

July 2015

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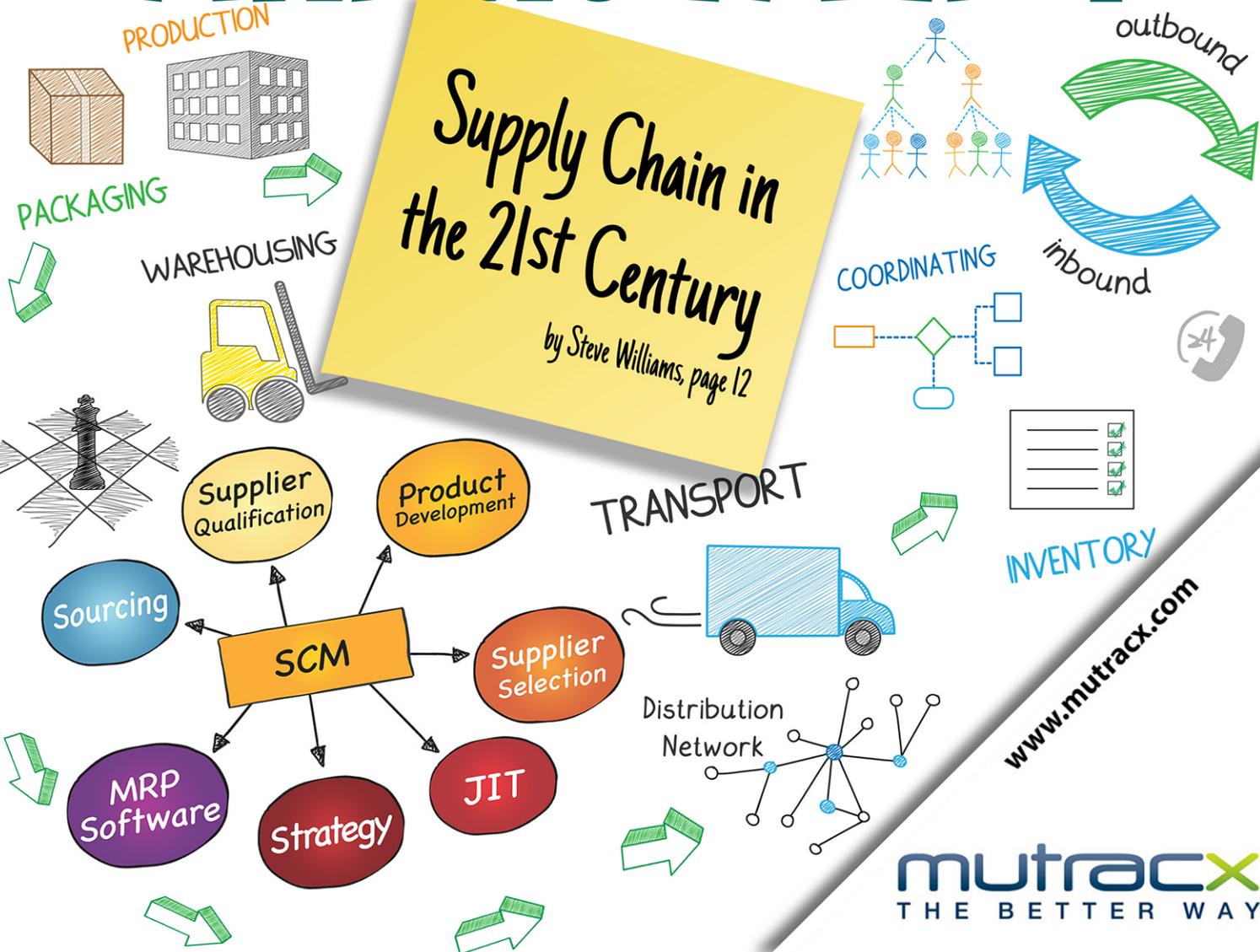
LOGISTICS

from POINT OF ORIGIN
to POINT OF CONSUMPTION

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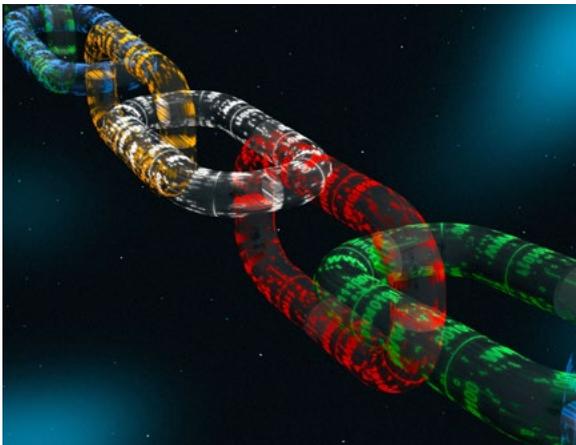
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July Featured Content

SUPPLY CHAIN MANAGEMENT

This month, *The PCB Magazine* takes an in-depth view of 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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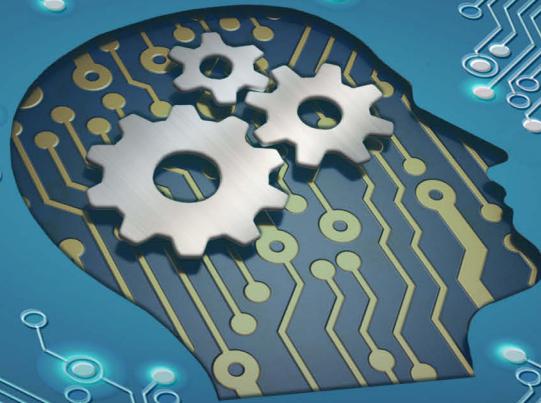


