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Rethinking Manufacturing

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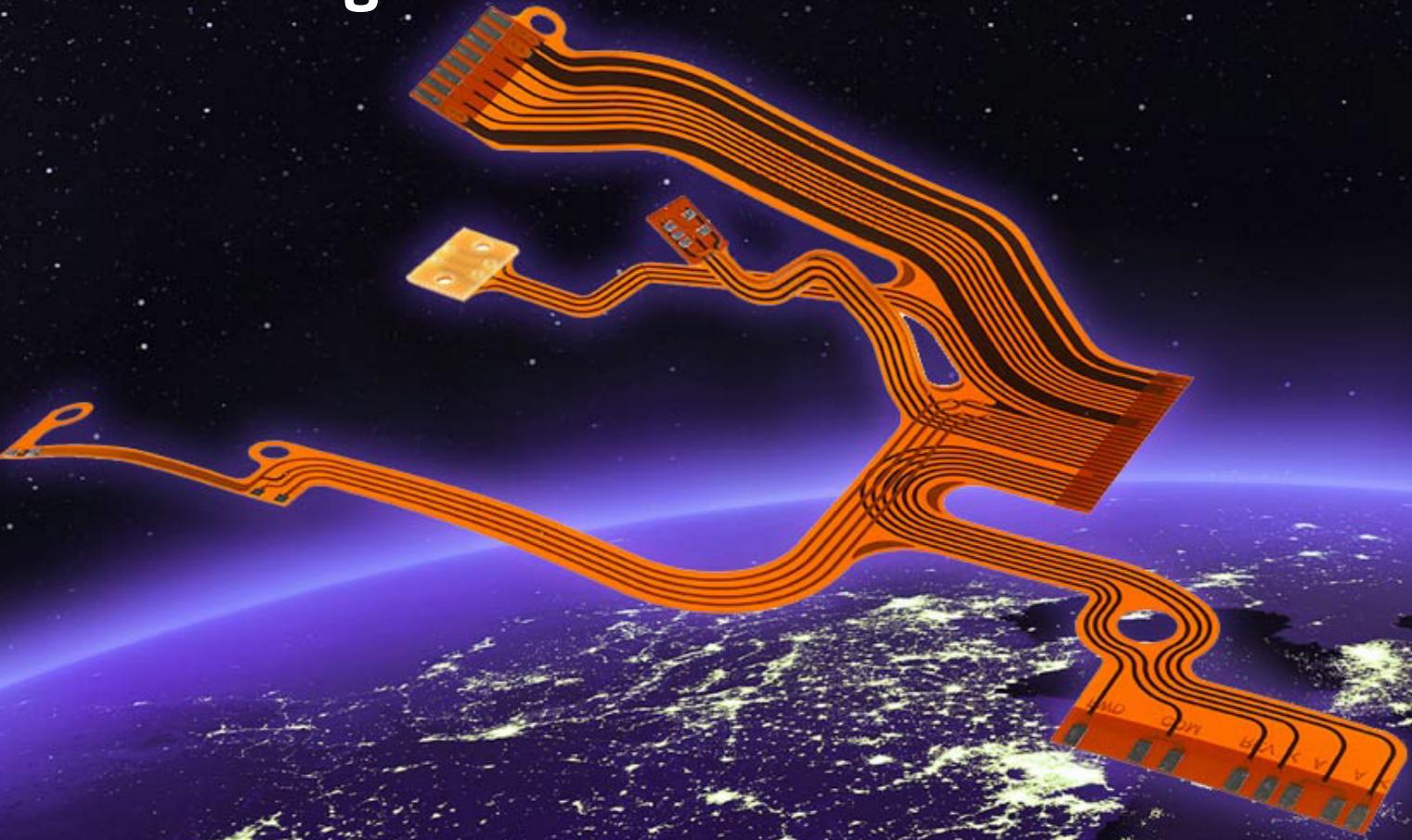


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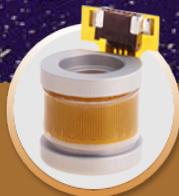
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Rethinking Manufacturing

Nolan's Notes

by Nolan Johnson, I-CONNECT007

These days, it seems we're all doing a lot of rethinking, looking at nearly everything from a different perspective. The rapid changes we've made in 2020 to help as many people as possible survive a pandemic also trickle down into our thought patterns. A measure of this change in thinking can be seen in academic research currently underway.

Part of my job is to keep a watchful eye for newsworthy content. One source I use aggregates technology-related press releases from major universities, including new discoveries, research papers, and thinktank-and-incubator stuff. In the last 45 days, the type of content announced on this feed has shifted away from technology and applied sciences to a heavier focus on sociology, anthropology, and epidemiology. The shift in the work being done in academia is just one mirror reflecting our changes worldwide. It's also a reminder that we shouldn't specialize too much.

In the middle of preparing this magazine, a colleague sent me a link to an article by Vikram

Mansharamani, a lecturer at Harvard. He wades right into the middle of this shifting discourse academia is having with the public ^[1]. Mansharamani states:

“The one certainty about the future is that it will be uncertain. The rapid advancement of artificial intelligence and technological innovation have commoditized information. The skill of generating dots is losing value. The key skill of the future is, well, not quite a skill; it's an approach, a philosophy, and way of thinking—and it's critical you adopt it as soon as you're able.”

Mansharamani's argument is that specialization is no longer as critical to success as it once was, which stands to reason, I suppose. During the industrial revolution, and into the digital revolution, it was the highly specialized experts who drew higher salaries; specialization was the most likely pathway to success. Mansharamani, however, argues that has changed:



“The rapid advancement of technology, combined with increased uncertainty, is making the most important career logic of the past counterproductive going forward. The world, to put it bluntly, has changed, but our philosophy around skills development has not. Today’s dynamic complexity demands an ability to thrive in ambiguous and poorly defined situations, a context that generates anxiety for most, because it has always felt safer to generalize.”

Hold this thinking up against the current dialogue in manufacturing, putting a spotlight on supply chain resiliency, and it makes sense. The supply chain, like the people, overspecializes to its own detriment in the end. Is it possible that technology moves fast enough nowadays that it takes a wide-angle thought process to grasp the real implications? Mansharamani makes a case for that:

“There’s an oft-quoted saying that ‘to a man with a hammer, everything looks like nails.’ But what if that man had a hammer, a screwdriver, and a wrench?... Our world is changing so rapidly that those with more tools in their possession will better navigate the uncertainty. To make it in today’s world, it’s important to be agile and flexible.”

Join us as we consider the process of rethinking manufacturing. We reached out to a wide range of thought leaders on the topic, and they certainly had something to

say. Inside the issue, you’ll find feature interviews with IPC’s Shawn Dubravac and Matt Kelly, Robert Murphy from Rockwell Automation, Dave Ryder and Eric Cormier from Prototron, and Chris Peters from the U.S. Partnership for Assured Electronics. You will also find insights from Robert Murphy, Ross Bernstein, and Dan Beaulieu.

In addition, we bring you columns from regular contributors Jennie Hwang, Ray Prasad, Eric Camden, Bob Wettermann, and Alfred Macha.

As I wrap up this column, SMTA has announced that SMTA International, the fall conference and expo traditionally held in Rosemont, Illinois, will be going virtual for 2020. According to the press release, a key factor in this decision was the fact that many participating companies will continue to impose travel bans on employees for their safety. Indeed, we are rethinking everything in manufacturing. Stay safe and be nimble and creative. **SMT007**

Reference

1. Vikram Mansharamani, “Harvard lecturer: ‘No specific skill will get you ahead in the future’—but this ‘way of thinking’ will,” CNBC, June 15, 2020.



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

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RETHINKING MANUFACTURING: Bracing for and Embracing a Post-Pandemic Decade

SMT Prospects & Perspectives

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

From a 30,000-foot view, global macroeconomics is facing gusty headwinds, bracing for impact from social-distancing lockdowns and economic shutdowns across the globe as a result of the coronavirus pandemic. Compounding to the pandemic, the world's two largest economies—the U.S. and China—are butting heads on trade and geopolitical affairs.

Additionally, at the time of this writing, the lawless riots in the midst of the protests for social justice, spreading from coast to coast in the U.S., are destroying properties and businesses in metropolitan areas, aggravating the already-disrupted businesses and adding to the financial losses as the result of the pandemic. The triple whammy of concurrent events puts the country in an unprecedented challenge economically, socially, and politically.

Against this potent backdrop, how should

our industry respond? How should we manage and rethink manufacturing? And what are the main issues at hand in near-term and long-term horizons?

COVID-19 has cost lives and caused sorrow and distress. Our hearts go out to all who are in grief. However, the pandemic has propelled our deeper thoughts and made us venture into the wide landscape of the mind. We will have a new normal in business and manufacturing, just as in our daily lives. One old saying states, “Never let a crisis go to waste.” What have we learned from the coronavirus crisis to benefit our future endeavors?

Three tangible areas in business and manufacturing are directly impacted by these concurrent forces: business strategy in manufacturing, supply chain strategy and management, and manufacturing operation practice, including the workforce.





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Business Strategy: Re-Evaluate Outsourcing

For manufacturers, the first order of business is to strategize the business model, assessing outsourcing, or not outsourcing. Over the last three decades, the electronics industry has been characterized by its fast-paced technological development, inevitable down-spiral pricing, and market globalization. These also have been the top drivers behind manufacturing outsourcing. The underlying concept of outsourcing can be expressed—simply put—as finding a better or more cost-effective way to have products made or services rendered, meanwhile freeing up the resources and time for “essential” or more critical tasks ^[1].

The history of outsourcing in the U.S. is worth noting. It is a reasonably fair statement to say that the electronics industry’s circuit board manufacturing essentially pioneered the process to implement a full-blown outsourcing strategy in the late 1980s and early 1990s (depending on how we define a starting point). Gradually but steadily, manufacturing outsourcing within the electronics industry has extended upstream from the board assembly level (semiconductor packaging, integrated circuits foundry) and downstream (system, box) along the food chain. This created a new market and business sector, which originally was termed as contract manufacturing (CM) and later evolved to electronic manufacturing services (EMS), which is deemed to be a more appropriate representation for its expanded services.

It is interesting to note that this fast-growing industry was not noticed by Wall Street until the mid-1990s (passing \$100 billion mark in 1999). Today, the same concept of manufacturing outsourcing has spilled over to other industries ranging from pharmaceutical to consumer staples, as well as to other functions, such as human resources and information technology management. In parallel, the scope of outsourcing continues expanding and its capabilities are proliferating, becoming an integral part of supply chain management.

When looking at the potential pros and cons of outsourcing, manufacturing outsourcing can potentially offer a number of advantages covering various business aspects, namely:

- Economics and cost savings
- Improvement in business focus
- Operational efficiency
- Technological prowess
- Capital allocation
- Time-to-volume
- Time-to market
- Geographical advantage
- Proximity to customers
- Shared risk or transferred risk down the food chain
- Streamlining the complexity of business

As an aggregate, these potential advantages offer tremendous appeal to a business, particularly in meeting the immediate competitive needs. The benefits can be vividly evident when a goal-oriented and well-thought-out strategy is effectively executed.

On the flip side, caution and alerts are in order. With the establishment of EMS, does this mean that technology-based companies can forgo core engineering competencies, including manufacturing technology?

It is always a strategic decision to take advantage of the benefits of outsourcing without losing the fundamental knowledge and know-how. The critical thought-process goes to assess core competencies and to sort out the functions or products for outsourcing from those that need to stay in-house. Even after a product or a function is identified to be outsourced, it takes engineering competencies to pose the “right”



questions to select the right EMS provider to produce quality products as intended.

In essence, outsourcing a non-value-added task is one thing, but to give up the critical knowledge base is entirely another. Overall, outsourcing should be dealt with as a well-planned strategy, not as a relief tactic. And the outsourcing strategy should be discerned between the temporary lift and long-term business enhancement.

Recalling years ago, during a dinner meeting with Dr. Kazuo Inamura—the founder and chairman of Kyocera Corporation—I queried directly his view on outsourcing manufacturing. He replied just as point-blank, in paraphrasing, “How can an engineer not do manufacturing, and how can an engineering company not produce products?” He made his point, and I understood his sentiment.

Considering a product development cycle, from an innovative concept to technology development, to manufacturing the product, to introducing the product to the market place, each of the key milestones is pivotal to a product’s eventual success. The spirit and the principle of manufacturing are a part of a product and should be thoroughly embraced and comprehended with or without employing an outsourcing operation.

Under today’s competitive climate and with appropriate business justification, to outsource certain functions could be advantageous and constitute a smart business move. I have witnessed—and been actively engaged in with joy—the phenomenal development of the EMS operations ranging from the fledgling operation to the robust enterprises across three continents. EMS operations continue to have my genuine good wishes. However, it is prudent for OEMs or ODMs to maintain and acquire the engineering strength and know-how to prepare for future readiness.

Supply Chain Management

During this pandemic period, it is encouraging to note that the Institute for Supply Management’s manufacturing index for the month of May rose to 43.1% from an 11-year low of 41.5% in April, indicating that the pace of deterioration slowed as governments eased

coronavirus-related restrictions ^[2]. What have we learned from the coronavirus crisis?

Inventory and supply chain management will have heightened importance and priority to manufacturing efficiency and even to a manufacturer’s viability. Crucial questions to be addressed include:

- Is a reliable dependency on the chain of suppliers in place?
- What is the technology employed to monitor the chain of supply?
- Is a risk management program in place?
- What is the risk mitigation plan and its order of priority?
- Are the policies and procedures to address risks and threats in place?
- Do all strategic raw materials have an alternate source(s), if justified?
- Do all mission-critical components have alternate source(s), if justified?
- What is the level of visibility throughout the supply chain?
- What is the predictability of the supply chain?
- Is there an adequate system in place to ensure internal and external cybersecurity to reduce manufacturing supply chain cybersecurity risks?

Weighing the overseas sources juxtaposing with the domestic sources in quality, cost, delivery time, and in-time-availability becomes a strategic as well as an operating issue. Implementing the newly available technologies to minimize the risk and optimize the efficiency of supply chain management is also increasingly becoming a necessity.

Manufacturing Environment and Operation: Technology-Propelled and Data-Driven

Assuming there is a reasonable likelihood that we and coronavirus may co-exist for an indefinite period of time, and considering that social-distancing practices will continue, a near-term and long-term plan should be formulated and implemented with the goals to ensure workers’ safety and health while maximizing workplace productivity and optimizing manufacturing efficiency.



COVID-19 catalyzed remote work, and the required social-distancing has prompted the need for more sophisticated ways to monitor factory operations, including the deployment of data management and analytics in a “further and faster” manner.

One of today’s deficiencies in deploying the leading technologies as effective tools, such as AI, is the lack of a relevant and sufficient database. AI requires a vast amount of data to function as desired. Accordingly, preparing AI to facilitate manufacturing operations by initiating a “data” program to collect, clean, manage, and use the data is also increasingly important. Data tells the story!

Data capabilities as tools to remotely monitor factories, provide a clearer view of operations, equipment performance and maintenance, allowing the operation to speed up production, reduce waste, and avoid downtime by quickly identifying maintenance and production issues. By identifying and extracting relevant data sets to feed into artificial intelligence, we will gain the ability to predict production and supply-chain problems. With the use of AI, factories are able to go from reactive analytics, reporting on what happened, to proactively analyzing what might happen, and the suggested actions to take.

The better we are at leveraging the emerging technologies (AI in conjunction with IoT and

5G) to enable a real-time contextual understanding and the monitoring of the manufacturing operation and environment, the smarter decisions we are able to make ^[3].

Manufacturing Workforce

Unlike other industry sectors, manufacturing takes the physical presence of skilled and well-trained workers. However, some functions can be performed in remote work (or work-from-home). One of the advantages of remote work is removing the geographical barriers in hiring and allowing employers to seek the best skilled workers regardless of where that talent resides. A recent survey by IBM Institute for Business Value found that more than 75% of respondents would like to continue working remotely at least occasionally, while more than half want it to be their primary way of working after the coronavirus crisis ends ^[4]. When asked what it is about remote work that has worked well, according to the *Wall Street Journal*, the top three on the list were: no commute, reduced meetings, and fewer distractions ^[5].

It is expected that the development and deployment of emerging technologies will accelerate. As 5G is becoming more available and more reliable for advanced connectivity, innovations in how we work to achieve the maximum efficiency and output—including work-from-home—will become a part of



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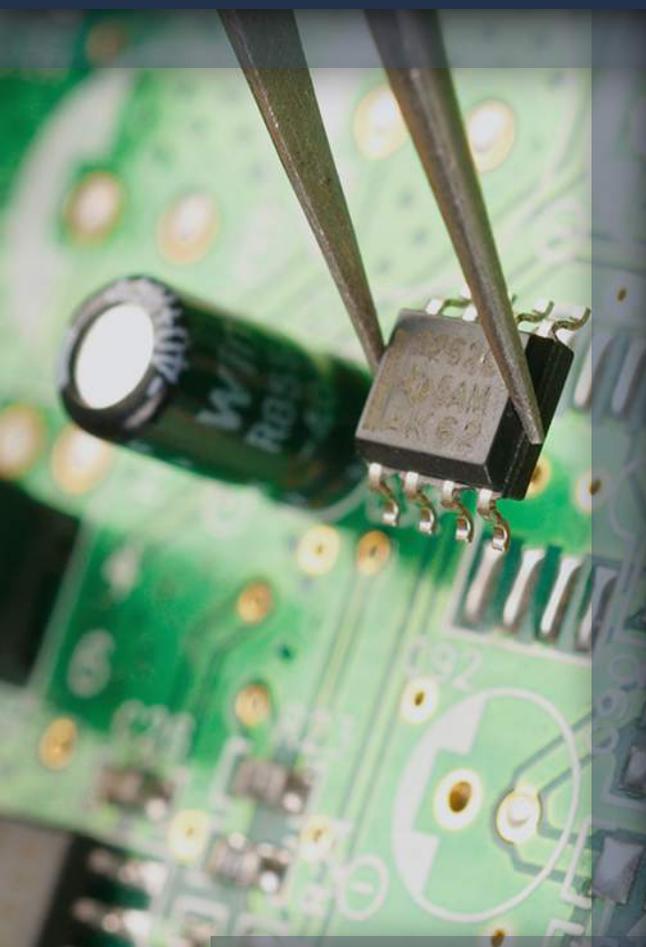
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the workforce in a “proper” extent. Going forward, a hybrid work model is most likely to be implemented throughout the companies and organizations, varying in extent with different natures of the business.

In the next decade, having a skilled and educated workforce, as well as continuing education and training programs—especially in data science and data engineering—will be even more important to competitive manufacturing operation.

To cope with the new world, it is plausible to address additional business decisions, including:

- Are factories logically, strategically, and preemptively distributed in terms of geographical locations?
- Is there a need for redundancy in factories?
- What criteria are to be established for making redundancy of factories?
- What are the key tasks to accelerate the adoption of new technologies—that is, to effectively and timely leverage AI, IoT, 5G, and associated infrastructure and supply chain to achieve the intelligence-teaming manufacturing operating in an integrated manner?

With its constantly changing and fast-paced nature, there is no industry quite like the electronics industry, with its technology, operation, and promise. For the last three decades, this most innovative and dynamic industry has made many companies and individuals prosperous. Also, as vividly demonstrated, change and coping with change have been a part of our being. The industry’s ability to adapt to change rapidly has been utterly stunning in the past. And I believe, wholeheartedly, that this ability will continue, as we overcome the compounded challenges of the pandemic, the economic recovery path, and the ongoing U.S.-China trade uncertainty.

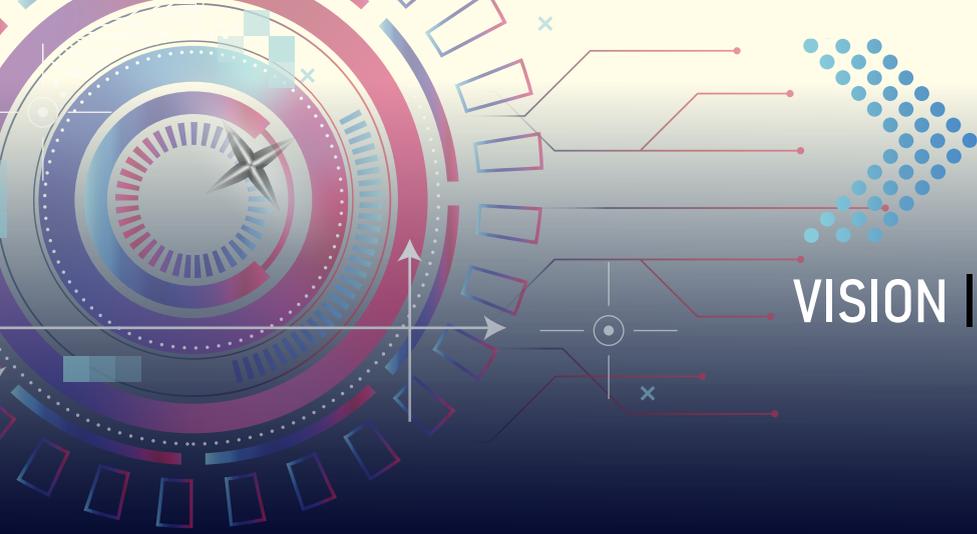
There is a rainbow after the storm. The beauty of these crisis experiences is that we are in the position to build a better normal, so let’s brace for the challenges and embrace the opportunities! **SMT007**

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Dr. Jennie S. Hwang—an international businesswoman and speaker and a business and technology advisor—is a pioneer and long-standing leader to SMT manufacturing since its inception as well as to the development and implementation of lead-free electronics technology. Among her many awards and honors, she was inducted to the International Hall of Fame—Women in Technology, elected to the National Academy of Engineering, named an R&D Star to Watch, and received a YWCA Achievement Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., and SCM Corp., she was the CEO of International Electronic Materials Corp. and is currently CEO of H-Technologies Group, providing business, technology, and manufacturing solutions. She has served on the board of Fortune-500 NYSE companies and civic and university boards; the Commerce Department’s Export Council; the National Materials and Manufacturing Board; the NIST Assessment Board; as the chairman of the Assessment Board of DoD Army Research Laboratory and the chairman of the Assessment Board of Army Engineering Centers; and various national panels/committees and international leadership positions. She is the author of 600+ publications and several books and is a speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees, as well as the Harvard Business School Executive Program and Columbia University Corporate Governance Program. For more information, visit JennieHwang.com. To read past columns or contact Hwang, [click here](#).



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Supply Chain Shock and the Factory of the Future

Feature Interview by the I-Connect007 Editorial Team

IPC's Chief Economist Shawn DuBravac, Ph.D., CFA, and IPC's Chief Technologist Matt Kelly, P.Eng, MBA, discuss technology and market trends they're currently following, as well as the recent digitalization of the supply chain and what that means for domestic manufacturing.

Nolan Johnson: Regarding changes in the dynamics for electronics manufacturing, a number of factors point to an emerging trend toward regionalization and the potential development of captive facilities in North America. We want to talk about those possibilities. Can you start with your overall perspective on these trends?

Shawn DuBravac: It's clear that the supply chain is in flux and that there are a lot of dynamics in play. This dates to before the current pandemic engulfing the globe. I would argue that supply chains are always looking to optimize a number of factors. As supply chains are

confronted with new challenges, the weight that manufacturers apply to those factors changes and evolves. Before the pandemic, the narrative that dominated supply chain decisions was trade tensions flaring up around the globe, most notably—but not exclusively—between the U.S. and China. There were trade tensions that were growing globally for a number of factors.

