

JUNE 2021

iConnect007

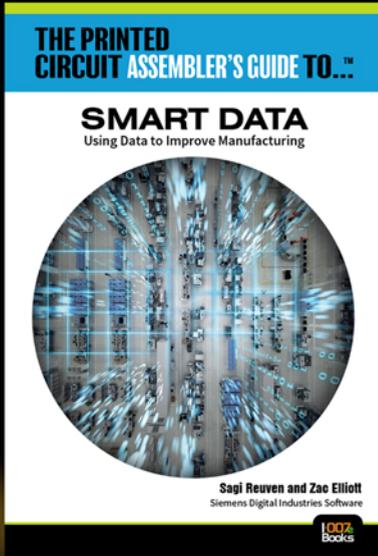
SMT007

$$X = X_c - 1$$



Get Smart!

(About Smart Factories)



DOWNLOAD 



DOWNLOAD 



WEBINAR

Implementing Digital Twin Best Practices with Expert Jay Gorija

ON DEMAND 



ROUNDTABLE

Achieving Operational Excellence in Electronics Manufacturing

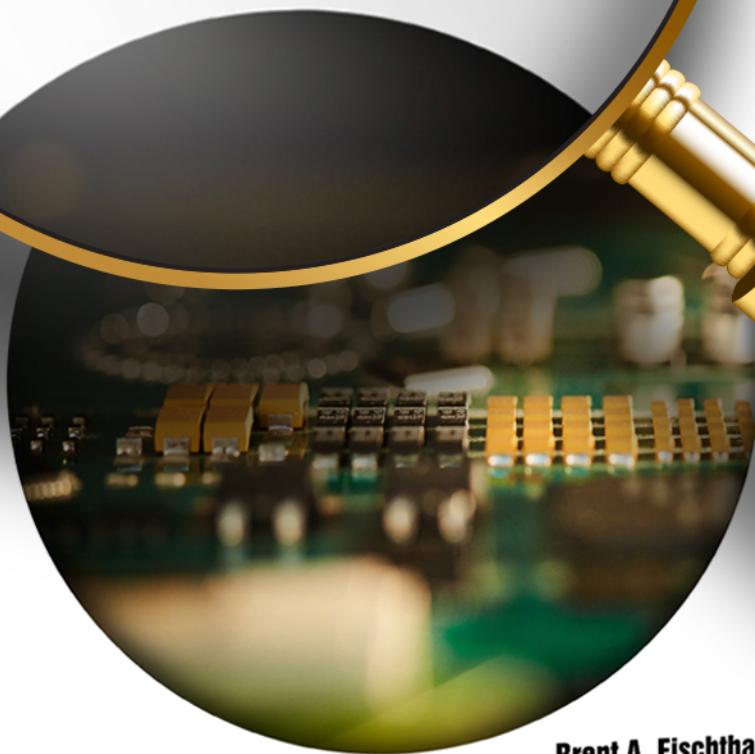
WATCH NOW 



Educational Resource Center

The how-to guide for intelligent inspection.

**THE PRINTED
CIRCUIT ASSEMBLER'S GUIDE TO
SMT INSPECTION**
Today, Tomorrow, and Beyond



Brent A. Fischthal
Koh Young America



Download Now

100%
Books

books
100%

SMT007

M A G A Z I N E

Surface Prep and Protection

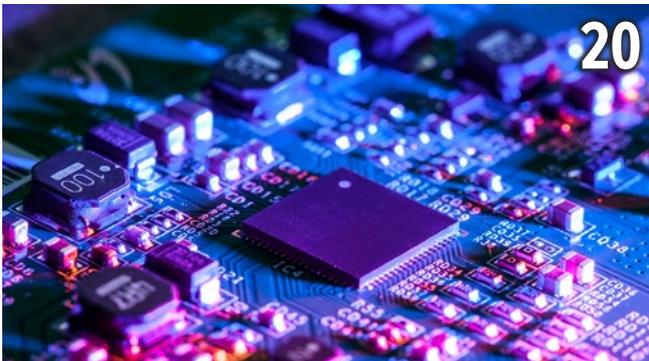
One key factor to a strong, reliable, successful solder joint is ensuring the right conditioning of the surfaces to be soldered. Then, once the solder joints are in place, protecting those joints from environmental stresses is crucial. In this issue, we investigate the current state of cleaning and coating as forms of surface preparation and protection.



10 **FEATURES**
Surface Prep vs. Cleaning
Interview with Tom Forsythe



20 **The State of the Coating Industry**
by Phil Kinner



24 **Cleaning and Inspection**
by Graham Naisbitt



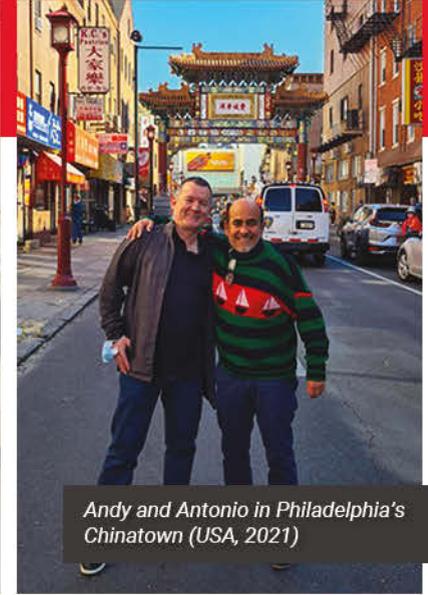
28 **Cleaning and Coating Webinar Highlights**
by Phil Kinner



7 Years and Running: Long-Lasting Equipment & Support



Manncorp Tech Andy Scheer, Antonio Ricaurte, and the AR Technologies Team (Ecuador, 2014)



Andy and Antonio in Philadelphia's Chinatown (USA, 2021)

Learn how a mix of in-person and remote services has helped [AR Technologies](#) run machines issue-free in Guayas, Ecuador since 2014. [Read More](#)

MANNCORP EQUIPMENT USED BY AR TECHNOLOGIES



High-precision stencil printer with automatic vision alignment



Pick & place with 160 feeder ports and 6,400 CPH placement



4-Zone inline reflow oven with predictive profiling

CHECK OUT OUR NEW WEBSITE

Online Pricing, New High-Definition Equipment Photos, and More!

CONTACT US!

Chris (East) 215.869.8374
Ed (West) 215.808.6266
sales@manncorp.com

ManncorpTM
www.manncorp.com

Hatboro, PA | San Diego, CA

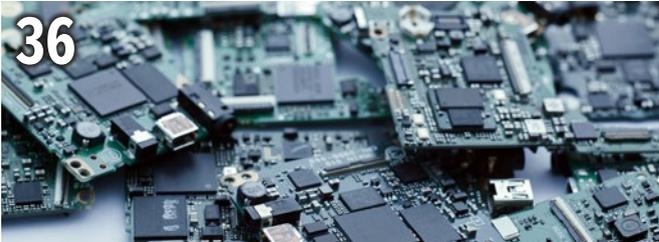
© 2021 by Manncorp

FOLLOW US!



SMT007

M A G A Z I N E



36

SHORTS

- 23** Rice Lab Uses Laser-Induced Graphene Process to Create Micron-Scale Patterns in Photoresist
- 27** Increasing Board Complexity Drives the Need for Accurate & Speedy Inspection 
- 47** Physicists Find Novel Way to Switch Antiferromagnetism On and Off
- 65** Slender Robotic Finger Senses Buried Items
- 75** NASA Invests \$105 Million in U.S. Small Business Technology Development

HIGHLIGHTS

- 30** MilAero007
- 48** Electronics News
- 62** Supplier
- 84** Top 10 from SMT007.com



DEPARTMENTS

- 87** Career Opportunities
- 100** I-007e Educational Resource Center
- 101** Advertiser Index & Masthead



ARTICLES

- 36** Failure Analysis Cases Studies on Solder DeWetting for Electronics Products
by Jasbir Bath, et. al.
- 50** ICAPE Group Offers Boots on the Ground Support in Asia
Interview with Roger Harts 
- 64** Joe D’Ambrisi Discusses MacDermid Alpha Acquisition of HK Wentworth
Interview with Joe D’Ambrisi
- 66** A Framework for Large-Scale AI-Assisted Quality Inspection Implementation in Manufacturing Using Edge Computing
by Feng Xue, et. al.

COLUMNS

- 8** If It Don’t Stink...
by Nolan Johnson 
- 32** Part 2—Making the Announcement
by Maggie Benson
- 76** Security is Key
by Imran Valiani 
- 80** It’s Pronounced ‘Tooling Hole’
by Chris Young

Gain knowledge, save time and improve your bottom line with ASC's

FREE RESOURCES



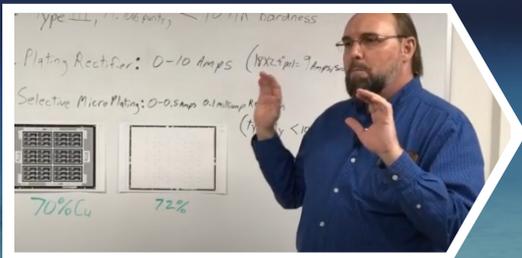
WEBINARS

Attend weekly free webinars focused on different PCB topics



eBOOKS

Download concise and relevant books written by the ASC Experts



EXPERTS BLOG

The ASC Experts help you learn more about advanced PCB technologies



ONLINE DFM

Upload Gerber files and get results back in just 60 minutes



American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

www.asc-i.com | (630) 639-5444

If It Don't Stink...

Nolan's Notes

by Nolan Johnson, I-CONNECT007

My uncles had a phrase, “If it don’t stink, don’t stir it.” It was just one of the euphemisms they brought back from the Navy... or maybe the Army... could have been the National Guard, though. You see, coming out of high school, they had each picked a different branch to enlist. All three of them served during the Vietnam era, though none of them saw action. My Army uncle stayed stateside; my Navy uncle cruised with the Mediterranean fleet; my National Guard uncle was stationed in Puerto Rico.

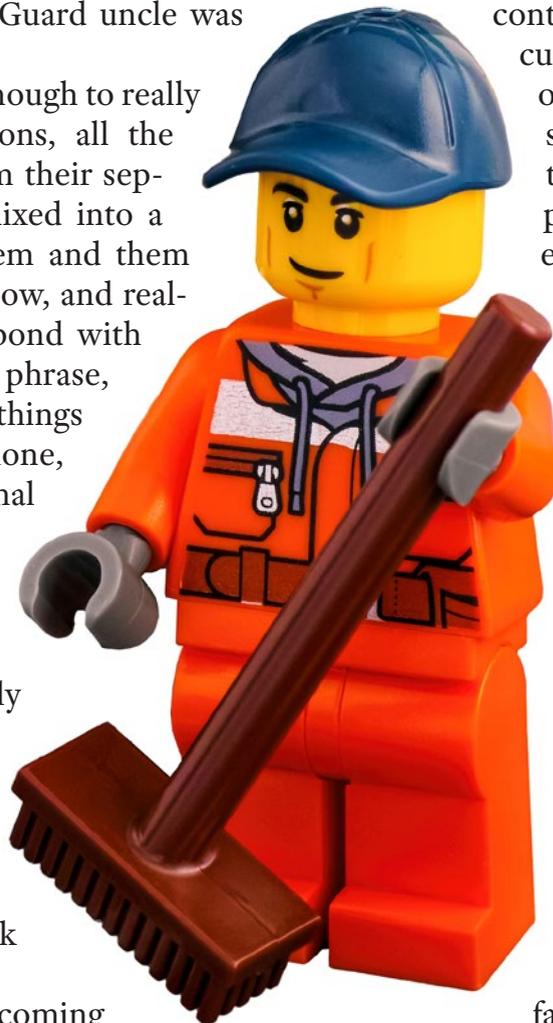
By the time I was old enough to really take in their conversations, all the salty turns of phrase from their separate experiences had mixed into a vernacular unique to them and them alone. I look back on it now, and realize it was part of their bond with each other. That one phrase, however, about leaving things that work well enough alone, has always been a personal favorite. In my youth, that comment evoked images of a slimy, grimy 55-gallon barrel full of sludge with a threateningly crusty-looking layer sealing in all the putrid nastiness underneath. As a young boy, I could relate to the urge to poke that crust with a stick and explore deeper.

And that phrase kept coming

to mind as we compiled this issue on cleaning, surface prep, and coatings. Not so much the image I had as a child, thankfully. We’re leading off this issue with a detailed discussion with Tom Forsythe of KYZEN, who clarifies the differences between cleaning and surface preparation. They are, he says, different in some subtle but significant ways. For example, in our context, *cleaning* can be defined as

the non-transformative removal of contaminants from the printed circuit board. *Surface preparation*, on the other hand, is doing something transformative to the surface to enable further processing. In other words, etching, polishing, or hot air leveling is surface preparation, not cleaning. Even though they may remove contaminants, they’re not cleaning. Part of Tom’s conversation also shines up the lens regarding “no clean” solder and flux products. In some applications, “no clean” is sufficient and using a no-clean protocol increases yields; in other cases, manufacturing simply must clean or risk other contamination issues. In this case, “don’t stir it” changes depending upon the specifics.

Whether it’s cleaning or surface preparation, the purpose is



to prepare for assembly, and soldering. In his writings, I-Connect007 columnist Joe Fjelstad often points out that solder joints are the number one cause of assembly failures. In fact, Joe advocates certain no-solder assembly techniques to eliminate entirely the solder joint and all the weaknesses that entails. But for the foreseeable future, solder joints will be a major factor in attaching components to boards, which means cleaning and surface preparation will continue to be factors as well. “If it don’t stink...”

Once you have those solder joints in place, protecting them from environmental effects becomes important. Coatings come in a wide variety of materials, with a wide variety of application methods, for an immeasurable number of environmental effects from which to protect the electronics. The considerations certainly seem overwhelming. Which is why we turned to Phil Kinner as our expert on the topic for this issue. Not only does Phil weigh in on the current state of coatings in an article on the topic, but elsewhere in the issue we highlight three micro-webinar sessions from Phil’s 12-part series, “Coatings Uncoated,” wherein

Phil packs in a primer on coatings, and a series of case studies in which it did need to be stirred up a bit.

Of course, what the whole editorial team came to realize was that, while the details may be changing with the times, the fundamentals in cleaning and surface prep haven’t changed much at all.

As a part of our ongoing coverage in 2021 for continuous improvement—the year of “ $X = X_c - 1$ ”—cleaning, surface prep, and coatings can be important factors in quality improvements. We enjoy hearing your personal stories about continuous improvement. If you have a continuous improvement experience to share, contact us at editorial@iconnect007.com. SMT007



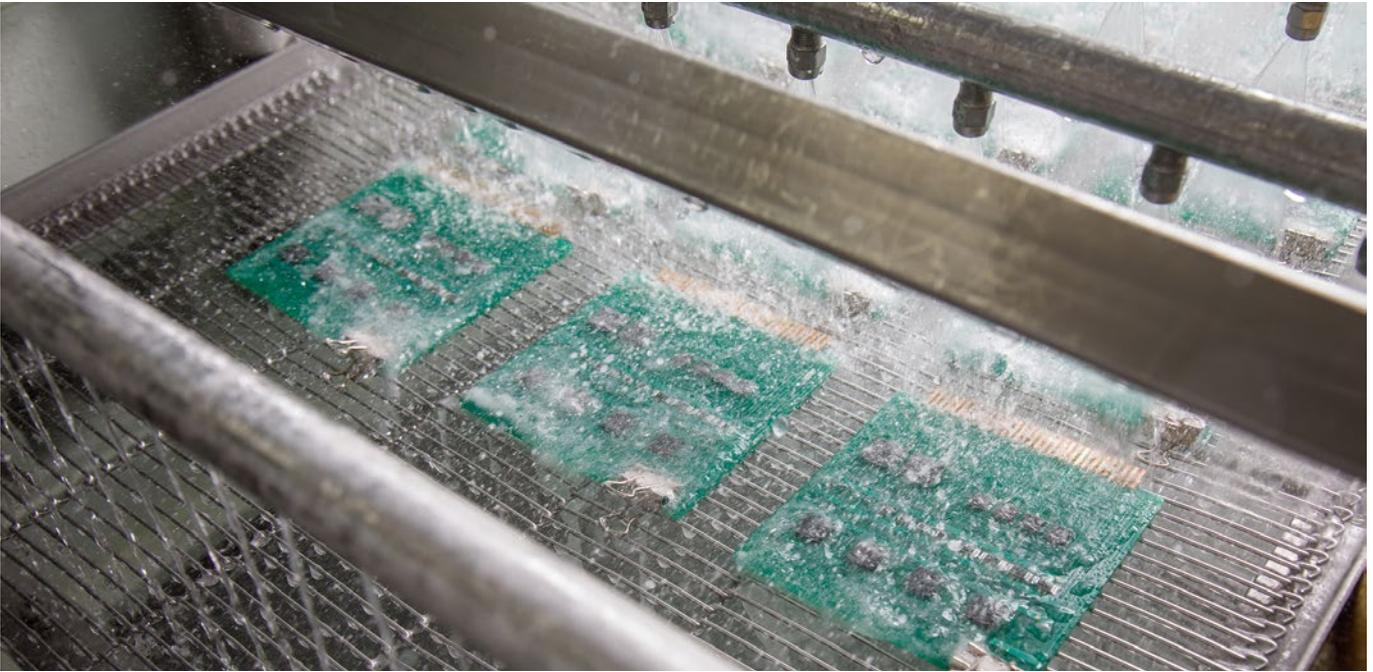
Nolan Johnson is managing editor of *SMT007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing. To contact Johnson, [click here](#).

jobCONNECT007

Companies seeking talent with circuit board industry experience post their jobs with us.



jobconnect007.com



Surface Prep vs. Cleaning

Feature Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson learns the differences between surface prep and cleaning in a discussion with cleaning expert Tom Forsythe of KYZEN, who says the two are not exactly one and the same, with technical jargon around the topic varying from industry to industry.

Nolan Johnson: Tom, let's start by talking about the difference between cleaning and surface prep. These two terms have different implications, and yet they all tie back to reliability for the assembler. How would you distinguish between surface prep and cleaning?

Tom Forsythe: This is a bit of a broad brush, but I believe surface prep is more commonly thought of as step one in a multi-step process. For example, surface prep could prepare a surface for plating. This term is commonly used in plating operations where they will go into a bath and prepare the surface to enhance the adhesion of the next step, and it's certainly

involved in components, advanced packaging, and in a way, probably board fab. Certainly, when they are trying to make sure the copper is stripped down, that's known as surface prep because it's fundamentally changing the surface to make it more attractive for the next step, whereas cleaning doesn't really change the surface.

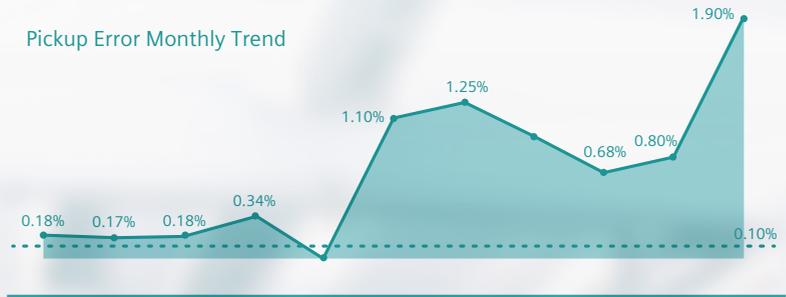
Cleaning removes unwanted contaminants from desired substrates. Generally, your surface remains the way you wanted it. Whatever is in your drawing when you're cleaning is what you have after cleaning, whereas surface prep is on the way to the drawing.

Johnson: So, we're in uncharted territory?

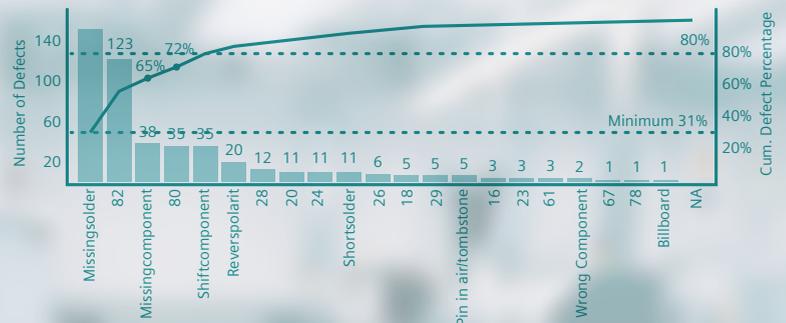
Forsythe: Yes. For example, milling, or often chemical milling, is commonly used in other industries. For example, the road that we live on had a rough winter, and it's getting repaved. Of course, in America and most of the world, they don't actually dig down to the dirt anymore. They scrape it down and then they put new tarmac on top. During the job, the road



Pickup Error Monthly Trend



Defects Pareto



Real-time Manufacturing Visibility

Do you know what's happening on your production lines?

Industrial IoT generates terabytes of data. However, approximately 70% of the data is not used due to the lack of an easy platform that will leverage the data in an intelligent manner to drive business decisions. With Siemens digital solutions you can connect to any machine to get insights, optimize productivity and address challenges immediately.



Webinar on-demand



crew put up a warning sign that read, “Milling operations this week.” I don’t think I’ve ever seen that on a highway sign before.

What were they doing? They were scraping down the surface so they could build it back up again, and that’s exactly what plating and chemical etch people do when they roughen a surface. Sometimes chemical milling can create depressions in certain areas of the surface. In essence, surface prep is changing the surface. Cleaning doesn’t have that notion of changing anything. We get in trouble when we change things. We’re supposed to clean the table; we’re not supposed to take out a saw and shave it down a little bit. The table is supposed to be what it was before that contamination got there.

Johnson: It’s more than cleaning.

Forsythe: It’s a different thing. That’s why surface prep tends to be more of what happens in a fab—making components and boards. Certainly, in the metal business, it’s used in many ways, like pre-plating, pre-painting, pre-coating, and so forth. It’s not a word that you find a lot in your bona fide assembly land. Surface prep doesn’t come up all that much.

Johnson: Where does it come up?

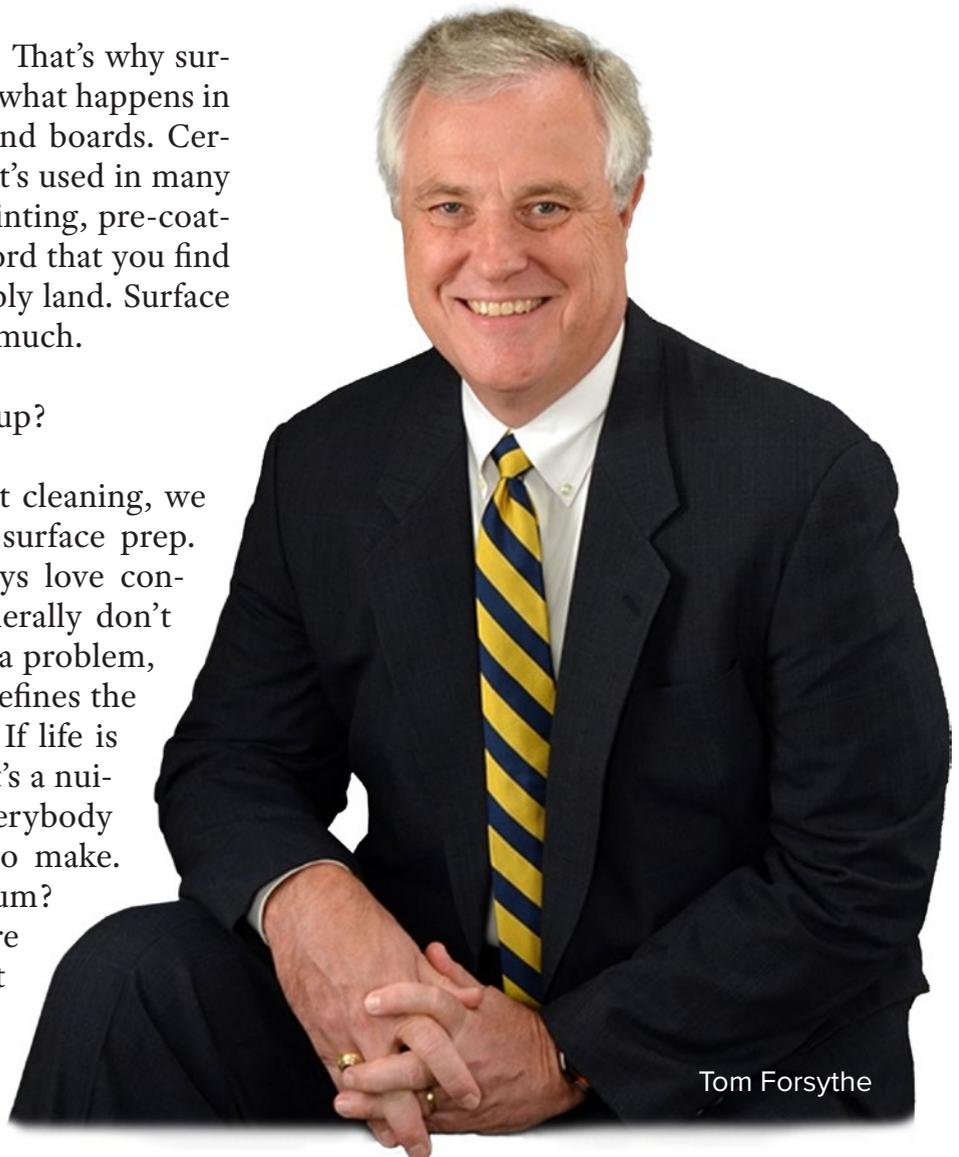
Forsythe: When we talk about cleaning, we are not really talking about surface prep. For example, automotive guys love conformal coating, but they generally don’t clean because if your car has a problem, you don’t die. That actually defines the whole spectrum of cleaning. If life is at risk, everybody cleans. If it’s a nuisance, nobody cleans. Everybody in between has a decision to make. Where are you on that spectrum?

We’re not fabricating; we’re sticking stuff together that mostly stays the same. Solder is probably the one thing that changes, and that

assembly goes on to a new life—whereas surface prep is associated with making the parts and the pieces on the way to that assembly.

Johnson: I like your distinction in that. The primary concern—and I know the contract manufacturers are going to tell me I’m oversimplifying—is making for a good solder joint.

Forsythe: Right. Step one is we’re making electrical devices that are supposed to turn on and do something. If we don’t have a good solder connection, obviously it’s tough to hit that goal. Now, how long everything is supposed to work is a different story. What are the risk factors? Medical and military all use no-cleans. They clean them all because their prod-



Tom Forsythe

uct must function on demand or lives could be at risk. Cleaning doesn't cost that much, and it helps their reliability.

There is a range in between those extremes. You could make a case that if I'm cleaning the part, I'm preparing it for that coating, and it's true, but nobody talks about that because most people that conformal coat don't clean. That would confuse people if we talked about that.

We operate in multiple industries. We operate in the metal side of the aerospace and automotive industries, and the general metal fabrication; they each come with their own different language. What we call batch cleaners, they call cabinet washers. Why do they do that? I have no idea why, but they do. It's a thing.

Think of our smartphones. They used to be free in America. Sign up for two years and the phone was free. That's no longer the case. With all that great utility and these days a relatively high price, we have expectations. We want it to last longer. We don't want it to fail. Well, now maybe phones are moving on that curve from nuisance to maybe not life-threatening, and that is generally more positive for the cleaning guy. The good news is there's lots of good technology out there that can solve these problems. There are good techniques to measure cleanliness and deliver it. We try to be deeply involved in all those areas, and that's why life is fun these days.