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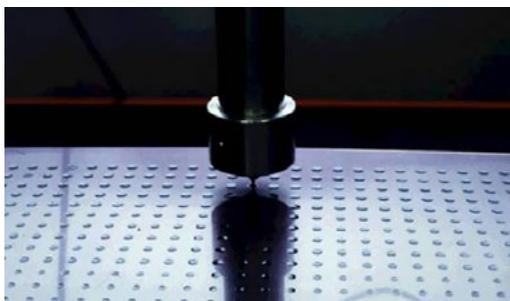
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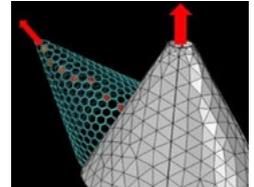


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Df @ 10 GHz	0.0030	0.0017	0.0031	0.0028 - 0.0036
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T-260 & T-288	>60	>60	>60	>60
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Optimized Global constructions for Pb-Free Assembly	Yes	Yes	Yes	Yes
Compatible with other Isola products for hybrid designs	Yes	Yes	Yes	For use in double-sided applications
Low PIM < -155 dBc	Yes	Yes	Yes	Yes

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“Supply Chain Management”: Overused, Underused or Just Misunderstood?

by **Patty Goldman**

I-CONNECT007

In a world of buzz words, “supply chain” and “supply chain management” (SCM) have certainly been right up there in our industry. Everyone sort of knows what the terms mean, or at least what they want them to mean. And everyone has assigned their own level of importance and interest to the idea of supply chain management. So of course it made perfectly good sense for us to highlight that subject in our July issues.

We started with a survey of our readers and received some thought-provoking results. We were interested in learning the biggest challenges our readers face with SCM. The main issues are summarized in Tables 1 and 2 below.



Table 1: What is your greatest supply chain challenge? (Vertical numbers represent percentage of respondents, multiple responses permitted.)



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“SUPPLY CHAIN MANAGEMENT”: OVERUSED, UNDERUSED OR JUST MISUNDERSTOOD? *continues*

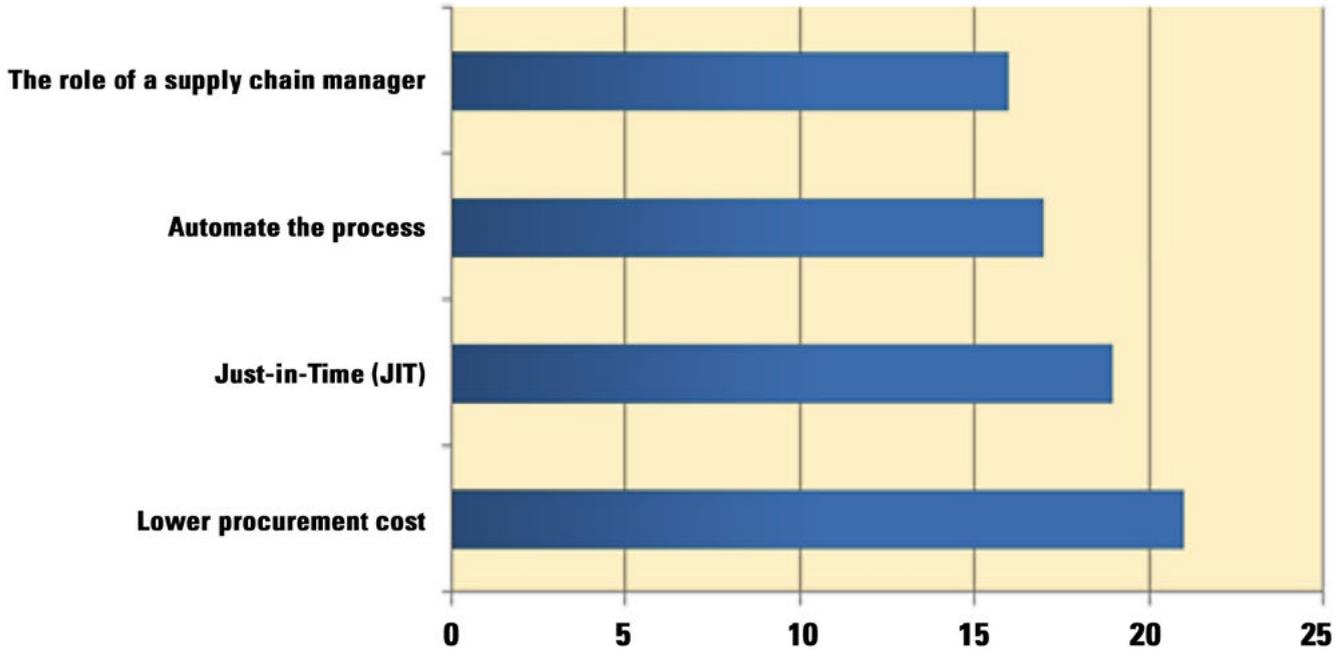


Table 2: What would you like to learn about regarding supply chain management? (Horizontal numbers represent percentage of respondents, multiple responses permitted.)

And this brings me to our lineup in this month’s issue. As an excellent starting point, Steve Williams gives an all-encompassing overview of supply chains and supply chain management, starting with a little history and progressing right through the nuts and bolts of a good SCM program. Learn how it is in everyone’s interest, up and down the whole chain, to know and embrace the concepts, and then put them into practice.

We always ask for comments in our surveys, and readers offered a number of observations pertaining to the difficulty in obtaining specialty laminates. So, we went to several sources and checked it out. As a result, we have Barry Matties’ interview with John Pavlak of Rogers Corporation.

Along a somewhat similar line, Barry also interviewed Insulectro’s Ken Parent and Jason Marsh. They had a lot to say about working with not only their customers, but their customers’ customers, via their “Accomplish Change Together” (ACT) program that addresses rigidly defined material specifications. A third supplier, Ventec also chimed in with their perspective on this month’s topic. Finally, Fred Long presents

the distributor’s point of view: It’s all about service and balancing the needs of both supplier and customer.

Our flex columnist, Dave Becker, points out some other characteristics of suppliers to look for that you may not have considered. While he obviously writes from a flex supplier point of view, the points made could apply to any supplier up and down the chain.

