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MEGATRENDS

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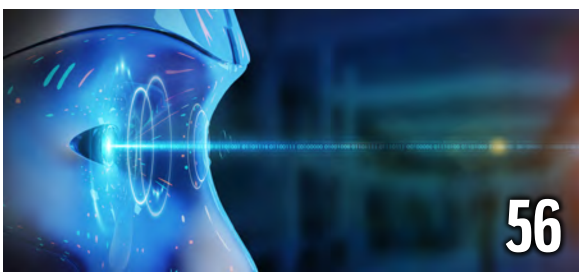

MEGATRENDS

Internet of Things (IoT), Industry 4.0, artificial intelligence (AI), automation, virtual reality/augmented reality/mixed reality (VR/AR/MR)—and now extended reality (XR)—these are just a few of the trends that are expected to shape the world we are living in today. How will these megatrends impact PCB manufacturing and assembly? We find out in this issue of *SMT007 Magazine*.

FEATURE COLUMNS:

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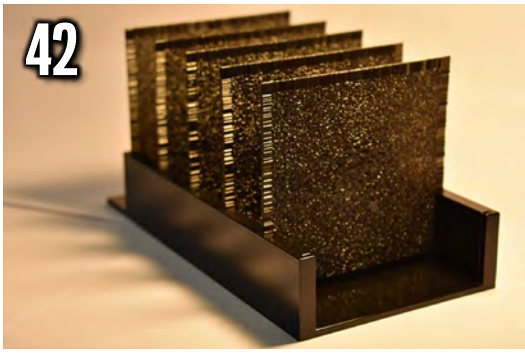

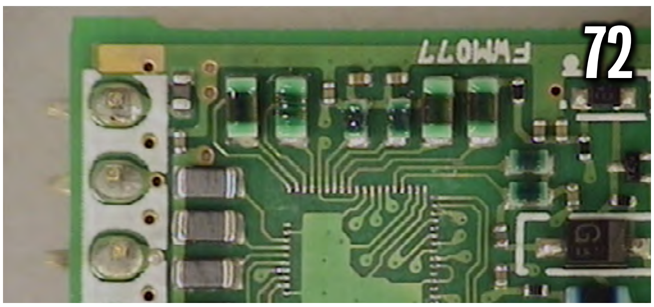

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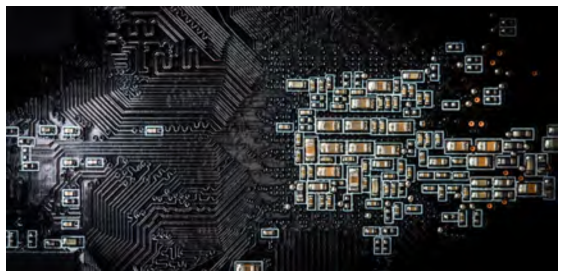

SHORTS:

HIGHLIGHTS:

DEPARTMENTS:

The Megadrivers

Editor's Note

by Stephen Las Marias, I-CONNECT007

Henry Ford did not invent the gasoline-driven automobile or the assembly line. But it was his innovation that helped reduce the time it took to build a car from more than 12 hours to just two hours and 30 minutes. [1] The moving assembly line, which Ford's team built in October 1913 at their Highland Park Assembly plant, was a revolutionary advancement in production. Mass production had myriad benefits: Ford could now build more cars faster than any competitor, and sell them for a lower sticker price, thus enabling almost everyone to own an automobile.

This innovation—the assembly line—through continuous improvements over decades, has become the highly efficient primary mode of manufacturing in a wide range of industries, including our own, and it has changed the way we live and work forever.

The assembly line's impact on auto manufacturing can't be overstated; it undoubtedly furthered the development and improvement of automobiles. In fact, right now, the automotive industry is still the major growth driver for the electronics manufacturing industry worldwide, especially with continued growth of electronics in cars, partially due to the increasing development in autonomous/driverless cars.

Now, as more machines become even more intelligent, the more efficient these assembly lines become. Enter robotics, Internet of Things (IoT), and data analytics—and we have a highly-automated, smart factories—a whole new level of manufacturing.

These are some of the global megatrends happening right now that are making a big impact in the world of electronics manufacturing. The continuing automation in factories, IoT, increasing use of data, robotics, 3D printing, and artificial intelligence are just a few that will define the next generation of industrial revolution—also happening now.

Meanwhile, over the past year, we have seen another growing trend in the financial industry—cryptocurrencies—the most famous of which is bitcoin. But Satoshi Nakamoto's innovation is not simply the bitcoin, but the technology behind it—the blockchain. Nakamoto's research paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System" [2], posted in a cryptography forum on November 1, 2008 [3], described how blockchain worked and how it tackles the double-spending problem in digital currency. It says this makes bitcoin one of the most secured digital currency right now because the blockchain technology includes records of every bitcoin in existence, and every bitcoin transaction ever made. No one can alter the transactions in the blockchain because all the computer nodes in the peer-to-peer network, upon which the blockchain technology is based, retain a copy of all the public history of transactions, making it impractical for an attacker to change, as honest nodes control a majority of CPU power.

How does this apply in manufacturing? According to industry experts, blockchain can be a game changer for supply chain management. According to Neil Sharp of EMS firm JJS Manufacturing, blockchain presents an exciting opportunity to create smarter, more secure supply chains. He wrote that blockchain opens a completely new way of tracking product journeys, providing a solid audit trail and real-time visibility for verified supply chain partners. For instance, it can track and record what materials have arrived where, who handled them, how they were transported, and where they came from as "blocks" on the blockchain.

In a whitepaper, the Technical Associates Group noted that blockchain could underpin new distributed manufacturing models brought about through the development of 3D printing, while playing a vital role in IoT by allowing more effective monitoring of manufacturing facilities. This ensures that equipment operates within its defined scope of action and that machine-to-machine payments are received accordingly. They added that blockchain could greatly ease the deployment of distributed 3D manufacturing, as it could enable low-cost, distributed and assured integrity for contracts, product histories, and production processes.

Which brings me to this month's issue of *SMT007 Magazine:* Megatrends. Inside, you will find how manufacturers consider trends such as IoT, AI, automation, augmented reality (AR), virtual reality (VR) and mixed reality (MR), and now extended reality (XR), and how they are integrating the technology into their manufacturing lines.

We have Michael Ford of Aegis Software discussing IoT; our resident columnist Dan Feinberg writing about XR; and Dr. Jennie Hwang's insights on AI.

Columnist Eric Camden examines the blazing speed of development in the electronics technology industry and the risks it presents in manufacturing. Zac Elliott of Mentor, a Siemens Business, writes about how computer integrated manufacturing (CIM) and IoT can make your factory smart, while Pratik Kirve of Allied Analytics discusses the smart robot revolution.

Changing of the Guard

For over three years, I've been managing *SMT007 Magazine,* writing on the latest SMT equipment and technologies, manufacturing challenges and issues, and strategies to address them, and speaking with and interviewing some of the industry leaders in the SMT, PCB assembly and EMS fields. Very soon, I'll be shifting to managing our newsletters, starting with the redesigned *SMT007 Week*—which will feature new sections, including our Read Threads (for more information on this, you may contact Barb Hockaday). Of course, we are still seeking your contributions—bylines, interviews, or tips and tricks for this. Just feel free to drop us a note here. Beginning with our October issue, industry veteran Nolan Johnson will be the new

Nolan Johnson

managing editor of *SMT007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing.

In his extensive career in electronics, Nolan has written applications software for Mentor, where he managed Mentor's initial OEM IC verification products. He also managed a series of technical training centers at ESI, Tektronix, and Synetics Solutions. In addition, Nolan held a variety of marketing and leadership positions at Clarity Visual Systems, General Electric, Rumblefish, and Planar Systems. I am sure *SMT007 Magazine* will be even more successful in the capable hands of Nolan.

Meanwhile, I would like to take this opportunity to thank you all for your help over these past years—whether it be about article contributions, interview requests, or expert meetings. I hope you'll extend Nolan the same support you have given me throughout these years.

I hope you enjoy this month's issue of *SMT007 Magazine*. Next month, we'll highlight the latest developments in the IPC Connected Factory Exchange (CFX) Initiative. **SMT007**

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1. History Channel, This Day in History: Ford's Assembly Line Starts Rolling.
2. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System.
3. Wired, The Rise and Fall of Bitcoin, Benjamin Wallace.

Stephen Las Marias is managing editor of *SMT007 Magazine*. He has been a technology editor for more than 14 years covering electronics, components, and industrial automation systems.

Transistor Technology will Improve Speed, Battery Life of PCs, Mobile Phones

Purdue University researchers have developed transistor technology that shows potential for improving computers and mobile phones. The researchers created a new technology design for field effect transistors (FETs), enabling them to offer better switching behavior for computers and devices compared with traditional FETs.

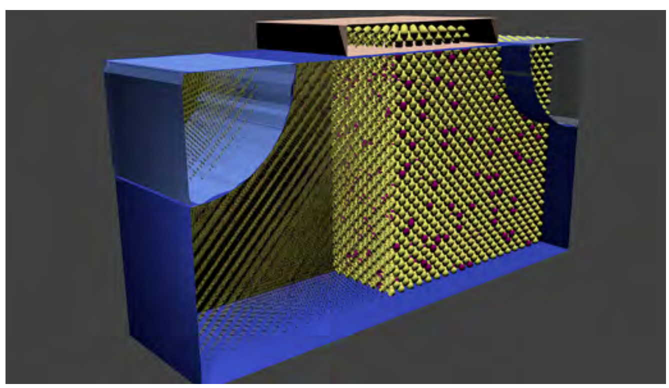
"Our technology is unique because it merges lasers and transistors," said Tillmann Kubis, research assistant professor in Purdue's School of Electrical and Computer Engineering, Network for Computational Nanotechnology and Purdue Center for Predictive Materials and Devices. "There is traditionally not a lot of overlap between these two areas, even though the combination can be powerful with the Internet of Things and other related fields."

The combination of the quantum cascade laser and transistor technologies into a single design concept will help manufacturers of integrated circuits who want to build smaller and more transistors per unit area. The Purdue technology is designed to increase the speed, sensitivity and battery life of computers, mobile phones and other digital devices.

The Purdue transistor and laser combination features a large on-current and a low off-current with a small subthreshold swing, which allows for increased speed and energy savings. The technology also combines or stacks several switching mechanisms that simultaneously turn the transistor on or off.

Prasad Sarangapani, Ph.D. student in the School of Electrical and Computer Engineering, and Kubis are working to optimize the technology and the overall effectiveness of the design.

(Source: Purdue University)



Artificial Intelligence: Super-Exciting, Ultra-Competitive

SMT Prospects & Perspectives
Feature Column by Dr. Jennie S. Hwang, CEO, H-TECHNOLOGIES GROUP

Swimming in the humongous volume of information and data (clean or dirty) is a challenge. A heightened challenge we face is that volume continues to grow and become increasingly complex. Will we miss some guiding information and useful data that we can use to our advantage? Will this overwhelming volume of data reach an unmanageable level? And how will we leverage technologies to make it manageable and useful and gain a competitive edge in a timely fashion?

Today, artificial intelligence (AI) and machine learning (ML) have become common everyday words; however, the present reality and future potential are yet to evolve (Figure 1). As a result, there has been sheer excitement about evolving intellectual and dexterous capabilities to improve our lives, businesses, and security; meanwhile, there has also been trepidation about unknown and unintended consequences.

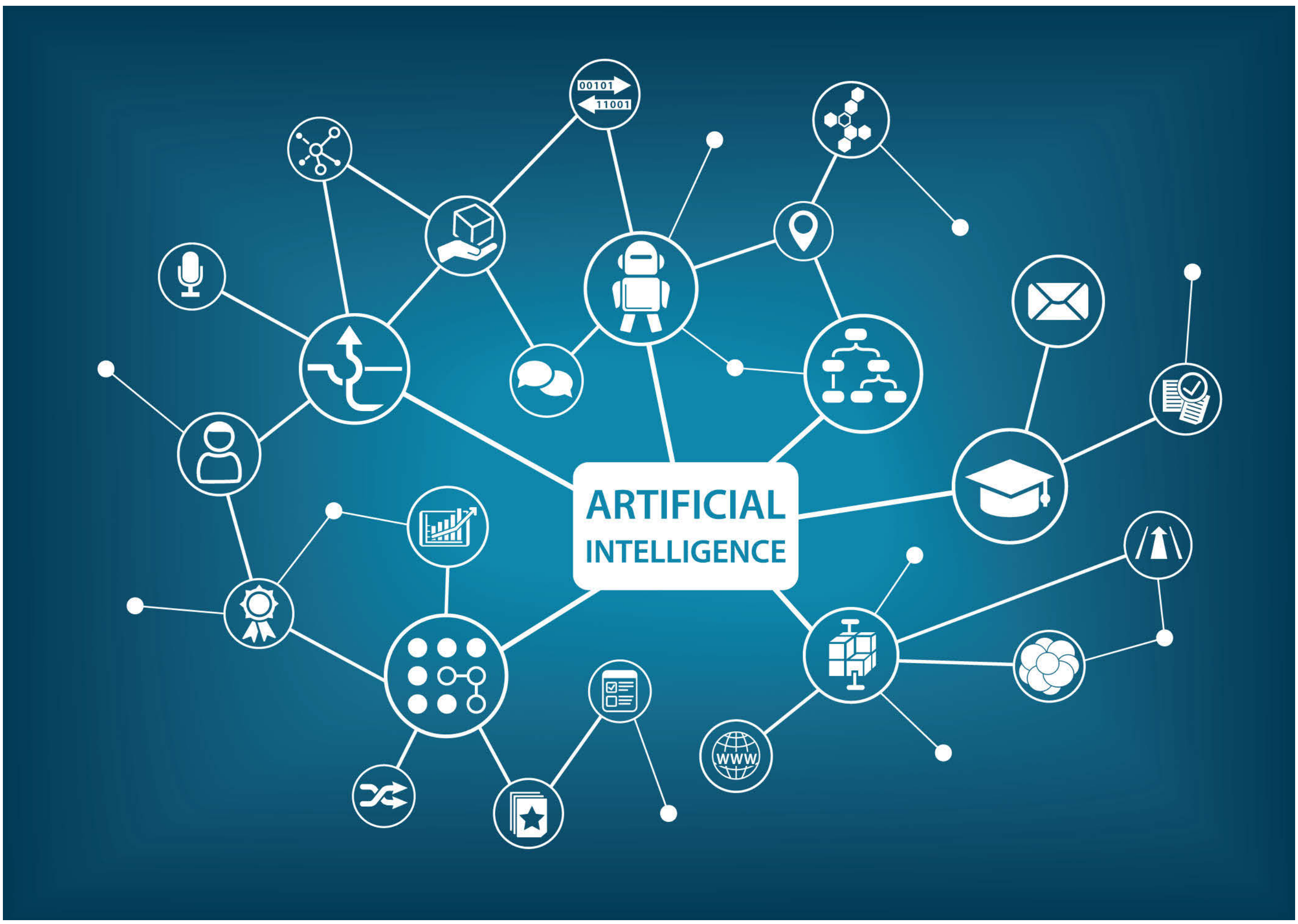


Figure 1: AI will impact a multitude of fields, including education, business, and military.

Platform

AI is expected to intake data through ML to analyze data, create a model, and make decisions based on that data. AI is also expected to create model-based learning and modify it with new data. It should be a system that is driven by data and will offer the ability to learn and react based on a generalized strategy-for-learning by using algorithmic models. By so doing, new insights are beneficially generated without relying on rules-based computing programs.

The ability to incessantly chew through any amount of data and unlimited combinations of variables and parse data, capture knowledge, and make a deterministic or predictive model makes ML surpass human capacity. Being unconstrained by preset assumptions of statistics can also allow ML to surpass human analysts by making predictions with higher degrees of accuracy.

As a result, wherever there are too many potential combinations and too much complexity, ML can be a potent tool. And an AI system, whether it emulates human performance or replaces humans on the execution of routine or non-routine tasks, can facilitate decision-making and process automation.

Another beauty is that the machine is sleepless and works 24/7. Machines are free of time zones and independent of geographical territories in performing data collection, aggregation, algorithms, and processing power, which has enabled AI and will continue to make breakthroughs. A variety of applications have employed AI to different extents, ranging from financial services to business operations and military prowess.

In business, AI and ML can apply to every function of doing business. They are going to play an impactful role in business intelligence and analytic solutions by creating the expertise to rapidly transform learned data into action to create competitive advantages. AI will also help IoT data analyses in data preparation and discovery, predictive analytics, and geospatial information gathering. One example is to develop management processes that build the most effective teams of judgment-focused humans and prediction-focused AI agents.

Figure 2: Military AI applications in urban environments [1].

In military, emerging technologies will shape the next generation of war. For instance, through human-agent teams and advances in AI, soldiers will provide commanders with real-time information about the adversary, which can be gathered from a variety of different sources. Army robotics give individual soldiers the capability to control swarms of robotic systems for missions that often require large numbers of troops to accomplish. A single soldier could conduct reconnaissance over large areas with dozens of robotic systems, which would be especially important in conditions such as dense urban environments. The exceptional challenge with urban environments is that everything takes substantial manpower to overcome and control. Intelligent teaming and robotic systems can have significant impacts and tactical advantages to deliver integrated cross-domain capabilities in multi-domain battles (air, ground, marine, space, cyberspace) to win in a complex war (Figure 2). The concept could also be developed to enhance battlefield communications when networks are hampered by enemy activity or natural obstacles are encountered.

Global Race

AI talents are key, yet in shortage with demands exceeding supplies. Funds abound with exponential growth during the last decade. Thus, more money will be pouring in from both private and government sectors to nurture new talents to fill the AI talent gap. Meanwhile, thousands of startups in this arena are burgeoning around the globe.

Reportedly, the UK has launched new university courses focused on AI and added funding for doctoral students at top universities. The UK has set up a parliamentary select committee on AI dedicated to consider and make recommendations on the economic, ethical, and social implications of advances in AI.

Moreover, China is now embarking on an unprecedented effort to master AI. Its government is planning to invest tens of billions of dollars into AI technology in the coming years, and many Chinese companies are investing heavily in educating and developing AI talents. The Chinese government is pushing hard for the development of AI and IoT in China, as well as commercial AI companies. If this nationwide effort succeeds, China could emerge as a leading force in AI. China's success in building supercomputers demonstrates its potential to catch up to world leaders in AI hardware [2].

