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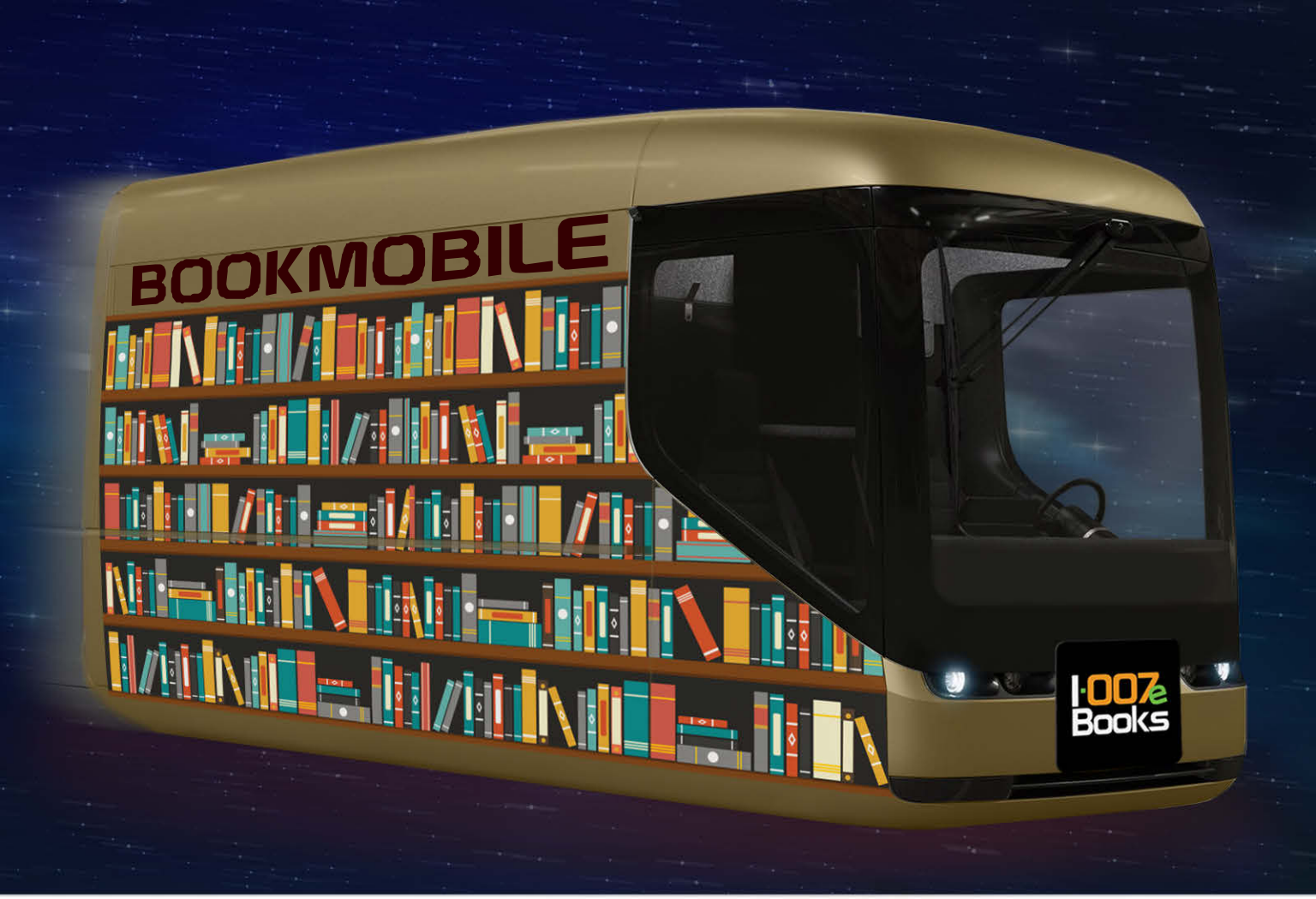
BUILDING THE SMART FACTORY SUPPLY LINE



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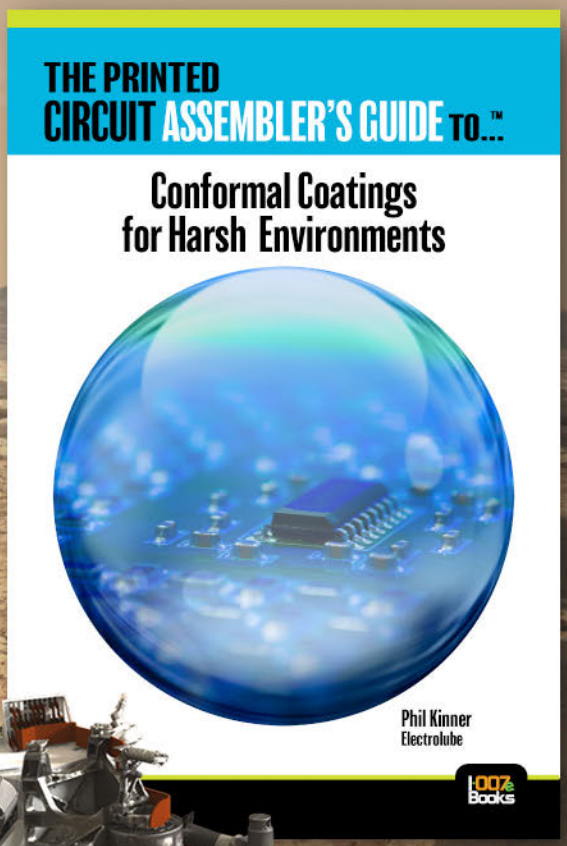

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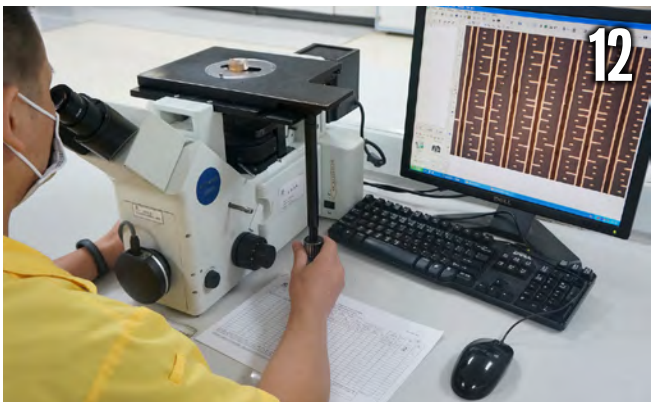
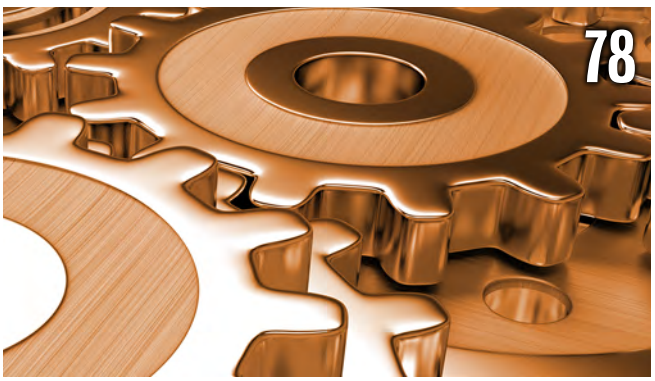
SMT007 MAGAZINE

Smart Factory Supply Line

We've been building automated factories for quite a while. However, the time has come for smart factories in our segment of the electronics industry. In this issue, we explore smart factories, the technologies required, and the shift in thinking that Industry 4.0 and smart factories will bring to our world.





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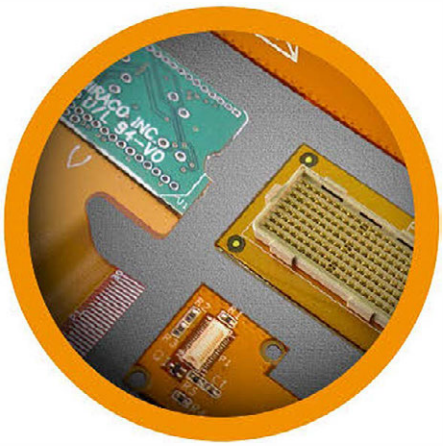

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Smart Factories: A Shift in Thinking

Nolan's Notes

by Nolan Johnson, I-CONNECT007

Happy Holden will tell you that smart factories are nothing new. And Happy should know; he helped develop the smart factories of the 1970s and 1980s at Hewlett-Packard. No surprise then that Happy is right: components that make up the smart factory foundation are not new, at least not at a basic technological level. Factory automation still uses PLCs, sensors, robotics, etc. But two things are quite different today:

1. Across the globe, governments and key industry players are striving for cleaner, greener factories for the sake of the environment
2. The 21st century allows for interconnected, multifaceted use of the data available through all these sensors and robotics

To Happy's point, smart factories have been around for 30 or 40 years; the interstate highway system has been around even longer. Yet it's the innovative and unanticipated use of both fundamental infrastructures through new and wider connectivity that changes, well, everything.

The technology that enables an automobile to drive itself is cutting edge, innovative, and a little scary to most of us who were born in the 20th century. Stop to consider, though, that these autonomous vehicles are being built to operate on the roads, streets, and freeways originally surveyed and constructed to accommodate a fraction of the cars they carry today—cars that relied on humans to be the operators and to perform the labor of driving. I'm sure that the civil engineers hired by President Eisenhower's administration to create the interstate highway system were not thinking about self-driving cars when they drafted their routes and cloverleafs. Still, today's innovators have shown we can build an autonomous vehicle (using well-established technologies such as radar, Lidar, and cellular connections) that will function on those original roadways.

With government pressure to increase sustainability, safety, and access—along with emerging supporting technologies like 5G connectivity and alternative powerplants, followed new vehicle usage models under development, such as shared vehicles—the time has come for the automotive industry to reshape itself and its products. The component pieces may be evolutionary, but together, they implement a revolutionary change in the use-model for our roadways and a fundamental shift in how we as a culture will think about automobiles.

Again, Happy is exactly right. We've been building automated factories for quite a while; we know we can. The time has come for smart factories in our industry. The time has come for our autonomous technology revolution. Governments are currently putting increasing pressure on factories to be sustainable and green. Mature,

(Image: Victory Giant Technology)

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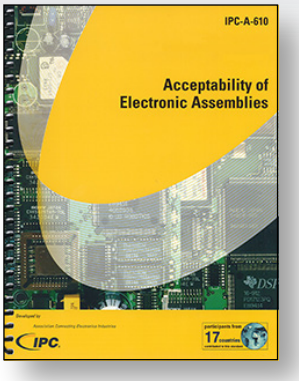

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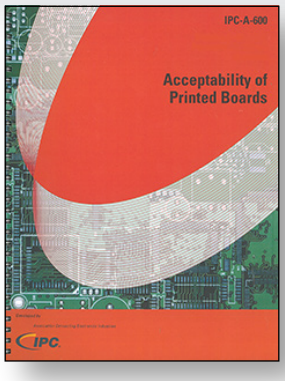

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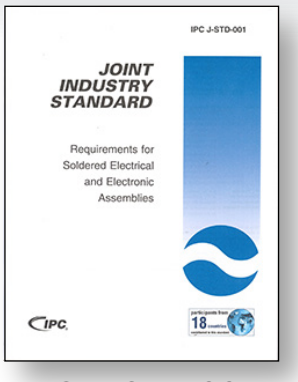

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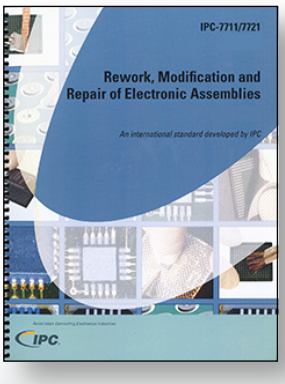

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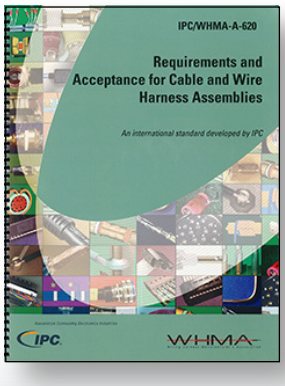

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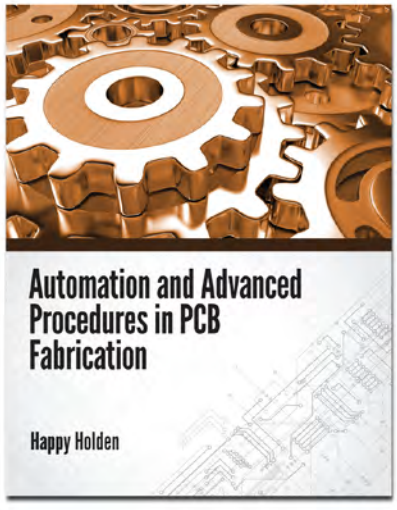
well-established technology for factory monitoring is being stitched together in new ways, benefiting from interconnects and a ubiquitous data communications network worldwide. It's the same monitoring, but it's no longer functioning as an island in the overall supply chain.

In this issue, we explore smart factories from a wider angle and a higher-level perspective. The focus isn't so much about the technologies being used, nor is it just about the machinery; instead, it concerns the shift in thinking that Industry 4.0 and smart factories will bring to our world.



For our first practical example, Barry Matties takes us on a tour of DSG, a China-based fabrication facility. DSG's recent performance shows that, done right, concentrating on smart factory fundamentals can be a big help to your business—not a hindrance.

Neil Sharp discusses four core electronic component packaging issues in "Improving the Efficiency of Your PCBA Production." Neil's points keep current processes streamlined and costs controlled, which are necessary best practices at any level of automation.

Our first feature, "Automation and the Smart Factory: Introduction to Industry 4.0" by Happy Holden, lays the philosophical groundwork for thinking in the smart factory future. Happy's working definition for automation includes some excerpts from his book *Automation and Advanced Procedures in PCB Fabrication*, which is also recommended reading for more on this topic.

At the CES Show in January, I met with Phoebe Francis, a representative for the Wireless Power Consortium (WPC). The WPC is at the center of standardizing wireless power systems across all industries. If you're familiar with Qi, then you know part of the WPC's work. Whether on the shop floor or in the end products built there, wireless power systems are on the increase—yet another point technology contributing to the smart factory revolution.

Then, Barry Matties brings us on a tour of Victory Giant Technology, a Chinese-based manufacturer implementing smart factory solutions as they transition from traditional manufacturing to automated systems, and from a half-billion in revenue to well over one billion.

Cybersecurity will be crucial to Industry 4.0 as factories interconnect across multiple locations and geographies. I Spoke with Anfield Group's Chris Humphreys about current cybersecurity concerns in the industry. This may be a spoiler, but cybersecurity cannot be an afterthought in your Industry 4.0 plans.

Happy Holden returns with "A Working Definition of Automation." Here, Happy delves into technical details on how to plan for your smart factory transition.

Happy Holden's "What Do You Know About Automation?" 10-question quiz will test your mastery of the technical details, protocols, and standards that serve as the connections and channels for moving smart factory data. See how you do!

In "How Smart is Your Factory?" columnist Eric Camden reminds us that working smart is not simply equipment and data capture. Careful attention to every detail in reducing contamination and handling damage must be considered.

Anchoring this issue, Bob Wettermann focuses on "Inspection of BGAs After Rework." In particular, Bob looks at IPC-A-610 and IPC-7095 for visual and X-ray inspection.

The I-Connect007 editorial team is always open to your suggestions for topics or feedback. If this issue caused you to rethink what you know about smart factories and the global transformation under way, let us know. You can reach us at editorial@iconnect007.com. **SMT007**

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

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Mauro Dallora, COO

DSG: Breaking Ground on the Smart Factory Revolution

Feature by Barry Matties
I-CONNECT007

Mauro Dallora leads the I-Connect007 team through the Dongguan Somacis Graphic (DSG) PCB Co. Ltd. facility in China, lays out the company's strategy for becoming an Industry 4.0 smart factory, and explains the current ongoing major expansion. Read about various topics in this factory tour and interview.

I-Connect007 first visited DSG about eight years ago. At that time, DSG was four years into taking on the challenge of building a PCB manufacturing factory from the ground up in Dongguan, China. As a joint venture between SOMACIS SpA and Graphic Plc, Mauro was charged to handle the enormous project, and he did just that.

Mr. Giovanni Tridenti, Mauro, and a few young guys arrived at the dirt lot in Dongguan with a suitcase, a checkbook, and a lot of ideas. Then, they got started. Two years and a million decisions later, the showcase factory was tooled with state-of-the-art equipment, well-thought-out systems, and an entire team of exclusively Chinese workers producing world-class PCBs.

At that time, most of the employees lived at the company's newly constructed on-site dormitories. Mauro was also responsible for training his team on not just the process of building a board but also how to take care of customers, the facility, and process equipment. Aside from all of that, he also had to build a cafeteria to feed and nourish the workforce properly. Again, this was from the ground up in a China that was very different from today.

China is a rapidly and ever-changing environment from business to social issues. It was not that many years back when a large segment of the population relied on bicycles as their primary mode of transport. Today, the

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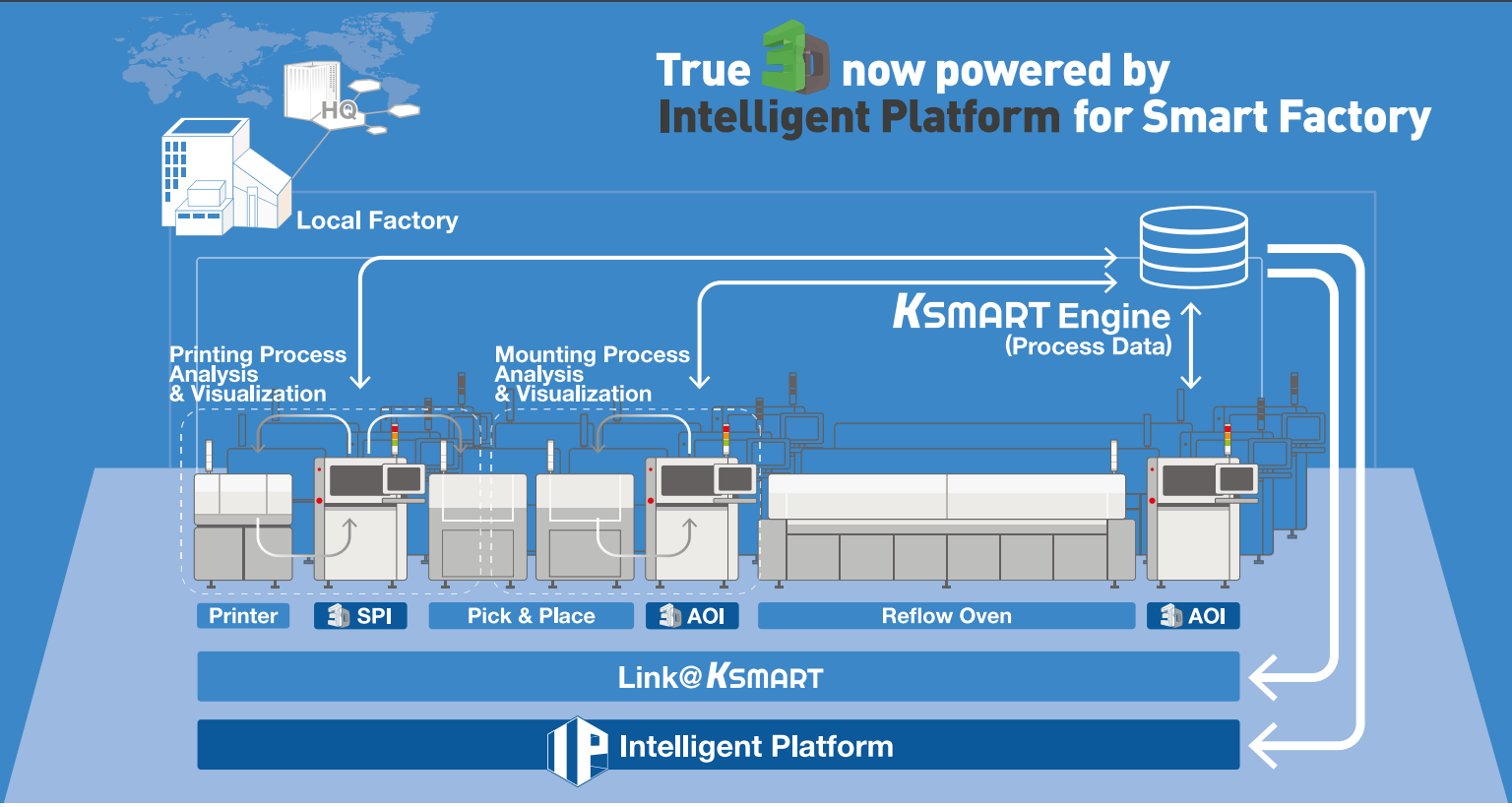

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roads are congested with private cars and ride services, and all are filled with people connected on their mobile devices. Not only are the roads congested, but factories are now faced with a new problem—parking. Since most factories were built before the boom in privately owned vehicles, allowing space for employee parking was not a consideration. In my recent visit to DSG in Dongguan, China, that's exactly what Mauro commented on:

Mauro: Look at the cars. When we started the facility, there were two cars—the company cars. Now, operators come in by car, and you can see the road is full of our employees' cars.

Barry: Parking space for cars isn't the only change facing Chinese companies; wage pressure is a growing and ever-present concern. What have wages been like over the past 13 years, and what sort of percentage increase has there been?

Mauro: Wages increased from 20–25% year to year. The labor cost is a big matter because you have to spend on recruitment and for them to go through the procedure including taking them to a hospital for examination. Then, before they can do any operation, they must take at least one month of training in the factory. It is a big investment.

Now, after 13 years of meeting all of the challenges with success, Mauro and the leadership of DSG recognize their factory will be less and less competitive if they do not make some serious changes. This is much more than updating a few pieces of equipment; it starts with the idea of becoming a leading 4.0 smart factory. The goal is to be a factory that will meet the needs of future technology and increase capability and yields while counteracting the demanding wage pressure and other rising costs faced in China.

To accomplish this new manufacturing model, Mauro is again leading this major project to retool and expand the entire factory. The plans have been made, the smart systems have been mapped out, new equipment has been ordered, and the ground has been broken.

As you would expect, the new digital smart factory will be managed in real time. Every item will be tracked and monitored throughout the entire process from planning to shipping. Automation will take over, and process operators will become a thing of the past. Incoming work will be uniquely marked so the machines will automatically adjust their parameters accordingly. All of this automation will be supported with high-level mechanization to keep it a hands-off process virtually from start finish. Mauro describes it this way:

Mauro: We are talking about a smart factory—Industry 4.0. Each piece of equipment will be able to read and record every single panel in real time. We will no longer manually record process by process; instead, every single board will have identifying marks, and everything

will be done automatically. We will have a central control room where we have access to all of the information, and we will have full traceability in real time for every single board not only for us but also for the customer.

Also, we have a commitment to double the size in revenue in five years. In South China, if you have a company that strategically fits with the region's growth plan, you get support from local government. If you're not strategic, forget Guangdong because the labor cost will be too high, fewer people are available to employ, and there are tough environmental regulations and social requirements. There's no way you can make clothes or garments here anymore.

Barry: Is the city looking at requiring more automation in factories as part of their strategy?

Mauro: When I presented the expansion plan to the authorities, they were very happy, but had one requirement—they didn't want more operators. Engineers were okay, but no more operators. Thus, automation is the only answer to grow. They have a vision. One important thing is if you are not a strategic company, you cannot stay here. We can stay here because we are a strategic company and are bringing technology that is strategic for China.

Barry: Creating a smart factory is not a simple task. There isn't an off-the-shelf plug-and-play software package. Everything is custom to your situation, and the level of attention to every detail is demanding. How is designing the new factory being handled? Do you have a team of engineers working on this project?

Mauro: For this new expansion, we had to develop a new department called the industrial engineering department. It's going to be a strategic department that requires strong competence in technical, equipment, and software matters. We have to look at the overall process from a 4.0 viewpoint, so people clearly understand how it's supposed to work with efficiency. They need to understand the integration between the process and human being, optimizing the working procedure to make the job easier with a focus on continuous improvement. It's important to eliminate procedures and operations that do not give added value to products. This requires strong attention to detail, which is big change for a non-4.0 factory.

Barry: But it's what the market demands.

Mauro: Yes. Without the change, we would be less competitive in two or three years. It's something that's a must and not negotiable. Our final target plan is to reduce manpower by approximately 40% and the factory lead time by 50%.

Barry: When do you expect this to be completed?

Mauro: To be practical, two to two and half years.

Barry: What sort of revenue gains do you expect to get out of all of this investment?

Mauro: Revenue-wise, it's designed to be more than twice.

Barry: What are your sales now?

Mauro: This year, this plant is around $70 million.

Barry: So you'll be $140ish?

Mauro: Correct, $150, more or less.

Barry: And with the same or fewer people?

Mauro: Much fewer people. We will have the same amount of first-line managers, and roughly the same amount of engineers—maybe a few more—but 40% fewer operators. The bigger labor cost is the first line of managers and engineers. We've retained all of the first line of management since the very beginning; we're doing quite good so far in that regard.

Not only will the new 4.0 thinking change the manufacturing but it will also carry over into the green strategy. The regulations for industrial waste streams in China are getting much tougher. In this next section, Mauro addresses how they are handling environmental regulations:

Mauro: We will recover between 80–90% of the water. With the same amount of water we are discharging now, we should be able to double the manufacturing capacity. We may even be able to decrease the water consumption level.

Barry: Is getting to 80% reduction suitable for the city?

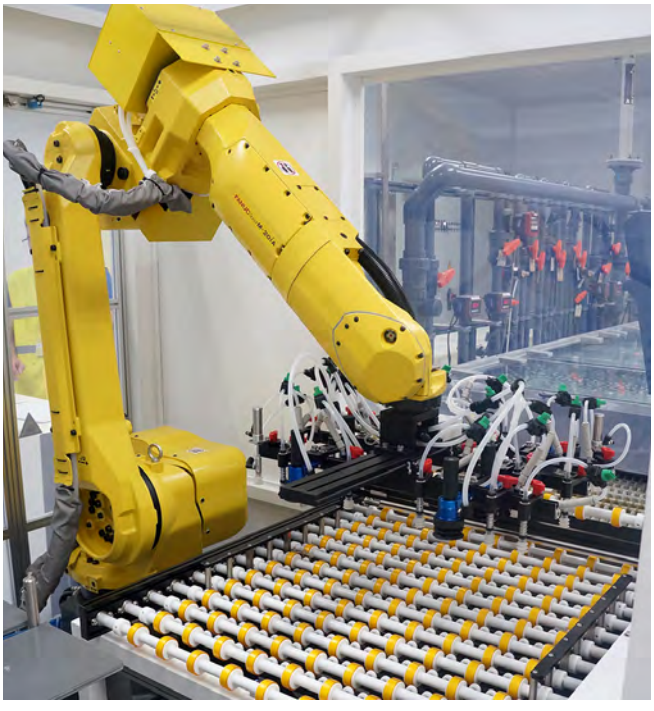
Mauro: They are asking for 60%. We have already achieved that. We also have the license for 70% because we achieved something closer to 70%. Reaching 90% is already a big challenge, and 100% is not really practical, to be honest.

Barry: Are the regulatory bodies taking it seriously?

Mauro: Yes. We have a live camera looking at the discharge, and automatic sample systems linked to the Dongguan Environmental Bureau. They push a button, and it takes samples at any time of the day.

Barry: So, you better pay attention. I imagine the penalties are quite severe.

With the new smart factory strategy, waste reduction plans, and lower total operating cost, DSG is poised to continue their strong leadership position in China offering a high-mix, low-volume (for China) manufacturing solution that is sure to give them a competitive advantage. With the new operations, Mauro discusses the shift in the types of employees who will be needed:



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Barry: More automation means fewer opportunities for employment. What do they think is going to happen to all of the operators from an employment point of view, and doesn't that create a whole new set of problems for China?

Mauro: You're talking about the first revolution of automation. Of course, it will have some impact on eliminating mainly operator jobs, but nobody knows what the final balance of job losses to 4.0 automation will be. However, it will have a big impact.

Barry: I would think that your front-end engineering would be one area that's going to grow a lot. With 4.0, it's all about the right data coming in to get the work to go through your smart factory. We hear so often that when orders come in, most of the files need work and are not correct. Is that what you experienced here?

Mauro: We have, which is why we have our DFM engineering team and system in place to avoid wasting time and costly mistakes when engaging with a new customer. We just provide them this DFM solution, which checks all of the parameters. Can we do this or that? Then, our strength is co-engineering because sometimes the customer is developing new designs or projects with us. Our technical engineers work very closely with our R&D customers. We have a large R&D department for developing new technology and communicating with our customers.

Barry: How willing are the customers to engage with you early in their projects?

Mauro: Some don't have a choice because they cannot find any capable manufacturing for the new project, so they choose to engage with us. Others are more reluctant or don't care much at the design stage. This is a pity because if you want to make a product efficient with good yields, you have to invest at the beginning in the design stage. However, not all the customers are ready to do that; they would d rather go around later and see supplier prices. We stress to our customer what we call co-engineering where we can offer this for free, just give us all the data. In 24 hours, we provide you advice on materials, and the design and size to make the product more manufacturable and have better yields.

Barry: With the data properly sorted out, the work will move through the 4.0 factory floor smoothly with very little human contact. The goal of any smart factory is to eliminate product and human contact 100%. This is still a difficult task for existing factories. Often, you're constrained by the building that you're already in.

Mauro: Yes, we are constrained too.

Barry: Are you looking at using AGVs in the factory to move work?

Mauro: Because we are going to optimize the layout to get the process closer to each other

and we're going to combine some process, this will minimize the utilization of AGVs.

Barry: So, it can just be a simple transport conveyor?

Mauro: Whenever possible because AGV implies a longer distance to travel. From my view, AGV is the last option. If you cannot have an optimized layout, then you go to AGVs. Even more important is automation; without extensive automation in place industry 4.0 is meaningless.

One key benefit of a smart factory is that it allows you to make process adjustments on the fly to improve yields and the overall quality. As a board goes through each step, the machines can automatically adjust based on real-time data it receives, allowing it to optimize each panel. This is a strong argument to build a factory that produces at a lot size of one. When we stepped into the impressive drill room at DSG, I asked Mauro if he planned to retool the multiple spindle drills with single-head drill machines. This was his response:

Mauro: No, we will use multiple heads.

Barry: But don't you get more flexibility with single-head drill machines?

Mauro: We are not planning for a lot size of one; our lot is mainly 40 panels. The cost difference between a single-head and a six-head drill machine is approximately 35–40%. The footprint is much bigger with a single head.

Barry: When you're doing a 4.0 factory, doesn't it make sense to consider building lot size of one because it gives you more flexibility?

Mauro: I still believe that we'll work out an algorithm, but as I said, our ideal lot size is around 40 panels—not one. When you say a lot size of one, it is very theoretical. When you go to practice and make the data analysis, you can see that the ideal lot is 40 panels.

Barry: I bring this up because after recently touring the new GreenSource Fabrication facility designed by Alex Stepinski, it's a smart factory designed to produce any panel at a lot size of one.

Mauro: If you are making prototypes, that could make sense.

Every company needs to tune their factory to meet their specific requirements. DSG is a high-mix, low-volume (again, for China) PCB manufacturer, and their smart factory will give them a lot of advantages. They produce a wide range of products that include demanding quality standards.

Barry: The product mix you're producing here includes high layer count, high-density work, and rigid-flex, correct?

Mauro: Yes. We're up to 26-layer rigid-flex dissipaters, which are complex boards; it's also challenging to manage them. High-end rigid-flex is a fast-growing demand for us, and a very good market. Of course, what is driving technologies is high frequency, high speed signal, signal integrity, special materials with low loss applications, embedded capacitors and resistors, tight registration, and heating dissipation. Cosmetic requirements are also an enormous challenge.

This year has been the best year ever for the company. We reached record sales. The group

strategy is very effective. The group has footprints in Europe (Graphic Plc, U.K., and SOMACIS SpA, Italy), the U.S. (SOMACIS Inc., Poway, California), and China.

Barry: What do you attribute your growth to?

Mauro: The two main group assets are technical capability and reliability, besides the group strategy mentioned before. We engaged with some important customers and markets. For some, the layer count is not very high, but they can squeeze all the complexity into a PCB in just a few square inches. It's highly complicated with high-frequency products, tight registration, and special materials. For these kind of products, we have been one of the few suppliers that can deliver reliable products. Another fast-growing market is automotive including antennas, radars, and other devices for automatic driving systems.

Barry: Are you seeing more and more Chinese nationals become customers?

Mauro: We have some big nationals that just came on board, and we are dealing with some big Chinese engineering labs. Chinese electronics are growing very fast. Also, we are dealing with multinational companies because that's where we started.

Barry: In terms of the way that DSG sells services, do you use a direct team or reps?

Mauro: We mostly make direct sales because of the products we make. We need to have direct contact with the customer's design, so it's mostly direct service; there are very few intermediates.