Finally, for those of you mainly interested in problem solving, Karl Dietz addresses dry film photoresist in his regular column.

Since this is *The PCB Magazine*, most of the articles were contributed by suppliers to PCB manufacturers. You may also want to check out what other parts of the supply chain have to say in our July issues of [SMT Magazine](#) and [The PCB Design Magazine](#). **PCB**



Patty Goldman is a technical editor at I-Connect007. An industry veteran, Patty’s strengths are in market/strategic analysis, practical problem solving, organization/execution, and research.

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Supply Chain in the 21st Century

by **Steve Williams**

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Introduction

The shift away from vertical integration has pushed the topic of supply chain management 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.

What is a Supply Chain?

Defining terms is always a good point to start, and I have chosen to use the definitions supplied by James B. Ayers in his paper, "A Primer on Supply Chain Management":

Supply chain: Life cycle processes supporting physical, information, financial, and knowledge flows for moving products and services from suppliers to end-users. Supply chain management: Design, maintenance, and operation of supply chain processes for satisfaction of end user needs.

Printed circuit board manufacturers have always expected their OEM and EMS customers

to actively manage them; however, 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.

When asked to discuss supply chain strategy, we are often greeted with the response "Yes of course, we have a purchasing department." Supply chain management has progressed far beyond the old-school purchasing mentality to become a key component of the modern business organization. We are all just pieces in the supply chain puzzle, and it is the supply chain that is responsible for getting the final product to market.

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

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SUPPLY CHAIN IN THE 21ST CENTURY *continues*

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

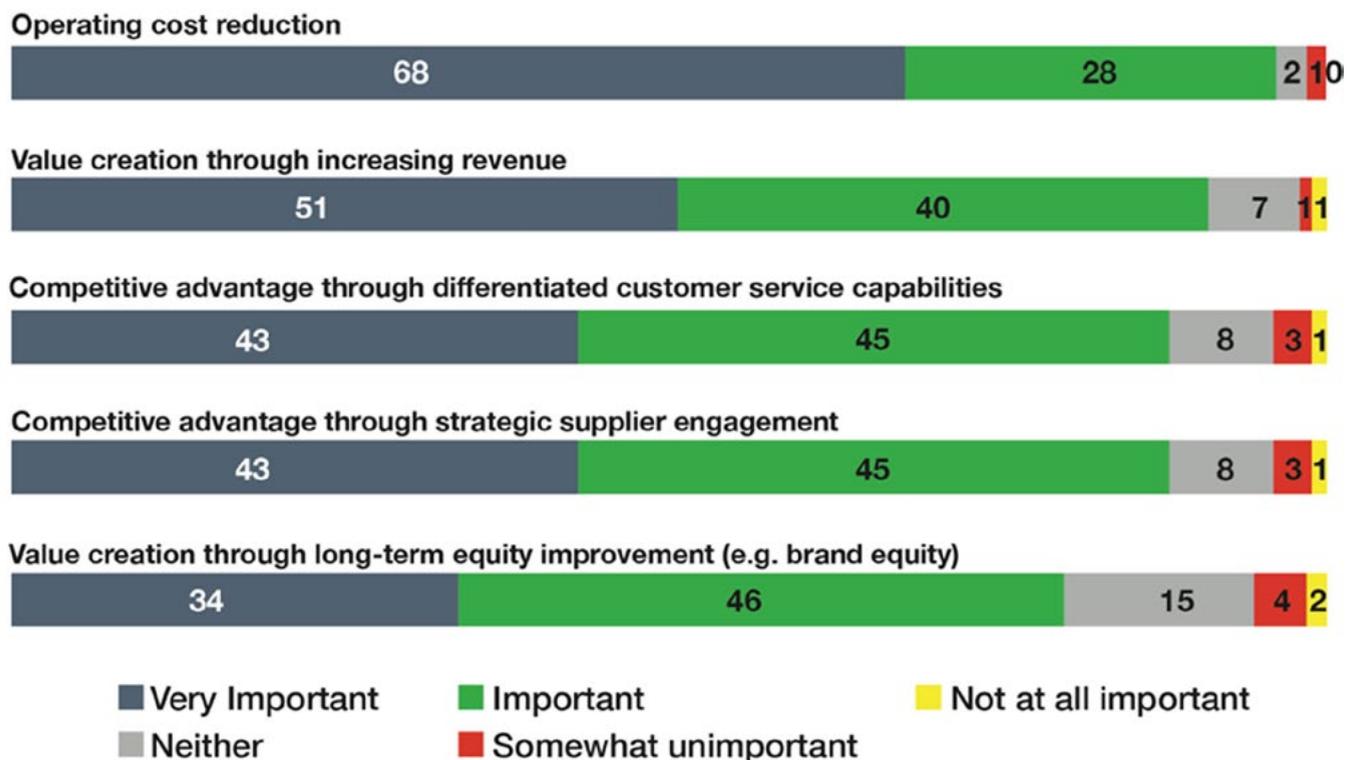
A recent chief supply chain officer survey shows just how concerned supply chain executives are (Figure 1). Respondents from 18 different market sectors participated in the survey including high tech, industrial, consumer products, automotive, aerospace & defense, and

medical equipment. Interestingly, more than half of the survey participants value the supply chain function as equal to sales/marketing, R&D and product development.

What is Supply Chain Management (SCM)?

Supply chain management is quite simply the process of actively managing supply chain suppliers and activities to maximize customer value and achieve a sustainable competitive advantage. Supply chain activities cover everything from product development, supplier selection and qualification, sourcing, manufacturing, and logistics. The most visible side of supply chains are the physical flows: transportation, transformation and storage of goods and services. However, just as important are

How important is it for your company’s business strategy to focus on supply chain improvements for the following?



Source: Chief Supply Chain Officer Report 2013 © SCM World (www.scmworld.com)

Figure 1: Results of a supply chain officer survey.

information flows that allow the various supply chain partners to plan, coordinate and communicate day-to-day activities up and down the supply chain. This also includes soft activities such as the sophisticated software technology required to manage forecasting, MRP, POs and supplier performance.

