a camera that's looking for that, right? So, why reinvent that multiple times for each piece of equipment? That's going to be a building block.

We're creating all these building blocks that we can say, 'Oh, this piece of equipment needs a barcode reader. It reads barcodes, and it's looking for 00.' It's pulling those together, and now we can create the standard so that this is how we pull that information across from machine to machine. It's consistent across the board. If what we're calling a fiducial, then every piece of equipment's got to use that same terminology and the same criteria to describe that block. It's that commonality at a low level, at the right level, so we're not forcing people to tell them how necessarily to do things. So, what information needs to be portrayed? When I worked at Lucent, we used to talk about the 'whats' and the 'hows', and the whats are what you need to have at a lower level, so that you can standardize.

Everybody can agree to that, everybody knows that a product has an ID. We want to standardize on that ID and say, 'this is the ID.' Every board has the point zero, the starting place where we zero out from, so all my dimensions are from this point forward. Everybody agrees to that, so we're going to make sure that definition is the same across the board. By doing that, you can then build upon it, but you're still not inhibiting innovation on the software provider or the machine vendor to do things differently, or even the OEM. There's still an opportunity for them to make improvements or adjustments, or they can decide what information they want to maybe feed upstream to keep track of quality, production, or for whatever reason. It still allows everybody to do things differently when you get down to the 'hows.' How they do it, it may all vary, but if we're communicating the



same language across the board, it's going to make life so much easier for everybody.

Las Marias: CFX aims to provide or enable true plug and play interoperability of the equipment, device, and the software.

Jaster: That is our goal.

Las Marias: So far, what have been the challenges in that aspect? We're dealing with a lot of vendors here.

Jaster: Yes, and somehow, I got lucky. I don't know what I did, but my vendor support has been great from day one. I think part of it was that I went into the very first meeting and said, 'This is for you. We want to do what is right for the industry. We've got no preconceived ideas. We want it to be not non-tool specific. It's not like you're going to have to go off and buy vendor A's product, or use a particular product.'

I think it helped because I do have manufacturing and design experience, and that helped me a bit in communicating to folks. Because I've been there, and I've actually had to run

Mylar tapes to run sequencings machines for through-hole components and figure out what's the best way to layout and insert those parts on the board. Been there, done that, and I understand the complexities of the shop floor.

It's only gotten more and more so as the industry has evolved. Part of it was being in the right place at the right time. I had help from my chairs in pulling the right people into that room, and I cannot say enough about my three chairs: Jason Spera from Aegis Software, Mark Peo from Heller Industries Inc., and Mahi Duggirala from flex. The three of them are wonderful. They're open and they're willing to listen to all ideas. They're not there pushing an agenda.

Sometimes, we've had a meeting or two where people were kind of pushing an agenda,



and we basically said, ‘No, stop it. IPC doesn’t allow commercialization.’ We don’t want people pushing their own agendas when it’s product specific or vendor specific. Some of that came up, and the wonderful thing is that a good, strong, solid team of people pushed back at the right points in time. I’m not saying it happened a lot. It really has been a very good group to work with. They’re very interested. At first, there may have been a little skepticism. Could we really keep it generic enough that everybody could use this? But when we came up with the building block approach, people thought that was unique and a great idea, so let’s go for it. Probably the biggest problem we have in all of standards committees is that they’re made up of volunteers. Our volunteers have been great, a lot of them have given it plenty of time, but there just never seems to be enough time. You always wish you had a little more time with folks where you could maybe get a little bit farther, a little bit faster. So, you’re always limited by people’s time that they can commit to a project. But let me reiterate, IPC has great volunteers.

We are making great strides. We had our first meeting over in Germany at productronica. We’ve never done that before, but my colleague over there who runs some of the standards meetings, Andreas Ojalil, ran that meeting for me. We have a lot of our committee members over there, so they’re continuing to work it. People are excited because they see where this is going, and they see that this is going to be machine to machine, it’s generic,

and you don’t have to use a particular message broker. You’re not tied to any one competitor’s tools. It’s going to give you what we need without forcing you to do something you don’t want to do. You’re not giving away the secret sauce, which is critical.

Las Marias: I think one big factor is the increasing trend towards Industry 4.0. This is a version of that when it comes to the factory floor in the electronics in the industry.

Jaster: And that was part of it, too. When we started, we said we wanted it to address Industry 4.0, and everybody in that room said, ‘Well, what’s the definition of Industry 4.0? Because everybody’s got a different definition.’ That’s one of the things that this team said, ‘For this team’s perspective, this is what we mean by Industry 4.0, this is our interpretation, and this how we’re going to address it.’ People agreed, so it may not fit some other models, but it’s going to work for the folks who the standard is intended for.

Las Marias: What about the legacy systems that are being used by manufacturers or electronic assemblers? Do they have to install new systems or equipment?

Jaster: They won’t have to install new equipment. This is intended to work with all existing equipment, and it will, because it’s at a high enough level that it will work. When it really is going to come into play is for the equipment manufacturers and the OEMs, and even the software providers. They now know if they work to this standard that it’s going to be easier on implementation. With any standard, you don’t have people going, ‘Okay, we’re going to cut it in tomorrow.’ It doesn’t happen that way.

It’s like with a software update in the CAD world. A CAD vendor comes along with an update for their program. A company will decide when they want to implement that. They may implement it on new designs, where you still have to have things around for old designs.





With factories and producing products, even in the design community, most of our customers or our members are not consumer products. Consumer products you can do a lot of things and change over in a year, because you can change a whole product.

In the defense industry, the automotive electronics industry, we have a long-term approach to products because we must have long-term support. In telecommunications, my background, we always had to support the old as you move to the new. I believe going to the CFX standard will be a phased approach. At some point in time people on the factory floor may want to start implementing CFX even with some of their older equipment, or older programs, etc. But because it's a standard, it should be easy and adaptable to do. Once we get the tool kit available, which Aegis has just graciously signed over to IPC, we're going to put it on a public website so that people can go in and start working with it. I haven't seen it yet, but I am told it's very easy to program in this new environment using the AMQP 1.0, and it's going to be very simple for folks to make modifications and update things. Obviously, every factory and every machine vendor will have to determine when they want to start implementing this. But again, that's the wonderful thing about it being at the 'what' level, and not at the 'how' level. It allows that flexibility.

Now, what happens to the old standards? They're still going to be around. It'll take us a while before we say that we're not going to support them. We won't necessarily do any updates to them, but we don't necessarily say that you can't get the standard, because if somebody's currently using a particular standard and they want to buy a copy of it again, we can do so. You can't necessarily just throw it out just because you got something new. You always have to look back and make sure you can deal with legacy products.

Las Marias: That's true, because a lot of manufacturers have already invested millions in them.



Jaster: Right. You always have repairs, you always have legacy issues, and you have old machines on the factory floor. My guess is, as people bring in new equipment, they'll start using the standard. They'll see how easy it is to develop and use, as well as transmit data back and forth. The bi-directional ability is going to be great. Then they may take on projects to update other programs on their floor, even for older equipment. It'll be easy enough to do moving forward, once they get used to using the new standard.

Las Marias: Right now, you have the software toolkit from Aegis, which is the CFX messaging library, and then the transport mechanism AMQP 1.0. Are there any other new developments with CFX?

Jaster: Right now, we're working on those building blocks and defining what those building blocks should be. The next step is getting those building blocks in place and getting the standard definitions there. Come APEX, we actually hope to be able to demonstrate on the show floor how simple and easy it is to use these building blocks to run the machines. I'm hoping we will have demonstrations there, but the key now is getting all those building blocks together and determining at what point we want to go ahead and actually publish the standard. It's just more work right now and getting those blocks built.

Las Marias: Apart from the demo, what should the industry expect at APEX regarding CFX?



Jaster: Well, hopefully the standard will be released next year. The standard will be released for the building blocks that we know of today, but as industry changes, we need to keep making sure that we are in tune with industry and continually look to make sure the standard stays up to date with where the industry is going.

I would love to see if we can integrate it into making sure that it's communicating well with the 2581 data. I really want to get this continuous backbone of data and expand it out. Right now, we're really focused on circuit assemblies. Can we expand this into printed wiring board assembly? I think we can, so is that the next phase we tackle? I don't know. We have a standard component traceability. We need to make sure that component traceability works well with the CFX standards so that we can make sure we're providing that information back. I'm also responsible for a number of standards related to material declarations for RoHS and REACH. I would like to get those standards connected in as well, so that they're all talking to one another. I want a set of standards to support a data backbone for the electronics industry.

As you know, when you're putting in data it is basic quality 101. Do it right the first time. If design inputs the data and it is correct, which it has to be, then it transfers automatically over to production. If they don't have to touch anything, not only do you speed up your process, you improve your quality, you have fewer er-

rors, and you have less manual intervention. Now we don't have to worry about transmitting data from machine to machine because they can all talk to one another with CFX.

Then you worry about, how do you take this data, and move it even farther outward in through the thread? We really need this backbone of data to support manufacturing. Data has always been key, and we've gone from paper, to flat files, to somewhat intelligent files, to now extremely intelligent data, and we just need to take that and keep using the technology as it becomes available to us. The other part is making sure it's secure. You always have to make sure your data is secure.

Las Marias: The traceability, the standards, and then RoHS and REACH. They will be connected, but not really integrated into the CFX, right?

Jaster: Not yet. That's another phase. When the directives came out for RoHS, we needed things, and so standards were written. Now we're working on connecting the factory. My goal is someday to get them all talking to one another.

Las Marias: Do you think this will be able to somehow pave the way for something like the lights-out assembly factory?

Jaster: Not yet. Do I think robots are going to completely take over the factory? No, because people still add value. Will it get us to a point where you can engage your people to instead of doing busy work they are doing something of more value? Definitely. Instead of people having to manually do something over and over, or correct problems over and over, it's going to help improve the quality, improve the data, and then allow employees to spend time working on other activities and things that can help the overall manufacturing process. How can they improve the secret sauce, or what can they do differently within their factory, versus



other factories, to make their product better than somebody else's? It's going to take people away from doing that drudgery, like double checking and triple checking data all the time, into allowing for more innovation.

Las Marias: Moving forward, as new technology developments happen in the industry, how can others in the electronics assembly industry join in or contribute to the CFX?

Jaster: All they've got to do is call me, email me, talk to one of my chairs, or talk to another committee member. To participate on an IPC committee, you do not have to be an IPC member. Obviously, we would love everybody to be an IPC member, but you don't have to be. We take any and all volunteers. We are welcome to include people in the process. When this goes out for industry review, we want folks that maybe haven't been involved looking at the document and making sure that we haven't missed something. When I teach hardware methodology, I always have a section on why we need design reviews, or why you need to do a test plan review. People get so focused on what they're doing and think they've got everything covered, but you always want that fresh set of eyes to look at it to make sure that you didn't forget something.

Going out for industry review is going to be very critical on this document. I have nothing but the highest regard for this team. This team is doing an outstanding job. The comments we're going to get back are going to be for the little things we forgot, not the big things. I think the logic is strong. The way everybody on the team is approaching and looking at and agreeing to it, I know we're headed in the right direction. But you want to make sure that the little things aren't forgotten.

That's going to be where we're going to get some help, with the little tiny details. One screw

used to screw up assemblies on the shop floor. Somebody forgot to add a screw to the drawing to put the faceplate on, and guess what? You can't ship product. It's the little things that can always trip you up. Again, I feel very strongly that we are totally in the right direction. This is going to be an outstanding standard that everybody's going to be able to use, but it's good to have reviews to make sure we're looking at all aspects of it.

Las Marias: Nancy, do you have anything that we haven't talked about that you would like to share?

Jaster: The one thing I just really want to stress is that it has been a pleasure working with this team. I think we will have a major impact on the industry when we finally get the work completed. The level of cooperation within the industry is just outstanding. I am extremely proud of this team and its leadership. It is a delight to go to the meetings, and they're just a great group of people that really want to do what's right for the industry.

I'm not saying that my other teams aren't great, because I love my teams, but to see the manufacturers, the equipment manufacturers, and the software guys all in the same room, and nobody's trying to protect turf, is just amazing. You have competitors in this room and yet they're all working together to do what is right for the industry. They're doing what they believe is right for the industry. When we get the standard completed it will make a significant impact on the industry, in a positive way.

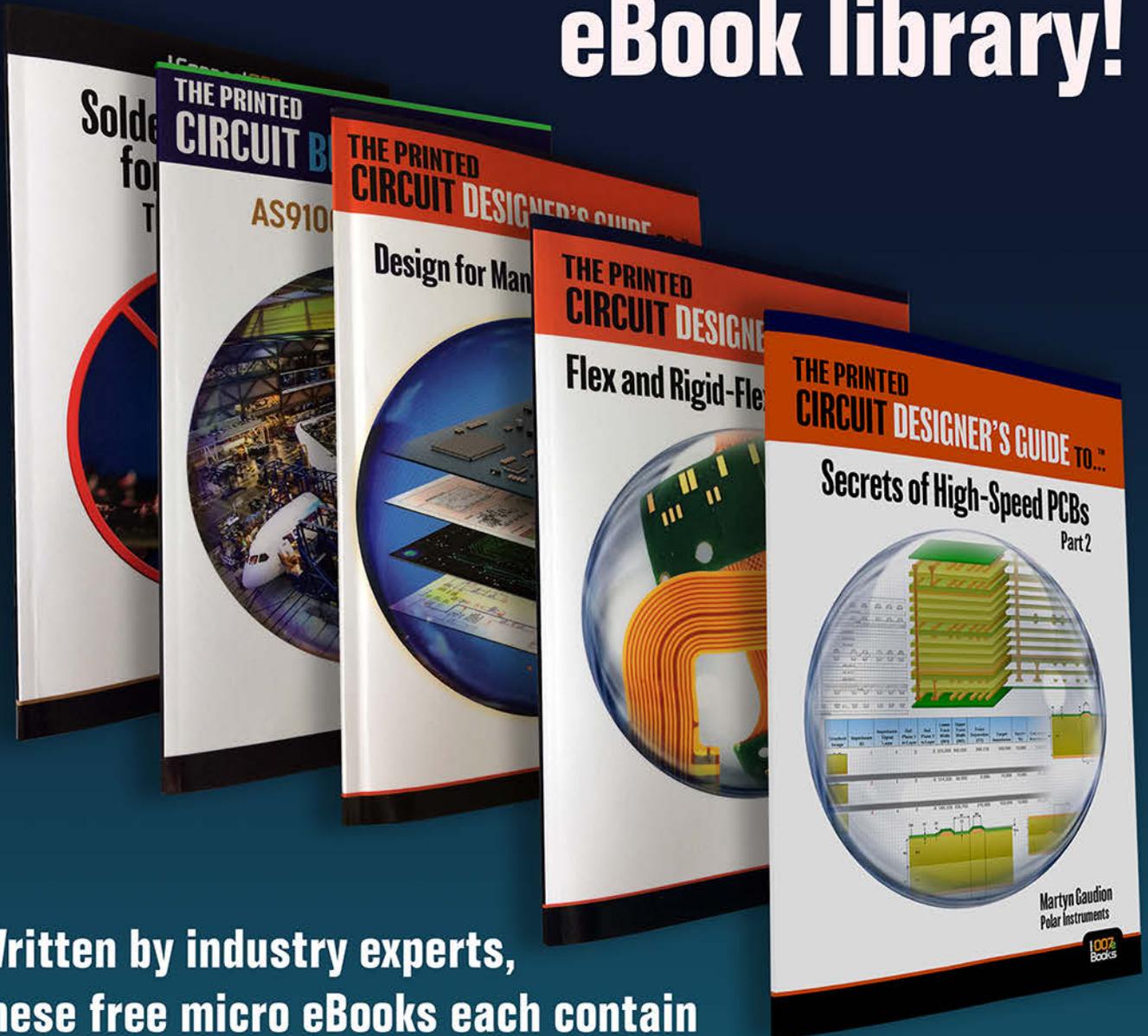
Las Marias: That's true. That's also what we at I-Connect007 strive towards—to be good for the industry. Nancy, thank you very much for your time.

