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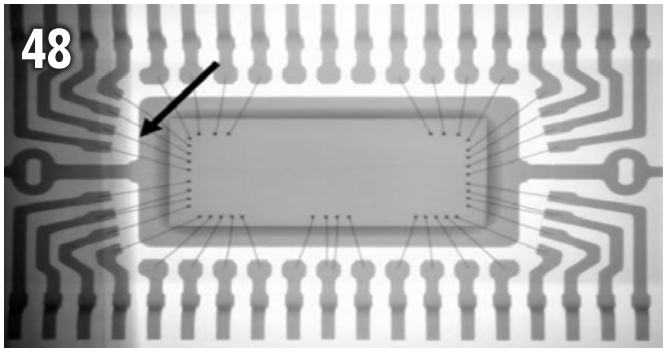
Counterfeit Concerns

The distribution of counterfeit parts has become much more sophisticated in the past decade, and there's no reason to believe that trend won't continue. What is the current state of counterfeit detection, what have we learned from past mistakes, and what might we expect to see from the counterfeit channel in the future?



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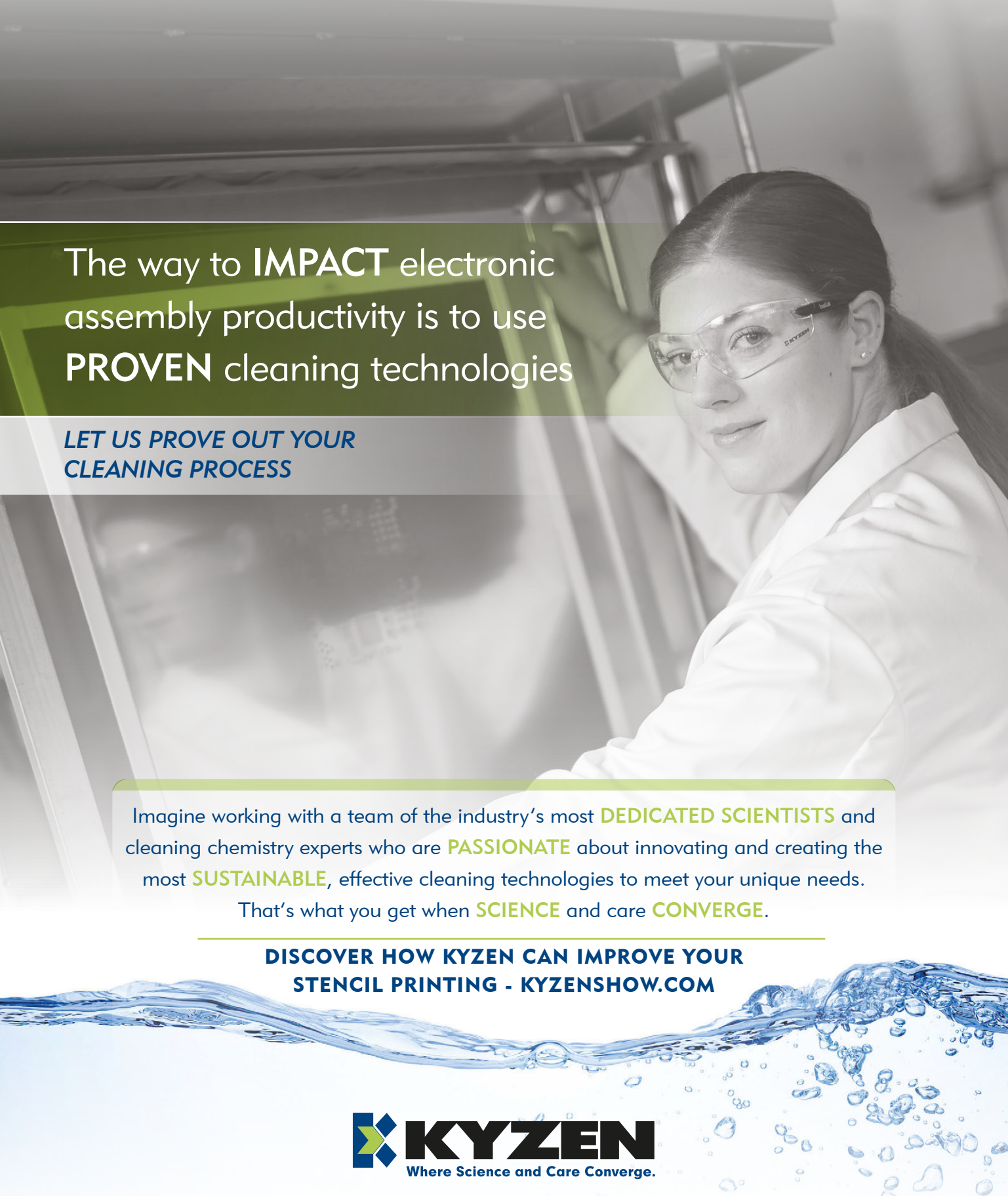

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‘Deepfake’ Components

Nolan’s Notes

by Nolan Johnson, I-CONNECT007

Folks in my age group tend to be the targets of text phishing, so when a friend recently shared a screenshot of a peculiar text conversation, it illustrated to me a growing trend in subterfuge. If you’re not familiar, these schemes start similarly with an invitation to some activity, followed by an apology for the “wrong number” and an offer to become friends, because “you seem like a nice person.”

Figure 1: A phishing text exchange went something like this.

In this example, after starting in English, the phisher inadvertently sends a follow-up text in the Chinese alphabet (translated as “Bella, I’m Evelyn. Are you not in Oregon now?”). Oops. That “technical difficulty” gives them away. Text phishing is a simple, brute-force ploy, and there are other little details which expose the sender as an imposter:

- Crater Lake National Park is truly spectacular, but at over 6,000 feet, the road to the park is closed for winter by November.
- “Bella, I’m Evelyn” is a giveaway. If this truly were a case of mistaken identity, the texter would have been much more informal.
- I can’t remember the last time I reached out to a friend or family member by manually putting their number. “Misdialing” just doesn’t happen like it used to.

It’s hard to talk about fakes and counterfeits nowadays without mentioning artificial intelligence. Mainstream media is awash in stories about what generative AI can do, and not always for the greater good of mankind. I recently read about a speech synthesis company claiming it could create a complete model of someone’s voice from as few as 45 key phrases. It wouldn’t take much audio to “steal” our voices, and it’s no wonder that we see a wave of deepfakes of government leaders and political figures across social media containing spoofed voices.

Of course, doctoring information to deceive is nothing new, but the level of sophistication now possible makes it increasingly difficult to distinguish real from counterfeit. Attention to

Figure 2: Crater Lake at nightfall, with Wizard Island in the foreground.

subtle details is the key to detecting and avoiding a counterfeiter, a deepfake, or a phishing text.

So, what does all this mean to the EMS industry? Counterfeiting has been an ongoing threat for the past 30 years or so, and one can argue that it's increasing in scope and volume. Our reputation as assemblers is at stake if we lose control of our parts inventories and find ourselves building product with counterfeit parts. While it might sometimes be as easy as paying attention to the component labeling, counterfeiting techniques now include functional spoofing of the genuine part—the EMS equivalent of a deepfake video, perhaps? Our vigilance and sophistication must rise to match the inventiveness of the bad actors. That is what inspired this edition of *SMT007 Magazine.*

We start with Paul Jarski, whose real-world experiences set the stage for our other conversations on counterfeiting. We then follow up with watchdog organizations like CALCE and ERAI, who share how they help prevent and/or mitigate counterfeits in your supply chain. We also contacted Tony Bryant, who developed (and conducts) a course on counterfeiting for IPC. In his article, Tony takes a deep dive into his counterfeit mitigation course syllabus to share how to respond when counterfeits are found or suspected. We also go back to a column by Bill Cardoso, who explains why you should "X-ray everything." We wrap it up with columns by Dr. Jennie Hwang, Tom Yang, and Josh Casper.

ERAI indicates that counterfeits are shifting to meet market shortages, maybe, but not letting up. In this world of artificial intelligence, we all must be on the lookout for deepfakes meant to persuade and, unfortunately, to deceive. So, whether it's a phishing scheme in your text messages, sociopolitical propaganda in social media, or counterfeiters in your supply chain, taking the necessary precautions will help keep you above the fray. **SMT007**

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

The AI Era, Part 3: LLMs, SLMs, and Foundation Models

SMT Perspectives and Prospects

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

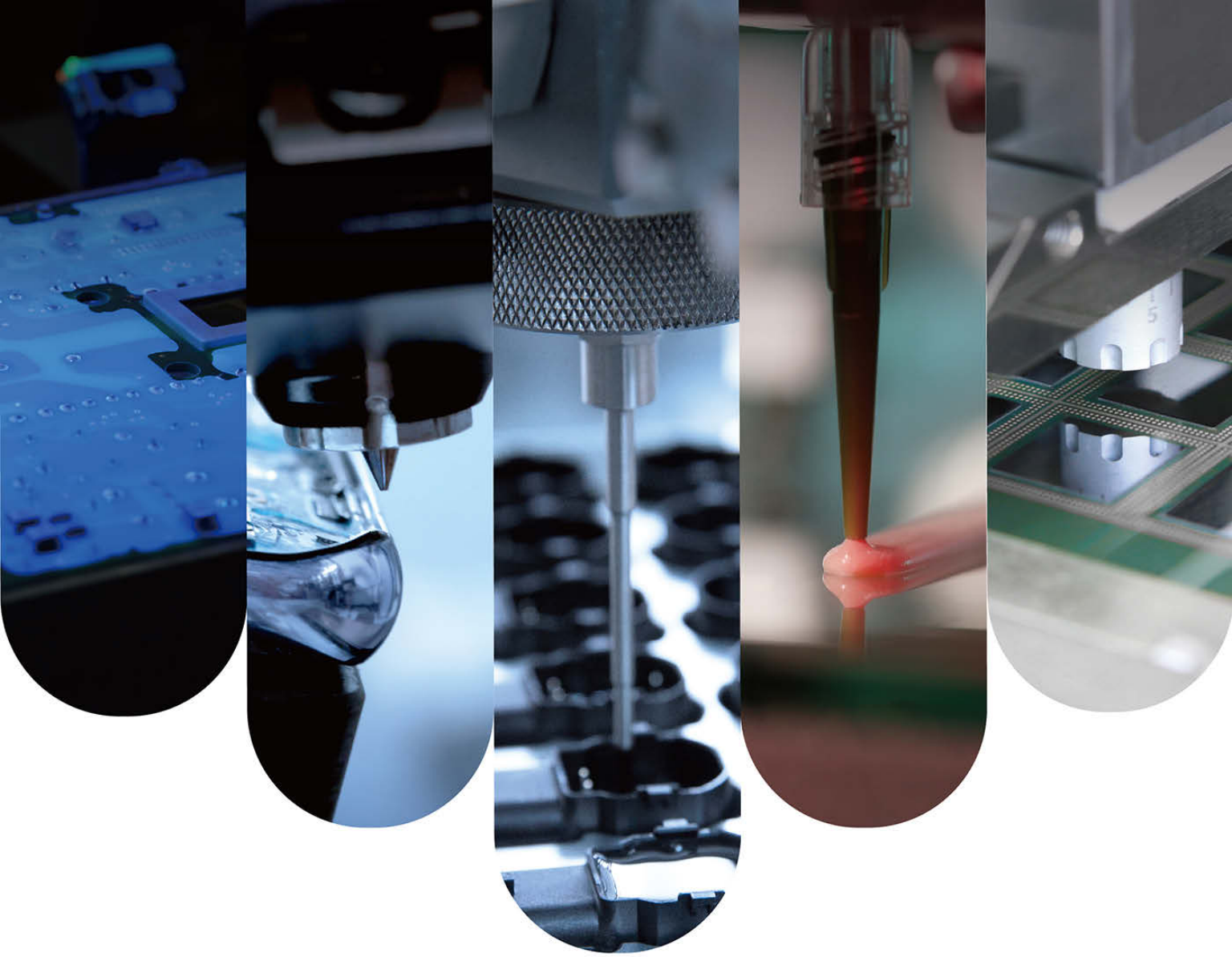
Since the introduction of ChatGPT on Nov. 30, 2022, and ChatGPT4 on March 14, 2023, large language models (LLMs) have been in everyday news and conversations. LLMs represent a significant advancement in AI, which has the potential to revolutionize multiple fields. This column offers a snapshot of LLMs from the user's perspective.

As a subset of AI models, LLMs are designed to understand, process, and manipulate human language and generate human-like text through learning patterns and relationships. A model is trained on vast datasets, which allow it to recognize, translate, predict, and generate text or other content and perform a wide range of tasks related to natural language processing (NLP).

The recent success of LLMs stems from the following:

- The introduction of transformer architectures
- The capability of increased computational power
- The availability and use of vast training data

LLMs' underlying technology is based on deep learning, particularly neural networks. Deep learning algorithms are capable of a wide range of natural language tasks. The most common architecture for LLMs is the transformer model, introduced in the groundbreaking paper, "Attention Is All You Need" by Vaswani in 2017[1].



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Transformer Architectures

Transformers can derive meanings from long text sequences to understand how different words or semantic components might be related. They can then determine how likely they are to occur in proximity to each other.

The key components include attention mechanisms that focus on different parts of the input sequence when generating output, and self-attention mechanisms to process input data—allowing the model to weigh the importance of different words in a sentence sequence and understand context when making predictions. Its feed-forward neural networks process the attention outputs to produce the final predictions.

"The architecture comprises an encoder-decoder structure."

The architecture comprises an encoder-decoder structure. The encoder processes the input sequence and produces a set of continuous representations (embeddings), while the decoder takes the encoder's output and generates the final prediction, e.g., a translated sentence or a continuation of text. Additionally, a multi-head attention mechanism can improve the model's ability to focus simultaneously on different parts of the input sequence. Multiple attention heads enhance the model's capacity to capture diverse linguistic patterns and relationships within the data. Transformer architecture also uses positional encoding to compensate for the lack of sequential processing and maintains information about word order.

Transformer architecture facilitates effective pre-training on large datasets and subsequent fine-tuning for specific tasks. It is a key aspect of LLM development. This pre-training allows the transformer architecture to learn general language patterns while fine-tuning works on specific datasets to improve performance tasks. Many iterations are required for a model to reach the point where it can produce plausible results. The mathematics and coding that go into creating and training generative AI models, particularly LLMs, can be incredibly time-intensive, costly, and complex.

One of the unique advantages of transformer architecture is that it can handle input data in parallel. Parallel processing offers greater efficiency and scalability compared to other architectures, such as a recurrent neural network (RNN) or long short-term memory (LSTM), which process data sequentially.

LLMs

Based on the concept of transformer architecture, LLMs consist of intricate neural networks trained on large quantities of unlabeled text. An LLM breaks the text into words or phrases and assigns a number to each, using sophisticated computer chips and neural networks to find patterns in the pieces of text through mathematical formulas, and learns to "guess" the next word in a sequence. Then, using NLP, the model can understand what's being asked and reply. Because it uses mathematical formulas rather than text searching to generate responses, it is not ready-made information waiting to be retrieved. Rather, it uses billions or even trillions of numbers to calculate responses from scratch; producing new sequences of words on the fly. However, LLMs are computationally intensive, requiring high computing power and parallel computing, such as graphic processing units (GPUs).

LLMs are characterized by their large param-

Table 1: Key characteristics of ChatGPT models

GPT-1 to GPT –4 (4+)

Model	Launch Date	Training Data	No. of Parameters	Max. Sequence Length
GPT-1	June 2018	Common Crawl, BookCorpus	117 million	1024
GPT-2	February 2019	Common Crawl, BookCorpus, WebText	1.5 billion	2048
GPT-3	June 2020	Common Crawl, BookCorpus, Wikipedia, Books, Articles, and more	175 billion	4096
GPT-4	March 2023	(Unknown)	(Estimated to be in the trillions)	(8,000–32,000+)

GPT 4o
GPT-5> 60 trillion?

eters, which act as the model's knowledge bank. Table 1[2] shows the relative number of parameters and the maximum sequence length of the progressive ChatGPT models: GPT-1, GPT-2, GPT-3, and GPT-4. Models can handle tasks such as generating text, translating, making summaries, answering questions, and analyzing sentiments. They can also be fine-tuned to undertake specific tasks.

How large are LLMs? There is no universally agreed figure. However, they are generally characterized by the number of parameters (billions or even trillions) and the size of the training data they are exposed to. Usually, LLMs have at least 1 petabyte of storage (the human brain stores about 2.5 petabytes of memory data.)

This leads us to another related terminology: foundation models.

LLMs vs. Foundation Models

Foundation models are base models that provide a versatile "foundation" that can be fine-tuned and adapted for a wide range of applications, from language processing to image recognition. Foundation models are multimodal and can be trained on different data or modalities. In essence, LLMs are foundational models, but not all foundational models are LLMs.

LLMs vs. SLMs

Recently, "smaller" language models have come into vogue due to practical factors such as cost and readiness. So, what is considered a small language model (SLM)? In terms of size, there are no hard and fast rules. In general, LLMs typically have over 20 billion parameters. For example, GPT-3 has 175 billion as shown in Table 1, while SLMs range from 500 million to 20 billion parameters.

LLMs are broad-spectrum models trained on massive datasets, excelling at deep reasoning, complex context handling, and extensive content generation. SLMs are more specialized, focusing on specific domains or tasks. They may exhibit less bias and are less costly. They are also faster and potentially more accurate (less hallucination) and, accordingly, are more readily able to be put to work.

Artificial intelligence is still nascent but continues to advance. It would not be surprising to see the new frontier offering another level of capabilities and accuracy with a new architecture. **SMT007**

References

1. "Attention Is All You Need," by Ashish Vaswani, et al., Proceedings of the 31st International Conference on Neural Information Processing Systems (NIPS).

2. Professional Development Course: "Artificial Intelligence: Opportunities, Challenges, and Possibilities," by Jennie S. Hwang.

Appearances

Dr. Jennie Hwang will instruct a professional development course on "Artificial Intelligence—Opportunities, Challenges and Possibilities" at the 2024 SMTA International, Oct. 21 in Chicago. She will also deliver the keynote speech titled "Artificial Intelligence Era: Work, Life, Technology, Leadership, and Women!" at the Women's Leadership Program on Oct. 21.

Dr. Jennie S. Hwang, an international businesswoman, speaker, and business and technology advisor, is a pioneer and long-standing leader in SMT manufacturing since its inception, and in developing and implementing lead-free electronics technology and manufacturing.