Barry: What advice would you give a customer that is looking to do business with a PCB shop in China?

Mauro: It depends on what customers are looking for. For certain customers, prices may be the main driver, but a customer like the ones we are working with now look at the reputation of the company and global organization. Start by asking, "Can we have global regional support?" Look at the capability and reliability. Consider the end market and use. For example, for automotive, reliability is key because they are making millions of cars and no components can fail. The risk to call back millions of cars is huge. The same is true for other markets like aerospace and medical. Besides that, to better evaluate the company, take a factory tour. Look at their bathrooms. Talk to people, understand the company culture and organization, and you'll get 80% of the information you need. Then, you can carry on with the audits and all of the paperwork, which must be done as a procedure.

Barry: But it's the details inside the company that you pay attention.

Mauro: Absolutely. Start from the toilets.

Barry: That's good advice because if they don't care enough to keep their bathrooms clean, they just don't care enough. I always say look at the hand tools too. If the tools aren't in good order at the operator's station, that says something.

Mauro: Yes, if things are messy, housekeeping is part of the organization.

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Barry: And it also reflects the quality of the product that they're going to build. What about suppliers? How do your consumable and laminate suppliers factor in?

Mauro: That's a big issue for us. We were talking this morning about lead times, but the big part about the longer lead times is the material availability. It is a complex issue because we can't stock a wide range of materials, so we cannot risk having millions of materials in stock with short shelf lives. For high-speed or low-loss requirements you have to rely on Japanese or U.S. suppliers, and some local suppliers. Material delivery times are sometimes longer than the manufacturing time.

Barry: It's a big problem globally. How do you manage your supply chain? Do you have a team in place that looks at the forecast?

Mauro: First, forecast is a nice word, but customers are reluctant to give forecasts not because they're bad people, but because they don't have that visibility. It's a blind game.

Barry: Without visibility, how do you know?

Mauro: When they get visibility, they are also short-term requirements. The timetable to deliver the product is very short, so there is pressure on the supply chain. The pressure is coming to us, and we have to be reactive, fast, and efficient in customer service on the front end. But if you don't have the material, you don't have the material. We also tell the customer, "Whenever you have some forecast in place, we'll buy the material in advance, and 90% of the problem is solved." Visibility is short and difficult to forecast.

Barry: It's tough to make delivery commitments to your customers with such an unpredictable supply chain.

Mauro: And when we commit to delivery, the material might arrive late, but our customers don't care as long as their boards are on time. When delivery is critical, it's much more complicated because you have the CM in the middle. So, you have the communication from the OEM to the CM to us. It doesn't make the process easier because someone at the end has to be responsible for the forecasting, and the CM wants the OEM to be responsible for the forecast.

Barry: And they're not going to change the material with the snap of a finger because of approval cycles and quality.

Mauro: Talking about automotive or aerospace, forget it. Customers are reluctant to any change

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because it's a risk. To change something is to take some risk. To qualify a different process, even if it's better, takes time in this space.

Barry: So, the big demand is on material suppliers to add capacity or flexibility to deliver quicker.

Mauro: It's the only way to cut their logistics; be as close as possible to the customers, and designed for high mix, low-volume manufacturing. A fast-reacting attitude is also mandatory.

Barry: I know there are a few suppliers that are taking that approach, and more are sure to follow. You have been living in China and working with the Chinese for the last 13 years, so you've learned a lot and witnessed firsthand the social transformation of culture and wealth.

Mauro: The transformation was unbelievable. What took place in China as far as economic and social changes go has been absolutely phenomenal. If we talk about Western countries or continents, the big changes occurred after World War II from 1945 to 1970. Much bigger changes happened in China in just a decade boosted by the available technology and globalization opportunities.

Barry: And it's really in the last six or seven years that we've seen it accelerated here in China.

Mauro: Yes. I have a picture on my phone. A moving street shop on wheels was selling food and beverages by the river promenade—typical Chinese stuff. From the back of this handmade three-wheel vehicle, you can see an automatic payment device with a quad code for mobile phone payments. I went to the shop to buy some toothpaste, and two people were before me around the age of around 50. No one paid cash. I was the only one with cash.

Barry: They have really embraced digital currency. I tried to buy some local roadside fruit stand with cash, but they wouldn't accept it; they turned down the sale.

Mauro: Fewer people are using the taxis. Everybody is calling DiDi (a ride-sharing service). In a few minutes, the DiDi will come, you've already paid by mobile phone, you see the car coming on your device, and off you go. Until recently, this technology was not available.

Barry: Not long ago, most of these people were riding bicycles. Now, the movement to electric vehicles (EVs) or neighborhood electric vehicles (NEVs) is accelerating. It is reported that China is the largest market for plug-ins. For the 2018 NEV passenger car, sales through June were three times higher than in the U.S.

Mauro: There are big incentives for electric cars. In China, the big difference from the other continents is the country is already planning 10 years out. China already has a long-term plan and is buying strategic resources globally.

Barry: China is really driving change at a rate that people don't realize unless you've been here and witnessed it. Otherwise, you have no real understanding of how fast things are evolving.

Mauro: They built train transportation that runs from China close to my village in northern Italy. I'm not joking. Now, you can send goods from my village in Italy by train in two to three weeks, and goods can be brought from Guangdong to Europe by train in that amount of time. It's much more effective than ships. In a few years, it will be a high-speed train.

Barry: DSG has been here since 2005, and you built this factory from an empty lot all the way up. From those 13 years, what's your major takeaway from all of this?

Mauro: I've learned many lessons. First, it has been interesting to be in China in the last decade. China is maybe the fastest growing country in worldwide history, so has been a big experience. We have to keep up with this growth and move as fast as the economy and environment. Also, the change in people from 10 years ago is completely different. It's another world. Now, we are more similar to and social like Western countries, the new generation of Chinese are less keen on working in manufacturing than they were in the past.

The other thing that was interesting because the technology was growing very fast is overall industrial setup is changing quickly too. Right now, it's really challenging. We are making a huge $50 million investment to stay in the market and be competitive, which is a big change. A smart factory is an unbelievable change because it is not just a technical change but also a culture change; it's challenging. This is what the experience has been for me, and it has been interesting playing this game 13,000 kilometers from my hometown and country in a completely different culture.

Barry: Extremely different. Well, congratulations. It has been a huge success, and it looks like you're on a great path with 4.0—a challenging path because there was not a blueprint already made for you, so you have to create this for yourself.

Mauro: You're right. We all have to develop the roads of our own path because when you open that box, you can start and do many things. You have never-ending opportunities with Industry 4.0. It's the first step toward another important industrial revolution in a preparation for the second one, which will be much more critical. We are talking of the quantum computer era, from digital to quantum technology. When that happens, the decisions will move from human beings to a globally connected entity with unlimited access to information which will have much better and faster decision-making capabilities. The world will be very different at that time from the one we are experiencing now.

Barry: You talked about retiring.

Mauro: I am already retired. This is my retirement for the time being.

Barry: Thank you for your time, Mauro.

Mauro: Thank you. SMT007

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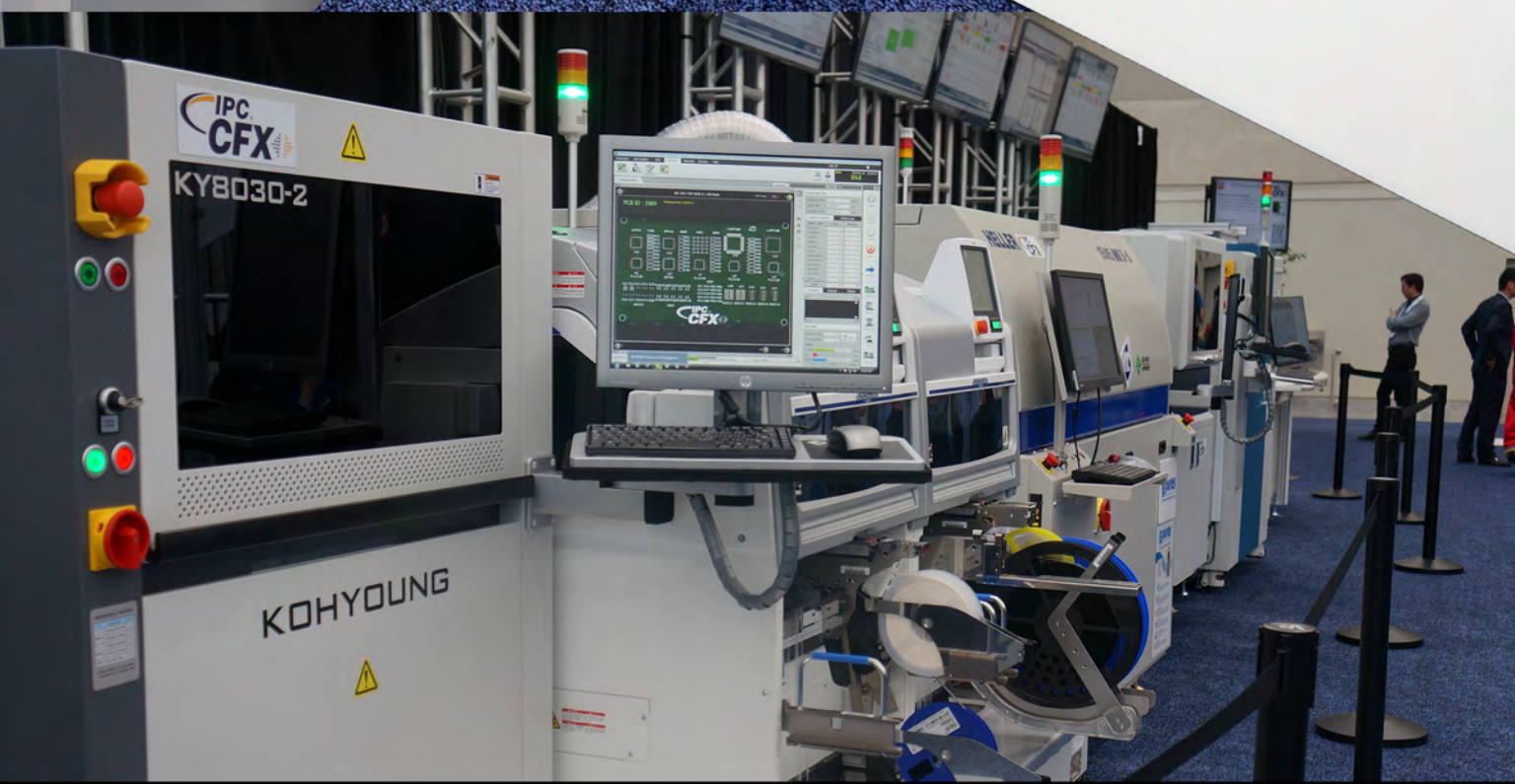

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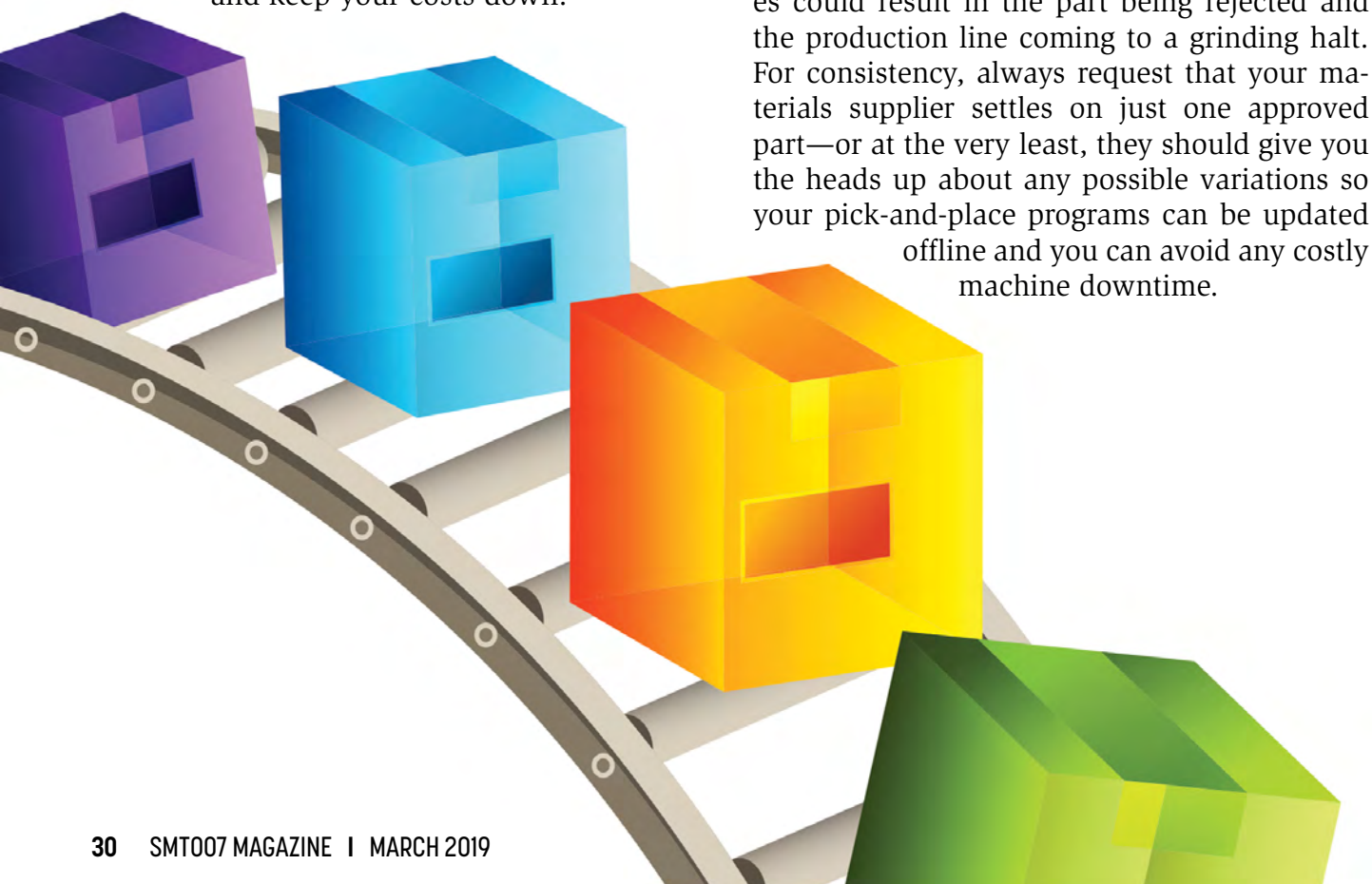
Improving the Efficiency of Your PCBA Production

Article by Neil Sharp
JJS MANUFACTURING

Ensuring you're hitting your build times is always a major priority in surface mount production. The challenge for many original equipment manufacturers (OEMs), however, is that the processes involved with printed circuit board assembly (PCBA) can be numerous and complex. And the smallest of details can make the biggest of differences.

In this article, we explore four core electronic component packaging issues that will help you streamline production, meet your targets, and keep your costs down.



1. Keep Component Variations to a Minimum

It's not uncommon to find that a design engineer has listed several similar components against the same board reference when specifying the bill of materials (BOMs). While this element of choice might be offered with the best intentions, it can prove a challenge as the parts that are supplied by different manufacturers can potentially vary in size and shape.

Surface mount pick-and-place programs are often set up against one specific part. Any deviations outside of the expected tolerances could result in the part being rejected and the production line coming to a grinding halt. For consistency, always request that your materials supplier settles on just one approved part—or at the very least, they should give you the heads up about any possible variations so your pick-and-place programs can be updated offline and you can avoid any costly machine downtime.

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2. Opt for the Most Efficient Packaging

The format in which devices are supplied can vary widely—especially when it comes to integrated circuits (ICs). Typical IC packaging methods can include waffle trays, tubes, and reels—each of which are often differentiated by a specific letter or number at the end of the part number.

If you're aiming for optimum efficiency, then taped and reeled parts are preferable as the use of tubed components relies on having operators on hand to change the parts over as the tubes become empty, which can delay the manufacturing process. There are, of course, certain situations where requesting taped and reeled parts simply may not be viable such as in the case of new product introductions (NPIs) where batch sizes are typically smaller. In those situations, it probably won't make commercial sense to purchase a larger quantity of device just so you can receive it in a taped and reeled format.

A poor-quality seal increases the risk of the cover tape dislodging, which can mean components could become damaged or lost.

If you do decide to change a part from being in tubed packaging to tape and reel, you will also want to make sure that the quality of the seal on the cover tape is sufficient. A poor-quality seal increases the risk of the cover tape dislodging, which can mean components could become damaged or lost.

3. Avoid Splicing Components

Sometimes, a combination of smaller amounts of taped and reeled components may need to be spliced together to create one larger, continuous strip. But if this splicing is poorly executed, there is an increased chance that the tape could become stuck in the surface mount machine feeders. And if the cover tape pulls away from the carrier tape, then you will be left with a jammed machine that will need to be resolved by an operator, leading to costly downtime.

4. Plan for Things to Not Always Go to Plan

Inherent within the manufacturing process is the knowledge that things occasionally don't go quite as expected. If a surface mount machine misplaces, drops, or damages a component, and you don't have more of that component in stock, then you're likely to be left with two tough choices. You can opt to carry on with the SMT build regardless and fit the part by hand once it arrives, or you can halt the job while you order (and wait for) the replacement part. The reality is that neither option is especially ideal. Fitting parts by hand can affect quality, increase the risk of damage, and impact your lead times. Meanwhile, opting to halt the job means your machines are sitting idle and costing you money.

Building attrition into your kit of parts may cost you a small amount at the outset, but it can potentially save you hundreds of pounds in additional rework. So, whenever possible, make sure you request a few more of each component than you actually think you're going to need. The smallest of details can have a massive impact on the efficiency of your PCBA production. By having a program in place to continually monitor and refine your processes, you will be able to identify and eliminate what is not working, retain a firm hand on quality, and boost your profitability. **SMT007**

Neil Sharp is the director of marketing for JJS Manufacturing.

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Automation and the Smart Factory: Introduction to Industry 4.0

Feature by Happy Holden
I-CONNECT007

Editor's Note: Parts of this article include excerpts from and expansions of *Automation and Advanced Procedures in PCB Fabrication.*

There's a lot of talk about automation, but I find that there is very little available on automation planning. This is one of my specialties. I started by studying for an MSEE in control theory, which went well with my bachelor's degree in chemical engineering because I specialized in process control and IC manufacturing.

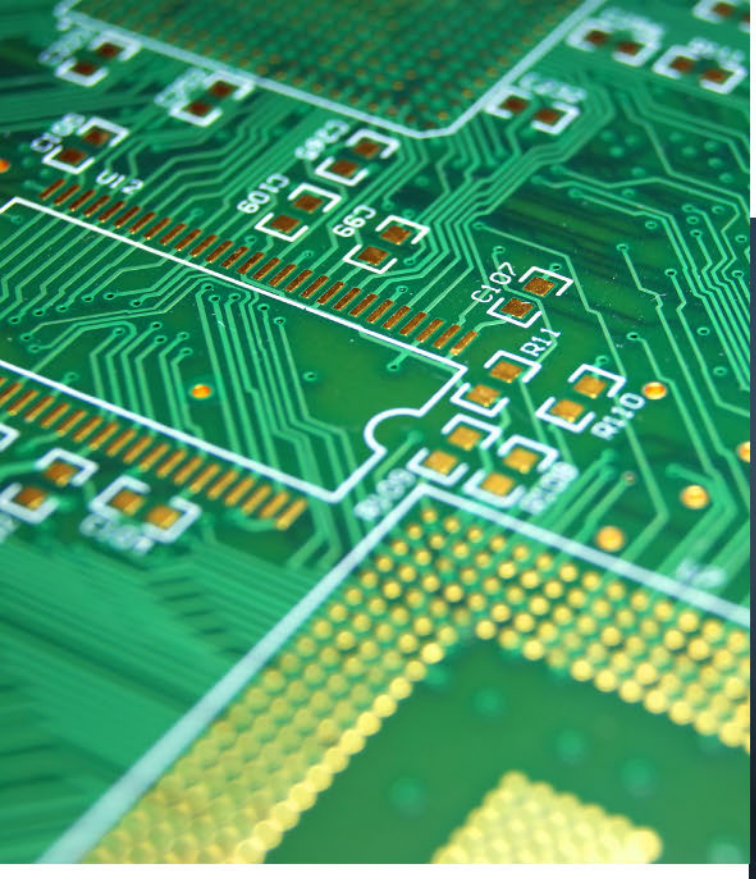
Before we get started, remember that the benefits will be derived only if certain cardinal principles are observed. This article briefly outlines the background of computer-integrated manufacturing (CIM) and its evolution to Industry 4.0 and smart factories.

The characteristics of successful automation application in manufacturing depend on how well business and technical management understand and promote the strategies, tactics, and philosophies used in modern manufacturing. Successful automation implementation can be enhanced in any company, small or large, by reviewing the philosophies of CIM, automation, management roles, mechanization, SPC, TQC, Lean, MRP, and DFM.

Computer-integrated Manufacturing (CIM)

The strategies outlined here are considered CIM, but the current vocabulary now is "Industry 4.0" or "smart factories." Products include various software, computer, networking, interface, and measurement systems. At that time, HP had been in the automation business longer than any other company. It all started with requests from the government and others for automated test and measurement systems. Because of the need to automate various measurement instruments and systems, HP created the first machine-to-machine, plug-and-play protocol called HP Interface Bus (HP-IB). This was later formalized into the IEEE-488 communication standard.

CIM architecture was defined as early as 1980 when the CASA/SME published a presen-



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tation of computer-integrated manufacturing to provide a common set of terms for its members. The ring surrounding the wheel represents various influencing factors for the development of CIM such as expertise as a human factor, productivity as an economic factor, and computer technology as a technological factor.

The wheel itself contains four functions, including engineering design, manufacturing planning, production control, and factory automation (Figure 1). If the individual functions are connected to each other and operate with a common database, an integrated system architecture is created and represented by the hub of the wheel. This development has resulted in the realization that CIM, apart from factory automation and functions, is indirectly related to the operational performance, such as design (product/process), and production planning and control.

Additionally, CIM is linked to common business administrative tasks such as manufacturing management, strategic planning, finance, marketing, and human resource management. A further innovation was the addition of information resource management and communications between the different functions. Therefore, a common database alone is insufficient for achieving integration. The all-embracing nature of the CIM wheel reflects the idea promoted by CASA/SME that CIM must be viewed as a concept embracing the company as a whole.

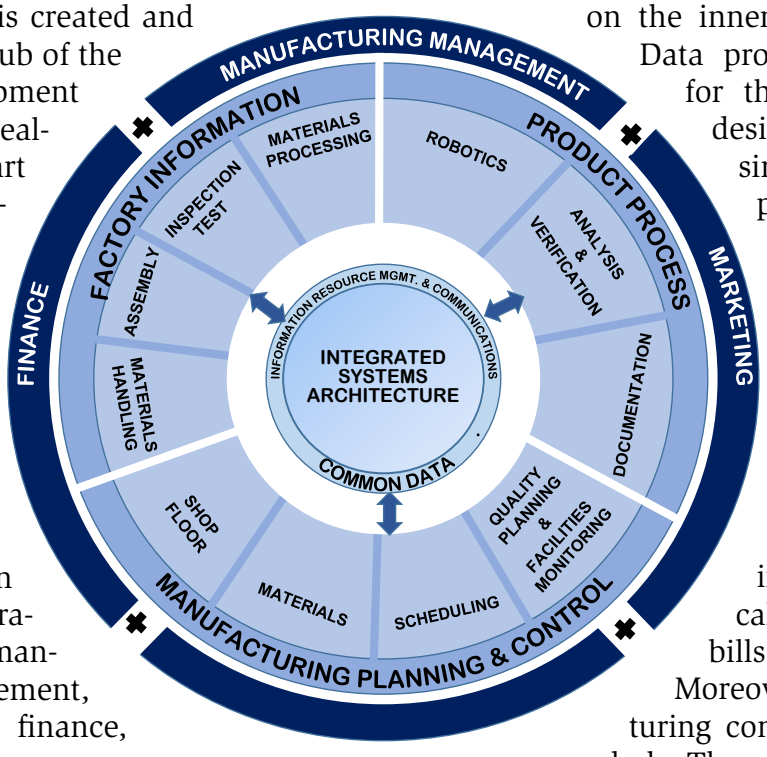

Figure 1: The CIM wheel defined by CASA/SME.

The Outer Ring

The common business administrative tasks related to CIM are located on the outer ring of the wheel. They primarily form the company's connection to the outside world. Data processing applications can be found in the most diverse areas. Most software systems applied in these areas were originally self-styled developments, which are increasingly being replaced with standard commercial software packages. Currently, this software is installed primarily on mainframes. Overlaps of its functionality exist mainly with the software of the production planning and control.

The Inner Ring

Functions related to the operational performance of the company are located on the inner ring of the wheel. Data processing applications for the development and design area are CAD simulations; analysis programs, such as the finite element method (FEM); and drawing storage and management, such as group technology (GT).

The types of data found in this area are diverse, including drawings, technical specifications, and bills of materials (BOMs). Moreover, data in manufacturing companies is often disorderly. There may be several types of part numbers and BOMs, or more than one GT or CAD system, each with its own computer internal representation of geometric data. The applied software rarely runs on the same hardware, resulting in many different hardware systems.

The second group of applications on the inner ring of the wheel is attributed to process planning, production planning, and control. It comprises tasks—such as routing generation, resource planning, material requirements planning, capacity planning, order distribution, supervision—and planning of quality assurance—such as quality process and resource planning. In the United States, software in the

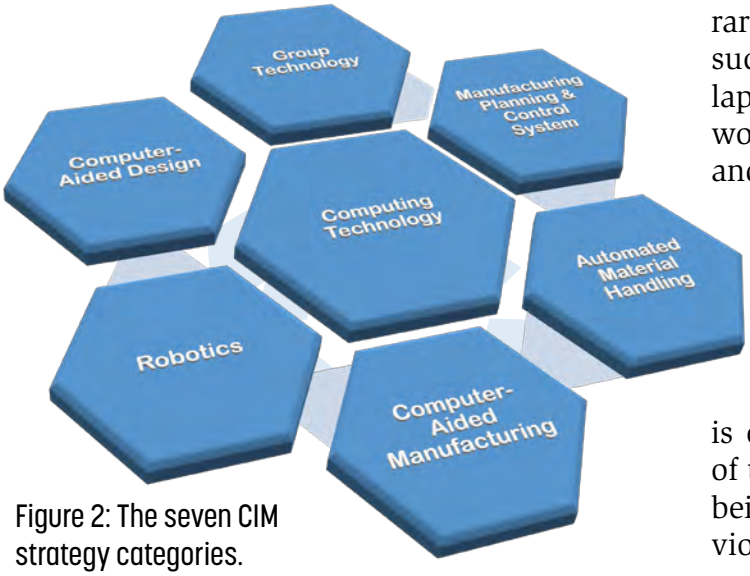

Figure 2: The seven CIM strategy categories.

production planning and control area mostly runs on large clients or servers, although the software itself is more frequently supplied by several software houses and not by the computer vendor.

As in the common business administrative area, the software packages, which are integrated within themselves, have a modular structure and their single components can also be bought and applied. Therefore, a company rarely purchases and installs all modules of such a package. This results in functional overlaps and data redundancy. One example of this would be material requirements, and planning and purchasing systems.

The third group on the inner ring includes the automation of manufacturing installations. Examples include robots, numerically controlled machines, flexible manufacturing systems, and computer-aided measuring and testing methods. This area is characterized by the extreme heterogeneity of the systems involved, the diversity of which being much more pronounced than in the previously mentioned groups of functions. These seven CIM strategies are shown in Figure 2, and Figure 3 shows the CIM hierarchy.

The Hub

These statements have shown that there are serious impediments to integration within these groups of applications. Few suppliers cover all three sectors. Therefore, suppliers have done little to nothing about interfaces, not to mention the integration of various groups of applications. Information and communication management, represented by the hub of the wheel which links everything, is intended to serve as the information management and communication control function between the single areas. It operates on a common, integrated database.

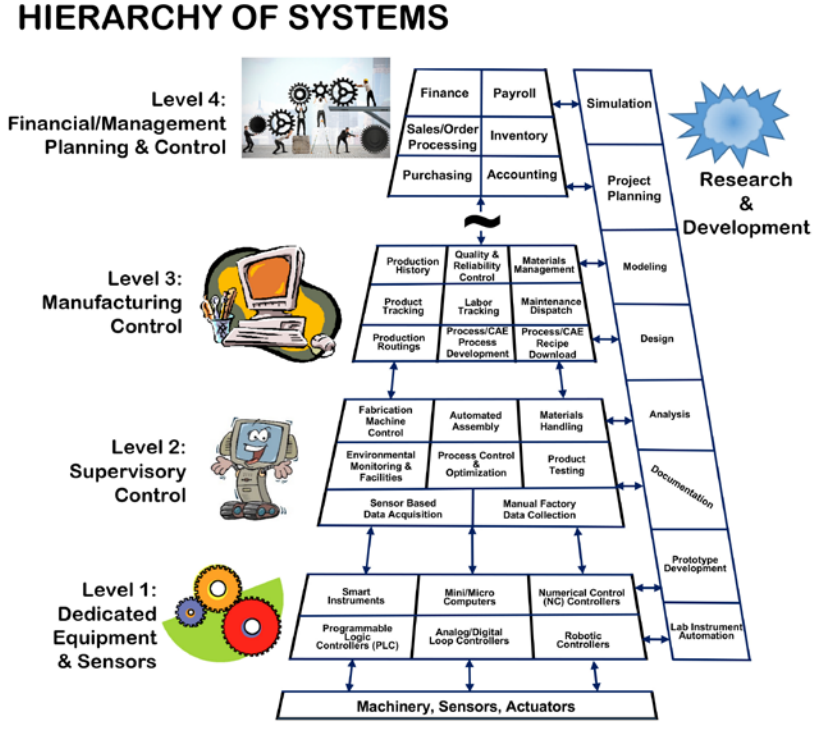

Figure 3: The CIM hierarchy of activities.

Key Challenges

There are three major challenges to developing a smooth-operating computer-integrated manufacturing system:

1. Integration of Components From Different Suppliers

Problems may arise when different machines, such as computer numerically controlled (CNC) conveyors, and robots use different communication protocols. In the case of automated guided ve-

hicles (AGVs), even differing lengths of time for charging the batteries may cause problems.

2. Data Integrity

The higher the degree of automation, the more critical the integrity of the data used to control the machines will be (Figure 3). While the CIM system saves on the labor of operating the machines, it requires extra human labor to ensure there are proper safeguards for the data signals that are used to control the machines.

3. Process Control

Computers may be used to assist the human operators at a manufacturing facility, but there must always be a competent engineer on hand to handle circumstances unforeseen by the control software designers.

CIM Subsystems

A CIM system is not the same as a lights-out factory, which would run completely independently of human intervention, although it is a big step in that direction. Part of the system involves flexible manufacturing, where the factory can be quickly modified to produce different products, or where the volume of products can be changed quickly with the aid of computers (Figure 4).

CIM Architecture for Manufacturing

Standards for computer interfacing and control are available for each industry. Some are designed specifically for automation, electronics manufacturing, fabrication, and assembly.

Automation

Two truisms are becoming increasingly apparent in industry:

1. Technology is rapidly advancing and leading to more complex products
2. More and more nations are awaiting advancing technology, resulting in a competition requiring an increased focus on product cost and quality

In a model developed for PCB fabrication, a new and important variable, the complexity factor (C), has been increasing steadily since the 1980s at an order of magnitude every 13 years [1].

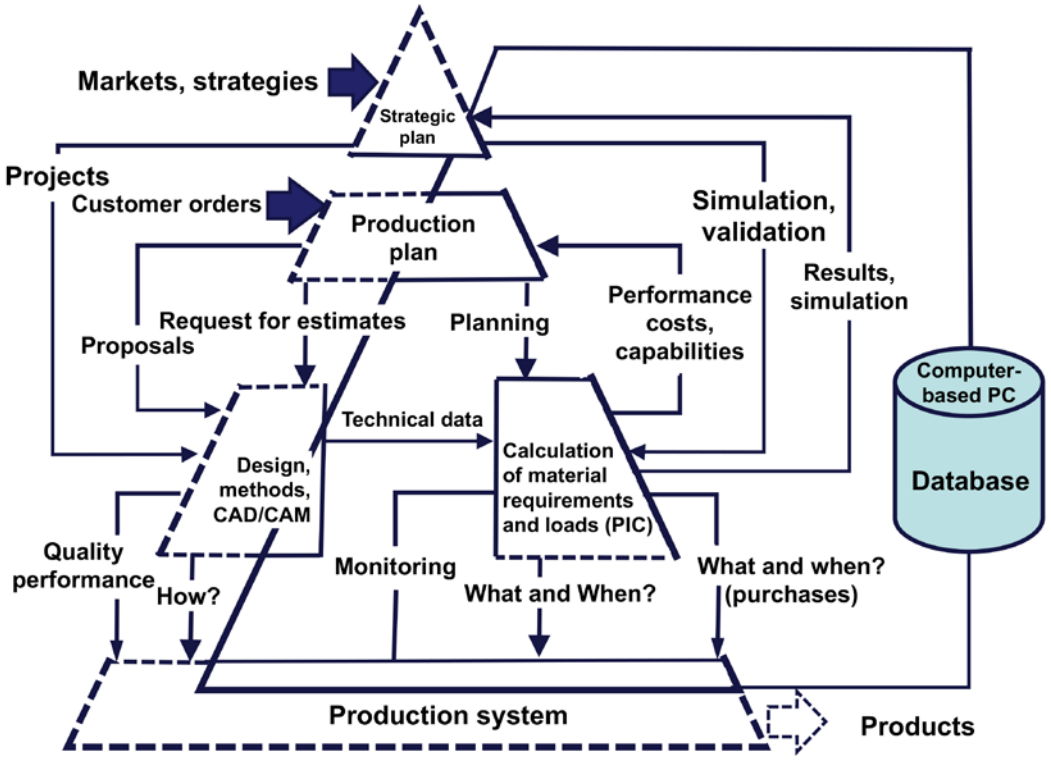

Figure 4: The CIM hierarchy of related/critical systems.