Companies were beginning to internalize those risks and were making adjustments accordingly. At the same time, one of the things that companies are always seeking to optimize is being able to deliver products in a timely manner. They're optimizing around cost and time. You naturally want to be in the market that you're serving, so some of the decisions that were being looked at involved areas of the world that were growing and evolving and what they wanted. Those are the dynamics that were influencing things over the last year.

Then, as the pandemic started to spread in China, it created some supply risks, constraints, and issues. It was a supply shock, not unlike the one that manufacturers have confronted in the past. Early on, it looked like a



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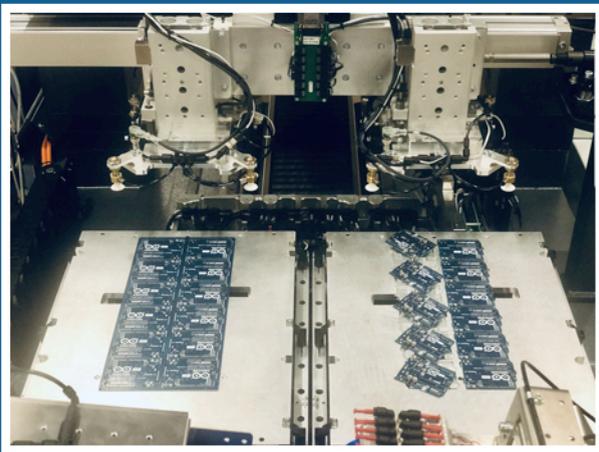
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Shawn DuBravac

supply shock, but it evolved into much more than a supply shock and became a demand shock as well. Companies and manufacturers are looking at all of those dynamics and how to optimize the factors. Some of the factors that manufacturers are optimizing have started to evolve and change as a result. For example, safety is much higher on everyone's list today than it was six months ago. Companies are adding that as one of their risk factors.

To your point about regionalization, some of these things were already in flux, and manufacturers were already looking at how to reoptimize their supply chain. They're continuing to have that conversation, and they're looking at what their regional strategies are. Companies will take all of this new experience and information into account and, in some instances, make changes. Notably, we see that manufacturers are starting to dedicate certain product lines to specific regions so that if the region is disrupted for any reason, then that entire product line will go down, but not every product line will go down. Whereas the way sup-

ply chains are globally distributed now, a disruption in any part of the world can have the potential to disrupt all of your supply chains throughout the world. To create some protection against those disruptions, you'll see manufacturers containing the entire manufacturing supply chain for given products within a region where possible.

Manufacturers were already looking at how to guard against some of these risks. The idea of dual sourcing is a way of guarding against some of these risks, but it is more difficult to do in practice than in theory. Another way of guarding against some of these shocks and risks is that you then dedicate and identify a specific region to be the sole manufacturer of a whole product line.

Matt Kelly: To build on that, I'd like to start with pre-COVID and get back to the tariff challenges. One thing to know is that the transformation of the supply chain, as we know it today, started from these tariffs. There are large OEM companies that were, when you work out the 25+% tariff on their products, spending single-digit millions—or more—inside of six months. This is a very large tax and erodes profit margin for the product line.

I have lived through the tariff transfer, which started around 2017–2019. Many products were being moved out of Asia into Mexico, for example. By the time last year rolled around, many large OEMs were already there. The migration that Shawn described happened quite a bit in commercial-grade computing and high-reliability electronics. They had already moved. That's from the EMS perspective, where the system is put together. There is an opportunity, and some of that's already occurred, where the geography and location have already moved. For regionalization, it makes sense that you want to be close to a hub.

However, the counter to this is you have to frame it with what we're making. Supply chains are not all alike. For example, you can't pick up the switching costs on your incoming material supply. That may not be an option. The example I like to give is a silicon fab. TSMC recently announced it was building a

new factory in Arizona for \$12 billion. You don't pick up and move a fab because you want it closer; it depends on what element of the supply chain we're talking about. The way I describe this is that it's a combination of moving into strategic geographies for those benefits, such as supply continuity, probably not cost. We're going to have to get used to spending more on things if we want that security close to home.

The other element is that we spent the last 20 years creating a horizontal global supply chain. We can't undo that as easily, so we have to find clever ways to work with the supply chain as it exists today because, for example, you can be looking at a very sophisticated system with 5,000 part numbers in it. It only takes one part number in that system to not be in hand for that start-to-build to be delayed. It could be a half-cent resistor from Asia. I use that example because although there is this trend to circle the wagons, if you will, and go regional, there are certain supply elements that will not migrate easily for economic and capability reasons.

I highly recommend the article "[Restoring American Competitiveness](#)" from the July-August 2009 issue of the *Harvard Business Review*. If you read it today, the technology and devices examples they use have changed, but the idea of "industrial commons" still applies. Industrial commons is when business leaders dream up the product line, engineers, and operational staff, right down to the people that maintain the facility. All that lives and breathes when you have that ecosystem nearby. It's a very interesting article.

Dan Feinberg: There's no doubt that we see supply chain changes, and all of us know of additional supply chain changes that are coming—some that we talk about, some that we don't want to talk about, some that we're not sure about, and others that we probably shouldn't talk about. Do you expect these ongoing supply chain changes to become relatively permanent? Do you expect to see some movement back to the horizontal supply chain you were discussing?



Matt Kelly

Kelly: That's a great question, but the issue is difficult to predict. My opinion is that it's going to be a hybrid. Jumping from one to the next, it usually doesn't happen in business in our economy. It's often an evolution. While there are driving forces to be regional, there's going to still be blended, horizontal supply chain aspects of it because you can't pick up, build, and move staff and equipment with the notion of a commodity. The idea of a commodity, by definition, means that anybody can do it.

The analogy I like to use here is a loaf of bread. For example, you make a loaf of bread in Asia, but now I want to make it somewhere else. Ship the bread pans, order the flour, move some ovens, and make bread somewhere else—if it was that easy. In that case, you can do it because it is a commodity. However, we all know that electronics are not built like that.

While the idea of commoditizing elements of the supply chain looks great on paper and in concept, it's not quite that easy. For example, on the EMS side, my estimate is it takes somewhere between four and six years for an EMS facility to produce exactly the way you want

with your feet up on the desk, feeling comfortable. Moving around and chasing supply chain elements is very taxing. You're always chasing quality and delivery and that sort of thing.

Barry Matties: The case could be made, though, that now is an optimal time for several reasons. One reason is that there's plenty of money out there. From the financial side, money's cheap. With so much money available so cheaply, is this a move we're going to see because of that?

DuBravac: Going back to your question about these changes being permanent, I would say yes, they're permanent, but they're not universal. You're 100% going to see people move toward more regionally defined and designed supply chains, but it doesn't mean that solution is going to be a one-size-fits-all.

Would it be an ideal world if everybody dual sourced every component? Yes, but that's not realistic. Does it make sense to automate certain pieces of your production line to maintain costs so that you can enter into a developed market? Yes, but again, it's not realistic because you're turning over these product lines every 12 months. It doesn't make sense in all cases. The economics will make sense for some, and they'll do it, but it won't make sense for others. It will make sense for large companies that have a lot of volume, but maybe not for others.

Matties: But the timing now is pretty good considering that there's a real mindset to have supply chains shift. There's a lot of money available. What are your thoughts on that?

DuBravac: You're right. The timing probably makes more sense now than it has in the past, and partly because the factors that executives weigh are changing. To Matt's point, cost isn't as valuable as it once was. People are willing to change things and weigh other things besides cost. The timing makes sense now, but not for everyone.

Matties: Matt, you're an expert in future factories. If we see a supply chain shift, doesn't it

make sense that people start building the factory of the future today?

Kelly: Absolutely. Money is money, but what are you going to use it for? It's great timing to see factory-of-the-future advancements take hold. A couple of interesting stats: You can't turn on your computer today without seeing droves of information regarding the factory of the future. It could be a webinar, an advertisement, etc., but it's the factory of the future.

It's about digitization, analytics, artificial intelligence, and blockchain. We all know those buzzwords, but the reality is that in the electronics manufacturing sector, less than 20% have assessed themselves and said that they are ready. You can see a very low adoption rate. We have all this technology that is ripe and money to spend, but we haven't adopted it. Those are all good ingredients to see some forward movement.

Matties: What does that factory look like to you?

Kelly: First of all, there are a lot of people in it, which is contrary to some conversations. The idea of being lights out and fully autonomous and replacing workers with equipment or machines? I'm not a subscriber to that. I'm not a subscriber to that as an engineer nor as someone who wants a gainfully employed industry as well. My view on a factory of the future is using all these technologies as tools in a toolbox, not replacements. Those tools enable a worker to become a superhero.

Today, you have a worker who does a specific task, which might be a lead on the front end of an SMT line. They are looking after maybe a couple of pieces of equipment at a maximum, and are very focused. When you bring in factory-of-the-future elements—digital frameworks surrounded by proper security, data analytics, real-time machine/equipment control, etc.—you've enabled that worker to do many more things in a day. That's the power of what all this can be.

Do you want that worker to go away? There will be some reductions, I'm assuming, but

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you're giving more power to the operators and engineers as well. You're improving productivity, essentially. You are also able to upskill those employees. You're not paying that person to move a part from point A to B, or solder a particular device over and over again. Some of that can be automated, and now that person is a higher value in your operations. That's my response in terms of integrating technology with the workforce. By saying that, I'm not expecting to make up 70–80% reduction in labor; it might be 10–15%.

Matties: It seems to me that the role of people will shift to more of the front end, making sure that the digital information is accurate and correct to run it through a digital line because digital manufacturing is in play and will continue to be in play. This is an opportunity for people to rethink that; the day of the operator moving a panel from point A to B, B to C, etc., will come to an end. Especially from a financial point of view, if you want to be competitive on the labor front, you have to reduce that cost of labor.

Kelly: Agreed. That's how I always frame it, too. I was hired at IPC to drive the factory of the future implementation and work very closely with Shawn, John Mitchell, and the entire executive staff. This is a focus of IPC. We have today's standards and technology sets, but we are already working on these new elements.

Matties: Most likely, you're familiar with Green-Source Fabrication out of New Hampshire; it's a bare board facility. They're not doing assembly yet in a digital factory, but they built a digital factory with zero waste. They didn't even need a wastewater permit. Happy Holden can talk quite a bit about it because he has studied this model, which will be a gamechanger and drive the ability for OEMs to consider having captive facilities again.

Happy Holden: The fact they have no production workers means that they have no training program or recruiting. They have engineers—maybe more than others would have—because

they're state of the art. They do semiconductor-sized geometries on PCBs. What's most interesting is they can do a lot quantity of one, which means that they can change the recipe in milliseconds. A human can't possibly memorize nor look up the details fast enough. I don't totally agree with you in this particular case for quality and productivity. Having no humans involved is their competitive advantage. That capability is not necessarily needed everywhere, but it's a different paradigm.

Kelly: You bring up a good point that the factory of the future is not just about a lack of lights or cool technology; there's a lot wrapped around it. I ask myself, "What do I want my factory of the future to look like 10 years from now?" It's about defining the kind of factory. Is it in silicon? Is it an EMS provider, where you're bolting metal to electronics? Is it a bare board shop? We can't apply this model to everything because it doesn't work; there are variations.

Matties: From a financial point of view, there's a lot of acquisition opportunities. What do you see in that climate?

DuBravac: A time like this opens up a lot of opportunities to acquire resources and capital. This was true even before the pandemic when you had supply chains that were reconfiguring themselves. You have people who are disposing of assets and acquiring assets that make sense for their portfolio. We were already in a period where acquisitions made sense from the economics of what was happening in the environment and in the industry. Whether the current environment supports the financial needs to make acquisitions is another story.

You see it in some sectors where companies sitting on a lot of cash continue to acquire the pieces that they want for the products that they'll deliver in the future. Outside of core manufacturing, if you look at Microsoft, Google, and Apple, they have all announced recent acquisitions, and arguably do so on a weekly basis. They're sitting on billions in cash, so to make a \$100 million investment doesn't change their financial position. One

of the challenges moving forward in this environment is access to the financial resources needed to make some of these changes. These are not inexpensive changes.

Johnson: Matt, following up on that, earlier on in our conversation, you mentioned that it takes about five years to get an EMS facility fully optimized, where you can put your feet up on your desk and let it run. Do you have any sense for how long a PCB fab shop would take to get to that point?

Kelly: It would be about the same—three or four years.

Johnson: Three or four years to get the wet chemistries and everything in place?

Kelly: People are going to look at that and say, “No way. That’s too long.” But people who have done it say, “Thank you for saying that,” because it goes quiet after a while. New products and technologies are usually measured in that product launch cycle, so once the product goes out the door, everybody assumes it’s great, and everything is figured out, but that’s not usually the case. There’s constant learning, and I’m not saying the quality or the reliability isn’t good enough. It has all been qualified, but there are business and operational procedures and things that are constantly changing, so it takes a good couple spins and the follow-on generation of a product.

And it’s not just the technology. We always look at the product at the end of the day, but Happy, you were talking about the workforce. Is the workforce doing what it’s supposed to do from an operator’s standpoint, from an engineering standpoint? Do they know how to get to business quotes in the business office? There’s a variety of things from the beginning to the final delivery of that product that is maturing. That’s why I say it’s somewhere between three and four years for a board shop, and four or six years for an EMS.

Johnson: During the opening remarks in this conversation, you suggested we’re on the

verge of a hybridized supply chain. I had written down the word “matrixed.” Until the ‘60s, the supply chains were very vertical. I grew up a kid for whom most of my relatives worked at the Tektronix headquarters. Tektronix did everything in the ‘60s on-site; they even machined their own screws for their oscilloscope products. It was a very vertical supply chain. That has all changed into a very horizontal global supply chain, as you were saying. It seems like there are portions going vertical again, creating a matrix organization. Does that ring true to you?

Is the workforce doing what it’s supposed to do from an operator’s standpoint, from an engineering standpoint?

Kelly: Yes, but again, my lens is it will still be dominated by the horizontal supply chain. This doesn’t change overnight; it took two decades to get to this point. There will be individual points where, for security and bottleneck reasons, they’re going to say, “We’re going to invest in this. We want to pull it closer to the final hub,” etc. We’ll call it a handful of strategic moves dominated by a horizontal supply chain.

Johnson: As I look forward, there’s going to be a mix. We’ll have the traditional job shop fab or EMS provider doing work for third-party clients. But there seems to be a lot of room for some return to captive or a consortium of companies that timeshare a facility that they’ve built and maintained. Are you hearing anything like that in the market at this time?

Kelly: I’ve seen nothing that I would say is a dominating trend at this point. I’m sure things are swirling. Picking up on expansion, one thing I do see, using EMS as our anchor, is if we look at the late 1990s and 2000s, we

were in more of that conventional CM model. The OEM owned the design, they partnered with someone to build it, and you know the rest of that chain. Over the last five to eight years, there has been more and more expansion happening by the EMS providers. That's how ODM was born, where they basically say, "We'll finish off the design for you. The OEM needs to own the design, but we'll finish up physical design, or we'll do the roll-up-your-sleeves-type work on the back end of design." The ODM is trying to capture more of that work upfront before they build anything. They're trying to open up the aperture to the left, closer to design.

Over the last five to eight years, there has been more and more expansion happening by the EMS providers.

They're also offering more final system build services at the back end, so instead of producing a PCBA, I'll make it up—10 PCBs come to a hub and they get put into a subsystem, bolted together and made into the final assembly. The EMS is also doing that now. I'm not sure if you've heard the terminology of a level build, like L6 versus L9, where that EMS provider is producing the final subsystem, including software and firmware loaded. They're trying to expand to the right as well. When an EMS now says, "I'll be your partner," they're expanding their service offering to the left on the design side and to the right on the final fulfillment side. By that, they're trying to expand their margins.

Matties: That makes sense. They have to keep adding value.

Kelly: Remember that with EMS, margins are razor-thin—around 2–3%. If you hit 10%, it's a good financial result.

Matties: As long as profit margins are so thin, if you have the right partner, there is no reason to seek out a captive facility.

Kelly: It's also the reason you don't want to move too much because the transfer and movement costs can kill 3% pretty quickly. That's why you want to get a good partner and keep them.

Matties: Maybe it's quicker for a captive facility to be optimal. What trends in technology do you see in the market that the industries should be mindful of right now?

Kelly: The number one trend is digital transformation. I know that sounds like a buzzword, but if you look at the level of sophistication, it's quite low. There's still a lot more to be done. Again, we have to partition this. Silicon semiconductor wafer technology is probably somewhere between 10 and 15 years ahead, so I'm not talking about that; I'm talking about EMS in electronics manufacturing, which includes PCBA, PCB, mechanical assembly, system fab, and final test.

The digitization of operations and changing the way people work alongside that digital transformation is huge. I know that sounds vague; everything is about digital, but there's a lot to it. It's how designs are made at the very beginning. Someone talked about design for manufacturing. That's still not done very well. Some people have figured it out, but at large, it's not designed for sustainability or some of those back-end processes. The digital aspect of it enables business-to-business, so transferring data securely is number two.

As soon as we talk digitization, it's probably in parallel. Security is right there. In the electronics manufacturing industry, if we're going to make real strides in implementation—not just describing these great technologies but making them work—we need common digital platforms. An example is IPC's Connected Factory Exchange (CFX) protocol, where we have a common language that allows data to be moved around. If we can't agree on the common digital thread, then we can't connect the way that we want to.



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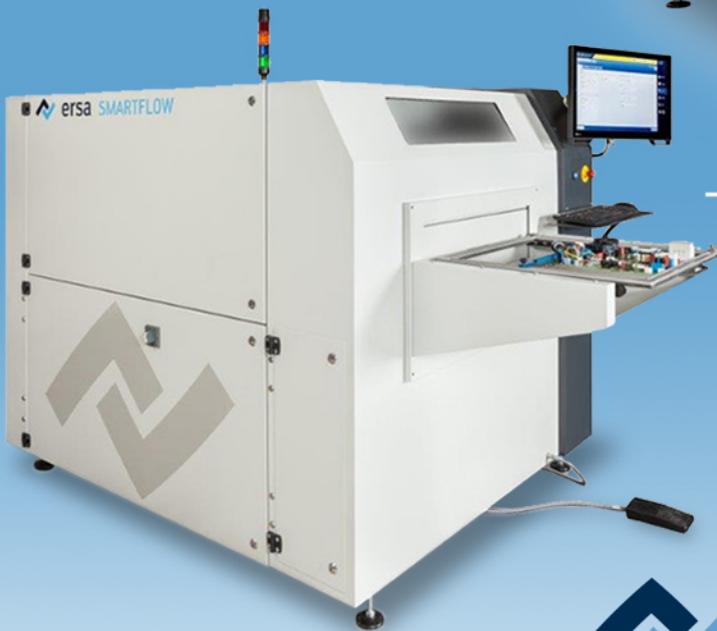
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Matties: It's the Beta/VHS situation.

Kelly: Yes. And there are different groups out there vying to do this. We totally understand that. Hopefully, the best technical solution will prove itself by its own performance.

Matties: With those trends, there has to be a big demand for retraining the workforce. How is IPC playing into that?

Kelly: Training and education is a very big portion of IPC's strategic focus. There are new platforms like IPC EDGE, which allows for digital training and certification.

Training and education is a very big portion of IPC's strategic focus.

Matties: IPC is an industry resource. We have to make sure that our readers understand the tools and opportunities available to them, especially as they move into the future.

Kelly: We often put technology first because it's neat. AI, neural networks, and machine learning are pretty cool, but if left alone, they will fail. One reason is that it's technology only and doesn't serve a business need. Two, where are the people? Some of the best insights I've gained lately are from Bob Murphy, SVP, Connected Enterprise Consulting, Rockwell Automation. He is adamant about putting the change management of people right beside all this technology change. It has to be done in parallel. If you don't do it, then you have all this stuff you've purchased and nobody knows how to use it, or they think it's the enemy. There's bias.

DuBravac: If you think about the investments a manufacturer needs to make, it's not only in capital and technology but also in people.

Those investments need to happen in tandem. We're in an environment where these shifts take place, and companies will need to make those investments so that they can be viable moving forward. That will require investments in both people and capital. Often, that investment in human capital is an investment in training and other things like that, too.

Matties: What final advice would you give to manufacturers today?

Kelly: My answer will be relatively narrow, but I'm keeping it narrow so we can progress the electronics manufacturing sector and start to work independently as businesses need to. We need healthy competition and differentiation so that people can make money, along with more emphasis on working together as a supply chain in the context of digitization. People are still doing their own things. "This is the best way to do it. This is my partner. This is a better mousetrap than the other." There's still a lot of "turf battling" occurring. We will not progress if this continues.

My call to action would be to agree to keep certain things off the table: business secrets and trade-offs. That's business as usual. But for linking the supply chain together, that's where IPC comes in. We need standardized processes and digital formats that everyone can read. Once we agree on these protocols, companies can work together. A good starting point would be to take a good look at your own company in terms of where you are in this transformation, and then don't just work independently. Instead, branch out to your supply chain to see how everyone can work together. Underneath that, standards bodies like IPC and others can be the framework for that to happen.

Matties: We appreciate your expertise. Thank you very much.

DuBravac: Any time we can help, let us know. Thanks, everyone.

Kelly: Take care. SMT007

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CYBERATTACK!

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Feature Interview by Barry Matties I-CONNECT007

Cybersecurity is a necessity in every business, and this interview is a must-read for helping you and your company to understand vulnerabilities and protect yourself from attacks. Remember, until an attack hits you, you have no idea how devastating it can be.

Eric Cormier and Dave Ryder of Prototron address the ransomware attack that locked them out of their system last December, bringing business to a screeching halt and forcing them into the arduous process of a full rebuild. With things finally starting to normalize, Eric and Dave now offer precautionary advice they've accumulated over the past six months.

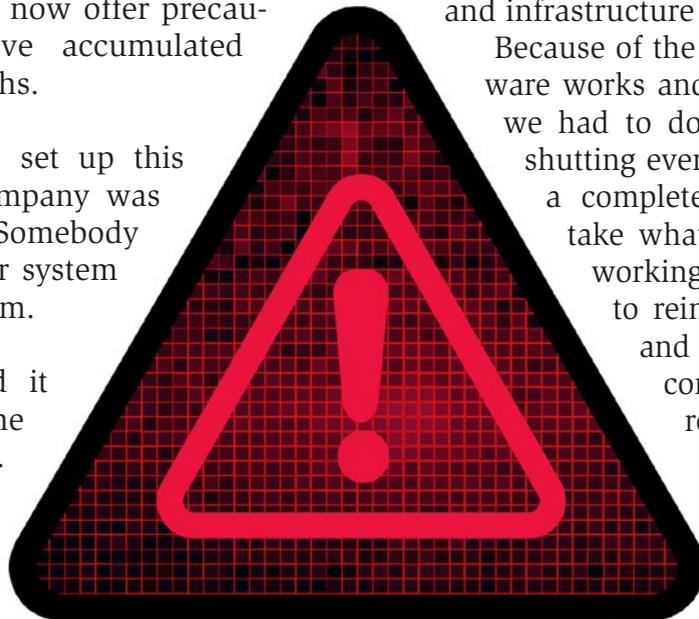
Barry Matties: Eric, to set up this conversation, your company was hit with ransomware. Somebody locked you out of your system and demanded a ransom.

