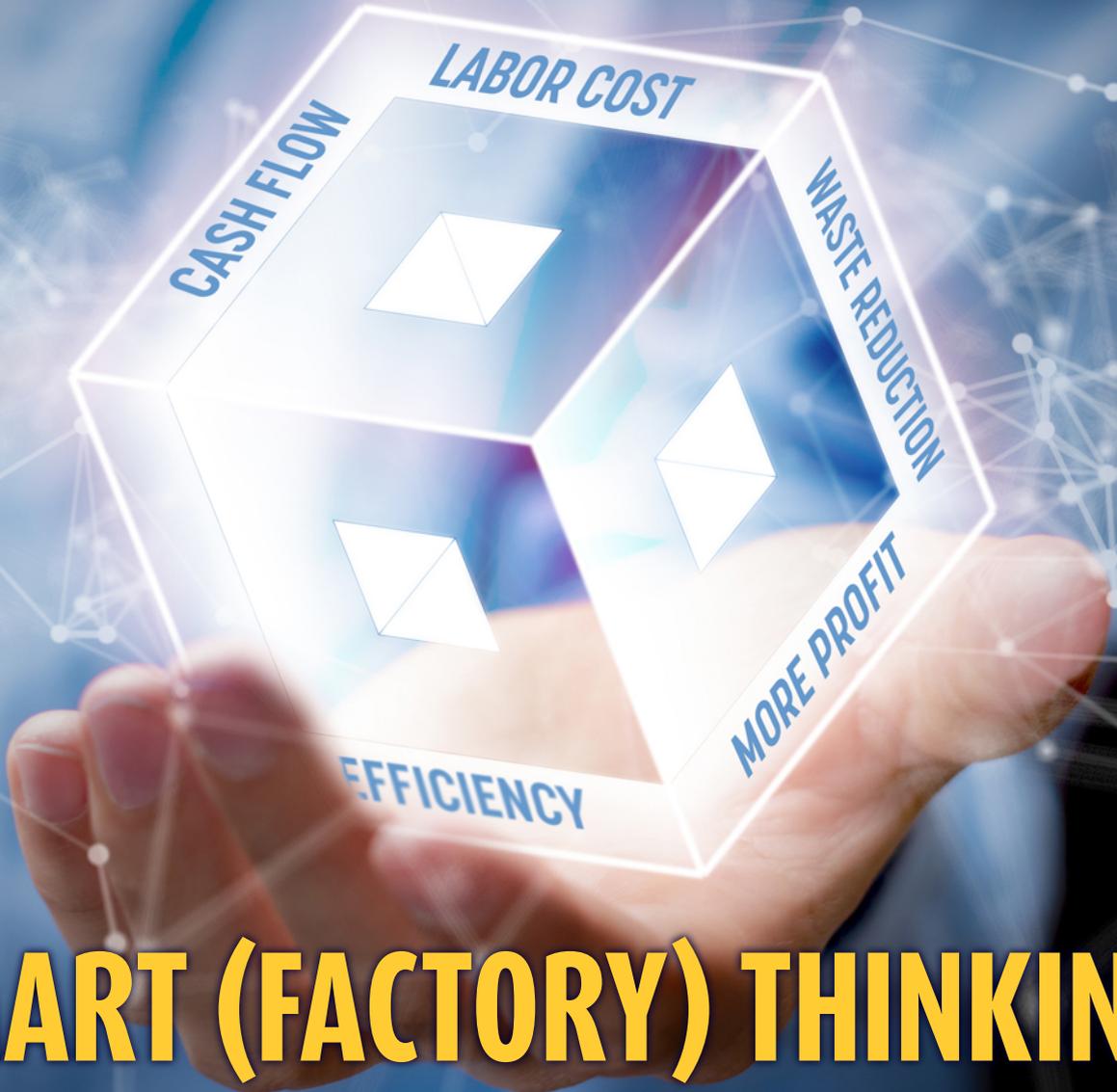


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## Smart Factory Implementation

In this issue, we set out to explore implementation details for smart factory concepts and expected to talk about sensors and protocols. As we dug deeper, it became clear that, in the end, the real smart factory innovation involves your business practices.



### 12 Business Practices Drive the Smart Factory, Not the Other Way Around (Part 1)

Interview with Sagi Reuven



### 20 CFX: Industry 4.0 Ready

by Chris Jorgensen



### 24 Smart Factories: Readers Share Their Progress and Priorities

Survey by the I-Connect007 Editorial Team



### 32 Cimatrix Helping to Digitize Factories

Interview with Ranjan Chatterjee



### 40 The Foundation of Industry 4.0

by Oren Manor

### 50 Happy's Smart Factory Protocol Primer

by Happy Holden





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**INTERVIEW:**

**70** Case Study: Example of ASKEY Applying QML Validation  
Interview with Qixian Zhang



**COLUMNS:**

**8** The Smart Factory Means Being Smart About Your Factory  
by Nolan Johnson



**62** Developments in BTC Guidelines: IPC-7093A, Part 1  
by Ray Prasad

**HIGHLIGHTS:**

- 48** Supplier
- 60** MilAero007
- 68** Market
- 80** Top 10 from SMT007.com



**SHORTS:**

- 30** Watching Magnetic Nano 'Tornadoes' in 3D
- 46** Siemens on Challenges and Trends in the Electronics Industry ▶
- 58** Michael Ford on M2M Communication and Smart Factories ▶
- 78** Intelligent Towing Tank Propels Human, Robot, Computer Research

**DEPARTMENTS:**

- 83** Career Opportunities
- 94** Events Calendar
- 95** Advertiser Index & Masthead





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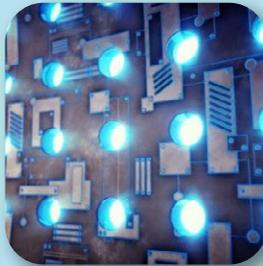
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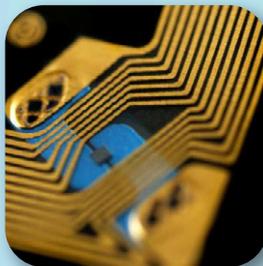
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# The Smart Factory Means Being Smart About Your Factory

## Nolan's Notes

by Nolan Johnson, I-CONNECT007

In my experience, it happened every time. Maybe it played out the same for you: one of my children would suddenly realize they simply had to be a gymnast (or a ballet dancer, or a fencer, or a pianist, or a guitarist), and that decision would require the purchase of all new gear and lessons for an all-new pursuit. Now, of course, one can't learn new skills without the right equipment, nor can we master a skill through self-teaching alone. Proper gear and expert help are both required.

However, the trouble was that my kids got lost in the gear and forgot to listen to the experts—every time. They became enamored with the toys but not the skills. I can't blame them, though. I sometimes have the same tendencies. I have three guitars, for example. I play one guitar 80% of the time; I could get by with just one, but nonetheless, I have three.

Likewise, my sailboat has her own siren's call for gadgets and gear. I have to be careful



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when considering each purchase. Do I need it? Does it bring me value? Does it make something better? Otherwise, I end up with a bunch of stuff that doesn't advance my pursuit, the acquisition of which just distracted me from my true purpose. I have to think about optimization.

In this issue, we set out to explore implementation details for smart factory concepts. Our expectation, based on what we heard in conversations with people in the industry, was that we would be talking all about the gadgets: PLCs, sensors, computing hardware, augmented reality, etc. Most discussions were about the pieces of equipment, so that assumption seemed reasonable.

Instead, as we dug deeper, we uncovered something else. It became clear that the real value is in the skills. It's not the sensors and controllers that make the factory smart; they simply measure things. Instead, it's about human intelligence and thinking outside the normal confines to recognize new ways to do the work faster and better. In the end, the smart factory is about your business practices, and the add-ons simply report on the results of your business practice improvements.

A well-designed smart factory doesn't need a new-construction site. Instead, all the smart factory needs is a set of optimized processes. It's not the facility that needs to be greenfield; it's the executive staff's thinking that needs to start over from scratch. We'll continue exploring this topic in April, as well. In the realm of the smart factory, there is so much more to talk about.

We fire up the line with Part 1 of our extensive interview with Sagi Reuven from Mentor, a Siemens Business. Sagi methodically outlines the need for business practice optimization as a crucial part of the smart factory. Next, IPC's Chris Jorgensen reports on how CFX is Industry 4.0 Ready. We follow with an article by Happy Holden, outlining his six principles for factory automation.

We also conducted an informal survey to gauge reader perceptions. What we saw in the survey data was more confirming than surpris-

ing. You can read the details in "Smart Factories: Readers Share Their Progress and Priorities." Then, Dan Feinberg catches up with Ranjan Chatterjee to discuss smart factory data management in "Cimetrix Helping to Digitalize Factories." To add even more thought to the topic of implementation, we've included an excerpt from Oren Manor's book, *The Printed Circuit Assembler's Guide to... Advanced Manufacturing in the Digital Age*, published by I-Connect007 (download your free copy at [I-007ebooks.com/amda](http://I-007ebooks.com/amda)).

As much as attention to business practices may be important to a successful implementation, so are the communication protocols. Data needs to move seamlessly if one is going to depend on it for analysis. Thus, we bring you "Happy Holden's Smart Factory Protocol Primer." Readers of *PCB007 Magazine* may recognize this as a section of a larger article published in the February 2020 issue; this material is important enough to reprint here, alongside the rest of the implementation discussion for SMT.

Columnist Ray Prasad is next with Part 1 of his series, "Developments in BTC Guidelines: IPC-7093A." Next, we showcase the IPC QMS Validation Program with a case study interview at Taiwan's ASKEY Computer Corporation submitted by PCB007 China's managing editor, Edy Yu. Process validation programs work hand-in-glove to certify new business practices effected through the conversion to smart factory concepts.

That brings us to the end of part one on smart factory implementation. We will build upon this foundation next month. This is a time of transition for the industry; if you have feedback, news to share, or a story to tell, contact us anytime at [editorial@iconnect007.com](mailto:editorial@iconnect007.com). **SMT007**



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

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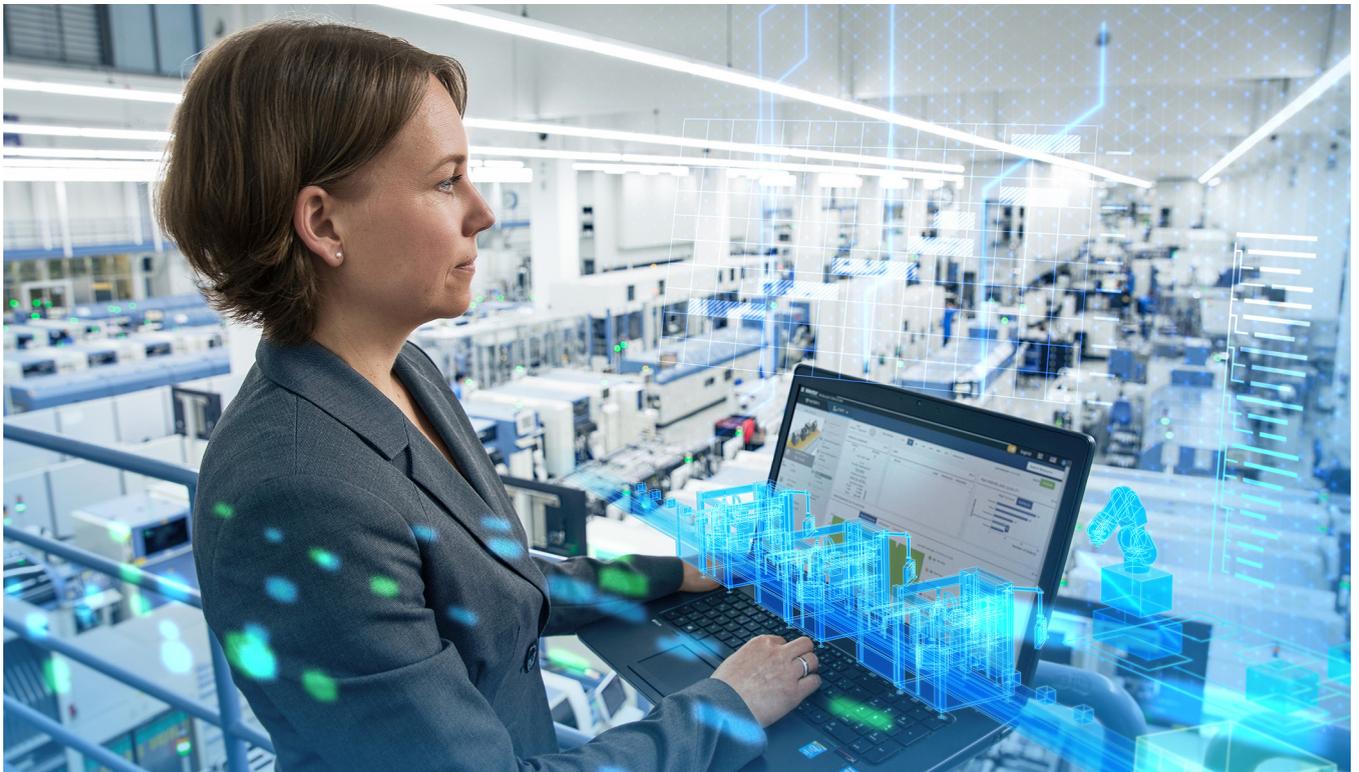
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# Business Practices Drive the Smart Factory, Not the Other Way Around (Part 1)

**Feature Interview by  
the I-Connect007 Editorial Team**

In Part 1 of this conversation, Sagi Reuven—business development manager at Mentor a Siemens Business—makes the case that smart factory implementations must start with traditional process analysis and improvement before the data capture process is useful. He also covers how sometimes the key to utilizing Industry 4.0 comes from a change in mindset rather than a drastic change or investment in new equipment or processes.

**Nolan Johnson:** Sagi, the topic we'd like to explore is this: How does a PCB manufacturer or an assembly house adapt to a smart factory environment in their existing facility without shutting down to do so? What are the strategies and steps, and how does Mentor/Siemens envision their customers taking this approach?

**Sagi Reuven:** It's a great question, and you touched on the point that we are concerned about. We're having the most issues whenever we approach a customer, even after they start the deployment. The first thing that we have to understand is that you work with manufacturers. We have two product groups, more or less. One, in particular, is focused on design and engineering. In that sense, implementing a new software solution is much easier. Customers can do that step-by-step; they don't have to shut down production, turn the machines off, or do it over the weekend. If there is a mistake or a bug in the code, it doesn't mean that the machine in the line or the conveyor will stop. You can continue to work with another machine, so it's much easier compared to anything you do on the shop floor.

We have two challenges. Challenge number one is the fact that, overall, we see that the executives and operators, bottom-up, are



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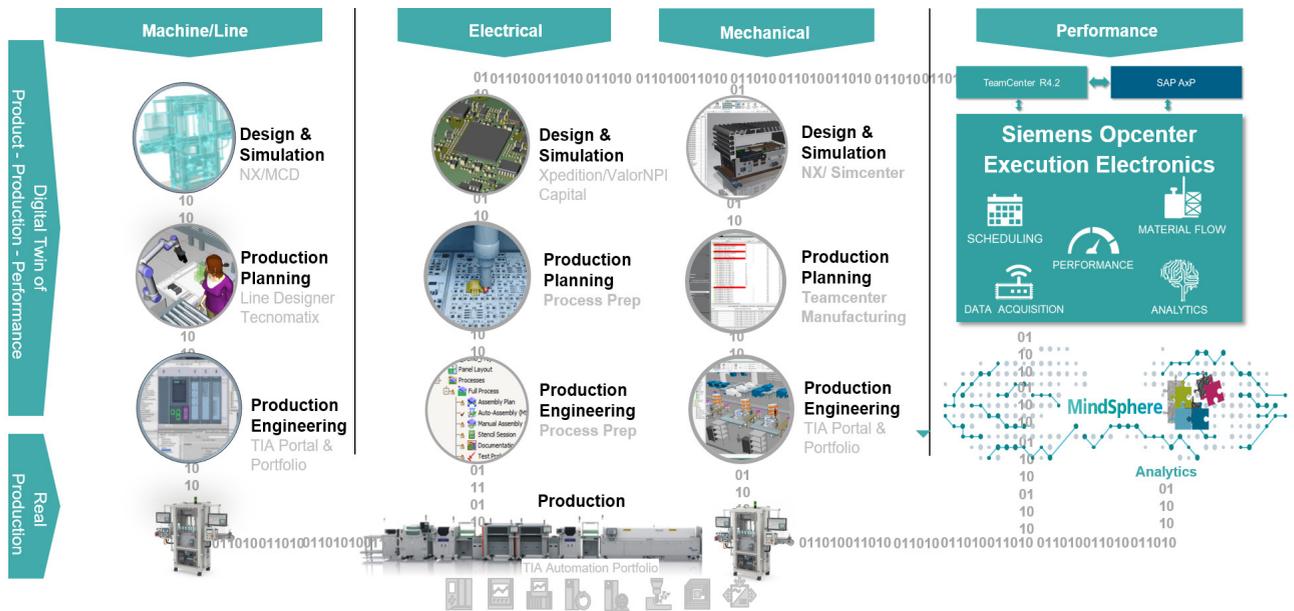
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all fully convinced already that you need to go digital. You have to digitalize everything that you do. We have stats from various market studies, and many of the executive staff are fully convinced to the point that they already started doing something about digitalization. However, we also have statistics saying that 44% of the executives are still in the mindset that it's not improving the profit. They are sold on the technology and the fact that they need to do it, or maybe it's coming from a customer requirement.

Customers—especially from automotive, for example—say they need to have full traceability. Everything has to be digital and fully documented, and they want to have it in the cloud for the next 15 years, so manufacturers do it because they must. But how do we convince them to move into that era because it improves their business capability, agility, and ability to deliver faster? How do we convince them that it can improve the profit?

For example, even if we managed to close some kind of a deal that they will digitalize the shop floor and they try to implement this, we still have to struggle to support the customer through the process of training the people to use the system to maximum advantage. It's not as easy as we would assume, even if the customer decides to buy it and go for it.

**Barry Matties:** Are you meeting resistance to the change, or is it just challenges in skillset?

**Reuven:** It's both.

**Johnson:** It sounds like customer reluctance.

**Reuven:** It is, but it's understandable; it's not easy to "zoom out" from your daily routine and change perspective.

**Matties:** If they have agreed to do this, why aren't they fully embracing this?

**Reuven:** At the end of the day, people are people. Even when a customer decides on a global roll-out, not all factories are implementing the solutions immediately; some factories, even within the same organization, are more open to change and, and for others, we need to support the customer through this digital journey. We need to help with extended training, which sometimes means you have to "sell" the solution again. You don't just want the customers to buy; you want them to use your solution to the full extent.

For the last six years, I managed two startup companies. Being a startup was always a challenge because it was not a big company, and I had to show customers that I had a huge dif-

ferentiation from what they were doing back then. When we go to a customer—or even to a user—usually, the first questions are, “What kind of problems are you facing in production?” What do you say when the customer tells you they don’t have any problems and that everything is in perfect working order? This is where the challenges come from. This is where the innovation part is not so easy because you have to convince them that you can bring a lot of added value to their business.

**Matties:** Are they fearful that they’re going to lose their job or that the digital factory is there to replace them? Is that it?

**Reuven:** Absolutely.

**Matties:** When you visit and want to convince a company to go digital, you cited several reasons to do it. Maybe there are some financial incentives, but in the end, the results are financial gains, lower labor costs, higher yields, and added capacity. Those four factors alone should motivate people, but does their reluctance stem from the investment they have to make?

