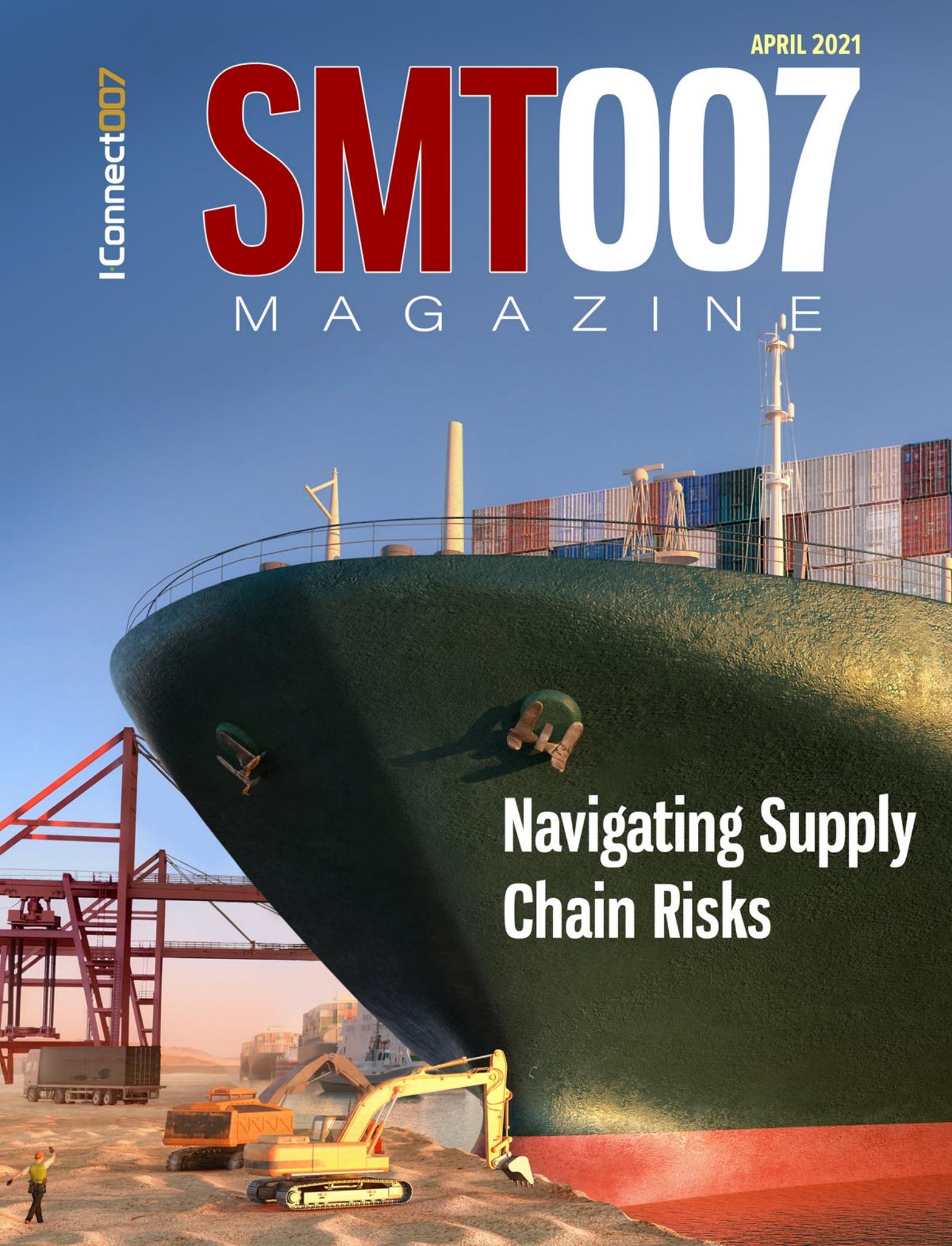


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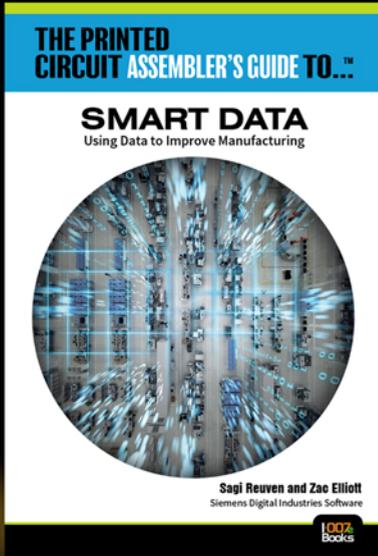
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A large green and red cargo ship is docked at a port. The ship's hull is dark green with a red bottom. A yellow excavator is positioned on the pier in the foreground, and a worker in a yellow vest is visible. The background shows a clear blue sky and a body of water with other ships.

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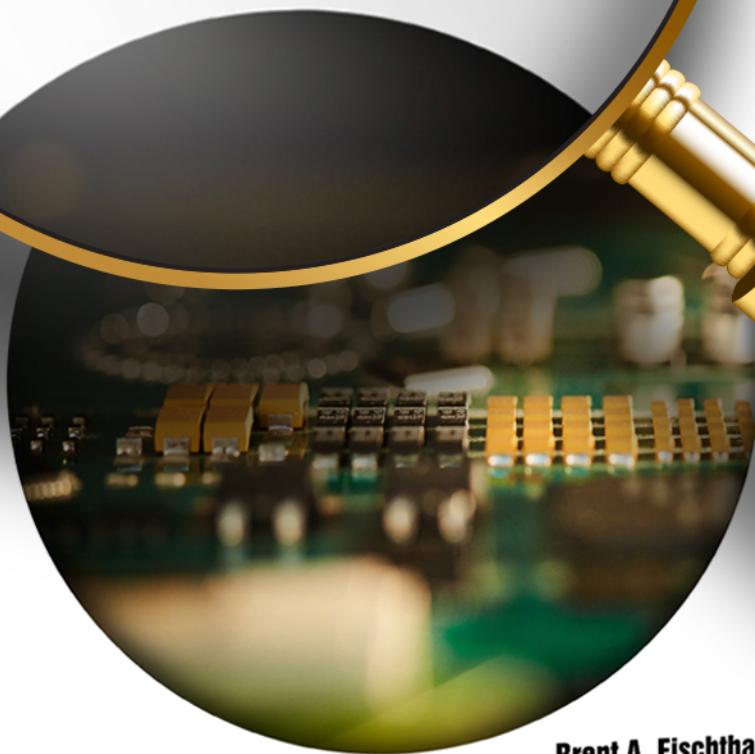
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Driving Cost Out of Your Supply Chain

In this issue, we once again take a firm hold on the supply chain. We investigate how to manage the reliability and the quality in your supply chain, question typical thinking about supplier success, and we ask what skills your supply chain manager should possess. After reading this issue, you'll deliver more leverage to your own supply chain.

FEATURES

10 **Supply Chain Cost Management is a Holistic Business Approach**
Interview with Tim Rodgers

24 **A New Captive PCB Facility in the U.S.**
Interview with Diane Maceri and Jessi Hall

36 **What Makes a Great Supply Chain Manager?**
by Timothy McLean

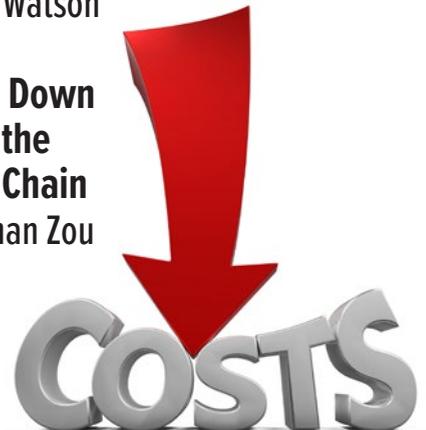
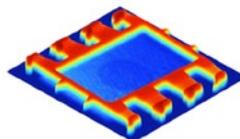
42 **10 Ways to Identify Counterfeit ICs**
by Bill Cardoso

FEATURES

54 **IPC Managers Forum: Vertical Integration**
by Pete Starkey

62 **Overcoming Component Selection and Sourcing Challenges**
by John Watson

78 **Driving Down Cost in the Supply Chain**
by Meghan Zou



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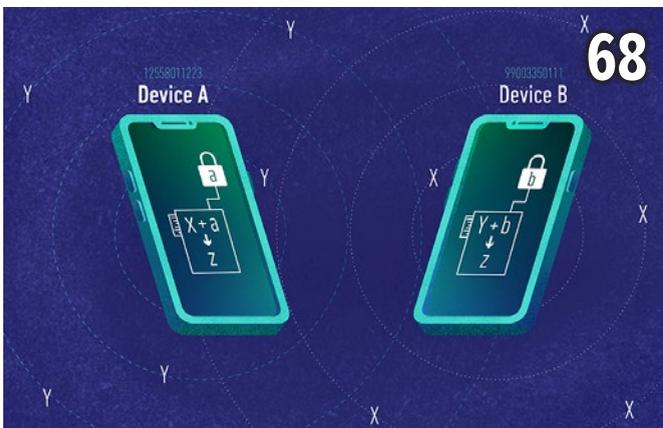
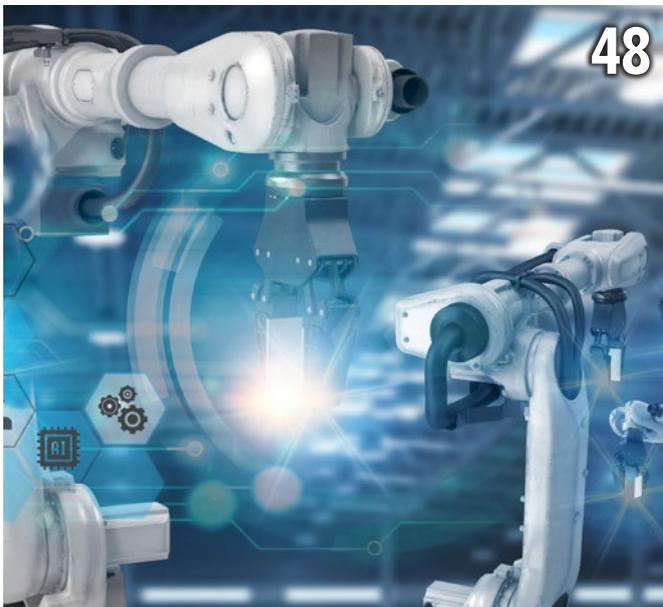
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COLUMNS

8 Driving Cost Out of the Supply Chain
by Nolan Johnson



48 Me and My Digital Twin
by Michael Ford

70 Major Drivers for Improving Yield and Reducing Cost
by Ray Prasad

HIGHLIGHTS

34 Electronics News

60 Supplier

76 MilAero007

82 Top 10 from SMT007.com



DEPARTMENTS

85 Career Opportunities

96 I-007e Educational Resource Center

97 Advertiser Index & Masthead



SHORTS

52 New Online Training Programs Enhance Delivery Options 

68 NIST Develops Privacy-Preserving 'Encounter Metrics'



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Driving Cost **Out** of the Supply Chain

Nolan's Notes

by Nolan Johnson, I-CONNECT007

It was just another Monday. We were in the midst of our weekly editorial team meeting and brainstorming upcoming topics for magazines. Our typical process begins with an open discussion about what's happening in the industry, what each member of the team sees as newsworthy, and what we're hearing as we talk with industry colleagues. It's a dynamic, organic start to what later becomes a systemized process for creating, gathering, editing, and publishing relevant content.

On this particular morning, the conversation gravitated toward supply chain. What was a low-grade, ongoing conversation in our industry, we now realize, was also a low-grade conversation in other industries as well. Sure, we'd reported on parts shortages and supply chain in late 2019 and early 2020. Yet, the situation has continued to evolve. Supply chain issues have become mainstream news as virtually all supply chains were affected in some manner by the pandemic lockdowns. The interactions of supply, demand, and distribution became a topic of scrutiny even for my 80-something par-

ents; we all became experts at understanding supply chain when we had to explain exactly why toilet paper was peculiarly absent from store shelves, while there was plenty of liquor still available. The vagaries of the distribution chain for all sorts of daily necessities suddenly became our concern; we no longer could take the supply chain for granted.

Yes, I know, some readers are shaking their heads at our "First World problems." It was interesting, though, to watch friends and family shift from complaining about the inconvenience to asking the question, "How exactly does the supply chain work, and why did this happen?"

As time went on, the initial crises in the supply chain began to resolve itself, only to be replaced by other issues. For example, toilet paper found a steady, if reduced, delivery schedule, but as some parts of the world reopened and exports started to ship out, not all the destination ports were ready to receive. From that, the world learned a bit more about how goods are transported across the globe to international markets.



We learned that there are critical parts of our global manufacturing network that rely on a few providers (sometimes, only one), and that a disruption in their manufacturing could quickly ripple through the whole economy. Semiconductors are an example, of course. Inventory shortages in the face of increased global demand (driven in large part by the electrification of the automotive industry), caused automotive factory shutdowns in December 2020 and January 2021.

And, of course, we learned a bit about manufacturer disruptions.

All these issues have been a part of the EMS industry supply chain since the very beginning: cyclical semiconductor supply and demand; counterfeit parts; white, gray, and black markets; and manufacturer disruptions.

All these factors led the conversation to impacts and strategies for responding. On this particular morning, the discussion zeroed in on increased costs and quality. Can you get a more resilient supply channel if you pay more? Can you get better quality if you pay more? Is it actually better to the bottom line to pay a bit more if that means your parts are predictable in both schedule and quality?

I-Connect007 Technical Editor Dan Feinberg made a comment that, once said, hung over the conversation like a banner at a banquet dinner fundraiser: “There’s a cost for bad quality, and a price for good quality.”

Dan’s point was that the more you can trust your supply chain to deliver exactly what you’ve been promised/sold, the more cost effective that supplier is for you. If you have to inspect every piece as it comes in the door, that’s a labor cost you incur because your supplier didn’t check quality to your specific standards.

So how do you solve these particular extrema problems? How do you maximize the value from your supply chain while minimizing the risk? Our experts told us, driving for the lowest price isn’t going to lead you to the solution.

In this issue, we once again take a firm hold on the supply chain. We investigate how to manage the reliability and the quality coming from your supply chain. We question typical thinking about suppliers and criteria for success, and we ask what sort of skills your supply chain manager should possess. After this issue, you should be able to throw another loop of chain around the purchasing department capstan and deliver more meaningful leverage to your own supply chain. **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](#).





Supply Chain **Cost Management** is a Holistic Business Approach

Feature Interview by the I-Connect007 Editorial Team

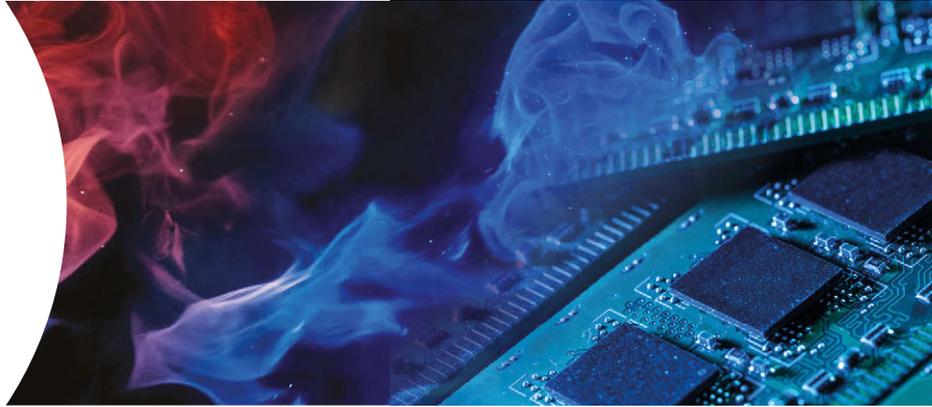
Tim Rodgers, a faculty instructor at the University of Colorado Boulder, teaches operations management and project management. Rodgers' background includes work at Hewlett-Packard, where he worked with Happy Holden among other industry luminaries, earning Tim credibility as an industry luminary himself. In this interview, Tim shares his take on the challenges and issues facing the supply chain in the upcoming year. He gives his advice for what supply chain managers need to be focusing on and the skills needed to succeed in supply chain management.

Nolan Johnson: Tim, what do you see as some of the major issues right now in supply chain management?

Tim Rodgers: Obviously, there's been a lot of diversification and interest in diversifying supply chains. Most electronics supply chains are

based in southern China in Guangdong Province. It's been that way for a long time, but for a lot of companies the pandemic has highlighted the risks associated with having a geographically concentrated supply chain. We're seeing that companies are interested in creating a more diversified supply chain, but they're discovering that it's a lot harder than it looks. I was just reading a story the other day about Apple doing iPad assembly in Vietnam, but I would be willing to bet that over 90% of the components that go into those iPads are coming from the same factories in China, as always.

I don't know if you remember this story from about 20–25 years ago, when Argentina decided to free itself of personal electronics that were made outside the country. One of their populist leaders decided to set up factories in Tierra del Fuego to make smartphones, which was going to have the added benefit of providing local employment. Well, they had to import everything, which meant the cost of these smartphones that were made in Tierra Del Fuego were outrageously expensive com-



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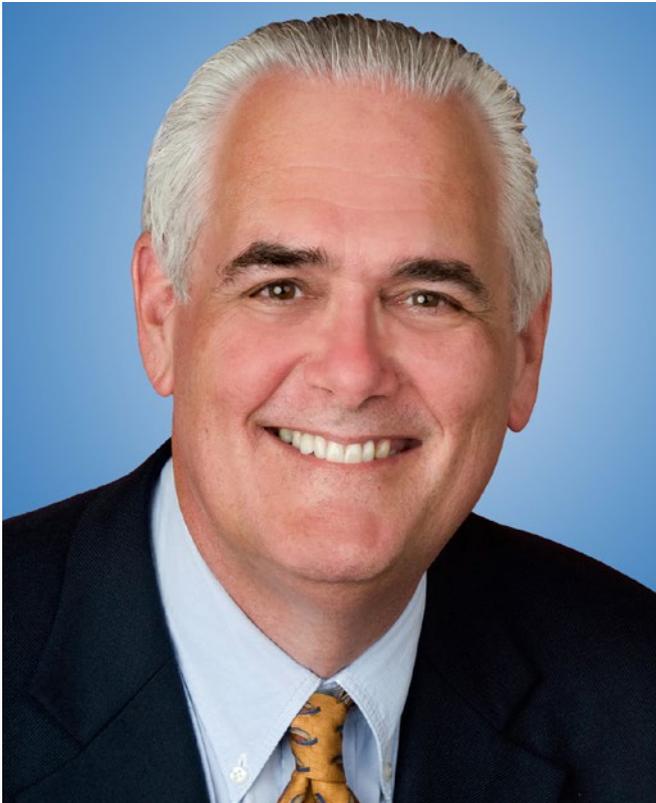
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Tim Rodgers

pared to smartphones that were being smuggled into Argentina via the black market. I just share that as a cautionary tale.