Eric Cormier: Yes, and it was actually Friday the 13th in December 2019. It was not a good day. From what we've been able to trace, it came from a piece of

equipment that we utilize for certain processes in the shop. It looks like somebody got onto the internet and accidentally clicked on some links.

With ransomware, what's insane about it—especially what we were hit with—is that it was built to not only infiltrate our network, but also determine the types of PCs we had in the shop in order to do the most damage. It ran from one PC, hit a couple of devices that weren't secure, and turned them into what they call “zombies,” which wreaked havoc across our facility. It originated in Redmond, and because our facilities are connected in Redmond and Tucson, it branched out and hit multiple PCs and infrastructure in our Tucson facility.

Because of the extent of how this software works and how advanced it was, we had to do a 50,000-foot view of shutting everything down and doing a complete rebuild. We couldn't take what we had that was still working and reuse it. We had to reinstall operating systems and go the full length of a complete infrastructure rebuild. It did some serious damage. And it's not necessarily something that can be controlled from a security perspective once





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it's been let in-house; it was very difficult to root out where it came from.

With the nature of cybersecurity today, we had tools in place that allowed us to determine—from an intrusion detection perspective and traceability of what went outbound—that our data was compromised internally. We were able to even have a third party look at it, and they verified that as well. We had a third party review everything and found that nothing was compromised externally, which meant that while our data was affected, it wasn't transferred out of our networks.

Matties: And they were able to access it through a piece of equipment that somebody had clicked the link on, or was it an open port that they found through this equipment?

Cormier: It required user intervention. Again, the best security is only as good as how far you can train your people on looking for and spotting things because 90% of all this kind of stuff comes down to a user error. When a certain user does trigger something, the ransomware gains the rights within the company network, and then it spawns beyond that. It's what started the whole process.

Matties: From that point of view, these ransomware people and hackers are pretty clever, and they disguise their emails to look like normal business emails and trick people into clicking.

Cormier: A lot of times, it could be an attachment that has a link in it that says, "You have to click this link to unlock the document," and it looks like it comes from a valid customer source. Sometimes, we see things come from a fake shipping company that looks like UPS and FedEx. They say, "Here's your invoice on your account or from your last shipment." Peo-



Eric Cormier

ple click it without realizing what it is. And that's where the "fun" begins.

Matties: Once they got in, they were able to go from system to system. However, they weren't there to access and steal information; they were there to lock you out of your data.

Cormier: Correct. It didn't affect servers, shared documents, or things that we had on our network. It encrypted those, but then it also spawned itself and hit local

machines, like your mailbox store on your local PC. It encrypted it, and the ransomware had the key. With the level of encryption that they used, it was almost impossible to decrypt without having some piece of the puzzle, like what passphrase or what key they used.

Matties: You were locked out of the system, and your business screeched to a halt. At that point, you had to make a decision: Do you pay ransom or not? That can be a tough choice one way or the other. Regardless of whether you pay, you were faced with having to reboot your entire system. You were vulnerable.

Cormier: And that's where the threat comes in: how far did it go and what was compromised? After a great deal of time spent analyzing that question, we looked at the amount of time that it would take to either patch all the holes or do a complete rebuild. We decided we didn't want to invest the time—especially with the number of resources that we had available to us. The numbers didn't line up for us to patch the holes and find out how far it went. It was to our benefit to get things back up and running as fast as possible by starting from scratch and restoring what data we had from backups.

Matties: Even if you took the patch approach, in the back of your mind there would always be

some level of doubt or concern as to whether you found everything.

Cormier: Right. You ask yourself, “Did we miss something?” Because all it takes is one thing missing and any amount of time you spent fixing it could be wiped out. If you spend hundreds of hours in a week to fix something and you missed one thing, you’re back to square one again, and you lost 100 hours. That’s where you weigh the risk. Is it best to start from square one? For some larger companies, that task would be too incredible to even think about. But again, most of those companies have the resources available to make that happen in the agile environment.

Matties: This caused business interruption and a new level of awareness that changed your security protocols. What have you done to keep this from happening again, since it came from somebody clicking on an email?

Cormier: Because we were doing the full rebuild, we went through and reassessed. And I hate saying this, but it was perfect timing because we were going through a process of becoming completely compliant with a few standards, like NIST, DFARS, and ISO 27001 and 27002. A lot of the planning and security required for that helped us. There were things that we needed to implement, push the envelope, and it required us to make those changes. Reviewing the security processes and what we have in place that has been required will help us in the long term.

Matties: We hear about these things, but we never think it could be us. Then, all of a sudden, it is us. And you’re not the only one who has been hit by this in the industry.

Cormier: Yes. There’s a substantial infrastructure that’s been affected by this very kind of situation.

Matties: And other fabricators, I understand, have been hit directly as well. Moreover, what advice do you give to somebody to protect

themselves? And specifically, are you keeping all email isolated from your network now?

Cormier: That’s one thing that we decided to go toward because a lot of solutions are cost-prohibitive, but there are options now for cloud compute and cloud email systems. It makes sense to make that change because it requires managing less in-house that could possibly be affected if an event like this occurs. Businesses that build this kind of cloud infrastructure put in place a lot more security to provide multiple levels of security. We found that it’s much more cost-effective to go with that approach than having things in-house nowadays.

As a recommendation, I would say to look at that kind of transition, even if it’s a hybrid cloud environment, to where you’re reducing your surface area of attack, the number of areas that could be affected, and services that could be affected if you do get hit with something. We’re living in a world where that’s not necessarily a requirement, but to do business, it is a good idea.

Matties: Is your email now isolated from your internal networks?

Cormier: Yes, and some of our file sharing and backup systems are now being compartmentalized.

Matties: On your internal systems, as we move into digital factors, a lot of equipment is connected to the internet for firmware updates and such. How have you changed the infrastructure, or do you have any concern about that connection point?

Cormier: I followed a model called “zero trust,” where you don’t trust anything inbound or outbound. Instead you have to manually approve certain things, including with the network. Now, I compartmentalize. I have a completely separate network where all proprietary equipment requires the internet be placed onto and it uses cloud solutions to share files back and forth. That way, if something hits one of our local machines, we’re not going to be affected

by a lot of our proprietary systems like we were before. So, that would be a recommendation I would make: use the cloud-based file systems and file-sharing sources to make that work.

Matties: Because of ITAR and other regulations, how does that cloud-based or hybrid cloud-based service fit into those situations?

Cormier: As of right now, there are only two mainstream providers that can meet the standards: Amazon Web Service's GovCloud (which is its full suite of AWS products, from S3 bucket storage and cloud compute to anything that you're looking for on the compute side), and Microsoft Azure. The GovCloud allows you to be pinpointed as a government entity, and you can tell it what boundaries you require your data to stay within. Then, you still meet those ITAR requirements and some of the defense requirements as well.

Matties: Third-party solutions are providing your security, but it probably provides you some relief in IT concerns or workload.

Cormier: Exactly, because there are services that we're able to turn on to monitor and alert us that are better than most security systems that we could try to bring in-house and pay a lot more money for. Again, the cost-benefit made too much sense not to move in that direction.

Matties: You have some new mechanisms. What other advice do you have for fabricators to consider?

Cormier: I recommend performing a risk analysis quite often to pinpoint your vulnerabilities, know how to drive yourself forward to fix certain points of weakness. Review and confirm on a regular basis that you're reviewing your disaster recovery plans. Then, ensure that everybody's on the same page as you add new services, etc. You have to constantly review those to make sure that you're not going to miss anything in case of an event like this.

Matties: Backup is something that's part of

the strategy. You have an isolated backup that is offsite, remote, and not connected as well. Have you changed your backup strategy?

Cormier: Yes. We've gone through a different approach for utilizing more cloud. Again, we're using Amazon AWS's GovCloud services and Glacier storage for a lot of our backup systems. We were originally sharing between facilities so that they were technically offsite, but again, this exposed a weakness that required us to switch gears and change tactics.

Matties: With offsite and go-between facilities, that seems like a reasonable and sound strategy until somebody finds the vulnerability.

Cormier: There are a lot of companies and solutions, and they meet a lot of these industry requirements, such as Veeam Backup Solutions and a couple of others that allow for your backup strategy to slipstream straight into a cloud platform, which is quite nice.

Matties: And you were lucky since it wasn't a data breach. It was a lockout situation.

Cormier: It affected availability but not the integrity or confidentiality of the data.

Matties: But even with the lockout situation, this shut your business down.

Cormier: Correct.

Matties: From a leadership and administration perspective, Dave, this is a business interruption that most people don't insure against. I'm not sure what the insurance companies are doing in that regard. Do you have any advice for people on what they should look at when insuring that type of business interruption?

Dave Ryder: First, let me address the insurance side of the issue. There are certain things you can do through your insurance company to ensure that you're covered in cases like this. Unfortunately for us, we were limited on that side of the insurance coverage, and it simply

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covered hardware if there was physical damage, meaning they were rendered useless.

We also had another issue with a specific customer. We submitted the invoice onto their system, but with our profile in their system, that's where we submit and place our bank and routing information. Somebody was able to log into our account and change that bank and payment information so that the vendor started paying to that wrong account. But when we reported it, it took them almost two weeks to even stop sending payments to it and to start a process of fixing the situation.

Matties: And how did you discover that was an issue—by receivables not coming in and you were making some calls to inquire?

Cormier: Yes. That was the first stage, but we also received an email. One of our accounting people had received an email about an account change. We immediately looked and I told them to change the password on that site. We didn't think anything further because it didn't notify us of what changed. That was another thing the hackers didn't have and didn't include in their system. By not knowing what changed, I assumed it was a password situation. We reset passwords and continued business as usual, and then discovered a couple of weeks later when we weren't getting paid that the information had been changed on their system within their profile.

Matties: The advice is, when you get an account change notification, don't assume anything. You should email them and verify what's being modified, especially when it's a financial account.

Cormier: Right. In most financial accounts, whenever you make changes like that, and you put in your financial information, it gen-



Dave Ryder

erally sends you a confirmation saying, "Your financial information was changed." It gives you specifics and time-stamps on when it occurred. In many cases, it will tell you what IP address the change came from. Those are certain things that you think would be a given but weren't in this case, and it has been a long process trying to get intelligence information back to make proper inquiries and resolve it.

Matties: The question that comes to mind is, "Are these two events connected, or are they isolated and coincidental in timing?"

Cormier: They were coincidental in timing. Everything occurred at least a month or two before our ransomware incident.

Matties: Good advice. Back to the insurance review, what changes or recommendations would you have people consider when looking at their insurance coverage?

Ryder: I would recommend getting a cybersecurity incident policy. That's what it has to be. And I've heard that some insurance companies are now at a point of not even writing policies like that because your hands are pretty much tied. These people can get into your stuff, and there's no preventing it.

But as Eric is pointing out, the policy has to be written specifically to that. Otherwise, your typical business interruption policy is not going to cover these kinds of things. We found out the hard way that business interruption insurance covers natural disasters, such as fire and flood. But even floods become an issue because if you don't have specific flood insurance, they may not cover that either.

Matties: This is a real out-of-pocket expense for you.

Ryder: It has been six figures several times over, but that's only in the cost of the replacement and equipment, etc.; that doesn't even begin to cover lost revenue. We were hard down for a full month in the Redmond facility, and we were limping along for the first month in the Tucson facility. We've recently gone back to a more normal sense of business, but the website had to be rebuilt because they seized and locked that up, and the repercussions are devastating. If customers try to look at your website and it's down, they move on.

Matties: There was relief for all customers when they learned that there was no data breach. What's the customer's attitude toward this?

Ryder: Sympathetic, but the first question they have is, "Did they get my files?" Fortunately, that's not the MO of these people. They're seeking Bitcoin ransom money, so it's virtually untraceable. But I don't think that they have any clue whether they're talking to a circuit board shop or an auto repair shop when they're encrypting your stuff. They don't care because they just want your money.

Cormier: There are a few cases where there have been data breaches along with these, but some of these companies had been breached previously without any knowledge of it occurring. It was preemptive in certain instances.

Ryder: Their goal is really about getting the customer's information, such as credit card and social security data. Files for a circuit board design are kind of useless unless you're building that product.

Matties: This happened in December, so it has been nearly a half-year process.

Cormier: There were a lot of odds and ends. We were technically operational within 30 days, but there are a lot of different proprietary software packages and proprietary systems that had to be brought back online individually, as well as the website. Those processes to

get back to the pre-event condition have been close to a six-month window.

The attack took out operating software for a lot of the equipment. It took out scripting for the front end, the CAM side of things, and all that was stuff we had built up over years and years of experience. They were able to encrypt the backup on all that. As Eric pointed out, we had to start from scratch. It took us years to accumulate all the technology and software programs that we had, and Eric and his team have been able to fix that in a few short months—a Herculean task.

Matties: With every disaster, there tends to be a silver lining. Any silver lining here?

Cormier: We've been able to implement new technology that we didn't have before. And it's a lot more end-to-end encryption for customers' safety. And there are new processes in-house, too.

We've been able to implement new technology that we didn't have before.

Ryder: We'll be a lot more secure than we had ever been before.

Matties: And there's no doubt you're going to carry that forward. Until it happens to you, you have no idea how devastating it can be. How was the law enforcement aspect of this? Was there an investigation?

Cormier: The Department of Homeland Security was helpful in pointing us in the direction of assessing whether we'd be able to have assistance in recovering from this, but there wasn't much in the way of investigation, or contact from them or the sheriff's office and local authorities. It was fairly minimal, to be honest.

Matties: They probably realize that these people could be anywhere in the world, and it's probably pretty unlikely to find them.

Cormier: At the same time, there are so many different municipalities and infrastructures being hit with ransomware that it has to be a priority for them to be investigated.

Ryder: The city of New Orleans got hit the same time we did. I understand the infrastructure of a city is far more important to society than a circuit board shop is, so their priorities go, as Eric said, with municipalities.

Matties: It's amazing how widespread this problem is. Why aren't more people talking about it and protecting themselves? Hopefully, the point of this whole interview is to get to that level.

There's no honor amongst thieves. There's no guarantee that if we paid we would get our stuff back, and they'd leave us alone.

Ryder: You don't hear much about it in the news. The first few issues that we heard about it seemed to be buried on page 12, and then you don't hear anything more about it. Nobody is immune to this stuff. They've encrypted hospitals and things of that sort, and a lot of them have chosen to pay, but we were advised by the feds not to pay. There's no honor amongst thieves. There's no guarantee that if we paid we would get our stuff back, and they'd leave us alone. There's nothing to say they wouldn't come back a week later and do the same thing.

Cormier: We also heard from technical sources that some paid to receive what is called a

decryption key tool but depending on file sizes and things of that nature, it wouldn't work 100% of the time. They had to hire in another firm to rebuild a decryption tool based off what they received to help them get data back that wasn't always 100% recoverable.

Matties: Even if you pay, you still have to go through all that diligence of what you've done to rebuild your systems for your own peace of mind.

Ryder: Yes. It may shorten the time it takes you to get fully operational again by paying, but if you're looking at it from a fiscal standpoint, at the end of the day, we're in it a lot more than we would have been for the price of the ransom, and that's through lost revenue as well as damage. Many people lost a lot of hours. We didn't have anything for them to do, so the damage was very far-reaching.

Matties: It's not just your shop; it's also about all your employees not working for a month.

Ryder: It impacted customers on the local level here. All of a sudden, for a period of a month, there were no quick turns being made in the Northwest.

Matties: In terms of customers, did they stick with you?

Cormier: It's hard to say, definitively, that all of them stuck with us. They were all sympathetic, and they were supportive when it made sense, but some of them have moved on. At the same time, COVID-19 showed up before we were through with the ransomware problem. It's hard to say what the issue with the customers is in a lot of cases.

Matties: Are things picking up for you now? I hear it's quite busy out there.

Ryder: We see a bit of an up and down on a daily basis. Unfortunately, in the Seattle market, we're heavily influenced by a big airplane manufacturer, and they're kind of slow right



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now. That has impacted our business, so we don't see the same numbers that I hear about in other areas of the country.

Matties: If you were doing ventilators, you would be full up.

Ryder: And there's not a lot of medical manufacturing in the Northwest here. It's a lot of aviation, aerospace, and software, which doesn't have anything to do with us.

Matties: I'm glad you were able to come back out of this stronger and better. Do you have any final thoughts or advice you'd like to share with the industry?

Cormier: Again, make sure disaster recovery plans are in place, and you're doing business risk assessments to verify where your pain points are. This is key, from an IT perspective.

Ryder: I would recommend that you have an outside party come in and review your level of security, as well as your insurance, for any problems. There's nothing to say that you will be hit with it, but if you are and don't have coverage, you're going to wish you did.

Matties: You were in a great spot because my understanding is the financials of your organization are quite strong, and you have low or no debt, but most companies aren't in such a great position.

Ryder: If we had debt, it would have wiped us out. As I said, we were hit with a one-two punch because the virus problem showed up before we were out of the woods on the ransomware issue. Effectively, in the Seattle market, King County, we're not even in phase one of being back and open for business. It's still a ghost town around here.

Cormier: I'd also note that if you don't have anything at all in place and you're looking, there are some fairly inexpensive online solutions. Some options are within the \$200-a-month range to help you put together plans for secu-

rity awareness training, etc. One that I utilized in the past is securityprogram.io. It's pretty inexpensive to get yourself started on awareness, training, and implementation for the right kind of security that your business needs.

Matties: You have been talking about a stress test on your systems. If you wanted to bring somebody in, is this a company that you would look to? Are there other resources that you would have come into your organization and work with you?

Cormier: Other resources I've utilized include IT firms that do penetration testing and internal security penetration testing. They give you an overview of deficits and where you need to be.

Ryder: Probably the easiest thing that businesses can do is make sure that they've trained and informed their employees who have access to email, the internet, etc., to be suspicious if you don't know who an email is from or if it looks weird. Make sure your IT team checks it out before you click on any attachments or links. Once you've clicked, you're going down a one-way street from which there's no return.

Matties: As you said, isolating your mail service from your internal infrastructure is a backup to that vulnerability of an employee clicking on a link, whether they intended to. Sometimes, these things get clicked. I'm glad you're back on your feet. Eric, I know it's a monumental task you went through, so I'm sure there were a lot of IT lessons learned on your part, too.

Cormier: Exactly. It gave me a lot to take with me to school because I'm going back for my master's.

Matties: Thank you both for sharing your story and advice for others. It's greatly appreciated.

Ryder: You're welcome. SMT007

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Human Factors in Automation

**Feature Interview by Nolan Johnson
and Barry Matties**

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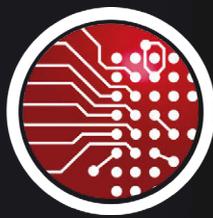
Bob Murphy, SVP of Connected Enterprise Consulting at Rockwell Automation, talks about the importance of combining people, processes, and technology solutions to achieve improvement—something that his team specializes in.

Nolan Johnson: Bob, could you start with a bit of background on you and the work you've been doing? Also, how are you communicating on this message around human factors?

Bob Murphy: I've been with what was originally Allen-Bradley and now Rockwell Automation for 41 years. I started as a production technician in manufacturing, troubleshooting earlier renditions of our products, and moved up through engineering, quality, and operations ranks to eventually hold the position of COO for our company, leading our entire supply chain for several years. I still report to our CEO Blake Moret, but I now preside over the Connected Enterprise Consulting function.

I latched onto the topic of how the people and organizational change dynamic element fits into transformation efforts several years ago. For the first time in the century-plus history of our company, we aligned all of our manufacturing operations. At the time, we merged 26 plants into one global operations organization called Operations and Engineering Services (OES). It includes all our manufacturing assets. It's all of our sourcing, material planning, and logistics functions, plus the engineering arm for our operations, but it's also all of the common engineering functions for the company where our product segment business units share similar design capabilities.

What precipitated the work from a transformation standpoint is that as we aligned all of these plants for the first time into one entity, not surprisingly, we highlighted a wealth of siloed solutions and applications employed across those manufacturing plants governing how work gets done on the shop floor. It can be really hard to leverage technologies and processes in conjunction with the people who engage with them consistently across an enterprise, and the fact was we didn't do that well across our plants. And where we actually



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had some processes deployed across multiple plants, the manner in which we designed them was, largely, not globally extensible. They honestly lacked the ability to truly scale out to the broader enterprise.

The founding COO, whose footsteps I followed, tasked me with the re-footprinting of our manufacturing supply chain. That involved critically assessing where we were with manufacturing. Did we need to be there, and if we needed to be there, were we doing the right things in that particular plant from a product and service perspective? Equally, we weren't presently manufacturing where we probably needed to be for a variety of reasons. I gathered a group of program managers, engineers, and practitioners to assess the current lay of the land, and we spent about two and a half years re-footprinting the supply chain. When the dust settled, we had transitioned from 26 plants across all regions to a total of 20 plants; of those 20, six were built as greenfields in that 2.5-year timeframe.

You can imagine an incredible amount of change transpiring within our manufacturing entity, and as we began to stand up the new manufacturing plants—which, in many instances, were some of our largest plants in the company—we had to decide what systems we were going to deploy. How were we going to create a more uniformed, standardized, capable, and contemporary global footprint to leverage our people, process, and technology assets? We couldn't continue to sanction all the local variations that existed across our plants for how work was getting done across what were generally very similar processes. That turned into the formulation of what has become a key market message for our com-

pany as we work with customers. We essentially “connected our enterprise” digitally in a far more contemporary and globally scaled uniform fashion. We did all of that internally, and we'll talk more later about the business results it created for us from a safety, quality, service, and productivity perspective.

As we were going through this, we found that it was very easy to focus on the technological aspects of what we were contemplating. Even the process definition and guidance

aspects came naturally to a company that's founded on engineering and design principles. As we deployed these new capabilities, we found that the human and change management ingredients became front and center, so we needed to shift our priorities. There were some slips, trips, and falls along the way, but we figured it out after enough of them to recognize we had to lean a lot harder into the people element of our digital transformation work.

We started spending a lot more time talking across our enterprise about why we were doing what we were doing, not just the what and the how. There was a real end in mind that was designed expressly to create a far more competent, capable, and content manufacturing associate. It was easy for me to want to avail all of that for our associates because I was an associate way back and I knew what it was like to deal with less than capable or complete information or have to migrate during the day from one to three to five different systems to get essentially the same type of work done.

Thankfully, the things we wanted to do resonated well, and we started spending more time communicating the whys and wherefores, and the buy-in, support, and anxiety—in a good



Bob Murphy

way—started to grow. That led to very significant improvements in the core metrics of our company from a customer and an internal performance perspective.

Three years ago, when it became apparent that our journey internally was something very meaningful for others in the industry to explore, we wanted to do something to inspire the same results within their manufacturing halls. We began to share our lessons learned with many of our customers—how we got there, and what we did to pivot in terms of early mistakes. They were very intrigued because it was just practical insights being afforded, and we weren't selling anything. As a function, we were operations, talking about how we do manufacturing differently, why, and what it took to get there. The popularity of those customer interactions led to an incredible amount of time spent by me as the COO and members of our staff engaging with these customers. Our CEO and I agreed it was time to create a capability within our company where we no longer went about sharing those experiences with industry part-time. There were simply too many people in search of the same things from an outcome perspective, which was making it difficult for us to do that well, along with our day jobs.

