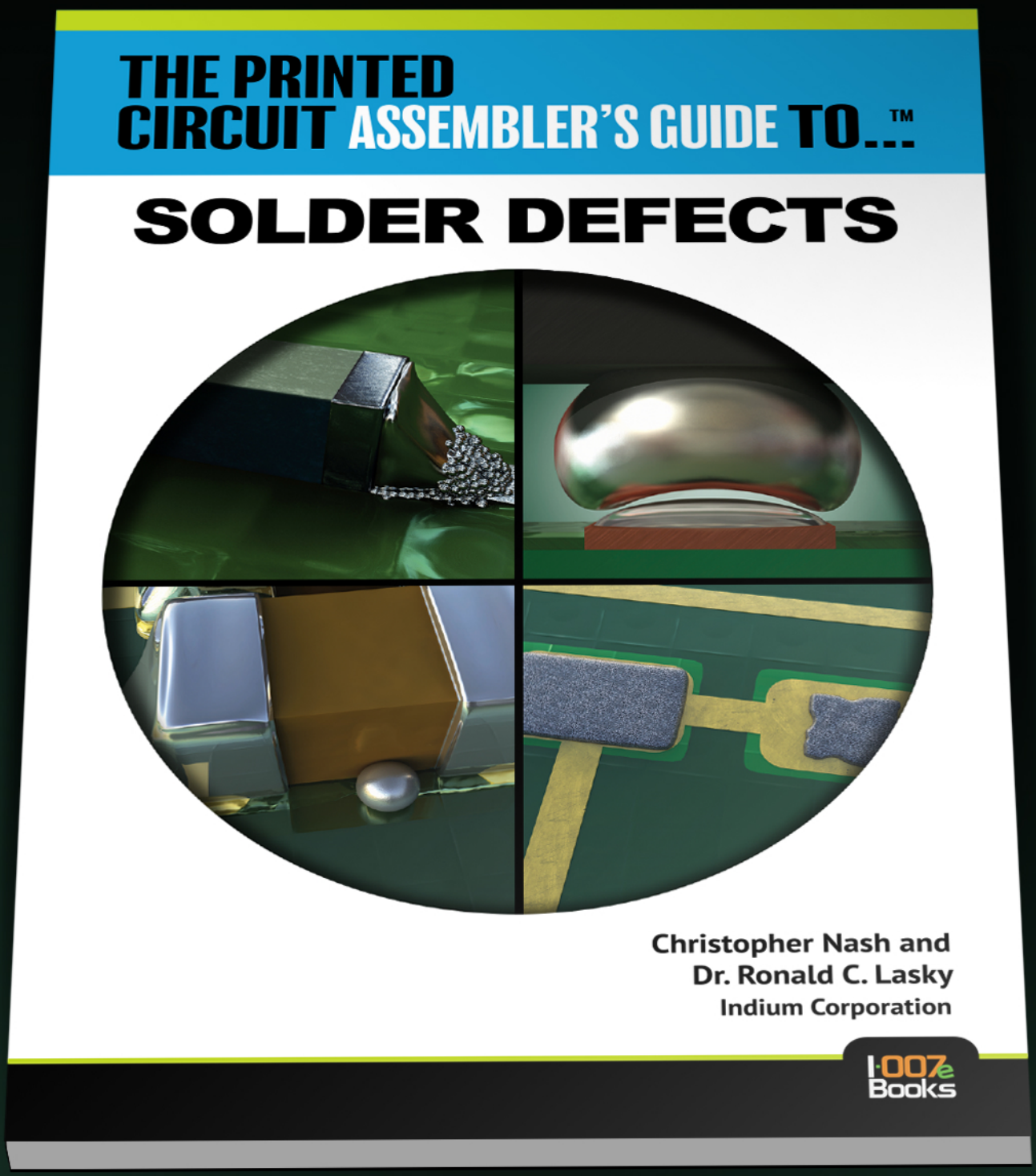
APRIL 2022

I-Connect007

SMT007 MAGAZINE



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SMT007 MAGAZINE

Factory of the Now

Global industry watchdogs are making the point that the Factory of the Future is actually the "Factory of the Now," and that North America is five to 10 years behind in adoption. So, what's it going to take for North America to catch up?

FEATURE INTERVIEWS & ARTICLES

FEATURE ARTICLES

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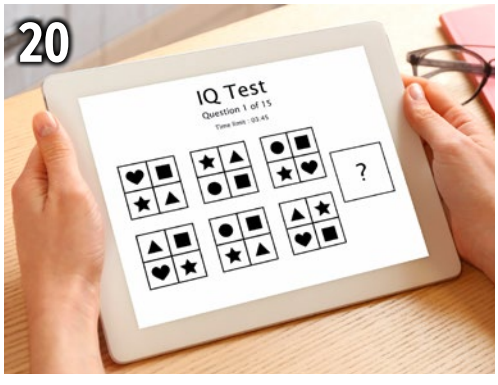
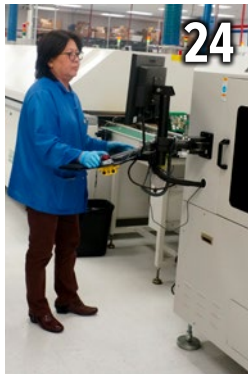
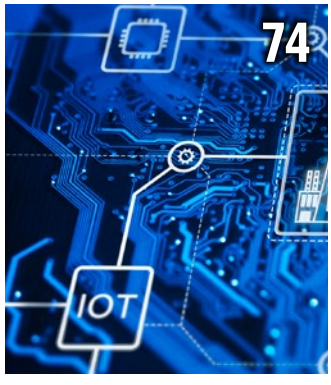
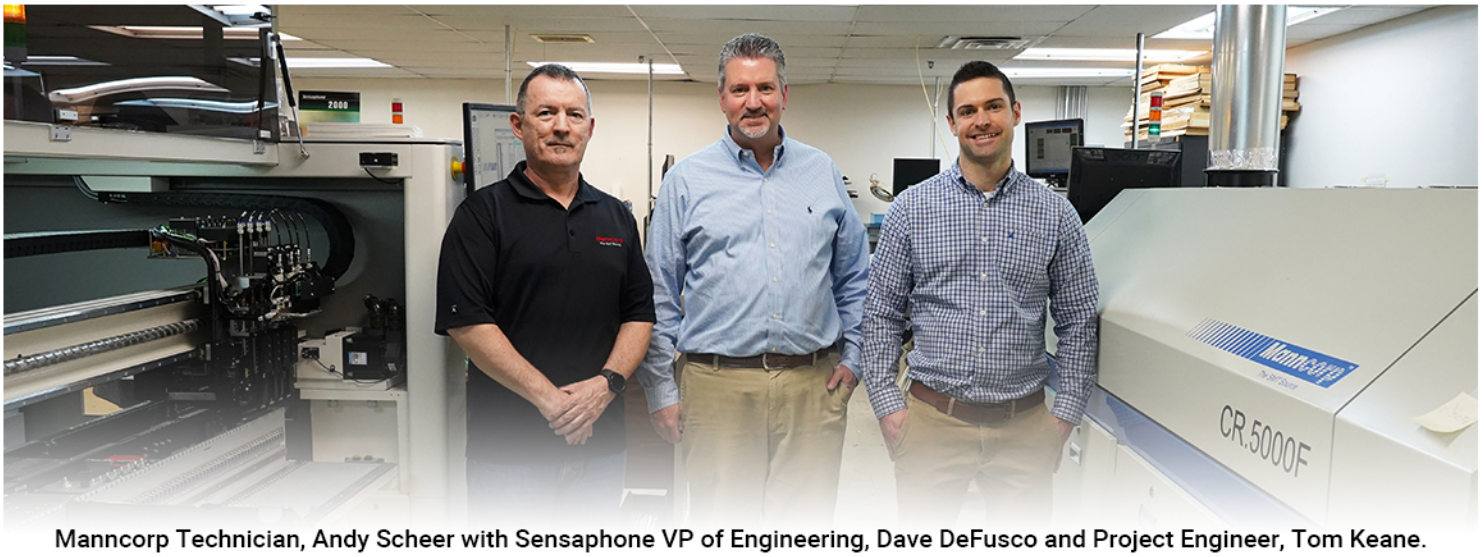






Manncorp and Sensaphone, A 12-Year Partnership & Still Growing

Each time Sensaphone adds a new machine, like the MC388 or CR5000 (below), Manncorp Tech, Andy Scheer goes to their Aston, PA facility to train their team.



Manncorp Technician, Andy Scheer with Sensaphone VP of Engineering, Dave DeFusco and Project Engineer, Tom Keane.

"There have been many times where Andy has stayed well into the evening to make sure that our machines are working properly and that we are fully trained in their operation," says Dave DeFusco.

Sensaphone uses Manncorp equipment to produce the Sentinel product line. The Sentinel series is easy to install and maintain, and is designed to last.

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What Are We Waiting For?

Nolan's Notes

by Nolan Johnson, I-CONNECT007

Someone spoke up over the din of editorial conversation about upcoming magazine themes, "I think the magazine tagline should be 'Factory of the Future: What the hell are we waiting for?'"

Now picture this: A bullpen office space with a big table in the middle of the room. It's slightly chaotic, with a bit of draft copy strewn about, some audio-visual equipment on a side table, ready to grab-and-go. Sunlight seeping in through partially closed blinds, creating sunbeams in the slightly dusty air of the room, the smell of fresh coffee, donuts, and shoe leather assaulting the nose. Feels just like the set for the 1960s-era *Village Voice* as portrayed on "The Marvelous Mrs. Maisel," doesn't it?

Except it doesn't look anything like that at all. I misled you a little with that description because that's the kind of environment journalism is expected to work in. That's still the

"present" in media, isn't it? Sure, the sets for the big news channels don't look like that, but that's the point; it's a set, not the real offices behind the back wall. It's just not how we work at I-Connect007.

No, our editorial meetings are teleconferences and have been for about 12 years. There is no physical headquarters. There is no bullpen office with an oversized table. We all work from our home offices or, if we're traveling, from a hotel room. The reality is, we all sit around our respective computer screens for our creative sessions.

I will admit that what I miss most about the old days is the smell of those donuts. Nothing said "sit back and let your brain spin up creatively" like the sugar and yeast high only a donut can give you. But I digress. The donuts didn't make the editorial team more productive; nor did that bullpen office, to be honest. It was simply the best, most efficient solution available at that time. But times have already changed.

The "media of the future" is now, and has been for some time. Barry Matties, our publisher, is unabashed about the fact that we need to be constantly changing, improving, updating, and trying new methods to bring the stories to the industry. As a company culture, we're trying the newest things as they're introduced to the market. Why? Because by the time we learn what the new technology can do for us, it's now ordinary. If you wait to learn about it until it's in the mainstream, you're too late.

Which brings me to the point of this issue: The future, ladies and gentlemen, is now. The Factory of the Future is a reality in some parts of the globe. So, if you and your facility aren't already migrating to Industry 4.0, you're at risk of being left behind. That's the message in our detailed interview with IPC Chief Technologist Matt Kelly, who follows up on his IPC APEX EXPO comments. That same message comes through loud and clear in our interview with Michael Kottke, CEO at Rocket EMS. His team has been implementing a digital factory environment for 10 years. Talking to Kottke helps you see where you'll be in five years, if you start now. I'm cutting my time estimate in half because Kottke and his team took a DIY approach at a time when there were no off-the-shelf solutions to even consider. It's a different world out there now. Which is why we also include additional perspectives from Aegis, Siemens, and Arch Systems.

Oddly enough, the topic I mention last is arguably where we all want to start: data security. To digitize your factory is one thing; to keep all that digital information safe is something else entirely. I met Ryan Bonner, CEO of DEFCERT, at the EMS Leadership Summit in San Diego in January. After a great conversation there, I called him to discuss data security issues in the context of a digital factory. While Ryan has plenty of first-hand experience in electronics manufacturing, he also draws from other industries to leverage their best practices. The key takeaway is that manufacturing sectors considered less high-tech than us are further along in digitizing their factories than the industry that's manufacturing the electronics they're using. Makes you stop and think, doesn't it?

There is a call to action here: Make your plan and implement it. Do what you need to do; it does not require buying all new equipment. There are other ways to get the data you need. But start to capture the data and then use it to optimize your business practices. Once you do, you will be—like Michael Kottke—addicted to the business intelligence you now have at your fingertips. What are you waiting for? **SMT007**

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

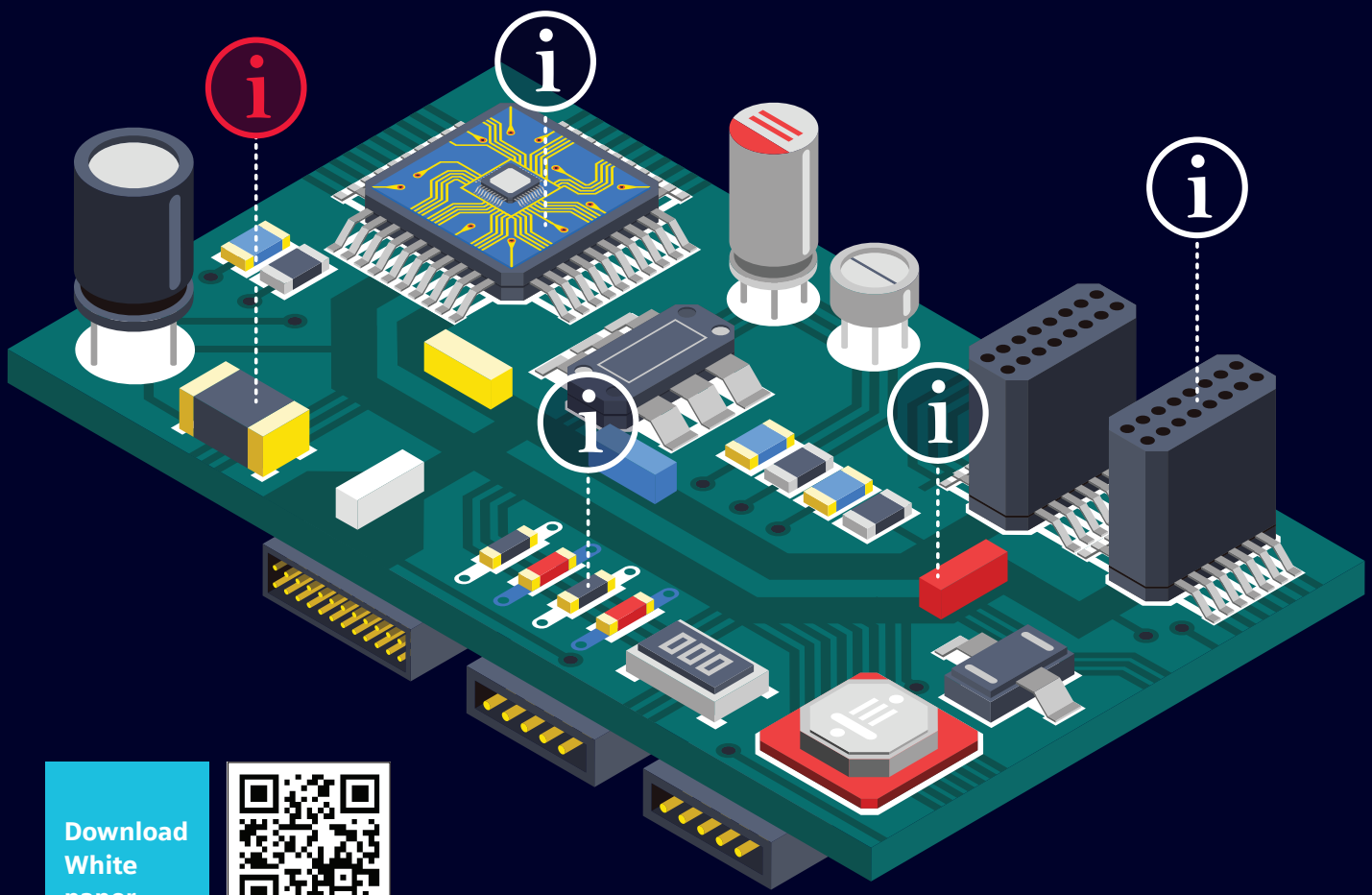
Matt Kelly: The Digital Factory Is Now

Feature Interview by the I-Connect007 Editorial Team

The I-Connect007 Editorial Team spoke with Matt Kelly, IPC chief technologist, about Factory of the Future. In this wide-ranging conversation, the team starts with the premise that factory automation is no longer a future topic, but a concern for right now. The conversation takes a closer look at the need for digitization, upskilling the workforce, ensuring ROI is gained from digitizing the factory and, at the center of it all, the need for a strong commitment to move forward as a company.

Nolan Johnson: Matt, you and John Mitchell have been making the point that North America seems to be five to 10 years behind Europe and Asia regarding Industry 4.0 and automation efforts. It was clear at IPC APEX EXPO 2022 that you were making that call to action. From your perspective, where does the electronics industry need to go?

Matt Kelly: First, we want to avoid the potential us vs. them, the U.S. vs. anybody. When we share the message that "North America is behind," it's meant to be encouraging and to set a tone of urgency. It's meant to say, "Don't kid yourself, because there are many companies that are already doing this." That's what I find really fascinating with the Factory of the Future. There are a lot more companies doing this than people think; they're just not talking about it. The reason is many are lower margin businesses investing hard-earned money back into their operations. Any gains they realize they want to either retain for themselves as profit, for organizational improvements



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Matt Kelly

or operational efficiency, or they're passing it along to their customers.

One of the difficulties is that many do not want to show their cards. Either they are remaining quiet about what they're doing, or they haven't started. They might not know where to start or what to do. Small companies think it's only for large companies, which is just not true. Most advancements we've seen during the pandemic are from small- to medium-size enterprises in Europe. That breaks the rule, right?

At the end of the day, we want to promote advancement across the globe to improve overall global supply chain and manufacturing advancements and to communicate that there is a big gap, which continues to widen, as long as North America does not implement Factory of the Future at the same rates as Europe and Asia.

Barry Matties: When we phrase it as "factory of the future," does that suggest we're still waiting for technology to become available, or is it already available?

Kelly: It's already available, and this brings up a good point about whether we need to change the Factory of the Future wording.

Matties: I think so, personally. It causes delays, allowing companies to say, "I don't have to think about this right now. Maybe a year, two years down the road." Meanwhile, as you're pointing out, there are companies today that are already investing in and implementing that future.

Dan Feinberg: By saying Factory of the Future, they think they don't have to worry about it now, but they do. Look at some of the planned factories, like Intel's new semiconductor facility, and some of the Taiwanese companies that are putting semiconductor fabs into North America. Are they using Factory of the Future?

Kelly: Yes, they are; they have to. The semiconductor industry has been automated and using closed-loop data feedback processes for over 20 years already, including in North America. They have to in order to achieve necessary yields and quality to be profitable.

Matties: How do we help the electronics industry to understand that we're not waiting for the future? We're not going to catch up if we're waiting around for the future to come to us.

Kelly: We must look at what we're building now. In fact, using the term "revolution" doesn't serve us well. We know very well it's more of an evolution. As an industry, we need to ensure we provide the building blocks today, not at some future date. For example, a company must first identify key business problems they wish to solve, then apply appropriate Industry 4.0 manufacturing techniques. Data analytics or other digital transformation concepts will improve manufacturing metrics like quality, yield, efficiency, and productivity. Start now, start small, deliver successful outcomes, and build upon that success with new initiatives and projects.

Digitization

Matties: What makes it the Factory of the Future? Is it sensors and big data, or is it that the machines are all automated?

Kelly: Hands down, the first thing is digitization; collecting and using data to its fullest, which is easy to say, and harder to do. With respect to automation, though, we need to continue to automate the end-to-end processes, from warehouse all the way to final assembly and test.

Matties: But that's something we can do today.

Kelly: Yes.

Matties: Do we have all we need to do that today?

Kelly: Yes. There is a hierarchy of technologies. For example, people say, "I'll use machine learning or AI." There is a lot of AI capability right now, especially vision-based AI, but you can't utilize AI without data. Data analytics, consuming data, and moving data are prerequisites to do AI and machine learning.

It's important to include sustainability. We need to be stronger about sustainability, starting with original design and moving all the way through. All too often this ends up at the bottom of priority lists, but it's a critically important factor that needs priority attention today. When it comes to sustainability, Europe seems to be doing a much better job than North America.

What makes a Factory of the Future? Is it automation? Sure. Continued automation is important. But, while many processes are automated, many still are not. Automation improvements in the warehouse are needed, for example. Back-end assembly automation advancements are also needed in test, mechanical assembly, final system box build, and the like. Data is great, but it's also dangerous. We need secure networks to protect manufacturing performance data. Companies are looking for more transparency with quality, yields, and deliveries, but that data needs to be secure between assembler and customer. It would be damaging to pass around quality data and yields, only to have it fall into the wrong hands.

Matties: Isn't there a dependency on the design data as well?

Kelly: Yes, and that's the biggest one of all. We know everything starts with design. The concept of a digital thread is the nucleus; it explains the data and everything else. Digital thread depends upon having your design correct in the first place; then it gets built up to the system level. You can see how it was made, what's inside, and how it was qualified. It really is the big view.

The concept of a digital thread is the nucleus; it explains the data and everything else.

Johnson: Matt, to that point, which is the tail, and which is the dog? Is the design tool environment driving the manufacturing changeover or the other way around?

Kelly: The design data should drive everything, but what continues to happen is that data is peeled off as needed. This has been going on for 50 years; we just peel off the data segments that each entity cares about. It's not a holistic view, even though it comes from the original design. For example, centroid data for component placement comes from the original board file. A stencil design comes from the top copper layer of a design file.

Matties: Obviously there's a huge benefit by bringing the factory into that digital thread.

Kelly: It's becoming a business—or a competitive—imperative. If North America wants to compete within commodity-based electronics manufacturing, it needs to be super productive and super-efficient. How do you do that? Factory of the Future approaches can enable that if you do it right.

Matties: Maybe digitized factory is a better term? The digitized factory gives you the competitive advantage, especially if you understand how to utilize that data. The data can be overwhelming if you let it.

Skilled Workforce

Matties: What about the workforce, Matt?

Kelly: There is a fear that we're taking away people's jobs. However, I don't really subscribe to that. I see it as a reduction in low value-add areas, but I would also look at it as making your engineer or operator able to look after multiple parts of a process. Instead of having multiple supervisors—for example, a front-end supervisor for print and for placement and a back-end supervisor—there can now be one supervisor who can look after the whole line. The idea is to give your workforce "superpowers." They have all this data at their fingertips; they can see production levels, quality, and yield in real time. To me, it's an upscaling of your workforce, not an elimination.

Johnson: There's a precedent in semiconductor as well. We're fabricating at around the same sorts of dimensions as semiconductor when they had to make changes in their manufacturing or lose profitability through low yields.

Kelly: Essentially, you're right. We're adopting what the semiconductor industry has already been doing for many years now.

Matties: Dave, I'm curious what your thoughts are on this subject matter.

Dave Hillman: Matt is exactly right. Some might feel that, if they bring in a machine, then there goes the workforce. Rather, why should a human being stuff a part into a board 500 times a day when a machine can do it? Put the people on something that a) a machine can't do, and b) actually requires a brain? Let's put the talent where the talent is needed. Repetitive tasks are what machines and robots are for. My colleague Tim Pearson used to work at a foundry that ran on statistical process control. That facility was hands off. In semiconductor, they're using gases and materials that tend to cause death when people come into contact with them. It was 100% automated; the machines did all the work, and spit out acres of statistical control data, which the people then managed.

Let the machines do what machines do best and let people to do what people do best. We're to that point in PCB assembly, too. I can take a machine, and I can put 5,000 resistors down on a board in two minutes. I don't need a person doing that work. The semiconductor guys are already there, they're utilizing data to drive processes, and the people are utilized where machines can't do things.