While there's a lot of interest in home-shoring and reshoring, I think people are discovering that these supply chains are a lot more complex, it's a much bigger network, and it's not as simple as it looks.

Johnson: That encapsulates the end-user demand perspective. Is there any change underway at the headwaters, from the top end of the supply chain?

Rodgers: I think the biggest factor influencing the motivation of suppliers is labor costs. As I mentioned, most of the electronics supply chain has been in Guangdong Province. Labor cost in that part of the world is rising significantly and has been for a long time. We're seeing a lot of Taiwanese and Chinese companies looking for lower labor costs. That's taking them to places like Chengdu, Chongqing—places in central and western China that are

becoming more attractive because of the new initiatives by the Chinese government to create new infrastructure in that part of China—making it a lot easier to ship by rail to Europe rather than the ocean route.

Let's face it, these suppliers are working with a razor thin margin already. Many of them are losing money but making it up in volume, as the joke goes. So, any way that they can find to lower labor costs is to their advantage. Transportation costs for this kind of stuff—we're not talking about washers and dryers, or airplanes—we're talking about electronic components. Transportation costs are pretty low, that's not really a problem, but labor costs are very, very high. If they can ship final assembly or higher-level assembly to lower labor cost parts of the world, if their production is already pretty highly automated, then lower labor costs are not going to help much.

Barry Matties: That's the case in southern China. My understanding is that many of the cities are mandating automation if you want to expand your business. They're not allowing employees.

Rodgers: Exactly.

Matties: You're talking about a cycle that's been going on forever, though. We've always chased low labor.

Rodgers: Absolutely.

Dan Feinberg: Let's say that the dollar devalues significantly over the next few years. What effect do you think that will have? Could that change things?

Rodgers: Absolutely. Again, we have to look at all the contributors to cost here, not just labor costs. Transportation costs have become ridiculously cheap. It's become really, really easy to move stuff. That wasn't always the case. These are small electronic components, so the rela-

tive effect of transportation costs is even lower. Over the past few years, I've been tracking not just changes in U.S. labor costs, but also labor costs in Mexico vs. China. As Chinese labor costs trend almost exponentially in the way they're increasing, both Mexican and U.S. labor costs are going up but not as much. We're starting to see a real convergence of those two.

Johnson: There's a point where the graphs are going to touch or crossover, so how close are we?

Rodgers: It depends on the skill level, of course, but for management we've already crossed over. The cost of qualified, experienced managers in China is probably on par, if you consider total compensation, with a lot of American managers in manufacturing and production. But it's becoming harder to find qualified managers in China. When it comes to entry-level, factory floor workers, it's going to take a few more years, but in terms of experienced manufacturing engineers, I think we're already there. This is creating several problems for companies that are trying to expand in China because the competition for labor is becoming really tough.

Matties: Do you see automation as the big equalizer here in America, though? There's got to be a push for this as we're seeing smart factories and such.

Rodgers: Certainly, the companies that are investing in smart factories, smart technology, and more automation are going to come out ahead. I'm seeing a lot more of this in China than in the U.S. Part of that is because it has become a national imperative; the national government is supporting that push toward smart factories, whereas in the U.S., it tends to be more of an individual company initiative. I'm a little bit worried. I used to believe that we didn't have a lot to fear because American ingenuity and engineering would figure out the next best way to manufacture and those new technologies would derive from the U.S.

I'm a little less optimistic now, just because we're only seeing some smart factory islands and some innovations around the internet of things. All that is wonderful, but it's not very well coordinated. It's meant to benefit individual businesses. I'm sure there are some academic partnerships that are helping to drive automation, but it's piecemeal as opposed to what we see in China.

Matties: I wonder what the motivation will ultimately be, because if you can still go to China and buy it cheap, why invest in a smart factory here?

Rodgers: It's a good point. It's a significant investment, and it's also a significant change in the way these factories are being run. In some cases, the technology itself already exists. We don't have to invent anything new, but actually implementing it is still more expensive than just buying it off the shelf. We're always going to take the path of lowest resistance.

We don't have to invent anything new, but actually implementing it is still more expensive than just buying it off the shelf.

Matties: Maybe, as we see, there's an acknowledged shortage of engineering labor for implementing a smart factory.

Rodgers: Yes, there is a lot of emphasis on employment, which I think is important. I understand why people are worried, but these smart factories will require fewer people to run them. If our emphasis is on employment—keeping more people and just growing the size

of the labor force or trying to save old 20th century jobs—we're going to miss the bus completely.

Matties: It's market proximity as well. When you start looking at India and China, you're looking at about two and a half billion people vs. 300 million here in the U.S.

Rodgers: Yes, that's actually leading to some interesting stuff. A few years ago, a large OEM decided to move its manufacture of white goods—washers and dryers, dishwashers, stuff like that—from China to Louisville, Kentucky. If you're serving a market that's fickle—a market that wanted red ones yesterday and blue ones tomorrow—you might be better off locating closer to your market. If you're selling to the U.S. market, you may be willing to accept higher costs because you need that market responsiveness.

Originally, we saw a trend where Chinese consumers really wanted to buy from companies outside of China because they were associated with quality. Now, we're seeing a lot more emphasis on buying locally made along the same lines as the "Buy American" initiatives that we see in the U.S.

Matties: There is a nationalistic mentality out there right now that we want to support our own countries, like you're saying, and there's going to be a consumer drive that may have an influence here.

Rodgers: What I see from Chinese consumers is a lot more pride in local production. I think there are some Americans that feel that way, but I don't think most Americans are willing to spend more to buy something.

Matties: Plus, Chinese quality has increased over the last decade.

Rodgers: They're getting a lot better. For example, Haier is becoming an international brand. Next to Lenovo, it's the most famous native Chinese brand.

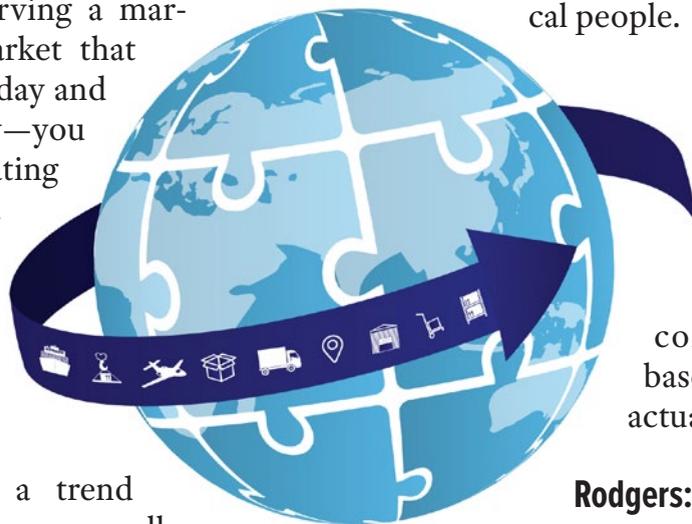
Holden: Yes. But we have a good case study here of a smart factory making bare printed circuit boards at lower costs than China because of their high yields. It's just that we've had the difficulty of getting that case study out among the financial people rather than technical people.

Matties: It's high yield, high capability, and very low labor cost. This is a model where you could plan it anywhere and compete, provided the base materials are there to actually make it go.

Rodgers: As long as transportation costs are low, you can place it just about anywhere.

Matties: What should a supply chain manager be looking at? What should be their primary concerns these days, Tim?

Rodgers: They need to move away from focusing only on cost. They need to think more about assurance of supply, and this is a tough one. That's one of the big lessons of the pandemic. I don't think this has hit the electronics industry quite as much as it has hit other industries, but it should be a wake-up: concentrating your supply in one part of the world is very risky. We all remember the tsunami in Japan and the volcano in Iceland. These created a lot of problems. I have a good friend who used to work at Seagate, and he said the logistical diffi-



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culties in moving stuff from China and South-east Asia to Europe was a real nightmare.

I sympathize with folks who work in supply chain because there's going to be a lot of talk about risk and assurance of supply for the next few years; everybody is going to remember the pandemic. But the extreme pressure on cost and price is not going away. The memory of the pandemic will fade, but the cost pressures will always be there. Right now, the pendulum will swing toward higher cost and higher assurance of supply. But I predict, maybe five to 10 years in the future, people will return to those cost and price pressures again.

Matties: If you don't have a second source for your supply line, you may be held hostage to what you have.

Rodgers: Good point. How do we create a diversified supply? Do we have enough power as a buyer to influence suppliers and get them to diversify? Can we get them to locate other production facilities? If so, it gives us all a lower risk and more confidence. Obviously, big buyers have that kind of power to make that kind

Obviously, big buyers have that kind of power to make that kind of stuff happen, but smaller buyers are going to be stuck shopping around.

of stuff happen, but smaller buyers are going to be stuck shopping around.

Matties: Let's bring it down to scale, with small companies of 100–200 employees. What do they do in their supply chain management to build?

Rodgers: The good news here is that we have the internet. We don't have to go to the yellow pages anymore and rely on local buyers. Online marketplaces can help us identify alternate suppliers. Of course, there's always uncertainty when you work with a brand-new supplier, and there's not a lot of appetite for business travel these days, so it's really hard to assess a supplier without actually walking the factory floor. Smaller companies will have to take some chances; rely on referrals.

They also need to understand where their company is going. It's not just about what they need to buy today, but what they need tomorrow and the year after. The supply chain needs to be there when we get there—in five or 10 years, will we have a supply chain that can support that? In supply chain, you can't just be a buyer who executes purchase orders. You need to think strategically. What kind of suppliers are we going to need? What's happening in the world? For example, what's happening in Myanmar right now? Some people were thinking that Myanmar would be a good place for electronics manufacturing, but not quite so much anymore.

Matties: In our industry, as you know, counterfeit is a big issue. In my mind, that's probably one of the greatest risks.

Rodgers: Yes, and not even realizing it. If you're a small company, how are you supposed to avoid that? I really sympathize with them. Lowest price probably comes with way too many risks. You will pay a bit more to have confidence, but how do you make those decisions? If these suppliers in places like China are being used already, then there's going to be a trail of some kind; there are going to be clients and customers who've had experience working with them. If they don't have a trail, that's a red flag.

Matties: When you look at inventory management, what messaging do you share with your students?



The recent Suez Canal blockage held up trade valued at over \$9.6 billion per day, according to data from Lloyd's List.

Rodgers: We talk a lot about safety stock—variability of demand. There's a reason we call it forecasting; we really don't know what the demand is going to be. We hold safety stock in order to protect ourselves from a sudden increase in demand, and usually it's better to hold a little bit more inventory than not enough inventory. We caution students that when you don't have enough inventory you run the risk of a stock-out, which affects your customers who have money in their pocket and want to buy. You've done the hard work and convinced them to buy your product; that's good news as far as your marketing and sales organization, but you don't have products to sell. That's a tragedy. Those customers may never come back.

For most businesses, it's better to spend a little more money on safety stock and excess inventory than to not have enough inventory. Again, if we're worried about risk in the supply chain, like a tsunami in Japan, a volcano in Iceland, or shipping delays at the port of Los Angeles—which is what's going on now—it's better to hold extra inventory.

Holden: What fundamentals do people not know about or forget about that you would emphasize vs. a thing that everybody talks about?

Rodgers: Besides inventory management, I would emphasize basic production planning. There are lead times associated with all of these decisions. Factories and supply chains don't have extreme flexibility. Sometimes it is better to have a supplier across the street than a supplier on the other side of the world because the lead time is shorter. A decision you make today could take weeks to properly implement.

Supply chains are hard to turn, like a container ship. It takes a long time to implement all the processes, to suddenly change the supplier. To increase the order quantity from a supplier could take weeks or months. Because suppliers don't necessarily have a lot of extra capacity laying around, you've got to do a better job of planning.

Matties: Do you see a desire at EMS companies for that sort of model, or more of a vertical integration and captive facilities?

Rodgers: Captive has to clearly provide a competitive advantage. You can't justify the expense unless you get some kind of competitive advantage. By building your own products, do you achieve some level of performance or quality that you can't get through a mix-and-match approach? Obviously, there are a lot of

electronics products where the innovation is in the design, not the components, and that's what makes those products so popular and so low cost; you could buy components from a variety of different suppliers, and you still get the same performance. Now, for Gentex, it's not just the design that provides a competitive advantage, it's the specific components and the system working together: the design, manufacturing, and integration of the different components. That's where the competitive advantage comes from. It's a completely different kind of product; it's obviously going to be more expensive, but consumers are expected to understand that and be willing to pay more because they're getting higher performance.

But for the mass produced, consumer electronics I just don't see that being a winning strategy. Even Apple continuously reviews their model, always determining what part should be in-house and what part should be outsourced.

Matties: A lot of what is left in the U.S. is the medical and military industries. What sort of impact or conversations should we have around supply chain in those markets?

Rodgers: Obviously, they're both very highly regulated in their own ways. That puts restrictions on what you can do as far as components and manufacturing is concerned. Certainly, for military applications there are national security implications. There are export and import controls that prevent people from using the lowest cost components. Huawei is being starved for components because of their association with the Chinese government. With military applications, we get into issues of national security. For medical applications, these are highly regulated environments where manufacturing itself is regulated. It's not just the designs and the components, but the location of the manufacturing sites and how those sites are being managed; it all has to conform to very strict regulations. With those two markets, certainly

there are cost pressures, but it's a lot easier to resist those pressures because of the nature of the products and the desire to keep things local.

Matties: Tim, you're teaching a class on supply chain. Who are your typical students?

Rodgers: My classes are at the College of Business, both at the University of Colorado and at Colorado State University. We send a strong message to our business students that, regardless of whether you work in marketing, finance, accounting, operations, or supply chain, you are impacted by supply chain. If you're in a pure consulting business where your supply chain is office supplies and real estate, maybe you won't be quite as impacted; but for most of our graduates, they will end up working at companies where supply chain is a critical part of doing business. Smart companies understand that their suppliers should be treated as an extension of their internal operations. They realize the suppliers are not somebody that you can squeeze, trying to extract more cost savings from. Suppliers are in business too, and if a supplier is losing money because of their relationship with you, don't be surprised when they don't knock themselves out on your behalf.

I also teach in our MBA programs, and I feel our MBA students have a better appreciation of supply chains. Those students bring more life experience into the classroom.

Matties: When you're looking to hire a supply chain manager, what should you be looking for?

Rodgers: It's a mixed bag. Certainly, they need to have some understanding of finance and accounting. They need to understand where costs go. They can't be too swayed by people who talk about labor costs, because it's not the only thing. You might choose to buy from

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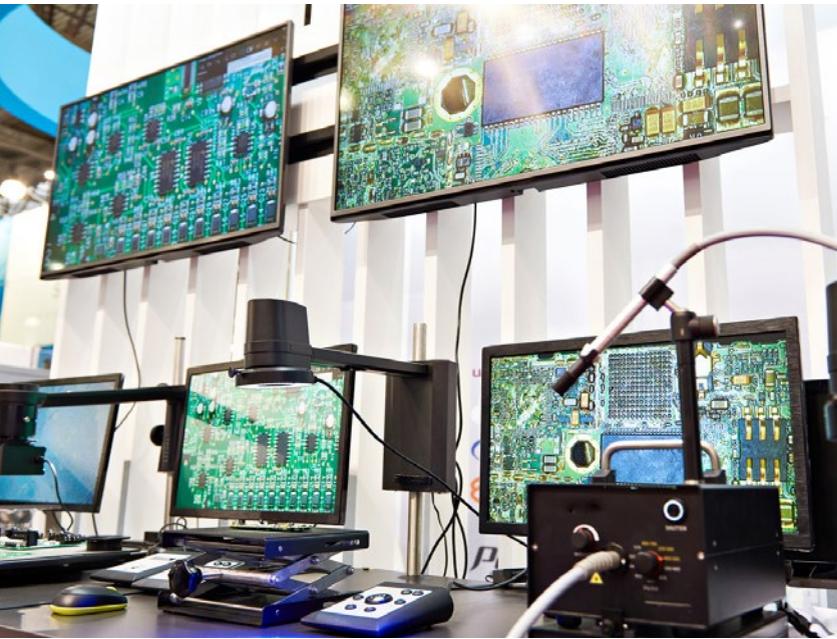


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a location that has higher labor costs, but the other costs are lower. It's important to understand what goes into cost accounting. Really effective supply chain management understands where price comes from: cost is an element of price, but it's not the only element.

Holden: Have you been able to inject your experiences as a quality manager into your teachings?

Rodgers: Oh, absolutely. We often talk about the cost of quality. You can buy a cheap component, but what about internal failure rates, or warranty costs? These must be considered. I used to really hate the idea of incoming inspection, and I always looked for ways to charge that back to our suppliers.

Now, I understand that doing an occasional audit of incoming material is a good idea. But if I have to do more than an audit, I'm going to be really angry at our suppliers because that's a cost of quality. Some might even call that a hidden cost of quality. I want our students to remember that when they think about the total cost of something that they're buying. It doesn't just end with the P.O.

Matties: Did you find a way to charge it back?

Rodgers: Yes. A lot depends on how much power you have as a buyer, but if you're a small-time purchaser you may have a lot more trouble.

Matties: I completely agree with you. The cost of inspection of somebody else's process is a failure of their process.

Rodgers: Absolutely. Many of our suppliers would say, "You don't have to do incoming inspection; we'll do outbound inspection." That's the wrong answer. Wrong, wrong, wrong! You get quality by testing and by having good processes. In many cases, it's harder for smaller companies, but if we could actually

teach our suppliers how to achieve quality, it's better for everybody.

Matties: This is a big push for us in 2021. We're calling it the year of continuous improvement, and we've introduced the simple formula: $X = X_c - 1$. If you can take your current process and reduce it by one, whatever it happens to be—one rotation, one spin, one iteration—and you just live this over and over, everybody wins.

Rodgers: That sounds good to me. Again, that's consistent with the spirit of continuous improvement.

Matties: Absolutely. Because you're right, if you're doing outbound inspection, you're just a sorting device. You're not building quality.

Rodgers: You're spending time and labor on your side doing testing, which is going to add to your cost. It just creates the same pressures. Honestly, if we're going to play that game, I'd rather do the inspection myself than rely on you. But again, it's the wrong answer.

Holden: Do you meet with your university peers who are also teaching supply chain? What's their background?

Rodgers: The folks at Colorado State University have a pretty strong supply chain program, and the University of Colorado Boulder has a Master's in Supply Chain Management that's becoming very popular. They're both pretty influential as far as the Rocky Mountain region is concerned, at least. I think our nearest neighbors with a strong supply chain program is Arizona State. There's a lot of communication among us. We host conferences, and we get together, not just with academia, but those who actually work in supply chain. There's a good dialogue going on.

Matties: You bring up a good point: Often, we hear about the influencer vs. the purchasing manager, saying "I don't have any control. It goes to purchasing and they decide." But you're saying they need to be talking about the engineers, and the engineers need to come in and talk to the purchasing managers as well.