**Reuven:** I have a great example because I’ve had this discussion with various customers from the smallest customer to the largest corporation with 300–400 lines that are spread around the world. We all know IoT because it’s a buzzword in all the Industry 4.0 areas, whether it’s in the process industry or electronics. Everyone is talking about industrial IoT (IIoT), and it’s so important—even to the point that many organizations say they have a chief IoT person. Some organizations want to develop the IoT solution internally.

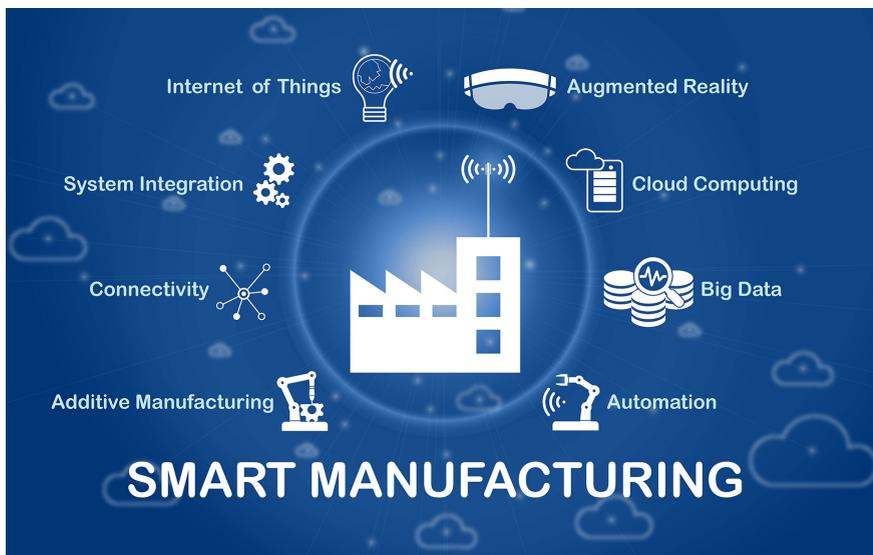
In my opinion, they are looking in the wrong direction. They are domain experts with valuable knowledge, and their capabilities as domain experts are not in building an IoT device, which is only an enabler; it’s an infrastructure tool. They need to get an IoT

device from a company that is focused on selling IoT devices. Then, they can take all the information and find a way to improve the process and material handling, including finding out why they have bottlenecks in production. They need to improve the yield and improve the profit in the financial reports of the company. That’s where they need to focus their expertise—leveraging their knowledge to drive excellence in manufacturing. Currently, many companies are focused on the technology and platform, but not the real target of this digitalization journey.

Industry 4.0 is not about connecting another machine and collecting the data; it’s about the mindset of understanding that we solved most of the problems. Now, we are looking at improving and moving toward excellence. This is no longer trying to find the problem to solve because we pretty much solved all the problems that we had. You can buy it out of the box from most companies in this area, but you need to focus on how to use the knowledge in the data and the software solutions that you have to improve your business.

**Matties:** Who inside the factory is responsible for this? Is there a position that needs to be created in each company, or do they tap into somebody who is already employed to do this?

**Reuven:** It will either be the people who are in charge of IT combined—sometimes with pro-



curement or supply chain management—because this is related to materials. Global organizations sometimes hire or allocate a specific person to be in charge of the project. It's a digitalization project or an IoT project.

**Matties:** In all fairness to IT people, they do a great job, but traditional IT is not centered around designing smart manufacturing. Their jobs are more infrastructure, data security, and email and website management. Not to minimize their work, but it seems like what you're describing is a logistics person. What you're talking about is business processes from a systems point of view. It seems like a lot of these organizations may even have a need to hire a logistics implementation expert or create this new position in the company because all this is new for manufacturing.

**Reuven:** It's a real challenge. They think, "There's Industry 4.0, but what does it mean? We need to make everything digital, connect all the machines, and have a dashboard." There is no business context for why they even want to do all this. We are working on more POCs to show what can be achieved.

**Matties:** The case could be made that you're lowering costs, adding capacity, increasing yields, and reducing human touch time. There are so many benefits, but the barriers to entry seem overwhelming from their point of view.

**Reuven:** Usually, when we get into this kind of situation, the business consultants in our group will go in for a workshop, and they will try to break down the silos. It's not a sales activity. It has nothing to do with what we do on the software level. It's purely a form of a Lean Six-Sigma workshop where we try to map the processes in the factory. Procurement, material handling, and IT will all sit in the same room and hear each other; then, they will build some kind of a diagram that will show how one thing affects the other. All of a sud-



Sagi Reuven

den, what happens during those workshops is that people say, "I didn't know that what I do affects your job or your area in the factory." Then, they start to realize that this is not just about implementing a solution. It's not just about installing another piece of software to have traceability; it's about improving the visibility, which may sound so simple, but it's super important. This alone

can justify a project.

**Matties:** You're describing best business practices. If they don't realize their systems are connected, you're taking them back to basics at that level and then overlaying digital communication in between.

**Reuven:** We have some anecdotes about that. Also, people often don't understand how things affect decision-making in the factory. I can think of one example that makes a lot of sense for why you need this digitalization and what kind of advantage it can give you in simple decision-making. One factory was considering buying another SMT line. They ran an analysis and found out that they were only using 58% of their maximum machine capabilities. They ran a changeover trend analysis and realized this was the bottleneck. They managed to improve utilization of the equipment to 84%, and they were able to deliver the required capacity without having to buy another line—a capital equipment savings of about \$2M.

**Matties:** It goes back to what you're talking about: best practices in business management and looking at your systems and understanding the flow and bottlenecks. Oftentimes, in North America, we hear about high-mix, low-volume, needing flexibility, and that it's easier for us to be manual—even to the point where they don't rely on a computer to schedule the work going through the shop to optimize their capacity. What do you tell somebody who has that as an argument?

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**Reuven:** I would explain that we have no intention to replace them but quite the opposite; we want them to become a super-user. I understand that they think they will lose their job, but they can improve their job and then do something else with their time. Instead of scheduling manually with the three lines they have, they can take a scheduling tool and break down the lines into cells, for example.

The new concept is to break the line into cells; it's no longer the traditional line. You have the pick-and-place machines, oven, and AOIs all broken into cells. You can use the software for your planning, but because you can do it in a much better way, not only do you not have to do it manually, but you can take it to the extreme and innovate. You can make the most out of the equipment you have right now and be creative.

**Matties:** Do you have any statistical information quantifying the benefits gained?

**Reuven:** It's not thoroughly documented yet because it can take quarters or years to see the long-term trends. I'm trying to explain to them that they can better utilize their skills because most of the people in the industry—especially in the small factories—are very knowledgeable. They have years of experience. And the fact that they have so much knowledge means they can make the most out of using the software, not the other way around.

This goes back to the same question about solving a problem. "I don't know how to do

good scheduling, so I will buy software to cover for the knowledge that I'm missing." No. I'm saying that the fact that you have this knowledge—and you know how to do manual scheduling and planning—means that you will be a super-user. You will get the most out of the software. The mindset should not be about solving a problem but about achieving excellence. Reduce DPMO, improve yields, maximize equipment utilization, and maximize OEE; that is where you make your profit.

I'm convinced that out of all the Industry 4.0 pillars, this is the fastest way to get a return on investment with minimum risk. Every show I attend, I see these AGVs all over the place, and it's exciting. On the other hand, this is a huge investment. For some reason, people will buy another piece of hardware, but they will not spend \$50,000 for planning and scheduling software that can dramatically improve the profit. There is no other way. We had one workshop using no machine learning or anything advanced—just basic analytics. Again, they had four lines and were not using the maximum capacity of the line. We measured how many components they placed per hour per line.

Then, we looked at the specifications of the machine. Are they using the maximum capacity of the machine? The answer was no. Often, it's straightforward, such as, "Let's buy more equipment." Maybe they just need another test machine or to do better planning and scheduling, but they have to start with data collec-



tion to have real visibility. That's the first step. If you were to go back to how you do it step by step, then the first step would go to collect basic information and do data acquisition and analytics. Then, you have to ask yourself, "How do I improve?"

**Matties:** The question also becomes, "Where do I improve?" Obviously, if there's a bottleneck, that may be one area. Many people may want to just step into it, start with inventory control, and then move on to the next piece. We see some of that happening where they bring in an inventory control system. Do you see people piecemealing this in, or is the approach more all-in, and they want to convert the entire factory?

**Reuven:** Materials are definitely a big issue. I just prepared the material management presentation, and I looked into the financial reports for a public company. The company's revenue was \$2.6 billion, and the cost of materials was around \$2.4 billion. It's not a game. It goes into the financial report and affects the stock price.

If you have better visibility, that is a good example. It's also growing because the lead time of the component is becoming challenging, and it will become more and more challenging now with the coronavirus and supply chain stuff. If you have 10,000 components on the reel and take the reel out, from an ERP perspective, it means that you now have 10,000 components on the shop floor—not in your inventory.

But, as you mentioned, we are going toward high-mix, low-volume, meaning you have 10,000 components on the shop floor on this reel, and your ERP took out 10,000 components. It can take you a year to use all 10,000 components in low volume. If you have exact consumption with material management, you will always have the exact number of components in the ERP. Instead, 10,000 components will not be out; they are on the WIP, and then they are out from the inventory.

Your inventory is not only managed better on the shop floor, but you send the just-in-time material to optimize the line, and the line won't



stop because you keep feeding it with material and doing verification. However, you also have something that affects financial reports. If you have more value on the inventory and fewer millions of dollars on the shop floor, you have less excess.

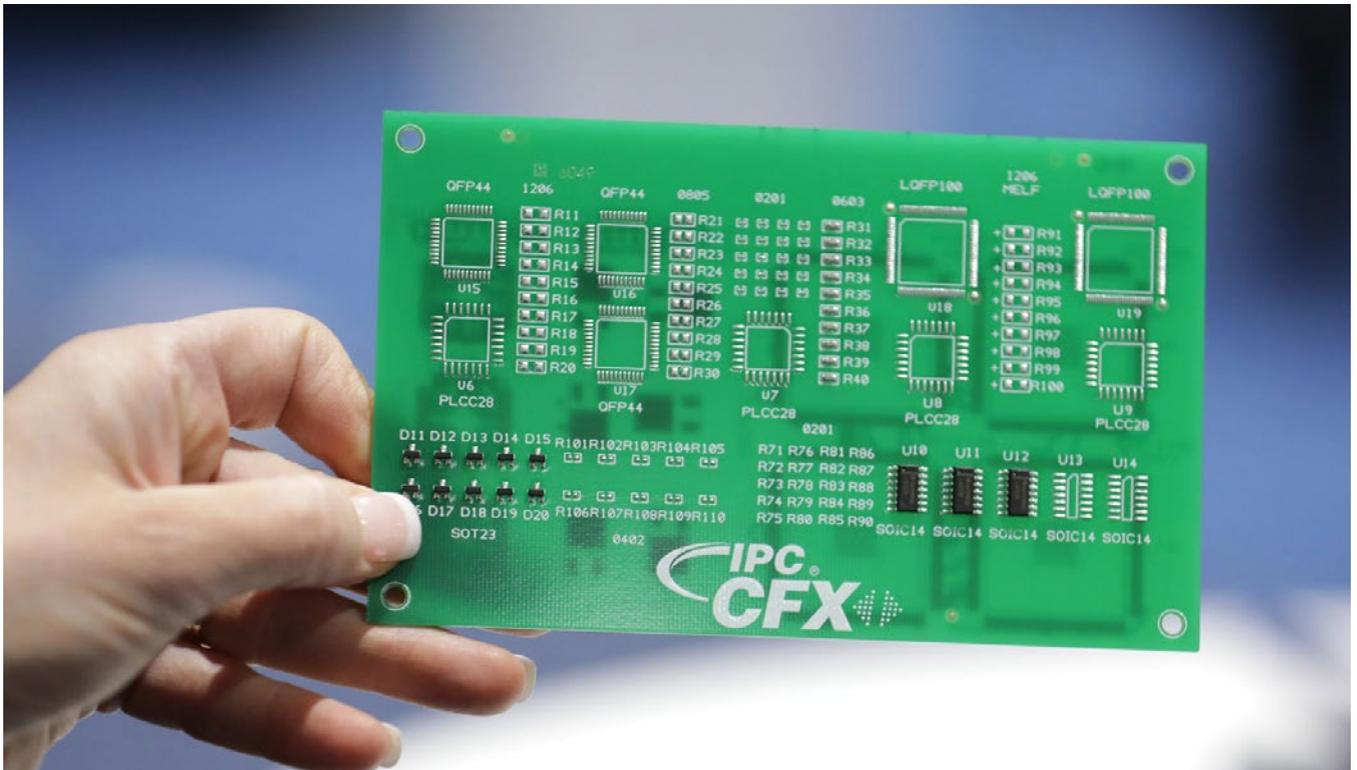
You can also improve your inventory and procurement process. With the lead time, it's becoming more and more challenging. We had some customers complain about the lead time, especially from sensors. With some oscillators, it has to do with the material, and they get a lead time of 26–52 weeks.

Again, when you are from the shop floor level, you say, "That's not a problem," but it goes into the financial report. It affects your bonus and stock price; it truly affects everything. Every fraction that you can save or improve affects you financially.

**Matties:** The savings of human time tracking and counting components—as well in your inventory through these automated accounting and inventory management systems—is dramatic. You're going from hours to seconds.

**Reuven:** Exactly. SMT007

*Editor's note: Stay tuned for Part 2 of this interview in the April 2020 issue of SMT007 Magazine.*



# CFX: Industry 4.0 Ready

**Feature by Chris Jorgensen**

IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

The show floor at IPC APEX EXPO 2020 in San Diego, California, was as busy and congested as ever, and the IPC Industry 4.0 digital factory—powered by CFX—took center stage for its demonstration as a true plug-and-play Industry 4.0 solution, illustrating that there is nothing else quite like it in the industry right now. The demo showed a real-world factory line assembly operation with the added benefit that attendees were able to see how the CFX machine-to-machine communication standard sets the process in motion and the data that can be gathered using CFX.

According to Marc Peo, president of Heller Industries Inc. and the 2-17 Connected Factory Initiative Subcommittee co-chair, “The objective of the demo was to show the industry that CFX could be truly ‘plug and play’ with a wide range of different vendors and only two days set up time. We are happy to

say that we achieved that goal with time to spare!”

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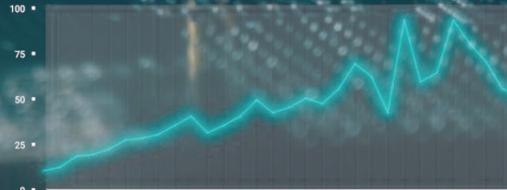
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Line participants included the following:

- Aegis Software: Software support
- ASM Assembly Systems: Screen printer and pick-and-place machine
- FlexLink Systems: Laser marker and conveyors
- Heller Industries Inc.: Oven
- Indium: Solder
- Keysight Technologies: ICT
- KIC: Oven profiler
- Koh Young America: AOI
- Purex: Air filtration
- SICK: Conveyor

During hourly line tours, boards were processed with two variations of component placement on the same boards. Tour visitors could follow the board assembly down the line to see the CFX data pulled out during each operation that could be used for quality control, improved production, etc. Tour participants were then able to step into the CFX education area, where CFX supporters shared their insights into CFX, why their company supports it, and how they are using it.

IPC APEX EXPO attendees did not have to be on the tour to view the CFX messages streaming from the equipment. All CFX messages, including those from dozens of machines in vendor booths participating in a CFX virtual demonstration, streamed more than 176,000 CFX messages to [connectedfactoryexchange.com](http://connectedfactoryexchange.com), which anyone could monitor live on their laptop or mobile device.

More than 400 people participated in the tours and CFX presentations during the week. From those attendees, IPC saw a shift in visitor interest. In past years, the demo visitors were largely equipment vendors and software suppliers looking for a solution for their customers' equipment communications problems and to meet their Industry 4.0 roadmaps. This year saw a large number of EMS providers and OEMs taking part in the tours as well as attending the 2-17 Connected Factory Exchange Initiative Subcommittee meeting that same week.

This shift in interest is a strong leading indicator of coming industry adoption of CFX. In addition to the standard equipment vendors learning how to use CFX, there was an increase in the number of manufacturers attending the tours and asking questions about the upcoming IPC support programs in education, equipment validation, self-evaluation, and technical support. These are all items that will make it easier for manufacturers to shop for CFX-enabled equipment. Support programs are expected to roll out within the next month.

For the most current information on CFX, visit [cfx.ipc.org](http://cfx.ipc.org). SMT007



**Chris Jorgensen** is IPC's director of technology transfer.



# Smart Factories: Readers Share Their Progress and Priorities

## Survey by the I-Connect007 Research Team

We recently surveyed readers on the topic of smart factories, specifically exploring reader perceptions of what a smart factory entails, along with implementation plans that may be on readers' minds. This survey offers an informal sampling of those responses.

Our survey did not require any of the questions to be answered, so not every respondent answered every question. However, what emerged shed some interesting light on what readers are thinking with respect to Industry 4.0 and the smart factory.

## Overall Themes

Looking at how respondents ranked their top three from this list of 10 objectives, some patterns do emerge (Chart 1). The three objectives most listed as a top priority were increased throughput, higher yields, and higher profit margins. This suggests that the ability to support more sales revenue is top-of-mind.

In the second-priority category, the top three concerns were reduced labor cost, less waste, and expanded capabilities (with lower operating costs close behind). Respondents are looking to control expenses next.

