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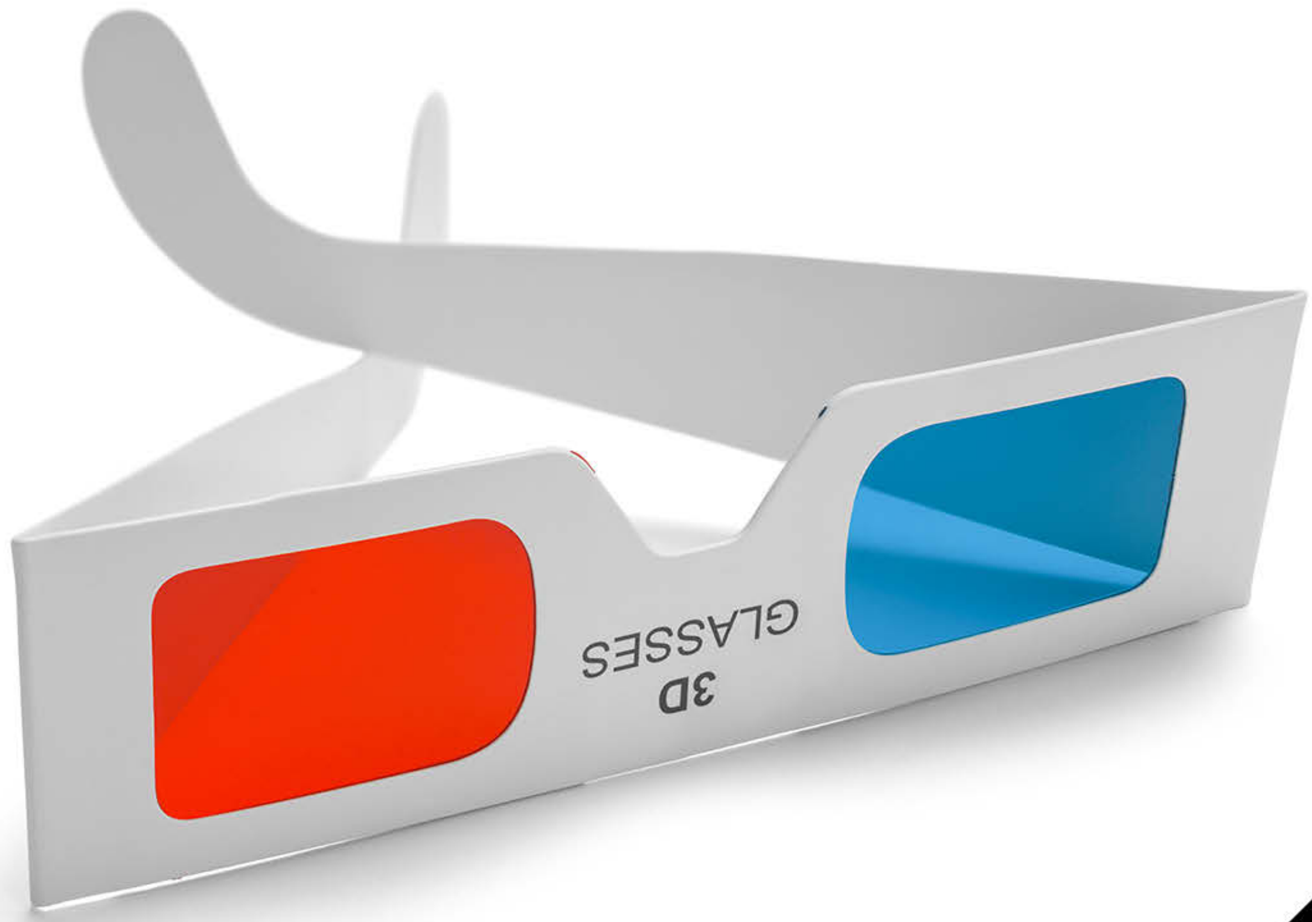

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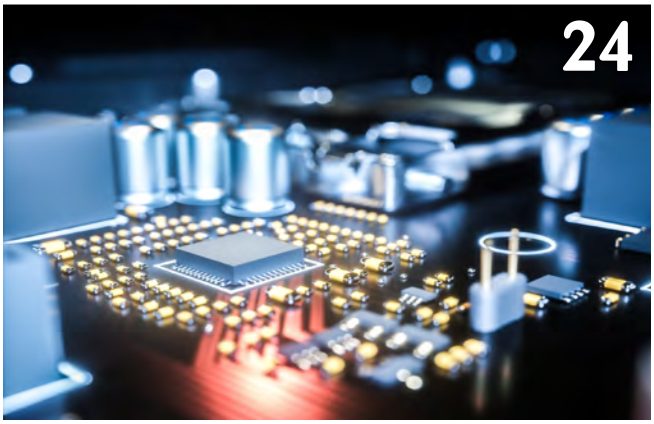

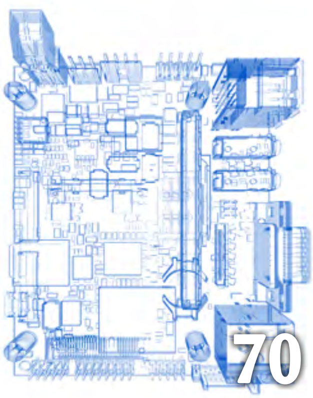

The Need for 3D Inspection

This month, *SMT Magazine* looks into the myriad challenges in inspection, and highlights the need for newer AOI technologies to improve production yields and ensure reliability.

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42

62

80

The Need for 3D AOI

by Stephen Las Marias
I-CONNECT007

The continuing trend towards miniaturization of components, more advanced component packaging with finer lead pitches, and increasing component densities in smaller PCB sizes are driving the need for an even more accurate inspection systems to detect defects in PCB assemblies.

According to a new report by industry analyst MarketsandMarkets, the global AOI market is expected to reach $1 billion by 2022, registering a CAGR of 17.1% between 2016 and 2022. The report added that 2D AOI systems, which have been widely accepted and have been in use for many years, will continue to hold a larger share of the overall AOI systems market due to their advantages such as cost-effectiveness, high-speed inspection, and the ease of programming.

In fact, in our recent survey on inspection, majority—or 60%—of the respondents from the EMS and PCB assembly industries say they are still using 2D AOI.

Technological advancements in terms of cameras, optics, and lighting have made 2D AOI suitable for detecting defects such as missing or wrong components, loose components, component misalignment, solder bridges, and solder balls, to name a few.

However, 2D AOI has its own set of disadvantages: it is incapable of true co-planarity inspection; it doesn't provide volumetric measurement data; increased probability for escapes; and it has a high false call rate, according to an article by Brian D'Amico of Mirtec Corp.[1]

Meanwhile, Kevin Garcia of Nordson YESTECH explains that, while the coplanarity of height-sensitive devices such as BGA packages and leaded components can be inspected in 2D using multi-angled colored lighting and side-angle cameras, these will be susceptible to an increase in false calls, a need for additional programming and cycle time, and possible escapes.[2]

Q: Are you using 3D as part of your inspection strategy?

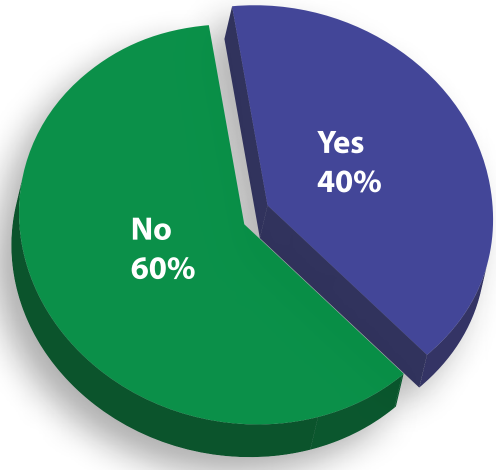


Figure 1. *Source: I-Connect007 Survey*

These factors underscore the need for 3D technology in inspection strategies. According to the report by MarketsandMarkets, various advantages of 3D AOI systems such as capability to inspect co-planarity of components, detecting lifted leads, and reduction in false call rates are contributing to the growth of the 3D AOI system market. In fact, 3D AOI systems are expected to grow at a high CAGR in the overall AOI system market between 2016 and 2022.

Going back to Figure 1, majority of those who answered "No" commented that they do have plans to adopt 3D AOI in their inspection lines; some within the next 12 to 18 months.

Before, inspection was viewed as something that doesn't add value—human visual inspection was often enough. However, as reliability became critical in markets such aerospace and automotive electronics, the potential cost of failure overcomes the cost of installing automated inspection systems that would ensure quality and reliability of the systems being manufactured. Thus, every manufacturer now utilizes 2D or 3D AOI inline or offline in their manufacturing plants. According to our survey, major-

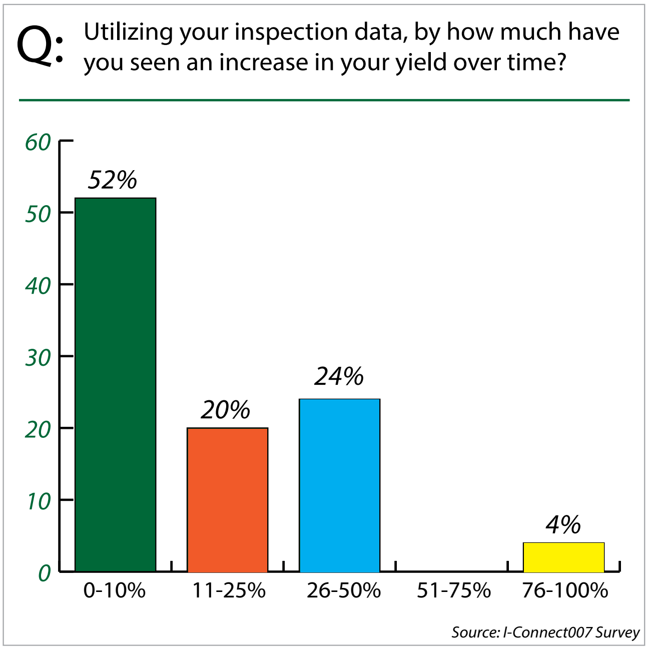


Figure 2.

ity or more than 60% of the respondents with inspection equipment installed have seen improvements in their manufacturing process—through early detection of potential defects and improving failure rates. This has also led to increased yields—according to more than half (52%) of the respondents, having an inspection strategy has resulted in at most a 10% improvement in yields. Nearly a quarter (24%) of the respondents, on the other hand, have achieved between 26% and 50% improvement in yields.

This month's issue of *SMT Magazine* features interviews and articles focused on AOI, and especially highlights the need for 3D AOI in electronics assembly and SMT lines. Industry experts from EMS firms STI Electronics and Flex, and AOI suppliers Koh Young Technology, Vi TECHNOLOGY, Saki Corp., and Viscom discuss the challenges, increasing requirements from customers, and technology developments in the PCB inspection space, and talk about inspection strategies to adopt to improve defect detection and failure rates in your manufacturing lines.

Meanwhile, Tom Borkes returns after months of traveling to write a new series in his column. Rich Heimsch, on the other hand, concludes his column series on long-term storage of electronic components.

Finally, we also have an interview with Shenzhen Axxon's Ivan Li, who focuses on the dispensing market trends and their recent acquisition by Mycronic.

I hope you enjoy this month's issue of *SMT Magazine*. Next month, we'll focus on the military and aerospace electronics segment—challenges, opportunities, and latest technology developments. **SMT**

References

1. To view Mirtec news, click here.

2. To view Nordson YESTECH article about combining 2D and 3D AOI inspection, click here.

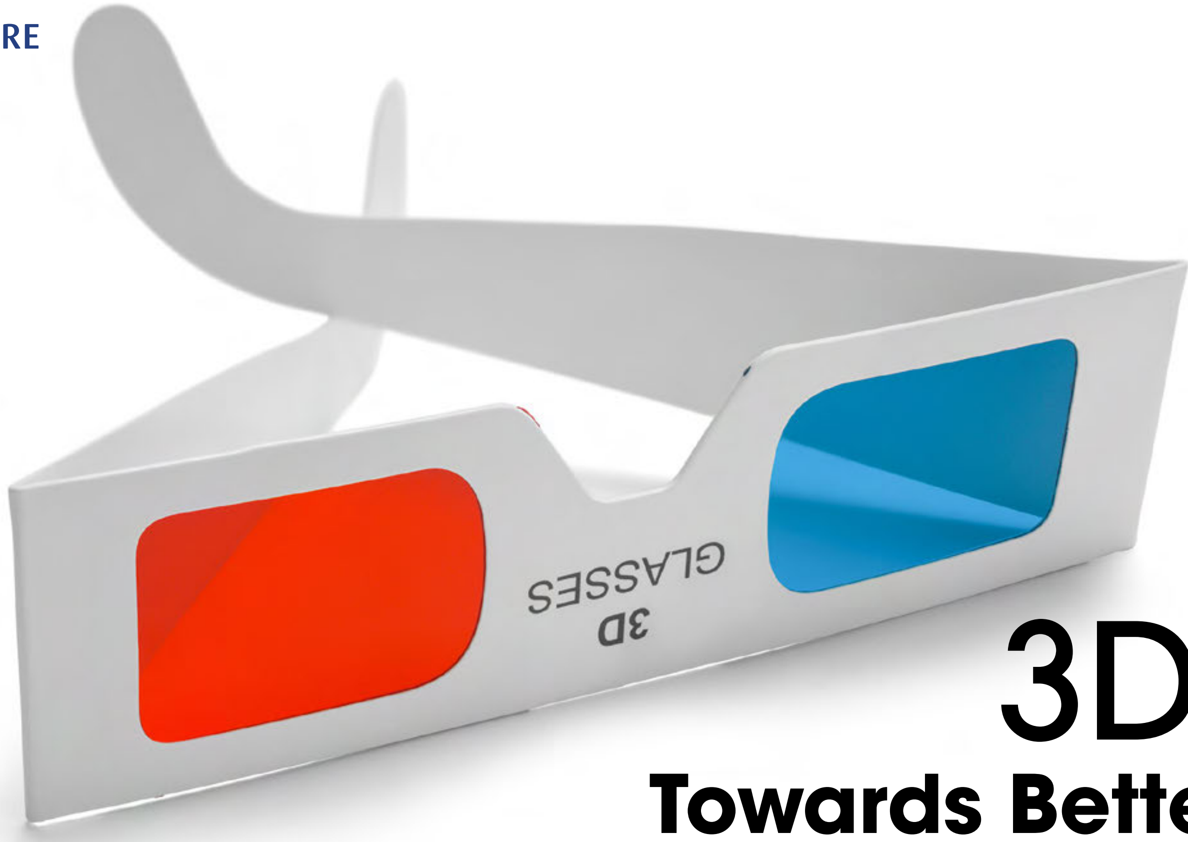
Stephen Las Marias is managing editor of *SMT Magazine.* He has been a technology editor for more than 12 years covering electronics, components, and industrial automation systems.

RTW NEPCON China: Data I/O on Securing the Supply Chain

At the recent NEPCON China event in Shanghai, Anthony Ambrose, president and CEO of Data I/O Corp., and Managing Editor Stephen Las Marias discuss the cybersecurity challenges facing the electronics manufacturing industry today amid the proliferation of connected devices and the Internet of Things. Ambrose also focuses on traceability and security strategies to protect the electronics manufacturing supply chain.

Watch the Interview Here

FEATURE



3D: Towards Better Inspection Capability

by Stephen Las Marias
I-Connect007

There is a critical need for inspection in the PCB assembly industry as the trend towards miniaturization of electronics systems and devices continue—on top of increasing requirements for reliability and quality.

For this month's issue of *SMT Magazine,* we spoke with Mark McMeen, vice president of engineering at STI Electronics, to know more about the inspection challenges and requirements from an EMS provider's standpoint. We also talked with Jean-Marc Peallat, vice president of global sales at Vi TECHNOLOGY, to find out, from a supplier's perspective, how they are looking at these challenges and addressing them through their product development efforts.

According to McMeen, the real challenge is being able to verify the solder fillets on very fine pitch QFNs and LGA parts. He said that's both done by utilizing the co-planarity of the part as well as being able to get a 3D viewing of the solder fillet on the side of the QFN and LGA.

"One of the challenges in inspection is the miniaturization of the devices and components," said Peallat. "Joints are getting smaller, fine pitch are getting denser; this trend became a challenge for all our inspection types. Embedding 3D technologies in inspection systems, and lately for the components inspection, is a solution to improve the quality and reliability of the tests."

Peallat explained that most of the 3D systems are using a top-down camera with projectors from the side. "I would say that that covers probably 95–98% of the vendors. In that case, systems are dependent on the top-down view from the camera. Some are using angled cameras, and one of the challenges is the calibration of the optics. Combining top-down cameras and angled cameras is a real challenge with no simple solution when PCB warpage is important."

According to Peallat, all these are common problems for all automated inspection vendors. "The other way to approach these process challenges is to use a global approach of inspection in your line. If you look at the QFN joint quality, it's a combination of what you have done at the print process and what you have done at component placement, not only individual,

independent processes. The biggest challenge we face today is the use of all the data from the inspection: we have 3D images, we have data, we have measurements. The challenge is to use that huge amount of information to improve the process," he said. "The past year, we invested to develop a solution that combines data from the SPI and the AOI. In fact, this combination gives more valuable and actionable information to the user than just a picture at the AOI review station."


Mark McMeen

That solution is called feed forward—a direct communication between SPI and AOI. Today, there are already systems that enable direct communication between the printer, to the pick and place machine, and others. What Vi TECHNOLOGY did, according to Peallat, was to focus on making SPI and AOI work together hand in hand to improve SMT line quality. In fact, the combination of these data, at the end of the line, offers more information about SPI parameters that really impact the quality.

Peallat noted that one of the benefits of this system is that users don't have to wait for the post reflow inspection to improve their process. Adjustments can be made at the printer level or at the SPI level to improve the process. Then you gain quality and also reduce your costs of rework. "I cannot disclose too much of this as we are currently working on an article, but we have done this with an EMS company on their automotive application," he said.

McMeen added that one of the challenges that they are also facing is the ability of getting the wetting angle. But he noted that the 3D AOI systems now are allowing them to ensure that on their passives, they are getting a 75% solder fillet going up the side of the part, 75% of the height, and then a nice wetting angle off of it. "If you're looking for a high degree of reliability and repeatability in your process, you're looking for getting the wetting on these caps and resistor faces up to 75% of its effacement and getting a nice fillet off of that."

At this point, McMeen asked Peallat about how 3D AOI allows them to get that measurement and why it's an improvement over 2D AOI.

"The 2D was not able to measure the profile of the fillet because even with a set of lightings, your 2-D image is a flat image," explained Peallat. "The only solution to measure 75% of the side of the component is to use 3D measurement. The challenge of 3D is what we call specularity, which is mainly when you have a very shiny joint, and the difficulty is to avoid the specular effect—meaning that you sometimes have a bright spot due to the angle of the light coming from the projector and going up directly to the cameras. Of course, 3D is a better way to measure this angle and the height of the joint. The challenge is, again, back to the size and the miniaturization of the component. Today, most of the systems have the ability to give you a profile of your joint, but the difficulty that I think most of the vendors have is to be clearly compliant to the IPC standards."

McMeen said STI Electronics now uses 2D and 3D inspection systems. "We have 2Ds throughout our plant and we're starting to add 3D into our final inspection. Then we want to migrate the 3Ds back through our in-process AOIs. We have clients that have requirements beyond IPC for aerospace applications, where we've got to be 100% up the face of the component. That has always been done by visual inspection by human inspectors, but the 3D AOIs are on the verge of being able to do that at speed and give you the repeatability that you need to be able to use that tool set so that you don't have to put as much burden on the human inspector."

According to McMeen, 3D, for the first time, gave them the ability to do co-planarity. "As you do these bottom terminations, you can now see if you're afloat or askew or a-lift, because in all honesty, a part should be fairly co-planar and flat, which means that you probably dispersed and wetted underneath those parts," he said. "If you start seeing a part or a corner higher, then that tells you that you haven't properly reflowed or that there was some type of outgassing event underneath that part, which should then trigger you to do more X-ray analysis.

"The beauty of the 3D AOI is that it's faster, it's more effective, and it'll tell you whether or not your parts are all co-planar. It's really aided us in our ability to do better inspection."

On this, Peallat commented that Vi TECHNOLOGY is also developing a way to make smart use of X-ray system. "We are developing solutions to enable the link you just mentioned. I'm talking about 3D inspection at the printer, at the post reflow stage, and being able to look at the data and use the data. We are working with X-ray companies to be able to utilize our data to drive a better X-ray inspection and focus on what matters," Peallat explained. "In fact, we want to offer solutions to our customers for smarter inspection strategy through the line, with the sole objective to guarantee the quality of the products by achieving zero defects line. Yes, 3D improves the detection of co-planarity defects even for very small components. The only point I would like to highlight here is that the challenge for 3D AOI equipment is to be able to inspect very small joints but also, at the same time, inspect the tall component. There are different technologies. Users need to make sure that their system is able to check coplanarities on the component taller than 5mm while, at the same time, their system checks for the quality of the joints for smaller components. That's a real challenge for the 3-D AOI technology."