Jaster: Thank you. **PCB007**





Download free books from our micro eBook library!



Written by industry experts,
these free micro eBooks each contain
valuable information on relevant topics in
an easy-to-read format.

Log in or register to access all our premium content at:

myconnect007.com



“ A comfortable approach to the selection, implementation, and testing of protective coating processes.”



Dr. Helmut Schweigart
Technology Development Head,
Zestron Europe

This FREE micro eBook, written by Phil Kinner, Electrolube's global business and technical director, will benefit anyone in the electronics industry who wants a better understanding of conformal coatings.





All the Details on IPC's Emerging Engineer Program

Teresa Rowe and Nancy Jaster, in charge of IPC's Emerging Engineer Program, explain to I-Connect007's Patty Goldman and Jonathan Zinski how this novel approach to attracting and supporting young people works.

Patty Goldman: Teresa and Nancy, let's start by having you tell us a little about what each of you does at IPC.

Teresa Rowe: I am a senior director of assembly and standards technology. I work with a technical team, as a staff liaison to the industry preparing IPC standards. My focus is in the assembly area. I'm also one of the leads for the emerging engineer program that we're going to be discussing today.

Nancy Jaster: I am also in the technical department as a staff liaison. My focus is more on IPC's design standards, and I assist Teresa with the emerging engineers program.

Goldman: Teresa, can you please describe the emerging engineers program and fill us in on this IPC program?

Rowe: The emerging engineer program started about three years ago. At IPC APEX EXPO 2018, it will have reached its third year. It was developed out of a conversation we had about attracting the younger generation to join our standards activities and to be more interested in our efforts as a global association for the electronics industry. We are attempting to pair emerging engineers, or individuals, who are in



Teresa Rowe

the early part of their career in electronics with someone who has been part of a task group or subcommittee, and part of our standards development processes, for a longer period of time. We like to think of it as a way to bring the two generations together to introduce our older generation to the newer technologies and newer thoughts, but also for our emerging engineers to gain the knowledge and exposure that they need to develop their careers.

We started very small and we have grown the program; we have tried to tailor it each year to not only have our engineers grow in the program, but also to introduce them to more detailed projects as the years develop. Nancy came on board at the tail end of the first year.

Jaster: The program is to help these young people develop leadership skills as well, because it gives them an opportunity to explore other areas, and to understand everything about the association. We've had real success in having some of our mentors take our emerging engineers and make them co-chairs of teams, so they can start learning the leadership skills that they need. It's an excellent program for people who are new in the industry or who haven't been there very long to get some leadership ability, as well as learn more about IPC and the standards development process. It really helps IPC out because it gives us some fresher views...not that we don't love our members who have been with us for a long time, but it gets us some newer people involved and starts expanding things, so we can be ready for the future as well.



Goldman: How many engineers, or how many sets of mentors and engineers are there right now?

Rowe: We have two that will be in their third year with us, and we have three in their second year. We are now looking at our applicants for our first-year group starting in 2018. The interesting part of this is that for our second-year group we actually have a university student who is one of our emerging engineers. We were excited in our second year to bring an individual on board who is a student, as opposed to actually working in the industry at the current time. He has developed a real interest in IPC and he's taking on a larger role, too, with some activities that Nancy has been working on.

Goldman: You said you have applicants. How does that part work? Who applies and how do you determine who you accept?

Rowe: There is an application process. We ask applicants to complete a benefits and commitments paper or page, which is on our website for the emerging engineer program^[1]. That explains the commitment for three years; as we both said, it is a three-year commitment for this program. We ask the individual to acknowledge that and for their supervisor, or the person they report to, to acknowledge that this is a three-year commitment on their part. We have had requests for additional information such as 'What do I do beyond the events?' for example. We've been able to work with each individual to understand their concerns as they're worried about that three-year time commitment. It does take that paper and it also takes a copy of their resumé. When that information comes to Nancy and me, we sit down together and review it to determine if that person meets the qualifications and requirements, and then we fill our slots accordingly.

We do have situations where organizations have asked for the person's mentor to be from their company, as well. We've been able to match those individuals up, where the men-

tor is someone who may be mentoring that individual at their company now. In other cases, it's someone from their organization, but maybe from a different site or a different location around the world. We've also had companies come to us and say, 'I have an emerging engineer candidate, and I would truly like to have someone mentor them who is not part of our organization to give them a broader knowledge base of other organizations and the way to rest of the world works.'

Jonathan Zinski: When you go through the application process, how many slots do you have to fill?

Rowe: We have been talking about five for our current year, plus a university student.



Goldman: I guess you need to have mentors, which I presume are mostly committee chairmen? Would that be accurate?

Jaster: We do have chairs that have been mentors, but the key is really that they're an active member on a committee. We want somebody who can work with the emerging engineer and direct them to the right standards committees that they may be interested and want to participate in. They don't necessarily have to be a chair, but it does have to be somebody who has been involved in the standards activities.



Rowe: Patty, we've seen TAEC lifetime members come forward and ask to be mentors.

Goldman: The mentors must have to make a three-year commitment too. What all is involved in that commitment?

Rowe: We certainly expect before the first meeting for our mentor and our emerging engineer to discuss the emerging engineer's interests. We encourage them to do that by teleconference, although email is fine. The emerging engineers discuss what their interests are, as far as professional development. In the first year, as they attend APEX EXPO, we require them to attend professional development courses and they have to attend standards committee meetings. They have to attend a series of other receptions and events. They have to acknowledge that they've attended all of these things. We ask them to keep notes. They do a report at the end of the event that shows us what they've done. The fun part is we ask them to take selfies when they meet individuals. We may send them off to meet someone, or a person that meets a certain set of criteria. We ask them to take a selfie and show us they've met the person and started to network and have a conversation. Then it's up to the mentor to follow up on activities for the remainder of that year.

Jaster: One of the things we have them do is go to the show floor. They have to meet with a number of exhibitors, because we want them

to get down on the show floor and see all that equipment and talk to some of the vendors on the show floor. It's really an opportunity for them to start networking and understanding the benefit of being at IPC APEX EXPO and getting the most out of it, because we really encourage them to do all the activities that are available to them. They basically get a one-of-a-kind opportunity for three years and we encourage them to take as many of the classes as they can, and to go to as many of the activities as possible, so that they can not only learn, but network and really get a full feeling of what the show and conference is all about.

Goldman: The commitment on the part of their company, presuming they're from a company, or university, is they have to get themselves to the meetings, to the show, and then IPC sponsors them for meetings and workshops. Is that correct?

Rowe: This is true for companies, yes. The commitment from the company is they have to get the emerging engineer to the show and sponsor their travel.

Goldman: I know there are a lot of workshops offered. Is there a requirement as to how many they should take each time, or is that open?

Jaster: The first year we said they have to take two classes.

Rowe: Then the second year we required one. We're now preparing our third-year activities. We'll be working on that. This will be our first group to reach three years.

Goldman: After this you'll see how well the first two participants, or emerging engineers, pick up on their own for next year.

Rowe: This is true. What we have noticed, to Nancy's point, is that one of our two emerging engineers has taken on a general vice chair position.



IPC's emerging engineers and their mentors.

See us at
DesignCon 2018
BOOTH 421

Don't Let Your Temperatures Rise



Let ROGERS' Thermal Management Solutions *Keep You Cool*

COOLSPAN® TECA Film • 92ML™ StaCool™ Laminates • ML Series™ Laminates & Prepregs

Heat can be damaging, especially when it is not managed. That's why Rogers Corporation invested so much time and energy into creating an array of material-based thermal management solutions to keep heat rise to a minimum in printed circuits. From automotive circuits to LED modules to power supplies, ML Series laminates and prepregs effectively conduct heat away from the source, while COOLSPAN thermally & electrically conductive adhesive (TECA) materials enhance the thermal management of new and existing designs. And for that extra cooling edge, 92ML StaCool laminates feature a thermally conductive metal bottom plate to enhance the heat dissipation.

Product	Thickness	Thermal Conductivity (Z-Axis), W/mK	Thermal Impedance, C-cm ² /W	Tg, C	CTE (Z-Axis), ppm/C		Dk, 1MHz	Df, 1MHz	Breakdown Voltage, kVAC	Flammability
					<Tg	>Tg				
92ML	8mils	2.0	0.52	160	22	175	5.2	0.013	>50	HFV-0

Don't let your temperatures rise. Use Rogers' thermal management solutions.



Advanced Connectivity Solutions

www.rogerscorp.com/acs

USA - AZ, tel. +1 480-961-1382
EUROPE - BELGIUM, tel. +32 9 235 3611



Jaster: Actually, two emerging engineers have become vice chairs.

Goldman: Fantastic. So they are delving into it. We all know how you can get really interested in this industry. Many of us kind of fell into it by chance, so it's nice that now we're making a concerted effort to bring people into the industry and not letting it happen just by chance.

Jaster: The nice thing is, because they do have the mentors, it's not like we're just saying, 'Here you go,' and they get overwhelmed by the size of APEX EXPO. They are getting some encouragement; they're getting direction from their mentors. I recall the first time I went to APEX EXPO—and I already had several years under my belt—it was almost overwhelming with the amount of choices of classes, technical sessions, and the show floor. Having somebody to help mentor them and help get them through that process and find the most benefit for them is very helpful. We owe a big thanks to our mentors for stepping up and doing that, as well.

Rowe: I second that. We have seen our mentors and our emerging engineers interacting off in a corner, or looking at the directory trying to

determine where they were going. It is real-time event. It's not a mentor saying, 'I'm here to help you and you come find me.' The mentors are reaching out to the emerging engineers and really guiding them through those activities.

Goldman: They volunteered to be a mentor and so they've got a real interest, and that's good to hear.

Rowe: They've taken it to heart.

Jaster: What was really interesting last year, our second year, was watching the emerging engineers bond as well. The second-year ones kind of took the first-year engineers under their wings and tried to help them along. To me it's just been an overwhelming success at how well the folks that are involved in the program are enjoying it and taking advantage of all the opportunities that they have.

Goldman: I take it you expect to continue to expand the program?

Jaster: We do.

Rowe: As we mentioned, we have slots open for this year and we have a number of applicants. The deadline was December 15, for the 2018 class. I know that we have some individuals who've expressed interest and we're just waiting at this point in time for their paperwork to come in. We do have four that have already sent their applications in.

If someone applies, we don't automatically accept them into the program. We review the applications. We also have had individuals apply and asked to be waitlisted, just like you have a university situation with delayed admission. We've had a situation already where we were able to accommodate the individual because he couldn't attend the first year. He said, 'I'm interested in this program, I just can't come to APEX EXPO,' so we delayed his start until the following year. We do try to ac-



commodate when we can, because we understand that this is a volunteer effort that their companies are allowing them to do.

Goldman: What feeling do the companies have regarding this?

Rowe: From my perspective, I don't think we'd have companies coming back and offering the second individual for the three-year program. We do have a company who has said, 'We have someone in their third year, and we'd like to have another person start this year.' We've had interest from companies that have taken the program to heart. Nancy and I talked about this just recently. They have embraced the idea of introducing these individuals to this activity. I've had feedback in another conversation from one of our mentors saying that the program has really helped the emerging engineer in that company to take on a bigger role. It's recognizing within the company that this is something that they've been selected to do and it was a choice, not only by their company, but by IPC. This is an opportunity to embrace for their career. This is my perspective from an assembly point of view. Nancy, I know you've had similar conversations with your design groups, correct?

Jaster: Yes. Again, the companies are really enthused to have people in this program. Our current emerging engineer, I don't think he's going to have any trouble whatsoever getting a job, because some of our mentor companies have already expressed an interest in him. It's giving him an opportunity to do things that he wouldn't have had the opportunity to do had this program not been there. He's already getting involved in industry and working on projects because he is an emerging engineer.

Goldman: Now, you've almost got a full slate for next year. How do people find out about this?

Rowe: Our marketing group has put out flyers

on the program at various IPC events. We have posters that we post at our major events. We've also used tabletop tents in our standards committee meetings. We've done some visual information for them. We also have a webpage^[1] on the IPC website.

Jaster: There's also usually a full page in our show directory as well.

Goldman: So if somebody doesn't go to the show or a standards committee meeting they might not find out about it? How does that work for university students? Just curious.

Rowe: We have spoken about the emerging engineer program at IPC Day and at some of the events on university campuses that we have attended in the past couple years.

Jaster: If you see me at any trade show, you know that I'm pretty blunt and ask young-looking people how long they have been in the industry. Then, I explain what the emerging engineer program is. I think some people wish I'd go away, but I'm out there talking all the time. I was at an event at PCB Carolina, at





Hall of Famers have pins, President's Award winners get pins, and they're a certain size. The emerging engineer pin is much larger and the mentor pin is unique as well. They are a pewter color, rather than gold. Each person is presented with one when they join the program, which they wear when participating in their events so that they can be identified.

Zinski: Are there any more specific requirements for people who are considering applying, other than being in the industry?

North Carolina State, and there were a lot of students there. I definitely brought it up to all the students there. We're trying our best to get to the student community as well.

Goldman: Is there some place where you list the emerging engineers and their mentors, so that when people see them at the meetings and so forth the rest of us can speak to them?

Jaster: We do make them show up at the breakfast for the keynote speaker. Certain lunches we make sure we have them stand up and they get introduced along with their mentors. Wednesday evening, we have a meet-and-greet with the emerging engineers at APEX. That is one of the activities they are going to be highly encouraged to attend, so they can meet other committee members, or other IPC members. Again, they really bonded as a group, so there's no problem getting them together for opportunities like that. They like each other, which is a good thing.

Rowe: We've also put their photos on our Emerging Engineer program web page^[1]. We don't have their names, but we do have their pictures that were taken at APEX EXPO 2017. We have special badge ribbons for them when they attend a meeting. Each emerging engineer gets a very unique, large pin. Patty, as you're aware, the TAEC members have pins, the

Rowe: We'd like for them to be interested in standards development, although we understand and we accept that at this stage in their career they may not understand what that means. This is a program for them to learn what IPC offers and an opportunity for them to be paired with someone who has been in the industry. Beyond being early in their career and having an interest in the electronics association or electronics in general, there aren't a whole lot of criteria that say they have to study this or that or whatever. Nothing like that.

Jaster: What's really been nice is we have folks that are more on the design side. We have other folks more on the manufacturing side and those who are interested more in the process-related type of standards rather than assembly standards. We've been lucky that we've gotten a nice array of people interested, not just all from one area.

Goldman: That's another good thing. Okay, I think we have covered just about everything here. Thanks so much for your time.

Rowe: Thank you very much. PCB007

Reference

1. IPC Emerging Engineer Program.

Excellon

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



COBRA II

Hybrid laser system



689

*6-station precision drilling
and routing system*



HS-1L DS

*Single-station, dual spindle
high-speed system*



136L

High accuracy and speed



154L

Large panel applications



HS-2L

2-station, high-speed



129

Single-station precision system

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



What to Expect at IPC APEX EXPO 2018: EXPO Veteran Alicia Balonek Shares

Alicia Balonek has seen it all. IPC's senior director of trade shows and events joined IPC during the dot-com bubble, and helped launch the first IPC APEX EXPO. Editors Andy Shaughnessy and Patty Goldman spoke with Alicia about IPC APEX EXPO 2018, what attendees can expect, and the organization's continuing efforts to attract talented young people to this industry.

Andy Shaughnessy: Alicia, I didn't realize you've been doing this with IPC for 18 years. I'm sure you've seen a lot through the years—including substantial changes.