A Brief History of Supply Chain Innovation

Supply chain management is not a recent revelation; in fact, the supply chain strategy used 5,000 years ago would give modern supply chain managers a run for their money. In ancient times, transportation technology was so basic that the cost of moving goods was the primary factor, so goods were put together close to the source of raw materials.

2700 BC

The earliest example of supply chain management can be seen during the construction of the ancient Egyptian pyramids. These early supply chain managers had to procure thousands of 2.5-ton blocks of stone, transport them across the desert and arrive at the site in time for the various stages of construction. Next time you are at the beach, try to push or pull a cooler filled with ice and beer across the sand and you will quickly appreciate how incredible this feat was.

300 BC

The invention of Roman rowing vessels (ships) revolutionized logistics and was the origin of intercontinental trade. This capability to travel across the sea allowed Alexander the Great the ability to set up a wartime supply chain moving troops, equipment and weapons into India.

700 AD–1500

Intercontinental shipping continued to evolve with the establishment of seaports in major cities around the world. The first postal service was implemented in Europe.

1800

Development of roadways and railroad systems added another dimension to trade and supply chain logistics including the first use of the steam engine and oil powered vehicles.

1913

Henry Ford invented the moving assembly line and began the early implementation of JIT both internally and with suppliers.

1956

The sea container was invented in the port of New Jersey, significantly impacting the evolution of world trade and globalization.

1960

Electronic data interchange (EDI) was first used to transfer data and documents.

1961

The first material requirement planning (MRP) system was developed in Racine, Wisconsin, and a year later IBM used this to develop the first bill of material (BOM).

1970s

The first UPC and SKU barcode was used at Marsh's Supermarket in Troy, OH.

1980

MRP was expanded to include all facets of an organization via ERP (Enterprise Resource Planning).

1984

Michael Dell developed the first make-to-order, direct-order fulfillment model.

1985

FedEx reinvented their express shipment model by giving their drivers hand-held computers that provide real time shipment information.

1988

Walmart implemented a cross-docking system that allowed them to track goods across all of their distribution centers and stores.

1990s

The Internet revolutionized supply chain management and collaboration with suppliers. The Toyota production system (TPS) pioneered by Toyota's Taiichi Ohno started to gain widespread acceptance in the U.S. to become the

SUPPLY CHAIN IN THE 21ST CENTURY *continues*

foundation for today's Lean manufacturing and supply chain practices.

1998

Amazon began to fulfill orders direct from manufacturers, eliminating the need for Amazon stores and distribution centers.

2000

MIT transformed inventory management with the development of RFID (radio frequency identification) allowing a synonymous track-and-trace methodology.

Today

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.

Managing Supply Chain Risk

Risk is inherent in all aspects of business, but most things start with the supply chain,

and unmanaged risk here can lead to catastrophic results. Figure 2 highlights some of the more serious risks that need to be identified and mitigated.

Competitive Advantages of a High-Performing Supply Chain

OEMs, ODMs, and other manufacturing organizations are 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

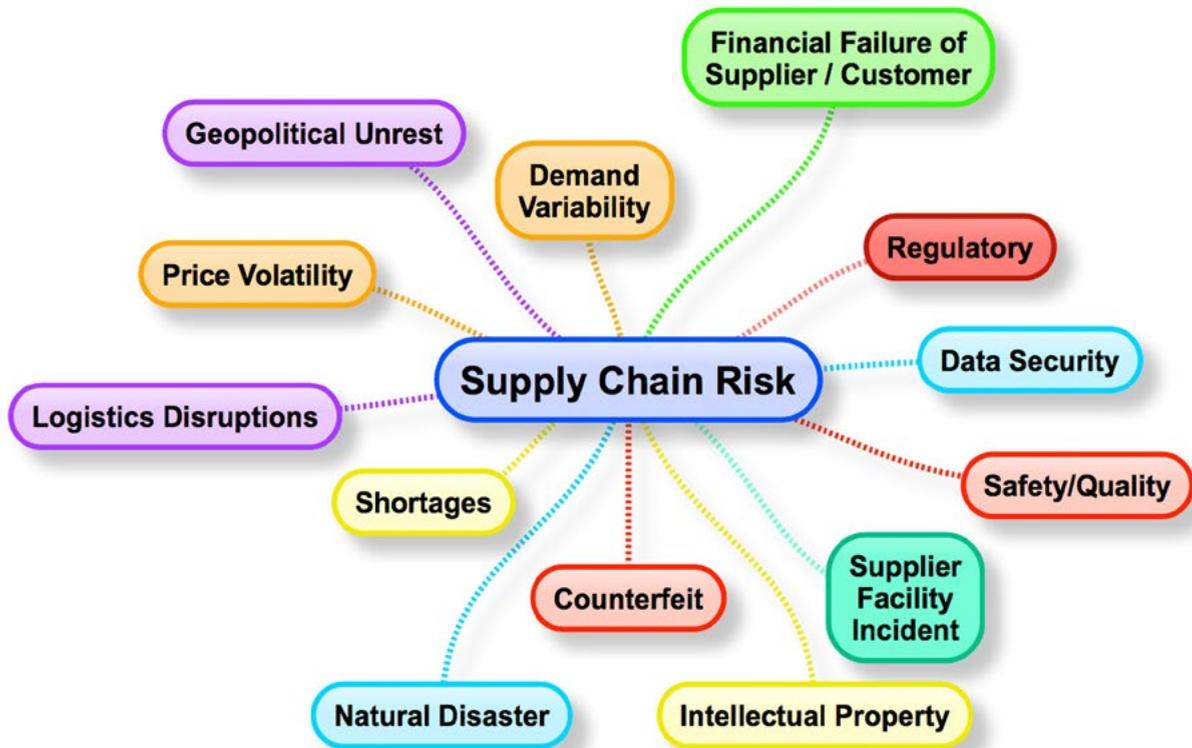


Figure 2: Supply chain risks.