Asked whether circuit board designers keep in mind designing a board for inspection or measurement, Peallat said inspection today is not driving the design yet. "I have seen that for years in the 2D inspection. For example, there are some component colors that are not the best for 2D inspection, but people kept using those colors to design PCBs. We could have the same comment for text without any industry standards. We had to work and be creative to overcome all those challenges. I would say today, AOI is not an input in the design for manufacturing," he noted.

Key Considerations

When it comes to inspection, one of the key important considerations an EMS or PCB assembler should have is an understanding of their defects spectrum, according to Peallat.

"You will say, 'Okay, but I need inspection to understand that'. That's why inspection goes along with a learning curve. I think most of the users today prefer 'end of the line' inspection as it gives the feeling of security," he explained. "We do believe that the future of the inspection is more about the complete solution. I think that's the trend you can see in the market today.

"For me, especially when you have multiple lines like EMS companies, one of the keys is the portability of the inspection programs from one line to another. It's something that is very important for users, and it is clearly embedded in the technology used by AOI or SPI systems. This is not often the case, and talking about any inspection strategy in an EMS company is all about flexibility, and sharing between lines."

"McMeen considers educating their designers more as one of the critical factors in their test and inspection strategy."

McMeen considers educating their designers more as one of the critical factors in their test and inspection strategy. "If you get parts that are too tall, we can't get our probes in to the real small ones that are in the shadow of these real tall ones. On high-reliability stuff, we spend a whole lot of time trying to make sure that we have access points, test points or access ways so that we can test the board. At the same time, we're trying to educate and move in that regard. We're also trying to do it with the intent that we can get better AOI coverage," he said. "With the introduction of 3D AOI, we now have the ability to do a better job of inspecting boards for solderability and even for bottom-terminated components due to co-planarity. We can now take a hard look with an automated approach and not have to rely as heavily on the human inspector. That's because 3D has opened up the ability to at least be able to rationalize and render views of what these 3D soldered joints really look like in real life. That is a major win for the EMS guys because now, we can have more test coverage and have more visual coverage, which gives us a higher degree of confidence that our product has no escapes. When I say no escapes, that there's any product that's not 100% compliant to the IPC standards or to the customer's expectation and his standards for acceptability."

> "It's not just the SPI variability. It's also the placement accuracy of the part onto the paste before you hit reflow."

Are they looking at more in-line processes and inspection as well in their strategy?

Yes, McMeen said. "I think Jean-Marc made a very good point. If we can tie in our SPI data off a Koh Young SPI machine, with the data from it being tied to the AOI data, now you're starting to get a better data set of information to judge how well your process is being controlled. Let me take just a minute and explain. If I have a SPI machine that's looking at my solder paste and I see any variability in it, I can take an AOI machine and look at the placement accuracy before I put it through reflow. It's not just the SPI variability. It's also the placement accuracy of the part onto the paste before you hit reflow. Then run it through reflow and run it through another AOI, which in this case would be the 3D AOI, to look at the quality of the solder joint that's been produced."

"Now for the first time, I can quantify and see my variability of SPI on the board that is in question, to the placement accuracy on that solder paste to that SPI data, to what does my solder joint integrity and reliability look like based on the placement of the part and what the solder paste looked like right after it went through the screen printer. This is the first time that EMS guys can now have a total view of what that reliability and repeatability looks like from the print through the placement to the reflow and to the actual product," McMeen explained. "By taking this data and analyzing it in a big data file, big data analytics, now you have the ability to really drive some improvements or tweaking to the stencil, to your placement accuracy, and ultimately to your reflow. We want to also tie in, at STI, the ability of gathering the reflow data and tying it back in at the time to the solder paste, the placement accuracy, and then the final 3D AOI of the solderability joint itself, the reliability and the visual of that joint."

Overall, the investment that companies put into their equipment and their testing parameters will ultimately lower their total operating costs and improve their product delivery.

"That is the correct assumption," said McMeen. "All of this data is to make us make higher first pass yields and to gather the data that's really meaningful to what's driving the issue. Instead of making decisions based on just the backend, now you're starting to look at what the in-process data looks like. Here's what the screen print and the solder paste looks like, how accurate the placement accuracy was based on skew of the placement of the part, what the reflow looks like and, ultimately, what the 3D AOI visualizes and recognizes as a good solder joint.

How are they consolidating all of this information, and analyzing and interpreting it? The cloud, according to McMeen.

"Right now, we're trying to gather and make our equipment smarter, thus we are putting it into a cloud. That way, we're tracing it back to the original serial number of that particular assembly that we're building. Now, we're starting to see what the assembly yielded on a first pass yield or what the 3D AOI results found, and what the 2D found. The 2D is what we use now for our placement accuracy and then on to what the SPI data shows us. If you can gather that data and tie it back to that assembly number, you now have a lot of data tied to that actual serialized number and now you're starting to make better decisions."

Making Smart Decisions

The bottom line is that it's all about making smart decisions. "We are completely on the same page," said Peallat. "Vi TECHNOLOGY has developed a direct communication between the SPI and the AOI. In fact, we trace boards with the serial number. When the SPI detects a defect, of course the board is tossed. The key is to get the right tolerances. One approach is to use warnings to define measurements close to the tolerances but still good. In that case, the board goes through the rest of the steps, and when the boards arrive at the AOI or the post reflow 3D equipment, then there's special attention to this warning. In fact, even if there is no defect on the 3D AOI, our system warns the operators: 'Warning at the SPI.' Let's say your limit was 70% and the volume was at 72%, it was good at the SPI, of course. But we raised this to the attention of the operator and we provide, at the same time, the 3D AOI picture of that joint. In fact, the operator can analyze it and validate it. Then, all this information can be fed back to the SPI to tighten the tolerances. This live process, live information, is a way to improve directly and not through a cloud data analysis, which is most of the time after the fact and requires a lot of energy and a lot of analysis. This is clearly the direction Vi TECHNOLOGY is going today. I was talking about this installation in Europe with an EMS company, but we believe that this short loop with clear, effective, actionable information will help our user to improve their process quickly.


Jean-Marc Peallat

Based on what Peallat said, it sounds like the most important part of test and inspection today is around data management.

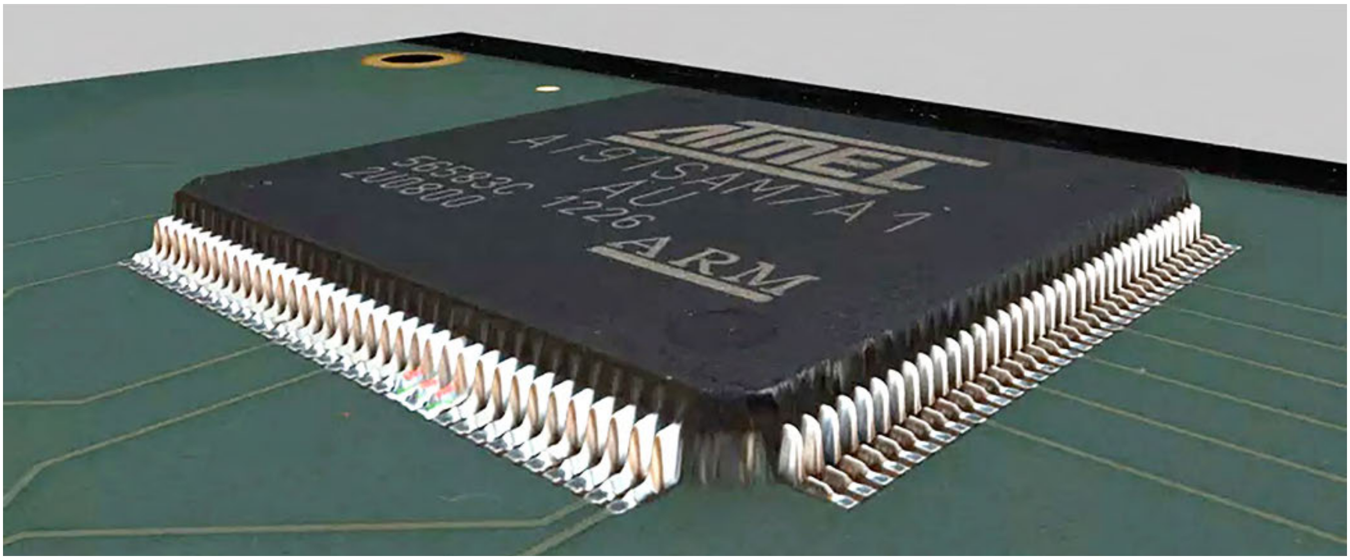
"Yes, but not only that, you have pictures," he said. "You have gigabytes of data that you can analyze, but when you are effectively—and I think Mark mentioned that earlier—when you're effectively working on the line to decide the quality of your product, there is no better thing than a good picture of what the machine has seen. Combining 3D pictures of solder paste and 3D pictures of post reflow analysis is the best information you can give to your operator to decide the quality of your product."

On ROI

When somebody's looking at making this capital investment, what should they take into consideration beyond perhaps the norms, like their return on investment?

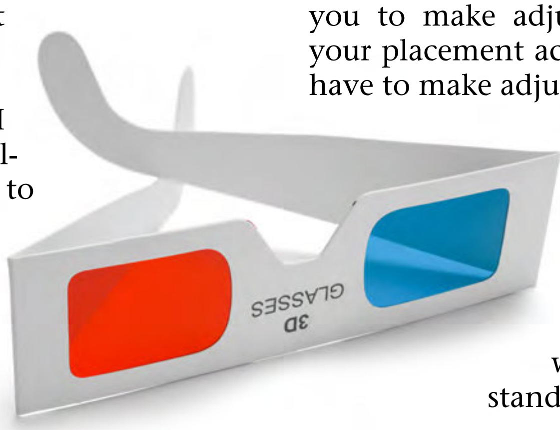
"I would say that the most important, of course, is the quality of the inspection," said Peallat. "But what does the quality of inspection mean? It's the capabilities of the tools to measure key variables accurately and repeatably, but also the stability through the use of the equipment. Some technologies are very easy to implement and some competitors claim they just need one board to program the machine; but in the long run, this one is not stable and request a lot of maintenance in the line due to components variation. So, stability and repeatability are very important. For solder paste, it is volume and accuracy. For years, we had people talking about repeatability, repeatability, repeatability, but you can be very repeatable and measure something the wrong way. Volume and accuracy, especially when the components are getting smaller and smaller, are very, very important. We see that is key for solder paste, and it's also key for AOI. When you talk about the criteria to select AOI equipment, I was mentioning the ability to have a wide range of 3D reconstruction, from 0 to 20mm without losing your accuracy or your speed. A lot of vendors are doing 3D only up to 3mm, for example, in order to be able to run through a good cycle time and with good accuracy."

There are a lot of variables as far as return on investment is concerned, according to Peallat, and that it is never easy to define within a quick answer. "We have developed some tools to calculate that, but it depends on your whole test strategy, of course, your defects spectrum, and what you use on the backend to test



your boards. We see that the return on investment most of the time is very short at about two years, and sometimes even sooner. We do understand it's a big investment, especially because inspection is not productive equipment in your line. It's an inspection, return on investment is about reducing the cost of non-quality," explained Peallat.

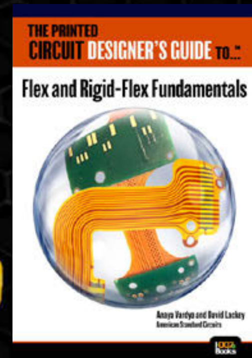
For McMeen, their rule of thumb is twofold. "One is this should pay for itself in less than 18 months, and if a human inspector can find something that the 3D cannot find, that's where the challenge is. That's what you'd want it to do. Everything that the human inspector finds goes back to our programming lab and they try to incorporate whatever escaped into the 3D AOI machine. Remember, human inspectors are only as good as about 70–75%, so the idea is that you really need to use AOI as a process tool because it never gets tired and it's not going to have misses, provided that you can program for it. For the EMS guys today, from my perspective, the 3D AOI is much needed, and the challenge is the time that it takes to program those more difficult components that take the burden off the human inspector.



"Every time a human inspector finds something that should have been caught by the AOI, we are going back and forcing ourselves to figure out how it escaped. Was it poor lighting? Did we not come at the right angle? Did we have the parameters set too loose or too tight? It's a learning curve, just as Jean-Marc said before. It takes a lot of time to program these pieces of equipment, but you're better off in the long haul because you're taking a burden off the human inspector and that's the main objective. It is a non-value added process, but it is one of those processes that you have to have to give assurances when you're producing hundreds, thousands, or millions of products."

However, while inspection is a non-value add from the perspective of the end product, the value in the inspection data collected during the process is overwhelming.

"The in-process data that you get is huge because that's going to be the data that allows you to make adjustments to your stencil or your placement accuracy, and then maybe you have to make adjustments to your reflow. All of those things go a long way to what your solder joint and reliability integrity is going to look like, but more importantly, its repeatability from job to job or assembly to assembly. I was looking at it from a final standpoint, but from an in-process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standpoint, it's the data set that's going to drive you to making fewer defects in your first pass yield, which is what EMS guys are all about. The last time I have to touch a product, the more profitable I am. The issue is: what can I learn from all this data that's going to make me produce a higher first pass yield on subsequent builds?" said McMeen. "There's an end game, which is making sure that your customer doesn't get any bad product, but more important to our profitability is the in-process data. That point needs to be brought out as a twofold thing. One is the customer doesn't care how many times you look at something as long as your product is defect-free. From our perspective for profitability, we want to produce it with the least number of defects coming through the first time."

Design Considerations

From a designer's perspective, being able to get the view angles right could make things easier at inspection, according to McMeen. "The more you put towering parts amongst your very fine parts, the more blocks it creates in our viewing angle. We're working with designers so they know it's okay to have some, but don't try to build whole cities with all the real tall parts intermixed in a real small area. If you have the space to inter-disperse them, then you're going to aid in the manufacturability. Not all designs lend themselves to that, and that's one of the challenges that we face here on the EMS side, because ultimately, you've got to have a board that meets the design objectives. I will say that for the first time, AOIs and how you electrically test boards are being driven further back into the design cycle than they have ever been before."

What about Industry 4.0 Strategies?

"Today, most of the systems are able to export data to external databases or systems," said Peallat. "Also, for a few years now, vendors have developed what we call closed loop, at the SPI with the printer vendors or at the AOI with pick and place. One example is the use for small components. Studies have shown that it is better to place small components on paste rather than pad, especially when you have very, very small components. Today, most of inspection equipment are able to communicate to other equipment and also most of them, like ours, are able to communicate with other software."

But according to Peallat, one of the challenges when it comes to communication with other equipment is getting a global view as the information exchange is very focused on a few parameters.

"Because the key point here is the amount of data you can get. With a PCB supporting about 1,000 components, it's a lot of data from inspection, SPI and AOI. The big question is, again, what do you do with that? When you have global manufacturing software, users focus on key global parameters and don't get into the process level with actionable data. This is the key to improve your quality," he said.

Macmeen said, "That is the goal of Industry 4.0—making all of that data interlinkable all down the manufacturing line."

In closing, McMeen noted that the ability and the power of the 3D AOI now allows users to automate a lot of what the human inspector's been doing; not 100%, but it's moving toward that goal. "Being able to do solder fillet formation and height has brought on a huge degree of efficiency, because now, we can rely on that data to ensure that we are meeting the IPC and customer standards. These machines are becoming more and more capable to solve some of the bottlenecks that we've had in the past. That is how you get into reliability. What does that solder fillet wetting angle look like and how far effaced was it? Knowing that goes a long way into assuring that you've met the standard." SMT

MilAero007 Highlights

[Celestica Reports Q1 2017 Revenue of $1.47B]

Celestica Inc. has announced revenue of $1.47 billion for the first quarter ended March 31, 2017, above the mid-point of previously provided guidance range of $1.4 to $1.5 billion, and up by 9% compared to the first quarter of 2016.

Zentech Narrows New Site Location Choices for Expansion in Maryland, Virginia

Zentech Manufacturing Inc. is reviewing available sites in Baltimore, Anne Arundel, Howard County and Virginia with a final site selection imminent.

Libra Industries Expands Sales Team in Texas

Libra Industries has added two new representatives: Gary Tanel from TechBiz Consulting LLC and David Smith will represent Libra Industries in Texas.

Congressman McCaul Discusses U.S. Policy Priorities with VirTex Staff

Executives and staff at VirTex's Austin, Texas facility held a town hall discussion with Congressman Michael McCaul (R-TX-10) on the federal policy issues facing the advanced manufacturing industry.

Kitron Posts Strong Revenue Growth in Q1 2017

Kitron's revenue in the first quarter amounted to NOK 585 million, compared to NOK 497 million in the same quarter last year. Operating profit was NOK 30.9 million, compared NOK 20.5 million last year.

Benchmark Electronics to Relocate Headquarters to Arizona

Benchmark Electronics, a global engineering, design, and integrated electronics manufacturing company, will relocate its corporate headquarters from Angleton, Texas to Arizona.

Stadium IGT Joins ADS to Advance Opportunities in Aerospace and Defense

Stadium Group's HMI division, Stadium IGT Ltd, has joined ADS, the leading trade organization for companies operating in the aerospace, defense, security and space market sectors in the UK.

Nortech Systems Reports Q1 Sales of $28M

Nortech Systems Inc. has reported net sales of $28.3 million for the first quarter ended March 31, 2017, compared with net sales of $29 million for the first quarter of 2016.

Ducommun Reports Revenue of $136.3M in Q1 2017

Ducommun Inc. has reported revenue of $136.3 million and net income of $2.1 million for its first quarter ended April 1, 2017.

Neways Records Higher Turnover and Order Intake in Q1 2017

In the first quarter, net turnover increased fully organically by 9.5% on a year-on-year basis, with higher sales contributions from semiconductor, automotive and defense sectors.


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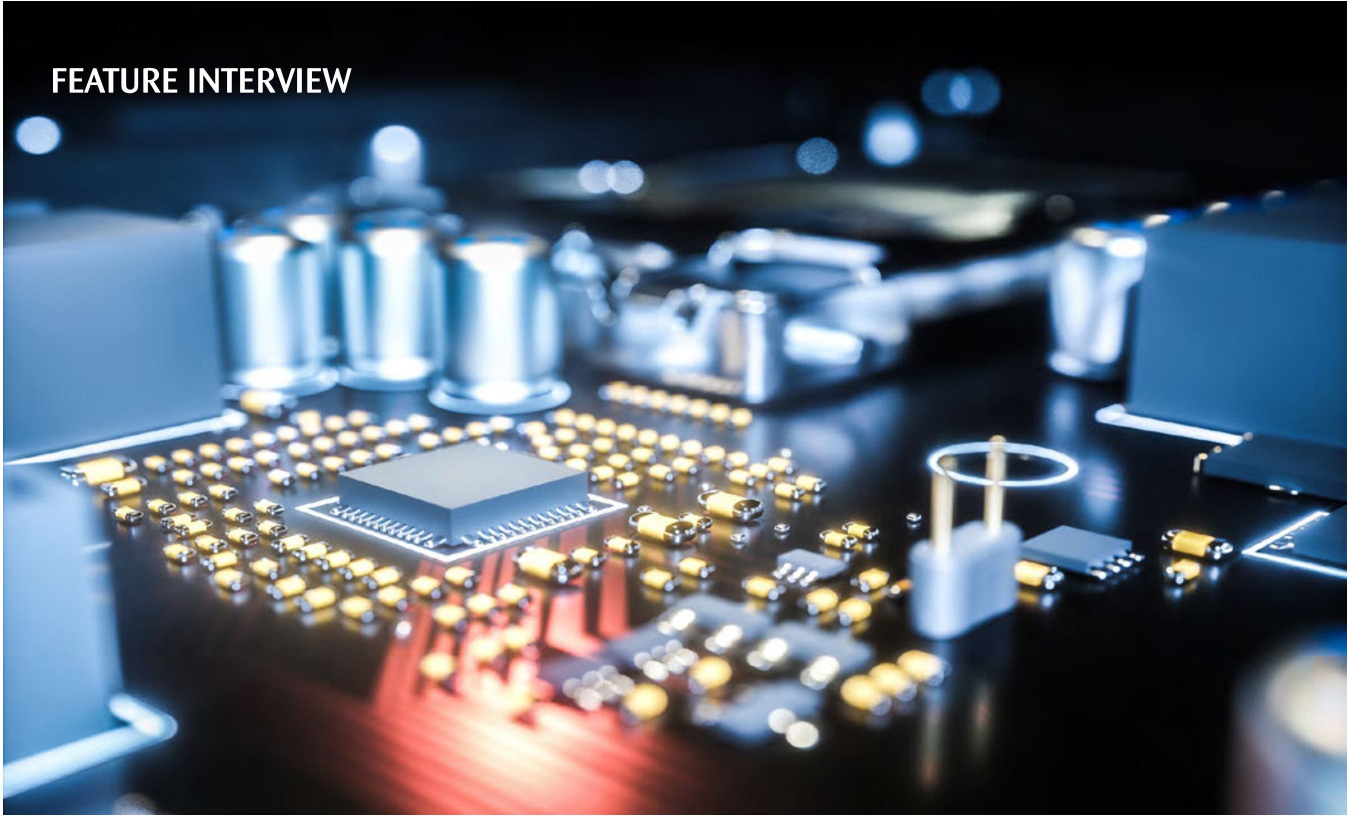
FEATURE INTERVIEW



3D Inspection Is the Way to Go

by Stephen Las Marias
I-CONNECT007

In an interview with *SMT Magazine* during the recent NEPCON China event in Shanghai, Guido Bornemann, head of sales in Asia for Viscom, talks about how the inspection technology is keeping up with the latest requirements and demands from customers. He also explains why 3D technology is the best inspection technology to utilize in electronics assembly.