Return on Investment

Johnson: When you say, "We need to be more digital," who is that message going to?

Kelly: There are two main groups that I can see. One is the big multinational companies. They work in the global supply chain right now, so they might be doing some of this in Thailand, Singapore, etc. But then there are North American manufacturers that might not be the multinationals. It might be a SME (small to medium enterprise) type of group. That's the dilemma: We must know exactly who we're sending the message to because objectives are different for a big company vs. a small one.

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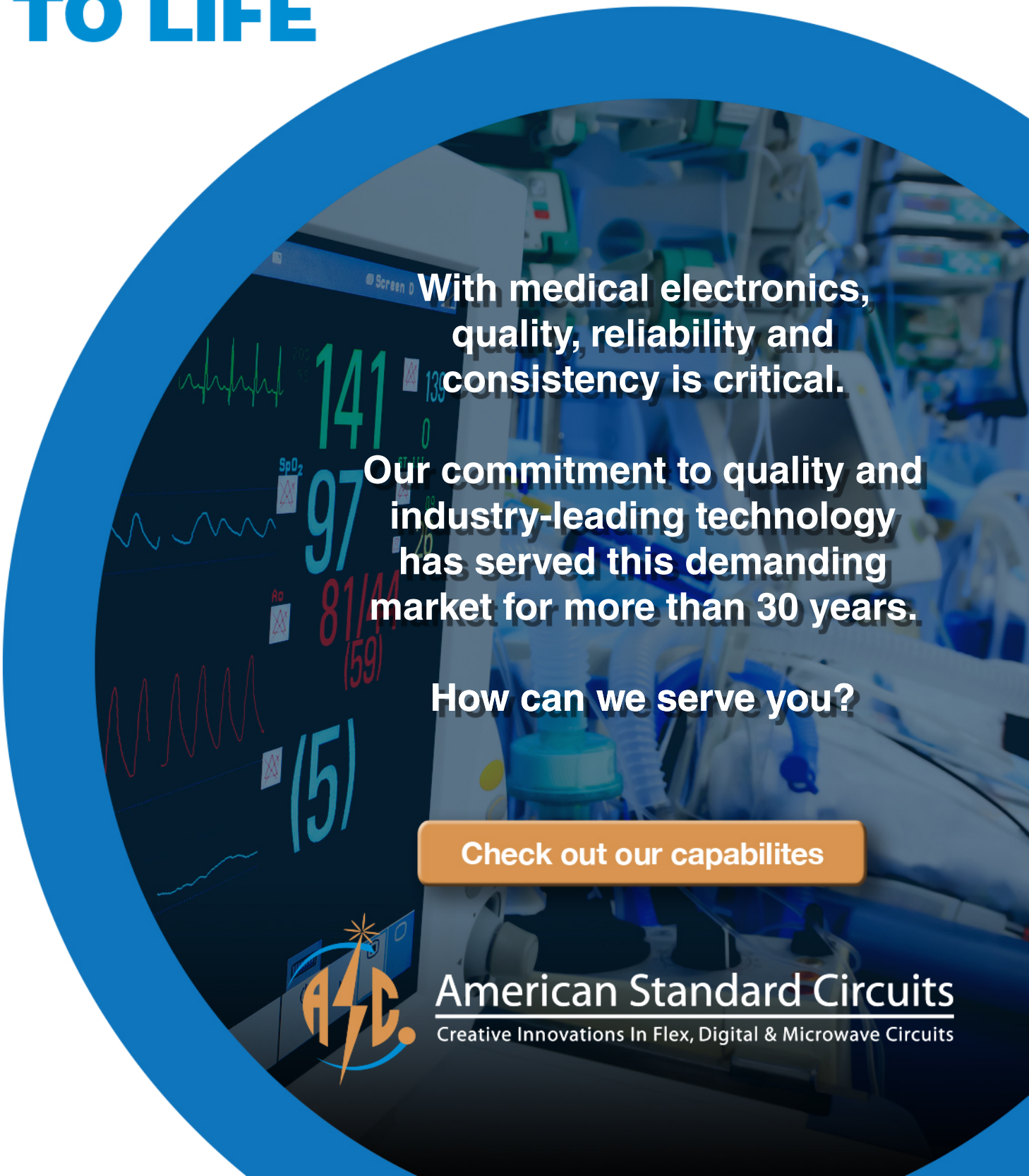
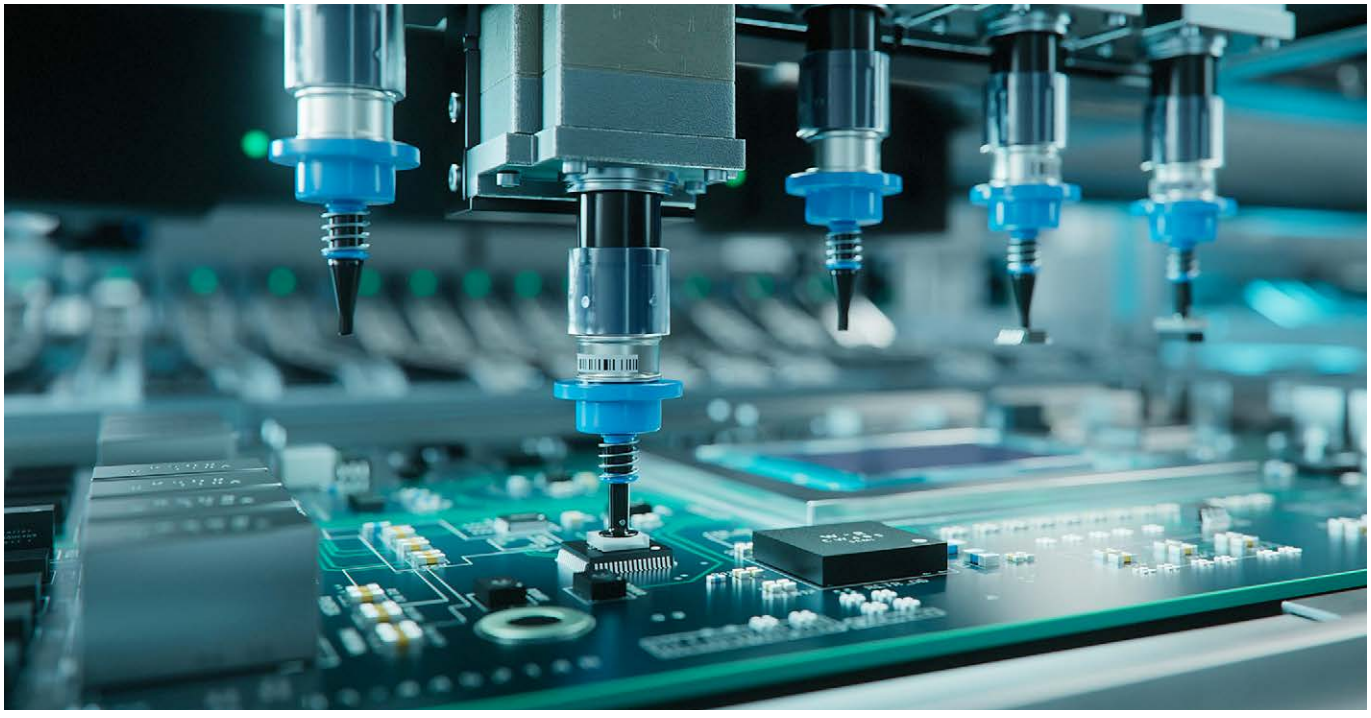




Matties: Tier two manufacturers, wherever they happen to be, are probably the group with the most room to move into digital. As you're pointing out, the big multinationals who are manufacturing are already automated.

Kelly: I first saw the signs of real commercial smart manufacturing in 2016 in Shenzhen.

Matties: We have some examples of it, too. One of the companies I toured four or five years ago was in Santa Clara. They had built their own communications throughout the entire factory. At that point, it was probably the best DIY that I've seen in the industry. The results they were getting back then were quite convincing. *[Editor's note: See 'The Future is Driven by Data' on page 24.]*

If you're looking to bring in sensors and digitize your factory—the data part of it—is this something that is more knowledge-based or cost-based?

Kelly: There's absolutely a cost, and that's why we need this kind of ROI discussion.

Matties: Where are they spending the money?

Kelly: Capital equipment. There's capital being spent on robots, cobots, and machinery. CFX (Connected Factory Exchange) can be used as an example: the adoption rate of CFX is growing; CFX connectivity is native in many new machines as is CFX integration with legacy equipment. The industry is now looking at new ways to activate CFX with legacy equipment as well. Of course, there's development and cost to do that.

But there's also a need for data scientists like Dave was talking about—statistical process control, gathering that data, making insights. There are data science functions that need to be activated much better than they are today. Naturally, all these activities have a cost. The question often asked is, "What does it do for me?" It always comes back to an operational improvement. It must come out in better yields, faster delivery, and faster NPI cycles. It doesn't have to be a revenue stream necessarily, but it's either that or a cost advantage.

Hillman: Cost is the easier way to do it. It doesn't have to save me money if my on-time satisfaction with my customer, or my on-time delivery goes through the roof to 99.9%, and you show

that's because of using the data analytics. That itself is value, that is money.

Matties: When I was in Santa Clara, the way they loaded their factory floor was optimized to degrees that they never achieved with just a human planning their production schedule. When you start adding up the benefits, the capability may also improve, you can open new markets, and you can attract new customers because you are a state-of-the-art facility. The marketing benefits extend deep and wide as well.

Kelly: This gets into a cost-plus discussion. Again, this is all positioning. If you go into Factory of the Future saying, "You've got to do it to be competitive and to make money," that's fine. But again, there are other issues which we're trying to raise, such as resiliency. I don't know how you put a dollar figure on resiliency, but as we know all too well today, a global supply chain model can cause havoc if you can't get the parts where they need to go. I've been trying to detail all the typical costs, but there are intangibles like the sustainability of the supply chain, or resiliency of the supply chain. There is value in being able to continue to produce no matter the circumstances.

Matties: These days, supply chain is always questioned and that leads to insecurity. That's a topic people definitely pay attention to.

Johnson: It's something you can measure in your on-time delivery to your customer.

Kelly: Agreed.

Johnson: Matt, we're talking as if there's reticence in the industry to invest and move forward. Earlier, you said there are plenty of companies doing this work, they're just not promoting it. If we were to generalize the industry, are we dealing with a lot of inertia to make this change in North America, or is it being done quietly?

Kelly: In mid-2020, the implementation rate was 20%; I don't think it's much higher now, maybe 25%.

Johnson: So, there are those leaders, those early adopters and then there are a lot of companies that are still further back on the adoption curve?

Kelly: Yes, but it depends on geography. If you did that measurement in Europe, it would be better. In North America, it's not as good, and globally, it's still low.

Hillman: I like this baseball analogy. In the movie "Moneyball," they examined what the Oakland A's did to remain competitive as a small market team. If you embrace the numbers the way Matt is suggesting, there are examples that are even simpler to examine than using semiconductors as a parallel. But statistics scare people, they're hard to deal with.

Management Commitment and Vision

Matties: How do we move forward? It's a choice, obviously, that OEMs and manufacturers need to make on whether they're going to invest the money. As you point out, Matt, at some point they're not going to have a choice; it will be a requirement to do business. Maybe they'll piecemeal it in over time?

Kelly: In terms of next steps, we have the big multinationals and SMEs. That needs to be put at the top of our list because we don't want an SME in North America to roll their eyes and say, "If I only had $700 million, I'd do it."

The conversation around the industry seems to be saying, "For the big multinationals, here are the types of things you can and should be doing." By the way, they probably are, and that's the stuff they're not talking about. It shows the leadership what the leading edge can do. I think the real implementation gap closure can be within the SMEs in North Amer-

ica. You don't need $700 million; these are the kinds of things that you could and should be working on."

Matties: Right. Step one is building the digital platform because you need to have that for all the other dependencies between equipment—your AI, your communication, and so on.

Kelly: That's why all the "cloud wars" have been going on for 10 years or more. Everybody saw the cloud infrastructure as something we'd be needing.

What's the Tipping Point?

Matties: Matt, with an event like IPC APEX EXPO, you had your Factory of the Future set up on the show floor. What feedback came out of the show?

Kelly: We see some nice trends showing up. For example, companies approached me regarding machine language and artificial intelligence within design. That's very good. But the quality of some other areas in Factory of the Future, I would classify as medium. We are still very much in an advocacy and education position right now.

Johnson: Happy, can you recall an industry-wide compelling event in semiconductor, where the industry said, "Okay, now we need to do this"?

Happy Holden: Yes. It had to do with the rapid increase in the complexity of semiconductors. When I was in college, we had six transistors per chip. Forty years later, we're now talking about billions of transistors. The complexity and the density pushes you over the edge, and we've discussed that with semi-additive technology and additive technology. We're at the geometries now in microns that the semiconductor guys used to be in. I think that's a tipping point for us. If you're going to do six- and seven-mil lines and spaces, you're probably not going to invest too much in digitization, but if you're looking at features in the microns range, it's a necessity.

If you're going to start playing in the game of 30-micron, 20-micron, 10-micron, or 8-micron, then you're going to have to do something different. The semiconductor industry did that because of complexity, and other factors like predictive maintenance. Not preventive maintenance, but predictive maintenance, because the equipment is getting so expensive, you can't afford any downtime. That focused a lot of automation and digitization for the semiconductor guys because of the value. But then right after that came the liquid crystal display, then photovoltaic that adopted the same strategy.

Dave brought up the example of a stencil. The logical next step with a stencil is that your AOI looks at the output of the solder paste step. Then, a little further down, after reflow, is there any tombstoning or something like that anticipated? Through various models, and utilizing the sensors and statistics, a cause and

effect emerges in terms of how you should have changed the pressure, the angle, the velocity, or the viscosity of the solder paste to decrease the number of defects.

There is a dependent variable in terms of how the stencil was designed to process in which you feed back not only to the stencil maker but eventually back to the OEM to say, "We have some best practices here that will improve quality, yield, and throughput. But it means you need to change some of your library functions, because we've been forced to change them for you in making the stencil because of what we're learning." The whole point of digitization is closing those loops for better performance, which hopefully at the bottom line means productivity, profits, and return on investment.

Matties: Matt, do you have any closing thoughts?

Kelly: I think we're all saying the same thing. Taking all this and putting it into real execution and implementation next steps is key in moving the needle forward. It's not easy.

Matties: No, it's not.

Kelly: Happy, I really like your approach. You should start small with very digestible projects that are successful and deliver value, so you can obtain funding for the next one. Treat it as Lego building bricks, for example.

Holden: It all starts with design. But when you're in manufacturing, it all starts with insightful engineering in terms of cause and effect and the root cause of this problem, however you define that problem.

Kelly: Thanks everyone.

Johnson: Thanks everybody. SMT007

Helping the World Build Electronics Better

Hundreds of experts from around the world will discuss electronics manufacturing standards in more than 80 standards meetings May 7–12, 2022 at IPC SummerCom in Milwaukee at the Wisconsin Center.

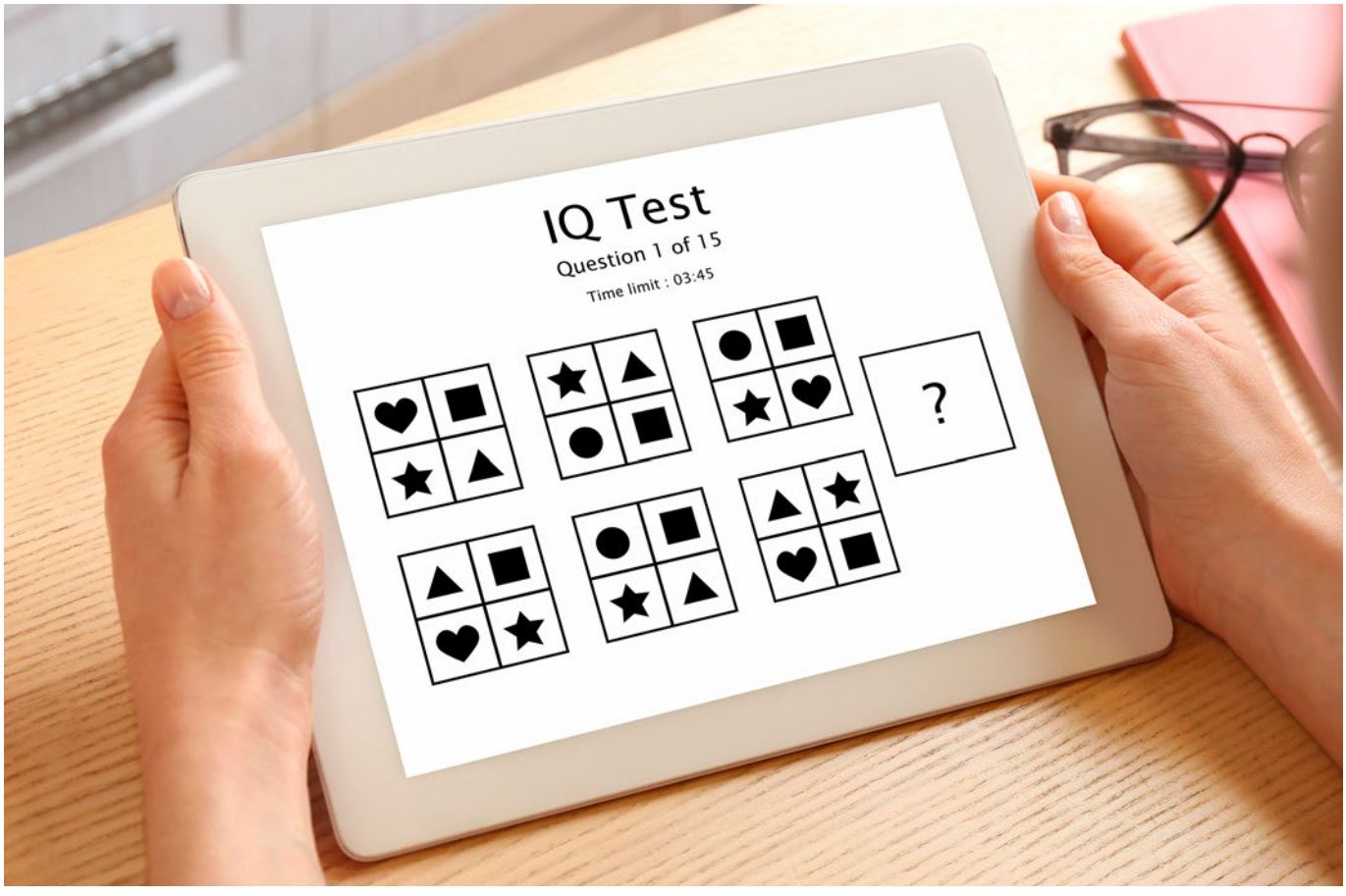
Facilitated by representatives from OEMs, PCB manufacturers, EMS providers, design firms, and other organizations, IPC standards development committees establish benchmarks for excellence in electronics manufacturing.

According to David Bergman, IPC vice president of standards and technology, "IPC's internationally recognized standards cover nearly every stage of the electronics product development cycle. Through standards committee meetings, everyone in the industry can engage in an exchange of ideas about current industry trends as well as the identification of new standards and updating of current ones. IPC standards help our member companies ensure superior quality, reliability, and consistency in electronics manufacturing."

Standards development committee meetings will cover: industry benchmarks in assembly and joining; assembly equipment, base materials; cleaning and coating; electronic documentation technology; electronic product data description; embedded devices; environment, health and safety; fabrication processes; flexible and rigid-flex printed boards; high speed/high-frequency interconnection; management; packaged electronics components; printed board design, printed electronics; process control; product assurance; product reliability; rigid printed boards; terms and definitions; testing; and wearable electronics/e-textiles.

This year, IPC SummerCom will be co-located with the Electrical Wire Processing Technology Expo (EWPTE). IPC SummerCom registration gives participants free access to EWPTE.

How Smart Are You?



Feature Article by Michael Ford
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The standard IQ test has been established for many years now. Though the content within these tests has been cleverly and carefully put together, there are different kinds of "smarts" among people. It is likely that those who are putting together IQ tests will favor the kinds of "smarts" that they themselves have. Humans are very complex, however. Everyone is different, with natural skills and abilities in a multitude of disciplines: technical, artistic, social, and others. Put us all together as a society, and we make a pretty good team, at least when we all work together and support each other.

You would think that in the case of manufacturing technology, the whole process should be a lot simpler. How would we assess the IQ of a Smart factory? There are many kinds of "smarts" that should be considered—as many as there are machine technologies and software automation opportunities. In humans, it is quite a challenge to improve our IQ, but in factories, it has become increasingly easy through the greater availability of data, and evolving software technologies. People with higher IQs tend to be specialists in a particular way. In our factories, we need a good balance of intelligence, for example, not only machine learning on a single machine, closed-loop feedback on a specific line configuration, or automated logistics decision on some of the materials.

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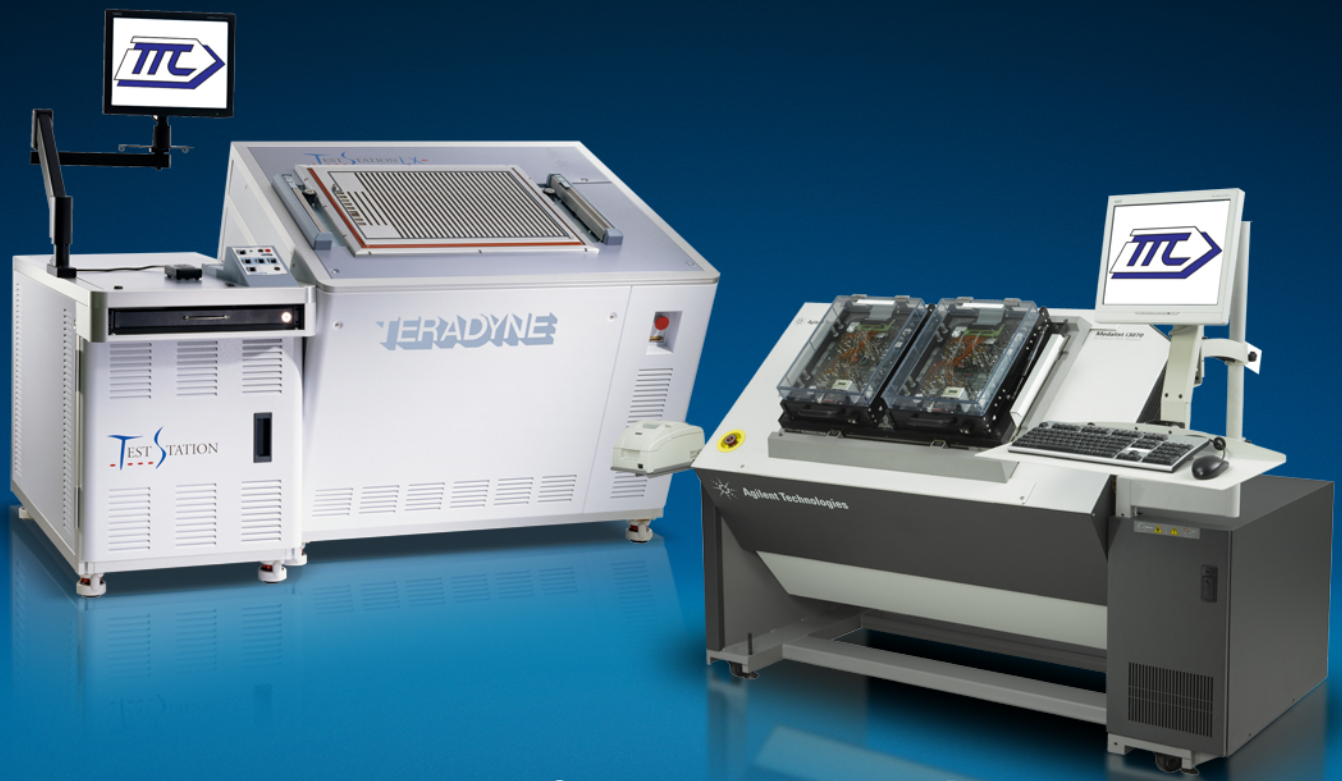

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In order to assess the artificial intelligence quotient (AIQ) of the factory, we need to look into all the main factors that potentially contribute; that is, the degree to which we are utilizing available and practical technologies. This way we can look for areas of improvement that typically, for example, would utilize existing data in a new way to automate an additional function, or gain insight into potential problems with greater detail.