Johnson: There may be one place where it is, in fact, surface prep at the assembler side. For example, if boards were built with immersion silver. Now we're managing tarnish. That's not necessarily cleaning, or is it?

Forsythe: Let's back up a step. You could say that simply using flux is surface prep because what the flux is there to do is to remove the oxides from the metal involved in making the joint. That's what flux does. Flux is an oxide remover. What you just described with the silver that tarnished, what are we doing? We're talking about removing the oxide. When we

remove that oxide, there's a little haircut going on in there. You're shaving it ever so slightly.

Johnson: It was silver. Now it's silver oxide. And we're taking it away.

Forsythe: Most metals oxidize. Some things, like aluminum, make a very thin oxide layer and then stop because it doesn't compound. For example, aerospace people with their aluminum—when they clean, they don't want to remove that oxide layer because it will change the dimensions on them. They leave the oxide layer. Of course, they're not soldering. They're screwing things together, mostly.

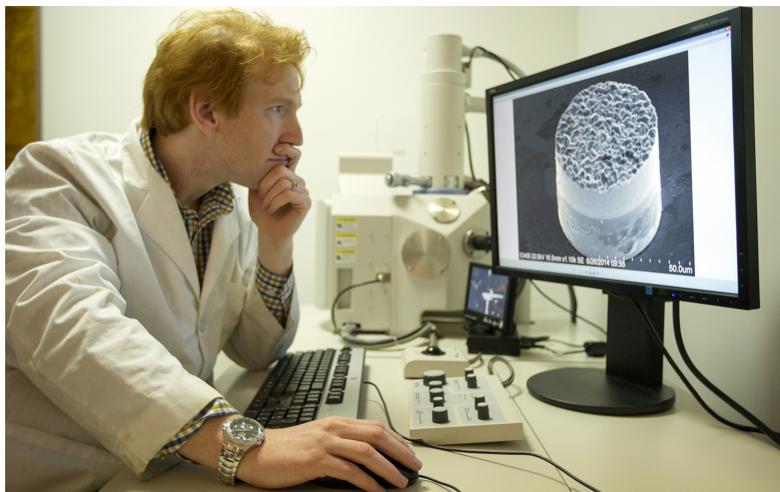
Oxidation varies. For example, ferrous oxide (more often known as rust) doesn't stop. Once you start to rust, it's on the way until all the iron converts to rust. Aluminum is on the other end of the spectrum. Yes, silver tends to tarnish, but sterling silver doesn't disappear. Now, once you

**Once you start to rust,
it's on the way until all
the iron converts to rust.**

remove that oxide layer, what happens next? It starts forming again. That's why we go through the soldering process. What are we doing? We're removing that oxide while simultaneously forming our joint. You're essentially soldering with no surface effect, and some metals take longer than others. In flash rusting you can remove all the rust. It gets wet. The whole thing will rapidly turn into rust again.

So, removing that oxide layer is a surface prep step. It's repeated on purpose in jillions of processes across many industries, but we just never called it that.

Johnson: Nowadays, they use water-soluble so that it is easily cleaned up.



KYZEN's labs are equipped with the latest analytical equipment and staffed with a team of highly trained chemists to provide support to customers worldwide.

solubles are the exception to that, but even they're experiencing a lot of issues these days. They had their day, shall we say, on average. Just like wave solder, nothing ever really dies in the electronics industry. I ask all the solder guys, "How much R&D have you put into something people are going to clean?" They reply, "About zero." If I know I need to clean something, and I'm on that spaceship or need that pacemaker, would I want to use something that's 30 years old? Why would that be attractive? What else do we use that's 30 years old? It's a short list.

Forsythe: Not exclusively, but mostly these days.

Johnson: Then we have processes and technology referred to as "no-clean," which you can leave in place.

Forsythe: Some people can leave it in place.

Johnson: Some of the reliability labs share that cleaning no-clean is often the cause of reliability problems, by exposing materials that weren't supposed to be exposed.

Forsythe: Right. It turns out that doing things badly mostly leads to bad outcomes. For example, why don't they just leave the no-clean on pacemakers? It's a tough question. Life is in the balance. Now, the soldering people view that example as a vast outlier, but you know what? If you're flying to the International Space Station, what's your perception of reliability? What about driving an electric car with batteries that you don't want to catch fire? I'm not so sure they're very different.

The idea that no-clean—left to its own devices is appropriate for every application under the sun—is a concept worthy of a little scrutiny. The world agrees with us, otherwise we wouldn't be in business. A few water

Johnson: Then there are the situational concerns with the components that you are cleaning around.

Forsythe: Cleaning is like dating—when it's going well, there's touching. If the cleaner can't touch the soil, it has no chance of removing it. If the cleaner can't touch it with some mechanical energy, it has less chance of removing it. It has some chance, but it's less. If the cleaner can't get there with some temperature, which for most substrates turns out to be the easiest one to make happen, likewise, that makes it harder. Just like when you're doing your dishes at home, try it with cold water and try it with hot water. It's a little easier with the second technique.

Because of decreasing standoffs and vertical gaps underneath devices, not to mention flush-mounted components, and the general density of things, cleaning absolutely continues to be challenging. Solder people have put most of their R&D investment into no-cleans. Likewise, we in the cleaning world have spent tons of money on R&D trying to make sure we can remove those doggone things. We can and do have data. It all works. However, if you do it poorly, it doesn't work well.

Johnson: Right, which then manifests as increased reliability issues.

never too busy for the little things...



Forsythe: If you assemble it poorly, they don't work well, either. If my pick-and-place system or my reflow oven doesn't work well, how's my reliability going to go? The reality is, we're in an industry where we've got to get everything right almost all of the time. We're not baseball, where if you bat .400, they remember your name for 100 years. We keep talking about four nines, not .400. You've got to do it right. That goes for every process on the line.

That's our world, but we like it, and so do our consumers. We certainly like that world when we get on an airplane, and it doesn't break very often. We like reliability and we think we should work hard to do well.

We certainly like that world when we get on an airplane, and it doesn't break very often.

Johnson: There's a push in the industry to be even more reliable. We're including even more electronics into personal transportation, moving toward electric vehicles. Even if you're not in an electric vehicle, the amount of electronics in your car or truck is dramatic.

Forsythe: Absolutely. There has been dramatic change over the last 20 years or so. Electric cars aside, just look at a typical pickup truck. Years ago, the only electric things were maybe the cigarette lighter, head and taillights, and the radio. That was it. Now, you can't even get into it without electronics. We can't run it without electronics and all those batteries. Batteries are good, but if they are made poorly, they also can do weird things, like catch on fire. That's why you can't take some batteries on airplanes. With that high reliability, it turns out that the general notion of electric vehicles is good for the cleaning guy.

Johnson: Then there's the other part of it in electric vehicles, for example. That's when you start looking at the sensors, the LIDAR, the optical sensors and the Wi-Fi, that need to be connected together for autonomous driving. Suddenly, that requires a mean time between failure that is much higher.

Forsythe: When no-clean came around, it was not a great time to be the cleaning guy. We said, "This really is pretty bad." But time has gone on, and we've all survived because of the combination of the increasing pervasiveness of what might be called mission-critical applications. Now, let's face it, with a manual clutch, you didn't even need a battery to start a car. You could jump-start a car by getting it rolling, then you'd pop it into first gear and the motor would start. It would work. That's not true anymore. That's not even close to true anymore.

The complexity of the systems is not the only thing that's changed; so has this mission criticality perception and expectation. There are more automated parts. That sensor that was just doing dumb things and was not very exciting, now someone could die if that sensor fails so I need an MTBF that's huge. That sensor is probably going to get cleaned to help achieve that level of reliability.

Johnson: And the manufacturer needs hundreds of thousands a month.

Forsythe: God bless them. We couldn't be happier.

Johnson: Tom, how do those pressures change solutions for cleaning? We're talking now about not only being thorough, but also dramatically increased throughput.

Forsythe: Cleaning is a combination of time, temperature, mechanical energy, and a selected operating concentration. We previously talked about the critical nature that the cleaning agent contact the surface to be cleaned. These

days most cleaning materials are water-dilutable, but you need the appropriate concentration of cleaning agent to get the job done. Half isn't good. Double isn't any better, usually. You need mechanical energy, and you also need time. You don't necessarily need a light year's worth of time, but you need time, and the variables are interconnected: if you use more heat, often you can clean more quickly. Same goes for more mechanical energy. Likewise, if the temperature is low, you probably need more time. If the mechanical energy is low, you also probably need more time.

Optimizing a cleaning process is balancing those parameters to get something cleaned well in a reasonable time. Because if you don't get it clean, it doesn't matter how long it takes, no one will do it. If you don't get it clean, it doesn't matter what the product costs, because no one will buy it.

Now, granted, we often employ accelerated life tests to get a more comprehensive picture of reliability. In the cleaning business, you start by trying to clean some parts and then you look at them. There's sophisticated testing often to do beyond visual inspection, but it always starts with looking.

Johnson: There are, however, parameters to pay attention to, job-by-job, design-by-design, to get it right.

Forsythe: Well, it's not generally quite that fluid. It turns out that assemblies all have their challenges, but most clients have a cleaning process that runs the same way for just about everything they make. There are exceptions to that. For example, there are parts and assemblies where water is bad, and those operations use

the solvent cleaning products. There are some edges to the box, but by and large, most people run an in-line or a batch cleaner and most everything they make uses the same process. It's not always true, but it is most commonly true. From that perspective, it's much like the wave solder machine or the reflow oven. If I'm using the same paste, I don't change the reflow generally from product to product. I might, but it's certainly not a draconian change. Obviously, my setup on my pick-and-place changes, depending upon the components. There are different devices and components involved, so

I must do it differently.

There's always a little adjustment to every process, but on average, I think a little less than there are from product to product. There are extremes, it's true. But the old 80-20 rule—if you're in “80” land, you're tinkering a lot less with the cleaning process than you are with anything else on your floor.

Johnson: I'm hearing that it's a pretty forgiving process window.

Forsythe: If you do the process design work right up

front, that is true. Now, if you just magically dream up numbers out of thin air, who knows? If you design and develop your process before going into production, and say, “Okay, this represents what we do. Let's work on this,” by and large, they are robust processes. There are automated control systems, and we sell some of those, where people will set it next to the machine and it monitors the concentration so it's always operating at the ideal concentration. It turns out that makes a lot of things better. Cleaning machines are generally pretty good at holding the desired temperature, just like wave solder machines and reflow ovens. They're



pretty good at that. That's usually okay. You have got your exhaust set up right. If you don't tinker with those ideal settings too much, it's not a process that typically requires a lot of fine tuning. Frankly, people that like to tinker tend to have more problems.

Johnson: You're not tinkering with this job-by-job, but over a time period, especially as the customer technologies and the customer needs migrate.

Forsythe: Absolutely. We don't even keep track of what technology generation we're on anymore because there's been so many of them. Why is that? Because our soils change. The soldering folks are trying to improve the product they sell to their customers. The customers are, in some cases, demanding those improvements. Soldering people are responding with products that meet those needs. Likewise, the designs are getting more compact and more compressed. Why? The end-users want it that way.

The designs are getting more compact and more compressed. Why? The end-users want it that way.

Those are two vectors that influence cleaning product development. We're constantly working on the next generation. We introduce the new product today, the next product's already in the works because we're continually trying to move the ball forward.

Now, of course, we all know that every new design approach does not change every assembly on earth overnight, with the possible exception of QFNs that seem to have gone everywhere. Those old products have their own surface, their useful lives. They are often in production for years. The same thing goes for clean-

ing and soldering materials. There are many customers that do not migrate to new technologies rapidly, and a few that never migrate. They keep those old technologies alive.

Remember, solder paste is nothing but dirt from our perspective. When it's done, the only part that really needs to stay behind is the metal. Metal is the deliverable. That's the part that winds up on the BOM. Now, if I'm encapsulating a no-clean, that encapsulation winds up on the BOM too, but if I clean all that stuff off, all that's left is the metal. The rest is just dirt.

Johnson: That's a great point.

Forsythe: I usually don't make an issue of that with the soldering people, but just like our discussion about surface prep, it's not the right phrase in our industry, but you can make a technical argument that's the case.

Johnson: Right, which helps this discussion, to stop and just look at it a little more philosophically than technically.

Forsythe: Absolutely.

Johnson: What's on the horizon, Tom? Any challenges emerging here?

Forsythe: All you have to do is read the newspaper: electric vehicles, constant medical innovations, the increased utility of our devices. Those are all things that are raising the bar for everyone, whether that's design, assembly, or cleaning. The R&D teams are dealing with some complex challenges and it can take months or years to solve them.

We also see how important environmental factors have become. Since KYZEN was founded in 1990, we've tried very hard to always be the green guy. How do we make it safer for the people? Of course, safety is a relative term. Cleaning must achieve the task, and you do so in the safest possible way, the most

economical, and the quickest time, but you've got to get it done.

Johnson: Cleaning uses chemicals, and water; you have spent material at the end of the process. What are the challenges of handling that, environmentally?

Forsythe: It varies by the process. If you're dealing with stencil or misprint cleaning, where you've got raw paste with all those solder balls and once it's cleaned, you have piles of metal, that can probably go out with the dross. That's got to be dealt within its proper mechanism. Frankly, when we were using lead—which was a very reactive metal—it was laying around cleaning products for a long time, and it was easier for cleaning products to absorb it. Not so much with tin, so that's gotten better over the years.

These are organic materials. For most people, their rinse water will have only minute amounts of the cleaning product in it and an even tinier bit of the soil. In most parts of the world, this will be in complete compliance for disposal down the drain because this is the same waterworks where your gray water goes to and is a massive scale waste processor designed specifically to address low-level organic waste.

Most of these rinse water streams have very low-levels of organic materials, so people sell closed-loop systems, and they work fine, but they don't have that scale that the waterworks can achieve. In some places, you need a special permit. It can be a hassle, so you have to do it wisely. In other places, it's easy to be compliant. The products themselves typically have higher organic levels than the rinse water. The soils will eventually build up in the wash tank if it is doing its job. It generates a little bit of waste, but it's not a lot and usually is not a big driver. The issues do come up from time to time. The solvent guys used to talk about that all the time because they liked to boil off the solvent. The soil doesn't really evaporate, their



Ultrasonic cleaning ensures the cleaning agent reaches every surface of the circuit boards.

approach is to wrap it in less solvent, so it's in a smaller box.

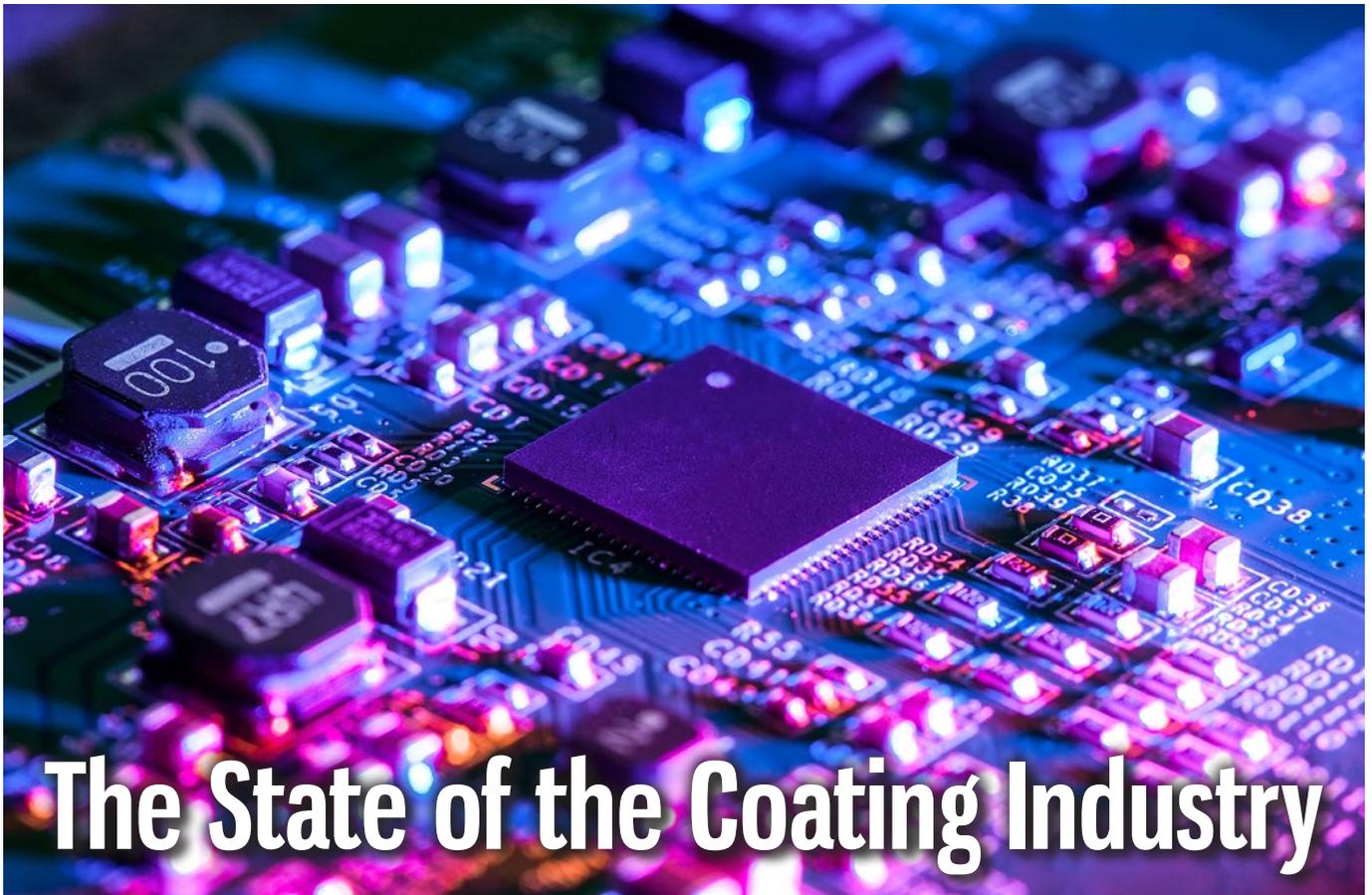
Fundamentally, when you really look at the nuts and bolts of waste, it turns out not to be the biggest issue. Eliminating lead has helped with that a lot, frankly. You only needed a few parts per million lead to become hazardous material. A few parts per million isn't really very much.

Johnson: Right. Tom, any parting thoughts?

Forsythe: The key to engineering and science is to get granular, and when you do that, the difference between surface prep and cleaning is easy to grasp. When you go up to 10,000 feet or higher, now it's not the same. There's a lot of surface prep stuff that's very clearly not cleaning. That's probably why in the assembly world that word never really caught on.

Johnson: This has been insightful for me. There are times when any of us can be in the industry for a long time and just stop, step back, look at it, and come away with a completely different, changed perspective, and a bit more context for everything. It's as simple as that.

Forsythe: That's the key to everything. The key is context. I'm glad I could be helpful. I appreciate the opportunity to talk about it. It's always fun. **SMT007**



The State of the Coating Industry

Feature Article by Phil Kinner
ELECTROLUBE

2020 was certainly an interesting year—one that most of us will choose to forget. The list of challenges was seemingly endless: plant shutdowns, project cancellations, component shortages, furloughs, working from home, Microsoft Teams, Brexit, and so forth. Fortunately, life continued largely unchanged for those of us on the R&D team at Electrolube and we were able to complete many of our longer-term projects without the usual day-to-day interruptions. I would say, a win is a win!

As a result of the tremendous progress heralded by the vaccination programme, hope of a return to “normality” is high. However, what will normality look like as we move forward?

Several trends have really stood out as the first half of 2021 comes to a close. First, 150°C appears to have become the “new normal” for the maximum required operating temperature

of conformal coatings for automotive use. This is an increase from 85°C or 120°C on the last generation of products. This new high is really pushing the limits of availability from traditional coating chemistries, but happily for us, this is not a surprise as we have been preparing for this very moment over the last few years—applying ourselves to the generation of solutions and products that support the new requirements.

Condensation resistance continues to grow in importance, increasing in prominence within many new customer specifications. Historically, conformal coatings have been predominantly applied to provide a barrier against the effects of humidity on the underlying circuit. This is not nearly as challenging a scenario as a condensing environment, where the presence of liquid water provides new tests, both to the thickness and coverage achievable. Liquid water will seek out any weak spots in the protection afforded and corrosion takes place



STRUGGLING WITH OBJECTIVE EVIDENCE?

25 years experience ...
we wrote the book*



AutoSIR2+
Surface Insulation
Resistance



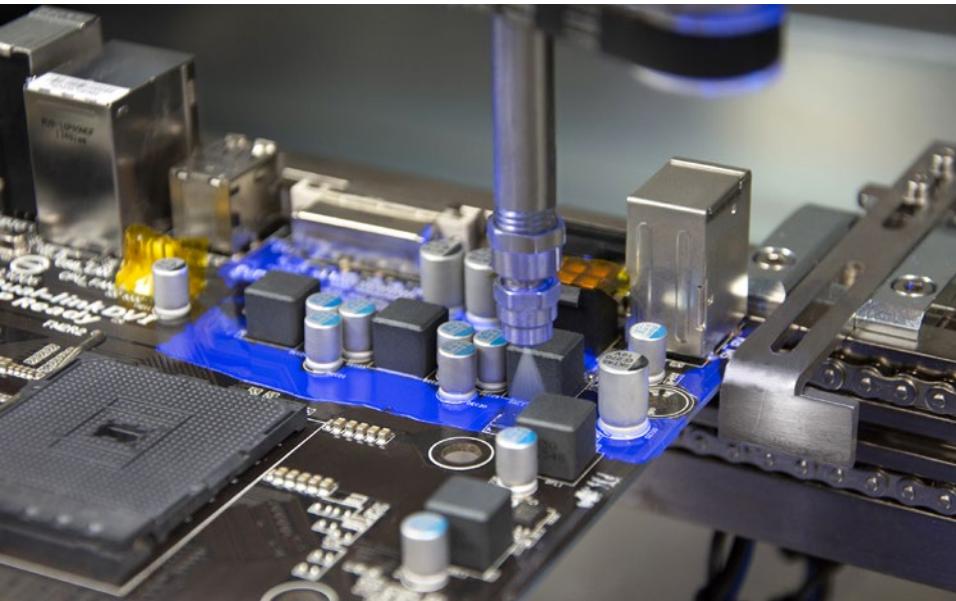
CM+ Series
Process Control
< 15 Minutes



Statistically 99.99966% defect free

*Download the
book here





A programmable robotic spray nozzle applies the conformal coating to selective areas of the circuit board for an efficient, repeatable result.

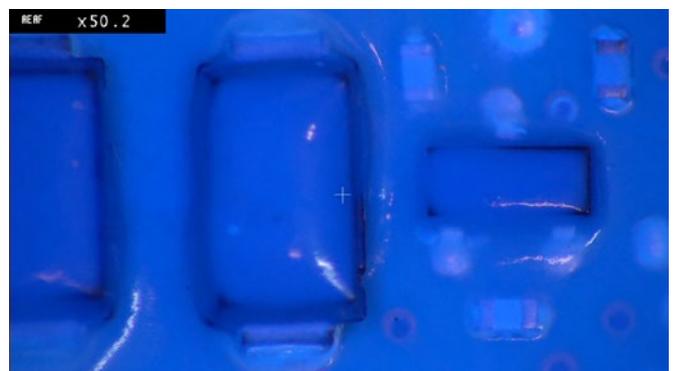
much more quickly if this is present. Liquid water can also change the electrical properties of many coatings, causing them to become less insulating than expected—leading to leakage currents and other unexpected electrical behaviours that result in faulty performance of the assembly. We have witnessed many cases of late whereupon companies are performing condensation testing of powered assemblies coated with historical materials and processes, which fail very rapidly, as predicted by the NPL's recent industry project. Thankfully, there are materials and processes available that can maintain operation and prevent corrosion and failure events under condensing conditions.

Environmental issues have really been in the spotlight over the past 12 months as pollution levels have dropped in many areas due to various lockdowns—despite huge ice sheet breakages and raging wildfires. Throughout the world, governments have pledged commitments to a variety of agreements aiming to reduce greenhouse gases and minimize climate change. For example, this year China has effectively banned the use of certain solvents used in many legacy coating formulations,

and heavily restricted the use of solvents in general coatings applications. Whilst conformal coatings are currently exempt from this legislation, it is not hard to imagine that they will be targeted in further legislation or perhaps even the next revision. This has had a knock-on effect with the environmental aspect of corporate social responsibility (CSR) starting to become more apparent at the material specification level. For the first time in my 22 years in the conformal coating industry, I have seen several specifications that specifically preclude the use of solvent-

containing or solvent-emitting conformal coating materials. This is not only a great step forward for the environment, but a great step forward for the material users as well. Solvent-free alternative materials are generally higher performing in condensing environments and can have the ability to meet the requirements of the increased maximum thermal operating temperatures.

The IPC-CC-830 Conformal Coating Standard Committee is currently looking to introduce several new classes of coating materials. This reflects the newer types of products that have been introduced to help meet some of these new industry requirements.



Electrolube AFA being applied under UV light.

However, since the pass/fail criteria remains the same for materials from different classes, users will still be required to ensure that the materials are fit for purpose and meet their requirements.

Electrolube remains committed to providing conformal coating solutions to meet current challenges but also pay attention to future requirements. The novel, high-performance, solvent-free 2K range of conformal coatings, initially introduced some five years ago, is finding commercial success in many applications. Improved environmental credentials, as a result of the solvent-free nature and lack of by-products from curing, sit happily alongside improved condensation resistance and are the hallmarks of the 2K range.

As for me, I am really looking forward to resuming live and in-person events where I can talk about conformal coating solutions and solve customer's challenges and issues with

them. I'm also really excited about the product launches we will be making later in the year, as well as unleashing future innovations from our R&D pipeline. Finally, I am really looking forward to our integration journey into MacDermid Alpha Electronics Solutions and the benefits that will see continued investment and the opportunity to work with a much larger global team. 2021 is shaping up to be a very exciting year personally, professionally, and for the industry in general. **SMT007**



Phil Kinner is the global business and technical director of conformal coatings at Electrolube. To read past columns or contact Kinner, click [here](#). Download your free copy of Electrolube's book, *The Printed Circuit*

Assembler's Guide to... Conformal Coatings for Harsh Environments, and watch the micro webinar series "Coatings Uncoated!"

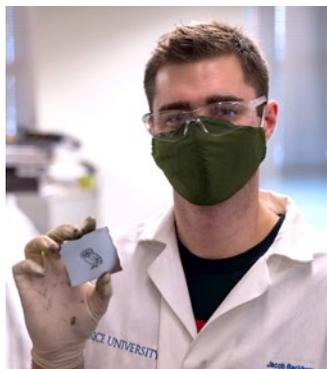
Rice Lab Uses Laser-Induced Graphene Process to Create Micron-Scale Patterns in Photoresist

A Rice University laboratory has adapted its laser-induced graphene technique to make high-resolution, micron-scale patterns of the conductive material for consumer electronics and other applications.

Laser-induced graphene (LIG), introduced in 2014 by Rice chemist James Tour, involves burning away everything that isn't carbon from polymers or other materials, leaving the carbon atoms to reconfigure themselves into films of characteristic hexagonal graphene.

