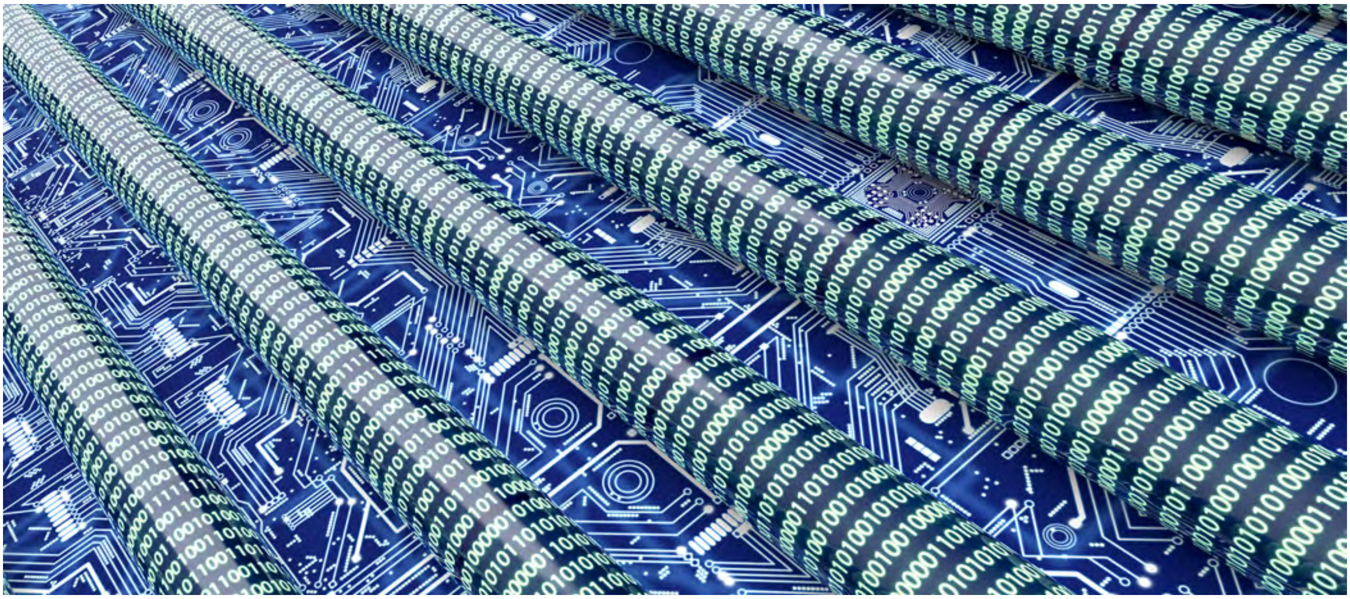

Reflow Your Solder and Your Data for Industry 4.0

A Conversation with Phil Kazmierowicz and MB Allen
KIC

I-Connect007 Managing Editor Nolan Johnson recently spoke with KIC President and Founder Phil Kazmierowicz and Manager of Applications and Sales MB "Marybeth" Allen as they each transitioned into new roles in the KIC leadership team. The conversation ultimately turned to the current dynamics in the industry, particularly Industry 4.0 and streamlining processes.

To kick off the discussion, Johnson posed this question: "Generally speaking, there are two key parts to improving the efficiencies: faster, more accurate throughput, and increased uptime. From your perspective, watching the reflow process, what do you see as the greatest activity in the market for reducing the likelihood of the reflow process becoming the facility's bottleneck?"

Kasmierowicz, Allen, and Johnson then delved into this question throughout a series of conversations and emails, which have been edited into the discussion that follows.

Faster, More Accurate Throughput

On the topic of throughput, Allen wrote, "A key component to an efficient manufacturing operation is optimization throughout the factory. One of the most effective ways to optimize is via software. Trial and error are a thing of the past. Optimization software not only assists with productivity but also defines and improves the process for the highest quality result. The optimization process for reflow starts in the early stages of setting up a product for solder reflow."

Allen continued, "Finding the correct recipe for a reflow oven to produce a PCB within the current, very tight, lead-free process windows could take significant amounts of both resources and time. Our predictive software tools assist a customer to find this recipe very quickly, likely in just two passes, which significantly reduces the amount of time just to set up a profile. In addition, our predictive software can give a customer an in-spec profile without even running a trial PCB. These two functions alone provide solutions for fast profiling for a high-quality product and within the specifications of the factory's requirements, which include faster throughput, lower energy costs, and, of course, difficult and challenging assemblies with a variety of process windows between components and solder paste."