She has served as chair of Artificial Intelligence-Justified Confidence for DoD Command and Control study, chair of AI Committee of the National Academies, and Review Panels of NSF National AI Institutes and Committee of Strategic Thinking for Engineering Research. An International Hall of Famer (Women in Technology), she has been inducted into the National Academy of Engineering, named an R&D-Stars-to-Watch, and received the YWCA Achievement Award. She has held senior executive positions with Lockheed Martin Corp., and was CEO of International Electronic Materials Corp. She is currently CEO of H-Technologies Group, providing business, technology, and manufacturing solutions.

She has served as chair of the Laboratory Assessment Board, the DoD Army Research Laboratory Assessment Board, and the Assessment Board of Army Engineering Centers. She is on the board of Fortune-500 NYSE companies and civic and university boards, Commerce Department's Export Council, National Materials and Manufacturing Board, NIST Assessment Board, various national panels/committees, and international leadership positions.

She is the author of 10 books (four as co-author) and 750+ technical/editorial publications. She is a speaker and author on trade, business, and education issues. Her formal education includes four academic degrees (Ph.D., M.S., M.A., B.S.), as well as Harvard Business School Executive Program and Columbia University Corporate Governance Program. To read previous columns, click here.

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Battling Counterfeit Electronics in Manufacturing

Feature Interview by Nolan Johnson
I-CONNECT007

Paul Jarski, product development manufacturing leader at Case New Holland (CNH), discusses his extensive experience with counterfeit electronics throughout his career. He highlights the challenges faced during market allocations, where counterfeit parts infiltrated supply chains, causing significant issues. Paul recounts the rigorous processes implemented to detect and prevent counterfeits, including advanced material analysis and testing. Counterfeit parts occasionally slipped through despite these measures, leading to costly and time-consuming audits and verifications to ensure product integrity and safety.

Nolan Johnson: Paul, tell me a little about your background.

Paul Jarski: I currently work with large and compact tractors at CNH. I'm the liaison between the product development and manufacturing organizations.

Prior to this role, I've spent most of my career in agricultural technology, both with CNH and other companies. With the advances in farming technology, the development of rugged electronics equipment has been and continues to be a critical part of the business.

So, you have an extensive background in managing counterfeiting issues.

Yes. For most of my career, I have been involved in the manufacturing, quality, and supply chain

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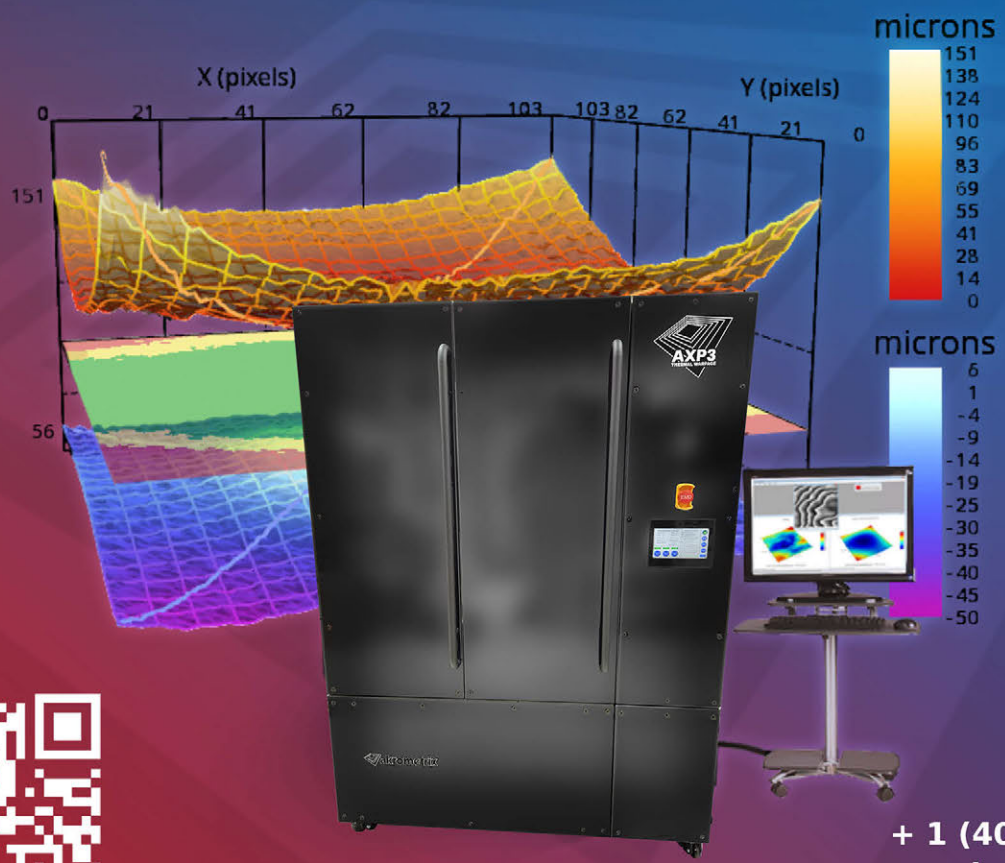

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portions of the AG electronics business. I started my career in this area as a process/quality engineer as a liaison between my company and EMS providers. We'd get a product stable and move it to the EMS provider. We still owned the design and controlled everything in the BOM, the AML.

Paul Jarske

We all know the electronics industry goes through allocations every three to four years. When that happened, we looked for parts. We went to the broker market if we couldn't get them through normal chains.

I remember some of the first brokered parts we bought in the mid-2000s. After the 2008 economic meltdown, everybody in the electronics industry had slashed their capacity. For the ag industry, it was a blip. In the space of a year, we went from building at 100% capacity to cutting production to going all out and needing to increase equipment capacity. When everybody in the electronics component industry had cut capacity, we had to go to the broker market to find components. However, we also realized the inherent danger in this approach, so we knew we had to be careful of what we purchased.

When we purchased components from the secondary (broker) market, we started implementing checks to verify authenticity. I remember clearly some of the first counterfeits. As soon as they came in, we suspected something was wrong. The labels were poorly printed on the reels, the silk screening on the physical parts wasn't spelled correctly, and you could rub the labeling off the part. I remember us throwing some samples in the X-ray, only to find there was nothing inside. We saw a lot of crude stuff. If you had an X-ray and a cotton swab with acetone, you could tell if you had a counterfeit.

Fast forward to the next market allocation in the 2013–14 timeframe and we found that counterfeiters had advanced their game significantly. In one instance we suspected a receipt of components but couldn't prove their authenticity. Erring on the side of caution we scrapped a six-figure dollar value of parts that we had bought.

This drove us to do some significant lessons-learned activities. We wrote up instructions on what to look for so we didn't experience the same costly issue. One of the activities included expanding the charter of the component engineering groups to support component authentication. In addition, the company's advanced analysis laboratory expanded its capabilities to be able to evaluate parts. The work instructions we developed instructed our buyers to reach out to the technical teams in these two groups to evaluate brokered components before use in production. With these instructions in place, we were quite confident that we'd be covered if anything was brought in outside normal supply channels.

Regarding the huge market allocations in the 2017-18 timeframe, these processes were not nearly as robust as needed. As many people familiar with the industry likely remember, the 2017-18 allocation differed from others in that it wasn't just one or a few impacted component types. Rather, every component type was impacted. From the simplest passive device to the most complex processor, everything in between. At the same time, the ag industry was at the top of its demand cycle. No one could build enough equipment to meet demand. Shutting down a multi-million-dollar-a-day vehicle factory for want of an electronic controller was not acceptable.

That allocation went on for so long that, in the postmortem, we found out our buyers had become tired. It got to the point where they'd ask a distributor or component manufacturer, "Will we get these parts on this day?" If they said no, the buyer bought from a bro-

ker. Around the same time, the folks in the vehicle factories would go online, find parts, then alert the buyers. That's when it got really ugly. People who had the best intentions but didn't know the complexities of the electronics industry were direct buyers to get parts from all different channels.

You were being directed to buy parts from somewhere, but these parts weren't verified?

Everybody meant well, but it was hard to control. I remember when the first components started failing. In-circuit and functional tests on the controllers had all passed. However, once they had the final application payload, they started to fail. At this point, we asked, "Why are these things failing?"

When it happened, I was in Europe doing obsolescence work. Reading these emails, I realized, "This could be bad. I think these are counterfeits." The confirmation came when we sent the manufacturer a picture of the label and the part. They said, "This is not one of our date or manufacturing codes. That's not one of ours." I was on a train to the airport at 3 a.m. to get back to the home office.

When I returned, I went to my colleague's analysis lab. As we looked at this part, another engineer said, "Here are those FET parts that are failing." We grabbed a picture of that part, sent it to that manufacturer, and they said, "That's not our part."

At that point, with two known counterfeits in our factory, we stopped everything. We had to audit everything in inventory to find what was purchased as a brokered part—over 100 part numbers and greater than 10 million parts. Once we had them all contained, we had to validate them. I'll never forget working over 40 days straight over the holiday season to lead the evaluations. It was an activity I never want to repeat.

One of our most eye-opening examples was related to multi-layer ceramic capacitors. The labels looked perfect in these cases, except the secret decoder numbers weren't quite right. We only found this out by working directly with the component manufacturer to review the labels, who told us they weren't legitimate labels.

We learned through these activities that most companies selling ceramic capacitors use contract manufacturers companies to make MLCCs according to their recipe. When the CMs run an order for, say, 100 million parts, they might get 110 million, depending on their yields. The customer company accepts only the 100 million ordered. Now, this CM is sitting on 10 million surplus parts, so they sell them. They end up in the hands of people who can replicate the label and sell them as legitimate parts. Technically, they are legitimate parts, but they don't move through the regular chain. The manufacturer code for these other parts is correct, but all the parts from the 100-million-part order are accounted for.

Given this example, the first question that came to us is, "What is the risk?"

We ultimately built test boards using these components and ran the AECQ 200 tests to confirm that the parts wouldn't fail. With a thousand capacitors in parallel, that's a lot of charge. We took the necessary safety precautions and were able to successfully complete the tests. What we learned was that the parts met the specifications, so there was no risk. You can imagine the financial investment required to do this type of activity.

The story arc you shared starts simply but becomes quite sophisticated.

It's important to understand the number of resources we had at our disposal, including technical personnel and analysis equipment. However, if the organization doesn't communicate across departments, these resources can't help protect the organization.

"Given the prevalence and sophistication of the counterfeit industry, the risk to component manufacturers is very high."

In your first example, you had a part that functionally passed the tests and looked legitimate until it was essentially in the field, and then it didn't work as expected. That's a pretty sophisticated situation. How do you catch those? It sounds like you did so by cross-referencing manufacturer lot codes with the manufacturer's records.

We did. The first time you talk to them, most manufacturers say, "We will not confirm anything. If it didn't come through our supply chain of custody, we have no comment." I completely understand the manufacturers' stance, given the legal ramifications. What we ultimately learned is that we needed to involve the right supply chain personnel that could share the history of forecasts, communications, and escalations on a particular part. We still had to go to the broker market to meet the requirements. Based on these facts, manufacturers typically would provide enough information for us to make informed decisions.

Don't manufacturers have a vested interest in determining whether these parts are fakes? what with people peddling parts under their brand and all?

Given the prevalence and sophistication of the counterfeit industry, the risk to component manufacturers is very high. Manufacturers need to protect themselves, and I understand their liability concerns.

In your example of having 10 million in overage and surreptitiously feeding them back into the supply chain, these were legitimate parts that could have been placed in the original order. The only difference is they're no longer in the chain of custody.

Yeah, these are counterfeit because the label in the chain of custody is fake. Two big organizations cover counterfeit parts. One is GIDEP, a defense aerospace clearinghouse for logging counterfeit and at-risk parts. The other is smaller but very powerful: ERAI.

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In those early audit investigations, before I knew about ERAI, we would look up the contact information for the broker we'd bought from. I'd get the broker's address and go to Google Earth. On my first search, the address was an awning in Hong Kong. Another was a parking lot somewhere in Hungary. That's when I knew we were very exposed.

Those two organizations must be extremely helpful in such situations.

ERAI was instrumental. They certify brokers. If you want to be part of ERAI and you sell a counterfeit, you lose your membership. ERAI personnel also understand the regulations in this realm and can provide guidance on proper disposition. In one instance, I'm aware of ERAI stepping in and saying, "Now that the customer knows that these are counterfeits, it is against the law to ship them anywhere." That ended the story.

Component verification has become a financial burden to the organization, especially since counterfeiters are more sophisticated. How do you respond to that threat?

One of the advanced ways that they slip them in is by mixing legitimate parts with fake parts in the same reel. Back in the day, you could check the first 10 off the reel. If they were good, the reel was good. When we started having issues again, we also learned to look in the middle or at the end of the reel.

As you said, we go into allocation from time to time. You find yourself in allocation and looking at possibly shutting down a $25 million-a-day factory for want of a chip. What do you do now?

Most larger companies now have well-defined procedures for detecting and avoiding counterfeits. One of the most straightforward methods is simply using known distribution or direct sourcing strategies.

If you have to go to the secondary market, validating any purchase is critical. There are legitimate brokers in the industry. There are also a lot of good testing and analysis facilities that have sprung up to combat counterfeits. While testing components may seem expensive it's money well spent to protect your organization. I can't stress enough that the purchaser must take it upon themselves to make certain parts are legitimate.

How is the working relationship between ERAI and the original manufacturers?

In my experience, the manufacturers don't want you to leave the primary supply chain, so historically, support hasn't been strong for organizations like ERAI.

Another avenue is to use third-party data service providers, which offer centralized repositories of datasheets and compliance data, including counterfeit risk. These services can be critical because they pull all that information into one place and access it for an annual fee. These services can really provide a company with limited resources an excellent means for accessing data efficiently.

You've been talking about going to the manufacturers to get a manufacturer or lot code matched up. Is this something that they're making available to clients? Can you do your own searches?


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Not yet, that I'm aware of. I think the industry will continue to move toward more transparency as it will simply be necessary to combat the ever-growing threat of counterfeits.

We can track the provenance and the chain of distribution for beef, thanks to the mad cow disease experience. We know exactly who had that food, when, and where, all down the chain. So, why not chips?

Exactly.

Can these counterfeiters be prosecuted?

Yes, but it's extremely difficult to catch perpetrators. It's similar to cybercrime in that respect.

What can EMS companies do to help keep this out of their supply?

I know several EMS providers with their approved broker lists, and they require their customers to waive any company that doesn't have their approval. One company I know is extraordinarily strict. If you're a broker and you sell them a counterfeit, you will never see their business again. I think that kind of rigor is important.

In other words, don't buy TVs out of the back of a van in the shopping center parking lot.

Exactly right. SMT007

Combatting Counterfeiting in the Global Supply Chain

by Dan Beaulieu

Enrico Hu, business development manager at WIN SOURCE, talks about the controversy over counterfeiting in the global distribution and how it affects his company.

"Global distribution indeed faces some controversies, primarily due to the circulation of counterfeit products and the volatility of supply chains. These issues not only undermine overall market trust but also pose challenges to the operations of compliant companies.

"The issue of counterfeit products is one of the most pressing concerns in global distribution, particularly in the electronic components industry. Counterfeit components can lead to equipment failures and even safety incidents, posing production risks to consumers while eroding the brand and revenue of legitimate manufacturers. Additionally, the instability of global supply chains, driven by political and economic uncertainties as well as natural disasters, presents further challenges to distributors.

Enrico Hu

"In response to these challenges, we have adopted proactive strategies. As members of associations such as ERAI, ASA, IPC, SMTA, and SEMI, we are committed to distributing only verified high-quality components. We implement stringent supplier evaluations and product inspection procedures to eliminate counterfeit products. We have established a robust global supply chain network and employ flexible strategies to address supply chain disruptions, ensuring we fulfill our commitment to 24-hour shipping for our customers."


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ERAI: The Counterfeit Watchdog

Feature Interview by Nolan Johnson
I-CONNECT007

Rick Smith is vice president of business development at ERAI, an organization founded in 1995 as a watchdog for the electronic component distribution section, aiming to combat bad business practices and counterfeiting. Rick definitely has some stories to tell about the hows and whys of counterfeiting, and breaks down some compelling numbers when it comes to fake parts being sold into the open market.

Nolan Johnson: Rick, why was ERAI formed?

Rick Smith: ERAI was formed to clean up, police, and promote the electronic component distribution world to the manufacturing community. When we formed, most of the incidents we tracked and reported on were just bad business practices. Shortly after China joined the World Trade Organization in 2000, we received our first report of a counterfeited integrated circuit. Since that time, we have put together the largest known database of counterfeit and non-conforming electronic components, as well as the companies reported for having shipped those components. ERAI also tracks and reports on many other supply chain issues including wire fraud, something that has just exploded in the last couple of years. We provide business, industry, and government intelligence to navigate the supply chain and avoid bad products and bad companies, thereby mitigating risk and preventing loss.

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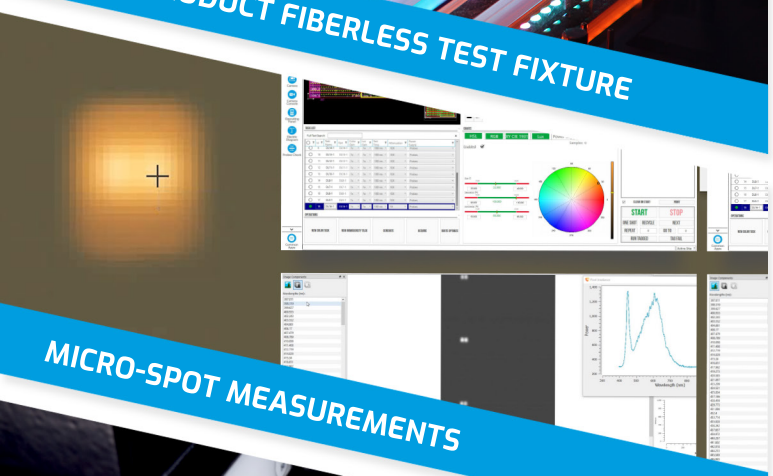

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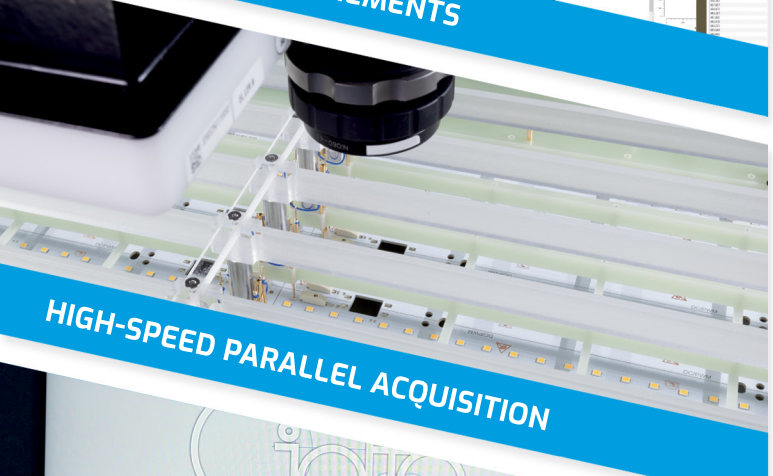

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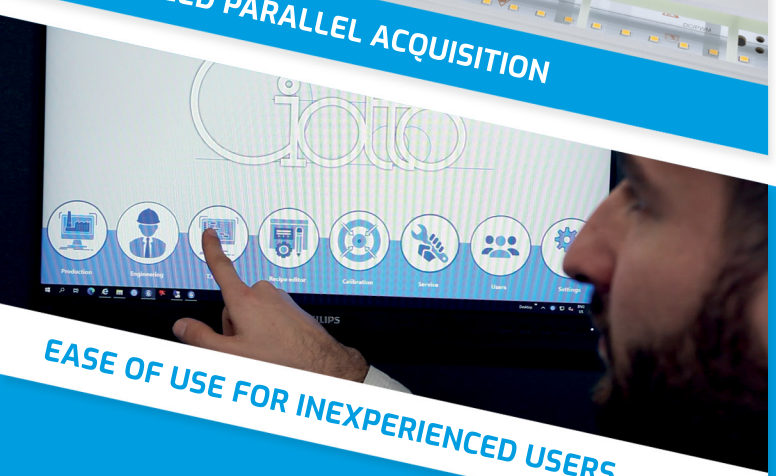

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Essentially, you're tracking the ethical and non-ethical behavior of suppliers. How did this start?