Automation is a strategic tool for controlling, managing, and directing a productive process by automatic means. It is usually complemented by product and technological innovations. As an engineering discipline, automation can be accurately planned and is mostly arithmetic, not propaganda. The chief ingredients in automation are adequate know-how and common sense.

There are numerous business and global factors behind the automation movement, but these are four that we're primarily concerned with:

1. Global competitive pressures
2. Growing complexity of product and working situations
3. Changing skill availability and job expectations
4. Technology availability and its costs

What has not been clear to management is that automation is mainly an approach to a company's future business strategy. Management's response to automation has usually been fragmented and reactive with numerous requests for new machinery, such as using more computers, and new processes and procedures. As a result, overlapping and excessive investment requests accompanied by additional staff too often of lead to inefficient or incompatible fabrication systems.

It is the role of integrated process planning, control, and monitoring as part of system management (Figure 5) to create the coordination of the CIM software architecture for manufacturing. The biggest challenge is the complete digitization of the product. As seen in Figure 6, the CAD systems must deliver more than just preliminary artwork and CNC files, but rather a complete recipe

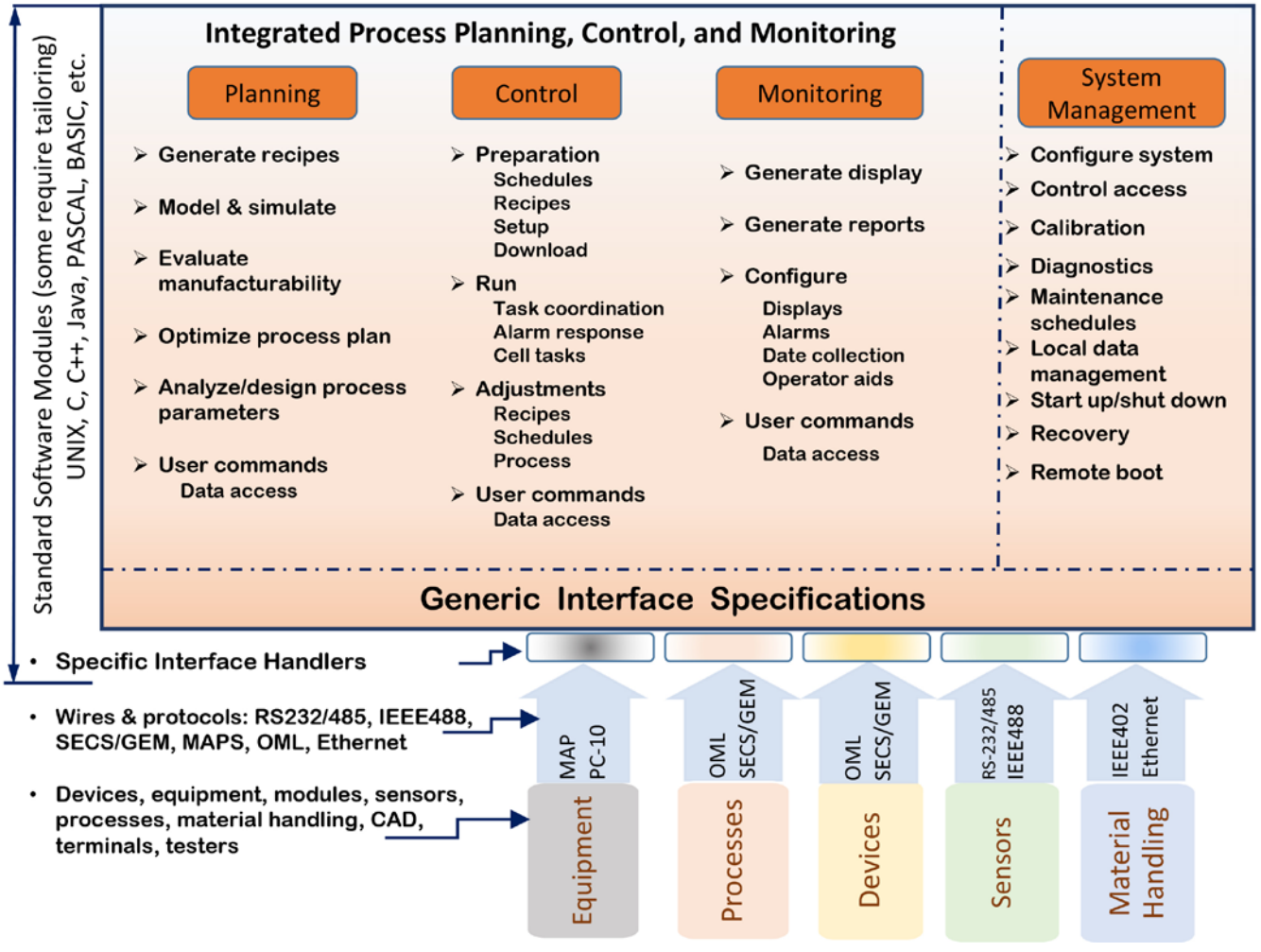

Figure 5: The automation software for manufacturing will be the same whether it is a CIM strategy or smart factory strategy.

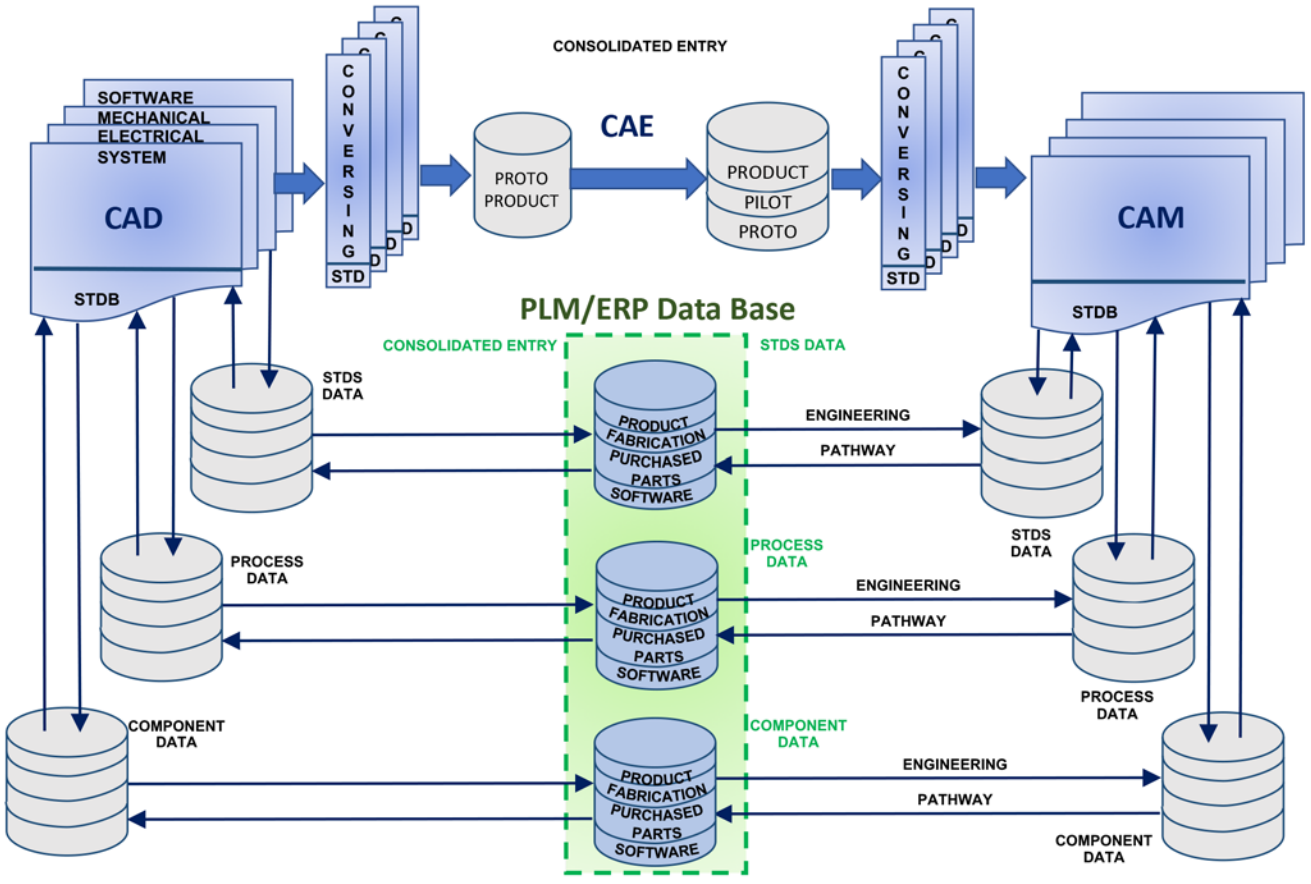

Figure 6: The smart factory/CIM hierarchy of functions for the information flow for CAD/CAE/CAM through PLM/ERP.

for the creation of the product—in this case, a tested PCB with a BOM and tested assembly.

CAD/CAE/CAM Design Hold the Keys

To have a smart factory, the automation systems must have knowledge of the product, its materials, and a complete recipe for how it is manufactured. The industry standard EDA companies are not accustomed to how a product is made or of the many indirect materials used in manufacturing. Thus, it will be a long time before their CAD tools can describe and provide all the digital data required for a smart factory's use, if ever!

The complete digitization of all relevant data of how a product will be made will probably come about through the customization of current or new CAM software supplied by software vendors that support a particular industry. Figures 5 shows the hypothetical information flows from CAD/CAE systems to the newer CAM systems so that enough data is present to power a smart factory.

The needed consolidated information will be:

- Relevant standards, inspection, and quality data
- Process and manufacturing data of the product for the CAM system
- Component and part information for manufacturing and assembly

Additional required manufacturing and assembly data and recipes are added at the CAM software and by the product PLM systems, so that smart factories now have all of the information required to build the product.

Smart Factory 1.0 and Industry 4.0

Today, lights-out factories and Industry 4.0 initiatives are the norms to integrate all of the islands of automation we have acquired over the years (Figure 7). This progress comes as a result of the automotive industry's application

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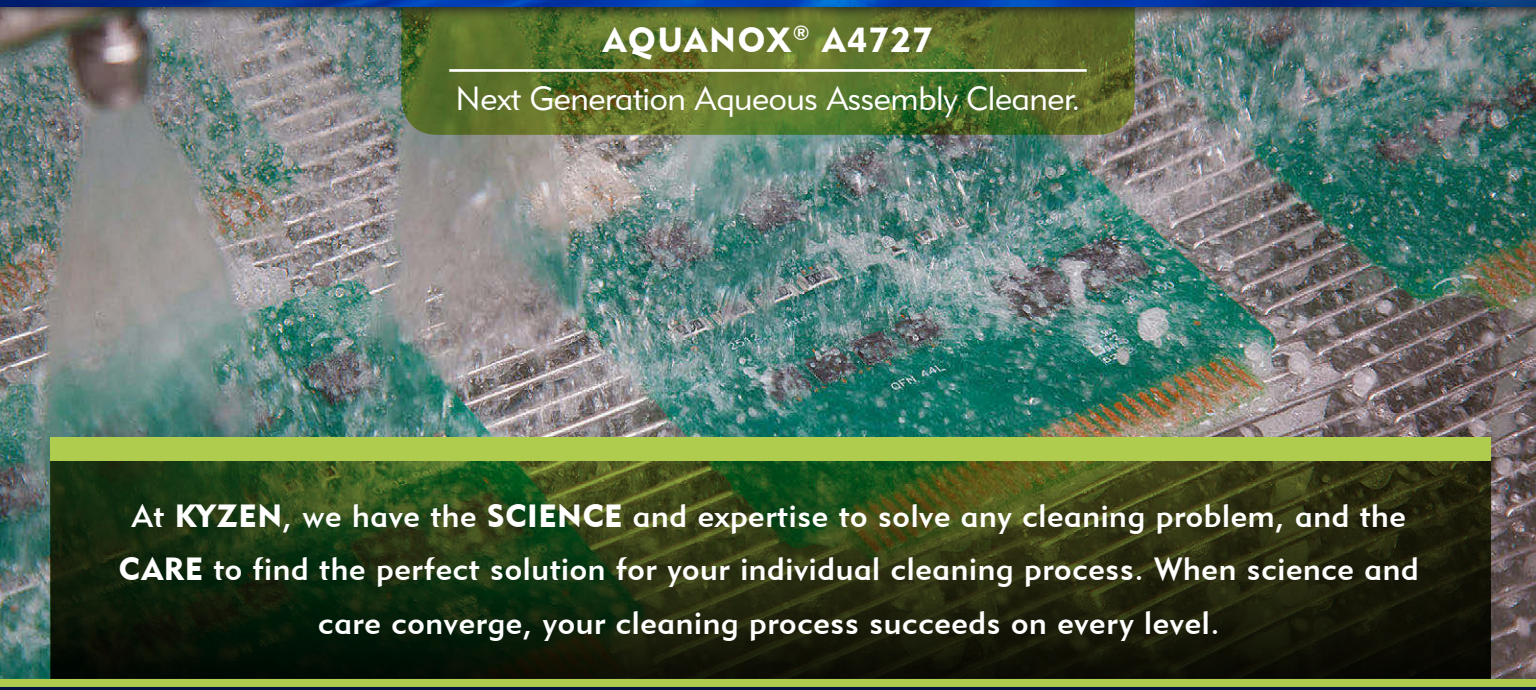

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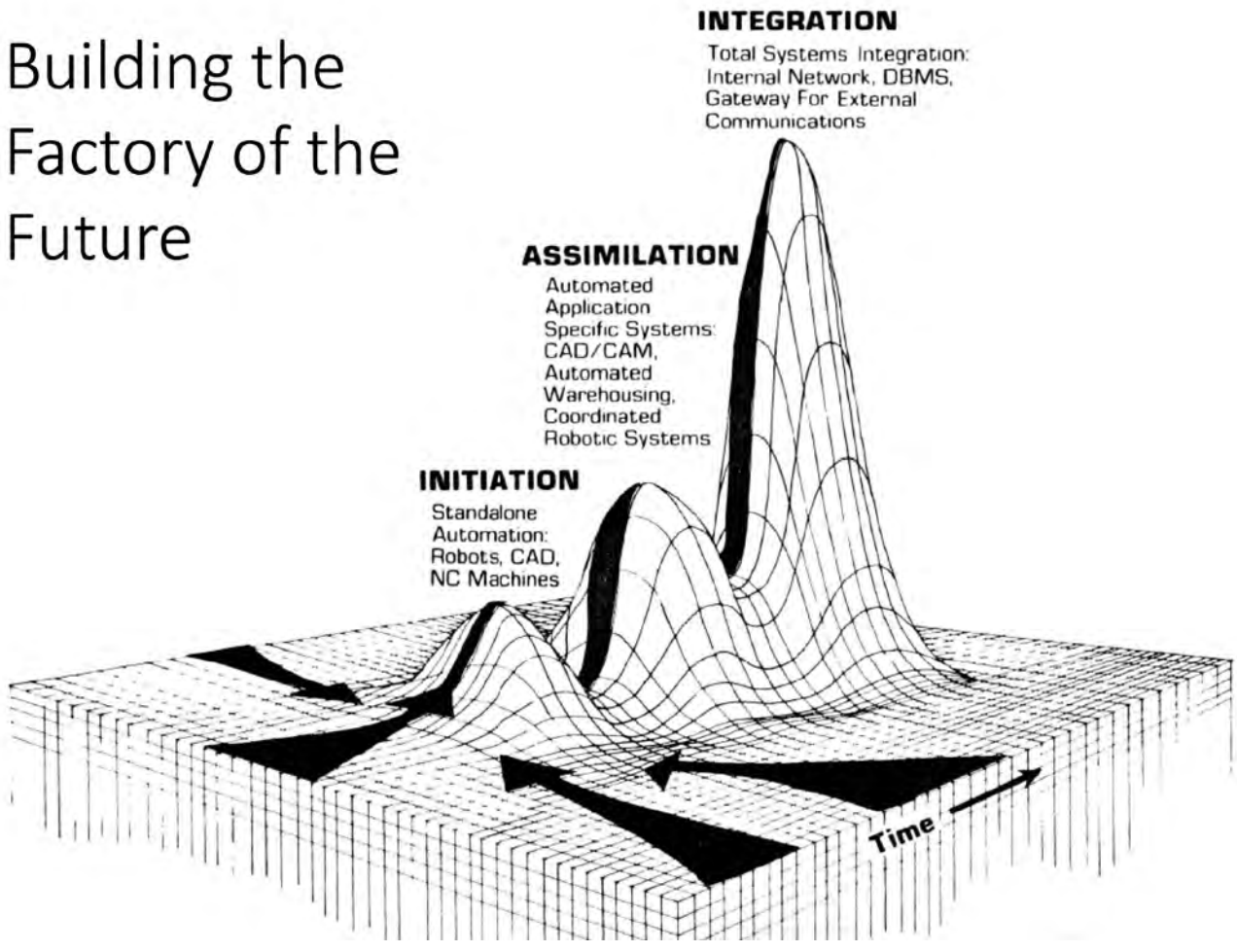


Figure 7: Building a smart factory or a factory of the future depends on the assimilation and integration of standalone automated systems, such as robots, CNC machines, conveyors, AGVs, AOI, process controllers, PLCs, and other smart machines into a coordinated symphony of manufacturing. (Source: The Yankee Group)

of PLCs, control systems, and robots to manufacturing.

The OSI communication standard is the physical and electrical definitions of how smart factory equipment and software communicates. The seven layers perform these tasks:

- Level 7, Application: Provide all services directly comprehensible to the application program
- Level 6, Presentation: Restructure data to/from a standardized format used within the network
- Level 5, Session: Manage address translation and access security
- Level 4, Transport: Provide transparent, reliable data transfer from end station to end station (e.g., TCP, UDP, etc.)
- Level 3, Network: Perform messages routing for data transfer between nonadjacent stations (e.g., LANS, WANS, ARP, ICMP, etc.)
- Level 2, Data Link: Transmit packets/messages between adjacent stations based on the station address
- Level 1, Physical: Encode and physically transfer electrical signals/messages between adjacent stations
- Level 0, Production: The actual production process

Figure 8 shows what the Germans foresee for Industry 4.0 using the ISA-95 hierarchy [2]. This is the same hierarchy as defined in the 1980s by CASA/SME's wheel. The only difference is the influence of the cloud and higher speed

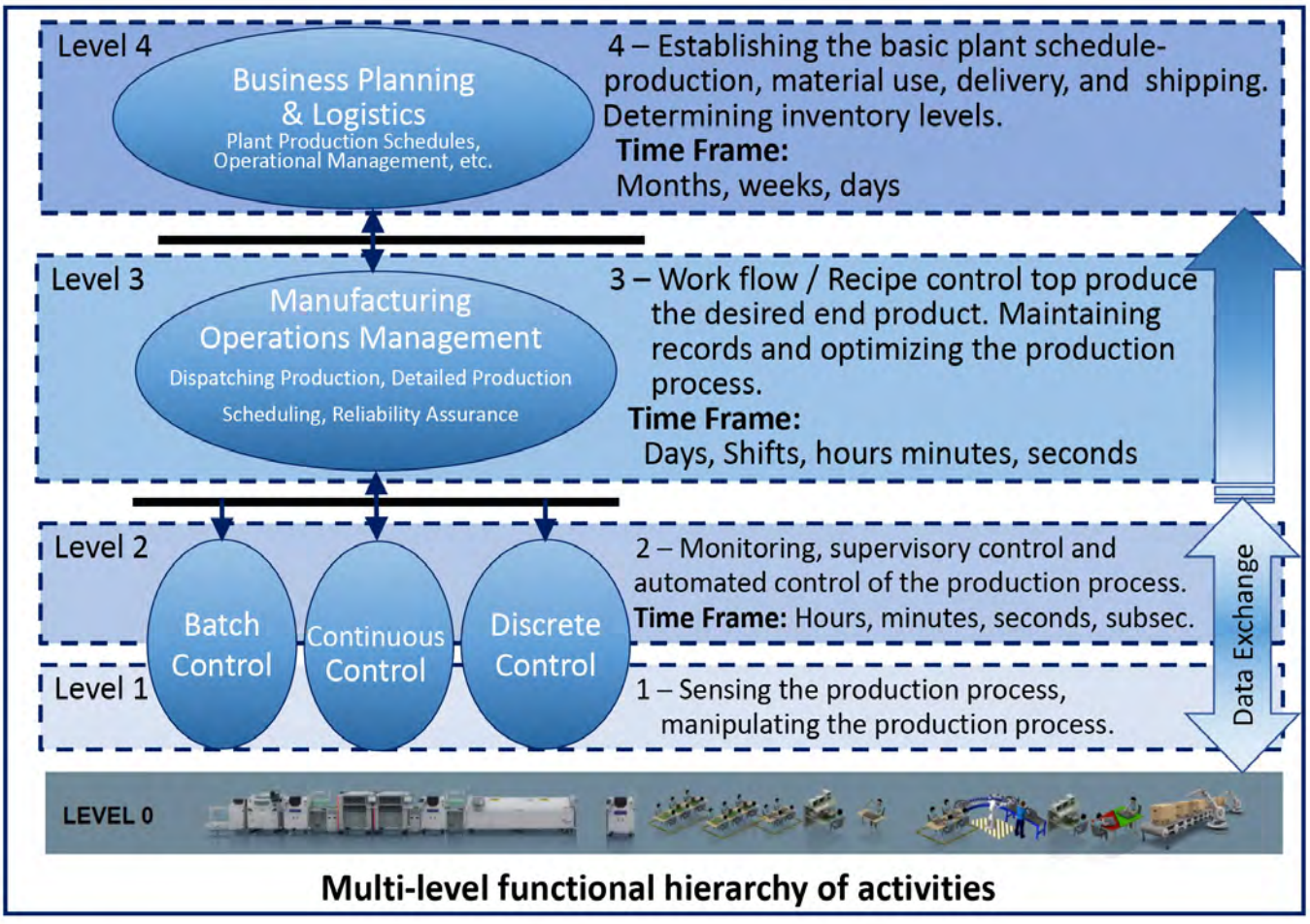


Figure 8: The ISA-95 standards are the latest explanations of the hierarchy of command and control software in modern manufacturing.

optical networks that can blur where the controlling software resides. The ISA-95 systems hierarchy model includes factory equipment at Level 0, the production process at Level 1, loop control at Level 2, MOM or MES at Level 3, and ERP and other enterprise systems at Level 4, using the cloud if necessary.

The ISA-95 standards came about in the late '90s. ISA was officially established as the Instrument Society of America on April 28, 1945, in Pittsburgh, Pennsylvania. Over the years, the name has changed to The Instrumentation, Systems, and Automation Society. In 2007, they simplified the name to The International Society of Automation with a membership of over 32,000 in 100 countries. Notice how the hierarchies in Figures 8 and 9 follow the hierarchy in Figure 3 closely.

ANSI/ISA-95, or ISA-95, is an international standard from The International Society of Automation. It is built upon ISA-88—the control activities for Levels 0, 1, and 2. It was created for developing an automated interface between enterprise and control systems (Levels 3 and 4). The objective of ISA-95 is to provide consistent terminology for suppliers and manufacturers and information models for communications. There are five parts of the ISA-95 standard, which can be seen at www.Isa-95.com.

Figure 9 illustrates the vast number of applications that can populate a modern smart factory today. Here are only 34 application areas from sensors, instruments, and PLCs to the plant logistics and scheduling software, but the total applications available can be many times larger. All of these operate within a response time from milliseconds to days. The communications between each level and inside a level follow the seven-layer OSI communication standard (Figure 10).

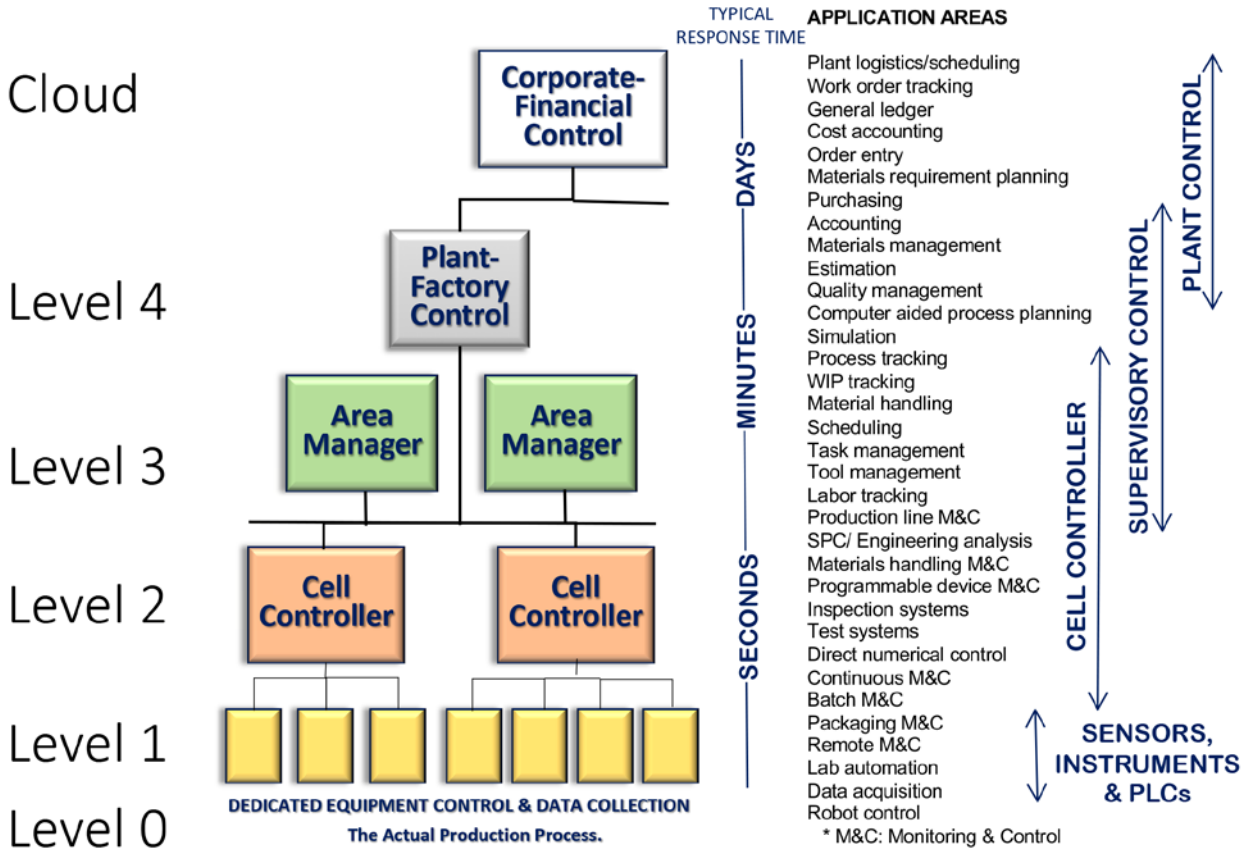


Figure 9: The generic ISA-95 application model defines the application software and typical response time for smart factories.

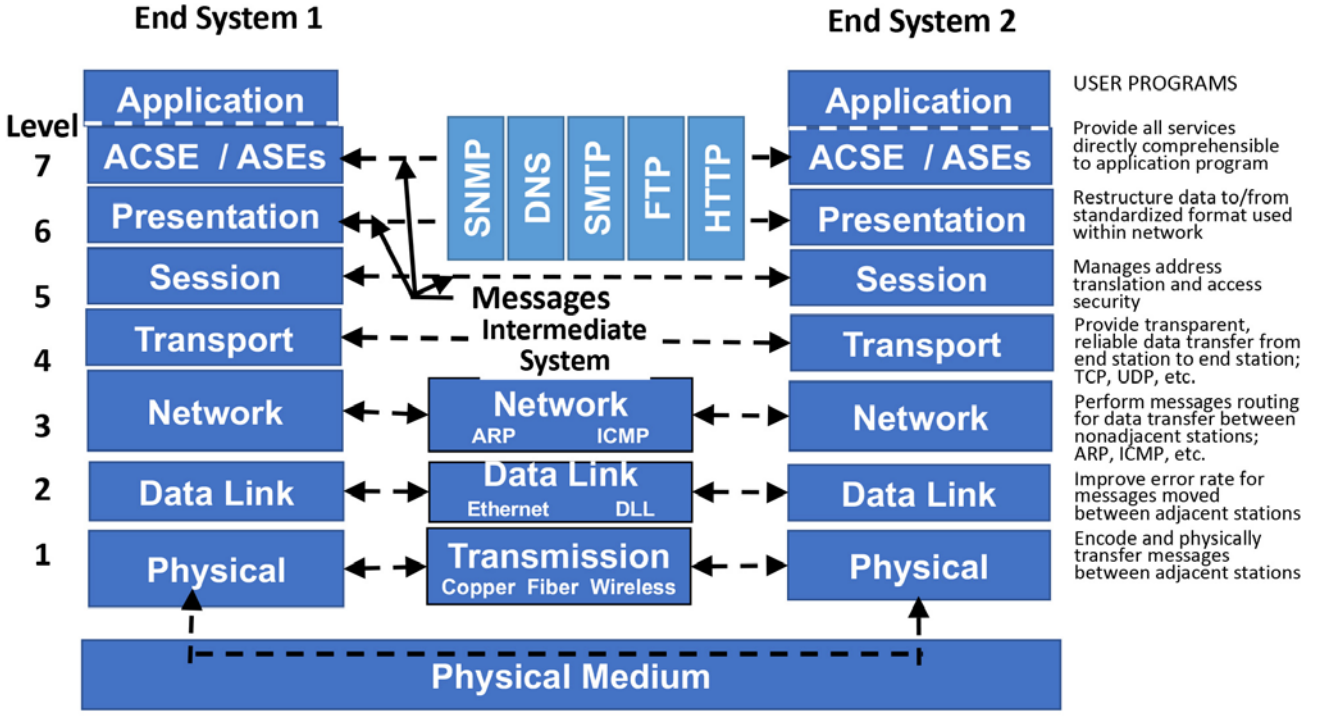


Figure 10: The seven-layer OSI communication standard. (Source: HP Journal, August 1990)

The communications physical and data link layers (Levels 0, 1, and 2) can be as simple as serial RS-232C, RS-422, RS 485, USB, or Bluetooth to the complex Ethernet (IEEE-802.3). There are three available versions of Ethernet: 10BaseT, 100BaseTX (fast Ethernet) and 1000BaseT (also known as gigabit Ethernet because it transmits Ethernet frames at a rate of one gigabit per second).

Levels 3 and 4 are the network and transport layers, which are popular for an automated factory are PLC protocols, such as:

- Modbus RTU
- ProfiNet
- DirectNET
- EtherNet / IP
- ModbusTCP/IP
- Ethernet TCP/IP

Levels 5, 6, and 7 are the software control layers and house the various application programs. More on OML, CFX, and the SEMI SECS/GEM protocols in a future publication. **SMT007**

Further Reading

To learn more about factory automation and smart factories, including planning, real examples and process control basic, download I-Connect007's free eBook *Automation and Advanced Procedures in PCB Fabrication* at i007ebooks.com/automation (Figure 11).

References

1. Holden, H.T. "Complexity Factor C." IPC Technical Review, March/April 1986.
2. https://isa.com/

RTW IPC APEX EXPO 2019: Electrolube Discusses Overcoming Secondary Cure Issues

Phil Kinner, technical director of Electrolube's coatings division, speaks with I-Connect007 Technical Editor Pete Starkey about how secondary cure issues with UV conformal coatings have been overcome and shows some typical examples. Click image to view.