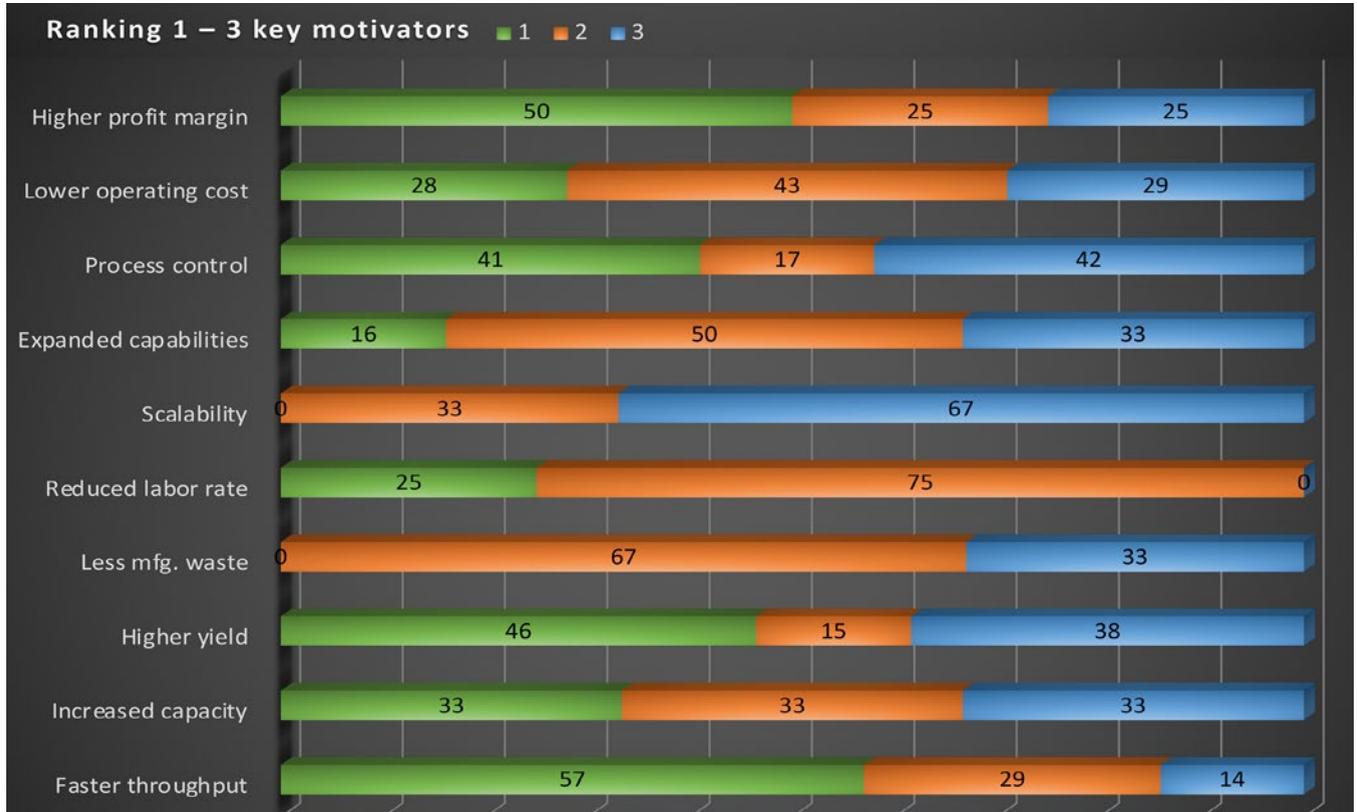
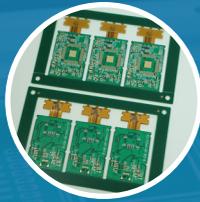
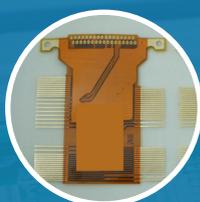
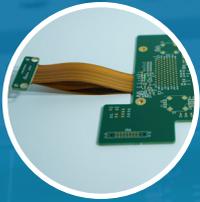
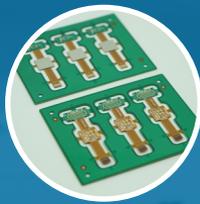
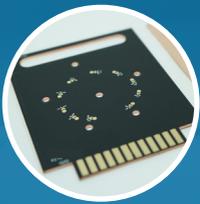


Chart 1: Of the following objectives, which are your top three key motivators (i.e., process challenges that you want to solve)?

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The leading response in the third slot was scalability, while all the other responses started to flatten out. Scalability is a slightly different kind of objective than revenue growth or cost containment.

Overall, these objectives suggest good basic business management priorities: grow revenue, reduce operating costs, and invest in expansion.

What roadblocks might the readers be facing in implementing a digital factory solution, and responses covered the entire spectrum of choices (Chart 2).

These responses align with some of the observations about digital factory obstacles made earlier in this issue by Sagi Reuven. In the “other” category, respondents most often mentioned inter-machine communications issues. These comments generally came from respondents who also report having started their transition to a smart factory. This would suggest that implementation in an existing facility may bring additional complexity to setting up data collection.

## Sectors

Next, let’s filter the responses based on which sector with which the respondent identifies to see if this uncovers any differences in perspective. Of the company role choices that we offered in the survey (i.e., original equipment manufacturer, PCB fabricator, assembly services provider, supplier, other), a significant majority identified as manufacturers and OEMs. In light of this, we will concentrate on these two sectors.

## Manufacturers

Responses from manufacturers were comprised exclusively of executive/management and engineering roles, with a nearly even split between the two roles. In response to the question asking to define what “digital factory” and “Industry 4.0” meant to them, two responses stood out:

1. “The digital connection between product and production data, equipment, and people in an automated way, using artificial intelligence at its limit.”



Chart 2: Of the following, which do you expect—or have already faced—as key roadblocks to implementing a digital factory?

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2. “Using the data from our production equipment in a meaningful way.”

When we asked about plans to implement digital factory infrastructure, manufacturers were surprisingly unanimous (Chart 3).

All of the respondents indicated that they have started/finished the transition already (one-third), or they intend to (two-thirds). While certainly not definitive industrywide, there is an indication here that manufacturers are taking an interest in smart factory capabilities. This corroborates Chris Jorgensen’s observations (See [article page 20](#)).

The top-three ranking in this audience revealed an interesting result in that answers were quite evenly distributed. The answers were so evenly distributed that we were forced to disregard the priority information and use only the aggregate response numbers. This analysis revealed one clear leader and a crowd in the second position (all responses grouped together).

1. Process monitoring and control.
2. A four-way tie between the following:
  - a. Faster throughput
  - b. Higher yields
  - c. Less waste
  - d. Higher profit margins

These results would suggest that process monitoring and control, while an objective

itself, is seen by respondents as a means of achieving the rest of the objectives selected.

### OEMs

Responses from OEMs drew primarily from manufacturing roles (in the 60% range). Engineering and executive/management roles also responded to the survey, but to a lesser degree than manufacturing roles. This is in contrast to the strong showing from management and engineering from the manufacturers.

In response to the question asking to define what “digital factory” and “Industry 4.0” meant to them, two responses stood out:

1. “Digital factory is using information for modeling in a factory. Industry 4.0 is the use of automation and connectivity to manage and optimize a factory for improved productivity.”
2. “I thought it would mean that all machines would run from a platform that allows each machine to talk to another, but I have found that recent years have pulled SMT equipment manufacturers in the other direction. They have become more protective of their own data and only do Industry 4.0 within their own platforms. It’s very disappointing.”

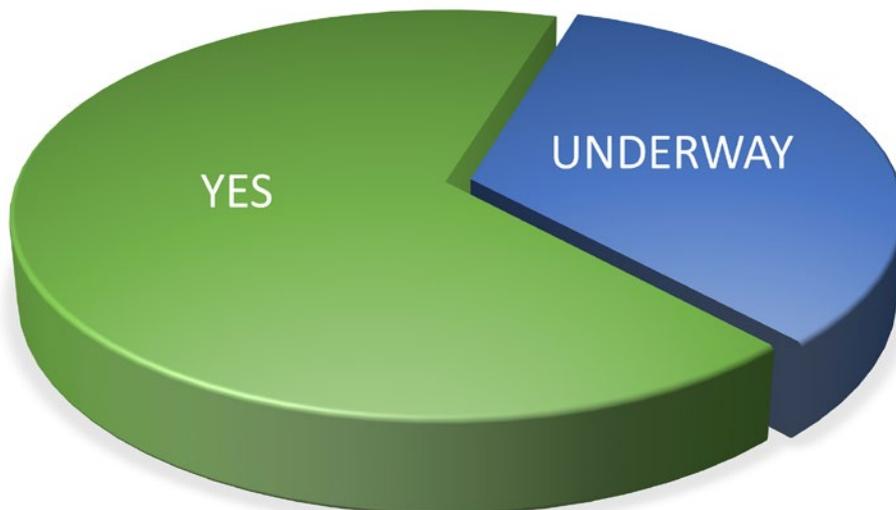


Chart 3: Does your company have plans to implement a digital factory infrastructure in the next two years?

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Chart 4: Does your company have plans to implement a digital factory.

With OEMs, plans to implement digital factory infrastructure was less clear than with manufacturing specialists, even down to the tendency for OEM respondents to leave this question unanswered (Chart 4).

When ranking objectives, OEM respondents, like manufacturers, were surprisingly even in their distribution. No one objective rose above the other as a first priority. But looking at the aggregate responses, we can determine that the OEM's primary concerns (at least among manufacturing roles who responded) were:

1. Higher yields
2. Process monitoring and control
3. Less manufacturing waste

## Conclusions

EMS companies and PCB manufacturers are, as a whole, more clear and motivated to act with respect to digital factory conversion than OEMs. This could be, in part, because some OEMs are likely to outsource fabrication and assembly to suppliers, thereby reducing the OEM's level of engagement. That said, many OEMs have their own manufacturing operations, which may be causing them to consider smart factory solutions as well.

Overall, as an informal test of the claims about the digital factory marketplace made by current smart factory experts, these numbers tend to corroborate their claims. **SMT007**

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## Watching Magnetic Nano 'Tornadoes' in 3D

A team from the Universities of Cambridge and Glasgow in the U.K. and ETH Zurich and the Paul Scherrer Institute in Switzerland used their technique to observe how the magnetisation behaves—the first time this has been done in three dimensions. The technique, called time-resolved magnetic laminography, could be used to understand and control the behaviour of new types of magnets for next-generation data storage and processing. The results are reported in the journal *Nature Nanotechnology*.

Magnets are widely used in applications from data storage to energy production and sensors. To understand

why magnets behave the way they do, it is important to understand the structure of their magnetisation and how that structure reacts to changing currents or magnetic fields.

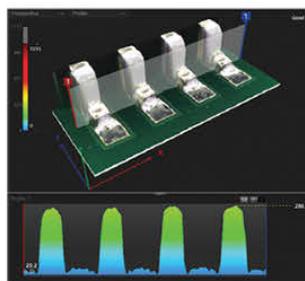
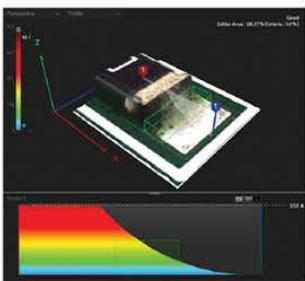
Moving from two dimensions to three is highly complex, however. Modelling and visualising magnetic behaviour is relatively straightforward in two dimensions, but in three dimensions, the magnetisation can point in any direction and form patterns, which is what makes magnets so powerful.

(Source: University of Cambridge)

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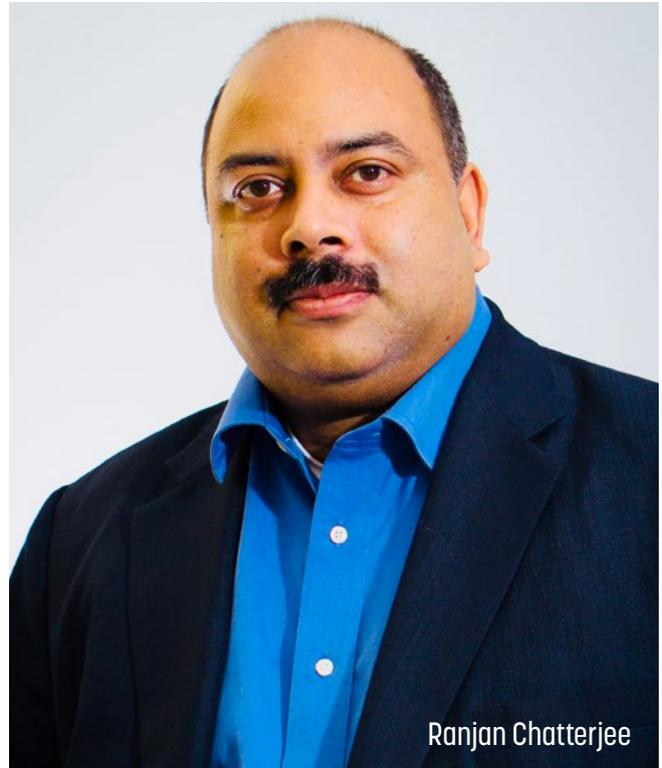
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# Cimetrix Helping to Digitize Factories



## Feature Interview by Dan Feinberg I-CONNECT007

Dan Feinberg met with Cimetrix's Ranjan Chatterjee to talk about how their new Sapience software allows factories to establish communication with a wide variety of equipment across multiple lines and multiple facilities across the whole industry.

**Dan Feinberg:** We're currently at IPC APEX EXPO 2020. How was the show for you today?

**Ranjan Chatterjee:** It was very good. We were busy. Yesterday, we had people coming before the show even started. Most people are here for a specific purpose, and discussions have been pretty meaningful.

**Feinberg:** Cimetrix's software products deliver factory automation. Tell me about it, particularly the software for connectivity, analytics, and sensing, which, from what I understand is your specialty.

**Chatterjee:** Yes. We work on automating the machines, collecting data from those machines,

and performing analytics on it. In other words, we provide software on both sides of the pipe as well. We provide the pipe as well. We provide you with control capabilities as well as connectivity capabilities on the machines to automate them. We connect any kind of machines across the whole industry, whether it's semiconductor front end, semiconductor back end, or PCB assembly. We have customers in all of these industries. Most wafer fabrication customers use our products to do analytics, and then we provide OEE and those kinds of things. We prefer standards, but sometimes we do custom projects.

**Feinberg:** The semiconductor industry and board fabrication are closely connected. What are some of the similarities you see between the two?

**Chatterjee:** Because of the advances in packaging technology, the boundaries between the industries are blurring. SMT machines are handling wafers now, for example. PCB industries are using a variety of non-traditional substrates that require a cleanroom.



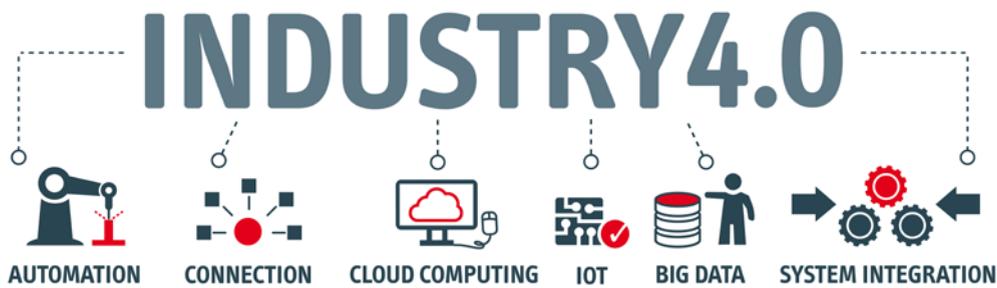
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**Feinberg:** Likewise, what are the key differences that make implementations unique between these two industries?

**Chatterjee:** The main difference is the cost and complexity of the manufacturing equipment and processes in the two industries. Investment in semiconductors is much higher. Still, the need for data and analytics is the same for every industry.

**Feinberg:** What other software do you have? What have you been working on?

**Chatterjee:** One of the main things we’re working on is this platform called Sapience, which is a platform for connecting any equipment with any protocol into various apps. We provide test APIs, and you can write an app. Think of it as like iOS, where you have the Apple store. They would provide you the ability to write your own application, and we will run the store; then, you will be able to connect to any kind of device, machine, robot, or a sensor.

**Feinberg:** Is Sapience structured as a product?

**Chatterjee:** The Sapience platform provides a scalable architecture that allows factories to establish communication with a wide variety of equipment across multiple lines and multiple facilities. The platform provides connectivity to any equipment that supports industry-standard protocols.

**Feinberg:** What are the implementations like for a customer?

**Chatterjee:** It’s pretty straightforward. The on-premises architected solution takes control and

security for factory implementations quite seriously. The core system installs easily using a packaged installer. Of course, a hybrid deployment solution can be installed as well, with software components residing in the public cloud. Scalability is achieved by combining the public cloud and horizontal scaling techniques.

**Feinberg:** It seems like you’re doing a number of large installations, which definitely helps validate your solution. How does this scale down for a smaller shop, of which we have quite a few in board fabrication?

**Chatterjee:** The Sapience platform is an out-of-the-box web-based engineering solution. The Sapience ecosystem is designed to quickly provide actionable data with minimal configuration. The Insight OEE Module automatically begins collecting real-time equipment utilization and alarm data as soon as it establishes an equipment connection. This means you can easily scale from one machine to hundreds.

**Feinberg:** For the smaller shop looking to go digital, what will the engagement with Cimetrix look like? What should I expect in terms of implementation help?

**Chatterjee:** For a smaller shop, we can be a unified platform on the factory floor. The Sapience platform provides rapid-deployment tools so that factories can mine all the data available from shop floor equipment. This drives actionable insights for optimal decision-making. We provide customers with installation and deployment help. We have worked with smaller customers that had one line—or a few lines—that were connected and working with real data in less than a day.



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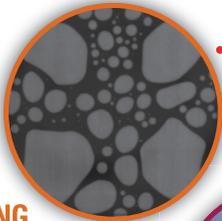


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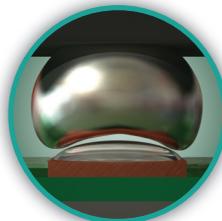
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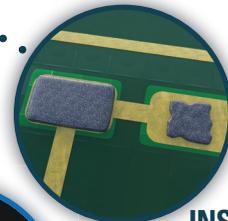
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**Feinberg:** The whole trend right now towards smart factories is a challenge for you, but it's also an opportunity.

**Chatterjee:** Correct. We have been working on smart factories for the last 20 years. About 15 years ago, when I worked at Motorola, we connected all their factories with Cimetric software. There were almost 20,000 machines and over 20 factories, which is what people are doing today. Now, the cost is an order of magnitude less. We used to pay a lot more. There's a lot of open-source software that you can use. The only difference is that it's cheaper and can be done quicker.

**Feinberg:** We're hearing a lot about smart factories now, and the industry is paying a lot more attention—especially when we have multiple facilities in numerous countries.

**Chatterjee:** Every board of directors has given their CEO a mandate to digitize their enterprise. That's why data has become valuable. They say data is the next natural resource after oil or more than oil. That's why everybody wants it, and that's why we are all about it.

**Feinberg:** What do you think your biggest challenge is over the next year or so?

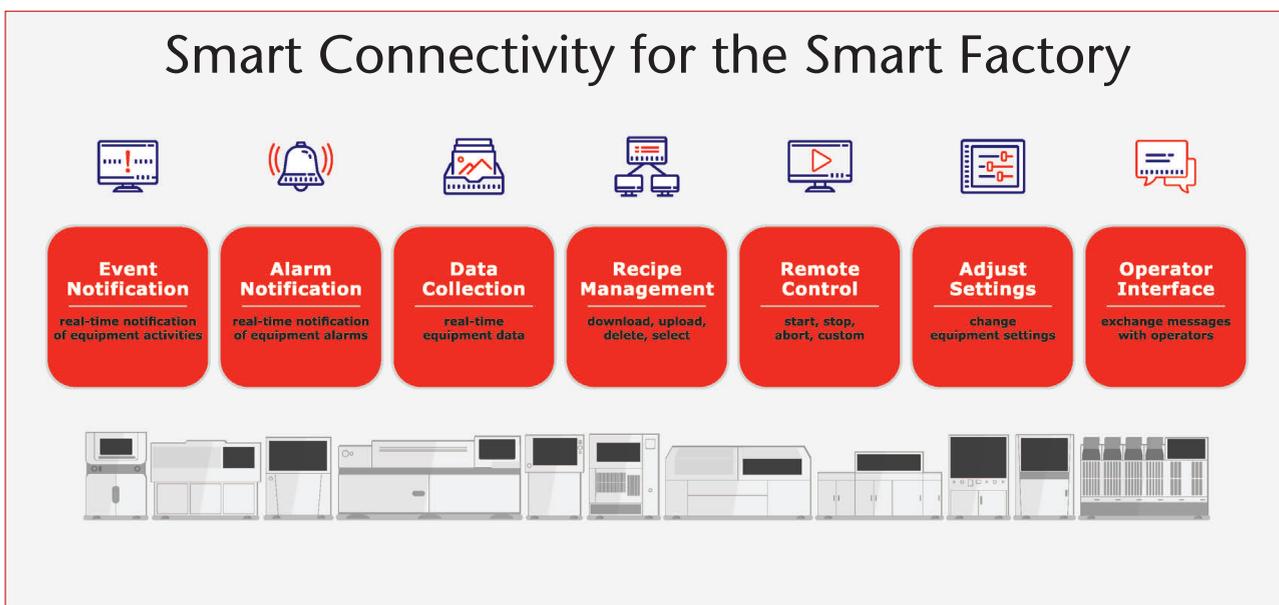
**Chatterjee:** The biggest challenge is that the market is very fragmented in the PCB assembly industry. In the semiconductor industry, they have standards and use them. They have automation, and they need it. Everything is progressing as it should, whereas in our industry, it is converging, but people are using similar standards—not a single agreed-upon standard. Then, the software companies have a lot of products—not one that meets everybody's needs. That causes a lot of problems for people trying to make decisions. Usually, the software costs too much to deploy. The integration cost is so high that it is impossible to implement at scale. If an EMS firm has 90 factories, and integration takes a few months for one factory, then you're talking about more than 180 months to get things done.

