

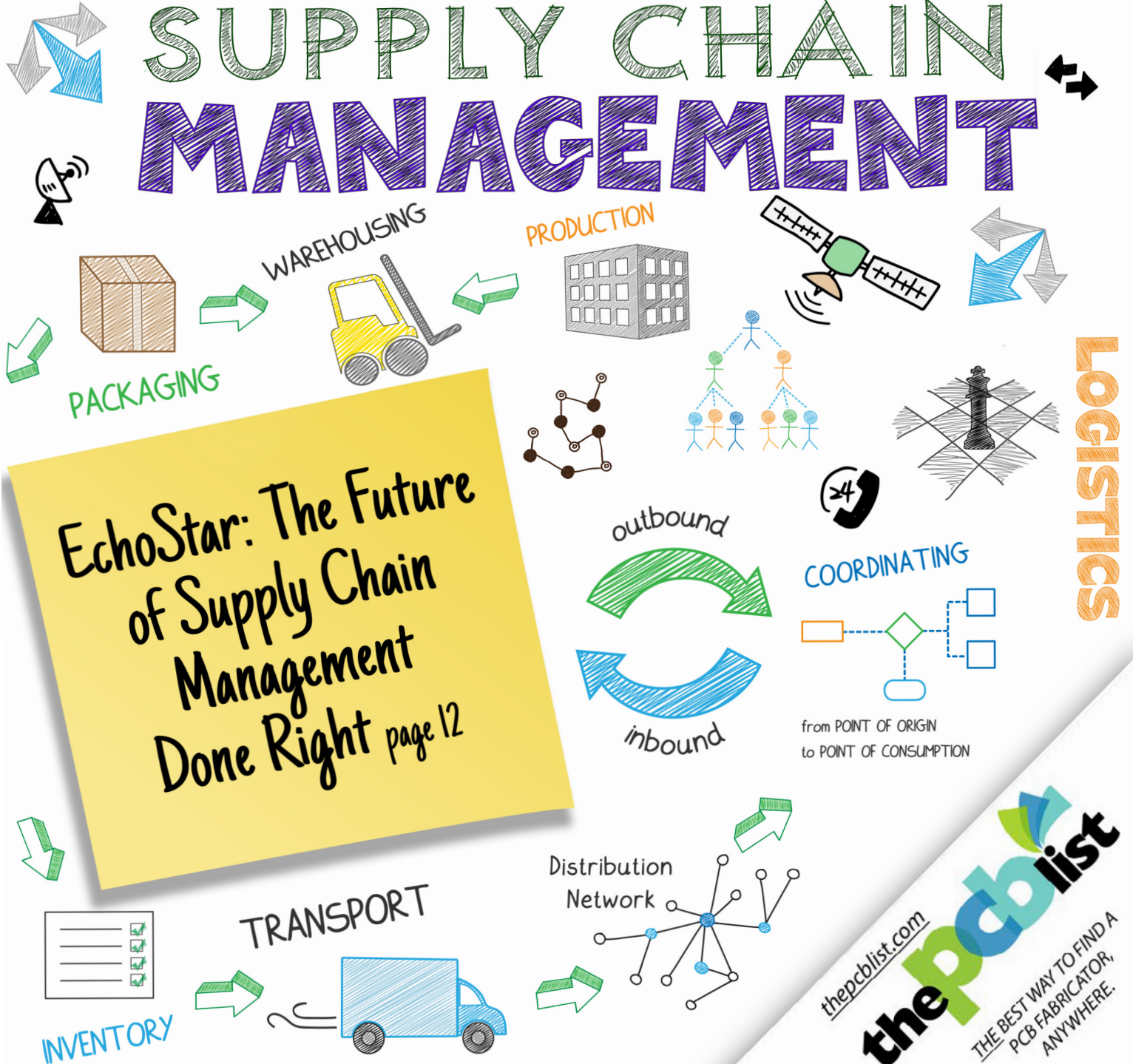
Beating the Supply Chain
Challenge: Interview with
SMT Corp. p.34

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p.38

Supply Chain in the
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Article Excerpt p.48

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Featured Content

SUPPLY CHAIN MANAGEMENT

This month, *SMT Magazine* tackles the supply chain—from various approaches to making it work for you, to what history has shown about its many iterations, and how some suppliers are setting the bar very high for the future of supply chain management.

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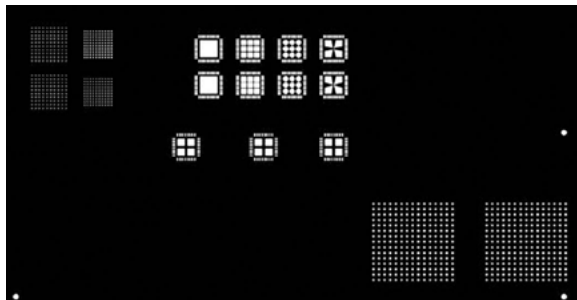
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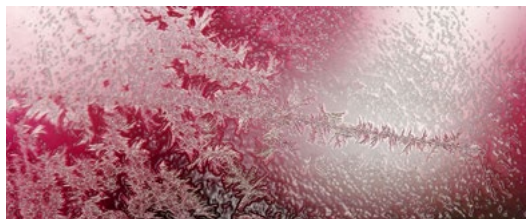
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The Theory Behind Tin Whisker Phenomena, Part 2

by Dr. Jennie S. Hwang

CEO, H-TECHNOLOGIES GROUP

As teed up in [Part 1](#) of this series, a plausible theory of tin whisker growth can be postulated through deliberating the combination and confluence of several key metallurgical processes.

These key processes include:

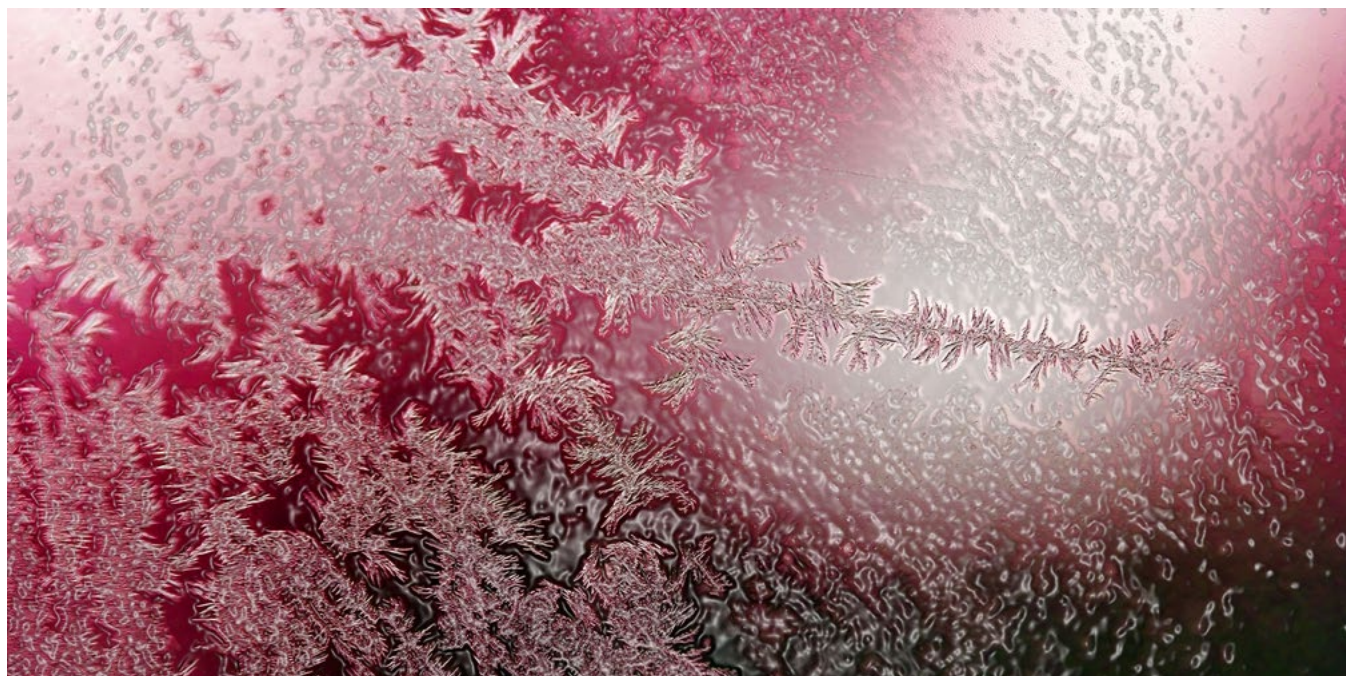
- Grain boundary movement and grain growth
- Energy dynamic of free surface
- Solubility and grain growth in response to external temperature
- Role of recrystallization
- Lattice vs. grain boundary diffusion
- Crystal structure and defects
- Reaction and dynamic of intermetallic compounds

In response to external factors, these processes, operating sequentially and in parallel, drive intrinsic structural changes leading to the conditions that nurture whisker growth.

Grain Boundary Movement and Growth

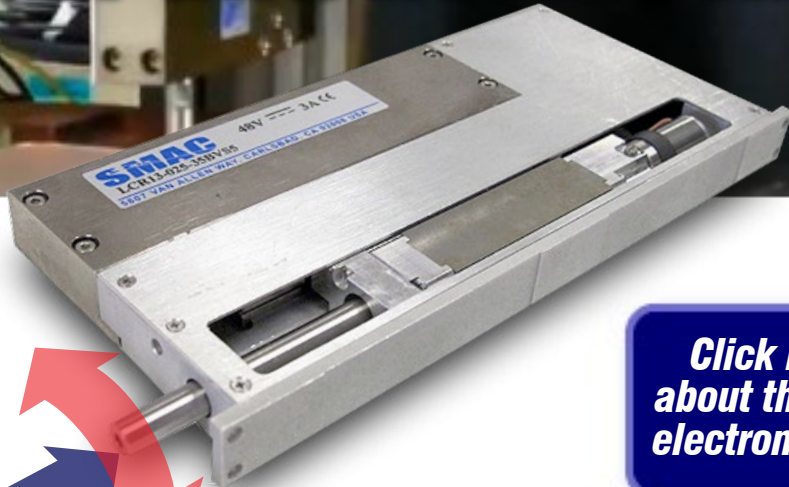
Grain growth cannot occur without the movement of grain boundaries, but its movement is not easy to predict. Thus, grain boundary (g.b.) is a critical, yet elusive character to the behavior of materials. Adding to the elusiveness of g.b., the provenance of the material history needs to be established before embarking on a detailed mechanical and microstructural characterization.

It often takes advanced equipment and analyses to identify g.b. and its movement. To uncover texture and grain boundary crystallography and to identify phases, electron backscatter diffraction (EBSD) and energy dispersive X-ray spectroscopy (EDS) are the useful analytical tools. Transmission electron microscopy (TEM) and electron probe are the tools to reveal dislocation structures and grain boundary sergent structures. Additionally, a scanning electron microscope-focused ion beam (SEM-FIB) sys-



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THE THEORY BEHIND TIN WHISKER PHENOMENA, PART 2 *continues*

tem enables the analyses of atomic layers in nanoscale. Complementarily, these analyses pave the groundwork for the engineering of grain and interphase boundaries.

In the context of an ideal crystal structure, the boundary between one grain and its neighbours (i.e., g.b.) is treated as a planar defect, which associated with a certain amount of energy. As a result, there is a thermodynamic driving force for the total area of boundary to be reduced. Grain boundaries limit the lengths and motions of dislocations and can also serve as attractive sites for nucleation of precipitates and second-phases.

When the stress reaches a certain level, it drives the formation of a new structure in order to achieve lower energy or stress-free state. Driving to the stress-free state involves several stages:

- seeding of nuclei (nucleation spots)
- nucleation
- grain and sub-grain growth
- impingement of grains
- classical grain growth

Through the reduction in the dislocation density and the movement of dislocation to lower-energy positions, internal residual stresses are lowered. At a temperature when dislocations are more mobile, they tend to pile up to lower the strain energy of the system by rearranging the excess dislocations into low angle tilt boundaries by a few degree misorientation (polygonization). The tangles of dislocations lead to sharp two-dimensional boundaries and the dislocation density within these areas decrease. These areas are sub-grains. Coarsening occurs after polygonization, where low angle boundaries recruit more dislocations while growing. Some sub-grains will have more dislo-

cations around them than others, which builds high mobility. In turn, the sub-grains garner more dislocations while growing so there are more dislocations around them until the dislocations are dissipated in this cyclic process. This creates a cycle of growth.

“
Classical grain growth is driven only by local curvature of the grain boundary, which results in the reduction of the total amount of grain boundary surface area. The driving force for this growth is essentially the surface energy of the grain boundaries. After recrystallization, if the temperature is maintained high enough, the grain size will grow, which is motivated by a reduction in the actual number of grains per volume resulting in the reduced total area of grain boundary.
 ”

Classical grain growth is driven only by local curvature of the grain boundary, which results in the reduction of the total amount of grain boundary surface area. The driving force for this growth is essentially the surface energy of the grain boundaries. After recrystallization, if the temperature is maintained high enough, the grain size will grow, which is motivated by a reduction in the actual number of grains per volume resulting in the reduced total area of grain boundary. The energy available to drive grain growth is usually very low and the growth tends to occur at a slow rate and is easily slowed by the presence of second phase particles or solute atoms in the structure. This grain growth is the third identifiable stage of energy release during shelf life under elevated (high enough) temperature. The process will measurably decrease the yield

strength of the material as the yield stress is inversely proportional to the mean grain diameter. Ductility, on the other hand, increases.

Grain boundaries' high interfacial energy and relatively weak bonding often makes them preferred sites for the onset of corrosion and for the precipitation of new phases from the solid. The properties of the second phase affect the g.b. A drastic example is that when the second phase, having a low melting point and zero contact angle, is being heated above the melting point of the second phase, it will cause the material to fall apart along its grain

THE THEORY BEHIND TIN WHISKER PHENOMENA, PART 2 *continues*

boundaries. This is a problem in metals, which contain trace impurities that are transformed into liquid phases that can “wet” the grain boundaries.

For tin whisker to occur, when g.b. plays a predominant role, low angle grain boundaries may become the initiating sites for whiskers due to their low energy. Low energy sites (e.g., low energy grain boundaries or recrystallized grains) serve as the foundation for whiskers. Whiskers often (although not always) originate at the intersection of grain boundaries on the surface or in the bulk of the deposit, not from the substrate interface. When there are more g.b. intersections on the surface, more whiskers will result. However, high angle grain boundaries are favored diffusion pathways that can be critical to sustain whisker growth. Tin material needs to transport to a whisker grain by either the surrounding grain boundary network or by lattice diffusion. This movement into the whisker grain pushes the free surface of the whisker grain upward, growing the whisker structure. The movement of high angle grain boundaries has implications for recrystallization and grain growth while sub-grain boundary movement influences recovery and the nucleation of recrystallization. Discussions will continue in Part 3 and Part 4 of this series. **SMT**



Dr. Hwang, an international businesswoman and speaker, and business and technology advisor, is a pioneer and long-standing contributor to SMT manufacturing since its inception, as well as to the lead-free electronics implementation. Among her many awards and honors, she is inducted to the WIT International Hall of Fame, elected to the National Academy of Engineering, and named an R&D-Stars-to-Watch. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and IEM Corp., she is currently CEO of H-Technologies Group, providing business, technology and manufacturing solutions. She serves as Chairman of Assessment Board of DoD Army Research Laboratory, Commerce Department's Export Council, various national panels/committees, international leadership positions, and the board of Fortune 500 NYSE companies and civic and university boards. She is the author of 450+ publications and several textbooks, and an international speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as Harvard Business School Executive Program and Columbia University Corporate Governance program. For further info, visit JennieHwang.com. To read past columns, [click here](#).

Research Simplifies Recycling of Rare-Earth Magnets

Despite their ubiquity in consumer electronics, rare-earth metals are, as their name suggests, hard to come by. Mining and purifying them is an expensive, labor-intensive and [ecologically devastating](#) process.

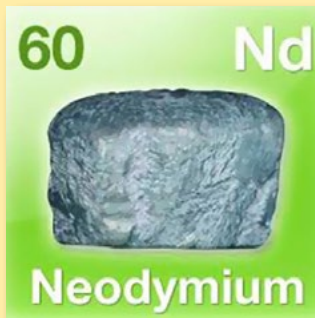
Researchers at the University of Pennsylvania have now pioneered a process that could enable the efficient recycling of two of these metals, neodymium and dysprosium. These elements comprise the small, powerful magnets that are

found in many high-tech devices.

In contrast to the massive and energy-intensive industrial process currently used to separate rare earths, the Penn team's method works nearly instantaneously at room temperature and uses standard laboratory equipment.

Sourcing neodymium and dysprosium from used electronics rather than the ground would increase their supply at a fraction of the financial, human and environment cost.