The process employs a commercial laser that "writes" graphene patterns into surfaces that to date have included wood, paper, and even food.

The new iteration writes fine patterns of graphene into photoresist polymers, light-sensitive materials used in photolithography and photoengraving. Baking the film increases its carbon content, and subsequent lasing solidifies the robust graphene pattern, after which unlasered photoresist is washed away.



Details of the PR-LIG process appear in the American Chemical Society journal ACS Nano.

"This process permits the use of graphene wires and devices in a more conventional silicon-like process technology," Tour said. "It should allow a transition into mainline electronics platforms."

The Rice lab produced lines of LIG about 10 microns wide and hundreds of nanometers thick, comparable to that now achieved by more cumbersome processes that involve lasers attached to scanning electron microscopes, according to the researchers.

Because the positive photoresist is a liquid before being spun onto a substrate for lasing, it's a simple matter to dope the raw material with metals or other additives to customize it for applications, Tour said.

Potential applications include on-chip microsupercapacitors, functional nanocomposites, and microfluidic arrays.

(Source: Rice University)



Cleaning **and** Inspection

Feature Article by Graham Naisbitt
GEN3

Determining acceptable cleanliness demands significantly more investigation than has historically been the case. Until recently, the industry has been too reliant on the use of a “cleanliness” level of $<1.56 \mu\text{g per cm}^2 \text{NaCl}$ equivalence. That has been removed from the venerable IPC-J-STD-001 now in Revision H.

With increasing packaging density, coupled with hostile operating conditions, the incidence of circuit failure has increased. Such failures are, most likely, the result of adverse electrochemical migration. Dendrites are the result.

Today’s non-negotiable requirement is to produce objective evidence. As can be seen from Figure 1, the two tools that have been proven to be up to the task, are SIR followed by PICT. What can also be seen is the plethora of issues that must be addressed.

For far too many years, the industry had been using the term “cleanliness,” which was particularly unsuitable because:

- Cleanliness assumes you have tested all possible contaminants on the board. You can’t do this.
- Process control assumes you are removing the same contaminants every time. You can do this reliably and reproducibly.



***LEAVING THE OTHERS
IN OUR DUST BY INVESTING
IN SPEED & TECHNOLOGY***

While others struggle just to keep pace, we stay ahead of the curve by constantly investing in the equipment, people and resources needed to be the best total PCB solutions provider in the industry.

VIEW OUR CAPABILITIES

EAGLE
electronics Inc.



www.eagle-elec.com

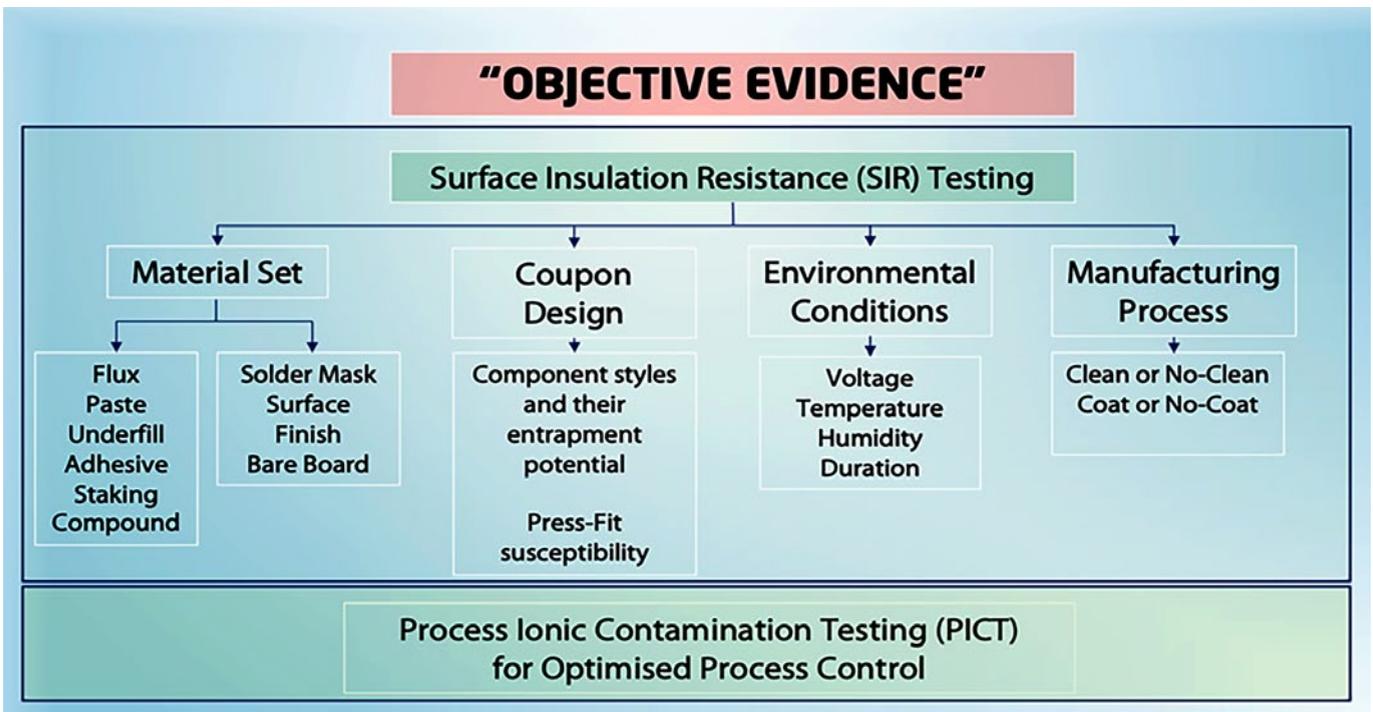


Figure 1: Types of objective evidence.

As explained in the new IPC WP019B, the requirement is to use SIR. This technique measures changes to insulation resistance by examining a representative example of the intended end-product from an electro-chemical standpoint.

- It determines whether the product will be electro-chemically reliable
- It is not able to determine what is presently causing a problem

If a problem is encountered, then other analytical methods are required such as ion chromatography and FTIR. These methods measure the amount of ionic residues on the test sample.

- It is not able to predict if the end-product will be electro-chemically reliable
- Nor is either of them able to detect non-ionic material that is most commonly present in modern process materials

As can be seen, there is no one-size-fits-all answer.

Regarding inspection, techniques such as 3D inspection microscopy and scanning electron microscopy are proving to be valuable inspection tools. However, care must be taken when conducting these levels of inspection as it is all too common to scare yourself at what you can now see for the first time.

New component technology, often incorporating bottom terminations (BTCs), are offering a challenge to those who clean, given that the component stand-off is so tight. It is not only the issue of ensuring penetration of the cleaning media to the underneath of the component, but the escape of the resulting “porridge.”

SIR is the most effective tool to measure the actual performance of the desired cleaning process, and is why GEN3 is collaborating with Zestron to help the industry move into this new territory.

New international standards have already been published to help industry address the issue:

International Electrotechnical Commission IEC

• *Authors' comment: (P) = Already published*

- **61189-5-501 (P):** Test methods for electrical materials, printed boards and other interconnection structures and assemblies. Part 5-501: General test methods for materials and assemblies. Surface insulation resistance (SIR) testing of solder fluxes.
- **61189-5-502 (P):** Test methods for electrical materials, printed boards, and other interconnection structures and assemblies. Part 5-502: General test methods for materials and assemblies. Surface insulation resistance (SIR) testing of assemblies.
- **61189-5-503 (P):** Test methods for electrical materials, printed boards, and other interconnection structures and assemblies. Part 5-503: General test methods for materials and assemblies. Conductive Anodic Filaments (CAF) testing of circuit boards.
- **61189-5-504 (P):** Test methods for electrical materials, interconnection structures and assemblies. Part 5-504: General test methods for materials and assemblies. Process ionic contamination testing (PICT).
- **TR 61189-5-506 (P):** An inter-comparison evaluation to implement the use of fine pitch test structures for surface insulation resistance (SIR) testing of solder fluxes according to IEC 61189-5-501 (TR = Technical Report).
- Where from? IEC.CH Webstore. **SMT007**



Graham Naisbitt is president of GEN3. He is a member of IEC TC91 WG2, WG3 & WG10, is a maintenance leader for a number of published documents having to do with cleanliness, and is on numerous IPC sub-committees and task groups on solderability and cleaning. Naisbitt is also the author of *The Printed Circuit Assembler's Guide to Process Validation*.

Increasing Board Complexity Drives the Need for Accurate & Speedy Inspection

Readers of *The Printed Circuit Assembler's Guide to SMT Inspection: Today, Tomorrow, and Beyond* are treated to a brief history of SMT inspection, learn the benefits of data-driven analytics and how intelligent software solutions can help companies analyze and optimize the production process. [Watch this video](#) or visit [I-007eBooks](#) for more info.

The image shows a video player interface. On the left is the cover of the book 'THE PRINTED CIRCUIT ASSEMBLER'S GUIDE TO... SMT INSPECTION: Today, Tomorrow, and Beyond' by Brent A. Fischthal, Rich Young America. The cover features a circular image of a printed circuit board with glowing components. To the right of the book cover is a large green play button icon with the text 'Download today!' in white. Below the play button is the URL 'I-007ebooks.com/smt-inspect' in green. At the bottom of the video player, there are standard playback controls and a progress bar showing 1:49 / 2:00.

CLEANING AND COATING

Webinar Highlights

Feature Article by Phil Kinner
ELECTROLUBE

Electrolube's Phil Kinner has been providing I-Connect007 readers with information, guidance, and practical tips on the uses and applications of conformal coatings through Team Electrolube's "Sensible Design" columns published over the last four years.

Now, we're revisiting four sessions from Kinner's 12-part micro-webinar series, "Coatings Uncoated." In the series, Phil examines conformal coating chemistries, including their properties, applications, issues to be mindful of, and the processes you should follow to achieve a successful coating outcome.

What is a micro-webinar? Divide a complicated technological topic into a logical sequence of concise, focused sections delivered online by a recognized expert, and you have an effective formula for transferring knowledge in clear-cut increments to a wide audience.

Kinner is a highly respected name and a familiar face throughout the global electronics industry. He is the acknowledged expert on conformal coatings. In these selected webinars, we concentrate on some of the coatings topics most closely aligned to cleaning.

Webinar 1: An Introduction to Conformal Coatings

In his introduction, Kinner explains the general characteristics of conformal coatings, groups coatings into three general types, and lists the seven generic categories recognized in the IPC-CC-830C qualification and performance specification.



Webinar 3: Corrosion and Tin Whisker Migration Understood

In this segment, Kinner covers the elements required to invoke corrosive damage and the role of cleaning. How can cleaning and conformal coating protect the board from corrosion and mitigate against the effect of tin whiskers?

Webinar 5: Not All Acrylics are Created Equally

How can additional data, including test results, ensure a greater understanding of the most suitable coating for your application? This segment shares highly focused educational information on conformal coating and encapsulation.

Webinar 12: The Next Generation: 2K Conformal Coatings

In this final segment, Kinner examines how these coatings differ from the more traditional options, such as how they perform like a resin and behave like a coating.

The entire "Coatings Uncoated!" webinar series can be viewed in an hour and covers a comprehensive range of hot topics and application-relevant case study overviews, as well as back-to-basic subject matter and issues, such as condensation and contamination. Each of the 12 segments can be viewed in about five minutes. **SMT007**

Download your free copy of Electrolube's book, *The Printed Circuit Assembler's Guide to... Conformal Coatings for Harsh Environments*, and watch the micro webinar series "Coatings Uncoated!"

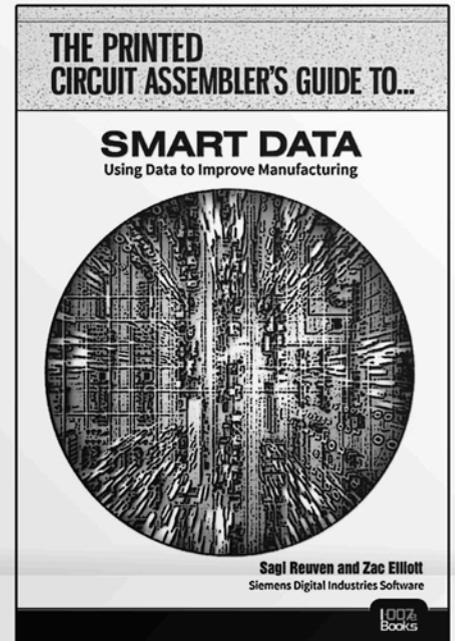
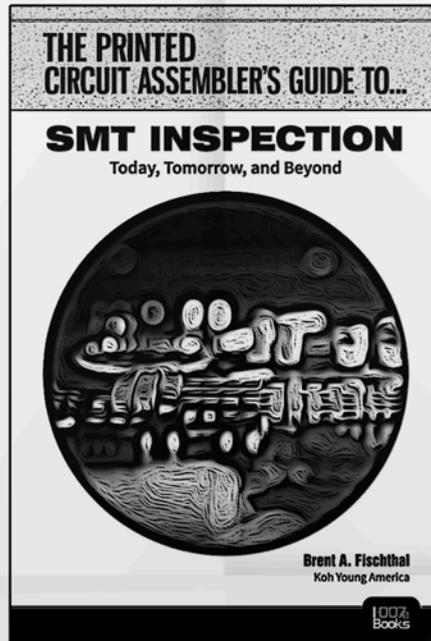
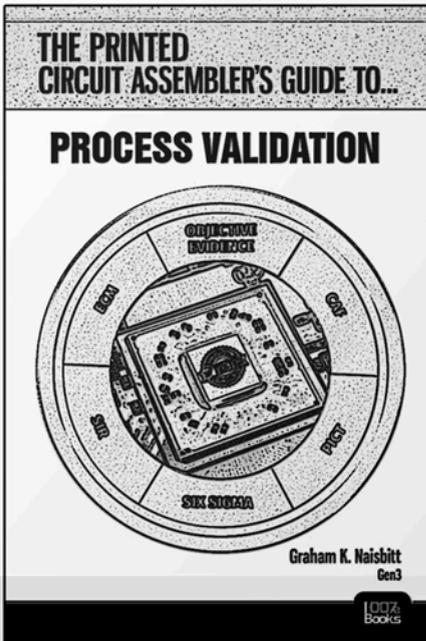
E-BOK*



STEP 1

STEP 2

STEP 3



DOWNLOAD

DOWNLOAD

DOWNLOAD

100% Books

*Some assemblers required



MilAero007 Highlights



PRIDE Industries: A Nonprofit EMS and Staffing Firm Moves Into Mil-aero ▶

PRIDE Industries is a contract manufacturing provider with a twist: The company provides training and coaching for job seekers with disabilities, including service-disabled veterans. If they don't have openings in their Sacramento facility, they may have a job for you in one of 15 other states.

Adventures in Engineering: Component Unavailability ▶

Component unavailability is a thorn in the side of everyone, from engineering to manufacturing, and is manifested in many ways—obsolescence, long lead times, raw material shortages, and catastrophic events (fires, natural disasters) to name a few.

Consider This: Termination of Flex Circuits ▶

There are many ways to terminate and connect flexible circuits to a rigid PCB. The most widely used technologies fall into four main categories: Reinforced male finger contacts, unreinforced male finger contacts, standard through-hole and surface mount PCB connectors and insulation displacement connectors.

TT Electronics Announces Move to Facility Near Dallas ▶

TT Electronics, a global provider of engineered electronics for performance critical applications, is consolidating its North American Sensors and Specialist Components operations and moving into a new, purpose-built facility in Plano, TX.

Lockheed Martin, Thales Australia to Develop Sovereign Weapons Manufacturing Capabilities in Australia ▶

Lockheed Martin and Thales Australia have finalized a teaming agreement advancing the delivery of an Australian guided weapons manufacturing capability in support of a sovereign national guided weapons enterprise.

Emerald EMS DataED Manufacturing Site Earns AS9100D Certification ▶

Emerald Electronics Manufacturing Services (Emerald EMS) announced that its DataED facility, located in Salem, N.H., is the third of its manufacturing sites to attain the AS9100-2016 Rev D certification, an essential quality control standard for serving the aerospace and defense market.

Lenthor Engineering Adds Joel Robbins as Business Development Manager ▶

Lenthor Engineering, Inc., a California-based designer, manufacturer and assembler of flex and rigid-flex printed circuit boards, has added Joel Robbins in the role of business development manager, with primary responsibility for the South Central and South East territories.

WHMA/IPC Announces Dates for M-EXPO 2022 ▶

The fourth M-EXPO Wire Processing Technology exhibition (M-EXPO) will be held in Ciudad Juárez, Chihuahua, Mexico, September 21-22, 2022. Due to ongoing COVID-19 health and welfare concerns, the event will not be held in 2021.

Your circuit boards delivered...

**1
DAY
LATE**

**2
DAYS
LATE**

**3
DAYS
LATE**

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

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



Prototron Circuits
America's Board Source

www.prototron.com

Part 2—Making the Announcement

Maggie Benson's Journey

by Ronald C. Lasky, Ph.D., INDIUM CORPORATION

(Editor's note: Indium Corporation's Ronald Lasky continues this series about Maggie Benson, a fictional character, to demonstrate continuous improvement and education in SMT assembly.)

It was now just after Christmas and Millie Johnson was nervous. There were all sorts of rumors about Benson Electronics (BE) being sold to a venture capital firm, and massive layoffs were expected. "Gramps" Benson had called for an all-employee meeting, and everyone at the plant expected the worst. Millie's son was a senior in high school, and she was so proud that he got a full scholarship to nearby Ivy University. However, there were still many costs not covered by the scholarship and, as a single mom, the thought of losing her job was just too much to take.

The meeting started, and Gramps Benson began to speak.

"I know there have been a lot of rumors about BE being sold to some venture capital firm...it's not true," Benson began. "My granddaughter, Maggie, and her fiancé, John, are taking over so me and the missus can retire."

There was an audible sigh of relief among the score of workers.

"So, let's see what Maggie and John, the new owners, have to say," he continued.

Maggie got up to speak, looking a little more self-assured than she felt.

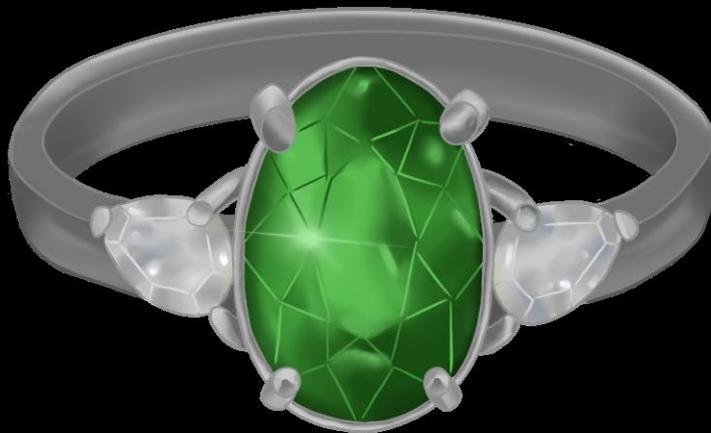
"I would like to start by saying that there will be no layoffs. As a matter of fact, we will be hiring. Also, as of today, everyone gets a 10% raise," Maggie said to the group.

The crew erupted in cheers and applause. It was a little hard for Maggie to continue speaking.

"We plan on leasing the building next door and adding a prototype line. We have a com-



Maggie Benson





AWARD-WINNING SERVICE AND SUPPORT

Koh Young customers have access to a global network of service and support locations. As customers join the Koh Young family, we want to ensure their success with solid training, technical service and applications support.

- Leverage our local, focused applications engineering team to meet your specific manufacturing challenges.
- Advance your skills with varying levels of training either in your own facility or at one of our Americas training centers.
- Gain from other offerings like preventative maintenance kits, service contracts, OEE improvement assistance, product traceability, extended warranties, calibration services, and more.



.....
WINNER
.....



TECHNICAL
SUPPORT



EXPERT
RESOURCES



KNOWLEDGE
BASE



SERVICE
REQUESTS



DEDICATION



GLOBAL TEAMS



EXCELLENCE



RELIABILITY

kohyoungamerica.com
America@kohyoung.com

mitment from Acme CEO, Mike Madigan, for more than enough business to fill the new line. So, if you know anyone looking for a job, have them contact me,” she continued.

“Before I continue, are there any questions?” Maggie asked.

“Some of us feel like we could use some training,” a young fellow named Josh commented.

“Let me handle that one,” said John. “We plan on implementing several levels of training for all employees. Our expectation is that we will be so busy with orders from customers that the training will require overtime, paid at time-and-a-half.”

This comment elicited more cheers. The meeting went on with comments and questions for 30 minutes before Gramps Benson mentioned that there was pizza, salad, and drinks in the breakroom for all.

While eating the pizza, most of the employees came up to Maggie and John to congratulate them and offer thanks for the good beginning. After a while, the folks went back to work and Maggie and John were left alone to chat.

“Frank Emory, my MBA friend, said that after a quick look at the books, it was obvious that there was one customer that was a stand-out in poor profit performance,” John began.

“Let me guess: Aqualine Industries,” Maggie stated.

“How did you know?” John asked.

“Because they have insisted that Excelsior solder paste be used,” Maggie replied.

“We evaluated that paste at Acme; it has terrible response-to-pause, but it is the cheapest,” John said. “Frank performed a cost analysis, with ProfitPro™ (Figure 1) and determined that if we used a paste like Maxima 78, we would save tens of thousands of dollars per month, even

though Maxima 78 costs \$0.03 per gram more.”

BE had a fixed price contract with Aqualine, so time lost to response-to-pause paste issues was absorbed by BE.

“Let’s switch to Maxima as soon as we can,” Maggie suggested.

“I guess now is the time for big changes, huh?” John said with a smile as he eyed Maggie’s engagement ring. Maggie returned the smile and responded, “It most certainly is.”

Epilogue

Excelsior was written into Aqualine’s contract with BE, but the contract was old and the current purchasing manager at Aqualine had no problem with BE switching to Maxima as long as BE paid the solder paste price difference.

Response-to-Pause

On a regular basis, electronic assembly lines have to be “paused” to add components to the placement machines and other necessary steps needed to keep the lines running. During this pause period, some solder pastes stiffen and the first print on the stencil printer must be rejected. The lost time due to this issue seems small, maybe a few minutes in each event; however, it can quickly add up to hours over a week as shown in this example (Figure 1).

Stay tuned for the next episode where Maggie, John, and the team address poor uptime.

Three days earlier...

Both Maggie and her now fiancé, John Isaacson, had always admired Professor Patty Coleman’s engagement ring. It was unusual in that it was an emerald surrounded by two diamonds.

They had taken Patty’s course, “Materials: The Substance of Civilization.”^[1] In the course,

Title of Run	Total Sales	Unit Profit	#Units	Total Profit	Δ to Baseline
Excelsior	\$32,525,031.00	\$8.98	281,602	\$2,528,963.62	
Maxima 78: 3 hours less downtime per week	\$33,729,580.50	\$9.54	292,031	\$2,785,963.38	\$256,366.77

Figure 1: Because Excelsior solder paste has poor response-to-pause, three hours of running time are lost each week. This lost time ends up costing BE more than \$250K per year.



Figure 2.

Professor Coleman mentioned that natural emeralds of good quality are so rare that all of the emerald mines of Colombia produce only a few good quality, 2-carat emeralds per year.

Secretly, John met with Professor Coleman and asked her where he could find a ring like hers. Fortunately, her father-in-law had connections, and he was able to get John the ring (Figure 2) at a very good price. Needless to say, Maggie was thrilled with the ring! **SMT007**

References

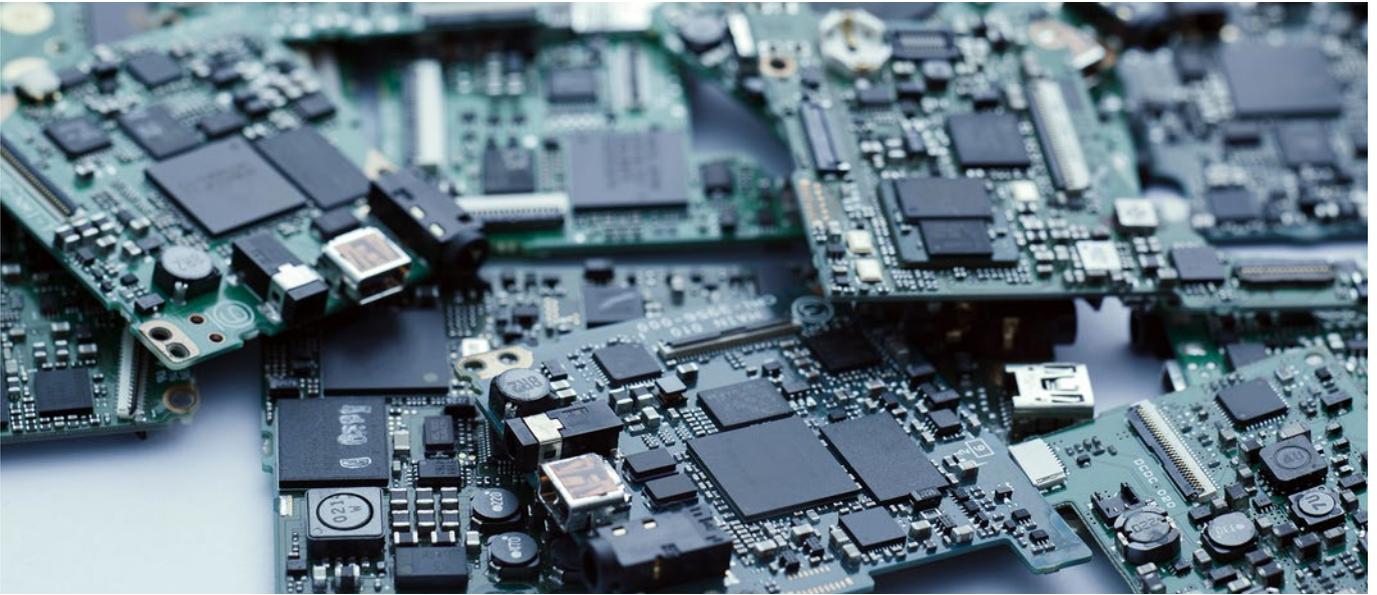
1. "Materials: The Substance of Civilization," Dartmouth University.



Ron Lasky is an instructional professor of engineering for the Thayer School of Engineering at Dartmouth College, and senior technologist at Indium Corporation. Image of Maggie Benson by Sophie Morvan. To read past columns, or contact Lasky, [click here](#).

1007e

Get smarter here.



Failure Analysis Case Studies on Solder De-Wetting for Electronics Products

Article by Jasbir Bath^[1], Kentaro Asai^[2],
Shantanu Joshi^[1], Roberto Segura^[1]

KOKI SOLDER AMERICA INC.^[1], LAKE ELSINORE, CA, USA
KOKI COMPANY LIMITED^[2], HIKI-GUN, SAITAMA, JAPAN

Editor's note: This article/paper was presented at IPC APEX EXPO 2021 and was published in the Proceedings.

Abstract

Over many years defect analysis has been used at the company to determine the root cause of various defects experienced in the field on electronic products from customers. Based on this work it has been found that around 25% of all case studies have been due to de-wetting issues.

De-wetting is an issue with the solder joint where the molten solder and the substrate/component repel each other during the soldering process. Due to this a very weak or no intermetallic bond is formed at the interface after reflow leading to defective and unreliable solder joints.