Alicia Balonek: Well, that's true. I started with IPC in 1999 and I was part of the launch of APEX in 2000, so this show is very dear to me and it was a great opportunity to be involved with a launch show. There's such a connection to the show, we've certainly experienced our fair share of ups and downs but for the most part it's been an extremely enjoyable experience through the years. There have been a lot of changes in the industry, especially on the board side, particularly in 2004 when IPC Printed Circuits Expo, a show produced by IPC since 1994, was co-located with APEX and IPC APEX EXPO was formed.

Every show is a new experience and we just seem to keep learning from that, and we do it for the industry. This is the largest event in North America for electronics manufacturing and it has been since its inception. Everything is under one roof, from one end of the manufacturing process to the very end of the process, and we're proud to be able to bring the industry together for this important event.



Alicia Balonek

Shaughnessy: We're glad it's not in Anaheim anymore (laughing).

Balonek: Well, for a show this size, especially with the extensive electrical and plumbing requirements, there aren't many facilities throughout the country that can handle this event, especially with the long move-in time. We have almost two million pounds of freight on the show floor. It's a heavy equipment show, so not only does it take time to get that freight onto the show floor, we also must make sure that we're giving the exhibitors ample time to calibrate the machinery and their assembly lines so they're ready before the show begins.

Shaughnessy: I think everyone really likes San Diego. It's hard to have a bad time here.

Balonek: Especially when you're coming from the Midwest or the East Coast in February. Everybody enjoys that warm weather and it is a great facility. I've been in this industry for a long time and I've worked in many different convention centers, and we have great staff from the San Diego Convention Center working with us. I couldn't ask for a better team. They look forward to our show every year.

Patty Goldman: So what will be happening this year?

Balonek: Well, it's not necessarily new, but a favorite of the event, is the show floor reception on Tuesday evening which is a great gathering place for attendees to network with the exhibitors. We're introducing "Passport to Prizes" this year and we'll be giving away an iPad mini, Beats



headphones, Google Home, and lots of other useful and high-tech prizes. When attendees register they'll be given a little passport card which will have the exhibitor sponsor's booth number and name on it. They have to go to those specific booths throughout the show to get stickers from them; on Thursday, they must drop off the card at the IPC booth, where we'll announce the winners that afternoon.

Goldman: That's something new that should be fun.

Balonek: Especially with the younger audience that we're trying to attract to APEX EXPO. Of course, they come for the education, but there should be a fun aspect of it too. They've asked for more networking opportunities and just fun things to do on the show floor.

Shaughnessy: People like it when they can get a beer together at the show.

Balonek: Exactly. Our keynote speaker this year is Jared Cohen, the founder of Google Ideas and now he's with Jigsaw, the Alphabet arm. We're excited to bring him to the show, and he's equally excited to speak to this audience. I think his quote was, "Wow. This is perfect for me," when the invitation came across his desk.

Goldman: A nice technical audience.

Balonek: Yeah, and that's the one thing with the keynote speakers that we do try to recruit for this event—they love speaking to this audience because they can speak at the same level as them. For lack of a better term, they don't have to "dumb it down" for us. We get it. Mr. Cohen will present, "Game Changers: Technology and the Next Big Disruptions."

Shaughnessy: Yeah, it was great having Mayim Bialik last year. She was great discussing engineers versus scientists. That was funny.

Balonek: It was interesting the questions they

were asking her. I always find that fascinating to see what kind of questions there are. I think my absolute favorite keynote speaker, though, was William Shatner.

Shaughnessy: Hard to beat that.

Balonek: I'm still trying.

Goldman: You've had some pretty good ones.

Balonek: Thank you. It's a hard industry to tap into. It's a very niche industry, so it's a long process of trying to figure out who would be the best fit. So, if you have any ideas, I'm always open to them.

Shaughnessy: I think it's good how you rotate. Instead of having all futurists or something, you kind of rotate and you even had a super famous guy like Shatner, but then the next year was Michio Kaku.



Balonek: That's an important thing when planning an event. You've got to keep it fresh every year so people keep coming back. One new initiative that we are doing this year is a STEM program for high school students, and that will take place on Thursday. We invited two high schools from Southern California that are involved in STEM programs. There's been a lot of talk in this industry about how to attract the younger employees for the industry. It's great to recruit at the college level, but



there's such an initiative for STEM now that we really need to start reaching out to people at the high school level before they even enter college so they can consider this industry as a career choice.

David Bergman, our vice president of standards and training is doing a cool presentation, "How to Make a Circuit Board out of Peanut Butter," for the students and then we'll take them on the show floor. Hopefully, after they see the peanut butter presentation, they'll see the equipment and the technology that makes the circuit boards and it will all come together for a better understanding of the industry. Then we have a lunch scheduled with a panel discussion with some industry leaders so they can ask questions about our industry. We hope that it will be well-received by the students and that we'll be able to recruit the next generation for this industry.

Shaughnessy: That's one of the things we constantly see: People are retiring. For some reason, especially in PCB design, there was a big flood of designers joining the industry in the '70s and '80s. We're seeing a few young people coming in, though.

Balonek: And that's good but we need to do more and that's where STEM comes in. STEM education is so important and it's nice to see schools offering these types of programs. My daughter is in middle school now and they refer to her program as STEAM in her school, she's involved in the program and goes to classes three times a

week. They have afterschool workshops too, so it's a really good to start at even a younger level to start tapping into where our future engineers are coming from.

Goldman: Is your daughter finding the program interesting and intriguing?

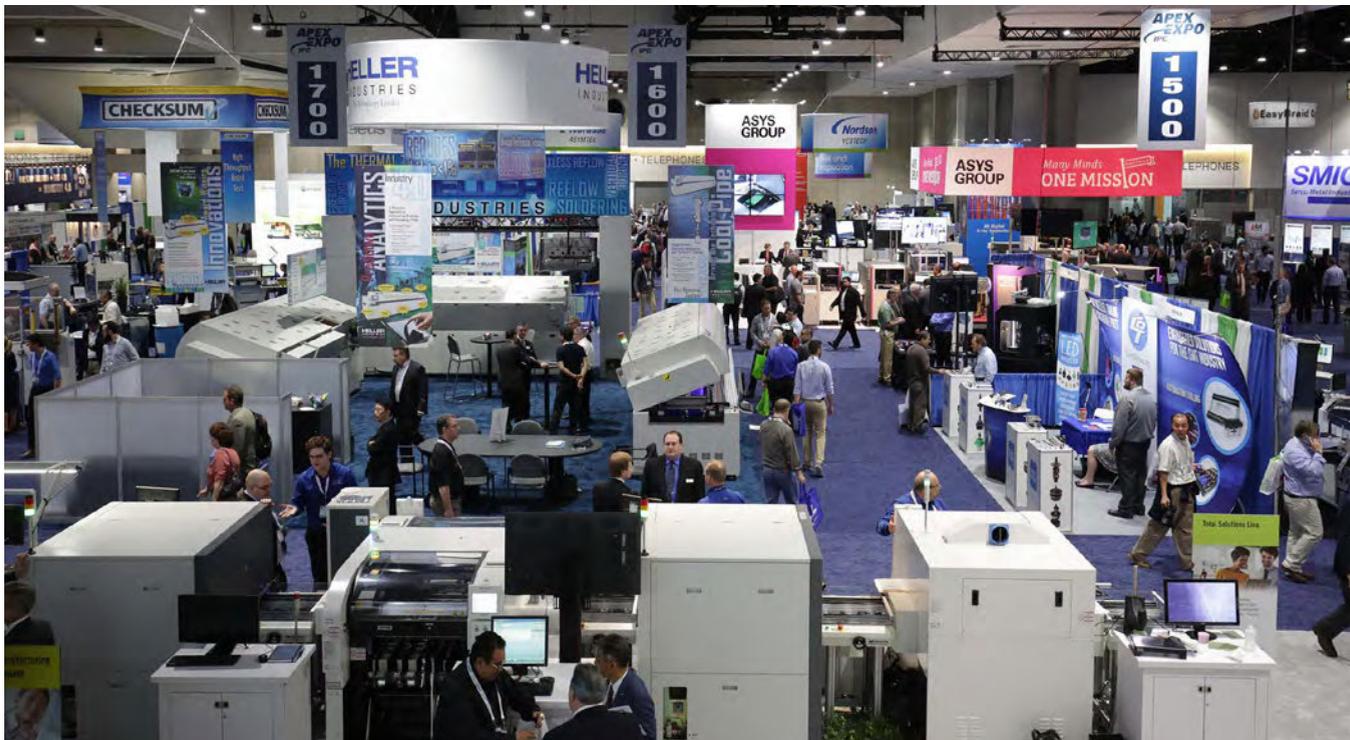
Balonek: Oh, she absolutely loves it, and especially the part that includes making slime. I don't know if you guys have young kids, but they're making it all the time. I cannot tell you how many gallons of Elmer's Glue I have in my house right now. But even with these small experiments, they're exposing themselves to science which is beneficial for kids. But back to the STEM program at APEX EXPO, we're able to provide this program through sponsorships and I'd like to take a minute to recognize, ASM Assembly Systems, Mycronic Inc., Nordson and Panasonic Factory Solutions Company of America for sponsorships. In exchange, they'll be invited to the panel discussion and the students will be visiting their booths during a special tour of the show floor. We'll also be making a donation in their names to the STEM program for the participating schools.

Goldman: That sounds like a fantastic program. I guess the important thing is to make sure it's not a one-time thing, right?

Balonek: Right. It's a pilot program this year and we hope to be able to offer it again next year and maybe even doing things in different cities. I know a lot of our members have production plants within their facilities so we could do something in their cities if they don't have the time to coordinate a program themselves.

Goldman: We recently had our newest team members visit a PCB facility—they are editors, not really PCB people. They were absolutely astounded at what was involved in making the circuit boards, and of course they related it to





their cellphones: “Oh my gosh. Who knew all this stuff had to happen to make one?”

Balonek: Exactly. I had no idea before I joined IPC.

Shaughnessy: Where were you before you came to IPC, Alicia?

Balonek: I worked at a financial association in the banking industry, which was cool, though, because that was in the ‘90s, so you saw a lot of changes in banking with the ATM machines coming out, retail banking, gas stations and grocery stores. It was an exciting time there. It was right around the dotcom era too.

Shaughnessy: That was the good time.

Goldman: Not as exciting as circuit boards, though, right?

Balonek: You know what? The longer I’m at IPC, the more exciting it gets. I finally get it. It took me a long time to grasp this industry. It’s exciting to see how engaged our members are too. That’s what I like most about working at IPC.

Shaughnessy: Everybody you talk to in the industry will tell you about their job. They’ll tell you how they love it, how they got into it. Everybody has some crazy path that led them to this industry.

Balonek: It’s funny. Engineers are typically introverts until you start asking them about their work in this industry.

Goldman: Alicia, what else should our readers know about this year’s show?

Balonek: I’d like to just share a few facts with you. Just the sheer buying power of our attendees that come to the show—many of them wait until they visit IPC APEX EXPO before they make their purchasing decisions for the year. In fact, through our attendee surveys, we know that 37% of our attendees indicate that they will be making a purchase within six months of the show. Then about 28% of our attendees actually make the final buying decisions for their companies, and 55% recommend or influence those buying decisions. We have the key decision-makers coming to this event.



Goldman: That's good. How about the size this year? How's that shaping up comparatively?

Balonek: We're expecting about 450 exhibitors in about 150,000 net square feet of space, and right now, the needle is pointing into the direction of selling out the show. We still have a lot to do, but that is our goal. As far as attendance-wise, we'll have total visitors of about 9,000, which encompasses about 4,600 attendees and about 4,400 booth personnel.

Shaughnessy: That's a lot of people. You do a good job just herding the cats and putting it all together.

Balonek: It's fun. We work so hard planning all year long, and, when I see it come together, I cry at every ribbon-cutting. I'm just so happy that all our plans went off without a hitch, although there are sometimes little bumps in the road. It's very fulfilling to me.

Goldman: I bet. Your baby gets born.

Balonek: Exactly.

Shaughnessy: I liked having the guitar players during the ribbon-cutting in Vegas. That was nice.

Balonek: Yeah, they were fun. My husband and I were on a trip in Vegas and we were at the Irish bar in Mandalay Bay, and that's how I found them. They were a lot of fun.

Goldman: Is that how you come up with your ideas, hmm?

Balonek: It's just amazing where you come up with ideas and what you're doing when you come up with those ideas. I also want to mention the First-Timers' Welcome Reception. We normally have a breakfast on Tuesday morning for them, but this year we're having a reception on Monday evening for the first-timers.

Goldman: You expect that to be a better time slot?

Balonek: I think it's a better time. Nobody really wants to get up for a 7:00 am breakfast meeting. And we will be holding the Women in Electronics reception on Wednesday evening.

Goldman: You have something every evening. Are those considered part of the show? Or are those separate?

Balonek: Yes. Those are free networking events and included in the exhibit hall only registration option.

Goldman: Well, we are looking forward to it. Especially after winter, we're always looking forward to San Diego. Thanks for talking with us today, Alicia.

Balonek: Thank you. **PCB007**





IPC APEX EXPO

App is Where It's At

In an interview with I-Connect007, IPC Exhibits Manager Kim DiCianni discusses the IPC APEX EXPO 2018 app and how this powerful tool will keep attendees on track. She also highlights its usefulness for exhibitors.



Kim DiCianni

Stephen Las Marias: Kim, can you please tell us more about yourself and your role at IPC?

Kim DiCianni: I am the exhibits manager at IPC. I handle all logistics, sales, operations, overall exhibitor tasks for the event as well as managing registration, the agenda planner, the app, and most things that have to do with exhibitors and attendees for IPC APEX EXPO. I've been with IPC for 12 years, and I've always worked on the show, so I've been growing with the event as IPC APEX EXPO evolves.

Las Marias: Please tell us about the app. When was it first created for the APEX show?

DiCianni: I started managing the APEX EXPO app in 2015. We created the app two years prior to that, but I don't know that it was as extensive or had the capabilities that it does now. It has come a long way from that first year.

Las Marias: How is the app helping the attendees?

DiCianni: The app provides everything that attendees could possibly want or need for the event, including being able to look up exhibitors by specific categories. If they're looking to focus on a specific category, not only can they

see what exhibitors are tied to that, they can see related tech conference and PD sessions, and any event related to something they're interested in. App users could filter for "adhesives," and it will tell them what exhibitors are related to it, and what sessions might be of interest to them.

Basically, what happens is when an attendee registers, they select their demographics. Their demographics then go into our online agenda planner, which feeds the app. It gives them suggestions of any exhibitor that would be of interest to them, any session we have, and attendees can add those things to their planner. If they add it to their schedule, they're able to see what time something takes place or what exhibitor they might want to see. They can browse exhibitors by name and product categories that the exhibitor selected.

We have "What's on Now?" which shows anything that's going on at that moment or coming up soon. They can look at any speaker's profile. They can see a list of attendees, or someone that might be of interest for them to connect with, and they can request a connection to that person. We have the maps of the show floor and the meeting rooms area. Users can see virtually anything that we offer at the event right in the palm of their hand, and it's always the most up-to-date information.

We have the show directory on site as well, but, as you know, once something goes to print, if something changes, it's no longer up to date. The app is always up to date. If something gets canceled at the last minute, we can do push notifications letting people know, or if



it was replaced by something or if the speaker changes. For the Tuesday morning keynote at 9:00 a.m., we can send a push notification at 8:00 a.m. as a reminder.

Jonathan Zinski: I was looking at your app from last year, and it was very extensive. I liked how you had links to check out the local area and find restaurants.

DiCianni: Many people aren't familiar with San Diego, so it helps. The app has social media links so they can look at Facebook, LinkedIn, or anything IPC is putting out during and after the show. The app we have now is called the multi-year. We use Core-apps and have since 2015, so if you already have the app on your phone from a previous year, it'll automatically add the new show, but it keeps the apps from the previous show also. So, if you made notes last year on something, you can go back, look at your notes from last year, and see if it is going on again. You're able to go back and compare the app. It never goes away.