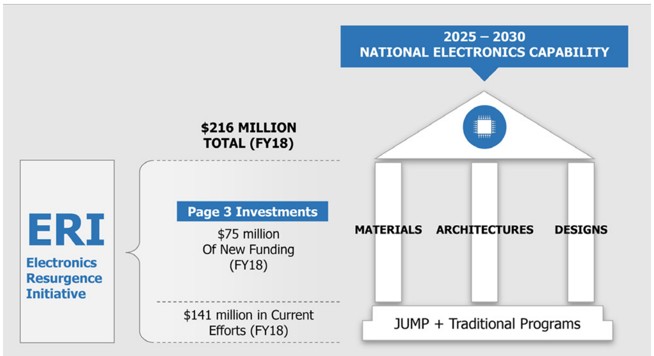
Hardware

Hardware plays a critical part in the AI era and works hand in hand with software systems. The increased workload and almost unlimited processing power propelled by AI/ML will require the most advanced semiconductors, packaging approaches, and manufacturing prowess ever developed to reach the interconnect density needed.

To enable AI and its building blocks—machine learning, deep learning, neural networks, new chips (processor and memory), and new architectures—a system design that delivers on targets such as low power consumption, high performance, low latency, high bandwidth, and high speed, will be the ever in demand. Inference processing in lieu of traditional program processing can be achieved only by fulfilling these performance requirements. Equally demanding is to assess and optimize for different types of AI workloads—

a business case to justify building custom-designed chips (e.g., application-specific integrated circuits, or ASICs).

Recently, DARPA's Microsystems Technology Office (MTO) established funding that could potentially reach upwards of $1.5B over it's lifetime. Dubbed the Electronics Resurgence Initiative (ERI), the fund will be used to work on advances in chip technology. The funding is a significant increase in hardware budget focusing on chip design, architecture, materials, and integration, as well as leveraging on ML to substantially speed up new chip design.



(Source: DARPA)

Materials Innovations

To face the challenges of the AI era, new semiconductor technology will call for materials innovations to develop a wide array of new processor integrated circuits (ICs) and memory chips. This is a demanding area in technology and a growing space in business.

Further, as global competition moves on and new technologies continue to become available, who will have the upper hand remains to be seen. Until now, the U.S. semiconductor industry has been in a leading position in AI hardware. This is an ongoing global competition among scientists, engineers, companies, and countries. There is a long way to go before reaching the full potential of AI to truly mimic human cognitive capabilities and functions (e.g., asking the right questions at the right time to solve the right problems in real time).

AI is creating a new paradigm. Ultimately, to best team up human-machine intelligence, we expect synergistic performance and capability by integrating judgment-focused humans and prediction-focused AI agents. AI should be destined to augment human cognition, capabilities, and capacities without causing ethical and social issues. That is the value and virtue of human-machine intelligent teaming! **SMT007**

Appearance

Dr. Hwang will present two lectures, "Reliability of Electronics: The Role of Intermetallics" and "Electronic Solder Joint Reliability: Principle and Practice," at SMTA International 2018 on October 15 in Rosemont, Illinois.

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Dr. Hwang, an international businesswoman and speaker, and business and technology advisor, is a pioneer and long-standing contributor to electronics hardware manufacturing as well as to the environment-friendly lead-free electronics implementation. Among her many awards and honors, she is inducted to the International Hall of Fame–Women in Technology, elected to the National Academy of Engineering, an R&D-Stars-to-Watch, and YWCA Achievement Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and CEO of International Electronic Materials Corp., she is currently CEO of H-Technologies Group providing business, technology and manufacturing solutions. She is the Chairman of Assessment Board of DoD Army Research Laboratory, serving on Commerce Department's Export Council, National Materials and Manufacturing Board, Army Science and Technology Board, various national panels/committees, international leadership positions, and the board of Fortune-500 NYSE companies and civic and university boards. She is the author of 500+ publications and several books, and a speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as Harvard Business School Executive Program and Columbia University Corporate Governance Program. For more information, please visit www.JennieHwang.com.

IoT: Driving Change in Manufacturing

Feature by Stephen Las Marias
I-CONNECT007

In our new manufacturing environment where trends such as data, robotics and artificial intelligence (AI) are proliferating, there are numerous strategies and tactics—predictive analytics, new OEM/supplier collaborative innovation models, technology platforms that support real-time business intelligence, and resilient and transparent supply chains that create virtual, vertically integrated manufacturing networks—that global manufacturing companies can deploy to capitalize on new market opportunities and stay ahead of their competition.

Enabling these strategies are key transformative technologies such as big data, analytics, and the Internet of Things (IoT). There are two categories for IoT: consumer and industrial. In the consumer space, imagine yourself arriving home from work. As you reach the curb in front of your home, your car will send a signal to your garage door to open. As you enter your home, your network will detect your presence and immediately turn on specific appliances, such as lights, the TV or stereo, air-conditioning unit, or whatever it has been programmed to do. As you sit down to relax, you eye your tablet resting nearby, and thinking about the workout you did earlier that day, you transfer the data collected by your smart watch to have a full view of overall impact of that workout on your health statistics. That's just a simple example of how the consumer IoT can function.

The industrial IoT, on the other hand, describes an integrated system of systems where sensors and actuators provide specific data such as measurements, timing, and equipment status, to name a few, all connected and visible throughout the enterprise. This is where the convergence of operations technology (OT) in the factory floor with information technology (IT) in the enterprise happens, all working together towards a single purpose—a more-efficient, profitable and successful manufacturing operation. With industrial IoT, companies will be able to view real-time data on their manufacturing processes, and compare

performance across their plants, or even shifts within their plants. With industrial IoT, they can also quickly scale their production up or down; manage their energy consumption; and manage, troubleshoot and fix their processes and plants, even when they are located around the world.

Still, most people continue to be confused when it comes to IoT.

According to Michael Ford, the European marketing director for Aegis Industrial Software Corp, "If you think about what IoT is, people's expectation is that we can exchange data between devices, obviously systems, quite like you would look up things on the Internet. And the technologies for creating the transported data between these systems make it easy to do. I mean, any software developer can go online, have a look at a couple of live bus controller units (BCUs) and set up a genuine IoT kind of communication protocol, maybe a device or two. There's no end of things that they can create. I was at a trade show recently in Italy, and there were many different stands there, each of them showing their own IoT solution that they'd been creating. They were advertising things like taking data into the cloud, or sharing data with people, etc. And in all those cases, it was simply that there was a mechanism for moving data from one place to another. This isn't groundbreaking technology; you could send it on USB sticks or email. There are so many different ways of doing it. So, I think that people are jumping on it kind of like a bandwagon, seeing that IoT is a popular technology and trying to create solutions that are IoT, but in actual fact are simply new ways of transferring the same data as we've been transferring before."

More and more equipment manufacturers are promoting Industry 4.0-capable solutions—and in a way, IoT can be seen as an element of Industry 4.0. The idea behind it is that factories would evolve to be able to be a lot more flexible, to be able to make the products that customers want, basically at any time that they need. In this manufacturing vision, customers can call their manufacturers about how many products they want, almost on a day-by-day basis. That must be achieved without accumulating stock, because anybody could build a load, put them in the warehouse and then call them off as needed—but then you've got the added cost of warehousing and risk of depreciation while they're being stored there. So, the idea of Industry 4.0 is that factories will be flexible.

"Now, this flexibility comes at a cost, because everyone in the SMT industry knows that the higher the mix of product, the lower the overall productivity of the machines," says Ford. "Looking at how that works, we see that people are using Excel spreadsheets to do planning, and we're seeing a lot of manual intervention in the decision making about what products should be made. And this is where the delays come in and why we are not able to optimize our factories for high-mix production."

On the other hand, Ford explains that if computers were able to make the decisions based on the data that's coming to them about the status and the progress and all of the things going on that support production, like the supply chain and tools, and if a computer could see that information and it was accurate and reliable, then it is in a position to start making a decision that previously people were making. "So, instead of people having meetings and sending emails and engaging in discussions and arguments in the canteen or around the water cooler, over the course of hours, days or even weeks, the computer can make a decision within seconds. Now, the key element to drive this is that that decision must be based on good information, and that information must be accurate and timely."

As we all know, Ford has been instrumental in promoting the IPC Connected Factory Exchange (CFX) Initiative, an electronics manufacturing industry developed standard forming the foundation/backbone of Industry 4.0 applications. IPC-CFX simplifies and standardizes machine-to-machine communication while also facilitating machine to business/business to machine solutions.

"What we wanted to do with CFX is very, very specific. We wanted an IoT technology, and as I explained, that is the mechanism of moving data from A to B in a much more efficient and faster way. But we are also defining the content of that data, so that if anybody comes in and says, 'Okay, I want to connect to you CFX network.' It doesn't matter who they are or what kind of machine they've got or any kind of the historical thing. It just doesn't matter. They can plug in their machine or plug in their software, plug in their solutions, and it works. And the reason why it works is because the IoT technology is standard, but also the content, the language that that IoT is speaking is also standard," explains Ford.

Traceability

One of the benefits of IoT is traceability, and according to Ford, this has become very important.

"People were seeing traceability as a way to avoid too much expense when product recalls had to be made or whatever; but these days, it has moved on substantially where we see traceability being used as the ultimate quality tool. You make 10,000 products, and one of them is faulty. What was the unique set of circumstances that caused that defect? To solve that problem, to discover the one-off defect causes, you need to have the traceability data. But there's so much traceability data that you need; to record that manually from different kinds of machines with different formats, again going back to this old legacy kind of thing as the principle, was never going to happen. But with a tool like CFX, where you're taking the data from the machines in a standard format, and you're getting every level of detail that you need, the CFX satisfies the level-four criteria for IPC-1782. So, since you get all of that data, now you've got two interesting things happening: You have a huge amount of potential to work out what was that thing that caused the defect, so your quality is going to go up; and on the other hand, the cost of acquisition of that data is almost zero, because you have CFX there for another reason. You have it there for lean materials; for adaptive planning; for Industry 4.0; or for all your metrics, KPIs and all the other things you want to do in your factory. So, it's there generating benefit anyway, but it's also giving you this traceability for free. You can take the CFX data, benchmark it against the digital product model for design, and then you can understand exactly all the quality data that you would need."

Traceability goes beyond quality; one of the biggest problems right now in manufacturing is counterfeiting.

"The stories that I've heard about counterfeiting are incredible considering the lengths that people go to hide counterfeit material together with genuine ones in ways that are set to defeat incoming inspection. So, no matter what you do, the only way you're going to test everything is ultimately to destroy it. And then you say, 'Well, that one was genuine, but I can't use it anymore.' It's a horrifically expensive problem as well, because we have to at least get through a fence where we are trusting the materials that come in, and that's a huge cost in manufacturing for us, a huge cost that we're all going to have to be paying for our electronic products in the future if we want to be safe, for example in cars or airplanes or wherever else the critical components will be used. Now, we need to put an end to counterfeit. It is good that we have techniques to detect it; it's great that we have techniques to avoid it; but, we need to stop it," says Ford.

And the way to stop it is to make people responsible. If you can prove beyond a shadow of a doubt that a party was responsible for the ingress of a counterfeited material, you will know the factory where it was discovered, you will be able to pinpoint the exact materials that

came into the plant. You can then do a trail through a secure mechanism, and you can see the history of where that happened. You will then have the evidence that you need, beyond reasonable doubt, to be able to highlight who is responsible.

"Now, as soon as this becomes normal, the counterfeiters are going to realize that their business model has gone south. Basically, they can still put materials in there, but when they do, they're going to get caught, and that means that they are going to move on to somewhere else and trying to find something else to give them a thrill. Because if they continue to do what they're doing, they're going to be caught and prosecuted. That means that we clean up the supply chain. If we can create traceability data without doubt in manufacturing and have a secure kind of distribution path for materials as they go from manufacturer to the factory, that combination will eradicate counterfeiting, and that is a big deal for the industry," says Ford.

Impact on Labor

IoT—and Industry 4.0, for that matter—are expected to bring efficiencies in manufacturing. And one part of that is labor.

"We have to remember that people are part of our digital factory as well, and like the machines, we can control them with data. Are we supposed to control people in the same way? And actually, I would say yes. Now, we hear a little bit about augmented reality (AR), which, whatever the technology may be, it's bringing information to the operator in real time as they do their job. So, the kind of AR can probably fence what the operator is doing. It can track what they're doing, so I would see that in the factory of the future, where we've got some kind of—we'll call it AI, for the sake of argument—that's taking the demand from the customer and working out the best ways to utilize the machines," explains Ford. "That logic is also going to be finding out the best way to utilize the workforce. And that is quite good, because in traditional manufacturing, you go in and see the manufacturing lines and people do the same job day in, day out. It's awful. The first company I worked at, there was a test that operators had to take, and if they failed the test they could not work on the production line. It's a kind of a job that certain people can do, but other people would go absolutely crazy. And it's got a bad rap in the market. Nobody wants to be doing something as repetitive as that.

"With this AR scenario, however, we are able to provide information for people to do a job which is a lot more interesting than if they had to learn everything about the job themselves. For example, an operator in the future will be walking into a factory, and they will maybe be told, 'Well, right now we're making this product, so I am going to give you the step-by-step instructions in your glasses and show you exactly how to do that.' So, you're up to speed immediately. You don't need training. You don't need a learning curve. Everything is provided, and you just do that. It could be an hour later, and they'll say, 'We've got a quality issue. We need you to go over and start to do a quality check exercise.' Maybe 40 minutes after that, 'We need some materials to be taken from the warehouse to this special point of use; please go over there and collect them.' Maybe there's maintenance to be done on a machine, where something needs to be adjusted or lubricated or something like that."

In this scenario, operators are now no longer tied to a particular job, and that they don't need exceptional experience or skills in order to be able to do a job with adequate performance and quality. According to Ford, the ability to take information and present it to people and guide them step by step gives them a reward-

ing mix of roles to do throughout the day.

"Now, the whole thing about being a production operator means that instead of just stuffing boards, you are operating many different facets of manufacturing and you're much more a part of the solution. So, I see that people are going to be a lot more flexible, and they're going to get a lot more job satisfaction from their ability to do more and have a much nicer environment to work," says Ford.

Ultimately, it will be a streamlined workforce because one goal in adopting technologies such as IoT and CFX is to reduce total labor cost.

"You can walk along production lines, and see people who are working extremely hard, and those who are not. You go back, and it's the reverse case. So, you keep a certain number of people in each different kind of role. If you've got people who are much more flexible, then you can have a lot less people. I saw an example in material logistics where we were not able to track what the logistics requirement was. You had to cover the peak, and so if you figured that five or six lines were going to change over at the same time, and you needed a certain rate of materials to be supplied, you had manpower to cover that. But guess what? Around 90% of the time, a lot of that manpower had nothing to do. If you knew exactly what manpower you were going to need and when, you could repurpose people from another pool to work in that pool. Overall, we saw a 30% reduction in overall manpower requirement, and that's just in a simple area like logistics," says Ford.

However, factories haven't fully embraced this potential. And according to Ford, the problem has been the lack of IoT.

"We've seen companies who have done extremely well with lean materials. They've got the machine connections. They see the demand. They're doing the predictive kind of delivery of materials. We've seen people doing closed loop systems, where they have the specific interfaces in the machines and they're able to have some amazing results from what they're doing. Then it comes to the question of scaling, and they spent whatever dollars to make that line work well. How much is it going to cost to do all your other lines in the process? And then they think yeah, that's a lot of different interfaces to develop. So, quite often, even the best industrial and engineering ideas in factories, even the best of them, do not take hold simply because of the cost and the difficulty to populate them with information," Ford explains. "This is where IoT is going to really open that opportunity, because when all the machines are speaking the same language, you develop an application, whether it's by an IT guy or an engineer on the line or a machine vendor or a solution provider, they will all work together. And somebody can simply create that solution once, with one interface, and it works everywhere. This is a completely different ballgame from what we've seen before.

"I saw one company recently in China where they're taking data from the SPI and using it to adjust and compensate on the solder paste and even the placement machines. They got their reject rate down to 4 PPM. It's just unbelievable what can be achieved, and yet they said to me, 'Look, we've got a great result here, the software we developed ourselves, but we


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can't scale it.' And so, the go-to people in that scenario are the machine vendors because the machine vendors are being pushed to create more and more from their machines. All in a different format, because for them it's the opposite problem. They've got 30 customers, and they've got 30 different format requests. And so, they're pulling their hair out now and saying, 'Look, we cannot sustain this. We want the customer's business. We want to do our best for the customer, but this is absolutely unsustainable.' Within the hour of our IPC CFX meetings, and this is what really blew me away in the first meeting, we have all these competitors sat around in a room, and normally they'd be kicking and screaming and fighting, and we'd probably have to call security, but no. They were sitting calmly together, each of them agreeing with the next. So yes, we all share the same problem. We share the same aim. We'd like to exchange data in a common format, where everything is plug and play, and we're not going to be competing anymore on these silly interfaces. We're going to be competing on our hardware and the software that goes around our hardware and how we make an excellent placement or inspection or whatever. That's how we go forward, because this is just ridiculous trying to keep everybody happy in terms of providing data. So, this is an amazing result of CFX that we see with these people now."

Changing the Status Quo

Nowadays, companies need to think about changing the way that they are manufacturing, because for so many years now, for instance, 30 years of SMT lines, we've all been doing things in a similar way, and the practices we've got are ingrained. And then come technologies and trends like the IoT or Industry 4.0—and people immediately assume that they're going to be making what they're doing a little bit better.

"And this is not true," says Ford. "We are not going to make what they're doing better. We're going to change what they're doing, because the way of doing things when you have a digital factory environment is completely different from the way of doing things when you're in the old analog environment. For example, with new product introduction, if it takes you eight working days to process a CAD and BOM for use in the production line, you get one shot. You decide what equipment it's going to go onto, and that's it, job done. With the digital factory, it takes you seconds to make that decision and to process that data. And so, you can say, 'Okay, I've got that configuration that produces 1,000 a day. I've also got another configuration that produces 800 a day. Now, I can meet my custom demand. I can make 1,000, or I can make 800 or whatever quantity that I want. And now I can ensure that my lines are working at 100% efficiency making that quantity.' And that's something that's never happened before. The old practice is engineers decide or they choose a configuration. It runs on that configuration for greater or worse, running at probably 20% or 40% efficiency for the life of the product. Now, you're able to move things around, choose the best line for the job, and you just doubled your productivity. So, we're able to change the way that engineering works. Instead of engineering defining the target, planning defines the target, and the planning is working in real time to optimize things.

"It's not just making NPI quicker. We're doing that as well, but having made NPI quicker, let's see how that changes the roles in the factory and how we respond to the customer when they come with their new requests. That's just at one example. There are many, many different examples of how people will be doing things differently in the digital factory, and people must wake up to that. They can't just assume that this PC is going to replace this person, but it does basically the same job. We're going to see a complete change, and so what I've been trying to write about in my articles and columns is to make an understanding of how these changes, if people can understand them and go ahead with them, are going to make that step change of an improvement." SMT007

MilAero007 Highlights

Congress Finalizes FY2019 NDAA with IPC Input on Mil Electronics ▶

IPC—Association Connecting Electronics Industries is applauding leaders in the U.S. House and Senate for finalizing the FY2019 National Defense Authorization Act (NDAA) and including a provision on military electronics backed by IPC.