In order to assess the artificial intelligence quotient (AIQ) of the factory, we need to look into all the main factors that potentially contribute.

A major challenge is the relationship between data acquisition and utilization, being very similar to the chicken and egg conundrum. Gathering data from automation represents many difficulties, including the electrical connection, protocol, data encoding, and differing language definitions and implementations between vendors, even when following familiar legacy industry standards. The IPC Connected Factory Exchange (CFX) is the first standard that addresses all these issues, founded in electronics, but applicable in all forms of discrete manufacturing. Whichever method of data acquisition is chosen, however, significant costs are involved, which in themselves lack a business purpose, as data itself represents little value until utilized. On the other hand, why develop Smart factory applications when there is a lack of data, or more seriously, where the data is not practicable due to lack of context and even a consistently defined meaning. To achieve the Smart factory business case, both data acquisition in a cost-effective way needs to be present, as well as a clear value-driven roadmap of data utilization potential.

The "Discover Your Smart Factory IQ" white paper[1] sets out the most common aspirations of those who have discovered Smart manufacturing applications, using a defined set of rules that guide the reader through the assessment of the current level of Smart factory achievement, as well as immediate readiness for the next stage of technologies, and then on to the ultimate roadmap toward all the benefits that data-driven manufacturing can offer. Any factory operation that is seeking to improve the level of digitalization, to make digitalization more cost-effective and affordable in terms of return on investment (ROI), or simply benchmarking differing operations within an organization to determine strategy, will find this white paper an invaluable tool in the practical measurement and assessment for Smart factory technology.

Call To Action

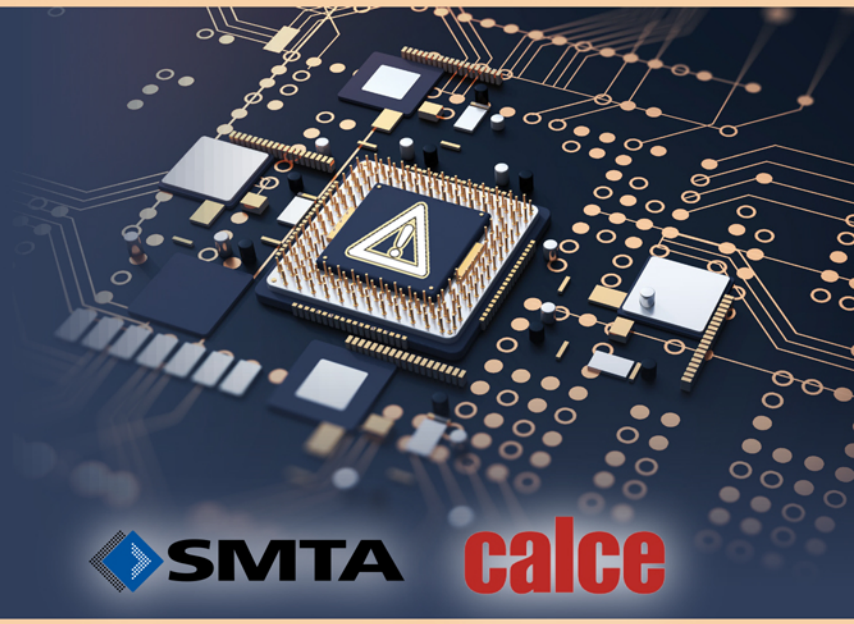
What is your Smart factory IQ? Where are your most effective investment opportunities for data-driven Smart manufacturing? This white paper enables you to measure and discover how Smart your factory is and identify cost-effective actions to close gaps and achieve your full digital manufacturing potential. **SMT007**

References

1. "Discover Your Smart Factory IQ," Aegis Software Corporation.

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

Symposium on Counterfeit Parts and Materials



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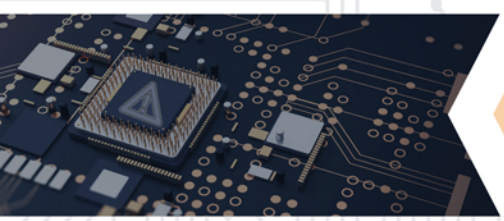
The symposium is organized by SMTA in conjunction with the Center for Advanced Life Cycle Engineering (CALCE) at the University of Maryland, College Park, MD, USA. This symposium is a valuable resource for quality and reliability managers, supply chain managers, brand protection specialists, inspectors, marketing and procurement policymakers, contracts and legal management, security specialists and government agencies. Our focus is to provide relevant information to the professionals that can be used for solving problems today while planning for a different business and technology environment in the future.



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The Future is Driven by Data

Feature Interview by the I-Connect007 Editorial Team

When we visited Rocket EMS in 2013 to observe a DIY 4.0 factory data collection and management system in action, we were very impressed. This was clearly a factory of the future, even back then. We recently followed up with Rocket's president, Michael Kottke, to discuss how this work has given the company a huge advantage over the competition. The moment he realized he's now in a data collection business that happens to build printed circuit boards, everything changed. Is this where all companies should be headed? Perhaps, but you'll want to take a cue from this type of innovative thinking.

Barry Matties: When we ask for a definition of Factory of the Future, we see it boils down to the data—incorporating it throughout the equipment, the facility, and your management, as well as interpreting and utilizing the data. There's also the mechanization of process, which is the automated aspect of the machines doing the work, moving material, and so on. When I visited Rocket EMS back in 2013, you were already well ahead of the curve.

Michael Kottke: The most important thing about the Smart factory is building the factory to what you need to support. I hear everyone talk about the Smart factory, the connected factory, but depending on what you're doing and what customers you're supporting, it means two vastly different things. If you're building 40,000 boards a month of the same thing, it looks a lot different than having 100 different customers a month. We want to look forward to what the customer needs and support that by building a factory that supports a high amount of change, very fast turns, and lots and lots of data. That's proba-

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bly what has driven us, and it's such an incredible ride right now.

Our new facility is in Carson City, Nevada, and it's significantly bigger than our Santa Clara, California, facility. Carson City will do more production than the one in Santa Clara because building production just isn't economically feasible to do in the Bay Area. It's significantly more expensive to build in Santa Clara than Carson City for many reasons, including power, insurance, and so forth. The overhead is a drop in the bucket. We can be much more competitive because we can do production in Carson City and leverage all the tools of Voyager, our software platform. We are actively extending Voyager to support multiple locations and full-blown production.

Matties: Michael, when did you start or bring your Carson City plant online?

Kottke: We secured it two years ago, started with the logistics and system integration, and added SMT mid last year. It's just awesome.

Matties: You're filling it to capacity, or do you have more room?

Kottke: I have so much more room.

Matties: Please talk about your software platform and how you decided to be a data-driven factory.

Kottke: Data is everything. I tell everybody that we're not a manufacturing company, we're a data collection company that builds printed circuit boards. It's gotten to the point now where there's so much data in Voyager that it drives every decision and predicts solutions. Now we have so much data that we can take it and look at everything from quoting and pricing a job, to equipment selection, and defect prediction scenarios where we can flag, "These components are something that we see a higher number of defects on. It's in a new design, so how do we prevent it?"

Matties: Now, your platform considers the work coming in, looks at the components and other factors, then optimizes the flow in your factory for the day, the hour, or the minute. You would be able to shift work around on the fly.

Kottke: We do. Voyager changes the schedule hourly. Just this morning, we were trying to figure out how to slip a hot job in for a customer that wasn't on the schedule. They wanted us to figure out how to build it today, and it's a big job. That's just a normal thing for us, but the rate of change that customers send our way just continues to increase.

Matties: With the platform you're using, it's not necessarily a human sitting there trying to figure this out. It's your platform that's doing all the computation, the AI if you will, to optimize your factory.

Kottke: That's right. A person double-checks the computations, though, because the platform isn't yet smart enough to figure out whether the customer is giving us accurate information. We probably get told every day that something's going to clear, and it doesn't. You wind up putting a job into the schedule, you can't run it, and then you're changing the schedule again.

Matties: Now to clarify, Voyager is your own platform that you developed?

Kottke: Yes, it's my genius marketing tool that we built because after so many years of trying to have third party software talk to the MRP and the QMS system, it was costing too much—something like $30,000 to $40,000 a month to have a bunch of software trying to talk to each other. We built our own and it's been a great investment.

Matties: There had to be some tangible ROI beyond just the software to realize some competitive advantage.

Kottke: Yeah, for sure. Voyager probably closes 90% of our sales tours. When you tell a customer you have data on almost three million boards assembled, it's compelling. Our record is 17 customers in a row. After the tour, they either ask, "At what point do you stop doing contract manufacturing and focus on software?" or they say, "Voyager is worth more than Rocket, so what's the plan?"

Matties: With the monitors everywhere in your facility, and the control you have with all the data coming at you, how do your competitors stand a chance?

Kottke: If our competitors don't collect huge amounts of data all along the process, I don't know how they can survive. Here's a great example: We just worked with a customer who was complaining about a pricing scenario. We were able to break down every single process step, and tie it all back to one single part. They were shocked. They said, "Why doesn't anyone else push back on us?"

Matties: And sourcing?

Kottke: We're doing a lot of really cool things. We're looking at purchase history for the last 10 years, and then we compare that to the current MRP demand. Here's another example. There's a connector for which we bought 1,500 pieces; the connector is $11 and some cents, in small quantity buys. We went back through and found we buy that connector 35 times a year because we have many customers who use it. With the data, business analytics, and some quick measurements, we realized that if we buy the components in 500-piece quantities, we could have bought them for $8 each. Thanks to the software, I can tell you that we have 11 component parts going onto boards that we've purchased more than a million of each. That's good information to know when you're a purchasing person.

Matties: That's big—now more than ever, due to the current supply chain.

Kottke: Now we're talking about a $4,500 positive PPV on one line item, for a customer that generates almost 700 line items. When we can start analyzing costs like that, for example, doing 35 line items where we're purchasing it, that's 35 line items on a purchase order or (worst case) 35 purchase orders. Now you take out maybe 32 receipts, 32 purchases, 32 invoices, and then you're starting to make huge advantages.

Matties: How do you manage this, in terms of programming and data collection, organizing, and sorting?

Kottke: We hired someone in business intelligence (BI) and that's all he does is create reports that highlight where the problems are and predict where they are likely to be in the future. It has been so worthwhile, especially when he keeps pointing out ways to save costs and I realize I had no idea. If you can cut 100 to 200 line items out a week, you're talking about a buyer FTE, a receiving clerk FTE, not to mention the part going through receiving inspection, and getting put into the stockroom. If you replace those 35 times with three, they put 500 parts in the stockroom one time, instead of 35, or three times, so you save labor across the whole process, and if you don't have somebody who's analyzing the data and looking at it, you miss that kind of stuff.

Matties: The data is there, you just have to extract and utilize it.

Kottke: In the movie "Flight of the Phoenix," a plane crashes in the desert. One of my favorite scenes is when the guy explains that if you walked to the nearest town 10 or 15 miles away and you're off by two degrees you would walk right past the town and never see it, even though it's just two degrees. I compare that to running the BI software; you find these glaring things that you would've just walked by and never saw. It's shocking.

Matties: What was the most surprising point in this journey for you?

Kottke: The material side is just shocking. At any one time, Rocket has over 100 active customers. The challenge with having 100-plus active customers is 100-plus different assembly-level part numbers, all the bonds to support them, and all the different part numbers. When you look at the purchase history, you start to see so many parts you could buy in larger quantities. As you track the movement of the item through the stockroom, and you look at the efficiencies of moving a part 500 at a time through the stockroom, you see just how much money and time was wasted with labels, bags, etc.

I know it sounds silly, but you will notice that there's less garbage in the stockroom because you're receiving a 500-piece reel and dropping it in place, instead of 20 little bags. I think the shocking thing is just how much you can nickel and dime yourself to death with little stuff that you don't see because it's just so small.

Matties: You don't see it because there's no one extracting the data to put it in front of you. Not everybody is equipped with a DIY digital factory. What made you special and why were you able to do it?

Kottke: When you start to look for the root cause of a problem and you don't have the data, it takes you so much more time and you can come to the wrong hypothesis, the wrong root cause. Once you start collecting the data, then you become obsessive, thinking, "I could collect this data, and I could collect that data, and I could pull this information." The more you start looking at it, the more addicted you become.

Matties: You don't have to be a software genius, right? You just make a choice and then find the people to implement the vision.

Kottke: Yes. Luckily, I wasn't a software genius, originally I thought it was going to be something relatively simple, but the Voyager team now consists of seven people. Everyone gives

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me a hard time that we grew Rocket into the Carson City location just so we could justify adding more people to the Voyager team. There's a lot of truth to it.

Everybody who comes in here just wants more data. They want to be able to pull up all the normal fault-finding information, like profiles and placement information. We're now at the point where Voyager will collect an image of the component that's receiving inspection. When the part comes in, it goes into receiving inspection where a camera automatically takes an image and uploads it to the lot code, date code, and purchase order, then ties it to a Rocket code. Now, when we issue that component, we know the kit, what component was issued to it, and the media—was it in a tape, a tube, or a reel? They can use that for programming because they know the rotation of the component. They can use that for doing the first article QC when they make sure that the board is built right and got the right parts loaded.

Once you start collecting that image, you can use it for other things. Some of the cool automatic robot arms are actually capable of doing the things that they said they could do 10 years ago. We're going to incorporate a bunch of that stuff into the program so that when it does a part marking, it verifies it against what was received.

Matties: Do you see a lot more automation in your new facility than in your current facility, like robotic arms and such?

Kottke: Not yet, because they can't yet do what they say they can. Every single arm that we put in here and tried has failed. We're hoping one of our suppliers has a new automatic arm that will work for inspection. We're going to try that out next, and we have high hopes. On the automation side, we are nowhere near where we thought we would be by now because you must have so much repeated process to get the ROI on the arm.

Matties: But your workflow is such a mix, you don't have that opportunity?

Kottke: Right.

Matties: When people talk about the Factory of the Future in North America, what does that mean to you?

Kottke: The Factory of the Future for me is still something that collects the ultimate amount of data so that you can make the business decisions going forward.

Matties: You've looked at automation and technology, but really, it's data and data management. We would like to mechanize and remove the human element of handling as much as possible. But the truth of the matter is there's still going to be instances where humans must touch it to do the job.

Kottke: True.

Matties: When you look at the ROI for Voyager now, it must be enormous.

Kottke: Here's one example. I have a bet right now with the BI guy that if he can do what I asked for, I will buy him a track car. If he's successful, he will have saved me 453 hours, which equates to $20,000 in costs, which rolls up to a quarter-million dollars a year. Better yet, it's low-hanging fruit.

Matties: That's the thing, low-hanging fruit in your organization is a lot different than low-hanging fruit in a non-data-driven factory.

Kottke: Yes. And if he can show me that he saved me $244,000, I'll buy him a $50,000 track car in a minute.

Matties: It puts an incentive there, for sure.

Nolan Johnson: A team of seven for your soft-

ware program is a significant investment in human resources. Would you say that you are getting the ROI you expected?

Kottke: We brought another person on recently just because we're able to show that these projects we're doing are saving $100,000, $200,000. We have one big project that, if we can pull it off, will save a million bucks. That's pretty crazy. So yeah, I can show the ROI on it.

Johnson: With the projects that you're working on, are these just iterative improvements that you're able to find, or is there something that just completely changes the structure underneath the business model?

Kottke: There is a project I'm working on that involves quoting, scheduling, and then tracking the profitability to the customer. I've looked at all the quote software out there, all the data tracking guys, the cost accounting modules, and what we're trying to do; it will be huge.

Matties: You're already using Voyager for your quoting?

Kottke: Yes, but nothing like it will be. It's like you've been watching a black and white TV, moving to an 8K TV, and saying, "I made a small improvement."

Johnson: Are you writing the Voyager software specific to Rocket's methods and facilities?

Kottke: You could use it anywhere. I have a friend who wants to try it out in their sheet metal shop, because the routing is the same. You set up the routing areas and route it the same way.

Matties: How much work have you turned away based on data?

Kottke: A lot. It's important that you have the right mix.

Matties: Right. How do you incorporate Voyager, if at all, into your employee training programs?

Kottke: Voyager runs the whole training program; it runs our whole QMS. You can't even log in and start working until you're up to date on your current training.

Matties: Would you give me an example of how that works and the benefit that you've received?

Kottke: Voyager tracks the training and performance of each employee. I know the attendance and what defects are tied to them. I know their training records and when they need to be trained next. When they log in in the morning, they get a quick reminder if something needs to be retrained. As a side note, if it's their anniversary, they get flagged to see Admin where they will get something like a free hoodie or a mug or backpack, so it incentivizes them to check their Voyager alerts and notices regularly. Sometime this year, I'll be able to do employee performance reviews through Voyager as well.

Matties: Now, when you look at the data, you're looking obviously at the throughput on partic-

ular jobs, and then aligning your workforce to the highest level of optimized output based on that. Is that what you do?

Kottke: In the stockroom, for example, if you have nine people doing a job, you can review; see the average, high, and low; go back and tie defects to it; and very soon, you know who to retrain and who to reward. We have these KPIs that come out every week on different departments highlighting where we are and aren't improving, who the weak links are, and who gets the bonus program.

We have these KPIs that come out every week on different departments highlighting where we are and aren't improving, who the weak links are, and who gets the bonus program.

Matties: Obviously you're investing a lot into your new facility. How long did it take to build that factory?

Kottke: We had it operational in about six months. We did it in stages and it has done so well. We started with logistics, followed by system integration and SMT, and now they're building full products in Carson City.

Johnson: Full products in Carson already? How would you describe the experience of building out a greenfield site with Voyager at the center of it?

Kottke: It was so fantastic to set up a site and have all the process control in place. We moved up a couple people from Santa Clara, trained them, dropped Voyager in place, and had complete monitoring of the process from the very beginning. It was amazing how quickly and easily it went up; it almost makes me feel like I know what I'm doing when it comes to a greenfield.

Johnson: You now have a huge lake of data, and you are doing some sophisticated, AI style analysis. That work is obviously having a positive effect on your business practices. It must be a monumental task to figure out how to turn that data into analysis and predictions.

Kottke: If you had told me two years ago that I would spend a lot of money hiring a business intelligence group, I would've said you're crazy. Now, I'm likely to say, "Can we make the BI group bigger?" because they're doing exactly what you're suggesting. I can ask them to look at a process, and they come back with wide eyes, saying, "Hey, did you know this?" or, "You're right, I saw this problem." We talk about it, and I say, "No, really? Is it really that number?" It's crazy what we find when we take a deep dive into the data.

Matties: Oftentimes I refer to needing a logistics expert—Voyager aside, of course—in business. They don't have to be a content expert, or know how to assemble boards, they just need to understand logistics. If you want to start the Factory of the Future, the first place is with what you have now with the help of a logistics guy to get a benchmark and build from there.

Kottke: Everyone laughs when I say Factory of the Future is really the guy who's smart enough to figure out what he's doing wrong. Because whether the answer is to put in this automation or change that process, having the data is the only way you're going to be able to figure it out.

Matties: In Factory of the Future, what's the key measure? Is it the greatest level of output

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for the lowest possible input? Is that the measure?

Kottke: You need to measure everything, all the time. Everybody who has come in here with the robotic arms and such say they are going to save me money. They don't make the cut because none of them have the data to back up their claims for my situation.

Matties: You need a team that understands the integration. If you start piecemealing a robot arm here, and a robot there, without a master plan, you'll just wind up with a hodgepodge of robotic arms doing who knows what.

Kottke: That's true. If you're not careful, you wind up having a cool automated system which needs five additional engineers to support the darn thing.

Matties: On a daily basis, what's the most important data set for you?

Kottke: Quality. If you're constantly getting better and more efficient, you need to make sure that the quality isn't impacted. If it's impacting the quality even a tiny bit, then it might not be better.

Johnson: With Voyager working so well, let's explore a particular supply chain idea. There is a lot of talk about moving away from "just in time" to "just in case."

Kottke: Oh yeah, and everybody should be.

Johnson: That thinking, for a less sophisticated EMS company, might be to just increase all inventory by 20%, to just stock more of everything in case something goes wrong. How does that compare? Can Voyager help ensure a "just in case" thought process rather than "just in time?"

Kottke: Honestly, Voyager can't help on this one. In April 2020, I told everyone that the light at the end of the tunnel is a giant train, so buy parts. Just before that, I was sending out emails to all our customers to prepare them. I'm now going to my customers and saying, "Here's the deal. If there's any way you can swing it, buy all the parts you possibly can. Especially with the long lead time and high-cost parts, let's figure out how to bond it, or secure the problem parts. But you're going to pay for the material because I cannot be a bank for you. You should not take a chance on me trying to schedule parts like we used to, because you'll be in hell."

Matties: Where do you see pricing headed?

Kottke: Oh, just crazy. The amount of broker buys and the PPVs is like nothing I've ever seen.

Matties: Are you doing any box build, Michael?

Kottke: We are, a lot.

Matties: Is that something that you had been doing for many years or is this something that you've recently added?

Kottke: We've been doing it for many years, but we're doing a lot more of it now.

Matties: You're seeing a growing demand for that service, a one-stop shop, so to speak?

Kottke: Yes. In our Carson City facility, it's affordable enough to do it. For somebody who's building a high-end box, that's not something that you want to just move internationally; it's less expensive to build it in Carson, because the landed cost is less expensive.

Johnson: How close are you to full capacity in the new facility?

Kottke: We'll probably be at our maximum capacity on the system integration for the next six months until we finish out the expansion in Carson. Right now, we have a small part of the building; we're renovating the other side to take over the balance now because we bought the building.

Matties: How many employees do you have?

Kottke: About 270.

Matties: Do you have any advice for EMS companies that are not digital or who are considering what they should do next?

Kottke: They should be digital. You don't want to be a TV repairman, right?

Johnson: Is your advice to roll their own?

Kottke: No. If they don't have the resources, it will take too long. Let me clarify: They should do it themselves if they have that kind of money to throw at it. Voyager development costs represent millions of dollars and tens of thousands of development hours. That's what it takes to try to do it on your own.

Matties: Finding the team today is quite difficult.

Kottke: Very difficult.

Matties: So, what do they do then? They're in between a rock and a hard spot.

Kottke: They must determine the best software solution available and what fits their factory. It's an absolute must. You just cannot collect enough data by manual processes to approach this. Unless they're a one-line SMT shop, where they just won't have enough data, that is.

Matties: Michael, do you have any final thoughts to share?

Kottke: You've just confirmed what I keep hearing: Not as many people are doing this as there should be, and I don't understand why. After all these years, it's baffling.

Matties: Thank you so much. With all this capability at your fingertips, I'm surprised you haven't made Voyager a commercial product.

Kottke: Wow, Barry. That's a great idea. Wish I'd thought of that. **SMT007**

What's That Noise? Is it Your Data?