That's when we created the Connected Enterprise Consulting function. I have a team of about 20 folks who were some of those deployment experts from a subject-matter perspective, and we brought in people from other realms of the industry who have had equally intriguing experiences. Now, we talk to current and prospective customers all over the world about what they're in search of from an improved business outcome or aspiration perspective and the transformation challenges they're trying to overcome. We often discuss how easy it is to get over-enamored with shiny technological objects, and if that's not coupled with high respect for the people element of transformation—as well as how processes and technologies come together—a firm is going to land well short of where they want to go. And if they finally do get there in spite of that respect, it's going to be an arduous trek with legitimate concerns for sustainability.

Our job is to help them find the considerations they have to entertain, and many times, engage in the development, partnering with them on their transformation roadmaps—the actual stages that they can go through to get improved performance as a company.

Johnson: You touched on three major factors: people, processes, and technologies. When you're doing your consulting work and talking to your customers and prospects, where do you start with those three?

Murphy: It has changed. When we started internally, because it was so natural, the focus was on technologies and processes. But we learned that you only go so far, and in some elements, you don't get anywhere without considering the human factors, change management, and the organizational dynamics at work. We have veered ourselves, and, with our clients, supported the notion that if you don't lean into the realities of how much change is going to be introduced—and how your people are going to embrace and adopt that in a willing and a knowing fashion versus a dictatorial one—just getting there is not the way to do business these days.

**When we started internally,
because it was so natural,
the focus was on technologies
and processes.**

When we're thinking of digital transformation, there's an IT component and an OT component. And the Connected Enterprise—in terms of the enabling technologies, processes, and services that we afford, as well as how we define that as being the convergence of IT and Operational Technology (OT)—those aren't just technologies; those are people. IT and OT are functions in corporations that everyone knows didn't grow up close together in the industry.

They grew up very much apart with different charters, and in some instances, those charters were 180 degrees out of phase.

Now, we have conversations with our clients around, “If your IT folks haven’t met your OT folks, I wouldn’t spend dollar number one on a digital transformation deployment plan. I’d try and get them together over lunch first so that you can have dialogue around the criticality of their close alignment moving forward.” There are organizational implications. It’s about how you deploy people beyond getting them involved in the process and comfortable with where and why you’re going to go somewhere different. You have to look at how you’re structured and contemplate if that is going to work in the long term. We talk about organizational alignment dynamics and how to create global process owners where you used to have local process owners; unfortunately, this continues to perpetuate the silos of ingenuity and creativity, which aren’t bad. But in our company many years ago, when they weren’t globally deployable or extensible, they weren’t going to solve our corporation’s problems.

You have to look at how you’re structured and contemplate if that is going to work in the long term.

Barry Matties: One of the things you’re talking about is a cultural shift because, in many cases, you’ve been with the company for decades, and in a lot of cases, employees see management fads come and go. Call it what you will, but you’re describing a lot of TQM principles. How do you get the employees to buy-in in a meaningful way? That must be a challenging aspect.

Murphy: It is, and there have to be proof points. You have to get to some phase of change that

involves the people, processes, and technologies. It has to be the evidence that demands a verdict that that was worth the trip. The best and most effective way to engender people wanting to get on the train versus not wanting to think about buying a ticket is to start small with a proof point of how people, processes, and technologies can transform a process, plant, or enterprise if they work well together. If you start small and create those proof points, they’re hard to argue.

Let me give you an example. I mentioned that we stood up six new plants across the globe. Logic would dictate that if one of those new plants—and this wasn’t an if because they all eventually did—started a process with brand-new people wearing a Rockwell Automation badge, in three months, the people, processes, and capabilities outperformed a plant which had been doing that function for 20 years. People recognized that, and their responses were, “That’s phenomenal. I want that. How do I get that? What shelf do I buy it on?” Others perceived that they were being lapped, wondered if it was good for them, and asked, “How did that new entity outshine me?” Still, others said, “Show me again. It worked for you once, but maybe you got lucky. Let’s see two or three other similarly difficult processes performed well with new people in a new area.”

That’s all fair, but we try to be respectful of all of those different responses to new processes being launched. We ensured that as one process began to outperform its legacy somewhere else, the last thing we were going to do was call somebody green and somebody else red from a performance standpoint. Rather, we created a role for the first time called the global process owner. One of the processes that Rockwell deploys across many of our plants is making PCB assemblies. It’s hundreds of very fine-precision parts mounted on a PCB, and together, they make a circuit(s) to perform a function.

In the past, within Rockwell, every plant that conducted that function had its own process engineering and edge applications that bolted onto the assembly equipment. The chip shooters, reflow ovens, optical inspection devices,



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etc., did as many things as they could locally to optimize those processes. But there was no one person who was looking over how all of those manufacturing cells were performing in contrast to one another and trying to figure out if there was a better recipe for processes, people, and technologies to be deployed that every cell could benefit from.

We set up a global process engineering function where we took who we believed were the subject-matter experts from wherever they were around the globe. This is truly how it worked; on Friday, Juan in Monterrey, Mexico, was responsible for that location's PCB assembly capability. Coming into this organization as a global process owner on Monday, he was suddenly responsible for improving the capability of six PCB assembly locations around the globe. Here again, we had to guard against the possible reactions of, "Is somebody else's good news bad news for me?" So, we began to deploy these resources in a fashion that was anything but judgmental or punitive;

they were sincerely helpful and incremental to advancing all those sites' process capabilities.

Quickly, the reservations dropped. We created a transparent view of data across the globe. Everybody could see how everybody else was performing. There were no walls anymore, and all the meaningful performance data was transformed to be consistent. It was digitally enabled, so it was accurate and available in real-time, and we had analytics that were irrefutable, professing, "If you do this, that will be the result." It wasn't just descriptive analytics we were leveraging anymore; it became much more about predictive and prescriptive insights being gleaned. That allowed one process after another to be deployed globally with more capabilities, and the level of performance rose for everybody over time. That created confidence in the people who were watching this happen that these changes were truly a good thing.

At Rockwell, our job is to expand human possibility. When people begin to feel that in a

measurable way, they feel pretty good about it. They're more capable. They're more confident in their jobs and roles. There's a tangible difference between the kind of work they used to do that might have been mundane and repetitive, if not error-prone, to predictable, confident, and more contemporarily enabled from a technology standpoint. That expands their capability, which expands the company's performance. As a company, our mission is to espouse those very same principles with our customers.

Matties: It sounds like what you transformed into is a company that's in an endless pursuit of process improvement rather than reactionary process engineering. When you look at the endless pursuit of process improvement or continuous improvement, what drives the engineering? Is it market-driven in terms of markets that you pursue, or how do you set your technology roadmap for your process?

Murphy: It is increasingly an outside-in driven roadmap, meaning we want our customers and their needs to drive what we should do internally to satisfy those new outcomes for which they're searching. For example, if our historical lead-time expectation for a given product or service is suddenly met with what used to be affection but is now disdain, something has to change. The increasingly short lead times for information, products, and services that we all enjoy as private consumers has established a new bar for what's expected by all industrial customers.

That filters down to our supply chain, so as we embark on what we have to do differently from a performance standpoint, our customers demand something to be done in three hours that used to be done in three days. The next question is, "How are we going to do that?" That sets in place the people, process, and technology solutions that should be brought to bear to achieve that order of magnitude improvement. It ranges from something as significant as that to the kaizen of "a little better every day in every facet of what we do" type of improvement activities.

What's different now is how that happens across our company, and many of our customers are not deploying resources toward continuous improvement on hunches or saying, "I have this gut feeling that we're not doing well enough in this given process capability." We let the data speak for itself, and we respond to that with whatever corrections, changes, revolutions, or evolutions we need to make in the process to respond to it. There's a respect for that information because we gather it similarly in every plant across the globe. Our operators engage with our equipment in an entirely similar construct now. They use a single pane of glass to conduct whatever affairs they're doing from a production, quality, and traceability perspective.

We leverage that technology to the benefit of the users, and for us, there's no more important user than our manufacturing associate. It's important that they have the right information, make the right calls, and add value versus conducting mundane transactions that, in the past, weren't adding a lot to our company or customers. Our focus on continuous improvement really hasn't changed in terms of its criticality to us, but how we do it, and what it has enabled in the way of markedly better outcomes has indeed changed.

Matties: When you do continuous improvement, you have to look to your suppliers to buy in as well so that they're delivering your raw materials when you need it and communicating with your systems in the right way. What was the challenge there?

Murphy: Supply chain is required to improve. You can't just look for step-function improvements in performance within the four walls of your manufacturing plants, whether there are 20 or 200. You have to look at the entirety of the supply chain, including the upfront sourcing, forecasting, and planning for that material, as well as the backend logistics and optimization of that network of getting products through distribution and to customers. We quickly began to take our continuous improvement and extend it beyond the four walls of our plant into that broader supply chain. We

knew there were some suppliers that were going to be fully onboard and capable of driving these improvements, allowing us into the digital construct of their information, so we could deploy the same optimal techniques of planning and delivering on that supply chain. Many suppliers were all-in and ready to deploy with us in that regard.

Others weren't nearly as ready and willing for a couple of reasons. First, they might have lacked the enabling technology and infrastructure and weren't at that level of being able to provide it so that we could integrate more seamlessly from a digital standpoint. Secondly, some suppliers believe that information is a part of their secret recipe or intellectual property, and this still persists in our industry. It very well can be a form of intellectual property, and to expose those parameters and information to the downstream supply chain could be viewed as a threat to them.

In response, we have to recognize that their hesitation is sincere. They're not just being difficult; they're genuinely concerned about what could go wrong if some of that information were used in an untoward fashion for them as a supplier. We make sure that we only ask for things that are not IP or recipe-oriented.

We make sure that we only ask for things that are not IP or recipe-oriented.

But we also talk to them about their reservations. We say, "Let's think back. How comfortable were you when EDI came on board initially? How comfortable were you with the types of information that were used or exchanged for personal purchases on your smartphone?" Early on, all of us had hesitancy about what could go wrong, and things have gone wrong. We have to respect that it has created some of this hesitancy by suppliers to engage in the transparency of information, but

we also have to share with them that when you open up the right information to the right partners, everybody can benefit.

Some of that is education and encouragement, but in many instances, I think it's just going to take time. The industry will become more comfortable with sharing pertinent information that is not IP, but is enabling from a supplier or a consumer standpoint, and will recognize that all parties have a chance to benefit from it. So far, we've had mixed results; some are well in our camp of thinking and supporting that full end-to-end digital construct of information exchange, and others are still hesitant.

Matties: We hear that there's some reluctance from fabricators about sharing their capabilities to designers to produce appropriate fab notes.

Murphy: When I hear that, I think, "How could reasonable people not understand that availing the most pertinent information to all parties is going to be good for all parties?" But when you think about where they maybe have been informed to be hesitant, you understand that human element of confidence versus hesitation. I believe that this journey will take a while for everybody to respect and understand that there's so much more to gain by sharing that pertinent information than there ever is to lose. Through cybersecurity and otherwise, there are ways to secure anything that could go wrong. When you're allowed to have that conversation and show them architecturally how they are protected, most people are going to come around, but that's a perfect example you cited of why wouldn't you want to do that. They're not ready.

Matties: The only answer I can come up with is that it's a fear-based response.

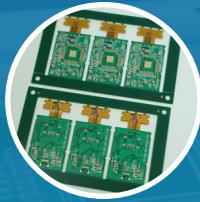
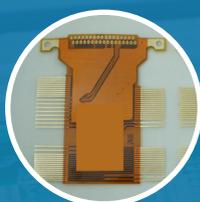
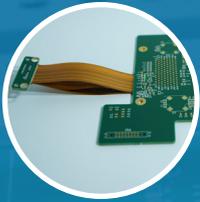
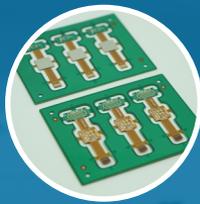
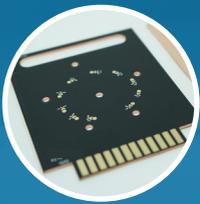
Murphy: Correct.

Matties: Do you consider yourself a smart factory?

Murphy: Yes. We are on a journey like everybody else to continuously improve. But we

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have a construct within our plants that is truly digitally enabled. We have a single source of truth around source information, and we have common KPIs that govern the performance measurements around how work is being done around the globe. We can access the vast majority of critical information in a real-time fashion. We have analytics running that don't just describe and monitor for us what happened; they begin to tell us when it is going to happen and create utilities that dictate how to ensure it never happens. It's a migration from descriptive to preventative and prescriptive analytics.

By no means would we ever say that we've arrived at a fully IoT-enabled capability within our manufacturing because technology continues to evolve. In some regards, we're the architects of that evolution, as well as our partners and others in the industry. We believe we do work more elegantly and smartly today than we ever did in the past. However, there are still things for us to learn.

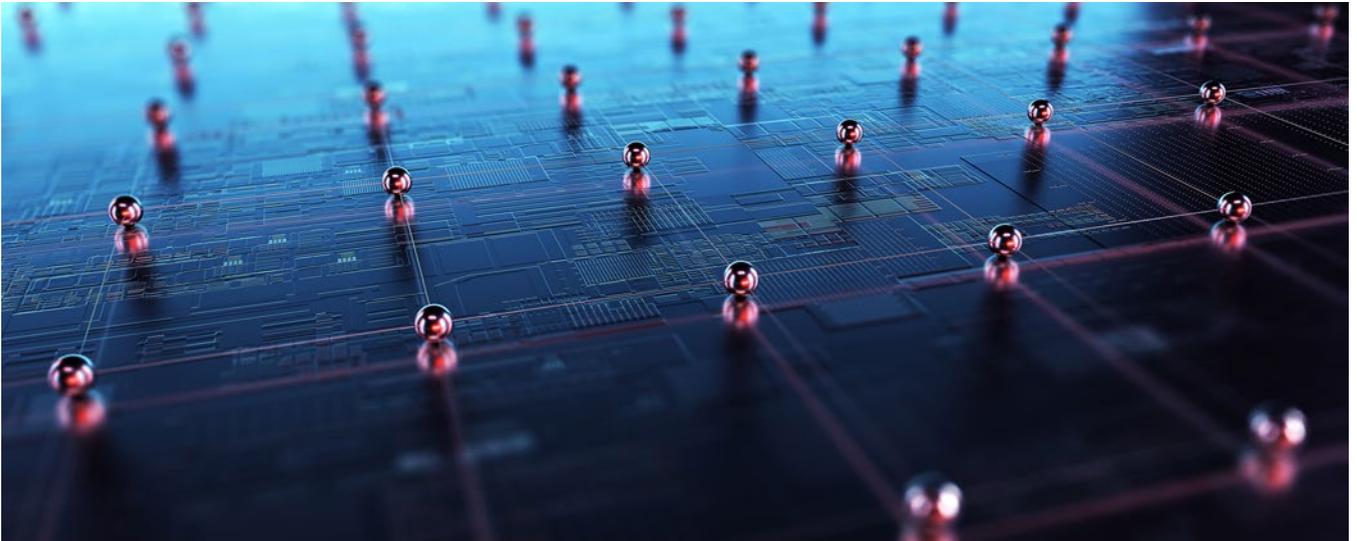
Matties: When companies are in the mindset of transforming and start sharing with their team that they're going to become a smart factory, oftentimes, employers hear, "I'm about to lose my job. A robot is going to take my place," and rightly so. In a smart, efficient manufacturing environment, you're going to remove the human elements and tasks that can be replaced by the equipment. What do you do with the people that may be displaced?

Murphy: That's a question that is very pertinent to the evolution of manufacturing. As a company that's focused on optimizing manufacturers' capabilities, we get that question a lot. Again, our brand promise is to expand human possibility, and we believe automation and enabling digital technologies can work hand in hand to achieve just that. For example, let's say that a repetitive, ergonomically challenging operation is being performed—a task involved that requires two people to perform a lift due to its weight—or there are potentially hazardous implications due to the ener-

gies being consumed to test something. Generally, anybody who has ever been involved in those processes would rather someone (or something) else do the task. That is where we believe automation can be deployed very effectively to mitigate people being exposed to ergonomically repetitive tasks or anything that could subject them to harm from a task hazard analysis standpoint. With all the important KPIs we track as a manufacturer, nothing will ever trump the safety and well-being of our associates.

In those instances where we might replace what was a manually-intensive process with a more automated solution, in the end, it's going to protect people and create a degree of certainty; in some cases, it will also lead to increased productivity that will make that process ultimately more profitable for the company. If those processes get chained together to become more capable, they can do more things per minute, per hour, and per day than they did before. They're going to create an opportunity for the company to invest in an expanded product portfolio or a manufacturing capacity expansion if those more predictable operations (leveraging a blend of automation and the human element) create a customer impression that is far greater than it was in the past in terms of service and quality. We're convinced because we've seen it ourselves. Ultimately, odds are there will be greater demand for those products or services.

Automation changes how we do what we do in manufacturing. Where in the past there might have been a need for less-skilled operators to perform mundane, repetitive tasks, manufacturers are increasingly in need of associates who are more comfortable engaging with a more automated construct of how work is done. Then, you get into the topic of reskilling, upskilling, and deploying people toward those new ways of getting work done. We feel that the evidence is clear within our company, and those of our customers who are thoughtfully deploying new and enabling technologies, that they don't restrict human opportunities; they expand them.



Matties: How do you deal with reskilling or retraining? Do you have internal training, or do you rely on external training?

Murphy: Both. In fact, we partnered with ManpowerGroup to develop an Academy of Advanced Manufacturing where we support those very similar needs on behalf of our customers. In that transition of the skills required to get work done, many manufacturers need more technicians—either light or fully technician capable individuals—and yet they're not growing on trees anywhere in the world.

It becomes even more intriguing in terms of how we're going about doing that. This was set up with a partnership between our two companies to recruit military veterans coming off service who may have incredible aptitudes from a technology, logistics, and leadership perspective, but they don't have a job. We put them through the paces of several weeks of accelerated technical training, getting them competent in supporting control technologies within manufacturing, and then we place them into full-time roles within our customers and sometimes within our own plants.

That's one method, but there are all kinds of internal and external partner training that is deployed to help be about that upskilling and reskilling. It's a real need because we all know that the workforce availability and transition that's taking place is creating some challenges for the industry at large.

Matties: When you start on the journey, in many cases, you have to start with the basics like how to have an effective meeting.

Murphy: Absolutely. It isn't always about knowing the difference between a capacitor and a resistor or how to troubleshoot a microprocessor-based application; it's often about how to effectively engage with each other. The relationships that exist on the shop floor today are vitally important, as well as the interdependencies that exist between associates. Largely gone are the days where someone simply works in one station on one line, conducting a task that doesn't require them to even look to the left or right. When you're digitally enabled and integrated, the manufacturing environment is significantly different, and the need to communicate effectively with your colleagues throughout the workday takes on added importance.

It often gets down to the important foundational basics of interacting clearly and thoughtfully with each other, and it's not just associate to associate; it's about supervisor to associate, as well as associate to engineer and salesperson that might bring customers through, which is an increasingly frequent opportunity because of sharing the story of how we do things in our plants. It's exciting but challenging. You must give it the energy, time, and commitment required to make sure that the human element is as capable as

that shiny object of technology that you've deployed.

Matties: We always say attack processes—not people—because if you're attacking processes, you're focusing on the right spot. If you're attacking people, you're placing blame where it doesn't belong because most errors are process-related. People inherently want to do a good job.

Largely gone are the days where someone simply works in one station on one line, conducting a task that doesn't require them to even look to the left or right.

Murphy: Perfectly said. All too often, historically, people are guilty by association with those processes, and boy did we have that wrong.

Matties: Yes, and there are many examples where we blame people when it was process failure. Back to the meetings and the structure, there are two parts: what you do and how you do it. In meetings you have, there's a process of having a meeting, and oftentimes, it's hard to be involved in the content of the meeting and facilitate the meetings. Do you have facilitators, or do you train facilitators to help people through the meeting process?

Murphy: We do, but I would not say every meeting has a facilitator if you think of the routine events that occur within the four walls of manufacturing plants. But if there's a new, customer-inspired need for us to do something differently—faster, better, or whatever the case would be—we have folks who are very capable of facilitating teams as we navigate through that continuous improvement oppor-

tunity. How do we leverage the available information, technology, and analytics, and how do we involve the people interacting with those processes in a thoughtful fashion? How do they own the change that we want to see happen as the customer that asked for it in the first place or the person that got assigned that objective in their performance review?

We respect the fact that there are people who are gifted with the ability to marshal others through change in an engaging and inspiring fashion, and we try and employ them as much as we possibly can. I don't want to leave the impression that every meeting has a facilitator, but the prudent use of them is something we have learned to respect within our operations.

Matties: The other area of managing people is accountability. Accountability is one area that we often fall short on because we don't like conflict. How do you deal with accountability in your continuous improvement culture?

Murphy: We let the information speak for itself, so we're accountable because we declare what our objectives are within our processes and plants, and they roll up in a pyramid ultimately of what matters for the customer. But we share that data of how we're performing completely transparently. I mentioned this before, but it was not common in our history to share the process capability outcomes of one plant to another. There weren't many people who were accountable across plants and drawing comparisons was a risky business with such widely differing KPIs and measurement points being employed. Now, however, we avail process capability metrics to everybody in the same fashion—including the associates, supervisors, and engineers—and our global process owners are chartered with lifting every location's performance up through the work they do. Leveraging that available and trusted information and insights has become integral to our success. The real-time and really accurate nature of it inspires confidence and trust. Everyone who needs to has access to it, so there's no place for us to hide whatever it's telling us, so there's built-in accountability.

Along with accountability, there is governance involved in the transformation. I don't think you can have everything followed completely voluntarily across an 8,000-person operations organization. There have to be guardrails established as far as when we create a global standard of how a process is to be managed; it is not acceptable for a local plant to vary away from that because somebody designed what they believe is a better mousetrap, so they built and deployed it. That would not be what we want to happen. Now, we obviously want that ingenuity to surface, but we want those ideas to come to the attention of our global process owners—all of whom have global user groups constantly gathering feedback from the plants, engineers, associates, and supervisors—and they use that as the mechanism for evaluating new ideas. But it is not acceptable for processes to run amok by trial and error from a

local fashion, or we're pretty sure we'll revert back to where we were a decade ago with silos of execution and capability.

Along with accountability, you need the right level of governance and control to ensure that what you developed in the way of global standards remains capable and persistent, but not ever believed to be perfect. That's very important, too. You must have the humility to know there are always going to be things you can do differently or better. Strict governance should not suppress those opportunities; rather, it should encourage exploring them in a controlled fashion across your enterprise. If you do, really good results are bound to happen.

Johnson: Bob, thank you for taking the time.

Murphy: It's my pleasure. SMT007

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ein Electronics Industry News and Market Highlights



DOT Autonomous Farming Platform Has Arrived in Ontario ▶

Haggerty Creek is the first DOT unit operator in Ontario and arrived in Bothwell on May 13, 2020. It has already taken to the fields of Chatham-Kent to be used in commercial fertilizer applications.

Robotics Reaps Rewards at ICRA: NVIDIA's Dieter Fox Named RAS Pioneer ▶

Thousands of researchers from around the globe gathered—virtually—a few weeks ago for the IEEE International Conference on Robotics and Automation. As a flagship conference on all things robotics, ICRA has become a renowned forum since its inception in 1984.

PTC Extends Alliances with Rockwell Automation and Microsoft ▶

PTC and Rockwell Automation Inc. announced Factory Insights as a Service, a turnkey cloud solution that enables manufacturers to achieve unprecedented impact, speed, and scale with their digital transformation initiatives. The new offering, unveiled during PTC's Global Partner Summit event at the LiveWorx® 2020 digital transformation event, marks a significant advancement to the collaboration among Rockwell Automation, Microsoft, and PTC.