Rick Smith

Our founder and president, Mark Snider, started a company in the early 1990s as an independent distribution broker. He was appalled by the number of bad actors. It was completely unregulated with quite a bit of financial fraud. For example, you would get an order and ship the parts COD. They would write a check, and the UPS guy would deliver the box. You'd get the check back from UPS in 10 days and 10 days after that, you'd find out the check had bounced.

So, Mark faxed everyone he knew in the industry. He said, "I'm going to stop selling to this guy. I got a stack of bad checks from him." Lo and behold, he got replies of, "He got us too." Mark started keeping track of that information and started this organization with the support of companies he had communicated with. He kept track of incidents and trends and sent that out weekly. By 2000, he had a website, and we started getting reports of counterfeit material.

That was a bold move. What a service to the industry!

Mark is a true believer. His son is a recently retired F-15 pilot, and his son-in-law is currently an active Navy diver. Mark was concerned about counterfeit material getting into defense products. For years, he was waving the flag at the Department of Defense, which really didn't catch on until about 2005. Now, virtually every defense contractor has some sort of counterfeit risk mitigation program in place.

I'm surprised to hear that the first counterfeit example of integrated circuits didn't show up until 2000.

In the 1970s and '80s, counterfeiting involved a few unscrupulous distributors who would change the labels to substitute a less expensive manufacturer's part for a higher-cost, more desirable manufactured part. That happened a lot with mechanical things like connector pins. To my knowledge no one was reporting in the 1970s and '80s. We now have 24 years of collecting data on counterfeit parts.

How has counterfeiting evolved since then?

A great deal. One of the significant milestones for counterfeiting came when China joined the World Trade Organization (WTO). At that time, it became easy to import products from China. Now, China ships a lot of high-quality product, but once they could deal more simply with countries worldwide, it was a big opening for criminals—the counterfeiters.

One reason counterfeiting became a big opportunity in China was the electronic scrap the U.S. sent for disposal. It gave the Chinese companies a lot of raw material to work with. They would remove components from scrap PC boards, sandblast the numbers off, recoat them with some sort of blacktop material, and then mark them with whatever part number they were trying to sell you—with no regard for what the chip inside actually did. It looked like the correct part, but when you hooked it up, it didn't work. That was the basic, most common form of counterfeiting.

We've also seen many lower-quality, less expensive manufacturers' products being switched for higher-quality, more expensive products. Extremely high-tolerance devices are being switched for low-tolerance devices. They make a lot of profit that way.

Lately, the Department of Defense and other areas have been concerned about cloned products, which are expensive products that have been reverse-engineered. The concern is bad state actors adding malicious code. There have been many eyes looking out for that lately.

Counterfeiting is a crime of opportunity, where there is demand for the product. The money to be made must be worth their while.

Until three or four years ago, wire fraud worked like this: A U.S. company would place an order with a company in China. The Chinese vendor would send photographs of the part, and everything checked out. The American company would then wire transfer $10,000. The next day, the Chinese company would email or fax a shipping document with a FedEx number, and the U.S. customer would go to FedEx, type in the number, and see that it's a 12-pound box. It seems legit. Seven days later, they get a package, but instead of the parts they ordered, it's a box of rusted forks.

It got so bad that vendors didn't even have the decency to ship you a box of rusted forks. They just took your money and ceased all communication. We put out several white papers about it, but wire fraud is still a big problem.

What can companies do to prevent things like this?

The best thing is to go into our database and verify the vendor. I could show you one case where the company had been reported 37 times for wire fraud; anybody who looked it up would have known that.

You can also access our database for the U.S. government's Denied Party list of about a half-dozen agencies—Bureau of Science and Industry, Department of Defense, Department of Justice, etc.—and it's mostly driven by sanctions. They have individuals and companies that Americans are not allowed to do business with through ignorance or manipulation. Very rarely is it through malicious intent, but some companies are shipping products to U.S. companies that the U.S. government says are not allowed to have our material in hand. So, these U.S. companies are getting visited by the guys in black suits with gold badges, getting their hands smacked and fined. That could have been avoided had they taken the 30 seconds to look at our database.

Since ERAI tracks trends and statistics, what are the numbers telling you?

This chart (Figure 1) shows the number of counterfeit part reports that ERAI has published from 2005 to the end of 2023. The yellow line is global semiconductor sales. Generally speaking, the number of counterfeit parts

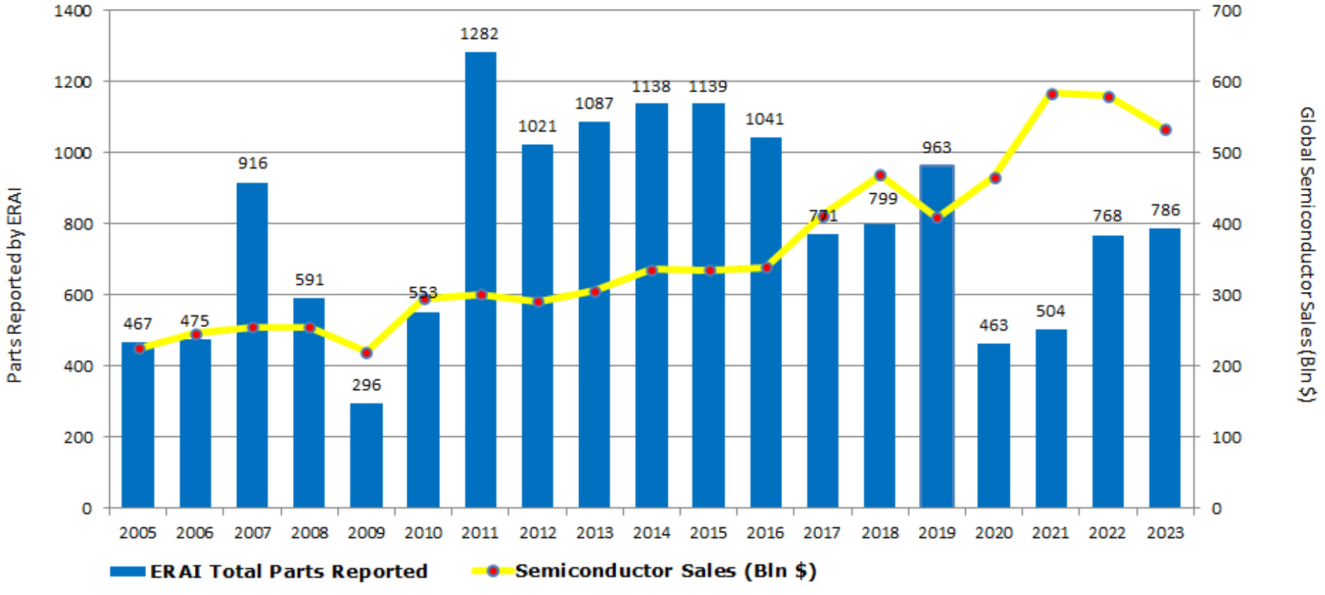

Figure 1: Reported parts vs. global semiconductor sales, 2005-2023.

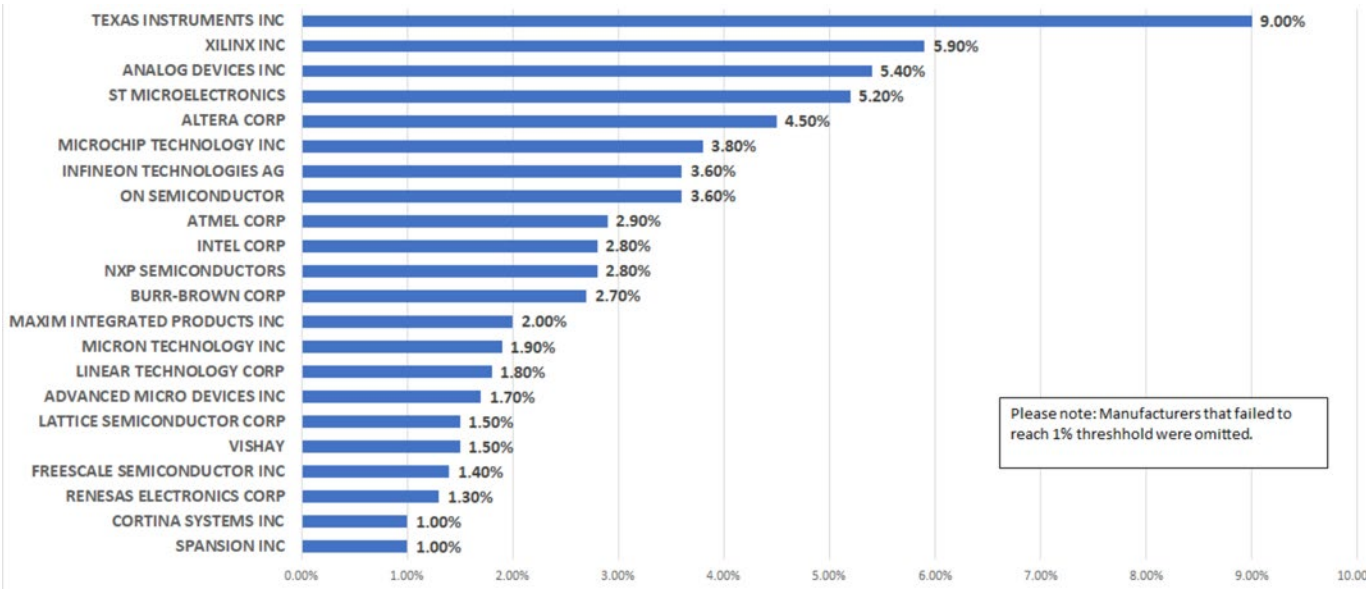

Figure 2: Most counterfeited OEMs in 2023.

rides up and down global semiconductor sales, which is logical. But in 2020, we saw a drop in the number of reported parts even though there was an increase in global sales due to COVID. There were fewer people working, and factories were closed, so there was less reporting, which got caught up in 2022. The 2023 number was significantly higher than 2022, and by June 2024, there were already roughly 800 incidents reported, which was well ahead of 2023.

In 2023, we also tracked the most counterfeited OEM (Figure 2). Texas Instruments was the most reported counterfeit brand. In 2023, there were 786 parts reported. Nine percent were TI parts, followed by Xilinx. Going back five to 10 years, it's still TI and Xilinx. Over the years, those top five or 10 companies change places from year to year.

This supports what makes a part likely to be counterfeited: There's demand for these chips, they're very high-volume, popular brands with

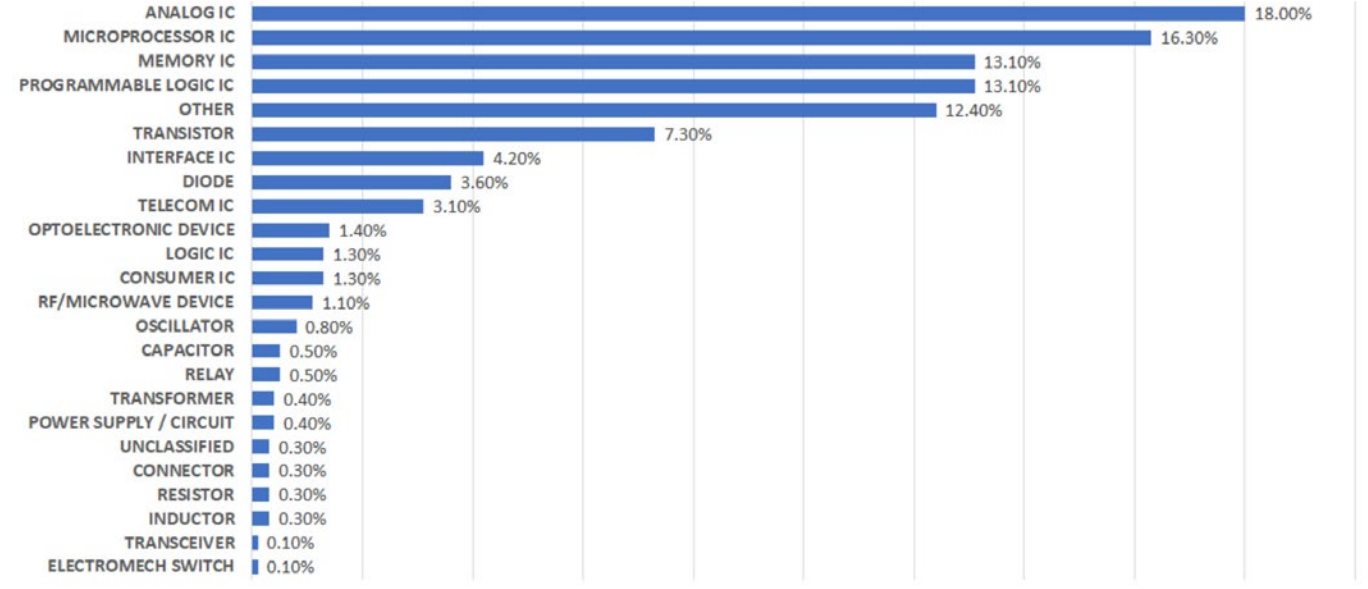

Figure 3: Types of electronic components reported to ERAI in 2023.

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a high average selling price—TI, Xilinx, the field programmable gate arrays, and things like that are very expensive parts. Unfortunately, counterfeiters have raw material in abundance in scrap boards to remark it and sell it back to us. If you break it down by component type, it is the same story. Analog ICs, microprocessors, memory, and programmable logic are typically expensive. When you get down to resistors, they're low cost, so you don't see much counterfeiting. From 2000 to 2018, the number one most reported counterfeited device was an integrated circuit.

It wasn't until 2019 that we saw, for the very first time, that shifted to an inexpensive chip capacitor because there was a global shortage driven by electric vehicles, laptops, and cellphones. At the same time, the industry was trying to move its customers from large case-size parts to smaller case-size parts, so a lot of manufacturing capacity was moved to these newer, smaller devices. All that created a perfect storm of extremely long lead times and companies desperately needing product.

For the counterfeiters, this was really simple. They could create premium prices because of the high demand and long lead time. They could melt these parts off the millions of scrap PC boards and sort them by case size, with no regard for the capacitance value, voltage, tolerance, or other factors. They were packaged on cheap paper tape and reel.

For one company that came to ERAI, we helped them get some of their money back and gave them proper training on how to inspect incoming capacitors and other devices. We sent an alert to our member base across 44 countries. Everyone now has the opportunity to avoid this supplier.

That seems to offer a lot of value to OEMs and brokers.

I demonstrate our services to companies all over the world. Sometimes, I'll hear things like, "We don't have to worry about counterfeits because we don't deal with obsolete material." I can show them that in 2023, over half of the parts reported were not obsolete. They were currently available from franchise distribution, direct from the factory, or the authorized supply chain. But there may have been long lead times. So, obsolescence is one of the driving factors, but not the driver for a counterfeit device.

That is an important point that was certainly driven home during the pandemic.

Another point of interest is that of all the geographic locations with known suppliers of

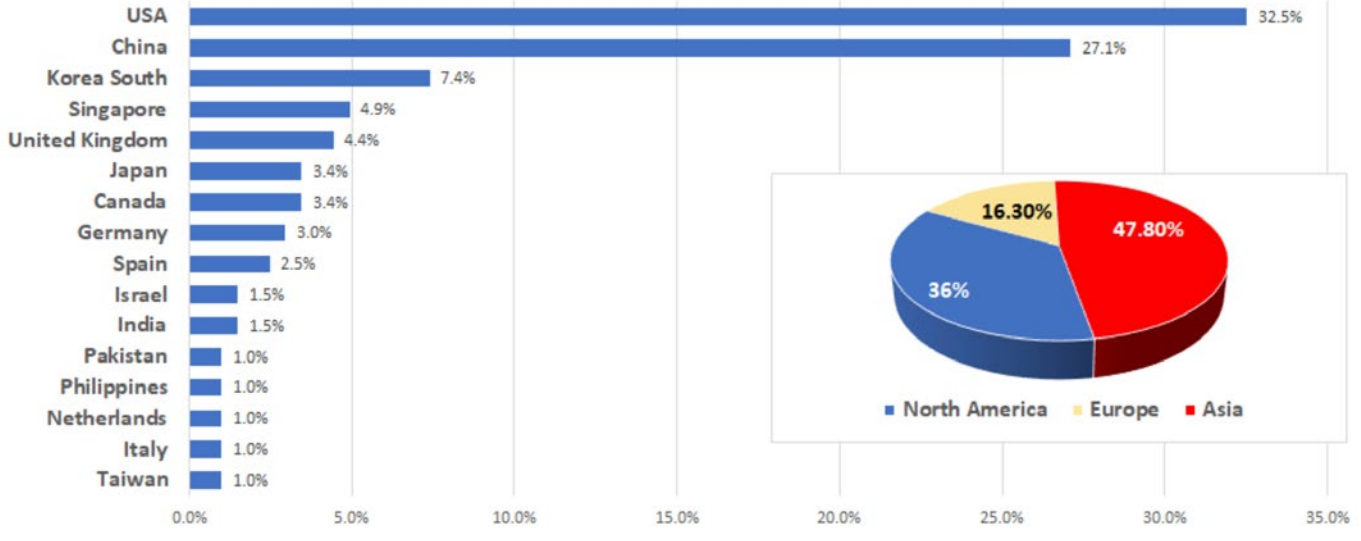

Figure 4: Geographic location of known suppliers of parts reported in 2023.

reported counterfeit parts, 32% are in the U.S. Now, that doesn't necessarily mean a company in the U.S. was counterfeiting a device. They probably bought it from a company in Asia. When a complaint is made, we'll contact the supplier. It would bode well for them if they cooperated with us and divulged their supplier information. It allows us to dig deeper into the supply chain to find the bad guys. Thirty-two percent of the time, for whatever reason, they will not say who their supplier is. In those cases, they're the ones who are reported for shipping the counterfeit part. The report goes out with their company name on it.