Case studies in this area will be reviewed based on root cause analysis and countermeasures to prevent these defects. These case studies are related to inferior component/board plating quality, contaminated plating on both the PCB as well as the component, foreign object debris (FOD) as a cause of the de-wetting of solder, damaged component plating, and improper off-set solder paste printing. The results of the failure analysis are reported.

Introduction

Electronics products are generally reliable. On occasion, defects occur during the manufacturing process which require determination of root cause to improve manufacturing yield and reliability. These defects are sent out to failure analysis laboratories or analyzed internally at the manufacturing company.

Solder paste material suppliers are contacted on occasion to provide input into a soldering defect for root cause analysis. Over many years defect analysis has been used at the company to determine the root cause of various defects

We are dedicated
to excellence through

innovation, technology and most importantly, service.



COMMERCIAL • MILITARY • MEDICAL • BAREBOARD



U.S.CIRCUIT

www.uscircuit.com



experienced in the field on electronic products from customers.

Reviewing the various defect causes, it was found that around 25% of all case studies have been due to de-wetting issues. The following sections will review a series of case studies related to de-wetting issues based on root cause analysis with input provided on countermeasures to prevent these defects based on the company's knowledge and experience in this area. These case studies are related to inferior component/board plating quality, contaminated plating on both the PCB as well as the component, foreign object debris (FOD) as a cause of the de-wetting of solder, damaged component plating and improper off-set solder paste printing.

Experimental

Electronic product from different customers was analyzed. All five cases investigated showed solder de-wetting. The five different de-wetting case studies were classified into the following categories which are then discussed in further detail:

1. Inferior board plating/surface finish quality
2. Contaminated plating
3. Foreign object debris (FOD)
4. Damaged plating
5. Improper process condition setting

Inferior board plating/surface finish quality (Case Study 1)

Defect observed

Solder de-wetting occurred on the pad substrate. The no-clean solder paste material soldered on the pad was Sn3Ag0.5Cu Type 4.

Type of analysis equipment used to observe and characterize defect

The surface and cross-sectional observation of the HAL (hot air solder level) board surface

finish treatment was performed using an optical microscope and a SEM (scanning electron microscope). The optical microscope used is shown in Figure 1. The SEM used is shown in Figure 2.



Figure 1: Optical microscope.



Figure 2: Scanning electron microscope.

Contaminated plating (Case Study 2)

Defect observed

Solder de-wetting occurred on the pad substrate. The no-clean solder paste material soldered on the pad was Sn3Ag0.5Cu Type 4.

Type of analysis equipment used to observe and characterize defect

SEM (scanning electron microscope) with EDX (energy dispersive X-ray) analysis and X-ray observation was performed on the pad substrate for both good and poor solder wetting. The X-ray equipment used is shown in Figure 3.



Figure 3: X-ray equipment.

SEM (scanning electron microscope) with EDX (energy dispersive X-ray) analysis.

Improper process condition setting (Case Study 5)

Defect observed

Solder de-wetting occurred on the pad substrate. The no-clean solder paste material soldered on the pad was Sn3Ag0.5Cu Type 4.

Type of analysis equipment used to observe and characterize defect

Pad substrates with good and poor solder wetting were observed by optical microscope.

The following section discusses the defects observed with the analysis equipment used for the different case studies reported.

Results and Discussion

Inferior board plating/surface finish quality (Case Study 1)

Analysis of board plating/surface finish quality results

An uneven HAL (hot air solder levelled) treatment layer thickness can be observed. The composition of the HAL surface treatment was Sn3Ag0.5Cu on the copper pad substrate. The area with the HAL treatment can cause de-wetting due to the Cu (copper) board pad substrate oxidation which is shown in Figures 4 through 7.

Foreign Object Debris (FOD) (Case Study 3)

Defect observed

De-wetting occurred at the SOT (small outline transistor) component lead. By observing the SOT solder joint having de-wetting issues by optical microscope the foreign object debris was found. FT-IR (Fourier Transform Infra-Red) analysis was performed on the foreign object debris. The solder paste reflowed at the SOT component solder joint was no-clean Type 3 62Sn36Pb2Ag tin-lead-silver.

Type of analysis equipment used to observe and characterize defect

Optical microscope and FT-IR (Fourier Transform Infra-Red) analysis was performed.

Damaged plating (Case Study 4)

Defect observed

Solder de-wetting occurred on the Sn-plated component. A no-clean flux was used with the solder.

Type of analysis equipment used to observe and characterize defect

The plated surface of the good and inferior solder wetted components was observed by

SEM Image on HAL Treatment

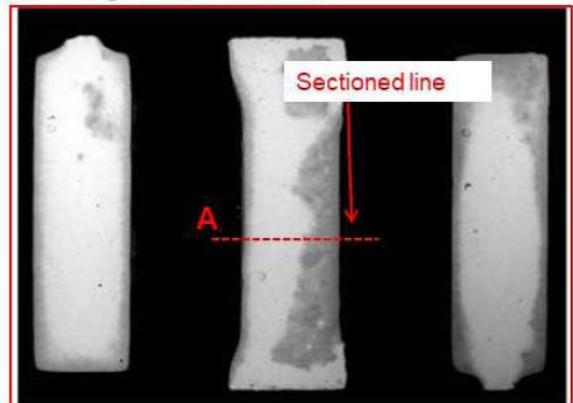


Figure 4: SEM image on HAL treatment.

Section A: Microscope image

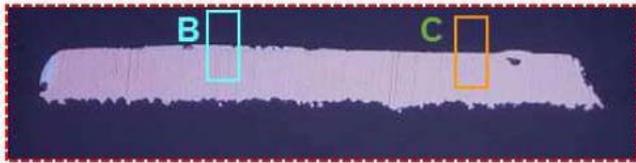


Figure 5: Microscope image showing areas analyzed.

Section B: SEM Image (Thicker Plating)

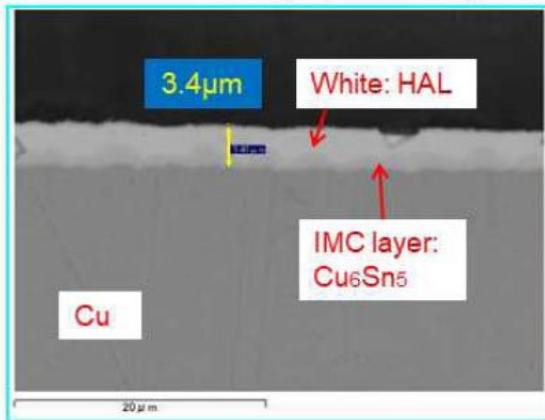


Figure 6: Section B: SEM image (thicker plating).

Section C: SEM Image (Thinner)

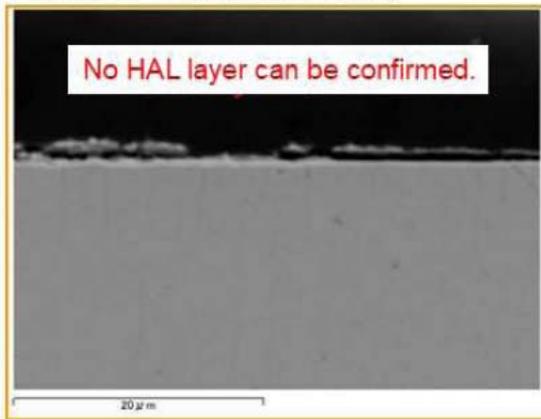


Figure 7: Section C: SEM image (thinner plating).

For Section B in Figure 6, the thickness of the HAL was 3.4 mm and the IMC thickness was 2.05 mm. For the thinner plating in Section C in Figure 7 there was no IMC layer observed.

Assessment of the cause of the board plating/surface finish quality defect

Based on company experience and knowledge with soldering defects, soldering mate-

rials and background/ experience with failure analysis work, the cause of the defect could be a contaminated substrate Cu pad before the HAL solder process and an inferior plating condition. This could happen on both the PCB and components. Inferior plating would mostly be derived from an uncontrolled plating process. An insufficient plating layer causes the inner layer to oxidize and removes the purpose of the plating in the first place. Solder cannot wet to the oxidized intermetallic compound (IMC) and results in solder de-wetting.

Discussion on possible solutions to the board plating/surface finish quality defect

One area to consider would be to improve the HAL treatment resulting in a thicker and more uniform coating. The preferred thickness of HAL coating is approximately 10 mm compared to 3.4 mm found with this board. The HAL coating should preferably be thicker than the IMC. The minimum HAL coating thickness would be around 5 mm and the maximum coating thickness would be around 10 mm.

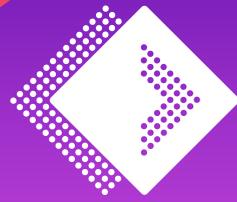
Other possible countermeasures to improve solder wetting would be to use a higher activity solder paste which can help to remove the oxidized film during reflow, or to reflow in a nitrogen atmosphere to reduce oxidation of the Cu substrate.

Contaminated plating (Case Study 2)

The de-wetting issue on the pad substrates is shown in Figures 8 through 11.



Figure 8: Dewetting issue on pad substrate.



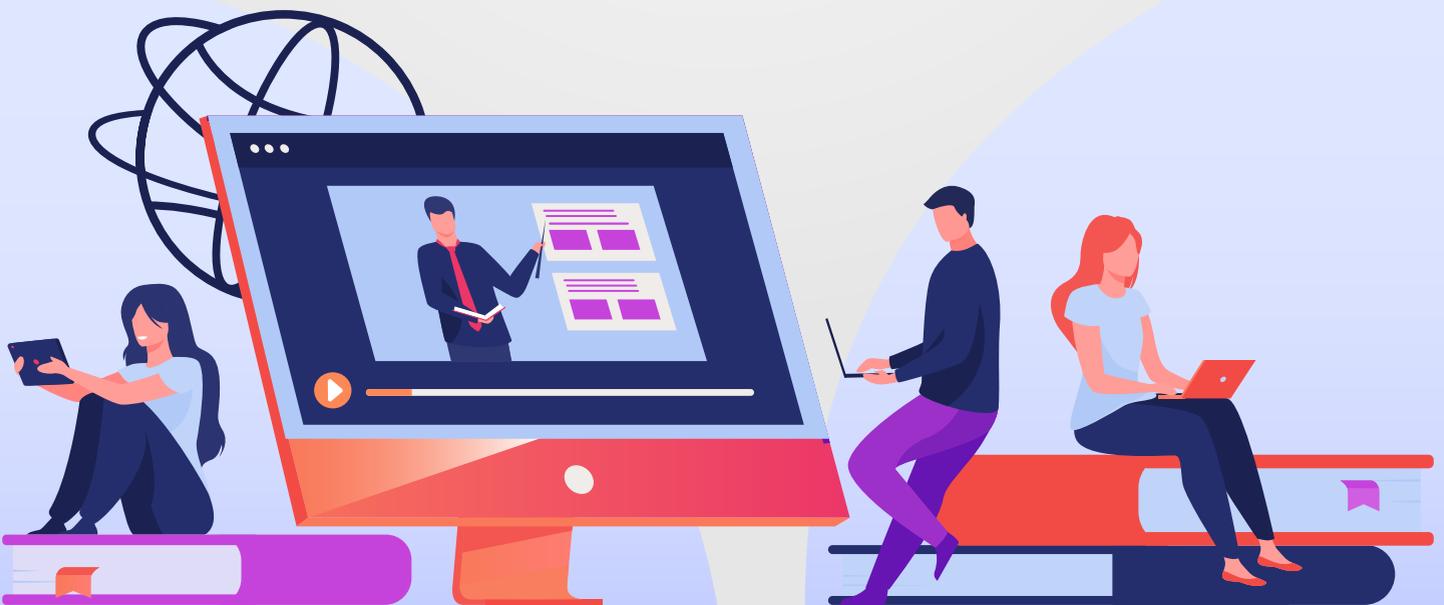
SMTA

A Global Association Working at a Local Level

VIEW OUR UPCOMING WEBINARS

Learn about new technologies, processes, manufacturing fundamentals, and essential professional skills without leaving your desk.

www.smta.org/webinars



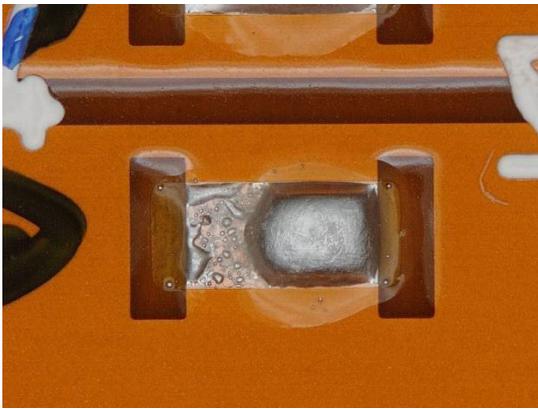


Figure 9: An additional example of the dewetting issue on the pad substrate.

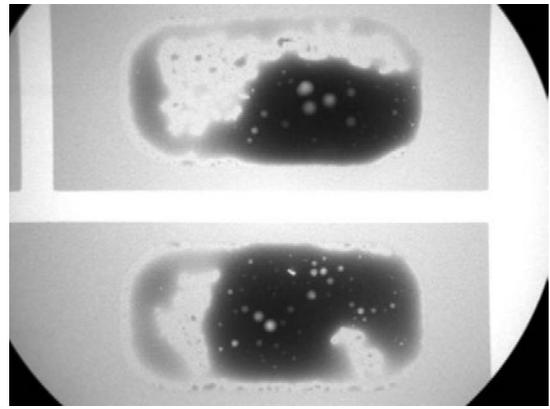


Figure 11: X-ray pictures of the dewetting issue at the pad substrates.

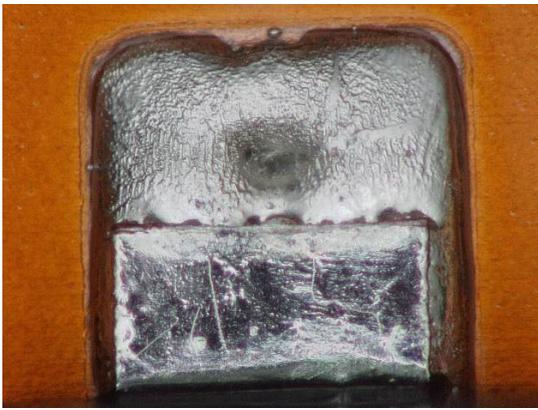


Figure 10: Dewetting issue at the component.

pad shows solder de-wetting. A microscope and X-ray image of the solder joint on the contaminated pad is shown in Figure 14.

Assessment of the cause of the contaminated plating defect

Based on company experience and knowledge with soldering defects, soldering materials and background/ experience with failure analysis work, the cause of the defect in terms of Cl contamination may be derived from the etching agent residue used during PCB production/fabrication. An insufficient cleaning process was suspected.

De-wetting due to contaminated plating can happen on both the PCB as well as the components. Insufficient cleaning of the plating solution, improper storage conditions after the plating process, or improper handling by the operator may result in contamination. Since most of the contaminants repel the solder, the contaminated pad shows solder de-wetting.

Analysis of contaminated plating results

Contamination from Cl (chlorine) was observed on the PCB pad surface which showed dewetting (Figure 12) compared with a PCB pad surface showing good wetting (Figure 13). The board surface treatment was OSP (organic solderability preservative) on the copper PCB pad substrate. Since the contaminants inhibit solder wetting, the contaminated

SEM Image on PCB Pad Surface (De-wetting)



EDX Analysis (De-wetting)

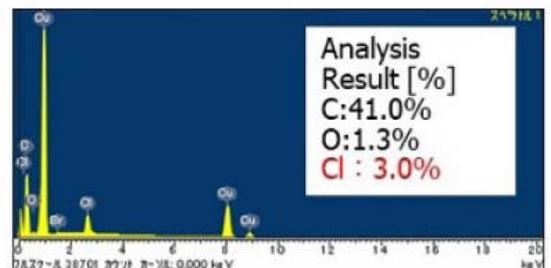
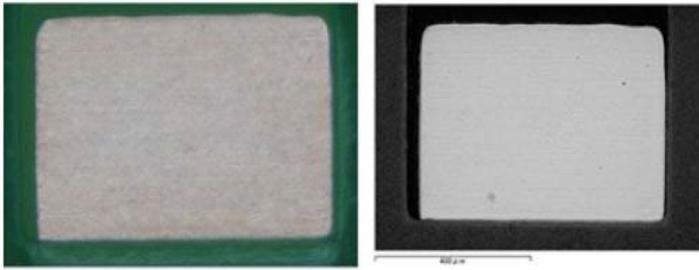


Figure 12: SEM image and EDX analysis on PCB pad surface showing de-wetting.

SEM Image on PCB Pad Surface (Good Solder Wetting)



EDX Analysis (Good Solder Wetting)

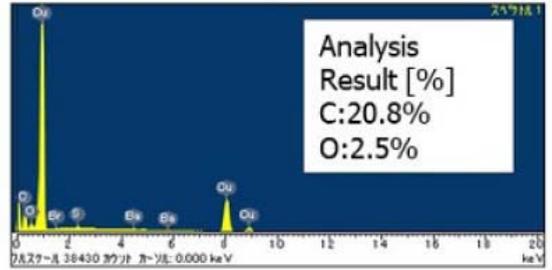


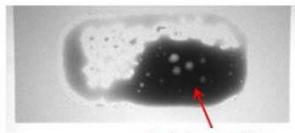
Figure 13: SEM image and EDX analysis on PCB pad surface showing good wetting.

Microscopy Image on Solder Joint on Contaminated Pad



De-wetting due to contamination from Cl

X-Ray Image on Solder Joint on Contaminated Pad



Black Area: Solder

Figure 14: Microscope and X-ray image on solder joint on contaminated pad.

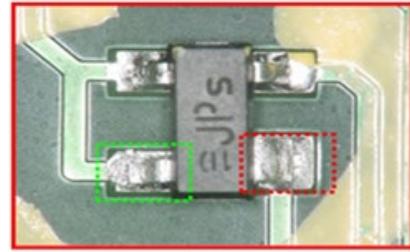


Figure 15: Areas focused on for de-wetting issue.

Discussion on possible solutions to contaminated plating defect

The main area to focus on would be improvement of the PCB fabrication process.

Foreign Object Debris (FOD) (Case Study 3)

The de-wetting issue on the soldered SOT component lead is shown in Figures 15, 16 and 17.

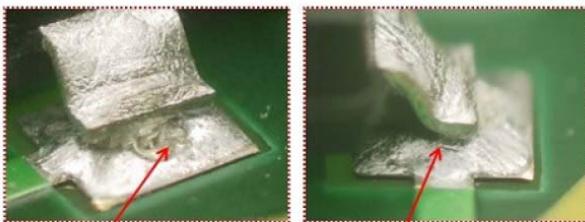
Analysis of Foreign Object Debris (FOD) results

The foreign object debris inhibited the SOT lead from contacting the solder and caused de-wetting. The SOT lead component substrate was copper with a tin plating surface treatment. According to the FT-IR spectrum analyzed, the foreign object debris had a similar spectrum to cellulose (Figures 17, 18).



Figure 16: FOD observed between SOT lead and solder fillet in red highlighted area from Figure 15.

Microscopy Image of De-wetting at the SOT Solder Joint



Trapped Foreign Object

De-wetting at the SOT Lead

Visual Image of Foreign Object

Remove foreign object



Figure 17: Microscopy image of de-wetting at the SOT solder joint and visual image of foreign object debris.

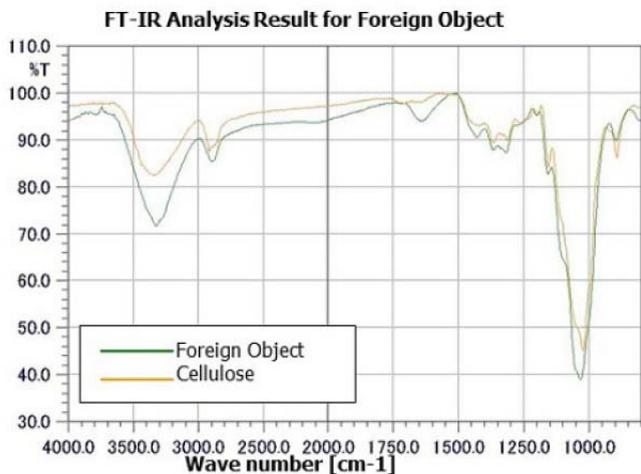


Figure 18: FT-IR analysis result for foreign object debris.

In this case, foreign object debris, seemingly irrelevant to soldering, caused de-wetting of solder. This can be derived from materials of the PCB and/or components, as well as foreign object debris (FOD) from the process. Some foreign objects are related to non-soldering material, such as fiber, hair, etc.

Discussion on possible solutions to the foreign object debris (FOD) defect

The main area to focus on would be to review the stencil cleaning process.

Damaged plating (Case Study 4)

Analysis of damaged plating results

Observations revealed damaged Sn plating on the component lead with a copper substrate. The damaged area's copper substrate was oxidized which resulted in solder de-wetting. An organic substance was observed at the damaged area which was determined by EDX observation. SEM images of the component plating surface with EDX analysis for the good and poor solder wetting areas are shown in Figures 19 and 20. Figure 20 shows damage on the tin plating surface with the copper substrate exposed.

Assessment of the cause of the foreign object debris (FOD) defect

Based on company experience and knowledge with soldering defects, soldering materials and background/experience with failure analysis work, the cause of the defect could be cellulose which is used in paper towels; thus, a piece of the paper towel may have been left during stencil cleaning which settled on the printed solder paste. Another source of the cellulose could be from the under-stencil wipe material.

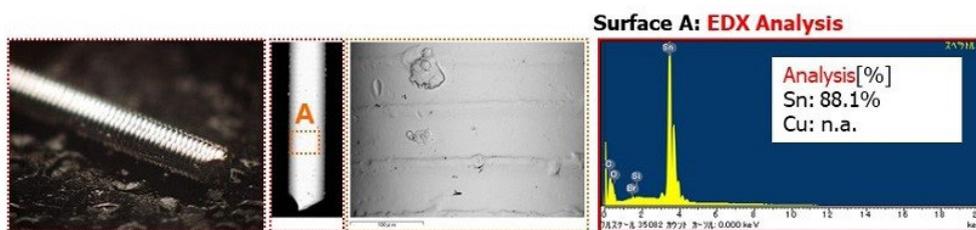


Figure 19: SEM image on component plating surface with EDX analysis (good solder wetting).

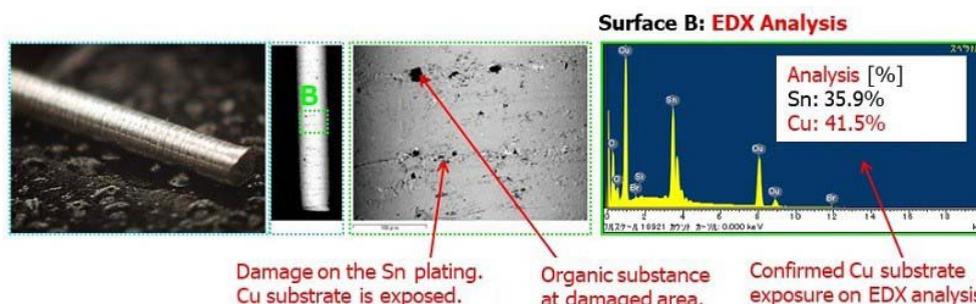


Figure 20: SEM image on component plating surface with EDX analysis (poor solder wetting).



Meetings & Courses

January 22-27

Conference & Exhibition

January 25-27

San Diego Convention Center | CA

Achieve **Digital Transcendence**

INNOVATION

TRANSFORMATION
FACTORY OF THE FUTURE

AUTOMATION

DATA ANALYTICS

DIGITAL TWIN

Get ready to transcend the norm as you transform through education, innovation and collaboration at North America's largest gathering of electronics industry professionals.

See you in San Diego at IPC APEX EXPO 2022!

IPCAPEXEXPO.ORG | [#IPCAPEXEXPO](https://twitter.com/IPCAPEXEXPO)

Thank you to all who have contributed to creating and supporting an excellent IPC APEX EXPO 2021 experience.

Assessment of the cause of the damaged plating defect

Based on company experience and knowledge with soldering defects, soldering materials, and background/experience with failure analysis work, the cause of the defect was damage in the Sn plating which was likely due to an improper component storage condition. It is assumed that the damage to the component was made while the components were being handled. The example shows how a damaged plating can cause de-wetting of solder. The plating surface is damaged during handling or shipping which causes the inner layer to be exposed. As the inner layer is oxidized, solder does not wet, and partially wetted solder may be observed.

Discussion on possible solutions to the damaged plating defect

The main area to focus on would be to review component storage conditions to eliminate the damage on the Sn plating surface.

Improper process condition setting (Case Study 5)

Figure 21 shows the de-wetting issue on the pad substrate. The board surface treatment was Ni-P/Au (nickel-phosphorus/gold).

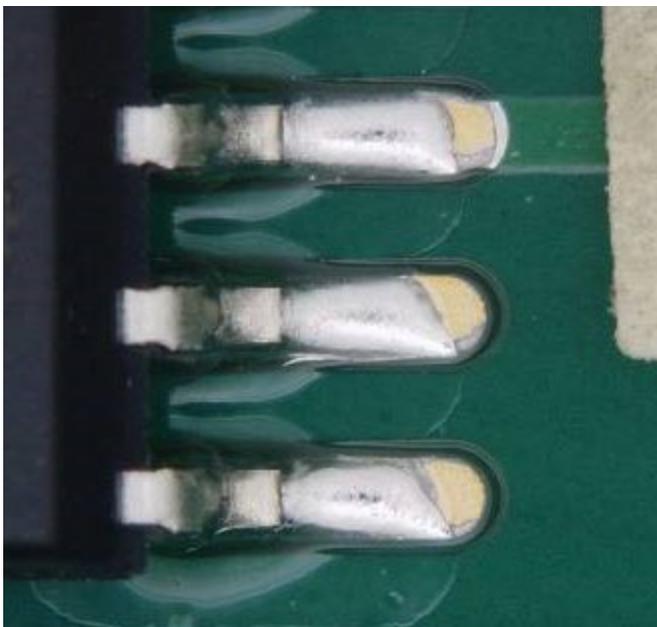


Figure 21: De-wetting issue on the pad substrate.

Analysis of improper process condition setting results

The de-wetted area indicated offset paste printing due to improper printing conditions. Since solder did not wet to the areas without paste deposits, the right-hand corners of each board pad showed de-wetting. When de-wetting is caused by offset paste printing, de-wetting is shown regularly as described in the following schematic image (Figure 22). This de-wetting was caused by misalignment during printing of the solder paste, not by contamination at the board pad.