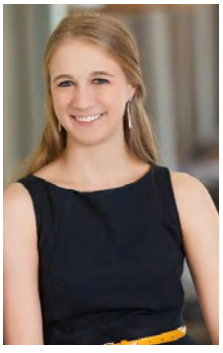
WPC's Standardized Cordless Power Solutions

Interview by Nolan Johnson
I-CONNECT007

According to their website, the Wireless Power Consortium (WPC) was established in 2008 as an open and collaborative standards development group comprised of more than 600+ company members around the globe. WPC's members are both large and small competitors and ecosystem partners including Apple, ASUS, Belkin, Bosch, Canon, ConvenientPower, Dell, Google, Haier, Huawei, IKEA, Lenovo, LG, MediaTek, mophie, NXP, Panasonic, Royal Philips, Samsung, Sony, TDK, Verizon Wireless and Xiaomi. All of these companies collaborate to design and evolve the world's most useful, safe, and efficient standards for wireless power. Phoebe Francis, a WPC representative who works as a senior manager in the Dallas offices for Golin, a PR firm, gave me the rundown on WPC and what it means for printed circuit manufacturing.

Nolan Johnson: I'm here with Phoebe Francis with the Wireless Power Consortium at CES 2019.

Phoebe Francis: Yes, I work with the marketing team for the WPC. At Golin, we handle all of the promotional activities for WPC and many of the members. Golin is also a member of the consortium. We provide marketing and PR services, and we've been with the consortium almost since the beginning.


Phoebe Francis

Johnson: My readers in electronics design, manufacturing, and assembly are certainly looking at wireless power solutions for their applications all the time. Where does the WPC fit for them?

Francis: WPC is a group of 650 different companies that all work together on an open standard for wireless power for cellphones, kitchen appliances, laptops, portable drills, etc. We have a variety of different standards that we work on, and members interested in adding wireless power feature sets to products can have their products certified by us as being

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safe and interoperable. That means that they will have access to the standard and testing services around the world to ensure that all of their products work together with other products on the market and that they're safe for consumers to use.

Johnson: In the whole design-to-manufacture flow, where does that certification take place? Who handles the basic blocking and tackling for you?

Francis: There are a variety of different ways to approach this. If the end manufacturer is the one who's doing the product from start to finish, then they would be the one who would need to certify. We also have subsystems which are pre-made, pre-certified solutions created by our members at a variety of different stages of the design process. Those subsystems can be added in as they are, more or less, with enough flexibility for people to still add competitive differentiation on top of that. Now, because those systems are pre-certified, it speeds up the certification process immensely. So, the end product that gets sold into the market is where it needs to be to get certified, but by using those pre-certified systems, the certification process is accelerated. There are a few specific requirements that must be met, which you can see listed on our website.

Johnson: So, that means that design teams are in charge of the concept and putting together the design and components. It's their upfront decisions that are going to determine whether it's certified or not. The certification is not going to happen until you have a finished good.

Francis: Correct.

Johnson: And that finished good may be manufactured overseas by somebody else. Does the certification need to take place at the manufacturing facility?

Francis: Once the product is completely finished and ready for market, it is sent to one of our certification labs. We have labs all over the world. Once it's done, they do all of the testing on it. So, if you've used one of those pre-certified subsystems, that greatly speeds up the process.

Johnson: I could see why that would be the case. What sort of company in the electronics manufacturing supply chain should be looking at membership with the WPC?

Francis: Companies that are involved in adding wireless power are of interest to us, which I know is very broad. We have member companies that are at the chip level all the way over to the end-consumer level and everyone in between. If wireless power is going to be one of the differentiators of your product, I would highly recommend that you seriously consider membership and certification of your products.

Johnson: Do you see major end-product companies such as the cellphone and home-appliance manufacturers starting to drive their supply chain to become members of the WPC? Are the major influencers pushing involvement up through manufacturing?

WPC's booth at CES 2019.

Francis: Our members are not required to disclose their product roadmaps, supply chain, or anything of that nature; they can keep that as confidential as they would like. But our members do prioritize the certification process, and they know

that by using certified subsystems, it speeds up that process. As I mentioned, we have members involved at various levels of the supply chain, but as long as the final product is able to pass the tests for safety, interoperability, and other factors required for certification, it is not required that all parts of their supply chain be WPC members, although it can help speed up the process in some cases.

Johnson: How does somebody get involved?

Francis: We have four different tiers of membership: full, regular, associate, and small business. You must be a member to get your devices certified, but you can choose the membership level that fits your needs. If you visit our website you will find a full chart that lists out pricing for each of those levels and what you get at each level. For companies that want to be extremely involved, be a part of this development process, and provide input into the standard itself, they can consider those higher tiers of membership. Companies that only want to get their devices certified as they come out can do the lower tiers of membership.

Johnson: And, of course, we're talking here at CES where your booth location is in one of the main lobbies next to the media center.

Francis: It's a great spot for foot traffic.

Johnson: How has the activity been for you? What's the acceptance rate?

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Francis: It has been great. We've had a lot of people stop by. The standard for wirelessly powered kitchen appliances that's in development right now and is going to be released later this year has drawn a lot of interest from folks. Imagine a small apartment in New York, San Francisco, or many parts of Asia where you have a tiny little countertop, and the rest is taken up by your stove. Now, imagine a wireless transmitter embedded in that countertop instead—no more stove. That transmitter can serve as your cooking and prep space. When you're done, you just put everything away and have a nice, clean countertop. It changes not only the look and feel of the kitchen but also the way that we use it and how we interact with our kitchens.

Johnson: Fantastic. Any closing comments, Phoebe?

Francis: If you're looking at wireless power as a differentiator for your products, definitely take a look at us. We're very willing to work with our members on their needs, and also help to promote and amplify their voice.

Johnson: Super. Thank you, Phoebe.

Francis: Thank you. It was wonderful meeting with you. **SMT007**

Building a Smart Factory Supply Line

Feature by Barry Matties
I-CONNECT007

I-Connect007 recently toured Victory Giant Technology (VGT) Co. Ltd. in Huizhou, China—one of China's largest PCB producers. Currently, VGT generates about US$500 million in annual sales, and have plans to reach $1.5 billion in the coming years. VGT's facility covers an area of 236,000 square meters with a staff of around 4,000. Its monthly production capacity achieved is currently 600,000 square meters per month and increasing.

Mr. Chen Tao founded VGT in Danshui Subdistrict, Huiyang District, Huizhou. Before this, Mr. Chen had been working in a Taiwan enterprise as the special assistant to the company president in the early days where he oversaw quality and sales. VGT started construction in 2006 and became operational in 2008. Today, they have three manufacturing facilities with more under construction. Today, Mr. Chen continues to lead his team through an impressive expansion plan.

Background

Our tour began in the front offices, and continued through engineering and into factories one, two, and three. The fourth factory—a dedicated HDI facility—is now under construction. Though some resources are shared between the factories, core operations are set up as individual factories. Factory one is basically a traditional PCB shop staffed with operators

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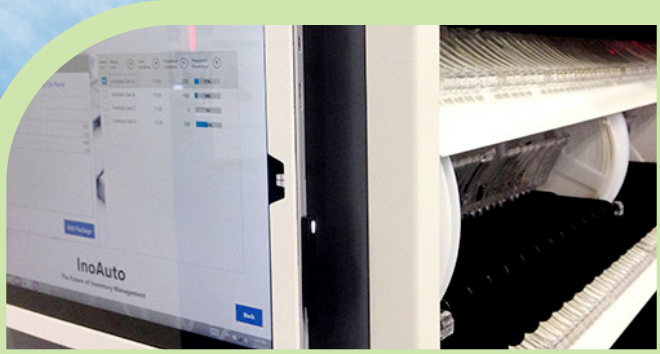

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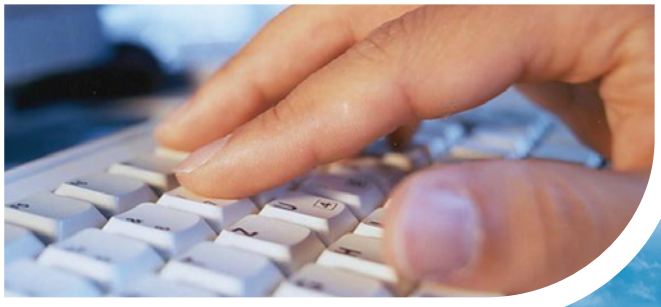

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running each process, but it is being upgraded to support higher mix, lower volume, and higher-tech products.

Factory two is a good example of what automation can do to reduce manpower. Built in 2007, and realizing a 30% reduction in labor, VGT determined that costs could be reduced further with a smart factory. That brought us to factory three—the smartest factory of all.

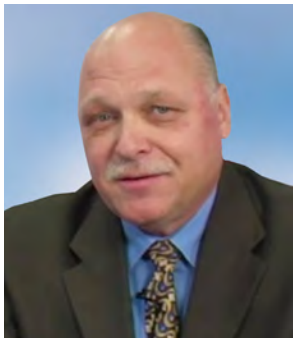
Designed specifically as a smart factory, this facility removes virtually all of the operators by using software and sensors to manage processes. Though the factory is not entirely optimized as a smart factory yet, work continues to that end.

'Andy' Zhou Dingzhong

VGT's COO Mr. Zhou Dingzhong describes it this way, "Compared to our original factory, productivity has increased by 40%, and labor is reduced by 70%. Also, the turnover time has decreased from six to seven days to two days due to the highly automated continuous process." He continues, "Also, our original factory uses manual handling of materials, which could increase the chance of scratches and defects. We designed our new factory with zero manual handling in mind, which made our yield go up by 5%."

With three plants running strong, VGT's ongoing expansion is very evident with construction crews building factory four. This new facility dedicated to HDI will be eight stories and measure around 1 million square feet; it should be operational in May of 2019.

To support all four factories, a new drill center was built, which will house 1,000 drills and be in addition to what they already have in place. There is also a new R&D center, which is under construction. This building will house the large amount of engineering and R&D staff. VGT has dedicated technical staff for R&D projects and a dedicated NPI staff for assisting customers in bringing their new designs to market.



George Dudnikov

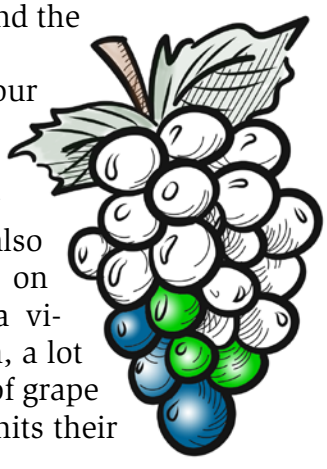
The new center will focus on developing new materials and processes to support 5G wireless, 100 Gbps networking, and automotive markets. Increasing density and improving signal integrity while reducing cost will also be prime focuses.

In addition to all of that construction, a new five-star hotel is being built on location for visiting guests. The property is very impressive with beautiful hills and mountains in the backdrop.

When asked how VGT manages all of their major construction projects, EVP and CTO George Dudnikov said, "We have an internal project manager. Also, our founder [Mr. Chen Tao] has provided a lot of target goal input to every factory here and does a lot of the layout."

Workplace Culture and the Environment

Creating a comfortable campus for employees is important in China as a part of the overall strategy to help keep employee turnover at a minimum. High turnover is a real problem for business in China, especially around the Chinese New Year when employees return to their home cities and often do not come back. I was told that turnover at VGT is lower than average for China. VGT strives to make their campus comfortable and provides amenities for the employees, including basketball courts, a small park for walking and relaxing, a vegetable garden that supplies the employee canteen with fresh veggies, and comfortable on-site dormitories. In fact, Dudnikov stays in the dorms when working in China. He now splits his time between China and the USA.



Employees work 12-hour shifts with one hour-and-a-half break for lunch and another half-hour break. Employees are also provided daily feedback on their performance with a visual grape chart. In China, a lot of factories use this type of grape chart. When an operator hits their KPI targets, they get a blue or green grape. And speaking of green, a real effort is being made here to minimize the waste stream and improve the environment. VGT recently invested over $15 million in upgrading its wastewater recycling capabilities and capacity to support the additional factory expansions. They have also installed rooftop solar panels to generate supplemental electric power. Being green and having a low carbon footprint is a goal for executive management.

A good work environment is also very important to the workers. With so much activity going on, the air quality is quite good. The distinctive PCB shop odor is not present. Local regions in China are getting serious about being environmentally friendly more than ever. It is reported that some companies are being asked to move out of certain regions because they can't support the environmental requirements. Meanwhile, VGT recently won an award from the Chinese government for being one of two board shops out of 200 with green production and a low carbon footprint; the other one was a quick-turn shop.

On our tour, I asked Mr. Zhou if their waste treatment goal was to be a green, zero-waste factory. Mr. Zhou explained, "Our top three strategies for the facility are to be a smart fac-

One of VGT's vertical continuous plating lines.

tory, and provide green manufacturing and high-quality, high-technology service." He continued, "As you mentioned, waste treatment is a large part of green manufacturing, and we want to achieve a 100% treatment and recycling in-house. Right now, we still have a little sludge and solid waste, etc., that needs to be treated by waste disposal companies.

Mr. Zhou further described, "Our plan is to put a dedicated recycling station on our shop floor to recycle all of the chemicals, scrap, and solid waste. Chemicals are a little tough, so we are outsourcing that part, but we are going to install vaporization equipment, which will turn chemicals into solid waste and can be treated through incineration. This way we can ensure that waste from the entire facility can be recycled.

Growth

VGT is a public company listed on the Shenzhen Exchange. In the last three years, VGT has grown with 35% year-over-year revenue growth—perhaps one of the fastest revenue growth rates currently in China. With continued organic growth, VGT is planning to break $1 billion in revenue in the 2022 timeframe.

VGT also claims to be the largest manufacturer and supplier of graphics cards. In 2018, they indicated that they shipped over 30 million pieces. Further, they reported that their current growth is in automotive, consumer products, HDI for IoT applications, smart home devices, and server and networking products. VGT also produces boards for the LED market, including copper and aluminum IMS boards.

Customers and Setup

VGT has customers visit the new smart factory nearly every day, so I asked Dudnikov what they're most interested in seeing, and what their reactions are after touring. He said, "Drilling and back drilling, plating, and our vertical continuous platers [VCPs]. Since we have a lot of special processes—such as VIPPO, full panel, selective gold, HDI, copper via fill, etc.—they are interested in those." Dudnikov continued, "Also, signal integrity is becoming a key area, and customers want to see our material qualification programs, but it really varies depending on the customers' needs." As far as customer reactions, Dudnikov noted, "They're impressed with the level of automation they see and the reduction in process and handling. The process controls are more consistent, and the equipment is leading edge, so it's going to help us get into finer lines and higher layer count products."

With the amount of work moving through the factories VGT has built a strong front-end department. Right now, their team tools between 30–35 new PTH jobs a day (not including HDI). VGT has a dedicated front-end engineering team for HDI focused on tooling jobs

for current HDI capability, but they are growing their capacity significantly with the new HDI factory about to come online.

Dudnikov explained, "Our plan and philosophy is to put a dedicated front-end engineer on a medium- or large-sized customer who gives repeat orders." He further said, "The first designs may come in and require a little more work on average, but we try to get what's called global deviations, and then we have a database where the approvals are entered into a computer system, and we don't have to ask the question again. That minimizes the amount of work that has to be done to the package." Also, "VGT offers quick-turn service of 10 days or less on new NPI orders, so streamlining the front-end process is strategic."

Factory One

After a tour of the front-end engineering department, Dudnikov led us to factory one.

Dudnikov: Factory one was built in 2005. This factory is still going to do some basic volume, but it will start building higher layer server products. Right now, we're running up to 14–20 layers and the target is 24–28 layers. In this factory, we have basic loaders and off loaders. PTH is horizontal and inline, so we're not loading baskets for electroless copper; however, the plating is still done in traditional vertical tanks with dip-and-rinse plating.

We have three panel plate lines and three pattern plate lines in this building, which is like the conventional U.S. plating operation. We also converted some of the tanks to pulse plating on the pattern side, and we've added additional LDI equipment to support higher mix, higher technology, and higher layer count, but not the super high volume.

Matties: Is the plan to automate this whole area?

Dudnikov: We're actually de-automating here. This factory is being set up for higher-end layer counts, server products, and things you can't as efficiently build on a fully automated line. In China, most people do panel plate, but when your microstrip lines and spaces are around three mils and below, it's hard to etch, so you go pattern plate and add a process for base foil reduction; same with higher aspect ratios because the plating process has to be different.

We still have older types of equipment, but it runs well, and there is some automation already. VGT pioneered a lot of automation even in the beginning factory. This is the old factory, so it has been upgraded a little bit. But to give you an idea, on our inner layer DES line, the standard AOI is inline. All of our etchers here are vacuum etchers, which helps with side-to-side etching. However, we still currently use offline digital micrometer microscopes to measure line width.

CAM sends down a file and tells the operator locations to measure line width on a core, and what that line width needs to be. Then, we put it into a database and calculate out etch factors, Cpks, etc. What we're trying to do now, working with Optima, is to get an assessment of line and space readings 100% inline—every core coming off. In the future, this data could be used to monitor the etchers and raise an alarm when something starts drifting out of control. This type of real-time metrology is the basis for a smart process.

Matties: What other shared resources are there?

The main chemical and reliability laboratory.

Dudnikov: We have a main chemical and reliability laboratory that supports all of the factories. The main lab is very well equipped with state-of-the-art equipment. We have everything from ICP ionic testing to four-wire Kelvin where we check on a scheduled basis each plating tank for higher aspect ratios (ARs) and validate the plating quality. We have an in-house SEM with EDX capabilities, so we do our own failure analysis. Each factory also has local labs located in key areas, and then the central lab double-checks their analysis and monitors the SPC.

We also have an IR reflow oven and air-to-air cycling, and a dedicated SI lab. We've been doing SET2DIL since I got here, but now we moved to Delta-L testing, and we're going to add a VNA this year. For CAF testing, we do all of our own material certifications. We'll certify materials either to the customer or automotive specifications to supplement supplier data.

Then, we have 16 flying probes; six of them have Kelvin on them right now. When we're doing anything over a 10:1 AR, we will test on a Kelvin prober. In addition, we have hipot and inductance testers. Our labs are very well staffed and equipped. This is an area that customers really get excited about. In the PCB business, process control and reliability assessment are the keys to quality performance."

Another shared resource is drill bit repointing. With all the drilling, we do all our own repointing. We control based on the diameter and hit counts; every pack of drills is serialized, and everything goes through automatic repoint. Our machines will repoint, check the quality of the point, check the overall flute length, make sure it's within the specification of our number of hits and tolerances, and then either reject it or pass it. It's fully automatic. Next, our team sets up the toolkits, and they will move them downstairs through an elevator system. Then, the operator pulls the kit when needed and drills the job. It's a very efficient operation.

Factory Two

Next, Dudnikov continued the tour in factory two.

Dudnikov: Our second factory is four stories, and it utilizes a higher level of automation compared to factory one. Here, we move from

In-house drill sharpeners.

Automated Mason electrical testers.

tank plating to vertical continuous plating. When VGT built this factory, they focused on removing certain operations and streamlining the process. For example, we match the deburr machine right to the permanganate desmear machine, and into electroless copper. We go through deburr, high-pressure water, ultrasonic rinse, and into permanganate, right-angle bend, and down the electroless copper line. There are absolutely no operators. One employee basically monitors the whole line. In a traditional board shop in the U.S., deburr would be a separate process, and then you would go to electroless copper—usually in tanks—and finally, plating lines, so there's a significant advantage here.

We have a loader after PTH. At this point, the panels have electroless copper on them. We then have a loading mechanism that gets wheeled over manually, and then the robot takes over and starts feeding the VCP. One or two employees run this process, and then there are a handful of employees that ensure the robots are doing what they need to do and queuing up the next slot. In the new smart factory, this product transfer is done by automated guided vehicles or AGVs; people simply monitor.

We have automatic imaging for solder mask, and we also have LDI for solder mask. Further, we have cameras in every department here that we can monitor. In the new smart factory, we have data being integrated. We still have cameras, but we're also integrating the throughputs, panels, lots that are going through.

We also specialize in hard gold fingers, and all of our gold plating is done in full panel form using VCPs. We do our masking with a laser cutter. Our CAM team opens the windows for gold plating, and then we have a hot-roll laminator laminate resist film. All of our gold plating is done in full body platers—not tab platers. This allows us to easily do selective gold—gold with ENIG, mixed finish, etc. It gives us a lot of flexibility. I believe VGT has the largest gold plating capacity in the industry.

All of our electrical testing is fully automatic, all of the testers are networked, and the throughputs are calculated on efficiency. We track how many test compressions we do, how many pseudo opens, and then calculate the final yield. Automatic off loaders sort boards into good, open, and short piles and eliminate pile management issues. In the new smart factory, we also track first-pass and second-pass yield in real time.

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Smart drill room.

Matties: So, between factories one and two, what labor reduction do you have?

Dudnikov: Maybe 20–30%, and the factory three has a 70% reduction.

Factory Three: The Smart Factory

Dudnikov concluded the tour with factory three—the new smart factory.

Dudnikov: Now, in the smart factory, the first floor is drilling and lamination. Inner layer is on the second floor, and then finishing is on floors three through six. Each floor is basically a separate factory setup in a serpentine process. The transfer between operations is mostly done with robots. As we get 100% of the intelligence system integrated, a customer will be able to go online, send us a job, and our system will automatically check whether we have material in stock, load that material, pull it out of stock, and release it to the floor within 30 minutes.

In the smart factory alone, we have over 200 drilling machines, and that's only a small fraction of our total drilling capability. By mapping out the drill programs and using our intelligent manufacturing system software to optimize which job goes on which drilling machine, one operator can drive up to eight machines. We have both Hans Laser and Schmoll drilling machines. We also have over 100 machines set up for back drilling, including some with CCD cameras. All of our machines are 200 KRPM spindles, six heads. Our standard panel is an oversized 24x28".

Matties: Did you find that to be better for optimization?

Dudnikov: Absolutely. That's how we get the cost down. In lamination, we have more than 12 Burkle full-sheet presses with 10 openings that are all oil heated. Loading the presses is all done by robots. Everything comes on rolls—prepreg, copper foil, etc.—and we do all our own sheeting and then goes into kitting for layup. Our tooling system provides extremely high tolerancing from layer to layer. If you combine that with predictive modeling on scaling, this gets us into much tighter registration capabilities. Every laid-up stack goes through an X-ray process, so we can check whether something was mislaid up, or if there's something significant and they could break it down and redo it all before committing to lamination.

After lamination, we use X-ray drills to form the tooling holes for drilling. This is another area that we're focused on smart processes. These machines can measure internal targets, and what we're trying to do is develop predictive models for scale factors because we're running such a variety of jobs and laminates. Do you know how many different materials there are in the market now? We want to be able to run jobs rather than run test panels.

Automated warpage measurement and hole check line.

In our process, we can collect data—copper percentage, core thickness, prepreg style, what the dimensional movements will be—and we can predict the scaling factors without doing any kind of samples. This reduces cycle time and the overall cost and increases quality.

After it drills in the tooling, our system will automatically de-flash, edge polish, rotate 90 degrees, do the other two sides, do a high-pressure rinse and wash, measure every panel in nine-point locations on overall thickness, and collect real-time SPC on our pressed out thicknesses. This is another example of a smart process. We can collect data on any stackup. And when you look at the control limits, you will see we are right in there; we do all of this with only a couple of technicians.

Matties: This must have reduced cycle time quite a bit.

Dudnikov: Yes. Well, you can't really feel it, but if you spend time in factory one and this factory, the velocity of the product is much faster here. A great area to really get a feel for the product velocity is after routing and final clean. Each board is measured for warpage and hole check on a conveyorized process. The boards fly through our process. In our inner layer fabrication, we use liquid resist, and then it goes into the yellow room exposure, which is all fully automatic. Next, it goes down the DES line. Then, every core gets 100% inline AOI both sides and is serialized. After verification, cores go right into horizontal alternative oxide. It's a serpentine and continuous process.

All the etchers here are also vacuum etchers. Again, if you compare it to a conventional shop in the U.S., you would etch it, rack it, and then you would have to wait until the AOI machine opens up. Next, you would manually sit there, AOI each one, and bring it to your verification station. In some cases, only one side can be "AOI-ed" at a time, which is a much slower process flow.

We are currently working on integrating AI to have the verification system learn different defects in real time. It will be able to determine whether it's a pseudo or real defect. All of the AOI data gets stored so we can do yield analysis. For each core after verification, we can go back and see if it had a short or an open, and then roll this up into Pareto charts and defect mapping.

In imaging, we have more than 12 double-sided automatic exposure machines with very good side-to-side registration and no operators. We do 100% LDI on outer layer and contact printing inner layer because the LDI gives you

Inline AOI with DES line monitoring.

Automated visual inspection line.

better image registration capabilities for outer layer. If you do predictive modeling on your IL scaling factors, then this works better and faster.

From deburr all the way through the finish panel plate, no one touches the panels; it's fully robotic. We cut the cycle time here as well as a lot of the process cost. The whole cycle time is around 60–70 minutes from start to finish. If you look at a traditional board shop between staging, rinsing, drying, racking, and queuing up, this could take about two full shifts.

Matties: And how are you managing all of the data?

Dudnikov: The data goes into a central server where the smart software is working right now. We have a dedicated software team writing custom code. Although the full software system is still under development, we have certain modules already in operation. This gives the process and production control people all the information they need. Every lot is tracked using either barcode readers or RFID. The plant manager can look in real time and see yield and production throughput for every process, department, and job. We see what the entire process is and our efficiency—all of the production metrics. At the same time, this tracking system also provides improved product traceability. Monitoring sensors alert engineers or technicians if a process has a problem. With multiple processing lines, the intelligent software will also plan for scheduled maintenance downtime. When fully implemented, the software will collect, analyze, judge, and plan, which optimizes factory efficiency and reduces cost.

Final Conversations

After our factory tour, we sat down for a conversation with Mr. Zhou and Mr. Chen Yong, managing director of VGT. Mr. Zhou, COO, has been with VGT for 15 years and has a lead role in the company's operations, expansion, and the implementation of the smart factory. When he joined the company, it only had 2,000 employees and one facility; today, VGT has over 4,000 employees and multiple facilities.

Barry: Mr. Zhou, when organizing a smart factory, what is the most critical consideration that you must make?

Zhou: The communication protocol. We have gathered over 100 suppliers to negotiate a common communication protocol in the beginning. We made sure that all our lines and systems were communicating with each other with the same protocol. We had a meeting with all our suppliers—including software and equipment suppliers—to unify one single common protocol.

Barry: What lessons have you learned in this factory that you will improve in the next factory?

Zhou: The first is that if one machine is down, it will bring the whole line down with it, so the requirement for machine quality, reliability, and maintenance needs to be higher.

Barry: With this type of facility, it seems to me that you are also looking for different type of employees—maybe at a process engineering level and fewer operators. What is your employee strategy?

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Zhou: Another philosophy of this facility is that we don't have operators in it—just technicians and engineers. They are responsible for managing the equipment. We require them to be capable and have an adequate educational background; only qualified employees can work there. Their salary is much better than regular employees, but they are less busy.

Barry: One of the core advantages of a smart factory is that it can optimize the work that is going through your factory. We plan well to use our resources as well as possible. Aside from that, what other benefit are you realizing?

Zhou: The most obvious one is profit. Efficiency, yield, and labor force combined also contribute to this profit improvement. The same product manufactured from our older factory and smart factory has a 5% profit difference today. As the labor cost is still rising, we expect the difference will continue to expand.

Barry: How many part numbers can you manage to process monthly?

Zhou: Four to five thousand.

Mr. Chen Yong, the brother of the founder [Mr. Chen Tao], started as a salesman. Now, as the VP of operations, he shares his insights about running a business this size, some of the lessons he has learned and shares important advice to young people who might be starting a business.

Barry: What is it like from your point of view running a company of this size?

Chen: PCBs are the basis for all electronics, and it will still be in use in the future for some time.

Chen Yong

I am very passionate about my line of work, and I work hard every day to make the business run smoother, add new customers, and sell more products. Being able to see our product in things around the world is very satisfying for me.

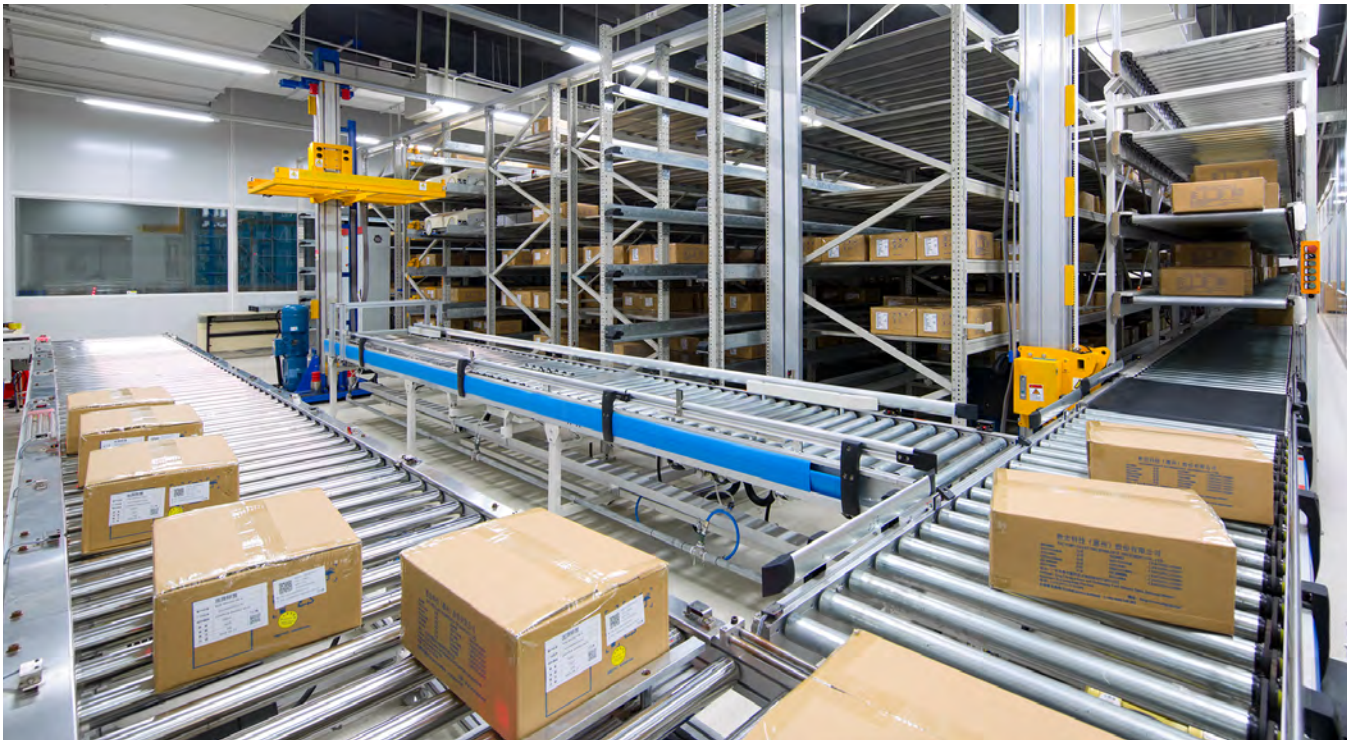
Barry: When you are running a business of this size, what are your greatest concerns?

Chen: We have some concerns about the market landscape. Overall, the market was not the best in 2018. If we can maintain good management both inside and outside, we are very confident that we can tackle any problem in the way. I am very positive about our future. We have a very good product portfolio, and as PCBs are inside a wide range of electronics, I would say this market will thrive.

Barry: The investment that you are making into this smart factory is very tuned to modern manufacturing.

Chen: Yes, the owner sees things quite far ahead.

Victory Giant Technology campus overview.



Automated warehouse.

Barry: Your brother is the founder of VGT. What is your greatest lesson you learned from him?

Chen: I think that would be attention to detail. There's nothing too small to be ignored. Our philosophy is to take good care of our customers to make sure they are happy.

Barry: There have been a lot of changes in the China workforce over the years. Before, people would stay in a job for years if not a lifetime. Now, people jump from job to job for a little more money, and nobody wants to do manufacturing jobs. How do you overcome this?

Chen: As a responsible enterprise, we want to provide a good environment and income for our employees. More than 10 years ago, the shop floor in a PCB fabricator was usually very smelly and hazardous. But if we provide a good environment and salary for our employee, they will continue to work here. Meanwhile, we need good management to reduce scrap and make more profit and increase their income.

Barry: When I walk through the facility, it is obvious that you care about your people. But it's also clear from everything I have been told and seen that there is a shift in the types of employees you will have.

Chen: Our future goal is to have zero operator—only technicians. We are realizing this step by step because a smart factory only needs technicians in this specific area.

Barry: What advice would you give to young people who might be starting a business?

Chen: For graduate students these years, according to my knowledge, I would say my advice is to stay longer in each job and start from the bottom. Some of them have very decent family economic conditions and would easily quit a job. They typically lack experience and knowledge for management, but wouldn't start from a regular employee just want to be a manager or supervisor from the beginning; that is not the way it works. They need to accumulate something first.