Celestica Subsidiary Wins Honeywell Supplier of the Year Award ▶

Celestica Inc. subsidiary AbelConn Electronics has received the Honeywell New Product Development Supplier Excellence Award.

Libra Industries Partners with CoPro Technologies for Mechanical Design/PCB Layout ▶

Libra Industries has partnered with CoPro Technologies to support its customers with mechanical design and PCB layout services.

Sonobuoy TechSystems Inks $9.3M in Contracts ▶

Ultra Electronics USSI, a subsidiary of Ultra Electronics Holdings plc (ULE) and Sparton Corp., has been awarded subcontracts valued at $9.3 million from their ERAPSCO/Sonobuoy TechSystems joint venture.

Lockheed Martin Rotary and Mission Systems Division Earn IPC QML ▶

IPC's Validation Services Program has awarded an IPC J-STD-001, IPC-A-610 and IPC/WHMA-A-620 Qualified Manufacturers Listing (QML) Class 3, to the Lockheed Martin Rotary and Mission Systems (RMS) business area.

Kitron to Invest in Poland ▶

Building on the strong performance in Lithuania, Kitron is planning on expanding its Eastern European presence and by signing a letter of intent for a production facility in northern Poland.

Saab Receives U.S. Army Order for Additional AT4 Systems ▶

Saab was awarded an ID/IQ contract for AT4CS RS in 2008. This order is an addition to a Delivery Order received in 2017. That order was valued at $13.4 million.

Rockwell Collins and Lockheed Martin to Present Dual Keynote at SMTA International 2018 ▶

The SMTA is pleased to announce Ron Heberlein, Rockwell Collins, and Tony "Brick" Wilson, Lockheed Martin, will keynote SMTA International the morning of Tuesday, October 16 with their presentation "The World's Most Advanced Fighter Jet Helmet – from Development and Production to the Fight."

Circuitronics Unveils Large-format PCBA Capabilities ▶

Circuitronics has invested in Vitronic Soltec's Delta Wave soldering system to accommodate PCB assemblies up to 24".

Celestica Releases Q2 2018 Financial Results ▶

Celestica Inc. has reported revenues of $1.7 billion for the second quarter of 2018, up by 9% compared to the same period last year.

Are Megatrends Putting Your Product at Megarisk?

Quest for Reliability

Feature Column by Eric Camden, FORESITE

"Mega" is a fun word to use because it elicits thoughts of grandeur and impressiveness regarding the topic at hand. From megaton to megalomaniac, when you use "mega" as a prefix, you know it's going to be big. A simple trend can only speak to two or three things going in the same direction, but a megatrend is a completely different ball game. In my exhaustive research (one hour on the Internet, so I am officially an expert), I found this fact in a paper by two researchers from Finland: "It took 38 years for radio to get 50 million users, television made it in 13 years, Internet in four, iPod in three, and Facebook in only two years" [1]. As a dad of a 10-year-old son, I would guess that Fortnite made it to 50 million in about 12 minutes.

What these numbers mean to our industry is the need to create electronics at blazing speeds that we haven't seen before. I have seen customers increase their demand on throughput without any thought to how that will affect reliability. If it takes one hour at 350°C to bake a cake, why can't we do it in 30 minutes at 700°C and get the same quality? I wish it worked that way, but it doesn't—trust me.

When the demand is higher than normal, you can't simply increase the belt speed on your soldering equipment and expect to make the same high-quality product. To be fair, the majority of handheld or consumer electronics fall into the Class I category, which aren't necessarily that reliable to start for long term,

on-demand use. In the Class II and Class III world, it's a megadifferent story. For example, demands for safety and hardware reliability in the military and aerospace segments are everything.

Assembly parameters are traditionally determined using manufacturers recommendations, trial-and-error methods, and in some cases, tribal knowledge. No matter how you go about that task, the important part is to look at supporting analytical data. No-clean flux is a prime example of a material that needs to be exposed to enough thermal energy for enough time to render the residues near benign. When you increase the belt speed to increase numbers, you will also alter the chemical composition after reflow soldering.

A few years ago, I put together a study to determine the effect of speeding up the belt on a reflow oven on cleanliness. With the first group of test boards, I used the manufacturer's recommendation—maximum ramp of $<2°C$ per second with a dwell time of 30–90 seconds at peak temperature. This was achieved with a belt speed of 1.5 FPM and a peak temperature of 250°C was reached with a dwell time of ~60 seconds. Ion chromatography was performed at multiple locations and component types. Table 1 shows the ionic content for what we consider to be acceptable for normal field service operation.

With the second group of test boards, I used a belt speed of 2.0 FPM and a peak temperature 10°C lower than the manufacturers recommendation. The integrated circuit (IC) analysis in Table 2 shows elevated ionic content that is meant to be outgassed under temperature or fully bound in the outer resin/rosin shell of the flux. Ionic content at these levels increases the risk for electrical leakage with normal available atmospheric moisture.

The increase of belt speed will pump out more parts, but at what cost? Being able to produce more parts in the same amount of time is always going to look great to the customer but needs to be judged against the amount of returns with "no-trouble-found" (NTF) designations or hard failures. NTF is a megabad condition because when a part fails in the field, it can't be reproduced, which makes finding the root cause nearly impossible. When a part returns to a repair depot, the low hanging fruit becomes items such as missing components, ICs that needs to be flashed, or beer stains on the board—you know, standard stuff you see from field returns.

Active flux residues aren't something you can see under a scope at 10x. You can see

all values in µg/in²		Ion Chromatography (Dionex ICS 3000) n/a = not applicable															
		F^-	$C_2H_3O_2^-$	CH_2O_2	Cl^-	NO_2^-	Br^-	NO_3^-	PO_4^{3-}	SO_4^{2-}	WOA	MSA	Li^+	Na^+	NH_4^+	K^+	Ca^{2+}
Third Party Lab Recommendations		1	3	3	3.00	3	6.0	3	3	3.0	150	1	3	3	3	3	n/a
Group # Board #																	
Raw Solder Paste		0.61	273.44	39.06	61.02	0.81	0.24	0.86	0	4.77	4.48	0	248.49	10.26	23.57	64.65	15.47
G3-B1	TQFP	0	2.58	2.45	1.97	0.37	1.33	0.08	0	2.59	0.39	0	1.91	1.60	1.41	0.91	1.53
G3-B1	LCC	0	1.88	2.16	1.41	0.32	1.53	0.05	0	1.46	0.40	0	2.84	1.55	2.89	2.03	3.29
G3-B1	BGA	0	2.46	2.24	1.41	0.42	1.06	0.04	0	1.22	2.78	0	2.06	1.38	1.34	1.53	2.38
G3-B1	Header	0	0.13	1.15	0.44	0.56	0.43	0.02	0	1.61	1.88	0	1.16	1.13	1.10	0.86	2.56
G3-B2	TQFP	0	1.31	2.28	2.00	0.43	1.30	0.28	0	2.28	2.02	0	2.24	0.79	1.89	2.33	2.30
G3-B2	LCC	0	1.33	1.98	0.93	0.31	1.28	0.03	0	2.23	1.47	0	2.99	0.81	0.96	2.80	2.29
G3-B2	BGA	0	1.63	1.94	1.04	0.66	0.88	0.01	0	2.68	1.24	0	1.16	0.92	0.96	1.74	3.02
G3-B2	Header	0	0.24	0.39	0.54	0.04	0.71	0.05	0	1.10	2.24	0	0.77	0.45	0.79	0.70	2.03
G3-B3	TQFP	0	2.08	2.38	1.39	0.41	1.23	0.15	0	2.24	2.25	0	1.69	1.76	1.15	0.24	0.67
G3-B3	LCC	0	1.41	2.73	1.07	0.53	1.49	0.04	0	2.56	2.08	0	1.88	1.71	1.09	1.99	2.43
G3-B3	BGA	0	1.88	2.02	1.25	0.19	1.54	0.09	0	2.53	1.91	0	2.05	1.57	0.90	2.23	1.47
G3-B3	Header	0	0.80	0.74	0.87	0.49	0.90	0.30	0	1.41	0.29	0	0.79	1.22	1.23	1.05	2.28
G3-B4	TQFP	0	1.34	3.06	1.28	0.28	1.27	0.16	0	2.91	1.59	0	1.19	2.32	0.98	1.96	3.29
G3-B4	LCC	0	0.98	2.43	1.06	0.23	1.84	0.05	0	2.64	3.06	0	2.01	2.08	0.90	2.40	2.58
G3-B4	BGA	0	1.67	2.55	0.36	0.27	1.18	0.14	0	1.58	2.43	0	2.39	1.68	0.95	2.35	1.96
G3-B4	Header	0	0.87	1.05	0.93	0.17	1.29	0.16	0	1.08	1.99	0	0.56	0.66	1.12	1.01	1.44
G3-B5	TQFP	0	1.34	3.06	0.75	0.26	1.42	0.11	0	2.66	2.72	0	1.31	2.63	0.76	1.16	3.83
G3-B5	LCC	0	1.52	2.30	1.53	0.48	2.78	0.17	0	1.57	2.37	0	2.92	3.04	1.06	1.71	1.64
G3-B5	BGA	0	1.74	1.31	1.25	0.29	1.34	0.11	0	2.42	3.38	0	1.31	1.51	1.26	1.93	1.31
G3-B5	Header	0	1.01	0.93	1.21	0.12	1.12	0.19	0	0.98	1.22	0	0.41	0.69	0.98	1.22	0.60

Table 1: Ion chromatography for the first group of test boards.

all values in µg/in²		Ion Chromatography (Dionex ICS 3000) n/a = not applicable															
		F^-	$C_2H_2O_2$	CH_2O_2	Cl^-	NO_2^-	Br^-	NO_3^-	PO_4^{3-}	SO_4^{2-}	WOA	MSA	Li^+	Na^+	NH_4^+	K^+	Ca^{2+}
Third Party Lab Recommendations		1	3	3	3.00	3	6.0	3	3	3.0	150	1	3	3	3	3	n/a
Group #	Board #																
Raw Solder Paste		0.61	273.44	39.06	61.02	0.81	0.24	0.86	0	4.77	4.48	0	248.49	10.26	23.57	64.65	15.47
G2-B1	TQFP	0.07	7.79	3.12	1.10	0.13	0.25	0.36	0	0.56	1.14	0	14.87	2.44	7.91	1.84	8.66
G2-B1	LCC	0.34	5.20	4.19	1.51	0.09	0.03	0.65	0	0.84	2.40	0	10.70	9.87	12.55	0.50	9.39
G2-B1	BGA	0.65	7.61	2.58	1.16	0.12	0.20	0.47	0	1.21	1.34	0	10.13	5.67	4.50	0.84	9.71
G2-B1	Header	0.97	1.18	1.16	0.62	n.a.	0.11	0.20	0	0.38	1.01	0	2.86	0.63	1.88	1.36	2.98
G2-B2	TQFP	0.96	8.57	3.64	2.03	0.18	0.04	0.85	0	0.51	2.63	0	12.18	2.89	5.83	1.29	7.35
G2-B2	LCC	0.63	11.75	3.59	2.37	0.09	0.30	0.33	0	0.27	1.31	0	11.01	7.44	8.53	0.71	3.53
G2-B2	BGA	0.66	12.71	3.13	0.87	0.10	0.10	0.05	0	0.69	2.55	0	11.06	5.34	8.81	1.01	10.43
G2-B2	Header	0.56	0.66	1.24	0.92	0.14	0.05	0.02	0	0.12	1.50	0	2.12	1.31	2.32	0.66	1.15
G2-B3	TQFP	0.82	10.08	2.89	1.38	0.08	0.13	0.13	0	0.94	2.38	0	10.86	1.07	3.76	1.03	5.49
G2-B3	LCC	0.59	9.86	3.11	2.56	0.22	0.13	0.89	0	1.11	1.39	0	10.96	8.71	10.11	1.07	10.22
G2-B3	BGA	0.50	7.88	2.41	1.27	0.21	0.08	0.36	0	1.05	1.95	0	11.40	5.55	4.70	1.18	12.47
G2-B3	Header	0.41	1.13	1.45	1.19	0.23	0.14	0.13	0	0.54	1.04	0	1.61	0.83	2.58	0.14	0.71
G2-B4	TQFP	0.19	10.67	1.13	1.40	0.24	0.60	0.35	0	0.62	1.86	0	12.58	1.83	5.98	1.54	11.06
G2-B4	LCC	0.10	12.53	2.99	2.08	0.11	0.21	0.14	0	0.42	1.24	0	11.85	2.87	4.21	1.32	6.32
G2-B4	BGA	0.31	11.83	3.84	3.26	0.26	0.07	0.24	0	0.33	1.59	0	12.96	3.15	4.65	2.01	5.54
G2-B4	Header	0.39	1.02	0.95	0.91	0.19	0.06	0.10	0	0.19	0.98	0	2.01	1.29	2.77	0.54	2.01
G2-B5	TQFP	0.22	8.44	2.16	4.01	0.14	0.11	0.18	0	0.27	2.20	0	13.10	2.98	3.96	1.22	3.67
G2-B5	LCC	0.44	9.61	3.02	3.25	0.22	0.27	0.07	0	0.28	3.01	0	12.43	3.01	4.02	1.63	4.21
G2-B5	BGA	0.38	9.74	4.01	3.64	0.34	0.30	0.11	0	0.30	2.57	0	12.22	2.57	3.65	1.25	3.96
G2-B5	Header	0.27	0.98	1.29	1.01	0.09	0.14	0.12	0	0.16	1.13	0	1.45	1.03	1.43	0.91	2.14

Table 2: Ion chromatography for the second group of test boards.

flux residues, but visual inspection alone isn't enough to determine if they are conductive or corrosive. When a board gets labeled with the NTF designation, many times, it's chalked up as a loss with no further follow up. That is most likely because the active flux residues will absorb loads of moisture and create an electrical leakage plate that will disappear as soon as the moisture dries out during shipping. The repair depot looks at the return and everything seems to be in working order. This condition will only increase with the act of increasing throughput without doing any of the hard work to determine if it's detrimental to the product.

However, there are probably parameters that will allow you to increase the throughput while not producing PCBAs that aren't megaquestionable. Increasing the temperature in the preheat zone is one way to do it, but it's important to look at the recommended rise rate from the manufacturer of the flux and the component manufacturers. Sudden increases in temperature can crack some types of components, including LEDs, aluminum capacitors, fuses, inductors, and transformers with wire coils. It will do you no good to increase the throughput if you are destroying the components.

Using a thermal profile system on the actual product is the only way to effectively monitor the temperatures at locations that are known to be temperature sensitive. Using a bare board or thermocouples in air will tell you what the temperature is in the oven, but not what the actual temperature is on your product. This will certainly be a trial-and-error effort until you find the sweet spot of throughput, acceptable solder joints, and benign flux residues.

Using a bare board or thermocouples in air will tell you what the temperature is in the oven, but not what the actual temperature is on your product.

The megatakeaway from this month's column is the final reliability level of an assembly relies heavily on the thermal profile used for soldering. When the peak temperature is too low, excess amounts of active flux residues are left behind, and when ample moisture is available from a normal operating atmosphere or from condensing moisture anomalies, there is a greater risk of failure due to electrical leakage and/or electrochemical migration. Active no-clean flux residues are conductive in general and when moisture is absorbed into the residue across non-common conductors, voltage easily flows between the two. This is why it's so important to monitor the effect of your throughput speeds when ramping up to meet the 50 million requested pieces to support the megatrends in the electronics industry.

I want to close with a megapology for using the word "mega" incorrectly so many times. As I said, it's a mega fun word to say. **SMT007**

References

1. "Megatrends in Electronic Business: An Analysis of the Impacts on SMEs," by Marko Ovaskainen and Markku Tinnilä, Modern Entrepreneurship and E-Business Innovations.

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

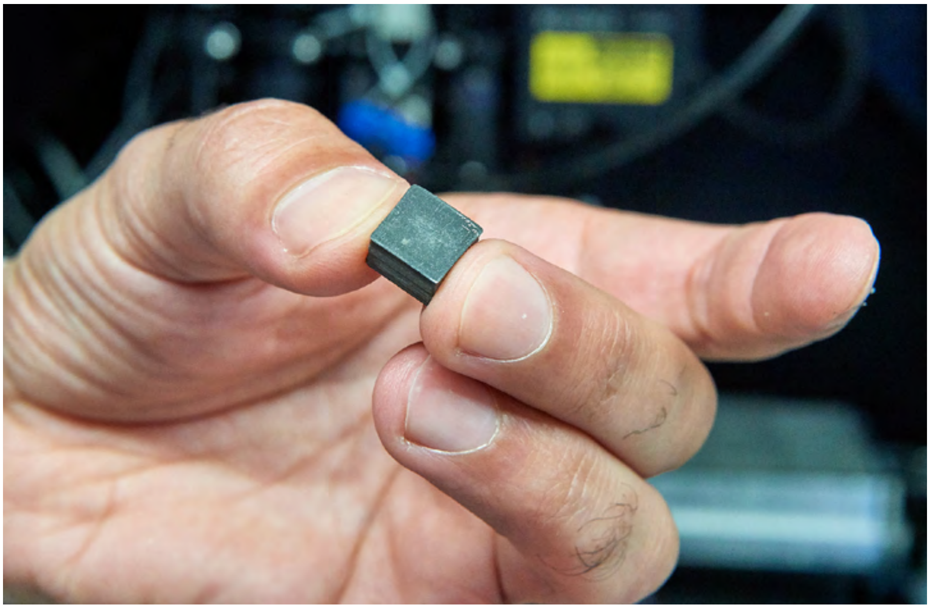
Smart Machine Components Alert Users to Damage and Wear

Scientists at the United Technologies Research Center and the University of Connecticut (UConn) are using advanced additive manufacturing technology to create 'smart' machine components that alert users when they are damaged or worn.

The researchers also applied a variation of the technology to create polymer-bonded magnets with intricate geometries and arbitrary shapes, opening up new possibilities for manufacturing and product design.

The key to both innovations is the use of an advanced form of 3D printing called direct write technology. Unlike conventional additive manufacturing, which uses lasers to fuse layers of fine metal powder into a solid object, direct write technology uses semisolid metal 'ink' that is extruded from a nozzle. This process allowed the UConn-UTRC scientists to create fine lines of conductive silver filament that can be embedded into 3D printed machine components while they are being made. The lines, which are capable of conducting electric current, act as wear sensors that can detect damage to the part.