Osaka Matsui Management: Amazon Desire to Acquire Self-Driving Car Could Save Billions ▶

Analysts at Osaka-based financial services company, Osaka Matsui Management, have advised that Amazon.com Inc.'s advanced talks to buy self-driving-car start-up Zoox Inc. has them speculating the acquisition could save the e-commerce juggernaut tens of billions a year and bring auto, parcel, and ride-hailing firms to their knees.

Deep Learning Robotics Granted New Patent for Robotic Learning ▶

Deep Learning Robotics Ltd., a leading technology company focused on robotics and automation solutions, announced that the United States Patent and Trademark Office granted the company a new patent: No. US10,571,896.

SkyWater Chosen for Volume U.S. Manufacturing of COVID-19 Detection Microchip ▶

SkyWater Technology announced it was chosen by investment firm Asymmetric Return Capital (ARC) and Linear ASICs, a fabless analog and mixed-signal semiconductor company, to volume manufacture a microchip with temperature sensing capabilities used in a low-cost, smartphone-enabled wireless patch that assists in the remote detection of COVID-19.

Foresight to Enable Mass Screening of COVID-19 Symptoms Using Thermal Cameras, Artificial Intelligence Expertise ▶

Foresight Autonomous Holdings Ltd., an innovator in automotive vision, announced that it has started developing a mass screening solution for the detection of COVID-19 symptoms based on visible-light and thermal cameras. In addition, the company has submitted a patent application to the U.S. Patent and Trademark Office for a system and method for the detection of people infected with the coronavirus.

Cerence Launches ARK Assistant: A Turnkey Automotive Voice Assistant ▶

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Organizational and Team Management in Times of Change

Feature Interview by Barry Matties

I-CONNECT007

Ross Berntson, president and COO of Indium Corporation, shares his perspective, thoughts, and lessons learned on managing his global organization as Indium Corporation responds to health issues, market demand shifts, and organizational change. This interview was conducted in May 2020.

Barry Matties: Ross, we recently conducted an [interview](#) with you on the manufacturing pledge Indium Corporation and a consortium of manufacturing businesses in central New York developed and signed. The realization is that it's not identifying the small things that you may not think about—like the salt and pepper shakers—but now we're rethinking nearly everything, including company strategy and markets. Let's start by talking about health and safety.

Ross Berntson: If you can keep a spirit of everyone being in this together and trying to create a safe environment, then a lot of good ideas come out from the people on the front lines.

That's so important because the big challenge that we're fighting right now is complacency. We're bringing in a local analytics professor on the fidelity of adherence to practices like in healthcare and in foodservice companies. She has been doing this work for a long time. She's going to help us come up with both metrics on the fidelity to the program, as well as ways to look at measuring how well we're doing at keeping that fidelity high.

Matties: And that becomes a very visible measure for your entire team to be aware of.

Berntson: We have a goal of zero on-site transmission, of course. And it doesn't mean zero cases. It's almost impossible to have zero cases. People in the company are married to health-care workers. We've already had positive cases in our employee population, but we haven't had that transmission through contact tracing on-site, which is our goal. We don't want any on-site transmission.

Matties: Are you doing daily temperature checks as they come to work?



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Berntson: We are. We have a health screening check that we do when people come in. We take everyone's temperature. But one of the biggest things we're finding is perhaps most people with a temperature don't show up because they know we're taking temperatures, which is good.

The thing that's harder to see is the person who has a loved one at home who's not feeling well. That's where we're spending a lot more time, trying to make sure we ask that survey question and provide some rigor around it by emphasizing that point. If you have someone at home who's sick, you need to stay home until we can figure out if they have exposure to COVID-19 or not to protect all the other employees.

Matties: What's the typical process for someone coming to work?

Berntson: It starts at home. We hope that if they have someone in their household who is sick or are exhibiting symptoms themselves that they call their supervisor and HR representative and don't come in at all. Assuming that's not the case, and they're on their way into work, they should have a mask with them in their car. Before they get out of their car, they should put on a mask, and they wear it throughout the check-in process because they are within that six-foot parameter of the screener. The screener is issued proper PPE and training on how to do the screening. The employees arrive, have their temperature taken, and are

asked a series of questions that are intended to make sure that they are not exhibiting any symptoms.

Then, they wash their hands if a sink is available. If a sink is not available, they use hand sanitizer. Next, they are then given a wristband like you would get if you went to a concert or a bar or something like that. The wristbands are a different color every day, which signifies you've gone through the screening process.

Matties: Once you go through that screening process, then you report to your workstation, whether it's in the office or the manufacturing area.

Berntson: Exactly. If your workstation enables you to be six feet apart from everyone else, you can remove your face mask and put it in a proper storage container that we've provided everyone. That becomes their operating condition. If, however, they are within the six-foot radius of someone else and don't have any plastic dividers, then they have to keep on their face masks.

Matties: Are you doing things like staggered lunch periods so that your break room doesn't get as full, or are you making any modifications?

Berntson: Absolutely. We have different arrival times so that everyone doesn't jam up at the screeners. They're either staggered by half-hour blocks with staggered break times and different end times. You want to make sure your site control is only set for a single point of entry; otherwise, you can't control your site. We make sure everyone's entering and exiting in that same corridor, but we also want to avoid congestion. Other companies are doing some other things that are clever. For example, if their facility allows it, they might have everyone enter in one entrance and exit through a different entrance so that you don't get that cross-contamination at the shift changes.

Something that another company that took the manufacturing pledge did was to institute a different smell every day. They have a series



of smells that you can buy, and they dip a Q-Tip into the vessel. If the person can't smell it, they're not allowed to enter. It's pretty clever. We have not instituted a similar process, given the number of individuals we have entering our facilities each day, but for a smaller facility, that would be a great little check.

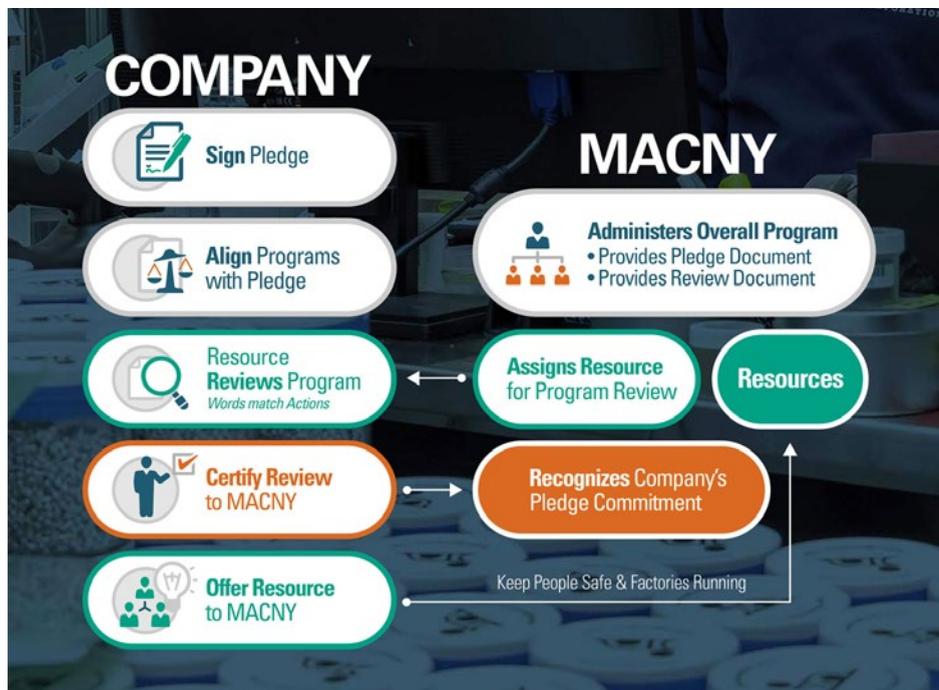
Matties: At the end of the day, when they've gone through their shifts and breaks, what's their departure routine?

Berntson: They report back to the locker room. We ask them to wash their hands before they leave so that they don't carry anything back with them, but we don't have a monitoring system for that. They put their mask back on before returning through that entry/exit area.

Matties: They go home and then start over again the next day. And, as you mentioned, you're also interested in what's going on in your employees' home lives, and they have signed personal pledges. Tell me a little bit about the pledge they sign.

Berntson: Our employees have signed a commitment to social distance as much as possible, which means minimizing their engagement in society. We started this when we were under the shelter-in-place orders by the state government when only necessary and essential travel was allowed. That became a piece of the puzzle as well, in our commitment to follow those guidelines. And if they need to go out, employees commit to using proper protective gear per the direction of their local state government. If they went to the grocery store or the gas station in New York State, for example, they would wear protective gear.

There's also a commitment to hand washing and proper hygiene. We manufactured our own sanitizers so we could equip all of our



Manufacturers Association of Central New York's innovative safety pledge program.

employees—including all of our factory people and their families, as well as those working from home—with sanitizer. And we procured enough masks to issue masks to all the individuals that work at Indium Corporation, plus their families.

Matties: On this pledge, is there any extension to where their family members sign a pledge as well?

Berntson: That's an interesting idea, but we didn't go that far. We had the employees sign it, committing to continue the spirit of what we're trying to do at our company when they're at home.

Matties: Maybe it sounds a little overreaching, but in today's world, people are just happy to go to work and want to preserve that ability. Their families certainly would want to support that, too. It sounds like a great model for others, and I'm glad you're sharing it. It's important to share what's working. How is it affecting your sales effort and your customer contacts? What demands or changes are you implementing, or are customers requesting that you implement?

Berntson: There are a couple of responses to that. One is just supporting our current customer base. And the good news there is when you're a high-end, high-quality supplier, there aren't a lot of problems. There are mostly opportunities to engage with customers on new programs, as well as existing business. But most of our customers are also in a tough spot right now. They don't have a ton of extra engineering resources with which to pursue new programs. We're in this mutual "stagnation" in terms of new programs. But the good news is—like any good company when you're growing, and you're bringing new materials science to the market—there's a good funnel of activity that's already underway. We've been able to maintain significant engagement remotely with our customers not only on supplying their current needs but also on their new technologies.

We've been able to maintain significant engagement remotely with our customers not only on supplying their current needs but also on their new technologies.

Some examples to that point: As people have ramped their ventilator production, they may have needed help with profiles or improving their line throughput. We've been able to do a lot of that work remotely. We've also been able to complete trials on new materials that have been underway around the world, including in China, Taiwan, Mexico, and France. We've been able to continue the trials of new materials and advance those programs. And finally, just in terms of spreading the word, we have a great deal of technical knowledge, which we want to spread from one engineer to another and to our customers.

We used to spread the word through trade shows through technical seminars in addition to face-to-face customer visits. We have moved that communication online. Our Indium Insider Series, which we launched in the last few weeks, serves that purpose. We've built a whole list of topics to keep the program going. We're still able to do an amazing amount of work with customers, despite the fact that we can't cultivate new customers quite as easily.

Matties: Do you see some shifts in what your customers are looking for? Has this created any changes to the product roadmap?

Berntson: I can't say that it's a change. Networking overall continues to be a huge driver of a lot of innovation. For example, there's innovation in fiber optics, transceivers, edge computing chips, and all the IC module advancement that's happening for servers. That's driving innovation in semiconductors and semiconductor packaging and the counterpart of the 5G phones. These are all well-documented trends, including the move to heterogeneous integration and all the needs for advanced materials to accommodate that assembly process; considering beam-forming and all the power that ends up in the top of these towers; and figuring out how to manage the thermals in that application and the ability even to do the old standards, like getting a good, low-voiding bottom termination component joint. All of that is going on right now. The urgency with which those challenges need to be solved has probably gone up.

What I find fascinating is that the semiconductor industry is super robust right now. Whether you're at the front-end fabs and fab starts or anywhere along the supply chain, semiconductors are booming right now. I look at that and ask, "What's driving that?" A lot of it is this desire for everyone to make sure they don't run out of chips when the rebound happens. There's some pantry loading going on, but it's also because we were at this innovation inflection point, and now everyone wants to gear-up and get their product out ahead-of-

time because they want to be the first to market when things rebound.

Matties: From a leadership role, how has your role changed in the last couple of months?

Berntson: There's not necessarily any leadership magic in this era; it's just communication. How good an individual is as a communicator is less important than the fact that they simply communicate with transparency, candor, and frequency.

I have hosted global forums. Everyone with a computer terminal at our company can access these forums, and then we record them and make them available for anyone on our intranet site. The basic format shares the state of the business, what's going on with COVID-19 from our perspective, and what's happening around the world. Then we ask, "What are your questions?" I take questions on any topic related to our company or the COVID-19 situation globally. That has been helpful for us as a way to stay connected with each other.

Matties: What sort of questions do you receive?

Berntson: Some of the questions might be, "Will Indium Corporation support antibody testing?" We will support it in terms of our healthcare program plans. "But do we recommend it? Will we implement it as a policy?" Then, we have that dialogue, and that's where transparency and candor come in because I'm able to say to the group, "We don't really know if the antibody tests are sufficiently reliable, and we don't know what we would do with the results once we get them." What to do with the data is a real concern. Let's say 50% of my employee base comes in positive, and 50% comes in negative for antibodies. What decision do I make based on that? Do I relax the social distancing and hygiene standards all of a sudden? No. We still have to protect the other 50%. And, by the way, there's a question as to whether antibodies even work. That's a dialogue we must have.

Another question from people working remotely was, "Phase One of the re-opening of New York was May 15. Does that mean we all get to come back to work?" No, it doesn't mean that. If you can still work from home, you need to work from home. Then, we answer questions like, "How's the business going? The economy's shutting down. Are we going to be okay? Am I going to be able to still have a job? Will my family be okay?" I'm able to give an honest assessment, which is that there are challenges, but our company is strong.

There's not necessarily any leadership magic in this era; it's just communication.

One of the big challenges I had in communication is that we have so many exciting new programs because we support many niches. Because of that, I can spend a whole hour regaling my team about how many cool new things we have going on. And if you don't listen carefully, you might think, "Wow, this business must be booming!" What I try to explain to the group, though, is that if you have a brand-new plum tree that you plant in your yard, it's exciting. You might even call your friend who loves fruit trees and say, "I just got a new plum tree," and get all excited about it.

But that plum tree is not going to produce fruit for three or four years. It's going to take a while to mature, grow, and establish itself. Getting excited about planting the tree is what I often do because that speaks to our future health. But it doesn't mean the bounty of the harvest is going to arrive the day you plant the tree. It takes a while. Further, if your whole orchard is suffering because the economy is down, one new tree doesn't adequately compensate for a whole orchard having a tough time. That's where it gets more challenging for people to digest how we are actually doing because I tend to get excited about the new programs.



Matties: Part of leadership is looking beyond today and knowing where you're headed and why. It's also about knowing what to expect when you get there and navigating the waters that you're currently in. It sounds like you have a balance on both of those and a good handle on it.

Berntson: Thank you. One of the questions in this whole discussion is, "What's our plan? What are we going to do?" I had to tell everyone that, "The only plan right now is to stay nimble."

This market has become so much more volatile and so much more dynamic. I've been able to use this to keep the company much nimbler. We may have adopted this out of necessity, but it's good for the company and each of our individuals. Once they get over the anxiety of having to stay flexible all the time, it has a rewarding component to it.

Matties: Obviously, you're pushing this thinking from the very top to the very bottom of the organizational chart. Do you foresee this changing your manufacturing methods as well?

Berntson: It could. It can speed the pace of innovation because we have gotten accustomed to change. People talk about how change is hard, and people resist change. Oftentimes, they're referring to explicit change objection or a desire not to do something different. But there are an

enormous number of subconscious barriers to change and innovation that are hard to even see. It's just the momentum of life. How do you diffuse knowledge, and then have people hear it? Because people have a more heightened sense of alertness—we need to pay attention, be alert, and think about our own behaviors and what's going on around us—it creates an opportunity for those subconscious barriers to change and become less rigid.

How does that affect our manufacturing environment? To change and innovate in manufacturing requires a whole bunch of people to be willing to change things in an environment that hates change. If you talk to any of my customers and say, "We're innovative. We're changing things," they're going to freak out because, in our industry, no one wants anything to change. But they still want everything to be cheaper, better, faster, and higher performing. Dealing with that is what we need to do well in manufacturing.

It comes back to the first thing in crisis management: again, communicate openly and frequently and with candor and transparency. That's what you do when you get hit with the barrier of someone not wanting to accept change. You just talk through what this change means. "Why am I saying this? What's the reason behind it? What's the driver? How does this create value for the company or for the customer? Go back to first principles—why do we exist?"

Try to create meaning in the change. The obvious next question is, "You do all that

really well, and then people still don't want to change." Sometimes, you get someone who's reticent to try something new. I usually find that if you can get them to do one piece of the puzzle—at least on an experimental basis—even if it doesn't work perfectly, it makes it easier for the next steps. Try to get some progress, and then that can be an initiation point for the crystallization of the change.

Matties: Start small, share successes, and let them feel it. Then, it starts to become contagious.

Berntson: The other approach is scarcity. Let's say you find an early adopter. The message

might be, "We're going to do this over here, and we're not going to let any of you people do it." That perceived privilege creates a desire. Coworkers say, "What's going on behind that wall? What are you doing there? How do I get in on that?" That creates a little interest and the right mindset for changing. I'm giving you all my tricks on change management (laughs).

Matties: We appreciate that. Thanks for talking with us, Ross.

Berntson: My pleasure. SMT007

Ross Berntson: Indium Corporation's Pledge for Safe Resumption Post-COVID

On May 20, Nolan Johnson spoke with Ross Berntson, Indium Corporation's president and COO, about the company's response to the COVID-19 outbreak.

Berntson details the company's work with a consortium of manufacturing businesses in central New York state, developing a manufacturing pledge to keep people safe and keep factories running. Indium Corporation has been one of the frontrunners in formalizing such procedures and in sharing lessons learned among all the participating companies.

Berntson encourages electronics manufacturing companies outside the central New York region to also participate in the pledge. Berntson offers a number of examples of unusual ways to reduce the viral spread and reminds us all that merely making new rules is not sufficient; finding ways to change habits and behaviors long-term is key.

For more information on the pledge, [click here](#).

Industrial Revolution 4.0: Hype, Hope, or Reality?

SMT Solver

by Ray Prasad, RAY PRASAD CONSULTANCY GROUP

If you are in the electronics industry—and I am assuming you are because why else would you be reading this column—you cannot help but notice the discussion about Industry 4.0, whether you are reading technical magazines or attending physical or virtual shows or conferences. No matter what the subject, if it piques your interest, some of you may move from noticing it to wondering about it and may even graduate to digging deeper into that subject.

This is what happened to me when I attended IPC APEX EXPO 2019. If you attended the same conference in 2020, you may have noticed a very prominent focus on Industry 4.0 and extensive effort by IPC on developing multiple standards to make the transition to Industry 4.0 faster and easier. In this column, I want to discuss Industry 4.0 as I understand it. I welcome your comments about my interpretation of Industry 4.0.

As we all know, standards make the transition to any new technology faster and cost-effective for the entire industry. The core mission of IPC is to build electronics better by developing standards. As we also know, IPC does not discover anything—the members do—and when they decide to share their knowledge, IPC develops standards to make progress faster and easier so that everyone in the industry benefits. IPC has released multiple IPC standards related to Industry 4.0 (Table 1).

Some of them are old and going through revision, and others are new.

Historically, it took about 100 years to move from the First Industrial Revolution or Industry 1.0 (use of steam power, mechanization, weaving) around the time of the American Revolution and its resulting independence (during the 1780s, give or take few years) to the Second Industrial Revolution or Industry 2.0 (introduction of electricity, assembly lines, mass production) around the time of the abolishment of slavery (not the real end, but at least on paper) from 1860–1870.

We had to wait another 100 years before transitioning to the Third Industrial Revolution or Industry 3.0 (introduction of the integrated circuit by Intel; use of electronics, computers, automation) in the 1960s, around the time my generation was graduating from high school

• Connected Factory Exchange (CFX)	• IPC-2591
• Hermes (Replacement of SMEMA)	• IPC-9852
• Cybersecurity	• New IPC-1792
• Digital Twin	• New IPC-2551
• Distributed Ledger (Blockchain) Council	• New Project Initiation Notification
• Model-Based Design	• New Project Initiation Notification
• Traceability	• IPC-1782
• PCB/PCBA Manufacturing Data and Transfer Methodology	• IPC-2581

Table 1: Factory of the future industry standards at various stages of development and release.



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or college, moving to Canada, or finding some medical excuses or admission to higher education to avoid being drafted for the Vietnam War.

Now, we have been in the Industry 3.0 era for about 50 years. If history is a good guide, you would think we need to wait for another 50 years before talking about the Fourth Industrial Revolution or Industry 4.0, but we don't want to wait for anything. Whatever we need, we need it now. We don't have time to go and pick it up; someone had better deliver what we need to us at our doorstep. We are busy at home, doing what we do, such as writing columns, or attending Zoom meetings.

This is why the title of this column is "Industrial Revolution 4.0: Hype, Hope, or Reality?" Before I expand on my point of view on Industry 4.0, here is my take. At this time, we have all three elements when we talk about Industry 4.0: some hype, a lot of hope, and a little bit of reality. I do not think it will be a reality in the next 3–4 years, but maybe in the next 10 years, and it is an optimistic view. However, it is still a very fast transition to a new way of doing things, considering the history of the previous two revolutions of Industry (1.0 and 2.0) that I mentioned.

The main reason for a much faster transition from Industry 3.0 to Industry 4.0 (about 60 years instead of the usual 100 years) is that the First and Second Industrial Revolutions were all about hardware change. The third revolution—Industry 3.0 about electronics and computers—started as a hardware revolution, but has been morphing more and more into a software revolution. From the same hardware coming out of Intel and other semiconductor companies, the software companies are able to get more performance, and it is reflected in their relative stock prices. And this Fourth Industrial Revolution is essentially all about software.

I should also note that this Industry 4.0 is not a drastic change if you really think about it since this change in software has been with us for the last 30–40 years. All we are trying to do is let the software play a major role in making the hardware do things faster with no waste. It is a lot easier to make things in your head

before really making it. In Industry 4.0, we are not only trying to imagine and build digitally but even test it digitally to make sure it works, costs less, and is of high quality before really making it.

What Is Industry 4.0?

Both manufacturing execution systems (MES) and enterprise resource planning software (ERP) have the ability to work together. Since both types of software bring different capabilities to the forefront, using them together can help bring your business more well-rounded results. ERP knows why decisions need to be made, while an MES knows how to make those decisions. Both systems have their own purpose, which can make them complementary components. This is what we are doing while we are in Industry 3.0 today.

Industry 4.0 connects ERP and MES to the machines on the shop floor, creating a two-way information-sharing system among all three layers: ERP, MES, and shop floor. It will connect suppliers, logistics, networks, and the industrial internet of things (IIoT) to physical manufacturing to collect and use data to make decisions—with or without human intervention—to improve quality and reliability and reduce cost. Think of Industry 4.0 as a digital factory that connects every layer of business to enable a lights-out factory to be possible someday.