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SUPPLY CHAIN IN THE 21ST CENTURY *continues***Supply Chain Management Roles**

There are many roles in supply change management, but the two primary ones are sourcing manager and supply chain manager. Suppliers often have a common misconception that they are synonymous, which they most decidedly are not. Where the confusion comes is that most small companies do not have the resources for dedicated positions and both are frequently handled by a purchasing manager-type position.

The Role of the Sourcing/Commodity Manager

The sourcing manager is the strategic arm of a materials/supply chain group and directs the team responsible for overall management of the supply chain. This includes new supplier identification and often qualification, contract negotiation, and assessment of quality, technology, and Lean. Depending on the commodity expertise in the team, they are often the liaison between the company's manufacturing and the supplier's quality and engineers when quality issues arise. As the top escalation point, sourcing/commodity managers are also the "hammer" when the tactical folks hit a performance wall (buyers, planners, quality, etc.).

Job Description: Sourcing/Commodity Manager

- Direct material commodity strategies to support existing and new sources of supply
- Partner with R&D, quality, purchasing, operations, supply chain and other key stakeholders to lead the development of forward-looking sourcing strategies and contingency plans for assigned commodities
- Design and maintain a supplier categorization process along with a method to communicate vendor status among the supply base
- Identify, evaluate & qualify new supplier sources
- Develop and negotiate performance-based supply agreements and related contracts with key suppliers
- Lead periodic business reviews with key suppliers

- Monitor latest supplier & market trends, technology, and innovations
- Negotiate price reductions
- Provide monthly status reports of annual goals and budget
- Overall supplier management and development responsibility

Job Description: Supply Chain Manager

Supply chain managers are primarily concerned with things like variability modeling, logistics, minimizing risk, economic order quantities, and inventory levels. Some of the very best supply chain managers I have worked with have been "Mr. Wizard" math nerds; they really do need to think differently. They have also been some of the smartest folks I have worked with. Developing a supply chain solution that takes a customer's forecast that has 200% variability, long lead-time BOM parts, and a customer that wants a 98% service level requires a lot of science (and/or black magic). Here is a short list of what supply chain managers do:

- Material resource planning
- Enterprise resource planning
- Demand & variability modeling
- Supply chain design
- Monitor supplier lead-times and constraints
- Minimize risk (inventory & availability) to both the customer & supplier
- Create metrics and tools to monitor and adapt supply chain models under constant variability
- Assist supplier lean initiatives to drive cost-saving initiatives
- Negotiate and manage supply chain program contracts

Supply Chain Management Concepts: The Seven Rights

There are as many supply chain management concepts as there are experts in the field, but when all is said and done is it simply about getting it right, or more specifically, the "7 Rights of SCM." The Cliff Notes version is highlighted in Figure 3 as getting the right product, to the right customer, with the right quality & quantity, at the right place and time, for the right price.

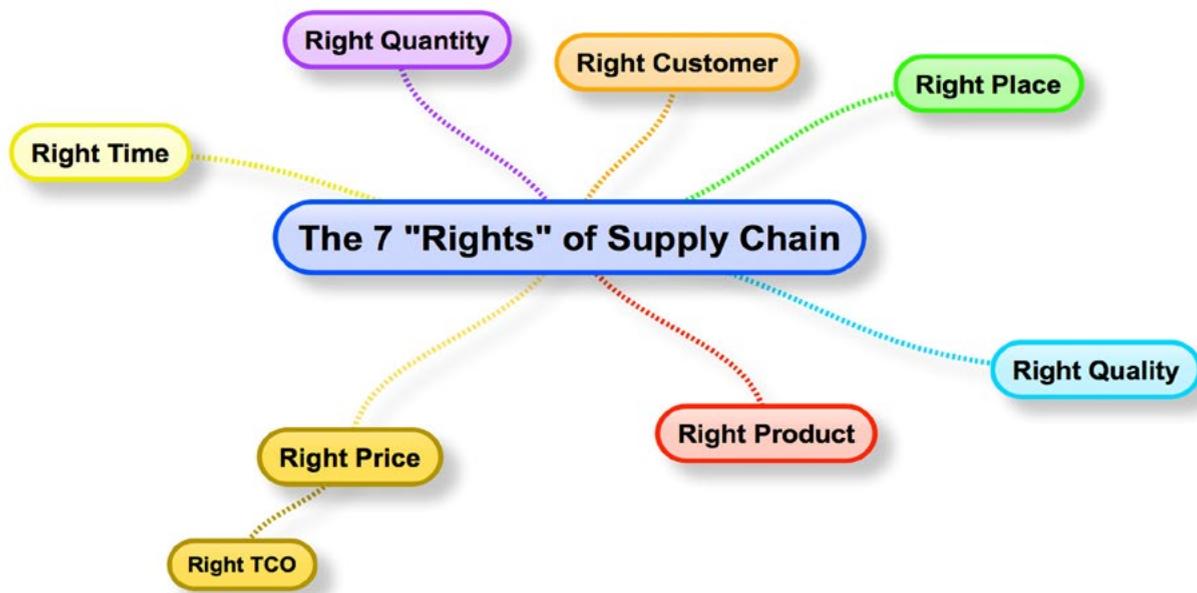


Figure 3: The Cliff Notes version of the 7 Rights of SCM.

Where companies have missed the boat (literally and figuratively) is the sub-bullet under “right price” that explains the “right total cost of ownership (TCO).” OEMs and contract manufacturers tend to focus on the lowest unit cost and basically ignore the significant risks of not making decisions based on TCO, such as freight costs, additional inventory, excessive obsolescence and loss of revision flexibility.

This was painfully obvious during the “Asian shift” (as coined by my friend Walt Custer) leading to OEMs and contract manufacturers racing to China only to learn the hard way what their true TCO of this decision was.

Supply Chain Strategy

Strategic sourcing has become a critical component in supply chain today as companies have realized that having a successful supply base takes a lot more than choosing suppliers based on RFQs and past history. Developing personal relationships with supplier management is mission critical when looking for a true partner and not a customer-supplier transactional agreement.