Rodgers: I agree, 1,000%. It's got to be a cooperation. Imagine if I were senior management at one of these companies, and I found out that I had engineers who wanted to do something really cool; they're able to produce a new product that we could sell at a premium, but somebody in supply chain put the kibosh on that because it didn't use their existing supply chain, or it was going to cost too much money. I would be furious.

Matties: Maybe the supply chain manager needs to sit in on engineering meetings on a regular basis.

Rodgers: Yes, absolutely!

Matties: And possibly some leadership meetings to understand where the company is headed.

Rodgers: I agree.

Matties: We talked about the qualities of hir-

ing a supply chain manager, but what sort of advice would you have for a current supply chain manager to strengthen their skills? What should they be considering for training and such?

Rodgers: My guess is that most of them don't really understand where cost comes from. They may be really good price negotiators, but it's better if you can understand where price and cost come from and how that contributes to production cost. I'm guessing, because so many suppliers focus on labor, they have no idea how much it costs to produce the components that they're selling. They put a price on it based on market conditions, and it has very little to do with how much it actually costs. Spending time on this will make them more effective negotiators.

I'm guessing, because so many suppliers focus on labor, they have no idea how much it costs to produce the components that they're selling.

I would encourage them to learn more about quality. It's a hidden cost that most in purchasing and supply chain management don't understand. All they know is how much they pay. They're measured—this isn't their fault—in most cases based on how much they pay for those components and how much they can take out of that price. They're not measured on the influence that those components have on downstream quality. I think they should be.

Matties: If your supply chain manager understands that these components you're buying from supplier A have to go through incoming



inspection, labor hours, and delay vs. if you pay just a little bit more from supplier B, you can eliminate that.

Rodgers: Exactly right. You must understand the total cost, including the total cost of quality. How many in supply chain understand warranty? When you buy a low-cost component, it goes into your product, and that product is sold to customers. Now we're on the customer's side of the supply chain. How often do those products get returned? What happens to those returns? What kind of root cause analysis is done on those returns? Can we trace those problems to specific components or suppliers? That information needs to get back to the supply chain managers. Again, that's all part of the total cost of ownership for those components.

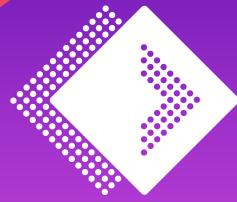
Some of those are hard to measure. But what about a customer who was so angry with us because we did such a lousy job with their quality problem or their warranty problem that they never buy from us again? That lost business can be traced back to a decision that was made by our supply chain management team to buy a low-cost component.

Johnson: The previous administration was working on Buy America programs, and the incoming administration has continued to work bringing manufacturing back to the U.S. Do the smaller shops get more leverage working underneath the umbrella of a government initiative? Is that going to be effective?

Rodgers: In theory, this is where individual smaller businesses can band together into trade organizations. These trade organizations are not always very effective. They look at each other warily because these are typically competitors that are not really interested in working together, but I think that's one of the ways that smaller businesses can create enough clout to be able to get the kind of changes that they're looking for. It's going to be really hard for a company of 150 people to develop their own independent supply chain, but if we see these government-led initiatives placing greater emphasis on buying American, and we see more influence of trade organizations that provide encouragement and support for these smaller businesses, there may be some hope for the future. But I guess my answer to you, Nolan, is yes. There is an opportunity here.

It's not going to happen because of an individual company. I think it's going to require some focused investment. There will also need to be some investment on the front end upstream. There will need to be some investment in factories. There will need to be the same great tax deals that we offered Foxconn to locate a factory in Wisconsin. We will need to think about the same kind of strategies to encourage American companies to make the same kind of investments in the U.S.

Matties: Tim, we certainly appreciate your time today. Thank you so much. SMT007



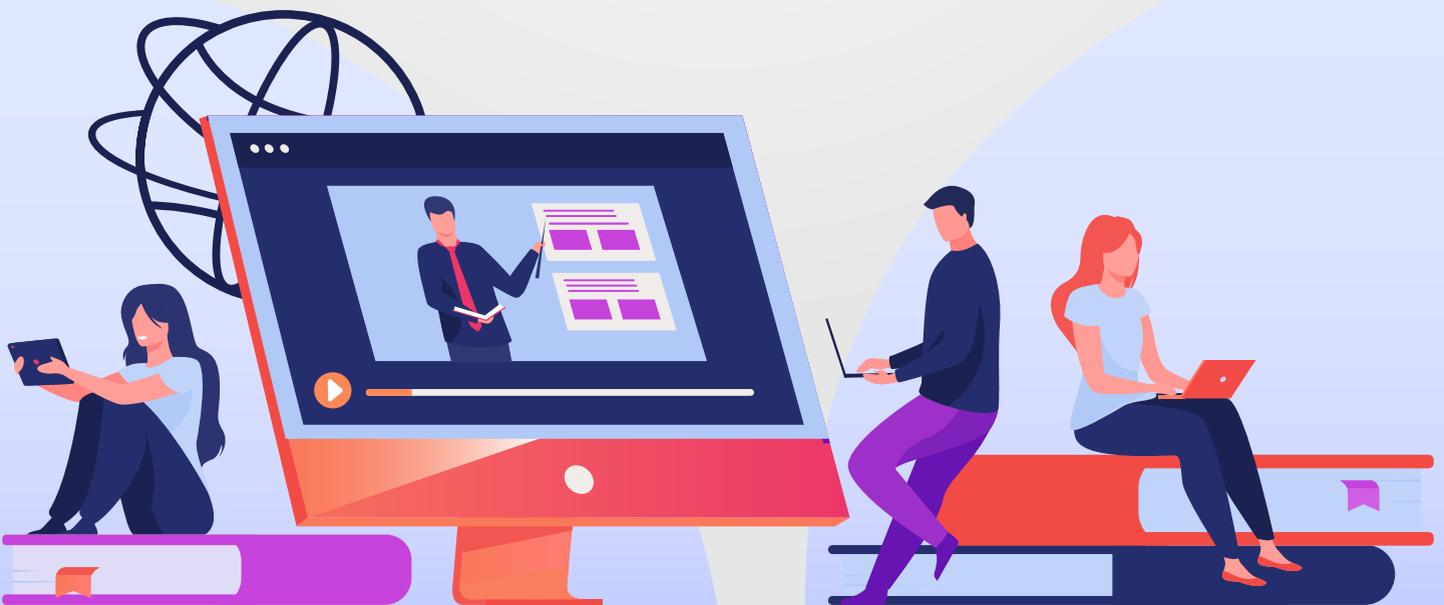
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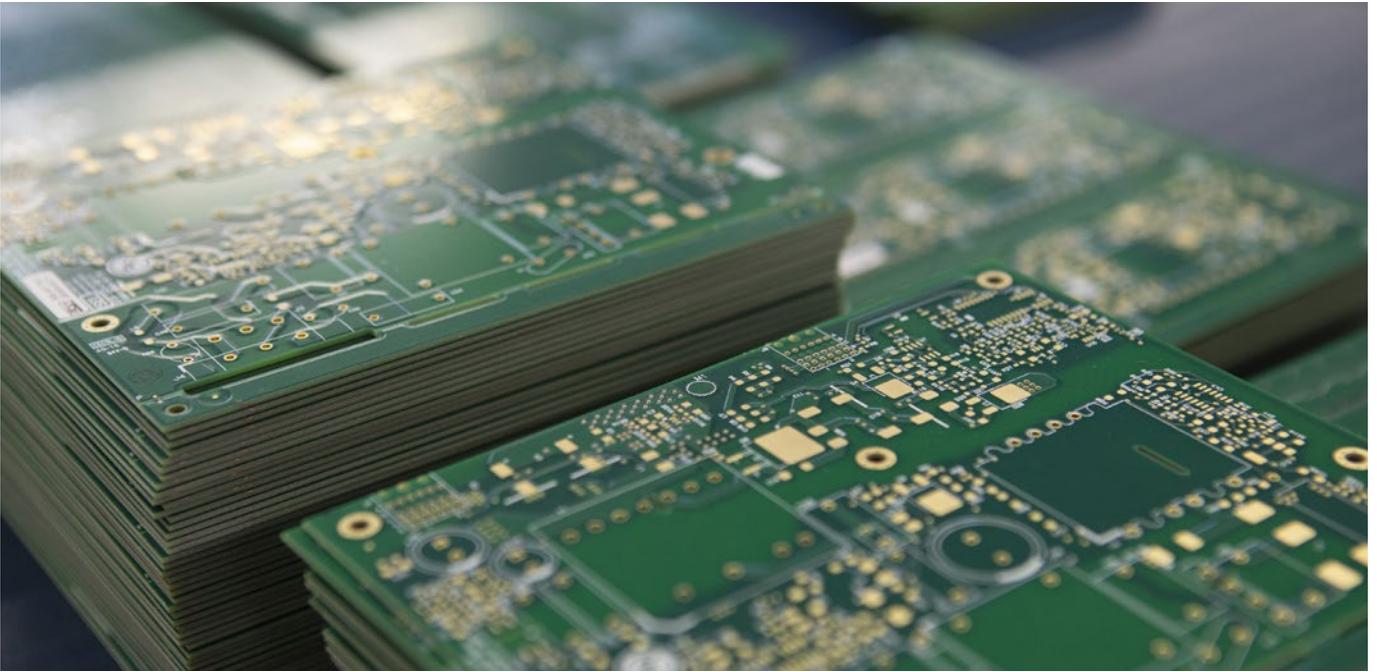
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A New **Captive PCB Facility** in the U.S.

Feature Interview by the I-Connect007 Editorial Team

Diane Maceri and Jessi Hall discuss how Schweitzer Engineering Laboratories (SEL) has been working with Alex Stepinski of GreenSource 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.

Barry Matties: Diane, can you give us an overview of the decision process to build a new captive PCB factory?

Diane Maceri: We produce a high volume of PCBs, they're lower complexity, and we have great supplier partners, but we have to take into consideration that they're buying equipment and working toward manufacturing more complex PCBs. There's always that tension between the capacity we need, and the complex needs of making a higher profit margin.

Because of this, and because we're always growing, we looked at whether we wanted to bring on another supplier partner to expand. Do we want to buy an existing PCB factory, or do we want to build our own? We weighed those pros and cons. Through a lot of work over the past two years, we concluded that we wanted to build our own factory. We met Alex [Stepinski of GreenSource Fabrication] and mapped out a path that looked very interesting to us as far as the facility not having waste and that kind of thing.

Matties: Alex really focuses on automated process. Is that what you moved toward as well—a fully automated process?

Jessi Hall: Our primary concern is the flow through the factory so, yes, I would say it's pretty automated, although not fully automated. There are some things where we don't feel the technology is quite ready and we want to ensure that we have a reliable product—that's very important for our industry. We decided to pursue automation for the things that make



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sense now, make sure we have space for future automation, and then we can invest in new technologies depending on where our designs go.

Matties: From a supply chain point of view, this must have been just a breath of fresh air. Now everything is under your control, even your timeline. What advantages do you expect to have from a supply chain perspective?



Diane Maceri

Maceri: It will ensure that our demand is covered, because we have a large volume of PCBs that we use every day. Another thing that's interesting about SEL is that we have a five-day lead time from the time we get an order from a customer until we're shipping it. Not that we don't have great partners, but this will ensure—since we have such a short lead time—we can tie that PCB demand straight into our assembly and out the door. It's bringing the whole process closer.

Matties: I would think that the cost of the circuit board itself has gone down a certain percentage. What savings, on a percentage basis, do you think you'll gain here?

Maceri: We don't know exactly. We have multiple different layer counts and so, at the lower layer counts, we're looking at a much higher percentage, but we don't know exactly what that would be. As you go up in layers, the percentage comes down a little bit.

Matties: You're going back to yesteryear, if you will, when there were a lot of captive facilities and then they moved away from PCBs. A reason they moved away was the environmental aspect, and I know Alex has been working on zero waste systems. Is that what you're adopting here as well?

Hall: Yes, that is one of the things that was very attractive to us about working with GreenSource: the zero-water discharge. There is waste that comes out of the facility, but it is non-hazardous industrial waste, primarily salts and dry film. No water from the manufacturing processes will leave the factory, and that is very appealing to us.

Matties: Were permits required?

Hall: I can't say for sure that there won't be any permits. It will depend on our environmental health and safety engineer who is leading that aspect of the project. He has been talking with local regulators and he doesn't have concerns. He is getting a good understanding of what we need to have in place in case we do need any type of permit.

Matties: Do you have your own in-house circuit board design team as well?

Hall: We do, and when Diane was talking about lead times and our manufacturing philosophies, there are a couple that are important to us. One is that we manufacture in the U.S., and we source as many of our components as possible in the U.S. That's very important to us. The second is the world class manufacturing philosophy, and part of that is shortening feedback loops. We have vertically integrated many other things at SEL, which shows us that by understanding how our components are made, it helps us do better designs, which leads to innovation in the component and the manufacturing process, or back into the design. We will do our own PCB designs, our own CAM work, manufacturing, and then through assembly.

Matties: I bet the designers are quite thrilled to have a test bed, if you will, for their new prototypes without needing all that lead time. They

can design it in the morning and have it built in the afternoon.

Hall: Yes. They are very excited.

Matties: There's some competitive advantages that will come with this new circuit facility. What competitive advantages do you see, other than cycle time?

Hall: Innovation. We consider the PCB to be a critical component and so by understanding how they're made we will be better at innovating. Also, by understanding the manufacturing processes, we'll be investing time and learning about new technologies that feed into manufacturing PCBs, which could open up other possibilities in design. It's just that really cool circular loop.

As Diane mentioned, we have close relationships with our partners—the factory will be located just 10 miles from where our designers are sitting, and it's also 10 miles from where the PCBs are used. When a problem occurs, whether it's in assembly or in the manufacturing of the PCB, we'll be able to resolve it even faster because I can make a call, whether it's a process engineer or whoever, and ask, "Can you be over here in 20 minutes?" And they can.

Maceri: Now we're going to be working with the PCB component suppliers, those supplier partners that we haven't worked with before. How often do they get to work with the designer, the manufacturer, and the assembler of that PCB material? What kind of innovation are we going to be able to do with those component suppliers?

It's just something we don't know yet, but we're opening up those discussions. Usually, they're supplying materials to a PCB manufacturer potentially building boards for a PCB assembler or contract manufacturer—who



Jessi Hall

knows who has designed it—and then it goes to a customer. Now, we're bringing that all together and that's exciting.

Johnson: Is there a pool of fabrication expertise in your area for hiring?

Maceri: PCB fabrication? No, not in our area.

Johnson: How have you tackled that challenge?

Hall: Part of it is our partnership with GreenSource. John Hendrickson is going to be the leader for this factory, and he has 21 years of design experience. He's worked extensively with our suppliers, as well as visiting many other suppliers. By working with GreenSource, we've also been working with our other supplier partners. We've already hired our chemical engineers and we are in the process of hiring other technical staff; they'll be working at GreenSource at least half the time until the factory comes online, running our boards, learning how to run the processes and how the equipment works.

And then, when they're in Pullman, [Washington], we'll have them working either on



The Schweitzer Engineering Laboratory headquarters in Pullman, Washington.



Manufacturing at SEL's Pullman facility.

the PCB design teams or out in process engineering so they understand how the boards are designed; how they're processed by CAM.

Some positions are harder to fill than others, as everybody knows. For example, finding technicians can be a bit of a challenge, so we have internal apprenticeship programs. We work closely with any of the universities and colleges in our area. We've partnered with Washington State University, University of Idaho, Lewis-Clark State College, and Purdue University to help us bridge that gap. We also focus a lot on internal training. Not everybody knows where Pullman is at, and not everybody wants to live in Eastern Washington, so growing our own is one of the best ways that we found to fill those gaps.

Matties: How many square feet are you allocating for this new facility?

Hall: 100,000 square feet.

Matties: Is this a greenfield site?

Hall: Yes.

Matties: What is your expected date of completion?

Hall: We expect to be starting production December 2022. The facility

is in Moscow, Idaho. Our two facilities that use most of our PCBs are in Pullman and Lewiston [Idaho]. Lewiston is about 35 miles away, and Pullman is 10 miles away. We purchased 154 acres at the edge of town, and the overall building size is 140,000 square feet.

Matties: I know Alex is putting together the blueprint of equipment and basically the whole roadmap, right? It's a package deal. Are you specifying any particular equipment?

Hall: It is a collaboration. For the most part, we've asked him to provide recommendations for everything. For things like the copper plating line, there's no reason not to go with that. There have been a few things where we decided to choose a different supplier just because we have somebody closer and it makes more sense for us. We rely on GreenSource's expertise, but we're also very involved with this. I think John talks with the GreenSource engineering manager at least once a day.

Matties: And it's going to be a lot more soon, right?

Hall: Yes, indeed.

Holden: One of the things I never got around to writing was the role that PC process engineers played in the development of new products. Because HP was vertically integrated, the



Future site of SEL facility in Moscow, Idaho, to be completed in 2022.

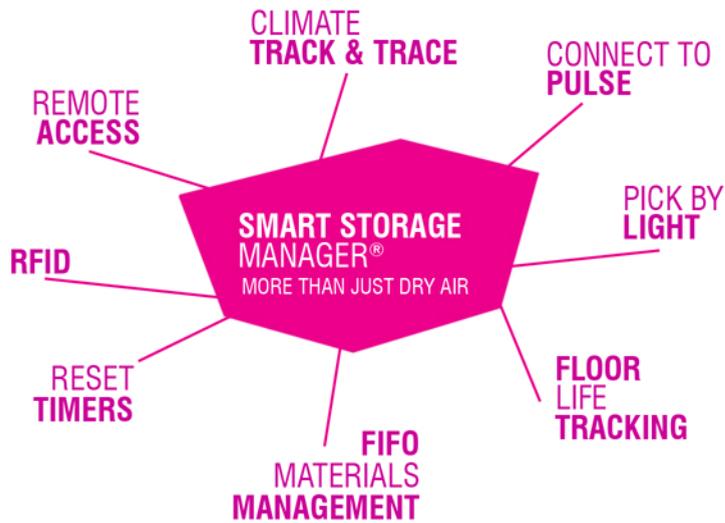


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The close proximity of the new fabrication facility to SEL's pre-existing manufacturing sites will increase cross-company collaboration.

printed circuit process engineers were part of the R&D team, and there was a lot of innovation and brainstorming that went on. In almost every super successful HP product there was a contribution from the bare board people.

We developed a replacement for gold on our own. We developed a way to eliminate the power planes to make fewer layers, landless vias, and things like that. There's a whole slew of technologies that came about because the printed circuit board can solve a particular problem that the electrical engineers didn't know could be solved.

Matties: It's in that collaboration where you will find, as you were saying, a lot of innovation to percolate over, and HP is certainly a model; but I think you're a modern-day model, if you will, to move into captive. I think this move makes a lot of sense in today's world.