The research was led by Eric J. Schelter, assistant professor in the Department of Chemistry in Penn's School of Arts & Sciences, and graduate student Justin Bogart. It was published in [Angewandte Chemie, International Edition](#).





EchoStar: The Future of Supply Chain Management Done Right

by **Barry Matties**

PUBLISHER, I-CONNECT007

The supply chain is a challenging process for many companies to manage. Starting with the wrong supplier can lead to severe consequences. The I-Connect007 team recently set out to look at which challenges and issues are plaguing the supply chain by conducting a survey across our readership. Overall, the results indicated that delivery time was one of the largest areas of frustration, along with product quality. We also asked specifically what our readers would like to learn to improve their supply chain management. Aside from the role of a supply chain manager, best practices were mentioned many times. We invited a few experts to share their knowledge on this topic, but aside from that, I set out to find an OEM that was really utilizing best practices and would openly share their strategies with our readers. I like to say the universe always provides and, as it turns out, the OEM found me.

My good fortune came about on a flight from San Francisco to Shanghai, when three gentle-

men sat down next to me. I overheard from an inquiring flight attendant offering preflight beverages that they manufactured product for Dish Network and were heading to China for some meetings. When the flight attendant turned her attention to me and asked if I was also with Dish, I told her that I was in the publishing industry. As people always do, she went on to ask what I publish, and I gave my usual answer, "Magazines for the electronics industry, but nothing you would know." One of the three guys across the aisle asked the name of the publication and when I told them, they said, "We love that magazine!" As we got to know each other, it turned out that not only were they readers of our magazines, but they were with EchoStar, the manufacturing and satellite half of Charlie Ergen's satellite empire, responsible for producing all of Dish Network's satellite set-top boxes, and a company that purchases a remarkable \$100 million worth of PCBs every year.

This is how I came to meet Les Beller, Andy Thomson and Micah Moore. They explained that they were on their way to Shanghai to

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ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

Electronics manufacturing bldg.1 and campus headquarters.

.....

meet with a couple of their EMSs. Our conversation led to the supply chain and the challenges that I had learned about in our recent survey. With 14 hours left to Shanghai, I asked Les if he might be interested in doing an audio interview, which we completed on the plane. I quickly realized from our discussion that EchoStar isn't your typical OEM. They take supply chain management to a whole new level. Without hesitation, Andy invited me to come visit their EMS partner in Shanghai, DD & TT Electronic Enterprise (DD&TT), to take a look at what they are doing. He assured me that I would be very impressed as DD&TT was the first and, at that point, only EMS supplier to receive the coveted EchoStar Diamond award. I knew my search for finding the right OEM for this article had been realized—all because of my seating arrangement on a flight to Shanghai.

It was Monday morning when our China Editor Edy Yu and I arrived at the DD&TT factory, a 37,500 square meter manufacturing facility. We were warmly greeted at the door and led to a conference room where the EchoStar team and a handful of the DD&TT team members had already assembled. After some introductions we were suited up with VIP passes and off to the factory floor we went. Our tour started with Alan Hoo, director of programs; Thomson Lai, plant manager; and Michael Shudinis, president of Tiger Technology USA and sales representative and consultant for

DD&TT, who showed us the different processes of a factory that builds and assembles, from start to finish, set-top boxes for Dish Network. As far as processes go, the flow was well laid out, each workstation was well equipped and the operators had all of the materials, tools and information needed to accomplish each task. DD&TT has a whole floor dedicated to EchoStar, who monitors everything alongside the production line so they know what's going on and can make immediate improvements. One example of this was with a new functional tester being brought online the day we visited. This is where I found Micah Moore, senior manager of test R&D and test engineering (global operations) for EchoStar, examining a tester for a WiFi module, and where I began to truly realize how deeply engrained EchoStar is in the processes of their supplier.

Here is my interview with Micah:

— — — — —

Barry Matties: *Micah, could you explain what's going on here? Are we looking at a new test process?*

Micah Moore: Actually, I've had this tester for just under a year but never got a chance to really validate it. I've just looked at it in person

.....



Micah Moore, senior manager of test R&D and test engineering (global operations).

ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

Hercules automated test area.

and checked some of the connectors and gave DD&TT a list of what things we need to look for before they roll out the productions. We're bringing new products here for these guys within the next month. Since I'm on site, I'm able to check it out and see that it meets our specifications in terms of the quality, throughput, maintenance procedures, etc. I'll also check their test procedures, the isolation on the chamber, along with several other things. They're getting the data for me. I just gave them a list with the things I want to look at before I sign it off and say I'm okay with it. What they're doing with this particular one is just a WiFi module that goes into a bigger product. This is the functional performance level testing that they'll do on that particular module.

Matties: *So your job is specifically in test engineering and test R&D?*

Moore: Yes, we have a test R&D group, so we design and develop solutions to help these vari-

ous teams with automation efforts. Each of the factories we work with has its own design and development team, so I'll have my team partner with them and develop solutions. We develop something and they can have access to it. They can use it and do what they want with it. For instance, this barcode scanner that they have is the same scanner we use on our production tester. That's something we gave them.

Matties: *Can they use it for other customers?*

Moore: That's the whole idea behind it. It's a help-me-help-you kind of thing. It's not just us coming up with good ideas; they have good ideas too. We each have some skin in the game and we come up with the best solution possible. No one owns it; it's both of ours. I might put it at Sanmina; I might put it at Jabil. They can put it on their other products. I don't care what they do with it, because we both had an interest in developing this, so it helps both of us. It helps them make money and it helps us make money.

ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

Matties: *Do you think this is a typical attitude that other OEMs have?*

Moore: It isn't, and that's part of why we're able to be so successful, because when we come on the floor these guys don't hide from us. When I come out here, they don't send everyone home or send them to lunch. It's not hard to find them, and they're not hiding things for a couple reasons. I have access that allows me to see everything in the factory from my desk, or anywhere in the world that I log in.

Matties: *Explain how you do that.*

Moore: It works because of how I set it up. I have a firewall and a VPN tunnel that connects the entire test system back to Denver. We can use that for troubleshooting, monitoring and data extraction. The premise is simple—our product, our test system, our data. We get the initial copy of the data and provide a summary and raw data log to the factory. This ensures the operator or anyone else does not have an op-


portunity to alter or manipulate test results. We can also use this remote access for pushing Agile updates directly to the tester for factory qualification before formally releasing. The anti-virus definitions for the testers live in my lab on a server that sits right next to my office, so every one of their unit test systems being used for production gets connected with Denver to receive the latest updates, multiple times per day. That's why I'm able to access it from anywhere in the world.

Matties: *You can do all this in real time?*

Moore: It's all real time. The relationship is such that they know what we're doing. There are no secrets; they know all the software I have on here and where it is. They have admin access to the machine to perform their job function, but don't have the only admin access. They are aware that I can monitor what they're doing. If someone is on there changing and manipulating stuff, I have visibility of that. All factories are governed by a set of business rules. The



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ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

ICT test (left), incoming inspection of plastic components (middle), line set-up (right).

business rules dictate what each company can and cannot do. For instance, they are not allowed to delete things, add things, and change things on the machine. They're allowed to do their job, and if they need to do something that seems like it's not part of the normal process, they need to send us a message. We use distribution lists, so the message goes to the entire test research and development team or the test engineering team. Once one of the team members reviews the request from the factory, someone will get back and say, "Okay we're good and we understand it." The same thing is true for our system hardware—our box is sealed. They're not allowed to open the box. We keep security tape on there and inspect it as part of our normal process for any factory visit. If it's ever broken, they are immediately issued a corrective action, which affects their scorecard and, in turn, their ability to get future business.

Matties: *So the scorecard is really an important factor in determining their level of business from you?*

Moore: During the business review, we discuss their performance relative to the standard we have published for all companies we conduct business with. Internally, we assess the perfor-

mance relative to their competition in a number of areas—test, paradigm shifts, quality, supply chain, improvements, etc. They're graded across the board on a million different things. We use the same scoring format for all factories.

When they lose points in any given area, even though my area is only a small segment of that, it drops the overall score which, when they're in competition for business with other suppliers, could mean the difference between getting a 30% share of the new business and getting a 70% share.

The relationship works so well because there are no secrets. We know what they're doing, and they know what we're doing, and we communicate with them regularly. We give them options if they're not able to find the particular HW we characterized and qualified in our lab. It usually involves them sending samples of the HW they have available back to Denver so we can integrate it into our systems and qualify it for production use. We might develop the solution in our lab and ship it to them so they don't have to worry. It just works perfectly. All of our hardware at that point is qualified and all works together. It's a team effort.

These guys aren't on the hook for doing any maintenance or support. We do that. We send

ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

people out here frequently to support production and we carry a checklist to remind us to do things such as vacuum the machines and do preventative maintenance. We can see when the machines are flaking out before it happens. We take a proactive approach rather than a reactive approach to supporting our test systems. We collect MTBF data on our system components and monitor usage patterns. We have a shipping container that can travel between factories so when a machine is down we are able to just ship the whole machine back. Each factory has a spare machine available on site. Once it's plugged in, we can load any software from Denver or anywhere in the world. We don't have to ship a CD with all the software on it. We can load it up and get it going right now. This approach minimizes downtime and factory team involvement.

Matties: *Your relationship with this company is that of customer-supplier, but it sounds more like an extension of your own company. They're just part of the team. Maybe payrolls and certain things might be different, but they're as invested in this process as you are.*

Moore: It's so effective, and it's different. I've seen the other side of the equation where you come on the floor and the people are physically hiding from you. Where is everyone? Are they



Debug repair.

off today? Or they're hiding things from you when you arrive.

When you have that transparent relationship, it's awesome because productivity is high. They know that I can see productivity. If you look in my lab in Denver you'll see I have a 50-inch monitor that cycles through the throughput of all the factories. I can see when the machines are online and offline. I can see the yield by product on the screen. Every 10 seconds it toggles between the different factories.

We have over 100 Hercules test systems deployed around the world, and they're all custom, but the network topology at each of the different factories is all the same. We have a particular scheme so I know exactly which factory I'm looking at, and it's secure, meaning you can't get to it from the outside.

I could get to it using the VPN tunnel. I use a scheme so that I know which factory is China, which one's India, which one's Guadalajara, or any other place we build. Then we have two different networks that we can speak to. We have a secure network, which you can put your database on, and we have a non-secure network, which is where the testers live because the operators have access to it. If they have a network issue it may not be secure; we help them fix that



ESD check at production floor entrance, shop floor data monitored and controlled.

ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

because if their network goes down, it affects not just them, but us as well. So we help these guys out like they are our own people. What we have been able to accomplish together has been truly remarkable.

Matties: *They aren't your own people and yet it's great that you work closely enough with them to get a fresh perspective and really expand on each other's creativity.*

Moore: Here's the perfect example. We designed the automatic button-pushing stuff in our lab, and then we threw it over the wall to them and said, "Here's what we have come up with in the lab. If you guys can come up with a better way to do it, feel free." And they did; here is their design. This one is not ours and looks completely different than what we have in the lab, but it works. So we're okay with it. They tell us, "Hey, this is what we came up with. Here's a drawing. What do you guys think of it?" We inspect and qualify it and provide feedback to the factory team to proceed.

You saw that barcode scanner they used on the Wi-Fi test; we didn't give them that. They

just used the same idea. They know how to use this because we trained them how to use that scanner. They have the confidence in the hardware because they know we have a fairly extensive and rigorous qualification process and we wouldn't be using it if the results were not favorable.

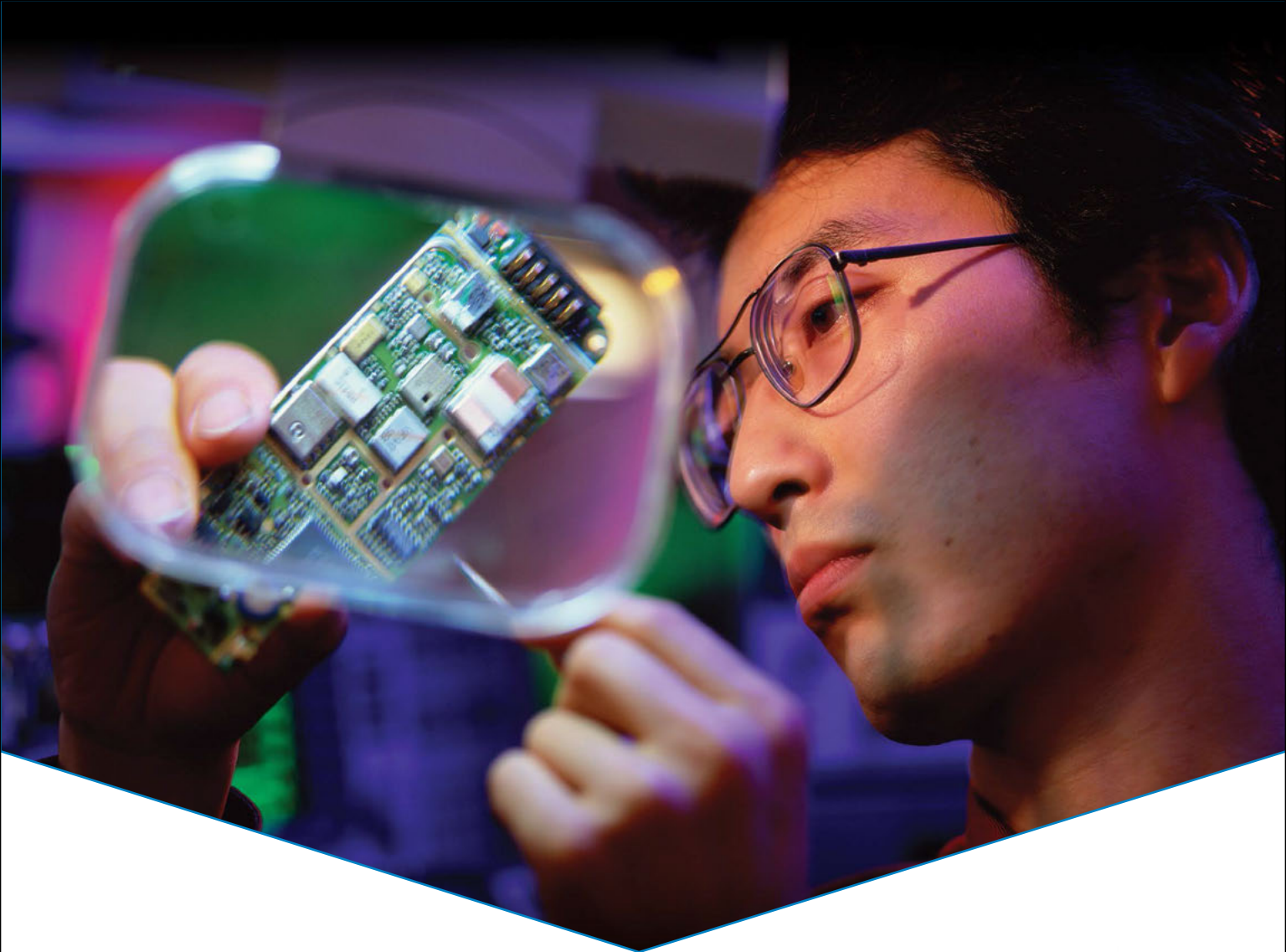
Matties: *They're just finding other ways to apply it. This is really good. This is a great business approach.*

Moore: It's an awesome relationship. I have a great supporting team and great support from the factory. The two teams work extremely well together. There is an open and trusting relationship, which allows them to be highly productive together. ■

On the whole, EchoStar has rather brilliantly taken control of the supply chain by embedding themselves into their EMS's factory—building a system to test the whole function



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ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

Micah Moore offers the DD&TT test engineering team suggestions for additional optimizations and improving efficiency.

of their box in order to save a lot of labor and cost. But at the heart of the matter is exactly what Micah described, an awesome relationship. Walking the floor with Micah it felt like DD&TT was more of a partner than a supplier. Each side helps the other to develop processes and really works to bounce ideas off each other and expand on designs that they can openly use and sell to other customers. They look out for each other as well. In the short term, Micah's team keeps the testers running and in good condition, but for the long-term it's clear EchoStar has a roadmap in place to introduce more automation and keep the testers compatible with future technologies. These are things that DD&TT, the supplier, won't have to deal with, yet will substantially improve their quality and cost. They are two teams from different companies, different countries even, but they are very much connected.