**Feinberg:** Cost and time are big factors.

**Chatterjee:** Yes. If you have to digitize an enterprise and the plan requires a four-year rollout, very few people will accept it.

**Feinberg:** That's true. Have current economic conditions been a factor?

**Chatterjee:** The industry has been growing kind of healthy. It doesn't seem like there are any issues that are structurally there. The IoT,



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IIoT, and electric car markets are driving semi-conductors and electronic assemblies. In general, it definitely looks good for both capital markets and software.

**Feinberg:** How do you think it's going to be over the next year to two years?

**Chatterjee:** It looks like it will probably grow. They have these same issues with China having problems, but in general, the market itself is going to grow.

**Feinberg:** You're in an industry segment that is needed, and there's a demand for it. 5G is something that is now starting to take hold, and there's even some discussion about the next standard for 6G. What effect will 5G have on your business and products over the next couple of years?

**Chatterjee:** Manufacturing companies usually aren't trendsetters; they will not adapt to things before the consumer industry. 5G will probably reach the consumer side this year. The rollout is happening, but handsets have to be available. The infrastructure has to get ubiquitous. The pricing has to be known. All that will take about a year to settle.

It will take another year for the whole consumer side of 5G to get fleshed out; after that, it will go into manufacturing and other sectors. Pricing will be key. Why pay a monthly fee when every machine in the factory is already hooked up for free? There's also a lot of RF interference in a factory, so will that cause any problems? Right now, wireless is not the preferred way to network a factory. We still have to see how well it works in an RF noise environment.

**Feinberg:** People are using good, old wired intercoms to communicate in many factories because you avoid that problem.

**Chatterjee:** Even two-way radios don't work very well in a factory.

**Feinberg:** Is there anything else you would like to share?

**Chatterjee:** Right now, there's a lot of talk about data security and putting data in the cloud. I believe that all of those things are going to get worked out very soon because it's less expensive to store data in the cloud than to buy your own archival hardware.

**Feinberg:** And set up your own servers.

**Chatterjee:** The low cost is going to drive cloud storage acceptance in the industry, and most things will be on the cloud soon—although maybe not all the raw data, of course. Then, it could be ubiquitous; a lot of things that are available in your manufacturing-related applications can then be available on your consumer devices. Right now, it doesn't exist, but it will happen soon.

**Feinberg:** For security reasons, do you see any use for a blockchain?

**Chatterjee:** A blockchain would be one of the technologies that could be used to secure files, but manufacturing is not where people are going to implement something first. Usually, it's banking and finance; they have more need for it, so they do it. Once banking and finance sort it out, and once it becomes trustworthy and repeatable and secure, then other people will use it.

**Feinberg:** Ranjan, I appreciate this conversation. Thank you very much.

**Chatterjee:** Thank you. SMT007



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# The Foundation of Industry 4.0

**Feature by Oren Manor**  
MENTOR, A SIEMENS BUSINESS

*Editor's note: The following is an excerpt from the book "The Printed Circuit Assembler's Guide to...Advanced Manufacturing in the Digital Age" by Oren Manor.*

At its basic level, an IoT device can be defined as any stand-alone internet-connected device that can be either monitored and/or controlled from a remote location. Each company using an IoT solution will also be building an IoT ecosystem, which is the foundation of Industry 4.0. This ecosystem is comprised of the components that enable devices to connect to the internet, such as remotes, dashboards, networks, gateways, analytics, data storage, and security—both software and hardware. One of the most valuable aspects of such an ecosys-

tem is to be able to take the silos of information collected, analyze that information, and then optimize processes across a company's systems to become more efficient.

When adopting IoT solutions, start with three main considerations. First, assess which parts of the production cycle can be automated and/or monitored most effectively with IoT devices connected to an analytics platform. IoT technology should be matched to the production cycle of your operation. Many categories of manufacturers throughout the world are producing unique goods across different industries. IoT solutions that work for some manufacturers will not work for others. Analyze all of the various digital technologies available and see which fit into your particular production process.

Second, assess ways in which solutions could improve the work environment rather



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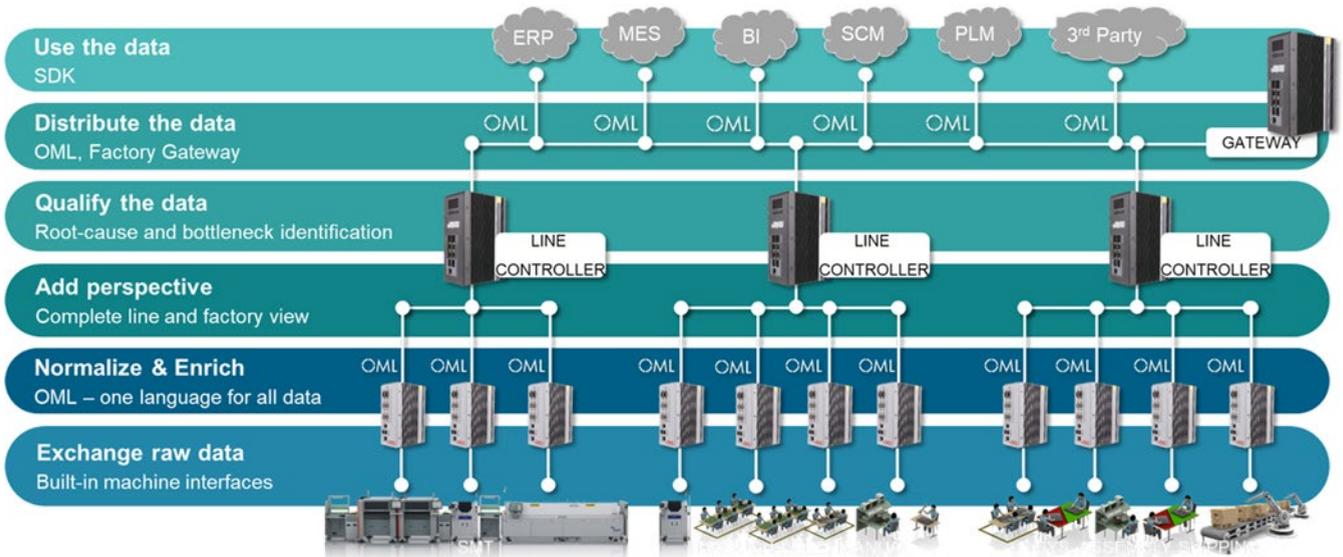


Figure 1: Big data flow.

than focusing solely on the return on investment (ROI). Instead, focus on implementing IoT solutions that make the manufacturing process more streamlined for your employees, even if it returns a minimal ROI or an initial increase in the cost of goods produced.

Third, be prepared to work with multiple IoT system providers. Few companies offer full-scale IoT solutions for manufacturers. However, divisions within major IoT providers can help each manufacturer integrate their IoT solutions with solutions from other vendors.

## Building on the Data Flow Layers: From Manual to Digital

When considering a data-management strategy, you can examine your data flow as moving in four levels. Industry 4.0 means going from level one and building to level four.

The first level is the data that is available, which is the status quo for many companies today. Data is available but difficult to use to make decisions or implement improvements. The data is in siloed systems and often requires manual work to integrate and translate into useful information. Problem-solving at this level is possible but extremely time-consuming. When a product quality or machinery issue arises, operators and engineers must scramble to gather data from various systems before they can decide what happened

and how to fix it. This approach drains time, resources, and money from the factory. Manufacturers at level one should move to level two as soon as possible or risk wasting millions of dollars in lost production output from unplanned downtime each day.

Level two makes the data accessible. A level-two data-management system integrates all of the disparate information sources into one single source of truth and continuously gathers and tracks production data. With the data in one location and always available, problem-solving becomes almost frictionless. When an issue occurs, operators and engineers can access the data in the system using data visualizations and dashboards, essentially leveraging the system as a query engine. With easy access to all the data, they are able to answer questions quickly, increasing plant productivity.

A level-two data flow allows engineers to address high-value issues that improve the product, conduct more efficient materials changeovers, or adopt a mass customization strategy. However, this reactive—and somewhat proactive—analysis still requires time, effort, and engagement from engineers.

To move from level one to level two, manufacturers must implement a new data architecture, which usually takes less than a year. To do this, you need to evaluate whether to build



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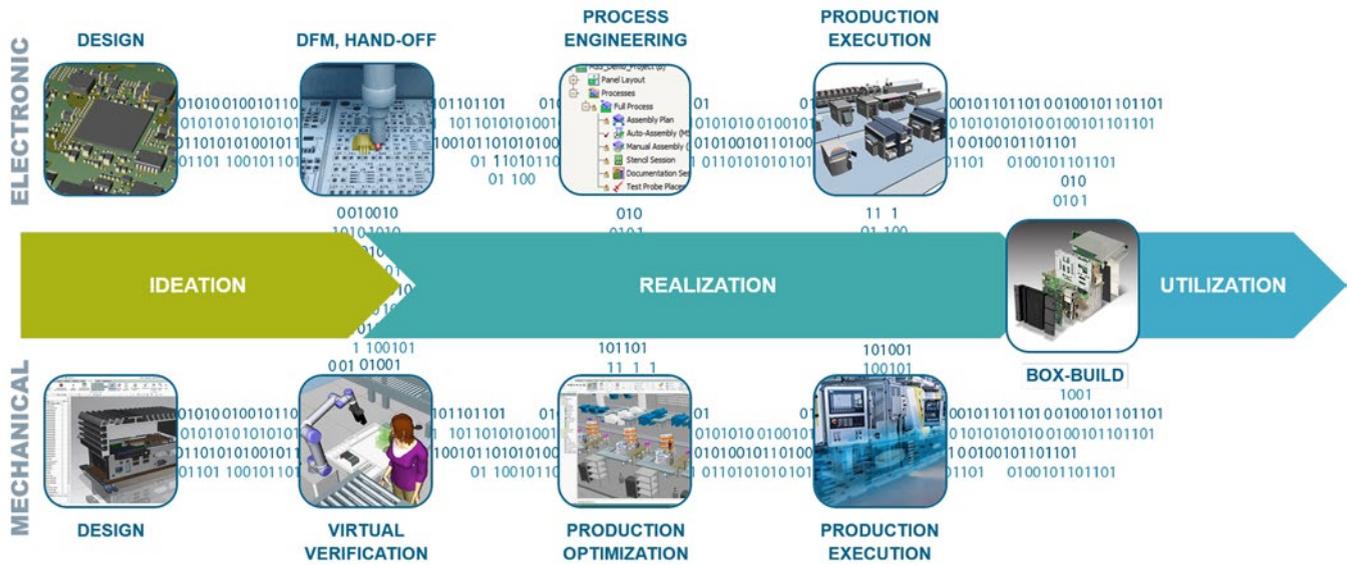


Figure 2: Digitalizing the entire manufacturing process.

your own system or select the right solution providers and partners. Also, when selecting a new architecture, make sure it allows you to scale the amount of data you can collect without paying higher marginal costs or sacrificing system performance.

At level three, your data is active. A level-three system shifts manufacturing operations from reactive problem-solving to proactive analysis and improvements. The system enables operators and engineers to be truly preventative and proactive in solving problems.

To move from level two to level three, new system capabilities—such as machine learning and AI—are added to the previous level’s data architecture. These new tools allow you to start generating insights in as little as two or three months, depending on your product mix. Built onto the level-two system that aggregates all your production data, these new features create an intelligent system that finds valuable insights and predicts failures more accurately on its own while delivering information to the appropriate person at the right time. Engineers do not have to query the system or perform manual process analysis to find the answers to solving production issues.

An example of level-three system attributes includes machine-learning models that predict product defects or machine failures and identify ways to produce products more efficiently.

In a level-three system, a person is still needed to make the changes that the intelligent system recommends.

Level four is when your data becomes action-oriented. At level four, the data system deploys the recommendations that it finds from analyzing manufacturing data. For example, a machine-learning model will identify an optimization, then generate and send the recommended new settings to the machine where it is automatically executed. In such a closed-loop, AI-controlled production line, the time it takes to execute on an insight discovered by the system becomes minimal.

Achieving level four requires datasets that are large enough and have enough validated cases to provide the information needed for the system to “know” the effects of a production change. The time needed to move from level three to level four varies based on the amount of time it takes to gather the necessary datasets.

Looking at building a smart factory in these four stages is helpful when making such a fundamental, and even monumental, change. No shortcuts can take a manufacturer from level one to level four. Those that have tried find their systems have so much process and data variability that they quickly become mired in complexity; they built on an unsound foundation with weak construction.

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The level three and level four manufacturing-management systems of Industry 4.0 require a huge amount of data, which can only be generated and made useful in level two. A

systematic approach allows manufacturers to progress realistically. In the earlier levels, you learn more about data systems in general and the data needed for your specific processes. You begin to amass the datasets necessary to enable the system to identify and execute production-process improvements based on data. With this methodical approach, manufacturers can implement digital transformation more quickly and with less frustration.

Throughout every level, process traceability is crucial to maintaining an accurate history of changes that results from smart machine learning and machine-to-machine communication, contributing to the dataset that can lead to a greater understanding of the implications of change. **SMT007**



**Oren Manor** serves as the director of business development for the Valor Division of Mentor, A Siemens Business. To download a copy of *The Printed Circuit Assembler's Guide to...Advanced Manufacturing*

in the Digital Age, go to: [I-007eBooks.com/amda](http://I-007eBooks.com/amda)

## Siemens on Challenges and Trends in the Electronics Industry



Dan Feinberg speaks with Fram Akiki, VP of electronic and semiconductor industries for Siemens, about the biggest challenges in the electronics industry, as well as major trends, including smart connected devices as used in autonomous transportation and robotics, increased complexity, and reduced time to market. **Click the image to view video.**

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# Supplier Highlights



## Will Moisture Management Expand to the U.S. Market? ▶

Rich Heimsch, Super Dry director, chats with Nolan Johnson about the growing demand for moisture management in North America versus its earlier adoption in Europe, and how moisture management fits into Industry 4.0 and the smart factory.

## MacDermid Alpha's ALPHA OM-550 Solder Paste to be Demonstrated by Vermes Microdispensing at IPC APEX EXPO ▶

MacDermid Alpha Electronics Solutions, leaders in innovative electronic interconnect technologies, had its revolutionary low-temperature solder paste, ALPHA OM-550 HRL1, demonstrated by Vermes Microdispensing on their latest solder paste jetting dispense system, MDS 1560 with DST (Dynamic Shockwave Technology), during this year's IPC APEX EXPO in San Diego, California.

## Dow Introduces First Solventless Silicone Conformal Coating ▶

Dow introduced at IPC APEX EXPO 2020 new DOWSIL™ CC-8030 UV and Moisture Dual-Cure Conformal Coating, the industry's first solventless silicone conformal coating with an ultraviolet (UV) and moisture dual-cure system for high throughputs.

## Koh Young America Honors Its Top-performing Sales Partners at IPC APEX EXPO ▶

Combining an award-winning portfolio of True 3D Solder Paste Inspection, Automatic Optical Inspection, and KSMART factory connectivity software with the industry's finest group of sales representatives helped Koh Young realize outstanding results in 2019.

## LPKF Introduces New Depaneling Laser Systems at IPC APEX EXPO 2020 ▶

LPKF Laser & Electronics is introducing the LPKF CuttingMaster family of laser depaneling systems for rigid and flex PCBs at IPC APEX EXPO. Available with different laser sources, power levels, and two different working areas, the CuttingMaster 2000 and CuttingMaster 3000 systems are suited to achieve the highest quality results for nearly every depaneling task.

## Technica USA-SMT Division to Represent Teradyne's Production Board Test Equipment ▶

Technica USA has reached a sales representation agreement with Teradyne Incorporated to represent its production board test equipment in Northern California, Nevada, Oregon, Washington, Colorado, Utah, Idaho, Montana, and Wyoming.

## KIC Announces Expanded Sales Territory for BarTron Inc. ▶

KIC announced the expansion of BarTron Inc.'s sales territory to include the states of Ohio, Kentucky, and Western Pennsylvania. BarTron has been representing KIC in Michigan for more than 20 years, and with this expansion, BarTron's Nick Papp and Matt Bonweg (who is a former decades-long KIC user), will represent KIC products.

## GÖPEL electronic Ends Financial Year With Historic Record Sales ▶

With a turnover of 40 million Euros, GÖPEL electronic from Jena, Germany, was able to achieve a sales record in the past fiscal year 2019. The strong previous year was exceeded by two percentage points, and the number of employees was also increased.

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# Happy's Smart Factory Protocol Primer

Feature by Happy Holden  
I-CONNECT007

*Editor's Note: This protocol overview was previously published as a section in "The Smart Factory: All the Bits and Bobs" by Happy Holden in the February 2020 issue of PCB007 Magazine. [Click here](#) to see the full article.*

The smart factory concept is built upon data interchange as the foundation. There has been much development in the area of industrial and manufacturing data protocols over the years, stretching back into the 1960s. This article surveys what are considered the most common protocols in use in the electronics manufacturing industry today, including IPC-CFX/Hermes, OML, SECS/GEM, and MAPS.

## Protocols for the Electronics Smart Factory

One way to shorten the development time of any smart factory automation protocol is to

leverage what is already out there. Three protocols have already been established in electronics manufacturing:

1. IPC-2591 Connected Factory Exchange (CFX) with the IPC-9852 HERMES standard.
2. Mentor/Siemens Open Manufacturing Language (OML).
3. SEMI's SECS/GEM-SEMI Equipment Communication Standard/Generic Equipment Model.

Modeling any PCB fabrication smart factory protocol after one or more of these existing standards will shorten their development time.