"This changes the way we look at manufacturing," says Sameh Dardona, associate director of research and innovation at UTRC, which serves as the innovation engine for United Technologies Corp. "We can now integrate functions into components to make them more intelligent. These sensors can detect any kind of wear, even corrosion, and report that information to the end user. This helps us improve performance, avoid failures, and save costs."



According to Dardona, this is a great example of collaboration between industrial research and academic research. "We always have new concepts that we'd like to try and explore. This collaboration allowed us to leverage the knowledge, expertise, and facilities available at UConn to help us address some of these technological challenges," he says.

(Source: University of Connecticut)

XR Update: Emerging Realities

Feature by Dan Feinberg
I-CONNECT007

The rate of advance in the use of XR in many areas, along with advances in the hardware and network capability supporting the use of XR, is accelerating. And because things are moving so quickly, let's do a quick review and an update on recent developments in this field.

The term XR is now being used to cover AR (augmented reality), VR (virtual reality), and MR (mixed reality). The first XR could be considered cave wall carvings. But in relatively modern times, I consider the original to be B&W movies. The first was made in 1878 and consisted of a "moving picture" of a racehorse made by assembling individual pictures from multiple cameras. Motion pictures were born on that day.

Figure 1: VR headset.

It took 40 years to reach the next big milestone, color motion pictures. The obvious next step would be motion pictures with sound—that took nine more years (1927), a long time—but the rate of advance had accelerated.

As I mentioned in a previous article, one of the first movies showing a train approaching at full speed caused a panic among those viewing it—some left their seats and, in a panic, exited the viewing area to avoid being hit by the train. Over the next decades, we went to higher quality, higher resolution, sound that synced well with image, initial 3D, and so on. All this led to the initial holodeck-like capabilities we are starting to see today.

Do not think of XR as just an entertainment driven technology. Yes, there are 3D TVs, although that segment has basically failed due to the need to wear special glasses (which will be eliminated in time); and yes, the XR gaming segment is growing. But the real drivers are industrial, medical, military and transportation under remote control. (If you want more detail on this growing and rapidly advancing group of technologies, you might want to read my

last two articles covering XR at CES 2018 and the Augmented World Expo (AWE) show.)

With the advances in computer hardware and the resultant higher capabilities, the approach of 5G connectivity, quantum computing, and artificial intelligence (AI), the mix of what is real and what is not, what is in your presence and what is a half a world away or does not really exist, is advancing rapidly and the uses of XR are increasing exponentially.

It has now been about three months since AWE 2018, and CES 2019 is less than five months away. What follows is what we can expect over the next year. Some is speculative, but expect much of it to be announced, discussed and even demonstrated at CES 2019.

One major advance happening faster than anticipated is the installation and activation of the first 5G networks. While 5G is going to be used extensively by far more than smartphones, it is smartphones that the public will first associate with 5G. The first phones with 5G capability will be available in 2019, a full year earlier than what was predicted just two years ago. The first fully commercial 5G networks will be launched in the USA, South Korea and Japan, and probably by multiple carriers. The first small commercial network is already running, set up by Finnish company, Elisa.

According to a study released by Qualcomm Technologies Inc., 5G is projected to contribute $3 trillion to real GDP, produce up to $12.3 trillion worth of goods and services by 2035, and support nearly 22 million jobs. 5G will elevate mobile networks to not only connect people vocally, but primarily to interconnect and control machines, objects, and devices. It will deliver new levels of performance and efficiency that will empower new user experiences and connect new industries.

Per my article on 5G last winter, here's a quick history of mobile interconnect generations and what they made possible over the last 25 years.

- 1G: delivered analog voice
- 2G: introduced digital voice
- 3G: added mobile data transfer
- 4G LTE: ushered in the era of mobile Internet
- 5G: will seamlessly connect the Internet of Things (IoT), a massive number of embedded sensors in virtually anything and everything

Figure 2: IoT.

All the XR enablers such as machine learning, AI, predictive analytics, quantum computing, and other technologies that are rapidly advancing and being accepted are remaking the business landscape today. A brave but perhaps scary new world is upon us, where every industry from agriculture to healthcare, medicine, military and commerce, to advertising/monetization and just about everything else, is innovating and accepting the innovations exponentially.

Figure 3: XR being used on the USS Ford.

Military: The U.S. Army will test HUD 3.0, an augmented reality system using a heads-up display that will let them see both the real world as well as allow them to determine where they and the other members of their unit are specifically, and more importantly, where the enemy is. What is not widely known is that HUD 3.1 is already in use. Breaking DoD reports indicate they are skipping 2.0 because of the sheer technological leap that is now available, hence 3.0.

Travel to previously inaccessible locations: Already, XR allows one to travel to and walk the sea bottom, tour an ancient city, take part in a relatively accurate historical battle, or go and do just about anything with three of your five senses immersed in a virtual world. We cannot yet accurately simulate taste and smell, but that is coming. But how about standing on the surface of Mars? You can't pick up that rock sitting on the Martian surface—not yet at least, but eventually, you may be able to control a robotic device and sense all as if you were there—but that is still well off and even 5G may not be fast enough. You can stand in places the Curiosity rover has explored, see that orange-yellow sky with the Martian red terrain on all sides, and feel like you're in an alien world, as if it were you rather than the rover actually perched on the surface of Mars. Or perhaps you just want to witness and feel what a rocket launch is like.

The point is that today's higher-end XR technology (using a real relatively powerful PC connected to a high-quality headset and haptic devices, not a smartphone and Google Cardboard!) allows you to do what was unthinkable just a decade ago. Thanks to a few innovative thinkers within NASA, this may all be available soon.

Medical: To get an idea of what is coming in medical technology, here's a partial list of upcoming papers to be presented at the Augmented Human International Conference scheduled for March 2019:

- Augmented Taste, Brain-Computer Interfaces and Artificial Intelligence
- Muscle Interfaces and Implanted Interfaces,
- Exoskeletons and Super Human Technologies
- Augmented Sports and Serious Games
- Human Augmentation
- Privacy and Security Aspects of Augmented Humanity
- Services and Applications for Human Enhancement, and many more.

Add to that the upcoming 5G-enabled advances in robotic surgery and diagnostic technologies that are already in use.

Remote Service and Diagnostics: We can certainly expect to see increased use of XR for remote service, which is so much more efficient and faster than sending out a service person. I would expect to hear announcements regarding newly available XR services very soon.

New Hardware: We can certainly expect to see the next generation of XR hardware, new headsets and perhaps the release of the next generation of the long-awaited Microsoft HoloLens. Also, there will be more powerful small computers allowing for better mobility and next generation haptic devices.

So, we know why the medical, military, entertainment, and service industries look to take advantage of XR. Meanwhile, here are some things that will speed up the adoption of XR for the average person:

- Increased affordability and comfort. If the devices become less expensive—and that has already started to happen—and if the devices are easy to use and comfortable, you can be sure the adoption rate will increase.
- XR for social and other events such as sporting events, virtual dating, virtual touring and travel, perhaps to the Grand Canyon or a space station (an extension of the virtual date).
- Expand XR beyond sight, sound and touch. Improved touch is already out there with improved haptics and adding the feeling of the wind or heat from the sun, for example, is now possible and improving, but it will be a long time before we can add taste and smell as these will require consumables, but it is something that is being worked on.

There is no doubt that XR capabilities are expanding. This is not a fad like 3D TV with its very limited applications; this is something that has infinite uses. Stay tuned for XR coverage from CES 2019, where it will certainly be a key focal point. **SMT007**

Dan Feinberg is the owner and president of FeinLine Associates Inc. and the technology editor for I-Connect007. To read past columns or to contact Feinberg, click here.

AI Device Identifies Objects at the Speed of Light

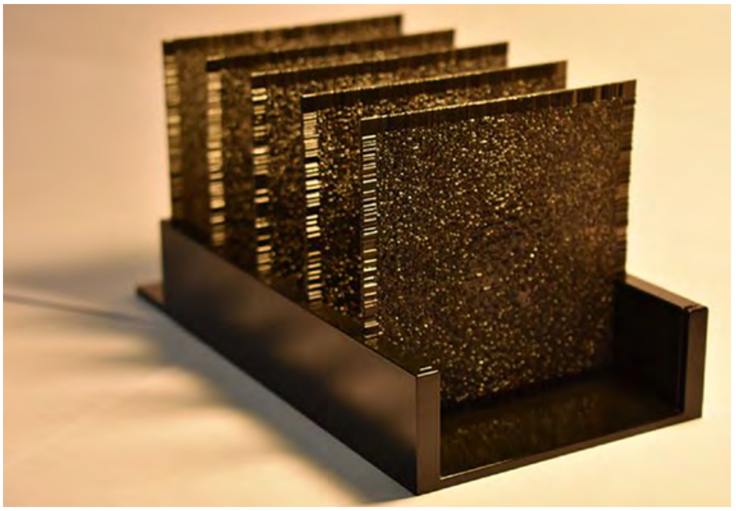
A team of UCLA electrical and computer engineers has created a physical artificial neural network–a device modeled on how the human brain works–that can analyze large volumes of data and identify objects at the actual speed of light. The device was created using a 3D printer at the UCLA Samueli School of Engineering.

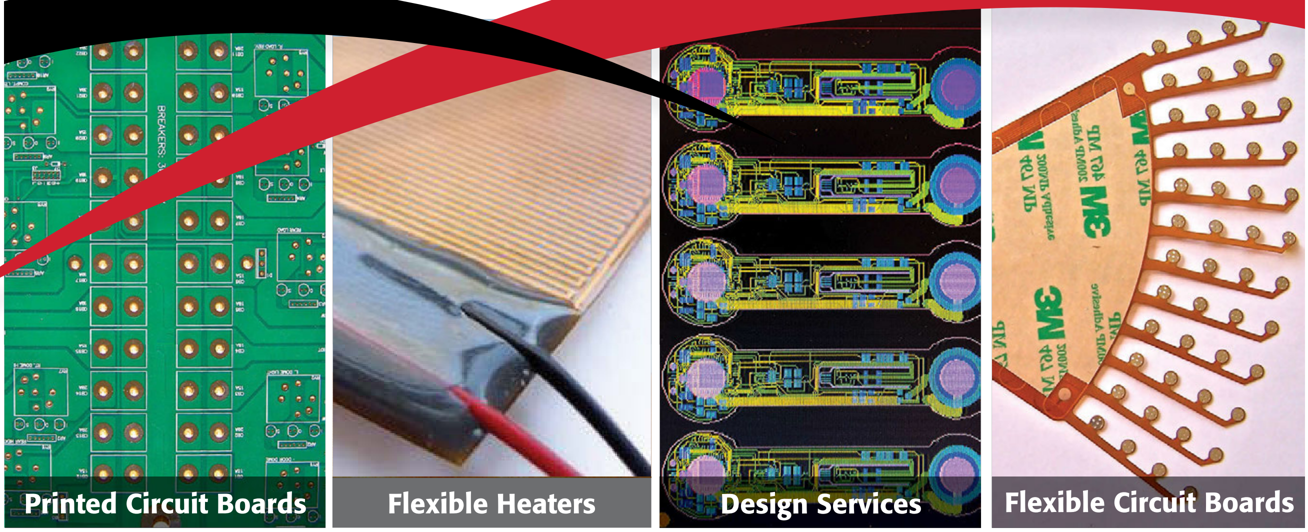
Called a "diffractive deep neural network," the UCLA-developed device uses the light bouncing from the object itself to identify that object in as little time as it would take for a computer to simply "see" the object. The device does not need advanced computing programs to process an image of the object and decide what the object is after its optical sensors pick it up. And no energy is consumed to run the device because it only uses diffraction of light.

New technologies based on the device could be used to speed up data-intensive tasks that involve sorting and identifying objects. For example, a driverless car using the technology could react instantaneously to a stop sign. With a device based on the UCLA system, the car would "read" the sign as soon as the light from the sign hits it, as opposed to having to "wait" for the car's camera to image the object and then use its computers to figure out what the object is.

"This work opens up fundamentally new opportunities to use an artificial intelligence-based passive device to instantaneously analyze data, images and classify objects," said Aydogan Ozcan, the study's principal investigator and the UCLA Chancellor's Professor of Electrical and Computer Engineering.

(Source: UCLA)




Printed Circuit Boards
Flexible Heaters
Design Services
Flexible Circuit Boards

smt007 Supplier Highlights

Nearing Retirement, Juki's Bob Black Reflects on a Long Career ▶

After more than 40 years in the electronics manufacturing industry, Juki's Bob Black is nearing retirement. Bob sat down with Barry Matties at the recent SMT Hybrid Packaging show in Nuremberg to reflect on his career and talk about the importance of strategic partnerships, even if that means playing nice with your competitors.

Factronix on Cleaning, the Market and More ▶

Stefan Theil, product manager at Factronix, discusses the growing need for cleaning in European electronics manufacturing and the demands he's facing from customers when it comes to finer pitches, automation, and environmental concerns.

Benefits of Low-Temp Soldering: I-007eBook Now Available ▶

Learn about the opportunities and solutions provided by low-temperature soldering in I-Connect007's newest micro eBook: The Printed Circuit Assembler's Guide to… Low-Temperature Soldering.

Molex CEO Martin Slark Steps Down ▶

Molex CEO Martin Slark would be retiring in November after 42 years of service.

Plasmatreat on Atmospheric Pressure Plasma ▶

At the recent SMT Hybrid Packaging 2018 event held in Nuremberg, Germany, I-Connect007's Barry Matties sat down with Nico Coenen, global business development manager of Plasmatreat, for a discussion on Plasmatreat's atmospheric pressure plasma (AP plasma) treatment process and its various applications in the electronics industry.

I-Connect007 Survey Shows Rising Use of Flex and Rigid-Flex ▶

In our recent survey on flex and rigid-flex circuits, the majority of our respondents indicated an increase in their use of flex and rigid-flex technologies in their designs, indicating a continued shift in flex technology usage.

Nordson SELECT Launches Automatic Solder Nozzle Tinning System ▶

Nordson SELECT, a Nordson company, has made available its automatic solder nozzle tinning system for all Nordson SELECT selective soldering machines.

Koh Young Technology Receives KOSDAQ Industry 4.0 Pioneer Award ▶

KOSDAQ recognized Koh Young Technology with the KOSDAQ "Industry 4.0 Pioneer Award" for its excellence in putting Industry 4.0 into practice.

GOEPEL Launches WLAN Connection for Boundary Scan Controller ▶

GOEPEL electronic's JTAG/Boundary Scan controller SCANFLEX II Cube gets an optional wireless LAN interface. Previously, the controller had USB 3.0 or LAN interfaces as standard. With the new option, another control interface is now available.

YXLON Invests in Four New Climate Chambers ▶

Responding to the growing demand for CT metrology applications, YXLON International has invested in four additional climate chambers in Hamburg: two dedicated to R&D for new and ongoing technology development; and two for production, where the YXLON FF20/35 CT metrology systems are fine-tuned for accuracy.

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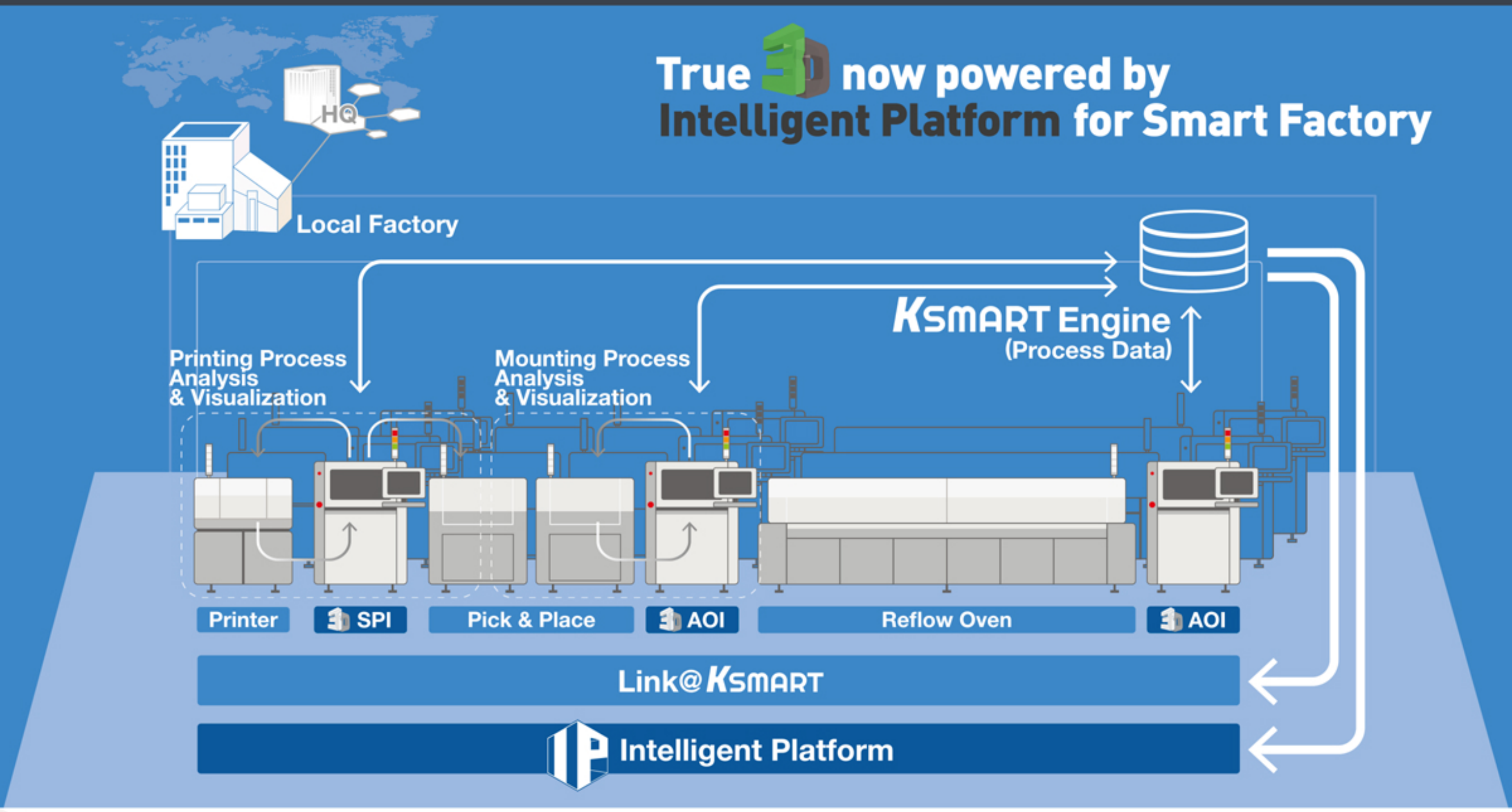

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How CIM and IoT Can Make Your Factory Smart

Feature by Zac Elliott
MENTOR, A SIEMENS BUSINESS

Abstract

With so many extremely clever scientists and engineers in our industry, the whole complex technology of electronics assembly requires people with specialist skills. When it comes to linking all these processes together, there is more than just a simple data connection to think about. The content of data from the myriad of different processes and technologies firstly needs to be understood and then needs to be transformed into information which is then actionable, not just by a human, but by a computer.