With Micah's state-of-the-art monitoring system, one could say the two are always connected—it's almost like EchoStar keeps their suppliers under 24-hour surveillance. Suppliers might feel as if they are constantly being watched over their shoulder, and I don't think that's far from the truth. It became clear after

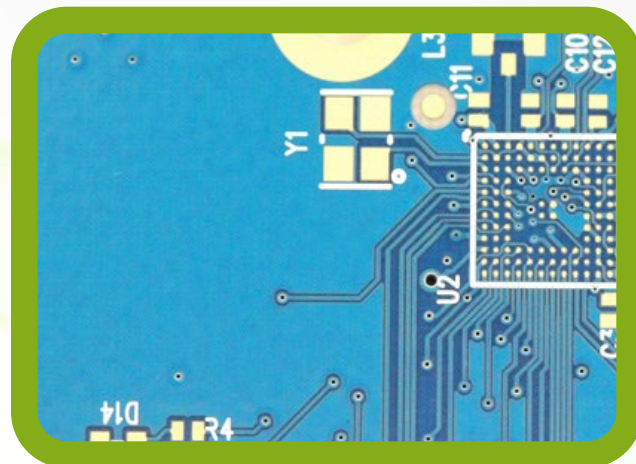
talking with Micah that EchoStar holds their suppliers to very high standards in order to guarantee quality results, but also because they want their suppliers to do things the right way and employ best practices. This became even more apparent when we finished our factory tour and returned to the conference room where I learned about their unannounced audits.

The EchoStar crew calls it the "five-minute agreement," and it's something every EchoStar supplier goes through. When EchoStar shows up unannounced, the supplier has five minutes from the time they're in the lobby to let them on the floor where they can look at whatever they would like. They get open access to everything. That's part of the deal. It reminds me of the saying, "If you have nothing to hide, you have nothing to worry about." However, it is clear that this isn't micromanaging or Big Brother-esque, but rather EchoStar keeping a supportive, yet watchful, eye on their supplier's processes. Like Micah said, there should be no secrets between the two companies. For all the benefits that come with being a supplier to EchoStar, it makes sense that they hold suppliers accountable. If EchoStar has some sort of data or reason to suspect a supplier is hiding fees or burying costs in their supply line, that's a rough start toward building a reliable relationship in which they're willing to share their R&D team and design ideas. With nothing hidden from each other, the relationship begins with truth and grows from that.



Back side of an SMT line.

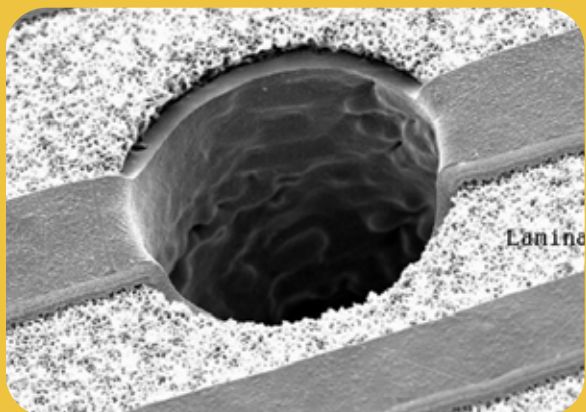
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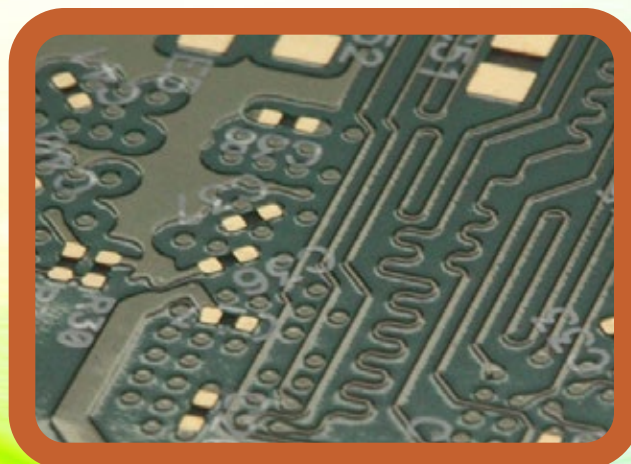


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ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

Next, I was able to share a word with Les Beller, senior manufacturing engineer and Andy Thomson, VP of operations, about EchoStar's unique relationship with their suppliers and how they go about choosing an EMS provider.

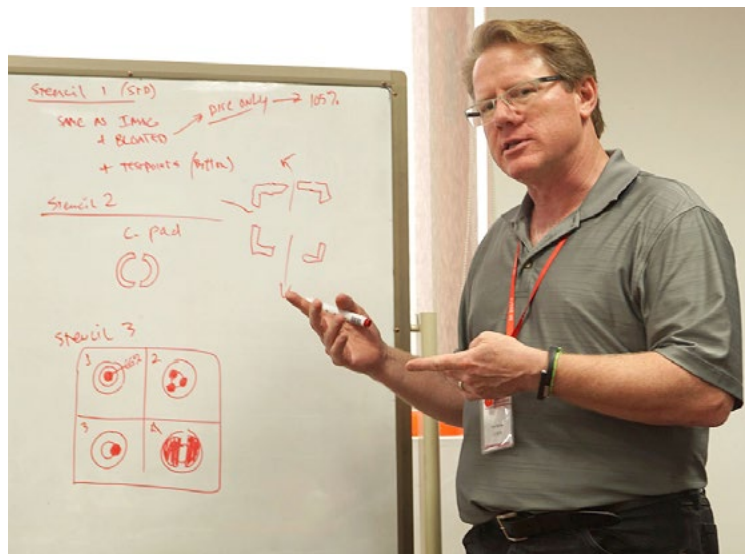
Matties: *It must be very rigorous for EchoStar's suppliers because you really inject yourself into a company; not everybody is going to be willing or capable of this.*

Les Beller: That's true. With the volume of business that we bring forward, a lot of people will let us see what they're about on the surface, and as time goes on and they see the benefit of our involvement and what we bring to the table, technically and through our experience, they tend to open up a lot more. This factory is a prime example of that. Early on, DD&TT needed some of that input, and we've grown really well together.

Over the years, we've developed audit processes for both contract manufacturers as well as suppliers to the company. We've got checklists, ongoing scoring requirements, sample qualifications, and we put up a lot of up-front regulations before we allow use of a supplier or CM. There's definitely a preset testing that they have to pass through and some of that includes actual part testing, like qualification from the hardware engineering group of samples. Will the part or product that is being supplied to us pass all of our requirements? Shipping, shock, consumer damage, consumer stress, as well as down to the piece parts supplier—where/when they're shipping their parts to us, and are they going to survive when they get here? Are they going to be able to do what the spec requires them to do to become one of the parts within our set-top box?

Matties: *So there's the technical capability side of it, but there's also, as Micah was pointing out, the cultural side. Andy, you mentioned that sometimes you go visit the dorms where people are living. Tell us why you do that.*

Andy Thomson: We do that because we're a



Les Beller, senior manufacturing engineer.

company that believes people should be treated like people and not like cattle. Quite frankly, we've fired smaller CMs we were using for what I considered less than humane treatment of employees. How people are treated is very important to us. When we walk into a factory we want people to be smiling and look at us, not have their heads down. We don't want to see any kind of nasty environment, like tools with makeshift handles made up of tape.

We had one vendor that we fired about five years ago, and their board of directors removed their key management soon afterward. Since then they've brought in some great people. First thing the new president did was close the cafeteria for executives and salaried employees and made it so everybody eats together. If the food was good enough for upper management, it was good enough for their workforce. Then they opened up an Internet café where people can pay a small amount of money and play video games and surf. The money goes into a 7-Eleven type of store on campus where they can buy things that are substantially cheaper than a store in town.

This is all in our supplier code of conduct, where it's written that we can show up unannounced at the doorstep of any supplier and be on their floor in five minutes. That's how we fired this board company. Then they changed and

ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

brought in all these great people and we brought them back. That's what we want to see. We love the new management and the people there.

Matties: *So you gave them the opportunity to improve and regain trust.*

Thomson: That was what I call a dramatic fix. I have a very heightened sense of smell. I can smell someone smoking a cigarette in a car in front of me on the road. I don't want to walk into a building and smell fumes. I don't want these young women—who have been working and saving their money for five years—to go back to their province and have a child with birth defects because they were subjected to bad chemicals building a product for us in an environment that was not treated properly.

Matties: *I noticed in their wave solder process they had a special filter for fumes.*

Thomson: It shows they're willing to take it a step further. Another supplier had an oven in Mexico and every time I'd come by I would smell fumes from it. I finally told them, "Enough! Get rid of it!" and they did. They brought in a Vitronics unit and no more fumes.

Matties: *It's really interesting: You're in a supplier/vendor relationship but it feels like this is just an ex-*

tension of your company when you walk through here—the way they've tooled the factory and how well your teams are connected. Micah was explaining his system of being able to see all the information in real time back in Colorado. That gives you some incredible insight for them to improve and for you to improve.

Thomson: We changed the paradigm of how we operate. When I came onboard it was just one of those things where finally I had the opportunity to implement all the things that I wanted to, but never could. When I worked for an EMS, I'd get these emergency calls, disasters pending, and look into them. I'd say, "Okay, this is some bad mojo and it's going south really quick. What would you like to do? You can do it two ways: You can throw people at it now, which will cost money, but fix this before it gets out of control and really in the customer's face, or you can rely on the people in that factory saying they're going to fix it, which they won't, and it's going to crash and burn. You're going to have all kinds of rejects and, at the end of the day, you're still going to have to throw more money and people at it, but you'll have lost the reputation of the plant with your customer. So what do you want to do?" Invariably the plant managers that had these issues would convince corporate that they'd have it fixed. Sixty days later I'd have a team inbound. If it was really bad, I'd be with the team.

Beller: Something I'd like to add on the turnover rates that we've seen in PCB factories is that after Chinese New Year some of the people just don't come back. Companies have gotten to the point where they have to give them half the reward upfront to bait them back and after Chinese New Year they get the balance of the bonus. We've found that with companies that have high fumes, poor lodging, nothing to do on campus, are a horrible place to live and work, it's easier for workers to jump ship and go to the guy down the street. Now you've just lost all your training. Turnover is something we watch very closely with both CMs and suppliers during qualification and during business years. You can literally watch the quality drop during this time of year when companies lose too much skilled labor.



Andy Thomson, VP of operations.

ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

Plastic injection molding.



Resin distribution hopper system.

Thomson: And they get more money to jump knowing conditions are not any better, but money is!

Beller: Agreed. And sometimes it's regional or cultural. We have seen this directly on many occasions.

Thomson: DD&TT is a company that has an extremely tremendous return rate. We've seen other suppliers we work with have their turnover rate drop after Chinese New Year. MTI in WUXI, Sanmina-SCI in Kunshan, all took proactive approaches toward engaging their people and having meetings with them. I would encourage their

plant manager or cell manager to get people off the floor at random, sit down and have lunch with them. Give them opportunities for reward. MTI ran with that. I brought the Kunshan guys to MTI so they could exchange ideas and both have had exceptional success. Make your employees aware they are the most important part of the process and valued by the company!

At Jabil's facility in Pune, India, it's different because there are other automotive businesses that will steal their people, so they do have serious competition. But they have such an active cultural engagement and daycare for children, as well as bringing fathers in to show that their daughters are being treated well at work and are respected. That's what we want. We want companies that treat people the right way because my philosophy is you can't watch everyone. You, as a supervisor on the line, are the company. If the people care about the supervisor and the manager, they care about the company because they are the company.

Matties: *And ultimately you get a better product.*

Thomson: You get a better product and you get higher profits, because when people care about their leaders they're going to do their best. They're not going to be daydreaming. They're not going to hide potential issues. That's the other thing, if you make a mistake, you raise your hand and you go fix it. Don't worry about chastising people.

Matties: *You guys are an OEM that's buying \$100 million worth of circuit boards and products a year. What advice would you give to a circuit board fabricator, an EMS, to really become a great contender in an OEM's eyes?*

Beller: There are a couple things: The first is the supply chain and the sources that you're using. We find oftentimes that the sources appear almost virtual. We go out to the factory sites as a rule now because several times there have been rep firms in the U.S. that present a "manufacturer" to us as a good source. We come over here and it's literally a garage or a small office that outsources everything and you really don't know who the source of the parts is. We qualify

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physical parts and we also qualify the primary manufacturer. It's important that the rep firm has enough experience, like Andy described with some chip makers. The rep firm also has to be consistent, dependable, experienced, and they need longevity with their manufacturer. A lot of these guys will ask what you need sourcing on and say, "Okay, I'll go find a rep real quick." It doesn't work that way. There are too many problems. To qualify a supplier, it's really a three-step program. It's not only quality assurance that does the factory audit, the supply chain group does a financial stability check, and then there's the qualification of the part itself. It's not just one simple step. It's actually a team of folks that actually have to qualify that supplier beforehand. In some cases and on very complex parts, we utilize the design team themselves as part of qualification process. Who knows the parts/process better?

Thomson: The scorecard and how EchoStar tracks quality is paramount. The most important thing you can do with managing any vendor is empirically measure their quality and be fair about it. If, for instance, we had a problem with the delivery and it was a vendor we said they had to use, and that vendor fell down on their sword and we happened to take points off for their DPPMs or for a CAR for that, we want them to challenge us and we'll change that

scorecard. At the end of the day, it's not really their issue, it's ours. If someone ships you junk because we told you to use junk, then how can I hold you accountable? We measure performance every quarter, and we have all of them come in and we sit down and go through the issues line by line; it's been pretty easy. I think the last QBR with these guys lasted less than 10 minutes.

Beller: As far as qualifying PCB suppliers, we get a lot of comments from the supply chain and suppliers that say, "You guys get more involved than anybody does." It's true, not just because we're crazy-technical, but because of necessity. We're auditing sample board impedance to prove their impedance design and for process centering impedance records when in production via statistical data monitoring, and DPPM by failure mode. We also audit them through our CMs by monthly problem reporting for "critical components." We put all this together and it becomes a quarterly business review with each of our suppliers. If you don't go out and look, you're never going to know where the problems truly are, so trust the data.

Thomson: We started to run a product in Jabil Mexico, and they said, "What do you mean you want to go to the floor?" It's a huge operation down there and we wanted to watch our product being built. When you build our product we



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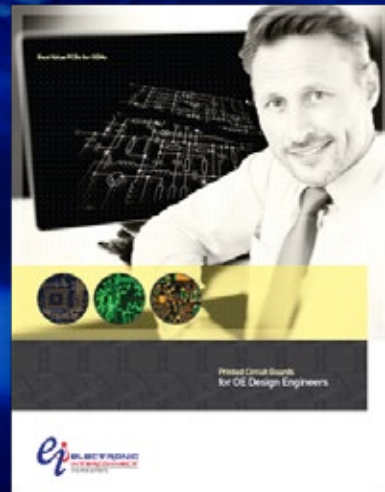
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ECHOSTAR: THE FUTURE OF SUPPLY CHAIN MANAGEMENT DONE RIGHT *continues*

Injection molding: outgoing quality control inspection.

.....
are a part of that and we want to see it. They said nobody else does that. Sorry, we're not everybody else. It was hard for them to get used to.

Matties: *But the results of the three-step process that you have, and the continual verification and injecting yourselves into the process, sounds like a formula that's made your product quality incredibly high.*

Thomson: Our CEO and president have been with the company since its beginning. In the last ATM (all team meeting), the CEO said that the quality of our products and the respect of our suppliers have never been greater. The president said it in one of his staff meetings as well. He said that we have never had a product with this level of quality in the history of the company.

Matties: *In terms of your supply chain management, doing all this minimizes the exposure that many people experience in supply availability.*

Beller: This involvement also lets you keep your pulse on the labor and part cost in different regions, which can be useful. ■

I saw this involvement firsthand as the two teams began reviewing a PowerPoint of DD&TT's recent audits and scorecard. EchoStar's suppli-

ers get a quarterly grade based on a number of things laid out in extensive spreadsheets: quality and shipping trends, defects per million opportunities (DPMO) for each component, NPI support, customer support, paradigm shifts, and the list goes on. The word that comes to mind is rigorous. Just last year, EchoStar's quality team did 175 audits re-qualifying or qualifying companies. This assures continued high quality and delivery performance for current suppliers. It also assures EchoStar's basic quality/cultural standards are met before they can be considered for the AVL. EchoStar's Diamond award exemplifies the highest standard of quality in manufacturing and supply chain management that the EchoStar team is striving to achieve. This award is not easily obtained, needing scores of 98.5/100 or higher for four consecutive business quarters. It is earned through dedication to process improvement and 100% commitment to work with the EchoStar team. If this is the level of effort needed from both the OEM and the EMS to achieve great quality and supply chain management, then it's no surprise why most companies struggle.

Many OEMs might be tempted to take the best price and run without considering much else, only to have it come crashing down later. EchoStar has an idea of best practices, which they expect their suppliers to live up to, more



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The management staff of EchoStar President, Mark Jackson, and DD&TT Chairman Jerry Lee.