## IPC-CFX/Hermes

An open network standard introduced by the IPC is IPC-2591 <sup>[1]</sup> introduced in 2018 (Figure 1). It establishes three critical elements for "plug and play" industrial IoT:

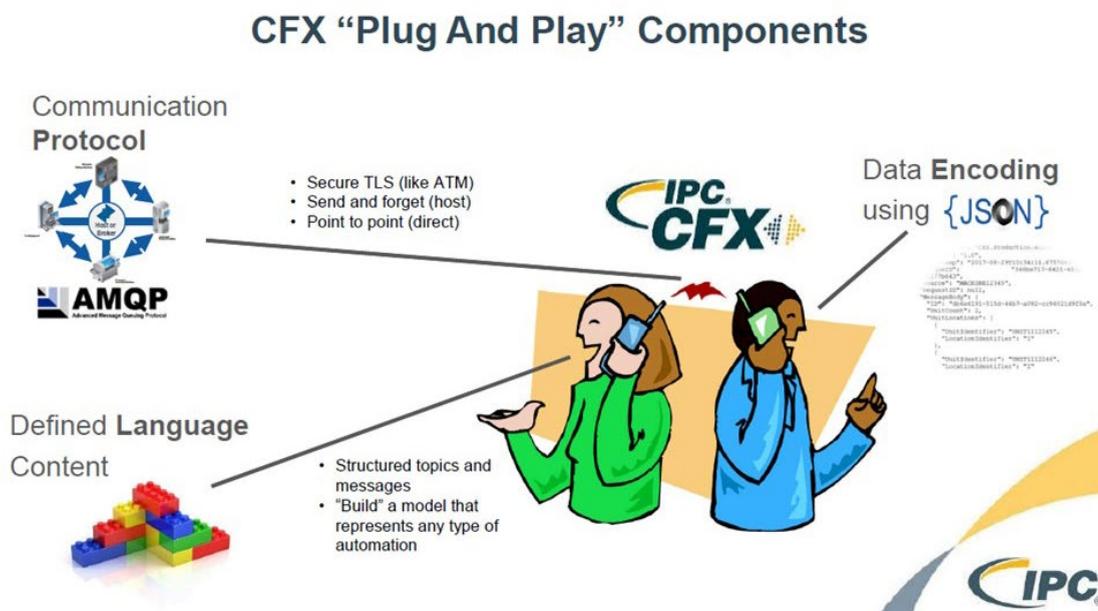


Figure 1: IPC-CFX is an open, free, M2M electronic assembly protocol standard. (Source: IPC)



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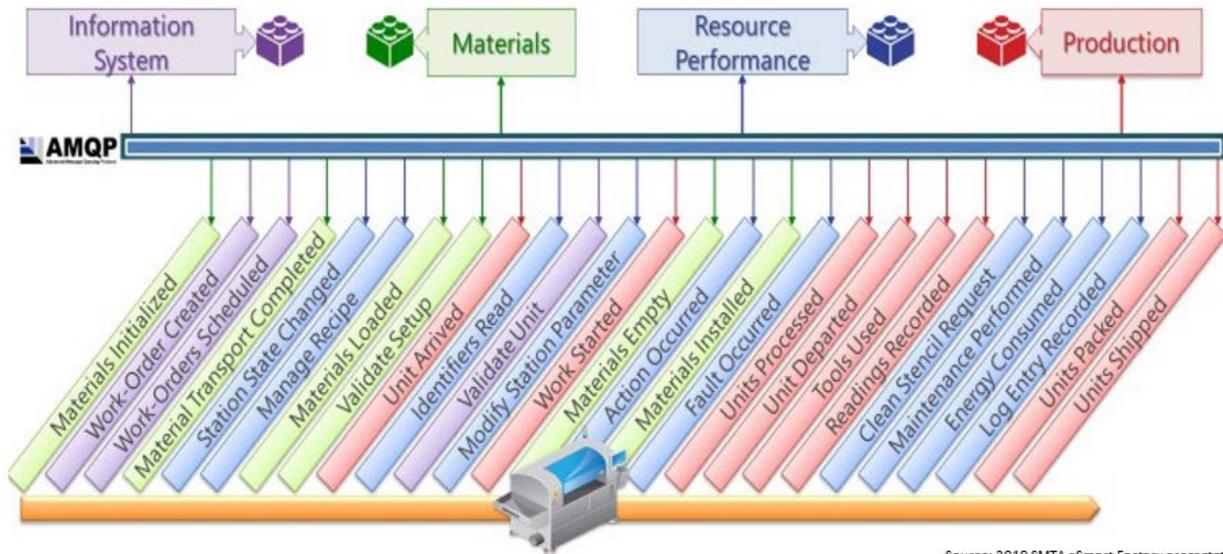
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Source: 2019 SMTA eSmart Factory presentation

Figure 2: CFX messaging. (Source: IPC)

1. A message protocol using AMQP
2. An encoding mechanism using JSON
3. A specific content creation element-structured topics and messages

The Hermes standard is a low-level line control protocol that passes information up and down the equipment line, including PCB ID, program name, and key product data. These elements allow for the creation of automatic decision-making and dashboard displays, alerts, and reports. Applications that improve productivity, efficiency, capacity planning, and quality while lowering costs. It allows the full traceability of components (IPC-1782) and feedback to design (IPC-2581).

Typical CFX topics and messages are seen in Figure 2. The IPC has established a methodology to add and edit new messages for the CFX standard, the “CFX message submission process,” to allow it to grow and be applied by more machines and processes. There are even CFX messaging for hand soldering.

To facilitate adapting machines and applications, there are free software development kits (SDK) available for Windows, .Net, Linux, LabVIEW, JAVA, etc. Already, hundreds of machines have been adapted and demoed with native CFX. The goal of the IPC Committee is

to facilitate a fully functioning Industry 4.0 digital manufacturing world.

Closed-loop feedback in real-time is now possible and available. IPC-CFX provides the tools and community to implement most of the goals of the smart factory, including DFX feedback via IPC-2581’s digital product model (DPM) back to design. An integral part of the success of IPC-CFX is the DPM standard created by IPC-2581.

### OML

OML was developed by the Valor Division of Mentor, which is now part of Siemens. OML is the messaging and communications protocols used by the Valor IoT box according to the ISA-95 application hierarchy (Figure 3) to connect SMT assembly equipment to the Siemens higher-level factory software and to displays and performance dashboards.

### Hardware

There are two unique pieces of “plug and play” hardware in Siemens’ IoT solution. They are:

- System processing unit (SPU): The factory gateway for networking and line controller for connections to machines

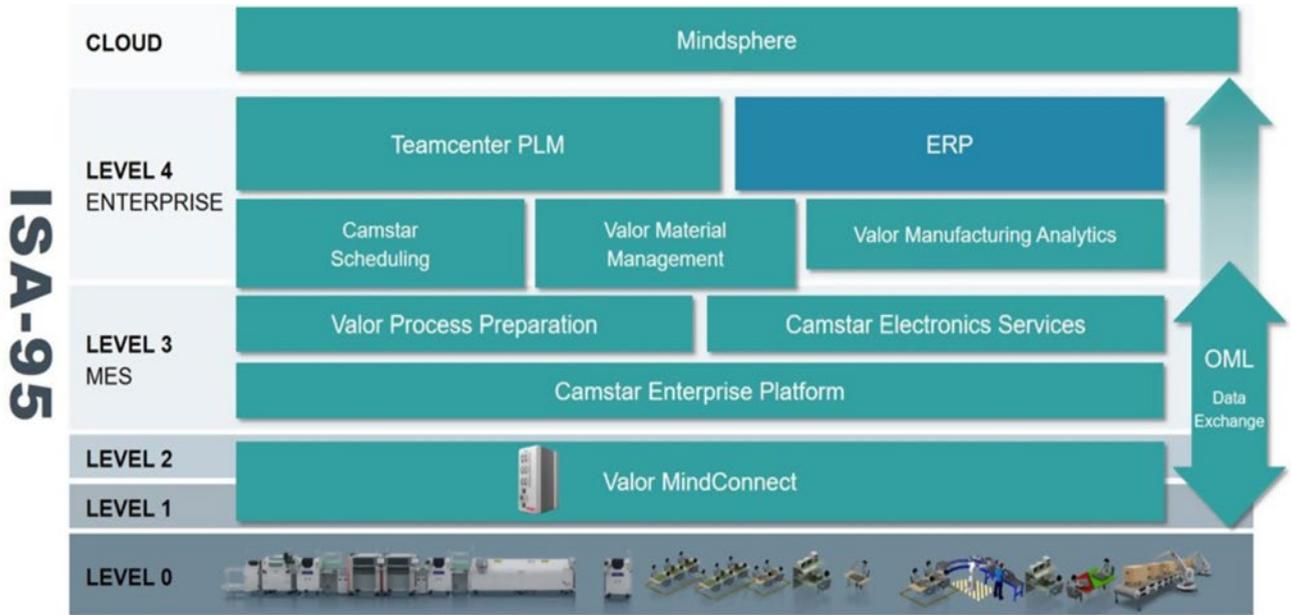


Figure 3: The Valor/Siemens IoT Manufacturing Control system follows the ISA-95 hierarchical MES application levels. [Source: Siemens]

- Data acquisition unit (DAU): Connects machines and manual processes using a variety of physical interfaces, such as RS232, digital I/O, USB, HDMI, LAN, SMEMA (Hermes), and light tower sensors.

## Data Formats

OML uses the JavaScript Object Notation (JSON) standard to represent each message. The use of JSON in the software industry has rapidly increased year on year, with the format now widely used in most web-based technology and across the Internet generally. For example, JSON can represent the same data, using significantly less space than XML, which means performance gains. However, like XML, JSON is still human-readable and can represent complex data. JSON is easily compressed to reduce size for further efficiency.

JSON is a fully open standard with mature future support in most major programming languages and platforms. The Siemens/Mentor hierarchy is seen in Figure 3. OML allows equipment suppliers and users to create recipes, control equipment, sound alarms, and collect data to solve problems automatically (Figure 4).

Figure 4 shows how the DAU and SPU collect, interpret, and normalize the data and provide it to higher-level functions that can use the data to take immediate actions through CamStar, Teamcenter PLM, and Mindsphere or other third-party software solutions.

## SEMI's SECS/GEM Protocol

SEMI's SECS/GEM was established in the 1980s and 1990s by the semiconductor industry and has been continuously updated to today. There are over 900 English SEMI Standards with many more in Korean, Japanese, and Chinese. SEMI also has standards for other industries like photovoltaic. The standards are open and non-proprietary. SEMI's documentation is useful to establish messages and responses for PCB fabrication protocols. Like IC fabrication, the PCB fabrication process is thermodynamic, so the IC fab model is very useful for PCB fabrication and is different than the kinematic PCB assembly model. It has been updated with current wireless networking and security and is a convenient model for additional PCB automation [2].

SEMI has PCB fabrication and assembly advisory boards working to connect the entire electronics supply chain into one digital thread.

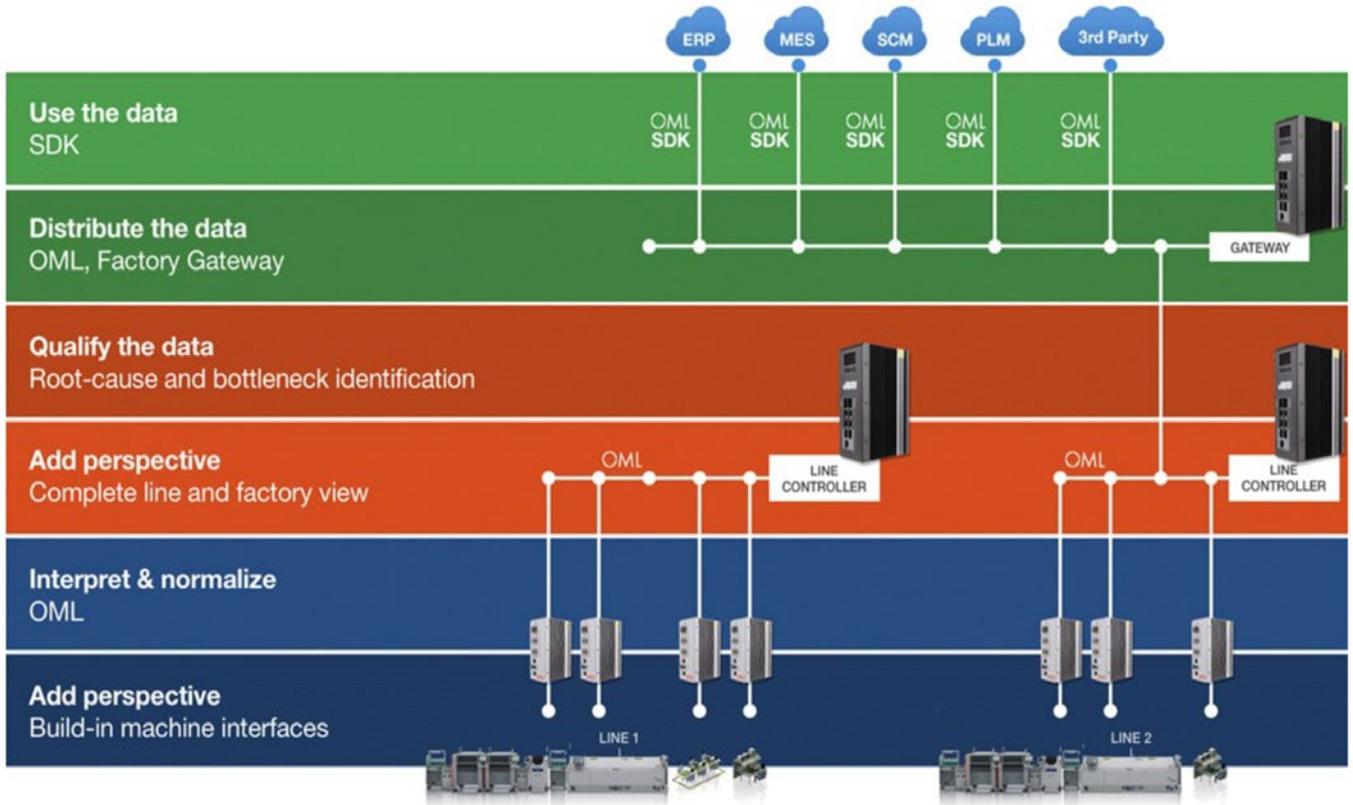


Figure 4: The architecture for Siemens' IoT implementation of OML. (Source: Siemens)

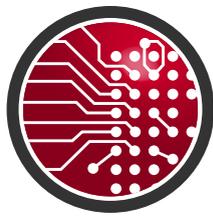
Because of accessibility, originality, and security, SEMI is looking at “distributed ledger technologies” (blockchain) as a possible technology to include in their general equipment model (GEM-E30) protocol.

As explained in the HP Journal article <sup>[3]</sup>:

“SECS I incorporates the use of RS-232-C cabling and pin definitions and a relatively simple line protocol. SECS II defines larger messages (up to 4.3 Gb) to request and send status information, transfer recipe data, report alarm conditions, send remote equipment control commands, and handle a material transfer. SECS I uses a simple ENQ-ACK handshake across an RS232-C line with checksums at the end of each message. SECS I also defines time-out intervals between handshake responses, individual message characters, and message responses. Message headers are defined in SECS I to include equipment identifiers, message identifiers, message block numbers, and other system information.”

“SECS II defines message types, format, content, and directions. SECS streams are groups of messages assigned to a general set of equipment functionality. Within each stream, the individual messages are assigned function numbers. For example, SECS stream 1 function 5 (abbreviated S1 F5) is a formatted equipment status request, and stream 1 function 6 is the reply with the status information. Similarly, stream 7 function 5 is used to request the transfer of a process recipe, and stream 7 function 6 is used to transfer the recipe. SECS II also defines whether a reply is required or not, the message content and format (including data item definition headers), and whether a message may be used from equipment-to-host and/or host-to-equipment.”

The GEM/SECS-II standards are protocol independent. Today, there are two protocols defined by SEMI: SECS-I (E4) for serial communication and HSMS (E37) for network communication. Most systems today are using the



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HSMS standard. HSMS does not specify the physical layer. Any physical layer supported by TCP/IP can technically be used, but typically everyone just uses an Ethernet network interface controller (NIC) with an RJ45 port.

A major advantage of the SECS standard is that it defines messages and their content; it defines how the messages are used together to perform a function. Equipment manufacturers are left to decide what messages to use to perform functions that were performed manually before. The GEM standard is built on top of SEMI standard SECS-II (E5).

The GEM standard has been adopted by other industries, like the photovoltaic (solar cell) industry, and used by many in the electronics industry. It can serve as a model for the PCB fabrication industry by reviewing these SEMI standards:

1. SEMI E4: SEMI Equipment Communication Standard 1 Message Transfer (SECS-I)
2. SEMI E5: SEMI Equipment Communication Standard 2 Message Transfer (SECS-II)
3. SEMI E30: Generic Model for Communications and Control of Manufacturing Equipment (GEM)
4. SEMI E37: High-Speed SECS Message Service (HSMS) Generic Services
5. SEMI E81: Specification for CIM Framework Architecture
6. SEMI E96: Guide for CIM Framework Technical Architecture
7. SEMI E128: Specification for XML Message Structures

## MAPS™ Protocol: Message Automation and Protocol Simulation

As explained in an overview tutorial by GL Communications Inc. <sup>[4]</sup>:

“MAPS specify a set of standard communication services for factory automation and has been accepted as an international standard by the ISO. It is a protocol simulation and conformance test tool that supports a variety of protocols for such factory floor controllers as PLC, robots, group con-

trollers, and cluster controllers. MAPS is one of the oldest and most used of the factory floor automation protocols, being pioneered by General Motors and adopted by General Electric for its factories.”

“MAPS is based on the reference model for open systems interconnection (OSI) of the International Organization for Standardization (ISO). It has three main components: file transfer, access, and management services; manufacturing message specification services; and X.500 services. The protocol includes SIP, MEGACO, MGCP, SS7, ISDN, GSM, MAP, CAS, LTE, UMTS, SS7 SIGTRAN, ISDN SIGTRAN, SIP I, GSM AoIP, Diameter, and others. This message automation tool covers solutions for both protocol simulation and protocol analysis. The application includes various test plans and test cases to support the testing of real-time entities. Along with automation capability, the application gives users the unlimited ability to edit messages and control scenarios (message sequences). ‘Message sequences’ are generated through scripts.”

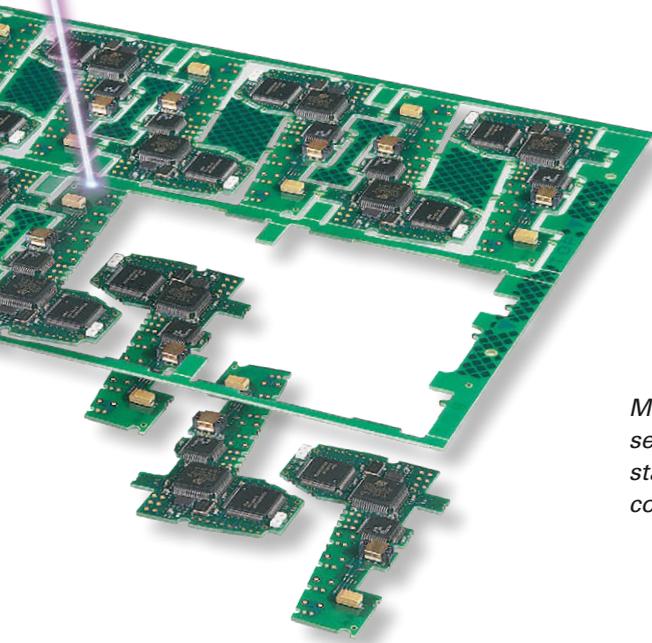
“MAPS is designed to work on TDM interfaces as well as on the IP/Ethernet interfaces. MAPS also supports 3G and 4G mobile protocol standards for testing the rapidly evolving mobile technologies. MAPS can simulate radio signaling protocols, such as LTE (S1, eGTP, X2) interfaces and UMTS (IuCS, IuPS, IuH), GPRG Gb, and GSM A over an IP transport layer.”

“MAPS test suite is enhanced to simulate multiple UEs and IMS core elements, such as P-CSCF, I-CSCF, S-CSCF, PCRF, MGCF in IMS core network. With the help of mobile phones and other simulated wireless networks, the VoLTE Lab setup can be operated in real-time for making VoLTE calls and for interworking with PSTN and VoIP networks. MAPS is enhanced to a high-density version and a special purpose 1U network appliance that is capable of high call intensity (hundreds of calls/sec) and the high volume of sustained calls (tens of thousands of simultaneous calls/1U platform).”