Las Marias: How popular was the app last year and the years before, in terms of downloads, and did the attendees find it useful? Do you have some sort of feedback mechanism that will gauge that?

DiCianni: Last year, about 20% of our attendees downloaded the app. It has increased each year since 2015, in terms of downloads and usage. Comparing 2016 to 2017, the number of people using speaker profiles, sessions, and exhibitors is growing as well as the overall use. I think every year we're seeing an increase in usage.

Zinski: Do you use analytics to see what features are being used the most and which aren't being explored as much?

DiCianni: I would say probably our largest hits are on the session views, exhibitor views and speaker views—they're all very high.

Zinski: What means are you using to advertise it? If I had seen it last year, I would have used it.

DiCianni: On the printed show directory that's given to all registrants the QR code is right on the front page of the directory. We had 8-1/2 x 11 signs across the registration counter with the QR code. It had a picture of a tablet, a phone with the logo and then the QR code to download it right there. On most of our directional signage throughout the hall upstairs in the meeting area we also had the QR code. I know we promoted it to exhibitors in newsletters, and it was promoted within the conference brochure last year that was sent to attendees in December.

Zinski: Is there a way in the app for users to leave feedback about features they'd like to see improved or that they'd like to see added?

DiCianni: Currently not in the app itself, we do not. We do send exhibitor and attendee surveys at the end of each show. I know on both the exhibitor and attendee surveys we do touch on usefulness of not only the app itself but the agenda planner and ask survey respondents to provide their ideas for suggested improvements.

Las Marias: Does the data on usage or functions and features being used by attendees help you decide what other features to include in the show next year?

DiCianni: Absolutely. For example, the app is confirming that people like to look at new products. We know speakers at a session might be important or the session itself





or certain products or new products. It helps when we see trends, what's important to attendees, what they're looking for, etc.

Zinski: You said the app is continually updating for each year, so if someone has last year's, and is interested, they could download it right now and it would update for the show?

DiCianni: The 2018 app is still being created and it has to go through the approval process from Apple, so that's where we're at right now is putting in the new graphics and getting it prepared for 2018. Before we can actually push it live, it has to go through an approval process. If you were to download it right now, you would be able to see '17, '16 and '15, and then as soon as '18 becomes available, it would come into the app as an update. It would tell you that you have an update for the app, and then '18 would become available.

Once a person registers, their information comes from our registration company, and it populates into the agenda planner. Then when the app goes live, basically everything in that agenda planner, all our sessions, everything comes into the app. We're in the process right now of actually finalizing the agenda planner itself. It should be done in the next week.

Zinski: I'm on Android, and I was looking on Google app store, and I saw two of your apps. One of them looked pretty old, and the other one was the recent one.

DiCianni: Yeah, prior to 2015, we used another company for the app, so that's probably the other one you're seeing, because I don't think they ever go away. We have requested for it to be removed, so I'll have to check that out. Another thing I wanted to mention is the operating platforms, because I know people worry about Apple having so many operating, the app is always up to date and will work with the operating systems as they update. So, there's never going to be an issue with that.



Zinski: That's good to know. It's frustrating when a phone pushes an update. Android was pushing out their latest operating system, and half my apps are just crashing because they're not ready.

DiCianni: Exactly, and that's something that is very important to us, and I have confirmed repeatedly that, no matter what updates these carriers are doing or what platform they're using, it will work with it.

Las Marias: Kim, is there a benefit to the exhibitors for using the app?

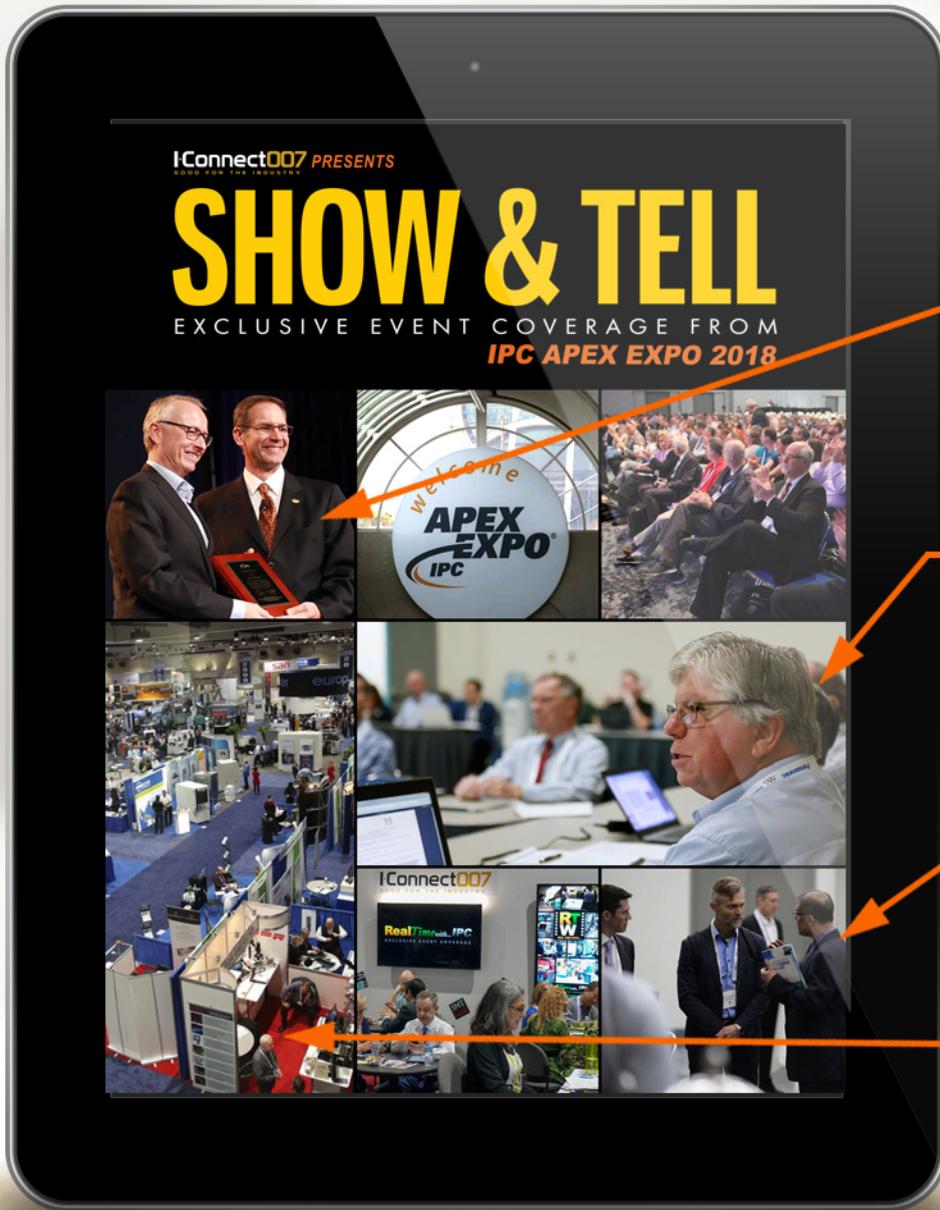
DiCianni: Yes, we offer a sponsorship opportunity for them. On last year's, we just had an IPC banner, but this year, we are offering that to exhibitors, and it would lead to their page. It could be a great promotional tool to get themselves out there.

Las Marias: Right, good exposure. Hopefully doing this preview will inform a lot of people way before the event, and come the actual event, they will know that they can download the app. Thank you very much for your time.

DiCianni: Thank you so much. **PCB007**

PROUDLY INTRODUCING OUR PREMIER ISSUE

IPC APEX EXPO Show Coverage Magazine



Special coverage of the IPC Awards and Hall of Fame Inductees

Exclusive attendee and expert Q&A with designers, fabricators, and assemblers

Our columnists put the show into perspective

Our cameras take you to the show floor and beyond

[Register Now](#)



MilAero Highlights

Ventec Proudly Supports 'Skate for the 22' Foundation ▶

Ventec International Group is proud to support the "Skate for the 22" Eagles vs. Boston Bruins Alumni hockey game on December 17 at the Edge Sports Center in Bedford, Massachusetts.

DARPA's Software Defined Radio Hackfest Creates Solutions for Spectrum Challenges ▶

The DARPA Bay Area Software Defined Radio (SDR) Hackfest came to a close on Friday, November 17 at the NASA Ames Conference Center in Moffett Field, California.

Global Defense Spending Forecast to Reach \$1.7T in 2018 ▶

Global defense expenditure is set to increase again in 2018 to reach its highest level since the end of the Cold War, according to the annual Jane's Defense Budgets Report released today by IHS Markit.

NASA to Test Advanced Space Wireless Network and Device for Returning Small Spacecraft to Earth ▶

NASA launched the Technology Educational Satellite, or TechEdSat-6, to the International Space Station on Orbital ATK's Cygnus spacecraft from NASA's Wallops Flight Facility in Virginia on November 12.

DARPA Digging for Ideas to Revolutionize Subterranean Mapping and Navigation ▶

Request for Information seeks concepts for novel systems and component technologies to disruptively augment military and civilian operations underground.

Lockheed Martin and NEC to Enhance Satellites, Space Travel with Artificial Intelligence ▶

Lockheed Martin and NEC Corporation today announced that Lockheed Martin will use NEC's System Invariant Analysis Technology (SIAT) in the space domain.

Eltek Reports Revenues of \$7.7 Million in Q3 of 2017 ▶

Revenues for the third quarter of 2017 were \$7.7 million, compared to \$9.3 million in the third quarter of 2016 (\$8.4 million excluding Kubatronik).

Drone Race: Human Versus Artificial Intelligence ▶

Drone racing is a high-speed sport demanding instinctive reflexes, but humans won't be the only competitors for long.

European Satellite Confirms General Relativity with Unprecedented Precision ▶

A space mission to test how objects fall in a vacuum has released its first results, providing an improved foundation for Einstein's famous theory.



ALL THE FUN OF THE FAIR: Behind the Scenes at productronica 2017

Ladle on Manufacturing, a column by Mark Ladle

VIKING TEST LTD.

The productronica show in Munich is the main marketing event that my company attends. It looks great when everyone gets there on opening day, but there is quite a lot that goes on behind the scenes to make it all happen.

Planning what we are going to display starts a few months in advance. Our policy is normally to show equipment that has been sold to our customers. The plus point for the customer is that we can usually offer a special price in return for their help. In return we get to show very current equipment on our stand.

The logistics of getting everything to the show also takes a lot of organisation. For Viking, we normally have a full 40-foot trailer of equipment to ship from the UK to Germany. It is a bit like conducting an orchestra—coordinating the production of equipment from several suppliers and timing the shipping of

machines to arrive at our office in time to check and prepare them for the show, repack, and load them to the trailer. At the same time, I have to make sure we have booked enough power supply and compressed air service to allow us to run the machines and make a dynamic display.

We use exhibition specialists to transport the equipment and set up the fabric of the stand, which is a huge help. It really pays to use companies who have good contacts at the show site to make sure you can get good access to services when you need them, such as forklift trucks. There is nothing worse than standing around for hours in the cold waiting for a forklift to show up only to find it is too small to lift your machine.

Getting to Munich from the UK with tools and equipment is a long day. Leaving home at 5:00 a.m. and driving a van full of kit takes



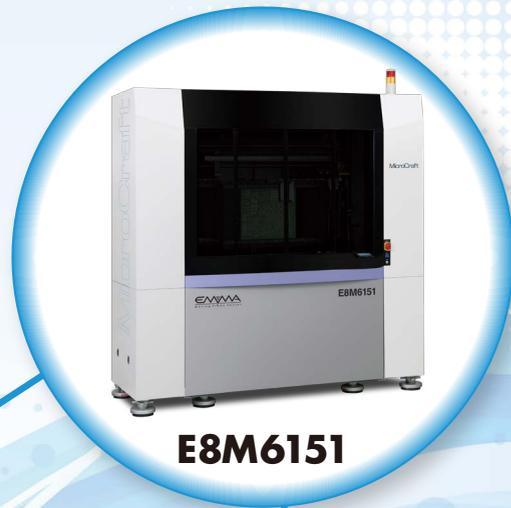
NEED FASTER THROUGHPUT?

MicroCraft's Latest Solutions for Quick Turn Shops



CPT6151

Both **solder resist** and **legend**
inks are printed with 1 machine.



E8M6151

3x faster than previous models



SC6151

10x faster final bake

pretty much the whole day. Every time I make this trip, it always seems that Munich is a little further away than I remember. This year we rolled into Munich around 10 pm ready to crawl into bed for a few hours' rest.

Set-up, Day 1

When visitors come to productronica, I am sure they don't realise what a huge mess it looks like during the set-up period. It is sometimes difficult to get up the aisles to your stand. There are workmen everywhere doing their best to get their part of the job completed as quickly as possible. Packing materials and all kinds of other debris seem to end up everywhere and the access gets more and more restricted. This year we had some large wet process modules on stand, which needed a reasonable size forklift to get them off the lorry and into position. It makes the heart beat faster when you see your customer's etching module swinging around 5 meters up in the air to clear the ladders and pallets being used on the

adjacent stands. There is a huge sense of relief when everything has made it into position safely.

Our build this year took two long and hard days of machine assembly and connection. I was assisted this year for the first time by my 20-year old son, Ben. It is not always easy working with family, but I will say I was so pleased to have his youth and enthusiasm available to help get the job done. Young eyes and strong hands seem to make things happen twice as fast.

Now I must admit that at this point I am already more than a little tired but there is not much chance for a rest. Time to shave and freshen up in preparation for facing the customers. This is a different type of work.

The Show

For people who have been in the industry for a while it is a real chance to catch up with old friends. Before I was involved in the sales of equipment, I worked in circuit manufacture and I have a lot of friends from back then who are still involved in the supply of machines and materials; the show is a real opportunity to catch up. This year our stand was right next to the guys from MPK who were very hospitable and had excellent coffee. I don't get that much contact with drilling technology any more, but this was a chance to look at current best practice and what the industry currently needs. I really liked their drill design with a single spiral at the tip for extra rigidity changing to a double spiral part way up the shank to maintain swarf ejection. There is always something new (or at least new to me!).

There is a lovely feeling when you see a customer approaching down the aisles with a big smile and a hand held out in greeting. This is how equipment sales should be—when you see people several years later and they are still really happy with the work you have done for them. We saw a customer from Slovenia where Ben and I had installed a small etch machine a couple of years ago when Ben had just finished high school. That installation was a combination of a father-son bonding road trip as well as the experience of building the machine.





ELECTRA

**High Performance Coatings
for the Electronics Industry**

Soldermask for the Digital Era

www.electrapolymers.com



5 pm Friday

The show closes to customers but another long evening is just starting for us. Everything must be packed up, ready to load onto the transport home, which is booked for Saturday morning. The pressure is on, as what went together in two days must come back apart in less than one. Ben and I had plenty of help from the rest of the team on our stand but as the tasks become more technical the numbers dropped back until we were on our own again for the last few hours until the early hours of Saturday morning.

A few hours in bed and back to the show grounds to super-

visualise the loading of the machines. We were in the van and heading out of Munich by midday. It is a long journey home but there is a good feeling of a job well done and the potential for a lot of future business.

We arrived home in the south of the UK at 2:30 am Sunday morning. I would describe the sleep that night as deep. We managed a day off before having to unload and check the equipment back into our office.

Done for another two years! That is, apart from dealing with the inquiries from the show. It can take quite a while to develop specifications and quotations for a diverse range of applications.