Here is a simple example. In a 4.0 Factory, an AOI system will detect a problem and then tell the offending machine to automatically take corrective actions without human intervention. I don't think anyone is really there today. In addition, machine vendors are not happy—in normal cases—when customers want automated adjustments; they prefer that a trained operator would confirm where a pattern has emerged, but we are far from that destination. It is better to think of Industry 4.0 as a journey and not a destination.

Let us take an example of what happens in a typical SMT line. In SMT assembly, there are three major process steps: print paste, place components, and then solder. On a manufacturing line, the defects could be caused at any

of these process steps (and many other things, such as DFM and incoming material quality, that we are not even talking about, to keep this example simple). It is possible that an AOI machine can detect misplacement and give instructions to a placement machine to take corrective action without human intervention. Some AOI and some placement machine companies work together to provide an auto solution without human intervention. Some companies are working on these features, and I am sure we will all hear when and if they work.

It is possible to take corrective action in the pick-and-place machine, but most of the SMT defects don't come from a pick-and-place machine. Most defects are related to paste volume, which is controlled by the stencil. It is very difficult to take corrective action on the spot for the paste printer from the feedback it may get from paste inspection systems. And it would be even more challenging to take corrective action in a reflow machine.

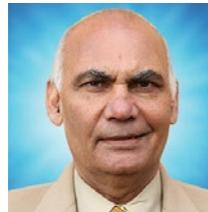
But we don't need to set the bar so high either, considering where most companies are today. For example, many companies collect lots of data, plot charts and graphs, and hang them on the wall, and leave them hanging there for the visitors to see but not necessarily diagnose the problem or take corrective action.

Conclusion

Let me conclude on a positive note. Manufacturers often collect descriptive data ("What happened?") and diagnostic data ("Why did it happen?") about their machines and devices,

but with Industry 4.0's end-to-end digitization, they can also gain predictive ("What will happen?") and prescriptive ("What action should I take?") insights into the status of their operations. We all know it is not a reality today, but I don't think it is total hype either.

My sense is that it is a genuine hope based on some insights into what is possible. This is why IPC is doing its best to pave the way for the transition to Industry 4.0. I also want to mention one other organization—the Manufacturing Technology Center (MTC) in the U.K.—where member companies have put in considerable resources and brainpower to work on Industry 4.0. You can learn more about what they're doing [here](#). Also, if you are interested and want to learn more about Industry 4.0 or actively participate, contact Chris Jorgensen at IPC. **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 has an upcoming SMT class in July (remotely by Zoom). More details at www.rayprasasd.com. To read past columns or contact Prasad, [click here](#).

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Electronics Manufacturing: A Critical Industry and Supply Chain



Chris Peters

Feature Interview by the I-Connect007 Editorial Team

Chris Peters represents the U.S. Partnership for Assured Electronics, where he advocates for electronics manufacturing as a critical industry. Here, he describes the current status, the supply chain, and what he sees in Washington D.C.

Barry Matties: Chris, tell us what you do and what your role is.

Chris Peters: My role is the executive director for U.S. Partnership for Assured Electronics, and my efforts are twofold. First, I am establishing the organization. We incorporated it in February. We've had to go through a considerable process to get registered, such as receiving a Dun & Bradstreet number, getting a CAGE code to do business with the government, and registering for award management for the government, as well as in the Cornerstone Other Transaction Agreement so that we can receive solicitations for the kind of work that we expect down the road.

The second part of my job is to start growing USPAE by finding initial members, both in the electronics industry and academia, to join. It's also about identifying opportunities—especially with the government—to bring through the contract vehicles that we look at to work closely with the industry and academia to solve government challenges.

Nolan Johnson: We have been investigating the current status of U.S. electronics manufacturing and supply chain as a critical industry. Can you tell us about the current status?

Peters: I've been working in supply chain—especially for the DoD—for a good while, and there was a growing awareness of supply chain issues even before the COVID-19 crisis. Since the COVID-19 crisis, there has been so much discussion about supply chain. For the first time, my parents understand some of what I do. It's a challenge. The issue has been that there has been a lot of attention paid to microelectronics by the DoD. Hundreds of millions of dollars have been spent on different programs focusing on the chip and wafer but not

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a lot on the ecosystem—the PCBs, the components that go in, and all of those different elements that play into it.

The COVID-19 crisis—and the fact that large manufacturers of ventilators could not get access nor ramp up their production because of the inability to get access to PCBs—heightened the awareness of the supply chain and the idea that a constraint or a compromise at any node in that supply chain could disrupt the entire chain and impact the system. The awareness of how supply chains typically have been organized for efficiency is growing. We run them very lean and have just-in-time inventory; there’s no “fat” in that supply chain. Everybody has now realized that an efficient supply chain isn’t necessarily a resilient supply chain in the electronics industry, and others.

The DoD is starting to rethink how we look at these supply chains. “What do we need to have as far as visibility into it?” Because typically, they can see down to the OEM or their prime contractor and not beyond that. We need to see into it and figure out how we manage and mitigate risk through the supply chain. People have a much greater awareness and knowledge about the supply chain, and we already see a much greater emphasis on this. Section 224 of the National Defense Authorization Act requires that the DoD put standards in place to ensure trusted electronics supply chains by 2021 and have those in practice by 2023.

Johnson: Could you outline what is in Section 224?

Peters: At a high level, it calls for visibility. When they say they want the DoD to have trusted electronics supply chains, the first thing you need is visibility. They need to understand who’s in the supply chain, and there have always been a number of problems with that. We’re going to start seeing a greater emphasis on having the prime contractor or the OEM report who else is in that supply chain.

Beyond that, we’ll start to look for ways to determine whether they are trusted. Again, most of my background in manufacturing is on

the mechanical side. I know electronics, but I’m no expert. Coming over to the electronics side, there’s great beauty in the IPC-1791, which was developed with the PCB executive agent—the PCB and interconnect. The value is for the DoD to meet the requirements in Section 224. IPC-1791 not only helps address some of the common issues you expect, like cybersecurity, but it also addresses physical security and information security, such as intellectual property (IP).

The big thing for me is supply chain risk management. It ensures that, depending on the level of production that you’re doing—Tier 1, 2, or 3—for Tier 3, you have dual sources for your supplies so that you have less risk of disruption if one supplier drops out. There’s a great opportunity for the DoD to use IPC-1791 to make sure that they have a trusted and assured electronics supply chain.

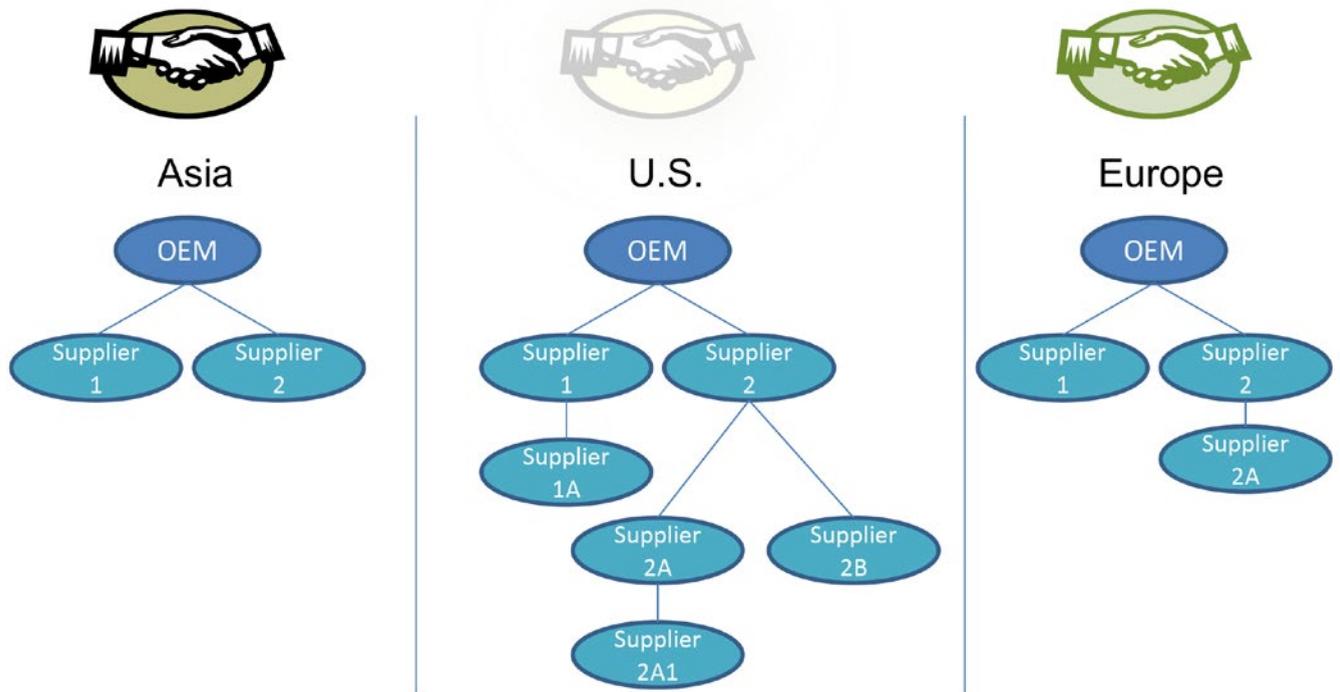
Johnson: With the government being focused on DoD projects right now, is there attention being paid to more consumer-oriented products or infrastructure products like telecommunications, medical, or consumer?

Peters: As they relate to the DoD, absolutely. Where those things are used—whether it’s medical or commercial off-the-shelf items used either by the DoD or in the facilities of organizations that produce for the DoD—a lot of attention is being paid to those things today.

Matties: What about things like ventilators, which would not necessarily fall under DoD’s watchful eye yet are critical to the good health of a nation?

Peters: Since my focus is on DoD, it’s hard for me to answer what other agencies are doing. The DoD is part of a larger government team looking at those challenges because it has its own stash of ventilators and medical supplies for DoD personnel. There is a much broader effort to consider how they address these challenges in the future. I have had several conversations with people about looking at different ways to approach this.

Less Willing to Cooperate



The U.S. culture places profit margins and shareholder value above sharing or partnering. Overseas companies are more open to collaborating for the common good.

In the past, we've had stockpiles of masks, ventilators, etc. However, the problem with stockpiles is they age and can't always suffice. But one of the amazing things in this COVID-19 crisis was watching how small- to medium-sized manufacturers in all the different regions and cities came together and helped produce what was needed. Part of the conversations I'm having with different government officials is asking, "What if we could leverage that? What if we could make that part of the plan that if there is a national crisis, we could identify and rely on a swarm of manufacturers to come together in an ad hoc fashion to help address those needs?" There is interest in new solutions like that by the government.

Johnson: As you described tracing up and down the supply chain, I was reminded of when the food supply chain was revamped in response to mad cow disease. It sounds like there are similar changes going on here. Is that a fair assessment?

Peters: It is, and the food supply chain is a very good example. You have much better labeling now. As a consumer, you can have much more confidence about where your food came from, and behind the scenes, there is a considerable amount of technology. You've heard about blockchain, which was first applied to the food industry supply chain. That same kind of information is crucial in electronics for a variety of reasons. We have challenges with counterfeit electronics. We have problems with even knowing where something came from, so if we have a problem we know about the other systems that have the same components in them.

IPC has another standard—IPC-1782—that was developed for the banking industry. It has a lot of applicability for the DoD because it provides a standard to ensure traceability so that I know where my parts came from, and I know where they're used. If I have a component in F35s, and they're in 25–35% of the F35s, I can know which ones to go to if there's a problem traced back to a certain component;

I have the traceability into where it came from and where it was used. That's something that has eluded the government for a good while, but between the challenges we see today and the technologies that are available, we'll begin to see a better ability to provide that lineage for those items.

Johnson: Is tracking the supply chain enough? Does that help create resiliency?

Peters: There are a number of aspects to resiliency. Resiliency is the ability to withstand a disruption and continue operations or to adapt in the face of those disruptions. There are ways and tools to do it. Forty years ago, you used to have everything integrated. Management sat on the second floor and looked over the shop floor and saw what was happening; if there was a problem with the line, and the red light went off, they would go down and resolve it. There are tools now where companies can do that. They are able to have that same kind of interaction very quickly, but those are more advanced companies.

What I'm seeing now are disjointed efforts that have a contract in place and exchange some information. Aside from that, there isn't visibility into what's happening. I can't look into their manufacturing line and see that my product is being produced or look at the production rate and recognize whether they are 30% behind and are never going to make the delivery date. That's where you see a lot of focus on the whole idea of Industry 4.0 or the factory of the future. Many of those tools are all about getting us back to where somebody at the management level can look across the floor and understand what's going on in that operation, whether it's within their organization or a supplier's operation.

We're starting to see a payoff for the adoption of Industry 4.0, or factory of the future, that either addresses those issues or provides much more resilience in the supply chain because there's much greater communication. It can still be accomplished by integrating, but challenges remain that have kept us from doing it for a good while. One of those is the global

supply chain. You hear a lot of people talking about the idea that we need to bring all the production back to the U.S. and do it all within our borders. There's value to some of that, but there are reasons that you have the distributor supply chain. The supply chain needs to be designed based on your desired outcome.

You want to produce things close to the point of distribution or consumption. I might need suppliers in the U.S., but also some in Europe or Asia or in other parts of the world. With that in mind, I still need some means of seeing across the companies that are in my supply chain and know what's happening. There is a lot of interest in integration, but the more likely solution is going to be leveraging new tools and technologies that give you those same benefits of integration without requiring the physical location of a place.

Johnson: I grew up in Beaverton, Oregon—the home of Tektronix. That company was a shining example of vertical integration. They made everything—even machine screws and knobs—at the campus. We have moved to the other end of the spectrum over the years, and it's the data that will allow us to get a vertically integrated-type view of the details in the supply chain without having to return to a completely vertically integrated company structure.

Peters: Exactly. The holy grail of all of this Industry 4.0 is that you have machines talking to each other so that they can keep each other apprised as to what's happening. But you're also providing much more data to humans to make more informed decisions. For example, you could know that three layers down in my supply chain for widget XYZ, there's a problem; they're falling behind, and there's some kind of increased vibration in one of the machines, so they have to take it down.

I could know those things in advance, and then my smart systems using AI and other data can look at how long it's going to take to repair and make a decision very quickly, such as we're counting on that unit for 30 production units a day. I can shift my work over to another company in a different location, continue



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that, and carry on while we get that machine repaired. All those things—with the right sensors and data and smart AI and technology—can allow that to happen very quickly. We see this a lot, especially in the high-volume, low-mix industries, such as automotive and appliances; many of those organizations are much more connected than we are in aerospace and defense, where our supply chains are more low-volume, high-mix, and that's providing a lot of good lessons.

There's a lot of work going on in South Korea, for example, where they have a wonderful effort being driven by the government that is doing a great job of embracing smart manufacturing with very quantifiable adoption metrics. They are subsidizing the cost of companies to implement different tools needed for smart manufacturing, like ERP systems and MDS systems, and starting to demonstrate the quantifiable benefits of that. We have a number of initiatives in the U.S. doing the same thing, working out of Oak Ridge National Laboratory. Some of the universities are looking at how we can pull these things together and manage a networked group of suppliers like we used to be able to do standing on the second floor, looking over the plant.

South Korea is doing a great job of embracing smart manufacturing.

Happy Holden: I don't want to say that we should give up the horizontal model and return to the vertical model of 40–50 years ago, but we may have extended the horizontal global supply chain too far by allowing the only metric to be about lowering cost. We didn't think about some of the secondary aspects, and some kind of correction is in order. I don't know what that is, but we need some leadership that directs how much of the supply chain should be corrected and how we go about retooling the industry so that we can maintain that crit-

ical supply. We went to China because of the low cost, and now we're discovering China's costs are going up among other things we didn't consider in going there.

Peters: That is a good point.

Johnson: Where are the gaps currently in the U.S., or in North America for that matter, in being able to achieve this vision?

Peters: I do some work with the National Institute of Standards and Technology, and in one of my presentations for them, I talked about some of the challenges we have in the U.S. compared to supply chains in Europe and Asia. In the U.S., we have embraced outsourcing to such a great extent that we would typically have more suppliers in our supply chain than they would in Europe or Asia to make the same item. We have a greater variety of disparate tools that don't talk to each other.

One of the biggest challenges we have is our culture. In Asia and Europe, it's much more about partnering to achieve something together to achieve a common good. In the U.S., most of our culture is on shareholder/stockholder value, so we tend not to partner as much as they do overseas. Some of those things need to have to a chance. Maybe we need some consolidation so that we don't have as many disparate nodes that we have to connect. We have to figure out how to make our tools talk to each other better, but we also have to figure out how to come together culturally to work collaboratively for the common good. Those are some of the big challenges that we face.

Matties: How optimistic are you that that will become a reality?

Peters: I see it more and more, and the COVID-19 crisis is going to have a significant impact on the nation's psyche and how we address things like that. If you look at what companies like Calumet and others did to ramp up production and help their competitors produce things that were needed for the regional hospitals and the first responders, that was a shock

to our system; however, it helped open the door to much better cooperation and collaboration within our culture. Other things, like the connecting technologies and the exchange of data, are easier. It's the culture that's harder, and I believe that the current crisis we've gone through is going to help reshape that culture.

Matties: It has given many a new perspective. Earlier, you mentioned cybersecurity. With the vision of connected factories, as it becomes more of a reality, what concerns do you have or advice would you give regarding cybersecurity issues?

Peters: I have a lot of concerns around it, especially in the operations technology environment—the shop floor. That's where I've spent a decent amount of time. I testified before the Senate Armed Services Subcommittee on Cybersecurity about this very topic last year. I spend a lot of my time with small- to medium-sized manufacturers around the country, and cybersecurity is hard enough when it comes to the IT side of things. When you think about our shop floors, we have machines and equipment that are still running Windows NT or DOS. We have to be able to get to machines quickly and shut down a line to prevent too much loss of product or, in some cases, prevent injury or death.

To help address this issue, and because there are no proactive solutions to the shop floor yet, companies are going to great lengths to isolate their shop floor. I know of one company that has completely isolated the shop floor; they walk design files and code files back and forth between the office systems and the shop systems on memory sticks rather than have them connected. That's defeating the purpose of Industry 4.0 and related advances.

The cybersecurity maturity model certification (CMMC) is putting in place a number of specific requirements. Some of those requirements are hard to enforce on a shop floor, such as multi-factor authentication; that's going to be difficult in a lot of cases. We can't patch some of these systems on the shop floor because if you do and they don't work for some reason, that's going to take that line down, which is

there to make money. If it's not running, it's not making money.

Often, we go for a long time without patching those systems. I have concerns about cybersecurity, and I would like to see the government step in to better address those things. We're going to need assistance—especially for the small- to medium-sized manufacturers—as we look at solutions for that. We need a grand challenge to identify the best solutions to protect the shop floor. We probably need some assistance financially to help them take on the capital expenditures that would be needed to upgrade their systems so they can be more secure.

Matties: Agreed. We've heard of two fabricators that have been hit with ransomware, and what you're saying makes a lot of sense. One fabricator hit with ransomware was locked out of everything, and the hackers demanded a significant ransom. This small- to medium-sized shop had no idea that they were vulnerable to that degree. They're going to need assistance, especially if we're trying to secure a supply chain. These people need help.

They're going to need assistance, especially if we're trying to secure a supply chain. These people need help.

Peters: I've been advocating for a while that the government needs to provide an awareness campaign similar to the "loose lips sink ships" approach of World War II where we raised awareness of the threat not just from the theft of IP but also from ransomware and other things that can shut down your business. That's one area that the government needs to step up.

I also think that the government needs to provide more assistance and resources for small- to medium-sized manufacturers. These companies can't afford to do it on their own. They're prime targets and a vulnerable link in

the supply chain. If I want information about a weapons system, I'm not going to go after Lockheed or Boeing—I'm going to go after a small- to medium-sized manufacturer where I can get some of the same information with a lot less hassle.

The government needs to step up and create a grand challenge so we can identify solutions to help solve these problems on the shop floor. It also needs to put in place some educational resources to help them, as well as provide additional funding if they need to do capital expenditures to improve or update their systems. That is a role the government should be playing but is not currently.

Johnson: These two things seem to dovetail. You need the security, because as you open up the data to make the supply chain more transparent and resilient, you also expose which companies might be vulnerable to attack.

Matties: And you need to see some hardening of systems. Is there anything we haven't talked about that you feel we should share with the readers?

Peters: Again, I come from the mechanical manufacturing side with metal and those kinds of things. Before, I thought the electronics industry was going to run a lot more smoothly. However, I'm finding a lot of common issues between mechanical and electronics manufacturing, especially when it comes to the challenges facing small- to medium-sized manufacturers.

Johnson: What kind of an organization is the U.S. Partnership for Assured Electronics?

Peters: It's a nonprofit organization to help ensure the U.S. government has access to resilient and trusted electronic supply chains. We'll be announcing members fairly soon, and we'll be a resource to bring them together with the government to solve problems, innovate new solutions, and address things in a way that isn't being done right now.

One of the challenges the government has is that many electronics manufacturers—especially PCBs and the components—are bur-

ied layers deep in the supply chain. We don't have access to them. USPAE is going to help bring them together so that the government can get the benefit of interaction with the ecosystem—not just the large companies, but also the small- to medium-sized companies, which can get the benefit of being able to talk directly to the DoD and even the primes for the large OEMs. I have DoD people looking to understand the challenges the industry is facing. What does the industry want right now and in the future? That would be a great partnership for us to work together on.

Matties: One of the big issues in our industry is skilled labor—finding the right people with the right skillset who are willing to take a manufacturing job. With the COVID-19 crisis and the rate of unemployment, we may see a shift in thinking because these may be the jobs that come online sooner than the entertainment and leisure industry.

Peters: One of the biggest challenges I hear from manufacturers is their frustration in getting a workforce. Typically, I hear that 40% of the applicants can't pass a drug test. I hear horror stories about them bringing somebody in, getting them trained, having high hopes, and then a week or two later, they walk away. As I hear all this talk post-COVID-19 and the need to bring every piece of manufacturing back to the U.S., there's no way we can handle it. Even if we built the facilities, we would not have the workforce to staff it.

Matties: It's a kneejerk reaction, of course, but there's a certain degree that will shift out of other countries.

Peters: I'm glad to help out, and I've enjoyed the conversation. The more of these things that we can do to help raise awareness within the industry, as well as different agencies within the government, the more good we can do.

Johnson: Thank you, Chris.

Peters: Thanks. SMT007



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Supplier Highlights



Pillarhouse USA Names Performance Technologies Northeast U.S. Rep ▶

Global manufacturer and supplier of selective soldering systems Pillarhouse USA announces the appointment of Performance Technologies Group, to spearhead sales efforts in Virginia, West Virginia, Maryland, and Washington DC.

CE3 Electronics Inc. Selects MIRTEC for Continuous Quality Improvement ▶

MIRTEC, a global supplier of technologically advanced 3D inspection systems to the electronics manufacturing industry, is pleased to announce that CE3 Electronics Inc. has selected MIRTEC as their 3D AOI partner with the purchase of an MV-6 OMNI 3D AOI machine.

Rehm Thermal Systems Offers Webinars on Soldering Technology in German and English ▶

Rehm will make sure you are still very well informed in these times by providing webinars on the pros and cons of soldering with nitrogen, the ViCON system software by Rehm, vacuum soldering with condensation and contact soldering processes, as well as dryer solutions.

Sciencescope Improves Inventory Management at Electronics Services Inc. ▶

Sciencescope International, an American supplier of cabinet style micro-focus X-ray systems, sold Electronics Services, Inc. (ESI), an EMS company based in Sioux Falls, South Dakota, an AXC800 III X-ray component counter.