There is no one person who can understand every aspect of every process, and every opportunity for smart factory functionality. Accessibility to new IoT manufacturing data connections is a multi-way technology. As well as higher level systems such as the manufacturing execution system (MES) or enterprise resource planning (ERP) systems making smarter decisions, the same IoT data is also available to every machine vendor, each of whom know their technology down to the finest detail. Here is where we will see the bulk of the smart solutions for assembly manufacturing coming from.

Driving this is the machine vendor agnostic data acquisition and utilization, with complementary functionality through machine, line, factory and enterprise levels. This promotes healthy differentiation between vendors in the same market space, not only in terms of machine performance, but also in terms of the smart solutions that they can provide based on the data collective.

This paper explores the changes in culture between the past, where data was simply sent point to point, and today's multi-layered IoT technology-based solutions, as well as the effects and opportunities that are here now for the taking.

Introduction

To create smart factories capable of autonomous optimization of interconnected processes, it is necessary to integrate the myriad of

disparate computer systems used in electronics manufacturing. Given the complexity and cost associated with this undertaking, the path to a smart factory may seem out of reach to all but the largest manufacturers. To enable the widespread adoption of smart factory functionality, it is therefore necessary to reduce the complexity, effort, and cost by defining a general approach to the smart factory infrastructure.

Industry Challenges

As business needs challenge the electronics assembly industry to support increased flexibility, lower overhead, and stricter quality standards, the industry is rapidly adopting improvements in automation and analytics to meet the challenge. The so-called smart factory and Industry 4.0 initiatives are aimed at further integrating manufacturing processes with business processes to autonomously and continuously optimize operations.

The unique challenge to the electronic assembly industry is the existing level of technical sophistication and automation presently used to manage the complex manufacturing process.

The unique challenge to the electronic assembly industry is the existing level of technical sophistication and automation presently used to manage the complex manufacturing process. Computer integrated manufacturing (CIM) systems are necessary to any electronics manufacturing operation. Many varied computer systems, automated robots, and technical experts work together not only to execute manufacturing but also to design streamlined processes, optimize the supply chain, and manage product quality. To begin linking these existing processes together can be an arduous task requiring a multidisciplinary team of technical process experts, product engineers, operational resources, and business process owners.

Although integration can be a complex and expensive proposition, there are tangible benefits to closely coupling the systems used to manage the equipment, the factory, and the enterprise. The ability to share information and control not only between individual equipment but also between equipment and business systems offers the ability to further automate and optimize sophisticated manufacturing processes.

Immediate Effects on Electronics Manufacturing

Considering the challenges facing the industry, electronic manufacturers will be seeking solutions that represent tangible progress toward the fundamentals of Industry 4.0 and the smart factory, namely autonomous, continuous optimization of operations. SMT equipment vendors have been the first to respond to the needs of the market by expanding the scope of their CIM systems beyond simply controlling the individual machine to managing the entire production line or other ancillary processes such as material management. Through partnerships with complimentary equipment vendors, entire end-to-end solutions can be offered to the market.

Although systems provided by the equipment vendor will be the optimal solution for their equipment platform and will begin to address the need for integrated, autonomous manufacturing, there is still significant complexity in connecting the web of business processes needed for most smart factory functions. Due to a variety of factors, many manufacturers have a mix of equipment vendors. A given manufacturing site may have multiple SMT platforms and a broad range of third-party equipment platforms to support. To integrate and connect these heterogeneous environments with minimal complexity and cost, it is advantageous to define a generic approach to the smart factory.

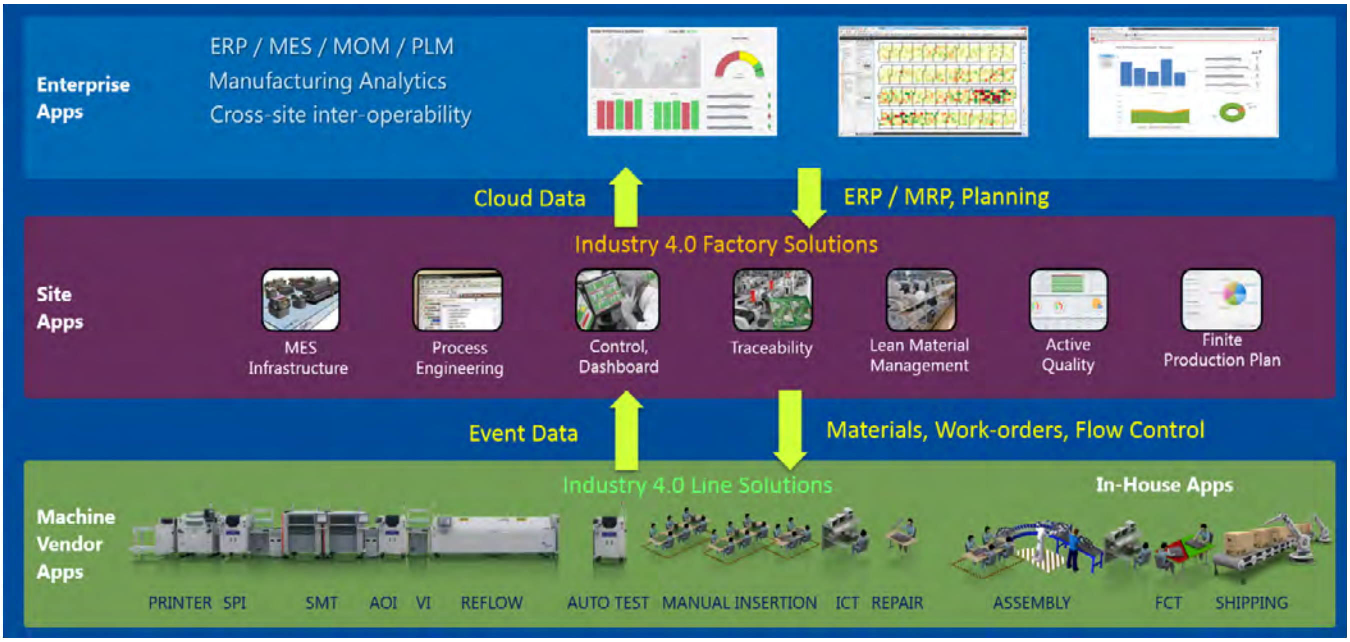

Figure 1: Smart factory layers.

Smart Factory Infrastructure

To define a more general infrastructure in which to work, the existing CIM applications can be grouped into the three primary layers that exist functionally: process applications, site applications, and enterprise applications. These groups of applications generally serve the same function in relation to each other, as shown in Figure 1.

At the lowest layer are the process applications which control or manage a given manufacturing process. These are the machine vendor applications, programmable logic controllers (PLC), sensors, or custom applications that run equipment, collect data, or guide a person or process. These applications may create event data that is valuable to other processes or to the higher-level infrastructure. To operate, these applications generally require information from the higher-level infrastructure, such as material information, work orders, and flow control.

Sitting above the process-specific applications are the site applications that manage the overall manufacturing flow. The MES infrastructure, process engineering, quality management, material management, and finite production planning applications are typical site-level functions. In many cases, these applications are consuming the event data created by specific processes to actively manage production operation to operation. The site level applications provide the flow control, work order details, and material information required by the process-specific operations.

At the top level are the enterprise applications that manage higher-level, cross-functional business processes. Some examples of enterprise-level applications are ERP, MES, manufacturing operations management (MOM), product lifecycle management (PLM), and business analytics. These applications may receive data that is aggregated from the process-specific applications and then summarized by the site level applications. The enterprise applications are responsible for providing the site level applications with the overall resource, material, and production plans.

With this delineation between the layers of applications in the smart factory, there is then a clear flow of data: business requirements flow down from the enterprise applications to the site applications. The site applications translate the requirements into concrete manufacturing plans, which flow down to the process applications. The process applications gather event data to send back up to the site applications. The site applications aggregate and summarize the relevant event data to be sent finally up to the enterprise applications.

Technical Requirements and Barriers

Beyond simply connecting and exchanging data, the integration of disparate automated processes and the computerization of human decision making requires normalized data on which to operate. Normalized data must be expressed in a single language with a consistent meaning regardless of the source of the information.

In the electronics assembly industry, there is currently no standard defining the complex data content required to model manufacturing processes. While various vendors support proprietary interfaces to their own technology, technical expertise is required to map the data content from one technology to another. Existing legacy standards focus on connecting and moving data, but there is no responsibility for the complex data content to the degree necessary for trusted decision-making. As a result, existing integrations and solutions tend to limit focus on a narrow slice of a larger business process or only function point-to-point between partner vendor solutions or custom integrations.

Emerging IoT Technology

The emergence of the Internet of Things (IoT) in the manufacturing industry offers the increased capability to connect processes and acquire data, but an infrastructure must be defined to manage the capabilities and distribute the information between multitudes of possible data streams. Considering the three levels of applications discussed previously and assuming a single language as proposed, a general approach to connecting the factory can be defined by the responsibilities of each layer of applications as shown in Figure 2.

Process applications will be responsible for exchanging raw data with equipment and operators and will normalize the events and information into a single language for consumption externally. Internally, each application can function optimally for the given equipment or process, but each application will expose the same generic interface to describe the manufacturing operations being performed.

Site applications will be responsible for adding perspective from the complete line and qualifying the data collected to identify root cause and bottlenecks. Since the process applications all produce the same type of normalized events in a single language, there is minimal effort required to connect processes for the highest level of detail and perspective.

Enterprise applications will be responsible for distributing the information from the underlying infrastructure for external use. In addition to the existing enterprise-level resources like ERP and MES, a gateway to the IoT manu-

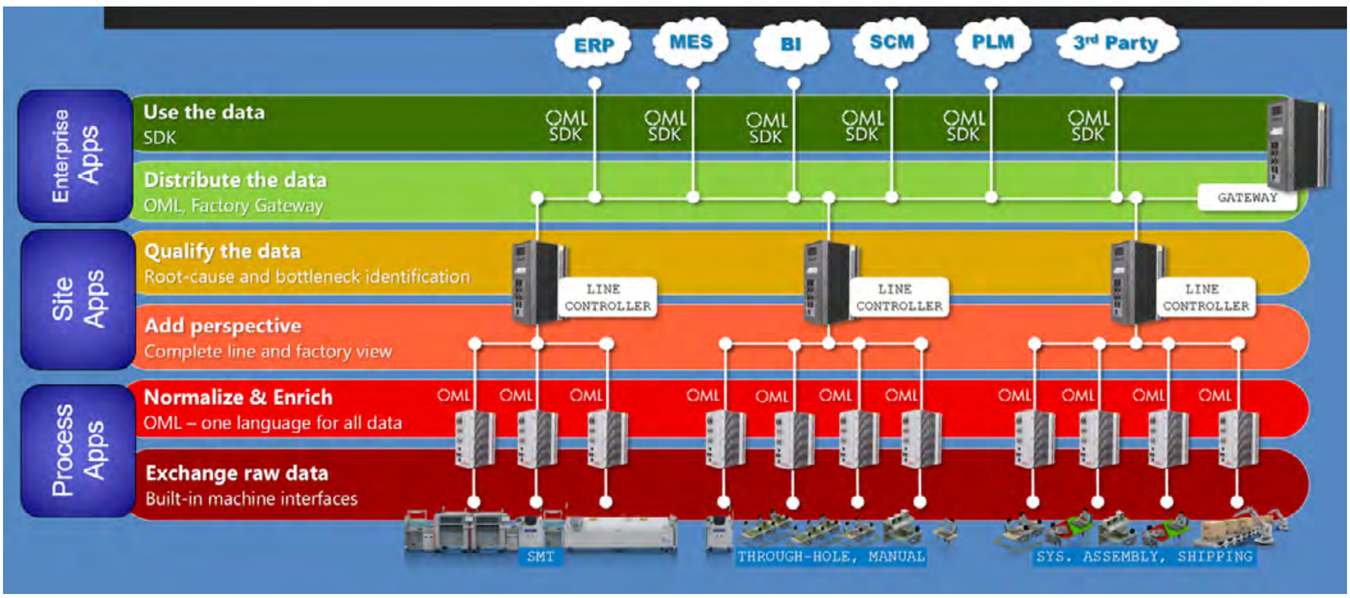

Figure 2: Smart layer responsibilities.

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facturing infrastructure should provide for the discovery of the resources in the factory and the events supported by the resources.

With this infrastructure, individual manufacturing processes can easily share information and control, and the entire manufacturing flow is exposed for external interface. Smart applications can begin connecting the individual manufacturing operations with business processes to optimize the production flow. Some example applications of this infrastructure are discussed further.

Factory Intelligence Application

Depending on the point of view, there are many different, yet valid, perspectives on the performance of the factory. For instance, the fact the factory is on shutdown may be significant to a planner looking at overall factory capacity, but it is less significant to the production manager who simply wants to know if the machines are running efficiently when they are scheduled to run. With a mix of different customers, products, factories, lines, and machines, there may be hundreds of different KPIs to consider. Some of these measurements may be complex requiring data from multiple processes, for example overall equipment effectiveness (OEE) calculations, where we consider not only the performance of the factory resources but also the quality of the products being made.

With all this complexity, it is often the case that a bottleneck is caused by some external force that is not being measured. A machine may not be operating because of an actual malfunction in the equipment, or it may be waiting for some upstream or downstream process. Perhaps the operator is on break, or there is a shortage of materials causing the downtime. To identify the root cause of a problem and provide for an actionable response, these external forces must be considered.

A site-level factory intelligence application would need to consider information coming from the both the enterprise applications and the process applications. To begin, the process-specific applications would provide performance data regarding the status of the equipment being managed. Next, the site-based constraints will be used to qualify any process status based on constraints such as the overall factory schedule, material availability, or the upstream/downstream bottleneck.

With information about process performance and external the constraints influencing production, many optimization opportunities are possible. The process-specific layer can optimize based on external knowledge from other processes and higher-level applications, while the site application layer benefits from detailed process information from each individual equipment.

Closed-Loop Feedback Application

A prime example of a smart application is in closed-loop feedback. In this scenario, measurements taken at one process are used to automatically adjust the operation of another process to maintain a consistent result. For example, the SMT machine could adjust placements based on drift data being measured at the AOI.

A site-level analysis application would need to collect the placement and material information from the SMT machine through the process-specific application managing that equipment. Next, the real-time measurement results coming from the AOI will need to be collected and analysed to identify a process control problem. The results of this statistical analysis can be fed back to the SMT machine so that adjustments and compensations can be made as appropriate for the equipment.

Since a normalized interface is used at the AOI and the SMT machine, this application would function across varying platforms while allowing each individual equipment to take the optimal action for its technology.

Finite Planning Application

The finite planning of the SMT schedule represents a significant opportunity to improve and optimize through automation and computerization. In the typical situation, the ERP system manages the customer demand and material requirements in very course granularity with little detail of the resources used in manufacturing. Once the work order demand is generated in the ERP system, much diligent work is put into developing a production plan to satisfy the orders. Complicated spreadsheets and workbooks are used to model the manufacturing flow and to manage constraints that are external to the ERP system. Unexpected changes in the customer demand or the manufacturing constraints are difficult to integrate into the existing plan. Optimization of product groupings happens infrequently outside of the day-to-day planning activity.

Considering the smart factory topology defined above, the automation of the finite planning process would function at each layer of the factory. At the enterprise layer, the ERP system will manage the customer requirements and the high-level site calendar. At the site layer, a digital model of the production process needs to be generated based on all the constraints in the factory. All of lines, machines, processes, materials, transactions, and resources must be considered in the model to create a simulation of the manufacturing process. The process specific layer must perform two important functions. First, it must supply real-time performance information from the manufacturing equipment through the IoT infrastructure. Second, it must supply the means to simulate production for the given process.

When all layers are working together, a fully optimized production plan can be developed. Demand from the ERP system is deconstructed into the individual manufacturing processes. Iterative simulations find the ideal manufacturing sequence using the static site constraints and the live performance data from the factory. A feedback mechanism between the planning application and the equipment processes provides optimized programs and product groups based on the discrete demand. Changes in the demand or the constraints can be continuously accounted for in the production schedule.

Lean Material Management Application

For many manufacturers of electronic assemblies, maintaining an efficient supply chain is key to success. Significant investments in ERP systems and automation ensure that there are materials in the warehouse to satisfy the customer demand but managing the movement of material from the warehouse to the machine is often burdened by many manual processes. Large line-side buffer stocks and lack of visibility into individual packages (reels, sticks, trays) of components contribute to a discrepancy between the real-world stock and the system inventory. With rich, detailed information available in the smart factory, a lean material engine can bridge the gap between the ERP inventory and the shop floor to provide just-in-time (JIT) material logistics to the machines.

The first step to developing the lean material management engine is accessing information held in various systems. The ERP system will provide the work order demand which defines the sequence and schedule of products to run. The warehouse management system provides the detail of individual components that are available for production. At the process specific layer, the equipment system will provide the machine program information, performance information, and material consumption details.

At the process specific layer, the equipment system will provide the machine program information, performance information, and material consumption details.

Next, using a production schedule, the current machine setup, and the live IoT data stream from the equipment, the lean material engine can determine when individual components will need to be replenished, either on the current order as reels are exhausted or on an upcoming order during a changeover. With the connection to warehouse management, the lean material engine can determine the ideal location from which to move components and automatically initiate the movement transactions. The consumption data reported by the individual machines can be aggregated and extremely accurate reports made to the ERP system.

Finally, the large line-side buffer stocks are unnecessary. Material is ordered from the warehouse or from Kanban storage only when it is needed on the machine. With the automated reporting of consumption and wasted materials from the machine, the ERP inventory is as accurate as possible

With the automated reporting of consumption and wasted materials from the machine, the ERP inventory is as accurate as possible.

Traceability Application

The collection of traceability data has traditionally been a difficult requirement for manufacturers. The complexity and cost associated with collecting detailed, accurate data could lead to inconsistent results as individual traceability requirements are negotiated between the customer and supplier on a product-by-product basis.