One of the next appointments on my calendar is a visit to China for the HKPCA show. In comparison to Munich, at this show I can relax and enjoy. The pressure is on someone else's shoulders. Definitely "All the fun of the fair." **PCB007**



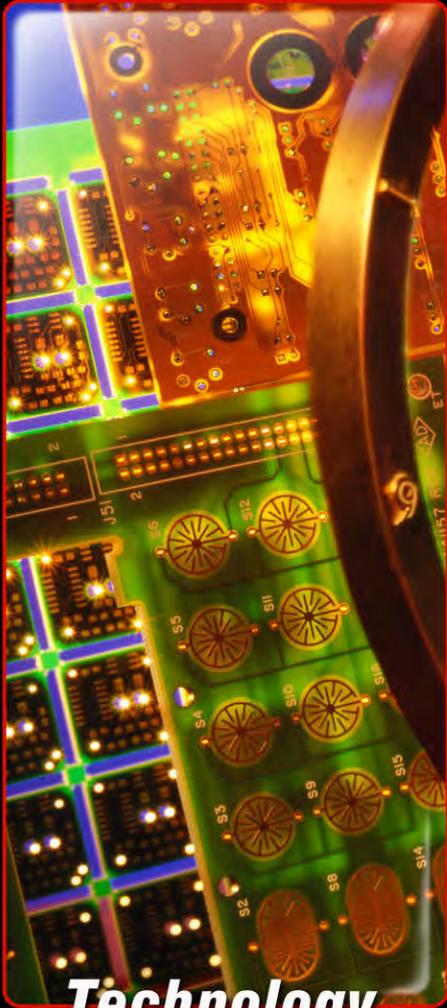
Marc Ladle is director at Viking Test Ltd. To read past columns or to contact Ladle, [click here](#).

What made it special for us was the wonderful hospitality of the customer. It is good to know the machine is working well for them and has made a positive difference to their business.

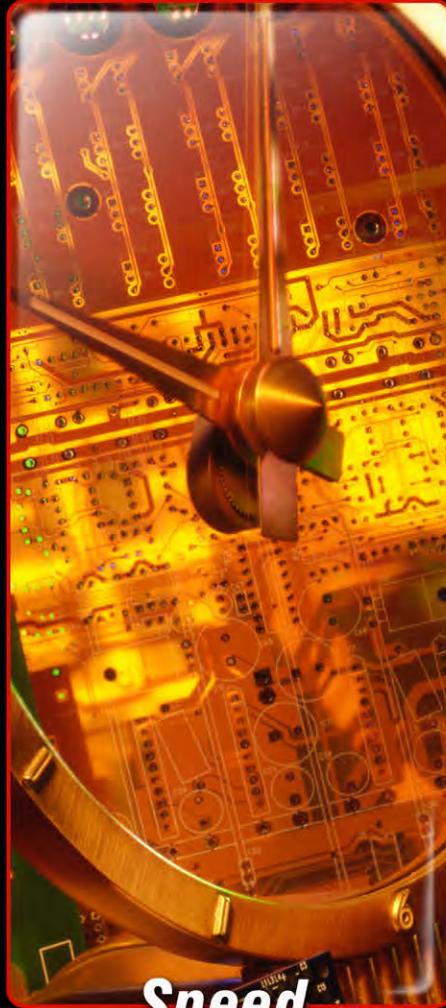
We managed a single night out in Munich (Wednesday) amongst the healthy throng at the Hofbrauhaus. It is always an entertaining evening. We bumped into a few customers and generally managed a little relaxation and some gentle business and teambuilding. For a lot of our customers, and competitors, productronica is the networking event of the year. The evenings are often just as important as the days and many of the real deals are struck after show hours.

By the time we have gotten to Friday, everyone is starting to run out of energy. But there is not much chance for a rest; the last few hours of the show were actually very busy for us. Quite a few new potential customers revisited our stand and double-checked technical information, which is always a good sign. According to the other exhibitors I spoke to, the show was busier this year with a lot of interesting enquiries. Perhaps things are looking a little more positive for European manufacturing than the news in the daily papers would sometimes have us believe.

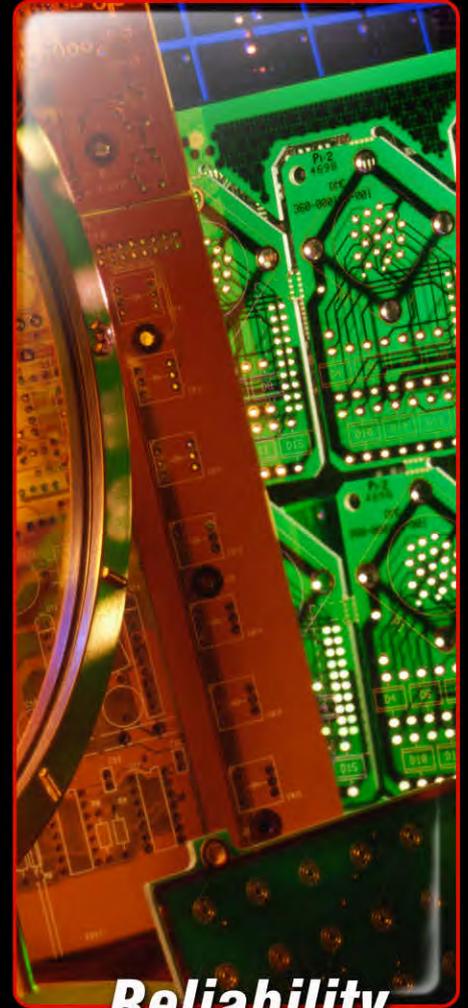
We Take the Time to do it Right
because you don't have the time to do it over.



Technology



Speed



Reliability



Prototron Circuits

High quality quick turn manufacturing, just another reason we are
America's Board Shop

Redmond Facility

15225 NE 95th Street, Redmond, WA 98052
Toll: 888.847.7686 Phone: 425.823.7000

Tucson Facility

3760 E. 43rd Place, Tucson, AZ 85713
Toll: 800.279.5572 Phone: 520.745.8515

CASE STUDY: Pits and Mouse Bite Issues, Part 2

Trouble in Your Tank, a column by Michael Carano

RBP CHEMICAL TECHNOLOGY

Introduction

In last month's column, I introduced a case study that centered on plating pits and mouse bites. There were three areas in the process that raised concern as to the potential root cause of the defect. Of course, as with the case in all troubleshooting situations, it is best to look at the problem with wide open eyes. Just because one is looking at an issue that is visible after copper plating, this should not mean that is the only place to look. And this case study illustrates that point quite clearly.

The Problem

Again, keep in mind that there seems to be two very different types of plating defects. One par-

ticular pit seems to be random, and that there is no pattern that can be detected (Figure 1). In this case, these pits can be seen practically anywhere on the board. In addition, the characteristic of this type of pit essentially is found to go down to the base metal. In Figure 1, the reader can easily see that the plated copper is evident around the pitted area. The pit itself can be described as irregular in shape. Obviously not the same shape as a pit caused by an air bubble.

There can be several possibilities here. One issue may relate to organic contamination of the plating solution itself. Or, is it possible that the primary photoresist was improperly exposed and that allowed resist materials to leach onto the copper surface? In general, interactions between the photoresist and plating process are quite subtle.

Resists have been associated with a variety of plating failures. These failures increase in severity as the technology shifts to higher circuit densities and smaller vias and pads. There are some reasonable clear ties between plating problems and photoresist, as in the case of resist development residues causing copper-to-copper peelers, or stripping residues causing ragged plated lines after etching. One should ask if the pre-plate cleaning is effectively cleaning the copper surface (the area that is exposed after developing) prior to the electrodeposition of copper.

Now, remember the fabricator is also dealing with another type of pit

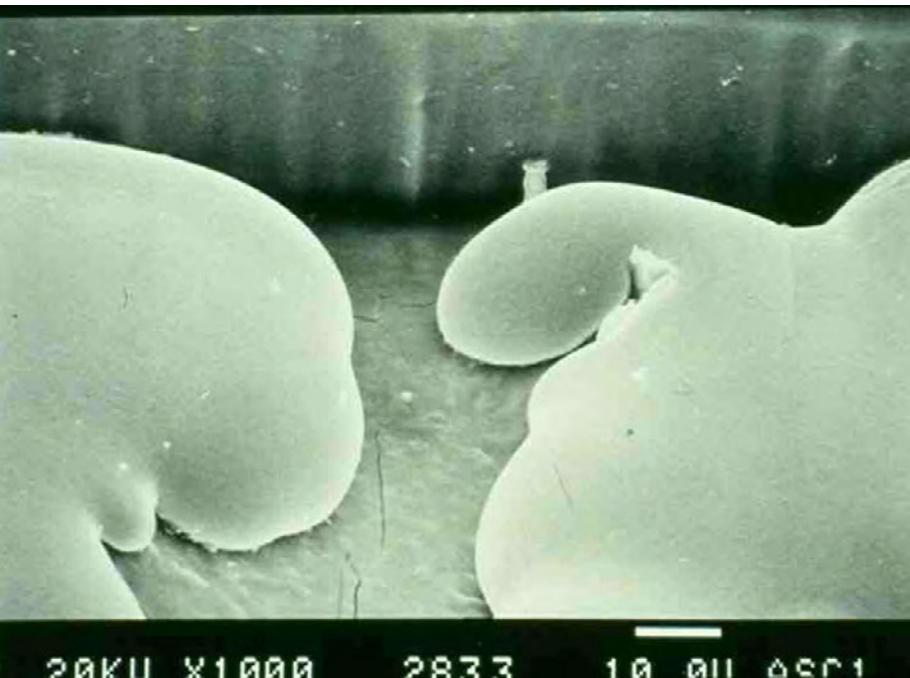


Figure 1: Pit down to base metal indicating residue inhibiting the electroplating of copper. Note the residue on the copper substrate surface which is most likely dry film and/or developer residues.



WET PROCESS LINE



Etchers



Scrubbers



Developers



PTH



Oxide Replacement

THIN CORE HANDLING • PC CONTROL • RELIABLE • LOW COST

CLICK TO VIEW OUR UCE WET PROCESS LINE



The leading European PCB Equipment and Parts Supplier

www.vikingtest.com
sales@vikingtest.com



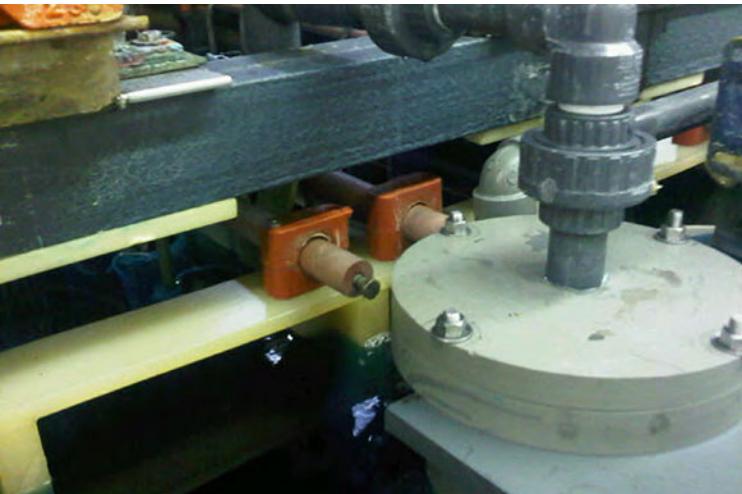


Figure 2: Solution filtration housing.

that is more accurately described as a mouse bite. This defect is seen at the resist sidewall/copper interface. These pits are more spherical in shape and do not always lead to the base metal.

An inspection of the copper plating cells provided some additional information that should be noted: All the copper plating cells in the facility utilize air sparger agitation. An observation by a member of the tech team indicated that small air or gas bubbles in the copper plating cells were a potential cause of the spherical pits along the edges of the traces and pads. Further, the team felt that the air agitation created very small air or gas bubbles that would lodge onto the resist sidewall leading to the spherical pits. The agitation system for these plating cells required further scrutiny.

To test the theory that air bubbles could be causing the defect, the fabricator sent panels to another fabricator for processing through their pattern plating line. The agitation for the copper cells was provided by eductors, not air spargers. (Eductors move the plating solution in a more uniform way and eliminate air bubbles.) After the panels were plated, inspectors noted that there was no evidence of pits or mouse bites along the resist/trace interface. However, there were still some random pits that indicated that residue on the base metal was inhibiting plating. This situation indicated two things: (1) air or gas bubbles at the fabricator were playing a role in the mouse bite de-

fects and (2) there was a residue or contamination that led to the irregularly shaped pits (the subject of next month's column).

Finally, another critical observation provided further insight to the mouse bite defect. Here one engineer noticed that plating solution was entering the filtration housing in two of the cells (Figure 2).

As this solution entered the housing, the air bubbles would become homogenized, so to speak, allowing the plating solution to become supersaturated with air bubbles. This situation allowed the bubbles to grow and eventually lodge onto the resist sidewall/trace interface^[1]. To prevent the air bubbles from entering the filtration housing, a system of baffles was installed. The baffles will prevent air bubbles from entering the filtration housing. Of course, a much wiser choice is to convert the agitation system to eductors.

Conclusion

The dominant cause of spherical or conical pits in copper plating is gas or air bubbles, which can be introduced into the plating solution from air spargers or through supersaturation of the plating solution with air bubbles. These bubbles grow on the copper traces at the photoresist sidewall, and thus inhibit plating. Some photoresists may contribute to air bubble (mouse bite) pits depending on the resist's wetting characteristics, degree of hydrophobicity, and surface imperfections within the resist itself. In Part 3 of this case study, the development process will be reviewed and any possible parameters that may contribute to the pitting defects. **PCB007**

References

1. "Reducing Copper Plating Pits in PWBs," R. A. Olson, *CircuitTree Magazine*, August 1991, pg. 30.



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



**THE RIGHT APPROACH
CONSULTING_{LLC}**

**I guarantee that you
will upgrade and simplify
your QMS in just 6 months.**

*In today's increasingly competitive market,
Quality Management is more important
than ever. I can help you upgrade to
ISO 9001: 2015 or AS9100 Rev D in six
months - guaranteed!*



**CLICK HERE TO LEARN MORE
ABOUT MY CERTIFICATION
GUARANTEE!**

TheRightApproachConsulting.com



Willy Wonka: The Lean Case Study

The Right Approach, a column by Steve Williams
THE RIGHT APPROACH CONSULTING LLC

Introduction

No matter where my travels take me, I hear a wide and limitless supply of excuses for why Lean will not work in “my” organization. One of my favorite ways of illustrating that Lean will indeed work anywhere is to take a Lean look at a very unlikely organization, Willy Wonka’s Chocolate Factory.