While the U.S. seems to be the number one country, Asia is the number one region. If you include China, South Korea, Singapore, Japan, and India, the Asian region has the lion's share of companies reported for shipping counterfeit devices.

Of the entities reporting to us, 67% are independent distributors, as you would expect. They're on the front lines, the first to encounter counterfeit devices. A great deal of our information comes from dozens of test labs around the country and the world, many of which we have had relationships with for 25 years. Franchise distributors come in at 9.6%. You would expect that number to be zero because they're franchised, but the truth is that they get counterfeits through returns. Distributors have a miscellaneous product code XYZ, where they go out to the open market to buy enough product to fill a customer's requirement. That becomes an opportunity for counterfeiting the OEMs. So, big manufacturing companies are a very small percentage of the product being reported to us. That tells me that the policies and programs they put in place are working. All these independent distributors find the counterfeit product before they get to the OEM.

This little sliver of the pie chart (Figure 5) is where we believe OEMs were frustrated that none of their approved independent distributors could source the product they needed, so they took it upon themselves to venture into the open market. They bought product from companies that they either didn't vet or didn't know how to vet properly, and they got stung with counterfeit material. I don't have hard data to support that right now, but we think that's what is happening.

It's the same with contract manufacturers. It's not zero, but these guys are counting on their own efforts and their trusted, rated, approved, independent distributors to knock out counterfeit products.

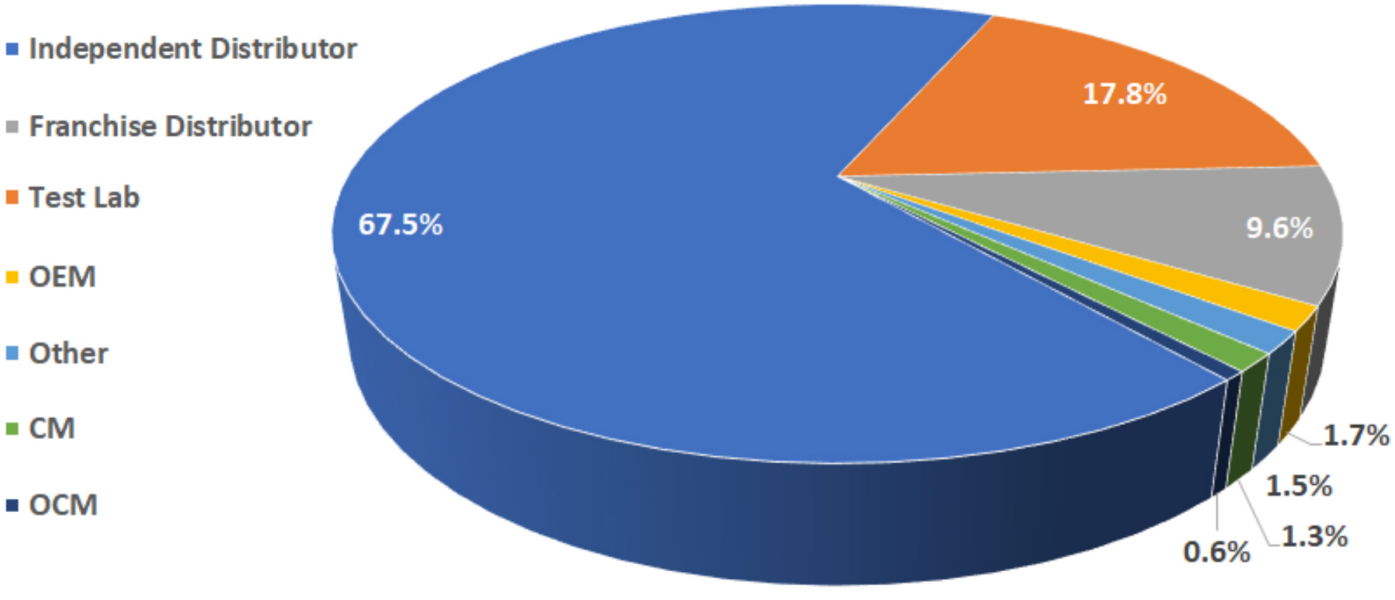

Figure 5: Types of entities reporting parts to ERAI in 2023.

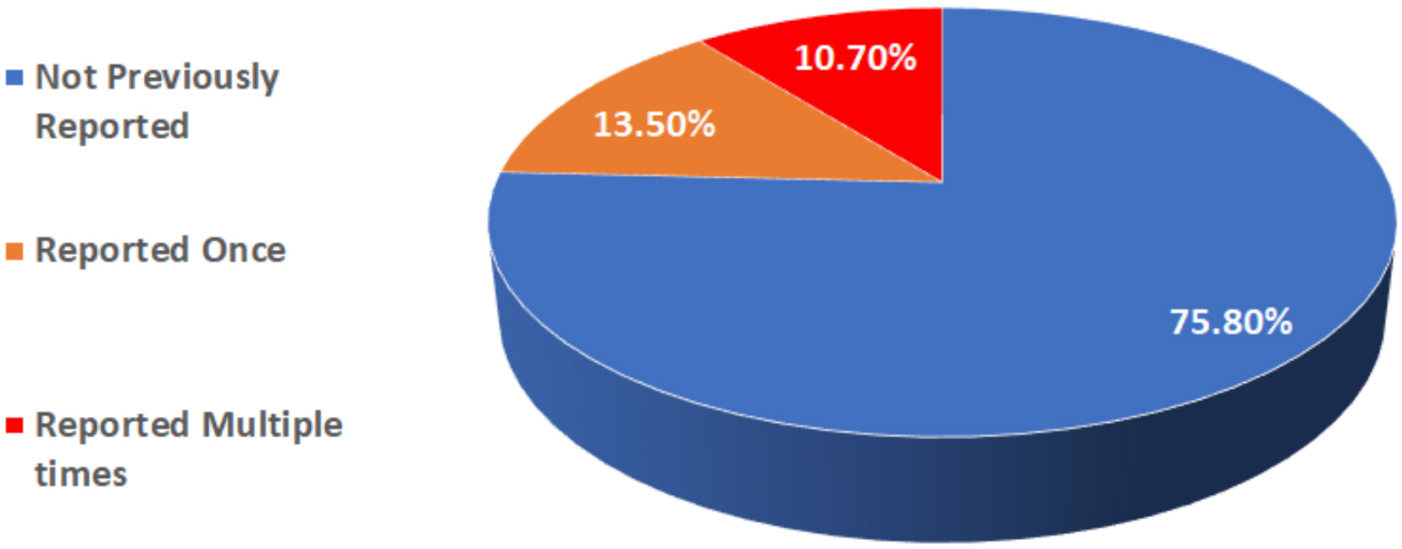

Figure 6: New vs. previously reported parts in 2023.

The data certainly tells a story, Rick.

Counterfeiting is a moving target. You can't predict what will be counterfeited. After you see a counterfeit device, you can look back and see that it makes sense because of the things I've mentioned, such as demand, price, and availability of raw materials. But in 2023, three-quarters of those 700 were reported for the first time as being counterfeit.

Why wouldn't an EMS company connect with ERAI? It sounds like it's self-evident.

A common objection is they say they don't need it because they only buy from franchised distribution, period, end of story. I hear that. You buying from franchise distribution is an ERAI best method. But with my 37 years of experience, I know for a fact that the franchise global supply chain simply cannot meet all the requirements on any given day. That's why the secondary market has grown and prospered for almost a hundred years.

I respect that decision, and ERAI will be here when you do have a problem. I am humbled and happy when somebody comes to me later and says, "Hey, we got stung." There's no shame in that game; let's help you out of this situation. Mind you, you don't have to be a member to participate in those kinds of services.

What sorts of scams and games do you think may be coming up next in the world of counterfeits?

We're seeing more cloned-type products that may pass because they operate correctly during incoming inspection, but may not operate at temperature. So, they must cross-section the part to verify the die inside is what they expected. With all the third-party semiconductor manufacturers, anybody with enough money could go in and say, "Look, here's my drawing. I need you to make me a hundred thousand of these, and then I will send them to a packaging house in Malaysia." That plant will stamp whatever they want on those packages. You don't know what shortage will drive a counterfeit.

Rick, thank you for your time and this important education.

It's been great talking to you, Nolan. **SMT007**

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I-Connect007

GOOD FOR THE INDUSTRY

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X-Rated Files

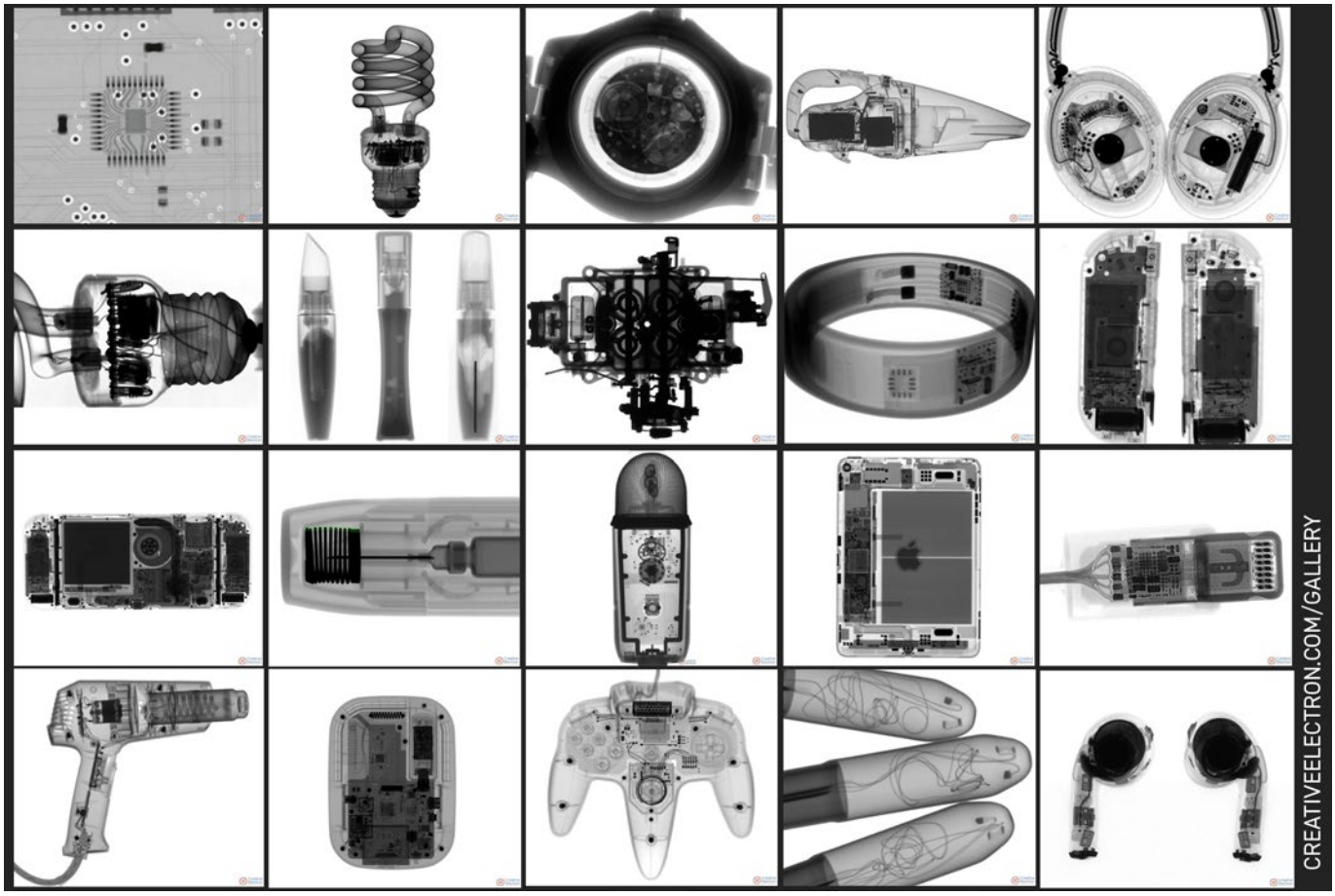
Feature Column by Dr. Bill Cardoso, CREATIVE ELECTRON

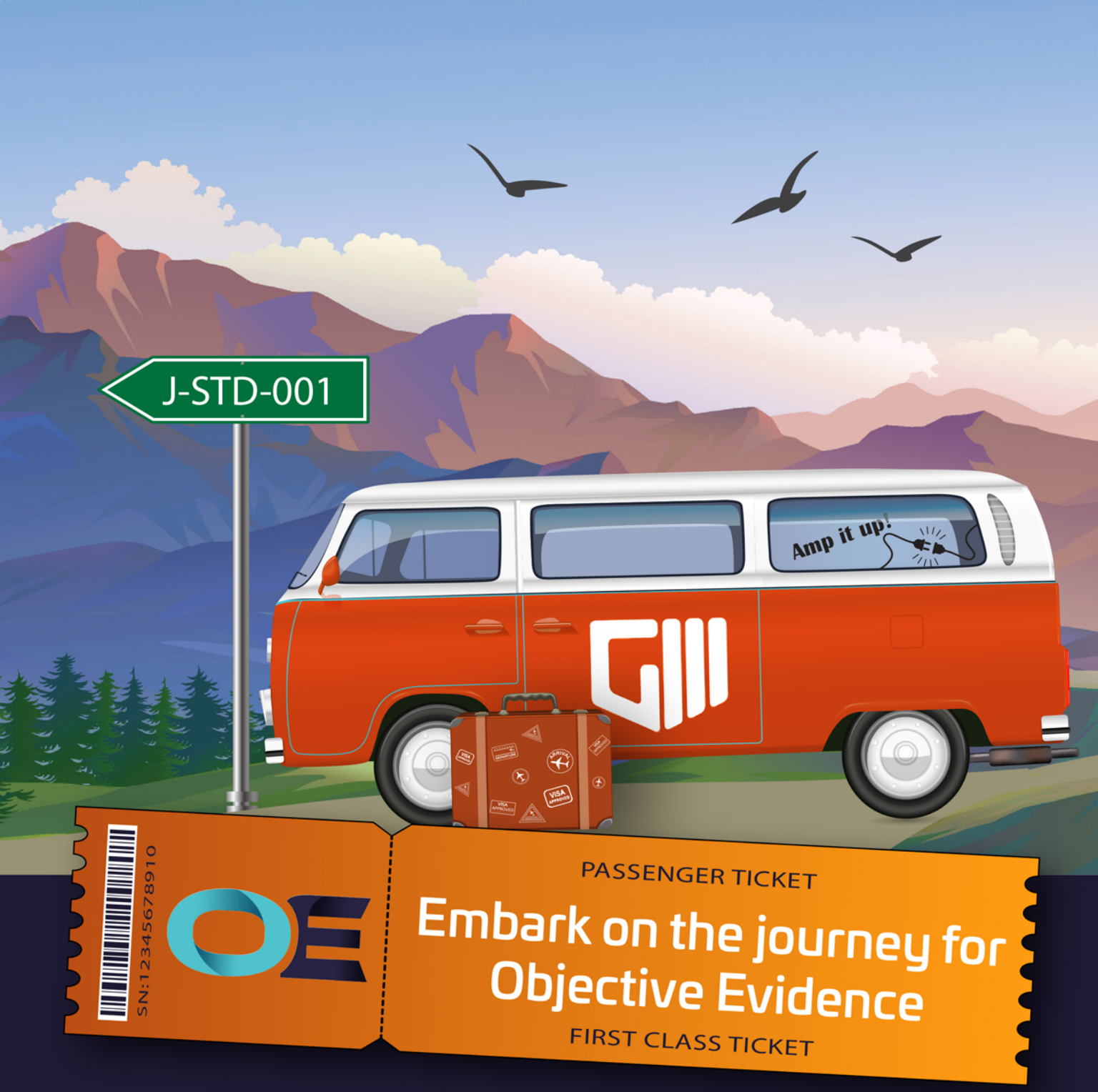
Editor's note: This column was originally published on SMT007.com in April 2022.

It should be clear by now that my enthusiasm for X-ray knows no bounds. From fighting counterfeits, inventory management and solder inspection, to quality control for an endless array of manufactured products, the usefulness of X-ray inspection tools is seemingly limitless. So, forgive me for not setting my bias aside, but when it comes to X-ray imaging, you probably fall into one of the following categories:

- You don't need X-ray and you know it (please, at least read the paragraph that follows)
- You need X-ray but don't know it
- You have X-ray but are underutilizing it
- You are the rarest of birds who has X-ray but just doesn't need it

It's from this admittedly biased vantage point that I have to ask: Why aren't you X-raying your product?





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Some will answer with a definitive "I just don't need to."

Of course, it's true that there are many products for which X-ray inspection can add little value. That said, if you are working on the assumption that your widgets can't benefit from X-ray validation somewhere in the manufacturing process, I hope that you have reached that conclusion because you have imaged those widgets on a contemporary, high-resolution, real-time imaging system. Quite often, we image samples for a prospective client based on a specific need, and find that there is additional, unanticipated information to be gleaned from getting a peek inside their product. True, you may not need X-ray, but as an imaging enthusiast, I'd encourage you to stay curious. Be open to the possibility that there may, in fact, be something you can learn in the process, and at little or no cost. I can't think of a single X-ray system manufacturer who doesn't offer complimentary sample studies.

"Radiation can damage my product."

There are exceptions, of course, (we wouldn't want to X-ray photographic film), but for most things, including micro-electronics, there is virtually no way X-ray is going to alter or harm a product during the imaging process. Yes, there are theoretical situations in which X-ray power and exposure time could do potential harm to sensitive materials, but the parameters that could lead to such an outcome are both predictable and easily avoided. Take micro-electronics, for example. All those chips that make our iPhones, pacemakers, laptops, or glucose monitors tick will receive a far greater dose of radiation exposure on a transcontinental airline flight than in a typical industrial inspection system. Keep in mind that most packages are X-rayed by customs and shipping companies at energy levels far superior to the ones inside imaging X-ray systems.