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## Conclusion

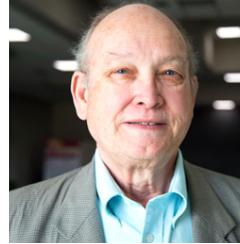
Each protocol was developed for specific purposes; no one protocol can perform all the possible data interchange functions that might be encountered on the manufacturing floor. When developing a strategy for your digital factory conversion, care should be taken to assess the capabilities and limitations of all protocols to ensure that your implementation is appropriate for your facility's specific needs. SMT007

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3. "Semiconductor Productivity at HP," HP Journal, July 1985.

4. Message Automation & Protocol Simulation (MAPS™), GL Communications, Inc.



**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. To read past columns or to contact Holden, [click here](#).

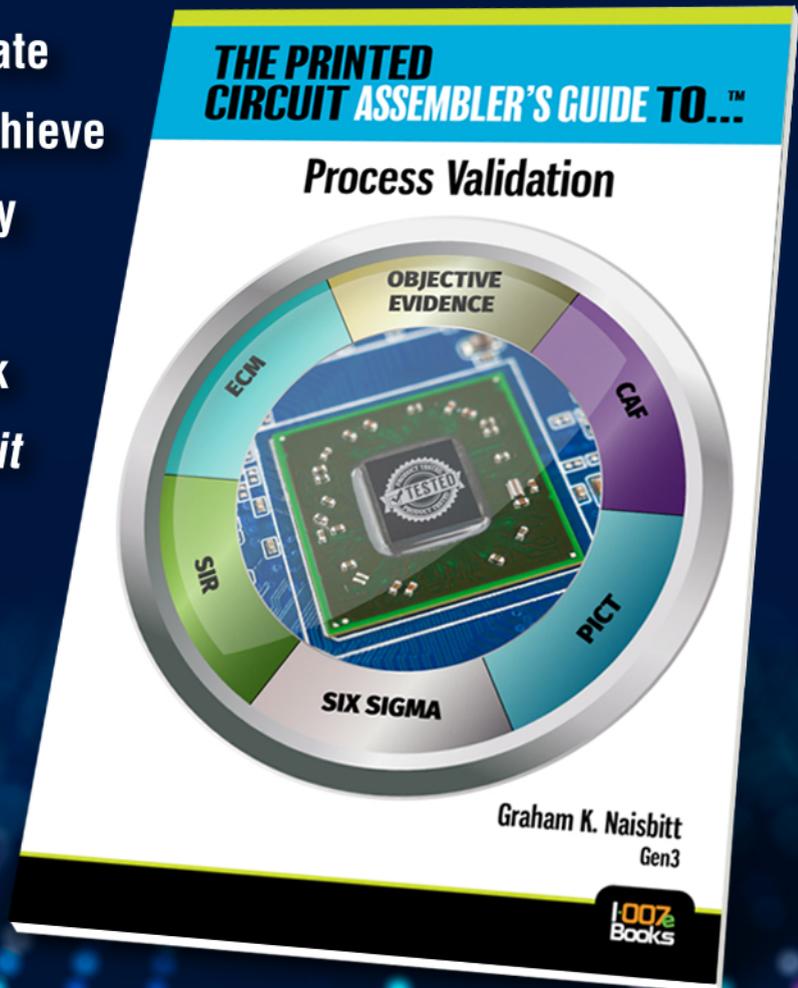
# Michael Ford on M2M Communication and Smart Factories



Dan Beaulieu speaks with Michael Ford, senior director of emerging industry strategy at Aegis Software, about machines talking to machines using IPC-CFX, as well as strategies to turn any factory with old or new equipment into a smart factory. [Click the image to view video.](#)

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# MilAero007 Highlights



## Blackfox Trains Veterans for Good Manufacturing Jobs ▶

Blackfox Training Institute has been training manufacturing technologists for over 20 years. Based in Longmont, Colorado, Blackfox is now focused on helping veterans of our armed services transition into good jobs in the manufacturing sector. During IPC APEX EXPO 2020, Nolan Johnson spoke with Blackfox CEO Al Dill about the company's veteran training programs, and how this effort is helping companies fill jobs that might otherwise go unfilled.

## Dr. Jennie S. Hwang Appointed to the Board on Army RDT&E, Systems Acquisition, and Logistics, U.S. Department of Defense ▶

Dr. Jennie S. Hwang was appointed to the Board on Army RDT&E, Systems Acquisition, and Logistics (BARSL), which has recently been established to advise the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASA[ALT]), the U.S. Department of Defense, on national security, engineering, technological, operational, management, and logistical issues.

## Absolute EMS Inc. Passes AS9100 Rev D Audit with Zero Findings ▶

Absolute EMS Inc., a leading provider of turnkey and consignment manufacturing services, is pleased to announce that it successfully completed its 2020 surveillance audit for the AS9100 Rev D SAE International Aerospace Standard with zero findings.

## American Standard Now Offers Book Binder Rigid-flex Printed Circuit Boards ▶

American Standard Circuits is now offering high-technology book binder rigid-flex printed circuit boards. Book binder rigid-flex technol-

ogy is a special rigid-flex design where the outer flex layers are increased in length, compared with the inner layers, by enough to keep them from interfering with each other and buckling.

## IPC's Raymond E. Pritchard Hall of Fame Award Presented to Steve Pudles of Zentech Manufacturing ▶

In recognition and acknowledgement of his extraordinary contributions to IPC and the electronics industry, Steve Pudles, president and CEO, Zentech Manufacturing, was presented with the IPC Raymond E. Pritchard Hall of Fame Award at IPC APEX EXPO on Tuesday, February 4 at the San Diego Convention Center.

## New Boeing 777X Completes Successful First Flight ▶

The new Boeing 777X jetliner took to the skies on January 25, 2020, entering the next phase of its rigorous test program. Based on the popular 777 and with proven technologies from the 787 Dreamliner, the 777X took off in front of thousands at Paine Field in Everett, Washington, for a nearly four-hour flight over Washington state before landing at Seattle's Boeing Field.

## Ravi Ravichandran Appointed as Chief Technology Officer of BAE Systems' Intelligence and Security Sector ▶

BAE Systems Inc. has named Dr. Ravi Ravichandran as vice president and chief technology officer for the company's Intelligence and Security Sector. As CTO, he drives the development, integration, and transition of next-generation solutions that advance the company's current programs and future technology pursuits.

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# Developments in BTC Guidelines: **IPC-7093A**, Part 1

## SMT Solver

by Ray Prasad, RAY PRASAD CONSULTANCY GROUP

If you attended the IPC-7093 meeting at IPC APEX EXPO 2020, you know that we completed the revision of this document and are now in the process of balloting it for final release within a couple of months.

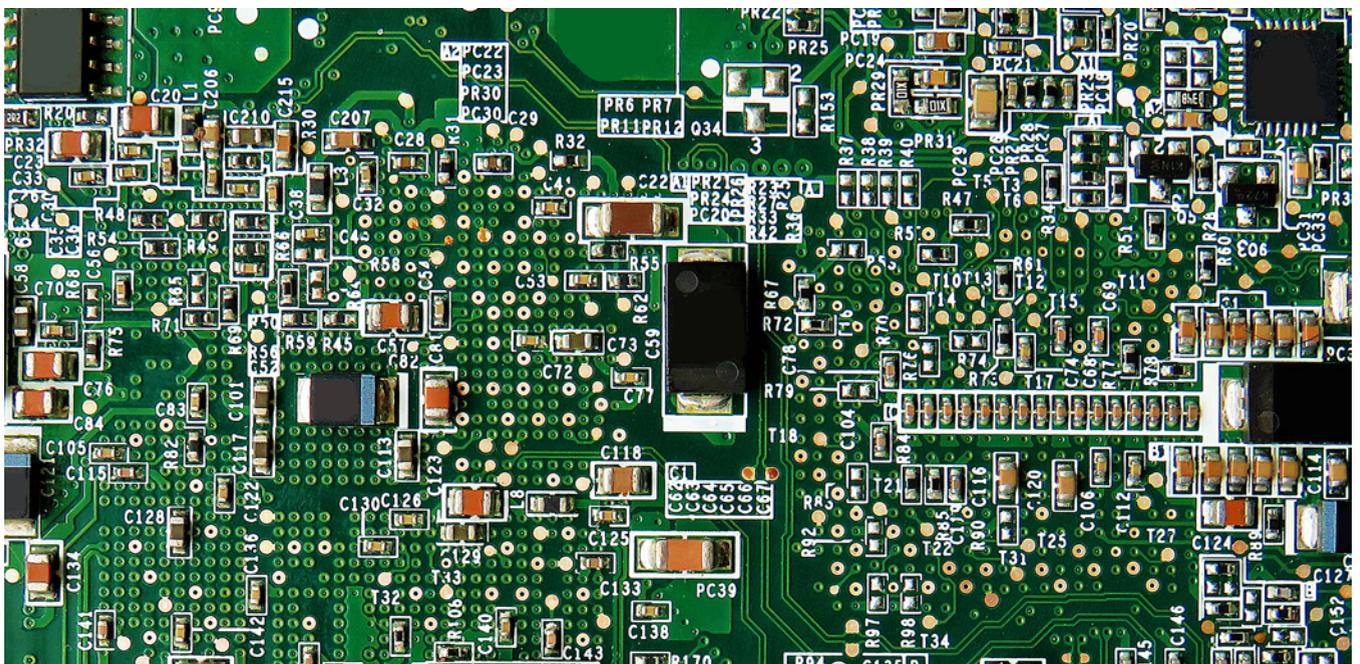
As the chair of this IPC committee, let me share the latest developments in bottom-terminated component (BTC) design and assembly guidelines in this three-part series. In this first column, I will give you an overview of this technology and standard. In my upcoming columns, I will take an in-depth look at the design, assembly, quality, and reliability issues in BTC technology that have been incorporated in this latest IPC-7093A revision.

Let me start by thanking all the team members of this committee. Special thanks to A-team members Matt Kelly (IBM, now IPC), Mark Jeanson (IBM), Udo Welzel (Bosch), Robert

Cochran (Mindchasers), David Hillman (Collins Aerospace), Michael Johnson (MACOM), Rob Rowland (Axiom), and Dr. Raiyo Aspaniard (Intel). These members put in countless hours attending numerous meetings and writing and rewriting various sections and reviewing other comments. Most important of all, this team was fortunate to have Chris Jorgensen as our IPC liaison, who kept us on our toes and nudged everyone to keep up with their commitments. Thanks to these people and many others, who made this a much better and more up-to-date document than the previous version.

## What Are BTCs?

BTCs have many names. Examples of BTCs include small-outline no-leads (SONs), dual-flat no-leads (DFNs), quad-flat no-leads (QFNs), land-grid arrays (LGAs), etc. Here is



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another way to think of BTCs. We are all very familiar with ball-grid arrays (BGAs). BTCs are like BGAs without the balls. Think of BTCs as a poor man's BGAs because BGA is the most expensive package, and BTC is the least expensive package. This minor difference in physical construction makes all the difference in cost, design, assembly, and rework between BTCs and BGAs.

## BTC Drivers

Why is there such a big interest in this package, and what are the main drivers for BTCs? These days, billions of BTCs are being assembled worldwide, primarily driven by mobile products in general and mobile phones in particular. Some smartphones have as many as eight BTCs in each phone. BTCs are also used as voltage and power regulators and in many other automotive and industrial applications. Designers find the small body footprint and minimal PCB area requirements very attractive.

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**These days, billions of BTCs are being assembled worldwide, primarily driven by mobile products in general and mobile phones in particular.**

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BTCs have excellent electrical and thermal properties, and they are a very robust package for handling without any concern for lead damage. One of the most attractive features of BTCs is the cost. In general, if a package costs one cent per I/O (e.g., \$1 for a 100-I/O package), it is considered a very good price for the package. BTCs can cost as low as 0.5 cents per I/O, or even less. That is an attractive price and why they are so widely used in high-volume applications, such as cellphones and other mobile applications.

## Disadvantages of BTCs

Of course, there are downsides to any package type, and BTCs are no exception. The most significant issue is the lack of good solderability of BTC terminations. It is easy to see why. BTCs are essentially built on a sheet of copper in a waffle pack like a sheet. After attaching the silicon and molding, the sheet is either chopped up or punched into individual packages. This results in an exposed copper surface at the end of termination. Exposed copper is very susceptible to oxidation; hence, the potential for getting a side fillet is very low even with an aggressive flux. This is why the IPC-610 standard does not require side fillets in BTC solder joints.

Speaking of using aggressive flux, it is generally a no-no for BTCs because there is practically no gap between the bottom of the BTC and the top of PCB surfaces. Flux trapped under the tight space is almost impossible to remove. Essentially, you have no choice other than no-clean flux when using BTCs, even if there is only one BTC on the board.

The other major issue with BTCs is flatness or coplanarity of the package. These packages require perfection. The package and PCB have to be perfectly flat. The amount of solder that is applied also has to be perfect. If all these conditions are not met, either there will be opens due to a lack of enough solder paste or too many voids and bridges due to too much solder paste. Overall, you need perfection in the package, PCB flatness, printing, and reflow. How often is that achievable in a high-volume manufacturing environment? Rarely.

In addition, because the terminal features do not protrude beyond the package body, visual inspection and verification of the solder interface are difficult. What this means is that the low package cost may not immediately translate into overall low assembly cost since this package presents many challenges in assembly, inspection, and rework. We will discuss the technical details as to how to address these concerns when I discuss design and assembly issues in the next two future columns.



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## An Overview of IPC-7093: A Standard to Be Released

As you can see, there are many benefits of BTCs, but there are some major concerns as well. This IPC-7093A describes design and assembly guidance for implementing BTCs and focuses on critical design, materials, assembly, inspection, repair, quality, and reliability issues associated with this package.

This document is not an academic exercise. The purpose of this standard is to provide useful and practical information to those who use or are considering using BTCs. The target audiences for this document are physical designers, process engineers, and reliability engineers and managers who are responsible for the design, assembly, inspection, and repair processes of printed board assemblies.

The intent of the document is to help you successfully implement robust design and assembly processes for printed board assemblies so that you have a good understanding of how to troubleshoot design and assembly problems for improved reliability for both tin-lead and lead-free assemblies using BTCs.

The team has been working on this revision for some time now but finally completed its revision a week before IPC APEX EXPO 2020. At the meeting, the committee voted unanimously to release the document for ballot. There will be a phone meeting of the A-team to review the comments before the final release. If you have any comments on this document, please send it to me or IPC. If you have something entirely new to add, we welcome that too, but we will consider it for the next revision B.

### Summary

BTCs have many benefits, such as smaller package size and excellent electrical (e.g., resistance, capacitance, inductance) performance, since there is no lead. They also have excellent thermal performance due to the direct thermal path to the PCB (Si die to die to Cu thermal pad to solder to PCB). And most important of all, BTCs are compatible with standard SMT processes (i.e., no special han-

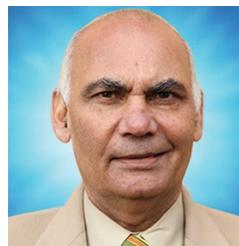
dling as in fine pitch QFP) and cheaper than any other package.

When implementing BTCs into an electronic assembly, one must keep in mind that these parts are not the only components that must be mounted on the board. The board will have other packages such as BGAs, fine pitch, and even some through-hole components; those components may have their own unique design and assembly implementation requirements.

There are two key issues with BTCs: providing the appropriate amount of solder paste and ensuring solder joint reliability. Lower paste volume can reduce floating and voids but increases the risk of solder opens, so a balance is required to ensure overall solder joint reliability.

When it comes to inspection, BTCs pose even more challenges than BGAs because endoscopes provide at least some information about the condition of BGA balls. BTC joints are essentially like postage stamps, so aggressive flux should not be used. Side fillets are not always possible since ends are sawed or punched and may not wet.

In the next two columns, I will discuss the details of design and assembly issues covered in this document that address these technical concerns to achieve higher yield, lower cost. In other words, I'll address how to meet the motto of IPC and "build electronics better." **SMT007**



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

tronics industry—and has decades of experience in all areas of SMT, including his leadership roles implementing SMT at Boeing and Intel; helping OEM and EMS clients across the globe set up strong, internal, self-sustaining SMT infrastructure; and teaching on-site, in-depth SMT classes. He can be reached at [smtsolver@rayprasasd.com](mailto:smtsolver@rayprasasd.com) and has upcoming SMT classes April 20-22 and July 20-22, 2020. More details at [www.rayprasasd.com](http://www.rayprasasd.com). To read past columns or contact Prasad, [click here](#).



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## **Iotic Wins Telecoms and IoT Award in NTT DATA's International Open Innovation Contest** ▶

Digital twin and digital ecosystem enablement specialist Iotic was declared champion of the telecoms and IoT domain at the recent grand finale of the 10<sup>th</sup> NTT DATA Open Innovation Contest in Tokyo.

## **Lockheed Martin and Oriden Team on Flow Battery Technology** ▶

Lockheed Martin and Oriden LLC, a Mitsubishi Hitachi Power Systems venture, announced a teaming agreement for future energy storage projects using GridStar® Flow, Lockheed Martin's innovative flow battery technology. This cutting-edge energy storage system is capable of storing six to 12 hours or more of energy and dispatching it as needed.

## **Bell Textron Teams Up with Sumitomo Corporation and Japan Airlines to Explore Air Mobility** ▶

Bell Textron Inc., a Textron Inc. company, announced a signed memorandum of understanding with Sumitomo Corporation and Japan Airlines Co. Ltd. to explore mobility-as-a-service (MaaS) and to foster the required infrastructure and regulatory environment.

## **Flash-memory Specialist Swissbit Offers Embedded IoT Security** ▶

Swissbit AG will present its range of highly reliable storage products for industrial applications at Embedded World in Germany. The company will be introducing its newly created business division, embedded IoT, which specializes in hardware-based security solutions for the protection of data and devices for IoT applications.

## **Omni-ID Announces New Range of IoT Devices** ▶

Omni-ID, the pioneer of passive industrial RFID tags, which are relied on by major global organisations to provide information on the location and identity of assets, announced the launch of a new range of Bluetooth low-energy (BLE) and long-range (LoRa)-enabled devices.

## **Keysight Technologies Joins Orbital Security Alliance (OSA) as Full Member** ▶

Keysight Technologies Inc., a leading technology company that helps enterprises, service providers, and governments accelerate innovation to connect and secure the world, announced that it joined the Orbital Security Alliance (OSA) as a full member.