Why Willy Wonka

The inspiration for this case study came from one of my Lean Principles graduate students, who told me that while she was studying diligently one evening, her son was watching the video *Charlie and the Chocolate Factory*. She said, “Professor” (I love it when they call me professor!), “as I sat there listening to the underlying ideas behind the Chocolate Factory, I got distracted in my reading and realized I was watching a show that is formulated on the idea of creating a Lean factory.” As we discussed this in great detail, she presented a very compelling argument to support her position. So, that following weekend I purchased the DVD, and sat down with

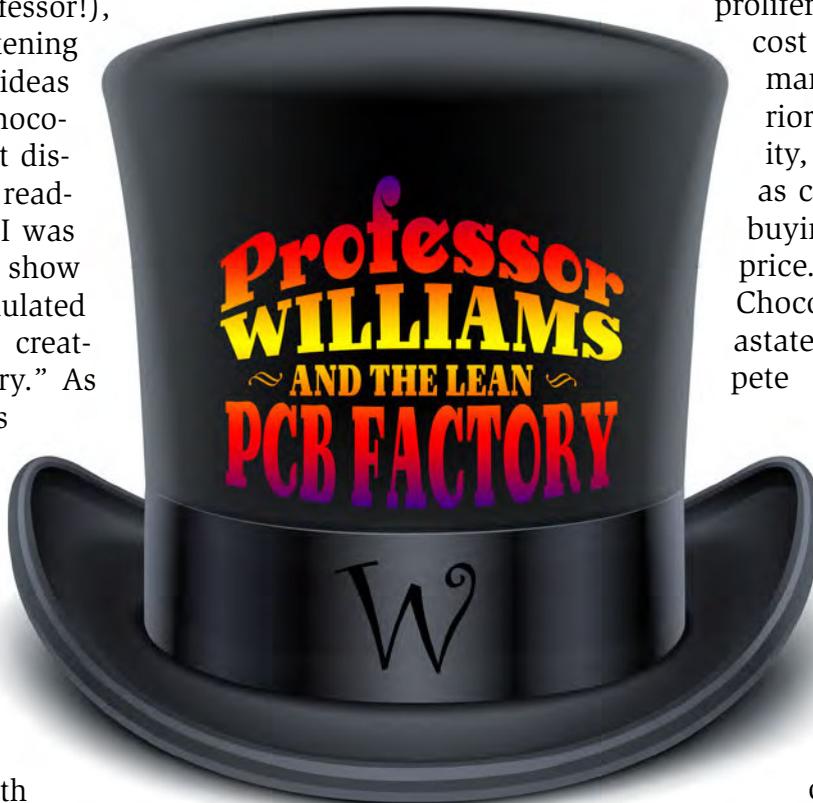
a bowl of popcorn, a cold Budweiser and my notepad and turned a critical Lean eye to Roald Dahl’s classic tale. What follows are the results of that session, which led to the development of a Lean case study that I now use both academically and professionally.

WILLY WONKA CASE STUDY

1 – The Need for Lean

Competition

The Willy Wonka Chocolate Factory was infiltrated by industrial spies trying to steal Wonka’s secret recipes and manufacturing technology. This espionage resulted in a proliferation of copycat low-cost products flooding the market, and while inferior to the Wonka quality, were quite successful as consumers made their buying decisions based on price. The Willy Wonka Chocolate Factory was devastated and could not compete with these low-cost candy bars, which resulted in the closure of the factory and loss of thousands of jobs, including Charlie Batch’s Grampa Joe. Grampa Joe was a lifelong employee of the Wonka factory



A New Beginning for PCB Fabrication

The Latest in AUTOMATION



Hakuto 630NP Series

Dry Film Laminator

Lamination Rolls (NO Hot Rolls)

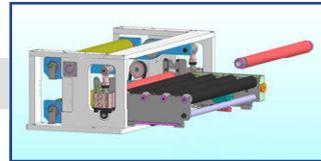
The NP Series Laminators are supplied with 4 standard EPDM (Acid Resistant) rolls which can be "removed and replaced in seconds".

Engineers can now use many combinations of rubber styles for various applications: thickness, durometer and rubber length.

EVEN Pressure and EVEN Heat

(Essential for the transfer of sub 5 mil features)

The new design eliminates traditional roll bending ensuring even heat and pressure across the entire surface of the panel.



EC24 Panel Cleaner

New Design for the PCB Industry

- Electrostatic Touchless Cleaning
- No Tacky roll consumables
- 4 Electrostatic Neutralizer Bars
- 8 High Pressure Air Knife Jets
- Panel Thickness (0.001" to 0.500")
- Panel Widths: 24", 30", custom
- Dust Particle collection



Kuttler Automation

New Robotic Technology

Example - 160 Series

- **RL-160** Loader
- **RU-160** Unloader
- **RLU-160** Loader & Unloader
- **RLE-160** Loader with Exchange
- **RUE-160** Unloader with Exchange
- **RLEP-160** Loader with Exchange & Interleave

Standard & Custom Options

- Loading
- Unloading
- DI Place/Remove
- Buffering
- Flip, Rotate, Divert
- AOI
- Myler Peeling



RL-160



1-800-668-5447 • www.matrixusa.us

TORONTO • SANTA ANA • SANTA CLARA • CHICAGO

and approaching retirement when the factory closed down. In a related story line, Charlie's father was also recently downsized at the local toothpaste factory after being replaced by a robot to reduce costs. Consumer pricing pressure had certainly caused the Batch family to fall on hard times.

Side Note: This part of the story was based on personal experiences from Dahl's childhood. The two largest British candy firms, Cadbury and Rowntree, sent so many moles to work in competitors' factories that their spying became legendary.

2 – Reducing Costs

Outsourcing

After closing the factory, Willy Wonka traveled the world looking for a low-cost country (LCC) in which to re-establish his business that would allow him to become competitive again. He was beginning to lose hope, but then Willy reached LoompaLand, where he discovered an entire population of highly skilled and dedicated workers, the Oompa Loompas, who were destined for extinction by the monsters of their native land. So, instead of bringing the factory to the low-cost country, Willy brought the low-cost country to the factory (reshoring)!

3 – Eliminating the Seven Deadly Wastes

Defect Waste

Jidoka built-in-quality was evidenced throughout the process, with my favorite example being the team of squirrels performing quality-at-the-source verification in the nut-shelling department. Years of continuous process improvement has resulted in the development of a chocolate waterfall that provides an automated, low-cost chocolate mixing system which produces Wonka's world-class "light and frothy" chocolate. Robust *statistical pro-*

cess control and capability study programs have allowed continuous process improvement that has resulted in the factory's ability to achieve and maintain the current six sigma level of performance.

Motion Waste

All the manufacturing processes were designed to be highly automated, with each having an advanced technology control center requiring minimal manpower to operate. Through the 6S methodology, all materials and tools are stored at the source to eliminate internal travel time waste. Every task within each control center has also been ergonomically designed for the Oompa Loompas so that every control, gauge, and monitor is within easy reach.

Waiting Waste

Given the vast size of the operation (the largest in the world), moving people and product around the factory is quite the task. Queue time (waiting waste) was virtually eliminated with the Wonka-invented flying elevator, which quickly transports employees and WIP throughout the factory. Lean practices are evident throughout the operation, and the art of chocolate making has developed into a continuous flow manufacturing process. A hovering spaceship sucks up thousands of gallons per hour of WIP from the chocolate river and transports it throughout the factory for real-time subsequent processing.

Overprocessing Waste

The factory was designed to produce only products featuring qualities that customers not only want, but are willing to pay for. Understanding customer needs and preferences was accomplished by performing a *critical to quality* analysis of Wonka's products based on voice of the customer feedback. The fantastical manufacturing technology employed by Won-



ka was all developed in-house in the Inventing Room, the organization's R&D lab. Driven by data mined from his *voice of the customer* program, Wonka was also concerned with eliminating waste for his customers as well. The invention of the Three Course Dinner stick of gum was intended to reduce waste in the home, as food, cooking time, and kitchens for that matter, are all eliminated by a single stick of gum!

Inventory Waste

Inventory has been minimized through the organization's just-in-time program, which has been implemented both internally and externally. All manufacturing processes utilize a *kanban pull system* that minimizes work-in-process inventory by only manufacturing what is needed, when it is needed. This system has also been implemented with Wonka's raw material suppliers, who have eliminated raw material inventory through electronic data interchange transactions and supplier-managed inventory programs. Kanbans have also been set up with Wonka's retail customers so that product replenishment is driven by consumption, not forecast.

Overproduction Waste

Overproduction waste is minimized in a variety of ways at the Wonka Chocolate Factory. First, the Wonka *voice of the customer* program assures that the factory is only making products that customers want, eliminating finished goods obsolescence. Next, the *kanban pull* continuous flow manufacturing system minimizes the work-in-process inventory that normally builds up between operations. Finally, the six sigma process performance level keeps defects to a minimum, and the *just-in-time* kanban systems eliminate raw material and finished goods inventory at the Wonka factory.

Transportation Waste

Transit time waste was greatly reduced by utilizing a very impressive global logistics system to distribute Willy Wonka candy bars from the factory to retail outlets throughout the

world. Order fulfillment is accomplished via a massive, well-oiled freight division that utilizes company-owned ground and air transportation. A cutting-edge "Television Chocolate" technology is also currently under development that will transport a chocolate bar through the TV to customers all over the world, thus eliminating transit time waste.

4 – Life Imitates Art

Or does art imitate life? In the end, Charlie's dad gets his job back at the toothpaste factory as a robot technician, keeping the machine that replaced him operating. One of the biggest fears people have of Lean is that they will no longer be needed. Charlie's dad was retrained and redeployed at a new position that was much more personally enriching, which happens every day in the real world. Willy Wonka's processes were environmentally friendly, with much of the by-products edible and biodegradable. The bottom line is that, yes, Willy Wonka was a Lean visionary and his Chocolate Factory a study in the ultimate goal of Lean: manufacturing perfection!

Although this is obviously a tongue-in-cheek look at a fictional company, the concepts and theory liberally applied by the author's imagination are technically sound and based in fact. It then follows that, if Lean can be successfully implemented in the fantastical setting of Willy Wonka's Chocolate Factory, it most certainly will work in your company.

Conclusion: Lean Works

I would be willing to take it a step farther and state that I can guarantee that Lean will work in any industry, in any organization if the following two conditions are met: (1) Senior management must fully buy in to the program, and (2) it is implemented correctly. As with any new program, initiative, or philosophy, management buy-in and commitment is mission critical.

Lean is not free, or even cheap, when you consider the time and human resources that must be expended on a regular basis. *It takes money to save money*, and an organization

can't realistically expect to significantly improve performance without investing in training, organizational infrastructure and cultural evolution. Sure, it costs money to implement any training program, but the initial training is only the tip of the iceberg. The major expense in a Lean program is the ongoing cost of human resources.

If management is not willing to allocate the appropriate time for their employees to work on Lean projects, the program is sure to fail, and fail spectacularly. The good news is that the hard dollar payback of a solid program can be equally spectacular. Fortune 500 companies have saved billions of dollars through Lean, but even the mom-and-pop small business that make up most America's jobs can see tremendous benefit through Lean practices.

My closing advice would be to *do something now!* Waiting for a plan to be perfect will only ensure that it never begins; doing something now is always better than doing something later. I will close with a quote from Karen Lamb, courtesy of my friend Tom Peters: "A year from now you may wish you had started today." And remember, *it's always about the dollars.* **PCB007**



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

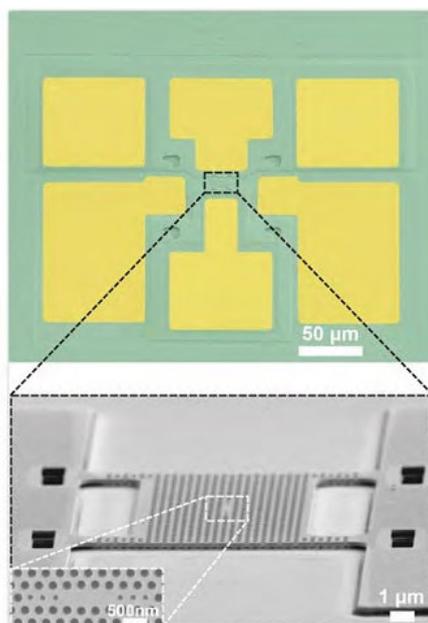
Micro-Spectrometer Opens Door to a Wealth of New Smartphone Functions

Use your smartphone to check how clean the air is, whether food is fresh or a lump is malignant. This has all come a step closer thanks to a new spectrometer so small it can be incorporated easily and cheaply into a

mobile phone. The sensor developed at TU Eindhoven is just as precise as the normal tabletop models used in scientific labs. The researchers present their invention in the journal Nature Communications.

The researchers developed an ingenious sensor that can make such precise measurements in an entirely different way using a special 'photonic crystal cavity,' a 'trap' of just a few micrometers into which the light falls and cannot escape. This trap is contained in a membrane, into which the captured light generates a tiny electrical current, and that is measured. PhD student Zarko Zobeni-ca made the cavity so that it is very precise, retaining just a very tiny frequency interval and therefore measuring only light at that frequency.

Professor Andrea Fiore expects it will take another five years before the new spectrometer gets into a smartphone because the frequency range covered is still too small. At the moment, the sensor covers just a few percent of the most common spectrum, the near-infrared. So his group will be working on extending the detectable spectrum. They will also be integrating an extra element with the micro-spectrometer: a light source, which will make the sensor independent of external sources.



The upper picture shows the entire device; the large yellow areas are contact pads. The lower picture shows the perforated membrane, and the inset zooms in on the photonic crystal cavity (the area without holes). (Image: Eindhoven University of Technology)



AVOID RISK AND CAPTURE VALUE FROM TAX CREDITS AND INCENTIVES

Tips for Electronics Manufacturers

TAX

As an advocate for lower corporate tax rates and incentives that stimulate business growth and investment, IPC has developed a webinar, **Avoid Risk and Capture Value from Tax Credits and Incentives — Tips for Electronics Manufacturers** on **January 31, 2018 at 1:00 pm ET**, that will cover two important tax topics:

- Taking advantage of tax incentives such as the Research and Development (R&D) tax credit
- Avoiding tax risks such as those associated with excise taxes

Proper tax planning extends beyond year-end filing and compliance. Understanding tax risks and evaluating the opportunities can position your company for future growth.

[MORE INFORMATION](#)

[REGISTER TODAY](#)

Electronics Industry Advocacy is More Important in 2018 than Ever

One World, One Industry, a column by John Mitchell
IPC-ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

From the Americas to Europe to Asia and beyond, the future of the electronics manufacturing industry is shaped in many ways by government policies.

This will be true like never before in 2018, as legislators and regulators the world over are eyeing policy decisions on issues such as technology research and development, taxes, workforce skills, and the environment. In the United States and Europe, heightened political turmoil is creating the possibility of unexpected policy shifts. Any one of these policy shifts could have multi-million dollar impacts on electronics companies.

An old saying in political circles is, “If you’re not at

the table, you’re on the menu.” So indeed, our industry deserves a seat at the table, given that IPC represents more than 4,300 member-companies across the electronics industry—from design, to printed circuit board manufacturing, electronics assembly, and testing.

Roughly 60% of our member facilities are in the United States, 20% are in Asia, and 15% are in Europe. Our members provide electronics products and services for a wide range of important industries including defense, aerospace, automotive, IT and telecoms, industrial equipment, and healthcare. The estimated annual revenues of this industry are \$2 trillion worldwide.

For all these reasons, as



The Road to Outsourcing CAM Engineering is Paved with VALUE!



	In-House	With Entelechy
Availability	48 weeks	52 weeks, 24/7
Overhead Cost	>30%	0%
Scalability	Limited	Unlimited
Redundancy	Variable	100% Bulletproof
Operational Efficiency	Status Quo	Continual Improvement
Total Cost	Fixed	Significantly lower

“ In our company, the CAM department was the bottleneck. As a result of our working with Entelechy, we can now accept orders that we had to refuse in the past.”

-Thomas Hofmann, CEO/Owner

HOFMANN
LEITERPLATTEN

Click here to check out our risk-free Quick Start program»

We deliver the highest quality PCB CAM and Mechanical CAD engineering services to customers around the world.



ENTELECHY GLOBAL

www.entelechyglobal.com

part of our mission to help ensure our members' success in the global economy, IPC maintains an active, multi-faceted government relations (GR) program. For example, one of the traditional ways we communicate with government officials is through formal correspondence and sometimes face-to-face meetings where they work. IPC members and our policy experts are occasionally invited to testify before government bodies on important issues.

We also host annual "fly-ins" which bring C-level executives from our member companies to world capitals for meaningful discussions of the issues. During IMPACT Washington, D.C. 2017, we facilitated meetings with more than 30 government officials. Within the last two years, IPC opened a new office in Brussels and held two IMPACT conferences there.

Another way we work to educate and influence government officials is through our "Meet the Policymakers" program, which invites legislators to tour our members' facilities and interact with the people who work there.

Another way we work to educate and influence government officials is through our "Meet the Policymakers" program, which invites legislators to tour our members' facilities and interact with the people who work there. In recent years, we have organized dozens of these visits, creating goodwill and a higher awareness of IPC and our policy priorities.