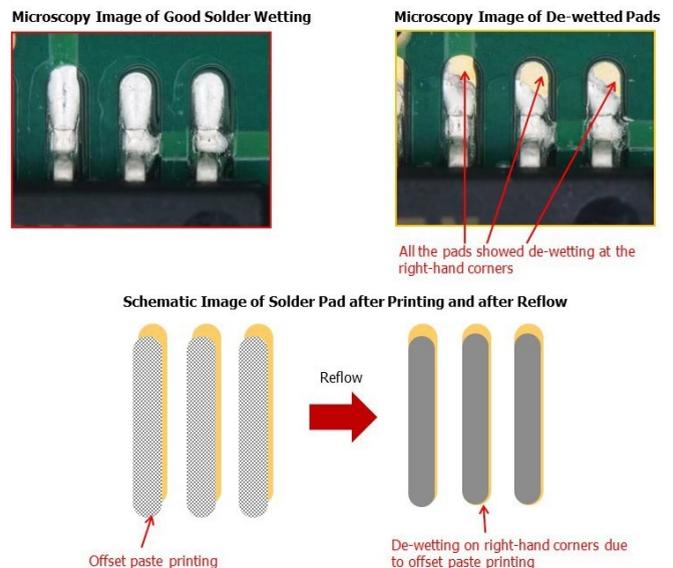


Figure 22: Microscopy images of good and de-wetted pads and schematic of offset paste printing causing de-wetting.

Assessment of the cause of the improper process condition setting defect

Based on company experience and knowledge with soldering defects, soldering materials and background/experience with failure analysis work, the cause of the defect was offset paste printing of solder paste. The example shows that an improper process printing condition setting can be a cause of solder de-wetting. In addition to improper paste printing, dewetting could also be caused by improper component mounting/placement, and/or reflow profile settings.

Discussion on possible solutions to the improper process condition setting defect

The main area to focus on would be to review and adjust solder paste printing settings.

Conclusions

The case studies discussed gave examples of the causes of solder de-wetting which were based on inferior board plating/surface finish quality, contaminated plating, foreign object debris (FOD), damaged plating, and improper process condition setting. The causes of the defects were determined using a variety of analysis techniques including optical microscopy, SEM/EDX, X-ray, and FT-IR analysis along with using company experience and knowledge with soldering defects, soldering materials and processes and background/experience with failure analysis work. **SMT007**



Kentaro Asai is manager of the Analytic Service Team, Research & Development Division, Koki Company Limited.



Jasbir Bath is a support advisory engineer for Koki Solder America.



Shantanu Joshi is an engineering sales manager for Koki Solder America.



Roberto Segura is a general manager for Koki Solder America.

Physicists Find Novel Way to Switch Antiferromagnetism On and Off

When you save an image to your smartphone, those data are written onto tiny transistors that are electrically switched on or off in a pattern of “bits” to represent and encode that image. Most transistors today are made from silicon, an element that scientists have managed to switch at ever-smaller scales, enabling billions of bits, and therefore large libraries of images and other files, to be packed onto a single memory chip.

But growing demand for data, and the means to store them, is driving scientists to search beyond silicon for materials that can push memory devices to higher densities, speeds, and security.

Now MIT physicists have shown preliminary evidence that data might be stored as faster, denser, and more secure bits made from antiferromagnets.

Antiferromagnetic, or AFM materials are the lesser-known cousins to ferromagnets, or conventional magnetic materials. Where the electrons in ferromagnets spin in syn-

chrony—a property that allows a compass needle to point north, collectively following the Earth’s magnetic field—electrons in an antiferromagnet prefer the opposite spin to their neighbor, in an “antialignment” that effectively quenches magnetization even at the smallest scales.

The absence of net magnetization in an antiferromagnet makes it impervious to any external magnetic field. If they were made into memory devices, antiferromagnetic bits could protect any encoded data from being magnetically erased. They could also be made into smaller transistors and packed in greater numbers per chip than traditional silicon.

Now the MIT team has found that by doping extra electrons into an antiferromagnetic material, they can turn its collective anti-aligned arrangement on and off, in a controllable way. They found this magnetic transition is reversible, and sufficiently sharp, similar to switching a transistor’s state from 0 to 1.

(Source: MIT News Office)



ein Electronics Industry News and Market Highlights



Exciting Advances From NVIDIA's GPU ▶

NVIDIA's Graphics Processing Technology Conference was a showcase of new developments, as well as an opportunity for engineers and developers to learn, enhance skills, and discuss new ideas. Just hearing about all the new developments and the accelerating expansion of AI in virtually all aspects of modern society gives those who attended a better idea of just how much AI is and will continue to change their work and our world.

AIStorm's AI-in-Imager Solutions Use Tower Semiconductor's Hi-K VIA Capacitor Memory ▶

AIStorm and Tower Semiconductor announced that AIStorm's new AI-in-imager products will feature AIStorm's electron multiplication architecture and Tower's Hi-K VIA capacitor memory, instead of digital calculations, to perform AI computation at the pixel level.

Fujitsu Signs Strategic Collaboration Agreement with AWS ▶

Fujitsu announced a Strategic Collaboration Agreement with Amazon Web Services, Inc. (AWS), an Amazon.com company, to accelerate the digital transformation (DX) of the mobility industry.

European Semiconductor Industry Committed to Use Responsibly Sourced Minerals ▶

At the occasion of the 14th Forum on Responsible Mineral Supply Chains of the Organisation for Economic Cooperation and Development (OECD), the European Semiconductor

Industry Association (ESIA) is highlighting the industry's commitments to source its raw materials in an ethical and sustainable manner that safeguards human rights within the global supply chain.

North American Semiconductor Equipment Industry Posts March 2021 Billings ▶

North America-based semiconductor equipment manufacturers posted \$3.27 billion in billings worldwide in March 2021 (three-month average basis), according to the March Equipment Market Data Subscription (EMDS) Billings Report published by SEMI.

ASUS Envisions AI-Powered Future in the Healthcare Ecosystem ▶

ASUS, a multinational company known for the world's most innovative motherboards, laptops, monitors, and other PC hardware, announced that cloud-based medical AI services developed by ASUS Intelligent Cloud Services Center (AICS)—the AI software division of ASUS— as successfully passed an external audit conducted by SGS Taiwan and obtained the ISO 27001:2013 certification for information security management.

Major Step Forward for Quantum Technology ▶

A team of researchers from Finland, Sweden, and Japan have developed a semiconductor component in which quantum information can be efficiently exchanged between electron spin and photons at room temperature and above.

PREMIER GLOBAL SUPPLIER for **WEARABLES**

FLEXIBLE CIRCUITS | EMS/ASSEMBLY | CONTRACT MANUFACTURING

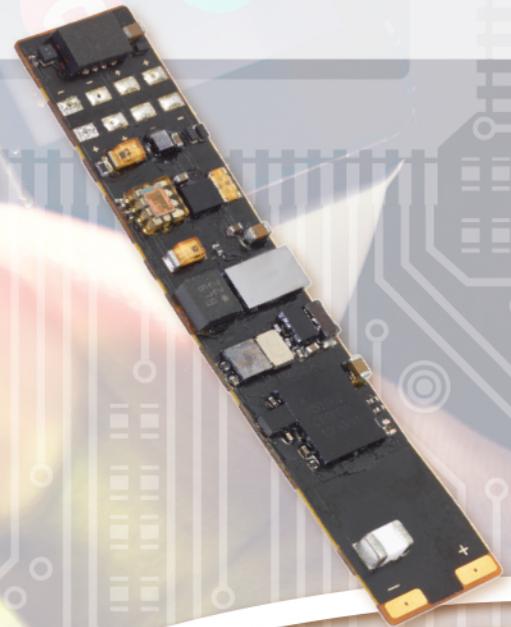
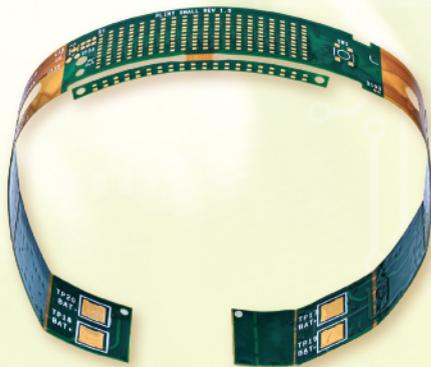
Industry leading Flex Design Support

**Flexible Circuits, Rigid Flex,
Membrane Switches, Plastic Moldings**

Specialized EMS/Assembly Services

**Product Module to Complete Product
Box Builds**

EXPLORE the
POSSIBILITIES!



Flexible Circuit Technologies
9850 51st Ave. N. | Plymouth, MN 55442
www.flexiblecircuit.com | +1-763-545-3333

ICAPE Group Offers Boots on the Ground Support in Asia



Roger Harts,
ICAPE USA Director

Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson speaks with Roger Harts about some of the current complications around manufacturing electronics in China and how ICAPE Group works as a vital supplier partner to OEMs and companies hoping to manufacture in Asia.

Nolan Johnson: Let's do an introduction, Roger.

Roger Harts: I am director of ICAPE USA and have been for the last five years. ICAPE USA is a member of ICAPE GROUP which is a global printed circuit board company, also manufacturing custom-made technical parts. My elevator pitch is that we do business in 70 countries across the world through 19 different sales offices to roughly over 2,500 customers. We deliver 22 million circuit boards a month, and another five million custom-made technical parts. It's a great organization and I'm happy to be part of it.

Johnson: How big is ICAPE Group, revenue-wise?

Harts: We finished at about \$160 million last year. And 2021 is very promising; the first half was a record period for the company. We're substantial, and we're a big player.

Johnson: We wanted to focus on ICAPE Group's work in China. Let's start with an overview; what's happening in China for ICAPE Group?

Harts: Even though our corporate headquarters is in Paris, France, our largest office is in Chang'an, just outside of Shenzhen, where we have over 250 people working in different departments such as engineering, purchasing, laboratory testing, quality, logistics, etc. Because of the pandemic it's very difficult to travel to China, to audit factories and maintain working relationships, but because of the size of our office in China, we can provide those types of services to customers. Prior to the pandemic, we flew in a lot of people to tour facilities and offices, and we worked with them to audit factories as well. Our China office has become a true advantage. In fact, it is the largest office for any company with a similar business model.

This means we can be in the factory, boots on the ground, speak the language, and under-

Our customers achieve as much as **80%** dross recovery using MS2...

How much can **you** save?

Calculate your savings with just 3 easy inputs:

Choose your alloy ▼

Production hours/day ▼

Wave machines ▼

Calculate Your Savings



PK
M·E·T·A·L

+1 (323) 585-5058

www.pkaymetal.com



Part of ICAPE Group's off-shore team located in China.

stand the culture; they can audit and provide information about our factories. In the past, customers would always fly to China and audit factories themselves. Obviously, that's not an option at this point, and I don't really know when it will be again, frankly. We've had to learn this new normal, and we now have the ability to put our employees at our production partners' factories and provide virtual audits. They have real-time communication with the factories to review documents, see the assembly lines, drilling and routing machines, the plating processes, all while we guide them through the factory with our own employees.

China is still very proprietary. They don't necessarily care for strangers walking through their factories—especially with cameras to document processes—so we were very fortunate to have long-term, contractually-obligated relationships with our production partners in China. This allowed us to streamline that process and get our new and existing customers up to speed. It's something that we've always done, because to be a vendor or a production partner for ICAPE Group, you must allow our employees to work in your factories.

That's not always an easy thing to accomplish, but it's a mandatory requirement from a factory perspective. We want to make sure that our employees are monitoring our customers'

part numbers as they're being manufactured, not just the inspection of the quality, but also to validate that the correct raw materials are being used and the lead times abided by. They monitor the corporate culture of the partner as well, to reduce turnover to maintain the correct capacity. Communicating that to our customers helps mitigate that risk of doing business in China or a disruption in the supply chain. This is so important, especially now.

Johnson: What are the types of disruptions you're seeing?

Harts: There's a shortage of raw materials, a shortage of copper foil, and lead times are unfortunately dramatically increasing. This is all a result of the pandemic in the last year.

The raw materials are in high demand and lead times are increasing because of the raw material shortage. Additionally, there is an increase in shipping costs because of flight restrictions for international locations. This impacts customers receiving parts from China. It's nice to work with a company like ICAPE Group that has those boots on the ground—to help lower the risk of disruption. It allows us to communicate proactively to our customers because we have a live presence in China.

Johnson: How have your customers reacted to the way you're doing this work? Your OEM customers are getting a brand-new experience thanks to the pandemic. What is their response?

Harts: I think OEMs especially want to be hands-on to ensure that things are manufactured to their requirements. Now, these types of interactions—Zoom and Teams, the video conferencing calls, the virtual audits—it's what we all call "the new normal." As a global company with 19 offices around the world, we know this

way of working. Our clients are more accepting, understanding that they don't really have a lot of options, and that we've created everything virtually now. For example, we've always participated in trade shows to create new relationships, and that's something that has been postponed indefinitely. I think we're going to see a few this year. Not sure just how many, but we are still doing it virtually.

This could be the future of how we do business. I see the industry embracing the digitalization of the manufacturing process, the Internet of Things philosophies, and allowing machines to communicate by providing real data back to customers. We will see the evolution in an industry that, I believe, will provide an incredible amount of data to the customers to help them control their processes and quality; I really look forward to embracing that. I digressed, but everybody has to understand that this is the state of the industry, and these types of interactions are their only option.

Johnson: There's that aspect of, "We do this because we have to," but is there, in your experience, an additional value-add that your customers receive from working in this manner?

Harts: Certainly. The resources that we have available to our customers are certainly a value-add that we know our direct competitors can't provide. We have a wealth of people—not just technicians or quality inspectors, but engineering, logistics coordinators, customer service, purchasing, and sourcing. We provide instant quality audits to our customers at the factory. We can have IPC-trained certified technicians at the factory to monitor processes and inspect quality.

With purchasing and customer service in China, we have the resources, if negotiation is necessary, to receive cost-downs for customers to communicate directly with the manu-



ICAPE Group's off-shore team located in Hong Kong.

facturers. As an OEM or a contract manufacturer that does not own a factory—or even ones that do—there is value in having a third-party source there to evaluate and understand the customer's needs, resolve those, and put a plan in place that achieves success.

Johnson: Yes, one can't say too much about having an advocate.

Harts: That's the truth. There's only so much you can do virtually; eventually someone must be there to touch it, feel it, validate it, and make sure it's accurate.

Johnson: I'm intrigued by your references to data. You've got the eyes and brainpower in the facility watching over your customers' processes and product. But you're also mentioning data. You can do quality reports instantly; there's a lot of information you can gather. That, in and of itself, presents a challenge. You can get buried in data and not be able to draw any conclusions at all. How does ICAPE Group help an OEM customer pull signal out of all this data noise inbound from another part of the globe?

Harts: Because of our industry experience, we can evaluate the data and filter out what's truly

important to the end-user or the customer, then provide advice based on our experience and interactions with other customers, as well as what they felt was very necessary. Data is important, but what ICAPE does better than anyone else is monitor the culture within our production partners. Data will eventually be available to everybody in mass amounts, but how do you provide data on the culture of the current production partner? Do they have a lot of turnover? Are their employees satisfied? What is the philosophy of the manufacturer itself?

For example, one year their sweet spot is 1,000 square meters. But like every other company, they want to increase production, sales, revenue and more. So, the next year, they decide to make 10,000 square meters their sweet spot. How do you attribute that to data? Our staff can examine that culture, and notice, say, that it's not that the manufacturer will quit producing for the customers that require 1,000 square meters a month, but monitoring whether there is a delay in lead time for that customer of 1,000 square meters or they're prioritizing customers that are now ordering 10,000 square meters. We have people in China that can monitor that situation.

We can see if the factory is increasing the lead time on our customers' orders or demands to increase price. Maybe we won't get quote responses back quickly because, if that customer is no longer a priority to that factory, those things happen. That's hard to analyze only through data. It is necessary to have an advocate for the customer—not the factory—to make sure that our customers' demands are being met. Our ability to control those uncomfortable situations is unmatched in the industry, in my opinion. I don't think anybody in the world does that as well as we do. ICAPE Group employees that are in the factory understand that responsibility.

Johnson: Picking up on that example, you have a situation where you see something going on in the factory of choice, things have somehow shifted your customer to not being a priority. What do you do?

Harts: We can do a couple of things. Obviously, because of our relationships with those factories, we will have conversations with them to make them understand that our customers still need to be a priority. We have a lot of leverage, but I mentioned our sales revenue earlier. We



ICAPE Group's partner factory (drilling process).



BLACKFOX

Premier Training & Certification

NOW OPEN
for Limited
In-Person and
Online IPC
Training
MORE INFO

Experience the Blackfox Difference!

Premier IPC Training & Certification

- High quality training and customer service
- Offering 6 certification programs at 6 locations and online
- *Colorado, Arizona, Guadalajara & Queretaro, Mexico, Malaysia and Singapore*
- Military Veterans Advanced Manufacturing Program
- IPC/WHMA-A-620 Space Addendum for trainers and specialists
- Online store supporting the training industry



[CLICK FOR COURSE SCHEDULE](#)

For more information contact us at
888.837.9959 or sharonm@blackfox.com

www.blackfox.com





ICAPE Group's partner factory (flying probe testers).

buy a lot of boards out of Asia. We do have a lot of leverage; however, because of our business model, we will have multiple production partners that are subject matter experts for our customers' types of technology. Based on the customer's request, we can communicate with the customer and ask them if they would like us to qualify an additional partner to run those part numbers through. Interestingly, as we have these conversations early on in our quoting process, multiple times we will suggest that customers qualify two different partner factories, and we'll provide them samples.

We have two super high-tech labs, one in Shenzhen at our office in China, and another lab in our North American headquarters in Indianapolis, where I'm sitting today. That allows us to easily qualify multiple sources for a single part number. Now, we'll generally always settle for one, but God forbid something were to happen—the factory burns down, there's an earthquake, a tsunami, or something—we have access to an additional provider—qualified and in place, ready to go—so that our customers have no shortage in their supply chain; this allows us to help them mitigate that risk. Now, not everybody does that, but it's a definite advantage that we bring to the table for those types of situations.

Johnson: That is definitely the resilience we need in the supply chain.

Harts: It truly is, and obviously I'm biased, but I think if you are sourcing parts in Southeast Asia, ICAPE Group needs to be in the conversation of a supplier partner for companies, certainly domestically in the U.S. There are so many advantages that we bring to the table, not just in circuit boards, but all our custom-made technical parts are a real asset that can help companies streamline their supply base because of all the different types of products that we

offer. It allows them to communicate real-time with a country that's half a planet away and 12 hours ahead of us. I don't understand why everybody doesn't use ICAPE Group!

Johnson: Does ICAPE Group have more facilities available for manufacturing in your network than just China?

Harts: We are always actively pursuing other sources in emerging markets like Vietnam and Malaysia, but we have vending partners in Taiwan and South Korea, domestic resources here in America, and we're pursuing partners in Mexico and Canada. Some manufacturers feel it will be more cost-effective and might eliminate the high price of shipping if they source within North or Central America. Our sourcing department does a fantastic job on the road trying to find new partners.

It's not easy. We're very, very picky. In the Shenzhen area alone, there are thousands of small factories that manufacture electronics; of those, we have narrowed it down to about 25 PCB suppliers and another 50 for custom-made technical parts, which includes eight electromechanical commodities that coincide with what our customers need that are populating circuit boards—things like heat sinks and cables, connectors, batteries, LCD screens, plastic parts, metal parts, and much more.

Johnson: Returning to the Americas for manufacturing, it seems the primary drivers are shipping costs and tariffs. Is that correct? Are there other dynamics going on?

Harts: That's correct. However, we also see a gradual increase in the cost of labor in China. It's not dramatic, but it's there. China is still your best option for electronics parts, and circuit board manufacturing is a toxic manufacturing process, so there are reasons why China will be a big player for many years to come. However, as the manufacturing process becomes more automated and labor costs can be reduced, countries like Mexico and other low labor cost-providing countries become very competitive. Being aware of that allows us to react to those types of demands. I often tell people we can provide any sorts of tools or products that a Fortune 500 company would have, yet we can still react like a startup; this means we have people in place, and we can be online very quickly on behalf of our customers. Our sourcing capabilities allow our customers to ask, "Hey, this is what I'm looking for. Can you help me find a provider for that?" We can react very quickly for them, and that's something they can't even do themselves. It's a big value.

Johnson: Why do you believe that China still seems to be the best value. And as market



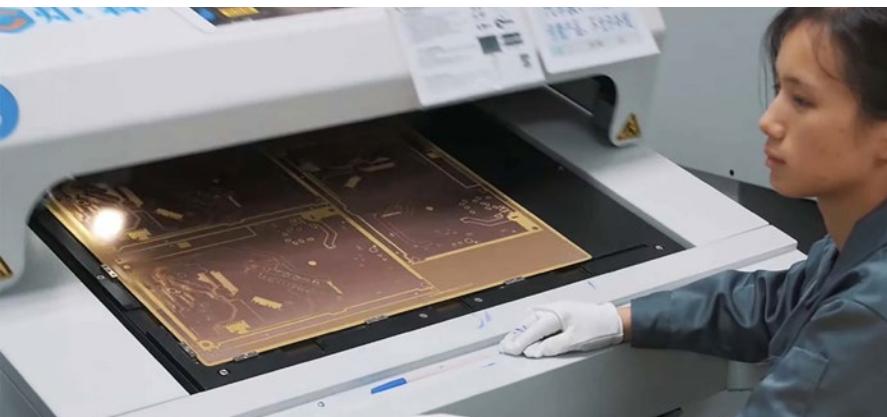
Quality at the heart of manufacturing.

changes happen in other regions, do you see a point where that balance shifts?

Harts: Not soon, for sure. China will always be competitive. Asia has the largest amount of raw materials used in this industry, which allows them to be competitive well into the future. Their labor costs also remain low, even with a rising middle class. The Chinese government can incentivize factories to make it more cost-effective for them to do business. For instance, the government can incentivize the build of a brand-new factory. They can entice factories to add on for little to no cost where, domestically, a manufacturing company must go out and buy property and build a factory. And when that can be subsidized by the government,

it allows them to be competitive long term. In addition, they benefit from the world's most extensive experience in the manufacture of electronic components.

For nearby countries that aren't impacted by tariffs, such as Taiwan, Thailand, Vietnam, and other emerging countries, their raw materials will most likely still be provided by China. I don't think we will see a mass exodus from there anytime soon, but we constantly monitor it, just to make sure that we always have



Strict control of raw materials and lead times.

the best production partner for our customers. Our customers can demand that of us, as well, and we're happy to do it; that's why we have a presence there.

Johnson: As we talk to our contacts in China, we hear that there is a strong government push to require better pollution controls. Do you see that dynamic as well, and how does this deliver value to your customers?

Harts: Our factories are required to follow any laws or regulations. We provide documentation to our customers with every order to ensure our factories are compliant. We noticed that when we audit our factories, they are making changes. China is truly embracing the Six Sigma business model and Lean manufacturing processes. They're not embracing it as quickly as some others, but they understand its importance and they're getting on board with it. We see that from our quality audits because we are in there all the time. It is not anything as stringent as what we have here in the U.S. market as far as EPA control, but China is making a push to be more eco-friendly. I love the people



Ensuring continuous quality performance.

who work for us—they're intelligent, happy, and enthusiastic, and we're just lucky to have such a large contingent. Our experience has been very fruitful and enjoyable. We understand the theory of [Chinese business leader and environmentalist] Wang Shi and the culture of the country as well; it's just an interesting dynamic, and we appreciate it.

Johnson: OEMs could decide to establish their own representation with their Chinese partners and self-advocate. For quite a while early on, that was what you had to do. Can you quantify the overall cost of self-advocacy? At what point does the ICAPE Group model become cost-effective?

Harts: It's hard for me to quantify it without understanding the types of personnel that they're going to use, but I also should say that if you have someone stationed there long-term, how does the OEM quantify whether that person has become more loyal to the people they work with on a daily basis than they are to the company they truly work for? For example, we had a large



Nathan Martin, ICAPE Group purchasing director.

Back by popular (on) demand!



Even though this year's show was a little different, our coverage is still like nothing the industry has ever seen!

[DOWNLOAD NOW](#) 



In-house PCB laboratory.

automotive manufacturer reach out to us pre-pandemic and his main concern was, “I have people over there. My question is, “Are they just telling me what I want to hear or are they telling me the truth?”

Johnson: Have they “gone native” so to speak?

Harts: It’s hard to believe that wouldn’t happen eventually, so we are constantly rotating our people in and out of factories to eliminate that possibility. We don’t want them to spend eight hours a day, five days a week with the same people and then develop that sort of friendship where they don’t want to get their friend in trouble. We have a rotation to ensure that doesn’t happen. And I’m not saying it would happen to every OEM, but it’s a possibility and I don’t know how a company would monitor that or quantify that. It would be a

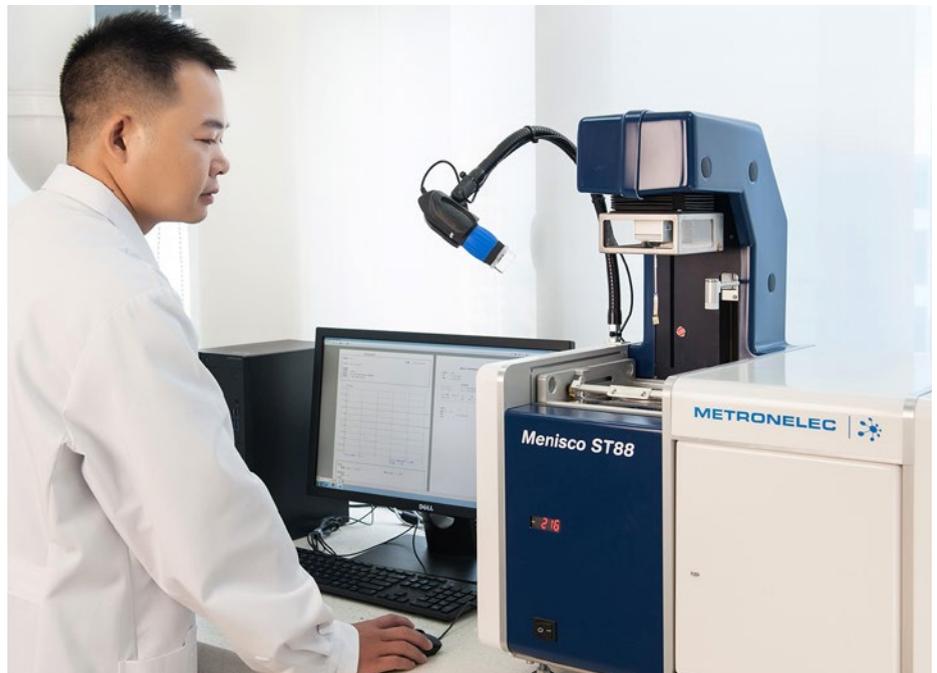
difficult task to undertake on a regular basis.

Johnson: The expense there is not in the direct costs, but rather what happens throughout the rest of the life cycle of your product.

Harts: Absolutely. When you start seeing quality concerns, that is when you can quantify it quickly; the cost of a recall gets really expensive.

Johnson: Roger, just one last question: Once key populations reach COVID herd immunity, do you see us returning to the old ways?

Harts: I certainly hope so. I don’t think it will go back 100% to the old ways. As I mentioned earlier, we do business in 70 countries across the world, but a key strategy for ICAPE Group is to have a local presence where our customers are. We want to meet people face to face, have lunch, coffee, buy donuts, whatever it is.



Leading-edge equipment to ensure IPC compliance.

I still believe that this is a relationship business. I remember my first job interview with my old director. He was concerned because it's a complicated product and wasn't confident that salespeople could get up to speed quickly. I looked at him and said, "But aren't they already buying what I'm selling?" He said, "Well, yeah, I guess." I replied, "So I just have to convince them to buy it from me," and he said, "Well, yeah, I suppose that's the case."