X-Rayted Files

Feature Column by Bill Cardoso, CREATIVE ELECTRON

We are in the era of data—big data—and that should be a good thing. But the sheer volume of data we are collecting can be overwhelming; its meaning and usefulness can become a burden, just more noise. All data is noise until it can be contextualized into actionable information. From that perspective, our goal with data collection should be to reduce the noise and organize data in ways that generate meaningful information that can be used to improve our processes. As manufacturing evolves further toward an Industry 4.0 future, here is a quiz to gauge where your organization stands in terms of making meaningful impacts with your data. Each answer is given a point value; at the end of the quiz, add up your points.

1. How is your inspection data collected?

- ☐ Manually (1 point)
- ☐ Automated (2 points)

Manual data collection can be cumbersome and time consuming. Automated data collection is far more efficient, though we must beware that the volume of data can generate a lot of noise if we aren't selective.

2. Do you use statistical process control (SPC)?

- ☐ No (1 point)
- ☐ Yes (2 points)

SPC is a great approach to preempting manufacturing issues and addressing them promptly should they crop up. Those who implement SPC experience less rework and far less scrap.

3. Is your SPC online or offline?

- ☐ No SPC (0 point)
- ☐ Offline (1 point)
- ☐ Online (2 points)

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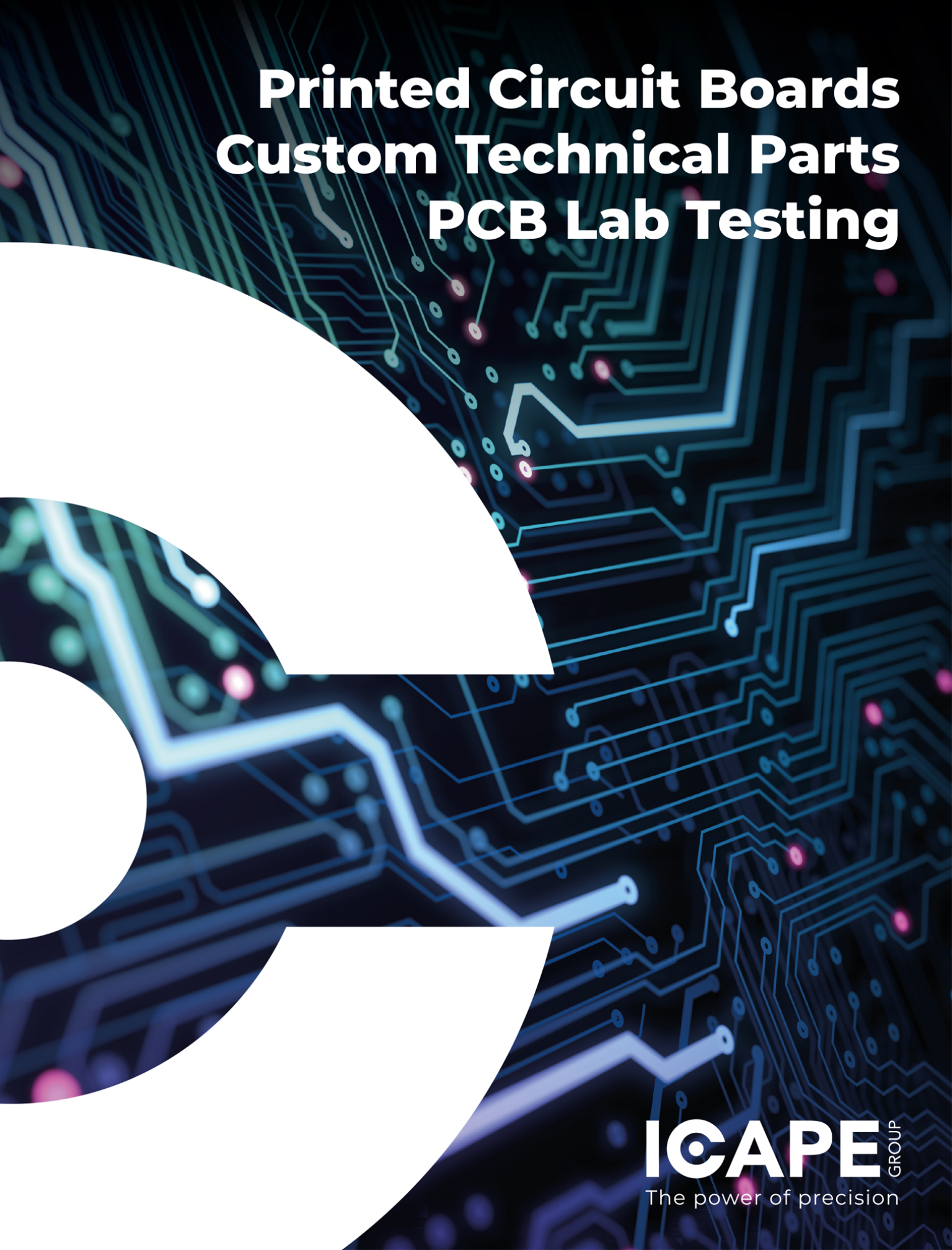

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The power of precision

4. Is all data from your production line available in one central location?

- ☐ No (1 point)
- ☐ Yes (2 points)

Centralizing your data-gathering is efficient and helps identify correlations of data from one piece of equipment to another.

5. Is data currently being used to diagnose issues in your manufacturing line?

- ☐ No (1 point)
- ☐ Yes (2 points)

This is the real power of data. Again, when data is gathered and filtered with the goal of generating actionable information that influences process, it produces efficiencies that are otherwise only attained through luck—and we know what a risky strategy that can be.

6. Is diagnosis of the line automated or manual?

- ☐ Manual (1 point)
- ☐ Automated (2 points)

The adage "time is money" was never truer than when you identify manufacturing issues early and address them immediately.

7. Are adjustments to manufacturing process that result from data analysis automated or manual?

- ☐ Manual (1 point)
- ☐ Automated (2 points)

Automating data collection, analysis, decision-making, and implementation results in maximum efficiency and minimum waste.

8. From cleaning to final inspection, is all data collected on the line available in an easy-to-read dashboard?

- ☐ No (1 point)
- ☐ Yes (2 points)

Visualizing data in a dashboard is another opportunity to identify meaningful relationships between equipment on your manufacturing line.

9. Is the data from other departments integrated with manufacturing data?

- ☐ No (1 point)
- ☐ Yes (2 points)

Combining data from other departments, such as sales and purchasing, can further support decision-making and efficiency.

10. Is data presentation tailored to its intended audience?

- ☐ No (1 point)
- ☐ Yes (2 points)

Data that is relevant to managers, for example, differs from what may be relevant in the C-suit. Tailoring data to its recipients is a great way to reduce noise and improve decision making.

Scoring your quiz is simple. If you hadn't guessed already, give yourself one point for every (1) answer and two points for every (2).

- **10-13: Don't beat yourself up, but perhaps use this as a wake-up call.**
- **14-16: You are on the right track, but there are still some efficiencies to be had.**
- **17-20: Wow, you're leading your industry in best practices. Great work!**

Collecting and organizing data can be as daunting as it is useful. Thinking strategically about your data, with a focus on making it meaningful and actionable, is important to staying competitive in modern manufacturing. In a recent conversation with Philip Stoten, he remarked on a future of "data haves and have-nots." I hope this quiz helps you ensure that you land amongst the former rather than the latter. SMT007

Dr. Bill Cardoso is CEO of Creative Electron. To read past columns or contact Cardoso, click here.

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

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

The Reality of Regulated Manufacturing

Feature Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson speaks with Ryan Bonner, CEO of DEFCERT, about government regulations for data and cybersecurity. A key component of moving to a digital factory will be to ensure security of the data required to operate a digital factory, and most importantly, customer design data.

Nolan Johnson: Ryan, what does DEFCERT do?

Ryan Bonner: We're a compliance consulting organization working mostly in regulated manufacturing spaces.

Johnson: Can you explain that?

Bonner: A regulated manufacturing space is anywhere you have regulations attached to data. When manufacturers produce goods or perform a service or process in the larger supply chain, sometimes the data that's associated with that work is regulated. In our case, it's mostly federally regulated. We work with organizations when they receive seemingly innocuous data that they've produced in similar fashion for other clients over the years, but now there are extra strings attached in the form of regulations. Those show up in different ways, but we must identify newer or better strategies for manufacturers to not only use and consume that data but also to safeguard it.


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Johnson: Great. Do you work only with electronics manufacturing or is your scope wider than that?

Bonner: It is a wider scope. There are certain industries that are hot right now. The semiconductor and printed circuit board industries are certainly important because of an extreme national interest in reshoring those capabilities. We also work with other manufacturers producing more traditional finished goods like vehicle systems and aerospace applications.

Johnson: Could you compare what you see from DEFCERT's perspective with respect to the state of the PCB manufacturing industry for DEFCERT compared to semiconductor, and compared to more general manufacturing?

Bonner: Being an outsider, I see that the PCB manufacturing industry moved its expertise and capabilities offshore because of the incentives to do it. You could do strong design work here and leave the manufacturing to someone else. But in other parts of the manufacturing verticals in the United States, there was always something holding the fit, finish, or the overall finished good itself domestically. Maybe it was assembly or prototyping, testing and trialing, or something else. The amount of manufacturing expertise and scalability that has left the PCB industry and now needs to be reclaimed, which is equally important, is a bigger shift than we see in other parts of the manufacturing base in the U.S.

Johnson: That's an interesting point. What we call a finished piece is actually a sub-assembly. A U.S.-based consumer electronics or appliance company making washing machines, let's say, will see the printed circuit board as a sub-assembly, while we see it as the finished product, To the OEM, it's just a component of the product that was moved to offshore sourcing.

Ryan Bonner

Bonner: Absolutely. As cyber-physical systems and integrated systems move into almost every arena of traditional products throughout the consumer and commercial and government space, we're realizing that chipsets are in everything now. It's not a localized or centralized function or capability.

It's interesting to plot the lines of that trajectory. When we want capability, we don't add it with a smoother surface, a better springload, or rate; we do it with computed capability and real-time information. If we want to keep building capability and subsequently competitive advantage, we must include computing horsepower in almost every application. The increased dependence on chipsets, especially distributed chipsets, embedded systems, and cyber physical systems, is apparent.

Johnson: We know that sensors are going into automobiles in a wholesale way, whether it's collision avoidance systems, radar, LiDAR, etc. 5G is promising to bring better data communications at the vehicle-to-vehicle level so that automotive vehicle telemetry from a vehicle a half-mile ahead of us, for example, can be used by my vehicle for advanced warning

about traffic conditions beyond line-of-sight. This data communication is coming together that creates a data center on wheels. It's no surprise that there is discussion about how you keep that data, those communication channels, secure and hack proof.

But it's those similar sensor technologies, based on internet of things and the like, that are being discussed to capture performance characteristics, to digitize the manufacturing process for analysis and optimization. Aren't we putting the same risks and exposures onto the manufacturing floor?

Bonner: Absolutely. When we think about the traditional manufacturing landscape, factories have largely functioned as a black box. Specifications and design requirements go in and finished goods with attestation and certificates come out. We're finding in complex supply chains, organizations want more telemetry, measurability, and real-time capabilities in these manufacturing environments, both within their own business, and between parties, which we're starting to see with things like digital twin factories. To cut back on the feedback loops and reduce the amount of time it takes to correct problems and issues, you need more sensors and connectivity on the shop floor.

We might not do all our quality control in the CMM lab in the corner of the factory anymore. We might have probes and measurement in the CNC machine itself. Anytime we add connectivity, we improve the network effect, which is good for business, but we also add risk. There's just a necessary risk management that needs to happen there. When I look at what we're seeing with the digitization of factories, I am seeing the exact same patterns that we experienced when we electrified factories.

Harvard Business Review published an article titled, "IT Doesn't Matter," which is a strange statement to make. The point made was that when electrification came to someone's hometown in the early 1900s, it was worth it to move your factory to a town that had electricity than one that didn't because of your ability to work when the sun wasn't up and to have automated machines that could do whatever you needed them to do. The competitive advantage was unreal.

But once everyone had electricity, there was no competitive advantage. Now it was about managing the risk of having brought electricity into your building. Do I have exposed lines or wires? Am I running the risk of a fire? What do I need to manage now that I have electrified systems? If we look at digitized systems, there are extreme advantages to digitizing early for manufacturers and "the juice is worth the squeeze" from a risk vs. reward perspective. You may be able to field the capability that no one has even thought of yet. But as those examples become more common, you don't have competitive advantage anymore. It's just the new normal.

At that point, you can start thinking about how you want to manage some of these risks. The risks we've brought onto the shop floor regarding digitization, and additional internet-of-things devices and operational technology that are network connected, is that now our shop floor has some of the same capabilities as our front office, like our normal computing environments, servers, PCs, and laptops. That means we have the same attack footprint now as those pieces of equipment, which is ripe for exploitation.

Johnson: This was evidenced by some PCB fabrication facilities in North America hit by a ransomware attack in the last two years.

Bonner: Absolutely. If you really want to hit a manufacturer where it hurts, you will shut down their production capabilities.

Johnson: In a previous article discussing a ransomware attack, the initial point of entry was an unsecured piece of machinery on the manufacturing floor.

Bonner: That is a common antipattern. Manufacturers allow the vendor to bring in their new connected system because it provides a new manufacturing capability, and they don't count the costs, if you will. They don't look to see whether the vendor's required connections into that system themselves are secure, properly segmented, or any other number of things. They just let the vendor do what they want, and they give the vendor whatever they ask for. There's often little or no governance. In the end, you have vendors being given open internet access to a multimillion-dollar machine for ease of support, but it's also easily accessed. When we see manufacturing equipment publicly accessible from the internet with very few controls in place, it's terrifying.

Johnson: Of course, that has the unintended consequence of exposing other computers on the manufacturing floor that may be out of date. It may be some legacy piece of equipment controlled by a computer that's still on XP because the operating software isn't migratable to the next, more secure version of the operating system.

Bonner: Absolutely. Unsupported platforms or operating systems are a huge area of concern. Any time we mix that volatile ingredient with internet access, we're asking for trouble. There must be very clear strategies for handling systems which can't be upgraded or secured in a normal way. We need a way to put that security in front of that device to protect it from the outside world or even your own network, or we need to have some way to put that piece of equipment in a box so that it doesn't pose a risk to others.

Johnson: Digitization is step one clearly, but there's a step zero, isn't there? Get your network secure. Think through the data and the security before you start putting sensors and things in place.

Bonner: There are certainly benefits to planning for the introduction of new capabilities. When that step is taken, we find organizations much more prepared to speak with the new equipment vendor or to better implement or deploy a new capability in a very informed way, where it doesn't just sneak up on them and then suddenly, they have new risks on their network. Some of the things we see organizations doing are creating brand new networks for their new connected equipment to live on and then slowly integrating that with other older networks if those exist. It's like a clean slate environment for the connected equipment so that you can very clearly understand what the normal behavior looks like for that equipment so that if something strange was to start happening, you'd notice it because you know what right looks like in that environment. There's also a big push toward Zero Trust.

Johnson: Zero Trust?

Bonner: Zero Trust security assumes that your entire network is not trustworthy to begin with. Zero Trust incorporates the idea of having this new equipment completely tunnel across the network through encrypted channels to only the resources that need it, rather than swimming in an open sea. It's a much more controlled process. It's hard to do in old networks, but more achievable in a brand-new implementation of new technology. If you can choose to adopt a Zero Trust approach for just the new equipment, that's still better than doing nothing.

There are a lot of embedded systems and IoT equipment which, in our haste to create new capabilities, we didn't give full consideration for native security for these tools. Now we have connected systems that are on the network, but they don't have all the trappings of a normal computer. Often, we need to add that capability. There are systems that would allow you to put a "layer 7" firewall in front of the piece of equipment you've just brought onto the network. It allows you to treat everything

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coming out of that firewall—which is actually the big piece of equipment—as if it's a normal first-class citizen on the network, if you will. All the ability to govern and secure it is there.

NIST has published some basic information on what it considers to be the basic secure characteristics of internet-of-things equipment. That can be helpful when you work with vendors in the manufacturing equipment space, to make sure that those characteristics exist in what you're about to bring onto the network. It's not the end of the world if those don't all exist, but at least you know what gaps you might have to fill yourself.

NIST has published some basic information on what it considers to be the basic secure characteristics of internet-of-things equipment.

Johnson: Earlier we talked about the government regulation dynamics now in play those reputable manufacturers in our industry must pay attention to and comply with. Can you give me a quick rundown on that?

Bonner: When we think about the convergence of regulation for manufacturers, there are things to be aware of. First, when we bring in regulated data from our customers, more data will flow through these increasingly connected systems. These systems aren't just simple axis data plotted onto a router for a CNC cut; these are entire three-dimensional models with simulation information and test data baked in. When we start to move those complex data models through our manufacturing environments, more of our systems have a more complete picture of what the finished goods look like, and what their value is to the market. When there are regulations attached to that, we need to be aware that when we connect our Industry 4.0 type shop floors, we are drastically increasing our burden for safeguarding.

When we see into the government side of things, especially in the Department of Defense, and things like NIST 800-171 or CMMC being brought to the forefront, the more we add connectivity and really rich datasets to our manufacturing processes, the more likely those regulations will follow those processes. We need to be aware of that and think about the expanding scope of regulation in that process.

We should also be aware of whether our business will be designated as critical in the United States. I don't have any clear notions as to whether sections of the printed circuit board industry will be considered critical infrastructure, but some of the newly passed legislation for incident reporting would bind many organizations to rapidly report incidents as they happen.

Laws like that require additional liability. If in the future we engage in any form of government contracting or even grant funded work that is attached to federal dollars, there could be increased burdens on reporting incidents in our environment, things we might not have reported in the past. Things like a major breach or a ransomware payout are required to be reported within 72 hours of certain criteria being met. That's a big shift, so we should just be aware of those things moving into our general vicinity as an industry.

Johnson: For the smallish boutique or prototype manufacturers moving a lot of jobs on any given day, that results in a great deal of data to manage.

Bonner: In the printed circuit board industry there are patterns we can notice about the work that we do. When we look at the traditional order of operations for a PCB manufacturer, the design work, the job costing, and

some of the design prep and production engineering are all very front loaded. When I look at the distribution of labor on a timeline for a particular job, the opportunities to better mitigate risk are all front loaded in the sense that we can make some decisions early on as a manufacturer of how much of our customer's data we choose to flow into production. There are always opportunities to produce against limited datasets or even modify datasets that don't affect the integrity of the data but do obfuscate or mask the end customer that the production job is for.

There are a lot of opportunities to think about using synthetic data in production or limited datasets in production, things that buy down the risk of that data being compromised in a production environment and really practicing something that we call non-persistence, where the data that we receive from customers, which is the complete picture, doesn't stay in our environment any longer than it must.

Johnson: A few moments ago, were you implying that participants in manufacturing can help influence the regulations that the government puts forward?

Bonner: There are opportunities to influence what goes into regulation. However, manufacturing usually waits to engage with regulators after the law has already been proposed or passed and then we're into enforcement. We do a lot of work in defense contracting right now and we see a lot of industry groups rallying to control the costs of compliance for certain cybersecurity measures that are now required of defense contractors. Here's the thing: They've already been baked into law. There are already executive orders and contract clauses in place. The ship has sailed. You're not getting those horses back into the barn. Your best bet would've been to influence legislators and regulators upstream.

The credit card industry is a good example of that. If you've ever had to take a credit card in your business, you know about an industry standard called PCI compliance or PCI DSS. There's no government involvement. The credit card companies themselves created that standard and enforce it through the banks to stave off regulation. When there were discussions about how we prevent credit card theft and fraud, the industry decided to step up and build its own standard that was better than anything currently available. It removed the need for regulators who create blanket policies and legislation.

That is an example of industry getting ahead of something when it sees a pattern emerging. If manufacturers in the printed circuit board industry want to stave off the next round of regulation, they need to create better manufacturing-oriented standards and then use that to educate up into the regulatory space. It's a multi-year process that requires vision.

Johnson: If the banking industry can find ways to cooperate on exchanging data, then what the heck is the printed circuit board industry waiting for?

Bonner: I see efforts by organizations like IPC trying to build some new additional standards for some of the things they do. You could easily pivot some of those efforts into best practices for adapting and adopting connected technologies on the shop floor for specific methodologies that minimize the impact level of data used in production. There are all sorts of things that could be created, but you're right, it needs to start sooner rather than later so that when the regulators start making reactive knee-jerk accusations of the entire industry, the industry has something to show for it and say it's been working on these topics. We've already been implementing best practices, and we're going beyond just reactive-only responses to regulation.

Johnson: What a great interview.

Bonner: Thank you. SMT007

MilAero007 Highlights

Connect the Dots: The PCB Design Secret Sauce for RF Applications ▸

Design and manufacture of PCBs for radio frequency (RF) technology is a unique animal. RF had been considered a niche, thought of only in terms of television broadcasts, commercial airline phones, and military radar systems. Now, light industrial and consumer applications ranging from remote meter reading to home security systems are just the tip of the RF iceberg.

IPC Applauds Biden's Focus on Semiconductors, Urges Passage of Competitiveness Legislation ▸

During his State of the Union address, U.S. President Joe Biden urged Congress to pass much-needed funding for semiconductor manufacturing and other advanced technologies as part of a new competitiveness measure.

Winonics Department Leaders Successfully Complete IPC-6012 Training ▸

Winonics announces the successful completion of IPC-6012 training for five department leaders in its Brea, California facility. The recent certifications are part of a larger company-wide initiative begun in 2021, with a plan to have all production employees trained and certified by the end of 2022.

Adventures in Engineering: 5G Expansion and Radar Altimeters ▸

The expansion of cellular broadband in the 3.7–3.98 GHz spectrum band has crossed into the working frequency range of radar/radio altimeters. Commercial RAs are intended to operate in the frequency band of 4.2 to 4.4 GHz. However, radar altimeter receivers may be sensitive to frequencies outside this range, and this is the basis for the FAA's current reluctance to wireless 5G wireless station deployment near airports.

Designers Notebook: Design for Test, Part 2 ▸

Current generations for PCB designs have increased in complexity. The product developer and assembly service provider, whether in-house or outsourced, must consider manufacturing efficiency, throughput, and process yield. While design for manufacturing is an absolute necessity for controlling manufacturing costs, design to accommodate product testing does need attention as well. The primary concern is to ensure that the end product will perform reliably without compromise.

NEOTech Partners with Hemisphere GNSS ▸

NEOTech, a leading provider of electronic manufacturing services and supply chain solutions for brand name OEMs in the industrial, medical, and mil/aero markets, is thrilled to announce a new partnership with Hemisphere GNSS, Inc.

JAVAD EMS AS9100D/ISO9001-2015 Annual Surveillance Audit ▸

JAVAD EMS (JEMS) announces that it has completed the annual surveillance audit of its AQMS system in compliance with AS9100D:2016 with no non-conformances at its facility in Silicon Valley.

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Big Data Can Bring Your Business Back

Feature Article by Zac Elliott
SIEMENS DIGITAL INDUSTRIES SOFTWARE

Let's face it, in the past, electronics manufacturing has not been a big business for North America. A majority of electronics are assembled in Asia where supply chains and operating costs offer many economic advantages. In North America, the electronics manufacturing industry has been generally focused on lower volume, high-cost devices, while higher volume products are produced elsewhere. However, the COVID pandemic and various legislation in the U.S. are changing the situation, making electronics manufacturing in North America a more attractive option.

How can factories in North America compete for the same type of manufacturing traditionally performed in lower cost regions? The answer is that they will not be competing, because they will not be performing the same type of manufacturing. Manufacturing is changing, and companies in North America are well positioned to work differently and surpass their global competitors.