"They are too complicated to use."

You're not kidding. Some X-ray inspection equipment is excruciatingly difficult to use, and can require extensive training and dedicated staff to truly utilize. If you've had experience on such a system, it could certainly color your view on the usefulness of X-ray equipment, especially in a manufacturing capacity. Fortunately, spurred in part by the move toward Industry 4.0, many X-ray inspection systems are far more user friendly than their predecessors. X-ray machines don't have to be intimidating, and can be remarkably easy to train on and use. With skilled operators in scarce supply, you may even opt for fully automated systems, operating autonomously with the help of artificial intelligence software. Not only do such tools reduce demands on staff, but they can eliminate human error, and provide instantaneous data about your manufacturing process. Yes, X-ray equipment can be complicated, but it doesn't have to be.

"X-rays aren't safe."

The simple fact is that exposure to high levels of radiation can be dangerous. It is also true that radiation exposure is virtually inescapable, as background radiation from cosmic rays, common building materials, even food, surround us 24/7. Early X-ray system were downright dangerous, especially for their operators, but modern X-ray equipment includes highly effective shielding that prevents radiation from escaping their cabinets. How effective? Quite often, an X-ray cabinet will release less radiation than background radiation of the manufacturing environment in which it operates.

"X-ray machines are too big."

Of course, you've seen those X-ray cabinets that are bigger than your entire lab. But just as we no longer have to put up with shoehorning a "brick" of a mobile phone into our jacket pockets, X-ray systems are available in significantly

smaller footprints. And like the modern smart phone, their smaller size doesn't mean downsized capabilities. Even the most space constrained labs can make use of powerful, high-resolution, real-time X-ray inspection tools.

"I can't afford it."

Once again, this may be true, but if it's been a while since you've explored X-ray system cost, hold that thought. I'm not going to suggest that X-ray machines have been subject to Moore's law, but some highly capable systems might surprise you with their relatively short return on investment (ROI). Speaking of ROI, depending on your industry, it may be fair to ask, "Can I afford *not* to have an X-ray system." For high-reliability products such as automotive, aerospace, and medical devices, letting a single defective part reach consumers can be far more costly than the price of incorporating robust inspection into your manufacturing and quality assurance best practices.

I know, the guy who makes X-ray machines says X-ray everything. But just because it is admittedly self-serving, it doesn't mean I'm wrong. Stay curious, set aside what you think you know about X-ray machines, and yes, X-ray everything. **SMT007**

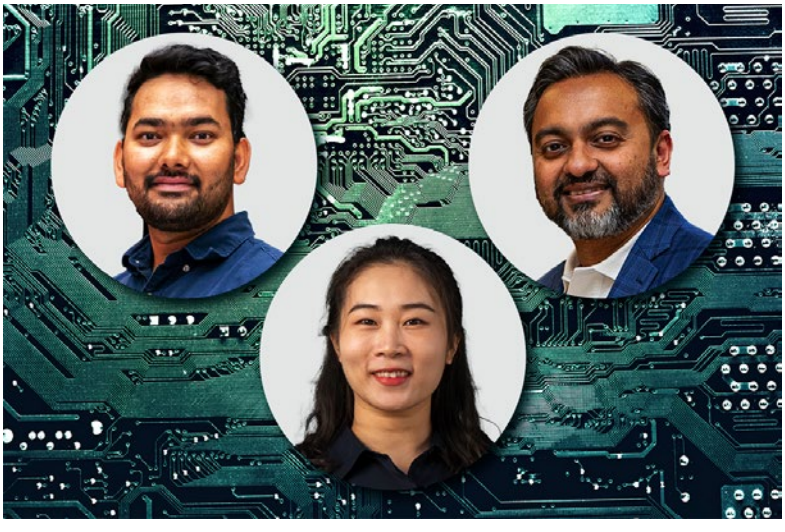
Dr. Bill Cardoso is CEO of Creative Electron.

New Computer Simulations Help Scientists Advance Energy-efficient Microelectronics

Thanks to advances in microchips, today's smartphones are so powerful they would have been considered supercomputers in the early 1990s. But the rising ubiquity of artificial intelligence and the Internet of Things—the vast network of connected devices that have enabled everything from smart grids to smart homes—will require a new generation of microchips that not only outpace previous records of miniaturization and performance but are also more energy efficient than current technologies.

As part of this effort, Berkeley Lab scientists are working to revolutionize the transistor, one of the fundamental components in computer microchips, for superior performance and energy efficiency. Recent work has shown the promise of new transistor materials that use an unusual property called negative capacitance to enable more efficient memory and logic devices. When a material has negative capacitance, it can store a greater amount of electrical charge at lower voltages, which is the opposite of what happens in conventional capacitive materials.

Now, a multidisciplinary team of researchers have developed an atomistic understanding of the origins of negative capacitance, enabling them to enhance and customize this phenomenon for specific device applications. The advance was made possible by FerroX, an open-source, 3D simulation framework that the team custom-designed for the study of negative capacitance. Their work was reported in the journal Advanced Electronic Materials. (Source: Berkeley Lab)



Counterfeit Concerns: Navigating the Risks

Feature Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson met with Diganta Das, PhD, and Michael Azarian, PhD, research scientists at the CALCE Electronic Products and Systems Center at the University of Maryland, to discuss the increasing issue of counterfeiting in the electronics and assembly industry. Diganta and Michael highlight the need for robust detection methods and standards to mitigate risks, specifically referencing SAE AS6171 for inspection and AS5553 for counterfeit mitigation. They cover real-world cases, like counterfeit network equipment scandals to relatively simple issues of consumer electronics accessories to illustrate the complexity of the issue and debate the philosophical implications of labeling products that contain a few minor counterfeit components as "counterfeit."

To address the problem, they suggest that standards organizations like SAE and IPC could play a crucial role. The conversation

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Diganta Das

closes with a call to action for EMS companies to actively participate in creating, shaping, and adhering to these standards to protect themselves and their customers.

Nolan Johnson: Counterfeiting of subassemblies seems to be something we didn't need to think about previously. What do you see?

Diganta Das: Counterfeiters are getting much more confident about putting together a whole infrastructure, not just for an individual consumer but even commercial B2B purchasers and others. One relatively recent case involved a company and its owner found guilty and sentenced for criminal acts in the state of New Jersey. In this case, the owner put together a system infrastructure of gathering and refurbishing old network control equipment, adding software that would beat the detection software, packaging it in authentic-looking boxes, and selling them as new. Government, hospitals, schools, and small businesses were among his customers. He had offices, eBay and Amazon storefronts, and appeared to be an entrepreneur of the highest level. After what was a decade-long investigation, the Department of Justice raided his offices, and his prosecution led to a guilty plea and prison sentence.

It's an example of the sophisticated strategies used by counterfeiters in other aspects of the supply chain, not just counterfeiting itself. The fraud includes putting up a "storefront" and a respectable appearance that will attract serious buyers.

In this particular example, we're talking about a situation where an EMS company doing assembly for an OEM may find themselves accused of counterfeiting or making an inferior product that they never put together.

Das: That's it exactly, and it's interesting to hear you state that risk; it often does not come to our mind like that. An almost philosophical debate that occurred as we started this (and isn't fully resolved) is when you find a circuit card (board) that an OEM verifiably makes, and yet a couple of capacitors and a resistor turn out to be counterfeit. Does that little sprinkling of parts make the entire circuit card a counterfeit? One can argue that it does. Incoming inspectors approved this product, which went through their manufacturing process. The board might even work. Surely, this can be seen as a mistake; we may not need to call the whole board counterfeit.

I am sure that is a passionate debate. One counterfeit part puts everything in jeopardy, and the potential liability for most companies is too great, but I guess it also depends on your end market.

Das: Yes, and I have heard that counterargument. If even one grain is bad, it makes it all bad. Therefore, the whole product is considered counterfeit if any component is counterfeit. The EMS company may have installed something as part of another system and passed it all through. They are now on the hook for liability.

Michael Azarian: A lot of literature and some base standards address the parts issue. Things get more complicated when we consider assemblies, for example—when we don't have

a taxonomy or a language to describe those complexities properly. For instance, if your car has tires that happen to be counterfeit, is your whole car counterfeit? If you add an aftermarket part to a product, we don't necessarily think of that as a counterfeit system. There are many entities in the assembly supply chain, and we need a way to categorize how we think about and deal with these kinds of problems from the standpoint of the whole assembly. Is there something in the assembly that someone inserted which potentially compromises reliability or security? Could it simply be a fraudulent grab to make money off somebody else's name? Is it 95% or more authentic, but does it have something about it that is different from its intended design? Assemblies come in many sizes, shapes, and varieties and for different end markets.

Das: Selling new multi-chip modules (MCMs) in an old format has been around for a while. For example, these may be power supplies in a molded plastic part. They look like a single part, but internally, there are coils and connections. It's a miniature assembly. Just because something looks like a single part, if it is internally made up of individual components, we generally consider that to be an assembly.

Your earlier example clearly involved someone who was a bad actor; he was acting with premeditated intent to counterfeit, as opposed to every effort to use genuine components. There's accidental vs. intentional, for sure, and it's more complex since there's a hierarchy to it. Where does the EMS provider fall in all of this?

Das: We have standards for the OEMs, such as AS5553. Those are primarily for OEMs and prime contractors, mainly in the military aerospace area. We have created a standard for authorized component distributors. Sometimes, within that distribution frame, they apply this standard to other things they sell.

There are standards for independent distributors, of course, and we are fortunate to have many participate in creating the standard. Mike leads the group for the laboratory detection techniques, which is AS6171.

Michael Azarian

For all of them, we have subject matter experts from the EMS industry joining occasionally. EMS is, of course, a broad category ranging from mom-and-pop shops to multi-billion-dollar companies, but I have not seen a standard specifically designed for EMS yet. As an observer, I know that some of the first policies regarding the counterfeit detection process came from the EMS industry. Lately, I've not seen as much involvement from that sector.

How should those standards be formed, administered, and regulated?

Das: Within the United States, the aerospace group at SAE International has taken the lead in creating all sorts of related standards. Earlier on, other groups worked on it, including SEMI and the old GEIA (Government Electronics and Information Technology Association). However, the full support of the EMS industry is needed to make it happen.

Azarian: It could also happen at IPC because that's where the EMS industry looks for stan-

dards and guidance, but IPC has not really tackled this issue head-on. They have done some good work in certain areas, such as tracking, that are peripheral to this subject. However, SAE has the history, infrastructure, and subject matter experts within its sphere of activity. They would be a good place to tackle this, but nothing has been started yet.

Das: In Europe and globally, IEC has done something, but lately, they've been citing SAE standards. SMTA has never been in the business of picking standards. SMTA has been a big booster for IPC, and has always provided a platform, although that has frayed a bit. They are another place that is a little bit smaller than IPC and may be able to get this done.

What can the EMS houses do to protect themselves and move this effort forward? What's the call to action?

Azarian: We're just scratching the surface here. Diganta's example of that outfit that put these network units together is interesting from the perspective of enforcement because the OEMs of equipment and assemblies are almost exclusively using trademark enforcement in this space. Cisco, for example, is one of the few companies doing anything to protect its trademark.

In the parts space, the original component manufacturers (OCMs) don't pursue counterfeiters. There are virtually no legal cases where they've gone after counterfeiters. Intel will go after companies using the Pentium logo, but in terms of counterfeiting, there isn't anything meaningful going on.

In some ways, the folks in the assembly space are operating in a dangerous sphere when it comes to legal liability. It is so hard to enforce laws when the offender may be in a different country. That's where having standards is essential so that the organizations themselves know how to identify and control that risk. When you look at all the different things that are required to secure the supply chain, one of the issues is accountability. That's not something we see on the parts side of things, but we do see that on the assembly side.

> "There are virtually no legal cases where they've gone after counterfeiters."

Is it accurate to say that EMS companies have limited control over what comes into and out of their facilities and that they don't have a lot of control over what might happen to that product once they've shipped it from their dock?

Das: I would say, of course, component-wise, their supply chain has well-established standards and laboratory methodologies. Even a database of images from an organization like Cybord, if they are willing to work with them on what can be detected, would be helpful. I think they should make that a requirement in their facilities because such organizations have the same level of inspection and risk mitigation requirements as the prime contractors. It may sound like that's a lot of responsibility, but most of the midsized EMS companies are actually in a better position than some of the prime contractors. That's because, in most cases, they have a lab where they're putting together the whole bill of materials.

I would recommend invoking AS6171 as a requirement for inspection. Now, if somebody

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looks at it for the first time, they will say, "If I adopt this, it will triple my prices." The technique is to invoke it only when you have an issue with the supply chain—when you know you did not buy it from the authorized distributor for whatever reason.

Nowadays, I fully understand that there are conditions where people will need to buy from the "open market." That is when you must decide whether to invoke that inspection regime, the AS6171 risk-based mitigation. We are not telling everybody to use XPS (X-ray Photoelectron Spectroscopy) and increase the lot cost by $5,000 every time. Just because AS6171 is very elaborate, it doesn't mean every test method is needed for every part.

That's a critical point.

Das: The second point is that EMS companies should look for authorized distributors that are AS6496-compliant, the authorized distributor standard. That may sound like overkill; the issue is that an authorized distributor and an original equipment manufacturer may have a contractual agreement, but that does not authorize the distributor for every single product, application, and market.

Intel makes it the clearest on its website. For example, there may be nine companies authorized as Intel distributors in a country. The moment you want to get the Intel network card, it's down to three companies. Change to another item; it's now down to two companies. So, an AS6496-compliant authorized distributor will clearly identify when they are not authorized for a particular product rather than imply that they are authorized for everything.

The purchasing manager in a large EMS house is one of the busiest people I know. They track as many as 50,000 things. When you work with somebody who is AS6496-compliant, you can have confidence that you will not accidentally get hung up with a bad or non-authorized distributor. You cannot rely on relationships when it comes to avoiding counterfeits. This must be a mantra for the purchasing agent: Something is only authorized for that specific transaction, and not in a general sense for every part number at every time period for every customer.

That makes a lot of sense.

Das: We have spent quite a bit of time on packaging inspection. If the Texas Instrument logo on the box is wrong, chances are the stuff inside is no better. The documentation that comes with it also matters. We are working on a documentation standard now and look forward to discussing it with you in more detail once it's been released.

In some ways, the beginning of this "standard documentation industry best practice" means weaving in the appropriate existing methodologies and blending them into your existing business practices. If you look at AS5553, it is the template for an organization's counterfeit mitigation plan. It is where it all started. Internalizing counterfeit detection processes in your organization and conforming to SAE standards are important for EMS suppliers and everyone in the supply chain. It becomes more important every day.

This has been enlightening and interesting. Thank you both for your time. SMT007

Combatting Advanced Techniques in Counterfeiting

Feature Article by Anthony Bryant

In today's interconnected global marketplace, counterfeit electronics pose a significant threat to industries ranging from aerospace and defense to healthcare and telecommunications. As counterfeiters employ increasingly sophisticated techniques, the need for robust strategies to prevent, mitigate, and identify counterfeit components has become critical. This article explores the advanced techniques used in counterfeiting, the potential involvement of state-owned enterprises (SOEs), and comprehensive strategies for combating this pervasive issue.

Advanced Techniques in Counterfeiting

Counterfeiters continually evolve their methods to produce fake electronic components that closely mimic authentic parts. Some of the most advanced techniques include:

- **Re-marking and re-packaging:** Altering legitimate part markings and repackaging components to misrepresent them as new or different parts.
- **Exploiting supply chain vulnerabilities:** Counterfeiters exploit vulnerabilities in the supply chain, introducing fake components that can go undetected until integrated into critical systems.
- **Reverse engineering:** This process involves disassembling genuine products to replicate their design and functionality, creating clones that are difficult to distinguish from the original.

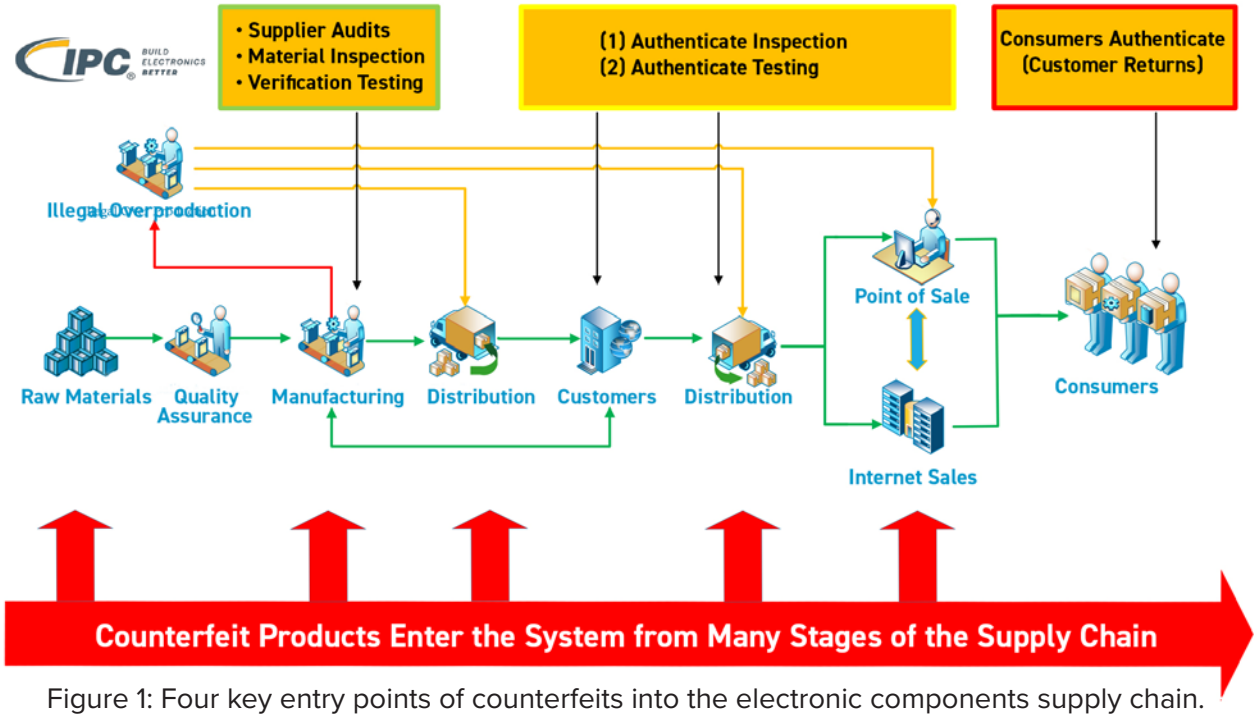

Figure 1: Four key entry points of counterfeits into the electronic components supply chain.