Barry: That's good advice. Thank you.

Chen: Thank you. **SMT007**

MilAero007 Highlights

RTW IPC APEX EXPO: Zentech on the Fourth Pillar of DoD Acquisitions and NIST ▶

Steve Williams speaks with John Vaughan, VP of sales and marketing for Zentech, about their dominance in the military/aerospace market sector, the new "fourth pillar of DoD acquisitions," and how companies that do not take the NIST initiative seriously will be quickly left behind.

Dr. Jennie Hwang Appointed to Chair the Board on Assessment of U.S. Army Centers ▶

Dr. Jennie S. Hwang has been appointed the chairman of the Board on Assessment of U.S. Army Centers, U.S. Department of Defense.

Circuitronics Now Offers 24/7 Online Quoting ▶

Circuitronics has added functionality to its website to allow customers to submit prototype and quick-turn estimates 24-hours a day.

SMTC Receives Five-year, $9M Contract From the U.S. Navy ▶

SMTC Corporation's subsidiary MC Test Services Inc. was recently awarded a $9 million, five-year contract to support the U.S. Naval Undersea Warfare Center Division.

Libra Industries Adds Robotic Conformal Coating Capability ▶

Libra Industries has purchased a Delta 6 robotic conformal coating/dispensing system from PVA. The system was installed at Libra's Mentor facility last month.

Zentech Earns IPC-1791 Certification ▶

Zentech has earned IPC-1791 Qualified Manufacturers Listing and is designated as a trusted assembler.

Jabil Advances Additive Manufacturing Market ▶

Jabil introduced a complete solution for creating, integrating and validating custom engineered materials for additive manufacturing.

Logic PD Joins Compass Electronics Solutions ▶

EMS and product development solutions company Logic PD has been included in the launch of a new platform brand—Compass Electronics Solutions (CES), the premier partner for connected device design, development, manufacturing, and support for the world's most innovative products.

Dorigo Systems Breaks Ground on Facility in Burnaby's Glenlyon Business Park ▶

The Pillon Holdings Group of Companies has broken ground on a custom-designed corporate campus for Dorigo Systems in Glenlyon Business Park (Glenlyon). This state-of-the-art EMS facility has been designed by architect Christopher Bozyk and is being developed and constructed by Beedie.

Kimball Electronics Reports 10% Growth in Q2 FY 2019 Sales ▶

Kimball Electronics Inc. has reported net sales of $284 million for its second quarter ended December 31, 2018, which is up 10% year-over-year.

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Anfield Group: Industrial Cybersecurity Needs To Be in Front of Regulators

Feature Interview by Nolan Johnson
I-CONNECT007

At the 2019 IEEE Rising Stars conference, I spent some time with Chris Humphreys, principal at Anfield Group, a cybersecurity firm consulting with numerous industrial and infrastructure clients. Humphreys taught a cybersecurity course for college student attendees to the conference. Afterward, we talked about cybersecurity, the dynamics of regulation, and the responsibilities that manufacturers have to the greater good above and beyond simply adhering to regulation. If your company is online at all (and who isn't?), your IT department needs to be competent in cybersecurity. Humphreys gives insight into the knowledge, training, and expertise you will need on-site simply to keep your customers' intellectual property safe.

Nolan Johnson: Chris, can you start by telling us about your company and role?

Chris Humphreys: Sure. I started the Anfield Group about 10 years ago—a cybersecurity and regulatory compliance and consulting firm based out of Austin, Texas. It brings together my regulatory experience with my cybersecurity and operations experience. It has blossomed into technology advisement, regulatory compliance mitigation, and program architectures from processes to tools including everything you need from cybersecurity, specializing in the industrial control systems space, to critical infrastructure, oil and gas, electric utilities, hydrochemical, and anybody in state industrial control systems.

Johnson: Would electronics manufacturing be out of your box?

Humphreys: No, it would not, especially since manufacturing involves the supply chain component that is becoming more and more prevalent here in North America now on the regulatory side. Regulation continues to be a huge growth area. Let's just say business is good.

Johnson: I can imagine. The IEEE Rising Stars Conference is largely organized to help young professionals, college students who are still active students, and recent graduates just moving out into the industry around IEEE make

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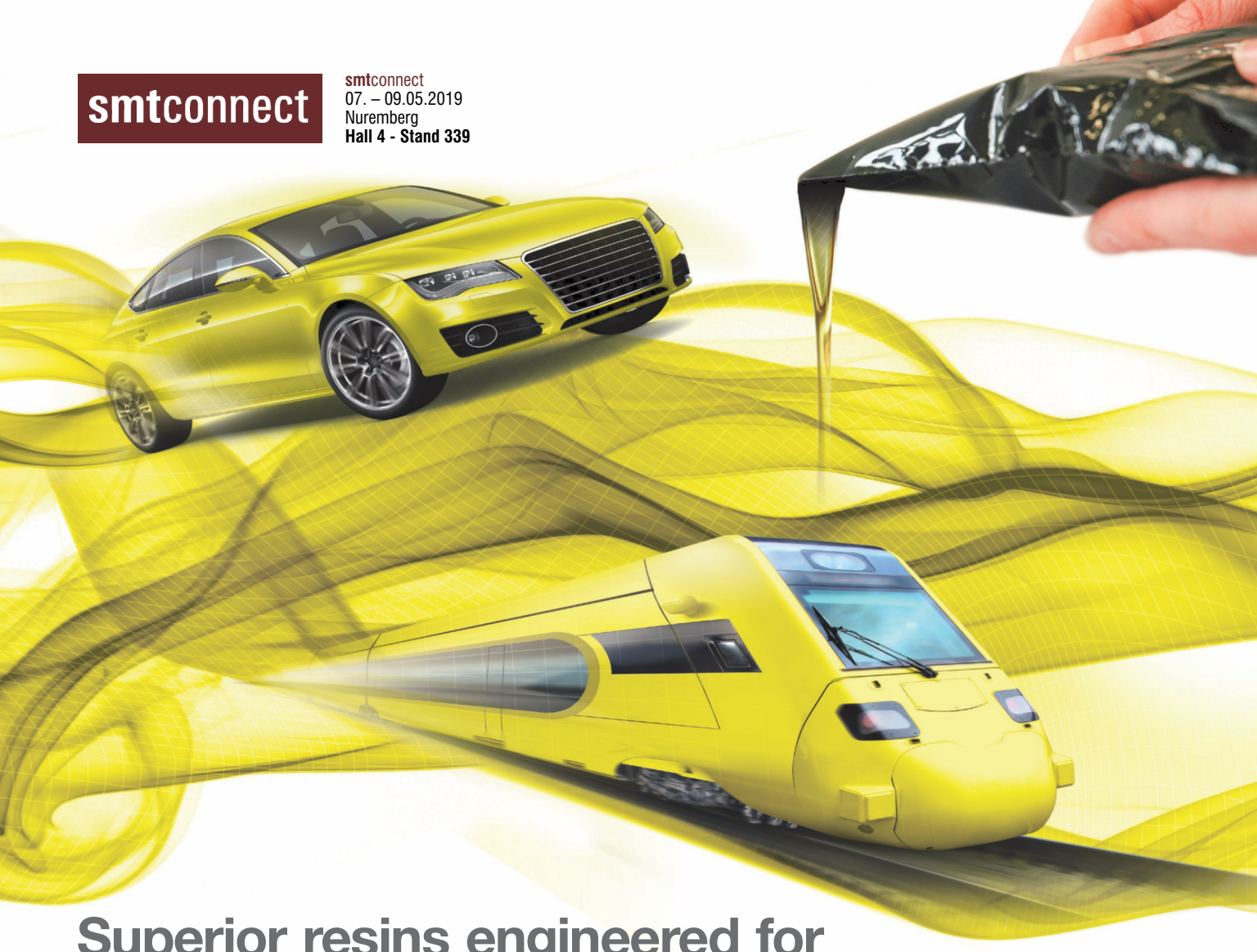

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that transition and be successful. You ran a workshop here yesterday.

Humphreys: Yes, it was very interesting. This is my first real exposure to this component of IEEE. Man, it made me feel old, but it just seemed like just the other day I was in their seats. I was telling some of the students in the competition that we were in, which I'll get into in a little bit, that they are very fortunate to have undergraduate academic programs now that can give them these skill sets. I'm prior military and a product of being in the right place at the right time. There wasn't that conventional academic route to career paths that we're in right now. I find that really refreshing, and the kids I saw yesterday were extremely intelligent.

I think the one thing I was trying to instill in them is having street smarts as well. It's good to have book smarts, but there's a skill set to be able to translate the technical stuff they're doing every day to an executive and keep it at a third-grade level, I joked. That's a skill set that they should definitely work on. I think they found that very rewarding and never thought about it, but I could see a lot of their eyes light up seeing how that would be important. That was my great partition of wisdom, if you will, to the younger generation.

The competition I mentioned earlier also went really well. It was based on a national-level exercise that I participated in earlier this year, which simulated a major natural disaster with a cyberattack—a time where we would be very vulnerable while recovering from the disaster. We did some injects from that scenario with them to not only think from the tactical perspective of hands-on keyboards getting systems back up but also the strategic idea around what capabilities exist that they could leverage to help them in that kind of a scenario. Thinking through the big picture scenario was something they hadn't seen before, and I think they got a lot out of it.

Johnson: Interesting. What do you think some of their key takeaways were based student feedback?

Humphreys: The feedback I received from students has been before the competition yesterday and before they were exposed to me, I think they tended to put themselves in a box career-wise such as, "I want to be an engineer that works on this system," or, "I want to be an expert in this singular system." I think my exposure showed them that their skill set is much broader than what they might think they want to do. It's great to have a singular scope if you're passionate about one thing and do it well, but don't get stuck in that rut because you might plateau. Then, 20 years later, you may be the expert on one system, but you could have done so much more with that skill set. I think for college kids especially, that was refreshing to hear because they might be on one track and not realize what opportunities are out there for them.

Johnson: Correct me if I'm wrong, but one of the basic tenets of security of any sort is to expect the unexpected, and how can you do cybersecurity if you're not also in that situation? Getting yourself into a technical skills box takes away that ability to non-linearly look at what's happening and deduce what's going on.

Humphreys: Absolutely. I'm the complete opposite. I never imagined being in this career field. The door opened up, and I went through it. I've learned the technical side on the back-end whereas these kids are learning the technical side up front, but they also need to have street smarts for the broader concept of what their skill set can offer in the world. Again, I just

turned 40, so I'm not that old, but I feel so much older when I'm talking to these kids and seeing where they're at compared to where I was at that age. In this day and age, it's very easy to get buried into your device and onto one path without being aware of the doors that are open to you. It was great to get that feedback from the audience on exposing them to ideas that they never thought about from their skill sets.

Johnson: This is a chance here to give you some feedback as well. I was standing in line for dinner last night, and one of the students and attendees of your competition was trying to summarize it to a colleague. I'm paraphrasing here, but he basically said, "I came out of it learning everything that I needed to pay attention to keep a site secure."

Humphreys: That makes me feel good because there are so many different areas that you need to consider holistically as a security professional and I don't know if that comes across in their academic programs. They're great, but, again, it's very easy to get on a single track. I want them to see tracks available beyond that. I'm glad that I was able to contribute.

Johnson: You have all these students and young professionals learning about cybersecurity so they can take it to their employers and mitigate what's going on there. But one step further down, let's talk about the employers themselves. If somebody is in electronics manufacturing, they have to deal with the fact that they may be sending IP data overseas electronically where there are ITAR issues and other sorts of IP protection concerns going on. This is a daily part of doing their business when their core competency is being a manufacturing facility. What should they be paying attention to right now?

Humphreys: In my session this morning, I told folks when you're interviewing for a job, that job description may be very singularly tracked, but as a young professional coming into a new career field, talk about the regulatory implications that they have to deal with. That will blow the recruiter off their seat because they're not going to expect it unless it's specifically called out in the job posting, which I guarantee it probably isn't.

If a young professional says, "I understand the operational side, which is what I'm passionate about, but I also understand how that impacts regulatory implications and the ever-changing climate that we're seeing on the regulatory side around things like supply chain management," they're going to stand out. They're going to be pushed right to the top of the candidate list because understanding the broader concept of the challenges of that organization that they're hiring with from a security perspective and knowing where their lane in the road would be with that current job position is going to be very impressive.

Johnson: You've just mentioned some supply chain issues, but what are some of the other regulatory challenges that you're seeing right now that would fit in?

Humphreys: In the electric utility industry, for example, I cite this example all the time about how technology and threat will always outpace regulation. The perfect example is our supply chain management standard in the electric utility industry under the NERC framework here in North America, which they just passed this at the end of this year. It was in response to the Stuxnet vulnerability of the Iranian nuclear program back in 2010–2011 when we saw the first instances of that.

And what did we do? We had a knee-jerk reaction and said, "This happened. Let's stand up a drafting team to develop a standard that will take many years to get in place." In the meantime, the bigger attitude we need to con-

sider if we're in an industry is that no regulation that says I shouldn't test third-party hardware or software or vet my vendors, so I'm not going to do that." If that's the posture we're taking, we're doomed. The thing that I've tried to advocate for is you have to look at this from a risk perspective, and compliance risk is just one input to that risk. When we're looking at supply chain now, I use that as the example of we've had eight years waiting for the standard to be in place, and yet people have neglected supply chain management because they didn't understand the risk associated.

Johnson: So, eight years of exploitation.

Humphreys: Exactly, and who knows what has happened. Again, the hard sell to executives and C-level folks is saying, "Do more than compliance," when there's a punitive component in the electric utility industry that says we just want to be compliant because it's a million dollars a day for the penalty. That scares people to death to just being compliant, and they don't want to do any more than that. But when I say, "The cost you're going to incur later to catch up to these standards and react to it is going to be far more costly than if had you mitigated that at the beginning and had the foresight to say, "I need to incorporate this as part of my risk. Supply chain management is something that I identify as a risk and a benefit to my organization regardless of any regulatory mandate."

Johnson: As an aside, just to stick this in parenthetically, based on what you've been doing, how much work do you do with ITAR for example?

Humphreys: Probably 25–30% of my work is mapping the regulatory requirements that deal with my other clients to ITAR standards, which is another thing that I specialize in. My clients will have multiple regulations that they have to deal with, but they're all asking the same thing, so I design their consolidated controls framework where I say, "Here's one control that fits many regulations versus siloing off the regulatory programs and designing processes around that. If I say there's an ITAR requirement that fits this NERC CIP one, let's leverage this. If there's a NIST requirement, let's leverage this." Overall, I aim to make a holistic controls framework for that organization that says, "You have a one-to-many control to satisfy multiple regulations, and ITAR is one of those inputs that I look at."

Johnson: For my readers, that tends to be the big element.

Humphreys: Absolutely. But like segregation of duties, network partitioning, data in transit and in rest, and all those things with newer frameworks are derivatives of NIST anyway. My foundation to any program is going to be based on NIST, and I roll everything else up to that because for any of these regulatory things—even internationally—you will see they cited some NIST guide as the basis for it. So, being able to digest that and parse that out to make it tangible based on the size and economy of scale of the entity is kind of where my niche is.

You're going to overwhelm people with some small co-op utility out in the middle of nowhere if you tell them, "You need to implement this full NIST program." They will respond, "You're crazy. We can't even spell that." But there's no reason why you can't make a program that's palatable and tangible to meet their risk model from a security perspective.

Johnson: That's great. Let's walk through that as an example. Imagine I have an electronics manufacturing facility doing $15 million a year with an active customer list in the significant four-digits; some customers require ITAR capabilities, and others don't. It's project-by-project deal whether it's ITAR-compliant or not. Most

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of the data is transferred to my facility electronically. Where am I exposed, and what do I do?

Humphreys: Well, you're exposed internally and externally without knowing what kind of protection and controls you have in place, but the data in transit and data at rest issues or challenges that NIST has a guide for is something that's an area in electric utilities, for instance, where there's no regulatory requirement covering data at rest and data in transit. They will say that your security logs and data aren't allowed to leave your electronic security parameter, which is hindering people from adopting cloud in the electric utility space. But if you took to the regulators with the NIST guide and said, "I've implemented these NIST best practices to protect my data in transit and data at rest. I'll take your compliance violation and fight it all day because I'm beyond what your compliance violation is," those are the kinds of things I would tell a manufacturing company to look at. Look at these guides to mitigate your hypervisor permissions or your jump post where that data is leaving and coming back and forth, and the multifactor authentication that you have when people access that file share.

25-30% of my work is mapping the regulatory requirements...to ITAR standards

These aren't overly strenuous safeguards to put in place, which is the other thing. People get really wrapped around the action and think this is going to be some hugely intimidating task to implement, but it's not that hard to put a couple of processes in place and stand up a hypervisor. Most of these folks have some kind of multifactor authentication method already in place. It's more of a procedural and knowledge-type process such as, "This is how we're going to do it now as part of our culture to mitigate these risks versus all of this effort to bring in new technology and tools."

Johnson: I need to bring in some expertise to take a look at this situation, put together a plan, and implement it.

Humphreys: Correct.

Johnson: I know I'm oversimplifying this, but how big of a company do I need to be to justify hiring somebody dedicated on my staff to do that? Where is that threshold where I should have somebody that I've hired versus somebody I'm working with on a contract for a project basis?

Humphreys: For example, a $15-million manufacturing company should easily have a dedicated staff of two to three people devoted to general-purpose IT. The unicorn is really the general counsel side with the technical, which is like the Bigfoot unicorn thing that you find out there. I'm contemplating going back to law school, to be quite honest.

Johnson: The technical recruiter on the conference call is the purple squirrel.

Humphreys: Exactly. That's your diamond in the rough, or whatever analogy you want to use for the mythical creature, but that's what you want to do. In the absence of finding that, if you can get the younger talent as you see here to have a sparkle in their eye on the regulatory side and retain them, that's the key. Have a plan to incentivize them to stay; keep them on their career route. And train them in-house. But at a $15-million company, you need two to three dedicated IT staff with one to two people with heavy regulatory and security backgrounds who are strategic thinkers and understand best practices.

Johnson: Okay, so a takeaway here is if I have an IT staff in my manufacturing facility that is dedicated staff—and all of them do—I better start making it an objective to get my IT staff trained on cybersecurity issues.

Humphreys: Yes. You need to have five people overall, and two of those people need to be strategic. The other three need to be tactical. That's basically to sum it up from a strategic standpoint.

Johnson: You're saying 40% strategic, 60% tactical.

Humphreys: Absolutely.

Johnson: If I need to get my staff trained, where do I go?

Humphreys: Well, the SANS Institute gives a lot of great online training. They're probably the worldwide leader. I wrote their security utility curriculum. IEEE probably has a lot of training and outreach as well. Academia now is offering some special programs in Texas; I remember seeing that at the University of Texas, San Antonio. I also know Texas A&M University has a lot of vulnerability assessment teams where the public can use their undergrads to come out and do work and assessments, and look at them to get the training that they need.

At the end of the day, there are training organizations that can do it. There might be some specialized graduate programs in information systems management in security, but to the level of hands-on manufacturing and things like that, I don't think that exists. I don't know if they do industry-specific or niche training, so if you wanted a training session for your readers in manufacturing, that needs to be created.

I think there would be a demand for that if you have enough of a base that we could go in and do a two- or three-day workshop. We would explain the end-to-end skill set you need, what your program needs to be comprised of, and how you need to monitor it and leverage what you already have. Many companies already have a lot of this in place, they just have to put it all together. I think that would be a great opportunity.

One of the reputational risks right now is circuit board manufacturing is under high exposure with the malware stuff being found and the chips data being found on those circuit boards coming from China. Those are all parts, whether we make them here or make them there, coming from the same place for the most part, too. Again, given my regulatory experience and the knee-jerk reaction to regulations, you'd better believe that every time the media posts some crazy security story that's done in a summit like this where hackers show up, it's easy to compromise one of these circuit boards; that's the best use case they can get for moving toward regulation of those things.

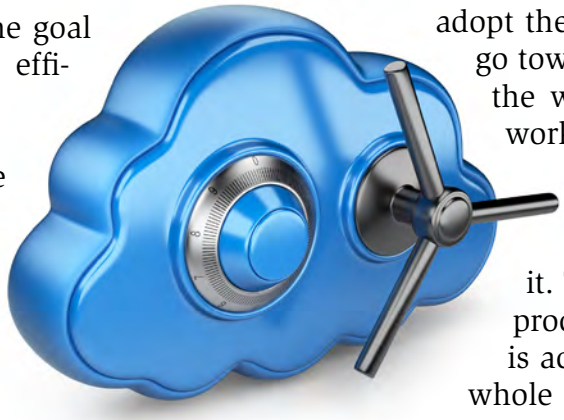
Johnson: The trouble is you can't see that through the manufacturing lens.

Humphreys: No, you can't. I think the regulation stuff is going to continue to grow. It's going to be the first knee-jerk thing everybody jumps to trying to corral it. It's not sustainable. You can't count on that to be the bar to be set for security and operational efficiency. It can provide a foundational layer for people that don't normally look at that kind of stuff, but it's definitely not the ceiling. Find that sweet spot to justify the efficiency gain and the risk mitigated by going ahead; beyond that is my niche. I can put that carrot in front of them and I can make them follow that carrot.

Johnson: Okay. At the risk of oversimplification, it's not enough just to do what's required through regulation; you need to do the right thing.

Humphreys: Yes.

Johnson: Of course, then the goal is to do the right thing as efficiently as possible.



Humphreys: Don't get me wrong, the regulators want to do the right thing; it's just a bureaucratic process involved to develop the regulations. It's too slow to stay up with the pace of technology and the threat.

Johnson: You can either go at the pace of regulation, which means you're going too slow and could be exposed, or you can go at the pace of technology that is way ahead of regulation, meaning you have to make some unregulated ethical choices.

Humphreys: You must look at risk to your organization, not just compliance risk from a regulatory standpoint. There's that whole plausible deniability defense that I fight all the time. Even if they do that and even if I'm compliant and have some issue, they can pass the buck to the regulator and say, "But I was compliant with your standards."

Johnson: "It's the standards that are the problem, not me."

Humphreys: I'd like to think that the majority of the world still wants to do the right thing and understands the reputational risk exposed to them, but it's not a plausible defense to say, "But I was compliant; it's the regulator's fault." At the end of the day, your customers are without your services.

Johnson: How often in the conversation does it come up around where the fear is that doing the right thing may turn out to be illegal later?

Humphreys: Not so much in the electric space, but I can see it in the manufacturing space. I'm encouraging the electrical industry right now to say, "Take those compliance violations and adopt the cloud." Because when you go toward a settlement with FERC, the way the compliance process works is you're issued an initial potential violation, it goes back to enforcement, and the FERC has to approve it. There's this long, drawn-out process until a financial penalty is actually assessed. During that whole process, it's not feasible for these small folks to retain the legal resources and all the time spent to fight it. But in the instances of adopting technology like the cloud, for example, I think you will win that fight by saying, "My justification for adopting the cloud was my risks in these areas were much higher than my compliance risk, and I had to do this." Those are the kinds of things that are going to draw FERC to move faster to get these standards up to pace to get technology.

It's unfortunate that it's incumbent upon the industry that's being regulated themselves to drive the regulations to change, but that's the world that we're in. Assess the risk to see if the compliance risk is less than the reputational, operational, and competitive risk. There're tons of competition with PCBs and things like that. If one word gets out that you had a compromise and there was an issue, think about how much that's helping out your competitors and how many customers you will lose.

To me, in that kind of an industry, that would far outweigh the regulatory risk for me from a business perspective. Again, calculating your risk model, that would need to be part of the training or outreach to your constituents of looking at the holistic risk model. How many different inputs do you have into risk in deciding how you're addressing cybersecurity? In your industry, I think compliance is probably middle to the bottom of the totem pole, and that might be valid.

Johnson: I think it is. Thank you, Chris.

Humphreys: You're welcome. SMT007

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A Working Definition of Automation

Feature by Happy Holden
I-CONNECT007

Editor's Note: Parts of this article include excerpts from and expansions of *Automation and Advanced Procedures in PCB Fabrication.*

Automation in a working context means more than just automatic machinery. Machinery implies mechanization. Automation also means the system information directs and controls people, materials, and machines. This concept is also known as systemization [1]. Therefore, automation is made up of two components, like a vector: mechanization (material flow) and systemization (information flow).

	Mechanization Class	Percentage Mechanized	Description of Actions
1	Manual	0%	Conducted by humans with simple tools
2	Semi-manual	10–25%	Conducted by humans with complex tools or machines; some activities are part of the hardware
3	Machine-assisted	25–50%	Conducted by humans with many tasks done by tools or machines
4	Human-assisted	50–75%	Conducted by machines with many tasks done by humans
5	Semiautomatic	75–99%	Most actions conducted by machines with humans in monitoring or supervisory roles
6	Fully automatic	100%	All actions conducted by autonomous machines with minimal to no human roles

Chart 1.

Mechanization Classes

Mechanization can be divided into six classes that indicate the amount of sophistication of machines and machine interactions with humans. The classes are rated based on the percentage of the work done by machines (Chart 1).

Systemization Levels

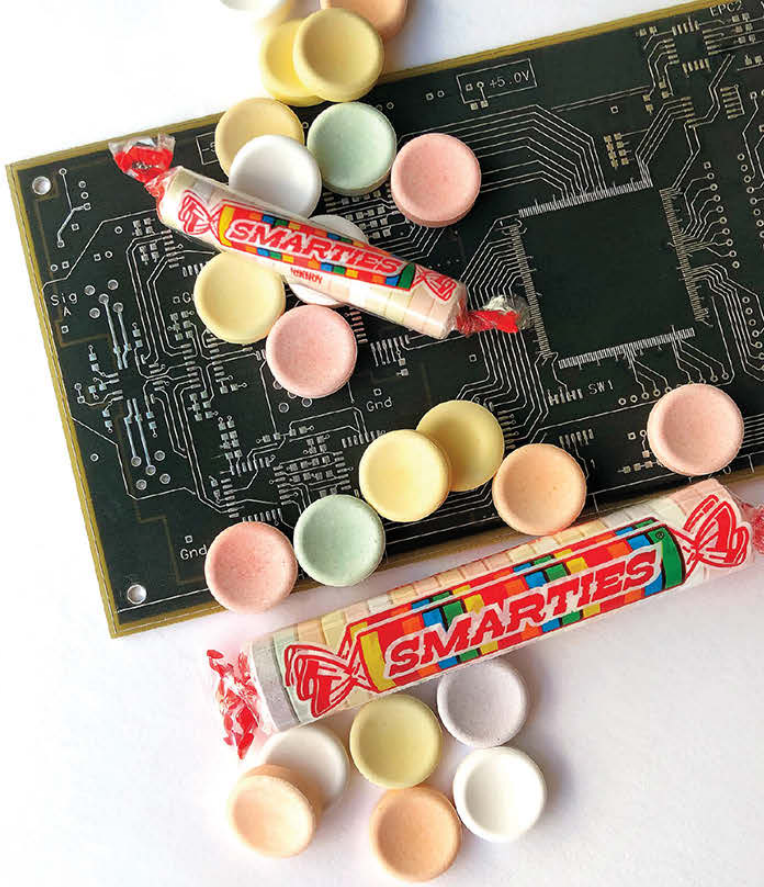
Similarly, systemization can be divided into six levels that indicate the amount and sophistication of blueprints, information, data, scheduling, and control that take place (Chart 2).

	Systematization Level	Percentage Collected by Sensors or Computers	Description
1	Manual information collection and distribution	0–9%	Set parameters; record past occurrences; documents and reports are produced at a later time
2	Batch computer/ human collection and distribution	10–24%	Capture information as events occur; documents are produced when and where required
3	Online computer/ human collection and distribution	25–49%	A continuous profile of events and information of a series of operations or movements
4	Real-time computer/ machine interface	50–74%	Dynamically compare actual events to those planned; alert, alarm, and advice messages are produced
5	Dedicated supervisory control	75–99%	Provide an alternative capturing the course of action
6	Fully automatic gateway/ network control	99–100%	Information management executes a control action when predefined conditions occur

Chart 2.

SUNSTONE CIRCUITS

Part 3 of 4



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Each level has an increasing percentage of machine/computer content handling the information required to fabricate, schedule, test, or move a product.

Automation Matrix

When both measures are applied to any activity in the process to tool or build a printed circuit, an automation matrix is created about that work center. This matrix allows for the current situation and future objectives or plans to be appraised, even if it is all manual (Figure 1). It is quite common for automation objectives to be made up of a number of steps or phases, allowing each step to be stabilized before the next one is taken. The automation matrix lends itself to this step approach.

Contrary to popular belief, the real work in automation is getting started. The time for management to start is now. In general, there will be five challenges that executives need to concentrate on if an automation program is to take root and flourish:

1. Commit to being the best
2. Build the team
3. Tear down traditional barriers
4. Gain knowledge of the tools and philosophies that create excellence
5. Use leadership to execute the strategies

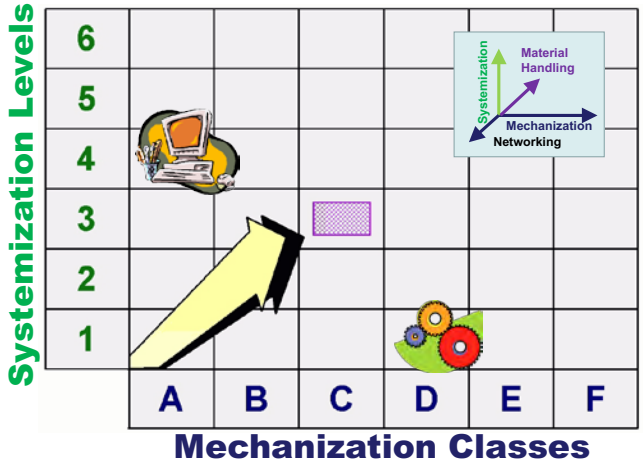

Figure 1: Automation vector is defined as systemization and mechanization, including material handling and networking between work centers.

Commitment

The first step is a commitment; more precisely, a shared vision is the most important step. The vision that must be shared is that of being the best and creating a roadmap for achieving that major goal. There will probably be changes along the way. The general manager can best affect major changes from the top, whether they are the head of a standalone company or of a major manufacturing division. Only the general manager can make a long-term commitment to being the best. This vision is shared because it will also require others to be committed to manufacturing and engineering excellence.

Building the Team

Successful automation can only result from a professional team effort. How can a company get everybody pulling in the same direction? Part of the answer is education through sharing information about technologies that are galloping out ahead of the decision makers. The general manager must hire people who can do the job when they think their team is internally or externally deficient. They must also adequately train the whole team, including the production workers, who are too often left out (Figure 2). The technical demands may require at least a temporary boost in engineering power or consulting. In many cases, the lack of adequately trained numbers of engineers limits the rate of improvement and increases the risk of failure.

Tearing Down Traditional Barriers

To build the team that is required, the general manager must tear down the traditional walls that have isolated the various functions that participate in manufacturing and engineering. They must build a strong partnership of equals from marketing, R&D, purchasing, production, engineering, manufacturing, sales, distribution, and after-sales service. These related functions should work together as a closely-knit team to achieve the overriding goal of being the best. These walls are not only barriers to the shared vision but also to the under-

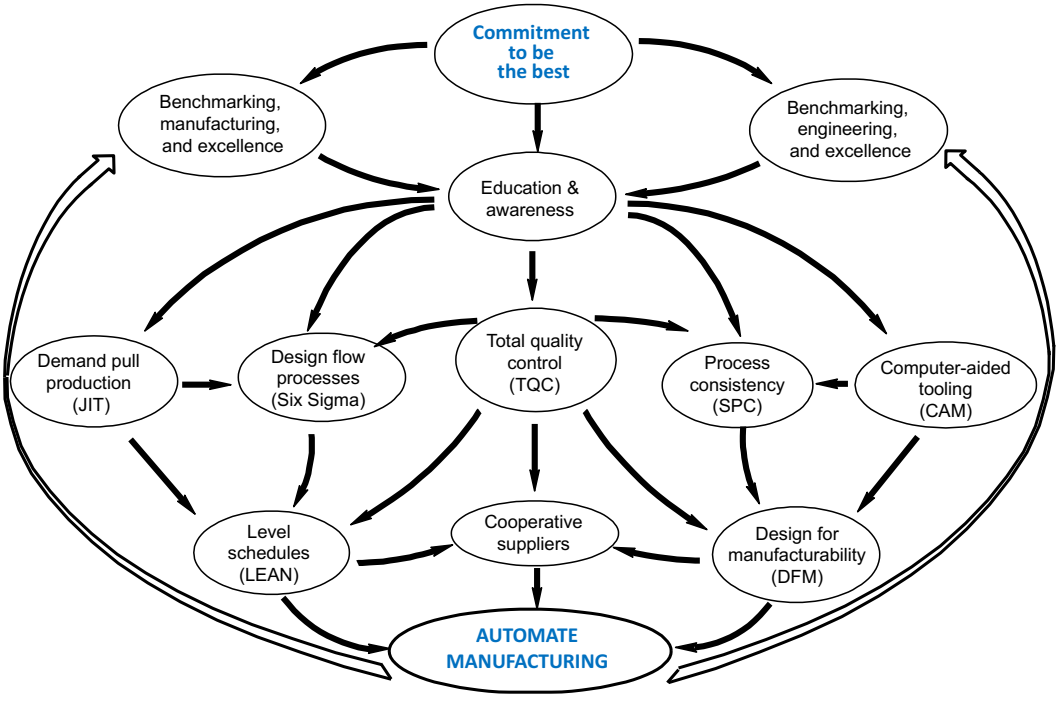

Figure 2: Commitment to manufacturing and engineering excellence is the basis for any automation system.

standing and consensus of what information is needed to develop the strategy for automation.