This is a relationship business. Those customers are going to buy circuit boards. People like doing business with people and companies they like. ICAPE Group or ICAPE USA are companies that everybody should love, and I am hoping that as things get back to normal, that personal interaction will be allowed. I haven't visited my customers face to face for an entire year and I miss some of the people that I interact with, people I've done business with for five



The culture of technical excellence.

years. I know them, their husbands, their kids, where they vacation. I miss them.

They're great people and I enjoy spending time with them and going out to lunch, and 50% of the time we're not even talking business. I hope that we can get back to that at some point. It really makes our jobs a lot more fun, and it's a great differentiator, too, when we're competing with direct relationships in China.

Being able to have those personal interactions is a benefit to us and it's always been part of our strategy.

Johnson: Thank you, Roger. It's been a delight.

Harts: Thank you, Nolan. SMT007

Sponsored Links

- [ICAPE Website](#)
- [ICAPE Brochure](#)
- [LinkedIn](#)
- [Youtube](#)
- [ICAPE China Video](#)
- [ICAPE Expert Services Video](#)



A customer-centric company.



Supplier Highlights



Mycronic to Acquire atg Luther & Maelzer ▶

Mycronic is to acquire atg Luther & Maelzer GmbH (atg), a leading global developer, manufacturer and supplier of advanced equipment for electrical testing of PCBs and substrate. The acquisition strengthens and broadens Mycronic's offering and creates a platform in the field of electrical testing.

MacDermid Alpha Electronics Solutions Announces the Acquisition of H.K. Wentworth Group ▶

MacDermid Alpha Electronics Solutions, a leading global supplier of specialty chemicals and materials used in the semiconductor fabrication, semiconductor packaging, and printed circuit board fabrication and assembly markets announced that it has acquired H.K. Wentworth Group, owner of the Electrolube & AF brands.

BTU Awarded for New Selective Solder System ▶

BTU International, Inc., a leading supplier of advanced thermal processing equipment for the electronics manufacturing market, announced that it was awarded a 2021 SMT China Vision Award in the category of Soldering-Selective for the Hentec Industries Valence 3508.

CyberOptics Receives New Order Valued at \$2.4 Million for Mini LED Inspection and Metrology ▶

CyberOptics Corporation®, a leading global developer and manufacturer of high precision 3D sensing technology solutions, announced that it has received a new order valued at

approximately \$2.4 million for its SQ3000™ Multi-Function systems for mini-LED inspection and metrology.

New Representatives for Rehm Thermal Systems ▶

Since 1 April 2021, Rehm Thermal Systems has gained two new representatives for its sales and service activities in Europe: Accelonix Ltd. is now the official distributor for United Kingdom and Ireland, while Ankatek will, in the future, look after the product portfolio in Turkey for Rehm Thermal Systems.

KULR Announces New VP of Operations ▶

KULR Technology Group Inc., a leading developer of next-generation thermal management technologies, announced Antonio Martinez will be the new Vice President of Operations.

PVA Names Jaime Erickson as Director of Operations ▶

PVA, a global supplier of automated dispensing and coating equipment, announced the addition of an Operations Department tasked with bridging multiple departments to ensure the company is providing its customers superior products and services that exceed their expectations in terms of delivery and quality.

Partnerships With Industry (PWI) to Combine Operations with PRIDE Industries ▶

For more than 35 years, Partnerships With Industry (PWI) has provided meaningful employment and training services for people with disabilities with excellence in the San Diego region.



APCT

Passion | Commitment | Trust

Can We Brag On How Flexible We Are?

EXCEPTIONAL QUICK TURN CAPABILITY IN THE FLEX, RIGID FLEX MARKET



APCT Offers Flex & Rigid Flex Expertise

- Design Guideline Support
- Build Guideline Support
- A Variety of Material Sets
- Certifications to Support Manufacturing



“Bookbinder Know-How”

APCT.com | 512.548.7435

Printed Circuit Board Solutions

APCT.com

APCT Santa Clara HQ

408.727.6442

APCT Anaheim

714.921.0860

APCT Orange County

714.993.0270

APCT Wallingford

203.269.3311

APCT Global

203.284.1215

Joe D'Ambrisi Discusses MacDermid Alpha Acquisition of HK Wentworth



Joe D'Ambrisi

Interview by Nolan Johnson

I-CONNECT007

Element Solutions' Executive Vice President Joe D'Ambrisi speaks with Nolan Johnson about MacDermid Alpha's recent acquisition of HK Wentworth. Joe shares some details on the transaction and outlines the expected benefits that come from bringing these two companies together.

Nolan Johnson: There has been some merger and acquisition news involving you. Could you tell us about it?

Joe D'Ambrisi: Certainly, it'd be my pleasure. First, a little background about Element Solutions. I'm sure most people think of us as a specialty chemicals and materials provider to the electronics industry. But what we fundamentally are is a solutions provider. Our recent acquisition of the UK company, HK Wentworth, and its two very strong brands, Electrolube and AF International will expand our portfolio of solutions to the industry. What attracted us to HK Wentworth is their very similar philosophy to Element Solutions in that they consider themselves a solu-

tions provider as well. They are constantly searching for opportunities where their customers have a specific technological or economic or quality or productivity challenge. And they innovate solutions specific to those customer challenges to improve their customers' outcomes—to make them more profitable, to make them more productive, to move them to a higher level of technological capability than before.

Johnson: How do you see this merger of these entities working together? Of course, in a merger or acquisition you're looking for a new whole that is greater than the sum of its parts. Where do you see that happening?

D'Ambrisi: That's exactly right, we believe that this combination of companies has a tremendous amount of potential in that regard. Our electronics business, MacDermid Alpha Electronic Solutions, has been assembled by combining several legacy organizations each with complementary strengths, either from a product perspective or a geographic perspective. HK Wentworth is one of those companies that provides us with an opportunity to further expand its portfolio offering.

The HK Wentworth brand includes a variety of products—conformal coatings, encapsulating resins, thermal interface materials—that are very complimentary to the Element Solutions portfolio. One of the things that MacDermid Alpha brings to HK Wentworth—and their very technically capable line of products—is access to a global commercial organization that consists of sales and technical service professionals—with applications experts located all throughout the world to help our customers solve their most difficult manufacturing challenges.

Johnson: Well, that leads into my next question. Look out a year or so; what can customers expect to see? What can customers expect to benefit from?

D’Ambrisi: One of the messages that we’ve communicated to both our new colleagues and the customer base at HK Wentworth is that we have done this before, and our approach

is always very cautious. HK Wentworth is a tremendous organization; it’s been very successful. It has not just a portfolio of products, but great people that support the organization. We want to make sure that we continue to take advantage of their strengths by taking a cautious approach to how we integrate the organization into MacDermid Alpha. From a customer perspective, that provides some comfort that to know they’re going to continue to get the same products from the same manufacturing plants made by the same employees in the organization that they have up to this point.

Johnson: Well, this certainly is exciting news.

D’Ambrisi: It certainly is. We’re thrilled about it. Our executive chairman is very fond of saying that our most valuable assets walk out the front door every evening, and we believe the people at HK Wentworth will add to that capability. **SMT007**

Slender Robotic Finger Senses Buried Items

Discerning buried items in granular material like sand is a tall order. To do that, a robot would need fingers that were slender enough to penetrate the sand, mobile enough to wriggle free when sand grains jam, and sensitive enough to feel the detailed shape of the buried object.

MIT researchers have now designed a sharp-tipped robot finger equipped with tactile sensing to meet the challenge of identifying buried objects. In experiments, the aptly named Digger Finger was able to dig through granular media such as sand and rice, and it correctly sensed the shapes of submerged items it encountered. The researchers say the robot might one day perform various subterranean duties, such as finding buried cables or disarming buried bombs.

Seeking to identify objects buried in granular material—sand, gravel, and other types of loosely packed particles—isn’t a brand new quest. Previously, researchers have used technologies that sense the subterranean from above, such as Ground Penetrating Radar or ultrasonic vibrations. But these techniques provide only a hazy view of submerged objects. They might struggle

to differentiate rock from bone, for example.

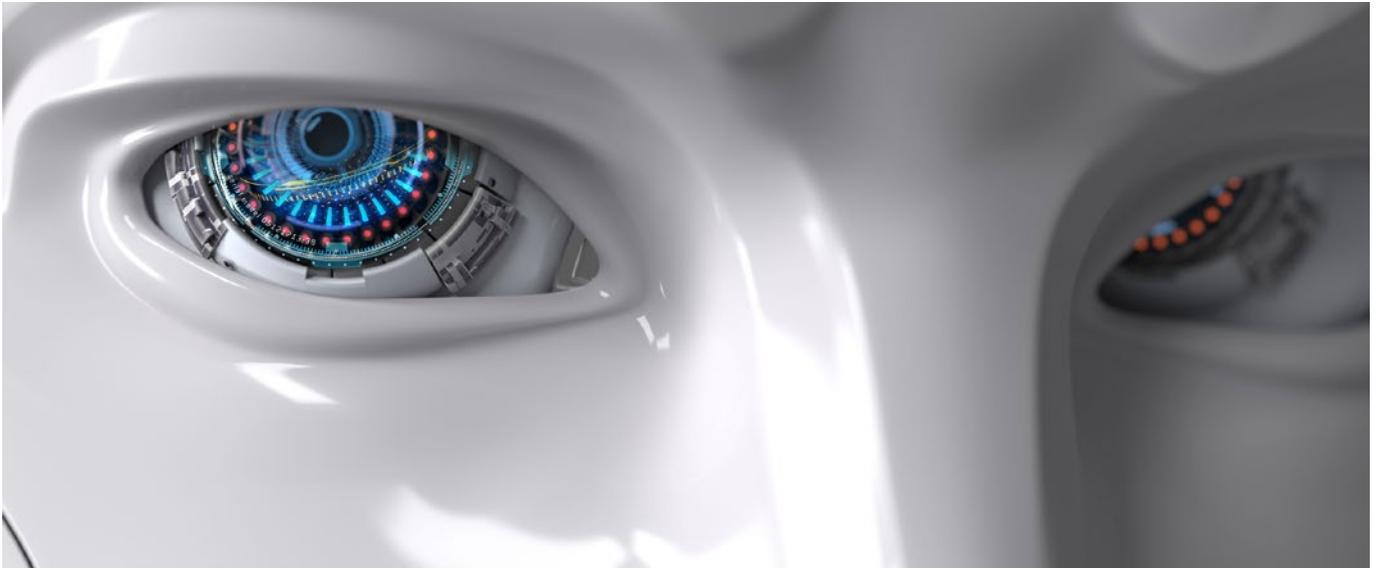
“So, the idea is to make a finger that has a good sense of touch and can distinguish between the various things it’s feeling,” says researcher Edward Adelson. “That would be helpful if you’re trying to find and disable buried bombs, for example.” Making that idea a reality meant clearing a number of hurdles.

The team’s first challenge was a matter of form: The robotic finger had to be slender and sharp-tipped.

(Source: MIT News Office)



Image courtesy of the researchers



A Framework for Large-Scale AI-Assisted Quality Inspection Implementation in Manufacturing Using **Edge Computing**

Article by Feng Xue, IBM, SINGAPORE, Charisse Lu, IBM, YORKTOWN HEIGHTS, NEW YORK, Christine Ouyang, IBM, YORKTOWN HEIGHTS, NEW YORK, James Hoey, IBM, POUGHKEEPSIE, NEW YORK, Rogelio Fernando Gutierrez Valdez, IBM, GUADALAJARA, MEXICO, Richard B Finch, IBM, POUGHKEEPSIE, NEW YORK

Editor's note: This article/paper was presented at IPC APEX EXPO 2021 and was published in the Proceedings.

Abstract

In recent years, neural network-based deep learning models have demonstrated high accuracy in object detection and classification in the area of digital image processing. Manufacturing industry has successfully implemented prototypes and small-scale deployment to employ artificial intelligence (AI) models for quality inspection. It has been proven that AI-assisted quality inspection can improve inspection accuracy, operation throughput, and efficiency, significantly through those prototypes and small-scale deployment. However,

the industry-known challenge of Operational Technology (OT) and Information Technology (IT) integration arises when scaling up AI-assisted quality inspection in manufacturing operation. While model accuracy is the main concern from an inspection point of view, IT implementation has to meet the requirements of high availability, scalability, security, and model and device lifecycle management.

This article discusses in detail the challenges in large-scale deployment of AI models for quality inspection operation and introduces a framework for large-scale AI-assisted quality inspection in a manufacturing environment using edge computing architecture. The framework focuses on IT architectural decisions to fulfill the OT requirement, including user experience in the quality inspection ecosystem.

Introduction

Quality inspection serves as one of the critical quality assurance tools in electronics manufacturing. The execution of quality inspection is strictly governed by the control plan

NORTH AMERICA'S LEADER IN TECHNOLOGY QUICK TURN



YOUR VIEW OF THE **SUMMIT**

TAKE ONE OF OUR VIRTUAL FACILITY TOURS



ANAHEIM, CA



ORANGE, CA



SANTA CLARA, CA



TORONTO, ON



www.summit-pcb.com



of the manufacturing process for a particular product. The inspection is usually performed on raw material (also known as incoming material inspection) and finished product (also known as outgoing quality inspection). In a high-complexity manufacturing process, such as wafer fabrication and integrated circuit packaging, inspection is also performed on in-process products as early in-line quality feedback. Quality inspection covers a wide range of items, from appearance, color, marking, and label, to defects and scratches.

An inspection process consists of two steps: image acquisition and image examination. Traditionally both steps are performed manually. The image is acquired directly from the product by human vision of the inspector and examined spontaneously by human cognition. As a result, traditional quality inspection is labor intensive and has great dependency on human skill and competency.

As feature sizes of interest become too small for human vision, advanced equipment such as magnifying lens, microscope, and techniques such as back lighting, dark field, and X-ray are employed to obtain the images that are examinable by human vision. Automation is enabled in image acquisition equipment and significantly improves the throughput of inspection processes for mass production. A good example is automated optical inspection (AOI) equipment used in printed circuit board inspection that has optical resolution to micrometers.

With the development of computer vision, rule-based algorithms are employed to partially replace human cognition for image examination, which further improves the efficiency and throughput of the inspection process. However, rule-based algorithms have limitations in object detection and classification and are normally used as a “coarse” screen of the images under inspection. It still requires human cognition to a great extent to accurately classify the images under inspection.

In recent years, neural network-based deep learning models have demonstrated high accu-

racy in object detection and classification in the area of digital image processing. AI models start to show great potential to replace human cognition in the quality inspection process through object detection and classification. Thus, AI-assisted quality inspection became very promising to fully automate quality inspection processes.

AI Models for Quality Inspection

While AI models are not the primary focus of this paper, a brief introduction to types of models popular for object detection and classification is important in understanding how they are used in quality inspection, considering both accuracy and performance.

The following are just a few of the mature AI model types that have been widely used in image recognition application and use cases:

- GoogLeNet
- Faster R-CNN (region-based Convolutional Neural Network)
- Detectron
- Tiny YOLO (you only look once)
- Yolo V3
- SSD (single shot detection)

GoogLeNet employs a 22-layer Convolutional Neural Network for image classification only, this means GoogLeNet cannot identify individual objects in each picture but is able to identify each image as a single category. GoogLeNet can be exported to run on edge devices making it highly portable.

Faster R-CNN, Detectron, and Yolo V3 models are optimized for accuracy. These models use rectangular bounding boxes to label the objects. Detectron models can also use objects labeled with polygons (segmentation) for greater training accuracy. However, training a data set that uses polygon labels takes longer than training with rectangular bounding boxes. YOLO V3 is an object detection image analysis model that has higher accuracy than Tiny YOLO, but requires more computer resources for both model training and model inference.

Tiny YOLO model is primarily optimized for speed and can be run anywhere but might not be as accurate as those optimized for accuracy, especially for use cases where small objects need to be classified.

Single Shot Detector (SSD) model is suitable for real-time inference and embedded devices. It is almost as fast as YOLO but not as accurate as Faster R-CNN.

Four models are trained and tested using training data set and test data set collected from actual quality inspection in IBM manufacturing facility. This quality inspection use case requires classifying small objects with high accuracy.

The key performance data is summarized in Table 1.

The results were as expected, matching with the characteristics of different models. As this use case involves small object detection, SSD, and Tiny YOLO do not meet the accuracy requirement. Therefore, only Faster R-CNN and Detectron are suitable for this use case. Both Faster R-CNN and Detectron have inference time of 4-7 seconds per image, which also meets the operational requirement for this inspection. The difference in inference memory usage between Faster R-CNN and Detectron has more impact in IT operation and cost than the quality requirement. The differences will be discussed later in this paper.

The selection of a suitable model type, as demonstrated in the example in Table 1, is determined by the OT and IT requirement of a particular inspection use case. The nature of the object under inspection, the throughput requirement, and the IT operation budget are three important factors in determining the most suitable model type.

Architecture Requirement for Large Scale Deployment

The selection of a suitable model type and the training to optimize accuracy ensures a good AI model that will be ready for production deployment to manufacturing floor. However, a new set of IT challenges arise in terms of practical deployment of the trained AI models onto manufacturing floors.

High availability

Quality inspection is the final gate before product shipment to clients. Availability of the inspection system has direct impact to shipment schedule and, hence, revenue. The system must have 24/7 availability with minimum maintenance intervals.

Scalability and performance

Manufacturing operation can span multiple geographies. The system needs to be scaled to

	Training Time (Hours)	Model Size (MB)	Accuracy (%)	Inference Memory Usage (GB)	Inference Time (sec)
Faster R-CNN	1.0	546.9	97	2.140	4-7
Detectron	0.33	338.1	99	3.197	4-6
SSD	1.5	107.3	48	0.925	4-7
Tiny YOLO*	7.0	63.1	1	N/A	N/A

Table 1: Model performance summary.

* Tiny YOLO v2 was used. Due to the low accuracy, inference was not performed. The inference time is expected to be less than other model types.

** GoogLeNet was not selected for this test as the use case required the use of an object detection model that GoogLeNet does not support.

*** YOLO V3 evaluation is ongoing at the time of writing this paper. Results will be shared in future publication.

manufacturing plants in many locations. The system should have the capability to be scaled out easily, i.e., adding a computer vision (for AI model training) instance, either on premises or on Cloud, as well as adding edge devices. Performance (speed, exception handling, etc.) has to be considered to support users around the globe.

User authentication and authorization

An important feature of the manufacturing quality management system is that only authorized and trained operators are allowed to perform the quality inspection. Therefore, user authentication and authorization for different user roles are required.

Model management and device management

Once deployed, lifecycle management of the AI models and devices (on which the AI models run) become critical to operations. Users require an easy and efficient way to manage AI model versions used in production. Device monitoring and recovery are also important to minimize disruption to manufacturing schedules.

Data security

Inspection data (images and results) is constantly generated from the inspection process. This data has to be securely stored and archived as critical and confidential data. The data shall be easily consumed by other applications (such as analytic applications, dashboards) in the short term and easily retrieved upon request in the long term.

Cost

In any IT deployment, the associated cost has two components: fixed cost and variable cost. Fixed cost includes hardware and infrastructure set up or purchase required. Variable costs include cloud consumption, if any, and maintenance cost of the hardware and infrastructure. For example, the inferencing memory usage of the selected model type has a

direct impact on the choice of hardware on which the AI model runs.

The IT architecture therefore must be carefully designed to address all the requirements above.

Edge Computing Solution

Edge computing is defined as “a distributed computing paradigm that brings computations and data storage closer to the location where it is needed, to improve response times and save bandwidth.”^[1] In large scale manufacturing, inspection data are generated at a large number of inspection points (equipment or station) within a plant and across plants, edge computing is a natural fit to distribute trained AI models close to inspection points so that inspection results can be returned to the inspector very quickly.

A solution architecture was designed for AI model and edge service deployment for quality inspection in manufacturing, based on IBM Edge Computing Reference Architecture[2]. The architecture was carefully designed for efficient model deployment as well as to fulfill all the requirements discussed in the previous section.

Figure 1 shows the system context of the solution architecture design, with consideration for external factors and constraints. It also ensures user experience is a focus item in the design.

The solution supports three persona groups:

- **Model Engineer:** Train and optimize AI models, manage the lifecycle of the AI models, and deploy AI models to edge devices
- **Edge Manager:** Set up and manage edge devices (or edge servers)
- **Quality Inspector:** Trigger and monitor the inspection process

The personas interact with these three external systems:

- **Data warehouse:** Database for all inspection images and results

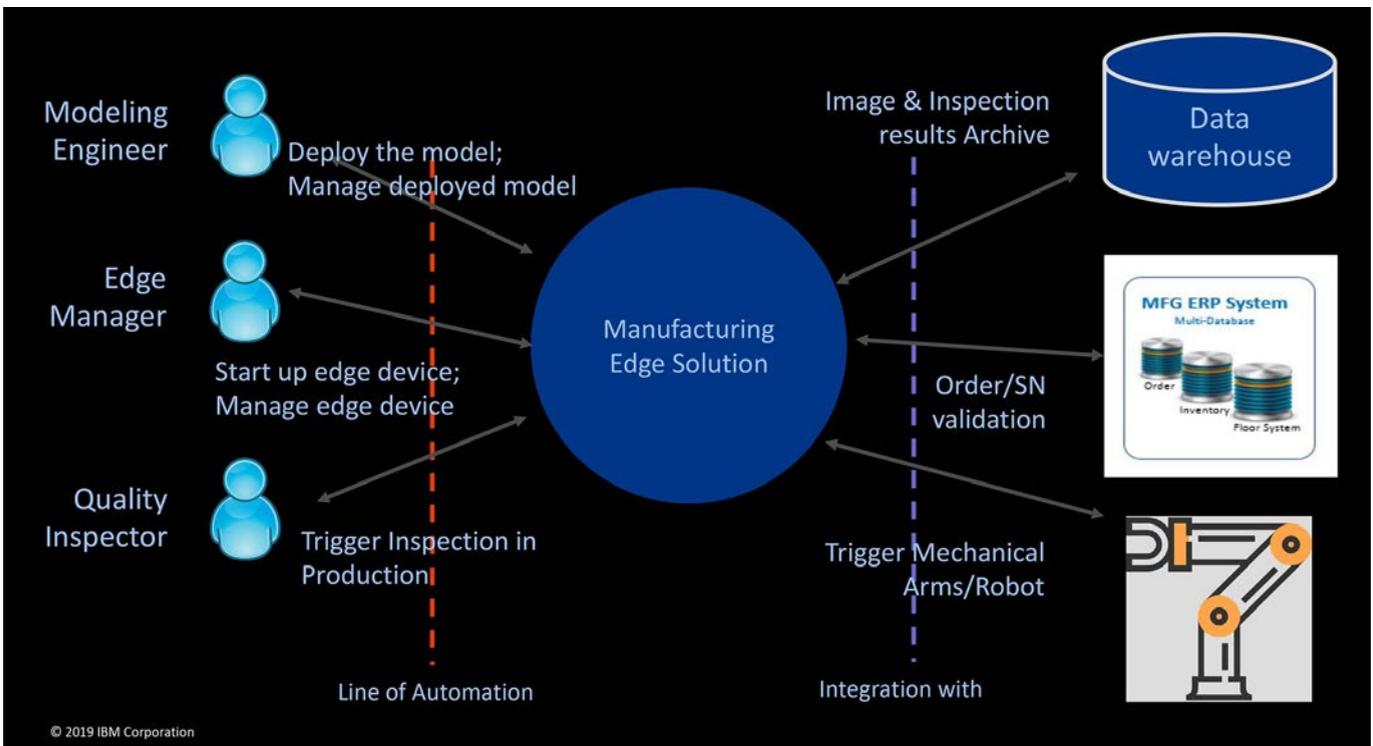


Figure 1: System context diagram of manufacturing edge solution.

- Manufacturing floor control (MFC) and enterprise resource planning (ERP) systems: Read/write manufacturing operation data
- Mechanical arms/robot: Perform automated image acquisition and production disposition

Figure 2 shows the architecture diagram of the edge solution. Architecture decisions are discussed at a high level without many specific details in operational model. Many options can be considered for the actual implementation of this architecture.

High availability

Hybrid cloud offers flexibility and high availability. Common applications and services (e.g., main application for model deployment, model and device management, model extraction service, model training service) can be deployed into different cloud infrastructures (e.g., private cloud, multiple cloud providers) based on the use case requirement, while maintaining high availability. The high avail-

ability of the edge applications and services, on the other hand, must be achieved through edge hardware redundancy and recovery as a more traditional practice.

Scalability and performance

Common applications and services can be easily deployed into multi-zones in a cloud environment. This enables quick scale-up of the solution while maintaining performance across geographies.

User authentication and authorization

Users are authenticated with Single sign-on for ease of use and security. Access to systems is based on roles and authorization policies.

Model management and device management

Deploying model management service and device management service in cloud offers the model engineers and device managers one single platform with high availability to manage the lifecycle of models and edge services/devices. MQTT (Message Queuing Telemetry Transport) protocol offers a lightweight

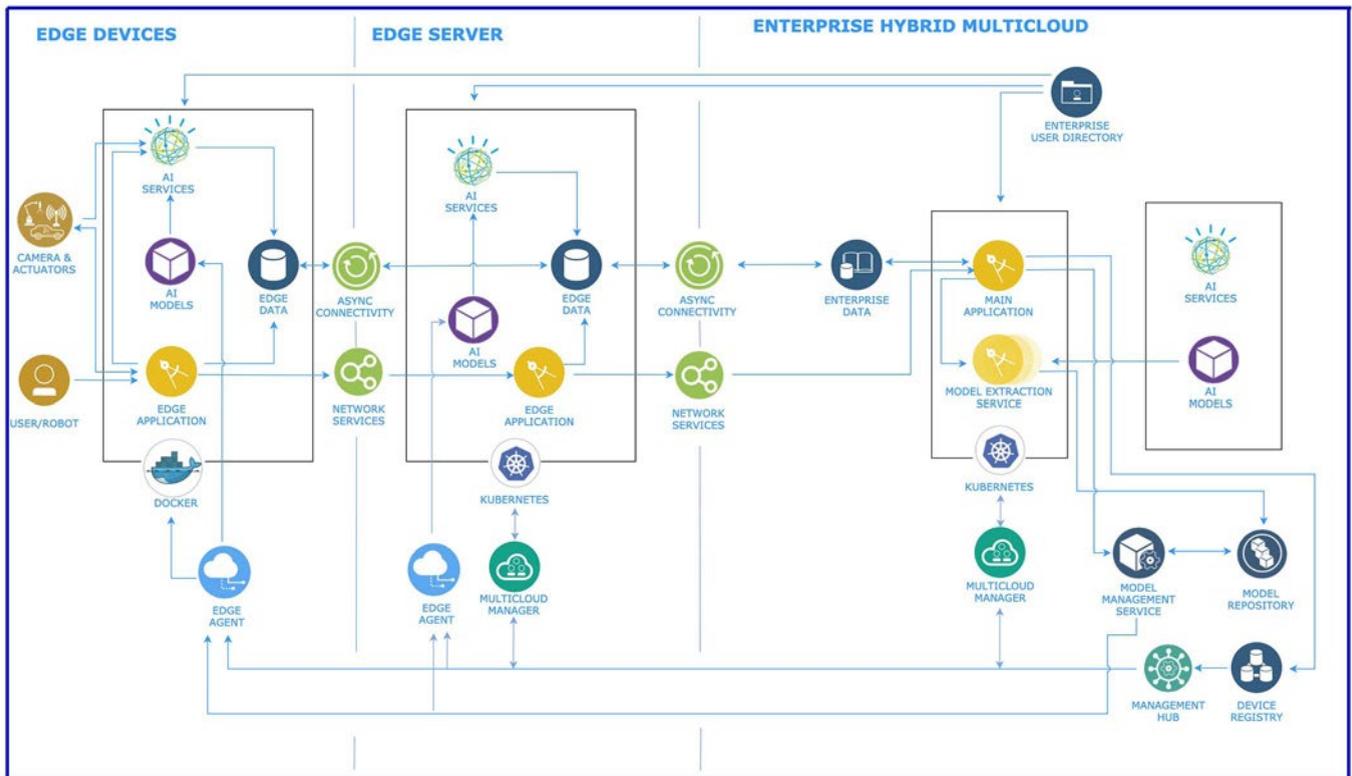


Figure 2: Edge computing architecture illustration.

implementation to monitor the healthiness of the edge servers/devices.