- **Use of cutting-edge technologies:** Counterfeiters leverage advanced technologies like artificial intelligence (AI), 5G, and quantum computing to produce highly accurate replicas that challenge conventional detection methods.

The Role of State-Owned Enterprises

Chinese state-owned enterprises (SOEs) have been implicated in producing cloned counterfeit electronic parts, particularly complex semiconductor chips like fine-pitch grid arrays (FPGAs) and microcontrollers. These components are essential in high-stakes applications, including medical, military, and aerospace systems.

The cloning process often involves reverse engineering authentic products and, in some cases, intellectual property theft. SOEs possess advanced manufacturing technologies that allow them to produce high-quality counterfeit components, making it challenging to distinguish between genuine and cloned parts. The involvement of SOEs is particularly concerning due to their access to advanced manufacturing technologies and potential for large-scale operations.

Examples of Chinese SOEs

- **China Electronics Corporation:** A major player in the electronics sector, involved in the production and distribution of electronic components.
- **China Aerospace Science and Technology Corporation:** Engaged in aerospace and defense, with capabilities that could extend to advanced manufacturing technologies.

Large-scale Counterfeiting Operations

The 2012 Senate Armed Services Committee investigation described seeing whole factories in China with 10,000 to 15,000 people set up for the purpose of counterfeiting. Furthermore, it is well known that clones of complex FPGAs currently exist and are manufactured by Chinese state-owned companies. This suggests industrial-scale operations that could potentially involve China SOEs, raising significant concerns about the quality and reliability of electronic components in critical systems.

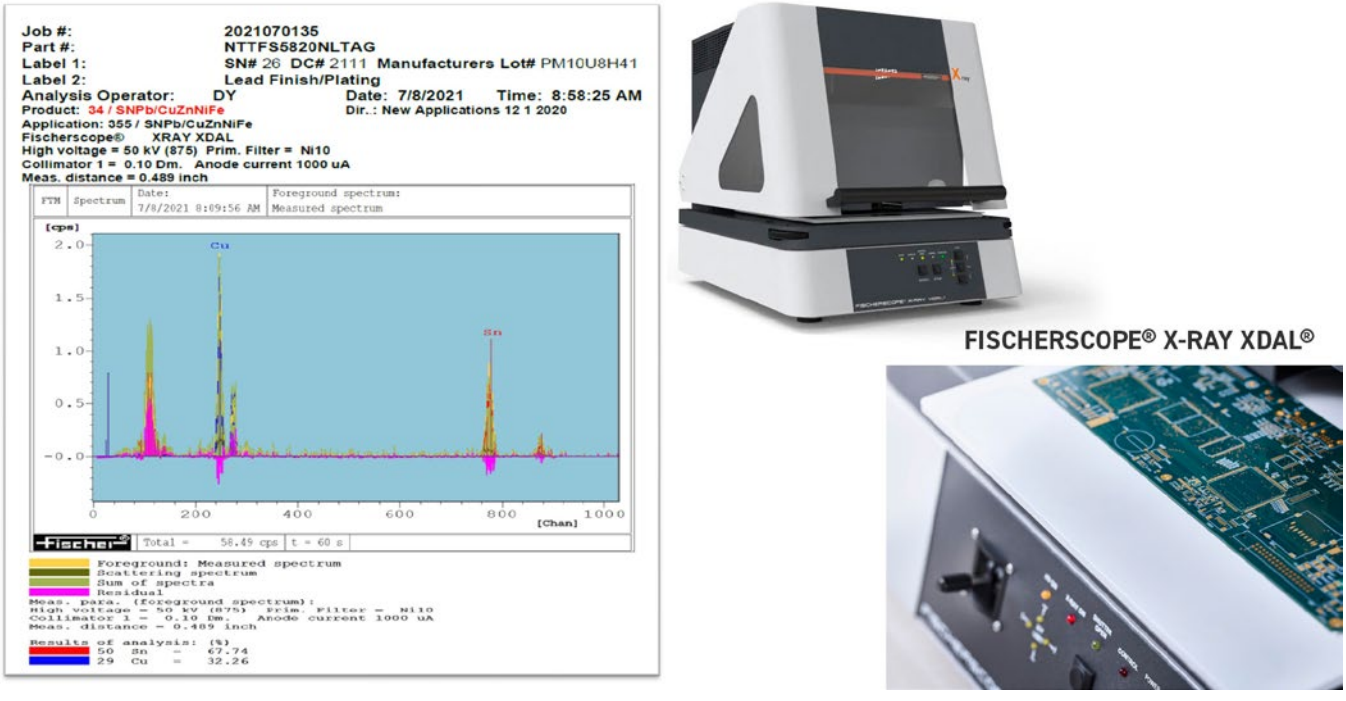

Figure 2: X-ray fluorescence illustration.

Prevention

- **Supplier verification:** Conduct thorough background checks on suppliers, verifying certifications and conducting audits.
- **Implementation of standards:** Adopt industry standards such as SAE AS5553 and AS6171 for guidelines on detecting and preventing counterfeit parts.
- **Anti-counterfeit technologies:** Employ digital watermarking, holographic labels, blockchain, and RFID tags to enhance product authentication and traceability.

Mitigation

- **Risk-based approach:** Implement a risk-based approach to identify and prioritize high-risk components and suppliers.
- **Quarantine procedures:** Immediately quarantine suspect components upon detection, marking them as nonconforming.
- **Supplier notification:** Promptly inform suppliers and procurement representatives of any suspect parts.

Identification (Detection Methods)

- **Certificate of compliance:** Verify the authenticity of certificates and documents provided with components.
- **Visual inspection:** Examine components and packaging for signs of counterfeiting, such as incorrect logos, misspellings, and improper date codes.
- **X-ray fluorescence (XRF):** Non-destructive technique for testing elemental composition of electronic components.
- **Advanced testing methods:** Utilize X-ray inspection, C-Mode scanning acoustic microscopy (CSAM), and decapsulation to analyze internal structures and materials.
- **Advanced spectroscopy techniques:** These are particularly effective for detecting sophisticated counterfeits, such as those that could be produced by SOEs.
- **Destructive physical analysis (DPA):** Disassemble, test, and inspect components to verify design, materials, construction, and workmanship.
- **Scanning electron microscopy (SEM):** Produce high-resolution images of a sample's surface, revealing detailed topographic features, and when combined with Energy Dispersive Spectroscopy (EDS), SEMs can provide qualitative and quantitative elemental analysis of the test samples.
- **Functional testing:** Perform functional testing to verify that components meet performance specifications. This can help identify counterfeits that mimic functionality but fail under specific conditions.
- **Quality conformance inspection (QCI):** This more comprehensive testing includes complete electrical tests over temperatures, post-burn-in full electrical tests over temperatures, and lot acceptance testing.
- **Fourier Transform Infrared Spectroscopy (FTIR):** FTIR is used to identify the chemical structure of a device's materials. By comparing the infrared spectrum of a suspect component to known good data, FTIR can reveal discrepancies in encapsulate materials or coatings, helping to identify cloned or counterfeit parts.
- **Cybord AI:** Cybord AI is a cutting-edge solution designed to combat counterfeit electronic components. This technology leverages advanced AI algorithms to analyze electronic components in real-time during the assembly process, offering a more efficient and cost-effective alternative to traditional lab testing. Cybord AI goes beyond mere detection; it also provides manufacturers with a verifiable record of meticulous component checks. This capability can potentially save companies from the crippling costs associated with product recalls in cases of field failures.

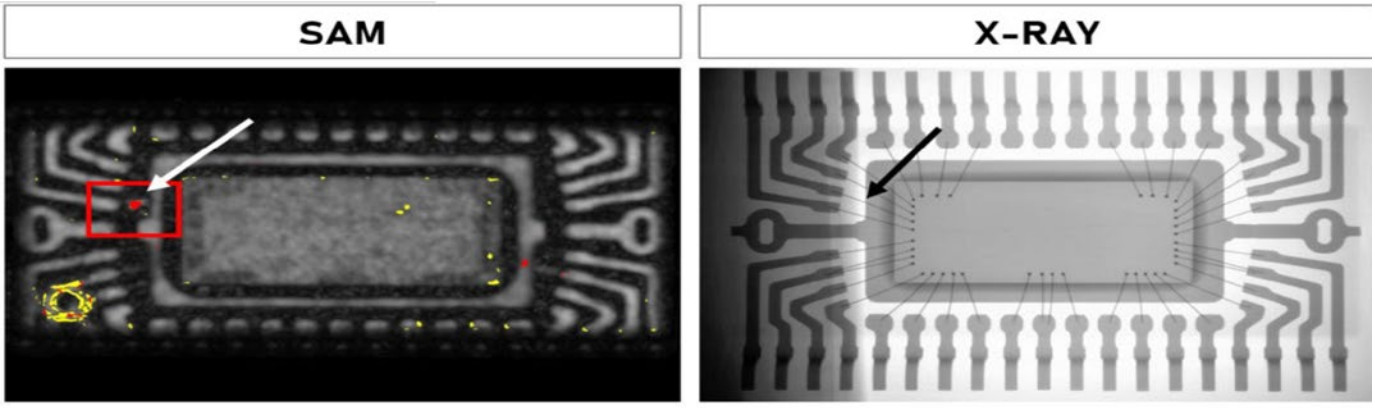

Figure 3: Example of counterfeit under X-ray.

The combination of these techniques provides a multi-layered approach to counterfeit detection, making it increasingly difficult for counterfeiters to evade detection.

By incorporating these advanced detection methods, particularly the advanced spectroscopy techniques, organizations can significantly enhance their ability to detect even the most sophisticated counterfeit components, including those produced by SOEs.

Quarantine and Disposal Procedures

Proper handling of identified counterfeit components is crucial to prevent their re-entry into the supply chain:

- **Quarantine:** Once identified, counterfeit components should be immediately quarantined in a secure location. This involves segregating them from genuine inventory and marking them clearly to prevent accidental use.
- **Documentation and reporting:** Maintain detailed records of all quarantined components, including their origin, identification numbers, and reasons for suspicion. Report these findings to relevant authorities and industry bodies such as ERAI and/or the Government-Industry Data Exchange Program (GIDEP) to prevent further distribution.
- **Secure disposal:** Ensure that counterfeit components are disposed of securely to prevent them from re-entering the supply chain. This may involve working with certified disposal companies that follow strict protocols for destroying electronic components.
- **Awareness of disposal risks:** Educate staff about the risks associated with disposal companies that may resell e-waste components instead of destroying them.

Environmental and Safety Considerations

- **Environmentally friendly disposal:** Consider recycling for raw materials or incineration in controlled facilities to minimize environmental impact.
- **Regulatory compliance:** Ensure compliance with environmental regulations and standards for the disposal of counterfeit goods. This includes adhering to international agreements like the Basel Convention, which governs the transboundary movement of hazardous waste.

E-Waste Statistics and Challenges

The global e-waste problem compounds the challenges of counterfeit component disposal:

- An estimated 62 million metric tons of electronic waste was generated worldwide in 2022
- Only 22.3% (14 million metric tons) was documented as formally collected and recycled

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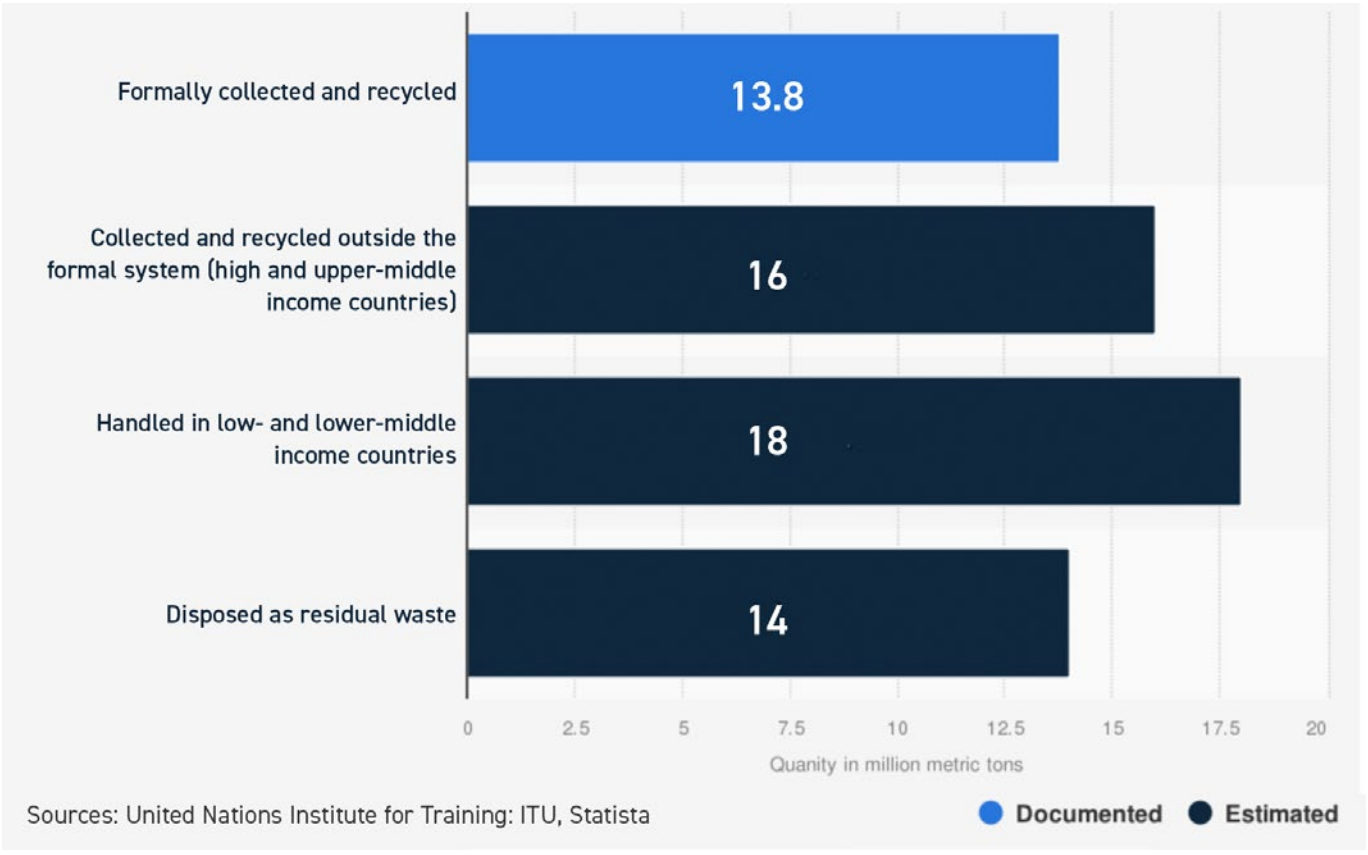

Figure 4: Management of electronic waste worldwide in 2022, by method (in million metric tons).

- Approximately 18 million metric tons of e-waste was handled in low and lower middle-income countries with limited management infrastructure
- An estimated 14 million metric tons of e-waste was disposed of as residual waste, likely ending up in landfills
- 50–80% of e-waste collected "for recycling" is exported to developing countries, with China being the largest recipient

Organizations should implement risk mitigation checks and balances to ensure that e-waste disposal processes are documented and followed meticulously.

Education and Training

To combat the growing threat of counterfeit electronics, organizations must invest in comprehensive education and training programs. The IPC course "Counterfeit Electronic Parts Mitigation for High Reliability Organizations" is an example of such a program, covering key areas such as:

- Applying industry standards
- Utilizing advanced testing methods
- Mastering supplier verification techniques
- Identifying and understanding advanced counterfeiting techniques
- Gaining insight into the role of SOEs in producing cloned counterfeit parts
- Developing effective detection, reporting, quarantine, and disposal procedures
- Implementing robust processes for preventing, mitigating, and identifying counterfeit electronic components

Conclusion

The potential involvement of Chinese SOEs in the production of cloned counterfeit electronic parts presents a significant challenge to global supply chains. These components pose risks to security, reliability, and economic sta-

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bility, necessitating robust detection and mitigation strategies. As the threat of counterfeit electronics continues to evolve, it is crucial for organizations to stay informed about the latest techniques and implement comprehensive strategies to protect their supply chains and ensure the integrity of their products.

By adopting a multi-layered approach that combines advanced detection methods, stringent supplier verification, and proper disposal procedures, organizations can significantly enhance their ability to combat even the most sophisticated counterfeit components. Continuous education, vigilance, and collaboration across industries and governments will be key to staying ahead of this persistent and evolving threat. **SMT007**

Anthony (Tony) Bryant is a trained expert in component counterfeiting techniques who has been collaborating with IPC on a new intermediate-level course on counterfeits.

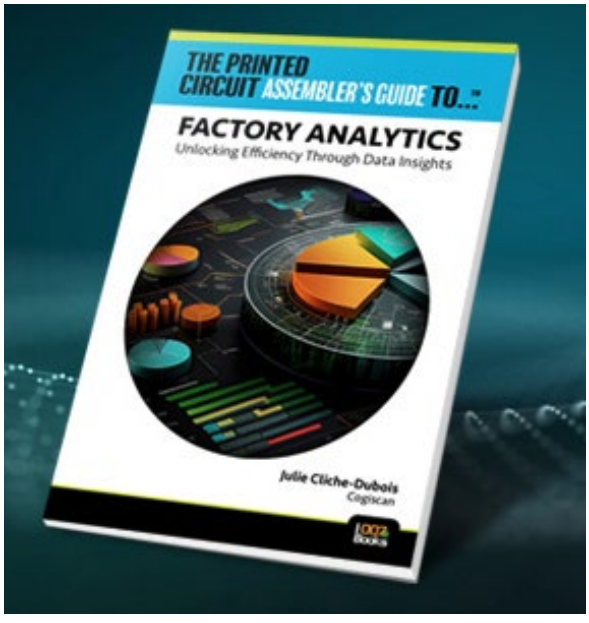
BOOK EXCERPT:

The Printed Circuit Assembler's Guide to... Factory Analytics, Chapter 6

by Julie Cliche-Dubois, Cogiscan

Chapter 6: Driving Meaningful Action

Normalizing and labeling shop-floor data is mandatory to feed an analytics tool with sensical information. Equally as important is the underlying infrastructure of the analytics tool; it should have a domain specific engine that interprets and manages the complexities of PCBA manufacturing. Without this data contextualization, the analytics tool can easily display inaccurate KPIs. Just consider how many configurations exist in PCBA manufacturing—from dual-lane or single-lane assembly or the configuration of panels in one-up or multi array, all these things need to be understood by the analytics system to perform any relevant calculations. Without this contextualization you won't have precision. Sure, you'll still get KPIs, but they likely won't be accurate.