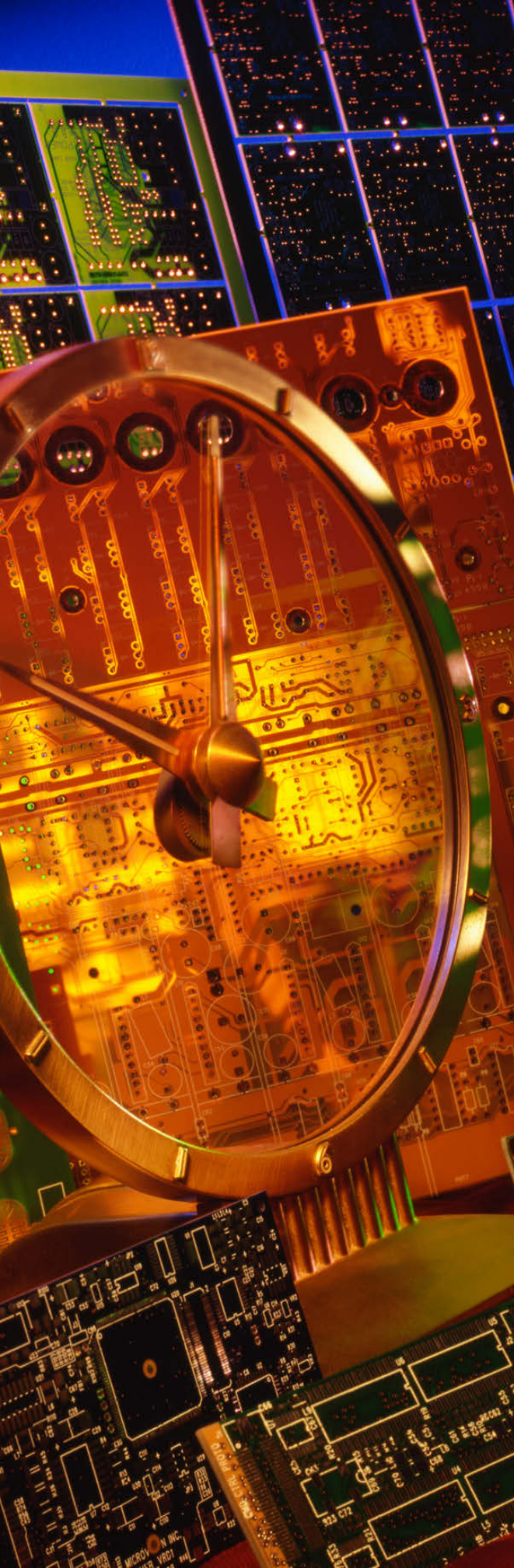
than just the margins and profit. I was impressed with the way they get the overall feel of a facility and look at the smallest details and understand that if the workers are unhappy or tools aren't up to par that these things trickle down the supply line and hurt overall quality. I've gone to Chinese factories and dorms for many years, and to see a big corporation hold themselves and their suppliers accountable to these standards and best practices is refreshing. Sure, there is a quality and business aspect to it, but to hear about refusing to deal with suppliers unless their workers are content and working in the best of working conditions—that shows a moral side. That's truly what best practices are all about and gives me hope for the future of manufacturing.

EchoStar shows that the more you contribute to and support your supplier and really grow the relationship, the more the two companies become engrained together. It is similar to how I've modeled my own business, based on meaningful customer relationships. To get such a strong relationship in place with a customer that they

can't imagine or remember what it's like without you. That's what EchoStar has done—what other OEM is going to be so involved and beneficial to their suppliers' process? When it comes time for pricing, the value of the relationship is such that in many cases suppliers give EchoStar a really good deal because they know they'll have access to Micah and other EchoStar teams for R&D and reducing cost.

This is manufacturing done right. It's the sort of mindset and next-level thinking that other companies are just starting to adopt. EchoStar's quality is the best it has ever been and EMSs are willing to sell for less just to be a part of their team. If you're looking for best practices and the future of supply chain management, this is it. **SMT**

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Beating the Supply Chain Challenge: Interview with SMTC Corp.

by Richard Ayes
I-CONNECT007

In an interview with *SMT Magazine*, SMTC's Seth Choi, vice president of global supply chain management and procurement, discusses how the supply chain has evolved over the past few years; the role of a supply chain manager in an EMS company; how SMTC is lowering their procurement costs; and what strategies they've set up in place to ensure the integrity and security of their manufacturing value chain.

EMS provider SMTC Corp. has been in operation since 1985. The company is based in Canada, with additional operations in San Jose, California; El Paso, Texas; Mexico; and China, in Dongguan, Suzhou and Hong Kong. SMTC is a truly global enterprise, and as such, one with complex supply chain issues and challenges.

Choi himself is responsible for strategic sourcing, pricing, assurance of quality, speed-to-market, and the continuity of supply in order to support global SMTC procurement strategies.

Richard Ayes: *What are your top supply chain challenges?*

Seth Choi: I would have to characterize managing customer controlled suppliers that have one or both of the following conditions as being the single greatest challenge for us. Those conditions are, first, parts with a single source where an alternative supplier has not been designed in, and second, where these suppliers have quality issues. These two factors

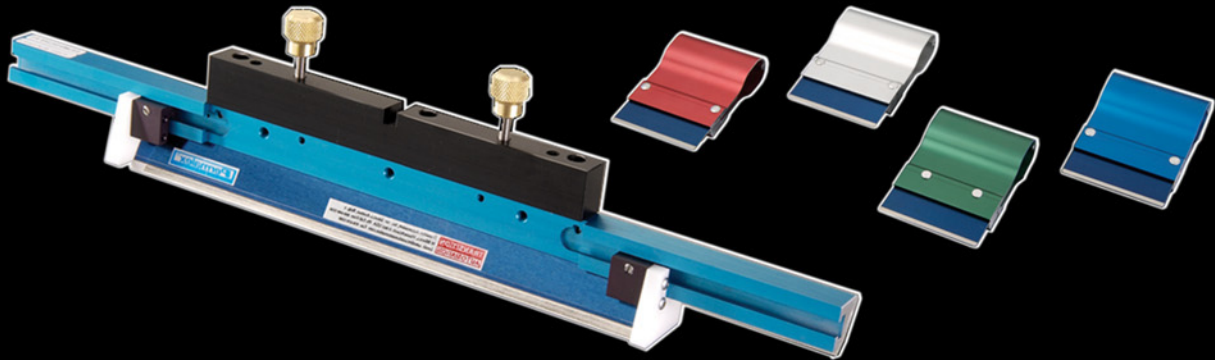


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BEATING THE SUPPLY CHAIN CHALLENGE: INTERVIEW WITH SMTC CORP. *continues*

go hand-in-hand. While the majority of our customers have a good handle on their suppliers, we do run into isolated cases where some of these suppliers consistently fail to deliver quality parts or miss the delivery date.

Production delays due to design issues also remain a problem. This is more common for startups that have an aggressive schedule for time-to-market, where their product has not had enough time to mature. Some raw material suppliers also have difficulties bringing their supply chain up to speed. This in turn would affect our ability to ramp in a timely manner.

Ayes: *Are certain materials or supplies difficult to obtain on a regular basis?*

Choi: In general, lead time and pricing constraints have not been major problems over the last few years. We have seen some isolated instances of specific parts go on allocation with little to no warning. This particular supply shock was probably attributable to demand spikes from large mobile device makers. We've also seen lead time increases on certain types of raw materials used in PCBs, LCDs, and logic and electromechanical, but nothing major.

Ayes: *What is the role of a supply chain manager in an EMS company like SMTC?*

Choi: The supply chain manager's role is more challenging and complex than ever. In addition to overseeing the daily product flows and managing the MRP executions of the buyers, the SCM is responsible for supply management, inventory control, supplier relationships and negotiations, training and communicating corporate initiatives, and developing and deploying customer specific supply chain strategies.

Because their role is complex in scope, the strategic responsibilities are supplemented by

global commodity managers who negotiate terms and prices. We also have a best practices and compliance team chartered to set forth processes and guidelines. The supply chain manager will then take these strategic initiatives and translate to their daily and long-term goals.

Ayes: *How do you lower your procurement costs?*

Choi: The obvious way is through the consolidation of our global demands. We try our best to take advantage of volume and commonality. Because we're a global organization, our ability to compare and hedge prices between suppliers in different regions also helps to obtain cost reductions.

We also take advantage by enabling our global and local procurement strategies. We have commodity managers in two different time zones and supply chain managers in three time zones. They leverage each other by being able to utilize their counterparts in a different region. If the primary commodity manager for mechanicals is situated in Toronto, but an issue or time sensitive task happens to be in Asia, he will reach out to his counterpart and take advantage of skills like language or extending the communication channel with an Asia supplier or even making a visit to the supplier in case of an escalation, or for qualifications. Saving expenses on travel cost is one thing, but being able to increase the time to execution and breaking down any language or cultural barriers provide a huge advantage to us. We are in essence providing these resources to our customers where many do not have a global presence. And because we're a tier 2 EMS provider, the speed of execution is much faster than a tier 1 provider.

Ayes: *How has your supply chain evolved and how different is the supply chain landscape now?*

If the primary commodity manager for mechanicals is situated in Toronto, but an issue or time sensitive task happens to be in Asia, he will reach out to his counterpart and take advantage of skills like language or extending the communication channel with an Asia supplier or even making a visit to the supplier in case of an escalation, or for qualifications.

BEATING THE SUPPLY CHAIN CHALLENGE: INTERVIEW WITH SMT C CORP. *continues*

Choi: As the global economy has slowly improved over the years we have seen a slow but gradual tightening of supplies. But we've also seen some isolated incidents of parts going on allocation, which we had not seen in previous years. There has also been a higher frequency of parts going to end of life. Suppliers for the most part will provide ample time ahead of the cut in date but we do see some of our customer struggling to come up with replacements.

One thing worth mentioning is that the global supply chain network and management of information between factories, distributors and the end users have become much more intelligent and dynamic. The amount of data and the speed to which it flows enable each of the links in the supply chain to react much faster than before.

In terms of the supply chain landscape now, you'll see a major trend towards consolidation of large manufacturers (i.e., Intel's recent acquisition of Altera), and more design registrations by the major distribution channels. The impact to the EMS providers' supply chain is yet to be seen but it will be interesting to see how things shape up in the next few years.

Ayes: *Do you have any strategies built around "Just in Time"?*

Choi: We have all of the traditional supply chain flex programs such as in-plant-stores, VMI, Kanban etc. Our offering on in-plant stores is not as common across other tier 2 EMS providers so this program really helps us to differentiate ourselves from the competition.

The other just-in-time programs lean more towards supporting ramps for our customers. As you know, setting up the system and databases required to control, manage and produce products take up some valuable time that is crucial in a delivery schedule. But at the same time we recognize a need to provide flexibility in a controlled environment.

Ayes: *How do you ensure the integrity and security of your supply chain?*

Choi: All the suppliers we evaluate to qualify are subject to a stringent set of guidelines and

requirements. These requirements enable us to assess whether the supplier can meet our expectations. We pair off a commodity manager and a supplier quality engineer to go audit prospective suppliers or problematic suppliers. By pairing them together, we're able to address both quality and commercial issues.

Also the best practices and compliance initiative which I mentioned earlier defines the requirements that speak to on time delivery and proper execution of MRP. This allows us to monitor the performance of the team but more importantly, identifies the risks if delivery dates slip and provides the reasons behind them. This is really important because MRP execution is not always so black and white. Sometimes we're unable to execute to the MRP signals for acceptable reasons.

Ayes: *How do you address supply shocks, or sudden changes in supply or demand for your raw materials and products?*

Choi: It's a matter of accessing all of your resources to come up with the right solutions. We don't hesitate in contacting our suppliers if there are any issues. If the supplier happens to be a distributor, we push for a three-way call with the distributor and the manufacturer. We notify our customers and engage with them to see if there are any advantages in getting them involved. We are quick to get on the ground and running so it's common for us to visit the factories, too.

Secondly, we are quick to get involved in the customer's design process if our involvement can help them. For instance, we encounter situations where raw material could be changing for a plastic our customer uses and it could potentially affect our delivery schedules or in some cases our quarterly revenue goals. While the customer does not expect us to be involved, we'll proactively push to help the customer however we can. **SMT**

Richard Ayes is an editor for I-Connect007 and based in Malaysia.



Cutting Cost, Not Price

by John Daker
RIVERWOOD SOLUTIONS

In any supply chain survey, the issue of cost comes up repeatedly, often as the number one issue. Even when it doesn't, there's a sense that all the other issues are important, and we'd like them fixed, as long as the price is competitive and constantly being driven down. In some cases, it's worse, and every other variable, such as risk mitigation, logistics management and quality control, becomes a given, with price becoming the only variable and influential factor when selecting a vendor.

But let's not get confused about what constitutes price and what constitutes cost. These are quite different things, and if you are just driving the price down through pressure on your vendors, you'll almost definitely suffer elsewhere. Here we'll explore the downside of focussing on price and suggest some of the practical ways you can reduce costs without having a negative impact on your product.

What's Wrong with Focusing on Price?

The answer to this is almost everything! I've seen too many companies work their way through vendor after vendor on a price reduc-

tion policy that is akin to the Spanish Inquisition, their path strewn with the bodies of non-believers. The truth of the matter is that suppliers are like spouses—if you've had more than three, it's probably you.

The strategy of driving price down in an adversarial manner creates a relationship that is as far from a partnership as it can be. A collaborative price reduction policy may work, but only when there is mutual benefit or where both parties are putting something in to make the supply chain operate in a more efficient way. This adversarial route breeds contempt and mistrust, and may force your vendor to cut corners and compromise—certainly not something that you want when the product they are building is destined for your loyal customers. Their output reflects on your brand, and could cost much more than you save as a result of field failures.

Let's Instead Focus on Cost!

If instead of looking at price—and by price I mean the price per unit on the invoice you receive from the vendor—we look at cost, there is much more to get your teeth into and much more on which to collaborate with your vendor. I'm not advocating ignoring price; that's certainly part of the cost. But when working on

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CUTTING COST, NOT PRICE *continues*

price, we should look at what we can do to help our vendor manufacturer and fulfil for less, not how we can reduce their margins. An insolvent supplier is never a good one.

Design Together, Design Better

From the top, let's look at the design of the product and of the supply chain. I've mentioned both of these together because taking a concurrent view on them is valuable. The sooner you start designing the supply chain, the more effective and efficient it will become. And the sooner you involve your suppliers in the design process the more efficiently and economically they will be able to build your product.

Your vendors are a great source of valuable data that will help you create an even better product, which can be manufactured and delivered in a streamlined way. Chances are they've done something similar before and because these guys make and deliver stuff, they've become quite pretty good at it.

We all know about design for manufacture, or DfM, but what about design for supply chain? This can be as simple as planning the packaging so the products stack better, or fit a pallet or container more efficiently. It could be designing around components that are readily available and don't leave us open to risk of shortages through single sources. Collaboration at this design and development phase is essential.

Be More Predictable

Forecasting comes up time and time again as something that creates tension between the customer and the vendor. Customers will say

that markets are volatile and their consumers are fickle, so they can't predict the future. They don't have a crystal ball, so they won't provide a forecast. That's fine, but even if you can't see the future, you should have a good handle on the past. And while past performance is no guarantee of future performance, it is a pretty strong outline indicator.

Sharing past trends with your vendor and assessing what events have impacted on those trends, will give everyone a sense of what is going on and a sense of involvement. Providing information that will impact on your sales numbers in a timely fashion will also allow for a more manageable and planned supply chain approach.

Communication is essential. You should involve your vendor frequently and early, letting them know when you expect a potential spike or drop off in demand, and tell them why. Let them know if you're looking at a new market or perhaps launching an offer that will bring in additional orders for a particular line.

Give the Customer Plenty, but not Everything

There's a lot of talk right now about mass customization, or the lot size of one. Products that can be ordered online and customized to the consumer's whim seem to be de rigueur. But what level of customization will enhance your sales and what level will give you and your supply chain an unnecessary headache?

Look carefully at the volume you expect to produce and the variations you want to offer. These may seriously affect the efficiency of the manufacturing process and the supply chain, as well as the total landed cost and the fulfillment cost of products. A couple of colors may be a great idea and may make your products appeal to more people, but does offering every color of the rainbow do anything more than that? Look at the Apple iPhone 6: two or three memory sizes, in silver, black or gold, and a supply chain that produces millions of units every week. There's a reason they don't offer 10 different colours and it's not simply because they don't have to.

If you are going down the mass customization route or even down a route of multiple

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models and options, work with your partners in the supply chain to figure out how to best deal with this additional variation. Provide data to help predict the most likely options, whilst understanding what can be built as a platform and what needs to go through the line in isolation.

Mitigate Risk Wherever Possible

Of course that's an obvious thing to say, but risk by its very nature is unpredictable. A supply chain needs to be ready for risk and a panic response to a supply chain disruption will be expensive. There are plenty of things that can be done to mitigate risk and reduce the cost of corrective action when the unexpected does occur.