Data security

Data backup and archive service shall be implemented to back up the edge data into an enterprise data warehouse. The service can run asynchronously between different edge devices and edge servers. The enterprise data warehouse shall be the interaction point for other applications or users to consume and retrieve the data, minimizing unnecessary access to edge device and edge server. Data is encrypted at rest and in transit between edge devices and cloud.

Cost

Cost is not directly reflected in this architecture diagram. It is more a function of the implementation options of the architecture decisions above. Therefore, cost factors shall be considered when deciding the implementation option for each of the blocks in the diagram.

Hybrid Quality Inspection Framework

While manufacturing companies are starting to deploy AI assisted quality inspection onto their manufacturing floors, it would take a considerable period of time to convert all their quality inspection operations to be AI-assisted. From a manufacturing operation point of view, a hybrid quality inspection framework is required to support both AI-assisted inspection and human cognition inspection concurrently on the manufacturing floor. This is critical for both risk mitigation of potential disruption from newly developed AI services, and for smooth transition from human inspection to AI-assisted inspection at organization level. Moreover, there would certainly be some critical inspections that require sampling verification by human cognition to ensure there is no drift of AI accuracy. In addition, although some quality inspection would remain with human cognition, manufacturing companies shall automate and digitalize their quality inspection in the area of image acqui-



You Belong Here



SMTA Members

- Broaden Technical Resources
- Develop Successful Careers
- Build Life-long Friendships

Make **Local and Global** Connections

Join Us Today

www.smta.org/belong

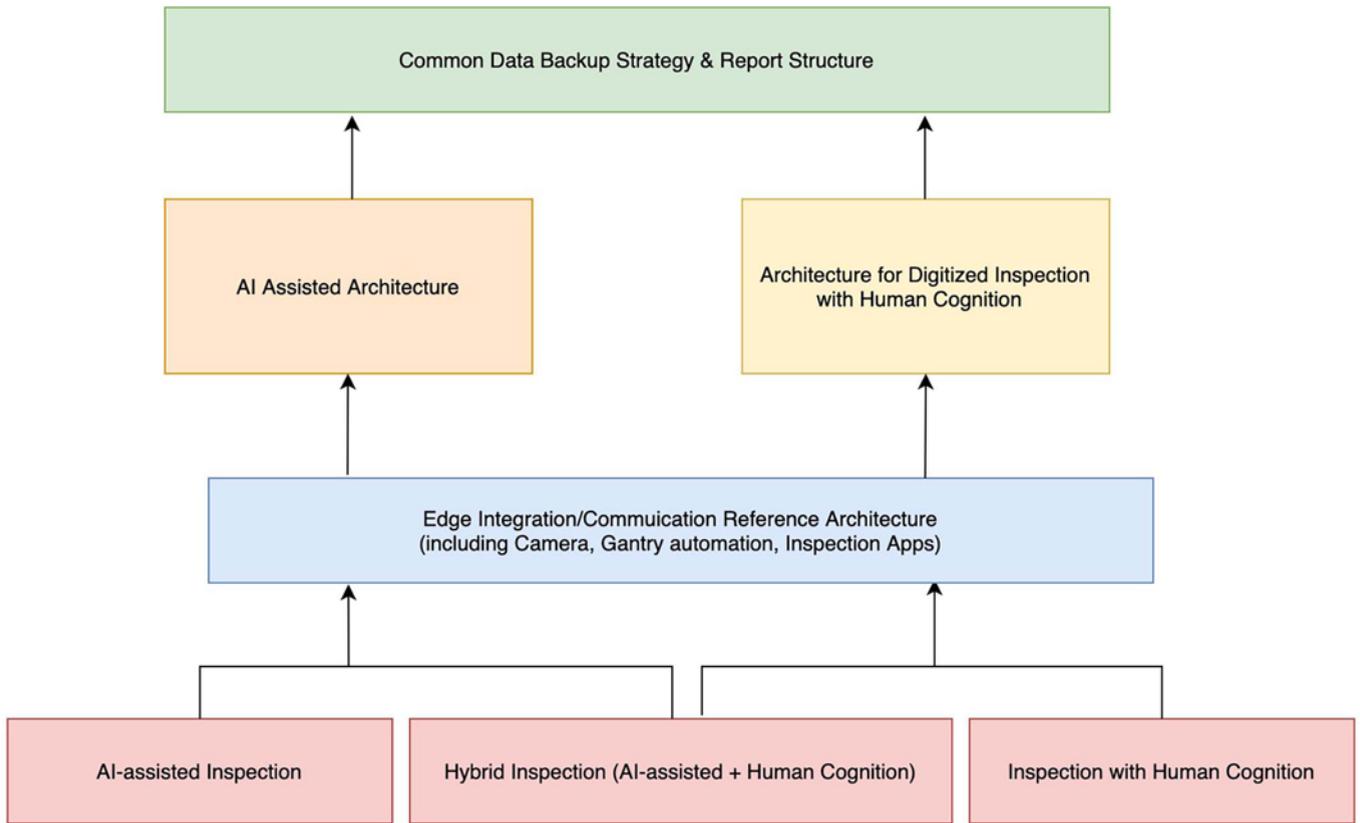


Figure 3: Hybrid inspection framework illustration.

sition (including edge mobile app), inspection checklist management, and inspection data.

Figure 3 shows the hybrid quality inspection framework proposed. In this framework, AI-assisted inspection and human cognition inspection share common edge integration and communication as well as common data backup and report strategy. The proposed framework offers three key advantages:

- Great operational flexibility to switch between AI-assisted inspection and human cognition inspection when there is a disruption in AI service
- A common data layer for the consumption and retrieval of quality inspection data
- As companies move towards more AI-assisted inspection, minimal investment would be required to upgrade the inspection stations at the edge.
- It would enable smoother transition into AI-assisted inspection by integrating

inspection with human cognition into the framework in early stage.

Conclusion

This paper discussed the prospect of deploying large-scale AI-assisted inspection onto manufacturing floors, both within a plant and across plants in different geographies. An edge computing architecture was presented as a viable solution to achieve the operational requirements in availability, scalability, performance and security. A hybrid inspection framework was proposed to address the operational needs of running both AI-assisted inspection and human cognition inspection concurrently on the manufacturing floor. A full solution based on the edge computing architecture and inspection framework are being deployed into IBM manufacturing facilities to transform the quality inspection process with higher efficiency and accuracy.

Acknowledgement

The authors of this paper would like to acknowledge the contribution of the following IBM colleagues to the content of this paper: Igor Khapov, Ekaterina Krivtsova, Dmitry Gorbachev, Ilsiyyar Gaynutdinov, Ilya Trofimov, Yuri Pravosud, Thomas Cook, Jeff Komatsu, Julian Reyes, Aaron Civil, John Bacon, Dingguo Xiong, Hailin Zhu. **SMT007**



Feng Xue is a senior technical staff member at IBM



Charisse Lu is a senior technical staff member at IBM



Christine Ouyang is a Distinguished Engineer at IBM



James Hoey is a manufacturing engineer at IBM



Rogelio Fernando Gutierrez Valdez is a senior engineer at IBM



Richard B. Finch is a senior technical staff member at IBM

References

1. Hamilton, Eric “What is Edge Computing: The Network Edge Explained.” <https://www.cloudwards.net/what-is-edge-computing/>, 27 December 2018.
2. IBM Edge Computing Reference Architecture, <https://www.ibm.com/cloud/architecture/architectures/edge-computing/overview>

NASA Invests \$105 Million in U.S. Small Business Technology Development

NASA has a long history of supporting America’s entrepreneurs as they develop technologies from ideas to commercial readiness. The agency’s Small Business Innovation Research (SBIR) program is furthering that legacy with 140 new Phase II awards to 127 U.S. small businesses that will help them move their innovations to market.

The awards to these small businesses, located across 34 states and Washington, D.C., total \$105 million. NASA’s small business program is dedicated to finding the most useful technologies for the agency and the commercial marketplace, and sourcing those innovations from a diverse group of entrepreneurs with different backgrounds and perspectives. The companies chosen for Phase II funding include 33 women-owned, minority-owned, and veteran-owned small businesses.

The awardees all received initial SBIR Phase I contracts in 2020 to demonstrate the merits of their innovations and show how they could contribute to NASA’s efforts in human exploration, space technology, science, and aeronautics. The Phase II awards will provide them each with up to \$750,000 to advance their technologies toward potential commercialization. The companies will spend up to

two years developing, demonstrating, and delivering their proposed projects.

NASA aims to help small businesses focus on commercialization. The program offers additional funding opportunities for small businesses if their Phase II work proves successful, helping them find customers outside the agency.

“The Phase II contract period is an exciting time, as small businesses put their ideas into practice and develop prototypes attractive to NASA and private investors,” said NASA SBIR Program Executive Jason L. Kessler. “The selected technologies have displayed great potential impacts for their respective sectors, and we are proud to continually invest in today’s booming aerospace economy through these small businesses.”

NASA’s SBIR/STTR program is part of STMD and managed by NASA’s Ames Research Center in California’s Silicon Valley. (Source: NASA)



Security is Key

Time to Market

by Imran Valiani, RUSH PCB

New product introduction (NPI) is on the rise. With crisis comes innovation and the COVID-19 pandemic is no different, as hundreds of new and innovative products are being developed and rushed to the marketplace.

There are all kinds of new and improved medical devices such as respirators, ventilators, and vaccine storage; expedited shipping on temperature monitors, sanitizers, and purifiers; and quick and accurate tests and numerous other medical devices. There are also other new products being rushed to the market, everything from automatic door openers to office occupancy monitoring, and much more.

This tsunami of new products coming to market also includes innovations and inventions in the automotive marketplace, from electric and autonomous vehicles to battery chargers that

are easier to use and longer lasting than anything currently on the market.

Adding to this is the fact that people have been locked down for well over a year, giving them creative time like they have never had in their lives. Artists are finding new ways to create art; singers are putting out new albums, and inventors are inventing like crazy.

Of course, they all want to get their creations and inventions to the marketplace as rapidly and as easily as possible.

There has never been a higher demand for faster time to market than right now. Those of us working in this space must get ready for a perfect storm of highly competitive companies wanting to get their products to market first.

If you're in this end of the marketplace, you had better be ready for it. If you're not, sharpen



The Test Connection: Your Test Expert

Seica Pilot V8 gets a new partner in test.
Meet Seica Pilot V8 Next.



Contact us for your "Next" project!

LEADING-EDGE TEST SYSTEMS



Flying Probe



In-Circuit Test



Boundary Test



Functional



The Test
Connection, Inc.

Providing test services worldwide since 1980
www.ttc.com | 410.205.7300



your pencils because every company in electronics is going to be looking for you to take their products to market—quickly, efficiently, and productively.

But one aspect of NPI QTA that we probably don't talk enough about is confidentiality. In the past, we have been judged by three "legs" of NPI QTA: delivery, quality and price. Now, I propose we add confidentiality as the fourth leg, and also the one growing in importance.

With so much innovation, many ideas and concepts are likely to get stolen, or I should say "seemingly stolen." By this, I mean that when a lot of companies are working on the same kinds of products at the same time, there is bound to be some cross-pollination of ideas that could lead to lawsuits or at least severe misunderstandings. And of course, much of the time we are all working on products with either no patents yet, or best-case, patent pending.

**With so much innovation,
many ideas and concepts
are likely to get stolen,
or I should say
"seemingly stolen."**

This means that our customers are very sensitive about who is actually building their products and whether they are truly trustworthy.

For these reasons, we must develop privacy and security systems in our processes that will alleviate our customers' fears of patent infringement or stealing of their new product ideas. We are all going to have to tighten our security systems to make sure that no product information in any way leaves our companies.

It is a known fact that often we will simultaneously be building two or sometimes three

competing companies' products, and we must make sure that these products' lines never cross in any way. We also must make darn sure that we don't inadvertently expose one company's product or product secrets to one of their competitors.

So far, this has never posed that great a problem, but I see that it may change. We are seeing a drastic rise in customer concern for having their new products stolen by a competitor. I believe this concern will continue to rise in the next two years, at least.

Adding to this concern is the rise of the "anybody but China" (ABC) thinking when it comes to American OEMs losing their faith and trust in Chinese companies. There is currently a move to find suppliers with non-Chinese companies in Southeast Asia; it is something we need to address immediately.

While for years it was perfectly acceptable for Americans to buy components and other products directly from China, the trust in China (for whatever reason) is waning to the point where OEMs no longer want to deal with China. This is creating havoc with the supply chain as we've known it for the past 20 years.

Part of this concern is, of course, to produce the intellectual property (IP) that is being developed here by American OEMs. Once again, it is a matter of product security and patent infringement.

We now must demonstrate our trustworthiness when it comes to security and the protection from IP theft to our customers. We are going to have to make them very comfortable that they can trust us with their products of the future. **SMT007**



Imran Valiani is an account manager at Rush PCB. He can be reached at imran@rushpcb.com. To read past columns or contact Valiani, [click here](#).

BUILD A BETTER WORKFORCE

- Electronics Assembly for Operators
 - IPC-A-610 for Operators
 - IPC-J-STD-001 for Operators
- Wire Harness Assembly for Operators



2/3 of electronic industry companies have difficulty finding production workers.¹

VS



Upskill Your Employees with IPC Electronics Workforce Training

IPC Electronics Workforce Training helps you bridge the skills gap. If you need to train assembly operators or wire harness assembly operators, these courses deliver consistent training and are easily scalable.

See our current course listing on training.ipc.org.

Courses can be offered directly to employees or integrated into your training programs.

¹IPC. (2017). Findings on the Skills Gap in U.S. Electronics Manufacturing.

It's Pronounced 'Tooling Hole'

Adventures in Engineering

by Chris Young, YOUNG ENGINEERING SERVICES LLC, AND THE GOEBEL COMPANY

Tooling holes are more than a type of mounting hole used in PCBs to aid in the assembly of printed circuit board assemblies (PCBAs). Tooling holes are used for aligning, inserting, and extracting PCBAs in higher level assemblies because they are precise mechanical references embedded into the PCB. The differences between mounting holes and tooling holes are subtle but important, nonetheless. Tooling holes deserve their own designation within the PCB design environment.

As precise mechanical references, tooling holes are used in a wide range of higher-level assembly processes. When matched appropriately with dowel pins, tooling holes can be used for precision alignment of PCBAs in electromechanical assemblies. A dowel pin is typically a cylindrical metal rod that has a chamfered end. However, they do come in many shapes and sizes. Figure 1 shows an example of how a PCBA can be aligned with a pogo pin

plate assembly and a board stiffener.

Dowel pins are used to align a PCBA, board stiffener, and pogo pin socket plate. The sub-assembly shown is part of a clam shell test fixture used to test a panelized set of PCBAs (commonly referred to as a DUT panel). This alignment is critical because the pogo pins that are inserted in the sockets interface with the panel PCBA for parametric and functional test of the individual devices under test (DUTs). Precise targeting of the pogo pins in the test fixture to test points on the DUTs is critical for repeatable error-free high-volume throughput.

Tooling holes are not only round holes in the PCB; they can take on many different shapes to aid in the higher-level assembly process. I have seen slotted tooling holes used to keep a PCBA locked in a single dimension so that two high insertion force connectors can be mated properly. Triangle, hexagon, and semi-circle shaped tooling holes have been used as keying mech-

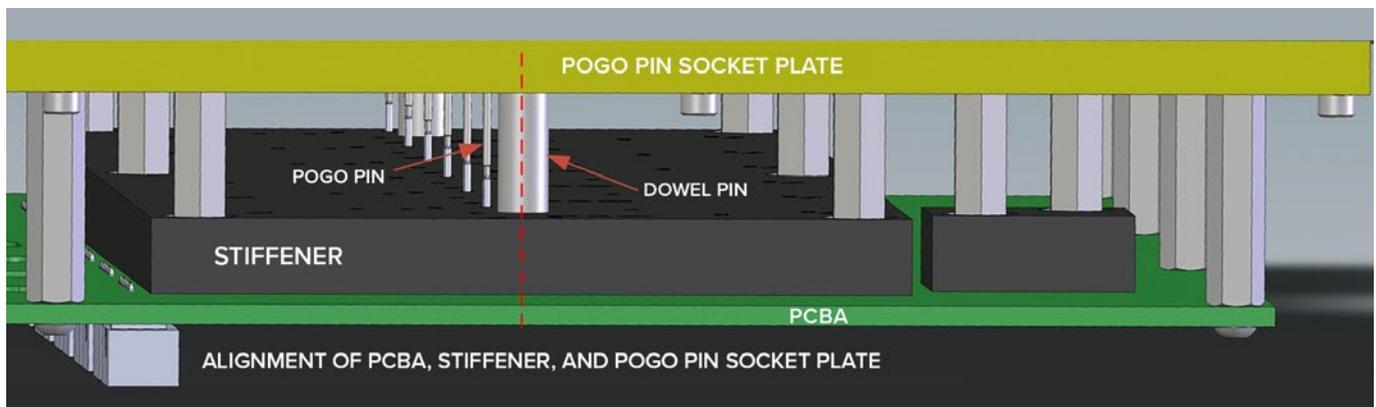


Figure 1: Example of a tooling hole.

GLOBAL. AHEAD. SUSTAINABLE.

**APEX
EXPO[®]
IPC 2021**

VOIDLESS REFLOW.

DRIVEN BY KURTZ ERSA.

Ersa EXOS 10/26: Voidless reflow soldering with vacuum.

With the EXOS 10/26, Ersa offers a vacuum reflow soldering system with eleven heating zones, three heating circuits for the vacuum chamber and four cooling zones for extremely voidfree connections in electronics production.

The absolute highlight of the EXOS is the vacuum chamber, which is part of the peak process area - this allows the void rate (depending on paste, component and PCB) to be reduced by up to 99 %.

The conveyor system is divided into four segments. Infeed, preheating and peak zone, vacuum module as well as cooling

zone are equipped with their own individually controllable conveyor. The conveyor system of the vacuum section is free of lubricants and therefore - like the system as a whole - very low-maintenance. The EXOS software also allows the operator simple and intuitive operation of the various functions and ensures safe continuous operation.



Ersa EXOS 10/26 convection reflow soldering system with vacuum module

anisms so that similar looking PCBAs do not get installed in a wrong backplane or assembly by mistake. The premise here is that tooling holes have a multitude of uses and vary in size/shape.

My main point of contention with identifying a tooling hole as a type of mounting hole is the ambiguity involved in such a classification. When designing the mechanical features of a PCB, how do you differentiate mounting holes from tooling holes? Is it implied by their locations? Do you have callouts in the fabrication data? Do you export a step file of your design for use in a 3D CAD tool? Is it based on the tolerances assigned to different drill holes in the design? This leads to miscommunication of where tooling holes need to be placed, usually because assumptions are made. The typical result is that a re-spin is in order.

Early in my career I was responsible for a board design that involved a right-angle, high-density connector with over 500 pins. Each pin had an insertion force of one-eighth pound and an extraction force of one-fourth pound. It took a little over 62.5 pounds to insert the board and over 125 pounds to remove the board. These force specifications were valid for a narrow angle of entry/exit of the right-angle connector to the backplane connector. Two sets of tooling holes were used to accomplish appropriate insertion/extraction. Round tooling holes served the dual functions of insertion/extraction load points and PCBA assembly/clamshell test alignment. Slotted tooling holes were used to minimize rocking at an angle during insertion/extraction of the PCBA. These tooling holes were placed and treated as mounting holes in the design. When these PCBs were built, the fabricator asked for relaxation of the requirements of the mounting holes in the design. They were given permission by our manufacturing engineer and the round tooling hole placement was adjusted on one side of the PCB only. This introduced a forced rocking angle that was not caught during development and certification of the product. When the

product entered mainstream production with higher quantities and part variations, the backplane connectors started ripping out of the backplane when board extractions were performed. It turns out the uneven placement of the tooling holes was responsible for two connectors binding, and the press fit backplane connector ended up being the loser in the tug of war that would ensue. The root cause of the problem was identified as a lack of specifications surrounding specific mounting/tooling holes causing the manufacturing engineer to make an incorrect assumption. The result was three re-spins: my board, the backplane board, and the insertion/extraction tool, to specifically avoid this issue in the future.

How can we solve the issue of ambiguity surrounding tooling holes? CAD tool vendors have and are implementing cross-platform integration between PCB and 3D CAD tools. This is progress in a good direction but does not solve the issue at hand. PCB and 3D CAD designers still need to communicate the specifics about what they are co-designing. Direct integration between CAD platforms do not differentiate between tooling and mounting holes because they are defined as the same thing: a mounting hole. What I am proposing is a specific designation for tooling holes within the CAD tools themselves—a separately searchable, reportable, and identified item defined explicitly as a tooling hole. This type of unique treatment is like a fiducial, test point, and/or mounting hole. The idea is to explicitly identify tooling holes within the CAD tool environment to avoid assumptions and miscommunications which inevitably lead to redesigns. I would like to start a new tooling hole motto, “There is no ‘M’ in Tooling Hole.” **SMT007**



Chris Young is owner/lead engineer of Young Engineering Services LLC and chief hardware engineer at The Goebel Company. To read past columns, or contact Young, [click here](#).

Distinctly different.

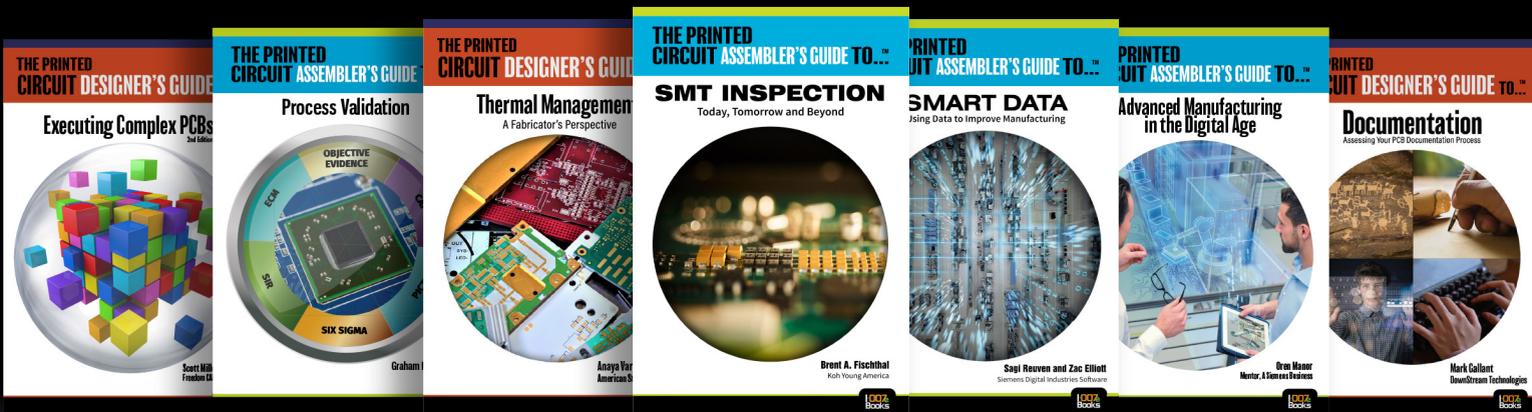
Our books are written by recognized industry experts. At around 8,000 words, they are unique in that they are able to be incredibly focused on a specific slice of technology.

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

Stephen V. Chavez
PCEA Chairman, MIT, CID+



VISIT OUR LIBRARY

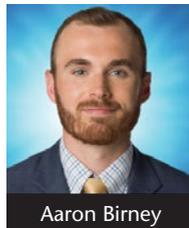




Editor's Picks from SMT007.com

1 Foundations of the Future: Emerging Engineers Benefit from Mentorship ▶

While the Emerging Engineer Program was traditionally created for early-career professionals, IPC and the IPC Education Foundation decided to reserve slots for five qualified student candidates to earn a spot in the professional development and mentorship program.



Aaron Birney

2 Maggie Benson's Journey: Setting the Stage for Continuous Improvement ▶

Indium Corporation's Ronald C. Lasky has launched this series of columns about Maggie Benson, a fictional character, to demonstrate continuous improvement and education in SMT assembly.



Ron C. Lasky

3 X-Rayted Files: Crafting Our 'Next Normal' ▶

So many things that we took for granted as practices and behaviors etched in stone, were interrupted, suspended, or eliminated entirely. As we exit the tunnel into the light of the post-pandemic, we will be challenged collectively in crafting the next normal.



Bill Cardoso

4 An Inside Look at the IPC Committee Process ▶

As IPC committee meetings were in full effect at this year's APEX EXPO, Nolan Johnson and Barry Matties have a discussion with many of IPC's directors and program managers—Teresa Rowe, Chris Jorgensen, Deb Obitz, John Perry, Andres Ojalill, and Patrick Crawford—to gain a better understanding of how committees work.

5 A New Captive PCB Facility in the U.S. ▶

Diane Maceri and Jessi Hall discuss how Schweitzer Engineering Laboratories (SEL) has been working with Alex Stepinski of Green-Source Fabrication to build their own captive PCB facility in Moscow, Idaho; the thought process behind that decision; and their involvement in the Managers Forum at IPC APEX EXPO 2021.

6 Hans-Peter Trantz: Dieter Bergman IPC Fellowship Award Recipient ▶

In this wide-ranging interview, Patty Goldman speaks with Continental Automotive's Peter Trantz about his IPC involvement with press-fit and other automotive standards which have earned him the coveted Dieter Bergman IPC Fellowship Award.



Peter Trantz

7 A Tribute to Dieter Bergman ▶

In 1962, while at Philco Ford, Dieter became the company's official representative to the IPC. Dieter tag-teamed with his friend and co-worker Gerald Ginsberg on the development of a prolific run of technical publications. For his standards contributions, Dieter received the IPC President's Award in 1968, the same year he assumed chairmanship of the IPC Design Committee.



Dave Bergman

8 Her Voice: Arbitration or Root Canal? ▶

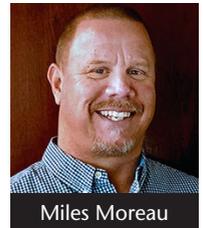
As a business owner—and I'm sure anyone else in business will attest to this—it's inevitable that at some point in time, you will be faced with a dispute in spite of having a contract in place and in spite of the clarity of the wording.



Christine Davis

9 Process Control in Solder and Reflow ▶

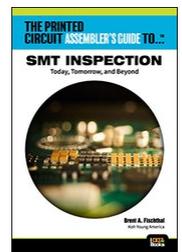
Nolan Johnson speaks with KIC's Miles Moreau to get his perspective on topics such as wave process inspection (WPI), wave solder, and vacuum reflow, and how they will fit into Industry 4.0 and smart factories.