Stephen Las Marias: Guido, what are the greatest challenges that your customers are facing right now?

Guido Bornemann: Right now, there is a lot of energy going into avoiding false calls. If you look back five years ago, mainly the automotive industry needed to find all the defects and false calls, and things like false alarms were not so important. We still find all the defects there, but now they don't want to the risk for false calls. That means we have to find all the defects at zero false calls, because every false call is a potential escapee. The machine is correct, but the operator may be classifying it as a false effect. So, the challenge is to find all the defects at the highest yield rate.

Las Marias: How are you helping your customers do that?

Bornemann: 3D, of course, is the way to go. The more information you get, the easier it will be, and there are a lot of features we are just introducing, such as the 360-degree view. That means we're taking 2D, 2.5D pictures from all angles, and we are displaying them on the classification station of the machine. It means the operators don't really need to be present at the machine, but can see the whole view on the monitor and then classify properly and correctly.

Las Marias: Before, people aren't giving too much of a though on inspection. What drove them to increasingly integrate inspection systems into their SMT assembly lines?

Bornemann: If you look back a couple of years ago, people didn't consider inspection because there's no value add in it, or it's really late ROI. Inspection, in general, was basically just, "Let's put it to ensure that I only deliver perfect prod-

Guido Bornemann

ucts for my customer." But recently, the implementation of closed loop uplink functions was really helpful, because you have all the information available at the end of the process. And now, we developed a lot of software features to help the customers use this information to optimize their process. It means producing less defects and really evaluate what is going wrong in your process, and then to utilize this information to optimize your process—and therefore, cut down defects and cut down the cost.

Las Marias: That involves a lot of data.

Bornemann: Yes. While the collection of data is important, utilization of that data is also very important. So, we developed proper software tools that evaluate if the defects are coming from the pick-and-place machine or from the oven, for instance, and we work together with suppliers to feed that information back and prepare the data, store them properly, or feed them back properly to other machines in the SMT process.

Las Marias: How do you help customers with their inspection strategy?

Bornemann: All in all, you need to have a proper 3D approach. There are a lot of 3D machines available in the market. 3D has limitations, especially when you have very tall capacitors and you have small chips in the shadows. So you need to have a technology that can cover this. The combination we are doing is for 3D, but we still have the options of 2D or 2.5D, making it possible to inspect the whole boards. If you only do it by 3D, you'll have still limitations. So, you have to have a proper 3D performance, plus the opportunities to still inspect the boards or the components where they are limited. So, this is basically what we are doing.

I mean, one of the biggest limitations, usually, was speed. So, you could go into 3D but you were really facing a speed issue. What we have done is we have increased our field of view of our angular cameras. And with this, we are promoting our so called XM Plus module, which is really tackling these limitations. So now we have a system which can do a full 3D measurement at in-line speed. This I would say is one of the key factors to really make a full 3D in-line measurement, in-line capable.

3D is the way to go, because especially components are getting smaller, boards are getting more populated. There are the limitations of the 2D, which is basically like lifted leads of small QFPs, fine pitch QFPs, and it is tombstoning very small chips. You really reach the limitation over to the system. 3D helps you on, like I mentioned before, with first pass yield. This is getting more and more important, so 3D is helping you to increase your yield. Because simply you have much more information available and this is the way to go.

Las Marias: What are some of the key factors to consider when selecting a 3D AOI system?

Bornemann: Basically, you should make sure that this is in-line capable, and that this is real measurement. You know, the difference between inspection and measurement is that inspection only tells you whether it's good or bad; but the measurement is the one that is really helping you. There's a lot of systems in the market who claim to do measurement, but if you look closer, it's just inspection. If you go for an

SPI measurement, it's rather easy because you have just height differences of a very few micro meters. If you go for post reflow, measurement becomes more challenging, because we have from small components up to very tall components. You have to cover a whole range.

Speed, of course, is the second factor. You have to make sure that your measurement speed is in-line capable and covering your whole board, and not only certain components.

Las Marias: You mentioned earlier that it makes sense to have a setup wherein you got 2D or 2.5D, and 3D, in an inspection line.

Bornemann: Yes. Basically, we would start from the 3D, but there are a few limitations. We have a lot of limitations on the 2D, you still have a few limitations on the 3D. So, we still believe that implementing a couple of 2D factors into our 3D system is helping you on speed, on inspection, and quality. OCR is an example. For OCR, you don't necessarily need 3D, but 2D inspection of OCR can help you a lot in increasing the speed. So, a combination of 3D, 2D, and 2.5D is really the best solution for speed, inspection depth and inspection quality.

Las Marias: How do you convince customers who are still very much focused on the cost issue?

Bornemann: Cost, of course, is a very important issue. Here, we're coming back to the speed again. Because the more throughput we can offer, the easier you can utilize the machine and the sooner you get your ROI. Looking into Asia, we are also offering price-performance machines, which include the full range of our high-end machines at certain limitations. Cost, of course, is a very important factor in Asia, and we're able to handle this with our so-called Asia machines as well.

Las Marias: I think the cost of failure when systems break down is higher than installing systems earlier on in the process, right?

Bornemann: Correct. That's why, you know, we are made in Germany, so sturdiness, repeatability is really an important factor. Especially when you go into high-end manufacturing, of course, where you want to make sure that if you test the board today and your customer brings back the board in two years, the results are still the same. So that's why we spend a lot of effort into repeatability, sturdiness, and I would say that is one of the really big advantages our machines have.

Las Marias: What can you say about the China market right now?

Bornemann: We still see huge opportunities here. You know, we are coming from the automotive, and our long experience can really help us. We see a lot of local automotive manufacturers now, which is a big opportunity for us. We managed to get into the smartphone business here, and China is still driving the business. For us, the China market is still a great challenge, but also a really, really great opportunity.

Las Marias: What about competition?

Bornemann: Yes. Everybody wants to go into China. The demands of Chinese customers are growing, and so we are seeing that they are coming closer to the demands of European automotive customers.

Las Marias: Is there anything else you would like to talk about?

Bornemann: I think we covered most of it. 3D is the trend to go with. Local customers in high-end industries are getting more and more important for us. China is still the SMT driving market, and I believe we have to be here. We are celebrating our 10-year anniversary of being in China this year, which also shows we are a global company with a local focus, with long-term partnerships. I believe this is also a very important key factor when you want to go into China as a foreign company.

Las Marias: Guido, thank you very much for your time.

Bornemann: You're welcome. **SMT**

Supply Lines Highlights

RTW NEPCON China: Metcal Highlights Innovation in Hand Soldering Technology
At NEPCON China, Bryan Gass, vice president of Metcal, discusses how their Connection Validation soldering station will revolutionize the hand soldering technology industry.

Super Dry Totech Component Trolley Saves Time and Space at 'Goods In'
A Super Dry Totech development for a major OEM reduces the steps between receiving components and getting them to storage.

Electrolube Extends Aromatic Free Acrylic Coating Range
Electrolube has extended its successful Aromatic Free Acrylic Coating range with the release of AFA-G.

Alpha Assembly Solutions Wins Prestigious Awards at SNEC PV Power Expo
Alpha Assembly Solutions has received two awards at SNEC PV Power Expo, recognizing its high level of technological contribution to the solar energy industry.

SHENMAO Technology Joins iNEMI
SHENMAO Technology Inc. has joined iNEMI (International Electronics Manufacturing Initiative) to participate in advancing manufacturing technologies.

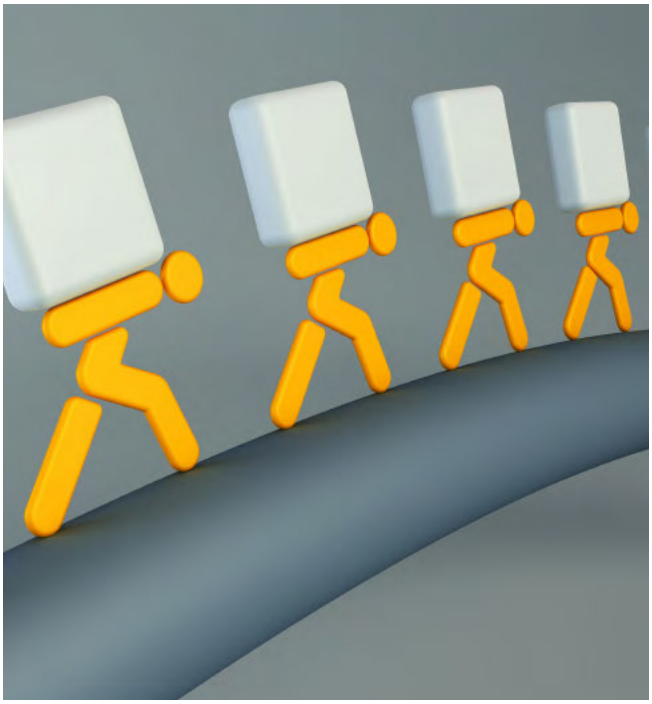
Mycronic's MY700 High-speed Jet Dispenser Marks Launch of Next-gen MYPro Series
The all new MY700 high-speed jet dispenser, for jet printing of solder paste and dispensing of assembly fluids, is the first release in Mycronic's next-generation MYPro series product lineup.

BTU Installs Pyramax Reflow Oven at NextFlex
BTU International Inc. has installed a Pyramax 100A demo unit at Silicon Valley-based NextFlex, a public-private consortium of companies, academic institutions, nonprofits and governments, whose mission is to advance US manufacturing of flexible hybrid electronics.

VJ Electronix Summit 1800i as Popular as Its Predecessor
VJ Electronix Inc. has reported success with the new Summit 1800i, the improved version of the world's most popular rework system.

Indium to Showcase Indium8.9HF Solder Paste at MEMS and Sensors Technology Symposium 2017
Indium Corporation will feature its MEMS microphone lid-attach Indium8.9HF Solder Paste at MEPTEC's 15th Annual MEMS and Sensors Technology Symposium on June 6, in San Jose, California.

AIM Receives Best Presentation Award at the SMTA China East Vendor Conference
AIM Solder's Derek Wang, technical support manager, has received the award for Best Presentation in his technical session at the recent SMTA China East Vendor Conference in Shanghai, China.



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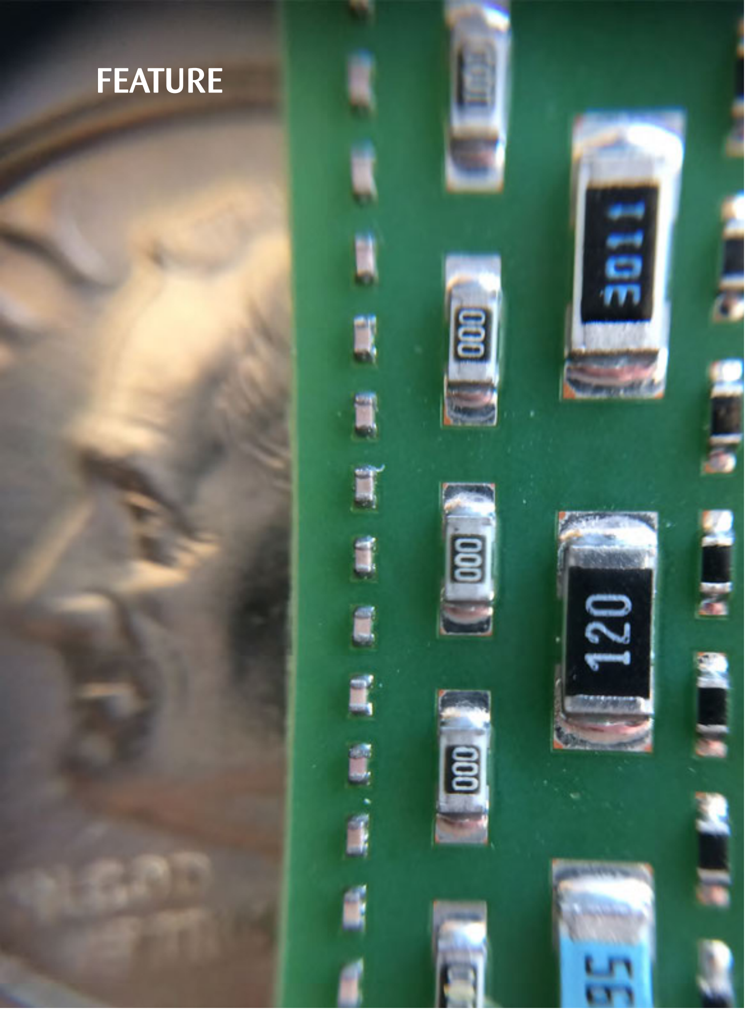

AOI Capabilities Study With 03015 Components

By David Geiger, et al.*
FLEX INTERNATIONAL

Abstract

Automated optical inspection (AOI) is advantageous in that it enables defects to be detected early in the manufacturing process, reducing the cost of repair as the AOI systems identify the specific components that are failing removing the need for any additional test troubleshooting[1-3]. Because of this, more electronic contract manufacturing services (EMS) companies are implementing AOI into their SMT lines to minimize repair costs and maintain good process and product quality, especially for new component types. This project focuses on the testing of component package 03015 which is challenging for AOI.

Highly-automated and effective test methods are becoming a more and more important topic in our industry today. Advances in modern manufacturing technologies have been making factories smarter, safer, and also more environmentally sustainable. Finding and implementing smart machines which provide real time information is critical to success. Currently, we have been successful in using 2D/3D AOI for production; however not for the upcoming 03015 components. Therefore, we are working with AOI vendors to ensure successful testing of this component type, with a special emphasis on optimizing algorithm threshold settings to detect defects.

We have been working with five AOI vendors with five test vehicles (PCBAs). Each PCBA board has 246 components with three different pitch sizes (100 µm, 150 µm, 200 µm). The results of Attribute GR&R, Defect Escapes, and False Call PPM (parts per million) will be presented.

Based on the data which we received up to now, every set of data (five sets—still waiting for results of AOI System 3) is from the algorithms of 2D AOI, although some machines have the 3D AOI capability. These machines have shown different levels of performance. AOI System 5's results have an excellent acceptable level for Attribute GR&R; both AOI System 5 and AOI System 6 have only several percentage points of a Defect Escape rate. However, this study is just in

its infancy; more improvement and testing will be performed. We will continue to provide new test results from all suppliers.

Introduction

The printed circuit board assembly (PCBA) industry has long embraced the smaller, lighter, faster mantra for electronic devices, especially in recent years[4-5]. With the increasing use of smaller components, more consideration is required to study and implement changes; not only for SMT processes, but also for testing. There have been some studies conducted for SPI (solder paste inspection) with 03015 components[6-7], however, there are very few recommended practices for AOI.

The 03015 [0.3 mm x 0.15 mm] device is a microchip component. For reference, please note that a human hair is approximately 0.1mm. To ensure a successful implementation of the 03015 components, besides for these three critical areas—placement equipment, assembly materials, and process control—the capabilities of machines used to test these component types is another critical consideration. Now, 3D SPI is more commonly used in the SMT process, and 3D AOI is quickly catching up.

During the initial stage of our study, we first tested these five boards with 03015 components on our 2D AOI machine in our Milpitas manufacturing site. Next, we provided the boards to the R&D labs of five AOI vendors who all have 3D AOI machines. Working with various R&D engineers, it was obvious this was a challenging task for their current AOI systems, especially for 3D AOI systems due to component reflection.

Our test data and results showed that the 2D AOI machines have different capabilities in detecting defects for 03015, such as misalignment, tombstoning, and shorts. While the defect escape percentage decreased, false call PPM increased, therefore, optimized programming should be based on test data analysis.

Experiments

In total, we asked five AOI vendors (R&D engineers) to work on this project. We received four sets of test data—AOI System 3 data is to be provided later. The test procedure is the same for all machines with five boards.

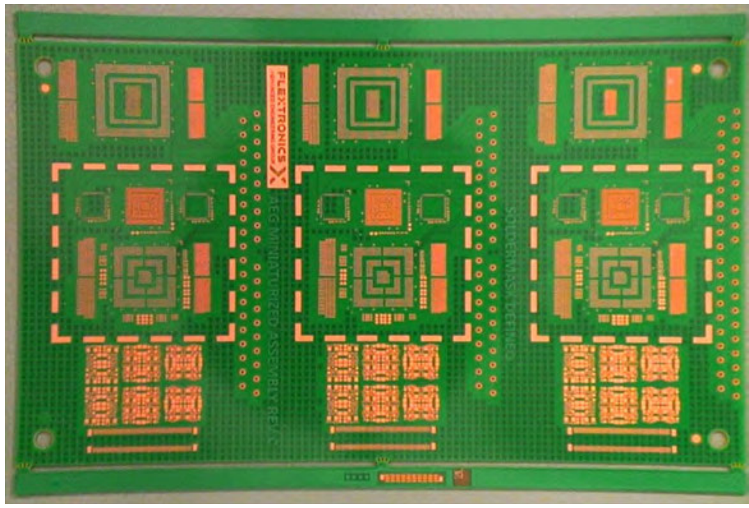

Figure 1: Company Miniaturized Test Vehicle.

Test Vehicle

Five boards with 03015 components were tested on the AOI machines. Figure 1 is our test vehicle, which has three areas for different pitch sizes. The pitch areas are indicated as different color arrows: red color (A – 100 µm), yellow color (B – 150 µm), and blue color (C – 200 µm).

The 03015 component was a production resistor: 292 µm, 143 µm, and 100 µm corresponding to its length, width, and height, respectively, as shown in Figure 2, where area A is without fab mask. There are a total of 87, 81, and 78 components in areas A, B, and C, respectively. The pad size (length, width) is 150 µm by 150 µm on the PCB fab. Figure 3 shows pictures for area A (right column), area B (center column), and area C (left column); after print (top row), after placement (center row), and after reflow (bottom row). There are different colors for optical pictures due to 03015 component reflection, which increased AOI testing difficulty.

Attribute GR&R

We used 78 components with a pitch of 200 µm on Board 4 for the Attribute GR&R study; the board was tested a total of nine times (three operators testing the test vehicle three times). Then, we used production statistical software for getting Attribute GR&R. The Attribute GR&R data results (Within Appraisers, and Appraiser versus Standard) of AOI 1, AOI 2, AOI 4, AOI 5 and AOI 6 are shown as in Figure 4.

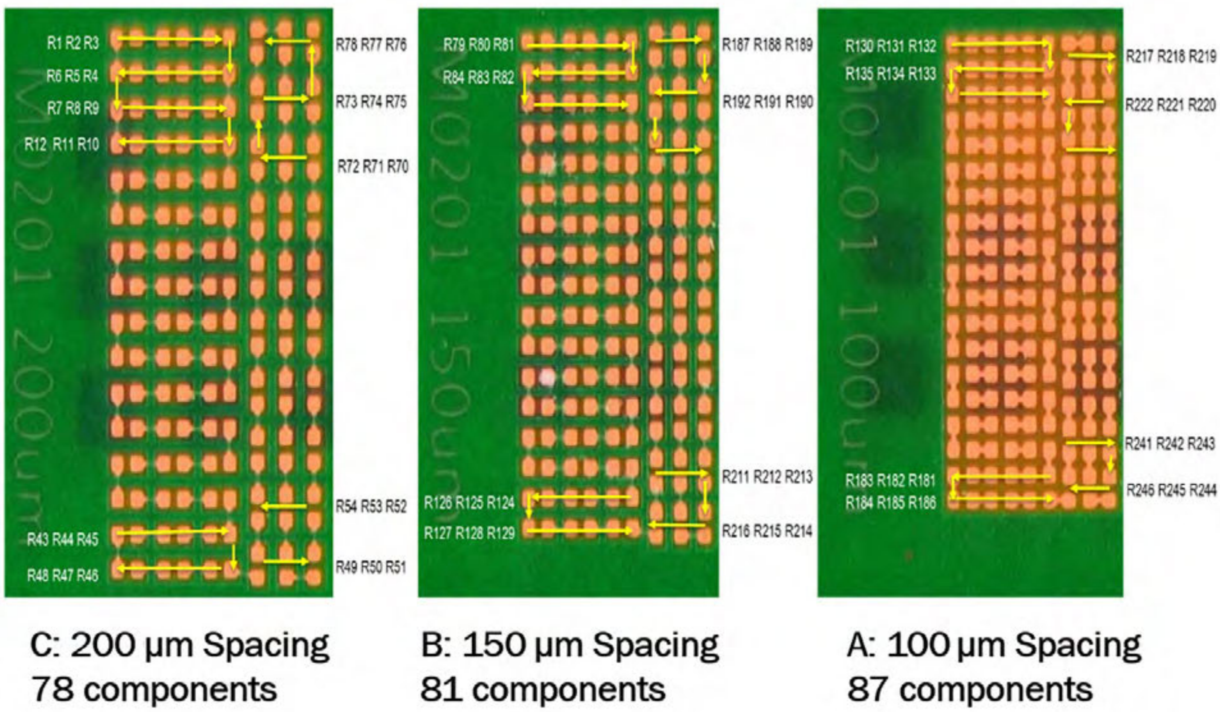

Figure 2: Three areas of 03015 components.