The important thing is to have a risk mitigation strategy, not a risk migration one. Many companies seem to think if they pass risk onto their suppliers they are mitigating or reducing their risk; that may be the case financially, but it will come at a cost. And if the outcome is that a problem occurs and your supplier is liable, you will still have that problem, along with all the associated stress and brand damage.

Some supply chain disruptions will come out of the blue, like Fukushima or the Thailand floods, both of which had a severe impact on supply chains. However, in these cases, as is in many others, some supply chains suffered more than others. Those that were single-sourced suffered more. Those with the least visibility suffered more. And those with the least agility and flexibility suffered more.

"Plan for the unpredictable" may be a glib phrase, right up there with 'failing to plan is like planning to fail', but as with most glib phrases there's something to be said for considering their tenet. This isn't unlike my forecasting comments earlier; you may not be able to see the future, but you can review the past. Do you have a plan that can be swiftly executed? Do you have contingencies in place?

Lastly, look at the supply chain in terms of its vulnerability. A robust supply chain will have multiple sources for most components and services, and it will have goods in stock, preferably consigned by the vendor, to support any interruption. Build a robust supply chain and monitor it dynamically, making sure you have con-

sidered as many what-ifs as you can and you have enough flexibility and agility to deal with them. Finally, keep your fingers crossed that the things you've considered are the things that go wrong. Be ready for surprises.

You Can't Fix What You Can't Measure

Visibility and traceability are at the very center of a good supply chain. The visibility is needed to allow the supply chain to flex as things in the market and within the supply chain change. Traceability is needed to ensure that when something goes wrong you can trace the problem right back to source and fix it quickly.

The performance of every part of the supply chain needs to be measured if it is to be improved. This is true of cost, quality, speed—everything. If you do not have performance indicators it is highly unlikely that you will be able to improve performance or make savings. In fact, if you don't measure the right things you'll merely fix only what you measure.

If you pick a single KPI (key performance indicator) and measure your vendor by that, it will be that statistic that they work to improve. What you need is a holistic approach that measures the entire supply chain, showing the impact of one part on another. There is no point in changing a device to reduce the BOM (bill of materials) cost if it results in a more complex assembly process, a longer time in test, or worse still a failure in the field. If you only measure the BOM price, this will happen, and the results will not be what you had hoped for!





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CUTTING COST, NOT PRICE *continues***What is with Landed Costs?**

There is a lot more to getting your product delivered to the consumer than just placing an order with the vendor that quotes the lowest price. The calculation of landed costs is much more complex than adding the BOM costs to the labor costs. For this reason the drive to manufacture in areas of the world where labor rates are at their lowest is rife with risk and misinterpretation and littered with stories of failure.

When calculating landed cost there are many things to take into account. Firstly, what will it cost to manage the supply chain? If you choose to manufacture in an entirely different time-zone and geography from your R&D and purchasing, how often will you need to visit and what impact will that time have on your product development and product introduction cycle? What about the proximity to your customer? Where are they and what level of direct or indirect fulfillment do you need to provide? What about all the costs related to shipments? And what about the cost of the time taken for your product to reach you or your customer if it is at sea for four weeks, plus the associated cash flow implications of that stock? Then there's a whole story about reverse logistics and what the supply chain looks like when field failure or a recall occurs.

Regionalization, On-shoring, and Right-shoring

What we really need to consider when selecting a supply chain geography is where the

best place is to make our product in terms of cost, not in terms of price. A lot has been said in the media around the on-shoring debate and the idea that manufacturing is moving back from low-cost environments to higher-cost geographies. I don't see this. I see product moving to lower-cost geographies that are spread around the world rather than just in Asia. That means Mexico for the Americas and Eastern Europe.

The important thing is to pick the right geography for you. That might be Shenzhen or Chengdu, but it might also be around the corner from your headquarters or your biggest customer or perhaps a distribution hub.

The important thing is to pick the right geography for you. That might be Shenzhen or Chengdu, but it might also be around the corner from your headquarters or your biggest customer or perhaps a distribution hub. It might even mean the vendor being close to your design team and speaking the same language.

More importantly, perhaps your best solution is not being a single geography at all. You may need a multi site supply chain to fulfil your product in multiple countries. You might even need a local NPI (new product introduction) facility that you can collaborate closely with, which then provides a gateway to a larger global footprint.

Think Outside of the Box and Beyond the Vendor

Your supply chain isn't just you and your vendors. It is you, your vendors, their vendors, and their vendors' vendor. You need to integrate the entire supply chain and you need end-to-end visibility and traceability—to mitigate risk, as mentioned before, as well as avoid surprises.

Some of the suppliers to your outsourcing partner will be on your AVL (approved vendor list) and some may not, but everything they do impacts on you, on your costs and on your brand, so get involved.

This can be a great source of savings in the supply chain. Looking at the entire supply chain collaboratively can make things run more





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smoothly as well as reduce the costs your vendors pay their suppliers.

Complete traceability is seen as somewhat of a holy grail in the supply chain industry and there's plenty of debate around the topic. The Internet of Manufacturing (IoM), Internet of Things (IoT) and Industry 4.0 have all been offered as potential saviours in this arena. The truth is probably simpler, and that's that a well-designed and well-defined supply chain needs traceability and data as the constant thread that runs through it.

Ask the Accountant

Don't underestimate the value the finance team can add in designing the supply chain. When you chose a partner, a supplier, or a manufacturing geography, this can impact on many hidden areas, such as the cost of cash, the tax implication on the business and those related to the product. Duties and tariffs are hugely variable and just because shipping from one geography to a particular market works, there may

be different tax or duty implications when you start shipping to an emerging market elsewhere in the world.

Payment terms will also have an impact on the final cost of the product and if not measured can impact adversely on the businesses ability to generate cash, and that's what you're here to do after all.

Be Careful What you Wish for!

If you are just driving price, just measuring price and just rewarding your purchasing team on price, then chances are you'll get a lower price. You probably won't get a lower cost, and you certainly won't get a better supply chain. **SMT**



John Daker is the director of business development at Riverwood Solutions.

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Supply advantage High-Performing value

Supply Chain in the 21st Century

by **Steve Williams**

STEVE WILLIAMS CONSULTING LLC

The shift away from vertical integration has pushed the topic of supply chain management (SCM) to the forefront of strategic planning for many manufacturers. Having a supply chain that provides a competitive advantage will be the differentiator in today's business environment.

According to James B. Ayers' paper "A Primer on Supply Chain Management," a supply chain involves life cycle processes supporting physical, information, financial, and knowledge flows for moving products and services from suppliers to end users. Meanwhile, he defines supply chain management as the design, maintenance, and operation of supply chain processes for satisfaction of end-user needs.

The fundamental concept of supply chain management is based on two core principles. The first principle is that virtually every product delivered to an end customer has gone through a number of touches in a number of manufacturing and/or service organizations.

These organizations are referred to collectively as that product's *supply chain*. The second principle is that while supply chains have been around for thousands of years, most companies have only been concerned with what was happening in their own sandbox, so to speak.

In fact, PCB manufacturers have always expected their OEM and EMS customers to actively manage their supply chains. Many still have not filtered that expectation down to their sub-suppliers. Customer audits are a way of life for printed circuit fabricators, but it is surprising to see how many of them have never visited, much less audited, their own key strategic suppliers. I think it is reasonable to expect that a supplier actually visit, audit and collaborate with their key sub-suppliers on a regular basis.

Few businesses took the time to understand, much less manage, the entire "chain" of suppliers and activities that were required to transform raw materials into finished, delivered product to the end customer. This lack of understanding often led to extremely dysfunc-

tional supply chains, and of course, unacceptable delivery and quality performance.

Competitive Advantages of a High-Performing Supply Chain

Supply chain management is a term that has grown enormously in the last few decades. Companies have found that SCM is a crucial element of business today and one that provides a competitive advantage to expanding in global markets. OEMs, ODMs, and other manufacturing organizations are now realizing that investing in the development of a high-performing supply chain can provide the competitive advantage that will differentiate them from the competition and add value to the bottom line. Some of the key advantages include:

- Most favored customer status and loyalty
- Value creation through long-term supplier relationships
- Improved supplier performance expectations

- Accelerated new product introduction
- Value-added services
- Preferred pricing and financial terms
- Flexibility leverage

World-Class Supply Chain

Your goal should be to have a high-performance supply chain that is on par with the best companies in the world in your industry. But if you take an unbiased look at yours, you will probably find that it comes up short in a number of areas.

Ask your management team “How confident are we in our organization’s supply chain and its ability to actually perform in a way that supports our business needs?” If the answer is “not very,” you may be surprised to learn you aren’t alone.

Editor’s Note: You can read the full version of this article in the July 2015 issue of The PCB Magazine.

MAPI U.S. Industrial Outlook: Growth Decelerates in 2015

Several factors have emerged to temper the manufacturing production forecast for 2015 but a rebound is anticipated for 2016, according to the MAPI Foundation’s [U.S. Industrial Outlook](#), a quarterly report that analyzes 27 major industries. The MAPI Foundation is the research affiliate of the Manufacturers Alliance for Productivity and Innovation.

Manufacturing industrial production fell at a 1.0% annual rate in the first quarter of 2015—after 3.5% growth in 2014—primarily due to the severe winter weather in January and February that disrupted construction, transportation, trade, and commercial activity.

The MAPI Foundation forecasts manufacturing production growth of 2.5% in 2015 and 4.0% in 2016. The

2015 forecast is a decrease from 3.7% and the 2016 forecast is an increase from 3.6% in the March 2015 report. Manufacturing will continue to grow faster than the overall economy, which the MAPI Foundation anticipates will advance by 2.4% in 2015 and 3.0% in 2016. For 2017, growth is predicted to be 3.1% for manufacturing production and 2.7% for GDP.

“A number of factors that drove growth last year have changed in 2015,” said MAPI Foundation Chief Economist Daniel J. Meckstroth, Ph.D. “A sudden, rapid decline in oil and natural gas prices was good for energy users but caused

problems in energy drilling, exploration, and the material supply chain; a sudden, rapid rise in the value of the dollar hurt our trade competitiveness; a large inventory buildup this past winter drove the inventory/sales ratio to unwanted highs; and finally, consumers are cautious and risk-averse.”



Electronics Industry News

Market Highlights



IDC: Global IoT Market to Grow 19% in 2015

The worldwide Internet of Things (IoT) market is expected to grow 19% in 2015, led by digital signage, according to a new forecast from International Data Corporation (IDC). The second annual forecast focuses on growing IoT use in 11 vertical industries, including consumer, retail, healthcare, government, manufacturing, transportation, and other industries, while also sizing IoT opportunities for 25 vertical-specific use cases.

Six Top 20 1Q15 Semiconductor Suppliers Show Over 20% Growth

The top-20 ranking includes three pure-play foundries (TSMC, GlobalFoundries, and UMC) and four fabless companies. It is interesting to note that the top four semiconductor suppliers all have different business models. Intel is essentially a pure-play IDM, Samsung a vertically integrated IC supplier, TSMC a pure-play foundry, and Qualcomm a fabless company.

Consumer Electronics Market Forecast to Reach \$1.55T in 2022

Increasing disposable income, decreasing prices of consumer electronic devices in the price sensitive regions and introduction of technological advanced devices are the primary factors driving growth of the consumer electronics market globally.

Industrial Chip Market Posts Record Growth in 4 Years

Based on the latest information from the IHS Industrial Semiconductors service, the industrial electronics category is expected to continue its strong momentum, as the top application-revenue driver in the semiconductor industry, through 2019.

Wearable Market Remained Strong in Q1

"Bucking the post-holiday decline normally associated with the first quarter is a strong sign for the wearables' market," said Ramon Llamas, research manager, wearables. "It demonstrates growing end-user interest and the vendors' ability to deliver a diversity of devices and experiences. In addition, demand from emerging markets is on the rise and vendors are eager to meet these new opportunities.

Global Server Shipments Up 13% in 1Q15

"The first quarter of 2015 was a particularly strong start to the year, with the strongest shipment growth since the third quarter of 2010, when the market was recovering from the downturn. It was also the second-largest-volume quarter ever," said Adrian O'Connell, research director at Gartner.

LED Market in Asia-Pacific to Reach \$35.79B by 2020

The Asia-Pacific LED market is expected to reach \$35.79 billion by 2020, at a CAGR of 15.7% during the forecast period (2015–2020). The high brightness LED segment is expected to grow swiftly and continue to account for the highest market share, contributing to over 60% of the total market revenue, throughout the forecast period (2015–2020).

High-tech Smartphones, Tablet PCs, Driving Camera Module Market

The global camera module market, valued at \$12 billion in 2012, is likely to exhibit a remarkable CAGR of 19.7% between 2013 and 2019 to reach \$43.06 billion by 2019, according to Transparency Market Research. This is mainly driven by increasing penetration of smartphones and tablet PCs and growing demand for technologically advanced versions of the devices.

Info-Driven Manufacturing Drives Photoelectric Sensor Market

Rather than develop independently, the photoelectric sensor market tends to develop in line with other automation markets, such as programmable logic controllers (PLCs) and programmable automation controllers (PACs). According to a new ARC Advisory Group market outlook report, the photoelectric sensors market in China grew moderately in 2014.

Small Businesses Optimistic but Slow Growth Plans

"Business owners are continuing the solid growth pattern reflected in the January survey, but at a somewhat slower pace," said Paul J. Sarvadi, Insperity chairman and chief executive officer. "One of the key contributions made by the nation's small business community is the ability to adjust quickly to economic uncertainties and turn them into profitable opportunities."

A red Formula 1 car is shown from a low angle, driving on a track. The car is sleek and aerodynamic, with a driver wearing a red helmet visible in the cockpit. The background features a blurred checkered flag, suggesting speed and competition. The overall scene is set against a clear blue sky.

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Industry 4.0: Who Benefits?

by Michael Ford

MENTOR GRAPHICS VALOR DIVISION

Benefits and return on investment (ROI) are not as black-and-white as you might think, and as engineers would like them to be. The reality is that even tangible reductions in cost may not be realized unless enabling factors are in place that allow savings to happen. For example, if an operator's time in a certain position is reduced by half, that leaves the other half of the operator's work that must be done, which means that the full reduction in the worker's time can only be realized if the remainder work can be reliably redistributed across other operators. For an increase in productivity to bring significant change to the bottom-line of a manufacturing business, there must also be the opportunity to increase the business volume to fill the gap. Thus, the intangible side of this equation is scrutinized more as the tangible side diminishes.

The good news is that control and management software for SMT/PCB assembly manufacturing provide different sources of benefit, from

which engineers can usually find just a single tangible return that can be enough to justify the purchase of a sophisticated system. However, focus on the vast majority of the rest of the system may be lost. This risk might not be thought through, adding tangible burdens and costs to the other areas of the operation rather than benefits. After installation of a new system, these effects can blow away the benefits that were identified as part of the ROI justification. After many cycles of this experience have occurred already in most PCB assembly manufacturing companies, people are realizing that innovation and investment in new systems may affect them in ways that are less than optimum, resulting in certain groups within the organization resisting pretty much every major innovation. The real problem is that they often are not wrong.

Now, along comes Industry 4.0, which, whether fully and properly understood or not, will certainly trigger a significant amount of



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INDUSTRY 4.0: WHO BENEFITS? *continues*

“automated” objection from the shop floor. For those who fully understand the nature of Industry 4.0, which is that automated communication and decision-making happen between pieces of equipment supported by sophisticated software, this can represent a nightmare scenario.

This may be a tough environment in which to introduce innovations, but this does not mean that Industry 4.0 is going to go away. One key reason is that the ideas and principles of Industry 4.0 have been a top-down initiative of the German federal government who were specifically looking for ways to create the computerization of the manufacturing industry. They may perceive Industry 4.0 as a way to reduce the overhead of low-skill labor and to address the competition of low-cost labor resources in other countries.

The computerization brought by Industry 4.0 means creating automation with software, in a layer above independent processes run by machines' internal computers, to create connectivity. With individualized process automation comes inflexibility because each automated process is dedicated to a particular product or product family. Instead of automating separate process operations, the computerization of Industry 4.0 automates decisions. Senior management and business leaders are attracted by this because they are decision-makers. Aspects of solutions that may be intangible to a factory engineer or manager can be quite tangible to people in higher levels of management, where they view future potential, what can be created, changed, and optimized.

The resource for management making decisions at this level is information. For many years, business intelligence has been working in the financial sectors, for sales forecasting and supply chain, creating information needed for business leaders to make critical decisions. To

use this similar business intelligence in manufacturing, the same kinds of tools need to be adopted. Thus we see the rapidly growing emergence of “big data” and the “Internet of things” concepts applied to manufacturing, with the sole purpose of gathering information for decision making. The required databases need to be fast, efficient, detailed, and accurate, and they need to be driven by transactional data coming directly from manufacturing.