Miles Moreau

10 Excerpt—The Printed Circuit Assembler's Guide to... SMT Inspection: Today, Tomorrow, and Beyond, Chapter 3 ▶

Initiatives like the IPC Connected Factory Exchange (CFX) and IPC-Hermes-9852 underpin efforts within the industry to develop standards and help create a smart factory. These M2M communication standards, guided in part by Industry 4.0, are altering the manufacturing process by improving metrics such as first pass yield and throughput by applying autonomous process adjustments.



For the latest news and information, visit SMT007.com. Subscribe to our newsletters or premium content at [my I-Connect007](http://myI-Connect007.com).

Career Opportunities



Is your team growing?

Find industry-experienced candidates at I-Connect007.

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

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

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

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

To get your ad into the next issue, contact:

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

I-Connect007
GOOD FOR THE INDUSTRY



Career Opportunities



Multiple Positions

Innovative Circuits, a quick-turn, low-mix, high-volume PCB manufacturer located in Alpharetta, Georgia, is growing and looking for talented individuals to join the team.

Front End Engineering Manager

Oversee CAM, programming/production engineering and quoting departments. Ideal candidates will have 15 years' experience working in a printed circuit board front-end department with flex and rigid flex circuit board construction.

Process Engineer

Responsible for the implementation and maintenance of chemical and/or mechanical processes used to produce flex circuits, rigid flex and rigid printed circuit boards.

Third Shift Production Manager

Oversee third shift productions workers, product schedule and reporting.

Wet Lab Tech

Perform all lab analysis using burettes, pipettes, pH/ion meters, atomic absorption spectrophotometer, laboratory balance, hydrometers, hull cells, CVS, and all other lab-related equipment.

CAM Operator

Inspect, modify, and contribute to the initial development of producing flex circuits, rigid flex and rigid printed circuit boards based upon customer requirements and data files.

Quality Inspector

Responsible for verifying that the product meets customer requirements prior to shipping.

Wastewater Technician

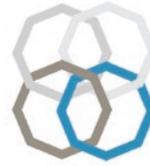
Operate, monitor, maintain and troubleshoot the wastewater treatment facility and its processes.

Production Worker

Machine operator and light chemistry in a PCB manufacturing environment.

Please visit the link below to view our opportunities and apply.

[apply now](#)



ventec
INTERNATIONAL GROUP
騰輝電子

Technical Support/ Sales Engineer, UK

We are looking to expand our UK technical & sales support team. As a technical support/sales engineer (home office/Leamington Spa) you will assist potential and current customers in appreciating the benefits of using--and optimizing the use of--Ventec materials in their printed circuit board manufacturing processes, and so enhance customer loyalty and satisfaction, spread the use of Ventec materials, and grow sales. You will provide a two-way channel of technical communication between Ventec's production facilities and UK/European customers.

Skills and abilities required for the role

- HNC, HND, degree or equivalent in a technical/scientific discipline
- Sales experience/negotiating skills
- Printed circuit board industry experience an advantage
- Good written & verbal communications skills
- Ability to work in an organized, proactive and enthusiastic way
- Ability to work well both in a team and independently
- Good user knowledge of common Microsoft Office programs
- Full driving license essential

What's on Offer

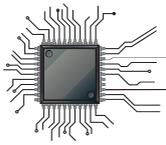
- Excellent salary and benefits commensurate with experience

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

Please forward your resume to anthony.jackson@ventec-europe.com

[apply now](#)

Career Opportunities



MivaTek

Global

Product Manager

MivaTek Global is preparing for a major market and product offering expansion. Miva's new NG3 and DART technologies have been released to expand the capabilities of Miva's industry-leading LED DMD direct write systems in PCB and Microelectronics. MivaTek Global is looking for a technology leader that can be involved guiding this major development.

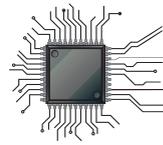
The product manager role will serve as liaison between the external market and the internal design team. Leadership level involvement in the direction of new and existing products will require a diverse skill set. Key role functions include:

- **Sales Support:** Recommend customer solutions through adaptations to Miva products
- **Design:** Be the voice of the customer for new product development
- **Quality:** Verify and standardize product performance testing and implementation
- **Training:** Conduct virtual and on-site training
- **Travel:** Product testing at customer and factory locations

Use your 8 plus years of experience in either the PCB or Microelectronic industry to make a difference with the leader in LED DMD direct imaging technology. Direct imaging, CAM, AOI, or drilling experience is a plus but not required.

For consideration, send your resume to N.Hogan@MivaTek.Global. For more information on the company see www.MivaTek.Global or www.Mivatec.com.

apply now



MivaTek

Global

Field Service Technician

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

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

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

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

More About Us

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

apply now

Career Opportunities



A Flex Company

Sheldahl, a leading provider of flexible interconnect products and electronic materials, is seeking candidates to join their diverse and skilled team.

We are looking for people who demonstrate:

- Intense collaboration
- Passionate customer focus
- Thoughtful, fast, disciplined execution
- Tenacious commitment to continuous improvement
- Relentless drive to win

Positions in America include:

Project Manager – Northfield, MN

Candidate will provide timely cost estimation and project budget definition, be responsible for maintaining customer relations, participate in meetings, etc.

[apply now](#)

Program Manager – Specialty Films

Candidate will work with our Specialty Films in the Aerospace, Medical, and Commercial Aviation markets providing timely cost estimation and project budget definition, maintaining customer relations, participate in meetings, etc.

[apply now](#)

Business Development Manager – North America

Candidate will provide leadership in the planning, design and implementation of customers' specific business plans and will provide vision, penetration strategies and tactics to executive managers in order to develop and drive external and internal senior-level relationships.

[apply now](#)



A Flex Company

Sheldahl, a leading provider of flexible interconnect products and electronic materials, is seeking candidates to join their diverse and skilled team.

We are looking for people who demonstrate:

- Intense collaboration
- Passionate customer focus
- Thoughtful, fast, disciplined execution
- Tenacious commitment to continuous improvement
- Relentless drive to win

Positions in Europe include:

Business Development Manager – France

Seeking out-of-the-box thinkers to help us take the ordinary to the extraordinary by cultivating current customer relationships and developing new business opportunities with our European team, based in France.

[apply now](#)

Business Development Manager – Germany

Seeking out-of-the-box thinkers to help us take the ordinary to the extraordinary by cultivating current customer relationships and developing new business opportunities with our European team, based in Germany.

[apply now](#)

Career Opportunities



Are You Our Next Superstar?!

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

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

View our opportunities at
Insulectro Careers (jobvite.com)

apply now



Packaging Engineer

Job description: The Packaging Engineer designs and deploys product packaging to ensure product integrity under varying shipping conditions. This individual is responsible for testing, analyzing, and selecting materials for packaging based on durability, function, ease of use and cost effectiveness. The Packaging Engineer helps ensure that packaging complies with all regulatory requirements.

Requirements: Bachelor's degree in engineering, packaging science and at least one year of related work experience. An equivalent combination of education and related work experience may be considered. Demonstrable skills with computer-aided design (CAD) software and other relevant programs.

Indium Corporation is a premier materials refiner, smelter, manufacturer, and supplier to the global electronics, semiconductor, thin-film, and thermal management markets. Products include solders and fluxes; brazes; thermal interface materials; sputtering targets; indium, gallium, germanium, and tin metals and inorganic compounds; and NanoFoil®. Founded in 1934, the company has global technical support and factories located in China, India, Malaysia, Singapore, South Korea, the United Kingdom, and the USA. Indium Corporation is an Equal Opportunity/Affirmative Action and Minority/Female/Disability/Protected Veteran Employer. We provide a drug-free work environment and a full benefits package.

apply now

Career Opportunities

SIEMENS

Siemens EDA Sr. Applications Engineer

Support consultative sales efforts at world's leading semiconductor and electronic equipment manufacturers. You will be responsible for securing EM Analysis & Simulation technical wins with the industry-leading HyperLynx Analysis product family as part of the Xpedition Enterprise design flow.

Will deliver technical presentations, conduct product demonstrations and benchmarks, and participate in the development of account sales strategies leading to market share gains.

- PCB design competency required
- BEE, MSEE preferred
- Prior experience with Signal Integrity, Power Integrity, EM & SPICE circuit analysis tools
- Experience with HyperLynx, Ansys, Keysight and/or Sigrity
- A minimum of 5 years' hands-on experience with EM Analysis & Simulation, printed circuit board design, engineering technology or similar field
- Moderate domestic travel required
- Possess passion to learn and perform at the cutting edge of technology
- Desire to broaden exposure to the business aspects of the technical design world
- Possess a demonstrated ability to build strong rapport and credibility with customer organizations while maintaining an internal network of contacts
- Enjoy contributing to the success of a phenomenal team

***Qualified applicants will not require employer-sponsored work authorization now or in the future for employment in the United States. Qualified Applicants must be legally authorized for employment in the United States.*

apply now



U.S. CIRCUIT

Plating Supervisor

Escondido, Calif.-based PCB fabricator U.S. Circuit is now hiring for the position of plating supervisor. Candidate must have a minimum of five years' experience working in a wet process environment. Must have good communication skills, bilingual is a plus. Must have working knowledge of a plating lab and hands-on experience running an electrolytic plating line. Responsibilities include, but are not limited to, scheduling work, enforcing safety rules, scheduling/maintaining equipment and maintenance of records.

Competitive benefits package. Pay will be commensurate with experience.

Mail to:
mfariba@uscircuit.com

apply now

Career Opportunities



Indium Corporation: Field Sales Representative

Field Sales Representative serves as lead sales contact and customer advocate to maintain existing sales and to drive new qualifications and sales of products and services through effective account management and coordination of efforts throughout Indium Corporation's Metals, Compounds, Solar and Reclaim (MCSR) organization. This position is ideal for a sales- and customer-focused individual with an engineering degree.

- Develop, cultivate, and follow-up with prospective and existing customers to generate orders
- Develop an in-depth expertise of product offerings
- Work to gain insight into customer activities for future R&D developments
- Respond to customer requests for product data, specifications, and service information
- Identify customer requirements, priorities, and opportunities
- Build strong, trusting relationships with key decision-makers and influencers at target accounts
- Gather competitive insight, including pricing, delivery, and performance information
- Visit customer facilities to observe manufacturing processes and exchange information
- Promote industry recognition of Indium Corporation, its products, and its services
- Be a key member of overall team, including worldwide sales organization, product management, operations, engineering, R&D, etc.
- Submit required paperwork in timely manner
- Work within established budget, while increasing market share
- Perform other duties and projects as assigned

Click below for more details on job responsibilities and requirements.

[apply now](#)



Our Summit Anaheim, CA, division currently has multiple open positions for planning engineers.

The planner is responsible for creating and verifying manufacturing documentation, including work instructions and shop floor travelers. Review lay-ups, details, and designs according to engineering and customer specifications through the use of computer and applications software. May specify required manufacturing machinery and test equipment based on manufacturing and/or customer requirements. Guides manufacturing process development for all products.

Responsibilities:

1. Accurately plan jobs and create shop floor travelers.
2. Create documentation packages.
3. Use company software for planning and issuing jobs.
4. Contact customers to resolve open issues.
5. Create TDR calculations.
6. Assist in the training of new planning engineers.
7. Review prints and purchase orders.
8. Create stackups and order materials per print/spec.
9. Plan jobs manufacturing process.
10. Institute new manufacturing processes and or changes.

Education/Experience:

1. High school diploma or equivalent
2. Minimum five (5) years' experience in the printed circuit board industry with three (3) years as a planning engineer.
3. Must be able to cooperate and communicate effectively with customers, management, and supervisory staff.
4. Must be proficient in rigid, flex, rigid/flex, and sequential lam designs.

[apply now](#)

Career Opportunities

Now Hiring

Director of Process Engineering

A successful and growing printed circuit board manufacturer in Orange County, CA, has an opening for a director of process engineering.

Job Summary:

The director of process engineering leads all engineering activities to produce quality products and meet cost objectives. Responsible for the overall management, direction, and coordination of the engineering processes within the plant.

Duties and Responsibilities:

- Ensures that process engineering meets the business needs of the company as they relate to capabilities, processes, technologies, and capacity.
- Stays current with related manufacturing trends. Develops and enforces a culture of strong engineering discipline, including robust process definition, testing prior to production implementation, change management processes, clear manufacturing instructions, statistical process monitoring and control, proactive error proofing, etc.
- Provides guidance to process engineers in the development of process control plans and the application of advanced quality tools.
- Ensures metrics are in place to monitor performance against the goals and takes appropriate corrective actions as required. Ensures that structured problem-solving techniques are used and that adequate validation is performed for any issues being address or changes being made. Develops and validates new processes prior to incorporating them into the manufacturing operations.
- Strong communication skills to establish priorities, work schedules, allocate resources, complete required information to customers, support quality system, enforce company policies and procedures, and utilize resources to provide the greatest efficiency to meet production objectives.

Education and Experience:

- Master's degree in chemical engineering or engineering is preferred.
- 10+ years process engineering experience in an electronics manufacturing environment, including 5 years in the PCB or similar manufacturing environment.
- 7+ years of process engineering management experience, including 5 years of experience with direct responsibility for meeting production throughput and quality goals.

apply now

Now Hiring

Process Engineering Manager

A successful and growing printed circuit board manufacturer in Orange County, CA, has an opening for a process engineering manager.

Job Summary:

The process engineering manager coordinates all engineering activities to produce quality products and meet cost objectives. Responsible for the overall management, direction, and coordination of the engineering team and leading this team to meet product requirements in support of the production plan.

Duties and Responsibilities:

- Ensures that process engineering meets the business needs of the company as they relate to capabilities, processes, technologies, and capacity.
- Stays current with related manufacturing trends. Develops and enforces a culture of strong engineering discipline, including robust process definition, testing prior to production implementation, change management processes, clear manufacturing instructions, statistical process monitoring and control, proactive error proofing, etc.
- Ensures metrics are in place to monitor performance against the goals and takes appropriate corrective actions as required. Ensures that structured problem-solving techniques are used and that adequate validation is performed for any issues being address or changes being made. Develops and validates new processes prior to incorporating into the manufacturing operations

Education and Experience:

- Bachelor's degree in chemical engineering or engineering is preferred.
- 7+ years process engineering experience in an electronics manufacturing environment, including 3 years in the PCB or similar manufacturing environment.
- 5+ years of process engineering management experience, including 3 years of experience with direct responsibility for meeting production throughput and quality goals.

apply now

Career Opportunities



SMT Field Technician Hatboro, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

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

We Offer:

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

[apply now](#)



SMT Operator Hatboro, PA

Manncorp, a leader in the electronics assembly industry, is looking for a **surface-mount technology (SMT) operator** to join their growing team in Hatboro, PA!

The **SMT operator** will be part of a collaborative team and operate the latest Manncorp equipment in our brand-new demonstration center.

Duties and Responsibilities:

- Set up and operate automated SMT assembly equipment
- Prepare component kits for manufacturing
- Perform visual inspection of SMT assembly
- Participate in directing the expansion and further development of our SMT capabilities
- Some mechanical assembly of lighting fixtures
- Assist Manncorp sales with customer demos

Requirements and Qualifications:

- Prior experience with SMT equipment or equivalent technical degree preferred; will consider recent graduates or those new to the industry
- Windows computer knowledge required
- Strong mechanical and electrical troubleshooting skills
- Experience programming machinery or demonstrated willingness to learn
- Positive self-starter attitude with a good work ethic
- Ability to work with minimal supervision
- Ability to lift up to 50 lbs. repetitively

We Offer:

- Competitive pay
- Medical and dental insurance
- Retirement fund matching
- Continued training as the industry develops

[apply now](#)

Career Opportunities



Sales Account Manager

Sales Account Management at Lenthor Engineering is a direct sales position responsible for creating and growing a base of customers that purchase flexible and rigid flexible printed circuits. The account manager is in charge of finding customers, qualifying the customer to Lenthor Engineering and promoting Lenthor Engineering's capabilities to the customer. Leads are sometimes referred to the account manager from marketing resources including trade shows, advertising, industry referrals and website hits. Experience with military printed circuit boards (PCBs) is a definite plus.

Responsibilities

- Marketing research to identify target customers
- Identifying the person(s) responsible for purchasing flexible circuits
- Exploring the customer's needs that fit our capabilities in terms of:
 - Market and product
 - Circuit types used
 - Competitive influences
 - Philosophies and finance
 - Quoting and closing orders
 - Providing ongoing service to the customer
 - Develop long-term customer strategies to increase business

Qualifications

- 5-10 years of proven work experience
- Excellent technical skills

Salary negotiable and dependent on experience. Full range of benefits.

Lenthor Engineering, Inc. is a leader in flex and rigid-flex PWB design, fabrication and assembly with over 30 years of experience meeting and exceeding our customers' expectations.

Contact Oscar Akbar at: hr@lenthor.com

[apply now](#)



Senior Process Engineer

Job Description

Responsible for developing and optimizing Lenthor's manufacturing processes from start up to implementation, reducing cost, improving sustainability and continuous improvement.

Position Duties

- Senior process engineer's role is to monitor process performance through tracking and enhance through continuous improvement initiatives. Process engineer implements continuous improvement programs to drive up yields.
- Participate in the evaluation of processes, new equipment, facility improvements and procedures.
- Improve process capability, yields, costs and production volume while maintaining safety and improving quality standards.
- Work with customers in developing cost-effective production processes.
- Engage suppliers in quality improvements and process control issues as required.
- Generate process control plan for manufacturing processes, and identify opportunities for capability or process improvement.
- Participate in FMEA activities as required.
- Create detailed plans for IQ, OQ, PQ and maintain validated status as required.
- Participate in existing change control mechanisms such as ECOs and PCRs.
- Perform defect reduction analysis and activities.

Qualifications

- BS degree in engineering
- 5-10 years of proven work experience
- Excellent technical skills

Salary negotiable and dependent on experience. Full range of benefits.

Lenthor Engineering, Inc. is the leader in Flex and Rigid-Flex PWB design, fabrication and assembly with over 30 years of experience meeting and exceeding our customers' expectations.

Contact Oscar Akbar at: hr@lenthor.com

[apply now](#)

Career Opportunities



ventec
INTERNATIONAL GROUP
騰輝電子

Customer Service Representative, UK

We are looking to expand our UK Customer Service/Internal Sales team. As Customer Service Representative you will provide great sales and customer service support and respond to the needs of clients from industries including Aerospace, Defence, Automotive and Pharmaceutical. Duties include:

- Maintain & develop relationships with new and existing customers
- Make rapid, accurate cost calculations and provide quotations
- Accurately input customer orders through bespoke MRP System
- Liaise with colleagues at Chinese HQ and other Overseas Business Units to manage domestic and international requirements
- Assist sales team with reporting, sales analysis and other items at their request

Skills and abilities required for the role:

The ideal candidate is a proactive self-starter with a strong customer service background. Friendly, approachable, and confident, you should have a good phone mannerism and be computer literate.

- Previous experience in a Customer Service background, ideally management or supervisor role
- Experience with MRP Systems
- Good working knowledge of Microsoft Office Tools such as Outlook, Excel etc.

What's on Offer:

- Excellent salary & benefits commensurate with experience

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

Please forward your resume to HR@ventec-europe.com

apply now



JOHNS HOPKINS

CAM / Process Engineer

The JHU/APL PCB Fabrication team is seeking a Computer Aided Manufacturing Engineer to support front-end data processing of APL manufactured hardware. You will directly contribute to hardware fabrication in support of National Security, Military Readiness, Space Exploration, National Health, and Research related to fundamental scientific advancement. This position includes a variable mix of core CAM work scope with additional opportunities for hands-on support such as bare board electrical testing, laser drilling, and mechanical CNC drilling and routing.

Responsibilities:

1. Computer Aided Manufacturing for rigid PCB, rigid-flex, and flexible circuits
 - a) Perform design checks, panel layout, coupon generation, file generation, stackups
 - b) Support manufacturability reviews with internal APL engineers (customers)
 - c) Generate work travelers
 - d) Communicate status to supervisors and internal customers
2. Support transition of software tools (Genesis 2000 to InCAM Pro)
 - a) Edit design rules checks and generate automation scripts
 - b) Develop new ideas to further the technical progress of our product
 - c) Develop CAM area through continuous improvement initiatives
3. Interface and inform APL Engineers on PCB design for manufacturing guidelines
4. Operate bare board electrical tester
5. Backup operator for CNC drilling, routing, laser drilling (on-site training)

For more details and to apply:

<http://www.jhuapl.edu/careers> and search for CAM.

apply now

Career Opportunities



American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

[apply now](#)



BLACKFOX

Premier Training & Certification

IPC Instructor

Longmont, CO; Phoenix, AZ;
U.S.-based remote

*Independent contractor,
possible full-time employment*

Job Description

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

IPC instructors will conduct training at one of our public training centers or will travel directly to the customer's facility. A candidate's close proximity to Longmont, CO, or Phoenix, AZ, is a plus. Several IPC Certification Courses can be taught remotely and require no travel.

Qualifications

Candidates must have a minimum of five years of electronics manufacturing experience. This experience can include printed circuit board fabrication, circuit board assembly, and/or wire and cable harness assembly. Soldering experience of through-hole and/or surface-mount components is highly preferred.

Candidate must have IPC training experience, either currently or in the past. A current and valid certified IPC trainer certificate holder is highly preferred.

Applicants must have the ability to work with little to no supervision and make appropriate and professional decisions.

Send resumes to Sharon Montana-Beard at
sharonm@blackfox.com.

[apply now](#)

Career Opportunities



eptac
TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

apply now



MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

Pre-CAM Engineer

Illinois-based PCB fabricator Eagle Electronics is seeking a pre-CAM engineer specific to the printed circuit board manufacturing industry. The pre-CAM Engineer will facilitate creation of the job shop travelers used in the manufacturing process. Candidate will have a minimum of two years of pre-CAM experience and have a minimum education level of an associate degree. This is a first-shift position at our Schaumburg, Illinois, facility. This is not a remote or offsite position.

If interested, please submit your resume to HR@eagle-elec.com indicating 'Pre-CAM Engineer' in the subject line.

apply now

Process Engineer

We are also seeking a process engineer with experience specific to the printed circuit board manufacturing industry. The process engineer will be assigned to specific processes within the manufacturing plant and be given ownership of those processes. The expectation is to make improvements, track and quantify process data, and add new capabilities where applicable. The right candidate will have a minimum of two years of process engineering experience, and a minimum education of bachelor's degree in an engineering field (chemical engineering preferred but not required). This is a first shift position at our Schaumburg, Illinois, facility. This is not a remote or offsite position.

If interested, please submit your resume to HR@eagle-elec.com indicating 'Process Engineer' in the subject line.

apply now

Career Opportunities



APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

[apply now](#)



U.S. CIRCUIT

Sales Representatives (Specific Territories)

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

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for more information.

mfariba@uscircuit.com

[apply now](#)

Learn From the Experts in Our On-demand Video Series



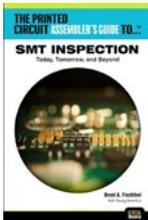
Live and on-demand webinars from KYZEN designed to answer all your cleaning questions.



Implementing “Digital Twin” Best Practices From Design Through Manufacturing with Expert Jay Gorajia, a 12-part micro webinar series.



The Printed Circuit Assembler's Guide to...



SMT Inspection: Today, Tomorrow, and Beyond

by Brent Fischthal, Koh Young America

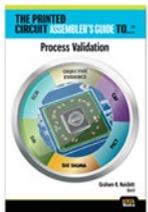
This book offers an accurate look at the aspects and challenges the electronics manufacturing industry faces with regards to SMT inspection and its surrounding technology. In-depth insight on new and exciting true 3D inspection technology is provided, with a look into the future of leveraging big data management and autonomous manufacturing for a smarter factory.



Smart Data: Using Data to Improve Manufacturing

by Sagi Reuven and Zac Elliott, Siemens Digital Industries Software

Manufacturers need to ensure their factory operations work properly, but analyzing data is simply not enough. Companies must take efficiency and waste-reduction efforts to the next phase using big data and advanced analytics to diagnose and correct process flaws.



Process Validation

by Graham K. Naisbitt, Chairman and CEO, Gen3

This book explores how establishing acceptable electrochemical reliability can be achieved by using both CAF and SIR testing. This is a must-read for those in the industry who are concerned about ECM and want to adopt a better and more rigorous approach to ensuring electrochemical reliability.



Advanced Manufacturing in the Digital Age

by Oren Manor, Director of Business Development, Valor Division for Mentor a Siemens Business

A must-read for anyone looking for a holistic, systematic approach to leverage new and emerging technologies. The benefits are clear: fewer machine failures, reduced scrap and downtime issues, and improved throughput and productivity.

Our library is open 24/7/365. Visit us at: I-007eBooks.com

PUBLISHER: BARRY MATTIES

barry@iconnect007.com

MANAGING EDITOR: NOLAN JOHNSON
(503) 597-8037; nolan@iconnect007.com

ASSOCIATE EDITOR: MICHELLE TE
michelle@iconnect007.com

TECHNICAL EDITOR: PETE STARKEY
+44 (0) 1455 293333; pete@iconnect007.com

TECHNICAL EDITOR: PATTY GOLDMAN

CONTRIBUTING TECHNICAL EDITOR: HAPPY HOLDEN
(616) 741-9213; happy@iconnect007.com

CONTRIBUTING TECHNICAL EDITOR: DAN FEINBERG
baer@iconnect007.com

SALES MANAGER: BARB HOCKADAY
(916) 608-0660; barb@iconnect007.com

MARKETING SERVICES: TOBEY MARSICOVETERE
(916) 266-9160; tobey@iconnect007.com

PRODUCTION MANAGER: SHELLY STEIN
shelly@iconnect007.com

MAGAZINE LAYOUT: RON MEOGROSSI

**AD DESIGN: SHELLY STEIN, MIKE RADOGNA,
TOBEY MARSICOVETERE**

CREATIVE TECHNOLOGIST: BRYSON MATTIES

COVER: SHELLY STEIN

**COVER IMAGES: ADOBE STOCK © RAIMUNDAS,
ADOBE STOCK © ROSINKA79**

SMT007
MAGAZINE

SMT007 MAGAZINE®

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

© 2021 BR Publishing, Inc. does not assume and hereby disclaims any liability to any person for loss or damage caused by errors or omissions in the material contained within this publication, regardless of whether such errors or omissions are caused accidentally, from negligence or any other cause.

June 2021, Volume 36, Number 6
SMT007 MAGAZINE is published monthly,
by BR Publishing, Inc.

ADVERTISER INDEX

American Standard Circuits.....	7
APCT.....	63
Blackfox Training Institute.....	55
Eagle Electronics.....	25
Flexible Circuit Technologies.....	49
Gen3.....	21
I-007e.....	2
I-007e Books.....	3, 29, 83
IPC.....	45, 79
Koh Young.....	33
Kurtz ERSA.....	81
Manncorp.....	5
P Kay Metal.....	51
Prototron Circuits.....	31
Show and Tell Magazine.....	59
Siemens Digital Industries Software.....	11
SMTA.....	41, 73
Summit Interconnect.....	67
Sunstone Circuits.....	15
The Test Connection.....	77
U.S. Circuit.....	37

Problems solved!



SUBSCRIBE NOW