To improve the effectiveness and consistency of traceability data collection, the IPC-1782 standard was developed to define a clear, industry-wide specification for traceability. The standard features several levels of traceability based on the risk involved in the product or process. The individual traceability levels vary in the detail and accuracy of the data being collected. At the lowest level, summarized data is collected manually by operators, and at the highest level, comprehensive data must be collected primarily from automated equipment.

When taken as part of the smart factory, the requirements for traceability data collection can be fulfilled by the existing process applications in the smart factory infrastructure. Previously, this paper explored solutions utilizing much of the data that would be relevant for traceability purposes: equipment status and progress, detailed material information, test and inspection results, etc. Since the process applications support a neutralized language and a normalized set of events, consistent information can be aggregated by the site layer applications regardless of the machine platform. This supports the need for detailed and consistent data regardless of the equipment platform.

Using the IPC-1782 standard format, the summarized traceability information aggregated by the site application layer can be transferred to the enterprise applications and externally to the relevant customer. Connecting the three layers of smart solutions through vendor-neutralized, standard formats, reduces the complexity required to implement a meaningful traceability solution.

Conclusion

Many opportunities exist today to implement improvements based on automation of manufacturing processes and business processes using the smart factory infrastructure. In this way, machine vendor solutions are enhanced through the exchange of information with other machines and site applications. By collecting data from all manufacturing processes, historically troublesome requirements, such as traceability, become easier to fulfil. This leads the industry to a greater adoption of smart manufacturing functionality. **SMT007**

Editor's Note: Originally published in the proceedings of SMTA International, 2017.

Zac Elliott is a technical marketing engineer with Mentor, a Siemens Business.

AI-Powered Inspection

Feature Interview by Stephen Las Marias
I-CONNECT007

Peter Krippner is the COO of Viscom AG, a manufacturer of automatic inspection systems including 3D AOI. Prior to that, he was the manager of software development and for 17 years, head of the company's Serial Products (SP) business unit.

In an interview with *SMT007 Magazine,* Krippner talks about artificial intelligence (AI) and its impact in the electronics manufacturing industry.

Stephen Las Marias: What can you say about AI and its role in manufacturing?

Peter Krippner: Whereas practical solutions like optical character recognition have become routine technologies and are rather not seen as AI, a very good example for artificial intelligence is autonomous driving, where individual vehicles make driving decisions self-sufficient and independent. In manufacturing, customers have voiced an increasing interest in operating SMT lines with fewer personnel; more precisely, with a maximum of two persons per line for all associated activities including AOI operation and verification. In such a scenario, AI has the potential to be very helpful.

Las Marias: Which part of the electronics manufacturing process will greatly benefit from AI?

Krippner: From our perspective, first, this is going to be the support and automation of AOI verification and then AOI programming. Different levels of automation will be available, so the customer can also proceed systematically. Initially, the AI can monitor human verification and report any deviating results (e.g., by issuing a message that it would classify a potential error differently than the operator). In Stage 2, the AI can assume more and more responsibility, and finally verify all components fully automatically.

As for AOI programming, we are now working on automatic detection of housing types for the creation of inspection programs. With the help of "deep learning" mathematical

methods, such as those derived from neural networks, the assignment of components on a PCB should gradually become largely autonomous.

Las Marias: How will AI change the electronics manufacturing/electronics assembly landscape?

Krippner: In the future—because of the rising difficulty in finding qualified SMT line personnel as well as general cost pressures—there will be either fewer specialists or more personnel with less experience in the AOI area. Nonetheless, first pass yield (FPY) will have to be over 90% right from the start and the number of escaped defects, zero. Preventing defect escape and false calls by personnel during verification then becomes a logical tactic. This is where Viscom steps in with new AI software developments, which should be ready for market over the course of next year.

Peter Krippner

Las Marias: What key challenges are you seeing in adopting AI in manufacturing?

Krippner: An immense amount of data—actually, big data—is needed to implement AI. The basic technologies and workflow related to AI-assisted verification have already been completely integrated in the Viscom software. Now data—as much actual data from the field as possible—is needed to train the AI algorithms. This training phase is currently in progress. All this is proceeding step by step, since each classifier trained in this fashion must be validated before use. This requires additional data that are not used for the training.

Over the long term, both the AI verification as well as the AOI programming will be automatic, achieving better results than before from the start. At Viscom, we follow the strategy of growing profits through innovation and technological leadership. One very influencing factor is our customers, who we want to continue to enthuse with progressive solutions.

Las Marias: What manufacturing trends will be greatly addressed by AI?

Krippner: Especially at high resolutions due to miniaturization, fast imaging systems and evaluation methods are necessary. Miniaturization will certainly go hand in hand with more computational power, which then will be available for even better inspection solutions. AI implies that machines can learn continuously and then succeed in solving new problems. A key issue is complete automatization. We will see more so-called lights-out factories in the future where human employees are no longer part of the process and machines can therefore produce.

Las Marias: Are you seeing wide implementation of AI in electronics manufacturing right now?

Krippner: Today's modern electronics manufacturing is Industry-4.0 driven. This explicitly includes Viscom's intelligently linked inspection solutions. Information is automatically processed and exchanged with other systems on the production line, which then can provide necessary corrections. Machines react autonomously to process fluctuations, exchange information with one another and then adapt their processes. This shows that even though AI is a relatively new trend here, electronics manufacturing is the right industry to successfully advance it.

Las Marias: 3D AOI is the latest in inspection technology right now. What can you say about the adoption of 3D in the industry today? How are you encouraging users/customers to shift from 2D to 3D?

Krippner: In the case of AOI, 3D is already the standard for high-end systems, resulting in less programming work and lower error rates. Our image results are excellent, including complete surround viewing of inspected

objects. In addition to the orthogonal camera, Viscom camera modules integrate up to eight angled-view cameras. This results in true-to-life accuracy for the display of individual components. A very high image acquisition speed for this nine-directional and virtually shadow free 3D reconstruction approach is kept by sophisticated Viscom-developed image acquisition hardware. The use of 3D technologies will increase in general. More and more customers want to use X-ray systems to inspect concealed solder joints and acknowledge the advantages of 3D technology (planar CT) here as well.

Las Marias: What are some of the challenges being faced by your customers, and how are you helping address them?

Krippner: High-performance manufacturing of advanced electronics depends on complex automatic processes where many different equipment suppliers are involved. Generally accepted cross-manufacturer standards will help our customers to enhance technological integration and interaction. Recently, there has been an increase in collaboration here and Viscom is part of it. Whether it be the Hermes Standard as a European initiative or IPC's CFX (Connected Factory Initiative) in the United States, it is clear to everyone in the industry that such cooperation produces added benefits. With its Open Interface 4.0 for connecting third-party systems to the AOI/AXI verification station, Viscom has also contributed independently to open standards.

Las Marias: What can you say about the future of inspection, including AOI, AXI, and SPI?

Krippner: In system technology, a certain mainstream can be observed and from my point of view it will be primarily in software, where the greatest competitive pressure will arise in the future. Here, individual creativity is required, and competition will produce the best solutions for customers.

Las Marias: Do you have any final comments?

Krippner: Our customers need us to be at the forefront of technological development so that we can help them significantly to master future challenges. There is a great emphasis at Viscom on continuous research and development. But it is also through close customer relations that Viscom products become highly competitive. For us, it is very important to be in direct contact with technical management and system operators of electronics manufacturers worldwide. One of our strengths is to provide individually customized solutions, which after successful implementation become part of our long-term experience.

Las Marias: Great. Thank you very much!

Krippner: Thank you! **SMT007**

Electronics Industry News and Market Highlights

Artificial Intelligence Contributes to Growth of China's Semiconductor Industry ▶

Wayne Shiong, partner at China Growth Capital and seasoned venture capitalist, predicts tremendous demand for chip and semiconductor technology due to break-through in artificial intelligence.

Telecommunications and Banking Drive ICT Spending in Central and Eastern Europe in 2018 ▶

Total spending on ICT in Central and Eastern Europe will continue its positive momentum to reach $127.3 billion in 2019, according to the new report by International Data Corporation (IDC).

Cord Cutting Continues to Gather Steam in Enterprises as Employees Become Increasingly Mobile ▶

The transformation of the access network is in full swing, buoyed by fundamental changes in how people work, the devices they use, and the adoption of new business processes centered around mobility and digital information, according to a study released by IHS Markit.

Technology Spending on the IoT in APeJ Valued at $292B in 2018 ▶

IDC projects spending on the Internet of Things (IoT) in Asia/Pacific (excluding Japan) to reach $291.7 billion in 2018, up by 12.1% year-on-year.

Apple's Strategy Towards 3D Sensing is Pushing VCSEL Industry ▶

The VCSEL industry took a strategic turn last year with the release of the latest iPhone.

Global DRAM Module Market Recorded 69% Growth in 2017 ▶

DRAMeXchange reports that the global sales revenue of DRAM modules for 2017 totaled $11.7 billion, amounting to a significant growth of 69% compared with the previous year.

New Business Models Stoke Growth Opportunities in the ASEAN Automotive Industry ▶

Sustained economic growth, infrastructure developments, and automotive OEMs' periodic introduction of models are giving a huge boost to the Association of Southeast Asian Nations (ASEAN) automotive industry.

Utility Drones Market to Reach $540M by 2023 ▶

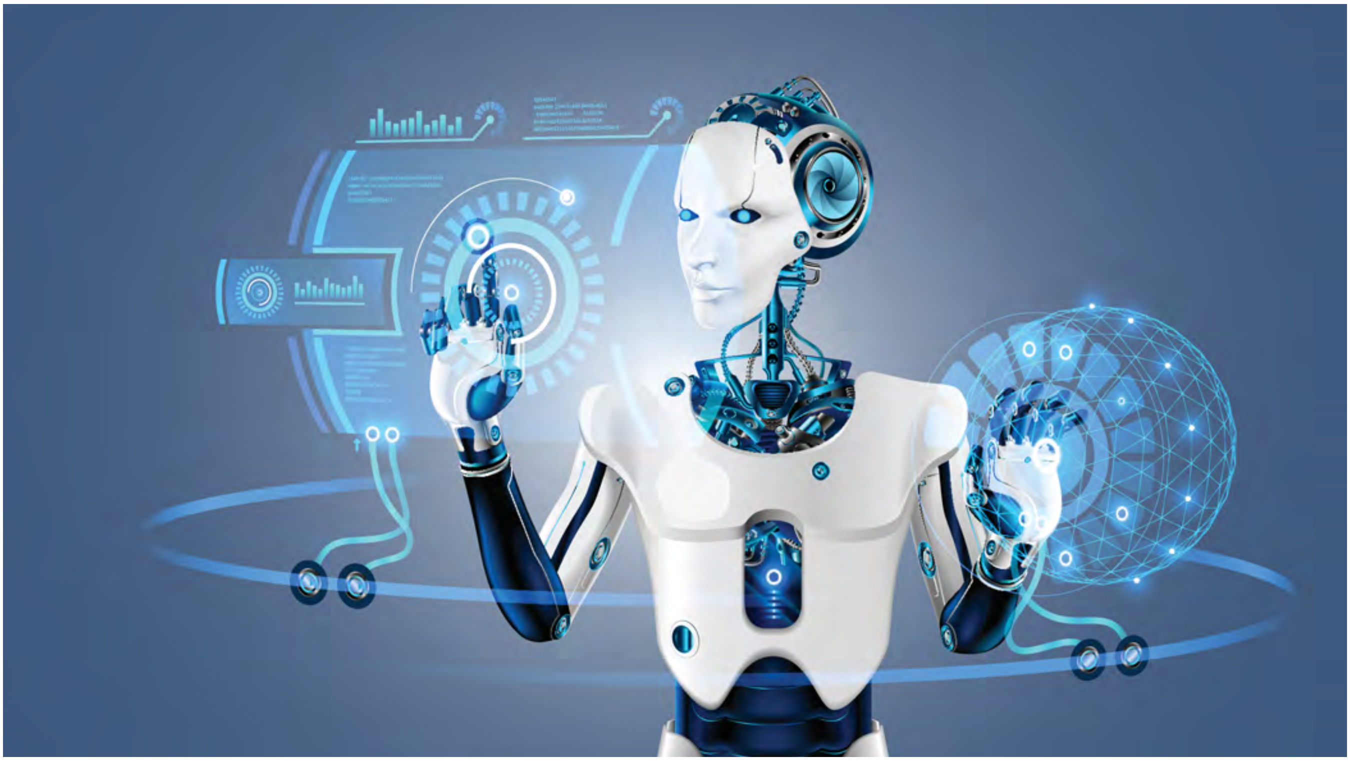
The global utility drone market is expected to grow from an estimated $110.2 million in 2018 to $538.6 million by 2023, at a CAGR of 37.34% from 2018 to 2023.

Growing Demand for Edge Computing in IoT ▶

The mobile AI market is expected to reach $17.83 billion by 2023 from $5.11 billion in 2018, at a CAGR of 28.41% during the forecast period.

Automotive mmWave Radar Market Expects Rapid Growth ▶

According to the latest research by TrendForce, the automotive mmWave radar market expects rapid growth with the shipment estimated at 65 million units in 2018; and a CAGR of 15% from 2018 to 2023.



Innovation is the Motto, Efficiency is the Aim: The Smart Robot Revolution is Here

Feature by Pratik Kirve
ALLIED ANALYTICS LLP

Science fiction writers may scratch their heads and invent something outstanding out of nowhere, but it is on paper only. It is only an imagination in which robots are behaving like humans and getting smarter day by day. However, the distance between imagination and reality has reduced considerably. Thanks to advanced technologies, robots are no longer just a robot operating on commands. They are getting smarter. Artificial intelligence (AI), data processing, and machine vision are some of the technologies turning the dream of robots being smarter into a reality.

"Robots are the next big thing," said Gene Munster, co-founder of Loup Ventures.[1] "You know it will be a big deal because the companies with the biggest balance sheets are entering the game."

Tech giants have geared up to launch smart robots for various applications in numerous industries. The Consumer Electronics Show this year in Las Vegas demonstrated the same. Not only big companies, but also small companies and researchers at universities have begun developing smarter robots to ease the work of humans and improve efficiency. From cleaning robots to farming robots, innovation has been the center of every effort taken for the development of smart machines.

Many governments have been encouraging the utilization of smart robots in various sectors. They have taken new initiatives to encourage the development of smart robotics. For instance, during a meeting with the Public Prosecution—a part of the Judicial Department in the United Arab Emirates—Omar bin Sultan Al Olama, UAE Minister of State for Artificial Intelligence, highlighted the importance of implementing advanced technologies to bring

improvement in government services, and lauded the efforts of the Public Prosecution to implement AI in the justice sector.[2]

The AI strategy is under the UAE Centennial 2071 project, a comprehensive, long-term government plan that encompasses a national strategy to make UAE one of the best countries in the world by 2071. Among its objectives is the development of education, with a focus on advanced technology and engineering.[3] In a statement, Sheikh Mohammed bin Rashid, vice president and prime minister of the UAE and ruler of Dubai, said the UAE seeks to be a major hub for developing AI techniques and associated legislation, adding that the country's UAE Centennial 2071 is founded on a set of fundamentals, primarily artificial intelligence across the government and private sectors.[4]

According to research firm Allied Market Research, the global smart robot market is expected to reach $17.56 billion by 2025, registering a compound annual growth rate (CAGR) of 19.6% from 2018 to 2025. Developments in the automotive sector, use of robots in the agriculture sector, and government regulation are boosting the growth of the smart robot market. Meanwhile, factors such as growth in industrial automation, advancement of robotics for the connected and digital world, and strong government funding for automation solutions, high manufacturing cost, insecure connections with robots, difficulty of reprogramming, regular maintenance, and software updates of the system are anticipated to either drive or hamper the market growth.

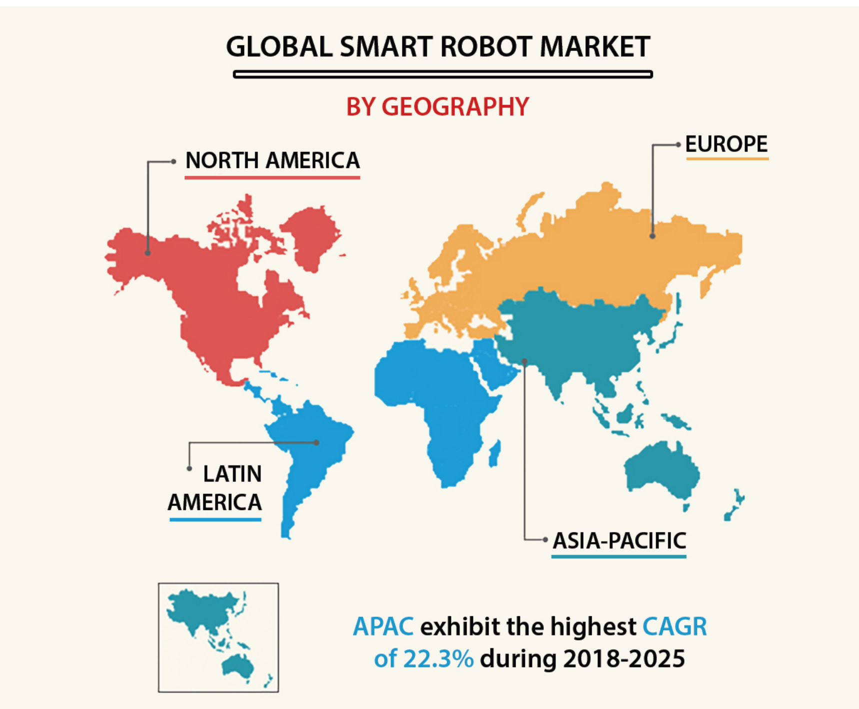


Figure 1: While North America currently dominates the smart robot market, the Asia-Pacific region will register the highest compound annual growth rate over 2018-2025 period, according to Allied Market Research.

Growth in Industrial Automation

Several industries such as manufacturing, healthcare, automobile, and construction are rapidly adopting industrial automation solutions. This leads to the increase in adoption of smart robots due to their highly stable and accurate performance. The main reason for such adoption is to have better quality and safety in terms of injuries that arise from machineries. In the manufacturing and production line, smart robots are deliberately used to move materials and perform a variety of programmed tasks.

Around 40% of the robots are used for material handling applications in most industries. For instance, Komatsu, a general machine manufacturing company, has developed a multi-purpose drone and bulldozer automation system for the construction industry. This drone flies above a construction site and is used for monitoring delivery, inventory, and overall progress of the project. This trend is expected to significantly drive the smart robot market in the future.