On one such occasion, a member site visit by Congressman Paul Ryan occurred just weeks before he was unexpectedly elevated to the position of Speaker of the U.S. House of Representatives, making it a very well-timed visit in

terms of IPC keeping strong relationships with congressional leadership.

From time to time, we also issue Member Alerts, asking our members to call or write their elected representatives on issues of urgent concern.

Not only do we have to keep policymakers informed of our views, but we also work to educate and inform our members about the policy changes coming down the road. In 2018, we'll continue to post frequent articles in the IPC Blog and IPC Global Insight e-newsletter; publish a quarterly e-newsletter on our advocacy work specifically; and host informational webinar and workshops on challenging policy compliance issues like taxes and environmental regulations.

Members in the United States can take their advocacy to another level by getting involved in the IPC Political Action Committee (IPC PAC)^[1]. Political action committees are transparent, regulated entities in which U.S. citizens and "green card" holders can join together to support political candidates with financial contributions to their political campaigns. The IPC PAC supports pro-manufacturing candidates in both parties who are sympathetic to IPC's policy positions.

All together, these advocacy efforts help our industry have an advantage in an increasingly competitive global economy.

How do electronics companies benefit from this work? One example is the 2015 PATH Act enacted by the U.S. Congress. This bill revived more than 50 tax provisions that had expired in 2014 and made the research and development tax credit permanent. Many of the provisions in the PATH Act were IPC lobbying objectives for many years; dozens of IPC members communicated with their lawmakers on this issue.

Another example is conflict minerals. IPC has been a persistent voice regarding the cost and unintended results of conflict minerals legislation, both in the United States and the European Union. While IPC members are deeply concerned by the human rights violations that have occurred in central Africa, where minerals mining revenues have fueled local conflicts, we have supported an approach that is

Get the spark you need to tune up your sales team.

When an engine doesn't fire on all cylinders, performance is limited. The same goes for your sales team. We provide the spark to get your sales to the next level ...and beyond.



We've helped dozens of companies big and small improve their bottom line.



Learn how we can help YOU 

 207-649-0879  danbbeaulieu@aol.com

focused on conflict resolution, not placing undue burdens on upstream manufacturers. Today, the U.S. and European governments are addressing these issues.

For 2018, our global policy priorities include:

- Advocating for workforce policies that help IPC members attract and retain more skilled talent
- Strengthening the defense industrial base
- Ensuring that environmental regulations are based on sound science and a fair balance of costs and benefits
- Promoting a conflict resolution approach to avoid overly burdensome reporting that does not have the desired effect for conflict minerals
- Adding our voice to the rising debate over electronics and motor vehicles
- Advocating for intellectual property protection
- Ramping up our advocacy and presence in China and the Asia-Pacific region
- Supporting open and fair free trade agreements
- Advancing efforts to lower corporate tax rates while maintaining incentives for investment and innovation

Which of these policy issues concerns you and affects your company the most? We'd love to hear your insights and experience, and are eager to have your participation in our advocacy efforts. For more information on our government relations efforts please contact Ken Schramko, Director of Government Relations^[2].

If you plan on attending IPC APEX EXPO, I encourage you to attend two GR-related events to learn more about IPC's advocacy efforts: a technical conference session on defense electronics on Tuesday, February 27, and a Buzz session on China environmental issues on Wednesday, February 28. For more information on these events, visit the IPC APEX EXPO show site^[3]. **PCB007**

References

1. [IPC Political Action Committee](#)
2. KenSchramko@ipc.org or 202-661-8094.
3. www.ipcapexexpo.org



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

Unattended Ground Sensors Market to be Worth \$458M by 2022

The unattended ground sensors market is projected to grow from \$363.8 million in 2017 to \$457.9 million by 2022, at a CAGR of 4.71% from 2017 to 2022. The changing nature of warfare and rise in the terrorism, geopolitical issues, and insurgencies across countries in the world are key factors driving the growth of this market. However, operational issues such as false alarms and power man-

agement are projected to hinder the market growth. In addition, susceptibility of sensor networks to cyber-attacks acts as a key challenge to the growth of the market. Factors such as the need for enhanced situational awareness, advances in Digital Signal Processing (DSP) and wireless sensor networks, and rise in incidences of border trespassing coupled with the upgrade of the existing border security infrastructure offer key growth opportunities to manufacturers of unattended ground sensors.

Infrared sensors are designed to alert users regarding an intruder's presence through transmission of an infrared light beam across the zone. An infrared sensor measures the heat being emitted as well as notices the motion of the object. It also detects the electromagnetic radiated energy generated by sources that produce temperatures below that of visible light.



PCB BUYERS - compare nearly 1900 manufacturers now at *The PCB List.*



Quick Search



Advanced Search



The best way to find a PCB fabricator, *anywhere.*



Recent Highlights from PCB007

1 One World, One Industry: Connecting the Dots Between Manufacturing and Community

Across the United States, the first Friday in October represents the annual celebration of Manufacturing Day. On this date, manufacturers and supporters come together to celebrate the longevity and success of our industry. Since 2012, Manufacturing Day has served as a chance to learn about the businesses that thrive in our communities and contribute greatly to the economy.

2 American Standard Circuits Wins 2017 Innovator of the Year Award

Anaya Vardya, CEO of American Standard Circuits, announced that his company was awarded the city of West Chicago's Brilliance in Business Award for Outstanding Achievement in Design and Innovation at the annual ceremony on Monday, December 4.



3 Flex Talk: FlexFactor: Faith in the Future

Take just a minute and read through this list of new product ideas. Can you identify the common thread? Yes, they are all enabled by advanced technology, but would you believe that these products were all pitched in the last year by high school students?



4 Papandrew Leads Advanced Circuits' New Offshore Division

Advanced Circuits is one of the largest PCB manufacturers in the United States. Now, the company is expanding the range of its services with the launch of its new Offshore Division. Recently, the company hired PCB veteran Greg Papandrew to lead the new division and help the company meet buyers' demand for offshore PCB sourcing.

5 Strategies for High-Density PCBs

As hand-held and portable electronic products and their circuit boards continue to shrink in size, the designer is faced with solving the physical differences between traditional printed board fabrication and what's commonly referred to as high-density interconnect (HDI) processing.



6 TTM Technologies to Acquire Anaren

TTM Technologies Inc. has agreed to acquire Anaren Inc. for approximately \$775 million in cash from affiliates of Veritas Capital.

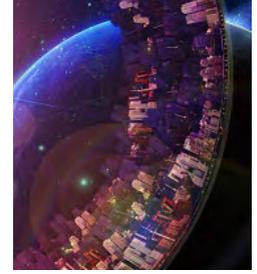


7 It's Only Common Sense: The All-Important Intense Customer Survey

Whether you are in the business of board fabrication or board assembly, the fact is that you are not building your own products. You are building your customers' products, which means that you are in the business of helping your customers be successful.

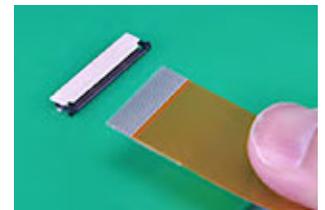
8 HDI: Today, Tomorrow and the Future

For the November issue of *The PCB Magazine*, our editorial team interviewed some of the top HDI experts in the PCB supply chain. Joining us on the conference call were Steve Bird, PCB/flex technology manager at Finisar, and Tony Torres of APCT.



9 All Flex Introduces Automated Online System for Custom Flat Flex Cables

All Flex, a manufacturer of flexible printed circuit boards and flexible heaters, has announced the addition of an automated tool for ordering customized polyimide flat flex cables (FFC).



10 A Conversation with EIPC Executive Director Kirsten Smit-Westenberg

The EIPC booth was a busy place during production, with several members and other organizations headquartered there, resulting in a constant stream of people stopping by to visit, get information and study the upcoming conference agendas.



For the Latest PCB News and Information, Visit: PCB007.com

Career Opportunities

Pssst!
Are You Looking
for Someone?



Place your notice in our Help Wanted section.

For just \$500, your 200 word, full-column—or, for \$250, your 100 word, half-column—ad will appear in the Help Wanted section of all three of our monthly magazines, reaching circuit board designers, fabricators, assemblers, OEMs and suppliers.

Potential candidates can click on your ad and submit a résumé directly to the email address you've provided. 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 or +1.916.608.0660 (-7 GMT)

I-Connect007
GOOD FOR THE INDUSTRY





Work where you live!

The I-Connect007 China team is seeking an experienced salesperson to generate and manage a revenue stream for our Chinese publications.

Key Responsibilities include:

- Sell advertising contracts for monthly magazine
- Develop and cultivate new business
- Keep timely and accurate records
- Generate and follow up on all leads
- Manage contract renewals
- Account management: work with local and international team to provide customer support
- Phone and email communications with prospects
- Occasional travel

Qualifications

Successful candidates should possess a university degree or equivalent, experience with managing and cultivating leads, projecting, tracking and reporting revenue. We are looking for positive, high-energy candidates who work well in a self-managed, team-based, virtual environment.

Compensation

This is a base salary-plus-commission position. Compensation commensurate with experience.

Requirements

- Must be located in China Mainland, South China area preferred
- Good command of Chinese language, proficient with English speaking and writing
- Able to follow established systems and learn quickly
- Able to maintain professional external and internal relationships reflecting the company's core values
- 2-5 years' sales experience
- Experience with Microsoft Office products
- Must be highly motivated and target-driven with a proven track record for meeting quotas
- Good prioritizing, time management and organizational skills
- Create and deliver proposals tailored to each prospect's needs
- Experience in the electronics industry desirable

[QUALIFIED CANDIDATES: CLICK HERE TO APPLY](#)

Career Opportunities

The logo for Saki, featuring the word "Saki" in a bold, red, sans-serif font.

The Future in Focus 

Field Application Engineer

Saki America Inc., headquartered in Fremont, CA, a leader in automated inspection equipment, seeks two full-time Field Application Engineers (FAE), one in the Fremont headquarters and the other for the Eastern and Southern United States.

The FAE will support the VP of Sales and Service for North America in equipment installation, training, maintenance, and other services at field locations. The FAE will provide technical/customer support and maintain positive relationships with existing and future customers.

Strong analytic abilities and problem-solving skills are a must in order to understand customer applications and troubleshoot issues. The FAE will perform demos and presentations for customers and agents as well as assisting in trade show activities. Candidate must have a minimum of a two-year technical degree, experience in AOI, SPI, and X-ray inspection, and strong verbal and written communication skills. The position requires the ability to travel about three weeks per month. Must be a US citizen and be able to lift up to 40 lbs.

[apply now](#)



eptac
TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor at EPTAC

Job Summary:

We are growing! EPTAC, a leading provider in the electronics training industry is looking for some great people to join our team. 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. 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 an enthusiasm for education, drop us a line or send us your resume. We would love to chat with you. Opportunities available across U.S. and Canada, especially in our growing markets of California, Chicago, Minnesota and New England. Some travel involved. IPC-7711/7721 or IPC-A-620 CIT certification a big plus.

Qualifications and Skills:

- A love of teaching and an enthusiasm to help others learn new concepts and skills
- Background in electronics manufacturing
- Previous soldering and/or electronics/cable assembly experience
- Previous 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 time, work as often as you like
- IRA retirement matching contributions after one year of service
- Training and certifications provided and maintained by EPTAC

[apply now](#)

Career Opportunities



PCB Assembly Supervisor— full time Accurate Circuit Engineering— Santa Ana, CA

Position Summary: Responsible for all assembly processes to ensure continued growth as directed by management.

Essential Job Functions:

- Create, implement, and supervise in-house manufacturing facility
- Recruit, hire, train, and supervise assembly floor personnel
- Extensive hands on experience with all aspects of PCB assembly
- Understanding of IPC-A-610 standards
- Research and acquire additional assembly resources
- Gather data on product shortages, lead times, price changes, etc.
- Coordinate the assembly activities with sales to ensure 100% on-time delivery
- Create, implement, and supervise daily quality processes to ensure 100% accuracy
- Document, monitor and review progress of the business unit
- Respond to internal and external customers in a timely manner
- Coordinate walk-through, site audits, etc.

Qualifications:

- Minimum 3 years as operations supervisor of electronics assembly house
- 5+ years' experience in the electronics industry
- Previous experience as a quality or operations supervisor preferred
- Ability to solve practical problems using pre-established guidelines
- Strong facility in Microsoft Office applications
- Excellent verbal and written communication skills
- Ability to work with people of diverse backgrounds
- Highly organized/excellent time management skills
- Ability to perform at the highest level in a fast-paced environment
- Valid California driver's license.

[apply now](#)



PCB Process Planner

Accurate Circuit Engineering (ACE) is an ISO 9001:2000 certified manufacturer of high-quality PCB prototypes and low-volume production for companies who demand the highest quality in the shortest time possible. ACE is seeking a skilled individual to join our team as a PCB process planner.

Responsibilities will include:

- Planning job travelers based on job release, customer purchasing order, drawings and data files and file upon completion
- Contacting customer for any discrepancies found in data during planning and CAM stage
- Consulting with director of engineering regarding technical difficulties raised by particular jobs
- Informing production manager of special material requirements and quick-turn scheduling
- Generating job material requirement slip and verify with shear clerk materials availability
- Maintaining and updating customer revisions of specifications, drawings, etc.
- Acting as point of contact for customer technical inquiries

Candidate should have knowledge of PCB specifications and fabrication techniques. They should also possess good communication and interpersonal skills for interfacing with customers. Math and technical skills are a must as well as the ability to use office equipment including computers, printers, scanners, etc.

This position requires 3 years of experience in PCB planning and a high school level or higher education.

[apply now](#)

Career Opportunities



Chemical Process Engineer

Chemcut, a leading manufacturer of wet-processing equipment for the manufacture of printed circuit boards for more than 60 years, is seeking a Chemical Process Engineer. This position is located at Chemcut's main facility in State College, Pennsylvania. Applicants should have an associate degree or trade school degree, or 4 years equivalent in chemical process engineering.

Job responsibilities include:

- Developing new industrial processes
- Providing process criteria for both new equipment and modifying existing equipment
- Testing new processes and equipment
- Collecting data required to make improvements and modifications
- Assisting in investigating and troubleshooting customer process problems
- Ensuring that equipment works to its specification and to appropriate capacities
- Assessing safety and environmental issues
- Coordinating with installation/project engineers
- Ensuring safe working conditions and compliance with health and safety legislation

Key Skills:

- Aptitude for, and interest in chemistry, IT and numeracy
- Analytical thinking
- Commercial awareness
- Ability to perform under pressure
- Communication and teamwork
- Problem-solving

Experience with circuit board processes is a plus.

Contact Arlene at 814-272-2800 or by clicking below.

[apply now](#)



Field Service Technician

Chemcut, a leading manufacturer of wet-processing equipment for the manufacture of printed circuit boards for more than 60 years, is seeking a high-quality field service technician. This position will require extensive travel, including overseas.

Job responsibilities include:

- Installing and testing Chemcut equipment at the customer's location
- Training customers for proper operation and maintenance
- Providing technical support for problems by diagnosing and repairing mechanical and electrical malfunctions
- Filling out and submitting service call paperwork completely, accurately and in a timely fashion
- Preparing quotes to modify, rebuild, and/or repair Chemcut equipment

Requirements:

- Associates degree or trade school degree, or four years equivalent HVAC/industrial equipment technical experience
- Strong mechanical aptitude and electrical knowledge, along with the ability to troubleshoot PLC control
- Experience with single and three-phase power, low-voltage control circuits and knowledge of AC and DC drives are desirable extra skills

To apply for this position, please apply to Mike Burke, or call 814-272-2800.