Maceri: What's fascinating is that John Hendrickson, who works for Jessi, has been in our PCB design group for 20 years and what you're saying, Happy, makes me excited to think of all that he can accomplish as the factory manager and having that PCB design in-house.

Holden: When you're vertically integrated like that and you have an offbeat idea, rather than

shoot it down or argue, you can say, "Let's build it, test it, and see. We can make prototypes really quickly and that innovation leads to discoveries."

Johnson: This conversation brings me back to the beginning of our conversation. Part of the motivation for the facility was that your boards weren't all that complex, and your suppliers were tending to move toward a higher complexity sweet spot. What do you see in the future for Schweitzer regarding the kinds of boards you expect to develop?

Hall: I don't know for sure. In having our own facilities and really understanding the manufacturing, I imagine that we will explore more of what we can do. Also, by having other partners and learning from equipment suppliers, then we will be able to learn about different technologies that may expand our capabilities.

Matties: We've been talking about and sharing the concept of captive facilities and co-op shops for some time now, and the COVID pandemic certainly has interrupted the supply chain for so many that the timing is really good. Did you make this decision during COVID or pre-COVID?

Maceri: It's been going on for a couple of years, but the final decision was made during COVID. However, I don't think that played much into it at all.

Matties: Well, this is exciting. There's going to be a lot of attention on your move to captive or vertical integration.

Maceri: We do a lot of vertical integration. This isn't new to our company and it's something our founder, Dr. Schweitzer, very much supports and promotes. Jessi manages all our vertical inte-

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Matties: So, when you think of vertical integration, do you look at every last little nut and bolt, or how do you weigh what's inside and what's outside?

Hall: That's a fun part of the team I lead, which is pretty cool. We look at a wide variety of things: What does the supply chain look like? Is there risk there? Can we find a supplier partner whose strategy matches our own and can meet the volumes that we need? As I mentioned earlier, we do want to manufacture in the U.S., so if there's not an option for that, then that's certainly a consideration. Is that part a critical component that needs some amount of customization? All these things are factors. Then, of course, do we already have something that's somewhat complementary? That makes the decision even easier.

Matties: Right. Now, when you look at supply chain, what risks do you evaluate? Do you have to have a second source, that sort of thing?

Maceri: Not necessarily. We build strong partnerships that are like family. If we have one supplier partner for a part category, however that partner has a good risk mitigation strategy—or it may be some vertical integration, so it's not necessarily dual sourcing, but something like geopolitical risk. We buy a lot of UL-certified components, which adds a layer of complexity to things. To move quickly, you have to go through the whole UL approval process, so it's really just the strength of the partners. For us, we're always growing; we have doubled in size every five years.

Matties: Wow.

Maceri: With that comes a constant scrutiny: do we have enough capacity? That's just part of the risk in what we're doing.



SEL's Lewiston, Idaho, facility.

Matties: Are your boards built in China or are they all U.S.?

Maceri: All U.S. They are a critical component and we put a lot into that. We don't want our IP to get out.

Matties: At what point in your journey did you find GreenSource?

Maceri: As we were looking at all these different options, someone said, "You know what? You really need to meet Alex Stepinski because he did this, and they have a lower complexity board and built an automated factory to build it." He was referring to Whelen [Engineering in Connecticut], whom we didn't know, so we reached out, and made the connection. Jessi and I went there and met him along with one of our executive team members, and John Hendrickson. Right away, we understood this was different from anything we had seen before.

Matties: Absolutely different. So, you were already in the mindset of bringing PCB fabrication back in-house?

Maceri: We were; that was one of the paths we were looking at when we met Alex.

Matties: Yes, and with his package of zero waste and low labor costs, it sure makes a lot of sense for companies like yours. I think we've covered a lot here. Thank you so much. **SMT007**



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UK Enterprises Step Up Intelligent Automation Projects ▶

More enterprises in the U.K. are deploying intelligent business process automation, partly in response to the effects of Brexit and the COVID-19 pandemic, according to a new report published by Information Services Group, a leading global technology research and advisory firm.

T-Mobile, Georgia Tech and Curiosity Lab Team Up to Fuel 5G Innovation ▶

T-Mobile and Curiosity Lab at Peachtree Corners, in collaboration with the Georgia Institute of Technology, announced the creation of the 5G Connected Future incubator program designed to support the growth and development of entrepreneurs and startups as they work to build the next big thing in 5G.

Purdue to Co-lead U.S. DoD-funded Project to Advance Adoption of Lead-free Electronics ▶

A new consortium funded by an award from the U.S. Department of Defense has selected Purdue University to co-lead its first project aimed at advancing the adoption of lead-free electronics in defense systems.

North American Semiconductor Equipment Industry Posts \$3B Billings in January 2021 ▶

North America-based manufacturers of semiconductor equipment posted \$3.04 billion in billings worldwide in January 2021 (three-month average basis), the first time monthly billings have reached \$3 billion, according to

the January Equipment Market Data Subscription Billings Report published by SEMI.

European Semiconductor Sales Up 6.4% YoY in January ▶

The European Semiconductor Industry Association announced that European sales of semiconductors reached to US\$3.453 billion in January 2021, an increase of 6.4% versus the same month one year ago.

SIA Applauds Sen. Schumer Announcement on Promoting U.S. Competitiveness ▶

The Semiconductor Industry Association released the following statement from President and CEO John Neuffer in support of Sen. Schumer's announcement about strengthening U.S. competitiveness.

Light-Emitting Tattoo Engineered for the First Time ▶

Scientists at UCL and the IIT-Istituto Italiano di Tecnologia (Italian Institute of Technology) have created a temporary tattoo with light-emitting technology used in TV and smartphone screens, paving the way for a new type of "smart tattoo" with a range of potential uses.

TruSpin Announces Breakthrough in Battery Technology ▶

TruSpin Nanomaterial Innovation, an advanced materials company engaged in battery technology, has announced the positive results of third-party tests evaluating the performance of the company's prototype batteries.



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What Makes a Great Supply Chain Manager?

Feature Article by Timothy McLean
TXM LEAN SOLUTIONS

Building a competitive and reliable supply chain is a critical success factor for any manufacturing business. This is especially true today, where we face constant volatility and disruption across global supply chains. In this environment, effective supply chain leadership is more critical than ever. So, what makes a great supply chain manager?

What is a Supply Chain Manager?

To be able to hire a great supply chain manager, you must understand what that title means for your business. Over the years I have come across many individuals carrying the supply chain manager title who were focused on only part of the role. Often supply chain managers are really procurement managers, warehousing and logistics managers, distribution managers, manufacturing managers, or supply chain systems and planning managers.

In fact, the whole point of having a supply chain manager is so that they can oversee the whole end-to-end supply chain from your suppliers—through every step of your manufactur-

ing and distribution network to your customer's door. The aim is to get your supply chain working as an integrated whole to deliver outstanding value to customers and shareholders. A supply chain manager who is focused on one aspect of the supply chain is likely to optimise that function at the expense of the performance of the whole chain. Therefore, the first step in hiring a great supply chain manager is defining the role correctly.

What Skills Does a Supply Chain Manager Need?

Given that we have defined the supply chain manager's role broadly, they need to have a clear understanding of the overall supply chain. While their career pathway may have been through manufacturing, logistics, finance, or procurement, the supply chain manager needs to bring to the role a broad understanding of each element of the supply chain. In particular, they need to understand the connections between different parts of the supply chain. For example, they need to understand why purchasing from the absolutely cheapest supplier may not be the overall lowest cost option to the business when supply chain risk and

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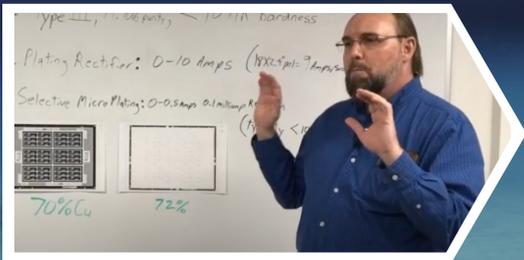
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Timothy McLean, Managing Director,
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responsiveness to market change is considered. Likewise, they may need to see why smaller, more agile manufacturing units located close to customers might be preferable to one big capital-intensive plant designed to “maximise efficiency.” They will understand how your company interacting with its suppliers can have a profound impact on your cost of sourcing. A skilled supply chain manager can really add value by applying their understanding of the connections and interactions between different elements of the supply chain from your suppliers’ suppliers through to your customers’ distribution network.

To help see these interactions, a good supply chain manager needs to understand Lean thinking. While it is not new, Lean is the most widely accepted and proven methodology to understand and improve the supply chain. A good supply chain manager will understand the extended value stream of their business. This means mapping the flow of value from suppliers through to the final customer and highlighting the areas or greatest opportunity

to reduce waste and cost, and increase customer value.

The management of large amounts of data and extracting useful information from that data is an ever more important aspect of supply chain management. Your supply chain manager does not need to be your Enterprise Resource Planning (ERP) system “super user,” but they really do need a deep understanding of how the technology used in your supply chain works. They need to be up to date with trends in supply chain technology, particularly around the use of “big data” and automation. This skill will enable them to ensure that your business makes the right investments in technology and gets value from that investment. It is very easy to be over-awed by technology and seduced by slick sales pitches and futuristic visions. A good supply chain manager will have the understanding to see past all this and select the right level of technology with the right technology partners to serve your business now and in the future.

It’s a Leadership Role So You Need a Leader

The career path of many supply chain managers often has them developing as technical specialists before they reach the more general supply chain role. Often, they have little experience at managing a team and are most comfortable working on their own when solving some technical challenge, implementing the latest software, or negotiating deals with suppliers. However, supply chain management is a critical leadership role in your business. Unless your business is very small and you intend it to stay that way, your supply chain manager will need to develop and lead a team of specialists. Therefore, the individual needs to have strong interpersonal skills, clear values, professional standards, and excellent communication skills.

Beyond managing their team, the supply chain manager will need to interact with many external organisations including suppliers, carriers,

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technology vendors, and warehouse landlords. Therefore, excellent negotiation and communication skills are essential. They need to be prepared to listen to and understand the perspectives of all supply chain stakeholders, including those from other cultures and countries. But they also must be able to clearly communicate their vision for the organisation and set and maintain high standards of performance.

Summary

As you will gather by now, the role of the supply chain manager is a demanding one, particularly in complex industries such as electronics or aerospace. Successful recruitment starts with clearly defining the role and then having the patience to search for the right person to fit that role. A common trap is to put too much importance on “industry experience.” When you put in a requirement like “must have at least 10 years’ experience working in the electronics

Successful recruitment starts with clearly defining the role and then having the patience to search for the right person to fit that role.

industry,” you greatly reduce the potential candidate pool. In fact, the supply chain for almost every discrete manufacturing industry has significant similarities to the electronics supply chain and candidates in those industries will develop similar skills and experience. Therefore, a supply chain manager with 10 years making medical devices or tractors may have a better overall skill set than the best candidate you can find from your own industry. Likewise, the regulatory environment in pharmaceuticals has similar characteristics to that in

aerospace, and so a defence contractor should not necessarily rule out a great candidate from the pharma industry. The reality is, your business and supply chain will be unique, and the new person (if an external hire) will need to learn all this, regardless of whether they have specific industry experience.

For those looking for a career in supply chain management, look to expose yourself to different parts of the organisation. Stepping from transactional buying to category management or strategic procurement, then on to supply chain management might seem like a logical pathway, but it will give you a very narrow perspective on the role. Better to look for horizontal steps into operations, logistics, sales, or planning to give you a more holistic understanding of the whole value stream and also give you the leadership skills you will need. Supply chain qualifications abound, however a good graduate degree such as engineering or accounting will give you the analytical skills you need and provide that valuable broader perspective. Good experience is then often more valuable than further qualifications, although some education in Lean thinking and supply chain courses such as those offered by APICS will not go to waste. Remember, a good supply chain manager needs to be able to see and understand the big picture. You can then hire people to be the technical specialists. **SMT007**

Tim McLean is co-founder and managing director of TXM Lean Solutions, global Lean and operational excellence consultants headquartered in Melbourne, Australia, and with offices in North America, Europe and China. Prior to establishing TXM, Tim worked for 16 years as a manufacturing and supply chain manager with major companies including Hoechst AG, PPG and Amcor. Tim is the author of two books, *On Time In Full: Achieving Perfect Delivery with Lean Thinking in Purchasing, Supply Chain and Production Planning*, and *Grow Your Factory Grow Your Profit: Lean for Small and Medium Sized Manufacturing Enterprises*, both published in the U.S. by Productivity Press.



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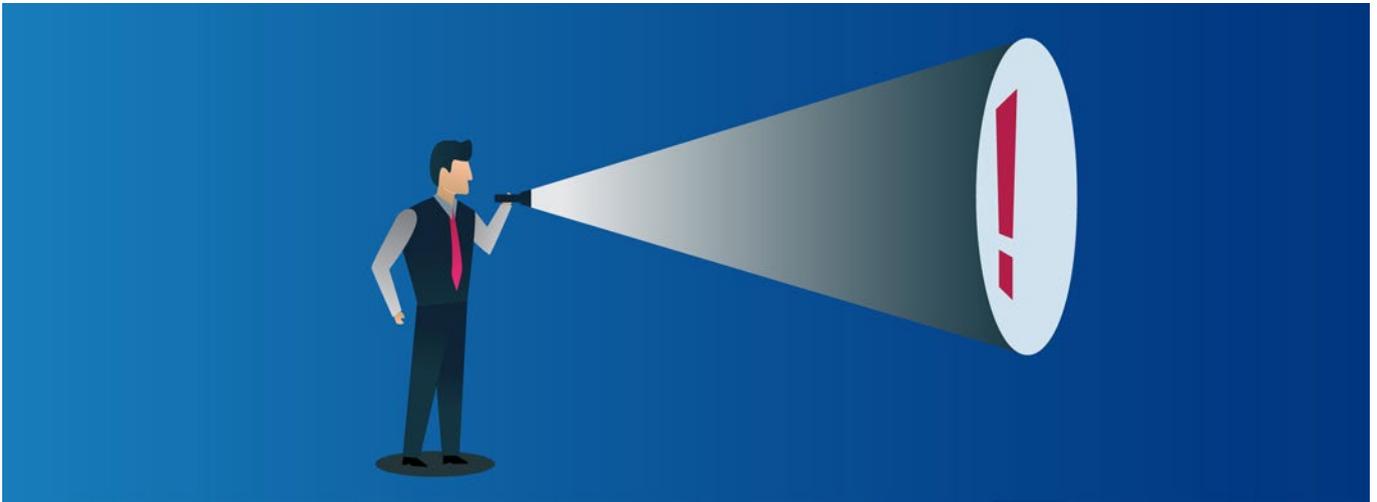
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10 Ways to Identify Counterfeit ICs

Feature Article by Bill Cardoso
CREATIVE ELECTRON

In my monthly column, I've expressed concern about the likelihood of increased counterfeiting as a knock-on effect of the chip shortage. Because the incentives for counterfeiters are high right now, as an industry we must be somewhat more vigilant in maintaining our best practices for preventing fake parts from corrupting the supply chain and our products.

Under normal circumstances the cost associated with counterfeit electronic components exceeds \$5 billion annually. The pressures of the current chip shortage will likely push those losses even higher for as long as the supply remains tight. Still, we all can agree that, if fake parts were to enter your inventory or end up in your products, while the reputational damage to your business will likely be significant, it can also be tough to quantify. Even harder yet would be assigning cost should counterfeit components in critical applications contribute to injury or loss of life.

So, how about a little refresher on some of the most effective techniques for component inspection using X-ray? While other visual inspection techniques provide important insight

into component quality and authenticity, nothing exceeds X-ray inspection for fast, accurate, non-destructive evaluation. The following are 10 ways to identify a fake IC using X-ray.

1. Same packaging, different inside.

Two components may look identical on the outside, have the same termination, and have the same marking, but be entirely different on the inside. X-ray is the only non-destructive way to look inside a device. These two 3D renderings show the entirely different structures of two devices from the same lot (Figure 1).

2. The good, the bad, and the ugly.

It is only with 100% inspection that you can be sure all the components are good. Criminals commonly mix good and fake devices in the same packs or batches to avoid detection. I am sure you can see which one is out of place in Figure 1.

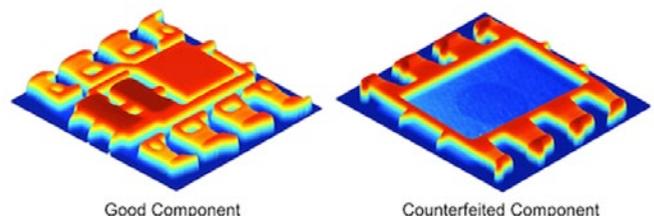


Figure 1: 3D renderings show the entirely different structures of two devices from the same lot.



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3. Known good devices.

Comparing incoming parts with a golden sample is a good way of searching for counterfeits. Figure 2 illustrates how different two devices from a single batch look. To compare accurately, check the lot code, the date code, the part numbers, the place of manufacturer, any external markings, and the construction of the device.

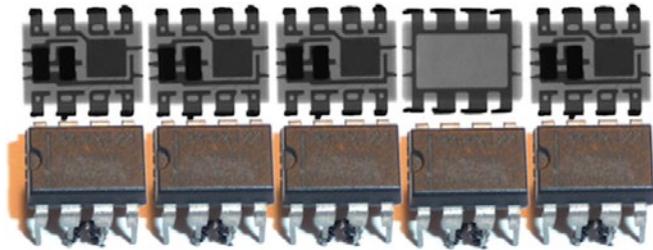
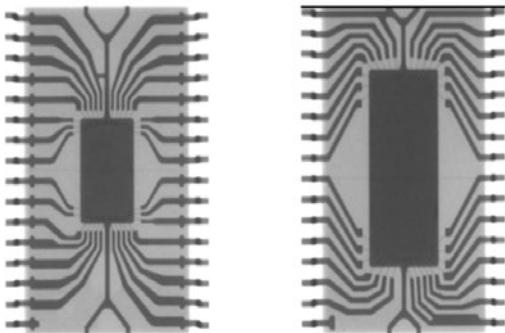


Figure 2: Illustration of how different two devices might look from a single batch.

4. Pinout mismatch.

The layout of the lead-frame and the wire bond diagram tells you plenty about the component. Check whether they differ when the wire bond diagram is overlaid on the X-ray image. In Figure 3, you can see the discrepancy in the VPP and VDD pins.



Good Component Counterfeited Component

Figure 3: Example of a discrepancy in the VPP and VDD pins.

5. Missing wire bonds.

An X-ray image can show missing wire bonds, indicating potential for counterfeit and the need for further analysis. However, beware that alumi-

num wire bonds do not show in X-ray images, so this could produce a false fail (Figure 4).