Phil Kazmierowicz explained the details. "Once the specification was defined mathematically, we invented the process window index, or PWI, which represents profile quality with a single number. In this way, oven recipes could be compared, allowing us to develop a software tool that we called Auto-Predict (now known as Navigator). This completely eliminates the guesswork as the software automatically finds an oven recipe that will process the board in spec.

"Our next group of products is used once you're ready to start production," said Kazmierowicz. "How do you know boards or parts were processed correctly? We monitor the temperature and speed along the oven conveyor during production. We can say, 'Based on these inputs, your output is still within the range that is going to work, and your boards are being processed in spec.' Or we can identify problems, such as if zone eight and nine changed significantly. Our setup tools help the customer find the correct oven recipe and our automatic systems continuously monitor production. Simply trusting that no changes to the oven have occurred since you last attached thermocouples to your board or silicon—however long ago—is just not enough. Now, more customers want our monitoring capabilities."

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Less Downtime

Allen summarized downtime as follows. "We all know that one of the worst things to hear in a factory is 'downtime' because this has a direct link to lost money/profits, delay in delivery, unhappy managers, owners, and most importantly, customers. With so much automation, there still tends to be the possibility of downtime in the reflow process. A reflow-related defect found by an AOI machine requires immediate action, for example. One of the investigative steps may be to run a profile to determine if there was any change in the reflow oven to determine if the fault is due to a process change, human intervention, or something else entirely."

"This downtime may be significantly reduced if a reflow process inspection (RPI) system is in use," explained Allen. "This RPI system will continuously monitor the conditions at the product level, provide the customer with data for each reflowed PCB, and notify the customer if a change is taking place and to what degree. If the current conditions are changing to a point where product entering the oven would not be in spec, a notification will take place and be automatically documented, and defective assemblies may be avoided. If there's a defect found at AOI, you can rule out the oven.

Allen further detailed, "Planning for changeover downtime plays a role in optimization. With the knowledge of what products will be run on a given day, shift, oven, and their related profiles, the software can assist with the optimized plan to limit this changeover time in the reflow oven. An example is starting with SnPb assemblies and/or lower temperature profiles and working up to higher temperatures rather than the reverse, which takes time for oven cool down."

Kazmierowicz added a few numbers. "Talking about automatic systems that monitor every board, our last estimate was that 7–8% of all of the ovens out there have one of these systems. There are a lot of upsides." This makes a larger point about Industry 4.0. For facilities with pre-existing equipment, not everything needs to be purchased new. Controller or software updates may, for the right equipment, bring the current machines into the smart factory data exchange conversation. And that is the same value proposition for KIC customers. With facility idle time making up a large percentage of each month's available manufacturing capacity, changeover and recalibration become a critical part of the reflow department's contribution to increased efficiency.

"When the industry switched to forced convection oven technology, it was much better, as long as the oven was set correctly," said Kazmierowicz. "Different boards, more often than not, required different oven recipes, and the setup process was very labor-intensive. The engineer would run a profile, adjust the oven recipe, wait for the oven to stabilize, and then run another profile. Each iteration could take 30 minutes or more. We were the first to invent a system where the computer could model the oven environment, dramatically reducing the number of profiles required to find the correct oven recipe."

That begs the question: How does such a system provide that benefit? In the current Industry 4.0 environment, how does KIC change the 30-minute iteration steps?

"The key benefit to Industry 4.0 or the smart factory is information," said Allen. "Information is imperative to making knowledgeable decisions and most important for learning. From the information operators can correct, change, and optimize processes to achieve the highest quality products at the lowest cost and in the shortest amount of time. When automation is implemented—along with connectivity for usable, accurate data collection—software will provide answers to 'how' and 'why' to make these changes."

"With an RPI system, the process data can be output for each reflowed assembly, even to a specific barcode for traceability," Allen added. "This data is quickly and easily accessible, so a company has the information at their fingertips from anywhere. They can search production runs for quality information, troubleshoot, optimize, and improve processes for better line utilization and productivity."

Using Information as Feedback for Efficiencies

As the conversation moved toward data, it shifted gears into a discussion of current data interchange formats.