“
Business intelligence tools for manufacturing data would allow managers to see how decisions can be made to reduce this business pain, and comes at exactly the right time. With numbers being crunched right now, business planners are beginning to realize in many cases that flexibility has huge value.

As we have seen over the past 12 months of this column, having a live information flow and management, the ability to see and control what is happening on the shop floor, brings opportunity to execute changes faster without cost or risk. The classic Industry 4.0 example of the filling of soda cans in a factory that can recognize each can by an RF-ID tag and automatically create the exact sodas required is an example of this flexibility in response to short-term “random” customer demand. The major issue and pain to business leaders in SMT is the inability to respond to increasingly changing demand, because they suffer the effects of depreciation in the value of finished goods stock. The increase in the number of unique products and variants continues to rise, with more stock than ever before held in the distribution chain, often at a global level, in spite of significant effort having been made to reduce it.

Business intelligence tools for manufacturing data would allow managers to see how decisions can be made to reduce this business pain, and comes at exactly the right time. With numbers being crunched right now, business planners are beginning to realize in many cases that flexibility has huge value. For example, with factories close to the market, very small distribution chains can realize savings that often exceed the cost differential of labor between countries such as Germany and China. This



Figure 1: Filling soda cans in a factory that can recognize each can by an RF-ID tag and automatically create the exact sodas required is an example of the flexibility provided by Industry 4.0 to respond to short-term random customer demand.

leads inevitably to questions about the viability of on-shoring or re-shoring.

This has now gone right around to solve the issue that the German government was looking for, but perhaps in a different way than was originally intended by some. Computerization is not simply automation to further eliminate the costs labor; the automation of automation brings opportunity for surgically precise management and control of the whole business. Industry 4.0 will therefore not fade away, or simply become an engineering anecdote. The motive, incentive, and opportunity are now being pushed from the top down. The challenge goes out then to production managers and engineers, to find out not only how technically the principles of Industry 4.0 can be implemented, but what effect this will have on people and their processes, within manufacturing and beyond, and perhaps most importantly to many, on their careers. Top-down decisions are much harder to satisfy than you might imagine because the details of applying solutions involves

people throughout the entire operation, resulting in significant issues.

As we have seen in earlier columns, in the SMT world, some great benefits can be achieved, but an almost equal number of fundamental changes need to be accepted for Industry 4.0 to work. Successful application of Industry 4.0 principles, including the associated “industrial Internet of things,” “big data,” etc., needs to be spelled out for everyone in key positions to understand how it affects them, that is, what is the benefit to them.

Next time, we start to look into the points of view of these specific people to see how these principles applied could change their lives for the better. **SMT**



Michael Ford is senior marketing development manager with Mentor Graphics Corporation Valor division. To read past columns, or to contact the author, [click here](#).

SMT007 Supplier/New Product Highlights



Nordson ASYMTEK Automates Dispensing for Manufacture of Hearing Aids

Nordson ASYMTEK, a Nordson company, a global leader in dispensing, jetting, and coating equipment and technologies, announces the sale of two Spectrum II S2-922 in-line dispensing systems to GN ReSound, one of the world's largest manufacturers of hearing healthcare solutions.

Speedprint Appoints GRSYS Services in Brazil

GRSYS Services offers quality solutions and services to the electronics industry. The team has a combined 15 years of marketing know-how with experience in equipment maintenance, process, service, applications and sales. GRSYS strives to be recognized as a company that provides solutions and services with quality, efficiency, agility while offering its customers competitive costs.

Japan Unix Launches New Multi-Phi Technology

The Multi- ϕ (Phi) Laser is a practical product for laser soldering users. When hand soldering, operators consider tip sizes/shapes. Now, with Multi- ϕ , they can do the same with laser. Multi- ϕ optimizes laser exposure diameters to fit any component size or board patterns. Laser beam spot diameters are adjustable without moving.

Japan Unix Upgrades Flash Soldering Series

The innovative flash soldering laser system is two times faster than a typical laser and can integrate pre- and post-soldering processes such as surface mount and through-hole devices. In addition to increasing speed, the Series can improve productivity.

Acoustic Surface Flatness of Components and Boards

Plastic packaged ICs, including BGAs, may experience warping as a result of processing. This article describes using acoustic micro-imaging tools to

measure and map the flatness of the top surface of a BGA package where warping may occur.

Dymax Releases New White Paper on Light-Cure Technology

Dymax Corporation's new white paper explains how light-curable materials in the manufacturing process actually allow for better process controls than other adhesive options, what the benefits of using them are, and what those process controls look like.

Count On Tools Expands Manufacturing Facility in Georgia

Count On Tools Inc. (COT) recently expanded its manufacturing operations at its Gainesville, Georgia headquarters. The latest expansion is in response to the growing market for custom engineered SMT nozzles and consumables.

USI de Mexico S. A. de C.V. Selects VERSAFLOW 3/66 Dual Track

Kurtz Ersa North America announces that it recently sold a new VERSAFLOW 3/66 selective soldering machine to Universal Scientific Industrial de Mexico (USI) S. A. de C.V. The system was installed and is in use at USI's plant in Jalisco, Mexico.

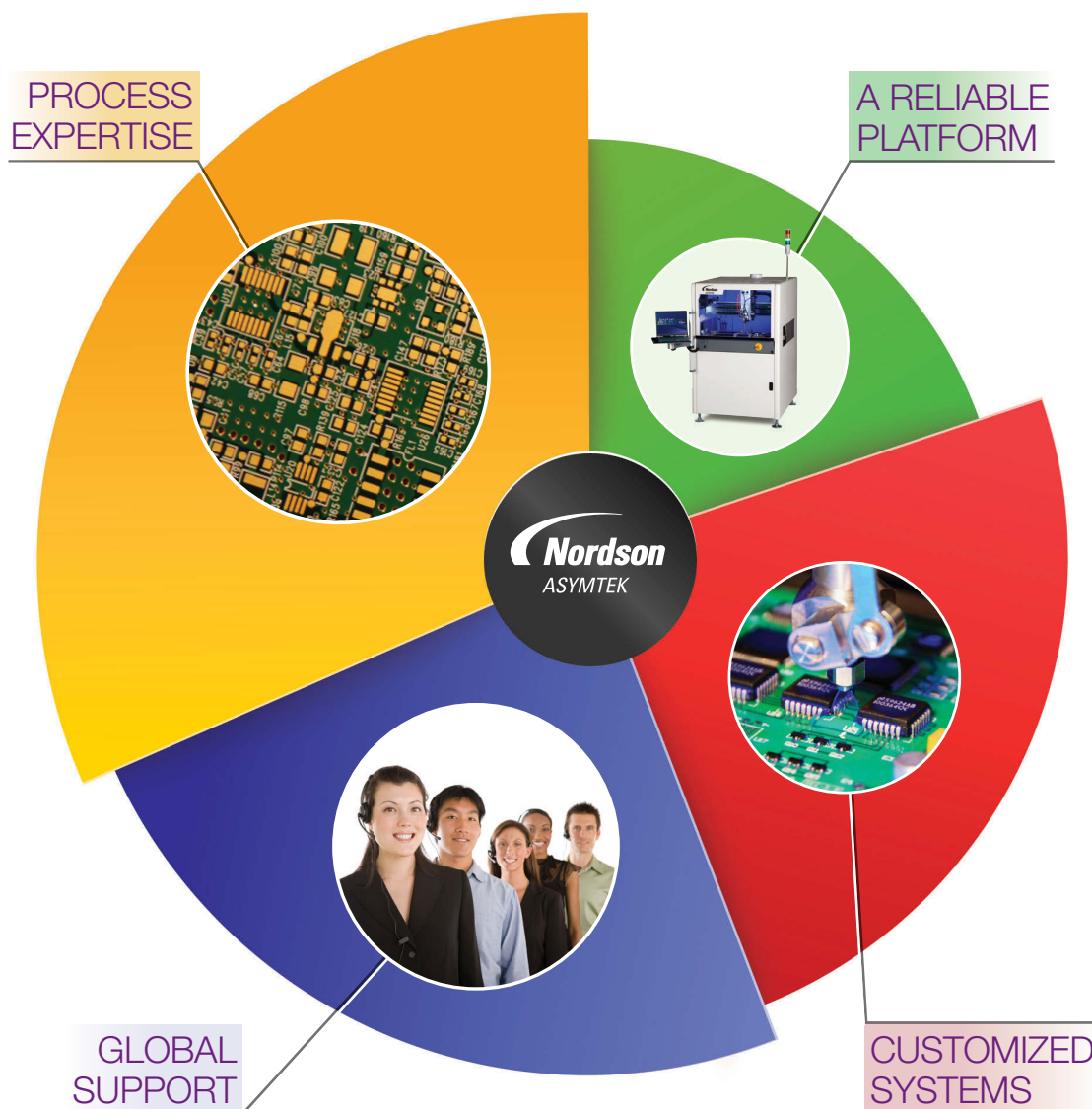
Japan Unix Debuts Optimal Laser Shape Rings

Japan Unix, a solutions provider for manual and soldering automation, introduces laser shape rings. Choosing the best laser spot shape to fit components and land shapes can reduce circuit board problems. Laser shapes are available in more than just the well-known circle.

Production Expansion for ZESTRON South Asia

ZESTRON South Asia has successfully begun its production of cleaning solutions at its new 4,650m² state-of-the-art facility in Penang, Malaysia.

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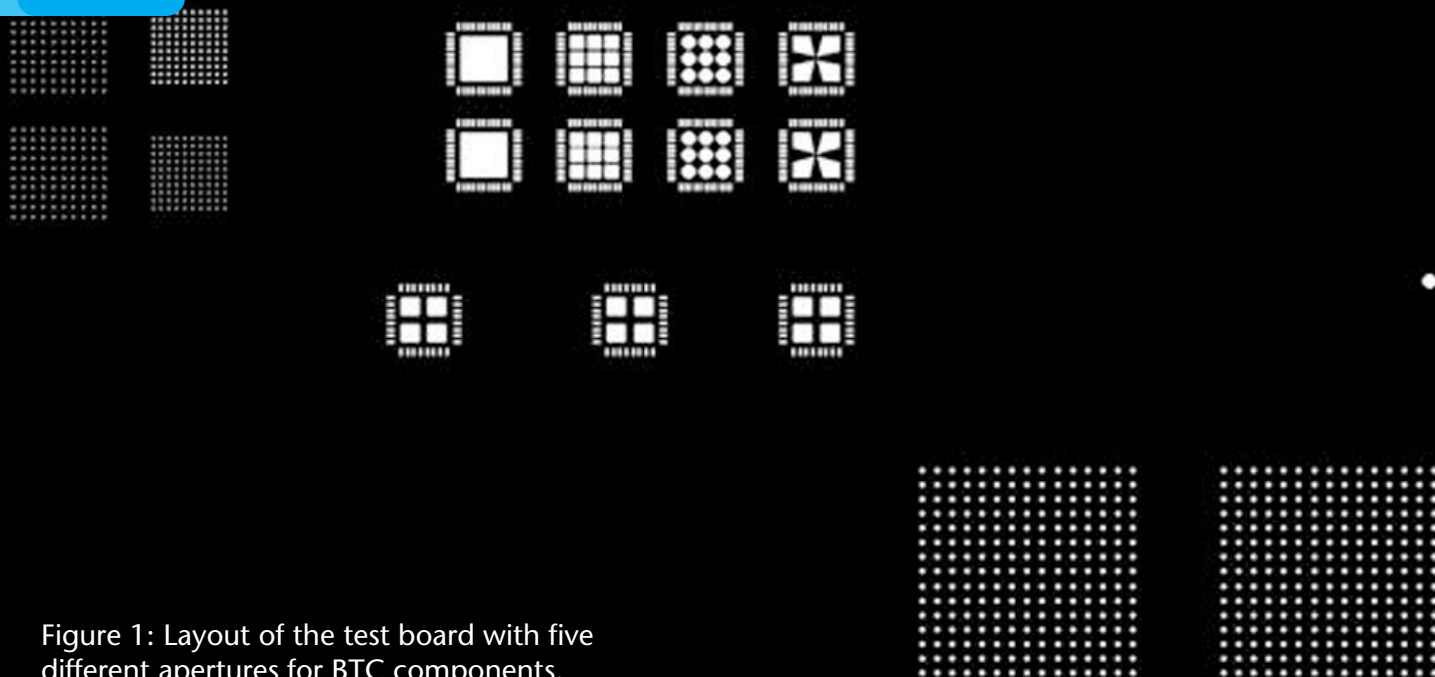


Figure 1: Layout of the test board with five different apertures for BTC components.

Benefits of Soldering with Vacuum Profiles, Part 2

by **Helmut Oettl**
REHM THERMAL SYSTEMS

Expanding on [Part 1](#), this article takes a closer look at the soldering process with a focus on vacuum profiles, as well as an evaluation project and the obtained soldering results.

Figure 1 shows the overall layout of the test board, although only the components with ground connection will be considered for this evaluation. Two identical apertures per variation are also included on each PCB.

The two stencils vary with regard to thickness and utilized manufacturing process. One stencil was used without any additional finishing steps and has a thickness of 120 µm. As opposed to this, the other half of the boards were printed with the plasma coated, electro-polished variant and a stencil thickness of 110 µm.

The difference between the soldering profiles is shown in Figure 2 and results from the use of the controlled vacuum profile depicted in the graphic. A pre-vacuum was used in the preheating zone, which stabilizes the test procedure because the soldering tests were distributed over

an entire day and thus, for example, absorption of moisture into the solder paste flux chemistry might lead to distorted results.

Stable conditions can be assured by reducing pressure, which lowers the boiling point of liquids, and therefore promoting ease of evaporation of volatile compounds like water, etc.

The use of the main vacuum extended the time above liquidus by 30 seconds in order to reduce the number and the formation of voids. Because the void reduction process has to be conducted for the most part in the molten state and must not be run too quickly, a longer period in the melting phase of the solder alloy has to be accepted. A final pressure of 10 mbar and a dwell time of 10 seconds were selected to achieve the following results.

A comparison of the soldering results for these two profiles is depicted in Figure 3. Minor differences between aperture-related results can be detected here, although they cannot be classified as significant. The results obtained with a vacuum pressure of 10 mbar are significant, with which all solder joints were produced with a void content of less than 2%.

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Automation in Electronics Manufacturing	Flexible Circuitry	Printed Electronics
BGA/CSP Packaging	HDI Technologies	Quality & Reliability
Black Pad and Other Board Related Defect Issues	Head-on-Pillow Board and Component Warpage	Reshoring
BTC/QFN/LGA Components	High Speed, High Frequency & Signal Integrity	RFID Circuitry
Business & Supply Chain Issues	Lead-free Fabrication, Assembly & Reliability	Robotics
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Conformal Coatings	Miniaturization	Surface Finishes
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More information: Anne Marie Mulvihill, AnneMarieMulvihill@ipc.org, or Andrea Pinc, AndreaPinc@ipc.org.

Conference Paper Timeline

Abstracts due August 14, 2015

Acceptance by September 4, 2015

Papers due November 13, 2015

Presentations due December 11, 2015

Professional Development Timeline

Proposals due August 14, 2015

Acceptance by September 4, 2015

Final presentation revisions due December 11, 2015

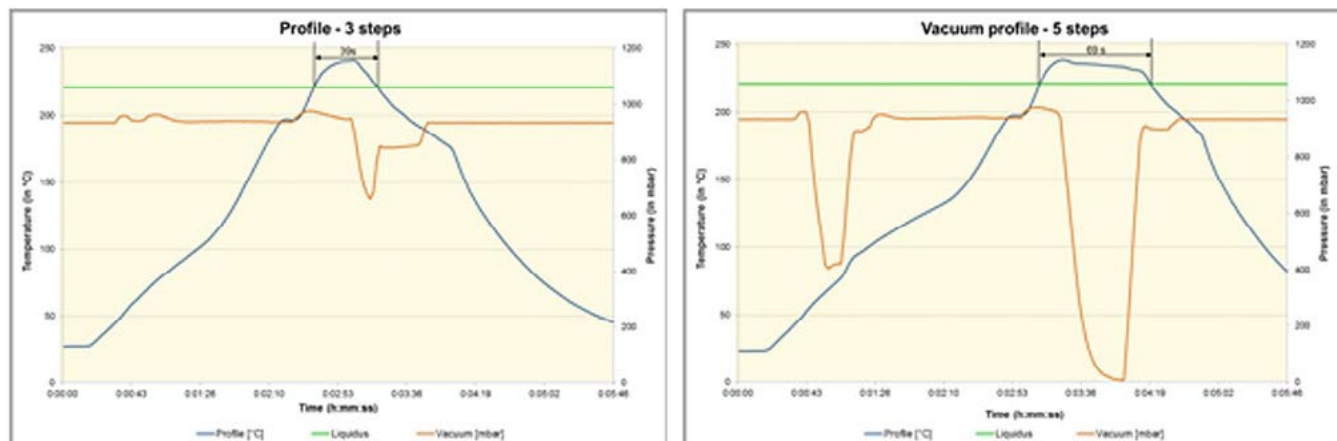
BENEFITS OF SOLDERING WITH VACUUM PROFILES, PART 2 *continues*

Figure 2: Soldering profile without vacuum (left); vacuum profile with 10 mbar and a dwell time of 10 s (right).