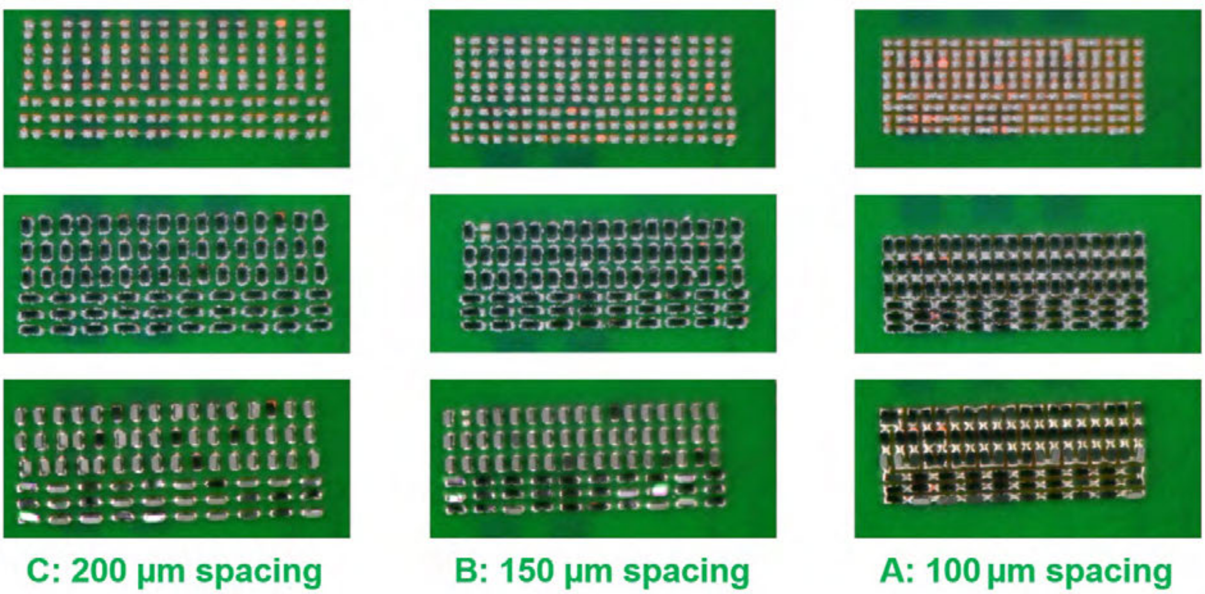

Figure 3: Optical picture: after print (top), after placement (center), and after reflow (bottom).

Table 1 lists the Attribute GR&R results of AOI System 1, AOI System 2, AOI System 4, AOI System 5 and AOI System 6 for the appraiser's agreement percentage, and agreement for each appraiser versus standard percentage. The standard results are based on the pictures from AOI machines and the microscope review; the results are also based on the AOI engineers' discussion/agreement. It is obvious that all these five AOI machines have very good or ex-

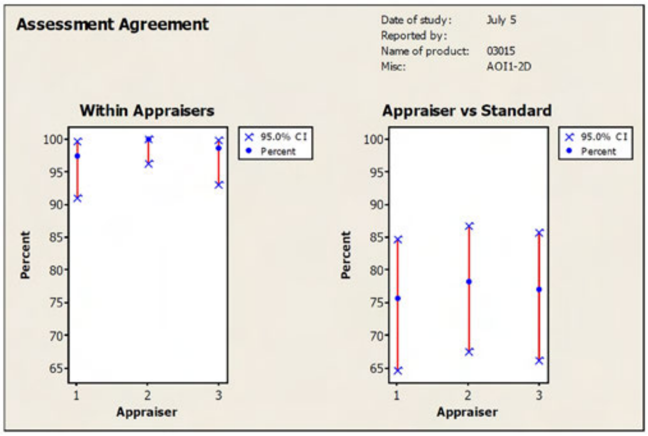

Figure 4a: AOI 1 GR&R.

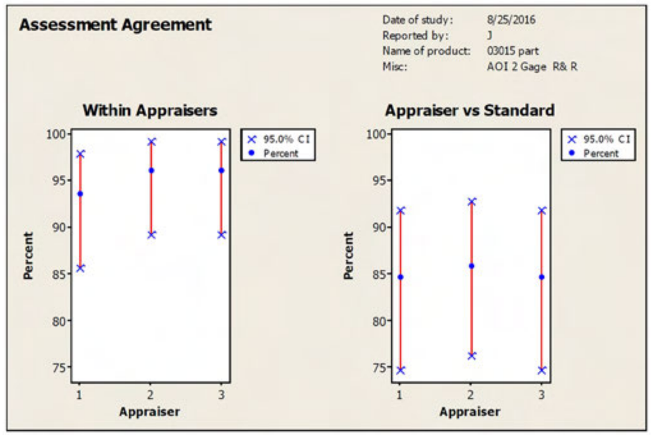

Figure 4b: AOI 2 GR&R.

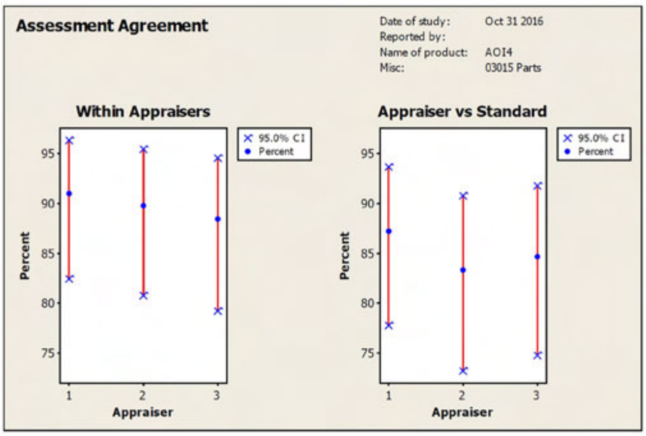

Figure 4d: AOI 4 GR&R.

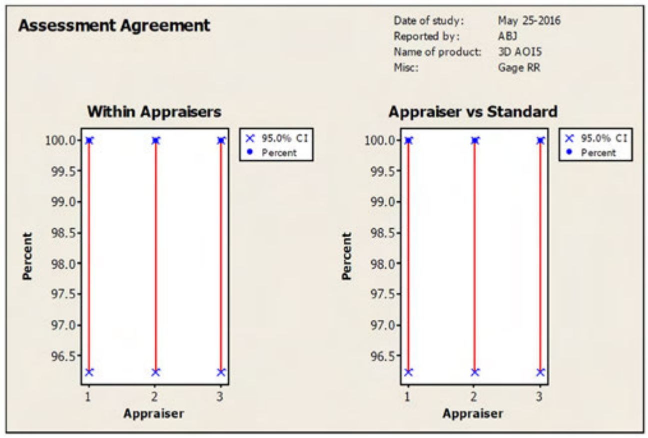

Figure 4e: AOI 5 GR&R.

cellent attribute gage R&R for appraisers agreement percentage. For the agreement for each appraiser versus standard percentage: AOI System 1's result is OK; both AOI System 2 and System 4 have good results. AOI System 6 has very good results, while AOI System 5 has excellent results.

AOI Testing Results

A total of 1,230 components on the five boards were tested for this project on different AOI machines, where AOI 1 is 2D AOI, the rest have 3D AOI capabilities. However, 3D was not used in this stage of the study. The main two items (defects escaped %, and false call PPM) were used to evaluate each AOI machine's test capabilities. The defective component location is confirmed by engineers of the company and the AOI Suppliers based on the AOI images, optical pictures, and optical metrology equipment. Figure 5 is the picture from the optical metrology equipment. It is clear to see that components R1, R6, and R7 are misaligned as defects;

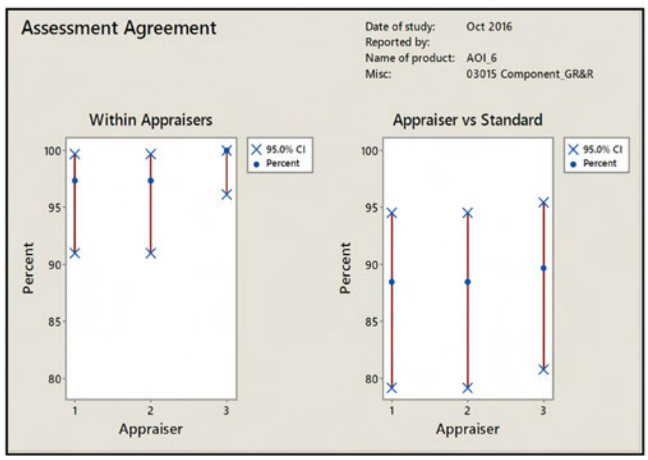

Figure 4f: AOI 6 GR&R.

Machine	Appraiser Agreement %			Agreement for Each Appraiser vs Standard (%)		
	Appraiser1	Appraiser2	Appraiser3	Appraiser1 vs STD	Appraiser2 vs STD	Appraiser3 vs STD
AOI 1	97	100	99	76	78	77
AOI 2	94	96	96	85	86	85
AOI 4	91	90	88	87	83	85
AOI 5	100	100	100	100	100	100
AOI 6	99	99	100	95	95	95

Table 1: Attribute GR&R Results for AOI 1, AOI2, AOI 4, AOI 5 and AOI 6.

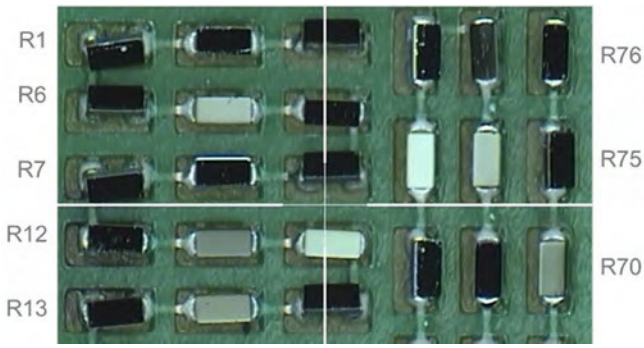

Figure 5: Optical metrology equipment picture for components with pitch 200 μm.

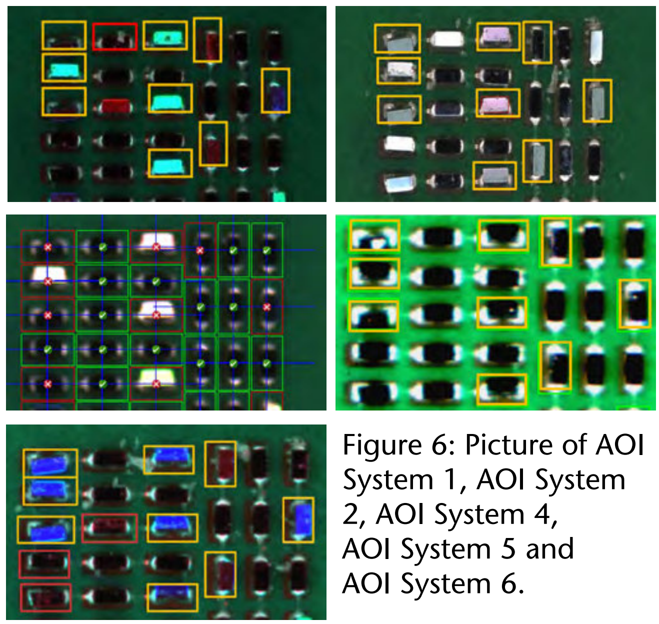

Figure 6: Picture of AOI System 1, AOI System 2, AOI System 4, AOI System 5 and AOI System 6.

the components R3, R9, R15, R72, R75, and R78 are confirmed as defects per the AOI image, optical image, and the engineers review.

Figure 6 list pictures of four AOI machines for the same 24 components on the same board, where pad pitch is 200 μm. For these 24 components locations, nine are defects. Both of AOI System 1 and AOI System 4 have one false call with a red rectangle, while AOI System 6 has three false calls; however, it has 100% agreement with the standard list for AOI System 2, and AOI System 5. A yellow rectangle indicates the component as a defective location. It is noted that all AOI machines (AOI System 2, AOI System 4, AOI System 5 and AOI System 6 are 3D AOI machines) used their 2D algorithm to test these five boards since the height of 03015 components could not be measured because a mirror surface material of the component created noise at the machines.

The AOI algorithm threshold for AOI System 1, AOI System 2, AOI System 4, AOI System 5 and AOI System 6 are listed in Table 2. All these algorithms are 2D AOI functional algorithms. AOI 1 machine was adjusted from the setting of 19 μm/pixel to 10.5 μm/pixel for improved resolution of the camera by the AOI System 1 support engineer at our site. AOI System 2 is the 3D AOI machine with 6 μm resolution with camera type as 12Mpix. However, AOI System 2 used its 2D algorithm (PadMatch) for testing 03015. The threshold settings are: Similarity: 55; Rotation: 4degree; Xshift, 35 μm; Yshift: 35 μm. AOI System 4 used its LW (length and width) tracking to test the 03015 component, the LW tracking is 2D algorithm, and its threshold settings for this project are: XY ± 35 μm, and for Theta, ± 10 μm. AOI System 5's main algorithms are: Classification Match, 180; Rotation, 5 degrees; Xshift, 35 μm; Yshift, 35 μm. The main algorithm for AOI System 6 are: hori-

Machine	Algorithm	Threshold
AOI 1	Pad Green Rectangular search region	Horizontal offset: 30 µm, Vertical offset: 45 µm, Skew: 10 degrees
AOI 2	Pad Match (Similarity, Rotation, Xshift, Yshift)	Similarity 55, Rotation 4 degrees, Xshift 35 µm, Yshift 35 µm
AOI 4	Length/Width Tracking	XY: ±35 µm, Theta: ±10 µm
AOI 5	X, Y, Rotation, Solder fillet	Classification Match 180, Rotation 5 degrees, Xshift 35 µm, Yshift 35 µm
AOI 6	Measurement of body offset from centroid	Horizontal Threshold: 100 µm; Vertical Threshold: 50 µm; Skew Threshold: 40 µm

Table 2: AOI Main Algorithm Threshold for AOI System 1, AOI System 2, AOI System 4, AOI System 5 and AOI.

Machine	Defects Detection %	Defect Escaped %	False Call #	False Call PPM
AOI 1	92.91%	7.09%	13	17981
AOI 2	64.78%	35.22%	22	17886
AOI 4	53.67%	46.33%	51	41463
AOI 5	97.91%	2.09%	37	30081
AOI 6	98.74%	1.26%	45	36285

Table 3: AOI Testing Results for AOI System 1, AOI System 2, AOI System 4, AOI System 5 and AOI System 6.

zontal threshold: 100 µm; vertical threshold: 50 µm; and skew threshold: 40 µm.

AOI test results are listed in Table 3. Both AOI System 5 and AOI System 6 have the very good defects detection percentage. It is noted that all the machine false call PPM are higher than our expectation which we wish is <5000 for false call PPM (parts per million). AOI System 1 data is for four of the five boards, and does not include pad pitch 100 µm for three boards due to its limit capability. The data of AOI System 2, AOI System 4, AOI System 5 and AOI System 6 are from all five boards with all 03015 components. AOI System 4 may have significant improvement with a new camera to be installed shortly. AOI System 2, AOI System 5 and AOI System 6 also have improvement steps in progress. AOI System 3 will provide its testing results after making some progress.

Conclusion

Current AOI machines have different levels to test 03015 components; however, all AOI machines involved for this project used 2D AOI function as 3D algorithms were not usable due to component reflection.

Attribute gage R&R results are acceptable for these five machines (AOI System 5 had excellent results).

Based on the data which we have now, AOI System 5 has the best performance for Defect Escape %; however, no machine had false call PPM (parts per million) <5000.

This study is just the beginning. More boards (with no reflection) are needed to test with the AOI machines, especially when using 3D algorithms. More improvements to the machines are coming from several of the AOI system R&D teams. SMT

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Acknowledgements

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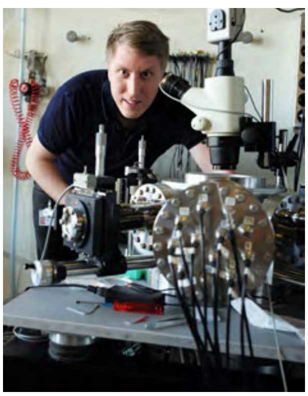
David Geiger, Zhen (Jane) Feng, Ph. D., Alan Chau, Vincent Nguyen, Hung Le, Stephen Chen, Robert Pennings, Christian Biederman, Weifeng Liu, Ph. D., William Uy, Anwar Mohammed, and **Mike Doiron,** Flex International.

Ballistic Nanowire Connections, A Potential Future Key Component for Quantum Computing

IBM scientists have achieved an important milestone toward creating sophisticated quantum devices that could become a key component of quantum computers.



In their paper "Ballistic one-dimensional InAs nanowire cross-junction interconnects" (as detailed in the peer-review journal Nano Letters), IBM scientists in Zurich have shot an electron through a III-V semiconductor nanowire integrated on silicon for the first time.

Using their recently developed Template-Assisted-Selective-Epitaxy (TASE) technique to build ballistic cross-directional quantum communication links, they pioneered devices which can coherently link multiple functional nanowires for the reliable transfer of quantum information across nanowire networks. The nanowire acts as a perfect guide for the electrons, such that the full quantum information of the electron (energy, momentum, spin) can be transferred without losses.

By solving some major technical hurdles of controlling the size, shape, position and quality of III-V semiconductors integrated on Si, ballistic one-dimensional quantum transport has been demonstrated. While the experiments are still on a very fundamental level, such nanowire devices may pave the way towards fault-tolerant, scalable electronic quantum computing in the future.

The paper's lead author, IBM scientist Dr. Johannes Gooth, noted that the milestone has implications for the development of quantum computing. By enabling fully ballistic connections where particles are in flight at the nanoscale, the quantum system offers exponentially larger computational space.

Long-Term Storage of Electronic Components and Compositions

by Rich Heimsch
SUPER DRY-TOTECH

In part one of this series, we reviewed some of the reasons why long term storage of electronic components is both a problematic, as well as an increasing requirement for many electronic assemblers.

Rapid changes in packaging design and material force companies to purchase forward quantities to guard against the impact of component obsolescence on their final product.

Product lifecycles have become very short with new models being released sooner than ever before. Many manufacturers in industries including automobiles, aviation and avionics, military and railway must guarantee the availability of replacement parts (including PCBs) for 10 or even 20 years. This demands the advance purchase and extended storage of components and materials. Further complicating the problem is that most components cannot be stored for more than a few years without very special handling procedures.

IPC JEDEC Standards

Though the original document was released almost two decades ago, and new technologies have been introduced since, IPC/JEDEC J-STD-033 addresses a broad range of fundamentals regarding moisture-sensitive devices and their proper handling. Updated several times since its initial publication, the 2012 Rev C clarified some storage time definitions, but very long term storage of the extent faced by manufacturers mentioned above is not completely addressed.


THE FUTURE OF ELECTRONIC MANUFACTURING
4.0
Real-time data from machine to machine (M2M) communication provides:
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• Unparalleled quality control
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5.3 Safe Storage: Safe storage means dry SMD packages held in a controlled humidity condition such that the floor-life clock remains at zero. Acceptable safe storage conditions for SMD packages classified as Level 2 through 5a are listed below.

5.3.1 Dry Pack: Dry-packed SMD packages in intact MBBs, stored per Clause 3.3, shall have a calculated shelf life of at least 12 months from the bag seal date shown on the caution or bar code label.

5.3.2 Shelf Life: The minimum calculated shelf life is 12 months from bag seal date. If the actual shelf life has exceeded 12 months, but less than two years, from the bag seal date and the humidity indicator card (HIC) (Clause 5.5.1) indicates that baking is not required, then it is safe to reflow the components per the original MSL rating. Although unanticipated, factors other than moisture sensitivity could affect the total shelf life of components.

Note: An HIC that has been continuously sealed in the MBB is typically accurate for at least two years.

5.3.3 Dry Atmosphere Cabinet: A storage cabinet which maintains low humidity by purging with dry air or nitrogen at 25 ± 5°C. The cabinet must be capable of recovering to its stated humidity rating within one hour from routine excursions such as door opening/closing.

- 5.3.3.1 Dry cabinet at 10% RH SMD packages not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 10% RH. A dry cabinet should not be considered a MBB. Storage of SMD packages in a dry cabinet should be limited to a maximum time per Table 7-1. If the time limit is exceeded the packages should be baked according to Table 4-2 to restore the floor life.

- 5.3.3.2 Dry cabinet at 5% RH SMD packages not sealed in a MBB may be placed in a dry atmosphere cabinet, maintained at not greater than 5% RH. Storage in a dry cabinet may be considered equivalent to storage in a dry pack with unlimited shelf life.

These guidelines address moisture within the component and mitigation of risks during reflow, but the solderabilty of components is also a significant consideration.