AIM Appoints Timothy O'Neill Director of Product Management ▶

AIM Solder, a global manufacturer of solder assembly materials for the electronics industry, is pleased to announce the appointment of

Timothy O'Neill to the position of director of product management.

Super Dry Totech Expands Long-Term Storage Solutions Offering ▶

Building on the success of Super Dry Totech's Long-Term Storage Solutions (LTS2), the most recent development is the acquisition of a new building to expand on capacity and to minimize risk by assuring continuity should a disrupting incident occur in one of the facilities.

Seika Upgrades Options for McDry Electronic Drying Storage Cabinets ▶

Seika Machinery Inc.—a provider of advanced machinery, materials and engineering services—is pleased to announce new upgraded features for all McDry electronic drying storage cabinets. Available options include MSD control tracking software and multiple data loggers, including wireless, intranet, and cloud-based systems with alert capabilities.

ViTrox Appoints Richard Osborne as Sales ▶

Director of ViTrox Technologies in USA Region ViTrox Technologies, a provider of innovative, advanced and cost-effective automated machine vision inspection systems and equipment for the semiconductor and printed circuit board industries, is pleased to announce the appointment of Richard Osborne as the new sales director of ViTrox Technologies based in the U.S.

New Automated Optical Inspection From Nordson EFD Verifies Fluid Deposit Placement and Accuracy ▶

Nordson EFD, a Nordson company, a manufacturer of precision fluid dispensing systems, introduces OptiSure™ AOI software and confocal laser as add-ons to its existing vision-guided dispensing robots.

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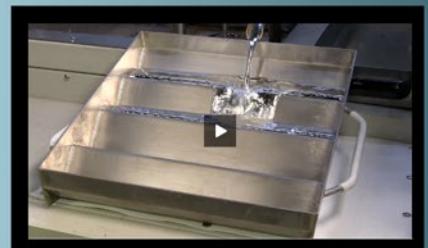
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Reliability Reboot

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

Hey, how about this global pandemic? Wild stuff. I am going to attempt to find a silver lining among the many dark clouds, and I am willfully overlooking the health issues and focusing on electronics with this month's installment. This makes sense, as I am not a medical doctor, but I have diagnosed more than a few ailing electronic assembly processes.

A few months ago, we started seeing delays in shipments from many of our offshore partners as they had to do the right thing and close their facilities for the greater good. We knew at that time that it would set off a chain reaction of availability issues for everything from silicon wafers and bare PCBs all the way to final production assembly for the end-user.

This has forced many companies to take a hard look at how and where their parts and assemblies are sourced and see what other options are available going forward to help deter this same situation from happening again if another round of global closures took place. Many companies willfully placed all their eggs in a single basket while wearing rose-colored glasses and, to this point, it probably worked out fairly well. Today, we are hearing many of

those same companies are looking to expand their supplier base, and with that, the possibility to rethink how they approve suppliers is born. Thanks, COVID-19?

Let's start where most things start—from the beginning. When I say "from the beginning," I mean from the suppliers of all the materials you use to build your assemblies. This list should include your PCB fab shops, component suppliers, solder paste and flux, adhesives and coatings, connectors, housings, and the list goes on. As I have mentioned about two million times, everything you use in the assembly process brings with it an inherent risk of contamination that can affect your product's reliability. When working in the Class II and Class III worlds, we all know that reliability is as important as it gets, so it's paramount to take this opportunity to be sure you are getting what you need regarding cleanliness.

The first thing I recommend is looking at your current requirements and then determining whether they are still applicable to what you are building today. Many times, those requirements were based on a product that has gone through a series of minor revisions over the years. When looked at individually, these



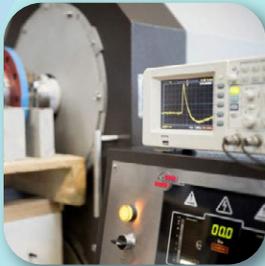


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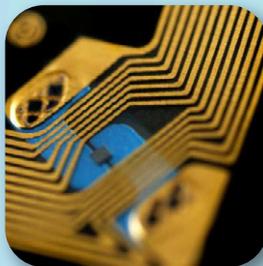
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changes seem small, but collectively, they have substantially changed the assembly. To me, that means the original set of building blocks may or may not be working the same as they did initially. They may still be working to the point that the product functions as it leaves the building, but go back and take a look at the pile of “no trouble found” returns and figure out the root cause from there.

Many times, you’ll discover that while the materials may not have changed, the way they are being used has. This is why it’s a great idea to take a look at qualifying new suppliers with updated acceptance criteria. For instance, many suppliers have been contractually obligated to test cleanliness using the IPC standard for cleanliness that was found in J-STD-001 but has since been removed. Since the test has been determined to be inadequate, it’s time to develop your own testing

Many times, you’ll discover that while the materials may not have changed, the way they are being used has.

plan specific to your product. That test may still include ROSE testing and the acceptance criteria of 1.56 µg of sodium chloride equivalence, but that can’t be determined until you have a larger data set that includes SIR testing for objective evidence.

IPC-WP-019 has all the information on this important (and some say drastic) change and what is recommended going forward. At a minimum, you should ask for ion chromatography testing for initial acceptance and then possibly on an annual basis as well. For all the interim shipments, you should be able to accept ROSE testing on materials like bare boards; but again, only if that is backed up with IC data.

It is also a good idea to ask for similar data from your component suppliers. Many com-

ponent assembly processes use the same plating processes as a bare board and can leave the same type of detrimental residues. When a component has plating residue, it can migrate up the leads into the body of the part and corrode wire bonds, among other failures. Package-on-package (PoP) components can leave all the same residues as a standard assembly process, so think of them more as tiny assemblies instead of components.

Speaking of assemblies, let’s discuss what you should be asking for on those. When you look at the witches’ brew of chemistries used to get us to this point, it is a miracle they haven’t simply melted into a pile of electronic goo. I assume that is how the electronic pioneers came up with the formulas that we use today; if it melted, back it off 10%, and try again.

Again, historically, cleanliness per the IPC was covered with the simple, quick, and inexpensive ROSE test. Per IPC WP-019, “This test methodology was originally developed in the 1970s; it was never intended to be used as a cleanliness test, nor as a test for product acceptability, it was only intended to be used as a process control method.” Unfortunately, this test has been used for product acceptance for many years, and that’s not a good thing. I won’t go into all the reasons why, but there is a mountain of studies out there for review.

For years, our lab recommended that customers build at least 20 assemblies, then test half with ROSE and half with ion chromatography. This gives you a rough correlation to figure out what your ROSE number needs to be—whether that is 1.56 or 156.00—as it is all based on the way the specific ROSE tester reads your product. Many large companies have gone the extra step of not only doing full board extractions for the IC test but also looking at specific areas of the PCBA to determine how clean it is.

Global extractions with either IC or ROSE will normalize out pockets of contamination across the full surface area of the assembly and most often results in a passing grade. A full board has never failed in the field; it’s always a specific component or soldering process.

Thus, it's important to know exactly how clean each individual process is to better address and optimize that and reduce the levels of active residues. These types of tests are being seen on more prints for new products but not being applied to legacy products due to existing contracts.

If you are planning on qualifying new CMs, this is a great time to revisit some of those legacy products and update the cleanliness criteria as if it were a new product. Of course, this applies to all the acceptance criteria for all types of testing and not just cleanliness. If you have a product that has been in the field for a few years and there is a trend on the fail-

ures, there should be a way to better screen for that in first article builds. While your company is taking this unexpected opportunity to expand your supplier base, you might as well expand your acceptance criteria to help produce a more reliable product.

Now, go wash your hands. **SMT007**



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

SMTA International Conference and Expo Goes Virtual

The Surface Mount Technology Association (SMTA) announced that its annual conference and exhibition, SMTA International, will proceed for 2020 as a completely virtual event starting September 28, 2020.

The decision has been made in light of the COVID-19 pandemic to ensure the health and safety of all those who attend. After reviewing all possible scenarios through weekly meetings with the board, executive director, and venue management, it became clear that an in-person meeting would not be possible given the specific require-

ments of the state of Illinois, as well as policies restricting travel at many participating companies.

The new virtual format will allow attendees to easily navigate within a simulated conference center environment. Attendees will have access to all keynotes, the exhibit hall, and virtual networking opportunities to interact and collaborate with other participants for a fully immersive experience.

The exhibition is free to all attendees and will take place live September 28-30. During this time, attendees will be able to roam the virtual show floor, view company products, and demo videos, and privately chat with exhibitors. Attendees will have continued access to the exhibit hall until October 23, 2020, without the option for live chat.

Attendees who register for the Technical Conference will have exclusive access to over 100 technical presentations on-demand from September 28-October 23, 2020, as well as the ability to download all papers in the conference proceedings.

The Women's Leadership Program will continue its annual gathering, hosting the Connection Reception on the evening of Wednesday, September 30.

Further details about SMTA International conference and exhibition are available online at smta.org/smtai.





The Future Just Isn't What It Used to Be

Feature by Dan Beaulieu
D.B. MANAGEMENT

We all want the COVID-19 outbreak to be over and we're wishing as hard as we can that it will be soon. So what happens now? What will the post-pandemic world look like, and when will things go back to "normal?" I think it will happen very gradually at first and then very quickly. In the near future, this will all be in our rearview mirror—or will it?

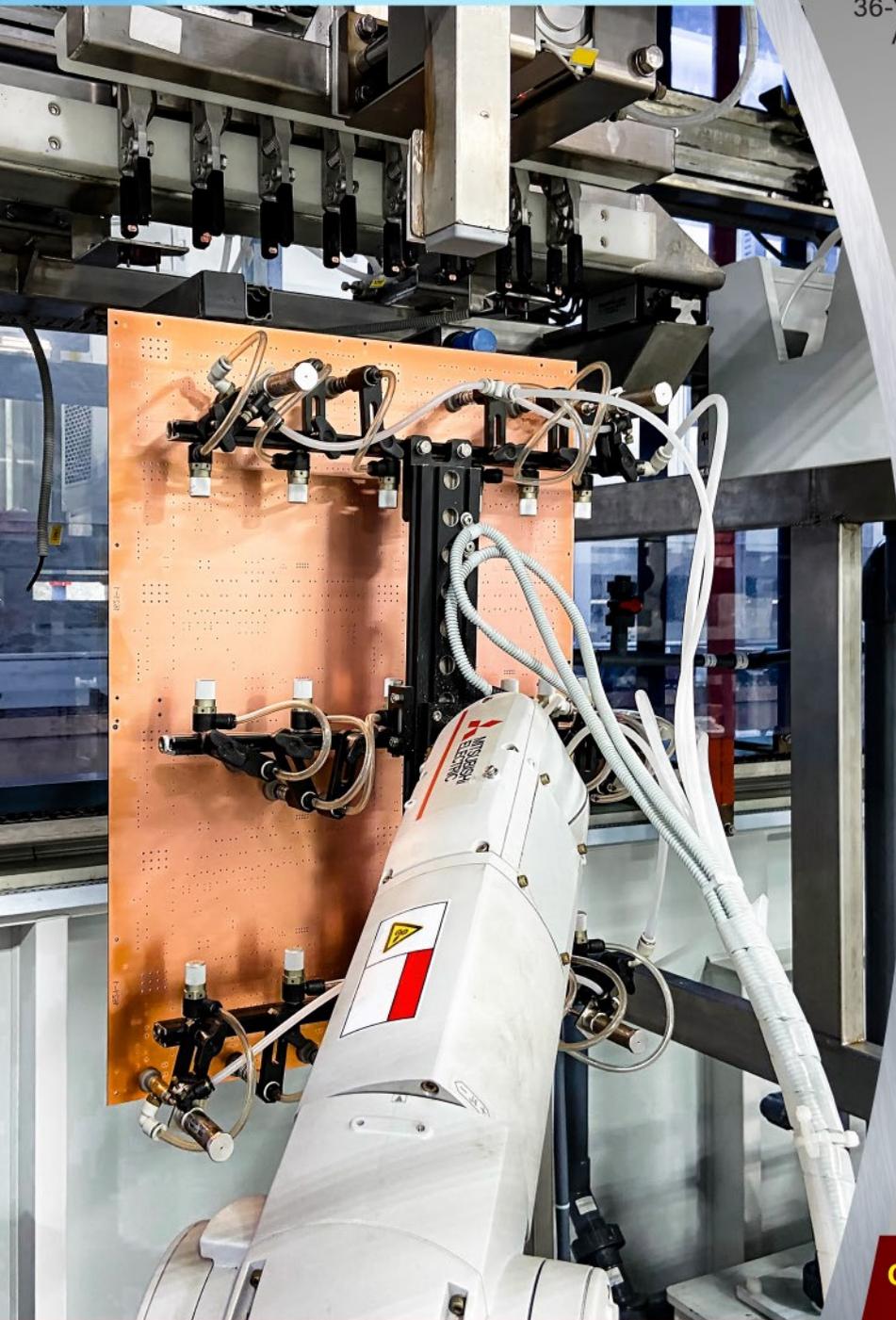
One thing is for sure: There will be a new world order, and things will be different. It will be up to us to figure out how to handle this new hand we have been dealt. Will we ever feel comfortable shaking hands again or going to sporting events, concerts, etc.? Will we ever feel comfortable and secure in our jobs or think we have enough money in our retirement accounts?

Here is an interesting thought: Will we ever knock government entitlement programs again? It seems that no matter the politics, we sure had our hand out when those PPP checks were being doled out. And what about toilet paper and other essentials? Will we ever feel like we have enough?

How many things have we taken for granted all these years, and will we ever take them for granted again? Think about the times when we would get on an airplane and fly anywhere we wanted, get in a car and drive anywhere we wanted, or go to restaurants, bars, supermarkets, and barbershops whenever we wanted. Now, even going to the dentist will be seen as a treat—maybe.

Many things in the world have changed, but what about how we conduct business and B2B selling? Will that ever be the same? I can tell you right now this change has already started, and will continue to change. Let's start with the big one in our industry. Will companies in the U.S., Europe, and elsewhere be so eager to turn over all of our business to countries like China? I think we have all learned a lesson. In the past few months, we have realized what the price of cheap lawn furniture, party goods, DVD players, and PCBs was in the end. We now see the position of true vulnerability we put ourselves in. It was an icy cold, rude awakening when we found out that ventilator boards came from China—especially when China shut down and GE Medical could not build ventilators. We also found

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out that big pharma was buying their drugs from China. Who knew or, more importantly, who wanted to know?

The fact is we have lost a lot of electronics infrastructure in the U.S. The Chinese did not come over here and take it; we went over there and handed it to them on a proverbial silver platter. Our large OEMs loved the idea of getting the cheapest PCBs, drugs, components, and just about anything you can imagine—all to the detriment of our own self-sufficient manufacturing infrastructure. Remember how we took comfort when Apple said, “Designed in America?” It made us feel good, but we all knew what was missing: “Manufactured in China.”

In the future, I see us being more careful. Hopefully, this will be a lesson learned. Let’s keep some of the important stuff in the U.S. Now, I believe in a global economy and I work with companies all over the world, but I believe that economics—like water—seeks its own level and that commerce is more powerful than politics and government. But for heaven’s sake, practice some prudence. Don’t give everything away so that the U.S. has nothing left. Use some common sense, I dare say.

In the future, I see us being more careful. Hopefully, this will be a lesson learned.

The predictable trend is that we will see more onshoring, especially with essential products being built by essential companies. Look forward to what that will bring, including:

- Keeping more production in the U.S., which means increasing the size of orders that stay within the country.
- More interest in establishing new factories of the future in the U.S. (less than a handful of new factories have been built stateside in the past 20 years).

- Faster new product introduction (NPI) because new products must get to market faster than ever.
- A growth spurt when it comes to technology. With innovation comes new and more demanding technology, something we are seeing right now.
- The return of the captive PCB shop as large OEMs realize they still need to have better control of their supply network. For the sake of R&D, proprietary processes, and intellectual property, they will have their own PCB shops—or at least labs. They could also have these shops build total concept products (design, fabrication, and assembly, which—in their own control—could vastly improve their time to market).
- PCB cooperatives where three or four non-competing OEMs come together and build their own PCB shop exclusively for their own use.
- More remote workers—especially engineers, designers, inside sales, customer service people, and CAM operators.
- More innovation. We are already seeing a slew of new products being developed. There is nothing like a good crisis to bring out creativity and entrepreneurship.
- Medical electronics exploding in the next 18 months.
- A higher demand for QS—a medical specification. Look for a rush of companies applying to qualify for their QS.
- Complete synergistic service offerings. Because of innovation and QTA, NPI customers will want to work with companies that are able to do everything design, fabrication and assembly very quickly. If you are able to do this already, get out there and market your services; if not, figure out how you can.
- Companies looking for trusted vendor partners. There will be much more of a dependency on their PCB and PCBA vendors as they look for companies they can work with, filled with people they can trust.

- More offshore companies trying to come into the U.S. Even before the pandemic, companies from both Asia and Europe were trying to establish a beachhead in the U.S. by buying an existing PCB or PCBA shop. Look for more of that happening in the next few years.
- More American factories with more efficiencies (think GreenSource Fabrication, where less than 25 people produce over \$40 million of high-tech PCBs). In the next few years, companies and factories of the future will start sprouting up all over the U.S. that are ecologically pure, engineering sound, and able to build any type of PCB in hours and days rather than weeks and months—all with most of the staff working remotely. The time for this concept has come.

And, of course, communications for working apart will emerge—more efficient ways for people living miles apart to come together on projects. This means vast technological improvements in online communications, including virtual meetings, sales conferences, job fairs, trade shows, webinars, and sales calls—not to mention a huge increase in virtual campuses and classrooms. And when you consider all of these changes, you come to the conclusion that we are just getting started. Once we start exploring the possibilities, we will discover all sorts of new and exciting ways to do things better than we have ever done them before.

Using all of these tools provides strong, clear avenues of communications and the opportunity for a global network of innovators to come together in a more inclusive and comprehensive way than ever before. Global projects will become the norm as great minds from all corners of the globe come together to create, innovate, and develop fantastic products of the future more quickly than ever before.

But one drawback will be the threat of cyberattacks. Cybersecurity will be more imperative than ever. As we become more connected, the need for more security will be more important

than ever. Look for that industry to grow very rapidly in the next few months or years.

Finally—and probably the most obvious at this time—is that we will see a trusted global network of medical people and researchers come together to create a system for early discovery and containment of new viruses. Keep lines of communication open and share knowledge and research so that we work together to subdue these deadly enemies that can threaten our survival in the future.

As we become more connected, the need for more security will be more important than ever.

I feel that we should look at emerging from these times with a great deal of optimism. We are already “connecting the dots,” using everything we have developed so far and all of the technology we have developed over the past decade to help us survive these hard times. Think about it. What would we do without the internet or cellphones right now? Where would we be without social media, and who would have thought it would be so important? These are all technology tools that have enabled us to handle these hard times better than any other time in history.

Also, 5G heading to 6G will provide us with greater bandwidth to handle many more connected devices. It will be the underpinning that supports the connectivity we have been talking about. A year from now, we will be saying, “Thank goodness that 5G came along just when we needed it. I cannot wait for 6G!” **SMT007**



Dan Beaulieu is president of D.B. Management Group.

Working Remotely: Redesign Your Information Systems

Operational Excellence
by Alfred Macha, AMT PARTNERS

Thousands of professionals have been working remotely since the 1990s when computers and internet access was introduced in the workplace. In the early 2000s, remote work was primarily practiced by information systems, software development, and customer-facing roles where getting on the phone or on the computer was the core requirement of those activities. In the past 10 years, remote work has increased considerably. According to one source ^[1], “At the end of 2016, more than 26 million Americans—about 16% of the total workforce—worked remotely at least part of the time, according to the U.S. Bureau of Labor Statistics (BLS). Between 2005 and 2015, the number of U.S. employees who telecommuted increased by 115%.”

The COVID-19 pandemic has disrupted every organization and forced companies to rethink who needs to be on-site to effectively do their jobs. Working remotely has suddenly changed to the preferred work option for many profes-

sionals. Service organizations that rely on electronic data delivery have the infrastructure to quickly adapt to remote work environments. However, manufacturing organizations are in a hard spot. The majority of employees need to be on-site to support manufacturing operations where assemblers, technicians, and inspectors work on processing or assembling parts to deliver products that meet customer requirements.

Manufacturing organizations have been forced to quickly adapt to provide remote work options for manufacturing support employees. Here is a model to help your organization keep remote work employees fully engaged in supporting manufacturing operations.

Robust IT Infrastructure

Make sure the right infrastructure and immediate online technical support are available for all remote employees. The communication platforms should be designed to withstand a large amount of data transfer within the organization. Have the necessary cloud data storage platforms in place to make data sharing seamless.

Standardize Collaboration Tools

Establish a common collaboration platform for online conferences. Common applications that work well and used by many organizations include Microsoft Teams, Zoom, Cisco Webex, and Google Hangouts. There are many





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Featuring speakers from Sanmina, FTG Corp, Summit Interconnect, and IMEC

DAY 2: Testing Strategies and Future Projects

Featuring speakers from Robisan Labs, CAT, Lockheed Martin, and Aeromarc, LLC

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other options, as well. The objective is for the organization's management team to have a consistent common application that meets the manufacturing support needs.

Redesign Your Information Systems With AI

The implementation of AI will rapidly accelerate to support operations. The objective is to attain real-time data from manufacturing operations via process monitors and dashboards. All these outputs need to be accessible remotely by manufacturing support personnel. A common platform that manufacturing organizations can use to achieve this is by the implementation of a manufacturing execution system (MES). MES software options have been available for a number of years, and with the new work environment, the implementation of these software solutions will be a necessity for organizations to provide an effective platform for remote work.

Before you select software, prepare a configuration of your design plan for your MES needs. The design plan needs to consider three data collection requirements from your manufacturing process(es) that manufacturing personnel should review when working remotely: enterprise requirements planning (ERP), verification of product attributes, and process controls.

ERP System

Most organizations have already established ERP systems where all business requirements are entered from sales orders, planning files, BOMs, inventory transactions, work orders, and material tracking steps throughout the production life cycle. These systems can already be accessed remotely. As the majority of the organization's ERP users will be working remotely, it will be necessary to upgrade the ERP system to be cloud-based supported.

In addition, consider the interaction of the MES software with the ERP system. Often, there will be an overlap of data collection entries. The MES system design plan should complement the established ERP system to minimize duplicate or non-value add data collection activities.

Verification of Product Attributes

Verification of product attributes is done via inspection and test methods. These verification activities are done in the production process by inspectors, technicians, or operators where measurements are taken and collected in paper logs or databases. These activities may already be automated in some work environments. MES applications can collect these measurements across all necessary processes for your product manufactured and have these measurements be available for immediate data analysis via cloud-based applications.

Quality engineers and other customer-facing employees can analyze and determine conformance to product requirements as the product is manufactured. Furthermore, data collection can also include pictures and videos that allow for visual verification of product characteristics. Access to this information allows for remote personnel to analyze and take appropriate actions.

Process Controls

AI can be accelerated with process controls. Sensor technology and data bandwidth advancements allow organizations to collect millions of process datapoints if necessary. It's important not to overwhelm the system with data collection that cannot be useful. The objective is to prepare a process control plan for all key process attributes to help engineers, technicians, and other personnel evaluate process performance to identify trends or out-of-control issues that can be addressed immediately as they occur. Cloud-based process dashboards should provide this monitoring for your critical parameters so that your engineers can not only evaluate your process but also collaborate with customers and suppliers to review process data in real-time.