For example, say there's a high defect rate at AOI that requires rework. When those PCBAs go through the AOI a second time to verify the work performed, if the analytics tool doesn't "know" that those units are re-runs, it will falsely inflate the total job quantity—and all the KPIs that use job quantity (of which there are many) will be inaccurate. The analytics tool must have a way to "read" the identity of those PCBAs and properly classify them as re-runs to ensure accurate KPI calculations.

Regardless of the analytics dashboard, such as commercial solutions like Qlik, Tableau, or Microsoft BI, all these systems do an incredible job displaying information clearly. What is typically missing underneath these visualization platforms is the domain specific engine to calculate KPIs correctly with contextualized data. Visualizing data is quite simple, it's getting the data normalized and calculated properly beforehand that's the tricky part.

Powered with a clearer understanding of factory performance, efficiency, and quality, it's crystal clear that manufacturers using factory analytics are armed with appropriate data insights to drive action to improve their manufacturing operation holistically.

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UNTAPPED POTENTIAL: Automating Warehouse Management Into the Present

Article by Josh Casper
HORIZON SALES

The push toward automation in electronics manufacturing has led to significant improvements in SMT and through-hole technology (THT) production. Today's manufacturers are outfitted with precision pick-and-place machines, sophisticated inspection systems, and advanced solder deposition solutions. These investments reflect a broader industry trend toward automating high-value production tasks to boost efficiency, improve quality, and reduce headcount in a shrinking labor market. While the spotlight has rightly focused on automating SMT production, one crucial area remains woefully under-invested: materials storage and handling.

This oversight is particularly concerning given the critical role that materials management plays in the overall manufacturing process. Materials—such as SMT/THT components, bare boards, and solder paste—are the lifeblood of production. How they are stored, tracked, and deployed directly impacts the effectiveness of the entire operation. Here, we'll explore the impact of material handling

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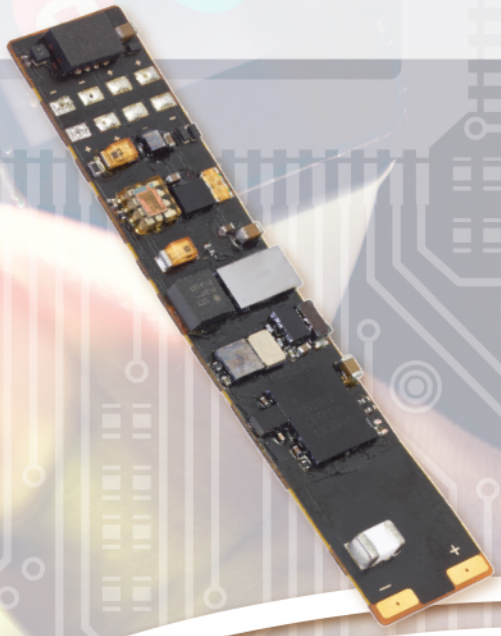

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and how automating this area can significantly enhance productivity, reduce costs, and ensure quality in electronics manufacturing.

The Impact of Manual Materials Handling

Manual materials handling remains a significant bottleneck in many electronics manufacturing facilities. In traditional setups, components are stored on shelves or in bins, with warehouse employees responsible for manually retrieving and deploying them to the production line. This manual process leads to myriad issues.

First, manual component kitting is one of the more labor-intensive areas of the facility. Operators are tasked with manually moving from location to location and retrieving one part at a time. For argument's sake, if an operator can pick a single part every minute (and that's being very aggressive), a smaller 60-piece kit would take at least an hour to pick. Now, multiply that across all the jobs and a manufacturer could be pulling in a single eight-hour shift. How many employees are dedicated to just pulling and returning materials? The time spent locating and moving materials slows down the production process, significantly negating the benefits of advanced automation on the SMT line.

Another common issue in manual picking is component misplacement. When reels are stored on shelves and tied to a manual location, it is entirely dependent upon the operator to ensure they're not only pulling the correct part, but also returning it to the correct location. It's human nature to make these mistakes, but they can easily compound, leading to line stoppages due to a single missing component. Worse yet, having the automated placement equipment placing the wrong component on multiple PCBs creates re-work havoc because it was incorrectly put in a kit by the manual picking operation.

Manual handling often leads to inventory inaccuracies as well. Without real-time tracking and automated management, it's easy for inventory levels to become misaligned with actual stock. This can result in overstocking, which ties up valuable space and capital, or stock outages, which can halt production and lead to costly emergency ordering. Component visibility is critical, especially in a world where component availability leaves much to be desired.

> "Manual materials handling remains a significant bottleneck in many electronics manufacturing facilities."

The Case for Materials Automation

Investing in automated materials storage systems can address glaring inefficiencies and transform the materials handling process. There are several storage systems on the market that cater to electronics manufacturing, however, they can be grouped into three main technologies: Pick-to-light racks, vertical carousels, and fully automated storage towers. Each offers different levels of automation and intelligence. Rather than spending the remaining balance of the article highlighting the differences between these systems, I

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> "There are several storage systems on the market that cater to electronics manufacturing..."

instead would like to focus on the commonality between these technologies and how overall automation offers compelling advantages to the traditional manual process.

1. Enhanced efficiency

Automated storage systems streamline the retrieval of components by either identifying exact component locations via visual cues (pick to light), or delivering exactly what is needed for the kit automatically utilizing robotics (automated storage towers). Both methodologies drastically reduce the time spent identifying and picking components. In many instances, picking a kit can go from multiple hours to just minutes. This immediately reduces headcount in the materials area, allowing manufacturers to re-allocate this essential labor to a higher skill area. Keep in mind, this level of automation not only augments the picking process, but also the re-stocking process of partially exhausted components.

2. Real-time inventory management

Many automated systems have a level of intelligence built in, allowing for integration with inventory management software. These systems now can provide real-time visibility into quantity levels, moisture sensitive floor life, and component history for FIFO enforcement. This accuracy helps prevent issues of overstocking and understocking, enabling manufacturers to maintain optimal inventory levels and make informed procurement decisions. In addition, most automated storage systems require the use of a unique identifier (UID), meaning the part is tracked down to the component level and not the batch level. For example, a manufacturer knowing they have 10,000 components on a single reel vs. 10,000 components spread across five reels allows the manufacturer to accurately pre-plan production, especially on jobs that utilize shared part numbers.

3. Improved space utilization

Automated materials storage systems are designed to maximize space efficiency. Many systems store parts dynamically, meaning a component can be stored anywhere the system has space available by tracking its UID. Manual methods utilize a static location dedicated to a part number, whether that part is in-stock or being utilized. By utilizing dynamic storage, compact shelving, and vertical space, these systems significantly reduce the footprint required for materials handling. This optimized space usage frees up valuable floor space for other critical manufacturing activities and can significantly reduce operational costs.

4. Scalability and adaptability

As production demands evolve, automated materials storage systems offer a unique level of scalability and flexibility. Inventory is an ever-changing area that is dependent upon the evolving needs of the business. These systems can be easily reconfigured to accommodate changes in component types, production volumes, and product lines. This adaptability ensures that manufacturers can quickly respond to market changes and maintain operational efficiency.

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Overcoming the Hesitation: Investing in the Future

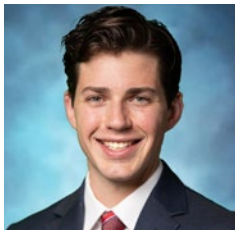
Despite the clear advantages, many manufacturers hesitate to invest in materials automation. This reluctance may stem from concerns about the initial cost, perceived complexity, or a lack of immediate visibility into the benefits. However, these challenges are increasingly surmountable with advancements in technology and a growing body of evidence demonstrating a rapid return on investment.

The initial capital expenditure for automated materials storage systems can be substantial, but it should be viewed as a strategic investment rather than just another expense. The long-term benefits, including reduced labor costs, enhanced efficiency, and improved inventory management, quickly outweigh the initial investment cost. Additionally, advancements in technology have made these systems more accessible, with options available to suit various budgets and facility sizes.

Integrating materials automation with existing production systems offers a complete approach to operational efficiency. By aligning materials handling with automated production processes, manufacturers can achieve seamless integration and maximize the benefits of both areas.

Conclusion

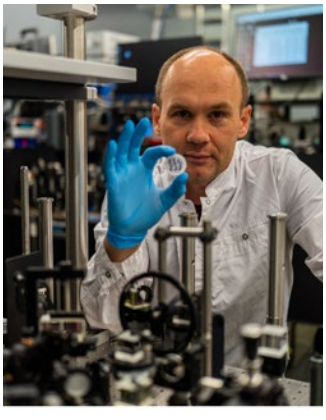
While the automation of production processes in electronics manufacturing has rightfully garnered attention, the automation of materials storage and handling remains an under-explored yet essential investment. Investing in automated materials storage systems enhances efficiency, accuracy, and visibility all while optimizing space and reducing costs. Embracing materials automation is not just a prudent investment but a necessary step toward achieving sustained success in a dynamic industry. **SMT007**



Josh Casper is regional sales manager for the West Region at Horizon Sales.

A Step Closer to Optical Computers: All Optical Universal Gate Developed

A research team from Skoltech and Bergische Universität Wuppertal in Germany has created a universal NOR logical element. It is based on polariton condensates, operates at room temperature, has multiple inputs, can work hundreds of times faster than electronic analogues, and is also completely optical—that is, it works without electric current. Importantly, such logic elements can be reproduced and connected on a circuit, that is, cascaded.



"To create a universal gate, we used the special properties of 'liquid light' capable of amplifying weak optical signals tens of thousands of times. To create such 'liquid light', we need to condense the polaritons into the ground state. If we draw a parallel, it resembles water vapor in the air, that turns into the water droplets on a cold window. We went further and learned how to condense polaritons not only into the ground state, but also into a non-ground state at higher energy. This effect has allowed for solving the long-standing problem of all-optical, logical elements which consists in disabling the optical signal with the help of light, switching a logical unit to zero," stated Denis Sannikov, the deputy head of the Hybrid Photonics Laboratory at Skoltech Photonics.

(Source: Skoltech)

Low-temperature solder's past, present, and future.

Look Inside

I·007e Books

MilAero007 Highlights

Danish Instrument Helps NASA's Juno Spacecraft See Radiation ▸

Scientists with NASA's Juno mission have developed the first complete 3D radiation map of the Jupiter system. Along with characterizing the intensity of the high-energy particles near the orbit of the icy moon Europa, the map shows how the radiation environment is sculpted by the smaller moons orbiting near Jupiter's rings.

Sandia Science & Technology Park Injecting Billions Into State Economy ▸

A study by the Mid-Region Council of Governments shows that over 25 years, businesses located within the technology park paid out $7.7 billion in wages. The park generated more than 6,500 jobs and nearly $4.4 billion in taxable consumer spending as a result of those jobs.

Airbus Ships the Third European Service Module to Cape Canaveral on Behalf of ESA ▸

Orion's third European Service Module (ESM-3) is leaving Airbus' facilities in Bremen, Germany, and heading to NASA's Kennedy Space Center in Florida, USA, where it will be assembled and tested with the Crew Module.

Intuitive Machines Strengthens Lunar Service Capabilities with $116.9 million NASA Lunar Contract Award ▸

NASA has awarded Intuitive Machines, Inc. a $116.9 million contract to deliver six science and technology payloads, including one European Space Agency-led drill suite to the Moon's South Pole.

Saab Secures New Order for Carl-Gustaf Systems from U.S. Air Force ▸

This order is a first for the U.S. Air Force, joining U.S. Army, U.S. Marine Corps, and U.S. Special Operations Command (SOCOM) as U.S. customers. The order will allow the U.S. Air Force to equip soldiers with a proven solution to effectively deal with multiple challenges on the modern battlefield.

Northrop Grumman Selected by US Army to Enhance Aircraft Survivability ▸

ATHENA (Advanced Tactical Hostile Engagement Awareness) is a next-generation missile warning sensor providing always-on, 360-degree situational awareness—elevating aircraft protection and survivability.

NASA, GE Aerospace Advancing Hybrid-Electric Airliners with HyTEC ▸

NASA is working in tandem with industry partner GE Aerospace on designing and building a hybrid-electric jetliner engine, one that burns much less fuel by including new components to help electrically power the engine.

The Government Circuit: News on Defense Electronics, Europe, and Sustainability ▸

This month, there will be a flurry of efforts in Congress by legislators to complete action on "must-do" legislation, especially spending plans for FY25, which begins Oct. 1. We're also continuing to advocate for our industry in Europe, and we're watching several ongoing policy concerns related to environmental regulation and sustainability policy.

DESIGN TIPS #124:

ETCH COMPENSATION

What is minimum space and trace? The answer depends on the starting copper weight.

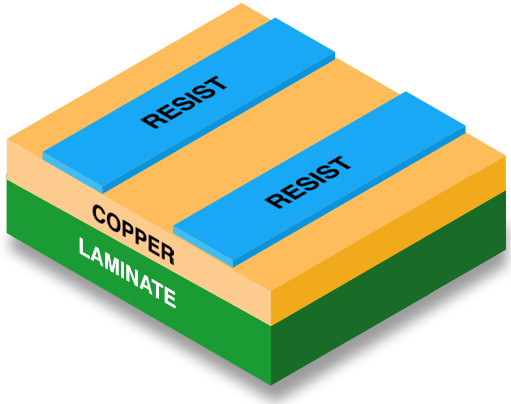
This is because we must do an etch comp on the traces in CAM to compensate for known etch loss. The space between traces after compensation will play a role in whether a board can be manufactured.

The lower the spacing width, the higher the cost. Designers don't always account for the proper starting copper weight after edge compensation.

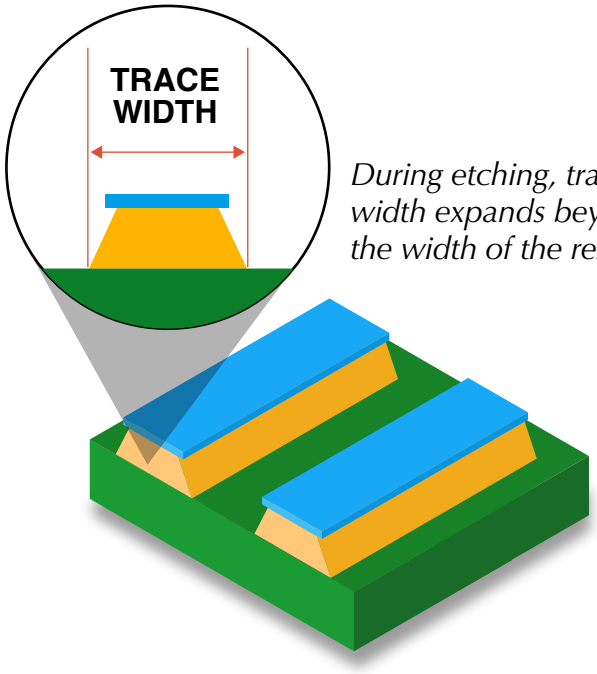
Design tips:

- For accurate starting copper weight, **add a half mil (.0005″) to all copper features**.
- **Start with 3/8 or 1/4 oz. foil**, reducing etch comp and less likely to cause a spacing issue.
- **Boards that call for full body electrolytic gold are not comped** to avoid gold slivers occurring during the etching process.

Before etching



After etching



During etching, trace width expands beyond the width of the resist.

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Comparing and Contrasting the U.S. and China PCB Industries

Global Citizenship

by Tom Yang, CEE PCB

I have spent a lot of time in the U.S., and I am frequently asked about the differences between the Chinese and U.S. PCB industries. It's always an interesting question, and I will try to answer it in this month's column.

Certainly, the U.S. was the leader in PCB manufacturing, including developing the processes and technology, which it taught to the Chinese in the late 1980s and '90s. As a result, China has become a force to be reckoned with in the global PCB market.

Having been educated in America and now leading a major PCB manufacturing company in China, I have a unique vantage point when it comes to comparing the two nations' approaches to PCB production.

Cultural Differences and the Impact on PCB Manufacturing

One of the most significant differences between PCB shops in the U.S. and China is their business culture and operations philosophy. America focuses more on innovation, quality, and technology. American PCB manufacturers tend to prioritize high-tech products for sectors like aerospace, military, medical devices, and high-mix, low-volume production.

In China, PCB manufacturing is characterized by large-scale production capabilities and cost efficiency. Chinese PCB shops are better at producing high volumes of PCBs at lower costs, which has allowed them to corner most of the global market shares, especially in con-

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Next year's IPC APEX EXPO marks our 25th anniversary and promises to be the most transformative yet! AI and other rapidly evolving technologies will challenge how we design and build electronics. With radical change comes new opportunities. Solutions for more power and efficiency, sustainability, supply chain resiliency, and workforce training. **Nowhere else in North America can you engage with the entire global electronics manufacturing industry all in one place.** Open your mind to innovative ideas, diverse perspectives, and new collaborations. **Reimagine the Possibilities at IPC APEX EXPO 2025.**

A special thank you to our sponsors, exhibitors, speakers, and attendees for making our 2024 event a success. See you in Anaheim next March!

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> "In China, PCB manufacturing is characterized by large-scale production capabilities and cost efficiency."

sumer electronics. This Chinese focus on scale and cost-effectiveness is driven by the massive Chinese domestic market and the global demand for affordable consumer electronics.

Technological and Process Differences

U.S. PCB manufacturers often invest heavily in R&D to stay ahead when it comes to technology. This investment has led to the development of advanced PCBs, such as those required for cutting-edge technologies like 5G, pilot driving, and AI computing. American PCB shops are also more likely to adopt stringent environmental and safety standards, which can drive up costs but ensure compliance with international regulations.

In contrast, Chinese PCB manufacturers have focused on refining their production processes to achieve the highest efficiency at the lowest cost. The technological advancements in Chinese PCB shops are more likely to be continuous improvements in reducing waste and improving production speed rather than groundbreaking innovations. However, this does not mean that Chinese PCB manufacturers lag in technology. They have made significant strides in areas such as high layer count (HLC) and high density interconnect (HDI) production, which are essential for modern electronic devices.

Quality Control and Standards

American PCB shops typically follow rigorous quality control processes. Industry certifications support these processes by industry certifications, such as IPC Class 3, which ensures the highest reliability and durability of PCBs.