The higher the technology, the more important the process for identifying, qualifying and managing your supply base becomes. Having a formal strategy takes a lot of work and resour-

es, but the payback in long-term, capable suppliers greatly outweigh the significant TCO of using a sub-par supplier.

Supplier Identification and Qualification

Strategically, deciding how to qualify new suppliers is the most critical step in the process. The underlying tool should be an audit/survey that measures the quality system, Lean and technology. Audits are frequently based on the ISO 9001 standard in some iteration, which would be preferable if ISO registration is another qualification criterion (highly recommended). There should be a re-audit frequency established and some provision for the supplier to provide demonstration of continued capability for the time period between audits. This could be in the form of quarterly Cpk reports, ISO surveillance audit summaries, etc. What is found too often are that suppliers have been grandfathered onto an AVL because they have always supplied materials, and that no one has ever audited the facility. Or, the only existing control is a self-audit that the supplier completes with no verification (which is probably fine since we all know that no one ever embellishes on their capabilities when filling out one of these!).

There are a couple of categories that make up a robust strategy: predictive assessment tools

SUPPLY CHAIN IN THE 21ST CENTURY *continues*

and ongoing supplier management tools. Predictive assessment tools are performance indicators that should give that warm, fuzzy feeling about the ability of a potential supplier to become a long-term partner that performs at a high level. They also can identify alignment between your technology roadmap and that of the supplier, and the financial assessment can help avoid the serious task of having to move business out of a supplier that has just gone out of business.

Predictive Assessment Tools

- Supplier preferred attributes GAP analysis (first screening tool)
- ISO certification (1st qualification filter)
- Supplier survey (quality system)
- Lean assessment
- Technology
- Psychographics (demographics on steroids)
- Supplier strategic direction assessment and index (matches supplier strategy/roadmap to customer's)
- Financial stability assessment tool (long-term viability)
- Supplier contract outlining Ts & Cs and liability coverage for product
- Establishment of commodity/supplier council or other approval body for approving new suppliers to the approved supplier list

Ongoing Supplier Management

You could call this section the “proper care & feeding of your suppliers.” To be successful in today’s supply chain environment, the customer/supplier relationship must be a collaborative one, and this requires time, effort and diligence. Regularly discussing performance, new programs & technology and the state of the relationship will foster collaboration and will put the supplier in a position to be successful.

Supplier Management Tools

- Supplier Rating System
 - OTD, quality, pricing/TCO, quote response, supply chain, etc.
- Quarterly business reviews (suppliers prepared data set)

- Performance review, quality concerns, responsiveness to SCARs and RMAs, price competitiveness, etc.
- Corporate update presentations (supplier & customer)
- Potential new programs/part numbers/technology (supplier & customer)
- Technology roadmap to drive future technology with existing suppliers

Location, Location, Location

Another aspect the strategy needs to consider is whether your supply chain should be regionalized or global. This is typically a hybrid based on the parts or commodity being supplied. Small, lightweight parts such as PCBs, electronic components, cables, etc., can be global suppliers because freight is not a major factor. Heavy, large form factor parts like sheet metal, injection molded plastics, machined housings and die casts make more sense to regionalize near the customer base.

Geographic consideration for large form factor products:

- Size/weight of end product—logistics, costs inbound/outbound
- Volume/demand by geography of end product
- Product life cycle
- Design stability
- BOM content/characteristics (e.g., country of origin)
- Labor content
- Intellectual property
- Technology/complexity
- Location of design engineers for value engineering/DFX
- Current location of manufacturing (where applicable)
- Current location of large form factor suppliers (where applicable)
- Supply chain scalability
- Regional presence, global leverage
- Lean supply chain pull methodologies
- Proactive capacity planning
- Accountable performance
- Risk mitigation planning
- Optimized tooling solutions



Outer Layer

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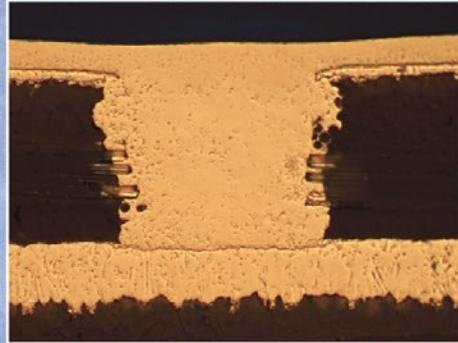
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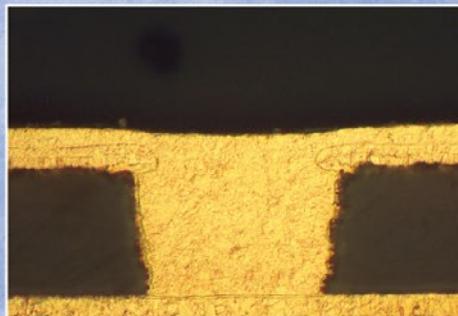
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SUPPLY CHAIN IN THE 21ST CENTURY *continues***Supply Chain Design**

This is where the magic really happens in a supply chain: the demand management and variability modeling that makes everything come together. And while the modeling is basically operations management math problems, the key is how they are applied to the real world. The underlying principle of supply chain programs is the realization that all forecasts are wrong, 100% of the time. Otherwise they would be facts. With that understood, it all comes down to a cost/benefit analysis; a customer wants a particular service level and there will be a cost to support it. For example, a customer may expect a 95% service level, which means that they expect their suppliers to be able to meet their inaccurate forecast, including push-outs and pull-ins, 95% of the time. Exactly how much variability is in their forecast and their lead-time will drive the appropriate supply chain program, and by extension, how much inventory will be needed in the supply chain pipeline. The biggest impact on how much inventory will be required is the supplier's lead-time to produce the product. There is a cause & effect direct correlation between a supplier's lead-time and how much inventory will need to be maintained. Figure 4 identifies the critical supply chain design inputs from both the customer and model needed to develop the "right" supply chain program.