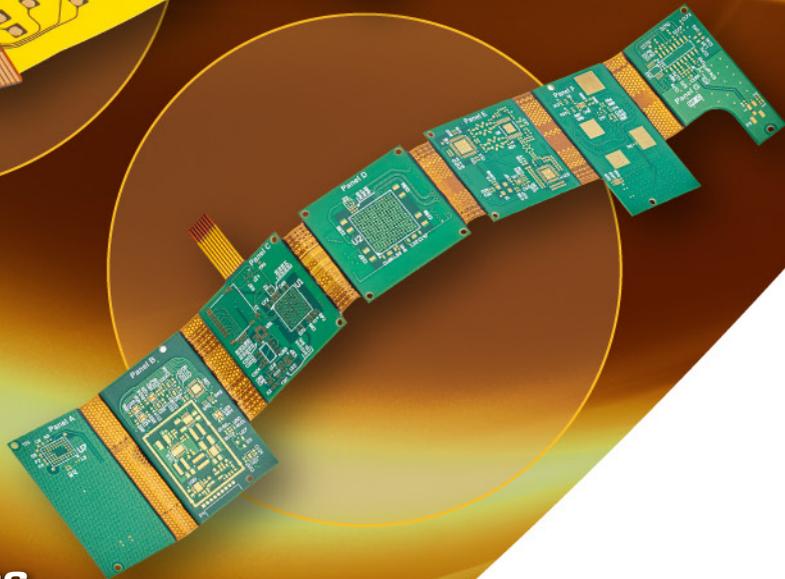
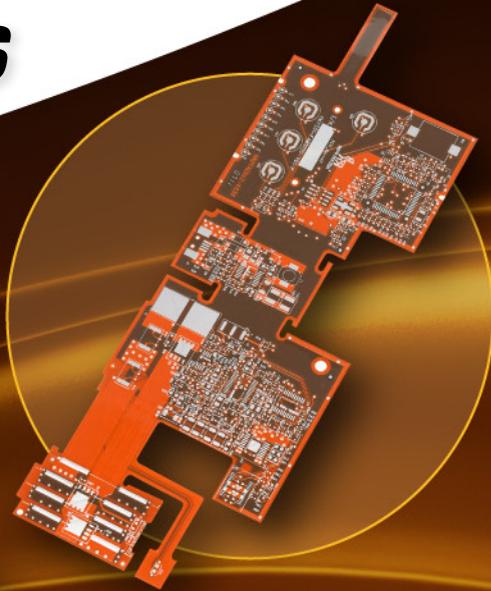
## **NEC Display Solutions Announces Series of Digital Cinema Projectors With Replaceable Laser Modules** ▶

NEC Display Solutions of America, a leading global provider of digital cinema projectors, announced the release of a new 18,000-lumen digital cinema projector to complete the world's first series of modular laser projectors, providing exhibitors with a truly versatile and future-proof solution.

## **ThinFilm to Energize Innovation in the Wearables and Sensor Markets With Ultrathin, Flexible, Safe Batteries** ▶

Thin Film Electronics ASA announced its updated corporate strategy focused on the design, development, and production of innovative battery solutions targeting existing market demand with differentiated solutions to power wearable devices and connected sensors.

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# Case Study: Example of ASKEY Applying QML Validation

**Interview by Edy Yu**  
I-CONNECT007

The services offered by IPC Validation Services include comprehensive technical consulting, SGA standard gap analysis, the qualified products list (QPL), and the qualified manufacturers list (QML). Currently, QML is reported to be the most frequently used IPC validation service aimed at offering validation service at product and business levels. The QML audit process not only normalizes manufacturing process, reduces quality problems, and lowers audition-related costs, but it also develops talent within the enterprise to ensure that standards are implemented accurately. In this article, I discuss QML validation with a Taiwanese company that has successfully gone through the process.

Headquartered in Taipei, ASKEY Technology (Jiangsu) Co. Ltd. was founded in 2001 as a subsidiary of ASUS. It is specialized in manufacturing and development of advanced electronic network communication products

covering broadband network communication products, xDSL, cable modem, VoIP, set-top box, PDT, as well as promising products, such as GPON, GPS, vehicle-mounted products, intelligent BUS stations, and other advanced, integrated products. ASKEY initiated an IPC QML validation process in 2014 and successfully passed the initial audit of Class 2 in June 2015. Now included in the IPC trusted sources list and ranked 12<sup>th</sup> worldwide and top three in mainland China (revenue), ASKEY plans to pass Class 3 validation in 2020 (Figure 1).

The PCB007 China team paid a visit to the ASKEY plant in Wujiang, Jiangsu, to learn more about their QML process. In this interview with Qixian Zhang, vice GM of ASKEY's Electronics Product Quality Assurance Department, he discusses what QML means to ASKEY and the electronics industry as a whole.

**Edy Yu:** Mr. Zhang, thank you for the chance to conduct this interview. Why did you choose to pursue the QML system?

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Figure 1: Examples of the ASKEY product portfolio.

**Qixian Zhang:** Thank you. The electronics manufacturing industry has always used IPC standards, though simply as manufacturing indicators in the past. There are too many IPC standards for us to systematically implement or even completely understand. The first time I heard about IPC QML, it was kind of a coincidence going back to an IPC meeting five years ago. Back then, we thought the IPC QML program was very good.

For a company like us, which specializes in manufacturing and production, standards have significant value. In the past, when we communicated with a customer, we would bring along the standards and consider each line item, one by one. With an IPC QML manufacturer certification, our customers can recognize that we have implemented the series of IPC standards. Of course, there is also the endorsement of third party supervision through this process.

We claim to be implementing IPC standards, but how do we

prove it? The simplest and the most authoritative proof is IPC validation; it is the best way to earn public trust, and it makes the customers rest assured they can put products in our hands because they know that we strictly follow the IPC standards.

Meanwhile, QML is a new thing with a high threshold for entry. Many specialized OEMs are having difficulty implementing it. We have our own requirements for self-validation. Through QML validation, we expect to learn about our

position in the industry and determine what stage we have reached. Our second goal is we hope that validation helps us improve the current process and enhance product line norms for better quality.

To sum up, our QML validation is driven by requirements from the industry, the customers, as well as ourselves. ASKEY has gone through many audits by ISO systems (i.e., ISO9001, QC08000, IATF16949, ISO13485) and the customers. However, the past audits were limited to spe-



Qixian Zhang

cific quality management systems and a specific customer's requirements on products and processes. Unlike these audits, the IPC QML validation process is conducted by industry experts in accordance with IPC standards and in a professional and targeted manner. It offers benchmark requirements and best practices gap analysis in a quantitative manner for every node in the process.



**Yu:** Were any production problems revealed and solved during the audit process?

**Zhang:** There were some problems. Many problems were revealed during early preparation. For example, we changed the usage of some materials due to different past understandings. What impressed me was that we used a lot of gold plating materials. It is an old perspective that gold is better than silver, which, in turn, is better than copper, as in the order from the traditional Chinese saying, “Jin yin tong tie [gold, silver, copper, iron].”

From the perspective of physical and molecular structures, however, IMC gold-tin alloy layers may become as crispy as gold or tin. Perhaps it is effective for the first welding, but it is weaker in reliability and anti-vibration features. There were many small technical problems like these that we didn't notice. During the stages of early instruction and middle-term implementation, many such problems were brought up. The team of IPC experts brought many useful suggestions for process improvements.

Validating PCB reliability is another example. We conducted inspections for incoming materials and confirmed product inspection standards provided by the suppliers, but we found that the actual requirements for testing PCB were different from the inspection reports. The standards require 95% of the trial cut area with specific requirements on welding temperature and time. We identified that requirements in reports are different from process standards.

After communicating and confirming with IPC experts, we asked the suppliers to revalidate according to the standards and supply us with compliant reports. We have learned a lot of things in the validation process.

**Yu:** Did completion of QML improve your company's work on sales and customer engagement? Do most of the customers understand QML, or do you have to explain it to them?

**Zhang:** In 2014, when QML was just launched, we were one of 12 QML-certified companies worldwide; that is a small number. Many people knew of IPC and its standards, but very few knew there was an IPC validation for QML. Instead, people tended to validate suppliers of raw materials, PCB, solder, tin in solder, or some flux.

This was all new to the customers, too. We designated special staff members to explain QML to them and let them know the definition of QML, the time when we acquired QML validation, as well as the nature of this validation. It was an effective method. Many customers felt good about it and gradually accepted QML.

For example, many European telecom companies in the past would contact us through third parties in Europe to conduct analysis and validation for the whole SAP process. Then, that third party wrote a thorough report about our company to the customers, which involved many details of the process, such as oxygen content, tin temperature, etc. Customers would rely on such reports to require improvements

from us. It was a time- and energy-consuming process that involved many highly technical and detailed problems. Because many of these things are beyond the customer's expertise, they hope for a trustworthy third-party expert to do it for them.

IPC QML validation is that third party. European experts also use IPC standards, so everybody is on the same channel of communication; hence, the trust is enhanced because no one understands their own standard better than themselves. As a result, this is very helpful for promoting the business. Now, after years of development, the industry is more familiar with QML, and many customers immediately ask if we have passed any validation, such as QML. The industry is gradually accepting it, too.

QML is not a compulsory standard at present, but I think it will become similar to ISO 9000 in that it will be a must for the electronics assembly industry. It is an obvious trend.

Many manufacturers still haven't received such validation yet, but perspective changes gradually. First, it is very helpful for business promotion, and second, it is beneficial to the improvement of internal quality management. Managers, like us, all wish for an effective mechanism with which to understand how our management is measured within the industry.

**Yu:** Is QML validation conducted for individual factory floors?

**Zhang:** Yes. Currently, the Wujiang plant is our focus. In 2014, it was our main produc-

tion base. In light of the outstanding effect of implementation, we are planning to spread into other plants globally. We have three factory floors in the Wujiang plant, each for a specific type of product, such as network products, automobile electronics, etc. Different products require different validations at various levels, so we intended for separate sites, staff, equipment, and processes. Different types of products tucked into the same plant site with various industrial standards in place would distract the workers and make them hard to concentrate. Therefore, total independence must be achieved in personnel and equipment management.

**Yu:** Do you have statistics on efficiency improvement?

**Zhang:** Through the IPC platform and our learning of IPC standards, we now understand the technology information and can use it for self-improvement. For example, under the premise of stable quality, we calibrate production parameters on the production equipment, optimize line layout, and made a straight SMT assembly line into a U-shaped line for shorter turnaround distance for the carrier (Figure 2). A single shift now requires 46% less manpower, and space is preserved for the intelligent linkage of equipment, and, therefore, greater flexibility for production.

To be specific, before the introduction of IPC QML, a production line might have some processes that consumed a lot of time and effort. For example, we may need time-consuming

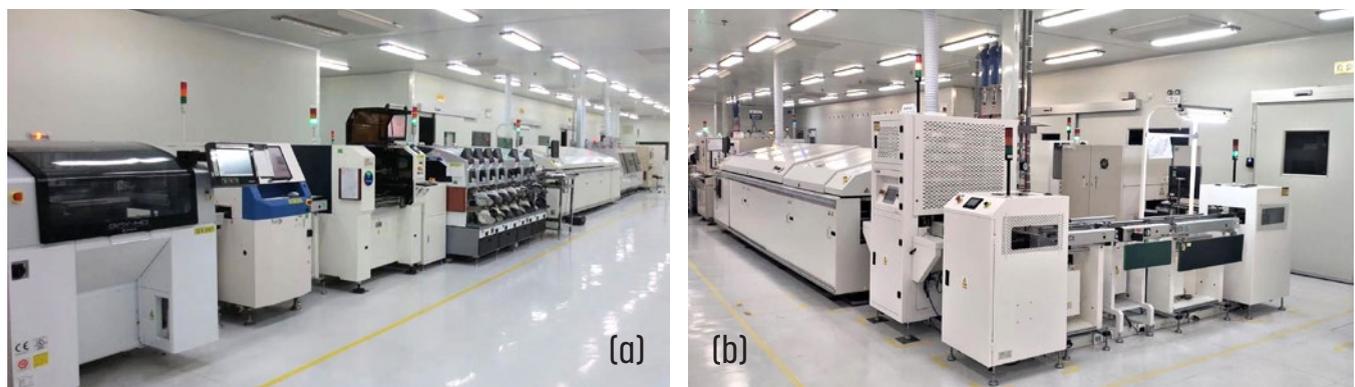
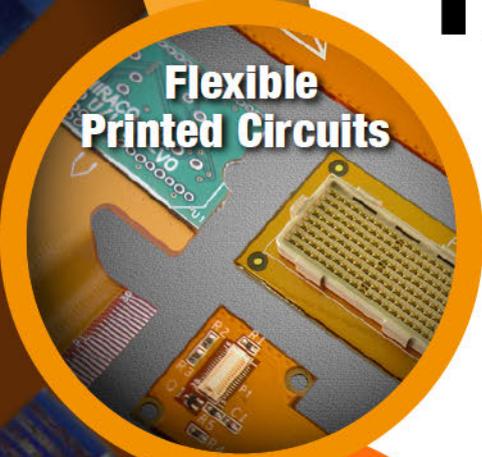
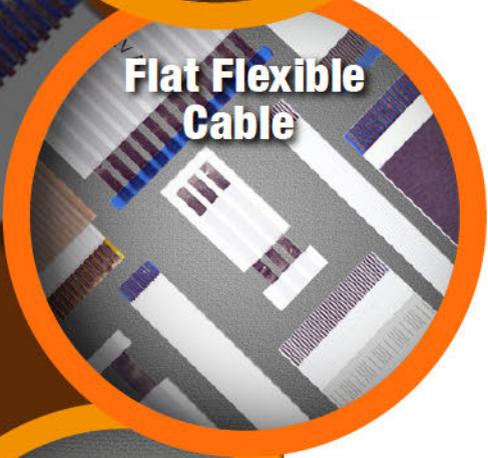


Figure 2: (a) Straight assembly line before optimization and (b) U-shaped line after optimization.

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visual inspections and even second count or reparation for misjudgment caused by equipment. After the introduction of this standard, however, the engineers would continuously debug the equipment to enable the stable status of the SMT line quality. An increasingly stable production line would require less manpower. A production line that required 7–8 workers in the past now only requires 3–4 workers for stable production thanks to the improvement of process and worker skills.

As products gradually stabilize, product turnover becomes the next aspect of improvement. We modified the line in some ways to shorten and improve logistics. The overall improvement is considerable; we achieved efficiency improvements with regard to both workers and time.

**Yu:** You mentioned an improvement in worker skills. Does QML validation involve training for front-line employees?

**Zhang:** Improvements in equipment and processes all depend on human operation. During the QML validation process, we organized a staged training system that covered new recruits and introduced them to different production requirements of different posts (Figure 3). The employees are trained to have a universal under-

standing of IPC standards as well as better skills and better engagement. We have more than 600 CISs (certified IPC specialists) in our plant.

**Yu:** More than 600 CISs; that is a very large number. Especially around the New Year, employee turnover is a traditional headache. What is the turnover for those people? Will that have any impact on the production and implementation of the new standards?

**Zhang:** Turnover of front-line employees is common in the industry. High employee turnover is the result of high living costs in the Yangtze River Delta. Our turnover rate is about 8–9%. Judging from present status after implementation of IPC QML, it is helping our crew stability. We have three CITs (certified IPC trainers) right now. CITs are qualified to train CIS personnel to help them acquire qualifications. The three CITs are senior employees of the company.

As long as we have the three CITs, any new employees coming to this facility will be trained in a staged manner with the final goal of acquiring CIS validation. That is the reason why we were able to train more than 600 CISs in recent years. Theoretically, some work does not require CIS validation, but it is very helpful to improve front-line employees' skills that help to stabilize our crew.

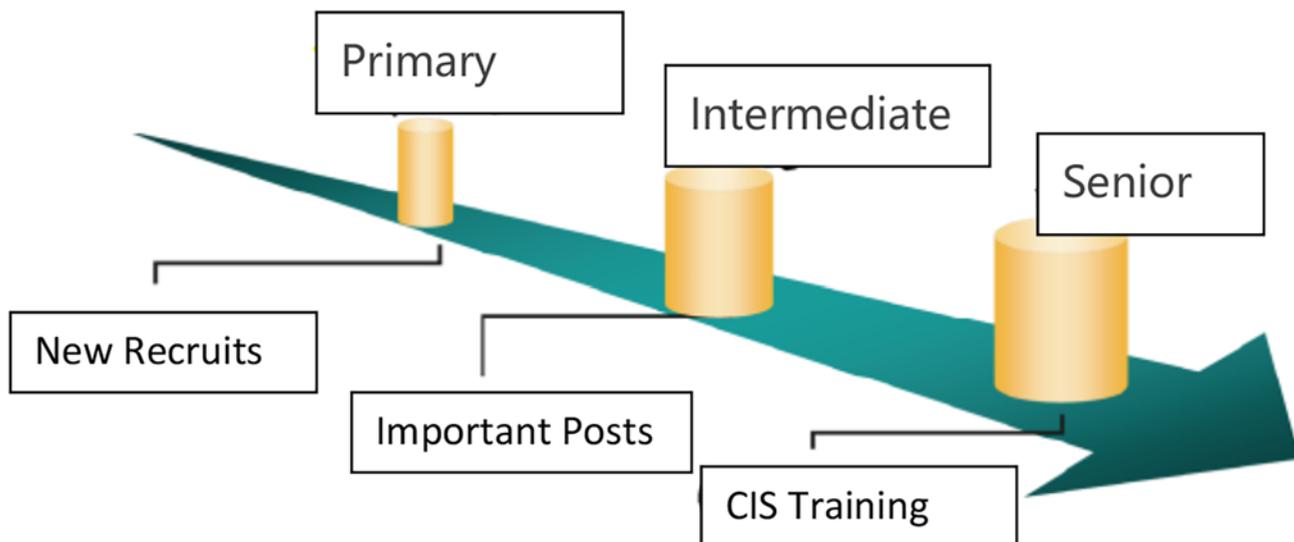


Figure 3: ASKEY supports IPC QML with a standardized staged training system.



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rial control, production and manufacturing, and customer satisfaction management together. It is where ASKEY is putting its efforts to deliver improved product reliability, stabilized production, and enhanced market competitiveness.

We have joined the IPC standards technology team to take part in the develop-

Therefore, introductory training is our focus. In addition, employees will receive further education every year. After all, there will always be new knowledge and standards. CITs are our seeds. They have always been a part of the entire IPC process from establishment and discussion of standards, training on new standards to further the education of the CISOs. That is their way to keep up with the industry and what makes us confident for the entire QML system.

ment of IPC-6012D and IPC-610GA standards. We take part as an IPC user and will communicate and cooperate with peers and experts from Europe and USA on the same platform. Looking into the future, ASKEY must continue to learn for self-improvement and to guide suppliers and customers in the process. In the electronics supply chain, we must build highly trusted sources and real-sense strategic partnerships for a win-win situation. SMT007

**Yu:** Any final comments?

**Zhang:** QML is the process that combines the quality control system with IPC standards to integrate product development, engineering management, supplier management, mate-



**Edy Yu** is PCB007 China's chief editor.

## Intelligent Towing Tank Propels Human, Robot, Computer Research

In its first year of operation, the Intelligent Towing Tank (ITT) conducted about 100,000 total experiments, essentially completing the equivalent of a Ph.D. student's five years' worth of experiments in a matter of weeks.

The automated experimental facility, developed in the MIT Sea Grant Hydrodynamics Laboratory, automatically and adaptively performs, analyzes, and designs experiments exploring vortex-induced vibrations (VIVs). Important for engineering offshore ocean structures like marine drilling risers that connect underwater oil wells to the surface, VIVs remain somewhat of a phenomenon to researchers due to the high number of parameters involved.

Guided by active learning, the ITT conducts a series of experiments wherein the parameters of each next experiment are selected by a computer. Using an "explore-and-

exploit" methodology, the system dramatically reduces the number of experiments required to explore and map the complex forces governing VIVs.

What began as then-Ph.D. candidate Dixia Fan's quest to cut back on conducting a thousand or so laborious experiments by hand led to the design of the innovative system and a paper recently published in the journal *Science Robotics*.

Fan, now a postdoc, and a team of researchers from the MIT Sea Grant College Program and MIT's Department of Mechanical Engineering, École Normale Supérieure de Rennes, and Brown University reveal a potential paradigm shift in experimental research, where humans, computers, and robots can collaborate more effectively to accelerate scientific discovery. [Source: MIT News]

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## Editor's Picks from SMT007.com

### 1 IPC APEX EXPO 2020: STEM Student Outreach Program a Success ▶

Nine groups of STEM students from the San Diego, California, area spent their day at the San Diego Convention center to attend the IPC APEX EXPO 2020 exhibition. Two hundred students were immersed in the world of electronics industry manufacturing and assembly.