Chinese PCB manufacturers focus on how to meet the quality levels required for large-scale consumer electronics, where the failure rates can be slightly higher because of the lower costs. This is changing, however, as more Chinese PCB shops seek to enter high-reliability markets. Chinese manufacturers are increasingly adopting international quality standards and certifications, which helps to narrow the quality gap between Chinese and U.S. PCB shops.

Economic and Strategic Considerations

Labor and supply chain costs in China are significantly lower than in the U.S., which gives Chinese PCB shops a competitive edge in terms of pricing. This cost advantage is compounded by the scale of production that Chinese manufacturers can achieve, allowing them to offer lower prices on large orders, which is particularly attractive to global electronics manufacturers.

However, this economic advantage is balanced by strategic considerations in the US, where there is a growing emphasis on reshoring PCB manufacturing because of national security concerns. The U.S. government has recognized the strategic importance of maintaining a strong domestic PCB manufacturing supply chain, particularly considering global supply chain disruptions. This has led to increased investments in the U.S. PCB industry, with a focus on high-tech, secure, and reliable production.

Moving Toward Collaboration

I like the idea of a collaborative approach between U.S. and Chinese PCB manufacturers. I strongly believe that instead of viewing each other as competitors, there should be a focus on partnership and mutual benefit. By combining the U.S.'s innovative capabilities and high standards with China's cost-efficiency and scalability, the global PCB industry can achieve greater heights. This collaboration could lead to the development of new technologies, improved global supply chains, and better products for consumers worldwide.

My vision for the future of the PCB industry is one where differences are not just acknowledged but leveraged for mutual growth. By understanding and addressing the cultural, technological, and economic differences, U.S. and Chinese PCB shops can work together to create a more integrated and resilient global industry.

This perspective is particularly relevant in today's globalized world, where the interconnectedness of industries requires a more cooperative approach to manufacturing. The global PCB industry, with its critical role in the electronics supply chain, stands to benefit significantly from such collaboration. **SMT007**

Tom Yang is CEO of CEE PCB. To read past columns, click here.

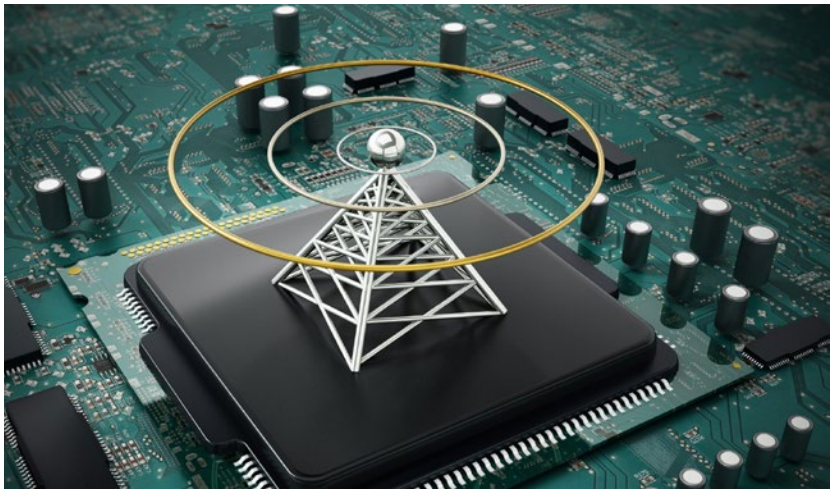
New Battery-free Technology Using Ambient Radiofrequency Signals

In a breakthrough for green energy, researchers demonstrated a novel technique to efficiently convert ambient radiofrequency signals into DC voltage that can power electronic devices and sensors, enabling battery-free operation.

Ubiquitous wireless technologies like Wi-Fi, Bluetooth, and 5G rely on radio frequency (RF) signals to send and receive data. A new prototype of an energy harvesting module—developed by a team led by scientists from the National University of Singapore (NUS)—can now convert ambient or "waste" RF signals into direct current (DC) voltage. This can be used to power small electronic devices without the use of batteries.

RF energy harvesting technologies, such as this, are essential as they reduce battery dependency, extend device lifetimes, minimise environmental impact, and enhance the feasibility of wireless sensor networks and IoT devices in remote areas where frequent battery replacement is impractical. However, RF energy harvesting technologies face challenges due to low ambient RF signal power (typically less than -20 dBm), where current rectifier technology either fails to operate or exhibits a low RF-to-DC conversion efficiency.

To address these challenges, a team of NUS researchers, working in collaboration with scientists from Tohoku University (TU) in Japan and University of Messina (UNIME) in Italy, has developed a compact and sensitive rectifier technology that uses nanoscale spin-rectifiers (SR) to convert ambient wireless radio frequency signals at power less than -20 dBm to a DC voltage. (Source: NUS)



TOP TEN

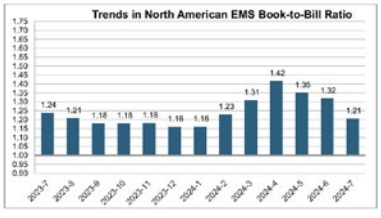
EDITOR'S PICKS

Rehm Thermal Systems Invests in Future Talent with New Training Program

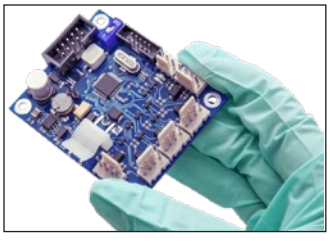
Every autumn, thousands of school leavers in Germany start a dual vocational training programme, laying the foundations for their professional future. In the first week of September, the eight young people, who will learn the professions of industrial clerk, mechatronics technician and warehouse logistics specialist, were warmly welcomed by the team of trainers and the HR department, represented by Natalie Werner.

IPC Releases EMS Industry Results for July 2024

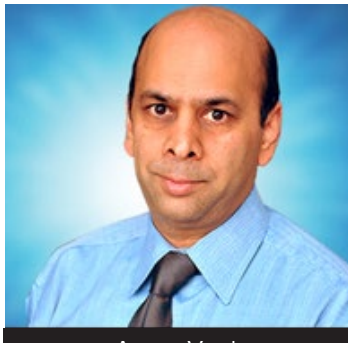
IPC announced the July 2024 findings from its North American Electronics Manufacturing Services (EMS) Statistical Program. The book-to-bill ratio stands at 1.21. Total North American EMS shipments in July 2024 were up 1.9 percent compared to the same month last year. EMS bookings in July increased 0.2 percent year-over-year and increased 0.1 percent from the previous month.



Cybord Raises $8.7 Million Series A to Expand Visual AI Electronic Component Quality and Traceability Solution



Cybord, the visual AI solution ensuring electronic component quality, authenticity, and traceability, has secured $8.7 million in Series A funding. Partnered with leading manufacturers including Flex and Siemens, Cybord is integrated into over 60 manufacturing lines worldwide. Funding will be used to accelerate the company's growth and further global distribution.



Anaya Vardya

Standard of Excellence: The Advantages of Working With Small PCB Businesses

For several large companies, especially those in the mil-aero industries, there are distinct and critical advantages to buying from officially designated small businesses. Yet, some companies have been less focused on these advantages than they used to be, so I thought it would be helpful to remind people of the advantages of working with these small businesses.

Making Waves With Solder Paste Jetting

As electronics shrink and PCB density grows, traditional solder deposition methods such as stencil printing face significant challenges. One solution making substantial waves is solder paste jetting. The development and commercialization of this technology has been around since the early 2000s. So, why now?

Dr. Jennie Hwang to Deliver Course on AI Opportunities, Challenges, Possibilities at SMTAI

As we move into the AI era, new tools and platforms are remaking our workplace including design, research, engineering, manufacturing and. Even for those of us who are not AI technologists, staying in the core knowledge zone is a viable strategy to remain proficient and competitive in the workplace.

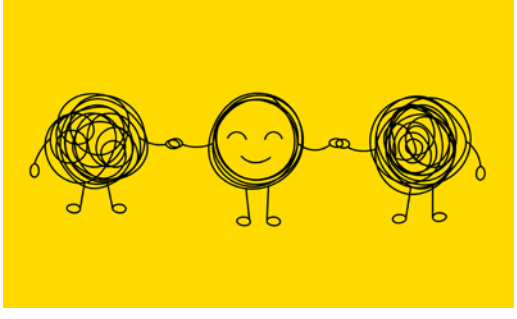
Global Sourcing Spotlight: A World Full of Product Expertise

When it comes to industrial and electronic products, certain regions and countries are renowned for their expertise and manufacturing capabilities in specific areas. I am sure someone could write a book, and perhaps someone already has, about why certain countries excel in producing certain products. The other day, I sat down and put together a list of countries and what they are known for.

Wriggling Out of 'the Squeeze'

At some point in the growth cycle of most businesses, they inevitably face "the squeeze"—when increasing complexity starts to overwhelm the business processes and management systems. The business then gets squeezed by rising overhead costs, falling efficiency, capacity constraints, and cash flow challenges.

Why a Culture of Thriving Matters



On every call with senior leaders, I hear the same thing: Their organizations are facing the cumulative fatigue of constant disruptions. This shift necessitates a transformation in leadership approach that prominently emphasizes empathy.

Celebrating the Vibrant Life of Paul Walker, EMS Visionary and Serial Entrepreneur

Paul was not just a businessman but a visionary who shaped the EMS industry in Toronto through his leadership at SMTC Manufacturing Corporation and Artaflex Corporation.

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We partner with the world's leading brands to bring advanced and innovative products to the market. Our expertise spans every stage of product development—from design to manufacturing and after-market services—and is powered by over 27,000 employees in more than 40 locations in Asia, North America, and Europe. Celestica's revenue is US$7.96 billion (2023), and the company trades on the Toronto and New York Stock Exchanges.

Our business is complex and intellectually stimulating. It's based on imagining and unlocking the potential of the future. And all of us here think that's pretty exciting. From financial rewards to health and wellness benefits and learning and development opportunities, we'll make sure you have what you need to thrive.

Join our team as a Global PCB Commodity Expert and lead strategic initiatives! You'll manage global negotiations, support key supplier relationships, and drive performance improvements. This role involves high-impact decision-making and complex problem-solving. Leverage your expertise in PCB manufacturing processes, auditing capabilities, pricing, and technology trends to shape our commodity strategies. If you are familiar with PCB manufacturing processes and good at negotiation, we want to hear from you! Apply today and make a lasting impact.

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PCB Manufacturing Technician

Join the Team at Accurate Circuit Engineering!

Located in Santa Ana, California, Accurate Circuit Engineering (ACE) delivers high-quality PCB solutions with a focus on innovation and precision.

Role: Accurate Circuit Engineering is looking for detail-oriented PCB Manufacturing Technicians for all areas in PCB manufacturing. Responsibilities include operating manufacturing equipment, performing quality checks, and documenting production data.

Qualifications:

- High school diploma or equivalent; technical training preferred
- Experience in PCB manufacturing or electronics assembly a plus
- Strong attention to detail and ability to follow instructions
- Familiarity with PCB manufacturing and testing tools is advantageous

What ACE Offers:

- Competitive wages and benefits
- Career growth opportunities
- Supportive work environment with comprehensive training

To apply, send your resume and cover letter to sales@ace-pcb.com with the subject "PCB Manufacturing Technician Application."

Accurate Circuit Engineering is an equal-opportunity employer and values diversity in the workplace.

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Career Opportunities

all4-PCB® NORTH AMERICA

Capital Equipment Sales Go-getter

all4-PCB is a well-established distributor that represents a wide range of manufacturing equipment for the printed circuit board manufacturing and chemical milling industries, as well as other high-tech markets.

Looking for a self-driven, dynamic, high energy, results-focused, well-organized sales personality—a closer. Ideal candidate is a fast learner, can retain a lot of information, and understands that selling machines is about selling a process solution to a customer.

A sales-driven personality with a high level of interest in and aptitude for learning about technology can be a star performer. The target market wants consultative selling addressing customer needs.

The sales process includes all means of customer prospecting with up to 50% travel expected. Generating quotations, clarifying commercial and technical details/expectations between customers and the international equipment supply partners, negotiations, sales closing, and the required follow-up work are all part of this role. The sales territory is the U.S. & Canada.

This technical sales representative position can be located in either all4-PCB's Glendale, Calif., office or remotely in an area with a higher concentration of potential accounts.

This role is ideal for applicants interested in a position that provides extensive international exposure, a generous commission system, and freedom to get things done in a small, yet professional, business environment.

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Service Engineer: Chicago

Join the Schmoll America Team as a Service Engineer—Where Innovation Meets Customer Excellence! Are you a technical mastermind with a passion for solving complex problems and delivering exceptional customer experiences? Look no further than Schmoll America!

We're looking for engineers to work in the Chicagoland area.

As a Service Engineer, you'll be the driving force behind our customers' success, providing top-notch technical support and maintenance services for our PCB industry-leading equipment.

What you'll do:

- Install, commission, and maintain Schmoll equipment at customer sites
- Troubleshoot and repair equipment with ease and precision
- Provide technical training and tailored applications solutions to customers

What we offer:

- A dynamic and supportive work environment where your voice matters
- Opportunities for professional growth and development in a cutting-edge industry
- A competitive salary and benefits package
- The satisfaction of knowing you're making a real difference in our customers' lives

What we're looking for:

- Engineering degree preferred
- 3+ years of experience in an engineering role
- Strong technical knowledge of electrical and mechanical systems
- Excellent problem-solving and analytical skills
- Willingness to travel (up to 75%) to customer sites and HQ in Germany

If you're a motivated professional looking for a challenging and rewarding role, we want to hear from you! Please submit your resume and cover letter to HR@SchmollAmerica.com.

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Career Opportunities

The Test Connection, Inc.

Sr. Test Engineer (STE-MD)

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

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

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

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

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The Test Connection, Inc.

Rewarding Careers

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

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

Associate Electronics Technician/ Engineer (ATE-MD)

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

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

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Career Opportunities

Europe Technical Sales Engineer

Taiyo is the world leader in solder mask products and inkjet technology, offering specialty dielectric inks and via filling inks for use with microvia and build-up technologies, as well as thermal-cure and UV-cure solder masks and inkjet and packaging inks.

PRIMARY FUNCTION:

1. To promote, demonstrate, sell, and service Taiyo's products
2. Assist colleagues with quotes for new customers from a technical perspective
3. Serve as primary technical point of contact to customers providing both pre- and post-sales advice
4. Interact regularly with other Taiyo team members, such as: Product design, development, production, purchasing, quality, and senior company managers from Taiyo group of companies

ESSENTIAL DUTIES:

1. Maintain existing business and pursue new business to meet the sales goals
2. Build strong relationships with existing and new customers
3. Troubleshoot customer problems
4. Provide consultative sales solutions to customers technical issues
5. Write monthly reports
6. Conduct technical audits
7. Conduct product evaluations

QUALIFICATIONS / SKILLS:

1. College degree preferred, with solid knowledge of chemistry
2. Five years' technical sales experience, preferably in the PCB industry
3. Computer knowledge
4. Sales skills
5. Good interpersonal relationship skills
6. Bilingual (German/English) preferred

To apply, email: BobW@Taiyo-america.com with a subject line of "Application for Technical Sales Engineer".

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IPC Instructor
Longmont, CO

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

IPC instructors will primarily conduct training at our public training center in Longmont, Colo., or will travel directly to the customer's facility. It is highly preferred that the candidate be willing to travel 25–50% of the time. Several IPC certification courses can be taught remotely and require no travel or in-person training.

Required: A minimum of 5 years' experience in electronics manufacturing and familiarity with IPC standards. Candidate with current IPC CIS or CIT Trainer Specialist certifications are highly preferred.

Salary: Starting at $30 per hour depending on experience

Benefits:

- 401k and 401k matching
- Dental and Vision Insurance
- Employee Assistance Program
- Flexible Spending Account
- Health Insurance
- Health Savings Account
- Life Insurance
- Paid Time Off

Schedule: Monday thru Friday, 8–5

Experience: Electronics Manufacturing: 5+ years (Required)

License/Certification: IPC Certification–Preferred, Not Required

Willingness to travel: 25% (Required)

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Career Opportunities

Prototron Circuits

Sales Representatives

Prototron Circuits, a market-leading, quick-turn PCB manufacturer located in Tucson, AZ, is looking for sales representatives for the Utah/Colorado, and Northern California territories. With 35+ years of experience, our PCB manufacturing capabilities reach far beyond that of your typical fabricator.

Reasons you should work with Prototron:

- Solid reputation for on-time delivery (98+% on-time)
- Capacity for growth
- Excellent quality
- Production quality quick-turn services in as little as 24 hours
- 5-day standard lead time
- RF/microwave and special materials
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- MIL-PRF- 31032
- ITAR
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- Completely customer focused team

Interested? Please contact Russ Adams at (206) 351-0281 or russa@prototron.com.

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

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

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

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

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

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

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Career Opportunities

INSULECTRO

Are You Our Next Superstar?!

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

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

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MivaTek Global

Field Service Technician

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

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

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

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

More About Us

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

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Career Opportunities

eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

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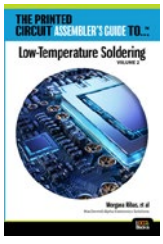
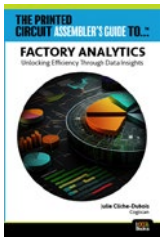


Low Temperature Soldering, Volume 2

by Morgana Ribas, Ph.D., et al., MacDermid Alpha Electronics Solutions

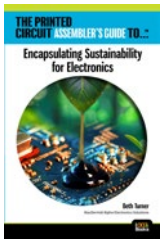
Since the first volume of The Printed Circuit Assembler's Guide to...™ Low-temperature Soldering was published over five years ago, considerable changes have occurred in the low-temperature soldering landscape. Read about innovations and challenges for achieving optimal processing with low-temp solder pastes, as well as what's next in LTS.



Factory Analytics: Unlocking Efficiency Through Data Insights

by Julie Cliche-Dubois, Cogiscan

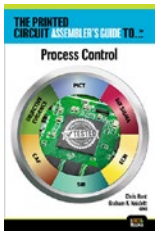
Using and understanding factory analytics is the future for electronics manufacturers. In this fast-changing, deeply competitive, and margin-tight industry, factory analytics can be the key to unlocking untapped improvements to guarantee a thriving business.



Encapsulating Sustainability for Electronics

by Beth Turner, MacDermid Alpha Electronics Solutions

This book discusses the growing demand for sustainable solutions in the market and highlights examples of bio-based resins and the demand from emerging technologies.



Process Control

by Chris Hunt and Graham K. Naisbitt, GEN3

In this book, the authors examine the role of SEC test and how it is used in maintaining process control and support for objective evidence (OE.) Issues, including solution choices, solution sensitivities, and test duration are explored.

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