There are two basic types of planning philosophies: traditional push planning and Lean pull systems. Push planning is forecast driven

and focused on what is:

1) estimated to be needed; 2) at lead-time 3) in advance of actual demand. The pull approach means that inventory is not ordered based on net time-phased future needs and is engineered to provide the flexibility necessary for service level drop-ins and other unscheduled changes. The mantra of a pull system is "Plan to forecast, buy to consumption."

Benefits of Pull

- Avoids building inventory in anticipation of demand which may not occur
- Caps worst-case inventory level where push cannot
- Eliminates nearly all (90%+) change message traffic and MRP nervousness on both buyer and supplier ends
- Smooths out order quantities to reorder quantity (ROQ) increments and multiples
- Synchronizes directly to downstream demand signals
- Supports the designed-for level of variability whether from the demand or supply ends of the chain
- Minimizes expediting inside lead-times

It is always a very interesting first discussion with a supplier when explaining that a supply chain program will actually save them money; even the most skeptical supplier has become a fan when they see the true reduced cost of doing business while executing under a properly designed supply chain program.

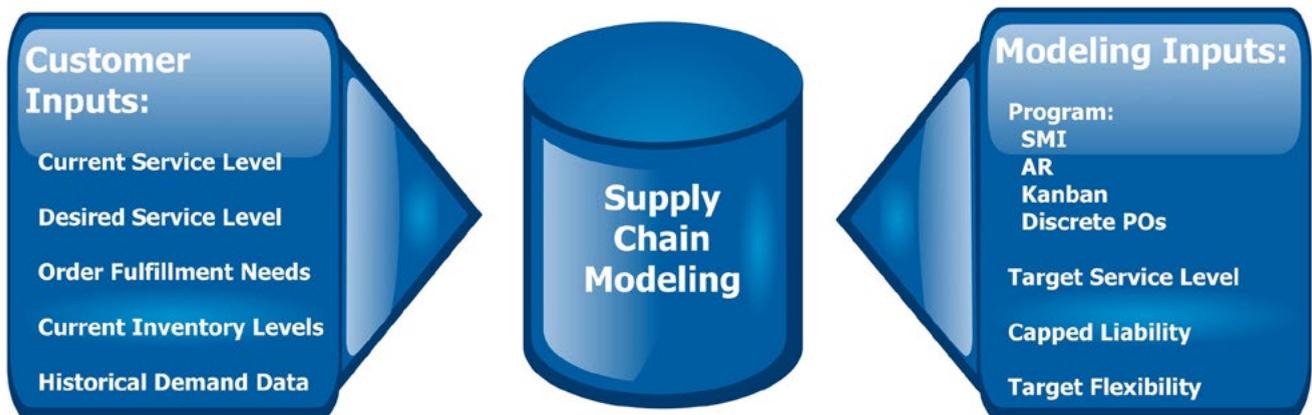


Figure 4: Supply chain design.

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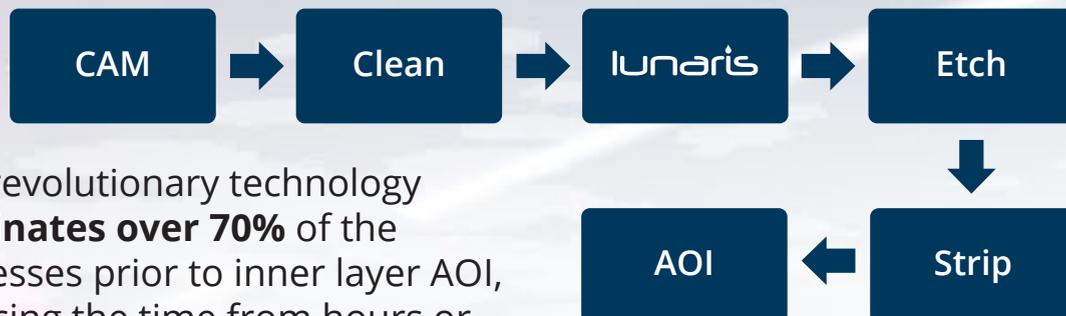


Inner layer production methods haven't changed much in over forty years. The basic process has remained the same: use lots of interdependent equipment and chemistry to completely cover a panel with photo resist. Then, use some more interdependent equipment and chemistry to remove most of it!

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SUPPLY CHAIN IN THE 21ST CENTURY *continues*

Demand over lead-time (DLT) plus the safety stock (SS).

$$ROP = D_{LT} + SS$$

Where

D_{LT} = Forecasted demand within lead-time

$SS = \text{Std. Dev. } (D_{LT}) * Z \text{ Score}$

Figure 5: ROP calculation.

$$SS = \text{Std.Dev.}_{(LT)} * Z \text{ Score}$$

$$ROP = SS + \text{Ave. DMD}_{LT}$$

ROQ = Max of:

EOQ, Ave. DMD_{LT} & MOQ

Figure 7: Sawtooth replenishment process.

$$EOQ = \text{SQRT}((2 * \text{ARR} * \text{PO Cost}) / \text{Holding Cost})$$

Figure 6: Economic order quantity (EOQ): The quantity at which the total cost of ownership is optimized.

Supply Chain Tools
Kanban Re-Order Point

The Kanban re-order point represents the number of units of inventory that, when reached, needs to trigger a replenishment order for the ROQ (reorder quantity). ROP is calculated in Figure 5.

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.

According to the results of Deloitte’s 3rd annual Supply Chain Survey, only 38% of executives claim to be “extremely” or “very” confident their current supply chain has the com-

petencies required to meet their needs. This number should scare the hell out of us because it means that almost two-thirds of executives aren’t confident about their supply chain’s capabilities! What’s more, just 43% consider their supply chain organization to be “excellent” or “very good” when it comes to strategic thinking and problem solving. Again, this translates into more than half of executives who feel their supplier chain is merely adequate. The good news is that there is always room for improvement, and by using the tools, methodologies and philosophies discussed in this article, which are appropriate for your particular business model, a world-class supply chain is certainly within striking range for the typical organization.