Automation is Strategic

There are numerous dimensions to automation strategies, which are all driven by top management. Do you know any of these strategies? If not, here are six fundamentals:

1. Develop a plan
2. Be aware of opportunities
3. Create a quality paradigm
4. Recognize myths
5. Understand the prerequisites
6. Avoid pitfalls

Automation is Tactical

Likewise, there are numerous elements to automation tactics:

1. Focus the factory
2. Consider the technologies
3. Implement a manufacturing management information system
4. Learn to pay as you go (justification)
5. Plan the steps and have a good methodology
6. Understand how to integrate

Six Automation Principles

For the rest of this article, the assumption will be that all the necessary preparations in strategy and tactics have been completed. Now, how does it all fit together for successful implementation? This problem affects large, wealthy companies as well as small job shops. Successful automation implementations depend on close adherence to some cardinal principles, which will be reviewed in further detail:

1. Superiority
2. Simplicity
3. Flexibility
4. Compatibility
5. Manufacturability
6. Reliability

1. Superiority: Automation Must Contribute to a Business Goal

In the simplest terms, the business goal is to be the best. However, "best" is relative. Thus, it can be rated based on experience, reputation, technology, profitability, engineering, or anything to compare oneself to competitors. The customer's perspective is important; what

do they say when rating the best? Examples might include quality, delivery, price, flexibility, technology, or service. The selection of which area of performance to which automation is aimed will have the most influence on picking vendors and programs.

The 20-40-40 Rule

In a publication about CIM [2], Wickham Skinner quoted the General Electric "20–40–40 Rule." The rule states that for the average fabrication and assembly production plants, only 20% of any ultimate cost saving and performance improvements come from productivity changes and conventional engineering concepts and techniques. Meanwhile, 40% can come from manufacturing policy and structure changes, such as TQC and Lean, and 40% from improvements in fundamental manufacturing technology.

This gives a clear alternative to smaller companies who cannot afford expensive automated equipment. Their management can make a much more affordable investment in policy and structure changes. This is just another way of saying "manufacturing philosophies." As mentioned earlier, the important ingredient is a commitment to be the best. Once this commitment has been made, then investment in education, awareness, and training can be made.

2. Simplicity: Automation Must Help Simplify Manufacturing

It is imperative to use automation technology to simplify the production task rather than make it more complex. Part of simplifying the problem is not automating any operation that is better done by human skills. The basis for this principle is that automation is consistent, untiring, and fast, but unlike humans, machines do not possess common sense or the ability to change their own programming when a glitch appears. To take advantage of automation, factors must be simplified from the previous manual technique.

Total Quality Control

Total quality control (TQC) is the foundation of any excellence program. It is a management

and operating philosophy totally committed to quality that focuses on continuous process improvements using data and the scientific method making perfection a goal. TQC requires universal participation and working as a team so that the result is customer satisfaction because expectations are consistently exceeded for both internal and external customers.

Vital elements of the TQC process include clearly understood and agreed-upon goals; appropriate performance measures; rigorous information collection, such as qualitative and quantitative analysis; an approach utilizing creative problem-solving; and participation by all members. Top management must drive this entire process. Thus, the working objective of TQC is to fix the process and make it work better. All activities are processes, so the TQC methodology starts with four procedures:

1. Identify the problem
2. Identify the causes
3. Eliminate the causes
4. Monitor the process

This may seem simple, but it only succeeds when everyone becomes involved. Workers, supervisors, engineers, and managers must receive training on the elements of TQC. Management should back every step of this training from providing initial instructions and statistics experimentation, to providing time for employees to learn these skills and reinforcing the commitment to being the best.

So, why has it taken so long for TQC to be accepted? It may be because TQC is counterintuitive to the current business culture. The current business culture causes companies to react to uncertainty by adding complexity; even the current reward systems encourage complexity. For example, a company might add a vendor if another vendor's performance is not trusted. Lead time may be added if the capacity is not trusted. Similarly, inventory may be added when levels are low, while rework stations may be added if the quality is low. If a

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company does not have the time to do something right, they may choose to add more time to do it over.

Gaining control over and reducing complexity through knowledge and understanding are the primary objectives of TQC. One major task of automation is to simplify and organize complexity. A simpler process has:

1. Less inventory
2. Fewer floor spaces
3. Fewer people
4. Fewer process steps
5. Fewer part numbers
6. Fewer options, accessories, manuals, and paperwork
7. Less chance of error

Per Unit of Output

TQC and Six Sigma are constant contributors to move product quality and manufacturing yields higher. The goal is to minimize variability and maximize quality (Figure 3). One role the computers of automation play in TQC is the collection, reduction, and analysis of information and data. When a problem has been solved, the systematization role of automation constantly monitors to keep it under control.

Standardization

Standardization is another method of simplification, which is why many companies standardize panel sizes in production. What they may lose in material cost they can make up for in improved performance from a simpler automated process. Other candidates for standardization are image transfer and CNC tooling, procedures, equipment, and training. Even tasks like costing and accounting can benefit from standardization. DFMA is one of the best ways to obtain standardization. Remember, automation will require simplification.

3. Flexibility: Automation Must Adapt to Changes Without Repeating the Initial Investment

Trends in Automation

Historically, if the manufacturing environment was simple enough, the product quantity large enough, and the product characteristics stable enough, one would invest in fixed or rigid mechanization. The only other option would be to leave it essentially manual. This could be applied equally to a single task or an entire manufacturing sequence.

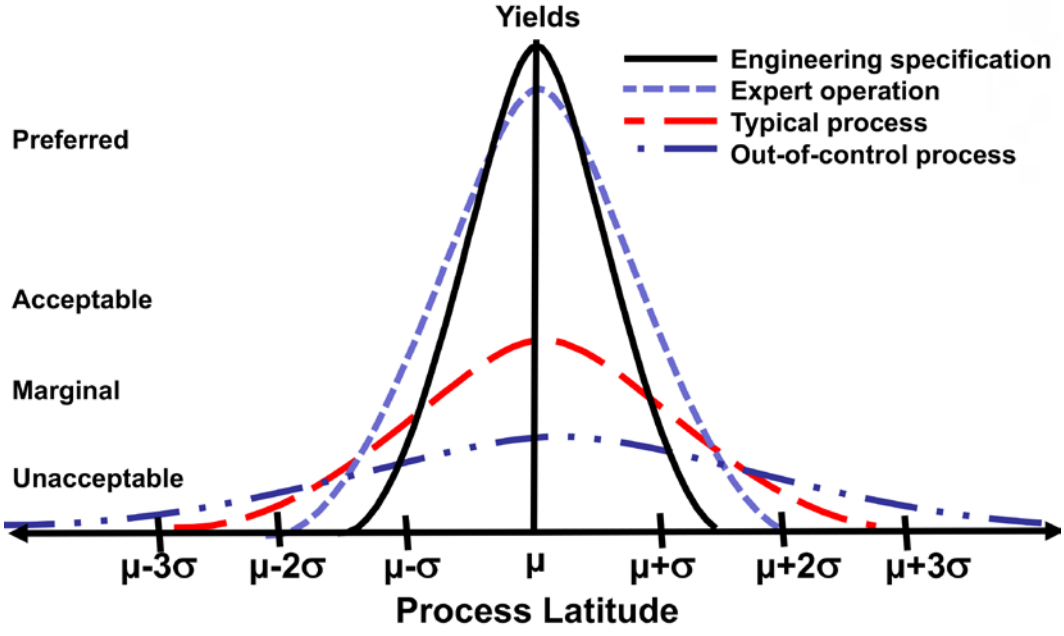

Figure 3: Narrowing the process latitude below two sigmas is the goal of TQC and Six Sigma programs.

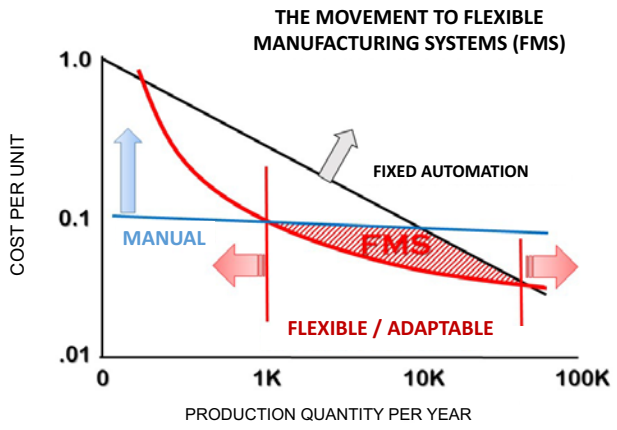

Figure 4: Flexible manufacturing systems are more cost-efficient and adaptable to any type of manufacturing.

Recently, the trend in automated systems has been toward flexible and adaptable systems. While labor and fixed automation are increasing in costs, newer technologies are bringing flexible systems down in cost. Viewed as a "per unit cost," this means that the intersection of flexible systems and manual or fixed systems is spreading. This spread covers the typical volumes seen in batch printed circuit production (Figure 4).

Flexible automation in printed circuits today is typically programmable and computer-aided based on CNC; direct numerical control (DNC) of shearing, drilling, contouring, and photo-plotting; computer-aided AOI; computer-aided test and process automation; and computer-aided manufacturing/artwork/tooling (CAM). Direct imaging and inkjet printing are examples of flexible automation that eliminate many human/machine steps. All of these techniques are automation because they have both mechanization and systemization content.

Modern Information Systems (MRP III)

Flexible automation that is mostly systemization would be the role of a modern information system. The technique for production processes is called manufacturing resource planning (MRP III). MRP III and the older material requirements planning (MRP) are management processes or techniques for taking the business plan and breaking it down into tasks of materials, inventory, schedules, and costs. Specifically, the detailed tasks include:

1. Business planning
2. Production planning
3. Order processing
4. Master scheduling
5. Material planning
6. Shop floor control
7. Vendor scheduling
8. Planned execution and feedback

The capacity to do evaluations and "what-if" scenarios is possible. MRP is a powerful discipline and philosophy, but it is based on company-wide teamwork and detailed implementation driven by top management. MRP III can be used in just about any size company making any type of product on a process or batch order flow. The four basic MRP III pack-

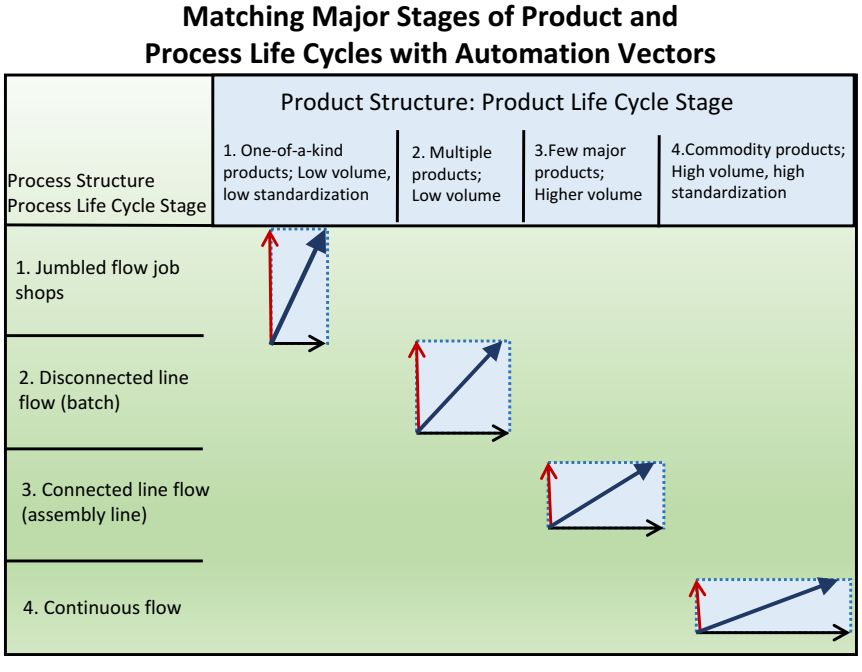

Figure 5: The information extent of systemization varies with the type of manufacturing.

ages (Figure 5) for discreet product manufacturing are:

1. Jumbled Flow (Job Shops)
   - Traditional MRP with varied routings
   - Material-based backward scheduling
   - Individual shop orders
2. Disconnected Line Flow (Batch)
   - Lot control
   - Serial number BOM effectiveness
   - 7000.1 cost accounting compliance
3. Connected Line Flow (Assembly Line)
   - Fixed routing cumulative MRP
   - Backflush inventory
   - Daily or weekly schedules
4. Continuous Flow (Process)
   - Capacity-based forward scheduling

MRP III systems will not be made obsolete by CIM or automation; just the opposite will be true. As manufacturing systems become more dependent on systemization to control the mechanization, manufacturing planning and control function will become more indispensable. Ten years ago, MRP was essential for:

- Capacity requirements planning
- Cost accounting
- Forecasting
- Master production scheduling
- Material requirements planning
- Order entry
- Purchasing distribution
- Resource planning
- Resources requirements planning
- Shop floor control

Today MRP II (III) has added:

- Computer drawing graphics
- Demand-pull interfaces
- Group technology
- Manufacturing decision support
- Preventative maintenance
- Production documentation
- Simulation throughput optimization

MRP III centers on the fundamentals of materials, and production planning and control. It stresses accurate data that increases visibility into manufacturing. MRP III provides a common language for communication—a company game plan that calls for company-wide teamwork and discipline to make it work. It is a basic, comprehensive approach to running a manufacturing operation. There are a large number of MRP III general-purpose systems available today at a very reasonable cost. There are also two or three MRP III systems designed specifically for printed circuit fabrication [3] (Figure 6).

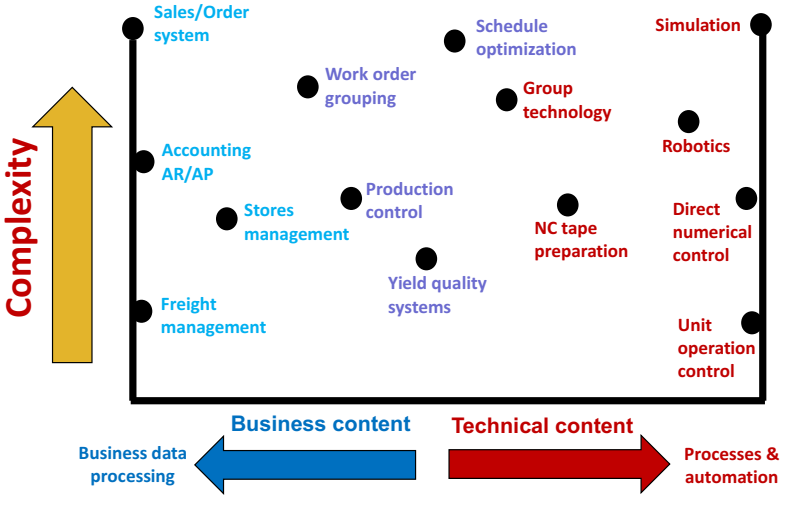

Figure 6: Business and technical systems software come in many varieties and complexities.

Consideration of Advanced Technologies

As mentioned earlier, 40% of potential performance improvement is contributed by advanced manufacturing technology. In applying the principle of flexibility to new equipment, processes, or materials, one can design the automated system to handle a wide variety of operations—not just one or two. Part of making the system flexible is building into its requirements the capability of adding new technology or replacing parts with new technology as it becomes available. This will require staying informed

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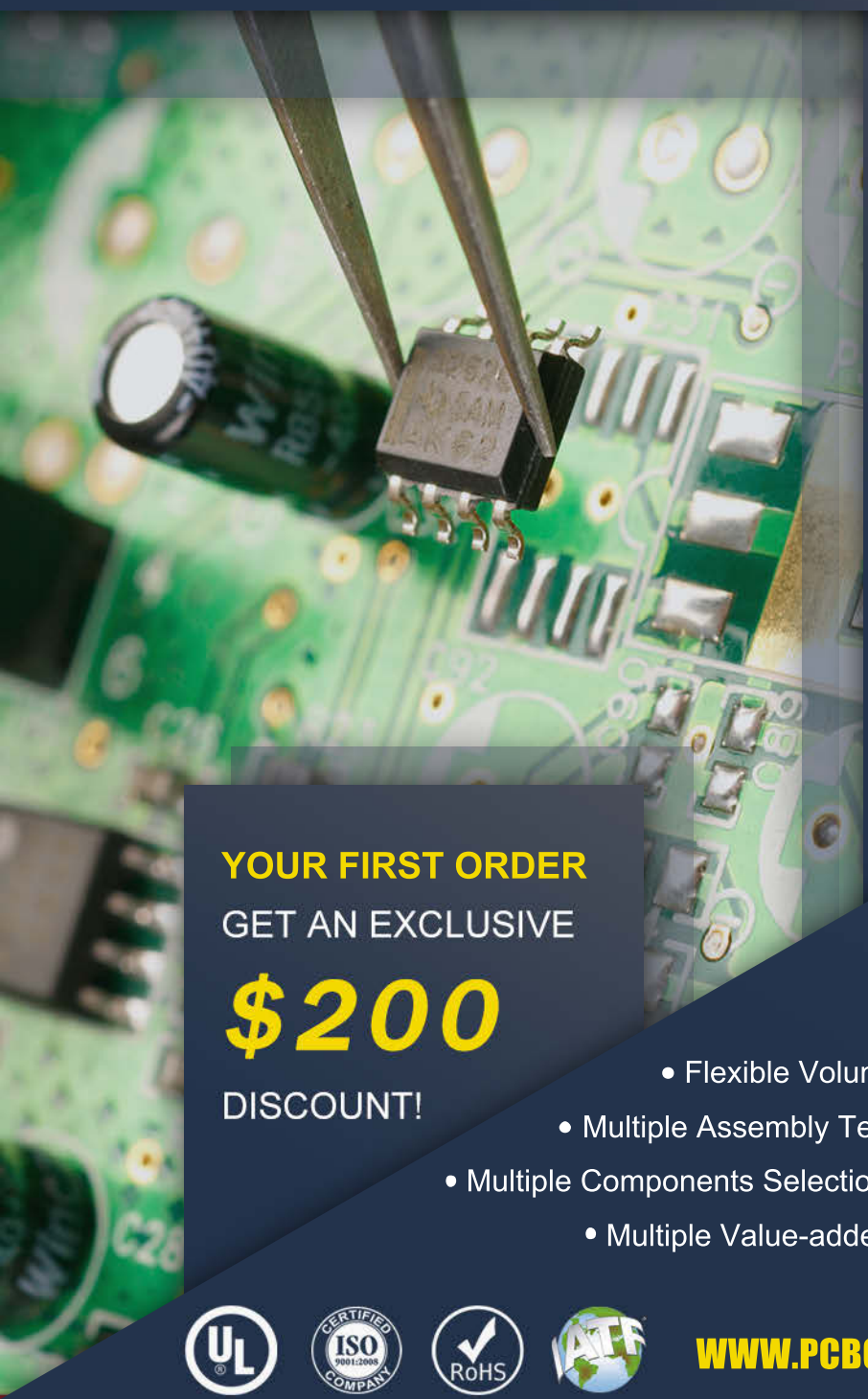

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about new trends and developments so that systems can be designed with both current and future needs in mind.

I believe these advanced technologies come into use as part of a wave theory; new technology is first picked up by a small group of initiators, the risk-takers, who make up 2–5% of the industry. Between the second and fourth year of this technology, the companies with reputations of being progressive have assimilated this technology into their operations; this group encompasses 15–18% of the industry. The remaining 80% of the industry will integrate this technology over the next five to 14 years.

By this time, if the technology is still viable, it will be common practice and knowledge. Remember, the printed circuit complexity factor will increase by 10 times every 13 years. This is one of the major driving forces behind the technology turnover and is a significant consideration in the automation planning cycle. A person can place themselves with respect to the waves by checking how many years a given technology has been out and using this as part of their technology acquisition targets.

4. Compatibility: Automation Must Evolve From and Coexist With Manual Techniques

One truth in automation is that if you cannot do something manually, what makes you think you can do it through automation? Automating for quality is a myth; automating for consistency either results in consistent quality or consistent scrap. The automated system must share the same heritage as the manual systems. The most suitable manual technique for automation is Lean or the continuous-pull production technique. It focuses on many of these problems in a conventional material flow system:

- Excess inventories
- Queues and safety buffers
- Extensive repairs and reworks

Lean Manufacturing

Lean (synchronized) manufacturing is a logistics approach designed to result in minimum inventory by having material arrive at each operation just in time (JIT) to be used. Figure 7 shows the "alligators" when you lower the level of the swamp with JIT. Orders in a

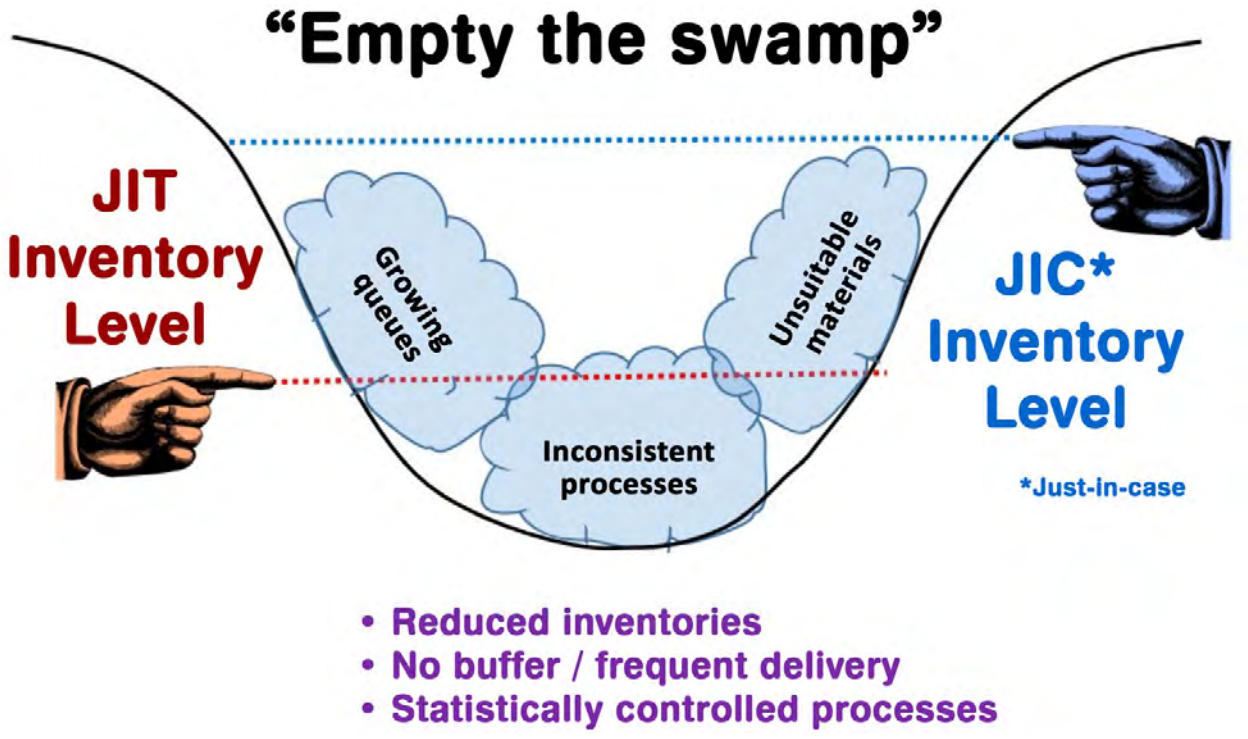
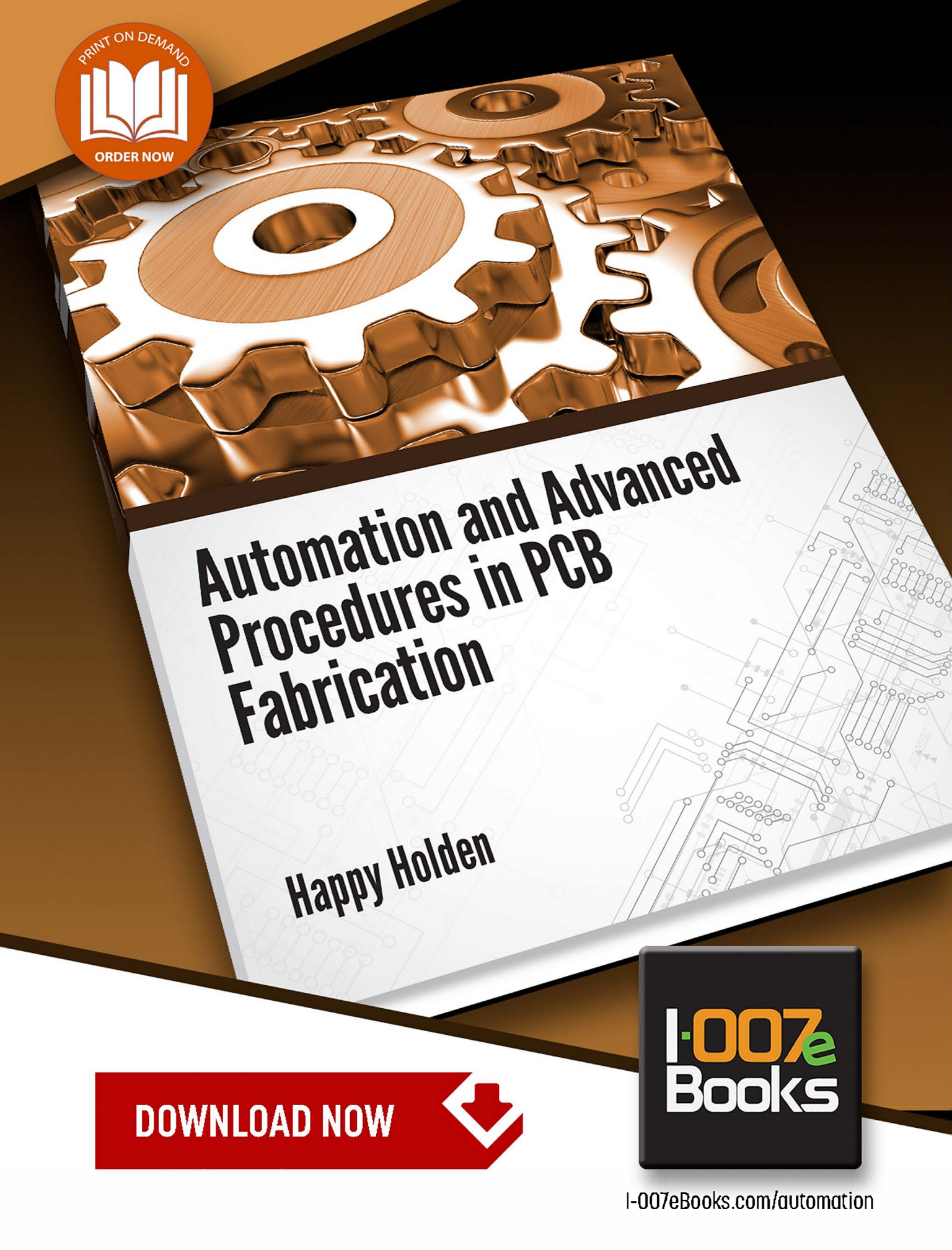


Figure 7: Lowering inventories through the practice of Lean and JIT uncovers many hidden problems.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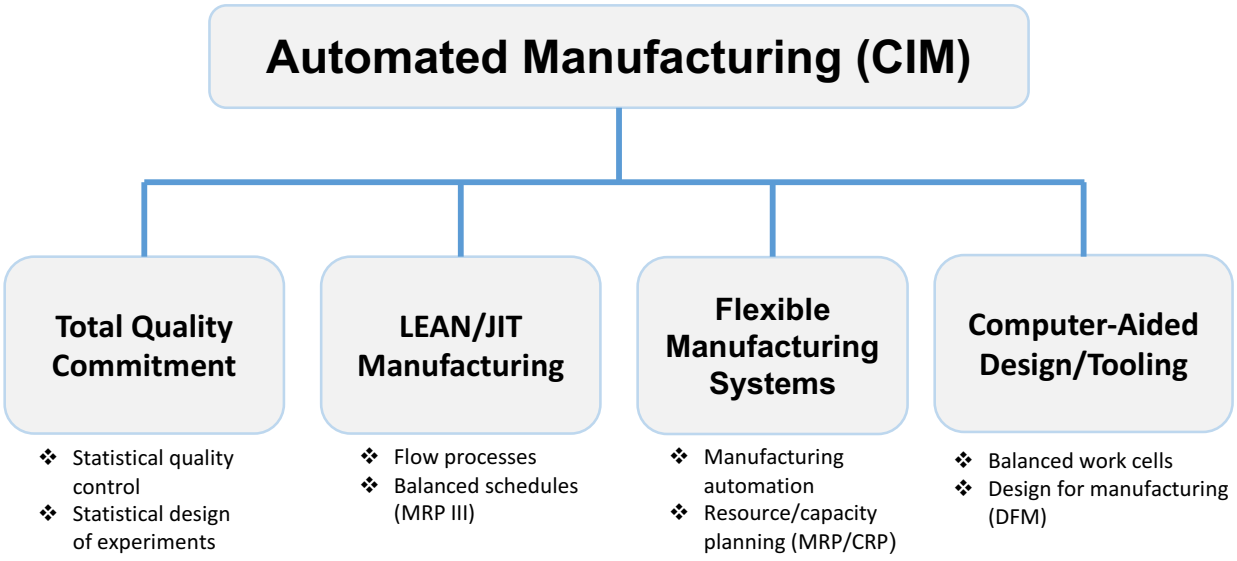

Figure 8: Automation fits with systems other than Lean/JIT such as TQC, DFM, SQC, FMS, CAM tooling, and others.

Lean system are pulled through the system by demand. They are often triggered by a reorder point system called Kanban. Every time a container of material parts is issued, the item is immediately ordered.

Lean applies to job shop, batch, and assembly line manufacturing, but is most common in high-volume, repetitive processes where a common product is being manufactured. The Lean approach reduces inventory and buffers of all kinds to a point where problems like unsuitable materials, late deliveries, or inconsistent processes cannot be hidden. Lean forces businesses to stop the line and fix the problem before rework is created. Lean implies changing the physical process and plant layout to reduce transit time, and therefore, costs and buffers. Again, this shares a common philosophy with grouped-flow manufacturing cells and TQC. TQC should exist within any business considering implementing Lean. The TQC methodology must be applied everywhere by top management, even to develop a strong supplier relationship and maintenance program (Figure 8).

The payback of a TQC/Lean program includes real savings. Higher quality is achieved, lower inventories are required, work-in-process inventory tracking is no longer essential, space is reduced, equipment utilization is higher, and direct/indirect labor is lower.

Automation Methodology

Automation methodology is a formal procedure for planning, designing, and implementing automation. It is particularly important when you want to start integrating several previously independent production tasks into one or more automated systems. The automation program can consist of six phases (Table 1). Phase 4—detailed design and requirements/specifications—is the most important phase (Figure 9).

The methodology stems from the previously defined automation matrix (Figure 1). Additional axes are added to the matrix to cover material handling (mechanization) and network communication (systematization) between cells or work centers. A simplified diagram is illustrated in Figure 10. The actual methodology will take up several drawings and utilize a number of worksheets to analyze and plan the data (Figure 11).