What's changing in manufacturing? Consumer trends related to the specialization and customization of products are moving the industry toward much smaller lot sizes. With

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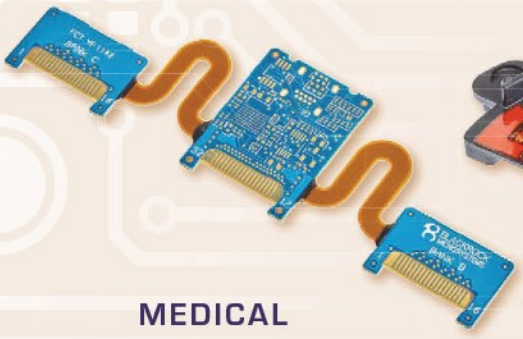

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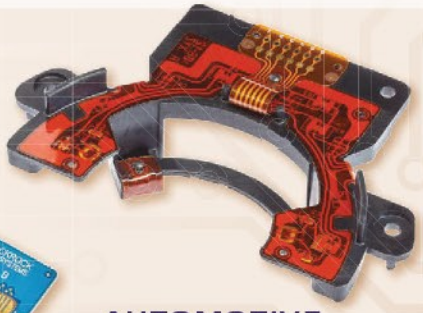

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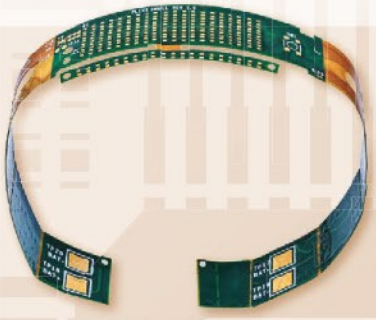

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a historical focus on higher mix production, manufacturers in North America have mastered the ability to provide their customers with responsiveness, flexibility, and quality. Carrying these capabilities forward is important to support the next generation of manufacturing.

How do manufacturers adapt? On the shop floor, manufacturing lines will become more modular to accommodate a higher mix of product on the same equipment, but what will really differentiate manufacturers is how they use data to support their operations. Leveraging data and digitalization will be the only way to maintain responsiveness, flexibility, and quality while supporting an increasing volume of high-mix products.

Leveraging data and digitalization will be the only way to maintain responsiveness, flexibility, and quality while supporting an increasing volume of high-mix products.

Boosting prediction accuracy is one of the key benefits of using data effectively, but this requires domain expertise and a deep understanding of the data. It also requires access to the data in the first place, and this is not always a trivial task. Many intelligent machine interfaces today will describe the processes and production operations occurring on the machine and allow for interlocking the equipment with external management systems. Most machines today do not provide information about their internal operation, and it is this detail that is needed to drive the next level of performance improvement, where a motor drawing extra power or a sensor operating marginally can signal a problem with the performance or reliability of the equipment. If that data is not available, companies can invest R&D resources to determine how to get to it.

To differentiate themselves from their competition, companies must provide intelligent, responsive, and supportive productization. Effectively balancing customization with complexity costs will allow companies to maintain profit margins significantly higher than their industry peers. Utilizing improved workflows and technology to maintain high output can provide a cost savings as compared to a mass production environment.

Smart manufacturing supports mass customization by providing insight on production efficiency, equipment usage, and status across the entire value chain. By eliminating silos of information and enabling the sharing of data, businesses can dramatically shorten NPI cycles and time to market.

Digital innovation and adoption of smart manufacturing strategies will also give businesses greater adaptability by providing better control and visibility into their supply chain and optimizing their capacity to build more products, faster and with profitable growth. By adopting smart manufacturing strategies, businesses will know up front that a design can be made, the manufacturing plan is up-to-date and synchronized, and the production system is optimized and performing as planned.

Siemens talks a lot about digital twins. The whole point of having a digital twin for an electronics manufacturing operation is to be able to analyze and understand what is happening, why it is happening, and how to improve it. By using software to create models and optimize processes, businesses can run multiple what-if scenarios that can be evaluated relatively inexpensively. They can save time and money by simulating and proving-out product designs and manufacturing capabilities before investing in new equipment and materials.

Companies that lack the ability to use data in an intelligent manner to drive informed business decisions are at a competitive disadvantage and will miss actionable insights about their customers and their products. Not knowing the best way to read, understand, and apply data can actually be costing your business. Those costs could take the form of lost revenue opportunities, lower efficiency and productivity, quality issues, and more.

For manufacturers planning their future, data is key to unlocking the ability to optimize their processes, reduce costs, and accurately measure ROI—all by being able to make good decisions about products, services, employees, and strategy. **SMT007**

See this additional content from Siemens Digital Industries Software:

- *The Printed Circuit Designer's Guide to… Stackups: The Design within the Design* by Bill Hargin (a free eBook available for download)
- *The Printed Circuit Assembler's Guide to… Smart Data: Using Data to Improve Manufacturing* by Sagi Reuven and Zac Elliott (a free eBook available for download)
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- Siemens' free, 12-part, on-demand webinar series "Implementing Digital Twin Best Practices From Design Through Manufacturing."
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Zac Elliott is technical marketing engineer for Siemens Digital Industries Software and an I-Connect007 columnist. To read past columns or contact Elliott, click here.

Lean Digital Thread

Keeping an Eye on Quality

by Zac Elliott

So far in this series of articles, we have looked at current trends in the supply chain and the challenges facing manufacturers. In general, the takeaway has been that we must do more with less:

- We need to be more flexible while simultaneously decreasing labor input
- We need to be more efficient while also managing component shortages

But as we strive to manage these challenges, one area where we cannot lose focus or sacrifice is the quality of products being manufactured. This article will look at how current trends impact product quality and new methods to manage the risk.

Challenges to Quality

Several trends contribute to challenges in maintaining product quality.

A higher mix of products: As digitalization, automation, and specialization disrupt consumer and industrial markets, there is an increase in the variety of electronic products being produced today. As the mix of products increases, the production volume of each device or lot of devices decreases. Taken to the extreme, lot sizes have decreased over time from thousands to hundreds to dozens to the now common lot-size-one production orders. With such small lot sizes, there is simply not enough production volume to debug manufacturing process and reach a steady-state quality level.

Increased new product introductions (NPIs): The number of engineering changes, revisions, and new product introductions is increasing across the board. With an explosion in the number of products and the increased product mix mentioned above, it is more difficult to identify trends related to product quality. This is driving manufacturers to focus on process quality as opposed to product quality.

To read the entire column, click here.

Electronics Industry News and Market Highlights

Broad Coalition Urges Congress to Fund CHIPS Act, Enact Strengthened FABS Act ▸

The Semiconductor Industry Association (SIA)—along with a broad coalition of 20 other tech, auto, medical, defense, and other business and labor groups—in a letter urged Congress to immediately enact $52 billion to fund the CHIPS Act and to enact a strengthened FABS Act to bolster domestic semiconductor research, design, and manufacturing.

SEMI Survey Highlights U.S. Chip Industry Competitiveness, Government Investment ▸

SEMI, the industry association representing the global electronics design and manufacturing supply chain, released the results of a survey of more than 400 U.S. member companies that highlight challenges facing the semiconductor industry.

Siemens Investing $54M in Its U.S. Manufacturing Footprint to Support National Infrastructure Projects ▸

Siemens joins President Biden at the White House to announce it will invest $54 million across key U.S. manufacturing facilities that serve critical infrastructure markets.

Keysight, Samsung Sign MoU to Advance Research & Development of 6G Technology ▸

Keysight Technologies, Inc., announced that the company has signed a memorandum of understanding (MoU) with Samsung Research to advance research and development of 6G technology, the next generation of wireless communication.

Foxconn Partners With, Invests in XRSPACE to Create Global Metaverse Ecosystem ▸

Hon Hai Technology Group (Foxconn), a global leader in smart manufacturing, announced the signing of a Memorandum of Understanding (MOU) with XRSPACE, the company pioneering the next generation of visual reality through VR in the metaverse.

Database Now Tracks Integrated Device Manufacturers, 475 Facilities ▸

SEMI and TechSearch International announced a new edition of the Worldwide Assembly & Test Facility Database offering significantly expanded coverage that now includes integrated device manufacturer (IDM) facilities.

Intel Advances AI Inferencing for Developers ▸

Since OpenVINO launched in 2018, Intel has enabled hundreds of thousands of developers to dramatically accelerate AI inferencing performance, starting at the edge and extending to the enterprise and the client.

Portable Generator Powers Small Safety Devices ▸

A new, stick-like, water-based device can convert energy from movement into electricity. The technology, which was reported in the journal Science and Technology of Advanced Materials, could be used to power portable devices, such as safety lights.

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Has the Industry 4.0 Gold Rush Ended?

Smart Factory Insights

Feature Column by Michael Ford, AEGIS SOFTWARE

Industry 4.0, though only five years old, already has a checkered history. With buzzwords flying, existing technologies—rebranded as Industry 4.0 solutions—have been in demand. Manufacturers embarked on the Industry 4.0 "gold rush" to gather as much data as possible, and by whatever means necessary, to get those nuggets of smart manufacturing credibility. Today, the more mature approach of Industry 4.0 is emerging with consideration of a real return on investment (ROI) as well as sustainability. Taking advantage of such maturity may have been the smartest option all along.

The early pioneers of smart manufacturing have been doing a great job, with immense investment, sacrifice, and some compelling success stories, especially for enhanced automation of continuous manufacturing in Asia and agile manufacturing in Europe; this has demonstrated how far automation can be expanded when aided by smart software.


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For these companies to "strike gold" was easy in some respects—assuming that there was enough investment available to meet the needs of bespoke solution development. This is because of the lobbying of machine vendors, utilization of middleware, and to financially assist custom solution providers to develop bespoke and specialist pieces of software, was based loosely on older industry standards and proprietary technologies. The downside of the approach was the inability to show a convincing ROI, especially considering the risks that had to be accepted with unplanned downtime as solutions needed to be adjusted and refined. The sustainability of such gold rush solutions has now become a real operational and financial burden as both requirements and technologies inexorably move forward.

The sustainability of such gold rush solutions has now become a real operational and financial burden as both requirements and technologies inexorably move forward.

The nice aspect about this early gold rush is that it has fractured the paradigm that manufacturing has been an area of short-sighted, tightly controlled investment. From the OEM perspective, manufacturing is a not-for-profit operation that simply converts raw materials into final products for sale with all associated profits accounted to the sales organization. There is extreme sensitivity in the manufacturing cost, as by the time the product has gone from the factory to the final point of purchase, the cost will have been marked up by 10, 100, or even 1,000 times (in extreme cases). An overspend of just a few cents on materials, energy, correction of defects, etc., can rapidly erode expectations for profitability, forcing up prices to a greater extent than many expect. Extreme costs of smart automation, therefore, have their effects if ROI is not rapidly achieved. The risk, however, is that in most gold rush examples, the effects are achieved slowly, a risk most manufacturers in the industry have been willing to accept.

As movies have recorded the history of squabbles and sacrifices made by those who rushed to be the few successful prospectors to make their fortunes in "them thar hills," I wonder whether the pioneers of smart manufacturing will be regarded in the same way. Gold today represents a very reliable, predictable, and safe investment, making or preserving money in a more ordered and controlled way, which, other than the occasional heist or two, allows everyone to work together. For smart manufacturing, the same condition is emerging, with increasing interoperability of solutions and data, based on standards specifically developed within the industry for this purpose. Solutions that adopt these standards, and the core principles on which they are based, are the solutions that make smart Industry 4.0 viable, thus enabling it to deliver a very reliable, robust, and sustainable ROI.

The fundamental principles that are common to the best of these standards are the essential ingredients that make the use and adoption of smart manufacturing solutions cost effective and relatively risk-free. They are discussed below.

IoT/IIoT Messaging vs. Integration/Interfaces

The use of messaging enables different applications and solutions to become interoperable and complementary to each other without depending on licensing of shared proprietary code, and hence intellectual property (IP). In the gold rush, many companies expanded their

solutions through code-sharing integration, either with different point-solutions that each provider had acquired, or by APIs with close partners. The costs for this development and ongoing dependency continue to be extremely high; it is duplicated repeatedly in slightly different ways for each customer.

The use of IIoT messaging, however, especially when defined by open standards, means that data is exchanged without any form of code dependency. Data can be freely exchanged between authorized parties and managed through standard security and access protocols. It should be noted that IIoT is very resilient to cybersecurity incidents, as there is no commonality of code or databases that would otherwise allow cross-contamination. Where an open standard is adopted, there is only one interface needed to connect everything, therefore avoiding costs of duplication and variation between use-cases.

Plug-and-play vs. Middleware

Though the use of IIoT allows for the open exchange of data, an equally important aspect of that data exchange is the mutual definition of the data content, that is, the language of communication. The principle of plug-and-play is to provide assurance that there is no need for the translation or conversion of data, which for the gold rush solutions proves extremely challenging and expensive to resolve. In the event of a slight change in any system behavior or specification, renewed development and testing could be required, which often results in lost operational time. The use of third-party technology to bridge the communication gap further complicates things as they are called in to fix sudden urgent issues for which they feel no responsibility—thus, justified premium rates to support. True plug-and-play requires an industry standard that aligns the meaning of all types of data into one language, such that there is no need for translation or conversion, bringing a massively reduced risk of failure throughout the life of any related solution.

Interoperable Specialization vs. Domination

Both software and hardware companies in the assembly manufacturing industry have their own areas of expertise and focus. In any factory, there will naturally be the need to use "the best tool for the job," with overall solutions made up from many different vendors and each selected for their specific capabilities to perform in their required roles. The attempt by larger companies to seek domination in this environment, which allows them to provide wider solutions extending far beyond their core competence, is a far weaker and unsustainable solution than allowing individual hardware and software solution providers working together in an interoperable environment. Solution vendors who commit to providing everything that is needed are often having to develop bespoke solutions that are specific to each customer to fill in the gaps between their current capabilities and customer expectation. The gold rush pioneers have been caught out by this in many cases, an issue which is rarely satisfactorily resolved, and in fact increases in scope as manufacturing requirements and solution technologies change.

To many, explanations of IPC's Connected Factory Exchange (CFX) standard may appear to be "just another standard" with which to exchange information around the factory, but when broken down into its fundamental values it is an excellent example of how it is becoming a complete game-changer. It is establishing the way in which all companies can now take a very much less expensive and risky path toward smart manufacturing. Hardware vendors that take their value to their customers seriously are embracing CFX and other initiatives that promote interoperability in the digital factory, with the forward-thinking software vendors also learning to do the same. Each provides a complementary value.

Is the industry yet in the situation that smart manufacturing is available at a low cost and risk to the operation? It is definitely on the way.

There is still work to do to see qualification of all machine communications against the IPC-CFX standard, but the number is increasing and accelerating with time. Other standards, such as the IPC Digital Twin, published at the end of 2020, are also poised to bring another level of interoperability throughout the industry, this time related to the secure exchange of data at a system level between previously difficult-to-bridge silos.

The Industry 4.0 gold rush is effectively over once interoperability is established. Smart Industry 4.0 manufacturing is now at a "Goldilocks moment." Rather than feeling the cost of data acquisition, operations are feeling the benefits from the use of such data. Value is created through the contextualization of collected information and relating operations together with production configurations, product design and BOM information, materials and tooling data—the holistic analysis of which detects and measures variation, identifies potential defects, and triggers actions and alerts that improve throughput, on-time delivery, quality, and productivity.

For those who want to differentiate themselves to gain competitive advantage, it can be done today with minimal cost and risk as compared to the gold rush days of Industry 4.0, if you are careful about the hardware and software tools that you select; those IPC qualified solutions that provide IIoT-based, plug-and-play exchange of data. Today is when the really smart people invest in Industry 4.0. Is that you? **SMT007**

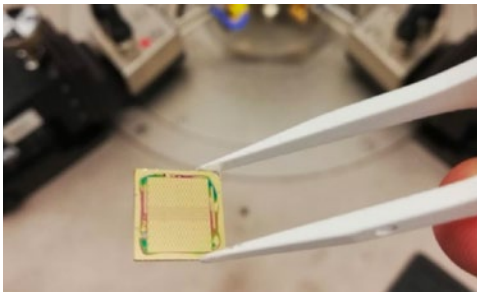
Michael Ford is the senior director of emerging industry strategy for Aegis Software. To read past columns or contact Ford, click here.

Nanowire Transistor With Integrated Memory to Enable Future Supercomputers

For many years, a bottleneck in technological development has been how to get processors and memories to work faster together. Now, researchers at Lund University in Sweden have presented a new solution integrating a memory cell with a processor, which enables much faster calculations, as they happen in the memory circuit itself.

In an article in *Nature Electronics,* the researchers present a new configuration, in which a memory cell is integrated with a vertical transistor selector, all at the nanoscale. This brings improvements in scalability, speed and energy efficiency compared with current mass storage solutions.

The fundamental issue is that anything requiring large amounts of data to be processed, such as AI and machine learning, requires speed and more capacity. For this to be successful, the memory and processor need to be as close to each other as possible. In addition, it must be possible to run the calculations in an energy-efficient manner, not least as current technology generates high temperatures with high loads.



The problem of processors' computations happening much faster than the speed of the memory unit has been well known for many years. In technical terms, this is known as the "von Neumann bottleneck." The bottleneck happens because the memory and computation units are separate, and it takes time to send information back and forth via what is known as a data bus, which limits speed.

"Processors have developed a lot over many years. On the memory side, storage capacity has steadily increased, but things have been pretty quiet on the function side," says Saketh Ram Mamidala, doctoral student in nanoelectronics at Lund University and one of the authors of the article.

(Source: Lund University)

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Electronics products are becoming ubiquitous in many aspects of modern life, including smart devices, internet of everything, wearables and self-driving vehicles, as well as the more established (but still growing areas) of communications, entertainment, medical devices, lighting, automotive, avionics and computing. The growth is largely driven by the continued increase in density of integrated circuits, the applications that utilize the greater functionality, and by steadily decreasing power consumption and cost.

PROFESSIONAL DEVELOPMENT COURSES

Electrostatic Discharge in Robotic Manufacturing Lines: Electrostatic Basics, ESD-Failure Mechanisms and Tool Risk Evaluation Methods

Peter Jacob
EMPA

Tolerance Mistaken: DFM impacts of not properly addressing limitations of material, industry standards and assembly process limitations

Dale Lee
Plexus Corporation

Design for Reliability and Reliability Testing of Electronic Interconnects

John H. Lau, Ph.D.
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Are Your Existing Machines Enough to Keep Up?

Feature Article by Jennifer Davis
ARCH SYSTEMS

Buy new or make do? It's an age-old debate for manufacturers who are trying to decide how best to manage machine assets inside their manufacturing facilities. New machines are expensive, but so is operating existing machines at a comparative deficit.

It's important to recognize that increased demand for machines is a good thing. The global economy demands more products at an ever-increasing rate, and that can certainly mean increasing the number of physical assets needed to produce those products. At the same time, manufacturers need to be much more flexible with current assets to deal with shortages. But most manufacturers don't have nearly enough visibility into the granular machine data from those existing assets to be as nimble as they need to be—and they know it. So, they're rightly asking if their current assets are enough to get them through or if they need to pivot now and buy new machines to keep up.

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The answer is both. Increasing dynamic machine utilization meets two critical needs for manufacturers. It allows for fewer machines to do more but also allows more machines to do even more dynamically. It's not simply a zero-sum game of whether you buy more machines. The goal should always be to buy more as manufacturing demand increases, while maximizing and constantly increasing the value of existing machines along the way.

Fundamentally, it's about creating the healthiest hardware and software ecosystem possible within the organization. Because moving hardware is a slow game, investment decisions must be intentional and long-term. Software, on the other hand, moves fast and allows ramp up and down the right way while making the most of what you currently have. This is certainly true when looking across your workforce and overall process operations and intelligence. But it's even more true when looking at machine assets, where massive amounts of capacity are still being left behind in nearly every factory in the world. Therefore manufacturers are starting to see some of the biggest upfront ROIs coming from adding dynamic machine capacity to their overall plan.

Fundamentally, it's about creating the healthiest hardware and software ecosystem possible within the organization.

More than 50% of all potential capacity is untapped. Nearly every industry expert agrees, with some arguing for numbers much higher. Today, there are trillions of dollars of purchased machine capacity across the global manufacturing footprint. Within electronics circuit board assembly alone, there is an estimated $100 to $200 billion. It's easy to see why manufacturers are now jumping at the chance to unlock even a tiny fraction, let alone 40–60% of that hidden capacity.

But the "how" of doing this is where most manufacturers are stuck. Most data projects and solutions are designed to contextualize manufacturing machine data for use in the manufacturing execution system (MES), and for good reason. No manufacturer needs further explanation about the value of modern MES systems. But when it comes to solving problems like utilization, attrition, even OEE, the MES and the data structured to feed it, fundamentally solve a different problem. Nor are they designed to solve those problems that require all the machine data. Therefore so many manufacturers are fundamentally blocked and haven't been delivered solutions that provide clarity into these new insights—those they desperately need to stay competitive in the immediate years ahead. This requires an entirely new category. Most importantly, it requires a near-perfect combination of domain experience and data expertise.

To obtain the data necessary to claim the untapped value in existing machines, it's critical that it's architected in such a way that it's available instantly and that all of it—yes, all of it—is stored indefinitely. Executing this crucial step without a specialized library of machine connectors will leave manufacturers stuck in "data project purgatory" indefinitely. This is key to making the data useful and available near-instantly. Importantly, this step is incomplete if the data—again, all of it—is not stored for future and historical analysis. There is little chance of predicting what you may need from the data in two years. But it's impossible to meet those needs in two years If you're not getting it and storing it correctly today.

With the data connected, flowing in, and stored correctly, manufacturers now have, for the first time, truly unified data from all machine types and vendors across their entire organization. This allows regional experts to

provide value quickly and remotely, making a solution anywhere and everywhere.

Without this type of unified data, manufacturers are blocked from tapping into insights that improve the key performance metrics. Unlocking this path allows manufacturers to begin the process of organizational improvement in perpetuity. Once started, one manufacturer may immediately undertake solving problems surfaced by insights into attrition rates. Another manufacturer will focus initially on machine-to-machine correlation as they try to solve a quality issue. Some will undertake multiple use cases simultaneously. All of them have matured operational visibility to where new use cases are being uncovered indefinitely. Clear and open views of machine performance expose the real situation and allow manufacturers to take an entirely new approach to asset management.

For those who are on this path, the question is no longer "buy new or make do." It is, in fact, both. Increasing the value of existing assets is a commanding competitive advantage. Those who do so find themselves positioned to meet increased demand as well as buying new machines to keep up with new demand. Best of all, they've unlocked new best practices in managing both new and existing assets and will continue to grow their organization in the light of that knowledge. **SMT007**

Jennifer Davis is head of marketing and communications at Arch Systems.

Supplier Highlights

X-Rayted Files: Should I Stay, or Should I Go? The Future of Trade Shows ▸

I've heard the question repeatedly over the last couple of years, "Is the trade show dead?" It's a valid question, and I'm not sure what the answer is, should be, or even what I wish it was. With a couple years under our belts now with canceled live events, some limited in-person events, and an absolute tidal wave of virtual events and webinars, I am developing an opinion.

Aegis Software: Unitron Group B.V. Chooses FactoryLogix' MES for Medical Device Manufacturing ▸

Aegis Software, a global provider of Manufacturing Operations Management Software (MOM/MES), announced that Unitron Group B.V. has selected the FactoryLogix IIoT-based MES solution for its factory in the Netherlands.

CyberOptics Reports Strong Q4, Record 2021 Sales and Earnings ▸

CyberOptics Corporation reported sales of $22.1 million for the fourth quarter of 2021 ended December 31, an increase of 31% from $16.9 million in the fourth quarter of 2020.

MacDermid Alpha Launches ALPHA OM-565 HRL3, Next Generation, Low Melt Point Solder Paste ▸

MacDermid Alpha Electronics Solutions announced the launch of ALPHA OM-565 HRL3, next-generation, high-reliability low-temperature solder paste formulated for a broad range of assemblies to mitigate warpage induced defects in temperature-sensitive chip-scale packages.