Johnson: Aren't CFX, Hermes, Jara, etc., creating an infrastructure for you, so you can take that information and use it somewhere else?


Phil Kazmierowicz

Kazmierowicz: Exactly. And once you have the information and start really studying it and using it, you realize that there is a change. Connecting to various manufacturing execution systems (MES) allows customers to have valuable data, which they may use to improve their processes, improve their quality, and save money. We are actively involved in Industry 4.0 and smart factory solutions for our customers.

Johnson: Because an investment in your product, it could be argued, is about operational efficiency and a margin boost.

Kazmierowicz: Yes, especially for a contract manufacturer trying to get business in an area, such as automotive, high reliability, safety, or medical where the customers are savvy enough to know when something is being processed correctly. The shops that they're competing with use our equipment, saying, "I have to compete with that company who has KIC equipment, so I better buy KIC too." Also, savvy companies are continuously looking at ways to save money and improve their quality. These are also our customers.

Johnson: But that's not all. Mil-aero, automotive, and medical are pushing on the industry to dramatically improve reliability by more than an order of magnitude while also increasing output by multiple magnitudes. That's a lot of pressure.

Allen: Product reliability for CMs is tremendously important, and they are being pushed more and more to prove this. This is particularly true for high-reliability products like automotive, medical, aerospace, and military. Automated traceability and live process control satisfy the requirements to prove that reliable product has been produced. The assurance of knowing exactly what's going on when a product has gone through a high-heat process is a huge benefit, or as one customer said, "It lets me sleep at night."

MB Allen

Johnson: What are some examples of other areas in the assembly process where the CFX data from KIC is useful? Who else in the manufacturing line is a customer of KIC's CFX contributions? How does KIC's data help increase the throughput elsewhere?

Allen: KIC was ahead of its time with reflow, curing and wave solder continuous monitoring, traceability, and output of data. We have thousands of systems in the field. Now, with Industry 4.0, customers are rapidly installing process inspection systems in their ovens.

There are several formats for the output of data, but there also has been, for many suppliers and customers, costly customized software development over the years. We work with many partners—MES companies, AOI, and others—to share our data. The new IPC-2591 CFX standard has been released, and KIC also provides our data in accordance with that standard. We've been involved in this project since the initial meeting and are very pleased to see the growing interest in adopting this. It is quite an advantage for companies to limit costs and still be able to start on the path to Industry 4.0.

Don't Forget Traceability

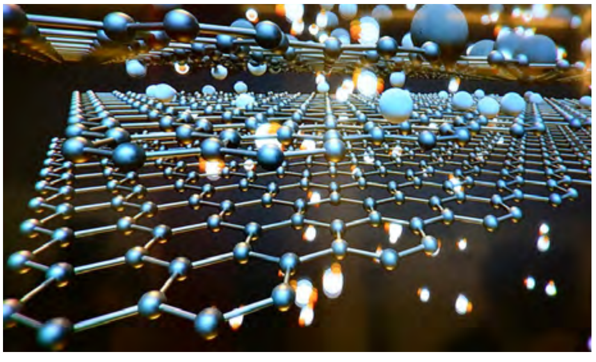
A side effect of process efficiency also seems to be increased traceability—another key service that manufacturers will be required to provide as electronics OEMs specify more strict reliability requirements for their increasingly complex board designs. **SMT007**

New Technique Could Pave the Way for New-generation Flexible Electronic Components

A team of engineering experts at the University of Exeter have pioneered a new way to ease the production of van der Waals heterostructures with high-K dielectrics–assemblies of atomically thin two-dimensional (2D) crystalline materials.

One such 2D material is graphene, which is comprised of a honeycomb-shaped structure of carbon atoms just one atom thick.

The research team has developed a technique that allows these structures to achieve suitable voltage scaling, improved performance, and the potential for added functionalities by embedding a high-K oxide dielectric. The research could pave the way for a new generation of flexible fundamental electronic components.



The latest research outlines a new method to embed a multifunctional, nanoscaled high-K oxide–only a within van der Waals devices–without degrading the properties of the neighboring 2D materials. This technique allows for the creation of a host of fundamental nanoelectronic and optoelectronic devices including dual-gated graphene transistors, and vertical light emitting and detecting tunneling transistors.

The research is published in the journal *Science Advances*. (Source: University of Exeter)