[apply now](#)

Career Opportunities



Electronics Expert Engineer

Orbotech is looking for an Electronics Expert Engineer to handle various hardware activities, including communication, data path processing, device interfaces and motion, as well as system supporting functions in a multi-disciplinary environment.

What Will Your Job Look Like?

- Providing cutting edge hardware solutions for challenging product line needs
- Developing board design and Logic in VHDL
- Defining and managing interfaces (software, algorithm, mechanics and electricity)
- Successfully integrating hardware with other product disciplines
- Supporting the product needs during and following release

What Do You Need to Succeed?

- BSc in electronics engineering
- At least 5 years of R&D experience in complex board design, mainly FPGA (communication interfaces, DDR controller, algorithm implementation)
- Experience in an Altera/Xilinx development environment
- Experience in ECAD design tools (DxDsigner, ModelSim) is an advantage
- Knowledge in laser interfaces, RF and analog is an advantage

Who We Are

Virtually every electronic device in the world is produced using Orbotech systems. For over 30 years, Orbotech has been a market leader in developing cutting edge inspection, test, repair, and production solutions for the manufacture of the world's most sophisticated consumer and industrial electronics.

[apply now](#)



Electronics Team Leader

Orbotech is seeking an Electronics Team Leader to join our electronics team, which develops multi-disciplinary systems, including vision/laser, image processing, and control and automation missions.

What Will Your Job Look Like?

- Lead a team of electronics engineers in a multi-disciplinary environment
- Lead electronic activities from requirement phase to development, integration and transfer, to production
- Be the focal point for other disciplines and projects managers
- Maintain and improve existing electronics platforms

What Do You Need to Succeed?

- BSc/MSc in electronic engineering/ computer science from a well-recognized university
- 5+ years' experience in digital board design, high-speed links, computing embedded systems, and HW/SW integration
- 2-3 years' experience in leading a team of engineers
- Solid skills in complex FPGA design with multi-modules
- Solid skills in high-speed board design, DDR3/4, PCIE, USB, IO, and optic links
- Ability to design and execute end-to-end solutions

Who We Are

Virtually every electronic device in the world is produced using Orbotech systems. For over 30 years, Orbotech has been a market leader in developing cutting-edge inspection, test, repair, and production solutions for the manufacture of the world's most sophisticated consumer and industrial electronics.

[apply now](#)

Career Opportunities



ventec
INTERNATIONAL GROUP
騰輝電子

Technical Sales Engineer

Positions available in the
Chicago area and California

Do you want to advance your career by joining a globally successful and growing world class CCL manufacturer and help drive that success? As a California-based member of the technical sales team, your focus will be on Ventec's core market segments: mil/aero, automotive and medical, offering a full range of high-reliability materials including polyimide, IMS and thermal management products.

Skills and abilities required

Non-negotiable:

- DRIVE & TENACITY!

Required:

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

Full product training will be provided. This is a fantastic opportunity to become part of a successful brand and a leading team with excellent benefits.

Please forward your resume to:

jpattie@ventec-usa.com and mention "Technical Sales Engineer - California Based or Chicago area" in the subject line.

apply now



ventec
INTERNATIONAL GROUP
騰輝電子

Ventec Seeking U.S. Product Manager for tec-speed

Want to work for a globally successful and growing company and help drive that success? As a U.S.-based member of the product and sales team, your focus will be on Ventec's signal integrity materials, tec-speed, one of the most comprehensive range of products in high-speed/low-loss PCB material technology for high reliability and high-speed computing and storage applications. Combining your strong technical PCB manufacturing and design knowledge with commercial acumen, you will offer North American customers (OEMs, buyers, designers, reliability engineers and the people that liaise directly with the PCB manufacturers) advice and solutions for optimum performance, quality and cost.

Skills and abilities required:

- Technical background in PCB manufacturing/design
- Solid understanding of signal integrity solutions
- Direct sales knowledge and skills
- Excellent oral and written communication skills in English
- Experience in making compelling presentations to small and large audiences
- Proven relationship building skills with partners and virtual teams

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

Please forward your resume to jpattie@ventec-usa.com and mention "U.S. Sales Manager—tec-speed" in the subject line.

apply now

Career Opportunities



BLACKFOX

Premier Training & Certification

IPC Master Instructor

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

For more information, click below.

[apply now](#)

Altium®

Business Development Representative at Altium

New Logo Business Development representatives are highly motivated and hardworking with an upbeat can-do attitude. They work with our New Logo Sales Team to displace our competition in accounts by offering Altium's unified PCB development tools within a defined region.

The New Logo Developer's (NLD) main responsibilities will be qualifying leads and prospecting into competitive lists, searching the web, and utilizing internal sales tools (Inside View, LinkedIn, Marketo, Salesforce) to uncover and work with opportunities for the New Logo Closer to close. They are expected to meet or exceed monthly, quarterly & annual quota.

Responsibilities:

- Develop lead opportunities by collecting information that includes business pains/needs, timelines, authority and project teams, budget, competitive information, etc.
- Aggressively drive daily prospecting calls to build pipeline of prospective clients and occasionally closing smaller deals
- Develop relationships with key partners in their territory to identify new business opportunities
- Plan and prioritize personal sales activities in conjunction with the New Logo Closer, with the goal of achieving sales targets
- Work alongside inside sales teams on specialized projects such as call-out campaigns, promo drives and webinar fulfillment
- Once trained, maintain an in-depth knowledge of Altium products and technologies, competitive products, and industry trends.

[apply now](#)

Career Opportunities



PCB Equipment Sales

World-class manufacturer of wet process equipment for the PCB and plating industries, Integrated Process Systems Inc. (IPS) is seeking qualified candidates to fill a position in equipment sales. Potential candidates should have:

- Process engineering knowledge in PCB manufacturing
- Outside sales background
- Residency on the West Coast to manage West Coast sales
- Knowledge of wet process equipment
- Sales experience with capital equipment (preferred)

Compensation will include a base salary plus commission, dependent upon experience.

[more details](#)

AD SPACE
AVAILABLE
NOW

For information, please contact:
BARB HOCKADAY
barb@iconnect007.com
+1 916.365.1727 (-7 GMT)

I-Connect007
GOOD FOR THE INDUSTRY

Altium®

Application Engineer

The application engineer is the first contact for our customers who have technical questions or issues with our product. We value our customers and wish to provide them with highest quality of technical support.

Key Responsibilities:

- Support customer base through a variety of mediums
- Log, troubleshoot, and provide overall escalation management and technical solutions
- Create various types of topic based content, such as online help, online user guides, video tutorials, knowledge base articles, quick start guides and more
- Distill complex technical information into actionable knowledge that users can understand and apply
- Continually develop and maintain product knowledge

Requirements:

- Understanding of EDA electronic design software, schematic capture and PCB layout software
- Bachelor's degree in electronics engineering or equivalent experience
- Sales engineering and/or support engineering experience
- Circuit simulation and/or signal integrity experience
- Understanding of ECAD/ MCAD market segments
- Understanding of micro controllers, SoC architecture and embedded systems market
- Database experience preferred (i.e., MySQL, PostgreSQL, Microsoft Access, SQL, Server, FileMaker, Oracle, Sybase, dBASE, Clipper, FoxPro) etc.
- Experience with PLM/PDM/MRP/ERP software (Program Lifecycle Management) preferred
- Salesforce experience a plus

Salary based upon experience. Comprehensive benefits package and 401k plan. Openings in USA, UK, and Germany.

For more information, contact Altium.

[apply now](#)

Career Opportunities



Do you have what it takes?

MacDermid Performance Solutions, a Platform Specialty Products Company, and daughter companies manufacture a broad range of specialty chemicals and materials which are used in multi-step technological processes that enhance the products people use every day. Our innovative materials and processes are creating more opportunities and efficiencies for companies across key industries – including electronics, graphic arts, metal & plastic plating, and offshore oil production. Driving sustainable success for companies around the world, and at every step of the supply chain, takes talent. Strategic thinking. Collaboration. Execution.

The people of MacDermid Performance Solutions stand united by a guiding principle: If it doesn't add value, don't do it. This belief inspires a unique culture where each team member has opportunities to imagine, create, hone and optimize. Do you have what it takes? Join our growing team of over 4,000 professionals across more than 50 countries with openings in research, finance, customer service, production and more.

MacDermid Performance Solutions and its affiliates are Equal Opportunity/Affirmative Action Employers.

[apply now](#)



Outside Sales/ Key Account Managers

NCAB Group USA is adding to our existing outside sales team in various U.S. locations:

- Ontario, California
- Itasca, Illinois
- Vancouver, Washington

This is a sales position that requires the ability to convert those cold calls into high-value customer meetings. What we are looking for:

- A "hunter" mentality
- The ability to create solid customer relationships
- A desire to excel and not settle for mediocrity
- 5+ years of experience in the PCB or semiconductor industry
- An excellent ability to present a product and do the "deep dive" during customer visits by asking open ended questions and identifying customer pain points
- The energy to move from prospecting to cold calls to getting the win
- Knowledge of "SPIN" selling
- A college degree
- Willingness to travel, domestically and globally
- U.S. citizens with a valid U.S. passport

Interested? Send your resume.

[apply now](#)

Career Opportunities



FPGA Design Expert

Orbotech is seeking a FPGA Design Expert to join our electronics team, which develops multi-disciplinary systems including vision/laser, image processing and electro-optics.

What Will Your Job Look Like?

- Lead image acquisition and processing activities in the team
- Engage in all aspects of FPGA design activity: requirement phase, coding, synthesizing, verification support and LAB bring up
- Participate in system definitions for current and next generation products
- Collaborate with other teams: SW, algorithm and QA

What Do You Need to Succeed?

- BSc/MSc in Electrical Engineering from a well-recognized university
- Extensive knowledge of VHDL
- 5+ years of FPGA development experience (requirement, architecture, RTL coding, simulation, synthesis, timing analysis, P&R, board level integration and verification)
- Experience in designing and implementing low-latency, high-throughput FPGA designs utilizing PCIe Gen2/3, Gigabit Ethernet, SERDES, DDR3/4
- Experience in complex FPGA such as Altera Stratix-II and Arria 5&10 devices
- Authoring documentation experience such as FPGA specifications and FPGA verification plans

Who We Are

Virtually every electronic device in the world is produced using Orbotech systems. For over 30 years, Orbotech has been a market leader in developing cutting-edge inspection, test, repair, and production solutions for the manufacture of the world's most sophisticated consumer and industrial electronics.

[apply now](#)



Arlon EMD, located in Rancho Cucamonga, California is currently interviewing candidates for **manufacturing** and **management positions**. All interested candidates should contact Arlon's HR department at 909-987-9533 or fax resumes to 866-812-5847.

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

Our facility employs state of the art production equipment engineered to provide cost-effective and flexible manufacturing capacity allowing us to respond quickly to customer requirements while meeting the most stringent quality and tolerance demands. Our manufacturing site is ISO 9001:2008 registered, and through rigorous quality control practices and commitment to continual improvement, we are dedicated to meeting and exceeding our customer's requirements.

[more details](#)

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/information regarding the manufacture and assembly of Printed Circuit Boards. The principal of Fein-Line Associates, Dan (Baer) Feinberg, formally president of Morton Electronic Materials (Dynachem) is a 50+ year veteran of the printed circuit and electronic materials industries. Dan is a member of the IPC Hall of Fame; has authored over 150 columns, articles, interviews, and features that have appeared in a variety of magazines; and has spoken at numerous industry events. He covers major events, trade shows, and technology introductions and trends.

Mr. Feinberg and his associates specialize 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



Dan (Baer) Feinberg

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

Telephone: (949) 498-7866
Email: baer@feinonline.com



www.feinonline.com



Events Calendar

47th NEPCON JAPAN ▶

January 17–19, 2018
Tokyo Big Sight, Japan

1st Autonomous Driving Technology Expo ▶

January 17–19, 2018
Tokyo Big Sight, Japan

DesignCon 2018 ▶

January 30–February 1, 2018
Santa Clara, California, USA

EIPC 2018 Winter Conference ▶

February 1–2, 2018
Lyon, France

MD&M West ▶

February 6–8, 2018
Anaheim, California USA

2018FLEX ▶

February 12–15, 2018
Monterey, California USA

IPC APEX EXPO 2018 Conference and Exhibition ▶

February 27–March 1, 2018
San Diego, California, USA

China International PCB and Assembly Show (CPCA) ▶

March 20–22, 2018
Shanghai, China

KPCA Show 2018 ▶

April 24–26, 2018
Kintex, South Korea

Thailand PCB Expo 2018 ▶

May 10–12, 2018
Bangkok, Thailand

Medical Electronics Symposium 2018 ▶

May 16–18, 2018
Dallas, Texas, USA

2018 EIPC's 50 Years Anniversary Conference ▶

May 31–June 1, 2018
Bonn, Germany

JPCA show 2018 ▶

June 6–8, 2018
Tokyo, Japan

IPC
Calendar
of Events



SMTA
Calendar
of Events



iNEMI
Calendar
of Events



PCB007
Calendar
of Events



PUBLISHER: **BARRY MATTIES**
barry@iconnect007.com

SALES MANAGER: **ANGELA ALEXANDER**
(408) 489-8389; angela@iconnect007.com

MARKETING SERVICES: **TOBEY MARSICOVETERE**
(916) 266-9160; tobey@iconnect007.com

EDITORIAL:
MANAGING EDITOR: **PATRICIA GOLDMAN**
(724) 299-8633; patty@iconnect007.com

TECHNICAL EDITOR: **PETE STARKEY**
+44 (0) 1455 293333; pete@iconnect007.com

CONTRIBUTING TECHNICAL EDITOR: **HAPPY HOLDEN**
(616) 741-9213; happy@iconnect007.com

MAGAZINE PRODUCTION CREW:
PRODUCTION MANAGER: **SHELLY STEIN**
shelly@iconnect007.com

MAGAZINE LAYOUT: **RON MEOGROSSI**

AD DESIGN: **SHELLY STEIN, MIKE RADOGNA ,
TOBEY MARSICOVETERE**

INNOVATIVE TECHNOLOGY: **BRYSON MATTIES**

COVER: **SHELLY STEIN**

COVER IMAGE: **CREATIVE COMMONS**

PCB007
MAGAZINE

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

© 2018 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.

January 2018, Volume 8, Number 1
PCB007 MAGAZINE is published monthly,
by BR Publishing, Inc.

ADVERTISER INDEX

atg Luther & Maelzer GmbH.....	17
Burkle North America.....	7
Cicor.....	9
DB Management.....	103
Electra Polymers.....	87
Entelechy Global.....	101
ESI.....	35
Excellon.....	73
Fein-Line Associates.....	119
Gardien.....	55
I-Connect007 eBooks.....	2, 3, 64, 65
IPC.....	49, 99
Isola.....	5
ITEQ.....	13
Matrix USA.....	95
Mentor, a Siemens Business.....	29
Microcraft.....	85
MivaTek Global.....	57
Mutrax.....	27
Panasonic Electronic Materials.....	37
The PCB List.....	105
Pluritec.....	23
Prototron Circuits.....	89
Rogers Corporation.....	69
Taiyo America.....	45
The Right Approach Consulting.....	93
Ucamco.....	41
Ventec International Group.....	25
Viking Test.....	91

Coming Soon to PCB007 Magazine:

FEBRUARY: WHO'S YOUR CUSTOMER?
External and Internal!

MARCH: NEW TECHNOLOGIES
What's coming in 2018?

APRIL: AUTOMOTIVE ELECTRONICS
Including trucks, trains and buses.

I-Connect007

GOOD FOR THE INDUSTRY



FREE SUBSCRIPTION



myconnect007.com

EDITORIAL CONTACT

Patty Goldman

patty@iconnect007.com

+1 724.299.8633 GMT-4



mediakit.iconnect007.com

SALES CONTACT

Barb Hockaday

barb@iconnect007.com

+1 916 365-1727 GMT-7



www.iconnect007.com