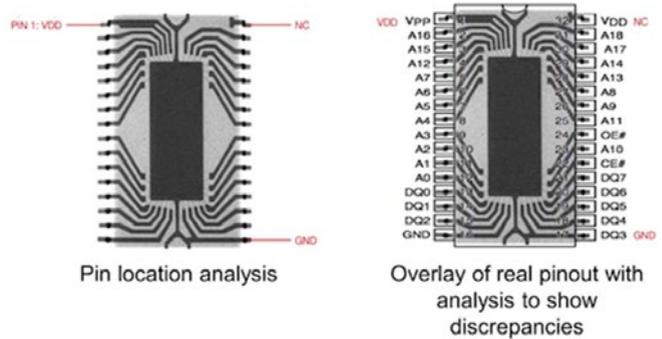


Figure 4: Example of missing wire bonds.

6. Internal defects raise red flags.

A full inspection of a part can validate mechanical integrity. For example, in Figure 5 a wire bond ball and a loop can be seen inside that package. This doesn't confirm the component is a fake, but it should sound alarm bells.

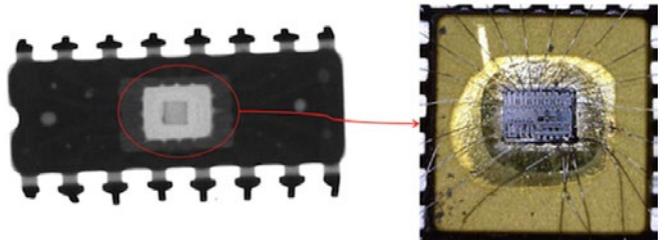


Figure 5: A wire bond ball and loop inside a package should sound alarm bells.

7. External defects.

External defects are a pointer to improper handling of a component. Figure 6 shows a ball grid array (BGA) component with dam-

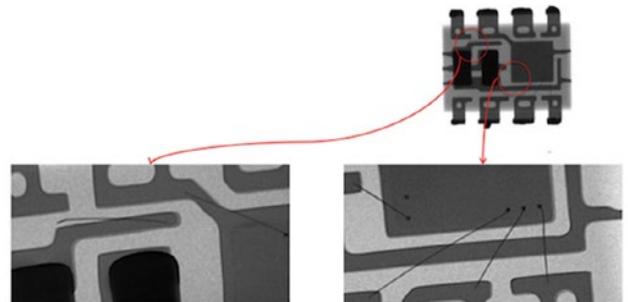


Figure 6: Example of a BGA component with damaged solder balls.

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aged solder balls. This type of damage is common when components are not packaged in the original tray, tube, or reel provided by the original manufacturer. Even if the component is deemed good by other tests, the fact that the parts are in the wrong package makes them suspect counterfeit.

8. Excessive BGA voiding.

Perhaps not seen strictly as counterfeiting, components are often pulled out of old boards, cleaned, and resold as new. Even if the parts are real, this process can make the parts sub-standard. However, when criminals pull ball grid array (BGA) components from boards, they need to have the parts re-balled.

The re-balling process is not trivial. The metallurgic interface between the component and the new balls is no longer pristine (as it was when the first balls were applied onto the virgin pads of the component). For this reason, it is common to find recycled BGA components with excessive surface voids. In Figure 7, the bare component shows a large amount of voiding that indicates a part that was pulled and re-balled.

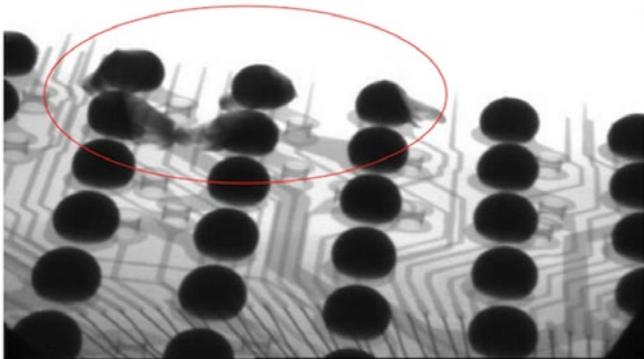


Figure 7: An example of a bare component with a large amount of voiding.

9. Bent pins.

An indication of improper storage of components is bent pins (Figure 8). This X-ray inspection can be done with the components still inside the tray, so they don't need to be removed from the package for a suspect counterfeit determination to be issued. Not only are trays of the wrong size often used, sometimes the trays with the

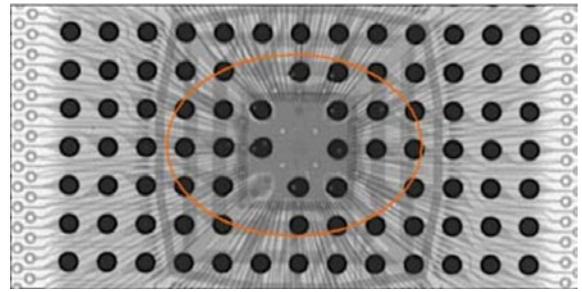


Figure 8: Counterfeiters will replace the proper material with lower-cost options.

wrong material are used. In these cases, instead of using the proper material to deal with ESD, counterfeiters replace it with lower cost options. These lower cost material options can damage the parts.

10. Excess die attach voiding.

Electronic component manufacturers invest heavily in the consistency of the products they sell. If a few of the components within a lot have anomalous die attach voiding (Figure 9), suspicion is drawn to the overall quality of the part and the lot. It may not have been stored in appropriate thermal and humidity conditions or may have been salvaged.

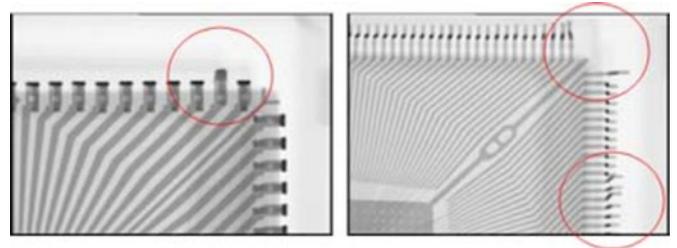


Figure 9: Components with anomalous die attach voiding.

With incentives at an all-time high for counterfeiters, it's a great time to review your receiving practices to ensure that you are keeping fakes out of your inventory and products. A little extra vigilance can protect your brand, your customers, and help beat the bad guys. **SMT007**



Dr. Bill Cardoso is CEO of Creative Electron. He is also an I-Connect007 columnist. To read past columns of X-Rayted Files or contact Cardoso, [click here](#).

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Me and My Digital Twin

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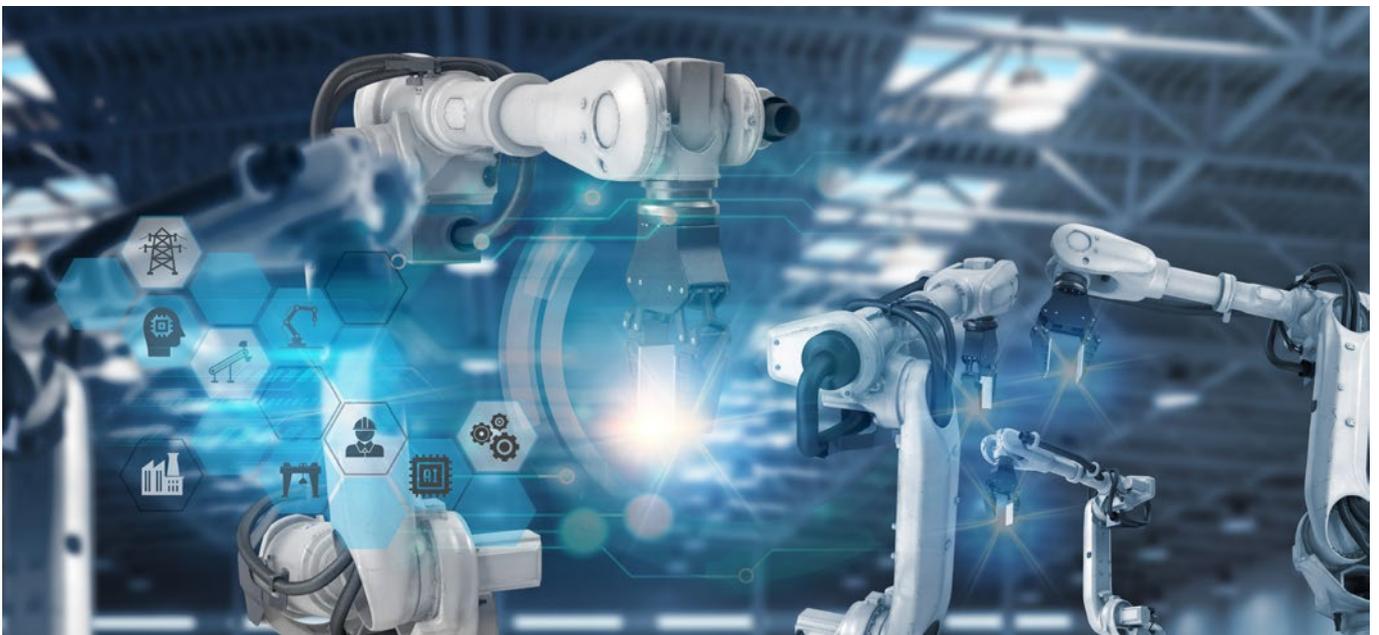
It would be wonderful to have a digital twin of myself, designed to take on all of the boring aspects of life, leaving me free to focus on what I enjoy doing. How much work would be needed to do this, given that the digital me needs to be developed, trained and configured to make decisions, and do things in the way that I would want? How can we ensure that the benefits from our digital twins outweigh the costs?

A fully functional digital twin involves more than it may initially seem. At first, we tend to think about access to information. To prepare my digital twin, I will need to prepare information about myself, details of where I live, the utilities, where I bank, the cars I drive, contact lists of family, friends and colleagues, security information, as well as my likes and dislikes, access to social media accounts, etc. How

about security? There is a great deal of trust to be considered when creating a digital twin, as there is scope for its use both for good and evil. Unlike my physical self, my digital twin can be copied and cloned an unlimited number of times, then used by anyone for anything. Having said that, most of the information is “out there” already. It is really surprising how much personal information is willingly or unwittingly shared through internet-based services, especially social media.

Digital twin lesson number one: Create a secure environment for my digital self. As we baby-proof our homes for newborn humans, we need to baby-proof our digital environment as well.

Likewise, manufacturing digital twins must be protected with cybersecurity measures, as information includes details of production



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More Than a Database

So far, my personal digital twin is just a database; I need more. As a person, I am connected to the world. Events happen, and as with most humans, I develop opinions which are linked to memories, food for thought, which evolves as I address and solve problems, and interact with other people. The manufacturing digital twin also needs to be connected. Things that we do and say are very tightly linked with events that we experience. Without this link, my digital twin would be limited to endlessly repeating old facts from the original database, not considering any changes to the environment, and unaware of specific needs and constraints. In other words, irrelevant.

The manufacturing digital twin also needs to be connected. Things that we do and say are very tightly linked with events that we experience.

The IPC Connected Factory Exchange is not going to help my personal digital twin, but does fulfill requirements of a manufacturing digital twin, providing real-time information that brings live visibility of every event and situation across the whole shop floor through a single interface and language. Wouldn't communication be great if every human on the planet had at least one common language in which we could all communicate?

With connections made, now we get to the tricky part. I would like my digital twin to not just exist, but to actually do stuff, specifically

things I don't want to have to do myself. Digital assistants can do this today but without any real intelligence beyond what they see about each of us in their database, albeit more than we are likely aware of.

For example, when I want to buy something, it is very satisfying to be able to choose the best item from all the choices offered. There are many products of the type that I need, all of which have different looks and specifications, and of course, prices. I need the best value item that gives me what I need in terms of performance, capability, and expected life; perhaps, I want a little more on top of that to show off a little (we are only human after all). There are likely to be several suppliers offering the same or very similar products that meet the criteria. As well as price comparison, I should also consider the delivery cost, time and reliability, supplier rating, after sales service record, etc.

There is only so much attention span that my human brain can muster, especially when key information seems deliberately hidden. We cannot get into every detail of differentiation; I certainly have better things to do. My digital twin, however, could do it all, and find the perfect solution. Millions of data exchanges across the internet cost virtually nothing. I can be very happy then that the choice "I" end up making is the very best one. For the manufacturing world, the new IPC 2551 Digital Twin provides the definition and structure as to how all of this can be done, linking information and interoperability between digital twin solutions, bridging the once separated worlds of product, manufacturing, and lifecycle digital twin elements.

Two Types of Algorithms

In addition to all the data, however, my thought process to do this needs to be coded into the digital twin, as there will be many conflicts, trade-offs, and compromises to consider during the decision-making process. Lower cost is good, but at the expense of quality? There is an algorithm therefore to be applied to

the digital twin data. As a software developer of more than 30 years, I find there to be two choices of types of algorithms.

My favorites are the heuristic-based algorithms, which model the thought processes of humans. Rules, often complex, are followed that determine calculations that lead to a specific answer. The difference between the software and my limited biological approach is that the computer will follow all possible tracks, rather than being limited to those within my own attention span. The danger of this algorithm, however, is that unless written in a very clever way, it is harder to change the thought process based on new ideas or concepts. The benefit, however, is that the results appear very quickly and are effective.

The second type of algorithm is a random mathematical model originally termed “genetic algorithms.” The connection of facts, such as the order in which a process could be done, is laid out at random, the effectiveness measured, then the order changed, and effectiveness re-measured. How the changes are made vary, the original genetics-based idea being to divide them in the same way as genes are shared from parents to a child—slice and dice, then try again, potentially billions of times. No matter how sophisticated genetic algorithms and the like become, the result will take time, geometrically increasing in proportion to the number of variables. The benefit is that unlike the heuristic model, there are no assumptions; a solution that no one may ever have considered could be found to be the best. The downside is that it takes time—a long time—to come up with the best solution. One of my own heuristic machine program optimization algorithms was once beaten by a genetic algorithm, shaving off a second or two of the machine’s run time. I did like to point out that the heuristic algorithm had taken five minutes whereas the genetic algorithm was still going after five days, four days after the production was supposed to have started. An “I’m bored” button then appeared to stop the genetic algo-

rithm and take whatever has been the best result thus far.

The interesting thing, however, about the genetic algorithm is that the “health” of each potential solution discovered is qualified by a function that measures the value of the solution. The need to have a defined method provokes similar limitations as seen with the heuristic method; to truly find new and original solutions is questionable. It is easier to change the ruleset of the genetic algorithm as compared to the logic of a heuristic model. If a solution were able to automatically change the ruleset, based on feedback of the real effectiveness of solutions over time, this would lead to the potential of actual “AI.” The human ability to change the constraints associated with a problem can be termed either intelligence or recklessness, depending on the nature of influencing factors. As a digital twin can be used for good or evil, will we trust the AI to modify itself in a way that we would assume to be in our interest?

As a digital twin can be used for good or evil, will we trust the AI to modify itself in a way that we would assume to be in our interest?

We see the trend of increasing amounts of data, more decisions to be made, more complexity, and more security, so the next stage of intelligence may be a hybrid of the two algorithmic types, whereby the simple cause and effect decisions are implemented as heuristic elements of an advanced genetic algorithm type of approach. This can include the building in of “laws” to protect human interest.

Saturation point reached; I don’t want to have to understand all of this “nerd talk” as

being simply the user of my digital twin. I simply want it to do the work for me, and just give me answers. Engineers and managers on the manufacturing shop floor will find their decisions augmented using the manufacturing digital twin, providing relief from having to do all the data gathering, formatting, and mind-numbing analysis manually, resulting instead in a clear vision of what will happen, should nothing be done, or perhaps if one of two things were to change—such as the introduction of a new product, material availability issues, or customer demand rates fluctuate.

Put away the abacus, notebook, calculator, Excel spreadsheet, or whatever tools that you have historically chosen to number-crunch and turn to the excellent digital twin solutions that exist within the modern IIoT-based MES solution. As software developers, we do the work, coding in the rules and methods, defin-

ing best practices, creating the ontology that turns data into actionable value. To create my personal digital twin would require far more work than I am prepared to put in, but when it comes to manufacturing software, there is an army of developers that have created and continue to evolve a singular solution applicable to all manufacturing environments, bringing true smart Industry 4.0 manufacturing for everyone.

If you are interested in exploring how a digital twin can benefit your factory, you can learn more [here](#). **SMT007**



Michael Ford is the senior director of emerging industry strategy for Aegis Software. To read past columns or contact Ford, [click here](#).

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IPC Managers Forum: Vertical Integration

Feature Article by Pete Starkey

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Denied by circumstances the opportunity to travel transatlantic to attend the IPC APEX EXPO 2021 in person, I sat up until late in the evening here in the UK, eager to catch the Vertical Integration session of the IPC Managers Forum. And my presence was well-rewarded—a most meaningful experience.

In my own early days, vertical integration appeared a fairly typical characteristic of the electronics industry and most of the big companies had their own PCB shops. They all worked to their own internal designs and standards and often developed their own techniques and pro-

cesses. But as the specialist independent shops were established, they could offer economies of scale and progressively dominated the business. They worked to national and international standards and bought their materials and process chemistries on the open market, resulting in a relative consistency of manufacturing technology. I can recall upwards of 400 board shops, from mom-and-pop to large corporations, in the UK alone, as recently as the late 1970s and early 1980s. Then there was a progressive drift of business to Asia and a steady decline in the number of manufacturers to today's figure of less than 40. And the industry very much relies on its suppliers for technical innovation, rather than do its own process development.

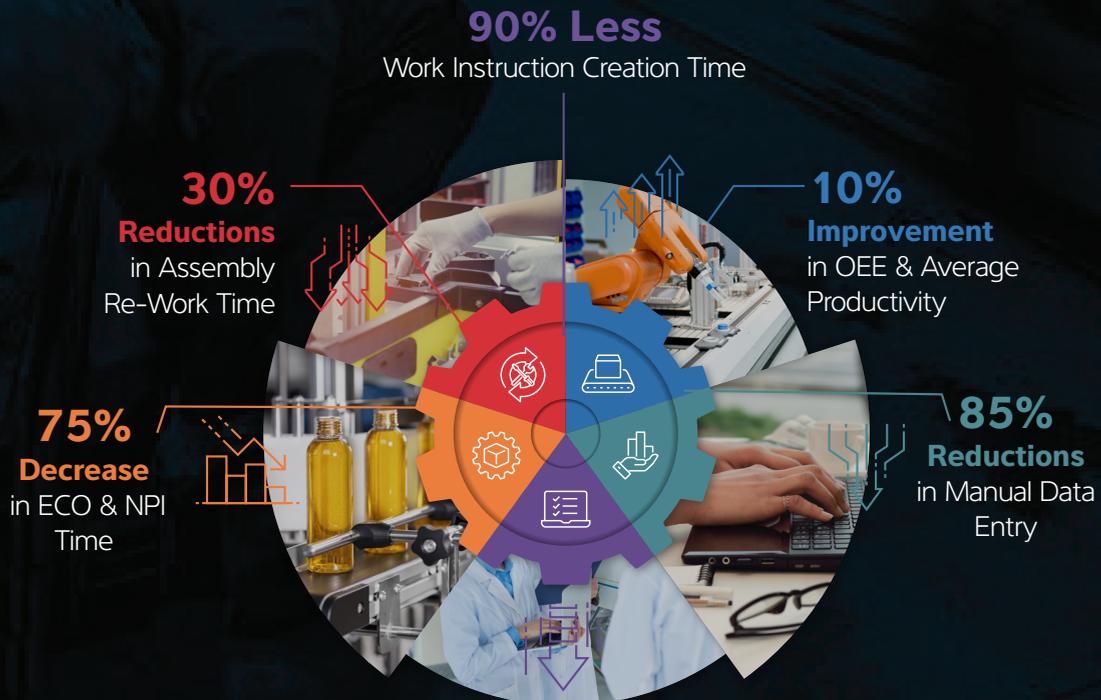




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So, it was refreshing to hear Alex Stepinski, Diane Maceri, Jessi Hall and Jeff Leblanc talking about a new generation of vertical integration in the programme entitled “Managing Challenges in Periods of Transition,” smoothly moderated by IPC Hall of Famer Gene Weiner.