The following are some of the recent development focused on smart robotics:

Scrub 50: The Future of Cleaning

Autonomous cleaning robots are making their mark by easing up the work of human counterparts. Robot cleaners will soon hit the floors in commercial buildings of Singapore. Property developer JTC, WIS Holdings, and Gaussian Robotics had joined hands and developed an autonomous

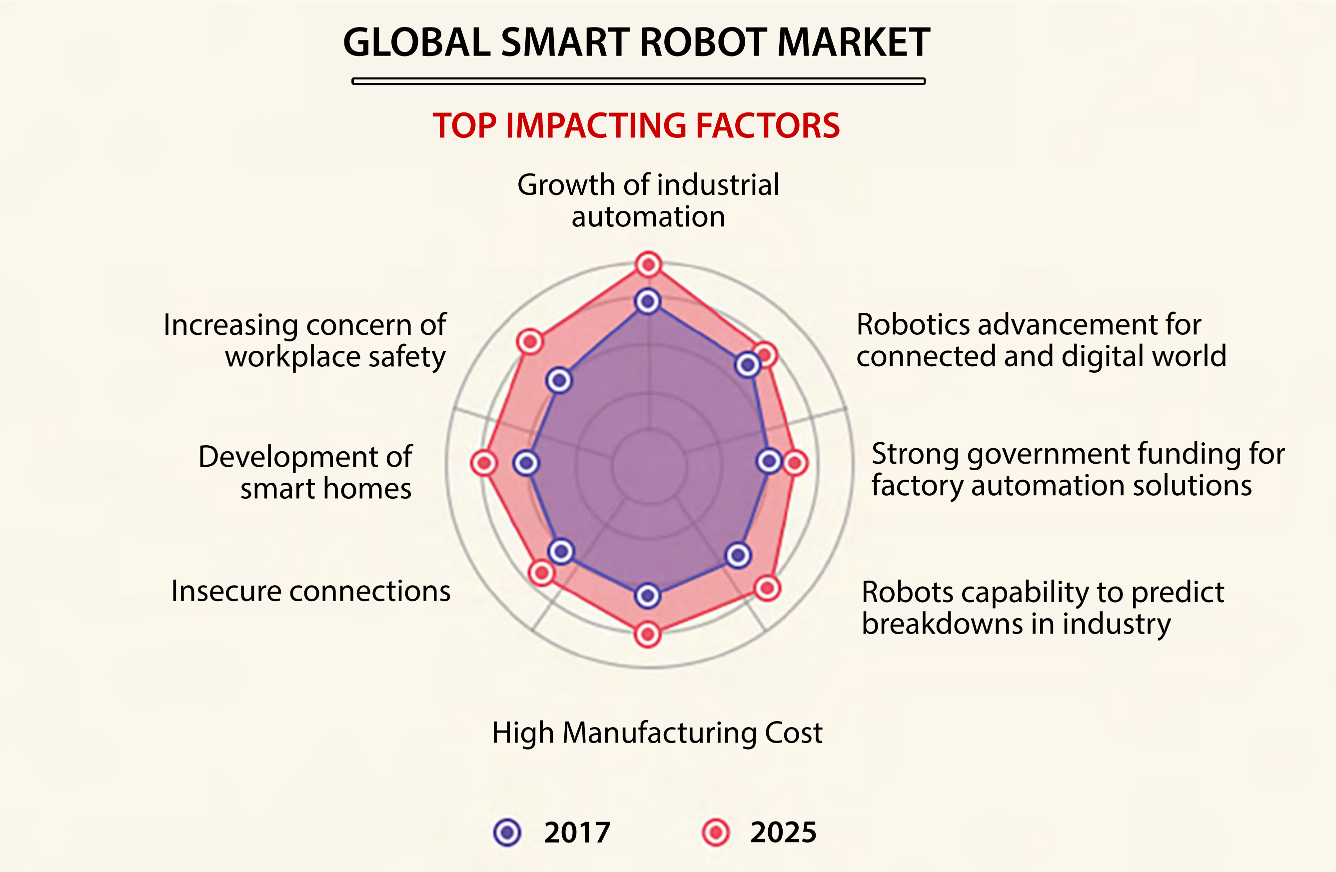


Figure 2: The increasing adoption of automation in manufacturing is among the key factors fueling the growth of the smart robot market.

cleaning robot Scrub 50 as a solution for labor crunch in the cleaning industry. This industry has been facing a problem with the aging workforce and the 1.1 meter robot is the solution. The technologically advanced robot has sensors to detect which area of the building it has been cleaning and send reports after the work is done. Furthermore, it is equipped with sensors, laser detectors, and cameras to avoid bumping into humans and other objects.

Kelvin Lee, the chief commercial officer of WIS Holdings, outlined that the demographics of the nation have been changing and there is a scarcity of young and able-bodied cleaning personnel.[5] It will be difficult in coming years to find workers for a cleaning job as the aging workers will retire. The developers have also claimed that the robot would employ smart cleaning practices and save many hours of human labor. They claimed that it usually takes 300 hours of a human worker to clean area of 5,000 sq. mt. in a month, however, the robot takes only 130 hours. The Scrub 50 can detect low battery and clean water supply and, without the need for human intervention, will take itself to the docking station and charge itself, rinse the tank, and refill the water. This prototype has been tested and will soon be launched.

Smart Robots: Farming to be Revolutionized

Farming is one of the areas in which smart robots would revolutionize practices. Governments, tech companies, and the farming industry itself have been designing robots to increase efficiency. Moreover, the robots would eliminate the back-breaking tasks of farm employees. Small Robot Company is a startup aiming for revolutionizing the way in which smart robots and AI can be helpful in farming. The firm is based on the concept of precision farming and aims to raise the productivity with the help of technology. Professor Simon Blackmore, at the National Centre for

Precision Farming at Harper Adams, has envisioned the tractors being replaced by the smart, lightweight, and highly precise robots for applications including weeding, harvesting, and others.

Many farmers felt that they have been served poorly by new technologies and existing machinery. One of the founders of Small Robot, Sam Watson-Jones, found that a radically different approach was needed to make the economics of arable farming sustainable. The smart robot they developed has come from and belongs to the farming community. Joe Allnutt, head of the technical team at Small Robot, said that they have been endeavoring to deliver precision farming with a little input from a farmer and attain the level of precision for crops that were not possible before.[6] The company combines robotics with AI to provide a Farming as a Service (FaaS) model. This will enable the gathering of information from various robots about the crops. Using GPS and sensors, the robots will be able to offer accurate information and solutions on each crop.

The smart robot they developed has come from and belongs to the farming community.

Robot Swarming: Team is Better than Solo

According to the recent study, robots work better in groups than solo. This study forms a basis for utilizing robots for rescue missions. Researchers from Université libre de Bruxelles conducted a series of trials. They published the study, "Autonomous Task Sequencing in a Robot Swarm," in the journal Science Robotics. In the experiment, robots needed to determine the tasks to be performed and the order in which they needed to perform in the group. Scientists demonstrated how these this can be carried out more effectively in a group of robots as compared to the robots performing by themselves. In a rescue mission, if robots detect a victim which needed to be pulled out of the rubble, they must be able to coordinate with each other and rescue the victim. Currently, human intervention is needed to convey what needs to be done to the robots.

This research offers a solution which involves modeling swarm robotics. This model involves programming robots based on the social behavior of animals such as ants. Artificial intelligence was used for programming robots to communicate and coordinate. They were given a simple task that needed to be performed in a sequence of three actions. They were set in three different points of space to complete the task. Only after completing the task did they know which order was correct. These actions became the basis for machine learning. Once they knew the correct order, they would coordinate and take decisions about completing the task together. However, the study needs further developments, but it forms the basis for smart robotics.

Smart Planter: Robots to Chase Sunlight and Grow Plants

Plants grow in the direction of the sunlight as it offers nutrients required for growth. The need to plant seeds in a way to get better sunlight has been eliminated. Chinese company Vincross has developed a mechanized robotic creature called HEXA that looks out for the light, takes the plant into it, and returns to the shade to let a plant thrive. The company developed a robot and designed it to hold a small plant. The robot is a six-legged structure which takes the plant to the sunlight or shade and holes itself into the ground whenever the water is needed. It is the brainchild of Sun Tianqi, founder of Vincross. Though he has explained the concept in a Vincross forum, it is unclear to how it determines the needs. It seems the model is under development and needs a lot of improvement. However, this is another example of how robotics is getting smarter in various applications.

ROBO-NEEL: Andro-humanoid Robot with Feelings

An andro-humanoid robot that expresses feelings such as happiness, anger, and sadness,

performs household tasks and helps elderly people. Neelamadhaba Behera from the Santaragadia village in Balasore district, Odisha, India, has built the robot named ROBO-NEEL in only 10 months. This robot can be used for multitasking tasks in restaurants, entertainment centers, and schools. The young scientist claimed that automation technology has been used for development of the robot that resembles humans in behavior and appearance.

"I have developed the technology in such a way that the robot can resemble anyone's face. We can use the robot in place of our dead relatives. It can also help elderly people by serving them and solving their problems," said Neelamadhaba, an 18-year-old who is preparing for entrance examinations to pursue the technical course.[7]

This robot becomes the first Indian androhumanoid, and it is advanced, smart, and has motorized systems and sensors for mimicking human joints, brain, and eyes. It receives instructions through its sensors and the controller asks the bot to act accordingly. It has a sound recognition sensor that will detect words and sound to respond accordingly. The face is silicon and will show human-like expressions.

On the other hand, Hanson Robotics' Sophia, said to be the world's first humanoid, had human-like behavior and was equipped with technologies including facial recognition, AI, and visual data processing. **SMT007**

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Pratik Kirve is a content writer at Allied Analytics LLP.

Cleaning with Data

With the ability to monitor the temperature and concentration of the bath, and automatically adjust either if needed, the KYZEN Analyst system has caught the attention of the electronics assembly industry. Tom Forsythe, executive vice president for KYZEN, discusses with I-Connect007's Barry Matties the updates on the tool and describes how KYZEN Analyst has evolved into an Internet 4.0 solution with the ability to increase performance and life of the chemistry. They also talked about the value that data provides to the cleaning process.

Read the interview here.

Filling the Gap: Underfill Rework

Knocking Down the Bone Pile

by **Bob Wettermann,** BEST INC.

Ball grid arrays (BGAs), chip-scale packages (CSPs), flip chips, and other component packages on handheld devices are commonplace today in consumer products, including GPS, cellphones, and computers. In addition, these devices are being used in high-end handheld devices, such as military personnel communicators or space data collection devices. Due to handling and the brittle nature of lead-free solders and packaging materials, these handheld products have used underfill to withstand the mechanical shock or impact when the devices are dropped or struck. The underfilling of these component packages to provide a compliant layer between the package and PCB is one method for increasing the reliability of these interconnections. Figure 1 shows a package before being underfilled, and Figure 2 illustrates the underfill removed.

Underfill is a polymeric material used to fill the gap between the electronic component body and the PCB and encapsulate the solder joints underneath the package. This material enhances the reliability of the component subject to mechanical shocks and impacts by distributing the forces. In addition, it distributes the thermal stresses caused by the coefficient of thermal expansion mismatch between the component and PCB. Typically, underfills have a high glass transition temperature (Tg), a high modulus (E), and a matched coefficient of thermal expansion (CTE) with respect to the solder. Underfill is the "bumper" and distributes the stress more uniformly on the solder joints, thereby increasing the reliability of the solder interconnections.

While there are reworkable underfills in theory, the practical challenges still make reworking an underfilled component very cumbersome and with low resultant yields. The concept of these reworkable underfills is that the material can be thermally decomposed at

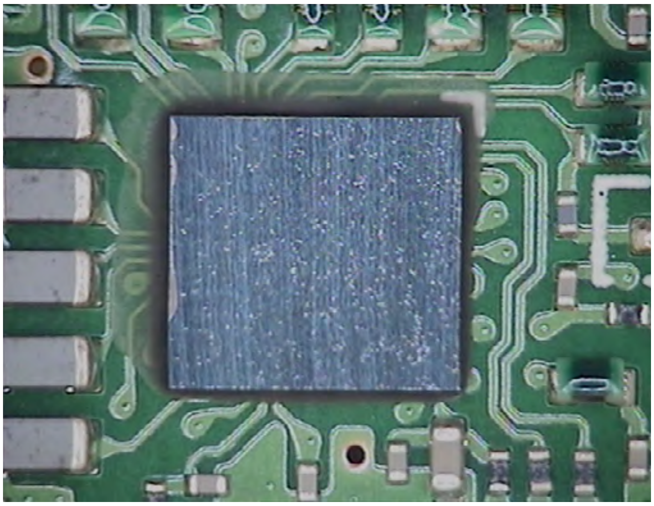

Figure 1: Underfilled device prior to rework.

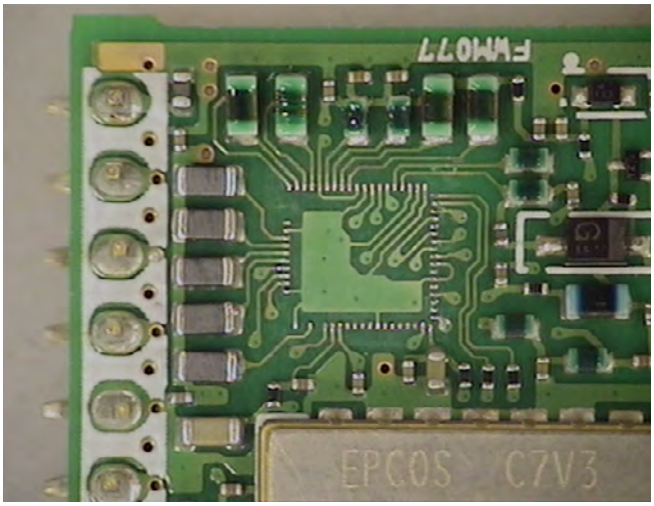

Figure 2: Device location after component removal and site preparation.


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low temperatures and then removed using various solvents or chemicals without disturbing the solder joints or destroying the substrate or neighboring components. While the marketing material may indicate that the material is reworkable, rework process challenges are numerous.

While the marketing material may indicate that the material is reworkable, rework process challenges are numerous.

Reworking these underfilled devices creates challenges for the rework technician. One of the biggest issues they face is that the softening point of the underfill is below the solder liquidus temperature. In practice, this means that when the device is reworked at one location on a PCB, a neighboring or mirrored underfilled device may reach the softening point and become plasticized. When this happens, the underfills will exhibit lateral pressure underneath the underfilled component. This presents a problem when the solder reflow temperature is reached on a neighboring underfilled device. This force presses on the reflowed solder, which causes the solder to squirt out from the proper location and solder to be pushed to neighboring non-common solder locations. This phenomenon creates a solder short.

A second challenge in reworking an underfilled component is the tack and adhesive strength of the bond created between the underfilled board and component. This force causes several practical process challenges in the rework process. The first is the force necessary to remove the underfilled device from the board. The force of the pick-up tube nozzle on the rework system will not be enough to pick the reflowed component from the board because the underfill holds it tightly to the board. This means that a twisting and prying force must be applied after the solder liquidus temperature is reached. These forces are such that neighboring devices can be destroyed, the mask can come off of the component or the board, or neighboring devices may even be disturbed in the rework process.

In addition, when the device is finally removed from the board, both the board surface and the bottom of the device may need to have the underfill scraped off its surface. This is done with lateral force and heat, both of which may scratch the mask or lift pads. When cleaning the device location on the PCB of the remnant underfill, solder mask may be also be scratched, pads may be lifted, or neighboring devices may be destroyed.

A third challenge with reworking underfilled components is that while one method or solvent may work on one type of underfill, this same material set process may not work on another board as they are constantly being changed. New generations of packaging materials and technology require new underfills that work with new alloys and solder masks, finer pitches, and ever thinner substrate materials. This will cause the challenges in reworking underfilled components to be ever present.

Rework technicians must take into account a variety of factors when considering whether or not to rework an underfilled component. However, without a full understanding of the underfill characteristics and a process development distinctive to the specific board material, underfill, and board design, expect the outcome to be low yields unless the board was designed with reworkability in mind. **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.