5. Manufacturability: Automation Must Be Supported by Product Evolution

The majority of PCBs are not designed and fabricated by the same group; different teams are in charge of the two functions. As a result, it is very difficult to change the design of a printed circuit. Feedback for printed circuit

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CIM-directed Modernization Plan

PHASE 1 ENVIRONMENTAL ASSESSMENT (4–8 Weeks)	**ACTIVITIES** • Conduct systemization review (flow, quality, etc) • Conduct CAD/CAM audit • Perform process scan • Perform organization review • Analyze business forecast	**DELIVERABLES** • Profile of systemization/ mechanization opportunities • CAD/CAM systems specification input • Assessment of organizational impact • Rationale for cost-benefit analysis model
PHASE 2 PROGRAM STRATEGY (6–10 Weeks)	**ACTIVITIES** • Perform macro-level stimulation for CBA • Establish performance targets • Create CIM strategy & automation plan • Develop documentation methodology for CIM system	**DELIVERABLES** • Documented CIM strategy & implementation plan • CIM architecture • Organization & staffing plan • Database mapping of functional processes
PHASE 3 CONCEPTUAL DESIGN (6–10 Weeks)	**ACTIVITIES** • Exploration of preliminary process equipment & automation alternatives • Initiation of requests for information (RFI) • Develop conceptual specifications for manufacturing support systems • Organize manufacturing technology teams	**DELIVERABLES** • Budget profiles on equipment/ software development created • Documented conceptual specifications for functional approvals
PHASE 4 DETAILED DESIGN & REQUIREMENTS/ SPECIFICATIONS (13–26 Weeks)	**ACTIVITIES** • Generation of detailed process/ equipment designs • Generation of detailed manufacturing support sizing of system specifications • Involvement with technology suppliers • Creation of integration plans • Execution of simulation model on automation alternatives • Creation of RFP specs for supplies	**DELIVERABLES** • Transaction (I/O level) design document for manufacturing system • REF Specification with functional sizing of system • Detailed cost/benefits model document • Implementation plan
PHASE 5 DEVELOPMENT (Cycle depends on Phase 4 scope)	**ACTIVITIES** • Selection of equipment, hardware, & software suppliers • Implementation of development hardware & software • Software programming • Debug & test subsystems	**DELIVERABLES** • Completed system software • Installed, operational equipment
PHASE 6 IMPLEMENTATION (Cycle depends on Phase 4 scope)	**ACTIVITIES** • Construct ATP • Execution of system test • Construct system & user documentation • Execute ATP • Trainer of end-users	**DELIVERABLES** • Acceptance of test procedures • Operational CIM systems • Technical & user documentation

Table 1: The automation project consists of six phases of planning and implementation.

designers can then take one or more of these three common responses to the design:

1. A printed circuit unsuited to the automated systems of the fabricator will usually have a higher quoted price than ones ideally suited. This has the tendency to send the buyer elsewhere; therefore, selecting the products the automated systems will handle

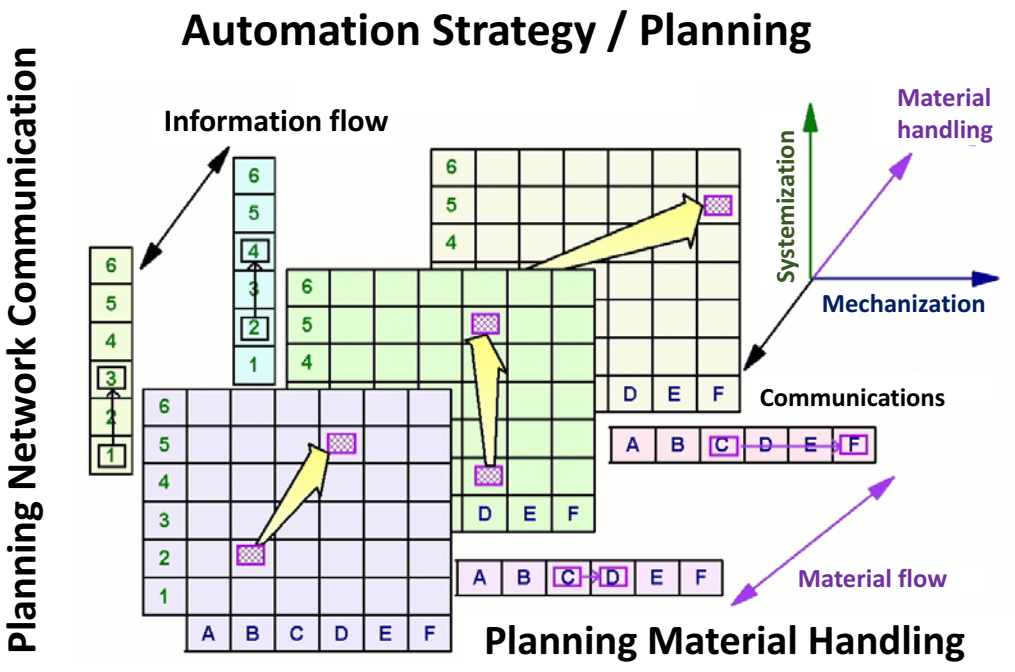

Figure 9: The automation requirements definition (Phase 4) is the most important phase and requires a thorough analysis of the automation vectors.

Figure 10: The added dimensions are the material flow between work centers (classes of material handling) and the information between work centers and control computers (levels of networking).

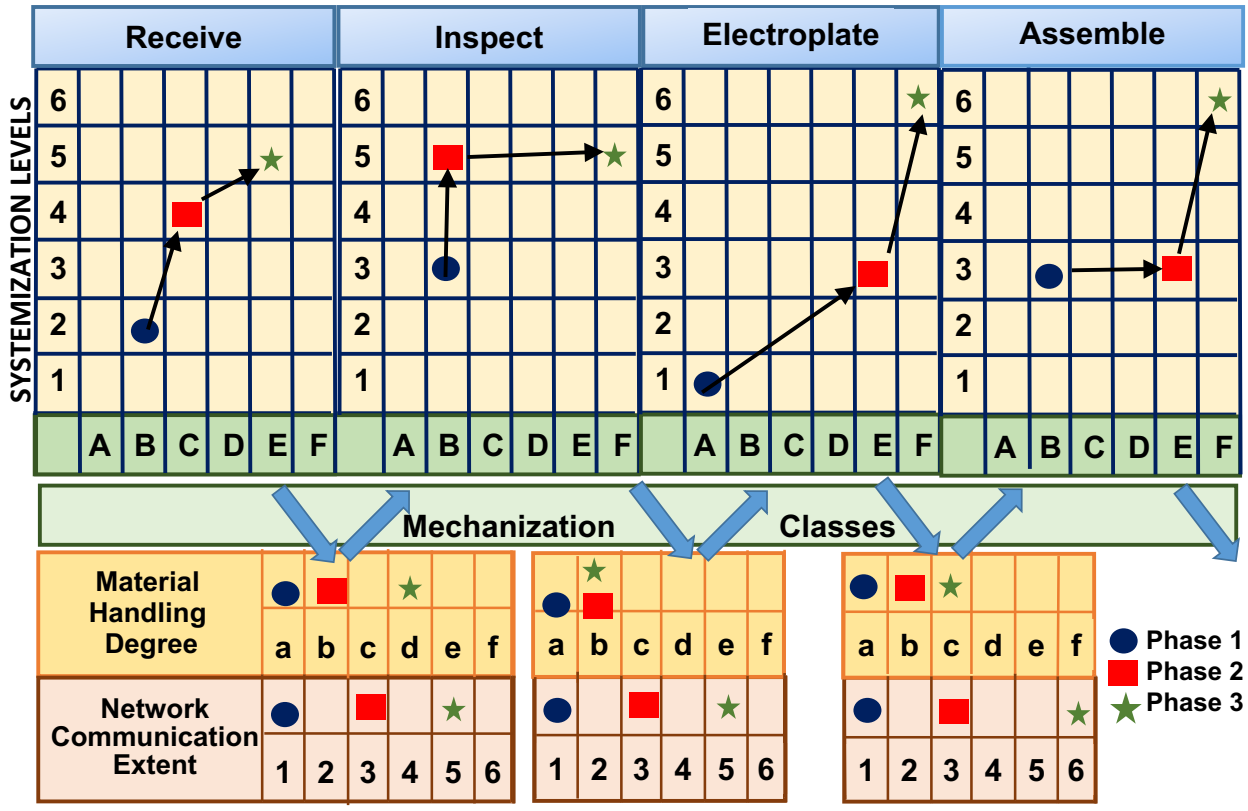

Figure 11: The automation methodology consists of automation plans for each work center plus plans for material flow and information flow between work centers.

2. Computer-aided tooling/artwork systems are used to process and methodize PC artwork files, put them on grid, clean up line spacing and straightness, align layers, standardize tooling, and provide NC and AOI programs. They can also design multiple image panels. All of these tasks change and improve the product. The printed circuit and its panel evolve, which will improve the performance of the automated system
3. DFM programs can be undertaken by the customer or product engineering

These programs are designed to lead the customer to do a better job at designing the product and making changes or edits that will improve the product and lead to corresponding cost savings.

DFM

DFM is a relatively recent engineering philosophy focused on improving the fabrication of parts or simplifying the assembly of products by analyzing value, tolerance, movement, difficulty, or suitability for automation. The approach can take many avenues but the goal is the same—simplify the product and make it easier to manufacture. One technique developed by Dewhurst and Boothroyd and further refined by Hitachi and General Electric involves the design for assembly being based on a rigorous analysis of assembly part count, the complexity of motion and parts, and assembly time. With this numerical rating, a more rational program of improvements is possible.

Other times, customer or product engineers in the manufacturing chain are called upon to implement the program. It is their job to supply customers with PCB education seminars, design and cost guidelines, and tradeoff comparisons. A manufacturability audit or recommendation may be in order if a company produces prototypes. By any means, the goal is to make the printed circuit more producible. This will lower the complexity factor (C). In fact, if

automation is going to be utilized, this product evolution is essential.

There are other facets of the philosophy, such as group technology, value engineering, tolerance and margin analysis, analytical troubleshooting, and experimental design. Like TQC, MRP III, and GT, DFM depends on accurate data and analysis. Information is essential.

6. Reliability: Automation Must Be Robust and Tolerant Enough to Keep Functioning Well, Even Under Adverse Conditions

Automation usually entails a sizable investment. If so, the return on this investment is most assuredly based on continuous use. Inoperability due to breakdown, spare parts, operator mistakes, or undue complexity cannot be tolerated. Prima donna systems are for research labs. A manufacturing system must be robust, easy to maintain and service, straightforward to operate, and have a track record that speaks for itself. Failure mode and effects analysis (FMEA) is a key TQC process to ensure that reliability issues do not interfere with customer satisfaction and profitability.

Processes and Raw Materials Consistency

Process and material characterization is a major factor in the reliability of a process. The latitude a process exhibits to variability in conditions and materials are chief factors in process control, quality, and yields. This is the main focus of manufacturing philosophies, such as statistical quality control (SQC) or statistical process control (SPC) [4].

The SQC approach is essential to providing process reliability and meeting a TQC approach. There are numerous sources of variability including materials, machines, tooling, workmanship, etc. They combine similar tolerances and are not simple summations. The end result could be large and unpredictable rejects and defects, or, if managed, small and predictable rejects and defects.

Reducing process variability means working on machine instability, maintenance, and calibration; improving tooling accuracy and ease of use; making setups reproducible and easy to adjust, or having no need for adjustments; and ensuring raw materials are properly specified and that vendors have their processes under statistical control. It requires training, coaching, and well-documented procedures.

Leadership to Execute the Strategies

Automation, although highly desirable, is about more than just buying equipment and processes from vendors. A successful automation program requires focusing on the business needs of the company. The first step is the commitment to being the best—not the purchases. Automation follows other manufacturing programs. It is not the start of the process. CIM fits with TQC, Lean, DFM, SQC, CAT/A, and FMS programs.

Improved performance can be achieved when these programs move the manufacturing response curve to the right, while customer improvement programs move PCB products to the left (Figure 12). As Figure 10 shows, a mediocre PCB at Point 1 can be improved to Point 2 or Point 2' by process improvement or product simplification. Better yet, improvement could move it to Point 3. This is the secret of Japan's enormous manufacturing success. Overall, management's challenge is to:

- Think strategically
- Examine the role of technologies
- Use manufacturing and engineering philosophies to support the company's business goals
- Support ongoing programs of education and training in new techniques

Seven Checkpoints

After covering automation planning, the difference between automation and mechanization should be clear. In printed circuit fabrication and assembly, most of what is advertised involves mechanization. However, true automated solutions are seen in assembly tests. The difference between the two is the networking and protocols that supply the information and data. Examples can be drawn from the semiconductor fabrication industry; this industry

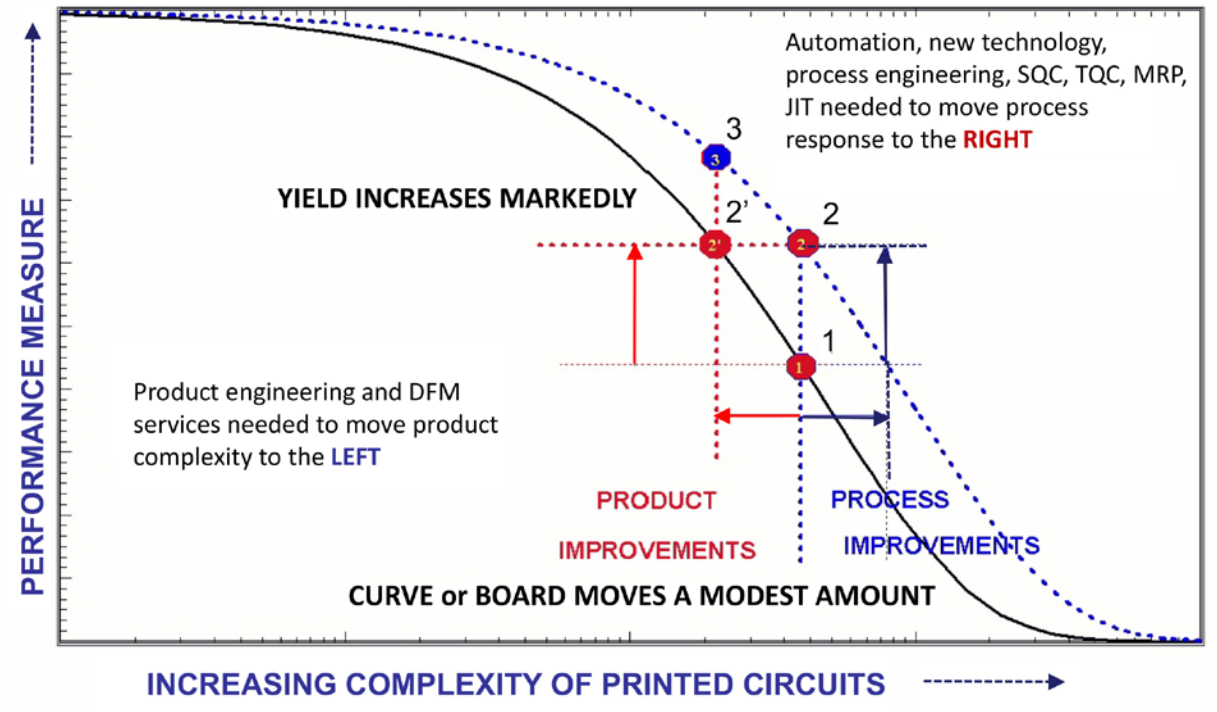

Figure 12: Improvement in yield and customer satisfaction is a combination of process improvements (2′-2) and product improvements (1-2) resulting in a markedly improved yield (1-3).

has employed fully automated factories since the mid-1980s.

The keys to automation success include seven checkpoints:

1. Believe that it can be justified. Many benefits will come from entirely unexpected sources
2. Recognize that enthusiasm, along with a champion, can work wonders
3. Start with a vision, but begin implementation before detailed planning is complete. Early success builds momentum
4. Realize that functional organization will try to get in the way. Don't let it happen
5. Get rid of obsolete traditions, which have no place in today's competitive environment
6. Rigorously apply TQC, or an equivalent, before proceeding. Understand that technology is only part of the answer
7. Lots of benefits will come from simple improvements. Success comes from people—not machines

These seven ideas—along with the strategies, tactics, philosophies, and principles outlined here—are all aspects of the commitment to be the best. SMT007

Further Reading

To learn more about factory automation and smart factories, including planning, real examples and process control basic, download I-Connect007's free eBook *Automation and Advanced Procedures in PCB Fabrication* at i007ebooks.com/automation (Figure 13).

References

1. Wu, Bevan P.F. "Manufacturing Strategy Towards Integrated Automation," Taiwan Productivity Center Conference, December 1983.

2. Skinner, W. "Re-inventing the Factory," *Harvard Business Review.*

3. O'Connor, J. F. "Making MRP Work in a Multiplant Environment," *PCFAB,* September 1985.

4. Wallskog, A. G. "Meet the Challenge of International Competition for PCB's Through Strategic Quality Planning," *IPC Technical Review,* March/April 1986.

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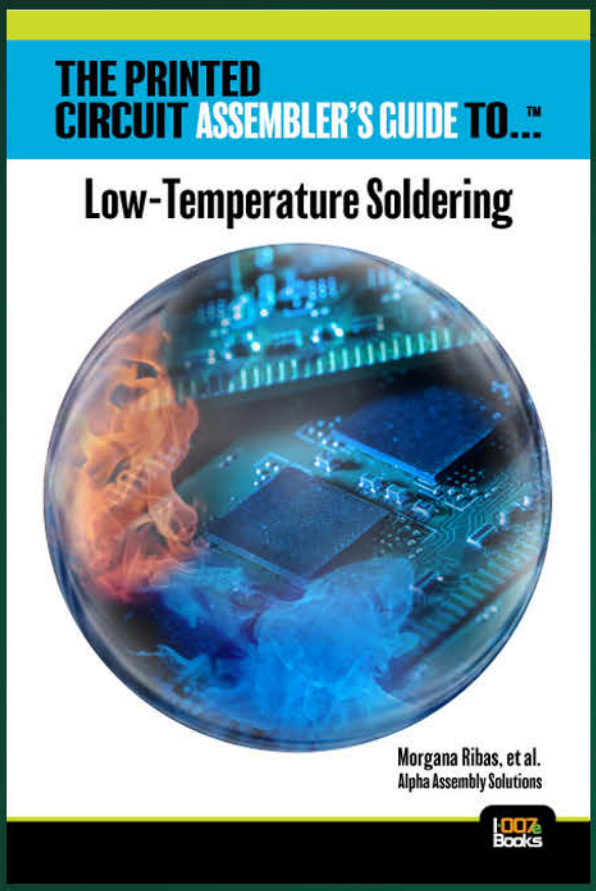

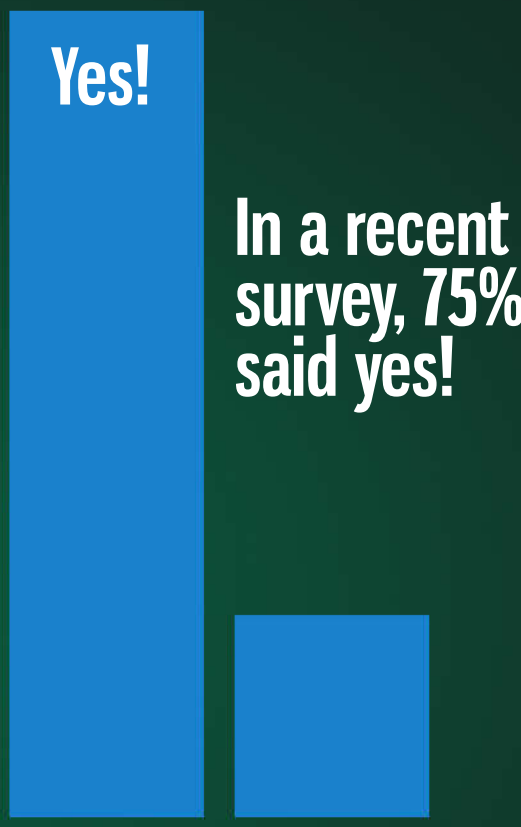

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Supplier Highlights

Electrolube Overcomes Secondary Cure Issues with New UV-cured Conformal Coatings ▶

Electrolube Managing Director Ron Jakeman and Marketing Manager Julia Vorley speak with I-Connect007 Technical Editor Pete Starkey about the successful outcome of the international collaboration between the company's R&D teams in the U.K. and China, which resulted in a brand-new range of solvent-free UV-cured conformal coatings about to be launched at IPC APEX EXPO 2019.

Award-winning Koh Young Process Optimizer ▶

Joel Scutchfield, sales director with Koh Young America, discusses the company's outlook and new product offerings, including their Koh Young Process Optimizer (KPO), which won an award at IPC APEX EXPO 2019 for the process control software category.

Barbara Nichtern as VP of Global Sales and Marketing at Yxlon ▶

Barbara Nichtern has taken over as the VP of global sales and marketing at Yxlon and is responsible for the entire product portfolio in the worldwide sales organization of the enterprise, which belongs to the Swiss Comet Group.

Altus' Axis: The Drive to Automate the Labor-intensive Task of Post-SMT Assembly ▶

At the dawn of SMT components and creating automated electronic assemblies entirely from SMT parts, many predicted the downfall of THT in the assembly of future PCBAs. However, the vision has not become a reality. To this day, a variety of components are hand-placed, soldered, inspected, and packed by CEMs and OEMs alike across the globe.

Mentor and Seica Partner for Data Prep and Testing Big Boards ▶

Mark Laing, business development manager of the Valor division at Mentor, a Siemens company, and Luca Corli, director of sales at Seica, speak with I-Connect007 Technical Editor Pete Starkey about the partnership between their two companies, which enables efficient data preparation for testing big boards, and accelerates NPI cycles.

Saki's AOI Systems are First to Be Certified by Panasonic for APC-MFB2 System ▶

Saki Corporation, an innovator an innovator in the field of automated optical and X-ray inspection and measurement equipment, announces that SAKI's automated optical inspection (AOI) systems are the first AOI systems certified to support Panasonic's latest Advanced Process Control-Mounted Feedback (APC-MFB2) system.

Three Long-time IPC Volunteers Receive IPC President's Award ▶

In recognition of their significant contributions of time, talent, and ongoing leadership in IPC and the electronics industry, long-time IPC volunteers Bhawnesh Mathur, Mark Wolfe, and Udo Welzel, Robert Bosch GmbH, were presented with an IPC President's Award at IPC APEX EXPO 2019.

IWLPC Tech Committee Unveils 2018 Award Winners ▶

The IWLPC Technical Committee is pleased to announce the best of conference, best presentation, and best papers in WLP, 3D, advanced manufacturing, and test tracks as chosen by the technical committee and attendees. Papers were evaluated based on technical merit, relevance, originality, knowledge of the subject, quality of material, and quality of presentation.

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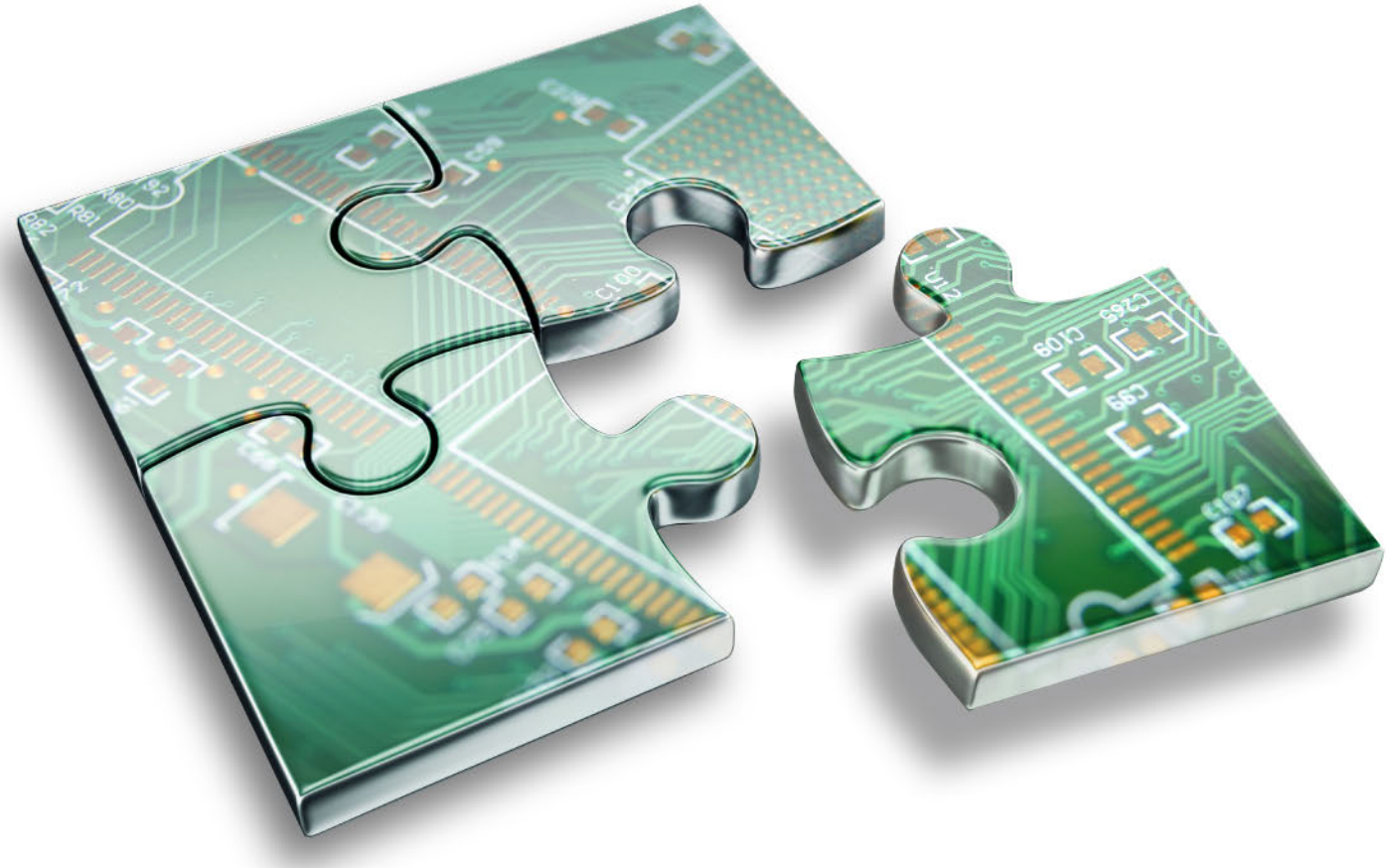

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What Do You Know About Automation?

Feature by Happy Holden
I-CONNECT007

Test what you know in this 10-question automation quiz! Hint: It helps to download and read I-Connect007's free eBook *Automation and Advanced Procedures in PCB Fabrication* at i007ebooks.com/automation.

Questions

1. What was the first plug-and-play equipment protocol?

a. TCP/IP
b. RS-232
c. IEEE-488.2 (HP-IB and GPIB)
d. IEEE-288 (HP-IL)
e. Ethernet

2. What was the first wireless plug-and-play equipment protocol?

a. IEEE-802.3
b. RS-232/RS-423
c. IEEE-488 (HP-IB)
d. HP-Ir

3. What is considered the first widely accepted automation protocol?

a. GM's MAP
b. RS-232
c. SEMI SECSII/GEM
d. IPC-2581

4. What automation protocol was used in the world's first "lights-out factories"?

a. General Motors's MAP
b. SEMI SECSII/GEM
c. IEEE-802.3
d. IEEE 802.11 Wi-Fi

5. What is the definition of automation?

a. More mechanization
b. Digitization of the factory
c. A vector made up of the stages of mechanization and the level of systemization (information)
d. The use of computers

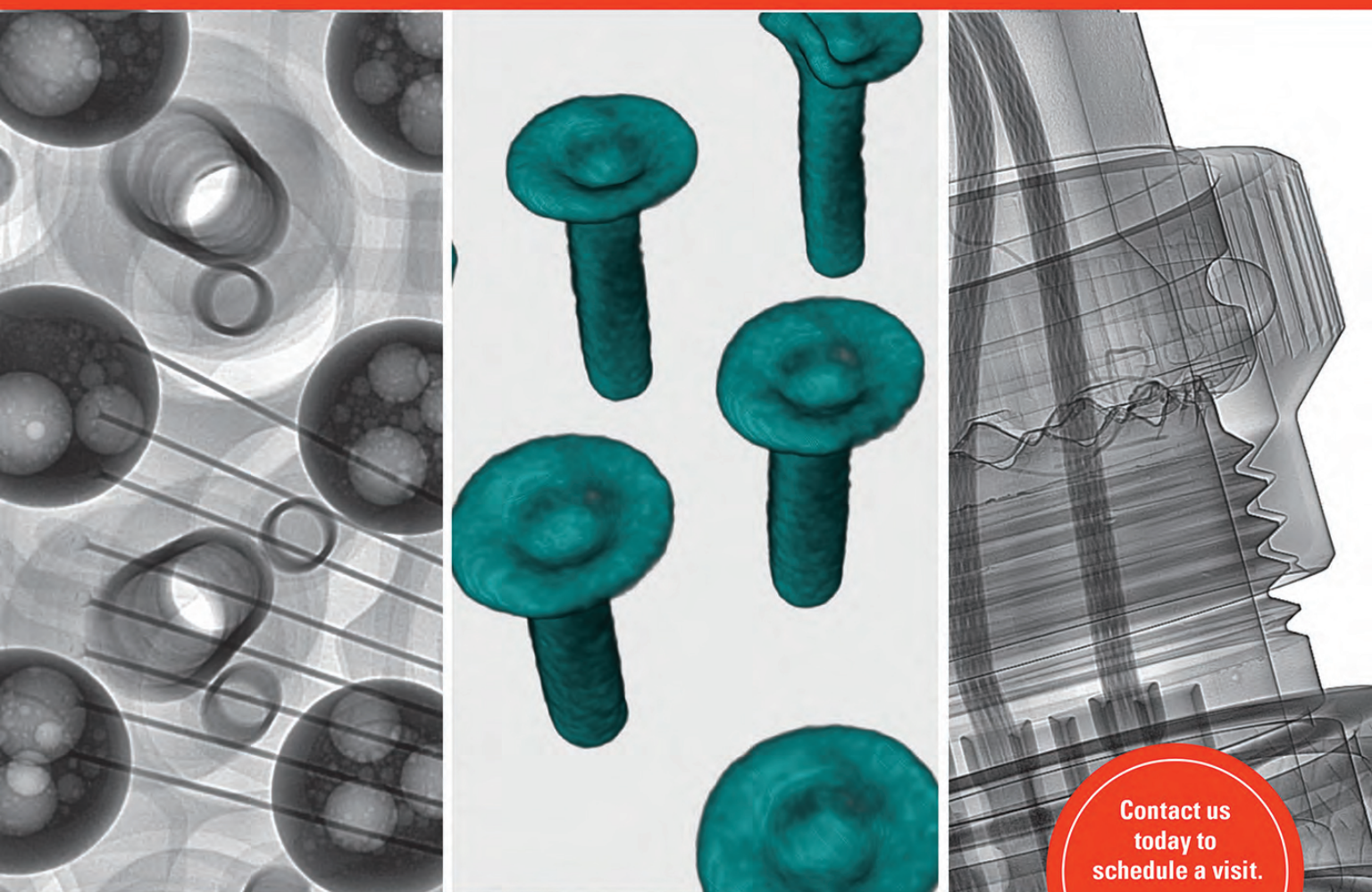
6. How is ROI calculated?

a. Profits divided by investments
b. The time it takes for profits to recover the investment
c. The equivalent interest rate the cash flows produced over the useful life of the project
d. The net present value of all of the investments cash flows

7. How can you categorize the stages of mechanization?

a. Add conveyors
b. No people needed
c. Automatic loading and unloading
d. Measure the percent of machine time for the total time of activities at a work center

When you see, you know.



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8. By the same token, how can you categorize the levels of systemization (information)?

a. Add computers
b. No people needed
c. Measure the percent of human information time for the total time of all information at a work center
d. Buy more software

9. What is the Connected Factory Exchange (CFX)?

a. Assembly equipment
b. Assembly software
c. An open standard electronic assembly protocol created by an IPC Committee
d. A new vendor for electronics assembly equipment

10. Which one below is NOT a basic sensor?

a. Wet chemistry
b. Nuclear
c. Temperature
d. Volume/count
e. Electrochemical
f. Specific gravity
g. Colorimetric

Answers

1. C: HP-IB, which later became GPIB and IEEE-488.2

2. D: HP-Ir, an HP wireless infrared bi-directional serial protocol for communication and control

3. A: General Motor's MAP (message automation and protocol)

4. B: SEMI (Semiconductor Equipment and Materials International), SEMI Equipment Communication Standard and General Equipment Model (SECSII/GEM) for the semiconductor IC fabrication in the 1980s

5. C: It is a vector made up of the stages of mechanization and the level of systemization (information)

6. C: The equivalent interest rate of the money invested based on the cash flows produced over the useful life of the project

7. D: Measure the percent of machine time for the total time of activities at a work center

8. C: Measure the percent of human information time for the total time of all information at a work center

9. C: CFX-IPC-2681 is an open standard electronic assembly protocol created by an IPC Committee

10. B: Nuclear sensors are not among the basic industrial sensors but are part of the electroanalytical sensors **SMT007**

Connecting Inconsistent Machine Data in the Shop Floor

Michael Ford, the senior director of emerging industry strategy for Aegis Software, speaks with I-Connect007 Guest Editor Kelly Dack about the challenge of inconsistent data from the many different machine vendors, and how IPC's Connected Factory Exchange (CFX) standard resolves the problem by connecting all machines in the shop floor.

To watch the interview, click the image.

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International Wafer-Level Packaging Conference
October 22-24, 2019
San Jose, CA, USA

Pan Pacific Microelectronics Symposium
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How Smart Is Your Factory?