Gene Weiner

Alex Stepinski, vice president of GreenSource Fabrication and managing director of AWP Group, is well-known as the pioneering developer of green and automated smart factories for the U.S. market that out-compete low-cost and ecologically unsustainable Asian plants. Latterly, he has led the integration of a PCB fabricator and a PCB equipment supplier into one integrated company that builds and develops smart factory solutions and industrialises new process concepts. His case study, “From inventor to contractor in several steps of vertical integration,” looked back over the previous eight years and forward into the future.

It had been a bold move to start-up a new PCB fabrication plant in the U.S., particularly in addressing the challenge of a “missing generation” of skilled labour resulting from downsizing of the industry, further exacerbated by the disadvantages of a high-cost region, onerous regulations and a reliance on an Asian supply chain.

Speaking from a hotel in Poland, with somewhat hit-and-miss sound quality, Stepinski reviewed the chronology of GreenSource from 2013, when design and build started for the Whelen factory, through its initial installation, some remarkable process innovations, and the acquisition of its equip-



Alex Stepinski

ment suppliers, to 2020 and a new integrated business plan with PCBs, wastewater recycling, and the supply of turnkey factories.

The original Whelen factory represented a \$12 million investment and produced around 50 panels per hour of mainly double-sided work, with HASL and ENIG finishes, by a staff of 19. By 2017-18, the capability had evolved to include multiple-build-up HDI, with 15 micron line-and-space and microvia diameters down to 30 microns, industrialising processes such as SAP and selective resistors.

Because it had been planned to avoid dependence on Chinese suppliers, the equipment for the upgrade was sourced in Germany but when the suppliers ran into financial difficulties it was decided to acquire them and to re-engineer their designs to support the GreenSource vision of smart workcells and recycling technology. The resulting equipment division became suppliers of the turnkey projects to Schweitzer Engineering Laboratories and Vicor Corporation, for whom the value proposition included factory design and equipment selection, technical details for permit applications, employee training at the GreenSource factory, equipment manufacture and installation, and commissioning and qualification of the processes. Stepinski listed the many benefits of his “Blue Ocean” strategy, which focused on integration of processes for Industry 4.0 in the PCB sector, substantially reduced the environmental footprint of PCB fabrication, and reduced the dependence on skilled labour for simple issues. A wide range of equipment was currently manufactured at the AWP factory in Poland, then tested and qualified in Charlestown, New Hampshire.

He described his patented Zero Liquid Discharge (ZLD) recycling technology; in his words “GreenSource uses more water in the bathrooms than in the board shop,” the first commercial installations of which would be at Schweitzer Engineering Laboratories and Vicor Corporation in 2021-22.

He listed current roadmap projects: a smart

warehouse system, on-line metrology systems, full digital twin for managing the plant, artificial intelligence and machine-learning-based scheduling, deep bind-microvia upgrades up to 10:1 aspect ratio, and automatic recipe generation by artificial intelligence and machine learning.

Schweitzer Engineering

Now that Stepinski had set the scene, it was the turn of his turnkey clients to reveal the reasoning behind their strategies. Diane Maceri, supply chain director, and Jessi Hall, senior director vertical integration at Schweitzer Engineering Laboratories (SEL), explained why and how they had decided to build a new printed circuit factory in Idaho.

Headquartered in Pullman, Washington, with one of its manufacturing plants in Lewiston, Idaho, SEL had introduced the world's first digital relay in 1984, and currently employed more than 5,000 people. They provided complete power system protection, control, monitoring, automation, and integration for utilities and industries worldwide, with the objective of making electric power safer, more reliable and more economical. The company had nine SMT assembly lines and specialised in quick-turnaround custom-configured devices. Most components were sourced close to the assembly facilities, and SEL worked closely with its suppliers, who shared its continuous-improvement philosophy. Diane Maceri made it clear that SEL had excellent relationships with its existing PCB partners. During the 1990s and mid-2000s, North American companies with high-volume PCB requirements were increasingly buying from China and the number of domestic board shops had declined from 2,000 to 200, the same pattern as I had observed in the UK. Those who



Diane Maceri

remained were focused on more complex PCB technologies, and there were few who could sustain SEL's requirements, either in volume or at an economic price.

SEL's PCB demand was growing, and a long-term strategy was needed to maintain supply while keeping up with technical developments and avoiding the need to purchase from China. After discussions with several American PCB fabricators who aligned with their strategy, and considering either buying a manufacturing company or building their own, they decided on the latter, with the help of GreenSource.

Jessi Hall took up the vertical integration story. She explained the benefits of World Class Manufacturing as shorter feedback loops and lead-times, reduced inventory, and improved quality control. SEL planned to



Jessi Hall

construct a 100,000 square foot purpose-built manufacturing plant in Moscow, Idaho, within easy reach of their factories that used PCBs and was close to the University of Idaho. Their decision was supported by their existing suppliers, and the full transition from buying-in to making their own was expected to take several years. Construction would begin in the spring of 2021 and opening was scheduled for December 2022. They were already hiring technical team members who would undergo training at GreenSource. The project was still at an early stage, and there would be many more lessons to share. But so far it was clear that there was a lot of information to consider regarding location, federal regulations, learning about suppliers, new technologies, and understanding staffing needs. Much of the expertise was already in the company, and where it wasn't, strong partnerships existed. A strong cross-functional team had been crucial to the progress of the project. Also critical was good communication with

partners and the local community. As well as their training at GreenSource, new team members would be encouraged to work within SEL to understand the needs and constraints of upstream and downstream customers.

Vicor Corporation

GreenSource's second turnkey client was Vicor Corporation, (with headquarters in Andover, Massachusetts), designers and manufacturers of modular power components. The presentation was given by Vicor's senior strategic sourcing manager Jeff LeBlanc.



Jeff LeBlanc

He explained that Vicor was an engineering-driven operation with a history of vertical integration and a fully automated manufacturing environment. There was a goal to develop competences aligned with the company strategy and a willingness to develop and invest in resources, with a focus on continued automation and improvement, along with a need for flexibility. Extensive use of business intelligence throughout the manufacturing process enabled a significant reduction in cycle time. Vicor built a large mix of product, more than 9,000 active models with many common platforms and components, and all new designs were built on the production line.

“So why is a power-solution manufacturer talking at an IPC summit about plating integration?” LeBlanc asked. “Why do you or anyone want to get into plating? Why not continue to partner/outsourcing these operations?”

Looking at the product going forward, Vicor's next generation and future architecture was built on the foundation of plating, imaging, and etching defined features. Processes became part of the product portfolio offering. So, it was not considered a return-on-invest-

ment discussion but more a risk of not investing in capability and what that would mean to Vicor's future portfolio, together with the risks to revenue if there were any gaps in the supply chain. Another consideration was that Vicor's products were not traditional and did not necessarily fit into a conventional PCB operation. There had already been a strategic alignment with GreenSource and a lot of development from which Vicor could leverage. One of the benefits of working with GreenSource and AWP was the knowledge that the significant amount of engineering involved would not fit well into a high-volume PCB operation and would be better carried out internally. And lastly, the process development going forward would enable new-technology product to be brought to market faster, in line with Vicor's strategy to accelerate NPI, to be a pioneer, to be first-to-market and to be fully automated. Looking at Vicor's surface-mount chip technology, the growth rate had been exponential with main markets being in computing, automotive, and advanced industrial applications. Other areas of market development included defence, aerospace, and artificial intelligence, all focused on high-end power with high efficiency and low thermal output.

LeBlanc described the 90,000 square foot expansion plan for manufacturing at the Andover facility, which now incorporated a large area committed to the plating cell, with a combination of mechanical and laser drilling, thickness capability from 0.05 mm to 8 mm, weight up to 10kg, and a capacity of up 8.8 panel square feet per week.

Construction was in progress...oh, the joy of building in New England in the winter-time!

As Gene Weiner brought the session to a close, he agreed that yes, there is definitely an exciting future for this new generation of vertical integration, led by visionaries like Alex Stepinski. **SMT007**

This article originally appeared in the March 2021 issue of *Real Time with... IPC Show & Tell Magazine*.

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Blackfox Adapts, Improves Through Pandemic ▶

The pandemic disrupted businesses around the globe, but many have learned to adapt and even improve their existing processes. Andy Shaughnessy recently spoke with Jamie Noland of Blackfox Training Institute about some of the lessons learned from COVID-19 and how the company has adapted and developed new ways of training its students.

Heraeus, perfecdos, Infotech Optimize Jetting Process of Sintering Pastes ▶

Three technology companies—Heraeus, perfecdos and Infotech automation—have jointly developed a solution that offers their customers ideally matched components and materials for jetting sintering pastes.

Mycronic Introduces New Range of High-Capacity MYTower Component Storage Systems ▶

Mycronic, a leading Sweden-based electronics assembly solutions provider, is introducing an expanded portfolio of intelligent compo-

nent storage systems designed to enable higher capacity and greater flexibility. Two new models in the MYTower series of near-production storage systems include an innovative high-capacity platform enabling automated storage of up to one thousand component reels per square meter of floorspace.

Competitive Edge Solutions to Launch NovaCentrix PulseForge Soldering Tools in New England ▶

NovaCentrix, a leading provider of photonic curing tools, conductive inks and the new PulseForge® Soldering high-intensity pulsed-light solution, has signed on with Competitive Edge Solutions, LLC as its newest manufacturers’ representative.

BTU to Show Vacuum Reflow Oven for Superior Profile Control at SEMICON China ▶

BTU International, Inc., a leading supplier of advanced thermal processing equipment for the electronics manufacturing market, announced plans to exhibit at SEMICON China.

New WPI from KIC Brings Complete Process Monitoring, Process Control and Traceability to the Wave Solder Process ▶

KIC, a market and technology leader in profiling and process monitoring, announced the release of the WPI—Wave Process Inspection System. The WPI system is the latest in KIC’s innovative line of products, and brings complete process monitoring, process control and traceability to the wave solder process.



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Overcoming Component Selection and Sourcing Challenges

Feature Article by John Watson

ALTIUM

Anyone who calls themselves a “geek” has probably uttered those famous words from Star Trek’s opening:

“Space: the final frontier. These are the voyages of the starship Enterprise. Its five-year mission: to explore strange new worlds, to seek out new life and new civilizations. To boldly go where no man has gone before!”

Most PCB designers would agree that we know precisely how Captain James T. Kirk felt because we often feel the same way when starting a new design. We are launching into something that we ultimately don’t know how it will turn out. We don’t know the difficulties we’ll face or problems we’ll need to fix. While we can control the design process and use our skills to make reasonable decisions, there are often huge hazards awaiting us in the “unknown.” One worsening problem for all designers is component procurement.

Every component has both static and dynamic information: static is the parametric

information, schematic symbol or footprint; dynamic data is the sourcing. Actually, it is incredibly dynamic and constantly changing, which can cause significant problems in your design. Component availability is so volatile that it changes by the hour.

It doesn’t make it any easier to select components at the beginning of a project as you don’t know what final components will ultimately end up in your design. From the start of a design until you eventually drag it across the finish line, significant problems can occur and it’s anybody’s guess what might happen.

One of the standard rules in design and engineering is not to make assumptions as this introduces a tremendous amount of risk into the design process. But, it seems this is what’s happening when we select specific components in this current environment.

Causes of Component Shortages

If we were using the defense readiness condition (DEFCON) alert state to illustrate the component shortage’s seriousness and severity, we would easily be sitting at a DEFCON 2.

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Component shortages are now impacting the electronics industry in a significant way. I have seen reports that several automobile manufacturers have temporarily shut down because of substantial component shortages. I see it as the perfect storm, where it's not caused by one particular reason, but a combination of situations. This was a hot topic at the end of 2019, yet here we are again. I don't think we fully recovered from the initial component shortage as the root causes still exist and have become even more severe.

I don't think we fully recovered from the initial component shortage as the root causes still exist and have become even more severe.

Impact of the COVID Pandemic

The pandemic's impact caused a worldwide slowdown of the electronics industry as the massive industrial machine came to a halt. It affected the supply chain on multiple levels—not just with manufacturers and suppliers, but it went so deep that even the mining of raw materials was halted. Nothing like this had ever happened before, and the industry was not ready. Everyone wanted to see the industry re-open, but in some ways, this has actually further complicated the issues, and it remains to be seen how the electronics industry will operate in the post-COVID economy.

The Imbalance Between Supply and Demand

But really, the root cause goes back to a more common problem—supply and demand. Even with the slowdown of component supply, the

demand still existed or even increased, most notably with autonomous vehicles and the mobile phone industry leading the way. For example, a conventional car with a standard combustion engine uses between 2,000 and 3,000 capacitors, while an electric vehicle uses up to 22,000 MLCC capacitors. Autonomous cars cause an even further drain on the component stock. But compared to 2019, the supply slowdown has spread to other component types, such as the semiconductor sector. This affects actives as well as passives.

Component Allocation

The practice of component allocation has made a difficult situation even worse. Basically, an allocation is a practice of rationing the available components to a relatively select few “significant customers.” Depending on the stock availability, some manufacturers and suppliers may not even take on new customers. Additionally, when some companies know that components are hard to get, they double- and triple-book orders, which further increases demand.

Impact on the Industry

Faster Depreciating of Some Families of Components

The component shortage has placed component manufacturers in the challenging position of making some hard decisions. Some product lines are not selling as fast as others, so those product lines are being re-tooled and moved to more prevalent components, which has caused some entire product lines to depreciate at a much faster rate. An excellent example is with some of the larger discrete components. As the electronics industry shifts to smaller devices, the larger-size SMT components are quickly going obsolete. This is a classic case of the tail wagging the dog.

Driving the Cost Out of Your Supply Chain

Usually, lower supply and greater demand translates to higher prices. That is the unseen

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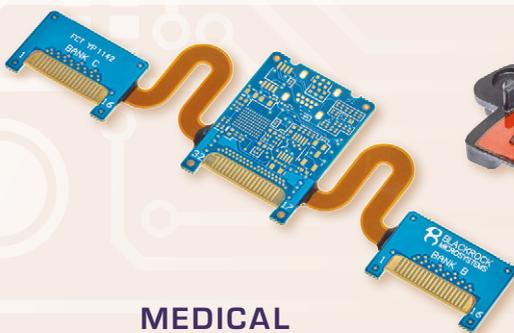
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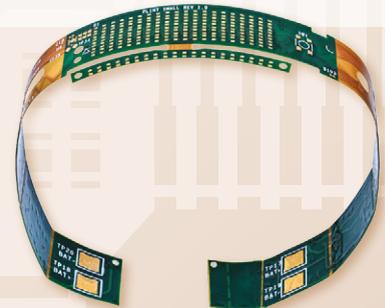
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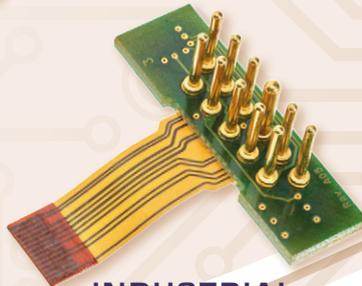
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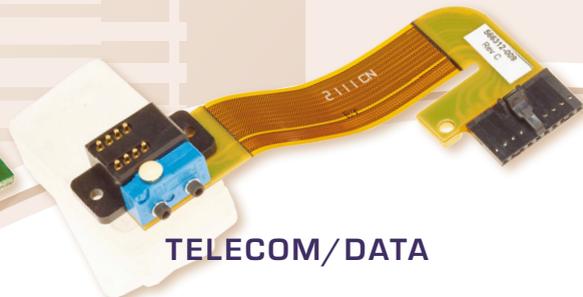
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story of this whole situation. The companies that find the components they want will pay much more for them. Manufacturers run by what I call the “ouch principle,” meaning the price will increase until the customer says, “Ouch.”

Give Up on Lean (Just in Time) Manufacturing

For decades, companies have followed the principle of Lean (aka Just in Time) manufacturing. Lean manufacturing follows the principle that components don’t show up on the production line until needed, which means that inventory stock is generally low most of the time. That system works well when the supply outpaces the demand. But now, with companies finding themselves in a reverse situation, they must reconsider Lean manufacturing; this involves better planning and scheduling of components. In fact, as I mentioned earlier, they are double- and triple-booking their orders, as well as holding company inventory. This has placed an undue burden on companies in regard to space and revenue tax changes.

Better Techniques and Relationships Between Design and Procurement

At one time, you could easily throw your design “over the wall” to procurement and, because of the ample supply of components, things went smoothly. But as our market has shifted from a supply to a demand scenario, that handoff to procurement has changed. More PCB designers have access to component availability, increasing the design team’s communication and relationship with the procurement team. Now, the vital information on a component status should quickly transfer between these different teams. Better decisions now are made earlier in the design process. This is a good thing, as initially designing with obsolete components is not the right way to start things.

Getting Through the Crisis

So, how do we get through this? First, be assured that this crisis will end. It may take

time for supply to catch up with demand, but it will happen. We know that.

One option—and probably not the best—is to bury your head in the sand and wait for it to go away. But this issue of low supply and increased demand is not a short-term problem and the sooner we realize that as an industry, the better.

As designers, we need to think “outside the norm.” With less supply for some components, we must be flexible. For example, do we need to use a 0.1mF 1% cap for our bypass caps? If you have any integrated circuits on your design, the answer is “probably.” Since this is the most common bypass cap value, everyone is scrambling for that specific component. You will open up a larger stock of components by changing the parameters; instead of a 1%, take it up to a 5% tolerance. Many times, the components used are “overkill” for the class of design. This simple change could result in a whole new stock of available components.

As designers, we need to think “outside the norm.” With less supply for some components, we must be flexible.