Because of surface oxidation, components and PCBs can suffer from reduced solderablity, which often results in complete failure. Diffusion of vapor and noxious substances in the inner structure of the components or PCBs can result in long-term disintegration of conductor paths and insulation layers. Both risks can be avoided by correct handling and dry storage.

The Oxidation Process—Contact Corrosion

In an ultra-dry atmosphere there is no corrosion. For corrosion to occur, two demands must be met: there must be a means of oxidation, and there must be a watery solution, which works as an electrolyte. The oxygen in the air forms the means of oxidation, the vapor (humidity) the electrolyte. The critical limit at which oxidation with oxygen takes place, depending upon the metal or alloy, at between 40 and 70% RH. This means that more than eight grams of vapor per m^3 must be present. As a side note, 0.5% RH, used commonly today, reduces water content to 0.05 grams per m^3.

The effects of long-term storage on the solderabilty of components was studied in some detail by DFR Solutions, including in one titled "Solderability After Long Term Storage." In this case study, the solderability was assessed for components from three different reels stored for up to five years to determine how much additional storage life was available. The components were either an ASIC in a SOIC package or a MOSFET in a TO-252 package. In both situations, the lead frame plating was tin-based[1].

Both oxidation and intermetallic formation occurred, as would be expected for the reasons described previously. Oxidation can be prevented with the use of low humidity storage, or potentially mitigated with the implementation of more aggressive fluxes.

Intermetallics, however, cannot be addressed in either of the same ways. Temperature therefore is an extremely critical parameter to control during long-term storage. Intermetallic growth rate is strongly temperature-dependent and doubles for each 10°C temperature increase. This aging process can be slowed by appropriate cooling. However, the risk of whisker formation of tin alloys increases with decreasing temperature. Studies and practice have shown that a storage temperature of 12°C is optimal to best mitigate both risks, while maintaining a storage humidity of <5% to arrest oxidation and preserve solderability. SMT

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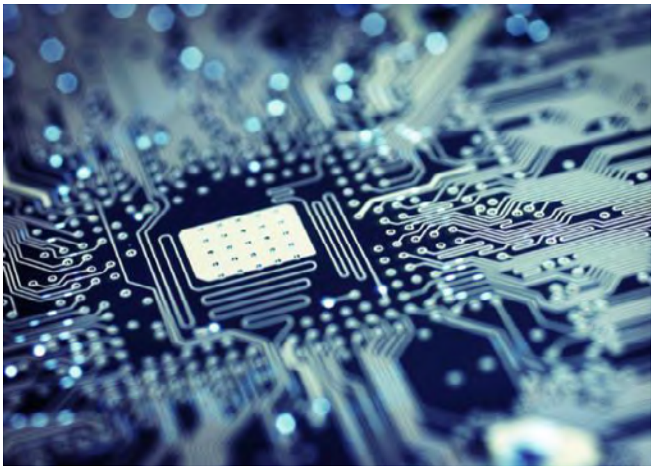
Rich Heimsch is a director at Protean Inbound and for Super Dry-Totech EU in the Americas. To read past columns, or to contact Heimsch, click here.

Miniaturized 'Heat Engines' Could Power Nanoscale Machines of the Future

Research from the University of Manchester has thrown new light on the use of miniaturized 'heat engines' that could one day help power nanoscale machines like quantum computers.

Dr. Ahsan Nazir, a senior lecturer and EPSRC Fellow based at Manchester's Photon Science Institute and School of Physics and Astronomy, wanted to see how heat engines performed at the quantum level. Heat engines at this scale could help power the miniaturized nanoscale machines of the future, such as components of quantum computers.

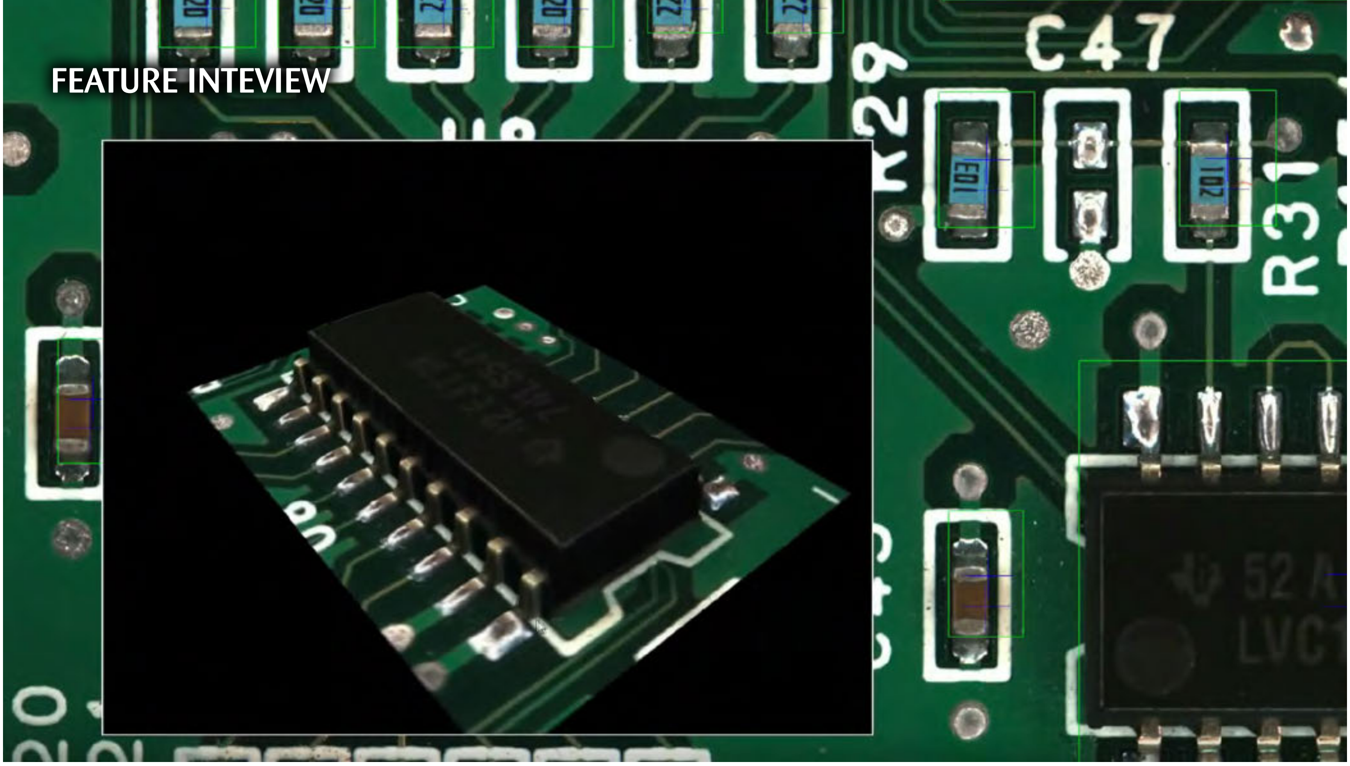
Dr. Nazir's research, published in the journal Physical Review E, showed that heat engines were inclined to lose performance at the quantum scale



due to the way such devices exchange energy with external heat reservoirs – and more investigation would be needed to remedy this challenge.

"Recently, much interest has focused on quantum realizations of engines to determine whether thermodynamic laws apply also to quantum systems. In most cases, these engines are simplified using the assumption that the interaction between the working system and the thermal reservoirs is vanishingly small. At the classical macroscopic scale this assumption is typically valid – but we recognized this may not be the case as the system size decreases to the quantum scale," explained Dr. Nazir. "Consensus on how to approach thermodynamics in this so-called strong coupling regime has not yet been reached. So, we proposed a formalism suited to the study of a quantum heat engine in the regime of non-vanishing interaction strength and apply it to the case of a four stroke Otto cycle.

"This approach permitted us to conduct a complete thermodynamic analysis of the energy exchanges around the cycle for all coupling strengths. We find that the engine's performance diminishes as the interaction strength becomes more appreciable, and thus non-vanishing system-reservoir interaction strengths constitute an important consideration in the operation of quantum mechanical heat engines."



Saki Discusses Industry 4.0 and True 3D Technology

by Stephen Las Marias
I-CONNECT007

Quintin Armstrong, general manager for North America Sales and Service at Saki America, speaks to *SMT Magazine* about the Industry 4.0 strategy for inspection equipment providers. He also explains why manufacturers are finding it more relevant than ever to have an inspection line in their assembly lines.

Stephen Las Marias: For starters, Quintin, tell us more about Saki.

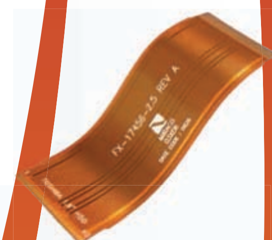
Quintin Armstrong: Saki is a Japanese company that has been in business for about 23 years now. In the AOI realm, Saki got their start developing the line-scan 2D technology, and that became the benchmark for 2D systems back in the early days of AOI. In more recent times, we've been involved in X-ray equipment. Saki has a full line of automated X-ray inspection equipment and, with the onset of 3D technology, Saki not only developed one of the first 3D AOI machines, but also developed a 3D SPI, utilizing the very same technology that Saki uses in the 3D AOI machines. That brings us up to the point where, now, when we look at Saki's lineup, we have all the 2D legacy equipment plus the full 3D lineup, SPI, AOI and X-ray.

Las Marias: What can you say about the Industry 4.0 trend? Do you think people are ready for it?

Armstrong: Of course, that's the current topic. We've seen some of these initiatives come up in the past and probably we never totally followed on through, but we do have a new situation too with the internet being so prominent. The Internet of Things is a real trend. Now, it's figuring out exactly what we can and will do with it, and how to go about that. There's a lot of activity going on with the machine connectivity, the hand shaking, feed forward, feedback, SPI to printer, SPI to placement, AOI to placement, etc. There certainly is some good potential there, but I think there's still a lot to be defined as to where it's going to go.

Las Marias: What do you see as the challenges?

mechanical
environmental
electrical
cost
SOLUTION



Quintin Armstrong

Armstrong: Well, one of the things is to have a standard for the information we exchange, the format of that information, and the avenue for channeling that information from one equipment supplier to another. Another thing that's very important is having data that is actually usable and actionable. It's one thing to transmit data, but you need to have some kind of useful data. So, things like accuracy come into question with the AOI inspection. Are you able to generate data that is accurate enough to actually provide some useful actionable resolve in the mating equipment?

And this is something that Saki has had a great deal of success in. Mainly because since the very first machines that Saki made, they've always been not only inspection but measurement equipment. So that measurement aspect has always been very important for Saki, for say, carrying down through the development of the 3D line up. Now, we see that being a nice benefit for us as things develop into this interconnectivity and Industry 4.0, smart factory.

Saki has the SPI and the AOI equipment and X-ray, all of that can provide feedback data to feed the process with the mating equipment and to trigger the mating equipment to make adjustments, correct placements, based on the data that's measured and fed back. Saki is working with several of the major suppliers, both with pick-and-place equipment and screen printers. A good amount of this is already done, and we're continuing to work with some of the other big players and pursue more to be able to reach out to all the major pieces of equipment in the line, and exchange useful data that can be used as we figure out just where all this is going to go.

We don't want to just limit ourselves or anybody else to just meeting up with certain suppliers, and there's a wide variety of equipment out there and a wide mix of how that equipment is mated together. It's important to be able to reach out to the entire market and be able to provide our solutions to the entire market and to work with the wide variety of suppliers.

Las Marias: Are standards now being developed towards that goal?

Armstrong: Well, let's say there's at least talk about the need for that. I guess it's not really clear yet just where we are with establishing those standards, but the need is identified and thought and action being taken in that regard.

Las Marias: In the AOI space, what specific developments are happening that are geared to supporting customers toward that trend?

Armstrong: Certainly, the connectivity aspect is very important, but what you're able to communicate through this connectivity is extremely important, and that's one of the things that's become very apparent as we move through the process. What kind of data and how accurate is your data? That determines how useful it's going to be, not only to the customer but in the production line itself.

If you can't give accurate data to a pick-and-place machine to make it into some kind of a meaningful correction, or the same with SPI to printer and so on, then you really don't have anything useful to work with. These needs became apparent and identified and fortunately, in our case with Saki, we're in very good position with that.

We have very accurate data to be able to communicate with the other machines, and that gave us a good step in the right direction right from the beginning, instead of finding out that maybe there was something we needed to correct before we'd be able to provide some accurate feedback. It's a benefit at that point.

Las Marias: What opportunities are you seeing in the market right now?

Armstrong: Certainly, this is an ongoing process. It's in its infancy stages and just starting out. So there's a lot of work to do in this. Having said a few sentences about what it's all about doesn't at all reflect the amount of activity that goes into it. One thing that you would hear most people express is figuring out now just exactly where we go with all this. How do we make it as useful as it can be? It's a lot of talk about collecting a lot of data, but not necessarily a lot of definition about what we can do with that data right now. So that's something that's ongoing and, of course, with so many suppliers with so many types of equipment, it's quite a lengthy process just to establish all of that type of interconnectivity and data feedback.

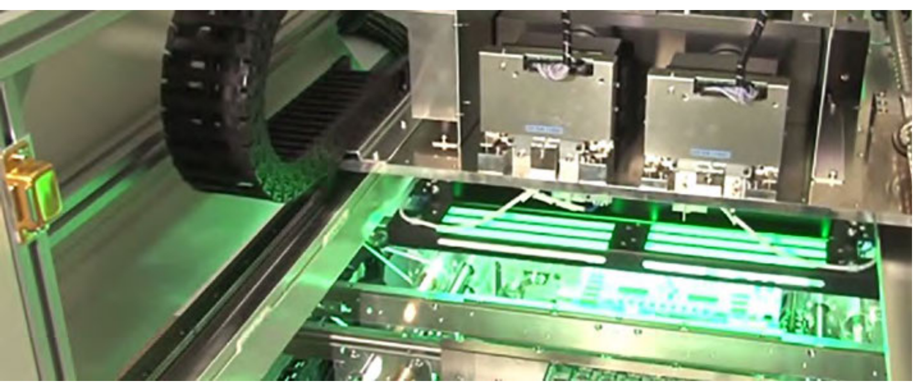
Las Marias: With all this data that will be collected out of inspection or production, it must require a really strong software development team.

Armstrong: Absolutely. One thing that's made that easier is we already had the quality data available to us and inherent in our systems to begin with. That has allowed us to now focus on this connectivity aspect and being able to exchange that data with other types of equipment. We also have a software group at our headquarters in Japan and in Europe. So there's a lot of activity going on with this, as well as, of course, in other projects like the focus on the miniaturization of components and then the need to be able to fully read and measure aspects for 0201 metric components. A lot of work going out in that area and it's all really tied together.

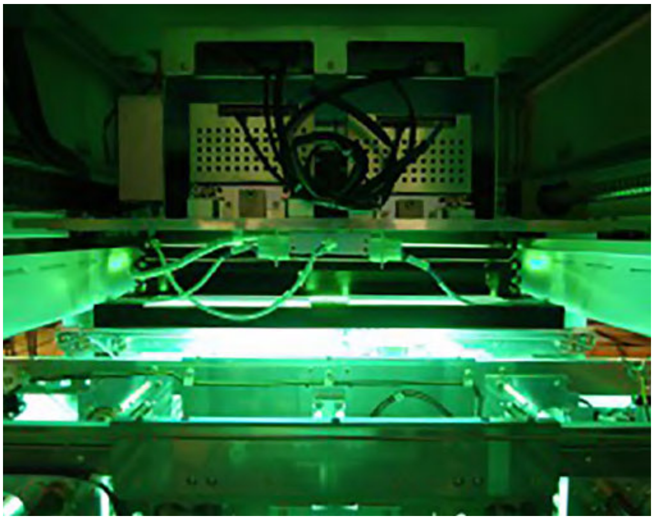
Las Marias: Manufacturers considered inspection as an added cost before, but nowadays they're finding it increasingly more relevant to have an inspection line in their manufacturing process.

Armstrong: There was a time in the early days of AOI where basically a lot companies just wanted to say that they had AOI, that they had an inspection process. But it wasn't necessarily utilized in a way that would be all that meaningful to actually improving the process and the end-product quality. This is again, another aspect for Saki that's really been an advantage, because since day one all the machines have been inspection and measurement machines. So, Saki has always had that capability for that kind of meaningful measurement and data that could be used and designed exactly with the idea of improving the process to improve the end-product quality.

As we move into the onset of 3D technology, maybe some of those that first had AOI just as a way of saying that they had inspection in the process, it now becomes something more meaningful and there's more that can be done with it. It can now be utilized in a more powerful manner. We've seen a big realization of that over the last couple years. I think there was a lot of reluctance with 3D in the beginning, but now everybody's realizing the benefits that that can bring versus the way AOI was viewed some years ago. So it really is being seen now how this can be used to improve the process and the end-product quality in a more meaningful manner.



Las Marias: How do you help those companies who have invested first in 2D AOI, and now need to transition to 3D as boards get more complex?



Armstrong: As new technology becomes available, and people see the benefits of it, they want to incorporate that technology into their process and into their factory. That really is a driving factor. The 3D technology, especially true 3D like Saki has, can be utilized in a manner that just wasn't there with the 2D technology. People are doing it because they're realizing the benefits that the 3D technology can provide. Saki, having the long legacy equipment in 2D, was able to carry all of that over into the 3D systems. So it makes Saki's 3D solutions even more powerful by bringing a lot of those features from 2D forward. Because the fact of the matter is some things are best inspected using 2D algorithms and other things are best inspected by 3D systems. Having a system that can handle both of those technologies equally as well is important to having a total inspection solution and inspection measurement. That certainly is a strength for Saki.

Las Marias: Does that mean they have to take out their 2D AOI and replace it with 3D AOI, or can that equipment work together?

Armstrong: In some cases, it may be where they would be utilized together or for different products or different parts of the process, because the need for 3D can also be determined by the complexity of the board and the criticality of the product that you're making. All those factors come into play. But basically it's all going toward 3D. The benefits are becoming clearer and clearer, and especially when you got a system like Saki's that incorporates the 2D and 3D so well, really it doesn't make sense to invest in old technology and limit yourself that way.

Las Marias: What do you think will be the next stage in the development for the AOI equipment space?

Armstrong: That's a good question. As we know, of course, the interconnectivity and Industry 4.0 aspects are going to continue to be of great interest, and then the miniaturization and being able to accomplish the miniaturization with speed improvements and the flow of the factory. Those are certainly important factors in being able to inspect a greater range of components and greater situations on a board, densities and so on. These are ongoing endeavors, but certainly continue in that direction, and we'll see where else.

Las Marias: Quintin, is there anything else you would like to discuss today?

Armstrong: I think we've pretty well covered it for this realm. It's certainly a fast-moving industry. Technology is fast moving. We see that with the Industry 4.0 endeavors, but there are a lot of good things going on.

Las Marias: How do you see this year developing?

Armstrong: This looks like a very promising year. We just went through an election year last year, that seems to have had some impact on things at times, but 2016 was good and there's optimism in the market for 2017. With a lot of things going on, like autonomous vehicles and things like that, there's a lot of activity and things evolve so quickly. We see some important things happening that I think will continue to drive the market. Of course, inspection and measurement is a critical part of that as these things get to be more and more complex.

Las Marias: Thank you very much, Quintin.

Armstrong: Thank you. **SMT**

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Electronics Industry News
Market Highlights

Power Industry Focuses on Renewables: Solar PV is the Fastest Growing
Increased decentralization, the need to decarbonize electricity generation, and digitization to boost operational efficiency are driving market opportunities in the power industry. Continued regulatory support for renewable energy in key markets will see global power investment reach $443.5 billion in 2017.

Global IT Robotic Automation Market to Grow at CAGR of 64%
The global IT robotic automation market generated revenue of $474.9 million in 2016 and is anticipated to contribute $38.88 billion by 2025, growing at a CAGR of 64.3%.

Strong Security Proves Essential for Enterprise Smartwatch Adoption
ABI Research forecasts enterprise smartwatch shipments will reach nearly 14 million in 2022, increasing from just more than two million in 2017.

IR Sensor Module Market to Reach $145M in 2017
With more high-end smartphones adopting 3D sensing, TrendForce estimates that the worldwide market scale of IR sensor modules for mobile devices will reach $145 million in 2017.

Worldwide Enterprise Tablet Market to Grow at a CAGR of 9% by 2021
The global enterprise tablet market is forecast to grow at a CAGR of 8.61% during the period of 2017 to 2021 amid increasing adoption among SMEs worldwide.

Fiber Optic Connector Market Worth $5.9B by 2025
The global fiber optic connector market is expected to reach $5.9 billion by 2025, according to a new report by Grand View Research Inc.

Integrated Passive Devices Market Worth $2.64B by 2025
The global integrated passive devices market is expected to reach $2.64 billion by 2025, according to a new report by Grand View Research Inc., mainly driven by growing demand from the wireless, electronic, handheld devices.

Spending on Consumer Video Media Services to Reach $314B in 2017
Global spending on consumer video media services will total $314 billion in 2017, a 4.2% increase from 2016, according to Gartner Inc.