Establish a Cadence

Remote work requires discipline and consistency. Establish a cadence of regular meetings and protocols on how to effectively review metrics and action items. Remote employees have the flexibility to work in their preferred environments but can be distracted and less

productive if a well-defined cadence of meetings and deliverables is not established.

Supporting manufacturing operations also requires immediate corrective and preventive actions depending on events occurring in the production environment. Remote personnel must be available at a minute's notice to address issues remotely during their assigned work schedules.

Conclusion

As we face a new reality in the workplace, manufacturing organizations can continue to operate effectively with the right platforms in place. Various software options are available

today, giving manufacturing organizations the ability to select the right MES for their needs. An effective MES will make remote work a seamless transition. **SMT007**

Reference

1. Z. Greenbaum, "The Future of Remote Work," American Psychological Association, October 1, 2019.



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

Astronomers Detect Regular Rhythm of Radio Waves With Origins Unknown

A team of astronomers, including researchers at MIT, picked up on a curious, repeating rhythm of fast radio bursts emanating from an unknown source outside our galaxy, 500 million light-years away.

Fast radio bursts (FRBs) are short, intense flashes of radio waves that are thought to be the product of small, distant, extremely dense objects, though exactly what those objects might be is a longstanding mystery in astrophysics. FRBs typically last a few milliseconds, during which time they can outshine entire galaxies.

Since the first FRB was observed in 2007, astronomers have cataloged over 100 fast radio bursts from distant sources scattered across the universe, outside our own galaxy. This new FRB source, which the team has cataloged as FRB 180916.J0158+65, is the first to pro-

duce a periodic or cyclical pattern of fast radio bursts. The pattern begins with a noisy, four-day window, during which the source emits random bursts of radio waves, followed by a 12-day period of radio silence. The astronomers observed that this 16-day pattern of fast radio bursts reoccurred consistently over 500 days of observations.

"This FRB we're reporting now is like clockwork," says Kiyoshi Masui, assistant professor of physics at MIT's Kavli Institute for Astrophysics and Space Research. "It's the most definitive pattern we've seen from one of these sources."

From September 2018 to February 2020, CHIME picked out 38 fast radio bursts from a single source, FRB 180916.J0158+65, which the astronomers traced to a star-churning region on the outskirts of a massive spiral galaxy, 500 million light-years from Earth.

As the researchers plotted each of the 38 bursts over time, a pattern began to emerge: One or two bursts would occur over four days, followed by a 12-day period without any bursts, after which the pattern would repeat. This 16-day cycle occurred again and again over the 500 days that they observed the source.

"These periodic bursts are something that we've never seen before, and it's a new phenomenon in astrophysics," Masui says. [Source: [MIT News](#)]





MilAero007 Highlights



SpaceX Manned Mission Promises More Success for Milaero and Electronics Manufacturing ▶

On May 30, 2020, SpaceX became the first non-governmental organization to send human cargo into orbit and to a successful docking rendezvous with the International Space Station (ISS). On June 1, Nolan Johnson spoke with military/aerospace consultant and I-Connect007 columnist Mike Hill about the significance of this mission.

Photo Slideshow From Historic U.S. Launch Into Space ▶

Hugs and cheers followed NASA astronauts Bob Behnken and Doug Hurley as they made their way from the Dragon capsule into the International Space Station just before 3:30 p.m. EDT Sunday, marking the first successful leg of America's return to a full-fledged space program. We've put together a slideshow of some of our favorite images provided by NASA, from the preparations to liftoff to the final docking and entry into the International Space Station.

From the Hill: MIL-PRF-31032 Offers a Rewarding Twist ▶

If you are fabricating PWBs to military specifications, the master drawing will state: "Fabricate to MIL-PRF-55110, MIL-PRF-50884, or MIL-PRF-31032." This sounds very complicated on the surface, but there is a rewarding "twist" if the fabricator is certified to MIL-PRF-31032. Mike Hill explains.

What It Takes to Be a Milaero Supplier, Part 4 ▶

The decision to pursue military and aerospace certification impacts every facet of the organization, and not every shop is prepared to

make this transformation. This is the final article in a four-part series, breaking down what it takes. In Part 4, Anaya Vardya explores what it takes to be a mil/aero supplier in the area of manufacturing.

AIDP and Andy Khawaja Set Sights on Bringing Artificial Intelligence to Mars ▶

Artificial Intelligence Defense Platform, a technology start-up creating AI technology for a safer, more comfortable future, and its Founder Andy Khawaja prepare to create a sustainable habitat on Mars with AI technology.

NextFlex Leads Recipients of \$5M in Naval Research Funding for Workforce Education Program Expansion ▶

NextFlex®, America's Flexible Hybrid Electronics (FHE) Manufacturing Institute, announced the expansion of its manufacturing workforce education activities with \$5 million in funding from the Office of Naval Research (ONR).

Airbus Wins ESA Contract to Construct Third European Service Module for NASA's Orion Spacecraft ▶

The European Space Agency (ESA) has signed a contract with Airbus for the construction of the third European Service Module (ESM) for Orion, the American crewed spacecraft. The contract is worth around €250 million.

NASA Telescope Named For 'Mother of Hubble' Nancy Grace Roman ▶

NASA is naming its next-generation space telescope currently under development, the Wide Field Infrared Survey Telescope (WFIRST), in honor of Nancy Grace Roman, NASA's first chief astronomer, who paved the way for space telescopes focused on the broader universe.

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Removing Conformal Coatings for PCB Rework

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

Conformal coatings provide protection for electronic assemblies against moisture, dust, chemicals, and heat in a variety of end-use operating environments. When the removal and replacement of components due to field failures or manufacturing defects need to occur, this overlying coating layer first must be removed before being able to remove and replace a component. The choice of the correct removal method for a specific coating is necessary so as to not damage the PCB or neighboring components.

Incomplete coating removal, such as on the underside of components, can result in pads being ripped off of the board when attempting to remove the component during the rework process. Incomplete removal of the coating may mean that solder can “squirt out” from encapsulated reflowed solder during the rework process, thereby causing bridging. These problems, as well as others, can result from improper conformal coating removal.

There are numerous methods for the removal of conformal coatings from an electronics assembly. The methods and materials used to remove

coatings are determined by the coating type, the hardness of the coating, as well as the size of the area requiring removal. The types of removal methods most often employed include chemical stripping, peeling, heating, mechanical abrasion, and laser ablation.

For some coatings, chemical solvents are used to soften up or partially dissolve the coating. The removal agent is either recommended or formulated by the coating manufacturer. Following the manufacturer’s guidance will limit potential board and component damage, though it is always a good idea to test the removal agent on scrap boards. In many cases, the solvent can be selectively applied using a swab, with the surrounding area being

masked off. Once the material is softened, the coating can be gently removed using a brush or wooden stick.

In many cases, a neutralizer then needs to be added around the removal area to stop the continuing effects of the solvent. Ionic residues can be left behind on the board if the removal



Mitigate the Effects of Tin Whiskers

Expert Phil Kinner explains how conformal coating and cleaning can protect your boards from corrosion and mitigate against the effects of tin whiskers!

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chemistry is not cleaned off thoroughly, thereby affecting the reliability of the assembly. Acrylic conformal coatings are the most sensitive to solvents, hence their easy removal using this technique. Silicone and urethane coatings are the least sensitive to removal solvents. In general, solvent removal techniques for epoxies, as well as parylene, are ineffective.

In general, solvent removal techniques for epoxies, as well as parylene, are ineffective.

Some conformal coatings can be removed by simply peeling or scraping them from the PCB and component surfaces. A dental pick, wooden stick, or sharp knife can be used to remove these soft coatings. This mechanical removal method may be used in conjunction with thermal or solvent removal techniques. Care needs to be exercised to make sure components, and the laminate are not damaged during the removal process. This removal technique is often employed when removing soft silicone-based or other flexible conformal coatings.

Another coating removal technique involves using a heat source to soften up or break down the coating. A hot air gun or soldering iron is usually employed as the heat source. After softening the coating, it can be removed by the application of gentle pressure with a dental tool or wooden stick. This removal method can work well with most types of conformal coating. Applying heat requires extreme care not to damage the underlying laminate or neighboring components. Acrylic, epoxy, and silicone coatings can be removed using this technique.

Microabrasion coating removal uses a variety of soft abrasives accelerated through a small inert gas-propelled nozzle to break down the conformal coating. Walnut shells, glass, plastic beads, and various powder mixtures are propelled to the surface to chip away at the coating. The air pressure, hardness of the removal

media, and nozzle diameter all have an impact on the efficacy of this removal process. An ionized air source is typically used to neutralize the static charge generated during this process. Proper masking of the board around the coating removal area protects the board and components. Typical conformal coatings where this process is used as a removal method include parylene, urethane, and epoxy-based coatings.

Laser sources are used in cases where precision conformal coating removal is required. The pulsed energy density of the laser gradually removes or ablates the coating material. A laser source with the correct energy level, frequency, and number of laser source passes needs to be established so that it only ablates the coating and does not damage the underlying or surrounding materials. Laser areas as small as a few microns can be selectively ablated. Parylene coatings can be removed in this manner.

Visual inspection determines if the conformal coating has been removed in the proper area. While there are analytical methods for determining whether the coating has been entirely removed, the UV tracer material as part of the coating formulation allows the coating to show up visibly under “black” lighting.

The removal of conformal coating in preparation for rework and repair on a PCB requires care as incidental damage to the laminate and components can occur during the process. The choice of method requires careful consideration, experience, and operator skill. **SMT007**

Further Reading

- IPC-HDBK-830: Conformal Coating Handbook Guidelines for Design, Selection, and Application of Conformal Coatings.
- IPC-7711/IPC-7721: Rework, Modification, and Repair of Electronic Assemblies.
- G. Caswell, “Coatings and Pottings: Issues and Challenges,” IMAPS, May 2014.



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

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Editor's Picks from SMT007.com

1 Ross Berntson: Indium Corporation's Pledge for Safe Resumption Post-COVID ▶

On May 20, Nolan Johnson spoke with Ross Berntson, Indium Corporation's president and COO, about the company's response to the COVID-19 outbreak. Berntson details the company's work with a consortium of manufacturing businesses in central New York state, developing a manufacturing pledge to keep people safe and keep factories running.



3 IPC's Shawn Dubravac: COVID-19 Outbreak Accelerates Industry Shifts Already Under Way ▶

On May 19, Barry Matties spoke with Shawn Dubravac, chief economist for IPC. While discussing other topics, Matties asked for Dubravac's perspective on shifts in the market, who observed that the recessionary trend might be behind us; the markets are already showing recovery. Still, it could take a year or so to fully recover.



2 X-Rayted Files: Why Do We Break Stuff? Intelligence From Teardowns ▶

The impulse to break a new gadget to "see what's inside" and to "learn how it works" is often the first sign someone will become an engineer. We've learned a lot in over a decade of teardowns, which have helped us to understand how the SMT industry has changed over these years. Bill Cardoso investigates.

4 Foundations of the Future: Scholarships, Leadership Roles, and Career Aspirations ▶

Scholarships are hugely important, especially when helping students avoid and alleviate college debt. Charlene Gunter du Plessis highlights some of the 2019 IPCEF scholarship winners, as well as a book on the topic written by Dr. John Mitchell, IPC president and CEO.

5 Critical Manufacturing Appoints E-tronix Upper Midwest Representative ▶

Critical Manufacturing, an ASM PT company, is pleased to announce the appointment of E-tronix as its manufacturers' representative for the SMT and electronics assembly market in the states of Minnesota, Iowa, North Dakota, South Dakota, Wisconsin, Illinois, and Indiana.



6 Indium Corporation Expert to Present During iNEMI Technical Session ▶

Indium Corporation's Dr. Hong Wen Zhang, R&D Manager, Alloy Group, shared his industry expertise during the International Electronics Manufacturing Initiative (iNEMI) Packaging Technology Integration Group (TIG) digital meeting on May 27.



7 Manncorp Assists Northwestern University's Efforts Against COVID-19 ▶

In the fight against COVID-19, Manncorp is behind the scenes, helping keep things going. Even in this time of social distancing, Manncorp is still dedicated to helping establishments—especially those on the frontlines—by providing equipment and service for bringing production in-house.



8 Quest for Reliability: New Solder, Same Old Testing ▶

Solder is inarguably one of the required building blocks for electronic assemblies and, apart from a few exotics, every assembly in the world has it. When it comes to meeting the lead-free requirement, opinions and historical reliability data are not taken into consideration. Eric Camden explores testing and reliability related to solder.



9 Survey Results: Five Tips to Stay Safe at Work ▶

Face masks, gloves, arrows on the floor, social distancing, working in shifts, working remotely—our work environment has been vastly altered over the past three months. How has it affected you and the people around you the most? Are you open to these changes, or do you find yourself resisting the changes? Here are five powerful tips for staying safe at work, according to the latest I-Connect007 survey responses.

10 Operational Excellence: Update Your Business Contingency Plan ▶

With the unprecedented events with COVID-19, companies are facing worst-case scenarios and looking at ways to manage work stoppage or limited production for essential manufacturing needs. Alfred Macha provides a practical guideline to create or update your business contingency plan to help you manage your business during a crisis situation.



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- Excellent team player that can lead projects and mentor others.
- Self-motivated, with ability to work from home with minimal supervision
- Multiple design tool skills are a plus

Primary Responsibilities

- Design project leader
- Lead highly complex layouts while ensuring quality, efficiency and manufacturability.
- Handle multiple tasks and provide work leadership to other designers through the distribution, coordination, and managing of the assigned workload.
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- Understand the customer's general business needs, and be able to effectively communicate Royal Circuits' unique approach to provide quick-turn PCB fabrication
- Develop and maintain technical knowledge of the various aspects of circuit board fabrication

PCB sales experience strongly preferred.

The successful candidate will demonstrate excellent communication and leadership skills as well as strong business acumen.

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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.

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Senior Process Engineer

Job Description

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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.

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- Be responsible for the implementation, maintenance, and improvement of all processes and procedures
- Review current and future technologies and make recommendations as to the most suitable direction for the future technical development of the company
- Ensure company is in compliance with legislative and regulatory requirements
- Supply technical support in all areas throughout the company in accordance with instructions of the operations director
- Collaborate with both quality and production departments to ensure the quality of the product
- Plan and manage the evaluation, introduction and acceptance trials of new equipment and processes
- CTO will manage the operational and fiscal activities of PCB engineering processes, procedures, technology, and the Somacis Process Engineering Team

Required skills:

- B.S. degree in chemical, electronic, mechanical or manufacturing engineering technology or 10 years of progressively responsible experience as an engineer in the PCB industry
- Minimum ten years' engineering experience in related manufacturing industry
- Ten years' progressively complex technical experience in PCB manufacturing processes involving the latest state-of-the-art applications and techniques

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- Expose dry film and liquid photo imageable ink
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If you are interested in this position, please contact Nita Buccino.
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Qualifications

Required: Bachelor's degree from a technical college/university in an associated field. Three years directly related experience, or equivalent combination of education and experience. Must possess a valid driver's license and have a clean driving record.

Preferred: Experience in control systems and electronic troubleshooting, as well as in general electrical and mechanical service tasks. Experience and knowledge in the PCB manufacturing process, with a focus on laser drilling and/or direct imaging.

Send resume to hr@burkleamerica.com.

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Process Engineering Director

Whelen Engineering Co., Inc. seeks full-time process engineering director in Concord, NH, to develop, plan and execute GreenSource Fabrication, LLC Div.'s process technology business strategy; manage process engineering activities, staff and compliance; improve process design, cost, quality and resource utilization; interact w/ customers and incorporate feedback; develop financial capital and labor projections; travel internationally for conferences, supplier and customer visits (15-25% work-time); write white papers, IP applications and give talks re. Division's products/processes.

Min. req.: U.S. Bachelor's or foreign equivalency in environmental science or engineering; min. 10 yrs. work exp. in: PCB fabrication process engineering; comprehensive and current experience in PCB fabrication/substrate markets w/ SAP tech; developing chemical and mechanical processes, chemistries and equipment for PCB manufacturing demonstrated by international experience implementing complex processes; ability to direct and troubleshoot PCB manufacturing problems; min. 5 years exp. leading, managing and training process engineering teams, developing and executing process technology business strategies and plans in worldwide PCB markets, including Japan, Taiwan, China, Europe; min. 3 years exp. giving talks, writing and presenting white papers; ability to travel internationally (15-25% worktime).

Send CVs to: Corinne Tuthill,
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Qualifications and skills

- A love of teaching and enthusiasm to help others learn
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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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Development Chemist Carson City, NV

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

Essential Duties:

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

Required Education/Experience:

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

Working Conditions:

- Chemical laboratory environment
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- Machine operators and production
- Research and development
- Operations

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Career Opportunities



SMT Field Technician Huntingdon Valley, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

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

We Offer:

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

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Sales Representatives (Specific Territories)

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

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for
more information.

mfariba@uscircuit.com

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Career Opportunities



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Zentech Manufacturing: Hiring Multiple Positions

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

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

Please email resume below.

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

For more information, click below.

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D.B. Management Group L.L.C. is currently working with many professionals who are seeking new positions. If any of these qualified professionals sounds like someone you would like to learn more about, contact **Dan Beaulieu** at **207-649-0879** or **danbbeaulieu@aol.com**. If you are a qualified professional looking for a new opportunity, contact Dan as well. Fees are 10% of candidates' first year's annual compensation. There is no fee for candidates.

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President, Company Leader, Business Builder

This professional has done it all. Built new businesses and turned around hurting businesses and made them successful. A proven record of success. This candidate is a game-changer for any company. He is seeking a full-time leadership position in a PCB or PCBA company.

General Manager PCB and PCBA

Senior manager with experience in operations and sales. He has overseen a number of successful operations in Canada. Very strong candidate and has experience in all aspects of PCB operations. He is looking for a new full-time position in Canada.

Regional Sales Manager/Business Development

Strong relationship management skills. Sales experience focused on defense-aerospace, medical, high-tech PCB sales. Specializes in technical sales. Also has experience in quality, engineering, and manufacturing of PCBs. He is looking for a fulltime position in the South-eastern U.S.

Field Application Engineer (FAE)

Has worked as a respected FAE in the U.S. for global companies. Specializes in working alongside sales teams. Large experience base within the interconnect industry. He is looking for a full-time position.

Business Development Manager

Understands all aspects of interconnect technical sales from PCB design and fabrication to assembly and all technologies from HDI microvias to flex and rigid-flex. Has also sold high-tech laminates and equipment. Proven record of sales success. He is looking for a full-time position.

CEO/President

Specializes in running multi-million dollar companies offering engineering, design, and manufacturing services. Proven leader. Supply chain manager. Expert at developing and implementing company strategy. Looking to lead a company into the future. He is looking for a full-time position.

PCB General Manager

Forty years of experience serving in all capacities, from GM to engineering manager to quality manager. Worked with both domestic and global companies. Available for turn-around or special engineering projects. He is looking for long-term project work.

Process Engineering Specialist

Strong history of new product introduction (NPI) manufacturing engineering experience: PCB/PCBA. Held numerous senior engineering management positions. Leads the industry in DFM/DFA and DFX (test) disciplines. He is looking for either a full-time position or project work.

VP Sales Global Printed Circuits

Worked with a very large, global company for a number of years. Built and managed international sales teams. Created sales strategies and communicated them to the team. One of the best sales leaders in our industry. He is looking for a full-time position.

Plant Manager

This professional has years of experience running PCBA companies. Led his companies with creative and innovative leaderships skills. Is a collaborative, hands-on leader. He is looking for a full-time position.

National Sales Manager

Seasoned professional has spent the past 20 years building and growing American sales teams for both global and domestic companies. Specializes in building and managing rep networks. He is looking for a full-time position.

Global Engineering Manager/Quality Manager

Has experience working with large, global PCB companies managing both engineering and quality staff. Very experienced in chemical controls. She is interested in working on a project-by-project basis.

CAM Operators and Front-end Engineers

These candidates want to work remotely from their home offices and are willing to do full-time or part-time projects.



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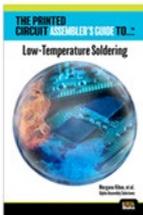
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Low-Temperature Soldering, by Morgana Ribas, Ph.D., et al., Alpha Assembly Solutions
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COVER: **SHELLY STEIN**

COVER IMAGES: **ADOBE STOCK © MAXICAM**

SMT007

MAGAZINE

SMT007 MAGAZINE®

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

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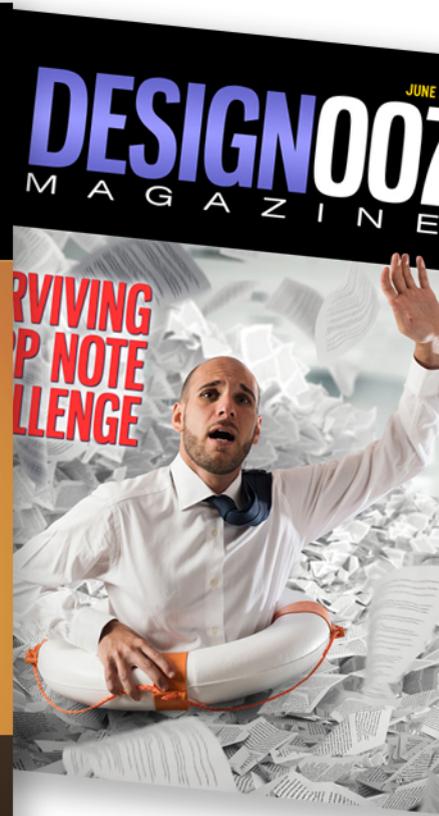
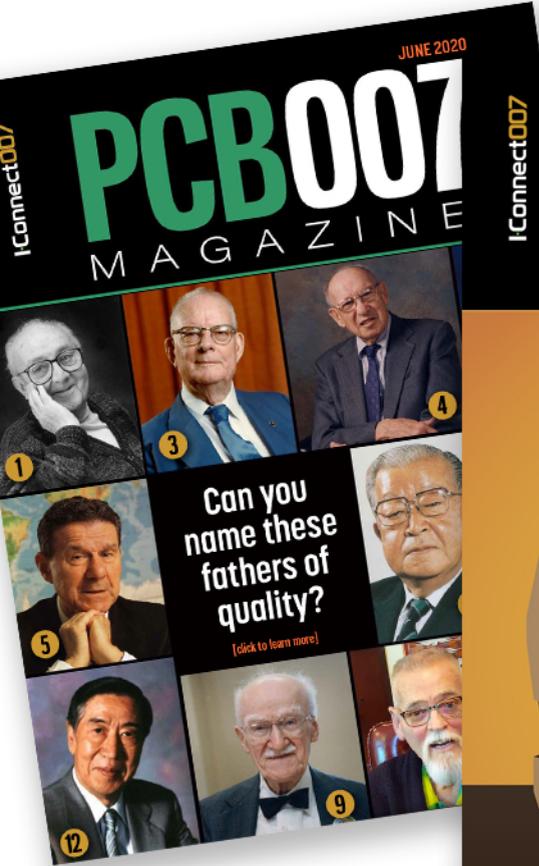
July 2020, Volume 35, Number 7
SMT007 MAGAZINE is published monthly,
by BR Publishing, Inc.

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