Another workaround is to have the PCB designer drive other areas of the process, which means giving procurement the list of possible problem components early in the design process. It wasn’t like this before. In fact, engineering and procurement often wouldn’t even speak to one another. Now, we make sure that the correct information filters to those who need it. No one likes to get a call from the assembly house that components are not available for our design.

Finally, we have started to use what are called multi-footprint components—laying multiple

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

footprints on the design for alternative components in case there is a shortage for our first choice. This has resulted in some interesting layouts to accommodate everything.

Plan Ahead

Benjamin Franklin said, “By failing to prepare, you are preparing to fail.” I like to follow the three “P’s” of getting through a crisis: plan, prepare, and be proactive.

Stay ahead of the problem by not starting with a design that is already in trouble. Engineers will often use a previous design, thinking that those components are available when many may be obsolete or in a depreciated state.

We cannot assume that everything is okay. If you see that parts are already having stock problems or are not recommended for new designs, that situation will not get any better over time. It’s best to realize that the further someone gets into a design, the harder it is to make changes without impacting your wallet or schedule. **SMT007**



John Watson, CID, is a customer success manager at Altium. To read his past columns, or to contact Watson, [click here](#).

NIST Develops Privacy-Preserving ‘Encounter Metrics’

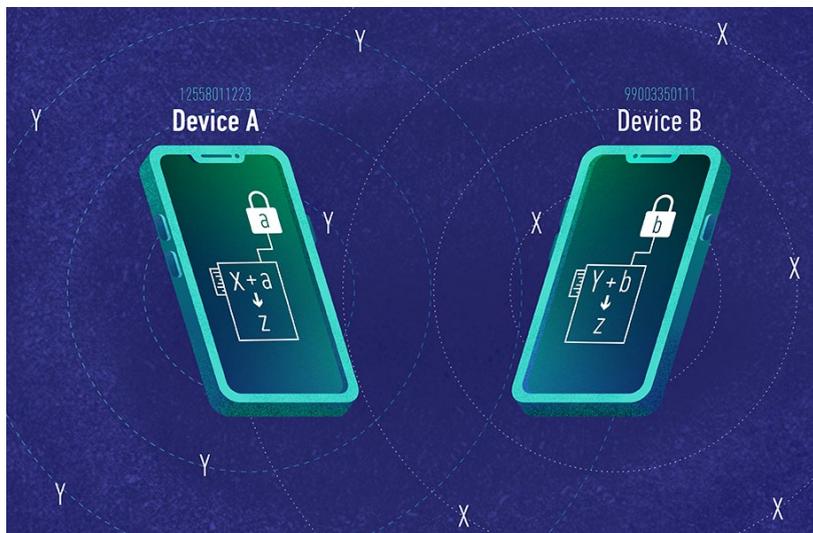
When you bump into someone in the workplace or at your local coffee shop, you might call that an “encounter.” That’s the scientific term for it, too. As part of urgent efforts to fight COVID-19, a science is rapidly developing for measuring the number of encounters and the different levels of interaction in a group.

Now, researchers are applying that science to a concept they have created called “encounter metrics.” They have developed an encrypted method that can be applied to a device such as your phone to help with the ultimate goal of slowing down or preventing future pandemics. The method is also applicable to the COVID-19 pandemic.

Their research is explained in a pilot study published in the Journal of Research of NIST.

Encounter metrics measure the levels of interactions between members of a population. There are numerous levels of interactions because there are so many different ways people can interact with one another in different environments.

To mitigate the spread of an infectious disease there is the assumption that less communication and interaction with people in a community is essential. Fewer interactions among people means there is less of a chance of the disease spreading from one person to another. “We need to measure that. It’s important to develop technology to measure



that and then see how we can use that technology to shape our working environment to slow future pandemics,” said NIST researcher René Peralta, an author of the NIST study.

(Source: National Institute of Standards and Technology)

Photo: NIST researchers developed a cryptographic system using encounter metrics. Encounter ID is a way of labeling an encounter between two people through a random number not linked to the device each person carries. To generate the randomized number Z, each device calculates using their private info (a and b) and what the other device is broadcasting (X and Y). Cryptography ensures that device A’s Z is the same as Device B’s Z.

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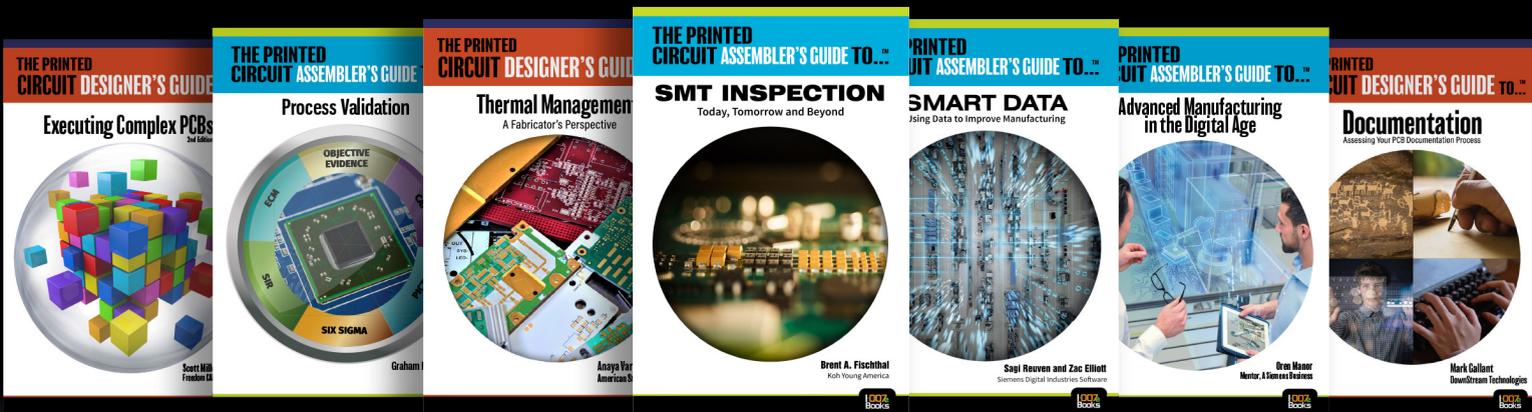
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Major Drivers for Improving Yield and Reducing Cost

SMT Solver

by Ray Prasad, RAY PRASAD CONSULTANCY GROUP

No matter how long you have been in the SMT industry, there is always something new to learn because SMT is constantly evolving even though it is a mature technology. For example, we have been manufacturing SMT products in high volume for almost four decades, but less than 10% of companies have a first pass yield of more than 90%. In other words, 90% of companies are conducting too much rework.

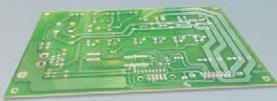
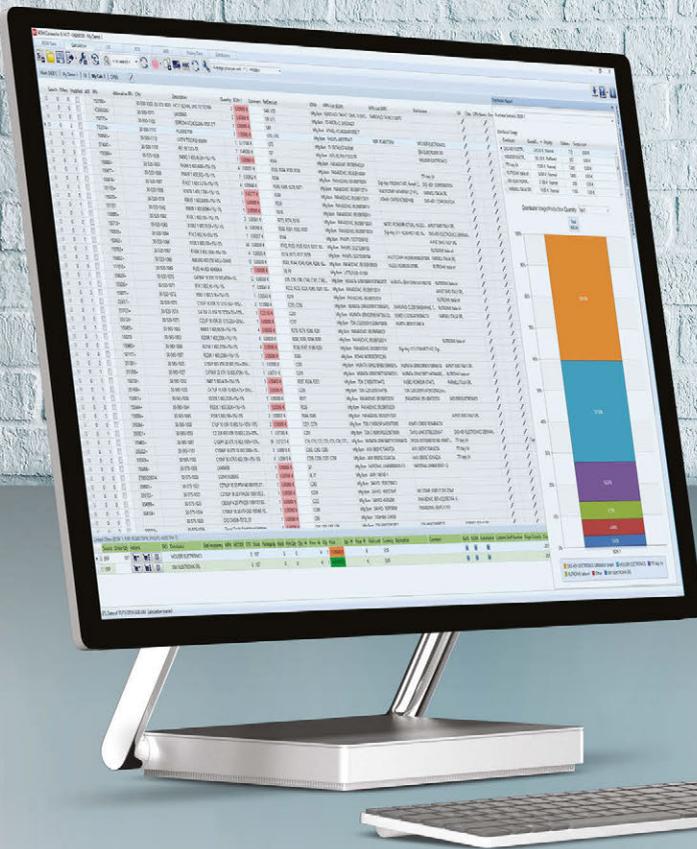
In some of my previous columns, I have gone into detail on the types of defects that are predominant. There are many reasons we worry about defects, but the key reasons are increased cost and reduced reliability. These defects must be reworked so that you can meet the delivery requirement without too much delay. Even if you can minimize the

delay in shipping the final product, if you must do rework, there is no way to prevent reduction in reliability. Why? Each time you heat the solder joint, you increase the thickness of the intermetallic layer. The intermetallic compound (IMC) is necessary to achieve a reliable bond between the component and board, but too much IMC is not good. It is brittle and if it is too thick you have potentially early failures in the field. There is nothing worse than field returns for any company since they are not only expensive to repair, but they can also adversely impact a company's reputation.

With the advent of fine- and ultra-fine-pitch, high-pin-count BGAs, 0402, 0201 and 01005 resistors and capacitors, as well as the widespread use of no-clean flux, yield problems are



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getting worse. With widespread use of lead-free, the yield problems are compounded. When yield problems persist, most people blame manufacturing. This is unfair and prevents companies from implementing the necessary corrective actions.

Who in the company is responsible for the defect? If you really think about it, no matter what your job title is or which department you work in—engineering, manufacturing, quality, purchasing, or management—what you have in common is the responsibility for quality and cost. You affect quality and reliability in different ways. No one group can ever solve this problem alone. If you take a 50,000-foot view of the problem, there are three major areas that affect quality: design for manufacturing, quality of incoming materials, and manufacturing.

How the board is designed, and what components are selected, impact cost and quality. This is mostly the responsibility of the designer.

How the board is designed, and what components are selected, impact cost and quality. This is mostly the responsibility of the designer. Just about everything you need for manufacturing is purchased from outside—components, boards, and materials such as solder paste and flux. The person responsible for vendor selection is generally the purchasing manager. Yes, defects are caused in manufacturing but there is nothing they can do about poor design or bad quality of incoming materials. So, let us look in more detail at these three areas: design for manufacturing, incoming material quality, and manufacturing.

Design for Manufacturability

Keep in mind that DFM is a key driver, if not the most important, of manufacturing yield. However, few circuit and board designers understand manufacturing processes. A DFM document must be company specific. Using an industry standard such as IPC-7531 (formerly known as IPC-SM-782 when I initially chaired this committee in the mid-'80s) is a good place to start. Some major items that should be included in a DFM for SMT products are:

- Establish design rules and guidelines while emphasizing the importance of differences between them
- Component selection criteria, including consolidation of parts lists to reduce redundancy and eliminate obsolete parts
- Paneling considerations
- Fiducial requirements
- Land-pattern design
- Solder-mask consideration
- Via-hole location
- Design for test
- Anything unique to your design

With widespread use of high-pin-count BGAs that cannot be inspected visually, sufficient test coverage for in-circuit test (ICT) should be seriously considered. Keep in mind that no inspection method is perfect. The only way to prevent defects from escaping to the field is to rely on overlapping test and inspection methods. Once a DFM document developed by a well-trained team is finalized and released, the possibility of DFM violation generally does not arise.

Creating a DFM document is not easy; it will, however, correct problems at the source and prevent their recurrence. This is critical in an environment where essentially all manufacturing is being outsourced or sent offshore.

Incoming Materials Quality

No matter what components, boards, solder paste, flux, etc., the designer and manufacturing people selected, the quality of incoming

material is controlled by the vendors who supply them. Who is responsible for vendor selection? The purchasing guy who used low price as the criteria for placing the order? When it comes to making the decision about vendor selection, how much focus is given on price vs. quality and the total cost?

“Garbage in, garbage out” could not be truer than in the assembly of SMT components where pitches are shrinking and process windows tightening. As a result, there is no way to improve manufacturing yield if the boards and components have poor solderability or unacceptable co-planarity. Referencing industry standards such as J-STD-002/003 is a good idea. Take another example: BTC is now a very widely used component. It is a very good component with many good features, such as excellent electrical and thermal performance, size, and weight, etc. But the one important feature of this package is that it is the cheapest package you can buy. As a rule of thumb, if you can buy a component package that costs one penny per lead (i.e., a 100-pin packaging costing a dollar), you have an inexpensive package. A BTC costs less than half a penny per lead—no wonder it is a very popular package. But when it comes to manufacturing, you need a perfectly flat package, and a totally perfect flat board. Since there is no lead or ball in this package, packages and boards must be flat to ensure a good connection. To compensate for flatness, you cannot print excess solder which will cause floating and excessive voids. And you cannot print very thin paste thickness since the potential for opens will go up if either the package or the board is warped. Plus, the ends of the BTC terminations are not solderable since they are exposed copper. So, if you consider these manufacturing challenges, the package is not as cheap as one might think. I suggest you refer to the just-released IPC 7093B (I chair the committee) for a deep understanding of the complexities involved in design and manufacturing with BTCs.

Manufacturing Processes

The key responsibility of manufacturing is to use process control for all the manufacturing processes. However, no matter how good the process controls are, or how well they program their machines to dispense or print paste or use the right profile, they cannot eliminate design- and material-related defects. Yes, they can compensate for some of the issues with some process changes but there is a limit.

How should one identify key manufacturing process issues? For manufacturing there are a lot of challenges. For example, the equipment must be characterized thoroughly. This can be defined as understanding all parameters that affect the equipment’s performance. A good understanding of all the key parameters that affect quality will take a lot of time and effort. Large companies can afford to assign many engineers to characterize the process. In small companies, “learn as you go” is the common motto since they don’t have the resources.

In small companies, “learn as you go” is the common motto since they don’t have the resources.

Vendors may say it is easy; it is not. For example, if you look at the data sheets of various solder pastes from different suppliers, what you will see is that just about any profile will work with their paste. That is simply not so. While you do consider their recommendations, there is no substitute for developing a unique profile for each product.

How should you proceed? First, characterize the process, then document the details of equipment- and non-equipment-dependent variables that control yield. There are some misconceptions that if you use a certain paste all your

defects will go away, or if you buy a particular convection oven, there's no need to develop a unique profile for each product. This is not true, as each board has a different thermal mass.

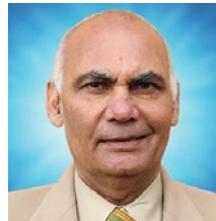
With the widespread use of BTC, BGA, and fine pitch, the challenges for manufacturing are only increasing. We briefly mentioned BTC issues in the incoming material quality section earlier. Dealing with BGAs is no walk in the park. One of the biggest challenges in BGAs has been the head-on-pillow defect. If you scan the literature, you will find multiple causes of head-on-pillow such as design and processes, paste, profile, etc. Some of it is true. But the inherent cause of head-on-pillow is the warpage of the package that very few component suppliers will admit to. This is a very involved subject that will require multiple columns to address. Suffice to say that even when you use the best possible paste and best profile and everything else you do in manufacturing, if the package is warped, you will not get rid of head-on-pillow. You can minimize the problem, but to eliminate it, the real solution is to use a package that does not exhibit unacceptable warpage at soldering temperatures (not room temperature).

For an in-depth look at BGA design and assembly challenges, look at IPC-7095, which I also currently chair.

Conclusion

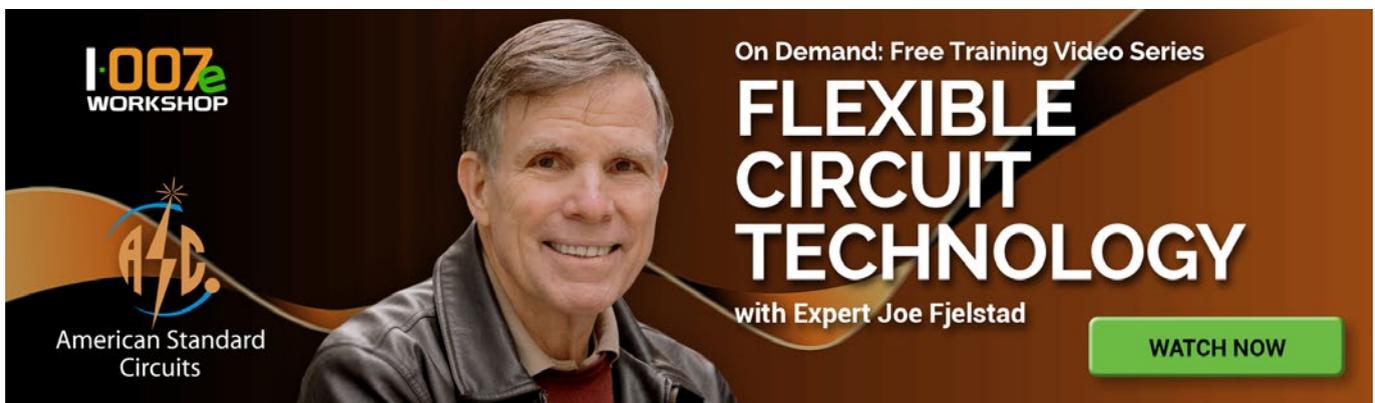
In addition to having the right design, quality incoming materials, and good manufactur-

ing capabilities, you need in-house detailed DFM and manufacturing process recipes; well trained personnel at all levels, including operators and technicians on the manufacturing floor; and process, design and quality engineers. Very few companies have detailed in-house DFM and process documents, and training budget is the first thing that gets cut at a lot of companies. Just keep in mind that no one gets up in the morning and says, "I am going to screw up three things today at work." They are all trying to do things to the best of their ability. Who is responsible for the in-house documentation and training? The top management. The buck for quality, reliability, and cost stops at the boss running the show. **SMT007**



Ray Prasad is the president of Ray Prasad Consultancy Group and author of the textbook *Surface Mount Technology: Principles and Practice*. Prasad is also an inductee to the IPC Hall of Fame—the highest

honor in the electronics industry—and has decades of experience in all areas of SMT, including his leadership roles implementing SMT at Boeing and Intel; helping OEM and EMS clients across the globe set up strong, internal, self-sustaining SMT infrastructure; and teaching on-site, in-depth SMT classes. He can be reached at smtsolver@rayprasasd.com and regularly offers in-depth SMT classes. Details about classes can be found at rayprasad.com. To read past columns or contact Prasad, [click here](#).