India IT infrastructure Spending on Pace to Reach $2.2B in 2017
IT infrastructure spending in India will total $2.2 billion in 2017, a 1.5% increase from 2016, according to a new report by Gartner Inc.

Global Inspection Robots Market to Grow at a CAGR of 17% by 2021
The global inspection robots market is forecast to grow at a CAGR of 16.68% during the period 2017-2021, driven by the fact that with their advanced capabilities, robots can help industries to minimize labor cost and focus on achieving higher operational excellence.

KOH YOUNG DISCUSSES LATEST

AOI INNOVATIONS

by Stephen Las Marias
I-CONNECT007

At the recent NEPCON China event in Shanghai, I caught up with Koh Young Technology's Overseas Sales Team Manager Scott Kim, to talk about the latest challenges and developments happening in inspection technologies. We also discussed the key factors to consider when it comes to buying inspection systems.

Stephen Las Marias: Scott, what are the new demands or requirements from your customers when it comes to inspection?

Scott Kim: Recently, more and more customers want to have 3D based technology, especially for measuring component heights. Previously, customers once checked the defects based on 2D technology, but now it's already moved to 3D. 3D has almost become the standard in this industry.

Las Marias: What's the key factor here for users to move to 3D?

Kim: The key factors are the false-call rate, escape rate and productivity. Comparing 2D inspection technology to 3D, there's a big gap when it comes to these parameters. So, more and more customers, once they evaluate a 3D AOI system, and compare the performance to their existing 2D systems, eventually they select 3D for their inspection technology.

Las Marias: Does it make sense to have both 2D and 3D inspection systems in a line?

Kim: Yes, as there's another key difference between 2D and 3D technology. In 2D, usually you just find the defects. Normally, 2D users, focusing on just defects, are reluctant to change to 3D without paying attention to false calls. However, 3D is different. We are measuring something, not just detecting defects.

For instance, we measure the height so that we have data, and based on that data, we set the tolerance. Beyond that tolerance means a defect, and within the tolerance, it's a pass. So, before having a reject, we have measurement data, which is the key advantage of 3D AOI. We

can utilize the measurement data. It's really big data, which includes volume information and offsets, everything. With that measurement data, you can optimize and improve the process. Eventually you will get very good productivity. That's the key benefit of using 3D AOI.

Las Marias: How do you help your customers understand this so that they can fully appreciate the benefits they can get in 3D?

Kim: To persuade customers and help them to understand the concept of 3D AOI, we need a tool. That's the software. Without a good, easy-to-use software, we cannot convince customers. That's what we are emphasizing today. That is the multi-line concept of production management, based on an intelligent platform. Intelligent platform means automation and more intelligent management provided by Artificial Intelligence (AI). We are putting a lot of resources to develop that area. Eventually, we want to make more automation and less human element in inspection.

Without having that kind of strong, powerful software technology or automation, it's useless. You cannot handle such big data. Therefore, someone needs to help to analyze the data. That's one thing that we are targeting and we are focusing on. More automation and more intelligent software platforms.

Las Marias: What is your strategy for Industry 4.0?

Kim: Our strategy for Industry 4.0 is a multi-line management concept. Previously, many customers had multiple lines, for example, 10 lines and 10 pieces of inspection equipment. This means the user has to manage 10 times of work because each system has no joint connection. Although in the modern day, everything is the same, but actually they work differently. For 3D technology, as I mentioned, we have measurement data. If we calibrate the system, the measurement data should be equal regardless of environmental change.

That means we can do centralized management. That's one of the things which we are targeting for Industry 4.0. A centralized concept so it doesn't matter if it's 10 systems or 100 systems, they will all work like one system.

Scott Kim

Las Marias: What other developments are happening in the 3D AOI space?

Kim: This year we are introducing another new technology. For example, although we have 3D technology, actually the camera projects from top. It means we get the information from the top. That's one of the limitations for 3D AOI. You cannot see beneath the components. This time, we introduced a camera technology from the side as well. Now we can inspect both the top and side. Conventionally, 2D AOI also has a side camera solution as an option, but our 3D side camera is different from others as it has been developed with 3D technology, which is why we call it a 3D multi-measurement camera.

We use four side cameras, but each side camera has 3D information—the same as the top camera. For instance, when we use top camera to inspect a solder joint, the information may be limited. We still have 3D, but the information is limited. However, if you use the side cameras as well in 3D, you will get solder joint shape, volume, height, everything. It's much more accurate than just having the top camera. And then we combine both data to deliver our customer a perfect solution.

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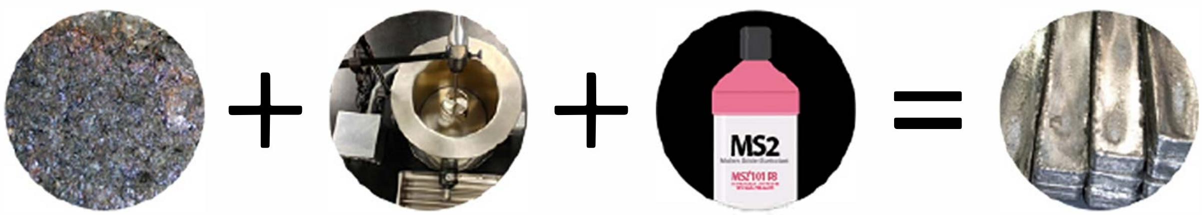

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Las Marias: Previously, manufacturers say inspection doesn't add any value. But nowadays, there is an increasing effort to install inspection systems in electronics assembly lines. What has changed?

Kim: The main change is the size of the component and the density of the component. Previously, the components were bigger, so inspection can be done by operators without any problem. However, component sizes now have become smaller and smaller, and PCB assemblies have become denser. It's very difficult to control the production and therefore the defects. It's necessary to use an automated inspection system.

However, it also leads to another issue. If the equipment isn't accurate, it causes more false calls, therefore the operator still must check whether the false calls are indeed false calls or a real defect. For customers, it means higher cost and more human resources. Just because you are using an automated optical inspection system doesn't mean your inspection is good. You need to use the accurate equipment to save you cost.

Las Marias: Having said that, what are the key factors to consider when it comes to 3D AOI?

Kim: Customer now are using very small-sized chips and components, so they should check whether 3D AOI is the type of the tool that can inspect for defects from the small sized components—which the normal 2D AOI couldn't check properly. That's the first one. Second, the labor cost is increasing nowadays, so customers should use an automated system without too many false calls to make their work easier and simpler. Now, we are even targeting automated programming and automated fine tuning. Eventually we think we can realize unmanned production by AI technology. So that's also the reason why we are putting a lot of resource into developing our AI technology, not just the equipment itself.

Las Marias: Scott, is there anything else you would like to talk about?

Kim: Other than the software and some accurate machine performance, we still have many new applications that can deliver good benefits for the customers. For example, we introduced a new feature in the SPI system. Conventionally, the inspection system only checks for defects, but this time, we delivered a solder dispensing solution with SPI, in which the SPI inspects the defect, for example, in soft shell solder or no solder pad. And then it can dispense solder and improve the solder joint. This can help improve the production yield.

Las Marias: Scott, thank you very much for your time.

Kim: You're welcome. **SMT**

RTW NEPCON CHINA: Mycronic Meets High-volume Demand With Solder Jet Printing

Mycronic VP for Global Dispensing and Managing Director Clemens Jargon discusses how the flexibility of solder jet printing helps reduce downtime in the line, thus increasing total line speed and enabling it to keep up with high-volume demand.

Jargon also focuses on their recent acquisition of China-based Shenzhen Axxon Automation Co. Ltd; the difference between the quality of yields in stencil printing and jet printing technologies; and their Industry 4.0 strategy.

Watch the interview here.

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Reading, Writing, Listening, Speaking and Analyzing Material Cost in the Global Economy, Part 1

by Tom Borkes
THE JEFFERSON PROJECT

"These are the times that try men's souls."

Thomas Paine, an 18th century activist and American founding father reportedly wrote that two days before Christmas in 1776, and it comes from his short essay entitled, The Crisis. Distributed in pamphlet form throughout the former colonies that had recently been declared the United States of America the war for independence was more than a year old when it was published.

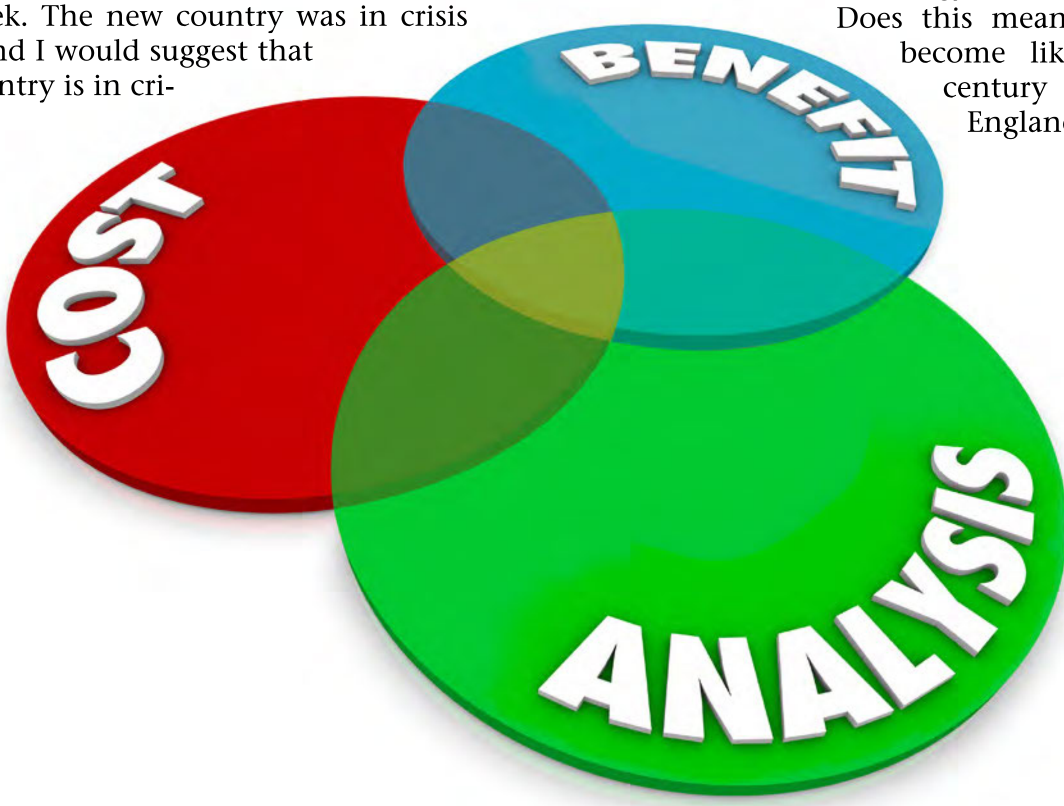
This new experiment in self-government began on a field in Lexington, Massachusetts, on April 19, 1775. At that time, the idea of people governing themselves was laughable to most of the world's population and to over one-third of the colonies in revolt.

However, a quick assessment of the condition of the country today could be summarized by the same quote, and could have been written last week. The new country was in crisis then, and I would suggest that our country is in crisis now.

But, instead of shouting "the British are coming," we should be shouting, "the Robots are coming." The intelligent machine labor invasion will lead to societal dislocation and disruption. The chaos will result from a significant segment of the population having no saleable skills to replace the jobs that the automation has taken away. Search YouTube for "Fast Food Company Develops Robots," to see an example.

Social unrest will ensue. The people affected will demand the government provide for them. Individual freedom and self-government will be traded-in for government welfare. Why is individual freedom important if the government gives you everything you need? The dystopia that will be created will be fought by a counter-resistance that will develop, but as said while back, "it is hard to vote against Santa Claus."

Is technology then the enemy? Does this mean we should become like the 19th century Luddites in England who pro-



tested (and destroyed) the weaving machines that were replacing the manual labor workers of the cloth-producing industry?[1]

Should we resist the use of the automated equipment that is replacing segments of the human workforce in our society—whether it is fast food production or workers on a progressive circuit board assembly slide line? In either case, it seems clear to me that this would be attacking the symptom and not the problem's root cause. An interesting, albeit at times a bit cringe-inducing, projection of this societal devolution is presented in the 1976 sci-fi film "Logan's Run," based on a 1967 novel by William Nolan and George Johnson. It's worth the two-hour viewing investment in my opinion. Remember, sometimes it's the thought that counts most. Actually, it's Jefferson vs. Hamilton all over again! An individual's value and inalienable rights vs. the government needing to control the "beast." You choose.

> **"Actually, it's Jefferson vs. Hamilton all over again! An individual's value and inalienable rights vs. the government needing to control the "beast." You choose."**

The first military engagement after the publication of the independence declaration by the Second Continental Congress was the Battle of Long Island, also called the Battle of Brooklyn. General Washington and his decimated troops fled across the East River to stop the bleeding as the British pounded the rebels to the point where most believed it was over—even George Washington was in despair! The legendary escape through Manhattan, New Jersey and into Pennsylvania led to Washington's bold surprise attack on the British (actually, Hessian mercenaries being paid to fight for the British) across the Delaware River in Trenton the day after Christmas in 1776. This was followed the next week by the Continentals' successful battle in Princeton, New Jersey. Nine-months later, the huge American victory in the second Battle of Saratoga, New York, in early October 1777 was the war's turning point as it gave the French (as well as Spain and the Netherlands) confidence to side with the rebels and against their perpetual enemy, England.

Jefferson believed that the ability of people to govern themselves was predicated on having an education and conducting their lives in a virtuous manner (i.e., doing the right thing when nobody is looking).

Without the population making decisions based on what was right, their government would fail.

Fast forward to the 20th century. Over the last several decades, we have had an analogous transformation from "government" rule to "individual responsibility and sovereignty" in electronic product assembly. Just substitute "company management" for "government." How? We have gone from the post-World War II production strategy of inspecting the quality into an assembled product by effectively putting an inspector behind every operator and assembler, to building the quality into the product. We do this by developing a statistically capable assembly process and having a production infrastructure in place that helps keep the process in control.

What is that production infrastructure? It is a combination of process and quality control measures and an educated human workforce. Therein lies the rub. This combination has been for the most part reactive with "uneducated" operators and assemblers being the direct labor on the factory floor. When defects occur, a higher "level" resource, e.g., a technician or engineer is called. Usually, it's too late and the defective product is moved to the rework operators. In-circuit test (ICT) and automated optical inspection (AOI) have become good (but expensive) tools to separate the good product we build from the defective product.

High levels of production machine data exchange that I call "Meta-Process Control," are being introduced[2]. In many circles, this has become known as "Industry 4.0." This is an extension of "proactive process control." It uses big data, the Internet and machine-to-machine

communications to proactively deal with material, equipment and other process variation theoretically without human intervention.

However, these complex systems require a workforce with high engineering skill levels. A workforce that not only can write code, but also understands the science involved in the electronic product assembly process. This will be the principal issue facing high tech manufacturing and production in the upcoming decade. So, all roads lead to education.

> “A workforce that not only can write code, but also understands the science involved electronic product assembly process. This will be the principal issue facing high tech manufacturing and production in the upcoming decade. So, all roads lead to education.”

I submit that it's not automation technology eliminating people's jobs that is the root source of the social angst and unrest that is surely around the corner. Then, what is it? It's an educational system that is not responding to the needs of the new industries that the automation technology is creating.

But, the fault does not solely reside in the secondary and post-secondary branches of the educational system. The primary (elementary) schools have allowed an erosion of the most basic skills needed for earning a living: reading, writing, speaking, and listening.

Teaching the fundamental skills needed to successfully compete both in post-secondary education (college) and the real world (industry) must be restored.

Social promotion in our primary and secondary educational system must end.

In many cases, and high-tech electronic product assembly is a good example, all roads lead to an ineffective system that is administered by an adult population that is detached from the real world. The social promotion of students and a fixation on school ratings has become a school's objective. Success in the real world is built on a foundation of reading, writing, listening and speaking. There are high schools in Connecticut that are graduating students who read at a 5th grade level and below. And, they represent 50% of the graduating population! What chance do these young adults have in the real world?

So, what does this have to do with the cost of materials for high-tech electronic products? People generally make decisions based on self-interest. Does this mean that they are selfish and do this at the expense of the general good? It could, but it doesn't have to. It really comes back to an issue we have discussed several times over the months in this column. Is it better to have 330 million equal pieces of the economic pie, or promote policies that increase the size of the pie? The choice is to have a population that is unequally rich, or a population that is equally poor.

In 1620, the pilgrims tried the “equal size slice” approach and failed miserably. The people of Harmony, Indiana tried to create a utopian town where people worked according to their ability and were compensated according to their need—again, failure. Today in Venezuela, a country rich in oil, people are starving to death[3].

All centralized authoritarian government schemes are confronted with the same challenge: trying to force all public policy through a narrow government funnel. History proves it never ends well. Never! The excuse always is that “centrally controlled economies will work and that failed attempts in the past are due to the leaders not knowing the best way to do it—we know the way!” They always lead to tyranny, corruption and public misery.

As we mentioned in our last column, there are four elements that need to be addressed when trying to compete against product assembly in low labor rate environments[4]:

1. High assembly yield loss causing labor costs in high labor rate operations to

balloon due to expensive rework. (Not an issue in low labor rate regions where rework labor costs can diminish the effect of poor process development and c ontrol.)
2. High indirect and general and administrative labor costs that must be absorbed and greatly inflate the labor sell rate.
3. Material cost differences—a potentially big issue. This is especially true for Tier 3, 4 and 5 operations that don't have facilities in low labor rate locations with a central procurement activity to leverage volume production and local favorable material pricing.
4. Government policy such as corporate tax, tariffs and regulation that affects the cost of doing business.

The first two are controllable. The second two are thought to be uncontrollable. But, are they really? How would we eliminate the disparity between component pricing when buying material for assembly in the Pacific Rim versus buying the same material for product production in Paramus, New Jersey? Make no mistake unless you are a Tier 1 or 2 product assembler with a global procurement group that serves multiple sites including ones in low labor rate regions, there are significantly higher prices when buying material for assembly in high labor rate markets like the U.S. Why? A paper was written addressing this in 2010[5].

There are two strategies to combat this inequity. The "unthinkable" approach is to competitively produce 0402 (English)/0201 (Metric) resistors, micro BGAs, bare circuit boards, et al., here in the States? Is it unthinkable? Why? We'll drill down into this fantasy next month.

The other approach is to demand our government, you remember the one that is supposed to do the will of the people and who, based on the Constitution create that "level playing field" we are always hearing about, use their international leverage. You know, the one that is by and for the people, the one that the people give up some of their inalienable freedom in the form of very limited government power. There isn't a good reason small- and medium-sized high labor rate assemblers should have to pay 10%, 20%, 30% or more when assembling in a high labor rate environment. Don't try and use the "shipping cost" excuse—it's negligible. Read the paper and inform me. I would appreciate being straightened out on this.

Until this is reconciled, getting the labor part of the cost worked out is like spitting into the wind, or like shoveling sand into the ocean. Or as George Carlin, also known as Al Sleet the hippy-dippy weatherman, would say, "RADAR has picked up a line of showers…but, the RADAR has also picked up a squadron of Russian ICBMs... So, I wouldn't sweat the thunder storms."

> "How do we get our government to challenge the manipulation of material cost? One way, is to organize and lobby."

How do we get our government to challenge the manipulation of material cost? One way, is to organize and lobby. Perhaps the Electronic Industry Alliance (EIA) would have been a good vehicle to act in behalf of electronic product assemblers. However, they dissolved and ceased operations in 2011. The ECA (Electronic Components Association) was designated to carry on passive standards development. They merged with NEDA (National Electronics Distributors Association) to form ECIA (Electronics Components Industry Association). Of course, JEDEC (Joint Electron Device Engineering Council) handles standards for active electronic components. All of these are technical standards-based organizations and not really involved in business issues. Maybe IPC, who was heavily involved in the lead-free debate, is the best hope. Or maybe a new lobbying organization needs to be formed. This is not a simple task as subjects like currency manipulation play a role in global material pricing.

Intelligent individuals are needed whose abilities are built upon strong reading, writing, speaking and listening skills! Do you know any?

At least that's what I think. Hey, what do YOU say? I'd like to hear your thoughts and opinions. **SMT**

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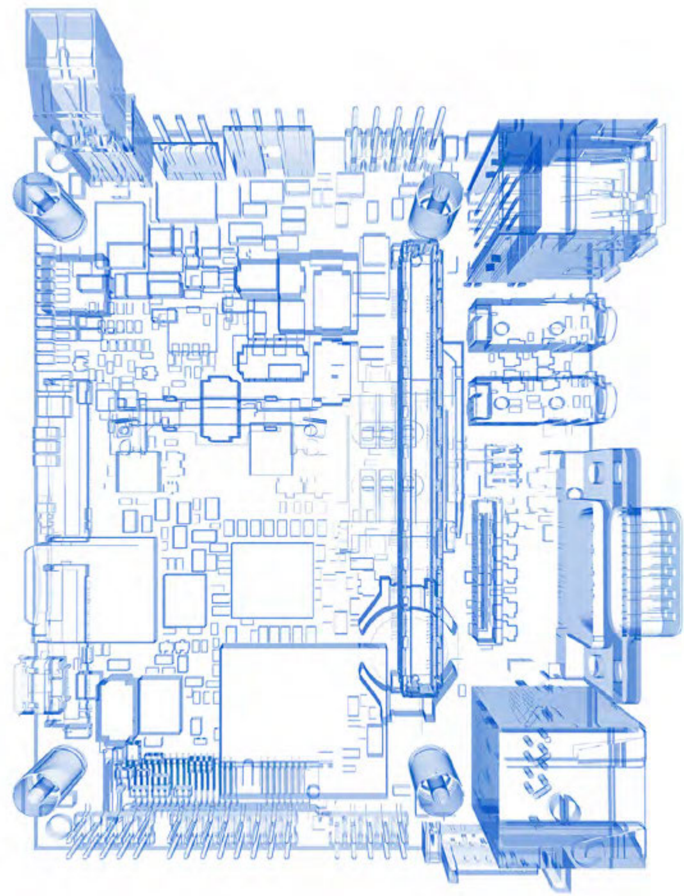
Tom Borkes is the founder of the Jefferson Project and the forthcoming Jefferson Institute of Technology. To reach Borkes, click here.