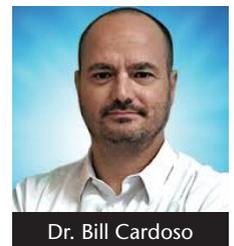
### 2 Libra Industries Acquires Bench-mark's Guaymas, Mexico, Facility ▶

Libra Industries, a privately held systems integration and electronics manufacturing services provider, announced the acquisition of Benchmark Electronics' Guaymas, Mexico, facility.



### 3 X-Rayted Files: X-Ray and AI—A Match Made in Heaven ▶

Dr. Bill Cardoso has been working with AI for a while now and seen real application and success in X-ray inspection, as well as failures. In this column, he shares how AI is changing the way we think about X-ray inspection.



Dr. Bill Cardoso

### 4 Operational Excellence: Take Your CAPA to the Next Level With 8D ▶

Quality professionals understand that the strength of an organization's quality system can be determined by reviewing the corrective and preventive action (CAPA) system that has been established. ISO auditors and regulatory inspectors will assess an organization's CAPA to evaluate the effectiveness of the quality system. Customers often use the mechanism of a corrective action request (CAR), which is part of the CAPA system, as the mechanism to request for a supplier to address a recurring quality issue.

## 5 Watch and Learn: Not All Acrylics Are Created Equally ▶

How can additional data, including test results, ensure a greater understanding of the most suitable coating for your application? The fifth episode of the popular webinar series, “Coatings Uncoated,” is now available to view. Author of *The Printed Circuit Assembler’s Guide to Conformal Coatings for Harsh Environments* and topic expert Phil Kinner from Electrolube shares highly focused educational information on conformal coating and encapsulation.



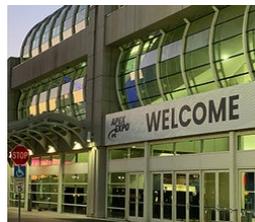
## 8 True or False: CFX Edition ▶

Since the release of IPC-2591—Connected Factory Exchange (CFX), Version 1.0—there has been a lot of buzz regarding CFX within the industry from all segments. Still, with all of the buzz, there are also some misconceptions floating around the industry regarding CFX. David Bergman takes some of those statements, using feedback from Subcommittee members, and plays a little game of “True or False: CFX Edition.”



## 6 IPC APEX EXPO 2020 Dawns on San Diego ▶

IPC APEX EXPO 2020 launched on Tuesday, February 4, and I-Connect007 started its exclusive coverage.



## 7 Zulki’s PCB Nuggets: 7 Steps to Successful Assembly for Medical Devices Using Microelectronics ▶

Seven major steps need to be taken to achieve successful SMT and microelectronics assembly for medical electronic devices. Zulki Khan explains how these key steps take on special significance for newly emerging implantable and ingestible medical devices and result in medical devices that are robust, smaller, highly reliable, more powerful, and lighter.



## 9 The IPC Education Foundation’s New Column ▶

The IPC Education Foundation’s new column with I-Connect007 will feature Charlene Gunter du Plessis, Aaron Birney, and Corey Lynn. These IPC Education Foundation members will share updates on programs and activities here. Find out more about the authors and read “Foundations of the Future” in the SMT007 Week Newsletter.

## 10 Machine Vision Products Introduces Versa AOI/SPI Solution ▶

Building on MVP’s 25 years’ experience of innovative automated optical inspection, the Versa system brings the latest 3D technologies to the company’s SMT and SPI offerings and is a significant advance in the flexibility of PCB assembly inspection.



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

# Career Opportunities



## Looking for the purrrrfect applicant?

Find industry-experienced candidates at I-Connect007.

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

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

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

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

**Don't delay, contact us right meow!**

To get your ad into the next issue, contact:

Barb Hockaday at [barb@iconnect007.com](mailto:barb@iconnect007.com) or +1.916.608.0660 (-8 GMT)

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GOOD FOR THE INDUSTRY



# Career Opportunities



## Employment Opportunities

National Technology, Inc., a manufacturer of high-quality printed circuit boards, is currently looking for candidates for the following positions in our Rolling Meadows Illinois Facility:

### Quality Control Manager

- Manage QMS in accordance with the ISO 9001:2015 system.
- Manage inspection departments, including final inspection, pre-mask inspection, AOI inspection and all associated quality inspections.
- Maintain continuous improvement initiatives.
- Generate and maintain monthly quality reporting.
- Manage internal and external corrective and preventive action.
- Responsible for maintaining the ISO status, including audits, training, procedures, etc.
- Maintenance and scheduling of calibrations.
- Be a liaison to our facility in India regarding customer related issues.
- Customer contact with RMA and corrective action.

### Process/Quality Engineer

- Develop and document new processes and technologies.
- Review existing processes for improvement opportunities.
- Assist in identifying and addressing manufacturing issues.
- ISO internal auditing and process related audits.
- Set-up and monitor process controls through manufacturing.
- Maintain regulator compliances.

Candidates for these positions should have a solid background in printed circuit board fabrication. An in-depth knowledge of applicable IPC standards as well as ISO 9001 standard will be required.

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## News Editor – Full Time Position

I-Connect007 seeks a positive, independent self-starter to manage news gathering process and work closely with editorial team. Qualified candidates will demonstrate strong organizational and communication skills and be able to work full-time remotely.

New hire will start with a portion of this work and ramp up with demonstrated mastery of the processes.

### Aptitudes

- Organized
- Time aware
- Team oriented
- Planning skills
- Meeting deadlines
- Good record keeping
- Problem solving skills
- Attention to details
- Strong follow-through skills
- Grammar and editing skills
- Knowledge of basic photo editing
- Knowledge of HTML a plus

### Attitude

- Ability to work remotely, often with only "virtual" supervision.
- Discipline to keep regular hours, communicate with team and deliver on deadline.
- Curious, investigative nature and interest in technology.

Objective: Submit editorial proof for the newsletter daily. This task includes news gathering, posting, categorization and simple editing functions.

- Gather news items from pre-planned primary sources for publication.
- Review and post all news items to the news manager prior to deadline.

**Interested candidates please submit resume by clicking below.**

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# Career Opportunities



## Talent for Hire

Have a position to fill? D.B. Management has the people you're looking for. Candidates currently available include:

- **Director of Operations, PCB and CEM**  
Grew previous operations to over \$100 Million.
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Over 15 years of experience working in the U.S. with offshore companies.
- **Two Highly Experienced Front End Engineers**  
Over 25 years of experience. Will work remotely.
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All four exhibit successful growth records.

Let D.B. Management help you with your staffing needs. Contact us now by calling Dan Beaulieu at:

207-649-0879

or emailing him at:

danbbeaulieu@aol.com

[more details](#)



## Sr. PCB Designer—Allegro

Freedom CAD is a premier PCB design service bureau with a talented team of 30+ dedicated designers providing complex layouts for our enviable list of high-tech customers. Tired of the commute? This is a work-from-home, full-time position with an opportunity for overtime at time and a half.

### Key Qualifications

- EXPERT knowledge of Allegro 16.6/17.2
- Passionate about your PCB design career
- Skilled at HDI technology
- Extensive experience with high-speed digital, RF and flex and rigid-flex designs
- Experienced with signal integrity design constraints encompassing differential pairs, impedance control, high speed, EMI, and ESD
- Experience using SKILL script automation such as dalTools
- Excellent team player that can lead projects and mentor others
- Self-motivated, with ability to work from home with minimal supervision
- Strong communication, interpersonal, analytical, and problem solving skills
- Other design tool knowledge is considered a plus (Altium, PADS, Xpedition)

### Primary Responsibilities

- Design project leader
- Lead highly complex layouts while ensuring quality, efficiency and manufacturability
- Handle multiple tasks and provide work leadership to other designers through the distribution, coordination, and management of the assigned work load
- Ability to create from engineering inputs: board mechanical profiles, board fabrication stack-ups, detailed board fabrication drawings and packages, assembly drawings, assembly notes, etc.

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# Career Opportunities



## CAM Engineer

Eagle Electronics is seeking a CAM engineer specific to the printed circuit board manufacturing industry. The candidate should have a minimum of five years of CAM experience and a minimum of two years of experience in Frontline InCAM software. The candidate should also be fluent in PCB and CAM language pertaining to customer and IPC requirements. The ideal candidate has experience with scripting Frontline InCAM software.

This is a first-shift position at our Schaumburg, Illinois, facility; this is not a remote/off-site position. Any offer would include relocation costs to the Schaumburg, Illinois, area along with competitive salary and benefits.

If interested, please submit your resume to [HR@eagle-elec.com](mailto:HR@eagle-elec.com) and include "CAM Engineer" in the subject line.

About Eagle—Since 1979, Eagle Electronics has provided customers with the highest quality printed circuit boards at fair and competitive prices. From providing customers with short standard lead times to very low premiums on quick turns, Eagle strives to provide the best total value in high technology rapid turn-around PCBs in the industry.

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## West Software Application Engineer

This position reports directly to the Orbotech West software support manager and works with customers to support Orbotech's pre-production software products. Acts as a focal point for technical issues, manages product implementation projects, provides customer training, and supports the sales process. Advanced knowledge of Frontline PCB products, including InCam, InPlan, InStack, InSight, Genesis, and Genflex. Ability to travel and manage time to maximize results. Requires both written and oral technical communication skills. Skilled in the use of scripting languages, including C-Shell, Perl, or Python. Knowledge of relational databases and HTML/XML highly desirable. Knowledge of PCB manufacturing processes. Familiar with the processes used in front-end engineering departments at PCB fabrication sites. Requires use of project management skills to organize and complete projects that involve the implementation of sophisticated software tools used in printed circuit fabrication facilities.

An expected average of 35%+ travel. College degree or equivalent technical education, in addition to a minimum of five-plus years of related experience. Experience supporting sales and sales activities is a plus. U.S. citizen with the ability to work and travel within the U.S., Canada, and internationally.

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# Career Opportunities



**ventec**  
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騰輝電子

## OEM Sales Manager Chicago/Home-Office-Based

Want to advance your career by joining a globally successful and growing world-class CCL manufacturer and help drive that success? We are seeking to hire an OEM sales manager to grow and manage key customer accounts with OEM's and Tier 1 manufacturers in the USA, focusing on Ventec's core market segments: mil/aero, automotive, and medical, offering a full range of high-reliability materials, including polyimide, IMS, and thermal management products.

### Skills and abilities required for the role:

- Non-negotiable: Drive and tenacity!

### Required:

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

Full product training will be provided.

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

Please forward your resume to  
jpattie@ventec-usa.com and mention  
"Technical Sales Engineer—Chicago"  
in the subject line.

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## Sr. PCB Designer—Mentor Xpedition

Freedom CAD is a premier PCB design service bureau with a talented team of 30+ dedicated designers providing complex layouts for our enviable list of high-tech customers. Tired of the commute? This is a work-from-home, full-time position with an opportunity for additional compensation for overtime work at time and a half.

### Key Qualifications

- EXPERT knowledge of Xpedition VX 2.x
- Passionate about your PCB design career
- Skilled at HDI technology
- Extensive experience with high-speed digital, RF, and flex and rigid-flex designs
- Experienced with signal integrity design constraints encompassing differential pairs, impedance control, high speed, EMI, and ESD
- Excellent team player who can lead projects and mentor others
- Self-motivated with the ability to work from home with minimal supervision
- Strong communication, interpersonal, analytical, and problem-solving skills
- Other design tool knowledge is considered a plus (Altium, Allegro, PADS)

### Primary Responsibilities

- Design project leader
- Lead highly complex layouts while ensuring quality, efficiency, and manufacturability
- Handle multiple tasks and provide work leadership to other designers through the distribution, coordination, and management of the assigned workload
- Ability to create from engineering inputs, board mechanical profiles, board fabrication stackups, detailed board fabrication drawings and packages, assembly drawings, assembly notes, etc.

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# Career Opportunities



Advanced Connectivity Solutions

## Senior Development Engineer

Rogers Corporation is seeking a senior development engineer accountable for the development of more complex products and processes, the establishment of sound technical bases for these developments, and effective interaction with technology, process, and platform innovation; operations; sales and marketing; and process engineering personnel to commercialize these developments.

### Essential Functions:

- Design and conduct experiments and interpret the results
- Report on projects in both written and verbal formats at all levels of the organization
- Perform technical troubleshooting of new products and processes; act as new product/concept incubator for new technologies and platforms, identifying opportunities for improvement and incorporation design for manufacturing requirements resulting in a viable, scalable product
- Provide ongoing process and manufacturing support to newly launched products as applicable
- Provide support in terms of analytical equipment maintenance, methods development, material analysis, and documentation of new process or products
- Manage capital projects for the purchase and installation of new process or support equipment; train employees in new processes

### Required Education and Experience:

Ph.D., Ch.E., M.E., or material science, or B.S. or higher in a technical discipline with accomplishment in product development and project management.

Rogers Corporation provides equal employment opportunities to minorities, females, veterans, and disabled individuals as well as other protected groups.

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## Gardien Is Hiring!

The Gardien Group, a leading solutions provider in the PCB industry, is looking to fill multiple openings in their China, Japan, Taiwan, and United States service centers.

We are looking for electrical engineers, operations managers, machine operators, and sales executives. Prior experience in the PCB industry is beneficial but not essential. Training will be provided along with excellent growth opportunities, a benefits package, and periodic bonuses.

Our global teams are from diverse cultures and work cohesively as a tight-knit unit. With performance and initiative, there are plenty of opportunities for professional growth.

Gardien is an equal opportunity employer. Employment decisions are made without any regard to race, color, religion, national or ethnic origin, gender, sexual orientation, age, disability, or other characteristics.

Interested candidates, please contact us with your resume and a cover letter. Kindly note that only shortlisted candidate will be contacted.

[Apply at careers@gardien.com.](mailto:careers@gardien.com)

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# Career Opportunities



## eptac

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### Become a Certified IPC Master Instructor

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

#### Qualifications and skills

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

#### Benefits

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

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### Technical Account Manager Chicago/Minneapolis

Insulectro, the largest national distributor of printed circuit board materials, is seeking a talented sales superstar for a Technical Account Manager role based out of either our Chicago or Minneapolis office. This role will focus on maintaining the existing customer base and developing new business within the assigned territory in both the printed circuit board and printed electronics industries. We are looking for the perfect fit of education, experience, and attitude that matches our company culture and enhances the service level to our customers.

#### Qualifications:

- A self-motivated business professional who is driven to succeed with a minimum of 3 years outside sales experience in the PCB or PE industry
- Proven sales/business development record
- Excellent communication and interpersonal skills
- OEM and electronic assembly experience is a plus

#### We offer:

- Competitive salary and commission plan with a comprehensive benefits package
- A fun, high-energy company with an entrepreneurial spirit
- A great group of people to work with!

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# Career Opportunities



## APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

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## Development Chemist Carson City, NV

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

### Essential Duties:

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

### Required Education/Experience:

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

### Working Conditions:

- Chemical laboratory environment
- Occasional weekend or overtime work
- Travel may be required

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# Career Opportunities



## Multiple Positions Available

The Indium Corporation believes that materials science changes the world. As leaders in the electronics assembly industry we are seeking thought leaders that are well-qualified to join our dynamic global team.

Indium Corporation offers a diverse range of career opportunities, including:

- Maintenance and skilled trades
- Engineering
- Marketing and sales
- Finance and accounting
- Machine operators and production
- Research and development
- Operations

For full job description and other immediate openings in a number of departments:

[www.indium.com/jobs](http://www.indium.com/jobs)

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## SMT Field Technician Huntingdon Valley, PA

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

### Duties and Responsibilities:

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

### Requirements and Qualifications:

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

### We Offer:

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

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# Career Opportunities



**U.S. CIRCUIT**

## Sales Representatives (Specific Territories)

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

- Florida
- Denver
- Washington
- Los Angeles

### Experience:

- Candidates must have previous PCB sales experience.

### Compensation:

- 7% commission

Contact Mike Fariba for more information.

[mfariba@uscircuit.com](mailto:mfariba@uscircuit.com)

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**ZENTECH**

## Zentech Manufacturing: Hiring Multiple Positions

Are you looking to excel in your career and grow professionally in a thriving business? Zentech, established in Baltimore, Maryland, in 1998, has proven to be one of the premier electronics contract manufacturers in the U.S.

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

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

Please email resume below.

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# Career Opportunities



**BLACKFOX**

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## IPC Master Instructor

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

For more information, click below.

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For information, please contact:  
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[barb@iconnect007.com](mailto:barb@iconnect007.com)  
+1 916.365.1727 (PACIFIC)

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**Meetings & Courses:**

January 23 – 28

**Conference & Exhibitions:**

January 26 – 28

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**IT'S THE  
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Come and collaborate  
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industry event everyone  
will be talking about.

**See you in San Diego at  
IPC APEX EXPO 2021!**

Thank you to all who have contributed  
to creating and supporting an excellent  
IPC APEX EXPO 2020 experience.





# Events Calendar

## WIN EURASIA (Electrotech) ▶

Tüyap Fair Convention and Congress Center  
March 12–15, 2020  
Istanbul, Turkey

## Electronica & Productronica China ▶

~~March 18–20, 2020~~ **POSTPONED**  
Shanghai, China

## Semicon China ▶

~~March 18–20, 2020~~ **POSTPONED**  
Shanghai, China

## LOPEC Exhibition and Conference ▶

March 24–26, 2020  
Munich, Germany

## SAMPE 2020 ▶

May 5–6, 2020  
Seattle, Washington

## SMTconnect ▶

May 5–7, 2020  
Nuremberg, Germany

## SEMICON Southeast Asia 2020 ▶

May 12–14  
Kuala Lumpur, Malaysia

## EMK Electronics Manufacturing Korea ▶

May 27–29, 2020  
Seoul, Korea

## NEPCON China 2020 ▶

June 17–19 (tentative new date)  
Shanghai, China

## International Microwave Symposium ▶

June 21–26, 2020  
Los Angeles, California

## Additional Event Calendars



## Coming Soon to *SMT007 Magazine*:

### APRIL 2020: Smart Factory Implementation (Part 2)

From planning to rollout, from investment to profitability, we continue our look at smart factory implementations.

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**SMT007**  
MAGAZINE

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## ADVERTISER INDEX

Aegis Software.....	9
Accutrace.....	37
American Standard Circuits.....	61
APCT.....	55
Blackfox Training Institute.....	77
Candor Industries.....	7
Cimetrix.....	27
CML Eurasia.....	11
Eagle Electronics.....	33
Electrolube.....	29
EPTAC.....	51
Fineline Global.....	47
Flexible Circuit Technologies.....	69
I-007e Micro Webinars.....	3
I-Connect007 eBooks.....	2, 59
Imagineering.....	39
Indium Corporation.....	35
IPC.....	93
Koh Young.....	41
Kyzen.....	63
LPKF.....	57
Manncorp.....	5
MEK, Marantz Electronics Ltd.....	45
Mentor, a Siemens Business.....	21
Miraco Inc.....	75
Mirtec.....	31
P Kay Metal.....	71
Pluritec (SMT).....	13
Prototron Circuits.....	79
Shin Yi PCB.....	25
SMTA.....	67
Sunstone Circuits.....	65
Technica USA.....	49
US Circuit.....	43
Zentech Manufacturing.....	17

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