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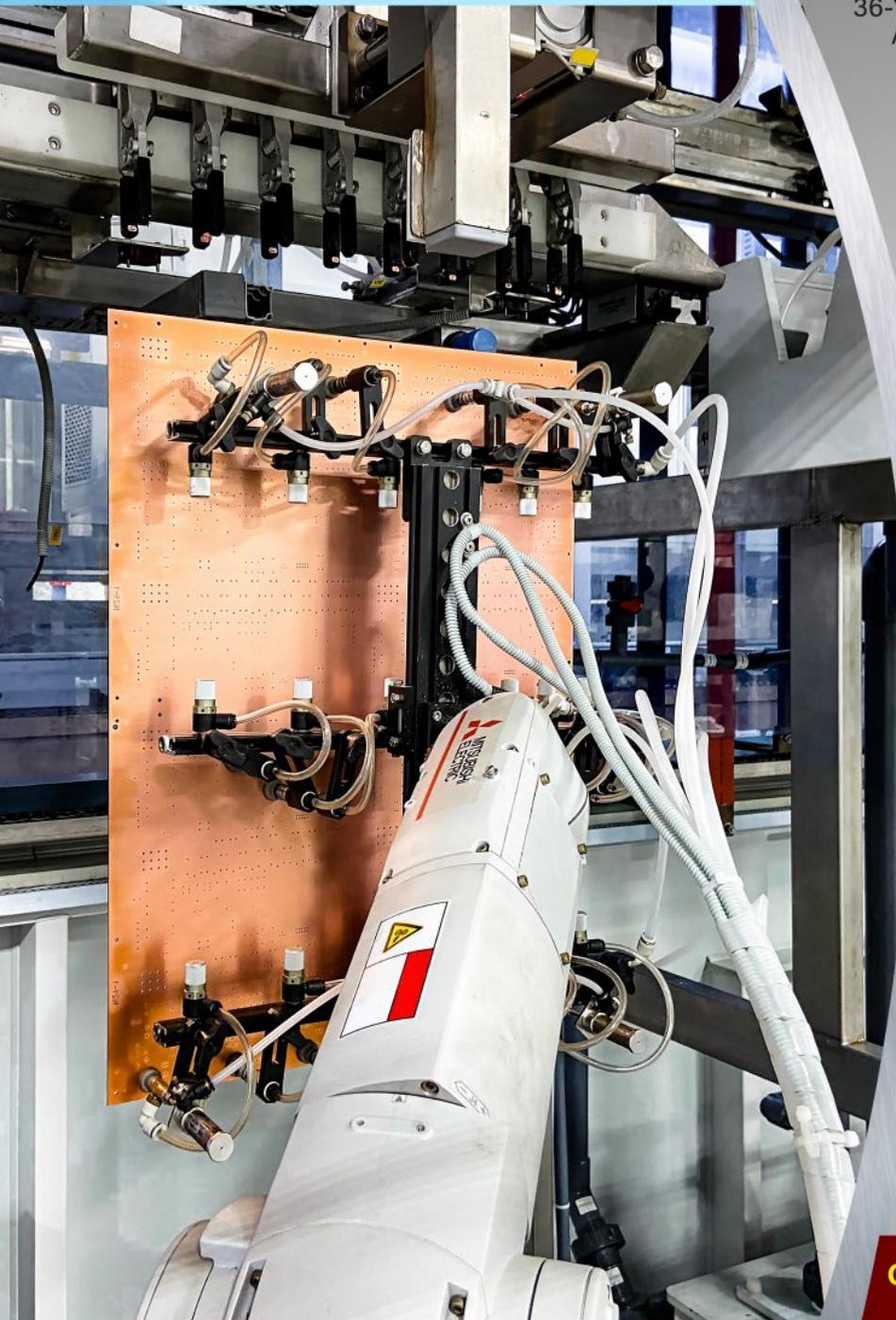
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MilAero007 Highlights



NASA Takes Steps to Reduce Aviation Emissions, Invigorate U.S. Economy ▶

NASA is seeking proposals for ground and flight demonstrations of integrated megawatt-class powertrain systems for subsonic aircraft. The deadline for proposals for this solicitation is 5 p.m. EST April 20.

Royal Circuit Solutions Continues Manufacturing Expansion ▶

Royal Circuit Solutions, a global manufacturer of high technology printed circuit boards, has completed the installation of over \$2 million worth of new equipment and expanded its printed circuit board manufacturing facility.

Ultra Awarded Canadian Surface Combatant Subcontract to Provide Hull-Mounted Sonar ▶

Ultra is delighted to announce a contract award to commence work on the S2150-C Hull-Mounted Sonar system for the Canadian Surface Combatant program.

IPC Commends President Biden for Executive Order on Industrial Supply Chains ▶

IPC commends President Biden for ordering a review of industrial supply chains critical to U.S. economic growth, innovation, and security.

NEOTech, Numerica Provide 3D Radar for C-UAS, Short-range Defense Missions ▶

NEOTech, a leading provider of manufacturing technology and supply chain solutions for brand name OEMs in the industrial, medical

and mil/aero markets, is thrilled to congratulate Numerica Corporation on the announcement of their new short range surveillance radar system.

Ventec's German Facility Receives AS9100-D (DIN EN 9100) Quality Certification ▶

Ventec International Group is pleased to announce that its European facility in Kirchheimbolanden, Germany, is now certified according to AS9100 Revision D (DIN EN 9100), the quality management standard for the aviation, space, and defense industries.

IPC Commends President Biden for Executive Order on Industrial Supply Chains ▶

IPC commends President Biden for ordering a review of industrial supply chains critical to U.S. economic growth, innovation, and security.

Sypris Wins Defense Contract Award ▶

Sypris Electronics, LLC, a subsidiary of Sypris Solutions, Inc., announced that it has recently received a follow-on award from a U.S. DoD prime contractor to manufacture and test electronic power supply modules for a mission-critical, long range, precision-guided anti-ship missile system.

Boeing: Southeast Asia Aviation Market Well Positioned for Recovery ▶

Boeing anticipates airlines in Southeast Asia will need 4,400 new airplanes valued at \$700 billion to support expanding demand for air travel over the next 20 years.

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Driving Down **Cost** in the Supply Chain

Feature Article by Meghan Zou

EPOCH

Driving cost out of the supply chain goes beyond reduction of raw material cost. Though many of the manufacturers today concentrate on negotiation with their raw material supplier(s) the hidden cost of internal supply chain goes undetected. To address the cost of the entire supply chain we should not only look at direct material cost but also at the cost of internal supply chain. At Epoch we looked at four areas in particular: planning/tracking, storage/delivery, inventory management, and supplier relationships.

Planning and Tracking

At Epoch International, a provider of engineering and manufacturing services to a diverse customer in such fields as telecommunication, automotive, medical, etc., this challenge becomes more acute due to the various sizes and diversity of production we run daily. Due to the vast variety and number of components used in various product lines,

Epoch realized early on that, without any ERP tool, it would not be humanly possible to manage the entire supply chain. Epoch has been utilizing Oracle EBS suite to operate its entire business operations since the early 2000s.

To further enhance its internal supply chain, Epoch has augmented the ERP with a series of in-house-designed interface modules. One of the early modules designed was a “barcode interface module.” This system has allowed the removal of all the manual entry into the ERP system by merely scanning the material as it moves from point of entry to the production floor. This system is very much integrated with the in-house developed MES system that monitors the movement of the product/material throughout the production stage.

Storage and Delivery

One area of cost that has been addressed by Epoch is the movement of raw material back and forth from inventory to production site. This has been achieved through the implementation of an environmentally controlled Point of Use Smart Cabinet. The company has deployed a series of



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these smart cabinets—designed and patented by Epoch—right at the point of use of the production. Bringing the inventory right to the production floor eliminates all movements back and forth between inventory and production. This also reduces the number of inventory staff since parts are picked by the production staff utilizing the fully automated locator and FIFO dispensers. The smart cabinet is fully integrated with the ERP system, ensuring full control of the inventory. Since the implementation of the smart cabinet six years ago, Epoch has doubled its inventory material line items without increasing any head count on its material management team.

Inventory Management

At Epoch we operate our inventory from various perspectives. Our cycle stock is linked to our MRP system and procurement in close coordination with production planner which re-aligns the delivery date to ensure timely delivery of products needed for manufacturing. With the volatility and long delivery of electronic components, a safety stock is always built in to ensure we meet the demands of customers. At Epoch we have established an internal “inventory team” consisting of sales, production, procurement, and material management to oversee the monitoring of the inventory. Having a diverse team that looks at inventory from sales, production, procurement, and material management perspectives becomes a challenge at times. But based on potential sales, previous historical data, and supplier delivery, the team has generally reached consensus on the level of safety stock to be built, to ensure on-time delivery and monitoring of excess inventory buildup. The pandemic and the shortage of electronic components has forced the team to drill down further, analyzing each



Meghan Zou

component’s past performance in forecasting and setting up the safety stock. With constant fluctuation in component delivery, the team finds itself constantly reassessing its safety stock.

Supplier Relationships

We recognize that without the full support of our suppliers, Epoch would not be able to drive the supply cost to its set targets. To ensure this close collaboration, we provide suppliers with long lead items with extensive forecast some as long as six to eight months. Epoch has also established VMI with many of its major suppliers and, to reduce excess workload for the procurement team, EDI is implemented with suppliers. In the past, a sudden surge in customer demand would mean spot buying of components at higher pricing. With the fluctuation of component availability and with much longer forecast provided to the supplier we have been able to reduce our inventory cost by around 4%.

Conclusion

As we have experienced, there is more to the reduction of supply chain cost than merely direct raw material cost. At times, the hidden cost of material management far exceeds the direct raw material cost. This is especially true when we run small volume production. In today’s world, we see many EMS and end customers focus only on cost of direct raw material, and at times setting arbitrary reduction rates of a certain percentage per year. We strongly believe that to reduce our overall supply chain cost we must look at technology, innovation, and close collaboration with our suppliers and customers. **SMT007**

Meghan Zou is Global Procurement Manager at Epoch International Enterprises. She has 18 years of experience in electronic procurement with multinational corporations.



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- PCB Design RF Boards
- PCB Design for Printed & Wearable Devices

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Editor's Picks from SMT007.com

1 X-Rayted Files: The Dark Side of the Chip Shortage—Counterfeits ▶

As the world slowly recovers from the COVID-19 pandemic, another problem plagues the global economy: the electronic component shortage. What some economists have deemed to be a decade of immense prosperity and growth, the “roaring ‘20s” started with a hiccup.



Bill Cardoso

2 Catching Up With Sean McConville, Niche Electronics ▶

Dan Beaulieu catches up with Sean McConville, vice president of business development at Niche Electronics, who shares his background in the industry, the strengths of his company, and how the pandemic has affected business.



Sean McConville

3 2021 Award Winners—IPC APEX EXPO 2021 Presentation ▶

Congratulations to this year’s IPC APEX EXPO award winners! On Tuesday, March 9, IPC presented their recognition awards during an online ceremony. The recipients of each award are listed here. Follow our I-Connect007 coverage for interviews with some of the award recipients.

4 EIPC Technical Snapshot: Cleanliness ▶

John Ling’s invitation to the fifth in EIPC’s: “In these confined days of lockdown, and exhortations to stay at home and only go out for exercise, this only exercises the natural inclination to hop on a ‘plane to some sunshine.’ Although not the same as Factor 20, one of our webinars gives a high degree of protection from harmful ignorance, and you do not have to go out in the cold.”



Pete Starkey

5 North American EMS Industry Up 9.7 Percent in January ▶

IPC announced the January 2021 findings from its North American Electronics Manufacturing Services (EMS) Statistical Program. The book-to-bill ratio stands at 1.18.



8 Koh Young Shows Full Suite of Solutions During IPC APEX EXPO ▶

Koh Young, an industry leader in True3D™ measurement-based inspection solutions, provided information about its award-winning KSMART Process Control Software, Neptune Dispensing Process Inspection, and KY-P3 Automated Pin Inspection solutions.



6 Her Voice: Nothing to Lose and Everything to Win ▶

An opportunity to quote a new job went sideways, until CAMtek owner decided to make a bold move. Columnist Christine Davis explains.



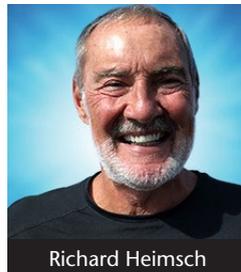
9 Knocking Down the Bone Pile: Salvaging Components for Other Uses ▶

Electronic components and their availability (or rather their lack of) have been in the news recently. Automotive suppliers are struggling with their supply chain as electric vehicle production, and the associated consumption of electronic components continues to expand.



7 Super Dry: Increasing Component Storage Needs ▶

Nolan Johnson speaks with Super Dry's Richard Heimsch about how the need for dry storage solutions has increased throughout the pandemic, including further demands for traceability and automation capabilities.



10 Foxconn's Chengdu Campus Recognized as Lighthouse Factory ▶

Foxconn Technology Group announced that a second of the company's factories, a factory based in Chengdu, China, has been recognized by the World Economic Forum (WEF)'s Global Lighthouse Network (GLN) as a Lighthouse factory.



For the latest news and information, visit [SMT007.com](https://www.smt007.com). Subscribe to our newsletters or premium content at [my I-Connect007](https://my.i-connect007.com).

Career Opportunities



How Do Your Team Members Stack Up?

Find industry-experienced candidates at I-Connect007.

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

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

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Career Opportunities



Micropack Private Limited Sales Representatives

Micropack is a leading Indian PCB manufacturer with a state-of-the-art facility in Bangalore. Our focus on quality and reliability is demonstrated by the fact that we are certified to Nadcap, MIL 31032 & AS9100, apart from many customer approvals.

Catering to both quick-turn and medium volume requirements, our product range covers:

- Double-sided & multilayer PCBs, up to 30 layers
- Rigid-flex PCBs
- High-copper PCBs
- Hybrid PCBs with FR4+ Hydrocarbon Ceramic Substrates
- Heatsink Multilayer PCBs—Metal core and thermal plate PCBs

We are looking beyond our borders for sales representatives to expand our customer reach in the United States, Europe & South America.

Candidates must have previous PCB sales experience and should understand the technical aspects of printed circuit board manufacturability.

Contact us for more information.
mp3@micropack.in

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We're Hiring! Atlanta Georgia Facility

ADVANCED CIRCUITRY INTERNATIONAL is a world class supplier of RF/microwave and antenna PCBs. We have four state-of-the-art facilities on three continents to serve our customers. From rapid prototype development to large scale production ramp-ups, we supply many notable OEMs and EMS companies around the world.

As we are anticipating rapid growth for 2021 and beyond, we are recruiting for the following positions:

- Manufacturing manager
- Process engineering
- Sales and business development
- Maintenance management

Qualifications:

- 5-10 years' experience working in the PCB industry
- The ability and drive to learn about our unique product offering
- Excellent written and oral communication skills
- Strong, honest work ethic
- Degree in engineering, operations management, or related field preferred but not required

What We Offer:

- Excellent salary and benefits commensurate with experience

If you want to be part of the upcoming **5G** revolution and the growth in RF/microwave and antenna PCB manufacturing, consider a career at **ACI**. We're located in the Northern Atlanta suburbs, where you will enjoy a moderate climate, affordable housing, low taxes, quality school systems and numerous recreational opportunities. Please send your resume in confidence to: Career@aciatlanta.com

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Career Opportunities



Circuit Engineering Planning Engineer

Experience

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

Responsibilities

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

Quality Engineer/Manager

Experience

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

Responsibilities

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

Sales Associate/Customer Service

- Should have a minimum of 2 years' experience
- Salary plus commission

All positions will be on location at Circuit Engineering, 1390 Lunt Ave., Elk Grove Village, Illinois, not remote!

Contact: Felix Simon: (847) 867-7942

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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.

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Career Opportunities



Senior Account Manager Midwest Region

Summit Interconnect, a leading North American manufacturer of advanced technology printed circuit boards across all end-user markets, is seeking an experienced, dynamic leader to drive new business in the Midwest Region of the U.S.

Headquartered in Anaheim, Calif., with additional locations in California and Toronto, Can., Summit's manufacturing features facility-specific expertise in rigid, flex, rigid-flex, RF/MW, and HDI PCBs.

The ideal candidate is highly motivated and should possess in-depth market knowledge, deep contacts across multiple markets and extensive experience in PCB sales with a demonstrated aptitude in proposing engineered solutions to complex requirements.

Reporting to the VP of Sales, the Midwest Senior Account Manager will be the primary hunter in the region and responsible for monitoring customer, market and competitor activity to build appropriate sales strategies for the region, create a strategic plan to grow existing and new business in the region, and be responsible for interfacing across all levels of the organization.

Preference is for the applicant to reside in region and be located within one-day travel to key accounts in the metropolitan business areas. However, the proven professional able to demonstrate reach into the region will be considered regardless of physical location.

Compensation will be a combination of salary and commission, with a comprehensive, competitive benefits package.

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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.

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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.

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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.

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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.

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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.

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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.

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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

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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

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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

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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

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Career Opportunities



BLACKFOX

Premier Training & Certification

IPC Instructor

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

*Independent contractor,
possible full-time employment*

Job Description

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

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

Qualifications

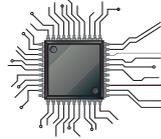
Candidates must have a minimum of five years of electronics manufacturing experience. This experience can include printed circuit board fabrication, circuit board assembly, and/or wire and cable harness assembly. Soldering experience of through-hole and/or surface-mount components is highly preferred.

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

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

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

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MivaTek

Global

MivaTek Global: We Are Growing!

MivaTek Global is adding sales, technical support and application engineers.

Join a team that brings new imaging technologies to circuit fabrication and microelectronics. Applicants should have direct experience in direct imaging applications, complex machine repair and/or customer support for the printed circuit board or microelectronic markets.

Positions typically require regional and/or air travel. Full time and/or contractor positions are available.

Contact HR@MivaTek.Global
for additional information.

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.

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Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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Career Opportunities



U.S. CIRCUIT

Sales Representatives (Specific Territories)

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

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for more information.

mfariba@uscircuit.com

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**Achieving Operational Excellence
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**Use of IMS Thermal Materials
in Multilayer Stackups**

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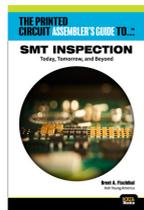
Live and on-demand webinars from KYZEN designed to answer all your cleaning questions.



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.



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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.



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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.

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ADVERTISER INDEX

Aegis Software.....	55
American Standard Circuits.....	37
APCT.....	43
Blackfox Training Institute.....	53, 61
Eagle Electronics.....	7
Flexible Circuit Technologies.....	65
Gen3.....	35
Heraeus.....	19
I-007e.....	2, 95
I-007eBooks.....	3, 69
I-Connect007.....	59
ICM Controls.....	75
IPC.....	33, 81
Koh Young.....	25
Kurtz Ersa.....	67
KYZEN.....	63
LPKF.....	31
MacDermid Alpha Electronic Solutions.....	11
Manncorp.....	5
NovaCentrix.....	39
P Kay Metal.....	49
Prototron Circuits.....	77
Siemens Digital Industries Software.....	71
Show & Tell Magazine.....	45
SMTA.....	23, 41
Sunstone Circuits.....	15
Super Dry.....	29
The Test Connection.....	79
US Circuit.....	47

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