FEATURE

2D X-RAY INSPECTION with Materials and Thickness Identification



by Paul D. Scott, Ph.D.,
IBEX INNOVATIONS,
and Evstatin Krastev, Ph.D., P.E.,
NORDSON DAGE

Abstract

X-ray inspection systems are key tools for quality control, yield enhancement, and failure analysis of PCBs and semiconductor devices. In many cases, these capable tools provide the only non-destructive techniques for inspection of electronic components. There have been significant improvements in the X-ray inspection capabilities (both 2D and 3D) in the last several years. In this paper we report a new development that permits material and thickness information to be obtained via 2D X-ray inspection.

While absorption contrast X-ray imaging is a very powerful inspection technique, it does not exploit all of the information present within the X-ray beam transmitted through a sample. A new technology has been recently developed that, instead of simply measuring the total absorption of the X-ray beam, also enables changes in the beam energy to be resolved. This allows the effects of thickness and density to be decoupled, enabling both to be determined. This quantitative composition and thickness information can then be used to provide new levels of insight in PCB and semiconductor inspection, potentially leading the way to a new generation of X-ray inspection technology.

It is quite straightforward to accommodate this technology in an existing 2D X-ray (2DX) inspection system. Advanced software algorithms need to be incorporated and an intuitive user interface is provided.

We present an overview of this new technology and give examples of other industries where this technology is being adopted, as well as example applications for the PCB and semiconductor industries.

Introduction

The need to inspect electronic components and assemblies non-destructively is the main driver behind the development and advancement of the X-ray inspection technology for the electronics industry. In many cases, X-Ray inspection (2D and 3D) provides the only non-destructive techniques to inspect optically hidden components and solder joints such as BGA, POP, QFN, flip chips, through holes, TSVs, microbumps, copper pillars, etc.

All X-ray inspection systems (2D and 3D) rely on absorption contrast imaging, where the contrast is generated by the stopping power of the sample. As such, higher density and/or thicker regions of a sample produce darker regions in a grayscale image. X-ray inspection systems use this method to image features such as wire bonds and ball grid arrays down to a feature recognition size of 100 nm (0.1 µm).

While contrast imaging is a very powerful and widely used technique, there is significantly more information present within the X-ray beam, which, until now, has not been exploited in electronics inspection. Instead of simply measuring the total absorption of the X-ray beam, a physical structure known as a multi absorption plate (MAP) can be placed in the beam path. This, coupled with machine learning algorithms, enables material type and thickness information to be acquired alongside the standard grayscale image.

Quantitative composition and thickness information can then be used to provide more detailed diagnostics in PCB and semiconductor inspection. Applications include, but are not limited to, analysis of solder types, track thickness measurements, and conformance to quality standards.

An overview of the theory behind the operation of the MAP is given below, as well as some simple examples showing the benefits of using the MAP technology to add additional capabilities to 2D X-Ray inspection. MAP technology also has applications in the security, medical and food processing industries. Nordson Dage has partnered with IBEX to bring the benefits of this technology to the electronics inspection, including inspection of PCBs and semiconductor devices. A range of examples is presented and the authors aim to start active discussions that would generate new needs and ideas for use of the technology for non-destructive inspection of electronics systems and components.

Basic Principles of the Map Technology

X-ray Interaction with a Sample

X-rays are generated using a tungsten target which produces a continuous spectrum, known as Bremβtrahlung radiation, as well as characteristic peaks at specific energies.

Adding a sample such as a printed circuit board into the beam attenuates the X-ray spectrum in the following way:

$$I(E) = I_0(E)\exp(-\mu(E)t) \qquad (1)$$

where $I_0(E)$ and $I(E)$ are the intensities of the X-ray spectra before and after the sample, respectively; $\mu(E)$ is the material-dependent linear attenuation coefficient; and t is the thickness of the sample.

If $I_0(E)$ and $I(E)$ can be determined, it is possible to extract the parameter $\mu(E)$ which relates to the material type and the material thickness.

A standard CMOS detector integrates the total energy deposited into each pixel over the user-selected integration time. As such, the detector is able to measure total energy deposited per pixel but not the actual energy spectrum. This means that it is not possible to decouple the material and thickness terms in equation (1), meaning that thin, high density materials are indistinguishable from thick, low density materials in a single 2D projection.

The Multi Absorption Plate (MAP) acts like a complex color filter for the X-rays by imposing a repeating modulation to the X-ray beam over a few neighboring pixels. This modulation results in a variation in the energy distribution of the X-ray beam incident on the neighboring pixels in a way that enables unique materials information to be obtained.

Extracting Materials Information—Simple Examples

Figure 1 shows the word IBEX constructed using a series of copper tiles with a background made up of foils of silver. The thicknesses of the foils have been selected in order to randomize the grayscale intensity transmitted by the tiles and hence obscure the word IBEX in a standard X-ray image. Analyzing the image with a MAP in place recovers the materials information. The intensities of the coloring in the bottom image of Figure 1 reflect the relative thicknesses of the tiles.

This materials information can be displayed to the user in terms of a basic mask identify-

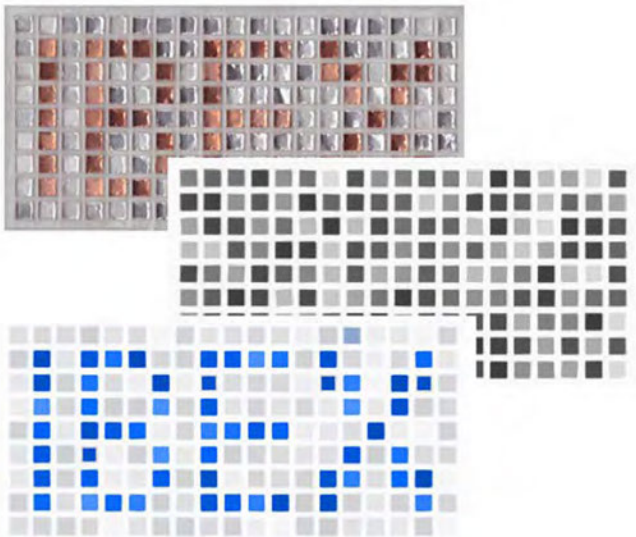


Figure 1: Optical image showing the word IBEX created as a mosaic of random thicknesses of silver and copper foils (top); X-ray transmission image showing that it is not possible to distinguish between the foils using absorption contrast alone (middle); materials contrast image showing that the missing information can be recovered using the MAP (bottom).

ing the materials, as an overlay of material identification on the absorption contrast image, or in the case of automated quality inspection systems as a pass/fail criterion.

Decisions on material type are made by reference to a materials space plot. The position of a point in this plot gives information on both the material type and thickness. An example is shown in Figure 2 for wedges of aluminum, iron and PMMA.

Machine Learning/User Interface

Machine learning algorithms have been developed to enable decisions to be made on material type and thickness based on the materials space plots generated from the image obtained using the MAP. The algorithms require training using a set of training standards. Once the training stage is complete, the algorithm is able to identify the material and thickness of previously unseen samples. Under ideal test conditions, the algorithm has been shown to have a misclassification rate of less than 2% and is able to identify thickness to better than 1% of the true value.

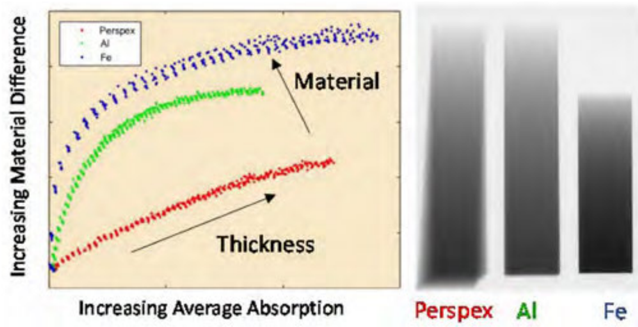


Figure 2: Materials curves (left) generated from training the system on the wedge samples (right).

Figure 3: Screen shots showing a user interface which is designed to allow materials training (top) and identification (bottom).

Once the MAP has been fitted to the CMOS detector, the calibration, database training and sample analysis are handled by a simple user interface which is integrated into the X-ray inspection system software. An example is shown in Figure 3, where wedges of three materials are trained and used to identify the material types on the right of the image.

The algorithm works at a rate compatible with image acquisition times and generates a standard grayscale image as part of the process.

Example Applications

This article is focused on discussing the X-ray MAP inspection technology for the electronics industry, including PCBs and semiconductor applications. In this section, we show some examples of the MAP X-ray inspection technology applied in the security and food industries. The intention is to enhance the reader's understanding of the technology and to facilitate the generation of ideas and requirements that can apply for the electronics industry.

Security Inspection

Security threats may be disguised within everyday objects such as laptops and mobile telephones, which are legitimately carried. X-ray security scanners typically use measurements taken at two voltage settings of the X-ray generator in order to generate materials information. This approach requires two scans. Using the MAP, the measurement can be reduced to a single scan at only one voltage setting.

A desk telephone, shown in Figure 4, was measured as an example of a complex object containing electronic circuitry and plastics. Data were collected at 120 kV, 0.5 mA, with a 0.5 s exposure, using a conventional, low-power tungsten X-ray source and a silicon flat-panel detector equipped with the MAP technology. Analysis of the image data leads to the materials discrimination image shown in Figure 4 (right). The color-scheme here is one typically used in security applications: plastics and other organic materials are presented in orange; so called poor metals, such as aluminum, are shown in green; denser metals are shown in blue.

We see the potential for the same techniques to be applied in PCB inspection to highlight inconsistencies in circuit boards and other electronic components.

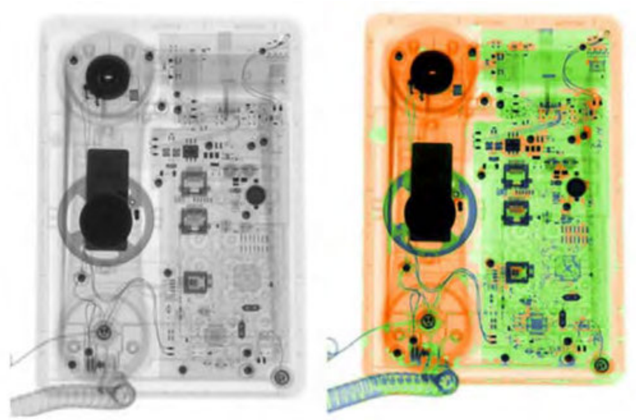


Figure 4: (Left) Absorption contrast image of a telephone. (Right) Materials contrast image showing plastics (orange), poor metals (green) and dense metals (blue).

Food Inspection

Detecting bone fragments in meat products is just one aspect of food safety which is important to both consumers and food producers. Fresh meat products pose particular challenges: The sample shape is not regular and there is variation from one sample to the next; the thickness of the product varies; the bone fragments are probably not visible on the outside of the sample; and the bone fragments are small

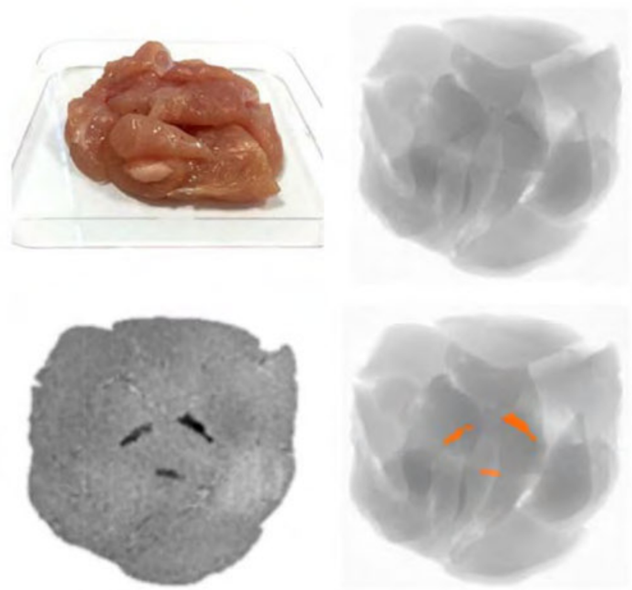


Figure 5: Top left: Chicken breast pieces with concealed bone fragments (dish 12 cm across). Top right: standard X-ray absorption image. Bottom left: materials image showing the material difference between chicken (mid-gray) and bone (black). Bottom right: materials information (orange) overlaid on the absorption contrast image to highlight bone fragments to the operator.

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For more information, visit www.IPC.org/events compared to the surrounding flesh. X-ray absorption contrast and image recognition techniques have limited application in this field as the bone fragments have a very similar X-ray absorption signature to the meat, resulting in edges and shapes that cannot be clearly identified (Figure 5, top right).

The MAP technology enables bone fragments in chicken to be identified by virtue of their material difference from surrounding chicken breast rather than by the absorption contrast formed in a grayscale image. Figure 5 shows an example of the detection of small bone fragments concealed inside a pile of chicken breast meat pieces.

This type of technique is particularly well suited to automated inspection systems and may be used to identify defects or impurities within PCBs and other electronic components that would otherwise be invisible in the grayscale image.

Map Enhanced 2D X-ray Inspection for the Electronics Industry

Incorporation of the MAP technology into a 2D X-ray Inspection System

A diagram showing the general outline of a modern 2D X-ray inspection system is presented in Figure 6. The heart of the system is an extremely sharp nano-focus X-ray source allowing 100 nm feature recognition and a worry-free design that does not require filament changes through the life of the system. This is coupled with a high-bandwidth/low noise digital flat panel detector (FP). Some of the most advanced FPs have up to 6.7 megapixels with a pixel size of 50 µm running at 30 frames per second. The samples (PCBs and other electronic components) are simply placed in the sample tray. The sophisticated five-axis sample manipulation system permits oblique imaging over 140° degrees (±70°). The FP detector can be

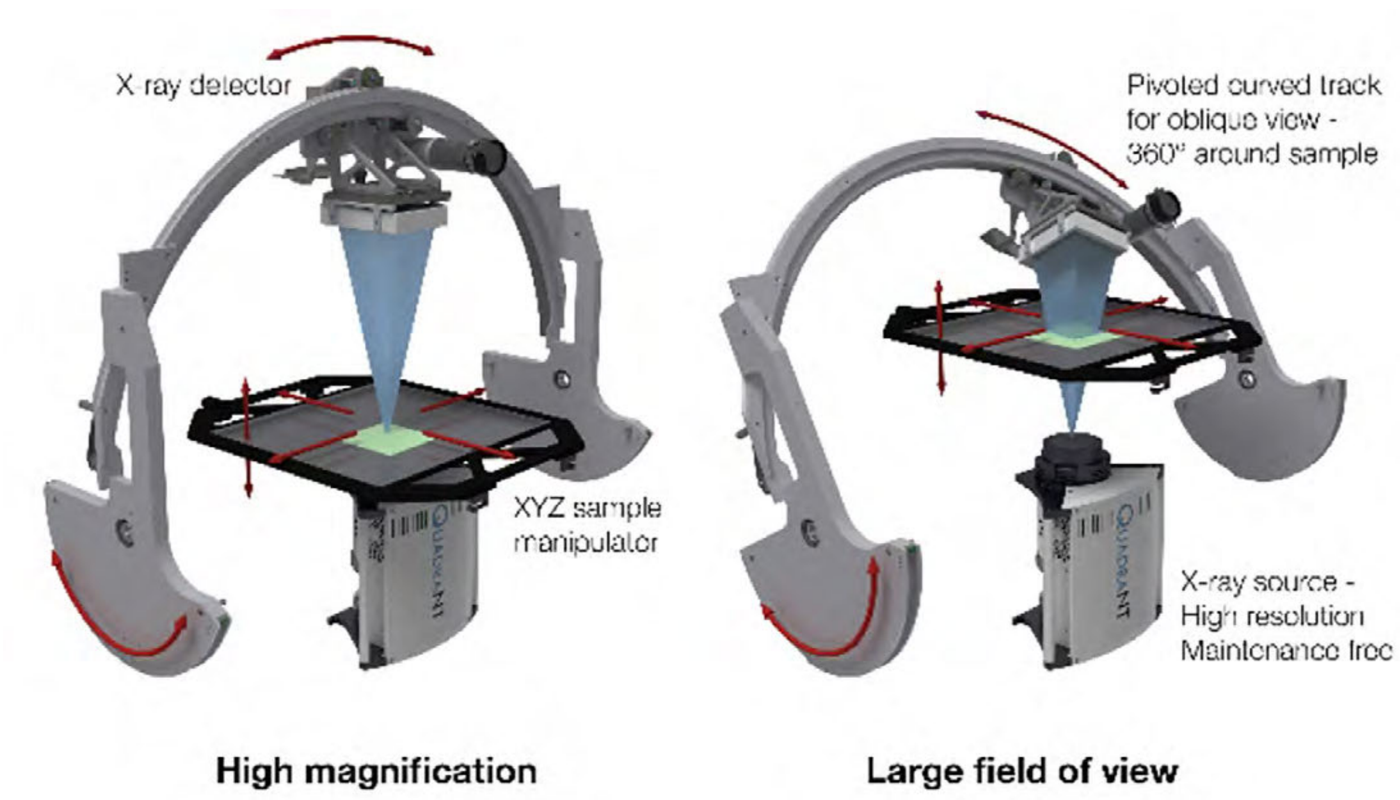

Figure 6: Diagram of a modern 2D X-ray inspection system featuring a maintenance-free sealed transmission X-ray source allowing for 100 nm feature recognition coupled with 6.7 megapixels digital FP detector.

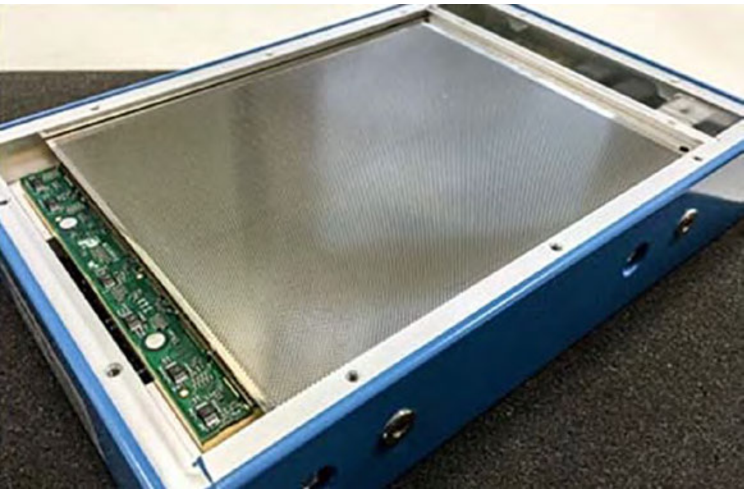

Figure 7: A MAP device installed inside a FP detector.

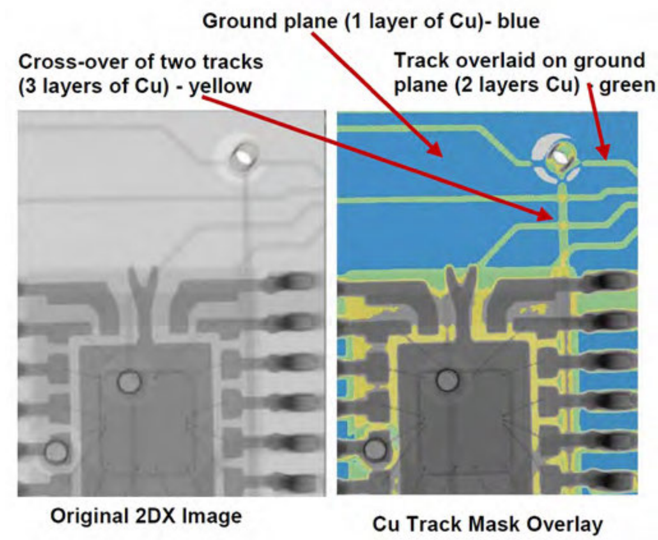

Figure 8: Example of automated Cu track identification using the energy information provided by the MAP technology. The various thicknesses of copper are shown as overlays on the grayscale 2DX absorption image (right). Left: conventional 2DX absorption image.

seamlessly rotated 360° around a point of interest. The inspection process is very simple, fast and extremely effective.