Averatek Opens New Channels for Mina Surface Treatment ▸

Averatek is pleased to announce the addition of Jeff Berlin of TEC Associates to its marketing efforts. As a manufacturer's representative, Berlin will be responsible for business development with Mina, a surface treatment that enables soldering to aluminum.

Cybord Raises $4M Seed Investment Led by IL Ventures to Disrupt the Electronics ▸

Cybord, an innovative software solution that implements AI & Big Data technology, announced that it raised a $4M Seed investment led by IL Ventures, a VC fund focused on transformational technologies for legacy industries, with co-investment by the Israel Innovation Authority.

Maggie Benson's Journey: A Buying Strategy Primer ▸

Ron Lasky continues his series of columns about Maggie Benson, a fictional character, to demonstrate continuous improvement and education in SMT assembly. The last column concluded with these questions: Will BE buy Ivy Electronics? What will the price be? What is in the action plan? What is 5S and the 8 Mudas?

Europlacer Continues to Outperform the Market ▸

Europlacer has enjoyed substantial growth throughout 2021 with the company forecasting the same level of achievement and success in 2022.

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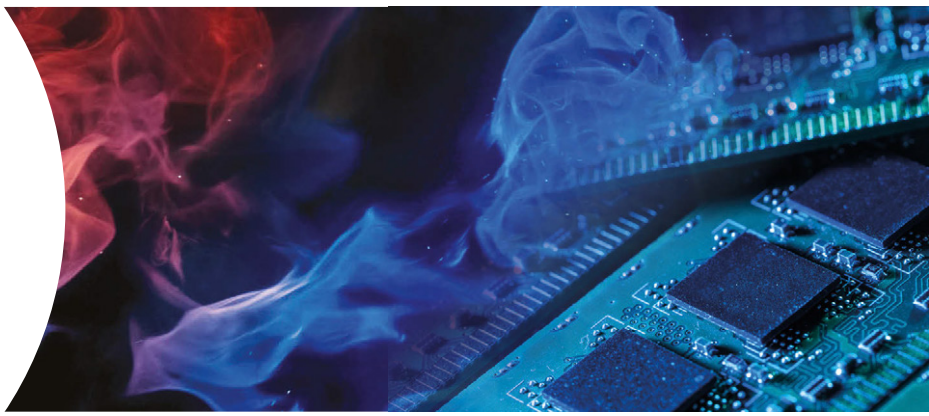

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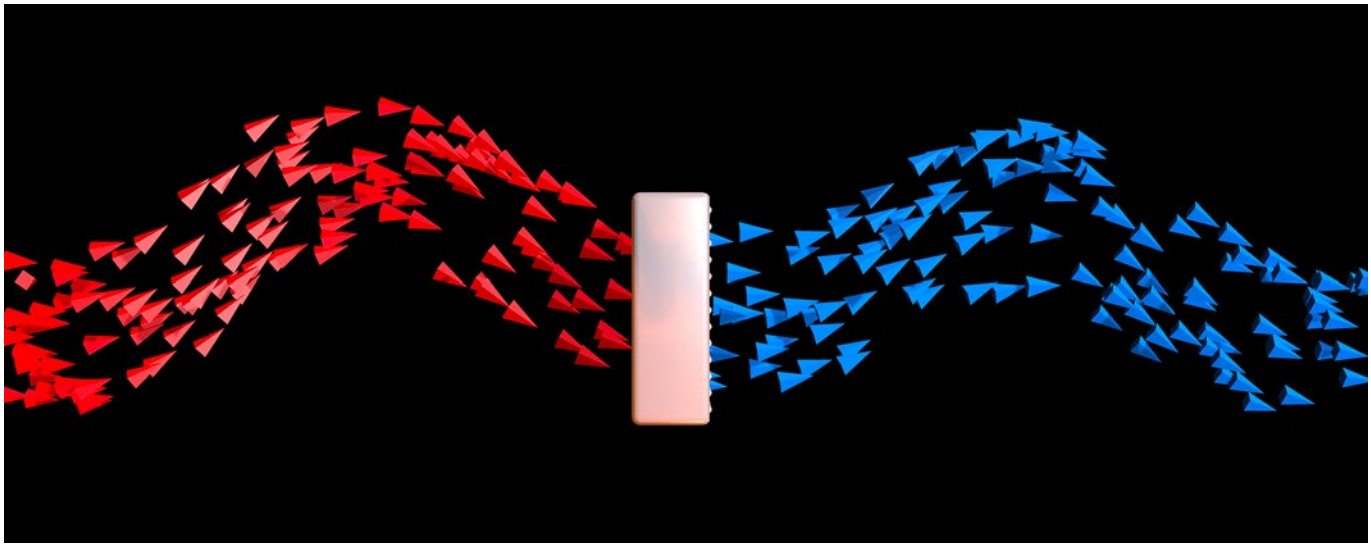

Article by Jeff Brandman
AISMALIBAR NORTH AMERICA

Heat has been a significant concern in electronics since the beginning of the electronics age when hot glowing vacuum tubes were first used to receive and transmit data bits. The transistor and integrated circuit effectively solved that basic problem but increases in integration resulted in increased concentration of heat, exacerbated by relentless increases in operating frequency. While improvements in electronics technology have been able to mitigate many thermal issues at chip level thanks to improved semiconductor designs devised to operate at lower voltages (thus requiring less energy) the thermal management challenge continues to vex electronic product developers. Moreover, with ever denser heterogeneous integration solutions now being introduced, this is expected to remain a concern to be addressed for the foreseeable future. Thermal engineers have long known that thermal energy must ultimately be "returned to the air" but getting it there in an efficient way is of great importance. They know also that there are but three basic ways of removing heat from a system: conduction, convection, and radiation; of these, conduction is by far the most efficient.

In the manufacture of printed circuits, especially those used in high power applications, the board itself becomes an obvious potential means of helping to remove heat. However, the choice must be made carefully to assure that it fits well into the scheme of traditional manufacturing, as the materials required must not only remove heat but must also maintain the high electrical insulation properties that are vitally important to printed circuit designers and the products they develop. This has been a primary focus of Aismalibar for some time and the company has accordingly developed a family of new thermal interface material (TIM) technologies designed specifically for printed circuits. SMT007

To read the entire article, which appeared in the March 2022 issue of *PCB007 Magazine,* click here.

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Report and Verify

Maggie Benson's Journey

by Dr. Ronald C. Lasky, INDIUM CORPORATION

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

Maggie and John were excited to visit Grandma and Grandpa Benson's for dinner where they would be discussing how things had progressed at Benson Electronics (now Ivy Benson Electronics). Frank Emory, Chuck Tower, and Tanya Brooks were invited as well.

When they arrived, Grandma Benson invited them in, and the group sat at the dinner table. After Grandpa Benson said grace, he said, "Well, it's clear you have made some terrific changes at BE. Frank, tell us what you, Chuck, and Tanya have done for my amazing granddaughter and her "okay" boyfriend to improve BE."

Everyone chuckled, then Maggie said, "He's my fiancé, Grandpa."

Then, Frank said, "Well, we started by changing one solder paste that had poor response-to-pause, and it saved quite a chunk of money once we replaced it. Even though the new paste was a little more expensive, it saved us more than $100,000 per year with the increased uptime."

"Wow, that is hard to believe," Grandpa Benson exclaimed.

Frank came prepared and showed Grandpa Benson the ProfitPro calculations.

"Okay, Chuck, tell us some more," Grandpa Benson implored.

"We measured uptime and I'm embarrassed to say it was only 15%, but by applying Lean principles we reached 30%," Chuck said. "Most

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importantly, we used feeder racks and minimized lost time due to 'shopping' for components. By communicating the importance of uptime with the team, they made improvements on their own as well."

John couldn't wait to speak, adding, "But what the team did for lunch was amazing."

"My granddaughter's okay boyfriend chimes in. Tell us more." Grandpa Benson said.

After a few more chuckles from all, John said, "The team worked out a way to avoid shutting the lines down over lunch. It brought uptime to 45%."

"Maggie, I know you were really the driving force behind all of this, so you should say something," Grandma Benson said.

"Well, it was a team effort, and Professor Patty Coleman was our coach, but we have neglected to say how important the people at both Benson and Ivy Benson were. After we shared the goals, they all chipped in. To recognize their efforts, we were able to increase salaries significantly. The productivity improvements and team efforts also increased morale," Maggie elaborated.

"I understand that some of the people were anxious when you took over," Grandma Benson replied.

"The folks were nervous, but we put them at ease by announcing there would be no layoffs, and that we would actually be hiring," Maggie said. "We also explained that we would be establishing training and education programs."

"Don't forget everyone also got a raise," John added.

"John is right," Maggie said. "We gave everyone a 10% raise the first day and several other raises as productivity increased."

"All of those raises were kind of gutsy," said Grandpa Benson.

"Yes, a little," Maggie responded. "But I remember that when I was a little girl you told me, 'Maggie, if you take care of the people, they will take care of you.' You were right, as our profits have exploded."

More pleasant conversation continued.

Meanwhile in the Ivy Benson Electronics breakroom...

Twenty-year-old Andy Connors and 19-year-old Sue March have become a little more than friends. Let's look in on them in the breakroom at Ivy Benson Electronics (Figure 1).

Figure 1: Illustration of Andy and Sue in the breakroom at Ivy Benson, discussing the SMT test.

"How'd you do on the SMT test Chuck Tower gave us?" Sue asked.

"I used the wisdom of one of my friends who works up at Benson Electronics, 'Better to not take the test and be thought a fool, than to take it and remove all doubt,'" Andy answered with a chuckle.

"Chuck told me I didn't do too bad," Sue said. "I was more than 10 points above the average, but I was

so embarrassed that I didn't know what SAC solder meant. I look at the jar of solder paste every day."

"Wow, that was the only thing I knew: S = tin (from Sn), A = silver (from Ag), C = copper (from Cu)," Andy said. "But I looked at the rest of the test and I only knew a thing or two."

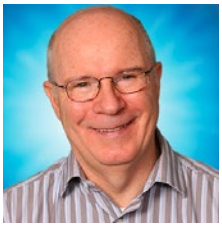
"I was a bit of a goof-off in high school and now I see the importance of learning," Sue responded. "It's obvious that math and science are important, but it seems that writing and speaking are, too. Look at what a good speaker Maggie is, and she is clearly a mover and shaker. After thinking about it, I'm going to take advantage of all the education that Ivy Benson will support."

"I'll bet I was more of a goof-off than you were," Andy told Sue. "But I hear what you are saying. After looking at Maggie, John, Frank, and some of the other bosses, I want to do better."

Andy reached for her hand. "How about we discuss this more over some pizza after watching the new Spiderman movie tonight," Andy teased.

"Okay, Romeo, but no PDA at work, okay?" Sue teased back.

Stay tuned to see how Andy and Sue's plans for more education work out. SMT007



Ronald C. Lasky is an instructional professor of engineering for the Thayer School of Engineering at Dartmouth College, and senior technologist at Indium Corporation. To read past columns, or contact Lasky, click here. Download *The Printed Circuit Assembler's Guide to... Solder Defects* by Christopher Nash and Dr. Ronald C. Lasky. You can also view other titles in our full I-007e Book library here.

NVIDIA Data Center Grooves to Tune of Million-fold Speedups

Cutting-edge AI is tackling the world's biggest challenges — but to do so, it needs the most advanced data centers, with thousands of hardware and software components working in perfect harmony.

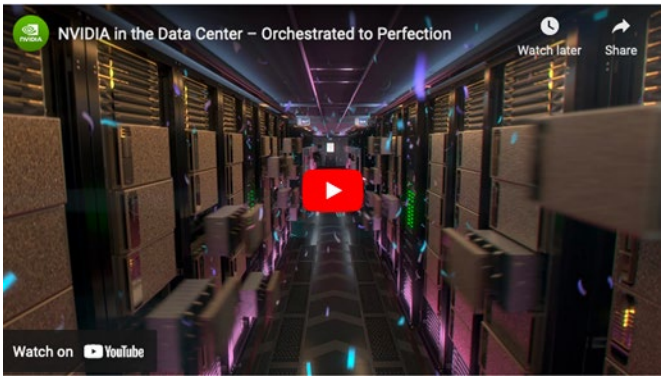
At GTC, NVIDIA is showcasing the latest data center technologies to accelerate next-generation applications in business, research and art. To keep up with the growing demand for computing these applications, optimization is needed across the entire computing stack, as well as innovation at the level of distributed algorithms, software and systems.

Performance growth at the bottom of the computing stack, based on Moore's law, can't keep pace with the requirements of these applications. Moore's law, which predicted a 2X growth in computing performance every other year, has yielded to Huang's law—that GPUs will double AI performance every year.

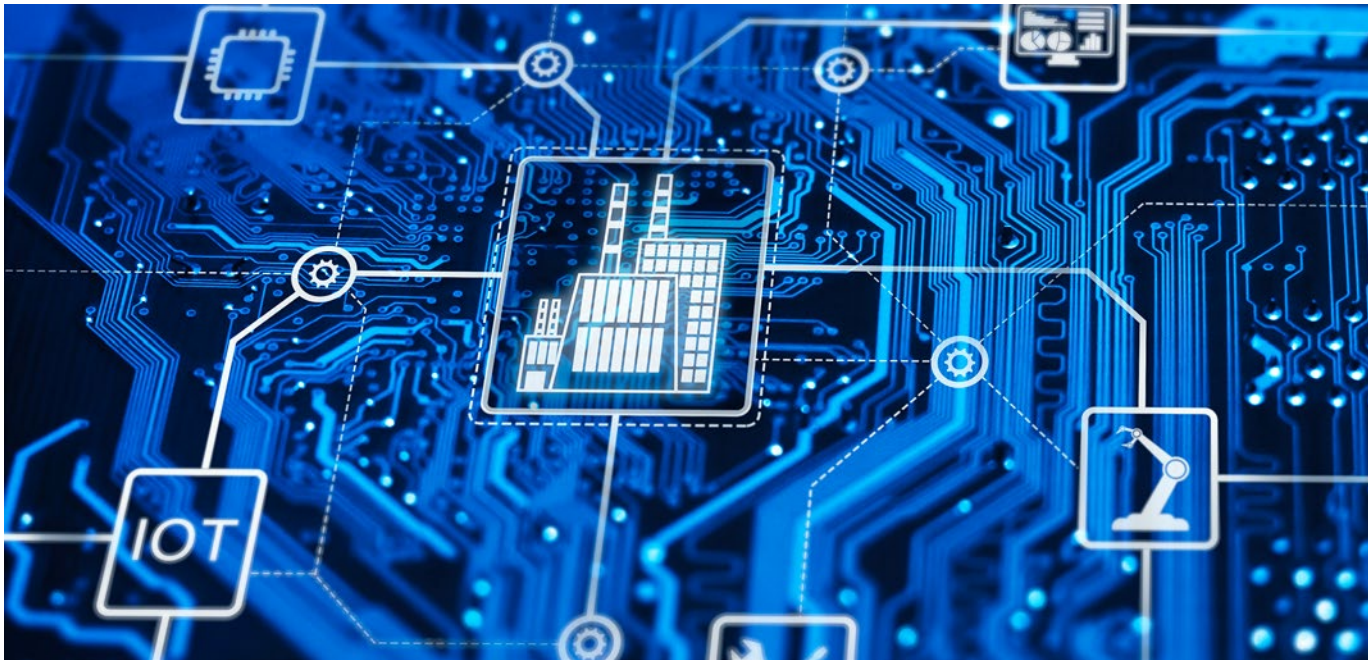
Advancements across the entire computing stack, from silicon to application-level software, have contributed to an unprecedented million-x speedup in accelerated computing in the last decade. It's not just about faster GPUs, DPUs and CPUs. Computing based on neural network models, advanced network technologies and distributed software algorithms all contribute to the data center innovation needed to keep pace with the demands of ever-growing AI models.

(Source: NVIDIA)

Video below: *The lighthearted video celebrates the ability of NVIDIA data center solutions to orchestrate unprecedented AI performance.*



The Journey to Your Smart Factory



Feature Article by Happy Holden
I-CONNECT007

Automation and computers have been my passion for the last 55 years, both as a student and a professional. This article will introduce the methodologies that have served me over the years in automating electronics manufacturing.

The hardest step is getting started. I know this because I have designed and built portions of nine automated PCB factories in my career, and a dozen more process factories, all automated by computers and the software that drives them. This article focuses on:

- Who should design it?
- What should they learn?
- How do you analyze and plan the automation?
- How long should it take?
- When is the right time?
- How much will it cost?

Let's get into some detail on these key questions to help you to get started.

Who Should Design It?

Independent factory automation consultants are exceedingly rare and, if you find one, they will most likely charge you for learning your processes and procedures. They will be restricted to their products which then restricts their choices of solution. It usually is a better investment to select your own engineers who are familiar with your processes and procedures and let them learn how to do the auto-

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mation planning. Then they can teach others, as the factory will need to pass along this skill repeatedly.

One recommended team configuration is having two engineers: a process engineer (usually a chemical engineer) and a control/data engineer (usually an electrical engineer). Having access to a statistician (either a university or a consultant) will be extremely useful. Both engineers should be capable of working independently, with the capability to quickly learn new skills, including statistical tools and data analysis. New college graduates, especially with a graduate degree, would be suitable. A bonus and compensations need to be established, as successful factory automation engineers are highly prized and heavily recruited.

What They Need to Learn

There are seven major topics to be addressed with the primary one being to meet your company's business objectives. The company should already have some long-term business objectives that will shape the priorities for an automation strategy and product roadmap. Achieving these objectives depends upon the other six topics listed here:

1. **Zero waste:** Waste of any sort, including materials, rework, repair, paperwork, environmental, or workforce, are all suitable focus for benchmarking (or best practices) analysis to improve performance.
2. **Internet-of-Things sensors:** New sensors to provide real-time data are the basis for most Smart factory automation. Sensors can be purchased to provide relevant information and integrated by low-cost programmable logic controllers (PLCs) for storage in the cloud. Some may have to be a DIY sensor, like the specific gravity unit or amp-hour unit from Chapter 4 of *Automation and Advanced Procedures in PCB Fabrication.*[2]
3. **Predictive analytics:** Using new sensor data stored in the cloud, regression analysis, and DOE procedures can create predictive models (digital twins) to reduce or eliminate defects or enhance product specifications like impedance control and registration.
4. **Zero-defect manufacturing:** Unless your yields are 100%, defects are your largest waste and benchmarking will provide project focus.
5. **Driving zero-downtime:** Downtime for equipment or process affects the bottom line and delivery performance; new sensor data and predictive models can eliminate this.
6. **Create solution templates:** Documenting automation solutions with a template that others can follow to solve similar problems and waste.

How to Analyze and Plan the Automation

Give your team the time to learn about some of the new tools and skills that will be required. This education starts with these seven resources:

1. *24 Essential Skills for Engineers:* 17 chapters to study (Figure 1)[1]
2. *Automation and Advanced Procedures in PCB Fabrication:* The chapters that will especially need to be studied are, "CIM & Automation Strategy" and "Mechanization in PCB Fabrication" Figure 2)[2]
3. *The eHandbook of Statistical Methods:* Use the free handbook and software from NIST to study the chapters on DOE and problem-solving (Figure 3) as it is the world's best engineering statistics training, including examples, and will be used by you and your team for the rest of their careers[3]
4. Siemen's *The Printed Circuit Assembler's Guide to… Advanced Manufacturing in the Digital Age,* which focuses on understanding the new roles for ERP, MES/MOM,

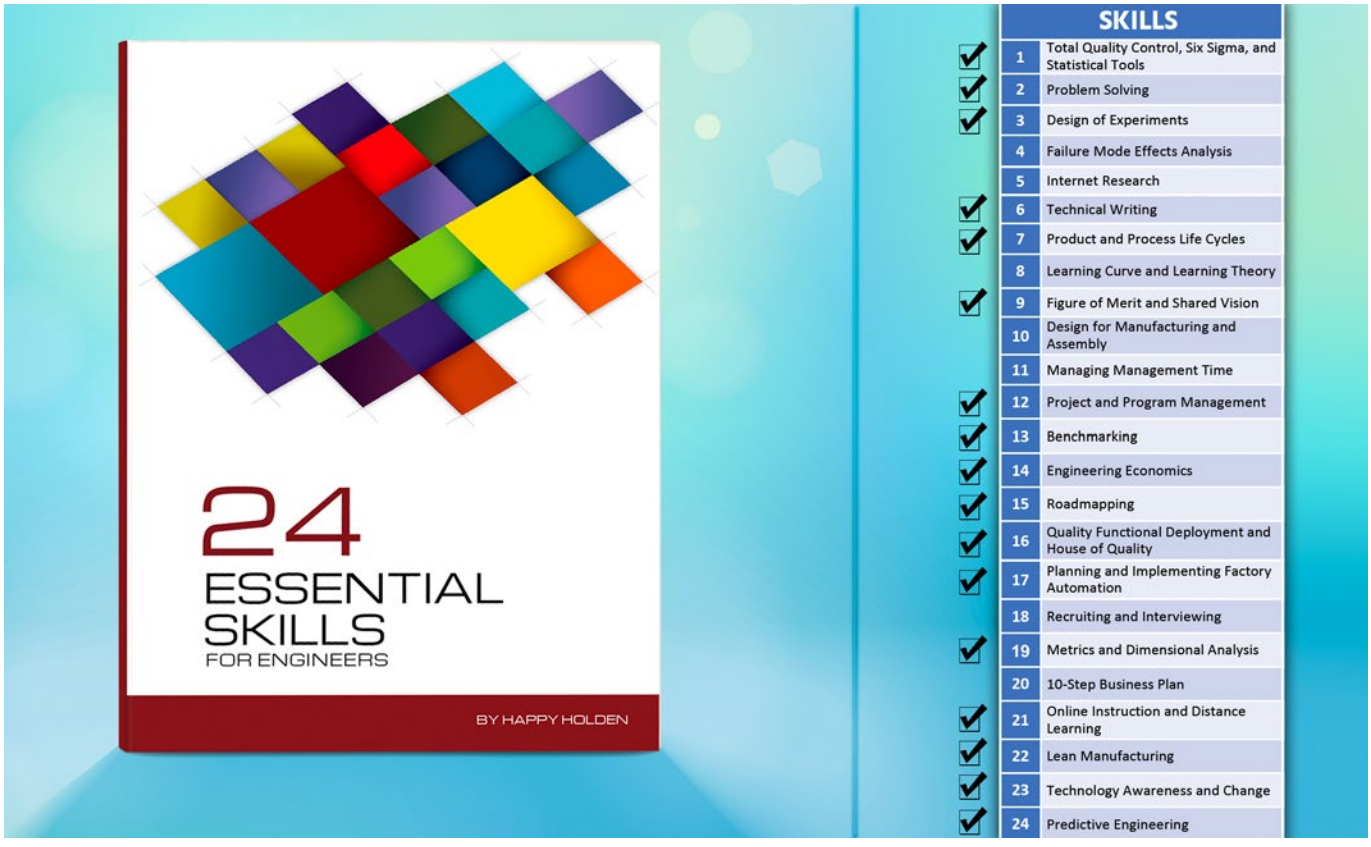


Figure 1: There are 17 chapters (indicated with check marks) in my *24 Essential Skills for Engineers* book that are essential to setting up a successful Smart factory.