Conformal Coatings: An Evolving Science

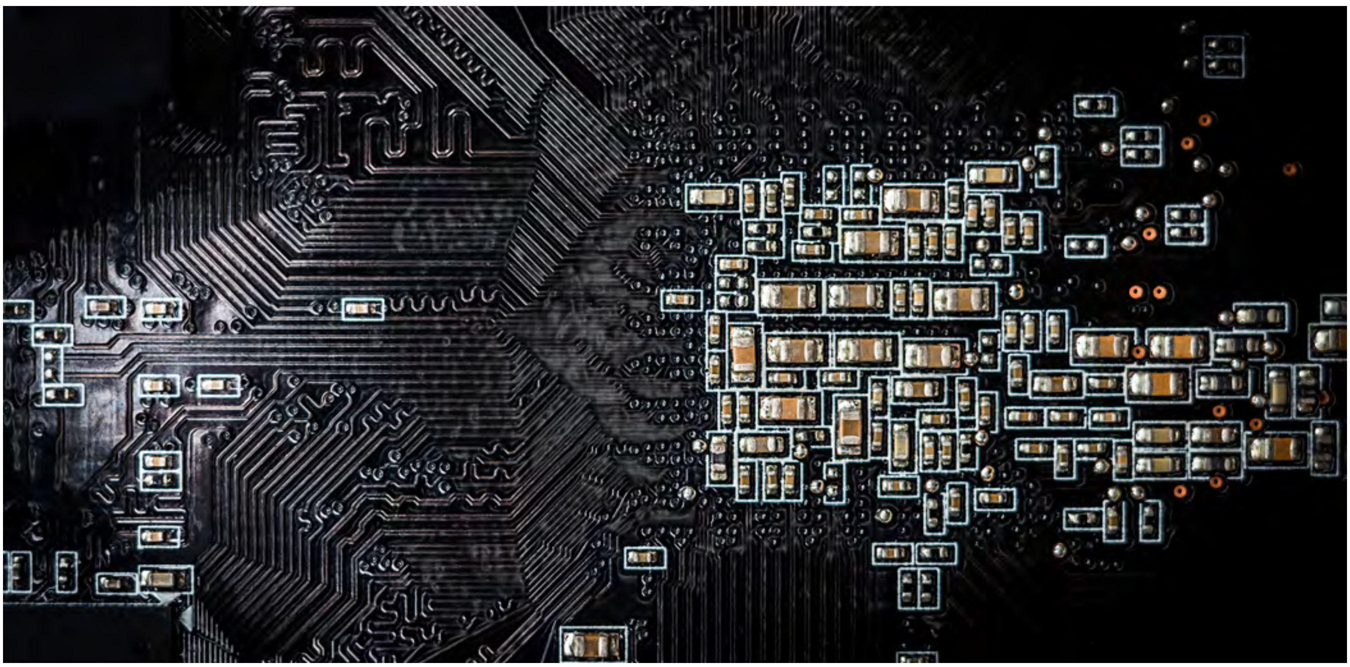
Sensible Design

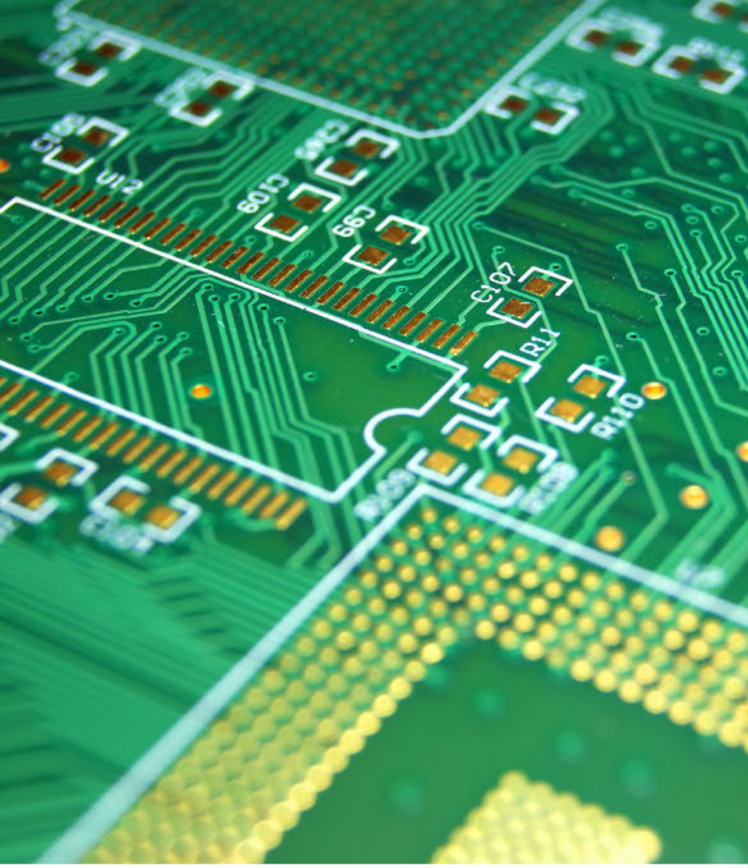
by Phil Kinner, ELECTROLUBE

In my previous column, I touched upon the environmental impact of conformal coatings and how the industry is striving to find new formulations—principally water-based, solvent-free materials—that have minimal environmental impact. In this column, I will return to the Q&A formula that my colleagues have adopted in past issues and attempt to answer trending queries from our customer base on coating properties, selections, and applications. In addition, I hope to shed more light on coating problems posed by electronics miniaturisation, which is certainly exercising the minds of designers and production engineers from a growing cohort of customers in the consumer electronics sector. Without further ado, here are five of the best questions that frequently arise when we enter preliminary consultations with our clients.

In an ideal world, what combination of properties would a coating exhibit?

The performance requirements of conformal coatings continue to become ever-challenging as electronic assemblies are subjected to increasingly hostile operating environments. The perfect conformal coating would retain high elasticity at both high and low temperature extremes and maintain its properties at high temperatures with no out-gassing. It would also provide an excellent barrier to moisture in humid environments and where there is a risk of liquid water splash. It would be highly resistant to solvents and corrosive gases but be easy to remove when repairs or modifications need to be carried out. Ultimately, the perfect coating would be intelligent, self-applying, and free of charge—but that's a whole different ball game!





On a more serious note, an ideal coating should also be solvent-free, and as I pointed out in my previous column in this series, there has been some progress in this area. A new range of innovative VOC-free, fast-curing, high-performance two-part conformal coatings are now available for application by selective coating. The two-part (2K) solvent-free selective coating process is an enabling technological breakthrough that allows all their benefits to be realised.

The two-part (2K) solvent-free selective coating process is an enabling technological breakthrough that allows all their benefits to be realised.

How does the design of the board impact the choice of coating material?

The design of the board doesn't directly affect the choice of coating material, although it will determine which application methods can be used to apply the coating. Certain materials are difficult to use in a dip process due to the material curing prematurely (e.g., moisture curing and UV-curable materials), so it could be said that the choice of coating is indirectly related to the board design.

The use of single component UV-curable materials has grown significantly over the past decade with rapid cure yielding productivity benefits for many. However, the current single-part UV materials often suffer cure issues when applied to boards containing tall components that shadow the exposure to UV light and necessitate out-of-focus cure heights and reduce light intensity and degree of cure. Consequently, a secondary cure mechanism must be introduced into UV curing—typically a moisture-activated or heat-activated mechanism.

What electrical properties are typically required of conformal coatings?

Conformal coatings form a protective, insulating layer. The most common electrical parameter tested is surface insulation resistance (SIR) testing, a measurement often taken before and after coating and subsequent exposure to harsh conditions to determine the long-term insulation performance of the coating. The coating should also have high dielectric strength, the minimum level required determined by the inter-track separation and potential difference between adjacent tracks.

Dielectric properties are an important consideration where the signal integrity of the circuit is concerned. Conformal coatings applied to such circuits must not affect signal integrity and the coating's dielectric constant and loss are parameters that must be considered when making a material selection and determining the coating thickness. Other than this, dielectric strength, breakdown, and withstand are commonly measured and reported properties that enable designers to ensure sufficient spacing between components and determine how much closer components can be spaced than without coating materials applied.

How is the best application method of coating materials defined?

There isn't necessarily a best method to apply a conformal coating. The application method chosen for an assembly will depend upon what existing equipment is available to the manufacturer, the coating processes in use, take time (the average time interval between the start of production of one unit and the start of the next), and the design of the assembly. This includes areas of the circuit that must be coated and those that must not (connectors, switches, etc.).

The best application method would ensure that each board to be coated receives coating coverage on all required metal surfaces at a sufficient thickness to afford protection against the environment. These requirements will change from each board design and envi-

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ronment and will invariably need to be tested and verified ahead of the production run.

How has the trend for miniaturisation affected the development of coatings?

The trend towards miniaturisation is most evident in consumer electronics and has led to the development of ultra-thin coating materials with thicknesses of less than 12 microns. This, in combination with internal gasketing and better case design, has enabled the production of vastly more water-resistant mobile phones and other handheld devices.

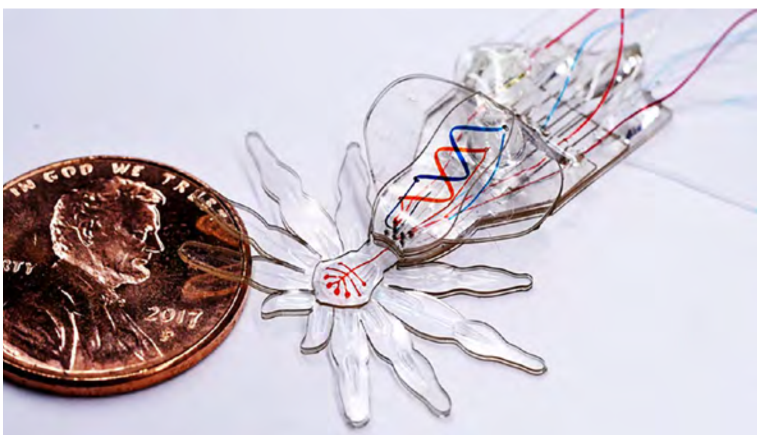
In more traditional applications, such as aerospace and automotive, there is a double issue of finer pitch components (reduced space between conductors) and a need to reduce weight, resulting in less protection being afforded by the board's housing. The impact of this is that coatings need to function more as a primary mitigation strategy against the environment. As a result, the performance requirements of these coating materials have increased dramatically, especially with regards to condensation resistance. **SMT007**

Phil Kinner is the global business/technical director for conformal coatings at Electrolube. To read past columns or contact Kinner, click here. To download your copy of Electrolube's micro eBook written by Kinner, *The Printed Circuit Assembler's Guide to... Conformal Coatings for Harsh Environments*, click here.

Researchers Develop Small, Multifunctional Robots

A team of researchers at Harvard's Wyss Institute for Biologically Inspired Engineering, Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS), and Boston University now has overcome the challenge of creating multifunctional flexible robots that can move and operate at smaller size scales by developing an integrated fabrication process that enables the design of soft robots on the millimeter scale with micrometer-scale features. To demonstrate the capabilities of their new technology, they created a robotic soft spider from a single elastic material with body-shaping, motion, and color features.

In their Microfluidic Origami for Reconfigurable Pneumatic/Hydraulic (MORPH) devices, the team first used a soft lithography technique to generate 12 layers of an elastic silicone that together constitute the soft spider's material basis. Each layer is precisely cut out of a mold with a laser-micromachining technique, and then bonded to the one below to create the rough 3D structure of the soft spider.



Next, a pre-conceived network of hollow microfluidic channels was integrated into individual layers. With a third technique known as injection induced self-folding, they pressurized one set of these integrated microfluidic channels with a curable resin from the outside. This induces individual layers, and with them also their neighboring layers, to locally bend into their final configuration, which is fixed in space when the resin hardens. This way, for example, the soft spider's swollen abdomen and downward-curved legs become permanent features.

"By developing a new hybrid technology that merges three different fabrication techniques, we created a soft robotic spider made only of silicone rubber with 18 degrees of freedom, encompassing changes in structure, motion, and color, and with tiny features in the micrometer range," said Sheila Russo, Ph.D., co-author of the study. She helped initiate the project as a Postdoctoral Fellow in Robert Wood's group at the Wyss Institute and SEAS and now is Assistant Professor at Boston University.

The study is published in Advanced Materials. (Source: Wyss Institute at Harvard University)

1 ASM Assembly Solutions on CFX ▶

In this interview, ASM Assembly Solutions' Thomas Marktscheffel shared his perspective on CFX and its current challenges, and dispelled the notion that CFX might be a cookie-cutter approach to the smart factory.


Thomas Marktscheffel

2 Overcoming Growth Challenges ▶

This article looks at seven common areas that can cause manufacturers a headache when their business is growing, along with solutions to help ease the pain.


Neil Sharp

3 IMI Climbs in Automotive EMS Ranking ▶

Integrated Micro-Electronics, Inc. (IMI) is now the 5th largest automotive EMS company worldwide in terms of revenue size at the end of 2017, according to the latest release of New Venture Research in July of 2018.

4 MC Assembly Installs 72-Panel Solar System in Florida ▶

EMS provider MC Assembly is harnessing the power of the Florida sun with its new solar panel array at its Melbourne manufacturing location.

5 Benchmark Facilities Earn MedAccred Accreditation ▶

In recognition of its compliance with the rigorous requirements for PCB assembly and quality systems established by the Performance Review Institute (PRI) and a consortium of OEM medical device manufacturers, Benchmark Electronics announced that its Minnesota facilities in Rochester and Winona have received MedAccred Printed Circuit Board accreditation.

6 Incap Estonia Now Certified to Latest Version of ISO 13485 ▶

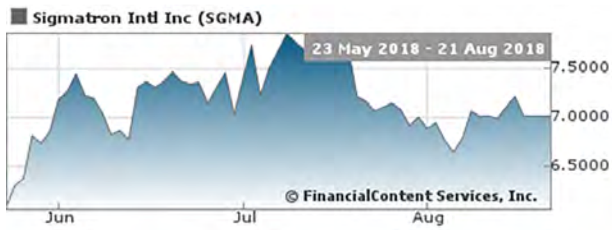
Incap's factory in Kuressaare passed successfully another audit and is now the only electronics manufacturing services provider in Estonia having the latest (2016) version of the certificate for manufacturing electronics for medical devices and related services.

7 Praesidian Capital Invests in Power Design Services ▶

Praesidian Capital has announced that it agented a $22.4 million senior debt investment to support the merger of Power Design Services LLC and Green Circuits Inc.

8 SigmaTron Reports Revenue Drop in Fiscal Year 2018 ▶

For the fiscal year 2018, SigmaTron International Inc. has reported a net loss of of $3.24 million, compared to a net income of $1.39 million in fiscal year 2017.



9 SMTA to Honor Members of Distinction Award Winners ▶

During the 2018 Annual Meeting at SMTA International, the SMTA will honor members who have shown exceptional service to the association and the electronics assembly industry.

10 EMS Index Down 5.7% in Q2 2018 ▶

Lincoln International's overall EMS index in the second quarter of 2018 was down by 5.7% from the previous quarter.

For the latest news and information, visit SMT007.com. Subscribe to our newsletters or premium content at my I-Connect007.

Career Opportunities

ELECTROLUBE
THE SOLUTIONS PEOPLE

Sales Development Manager

Electrolube has a new opportunity for a sales development manager covering the Midwest United States. This is an exciting role involving all aspects of sales development and account management for the Electrolube brand.

The successful candidate will have relevant experience within the electro-chemicals industry and a strong commercial background. This position will report directly to the U.S. general manager.

Applicants should apply in writing and submit a CV by clicking the button below.

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Ucamco
Former Barco ETS

International Field Service Engineer located in ITALY

The successful candidate will:

- Install and service our plotters and direct imaging machines at customer sites Europe-wide
- Carry out maintenance in the field
- Travel frequently (several weeks/month, 4x5 days/month possible)
- Assist product manager

We are looking for a team player who is:

- Strongly customer-oriented and experienced in on-site support
- Accustomed to travel, and willing to travel frequently
- Motivated, independent and enterprising
- Technically-minded with training/background in electromechanics/electronics
- Experienced with software (setup, configuration, and usage of Windows-based CAM front-end software and Linux-based RIP software)
- Fluent in Italian and English (German and/or French is a plus)
- An analytical thinker
- Capable of problem solving

The right candidate will be a valued member of a friendly, team-oriented, growing international company that is a leader in its field, dedicated to excellence in all it does. Dynamic and fun, the company offers a great working atmosphere, and this new position is forward-looking and open, with plenty of opportunities for enterprising individuals whose results could be rewarded with prospects for progression in technical development.

Apply to Anja Ingels after clicking below.

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Career Opportunities

MacDermid Enthone
ELECTRONICS SOLUTIONS

Product Group Field Manager
Waterbury, CT

Do you have what it takes? MacDermid Enthone Electronics Solutions is a leading supplier of specialty chemicals, providing applicatio specific solutions and unsurpassed technical support.

The position of the Product Group Field Manager will be responsible for creating and driving a strategic plan for the regional product line, including the following:

- Possess a thorough understanding of the overall PCB business, and specifics in wet processing areas
- Play an integral part in developing a commercial and technical customer strategy
- Create and deliver customer facing presentations
- Provide technical training for field staff
- Create and execute a product rationalization program
- Develop new product roll-out packages

Hiring Profile

- Bachelor's degree or 5 years' job-related experience
- Strong understanding of chemistry and chemical interaction within PCB manufacturing
- Excellent written and oral communication skills
- Strong track record of navigating technically through complex organizations
- Willingness to travel

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GO
Gardien

Role: Vice President Gardien Taiwan
TAOYUAN COUNTY, TAIWAN

Gardien Taiwan is a service provider of circuit board (PCB) quality solutions, including electrical testing, AOI optical inspection, engineering (CAM), fixture making, repair and rework. Gardien Taiwan operates service centers in Taoyuan and employs about 100 employees and is currently seeking a vice president to manage and oversee the entity.

Candidate Profile:

- Proficiency in Chinese and English (written and spoken)
- Excellent communication and organization skills
- Experience in change management
- PCB background appreciated, but not mandatory
- Management experience in internationally operating companies
- Savvy in standard office software (Word, Excel and Power Point)

If this sounds like you, please click here to send us an email with your attached CV.

About Gardien Group - Gardien is the world's largest international provider of independent testing and QA solutions to the PCB industry with a global footprint across 24 service centres in five countries and we cater to a whole range of customers, from small family owned PCB shops to large international fabricators. Gardien's quality solutions and process standards are trusted by leading high-tech manufacturers and important industries including aerospace, defense, and medical technology.

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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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Career Opportunities

Mentor®

A Siemens Business

Technology Communications Writer/Content Manager
Board Systems Division

Mentor Graphics, a Siemens business, is a global technology leader in EDA software, enabling global companies to develop new and highly innovative electronic products in the increasingly complex world of chip, board, and system design.

Job Duties:

The Mentor printed circuit board (PCB) technical writer/content manager will:

- Write and produce high-quality content for various properties (blogs, product collateral, technical white papers, case studies, industry publications, etc.)
- Gather research and data, interview subject matter experts, and transform complex information into clear, concise marketing communications
- Manage projects across multiple PCB product teams (high-speed design/analysis, advanced packaging, board design) within a deadline-driven environment

Job Qualifications:

The ideal candidate should possess:

- Strong writing and editing skills with experience in PCB design technologies
- Desktop publishing skills (InDesign) using project templates and knowledge of online publications and social media
- A technical background (B.S. in electrical engineering or computer science preferred; this role works closely with the PCB division's technical marketing engineers and managers
- Solid project planning and management skills; appreciation for adhering to deadlines; creativity for turning technical information into compelling content; teamwork and strong interpersonal communications skills; ability to be a self-starter

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YOUR JOB AD HERE

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

I-Connect007
GOOD FOR THE INDUSTRY

Events Calendar

PCB West 2018 ▶
September 11–13, 2018
Santa Clara, California, USA

IPC E-Textiles 2018 Workshop ▶
September 13, 2018
Des Plaines, Illinois, USA

electronica India 2018 / productronica India 2018 ▶
September 26–28, 2018
Bangalore, India

IPC Southeast Asia High Reliability Conferences 2018 ▶
September 26, 2018 – Singapore
November 1, 2018 – Penang, Malaysia

18th Annual NW Electronics Design & Manufacturing Expo ▶
October 3, 2018
Beaverton, Oregon, USA

SMTA International ▶
October 14–18, 2018
Rosemont, Illinois, USA

Webinar: Flexible Integration of AOI Systems into the THT Process ▶
October 23, 2018
Goepel Electronics online

International Wafer-Level Packaging Conference Exhibition ▶
October 23–24, 2018
San Jose, California, USA

IPC/SMTA High-Reliability Cleaning and Conformal Coating Conference ▶
November 13–15, 2018
Schaumburg, Illinois, USA

electronica 2018 ▶
November 13–16, 2018
Munich, Germany

International Printed Circuit & APEX South China Fair ▶
December 5–7, 2018
Shenzhen, China

IPC APEX EXPO 2019 ▶
January 26–31, 2019
San Diego, California, USA

Additional Event Calendars

IPC

SMTA Surface Mount Technology Association

iNEMI

smt007

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Connecting the electronics assembly factory.

NOVEMBER: **MEDICAL ELECTRONICS**
A look at the opportunities and challenges in the medical electronics industry.