The incorporation of the MAP hardware is very simple and straightforward. The MAP device is positioned inside the FP detector between the carbon fiber cover plate and the scintillator. Figure 7 shows an image of a MAP device installed into the CMOS detector used in the following examples.

Copper Track Identification

The ability to recognize the presence of copper tracks is useful for a range of inspection applications. Examples include auto-registration of X-ray images to drawing files, checking for missing components and identification of broken tracks in multilayer boards. This technique is not restricted to surface layers which means that the thickness of buried tracks can also be measured. Such measurements cannot be made using standard profilometry methods.

Figure 8 shows an example of automated track identification. Here, the track information is displayed as an overlay to the grayscale image. The board has three copper layers and each is identified by a different color in the overlay. This type of visualization gives us the ability to compare to a drawing file in a fast and simple way.

In some cases, it is important to know the precise thickness of the Cu tracks. For example, circuits involving power devices can overheat if tracks are not sufficiently thick. In the second example (Figure 9) the precise thickness of the copper is measured, enabling line profiles through copper tracks to be produced. In addition, a full three-dimensional representation of the copper thickness across the entire board can be generated.

Lead Solder Detection

With the introduction of restrictions on the use of lead-based solder, knowledge of the solder type used in manufacturing process has become increasingly important in order to ensure compliance. In this section, we show the potential of the MAP technology as a method for automatically identifying the presence of lead solder on a PCB.

Figure 10 shows the difference in materials space between an 80/20 lead/tin solder and a 99% tin/copper lead-free solder. Wedges of each solder type were measured on a Dage Diamond machine with a MAP fitted to the CMOS detector, at 160 kV and 3.9 W. The materials curves are clearly separated, showing that a machine learning algorithm could be developed to au-

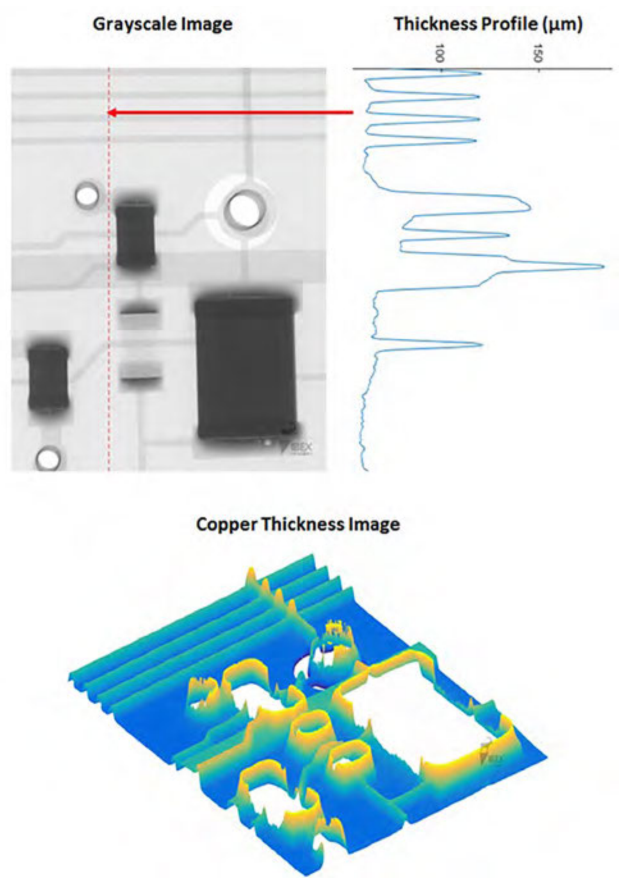

Figure 9: Illustration of how the MAP technology can be used to measure precise Cu track thickness information. This can be used to generate thickness profiles (top right) or a full three-dimensional representation of the copper thickness across the PCB (bottom).

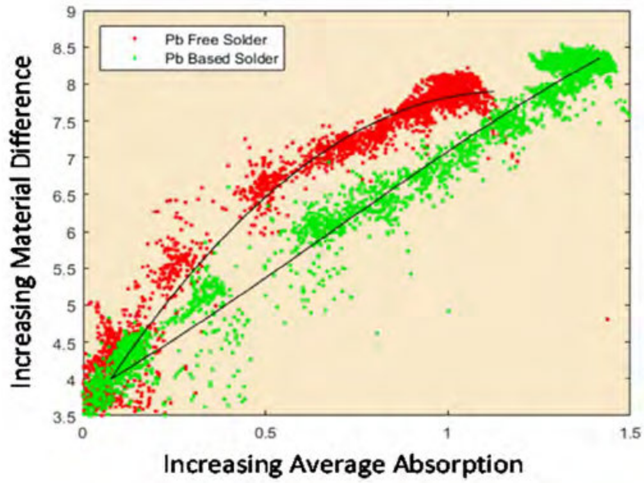

Figure 10: Materials curves for lead-free and lead-based solder samples obtained using the MAP technology installed in a Dage Diamond 2DX inspection system. The two materials curves are clearly separated, showing that a machine learning algorithm could be developed to automatically identify the presence of lead on a PCB.

tomatically identify the presence of lead on a PCB.

Conclusions

We have presented a newly-developed technology that enhances the capabilities of 2D X-ray inspection for the electronic industry. It provides additional material type and thickness information that has not been available to date in 2DX inspection.

The key to the technology is a physical structure known as the Multi Absorption Plate or MAP. This is coupled with sophisticated machine learning algorithms and training methodologies. Several cases were discussed to demonstrate applications in the electronics, security and food safety industries. Below are key enhancements gained through MAP technology:

- Enables users to visualize samples in a new way by looking at a materials image as well as a standard grayscale absorption contrast image
- Detection of defects and impurities that are invisible in the regular 2DX grayscale image
- Quantitative thickness and material information returned to the user
- Can be fitted to most flat panel detectors
- Near real-time operation
- Ability to adapt algorithms for automated inspection applications

The authors are very interested in discussions, ideas and collaborations within the electronics industry in order to focus the developments and take full advantage of this new, exciting technology.

Acknowledgements

The authors would like to thank Tamzin Lafford for her great help during the final stages of the paper development. SMT

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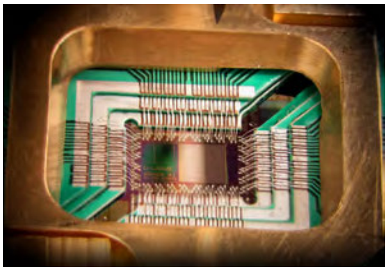
Paul D. Scott, Ph.D., is innovation manager at IBEX Innovations.

Evstatin Krastev, Ph.D., P.E., is director of Applications for Test and Inspection at Nordson Dage.

LCN Collaborates in IARPA-Funded QEO Program

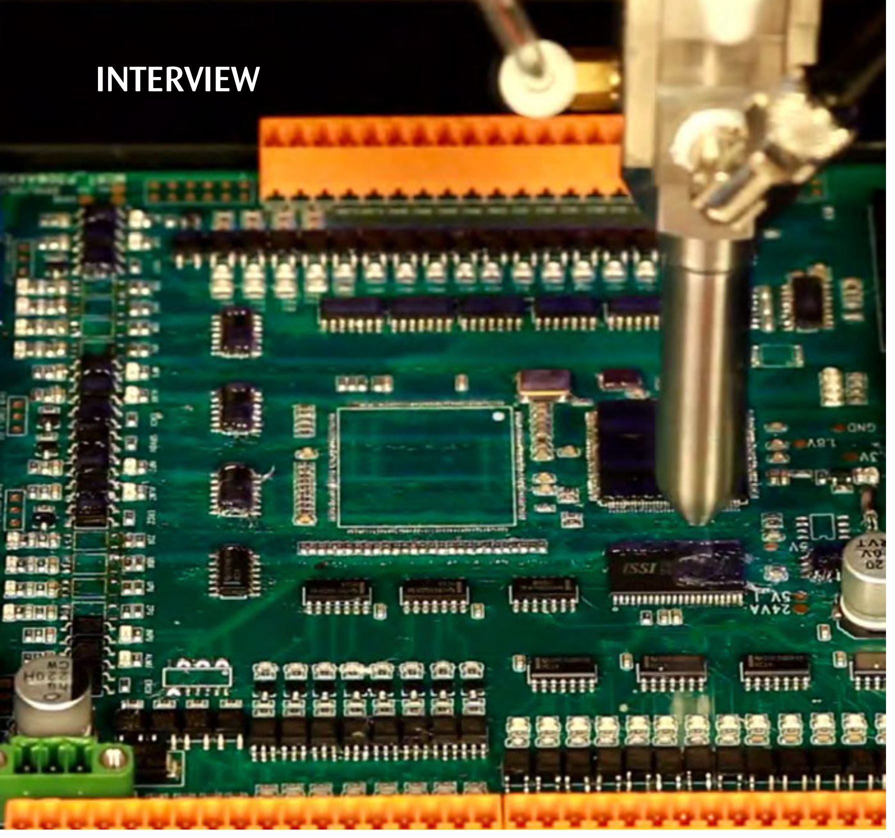
The Intelligence Advanced Research Projects Activity (IARPA), which sits within the Office of the Director of National Intelligence (ODNI), has embarked on a long-term research effort involving a multi-institutional collaboration including LCN academics, to develop special-purpose algorithms and hardware that harness quantum effects to surpass conventional computing. Practical applications include more rapid training of machine learning algorithms, circuit fault diagnostics on larger circuits than possible today, and faster optimal scheduling of multiple machines on multiple tasks.

Through a competitive Broad Agency Announcement process, IARPA has awarded a research contract in support of the Quantum Enhanced Optimization (QEO) program to the international team led by the University of Southern California. The University College London, the California Institute of Technology, Harvard University, Massachusetts Institute of Technology, University of California at Berkley, Saarland University, University of Waterloo, Tokyo Institute of Technology, Lockheed Martin and Northrup Grumman are also key collaborators. Participants providing validation include NASA Ames Research Centre and Texas A&M, and those providing government-furnished hardware and test bed capabilities include MIT Lincoln Laboratory and MIT.



"The goal of the QEO program is a design for quantum annealers that provides a 10,000-fold increase in speed on hard optimization problems, which improves at larger and larger problem sizes when compared to conventional computing methods," said Dr Karl Roenigk, QEO program manager at IARPA. If successful, technology developed under this program will provide a plausible path to performance beyond what is possible with today's computers.

INTERVIEW



Shenzhen Axxon Discusses Acquisition and Dispensing Market Trends

by Stephen Las Marias
I-CONNECT007

Ivan Li, general manager at Shenzhen Axxon Automation Co. Ltd (China), discusses their recent acquisition by Mycronic, as well as the latest developments in the dispensing market. Also discussed is the China market, and how the company is staying ahead of the increasing competition in the dispensing industry.

Stephen Las Marias: Please tell us a little bit about Shenzhen Axxon.

Ivan Li: Established in 2007, Axxon is dedicated to supplying professional dispensing solutions. Our products are focused mainly on three big fields: consumer electronics, automotive, and customized solutions. We provide total solutions to our customers.

Las Marias: What are some of the products you are showcasing here at the Expo?

Li: The products we brought to the show include a standalone benchtop dispensing robot and an in-line conformal coating system. The benchtop dispensing robot series includes a basic benchtop robot without a vision system, for easy and low-end dispensing demands, and a more-precise model with a vision system controlled by a PC. This is suitable for some high-mix and low-volume demands from customers.

Las Marias: What are the latest updates in your dispensing systems?

Li: There are new features in this industry, which lie in two aspects: one is people require more and more from the aspects of intelligence and smart technology. The other side is they want more flexible machines or solutions, to satisfy those high-mix, low volume, and quick change-overs demands during production. On these two aspects, Axxon is in a leading position in the China market.

Las Marias: Shenzhen Axxon was recently acquired by Mycronic. Can you tell us about any updates or changes so far within the company since the acquisition?

Li: Over the past decade, Axxon has been primarily focused on the China market. We wanted to bring our brand to the overseas market. On the other hand, we wanted to have some complementary technology collaboration with Mycronic. If we can merge very well, we will be able to come up with very new, innovative and cost-effective solutions for new applications.

The current product lineup of Mycronic and Axxon are pretty much complementary.

Las Marias: Speaking of the China market, how would you describe the landscape for Axxon? What are the challenges that you're facing there?

Li: Competition in the China market is very fierce, because the market is huge. Not only are a lot of overseas brands gradually building up their Asia offices and seeking to do more business in China, but within China, there are a lot of local companies rising up and doing the same thing as we are. Some local suppliers who are doing other kinds of machines have gradually shifted to the dispensing field within last two or three years. There are a lot of newcomers.

But from our point of view, when it comes to dispensing, we are a very focused company and we have accumulated a lot of experience in this segment. We understand the market, the process, and the trends. That is our advantage. We will continue to focus on our area. We're not expanding to different segments; we are confident we can deal with the competition in this market. More focus means a higher possibility for success.

Las Marias: From your experience, what are the major technical challenges that your customers face when it comes to dispensing?

Li: In the electronics manufacturing field, our customers are challenged with more and more requirements for integration. They're not only required to provide professional solutions in the dispensing process, but also post-dispensing—the inspection—and if there is something wrong, some automatic repair.

These are relevant requirements around the dispensing industry, and in this kind of situation we try to provide our customers a total solution; not only on dispensing, but also on the relevant processes. That's what we are now dealing with, those kinds of challenges. Actually, in the past two or three years, we found this direction to be correct and we've brought a lot of benefits to our customers, and the market recognizes it.

Ivan Li

Las Marias: What are the market trends that you're seeing right now?

Li: In our point of view, the home market will be targeted more on dispensing application requirements. Otherwise, there wouldn't be so many newcomers here, so the demand is increasing. On the other hand, the market has higher demand on quality and reliability. Also, Industry 4.0 is really popular and we need to embrace the concept when we're providing solutions or designing machines. Another point is that we think the dispensing field is at a stage where it's reaching a lot of newcomers and everybody suddenly wants to do business; but the market also has different feedback and responses to those companies.

So, they have to pass the test of the market, and gradually somebody who has the core technology will survive, and somebody who just has very superficial ambitions to get more business in the long term will lose. It needs accumulation. That's our understanding of the local market right now.

Las Marias: You mentioned that one of the requirements from your customers is integrated

solutions. What other solutions are you adding to your dispensing equipment so that you provide your customers with what they need?

Li: We're providing the total solution through other functions beyond dispensing; for example, before dispensing we have a precise locating or magazine load function. Post dispensing, there is a function that will check and inspect the effectiveness of the dispensing and the results. After that, maybe queuing, and of course, conveyers that load. Those functions can be provided simultaneously with our dispensing machine and can connect with post processes like AOI/ SPI seamlessly.

Las Marias: Do you work with other suppliers?

Li: Yes, we have partners to help us to provide the total solution. But we design the whole solution and provide it to our customer.

Las Marias: Ivan, do you have any final comments?

Li: This APEX show is the first time Axxon has brought machines to the U.S. market, so we are still learning and listening to the feedback. During the three days, we've had communication with customers and we have learned that the market here is really different from the Asia market. In Asia, the market is high volume, but here, it is low volume and high mix—so our machines need to have a different focus and function. Upon our return to China, we will bring the feedback and discuss internally, and we will try to provide the most suitable equipment for the specific market.

Las Marias: Ivan, thank you very much for your time.

Li: Thank you. **SMT**

Conductive Paper Could Enable Future Flexible Electronics

Roll-up computer screens and other flexible electronics are getting closer to reality as scientists improve upon a growing number of components that can bend and stretch. One team now reports in the journal ACS Applied Materials & Interfaces another development that can contribute to this evolution: a low-cost conductive paper that would be easy to manufacture on a large scale.

Researchers make conductive paper by coating it with an ionic gel. (Credit: American Chemical Society)

Current flexible electronic prototypes are commonly built using polymer thin films. But the cost of these films becomes a factor when they are scaled up. To address this issue, scientists have turned to paper; but the downside is that it's not conductive, and efforts so far to infuse it with this property have been hindered by scalability and expense. Bin Su, Junfei Tian and colleagues wanted to come up with a new approach.

Using a conventional roller process that's easy to scale up, the researchers coated paper with soft ionic gels to make it conductive. They sandwiched an emissive film between two layers of the ionic gel paper. When they applied a voltage, the device glowed blue, indicating that electricity was being conducted. It also showed electrical durability, withstanding more than 5,000 cycles of bending and unbending with negligible changes in performance and lasting for more than two months. The researchers say their conductive paper, which costs about $1.30 per square meter and could be fabricated at a rate of 30 meters per minute, could become an integral part of future flexible electronics.

The authors acknowledge funding from the State Key Laboratory of Pulp and Paper Engineering (China), National Natural Science Foundation of China and the Australian Research Council's Discovery Early Career Researcher Award.

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2 Full Video Coverage of NEPCON China 2017 Now Available

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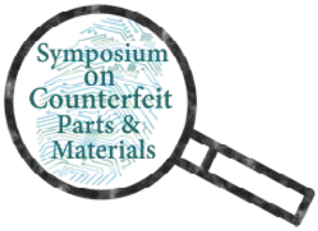
3 The Benefits of Applying Flux Directly to a Micro BGA

Technology trends continue to drive miniaturization in electronic components. As a result, product designers are often forced into specifying smaller and smaller devices on their bill of materials.

4 Electronics Industry Leaders Meet With Members of Congress and Leaders of Trump Administration

Senior executives from leading electronics manufacturing companies—all members of IPC—Association Connecting Electronics Industries—gathered in Washington, D.C. for IMPACT Washington, D.C. 2017 to advocate for a pro-growth, pro-advanced-manufacturing policy agenda.

5 SMTA/CALCE Announce Program for Symposium on Counterfeit Parts and Materials



The SMTA and the Center for Advanced Life Cycle Engineering (CALCE) announce the technical program for the Symposium on Counterfeit Parts and Materials this June 27-29, 2017 in College Park, Maryland.

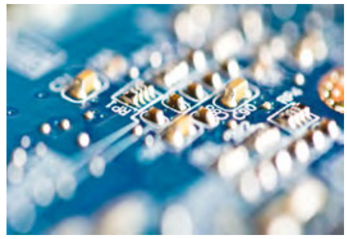
6 Flex Launches Renewable Energy Storage Solution

Flex has expanded its contributions to the renewable energy industry with the introduction of energy storage solutions to address the challenge of integrating solar and wind power into the energy grid.

7 Kimball Electronics Posts Net Sales of $233M for Q3 FY2017

EMS firm Kimball Electronics Inc. has recorded net sales of $233 million for the third quarter ended March 31, 2017, up by 9% compared to the third quarter of fiscal year 2016.

8 Enics Raahe to Focus on ODM Business, Cut 100 Jobs



Following its negotiation process with its employees, Enics Raahe will focus on ODM business and designing and manufacturing production testing equipment, while the electronics manufacturing services will be provided through Enics' global network—resulting in the loss of approximately 100 jobs in the factory.

9 IMI Income Up 33% in Q1 2017

Integrated Micro-Electronics Inc. has announced a net income of $8.7 million in the first quarter of 2017, up by 33% year-on-year.

10 IPC Welcomes New Senior Director of Learning and Professional Development

IPC — Association Connecting Electronics Industries announces the addition of Dave Hernandez, senior director of learning and professional development, to its staff at IPC headquarters in Bannockburn, Illinois.

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Events

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Birmingham, Solihull, UK

IMS 2017 International Microwave Symposium
June 6–8, 2017
Honolulu, Hawaii, USA

International Conference on Soldering and Reliability
June 6–8, 2017
Markham, Ontario, Canada

JPCA Show 2017
June 7–9, 2017
Tokyo, Japan

IPC Reliability Forum: Emerging Technologies
June 27–28, 2017
Düsseldorf, Germany

Symposium on Counterfeit Parts and Materials 2017
June 27–29, 2017
College Park, Maryland, USA

SMTA International 2017 Conference and Exhibition
September 17–21, 2017
Rosemont, Illinois, USA

electronicAsia
October 13–16, 2017
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TPCA Show 2017
October 25–27, 2017
Taipei, Taiwan

productronica 2017
November 14–17, 2017
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HKPCA/IPC International Printed Circuit & South China Fair
December 6–8, 2017
Shenzhen, China

PUBLISHER: **BARRY MATTIES**
barry@iconnect007.com

SALES MANAGER: **BARB HOCKADAY**
(916) 608-0660; barb@iconnect007.com

MARKETING SERVICES: **TOBEY MARSICOVETERE**
(916) 266-9160; tobey@iconnect007.com

EDITORIAL:
MANAGING EDITOR: **STEPHEN LAS MARIAS**
+63 906 479 5392; stephen@iconnect007.com

TECHNICAL EDITOR: **PETE STARKEY**
+44 (0) 1455 293333; pete@iconnect007.com

MAGAZINE PRODUCTION CREW:
PRODUCTION MANAGER: **SHELLY STEIN** shelly@iconnect007.com

MAGAZINE LAYOUT: **RON MEOGROSSI**

AD DESIGN: **SHELLY STEIN, MIKE RADOGNA**

INNOVATIVE TECHNOLOGY: **BRYSON MATTIES**

COVER: **SHELLY STEIN**

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