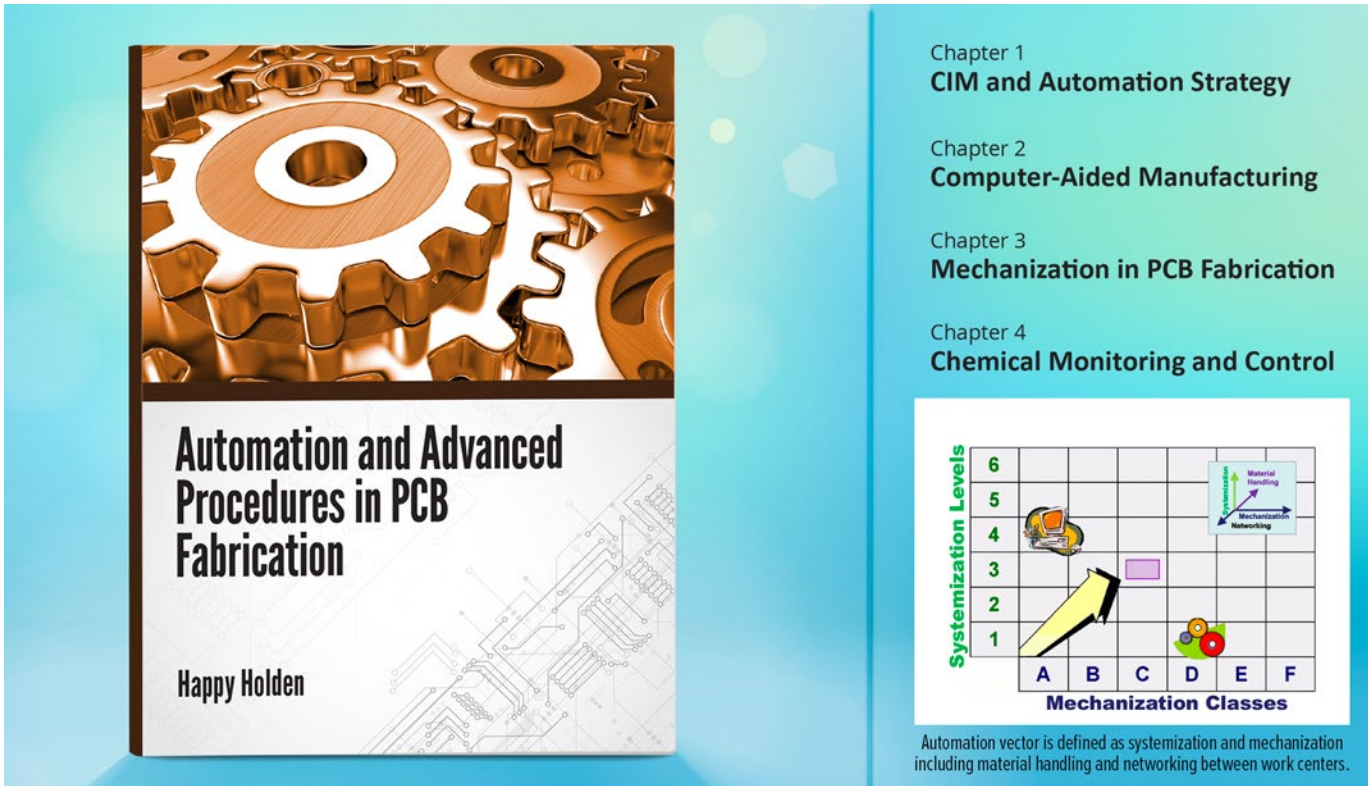


Figure 2: Use and study my book, *Automation and Advanced Procedures in PCB Fabrication*.[2]

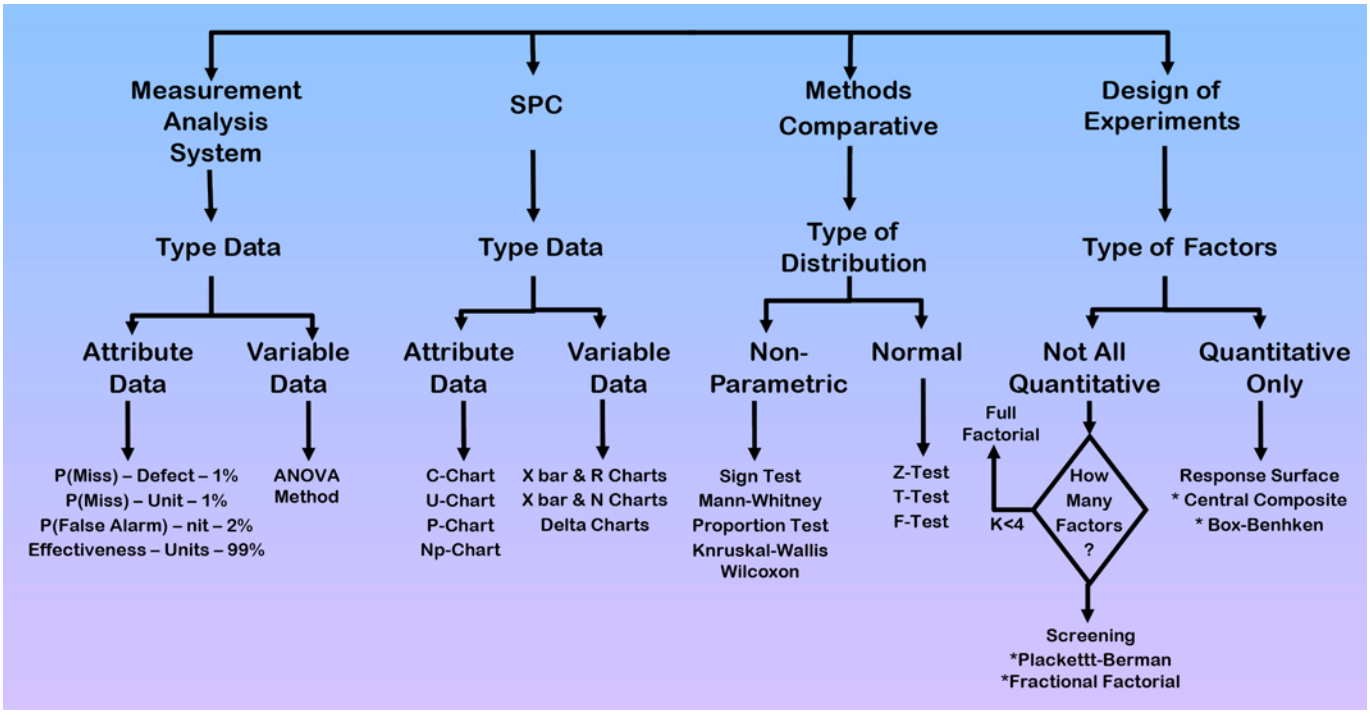


Figure 3: When selecting the right statistical tool for problem analysis, refer to the four techniques in this flow chart.

PLM, TIA, and APS in the hierarchy of factory control software (Figure 4)[4]

5. DAQs: Study data acquisition systems, sensors, and SCADA from ISA
6. PLCs: Learn "ladder logic" and "low-code" programming to utilize low-cost programmable logic controllers for sensors
7. Solution templates: Create solution templates for use by other engineers

How Long Should It Take?

Your team will need two to six months to educate themselves on the tools and skills required for this assignment. Minimum is eight to 40 hours of lecture per topic to have the expertise to do this job. In that time, they should review their situation and look for:

- A simple first project (from examples) that guarantees success and a great ROI; this needs about two months to implement. Success creates enthusiasm and support
- Successful training for more engineers or technicians to create solutions
- The data (including part number and date) before you can predict the outcome
- New processes or equipment that take longer to implement
- Insights that come from benchmarking competitors

Table 1 outlines the eight chapters and description of their contents for The eHandbook of Statistical Methods which can be downloaded at no charge.[3]

In collecting important data, many variables will be qualitative and not quantitative. As illustrated in Figure 3, selecting the right statistical tool by the type of data or type of distribution and type of factors will result in analysis tools that will not only solve problems, but provide linear and non-linear digital twin models for forecasting.

You should select two additional educational books or resources about PLCs, ladder logic, sensor technology, and data acquisition like Instrument Society of America (ISA) or National Instruments. Here are what I use in North America:

TABLE 1: Engineering Statistics Handbook Chapters and Descriptions			
1. Exploratory Data Analysis	2. Measurement Process Characterization	3. Production Process Characterization	4. Process Modeling
• Introduction • Assumptions • Techniques • Case Studies	• Characterization • Control • Calibration • Gauge R&R Studies	• Introduction • Assumptions • Data Collection • Data Analysis • Case Studies	• Introduction • Assumptions • Data Collection • Data Analysis • Interpretation and Use • Case Studies
5. Process Improvement	6. Process/Product Monitoring and Control	7. Product/Process Comparisons	8. Assessing Product Reliability
• Introduction • Assumptions • Choosing an Experiment Design • Analysis of DOE Data • Advanced Topics • Case studies	• Introduction • Test Product for Acceptability • Univariate and Multivariate Control Charts • Time Series Models • Tutorial • Case Studies	• Introduction • Comparisons: One Process • Comparisons: Two Processes • Comparisons: Three+ Processes	• Introduction • Assumptions/Prerequisites • Reliability Data Collection • Reliability Data Analysis

(Source: *24 Essential Skills for Engineers*[1])

- For PLCs and ladder logic: Refer to Siemens or Automation Direct
- To understand data acquisition systems and sensors, see ISA, National Instruments, or Keysight
- Understand the roles of management software: IOT, WMS, MES, IMS-MOM, EAM, QMS, ALS, FMS, FAST R, and IPM for predictive analytics and performance visibility

When Is the Right Time?

Once the engineers have been selected and are doing the preparation to open the factory, here are some important things to keep in mind:

- Distance learning can provide Total Quality Management, Six Sigma, Lean, DOE/regression, ISA-Sensors, DAC, PLC, and low-code training
- Establish the process for ongoing continuous improvements and solution templates
- Remember that new product/process development can be lengthy and involved, so it may not be advisable as part of this program

How Much Will It Cost?

Projects need not be massive. Projects can be a few hundred dollars (i.e., specific gravity sensor) to a few thousand (i.e., robot panel carrier):

- Utilizing a local metal fabricator to build for you the robot process panel carrier—it can cost only $5,000 and establish a working partner (*Automation,* Chapter 3[2])
- Establishing the roadmap of your future will provide candidates with the best ROIs
- Use the product life cycle if new processes and technology are part of that future
- Employ the new solution templates if you have started any

The Smart Factory

Starting to implement your Smart factory will require three areas of focus: sensing and collecting data in real time, connecting, and predicting.

Sensing: Collecting the data in real time; these nine bullets are just some ideas:

1. MES route, tool, recipe info
2. SECS/GEM tool/process state
3. WIP location tracking
4. Defect metrology tools
5. Product yields
6. SPC, APC, RtR, FDC
7. RGAs and other IoT sensors
8. RF, QCM, vibration, fluid flow
9. Sub-floor tool status and environment

Connecting: Uniting different and unique data sources. This may require some ingenuity to collect data from bar-code readers, BCD displays, PLCs, or other islands of automation.

Predicting: Using models to predict data on the outcome of machine/process events for alerting operators to predicting machine downtime for maintenance to improving processes for higher controlled impedance performance.

Once Level 0 (factory floor and sensors) and Level 1 (DAQs, PLCs and controllers) are connected and producing data, then comes the evaluation of factory setup and control systems software. These software products can provide real-time factory analysis as seen in Figure 5, and the software, including RMS, SPC,

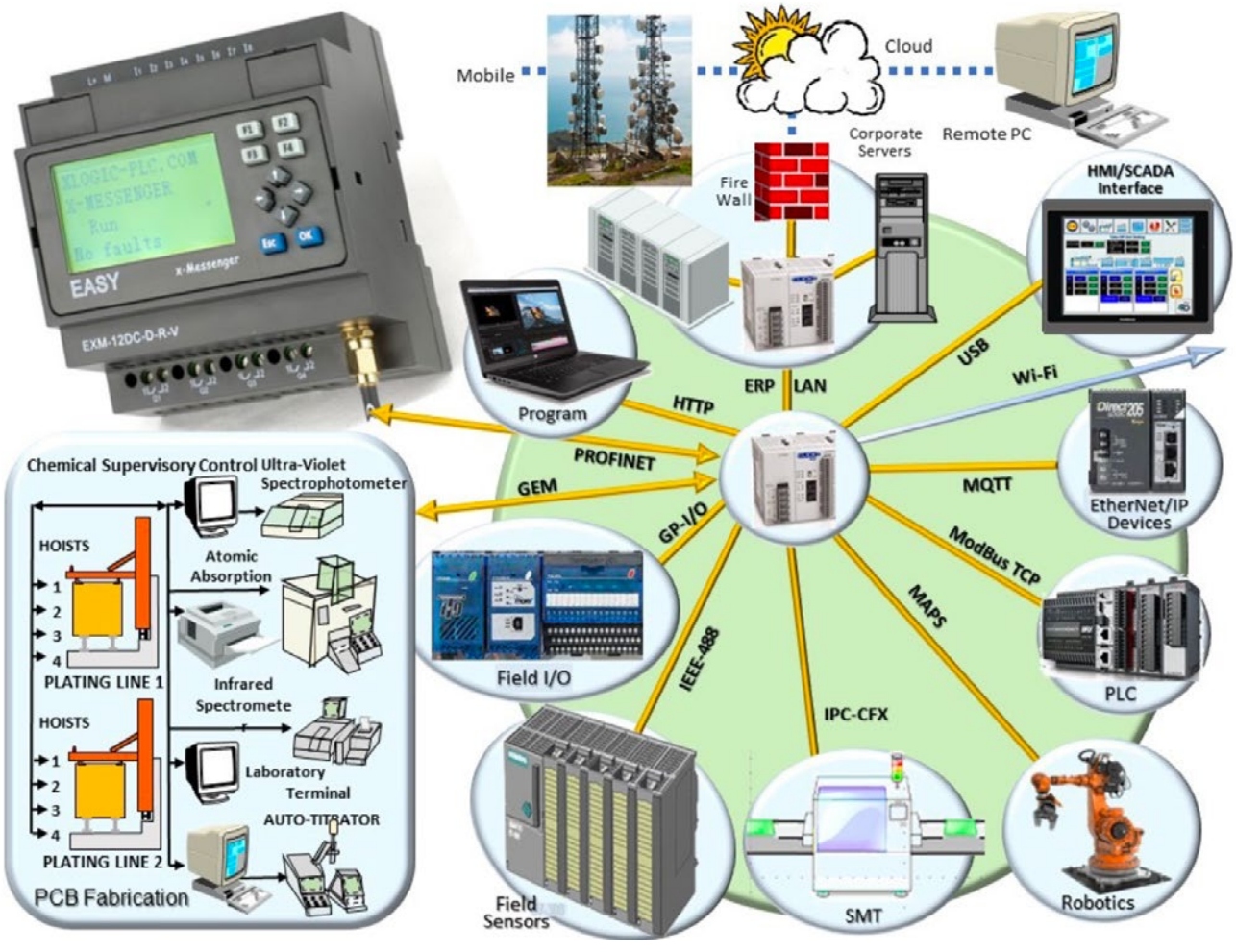


Figure 4: PLCs and sensors are the major source of data for the Smart Factory as well as the myriad protocols used to connect them.

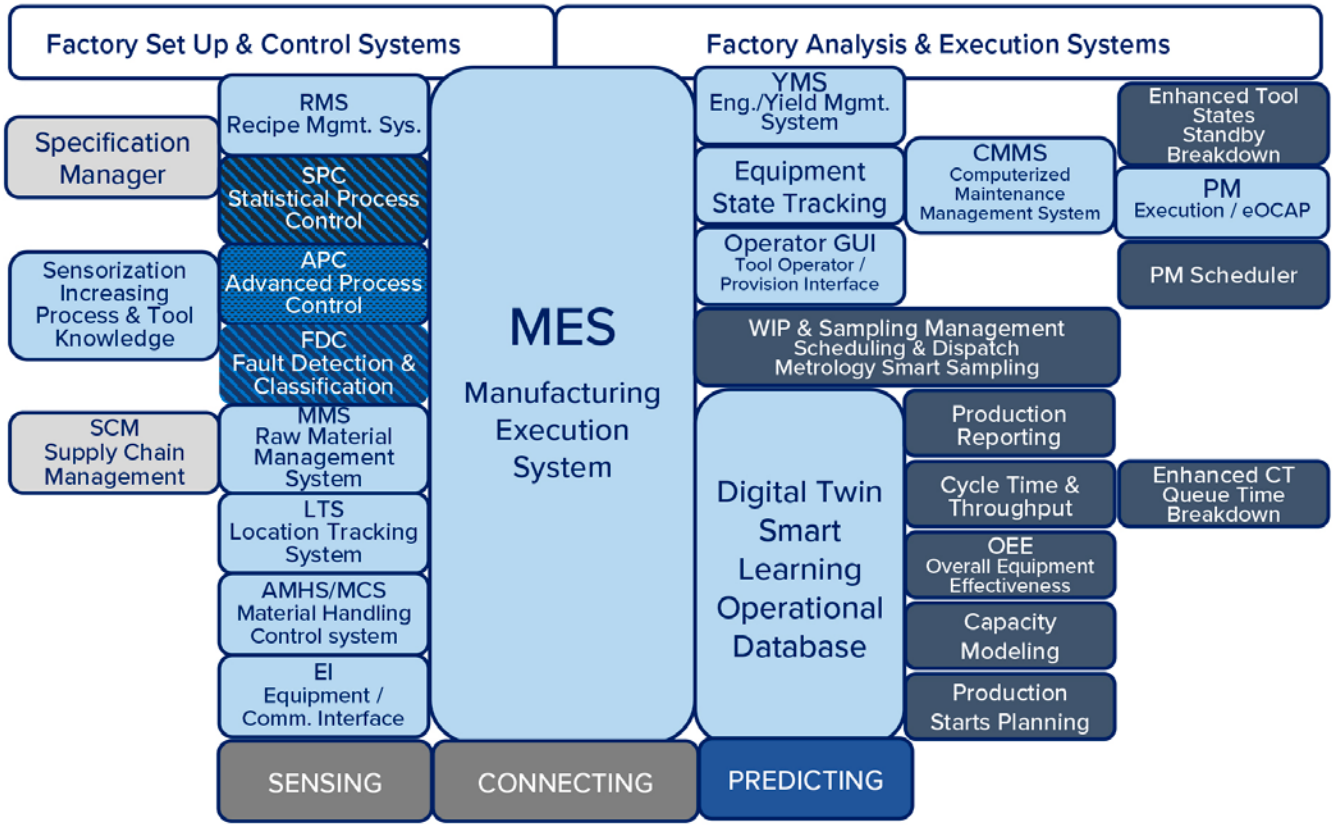


Figure 5: Typical Smart factory architecture. Software is available to implement factory setup and control, and factory analysis/execution systems.[5]

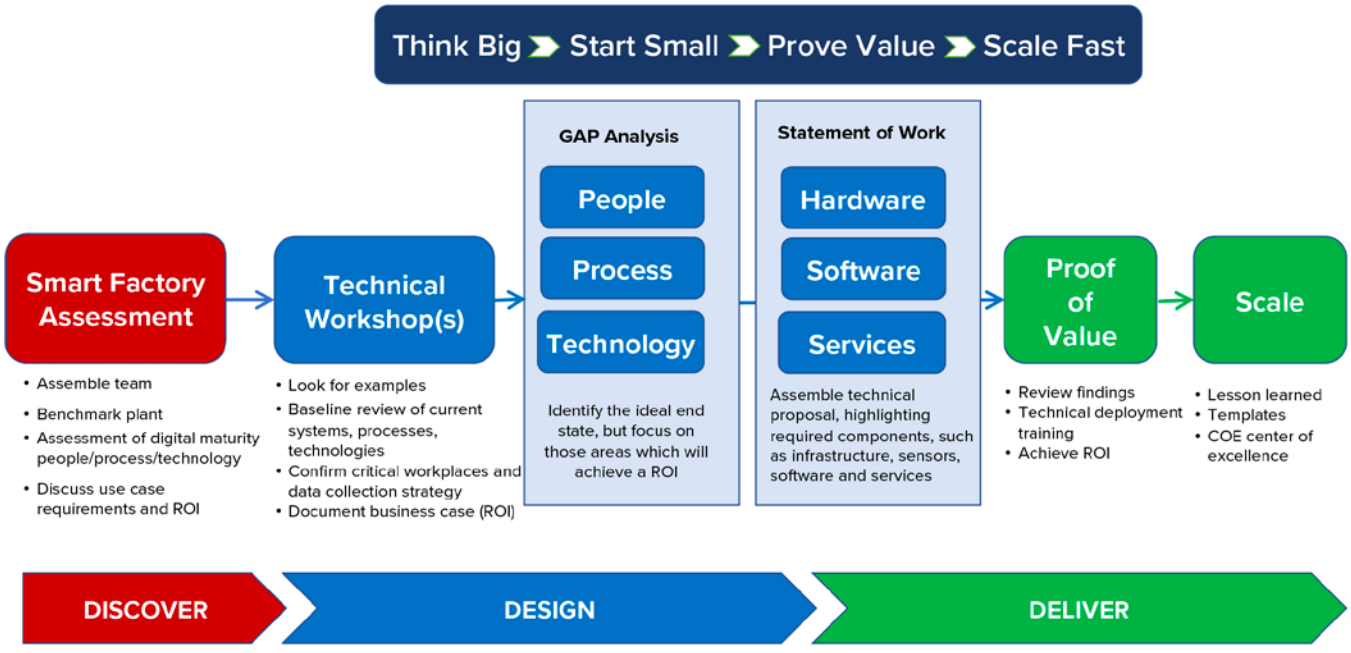


Figure 6: The predictive analysis is a major item in the Smart factory and follows the discovery-design-deliver journey.[5]

APC, FDC, MMS, LTS, AMHS/MCS, YMS, CMMS, WIP, queue time breakdown, OEE, and digital twins' predictions.

Conclusion

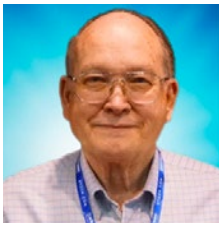
This article is a preview of my presentation for the ICT Annual Symposium on June 8, 2022. The presentation will include discussion of predictive analytics, solutions templates, and data protocols.

Here are your key takeaways:

- Start your Smart factory journey today; think big, start small, act now
- Look to staff the automation team with your own engineers plus training
- Initiate a Smart factory assessment, then make it operational with proof of value (ROI). This is a fundamental business transition; align the technology to business objectives
- Drive toward a Smart connected factory with a zero-downtime, zero-defect vision
- Improve your weak link: people, process, or technology. Benefits only accrue as far as the weakest link

References

1. *24 Essential Skills for Engineers,* by Happy Holden.
2. *Automation and Advanced Procedures in PCB Fabrication,* by Happy Holden.
3. *The eHandbook of Statistical Methods,* NIST, 1995.
4. *The Printed Circuit Assembler's Guide to… Advanced Manufacturing in the Digital Age, 2nd Edition,* by Oren Manor, Siemens Digital Industries Software.
5. *Evolution of the Smart Manufacturing,* by John Behnke, INFICON Webinar, March 2022.



Happy Holden has worked in printed circuit technology since 1970 with Hewlett-Packard, NanYa Westwood, Merix, Foxconn, and Gentex. He is currently a contributing technical editor with I-Connect007, and an I-Connect007 columnist. To read past columns or contact Holden, click here.