The results in Figure 4 of the extreme comparison of soldering at ambient pressure and with a vacuum of 10 mbar are also confirmed by the test run at 100 mbar. Void content (< 3%) and the number of voids can be significantly reduced in this case as well. Beyond this, the selection of aperture geometry and stencil type has a less significant influence on vacuum soldering results. However, one gains the subjective impression that in this case the plasma stencil has the tendency to leave somewhat less voiding, which could possibly be traced back to better release of the wet paste and the associated dimensional stability. And thus the stable, uniform paste release would have to be taken into consideration as an influencing parameter.

Summary

Soldering with the targeted use of a vacuum can contribute to a considerable reduction of the number of voids and void content. In order to assure that no negative effects occur, such as damage to sensitive components or solder splashing, it should be possible to profile the pressure curve like a temperature profile. The use of different aperture geometries or variously coated stencils doesn't necessarily result in significant differences during vacuum soldering. The theory involving outgassing ducts cannot be confirmed in this case, because they disappear already in the preheating zone. To a much

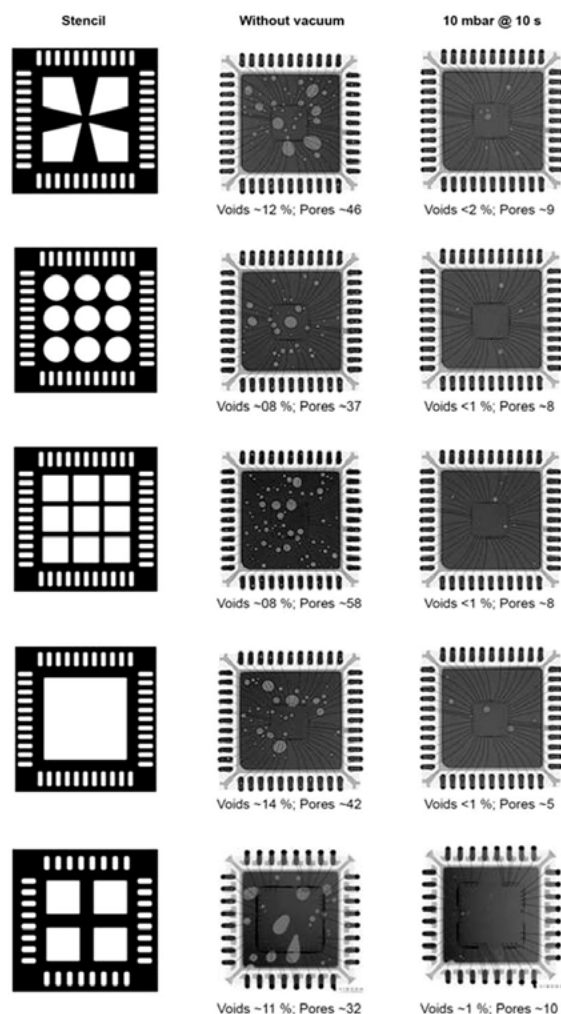


Figure 3: Comparison of stencil geometry with and without vacuum process.



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BENEFITS OF SOLDERING WITH VACUUM PROFILES, PART 2

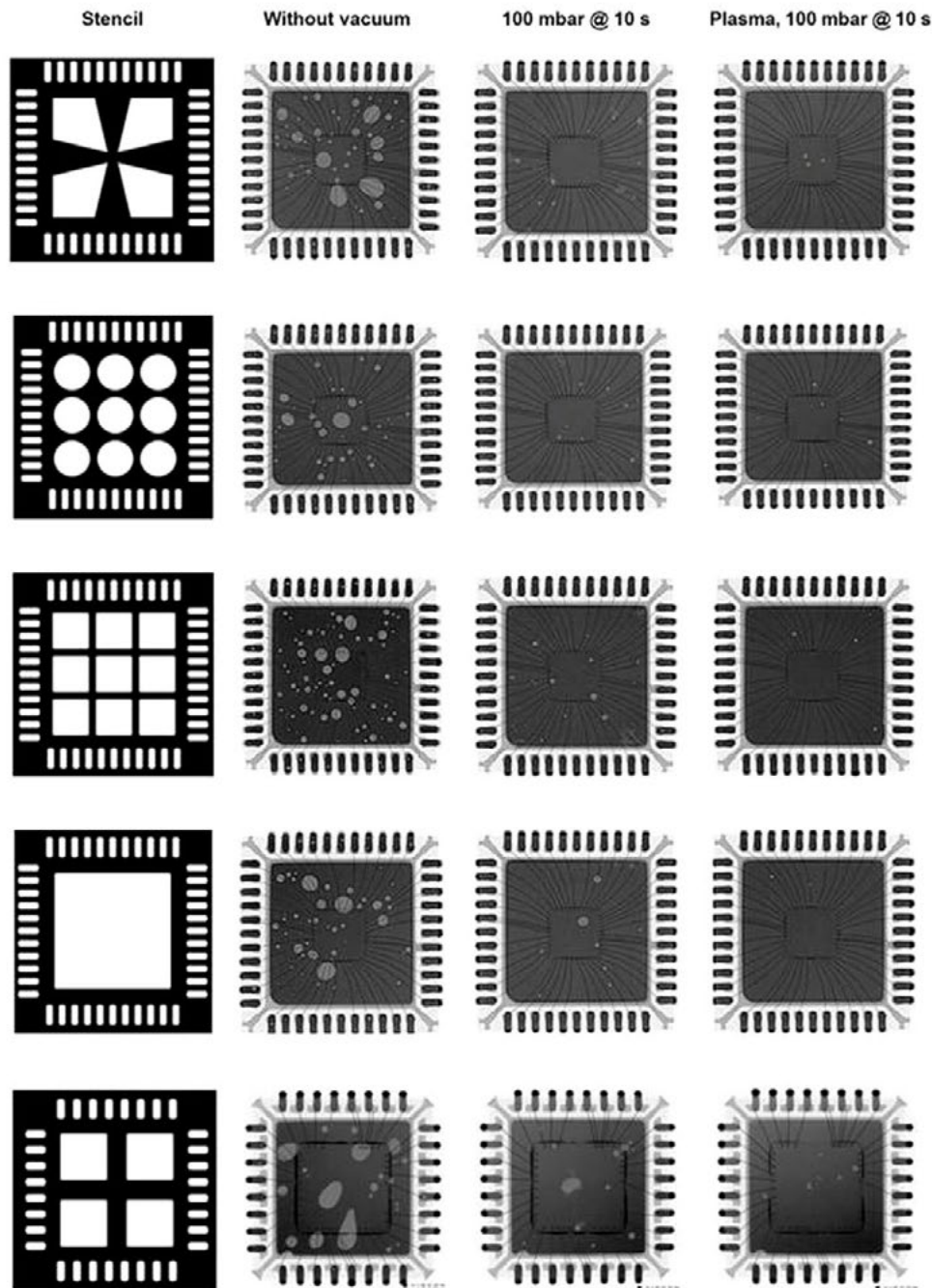


Figure 4: Comparison of stencil geometry, stencil type and soldering process.

greater extent, partitioning of a large ground pad can have a positive effect on wet paste print characteristics and wet paste print stability (e.g., scooping etc.), which may lead to better results. Nor can any single vacuum pressure value be specified, which always yields best possible results. Depending on the wet paste layer thickness, the selected solder paste and the stencil

aperture, results of less than 2% void content can be attained with vacuum pressure values ranging from 10 to 100 mbar. **SMT**

Helmut Oettl is head of application and product management for Rehm Thermal Systems.

I-Connect007 Survey Finds Lowering Cost, Automation among Key Supply Chain Concerns

by **Richard Ayes**, EDITOR

For this issue of *SMT Magazine*, the I-Connect007 team opted for a different approach when it came to planning the editorial content of the magazine. Our topic is the supply chain segment of the electronics assembly industry, and it is the singular topic this month for all our titles—*SMT Magazine*, *The PCB Magazine*, and *The PCB Design Magazine*.

But to really provide relevant discussions and insights on one of the most important aspects of a company's business—the supply chain—we did a survey to find out our readers' top supply chain challenges and goals, as well as what they would like to learn about supply chain management.

Top Supply Chain Challenges

As expected, some of the most common issues were highlighted, including cost, regulations, quality, and delivery lead time. Interestingly, there were other issues that surfaced, such as component obsolescence and industry best practices.

But one particular issue highlighted by our survey respondents was the difficulty getting materials or supplies. In particular, they mentioned laminate materials—specifically Rogers Corp.'s products—that take too long to arrive.

We reached out to Rogers for their response, which led to an interview. That interview will be published in the July issue of *The PCB Magazine*.

On Supply Chain Management

We also asked our readers what they would most like to learn about to help them manage their supply chains effectively and efficiently. While the

majority (53.3%) answered lowering their procurement cost, close to half of the respondents (40%) are considering automation to help them improve their value chain.

Other respondents mentioned savings that can be made by choosing the best chemistry, while others said they'd like to see metrics that will help monitor the business health of their suppliers.

Supply Chain Goals

At the end of the day, suppliers want their issues resolved. So when asked about their supply chain goals, most answered reducing cost—transportation and material costs—as well as shorter lead times and availability of components/materials.

Meanwhile, our goal here at I-Connect007 is to provide you, our readers, with relevant information and insights that will help you improve your production processes and achieve your manufacturing and business goals. Our July issue of *SMT Magazine* is a testament. Given the challenges and issues above, we are pleased to present different viewpoints, strategies, and techniques that will help you take your supply chain management to a higher level.



Mil/Aero007

Highlights



IPC Releases Report for Lead-Free Electronics in Mil/Aero Applications

The study examines the use of reballing lead-free assemblies in order to meet high-reliability requirements, and it estimates the average costs that this workaround typically adds to board production. It also estimates the price differential of scarce components and identifies the tipping points at which the industry can be expected to go fully lead free.

LACROIX Electronics Proves Position in Aerospace Sub-contracting

LACROIX Electronics proposes first class industrial know-how that guarantees development and industrialization of complex products under exceptionally rigorous quality conditions required by the aerospace sector.

Kitron Expands in Lithuania

Kitron officially opened its new production facilities and engineering services centre in Kaunas on Wednesday. This is a major manufacturing base for Kitron and underscores the strategic importance of the Lithuania division.

Ducommun Named John Deere Partner-level Supplier

The Partner-level status is Deere & Company's highest supplier rating. Ducommun provides John Deere Electronic Solutions with complex, high-reliability printed circuit board assemblies and electronic systems used in equipment for the agricultural industry.

Kitron Inks Frame Agreement with SAAB Avionics Systems

Kitron's subsidiary Kitron AB in Jönköping, Sweden, has signed a strategically important long-term frame agreement with Saab AB (Business Unit Avionics Systems) for military avionics and aeronautic electronic equipment.

OEL Earns AS9100, Invests for Growth

Outsource Electronics Limited, a member of the Season Group, has obtained AS9100 certification

for its facility in Havant, UK. This is the culmination of a series of major investments in the site over the past two years.

Plexus Earns AS9100 for Engineering Solutions in Europe

Plexus Corp. announced today that its Livingston Design Center in Scotland has achieved AS9100 certification. This center provides engineering solutions and award-winning customer service excellence to many of the world's leading branded product companies.

Commercial Aviation Market to Top \$300B by 2018

The introduction of new aircraft types and sizeable order backlogs point to significant expansion and changes to support requirements in the next five years. "Production in 2013 was \$161.7 billion, and that number is forecast to jump to \$317.5 billion by 2018," said Ben Moores, senior analyst at IHS Aerospace, Defence & Security.

Flight Navigation System Market 2014-2020

Flight navigation systems consist of FMS that comprises a navigation database, which contains elements from which a flight plan is made. In other words, it integrates navigation and performance with aircraft operations and harmonizes all the functions starting from pre-engine start and take-off to landing and engine shut-down.

EU Imposes Mandatory Conflict Minerals Requirements

The European Parliament voted 402 in favour, versus 118 against, with 171 abstentions on a proposal to require companies, including electronics firms, that buy gold, tantalum, tin and tungsten to certify imports do not provide financial support to conflict. The regulation applies to all conflict-affected high risk areas in the world, of which the Democratic Republic of Congo and the Great Lakes area are the most obvious example.

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KNOCKING DOWN THE BONE PILE

A Rework Dilemma: PCB Shields

by Bob Wettermann

BEST INC.

RF shields minimize radio frequency (RF) noise to prevent it from affecting the sensitive and critical electronic components beneath the shield. They also prevent such noise from interfering with neighboring devices or other systems in the vicinity. RF shields typically have a unique design and conform to the layout of the PCB. Often, the shields are not regular-shaped designs; rather, they are designed and are shaped by the PCB layout. Typically these shields can be found on handheld wireless device PCBs such as smartphones, netbooks, tablets, portable medical devices and audio/video players, to name a few.



There are two basic construction types for these shields. Some of them are a two-piece construction with a “fence” soldered to the PCB and a cover fitted over this fence.

Other shields are a one-piece construction with an open-sided can overlaying the components and soldered to the PCB. These one-piece shields are a serious challenge to rework and will be the focus of this rework discussion.

Challenges of Shield Rework

There are numerous challenges associated with reworking shields, including, but not limited to:

1. Devices are very tight and close to the shield itself—many times within a few millimeters. This means that the rework process, if not precisely controlled, can present problems in disturbing nearby devices.

2. Shield trace solder excavation and PCB board prep are challenging as well, especially for odd-shaped shields. Manual methods require extreme dexterity as the distance between the land of the shield and neighboring devices

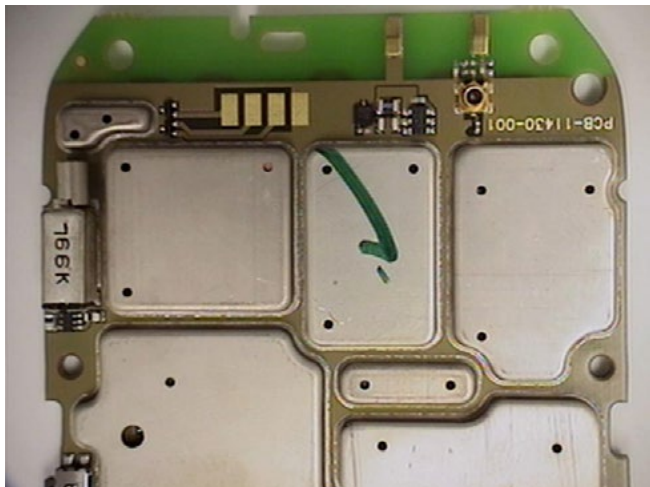


Figure 1: Example of multiple shields on handheld wireless PCB.

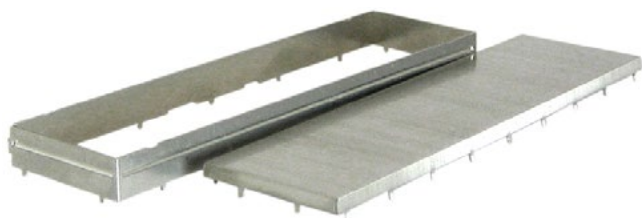


Figure 2: Example of two-piece shield.



Figure 3: Example of one-piece shield.

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A REWORK DILEMMA: PCB SHIELDS *continues*

is very small. This means that neighboring devices can be disturbed.

Resoldering of the shields can be very challenging as the gap between the shield lip and the board needs to be closed so as to not allow for any ingress or egress (in some cases) of RF signals. This means there is little room for error.

Reflow Methods

There are a variety of reflow methods that are used for single-piece RF shields, including the use of hot air convection, conduction and laser sources.

After removal, the shields themselves need to be discarded for a variety of reasons. First, the shields are typically discolored after having gone through multiple heat cycles. While these discolored, formed pieces are not a reliability concern, the end users do not want this inside their product and have augmented their inspection criteria to make a discolored shield a defect.

Second, in these rework processes, tin shields can become highly oxidized and nearly unsolderable surfaces. Finally, from a practical basis, the shield lips soldered to the PCB can warp after reflow (the shields are typically 2–4 mils in thickness) and thereby cannot then sit on the same plane as the PCB, rendering it impossible to close the gap between the PCB and the land of the board. This will make the purpose of the shield, which is to properly attenuate RF signals, a failed one.