Quest for Reliability

Feature Column by Eric Camden, FORESITE INC.

This month's topic is smart factories, and this means it is not just because machines share data but because a company designed their smart factory and how the data usage was planned to enable them to do something unique like producing a single-panel lot size in a hands-off manufacturing environment. That sounds like a mouthful, and it is, but the gist is that when you plan a production facility with the mindset that connectivity and optimization will be key aspects of your operation, it will pay dividends in the form of lower production cost, better traceability, and higher reliability. Okay, so that wasn't any less of a mouthful, but it did help elaborate the point. When I look at a smart factory in the view of producing a quality product, I look at all the education and due diligence required. This is what I am looking for to determine if a facility is a smart factory or not.

Starting with the receiving dock all the way to final packaging, every process step is an opportunity to contaminate the final product. Conveying this information to everyone in production starts at the top of the quality department and should be part of an overall focus on reliability. Too many times I do process audits at contract manufacturers, and there are a lot of "box checkers" that are doing the bare minimum regarding cleanliness. Many times, that is exactly what is spelled out on the print, and in the end, you get what you ask for—nothing. That means they are building product that is shippable and not much more than that. That isn't smart; it's quite the opposite. I've said it a million times, and I'll say it at least one more time that the cost of failure is always higher than doing it right the first time.

Having driven my point thoroughly into the ground, let's look at the assembly process steps and what to be on the lookout for. This isn't a fully comprehensive list, but it's certainly enough to help clean up a lot of what is going on out there. Trust me, I've seen a few good processes, but I've also seen a lot of terrible processes—a lot.

Incoming receiving and storage may seem like a fairly sterile area since there aren't any chemicals being used or boards being handled or parts that aren't in some type of packaging. The

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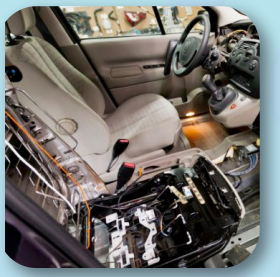
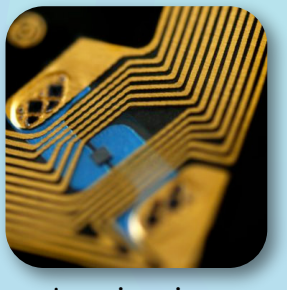


Automotive Electronics



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issues with this process are how and where parts are stored. Many times, I see warehouse racks that are in the same room as the receiving dock that is fully open to the outside elements. This can create spikes in excessive humidity that can impact parts that aren't marked for moisture-sensitive packaging.

For example, if it's a dock in a normally dry climate such as Mexico and it rains for some reason, the air can become saturated with dust and contaminants from the typically extremely dry ground. If a breeze carrying some of the dust and contaminants settles on top of the stored raw goods, this can cause issues with solderability or other reliability-related problems. If partially used packs of bare boards or components are stored in this environment, the risk increases. That is why it's important to have the smarts to separate the receiving dock and storage areas.

Moving on to the paste print process, the main thing to be smart about is controlling the humidity in the printer to help reduce solder balls and similar defect types. Beyond that, keeping track of the print life of the paste and the screen clean are the main opportunities for introducing some sort of failure.

The reflow process is the first opportunity to do some real damage by not being smart. The top things to think about are oven maintenance and proper thermal profiling of assemblies.

The reflow process is the first opportunity to do some real damage by not being smart. The top things to think about are oven maintenance and proper thermal profiling of assemblies. Oven maintenance is something that I see scheduled anywhere from weekly to annually with the level being varied. It is essential to keep the chains oiled and the fans exhausting, but it's also important to keep the interior free of excessive residues that collect and redeposit back on the PCBA surface. I normally see interior cleaning no more than twice a year, and depending on the number of pieces ran through, that may be woefully inadequate.

The paste flux residues are normally very concentrated forms of flux activators, and any of this material will be detrimental to reliability—no question about it. Properly profiling the assemblies is equally important because if the areas with the highest thermal mass aren't monitored, the required temperatures for rendering no-clean flux near benign may not be reached and the activators will remain active. If no-clean flux residues aren't properly processed, they can be as detrimental as leaving a water-soluble flux behind after wash. Not smart.

The PTH wave solder process is among the worst offenders of all as there are many ways it can go wrong. It truly takes a smart operator to know how to properly run a wave solder process. The main issues are excessive flux penetrating either the top side of the board or under selective pallet keep-out areas. If the pallets aren't properly cleaned, flux residues can build up in the corners, and any part of the board that comes into contact with that is at a greatly increased risk of field failure (if it even makes it that far).

If the hold-down springs don't have equal pressure at all points, there is also a risk that the board will raise up on the side that has less pressure. This allows spray flux to be deposited on areas of the assembly that were never intended to see flux. Any part of the board under the pallet will be shielded from the full thermal energy and remain active. What I am trying to convey is that it's not smart to leave any active flux residues on an assembly; you don't have to be smart to know that.

Next up are any hand solder operations that take place post-SMT or wave. This is where the smartest of operators are needed because there is nothing more dangerous to the reliabil-

ity of a product than a human with unfettered access to flux. If a part is difficult to solder, the answer is clearly more flux, right? While that may be technically correct, it's among the dumbest things in the history of electronics assembly.

There are a couple of good ways to use flux for hand operations, and they are to use the flux that is part of the cored wire or tacky flux used mostly for BGA rework. When using a cored wire with the proper feed rate, any flux residues will be near benign. The reason for recommending tacky flux is the application is very controlled, and the risk of flux spreading to neighboring components is much lower than using a bottle of liquid flux. Flux spread to surrounding components is a killer to reliability because it will be as active as flux gets next to right out of the bottle.

After some hand operations, there is a desire to clean any residues, which is another questionable operation. If it's no-clean flux and coating or RF issues are of no concern, just leave it in place. That's smart. If cleaning is required, it's very important to be mindful of where any effluent is being deposited. It's essential to effectively rinse the area that was just washed with IPA or some sort of solvent. Just be smart and see where all the effluent is draining. If that is under other components, they are now at an increased risk for electrical leakage. It's vital to use the right amount of flux and know where 100% of that is spreading, and if cleaning is part of the process, be sure it's effective and rinsed properly.

The final part of the assembly process that needs to be considered, at least for this month, is packaging. The points to consider are proper handling and using clean ESD bags/trays for shipping. I have seen many facilities reuse ESD bags that can collect processing residues and general debris over time. They can also lose their ESD properties due to damage. The same goes for trays used anywhere in the process including moving station to station or packaging to be sent to the next supplier.

Throughout all of the process steps I have mentioned, one more thing to think about is proper handling. Wearing gloves is essential, but knowing how to wear gloves is as important as anything else. Gloves should be changed any time an operator wipes their face, touches raw flux, or rubs a saltlick for some reason. Contamination is easily transferred to the PCBA surface and will greatly increase the risk of electrical leakage or electrochemical migration-related issues in the field. It's smart to know how easily any assembly process can affect reliability. **SMT007**

Eric Camden is a lead investigator at Foresite Inc. To read past columns or contact Camden, click here.

Download magazine here.

I-Connect007 Publishes Second Annual Show & Tell Magazine—All About IPC APEX EXPO 2019

The second annual *Real Time with... IPC APEX EXPO Show & Tell Magazine* is a supplement to our other monthly magazines and brings you exclusive, in-depth coverage of the recent event. This year, we feature 150+ pages of great content including multiple event photo galleries, video interviews, attendees' thoughts, reviews from our guest contributors and I-Connect007 editors, interviews with award winners and other industry experts, and coverage of the successful IPC STEM Student Outreach program.

Electronics Industry News and Market Highlights

Remote Patient Monitoring Revenues to Reach €46B in 2023 ▶

According to a new market report from Berg Insight, revenues for remote patient monitoring (RPM) solutions reached €17.5 billion in 2018.

Cognitive Computing Market to Expand Due to Growing Adoption of the Connected Devices ▶

The global cognitive computing market achieved the revenue of the $29.67 billion in 2016 and is expected to expand with the CAGR of the 49.9% to achieve a value of $1 trillion by the end of 2025, according to TMR.

Digitization Remains a Key Focus for Most Industries in 2019, but Challenges Remain ▶

More and more enterprises are looking toward new technologies such as machine learning and artificial intelligence, edge computing, and software-defined in their push toward digital transformation.

China's Smartphone Market Falls 14% in 2018 ▶

China's smartphone market falls 14% in 2018 with just under 400 million units shipped. In 2018, smartphone shipments in China fell to their lowest level since 2013 at 396 million units.

The U.S. Secures 5G Superiority, at Least in the Short Term ▶

The race for the leading role in the 5G connectivity has already started. While the United States, China, South Korea, and Japan are the four countries in the lead, the U.S. will win the 5G race in the short term, according to ABI Research.

Semiconductor Unit Shipments Exceeded 1 Trillion Devices in 2018 ▶

Semiconductor unit shipments climbed to 1.068 trillion units in 2018 and are expected to climb to 1.142 trillion in 2019, which equates to 7% growth for the year.

Installed Base of Wireless IoT Devices in Industrial Automation Reached 21.3M in 2018 ▶

According to a new research report from the M2M/IoT analyst firm Berg Insight, annual shipments of wireless devices for industrial automation applications reached 4.6 million units worldwide in 2018, accounting for approximately 6% of all new connected nodes.

Semiconductor R&D Spending Will Step Up After Slowing ▶

Now, 3D die-stacking technologies, manufacturing barriers, and growing complexities in end-use systems are among the technical challenges that are expected to lift R&D growth rates through 2023.

In 2019, CEOs are Most Concerned About Talent and Recession ▶

A new global survey reveals that CEOs view a recession as their biggest external concern for 2019. They cited attracting and retaining talent as their top internal concern.

Global Semiconductor Sales Reach $468.8B in 2018 ▶

The global semiconductor industry posted sales of $468.8 billion in 2018, the industry's highest-ever annual total, and an increase of 13.7% compared to the 2017 total, according to the Semiconductor Industry Association (SIA).

2019 Programs

NORTH AMERICA

IPC TECH ED

April 2
King of Prussia, PA
Process and Acceptability Requirements: Utilizing J-STD-001 and IPC-A-610 Together

May 7
Milwaukee, WI (in conjunction with Electrical Wire Processing Technology Expo)
The Evolution of IPC's Cable & Harness Documents — IPC-D-620, IPC/WHMA-A-620 and IPC–HDBK–620

September 10
Huntsville, AL
Process and Acceptability Requirements: Utilizing J-STD-001 and IPC-A-610 Together

November 12
Raleigh, NC (in conjunction with PCB Carolina)
Topic Coming Soon

December 3
Anaheim, CA
Process and Acceptability Requirements: Utilizing J-STD-001 and IPC-A-610 Together

MEETINGS

March 5–7
Raytheon in Huntsville, Alabama
PERM Meeting

May 21
Washington, D.C.
IPC IMPACT Washington, D.C.

June 15–20
Raleigh, NC
IPC SummerCom: IPC Committee Meetings

CONFERENCES

February 19–22
Dallas, TX
2019 WHMA 26th Annual Wire Harness Conference

May 14–16
Baltimore (Hanover), MD
IPC High Reliability Forum

June 3
Boston, MA
ITI & IPC Conference on Emerging & Critical Environmental Product Requirements

June 5
Chicago, IL
ITI & IPC Conference on Emerging & Critical Environmental Product Requirements

June 7
San Jose, CA
ITI & IPC Conference on Emerging & Critical Environmental Product Requirements

June 18–19
Raleigh, NC
IPC SummerCom: Materials Conference

September
San Jose, CA
i4.0 Connect Forum in cooperation with IPC and i4.0 Today

September 11
Philadelphia, PA
IPC E-Textiles 2019

EUROPE

April 1–2
Ingolstadt, Germany
IPC Tech Ed – Cleaning Forum (in partnership with Zestron)

May 6–7
Nuremberg, Germany
IPC Automotive Electronics High Reliability Forum

September 23–24
Prague, Czech Republic
IPC Wire Innovation Conference

September 26
Paris, France
IPC Transportation Electronics Reliability Council Annual Meeting (ITERC)

November
Brussels, Belgium
IPC IMPACT Europe

November 11–12
Munich, Germany
IPC E–Textiles Symposium

ASIA

June 25
Suzhou, Greater China
IPC WorksAsia Automotive Electronics Forum

September 3
Beijing, Greater China
IPC WorksAsia Aerospace & Aviation Forum

Oct 10–11
Shenzhen, Greater China
HSRC South — PCB Design Seminar & Competition
Productronica China 2019

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Inspection of BGAs After Rework

Knocking Down the Bone Pile

by Bob Wettermann, BEST INC.

After removing and replacing a ball grid array (BGA), the acceptability of the interconnection of the solder balls to the PCB should be assured. This assurance and the criteria for that assurance are the customer's outgoing inspection criteria. These acceptance criteria are outlined in a very general fashion in the latest version of IPC-A-610—Acceptability of Electronic Assemblies, Revision G as of this writing —based on the class of the assembly. Other approaches to the acceptance criteria can be found by augmenting the requirements of 610 guidelines with your own criteria based on testing outcomes or the suggestions found in IPC-7095—Design and Assembly Process Implementation for BGAs, currently at Revision C.

Most of the requirements for the inspection of BGAs are based on IPC-A-610 standards. The current standard does not require X-ray inspection. However, process validation can be used in lieu of X-ray inspection provided there is objective evidence of compliance. When visual inspection is done on a BGA post-rework, and the requirements of IPC-A-610 are the basis for inspection, the proper inspection magnification is taken from the latest IPC-A-610 standard. Solder terminations from the outside perimeter need to be visually inspected whenever practical. By looking at the ball-board or ball-package interface, the degree of wetting, the amount of remnant flux residue or any obvious cracks, shorting or other anomalies can be noted. In addition, visual inspection will usually determine the proper pin "1" alignment of the component body.

Other visual indications include missing solder balls, minimum electrical clearance distance to neighboring conductors, head-in-pillow defects, solder bridging, fractured solder connections, improper wetting, or lack of evidence of solder coalescing (if a paste print-based rework process is used). If X-ray inspection is utilized for BGA inspection, a couple of the criteria to look for during BGA X-ray inspecting taking place need to be reviewed.

If X-ray inspection is used post-BGA rework, then there are a couple of criteria called for in the IPC-A-610 standard. For collapsing (typically tin-lead alloy) solder balls, the maximum allowable voiding allowable is 30% of the inspection area. What is excluded from this amount are plating process-related voids, which should be established between the end customer and the company performing the rework. For non-collapsing balls, these voiding criteria are not established in IPC-A-610.

As a reminder, the BGA may need to be reworked for a variety of reasons. Some of the reasons for BGA rework include a defective component, an upgrade in memory size, or a change in a revision of the part. After removal

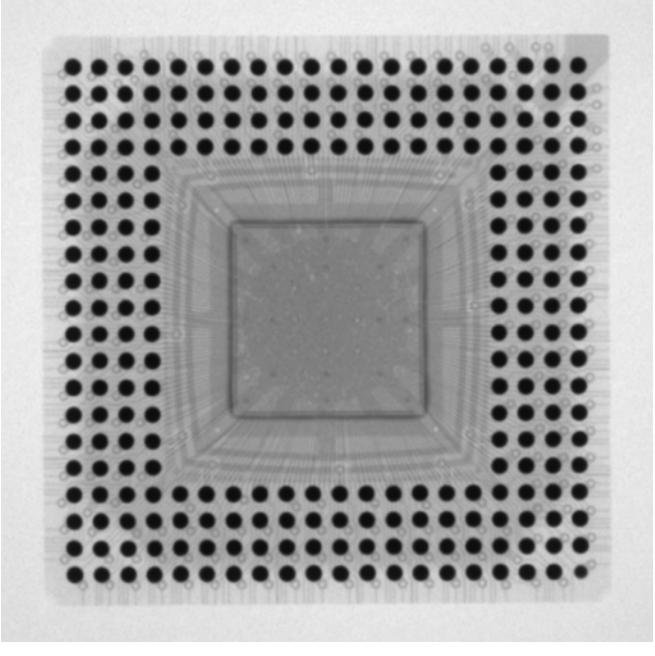

Figure 1: BGA X-ray image for inspection post-rework.

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NIST/Matt Turpin interview

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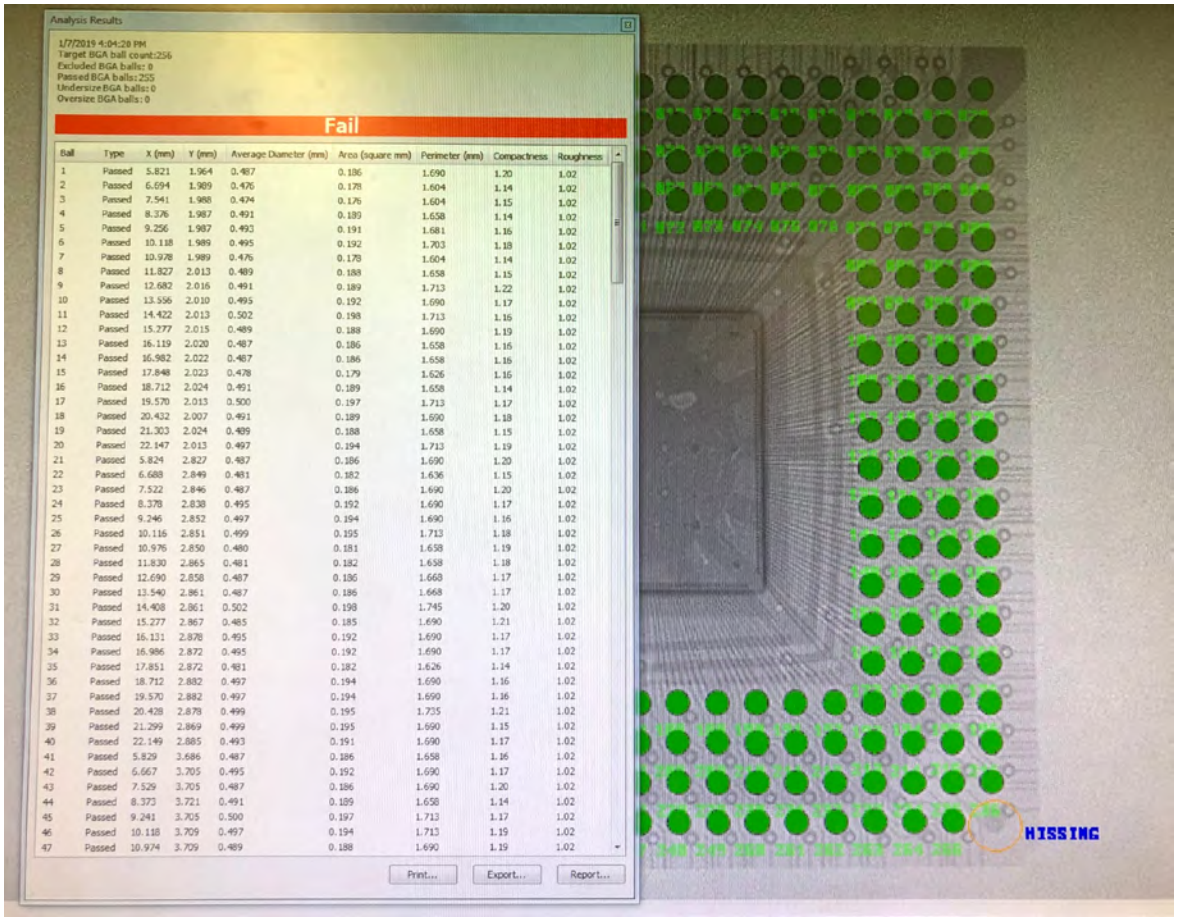


Figure 2: Automated BGA X-ray inspection post-rework can catch a missing ball.

and replacement of the component, inspection of the newly placed component—whether it is a new component or a reballed component—needs to take place to ensure the replacement components' interconnections.

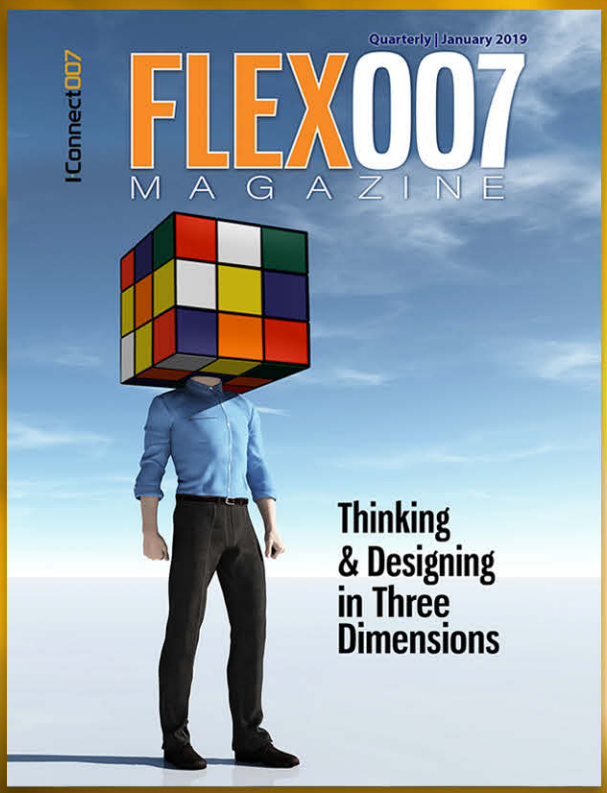
X-ray inspection of BGAs post rework (Figure 1) require inspection time to determine the acceptability of the solder interconnection. A "scan" of the BGA area from a far enough field of view to see the entire array is a good way to begin the BGA post rework inspection process. After this far field of view scan, the technician should zoom in to get a good visual indication at close range of the ball shape, size, and consistency.

Starting at one corner, the technician manipulates the X-ray back and forth over the array until all of the balls have been scanned. More advanced X-ray systems can be programmed with acceptance/reject criteria to more fully automate this process. More automated X-ray systems can scan for concentricity (i.e., ball shape), ball diameter, pitch, and other parameters (Figure 2).

Summary

Many of today's designs include a BGA or area array package. When this component needs to be swapped out for rework, the inspection of the replaced BGA may include both visual as well as X-ray inspection. Following the customer agreed-upon inspection criteria, there may be visual, basic X-ray inspection, or more advanced automated inspection of the reworked location may need to be made to make a go/no-go determination of the interconnection. **SMT007**

Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. To read past columns or contact Wettermann, click here.



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GOOD FOR THE INDUSTRY

1 Advanced Electric Technology Opens New Facility in Ayer, Massachusetts ▶

Advanced Electric Technology is a fully equipped brand-new facility. It will offer all CEM services, including surface mount, through-holes, NPI, BGA and micro-BGA, prototypes, quick turn, cable and wiring assemblies, box builds, and sorting and reworking of assembled boards.

2 Powerful Prototypes: Eight PCB Assembly Tips for 2019 ▶


Duane Benson

It's now 2019, and we are in for a wild ride. The last few years have been pretty crazy, and 2019 looks to continue that trend but amped up. While predictions might be fun to muse upon, they really won't help you get your job done. So, here are eight top pieces of PCB assembly advice for the coming year to make up for that.

3 Punching Out! Beware of Cultural Issues in M&A Deals ▶


Tom Kastner

Company culture is hard to define and manage, but it is a critical factor in making an M&A deal successful. It is also often ignored or misunderstood during and after due diligence because culture is a "soft" science instead of a "hard" subject like finances, legal contracts, IP, or accounts receivable, among other things, which makes culture a difficult factor to deal with.

4 IPC Finalizes CFX Standard ▶

IPC announces unanimous ballot approval of IPC-2591, the Connected Factory Exchange (CFX) initiative, by the 2-17 Connected Factory Initiative Subcommittee.

5 The Future of the Customer Experience in Mobility ▶

Based on the protocol stack that starts with 5G, moves up to AI, and continues to layer integrations and user interfaces and experiences on top of those lower-level technologies, how does this all apply to the current mobile experience? A panel on the future of mobility with representatives from several major companies covered this and more at CES.

6 Sanmina Wins Irish Medtech Association's Partner/Supplier of the Year Award ▶

Fiscal 2018 was both a transformational and transitional year for Cemtrex. While revenue in the electronics manufacturing (EM) segment decreased by 18% due to the loss of two customers, the EM segment currently has a $52,000,000 backlog, which should boost revenue for fiscal 2019.

7 IPC EMS and PCB Statistical Programs for Members Now Open for 2019 ▶

IPC's statistical programs for the PCB and contract EMS industries in North America are now open to new participants for 2019.

8 IPC Names Rising Star Awardees at IPC APEX EXPO 2019 ▶

In recognition of their leadership and contributions to IPC and the electronics industry within the past five years, IPC presented IPC Rising Star awards to Milea Kammer, Ph.D., Honeywell Aerospace; Matt Kelly, IBM; Hans-Peter Tranitz, Ph.D., Continental Automotive, GmbH; and MaryAlice Gill, Jabil Circuit, at IPC APEX EXPO 2019.

9 CEG Completes Acquisition of Protech Global Solutions ▶

Compass Electronics Group (CEG) has completed the acquisition of El Paso, Texas-based EMS firm and third-party logistics solutions provider Protech Global Solutions LP.

10 Benchmark's CEO Paul J. Tufano to Retire ▶

Paul J. Tufano

Benchmark Electronics Inc. announced that Paul J. Tufano, president and CEO, will retire after transitioning his responsibilities to a successor to be identified by the board of directors.

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Manncorp™

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

ventec INTERNATIONAL GROUP 騰輝電子

Technical Support Engineer, Germany

We are looking for a technical support engineer to join our team at our German facility in Kirchheimbolanden. The successful candidate will assist potential and current customers in appreciating the benefits of using and optimizing the use of Ventec materials in their PCB manufacturing processes, enhance customer loyalty and satisfaction, spread the use of Ventec materials, and grow sales. The technical support engineer will provide a two-way channel of technical communication between Ventec's production facilities and U.K./European customers.

Skills and abilities required for the role:

- Scientific and technical educational background
- Experience in the PCB industry in engineering and/or manufacturing
- Strong communications skills (German and English) with the ability to write full technical reports for group or customer distribution
- Ability to work in an organized, proactive, and enthusiastic way
- Ability to work well both in a team as well as an individual
- Good user knowledge of common Microsoft Office programs
- A full driving license is essential
- Willingness to travel regularly throughout Europe and occasionally to Asia

We offer:

- Excellent salary and benefits commensurate with experience

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

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

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ventec INTERNATIONAL GROUP 騰輝電子

Technical Sales Engineer, Germany

Want to advance your career by joining our globally successful and growing world-class CCL manufacturing company and help drive that success? Tasked with driving sales in the German-speaking markets, you will be a key member of the technical sales team. Your focus will be on Ventec's core market segments: military/aerospace, 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:

- Seven to 10 years of experience in the PCB industry in engineering and/or manufacturing
- Strong communications skills (German and English)
- Project management experience
- Detail-oriented approach to tasks
- Ability to manage tasks and set goals independently as well as part of a team
- Knowledge of Microsoft Office products
- A full driving license is essential.
- Willingness to travel regularly throughout Europe and occasionally to Asia

We offer:

- Excellent salary and benefits commensurate with experience

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

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

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Career Opportunities

Field Service Engineer West Coast

Pluritec North America, ltd., An innovative leader in drilling, routing and Automated Inspection in the Printed Circuit Board industry, is seeking a full-time Field Service Engineer, located on the West Coast.

This individual will support service for North America in Equipment installation, training, maintenance and repair. Candidate must be able to handle trouble shooting electronic and mechanical issue's as well customer applications in the field. A technical degree is preferred, along with strong verbal and written communication skills. The position requires the ability to travel 2-3 weeks per month.

Please send your resume to:
Carolina.zeppieri@pluritec.org

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Sales Personnel, Japan

The Gardien Group is looking to expand the sales team in Tokyo, Japan, and seeking highly motivated team players with a positive attitude. Prior experience in the PCB industry is an advantage but not necessary for the right candidate.

The role involves working closely with the customer to identify their needs and deliver the right solution. The candidate should be able to offer a high level of customer satisfaction to ensure ongoing sales.

Training will be provided along with a competitive benefits package, excellent growth opportunities, and periodic bonuses.

Interested candidates, please contact us at careers.jp@gardien.com with your resume.

Kindly note only shortlisted candidates will be notified.

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Career Opportunities

U.S. CIRCUIT

Sales Representatives (Specific Territories)

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

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for more information.

mfariba@uscircuit.com

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MivaTek Global

Multiple Positions Available

Want to work for a fast-growing company? MivaTek Global may be the place for your next career move. 2018 has brought significant growth, increasing sales and revenue. And, we are just getting started! To support the current customer base and fuel further expansion, we are looking for bright and talented people who are energized by hard work in a supportive and flexible environment.

Open Positions:

- Technical Service Technicians
- Regional Sales Representatives
- Regional Leader for Asia Sales and Support

Proven experience in either PCB or Micro-electronics and willingness to travel required for all positions.

More About Us

MivaTek Global is a distributor of manufacturing equipment with an emphasis of Miva Technologies' Direct Imager, Mask Writer, Flatbed Photoplotter imaging systems and Mach3 Labs X-Ray Drills. We currently have 45 installations in the Americas. Expansion into Asia during 2018 has led to machine installations in China, Singapore, Korea, and India.

To be part of our team, send your resume to n.hogan@kupertek.com for consideration of current and future opportunities.

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Career Opportunities

ELECTROLUBE
THE SOLUTIONS PEOPLE

We Are Recruiting!

A fantastic opportunity has arisen within Electrolube, a progressive global electro-chemicals manufacturer. This prestigious new role is for a sales development manager with a strong technical sales background (electro-chemicals industry desirable) and great commercial awareness. The key focus of this role is to increase profitable sales of the Electrolube brand within the Midwest area of the United States; this is to be achieved via a strategic program of major account development and progression of new accounts/projects. Monitoring of competitor activity and recognition of new opportunities are also integral to this challenging role. Full product training to be provided.

The successful candidate will benefit from a generous package and report directly to the U.S. general manager.

Applicants should apply with their CV to
melanie.latham@hkw.co.uk
(agencies welcome)

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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

Mentor®
A Siemens Business

PCB Manufacturing, Marketing Engineer

Use your knowledge of PCB assembly and process engineering to promote Mentor's Valor digital manufacturing solutions via industry articles, industry events, blogs, and relevant social networking sites. The Valor division is seeking a seasoned professional who has operated within the PCB manufacturing industry to be a leading voice in advocating our solutions through a variety of marketing platforms including digital, media, trade show, conferences, and forums.

The successful candidate is expected to have solid experience within the PCB assembly industry and the ability to represent the Valor solutions with authority and credibility. A solid background in PCB Process Engineering or Quality management to leverage in day-to-day activities is preferred. The candidate should be a good "storyteller" who can develop relatable content in an interesting and compelling manner, and who is comfortable in presenting in public as well as engaging in on-line forums; should have solid experience with professional social platforms such as LinkedIn.

Success will be measured quantitatively in terms of number of interactions, increase in digital engagements, measurement of sentiment, article placements, presentations delivered. Qualitatively, success will be measured by feedback from colleagues and relevant industry players.

This is an excellent opportunity for an industry professional who has a passion for marketing and public presentation.

Location flexible: Israel, UK or US

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BLACKFOX
Premier Training & Certification

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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Identity Branding

What do you stand for?

I don't know who you are

I don't know your values

I don't know what you stand for

I don't know your reputation

Now, what is it you want to sell me?

This may seem extreme, but don't assume your prospects already know or remember this about you...

In fact, they may know something quite the contrary if you leave it up to your competitor to educate them about you.

At I-Connect007 we can help you build and strengthen your brand.

Learn how we can help you!

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GOOD FOR THE INDUSTRY

Events Calendar

China International PCB & Assembly Show (CPCA Show 2019) ▶
March 19–21, 2019
Shanghai, China

Electronica China ▶
March 20–22, 2019
Shanghai, China

Semicon China ▶
March 20–22, 2019
Shanghai, China

Hannover Fair ▶
April 1–5, 2019
Hannover, Germany

MicroTech 2019 ▶
April 4, 2019
Cambridge, U.K.

SMTconnect 2019 Technology ▶
May 7–9, 2019
Nuremberg, Germany

Medical Electronics Symposium 2019 ▶
May 21–22, 2019
Elyria, Ohio, U.S.

Industry 4.0–Smart Factory ▶
May 29, 2019
The Israel Trade Fairs Center, Tel Aviv

PCB Pavilion @ LCD EXPO Thailand ▶
June 27–29, 2019
Bangkok, Thailand

Additional Event Calendars

Coming Soon to *SMT007 Magazine:*

APRIL: **MEET THE YOUTH OF THE INDUSTRY**
Today's tech students are the skilled workforce in our increasingly automated industry. We look at the emerging trends in people and technologies.

MAY: **MATERIALS**
We look at new developments in materials and supplies coming to the market to serve emerging PCB performance and reliability demands.

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