Glossary of Acronyms Used in this Article

- AMHS/MCS: Material handling control system
- APC: Advanced process control
- APS: Advanced planning and scheduling
- CMMS: Computerized maintenance management system
- BCD: Binary coded decimal
- DAC: Digital-to-analog converter
- DAQ: Data acquisition
- EAM: Enterprise asset management
- ERP: Enterprise resource planning
- FDC: Fault detection and classification
- GEM: Generic model for communications and control of manufacturing equipment
- FDC: Fault detection and classification
- FMS: Flexible manufacturing system
- IPM: Intelligent power management
- LTS: Location tracking system
- MES/MOM: Manufacturing execution system/ manufacturing operations management
- MMS: Raw materials management system
- OEE: Overall equipment effectiveness
- PLM: Product life-cycle management
- PM: Preventative maintenance
- QCM: Quartz crystal microbalance
- QMS: Quality management system
- RGA: Residual gas analyzer
- RMS: Recipe management system
- RtR: Reel-to-reel
- SPC: Statistical process control
- TIA: Totally integrated automation
- YMS: Yield management system
- WIP: Work in progress
- WMS: Warehouse management system

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TOP TEN

EDITOR'S PICKS

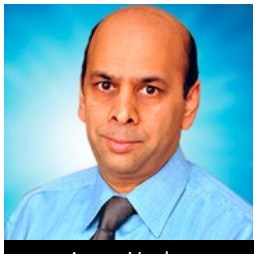
IPC EMS Leadership Summit: Peer Solutions to Supply Chain and Labor Development

EMS leaders gathered for the EMS Leadership Summit in January at IPC APEX EXPO. Expert and peer presentations on priorities ranging from the economy to the supply chain, cybersecurity, and software were interspersed with peer-to-peer discussions on several key topics.

SMT Perspectives and Prospects: Critical Materials, A Compelling Case, Part 1

It has come the time for a national strategy, in a deliberative and comprehensive manner, to address the critical materials/minerals. Doing so is increasingly critical to the long-term economy, national security, and the nation's global competitiveness. With the handling of conflict minerals as an exemplar, there is perhaps an even more urgent need to rally another concerted effort to tackle the critical materials/minerals.

Standard of Excellence: Partners Help Each Other



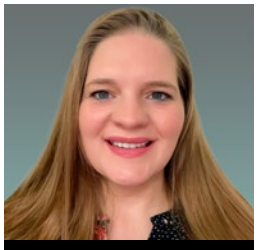
Anaya Vardya

I read the other day that the best place to get a referral or a testimonial is from your partners, the people who you work with. Things have changed. Now, your customers are the very people to ask and get a reference from. They are, after all, the ones who have the most vested interest in helping you succeed.

David Pogue: Is the Fear of Change Holding Us Back?

David Pogue, an American technology and science writer and TV presenter, sat down with the I-Connect007 Editorial Team after his keynote presentation at IPC APEX EXPO to talk about today's technology, the breakthroughs that have shaped our current landscape, and whether fear of change and innovation is what's keeping us from the next technological revolution.

New IPC Excellence in Education Award Presented to Tabbatha Greek, Honeywell Aerospace

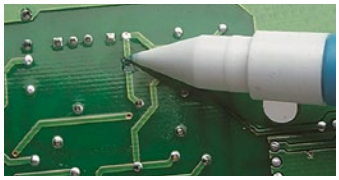

Tabbatha Greek

Tabbatha Greek serves as the Master IPC Trainer for Honeywell Aerospace, where she runs a private IPC Training Center. She has been involved with manufacturing training for more than 15 years. Through her experience, she recognized that the industry needed a better way to bridge the skill-gap in electronics manufacturing.

Conversations With Two IPC President's Award Winners

We interviewed two of this year's IPC President's Awards, Joe Kane of BAE Systems, and Zhiman (Susann) Chen of Zhuzhou CRRC Times Electric Co., Ltd. The IPC President's Award is given to IPC members who have exhibited ongoing leadership in IPC and have made significant contributions of their time and talent to the association and the electronics interconnect industry.

Knocking Down the Bone Pile: Solder Mask Repair Techniques for PCB Repair



One of the most common physical repairs (restoring functional capability of a defective PCB while not complying to meet original specifications) on a PCB is the repair of solder mask.

Flex Names Becky Sidelinger New President of Reliability Solutions


Becky Sidelinger

Flex announced Becky Sidelinger has joined the company as president of Reliability Solutions. Ms. Sidelinger will lead the company's Reliability Solutions, which includes the automotive, industrial and health solutions business units.

Sanmina, Reliance Create Manufacturing Joint Venture in India

Sanmina Corporation announced it has entered into an agreement to create a joint venture through an investment in Sanmina's existing Indian entity (Sanmina SCI India Private Ltd, "SIPL").

Smart Factory Insights: CFX IIoT Open-Source Hardware

The IPC Connected Factory Exchange standard, CFX, has triggered a revolution in the way that industrial machines communicate in a secure, IIoT-based, plug-and-play environment. Attention now is on how CFX can be connected to older, "dumber" machines, bringing 100% visibility and control across the whole manufacturing floor, thereby avoiding the numerous technical and financial pitfalls historically experienced.

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Skills and abilities required:

- Proven experience as operations supervisor or similar role
- Knowledge of organizational effectiveness and warehouse management
- Experience with ISO9001 or similar QMS
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- Excellent leadership ability and communication skills (English)
- Outstanding organizational skills
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Skills and abilities required:

- Extensive sales, product management, product application experience
- European citizenship (or authorization to work in Europe/Germany)
- Fluency in English language (spoken & written)
- Good written & verbal communications skills
- Printed circuit board industry experience an advantage
- Ability to work well both independently and as part of a team
- Good user knowledge of common Microsoft Office programs
- Full driving license essential

What's on offer:

- Salary & sales commission--competitive and commensurate with experience
- Pension and health insurance following satisfactory probation
- Company car or car allowance

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This position provides information from the product team to the marketing communications team. It is a multifunctional role that requires some experience within electronics manufacturing supply chain or knowledge of how electronic devices are manufactured, specifically PCBs, semiconductors, and the chemical processes utilized therein. The primary function of this role is to help in the generation of product marketing collateral, but also includes assisting in tradeshow content development, advertising, and launches.

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DETAILS OF FUNCTION:
- Develops and maintains strategic partner relationships
- Manages and develops sales reps:
  - Reviews progress of sales performance
  - Provides quarterly results assessments of sales reps' performance
  - Works with sales reps to identify and contact decision-makers
  - Setting growth targets for sales reps
  - Educates sales reps by conducting programs/seminars in the needed areas of knowledge
- Collects customer feedback and market research (products and competitors)
- Coordinates with other company departments to provide superior customer service

QUALIFICATIONS:
- 5-7+ years of related experience in the manufacturing sector or equivalent combination of formal education and experience
- Excellent oral and written communication skills
- Business-to-business sales experience a plus
- Good working knowledge of Microsoft Office Suite and common smart phone apps
- Valid driver's license
- 75-80% regional travel required

To apply, please submit a COVER LETTER and RESUME to: Fernando Rueda, Americas Manager

fernando_rueda@kyzen.com

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- Work with CAD: finalize files, attain customer approval prior to build
- Track timeline and provide customers with updates
- Follow up on prototype, assist with design changes if needed, push forward to production
- Work with customer as the lead technician/program manager or as part of FCT team working with an assigned program manager
- Help customer understand FCT's assembly, testing, and box build services/support
- Understand manufacturing and build process for flexible and rigid-flex circuits

Qualifications

- Demonstrated experience: PCB/FPCB/rigid-flex designer including expertise in design rules, IPC
- Demonstrated success in attaining business
- Ability to work in fast-paced environment, on broad range of projects, while maintaining a sense of urgency
- Ability to work as a team player
- Excellent written and verbal communication skills
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- Learn the properties, applications, advantages/ disadvantages of flex circuits
- Learn the intricacies of flex circuit layout best practices
- Learn IPC guidelines: Flex circuits/assemblies
- Create flexible PCB designs/files to meet engineering/customer requirements
- Review customer prints and Gerber files to ensure they meet manufacturing and IPC requirements
- Review mechanical designs for mfg, including circuit and assembly requirements, BOM/component needs and help to identify alternate components if needed
- Prepare and document changes to customer prints/ files. Work with app engrs, customers and mfg. engrs. to finalize and optimize designs for manufacturing
- Work with quality manager to learn quality systems, requirements, and support manager with assistance

Qualifications

- Electrical Engineering degree with 2+ years of CAD/PCB design experience
- IPC CID or CID+ certification or desire to obtain
- Knowledge of flexible PCB materials, properties, or willingness to learn
- Experience with CAD software: Altium or other
- Knowledge of IPC standards for PCB industry, or willingness to learn
- Microsoft Office products

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INSULECTRO

Are You Our Next Superstar?!

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

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

apply now

pluritec®

MACHINES FOR PRINTED CIRCUIT BOARDS

Field Service Engineer

Location: West Coast, Midwest

Pluritec North America, ltd., an innovative leader in drilling, routing, and automated inspection in the printed circuit board industry, is seeking a full-time field service engineer.

This individual will support service for North America in printed circuit board drill/routing and x-ray inspection equipment.

Duties included: Installation, training, maintenance, and repair. Must be able to troubleshoot electrical and mechanical issues in the field as well as calibrate products, perform modifications and retrofits. Diagnose effectively with customer via telephone support. Assist in optimization of machine operations.

A technical degree is preferred, along with strong verbal and written communication skills. Read and interpret schematics, collect data, write technical reports.

Valid driver's license is required, as well as a passport, and major credit card for travel.

Must be able to travel extensively.

apply now

Career Opportunities

American Standard Circuits
Creative Innovations In Flex, Digital & Microwave Circuits

Wet Process Engineer

ASC, the largest independent PCB manufacturer in the Midwest, is looking to expand our manufacturing controls and capabilities within our Process Engineering department. The person selected will be responsible for the process design, setup, operating parameters, and maintenance of three key areas—imaging, plating, etching--within the facility. This is an engineering function. No management of personnel required.

Essential Responsibilities

Qualified candidates must be able to organize their own functions to match the goals of the company.

Responsible for:

- panel preparation, dry film lamination, exposure, development and the processes, equipment setup and maintenance programs
- automated (PAL line) electrolytic copper plating process and the equipment setup and maintenance programs
- both the cupric (acid) etching and the ammoniacal (alkaline) etching processes and the equipment setups and maintenance programs

Ability to:

- perform basic lab analysis and trouble-shooting as required
- use measurement and analytical equipment as necessary
- work alongside managers, department supervisors and operators to cooperatively resolve issues
- effectively problem-solve
- manage multiple projects concurrently
- read and speak English
- communicate effectively/interface at every level of the organization

Organizational Relationships

Reports to the Technical Director.

Qualifications

Degree in Engineering (BChE or I.E. preferred). Equivalent work experience considered. High school diploma required. Literate and functional with most common business software systems MS Office, Excel, Word, PowerPoint are required. Microsoft Access and basics of statistics and SPC a plus.

Physical Demands

Exertion of up to 50 lbs. of force occasionally may be required. Good manual dexterity for the use of common office equipment and hand tools.

- Ability to stand for long periods.

Work Environment

This position is in a manufacturing setting with exposure to noise, dirt, and chemicals.

Click on 'apply now' buttton below to send in your application.

apply now

Career Opportunities

Manncorp™

SMT Field Technician
Hatboro, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

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

We Offer:

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

apply now

Prototron Circuits

Sales Representatives

Prototron Circuits, a market-leading, quick-turn PCB shop, is looking for sales representatives for all territories.

Reasons you should work with Prototron:

- Serving the PCB industry for over 30 years
- Solid reputation for on-time delivery (99% on-time)
- Excellent quality
- Production quality quick-turn services in as little as 24 hours
- AS9100
- MIL-PRF- 31032
- ITAR
- Global sourcing
- Engineering consultation
- Completely customer focused team

Interested? Let's have a talk.
Call Dan Beaulieu at
207-649-0879
or email to
danbbeaulieu@aol.com

apply now

Career Opportunities

Printed Circuits, a fast-growing printed circuit board fabricator, offers:

- Excellent opportunities for advancement and growth
- Dynamic manufacturing environment
- Excellent health, dental and other benefits
- Annual profit-sharing plan
- Signing bonus
- Additional incentives at the leadership level
- Clean facility with state-of-the-art manufacturing equipment
- Highly collaborative corporate and manufacturing culture that values employee contributions

Laminator Technician

Nature of Duties/Responsibilities

- Layup cover lay
- Layup rigid flex
- Layup multilayer/CU core boards
- Oxide treat/cobra treatment of all layers/CU cores
- Shear flex layer edges
- Rout of machine panel edges and buff
- Remove oxide/cobra treatment (strip panels)
- Serialize panels
- Pre-tac Kapton windows on flex layers (bikini process)
- Layup Kapton bonds
- Prep materials: B-stage, Kapton, release sheet
- Breakdown: flex layers, and caps
- Power scrub: boards, layers, and caps
- Laminate insulators, stiffeners, and heatsinks
- Plasma cleans and dry flex layers B-stage (Dry)
- Booking layers and materials, ready for lamination process
- Other duties as deemed necessary by supervisor

Education/Experience

- High school diploma or GED
- Must be a team player
- Must demonstrate the ability to read and write English and complete simple mathematical equations
- Must be able to follow strict policy and OSHA guidelines
- Must be able to lift 50 lbs
- Must have attention to detail

Wet Process/Plating Technician

Position is 3rd shift (11:00PM to 7:30AM, Sunday through Friday)

Purpose

To carry out departmental activities which result in producing quality product that conforms to customer requirements. To operate and maintain a safe working environment.

Nature of Duties/Responsibilities

- Load and unload electroplating equipment
- Fasten circuit boards to racks and cathode bars
- Immerse work pieces in series of cleaning, plating and rinsing tanks, following timed cycles manually or using hoists
- Carry work pieces between departments through electroplating processes
- Set temperature and maintains proper liquid levels in the plating tanks
- Remove work pieces from racks, and examine work pieces for plating defects, such as nodules, thin plating or burned plating
- Place work pieces on racks to be moved to next operation
- Check completed boards
- Drain solutions from and clean and refill tanks; fill anode baskets as needed
- Remove buildup of plating metal from racks using chemical bath

Education and Experience

- High school diploma or GED required
- Good organizational skills and the ability to follow instructions
- Ability to maintain a regular and reliable attendance record
- Must be able to work independently and learn quickly
- Organized, self-motivated, and action-oriented, with the ability to adapt quickly to new challenges/opportunities
- Prior plating experience a plus

Production Scheduler

Main Responsibilities

- Development and deployment of a level-loaded production plan
- Establish manufacturing plan which results in "best possible" use of resources to maximize asset utilization
- Analyze production capacity of manufacturing processes, equipment and human resource requirements needed to produce required products
- Plan operation manufacturing sequences in weekly time segments utilizing production labor standards
- Maintain, align, and communicate regularly with internal suppliers/customers and customer service on key order metrics as per their requirements
- Frequently compare current and anticipated orders with available inventory and creates replenishment plan
- Maintain master distribution schedule for the assigned facility, revise as needed and alert appropriate staff of schedule changes or delays
- Participate in periodic forecasting meetings
- Lead or participate in planning and status meetings with production, shipping, purchasing, customer service and/or other related departments
- Follow all good manufacturing practices (GMPs)
- Answer company communications, fax, copy and file paperwork

Education and Experience

- High school diploma or GED
- Experience in manufacturing preferred/3 years in scheduling
- Resourceful and good problem-solving skills
- Ability to make high pressure decisions
- Excellent written and verbal communication skills
- Strong computer skills including ERP, Excel, Word, MS Office
- Detailed and meticulous with good organizational skills
- Must be articulate, tactful and professional at all times
- Self-motivated

apply now

Career Opportunities

MivaTek Global

Field Service Technician

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

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

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

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

More About Us

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

apply now

Ucamco

Sales Engineer

Germany, Austria, Switzerland, Southeastern Europe e.g. Italy

Ucamco is looking for a sales engineer for our front-end software in the German-speaking area (Germany, Austria, German Switzerland) as well as adjacent markets in the South and East.

Ucamco is a market leader in PCB CAM, pre-CAM software and laser photoplotters with more than 35 years' experience developing and supporting leading-edge, front-end tooling solutions for the global PCB industry.

Responsibilities:

- Selling software solutions
- Selling support contracts and upgrades
- Developing and implementing customer acquisition plan
- Organizing and taking part in roadshows, seminars, exhibitions
- Follow up of current customers and sales
- Contributing insights into the marketing plan
- Reporting to Ucamco's sales director

Requirements:

- Fluent in German, good knowledge of English; other languages a plus
- Frequent traveling to prospects and customers– live contact is important
- Feeling for technical software
- Motivated to succeed as a solution seller
- Strong empathy for the customer
- Self-starter, able to work independently, organized
- Honest, trustworthy, dependable, credible
- Sales and technical expertise in PCB industry a big plus
- Knowledge of market and customer base in German speaking area a big plus
- Used to working from home office
- Traveling to headquarters in Gent (Belgium) for sales and customer meetings
- Good feeling for software is more important than strong sales experience

This is a salary-based position with a commission plan, company car, expense reimbursement, and benefits like health insurance.

apply now

Career Opportunities

The Test Connection, Inc.

Rewarding Careers

Take advantage of the opportunities we are offering for careers with a growing test engineering firm. We currently have several openings at every stage of our operation.

The Test Connection, Inc. is a test engineering firm. We are family owned and operated with solid growth goals and strategies. We have an established workforce with seasoned professionals who are committed to meeting the demands of high-quality, low-cost and fast delivery.

TTCI is an Equal Opportunity Employer. We offer careers that include skills-based compensation. We are always looking for talented, experienced test engineers, test technicians, quote technicians, electronics interns, and front office staff to further our customer-oriented mission.

Associate Electronics Technician/ Engineer (ATE-MD)

TTCI is adding electronics technician/engineer to our team for production test support.

- Candidates would operate the test systems and inspect circuit card assemblies (CCA) and will work under the direction of engineering staff, following established procedures to accomplish assigned tasks.
- Test, troubleshoot, repair, and modify developmental and production electronics.
- Working knowledge of theories of electronics, electrical circuitry, engineering mathematics, electronic and electrical testing desired.
- Advancement opportunities available.
- Must be a US citizen or resident.

apply now

Test Engineer (TE-MD)

In this role, you will specialize in the development of in-circuit test (ICT) sets for Keysight 3070 (formerly HP) and/or Teradyne (formerly GenRad) TestStation/228X test systems.

- Candidates must have at least three years of experience with in-circuit test equipment. A candidate would develop and debug our test systems and install in-circuit test sets remotely online or at customer's manufacturing locations nationwide.
- Candidates would also help support production testing and implement Engineering Change Orders and program enhancements, library model generation, perform testing and failure analysis of assembled boards, and other related tasks.
- Some travel required and these positions are available in the Hunt Valley, Md., office.

apply now

Sr. Test Engineer (STE-MD)

- Candidate would specialize in the development of in-circuit test (ICT) sets for Keysight 3070 (formerly Agilent & HP), Teradyne/ GenRad, and Flying Probe test systems.
- Strong candidates will have more than five years of experience with in-circuit test equipment. Some experience with flying probe test equipment is preferred. A candidate would develop, and debug on our test systems and install in-circuit test sets remotely online or at customer's manufacturing locations nationwide.
- Proficient working knowledge of Flash/ISP programming, MAC Address and Boundary Scan required. The candidate would also help support production testing implementing Engineering Change Orders and program enhancements, library model generation, perform testing and failure analysis of assembled boards, and other related tasks. An understanding of stand-alone boundary scan and flying probe desired.
- Some travel required. Positions are available in the Hunt Valley, Md., office.

Contact us today to learn about the rewarding careers we are offering. Please email resumes with a short message describing your relevant experience and any questions to careers@ttci.com. Please, no phone calls.

We proudly serve customers nationwide and around the world.

TTCI is an ITAR registered and JCP DD2345 certified company that is NIST 800-171 compliant.

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Career Opportunities

eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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SIEMENS

Siemens EDA Sr. Applications Engineer

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

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

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

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

apply now

Career Opportunities

ARLON ELECTRONIC MATERIALS

Arlon EMD, located in Rancho Cucamonga, California, is currently interviewing candidates for open positions in:

- **Engineering**
- **Quality**
- **Various Manufacturing**

All interested candidates should contact Arlon's HR department at 909-987-9533 or email resumes to careers.ranch@arlonemd.com.

Arlon is a major manufacturer of specialty high-performance laminate and prepreg materials for use in a wide variety of printed circuit board applications. Arlon specializes in thermoset resin technology, including polyimide, high Tg multifunctional epoxy, and low loss thermoset laminate and prepreg systems. These resin systems are available on a variety of substrates, including woven glass and non-woven aramid. Typical applications for these materials include advanced commercial and military electronics such as avionics, semiconductor testing, heat sink bonding, High Density Interconnect (HDI) and microvia PCBs (i.e. in mobile communication products).

Our facility employs state of the art production equipment engineered to provide cost-effective and flexible manufacturing capacity allowing us to respond quickly to customer requirements while meeting the most stringent quality and tolerance demands. Our manufacturing site is ISO 9001: 2015 registered, and through rigorous quality control practices and commitment to continual improvement, we are dedicated to meeting and exceeding our customers' requirements.

For additional information please visit our website at www.arlonemd.com

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American Standard Circuits
Creative Innovations In Flex, Digital & Microwave Circuits

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

apply now

Career Opportunities

APCT
Passion | Commitment | Trust

APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

We invite you to read about APCT at APCT.com 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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BLACKFOX
Premier Training & Certification

IPC Instructor

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

Independent contractor, possible full-time employment

Job Description

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

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

Qualifications

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

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

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

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

apply now

Career Opportunities

U.S. CIRCUIT

Plating Supervisor

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

Competitive benefits package.
Pay will be commensurate
with experience.

Mail to:
mfariba@uscircuit.com

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YOUR JOB AD HERE

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

I-Connect007
GOOD FOR THE INDUSTRY

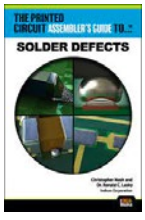
WATCH AND LEARN

Predicting Reliability in Electronics

In this engaging, 11-part micro webinar series, topic experts Graham Naisbitt and Chris Hunt examine the history of the influences of electrochemical migration (ECM) and the evolving use of Surface Insulation Resistance (SIR) testing that has been developed over the past 25 years by GEN3 and its association with the British National Physical Laboratory. GEN3 and NPL have created the standard that has now been in widespread use around the world since the turn of the millennium.

I-007e Books

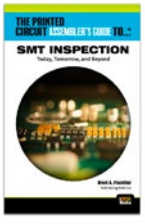
The Printed Circuit Assembler's Guide to...



Solder Defects

by Christopher Nash and Dr. Ronald C. Lasky, Indium Corporation

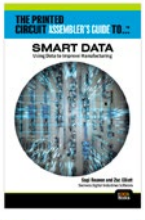
This book is specifically dedicated to educating the printed circuit board assembly sector and serves as a valuable resource for people seeking the most relevant information available.



SMT Inspection: Today, Tomorrow, and Beyond

by Brent Fischthal, Koh Young America

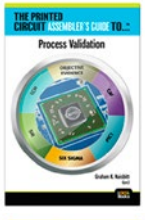
An in-depth insight into new and exciting true 3D inspection technology is provided in this book, along with a look into the future of leveraging big data management and autonomous manufacturing for a smarter factory.



Smart Data: Using Data to Improve Manufacturing

by Sagi Reuven and Zac Elliott, Siemens Digital Industries Software

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



Process Validation

by Graham K. Naisbitt, Gen3

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

Advanced Manufacturing in the Digital Age

by Oren Manor, Siemens Digital Industries Software

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

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

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COVER: **SHELLY STEIN**

COVER IMAGE: **ADOBE STOCK © PERLASTUDIO**

SMT007 MAGAZINE

SMT007 MAGAZINE®
is published by BR Publishing, Inc.,
942 Windemere Dr. NW, Salem, OR 97304

April 2022, Volume 37, Number 4
SMT007 MAGAZINE is published monthly,
by BR Publishing, Inc.

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