The most commonly used method for the reflow of these shields involves the use of a hot air system with a customized nozzle. A bottom heater is used to first heat the PCB to 100–125°C. Once this temperature is established, the hot air nozzle will come over the device. The nozzle itself is custom-designed to contour to the shape of the part, with the air baffles blowing the hot air towards the periphery of the part where the lip of the shield connects to the PCB land. The removal profile must be carefully thermocoupled as there are parts underneath the shield which should have limited heat exposure. In addition these same parts may be under filled, which can cause the solder on these components to experience “solder squirt out,” an unrecoverable defect in the rework process.

These undesired reflow problems along with the extended lead times of the nozzles makes the hot air removal method time consuming and expensive.

Another method for the reflow of the RF shields is the use of a conductive soldering iron. In this method a conductive tip, shaped exactly to the outline of the shield, is placed on top of the shield. It is powered by a very generously-powered power supply that can deliver enough thermal energy to the shield to remove it quickly. The downside of this method is that the tips themselves are highly customized and subjected to both a machining and plating process, resulting in an expensive, long lead time in the manufacturing process. The flip side is that this method is a very fast way to both de-solder and to re-solder shields.

Another method involves the use of a laser source. In this method, a material, which can absorb energy from the wavelength of the laser source being used is placed onto the shield. The laser then directs its beam to the selective area of this material on the shield surface and rapidly transfers this energy in the form of heat to the shield. This allows the shield to quickly be removed. The benefits of this approach are very rapid removal, thereby limiting potential peripheral part damage and little chance for neighboring device reflow. The downside of this approach is that the laser source is capital intensive.

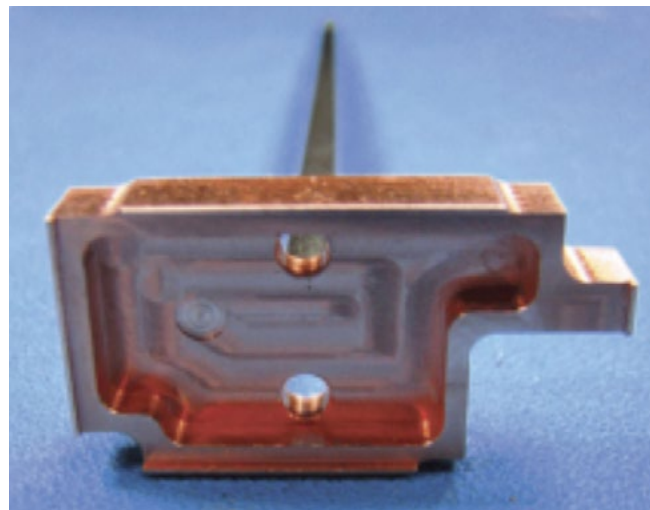


Figure 4: Customized RF shield conductive tip.

A REWORK DILEMMA: PCB SHIELDS *continues***Site Preparation**

Several methods can be employed in order to excavate the remnant solder on a PCB after shield removal, including the use of solder wick, non-contact hot air excavation and copper coupons.

The most common solder excavation method, especially predominant in cases where the volume of rework is low, is the use of solder braid. The keys to making sure all of the remnant solder is wicked off and flat with no neighboring device damage is to use the proper technique and materials. In terms of the materials for this method the use of the correct-sized braid, the proper flux and the correct conductive hand soldering tool is important. Using the correct size of braid is critical for correct removal as too large of a braid can damage neighboring components; too small of a braid can lead to inefficiencies in the removal process as well as potentially damaging the PCB laminate or solder mask.

The proper flux will ensure that the solder wets the braid properly. Finally, making sure the conductive power supply can deliver the power required for the application—especially if the board has a large thermal mass or the shield is connected to a ground plane, is required. In terms of technique the solder wick should be placed perpendicular to the area to be excavated and then lifted off during heating. It should

not be dragged across the surface of the PCB as this may damage pads, laminate and mask.

A non-contact hot air programmable excavation system can also be used to scavenge the solder from a PCB after the RF shield has been removed. In this system, the board is brought up to temperature using a preheater. Next, a solder excavation tool with both a heated nozzle and a vacuum source emanating from the orifice of the tool will be programmed to drive around the periphery of the shield land pattern on the PCB. This is a non-contact method and has the advantage of not being subject to the skill level of the operator for consistency and for not damaging either the land or the laminate of the PCB. While this method is quite slow, it is very repeatable. Like all air driven sources in PCB assembly it is imperative to keep the air systems clean or they will not work.

The final method being used for remnant solder removal involves the use of a pre-fluxed copper coupon. It is used as a wicking vessel to pull up the solder around the land. Custom flux-coated coupons, cut to the shape of the shield, are placed in to a rework station. Once they come to temperature they are lowered to the surface of the PCB. The remnant solder is then drawn to the coupon for subsequent removal. After this operation the spent coupon is discarded. This is a fairly slow technique, but results in less damage than the completely manual solder-wicking approach previously described.

Solder Deposition

Several methods are used to make sure that a consistent solder fillet is formed between the lip of the shield and land on the PCB. Manual soldering, solder dispensing and solder performs are all methods which can be used to close the gap. Manual soldering requires that the proper technique is used to ensure that the entire periphery of the shield has no gaps between shield lip and land. In many handheld consumer devices employing these shields, the spacing to neighboring shields or components is less than two millimeters, requiring a very high level of dexterity from the soldering technicians. Parts and neighboring shields can be easily damaged. Robotic solder paste dispensing is a very consistent way to get the same volume of solder

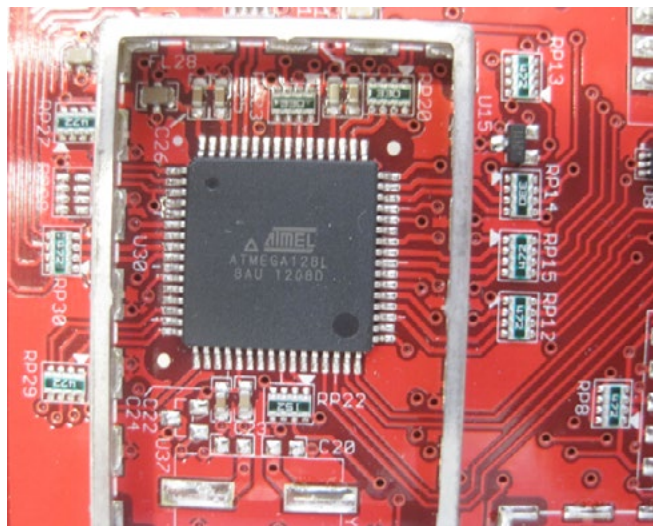


Figure 5: Example of parts being in very close proximity to shield.

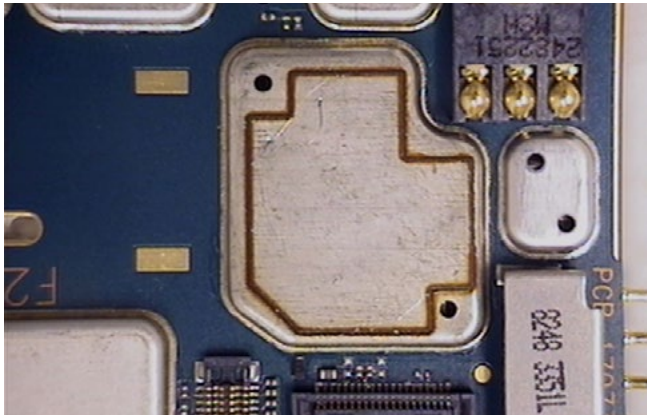
A REWORK DILEMMA: PCB SHIELDS *continues*

Figure 6: Shield scribed with laser.

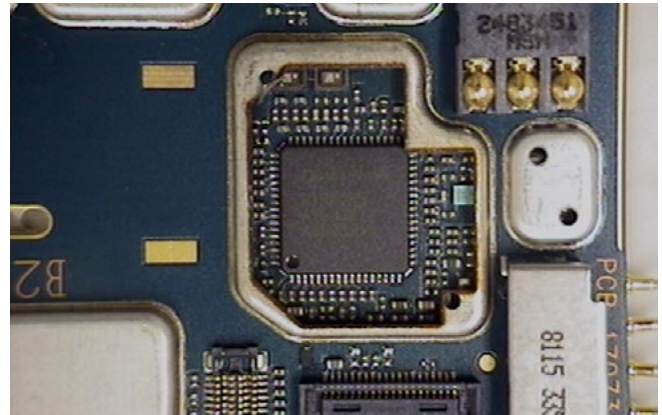


Figure 7: Hole opened in shield top.

paste down on to the land each and every time. Typically auger-driven systems ensure as repeatable of a dispensing volume as possible without indiscriminant “tails” or “gaps” in the solder deposition due to the sometimes inconsistent incoming pneumatic pressure. Finally, custom solder performs are another way to ensure consistent solder paste volume deposition along the lip of the shield. This is an expensive approach but one in which the various reflow methods previously described can be used to reflow the solder to prevent any gaps.

Open the Can Approach

Another approach in which the potential damaging side effects of the reflow process can be avoided is to selectively cut out a portion of the shield, rework the location directly under the area in which the cut-out was made and patch the shield afterwards. By using the proper laser wavelength and a very fast cutting profile, a select area can be cut out. After removal of the cut-out shield area, the hand soldering tool or rework nozzle can be used to remove and replace the device in question. This greatly reduces the likelihood of neighboring or underside components to go in to reflow or from being damaged. After replacement a special shielding tape can be affixed over the opening in order to close up the hole and maintain the efficacy of the shield.

Conclusion

With the proliferation of handheld wireless devices, the PCB assembly processes, including

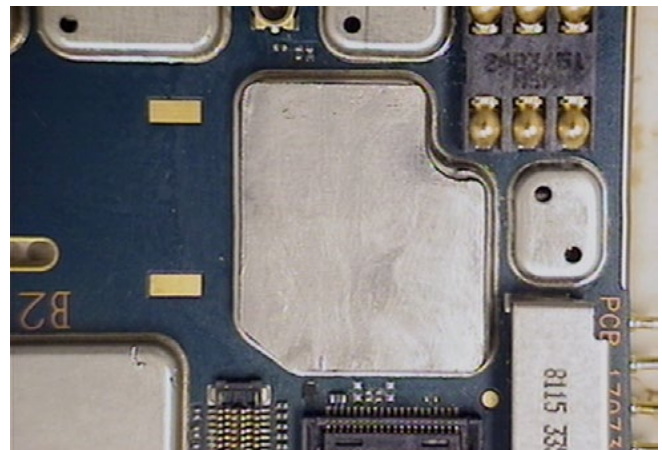


Figure 8: After removal, replacement tape “patch” eliminates need for reflow of replacement shield.

rework has become more challenging. A variety of methods can be employed in order to make the rework processes of reflow, site preparation and solder deposition easier given the complexity of the PCB and the volume of rework required. As devices get even more densely packed these challenges will only increase, requiring further developments in rework processes. **SMT**



Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. His column, *Knocking Down the Bone Pile*, will appear bi-monthly in *SMT Magazine*.



2015 Programs

September 9–11

**IPC India Pavilion at electronica India /
productronica India 2015**

New Delhi, India

September 26–October 1

**IPC Fall Standards Development Committee
Meetings**

Rosemont, IL, USA

Co-located with SMTA International

September 28

IPC EMS Management Meeting

Rosemont, IL, USA

October 13

IPC Conference on Government Regulation

Essen, Germany

Discussion with international experts on
regulatory issues

October 13–15

IPC Europe Forum: Innovation for Reliability

Essen, Germany

Practical applications for meeting reliability
challenges like tin whiskers, with special focus
on military aerospace and automotive sectors

October 26–27

IPC Technical Education

Minneapolis, MN, USA

Professional development courses for engineering
staff and managers:

- DFX-Design For Excellence (DFM, DFA, DFR and more)
- Best Practices in Assembly
- Advanced PCB Troubleshooting
- SMT Problem Solving

October 28–30

IPC Flexible Circuits-HDI Conference

Minneapolis, MN, USA

Presentations will address Flex and HDI challenges
in methodology, materials, and technology.

November 2–6

**IPC EMS Program Management Training
and Certification**

Chicago, IL, USA

November 4

PCB Carolina 2015

Raleigh, NC, USA

December 2–3

IPC Technical Education

Raleigh, NC, USA

Professional development courses for engineering
staff and managers:

- DFX-Design For Excellence (DFM, DFA, DFR and more)
- Best Practices in Assembly
- Advanced PCB Troubleshooting
- SMT Problem Solving

December 2–4

**International Printed Circuit and APEX South
China Fair (HKPCA & IPC Show)**

Shenzhen, China

December 7–11

**IPC EMS Program Management Training &
Certification**

San Jose, CA, USA

TOP TEN



Recent Highlights from SMT007

1 **iNEMI Managing Director: New, Disruptive Technology on the Horizon**

Dr. Haley Fu, managing director of Asia Pacific for iNEMI, and Publisher Barry Matties spoke recently. Fu gave her overview of the last eight years with iNEMI along with her opinion of what the most significant changes have been, globally and for the Asia market in particular.

2 **BGA or CGA: When is it Right for You?**

In this interview with TopLine President and Founder Martin Hart, I-Connect007 Publisher Barry Matties focuses on column grid array (CGA) and how CGA can solve delamination problems. CGAs, also known as CCGA, are not necessarily new, but are making a strong comeback in the high reliability market.

3 **A Look at Saki's Approach to 2D, 3D and X-ray Technology**

At NEPCON 2015, I-Connect007 Publisher Barry Matties sat down with Nori Koike, COO of Saki of Japan, to discuss the latest demands for 3D and their approach to inspection. With more than 20 years of experience, they have built a line-up of tools that covers the inspection spectrum.

4 **American Standard Circuits' Unique Offerings Contribute to Long-term Success**

At the recent IMS RF and microwave show in Phoenix, Arizona, Anaya Vardya, CEO of American Standard Circuits, sat down with I-Connect007's Barry Matties to discuss the current market trends, the company's recent equipment investments, and where American Standard Circuits' growth will likely come from.

5 The Truth about Conflict Minerals Reporting

Section 1502 of the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act requires companies to disclose annually whether conflict minerals exist in their supply chains. The first report to the SEC was due May 31, 2014. Bloomberg reported that only 6% of companies met an "acceptable standard of compliance."

6 Zentech Acquires Colonial Assembly & Design; Launches ZenPRO

The acquisition of CA&D significantly broadens the Zentech offering with CA&D's demonstrated expertise in circuit design and layout, systems level design, machining and sheet metal, and complex cable assembly/wire harness manufacturing.

7 NEPCON SOUTH CHINA 2015 Set for Shenzhen this August

The Chinese stock market has seen dramatic growth in 2015, with start-ups and the Shenzhen Composite Index rising to unbelievable heights. Behind the huge growth is a commitment by the national government to facilitating the sustained growth of industries such as internet+ and information technology.

8 Taking the Human Out of Hand Soldering: Is it a Must?

At the recent NEPCON Show in Shanghai, I-Connect007 Publisher Barry Matties stopped by the WKK booth where Japan Unix (represented by WKK in China) was displaying its new robotic soldering technology. In this interview, General Manager Hirofumi Kono explains why this new technology makes so much sense.

9 In 3D Inspection, can "Length = Height" Mean No Escapes?

During the recent NEPCON China show in Shanghai, I interviewed Kobi Ventura of ALeader Europe, an Israeli-Chinese joint venture with ALeader Vision Technology Ltd., which focuses on SPI and AOI inspection equipment. All of the machines are built in a state-of-the-art factory in Guangdong, China. Utilizing a unique length-equals-height modeling approach to inspection, Kobi states that they offer 100% escape-free technology, and it comes with a guarantee.

10 Nortech Receives GE Healthcare Supplier Award

"We appreciate the opportunity to win awards like these because it shows our total commitment to the customer and their goals," says Sr. VP of marketing & Sales Curt Steichen. "Nortech Systems is looking forward to continuing to serve GE Healthcare and all of our customers for their electro-mechanical design and production needs."

SMT007.com for the latest SMT news and information—anywhere, anytime.



EVENTS



For the IPC's Calendar of Events, click [here](#).

For the SMTA Calendar of Events, click [here](#).

For the iNEMI Calendar, click [here](#).

For a complete listing, check out *SMT Magazine's* full events calendar [here](#).

SEMICON West

July 14–16, 2015
San Francisco, California, USA

Ohio Expo & Tech Forum

July 16, 2015
Cleveland, Ohio, USA

7th Annual SMTA Vendor Show

August 21, 2015
Penang, Malaysia

NEPCON South China 2015

Aug 25–27, 2015
Shenzhen, China
electronica India
September 9–11, 2015
New Delhi, India

productronica India

September 9–11, 2015
New Delhi, India

SMTA International 2015

September 27–October 1, 2015
Rosemont, Illinois, USA

TPCA Show 2015

October 23, 2015
Taipei, Taiwan



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Coming Soon to ***SMT Magazine:***

AUGUST:
**The War on
Process Failure**

SEPTEMBER:
**Cars: The Driving
Force in the
Electronics
Industry**