The other take-away is that building long-term strategic relationships with your suppliers will get you on this path quickly and efficiently with a payback that keeps on giving. Don’t be penny wise and dollar foolish with supply chain management. A single problem from an unqualified or uninformed supplier will certainly cost you much more than an audit plane ticket would have! **PCB**



Steve Williams is the president of The Right Approach Consulting LLC and the former strategic sourcing manager for Plexus Corp. He is the author of four books, including *Quality 101 Handbook* and *Survival Is Not Mandatory: 10 Things Every CEO Should Know About Lean*. To read past columns, or to contact Williams, [click here](#).

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An Update on the Rogers Material Supply Line

by **Barry Matties**
I-CONNECT007

As part of a recent I-Connect007 supply chain survey, we found that RF laminate material can be very difficult to obtain. Rogers Corporation was named specifically in our survey as one supplier with a limited amount of material available. In fact, their delivery time was reported as being as high as 55 days for some materials at one point. In an industry where quick turnaround time is critical, this is one supply line that killed any hope of being quick.

Because Rogers was noted by name in our findings, we decided to go to them to learn about the current situation, and the short answer is that there has been improvement on delivery lead time with the promise of continued improvement.

The following interview is with John Pavlak, the director of global operations at Rogers Corporation.

Barry Matties: *John, can you please give us an idea of what happened to your supply line and explain what you are doing to improve.*

Pavlak: I can give you the story as I know it from my two years so far at Rogers. When I started in mid-2013, we had a plan to increase capacity because our market intelligence said that there was significant demand coming and it was primarily tied to the China 4G roll-out. The only difference between our plan and what actually happened, the 4G roll-out actually came in sooner than our original marketing intelligence. Fortunately, we had already kicked off projects to increase our global capacity. The challenge was that those were long lead-time and very expensive projects. We've invested more than \$30 million in the past three years into global capacity projects.

We had ourselves locked in tightly with different OEMs and fabricators, but the wave of demand came sooner than expected, so we spent the latter half of 2013, and almost all of 2014, working very hard to increase capacity in other ways before that additional capacity came online. Every one of our locations in the global regions added capacity through internal improvements on throughput and figured out how to get more lamination press loads per week. All of our teams pushed very hard and each of the regions were able to demonstrate at least another 20% of additional capacity, even without the new equipment.

We did everything we could internally to turn the screws to give ourselves more capacity. In the past, we would let our different regions control how they would prioritize orders to our customers, but because we were capacity-constrained and our volumes were above capacity, and we knew that was going to extend for a period of time, we actually went into a capacity allocation mode. We decided on how to allocate globally, so we improved our response time to a lot of our largest customers by prioritizing and setting aside lamination press loads for them, so they knew they had those to count on. Even

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AN UPDATE ON THE ROGERS MATERIAL SUPPLY LINE *continues*

though we extended lead times, our customers knew they had a defined amount of capacity reserved for them. It was not a fun time for our customers or us because the global demand exceeded our global capacity.

In the midst of that period, in Arizona alone, we were able to produce 36% more laminate in 2014 than we did in 2013. In China it was approximately 25%, and about 18% more out of our Belgium factory. When you aggregate it all together, it was well over 25% improved global throughput. Now we have the new capacity online; we added a thermoset treater in China for the RO4000 product line. It's a treater for creating the dielectric material we call pre-preg that goes into the laminate we make. We added 50% additional global pre-preg capacity when we brought it online in China, and it's up and running at full production speeds. On this treater we started the internal qualification in the latter half of 2013, and in 2014 we ramped it up from one shift, to three shifts, and we've moved that pre-preg production into China where the majority of our customers are. Now we have much significantly more pre-preg capacity than we need globally, so we are back ahead of the demand growth curve and are probably good for the next three years when we believe we'll need to introduce some additional pre-preg capacity.

From the lamination side, we had two large expansion projects in lamination going on, as far as new capital equipment. We have two presses we are adding in Suzhou. The first press we were able to expedite and we did get it online and approved in March 2015. We added that capacity and that press is primarily for the RO4000 product. That added about 10–15% more capacity globally; we also took our Belgium operation from six to seven days in lamination, and that added another 10%. Right now

we are at 25% more capacity than we had if you turn the clock back six months ago.

The other thing that has happened in the midst of this 18-month journey is the acquisition of Arlon, and what came with that purchase are not just the different sets of products and customers, but also some available capacity. In the Arlon factories we are presently looking at the individual types of machinery, what products are run there, and we are identifying what capacity we can extract out of the factory to possibly run Rogers' legacy products. We are going through that analysis now and we are positioned very well for the next wave of increased demand.

We've been able to bring our lead times down significantly, although I think the roughest period was when we had to take our lead times up to 55 business days on RO4000 materials. That probably caused the most angst in the customer base. I'm glad to report we have done two lead time reductions since late March.

We've also brought lead times down on RO3000 materials as well.

In addition to the lead time reductions, we are creating some strategic stocking programs at the master sheet level so that when we do get a customer order on those parts we can turn the order in less than five working days. I think we have a pretty solid plan going forward on all product lines. The entire period of the last 12 months we went through was very demanding for everybody; it was seen but not expected to come that early and so we were unfortunately behind the demand wave. It's like a guy in the ocean who is going to ride the wave; it just so happened the wave came sooner than we ex-

“
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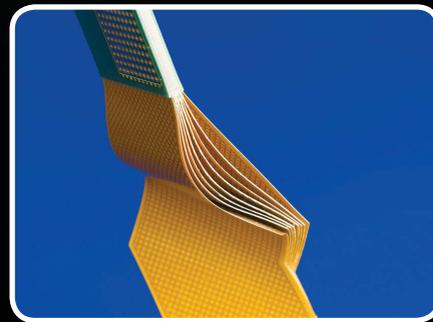
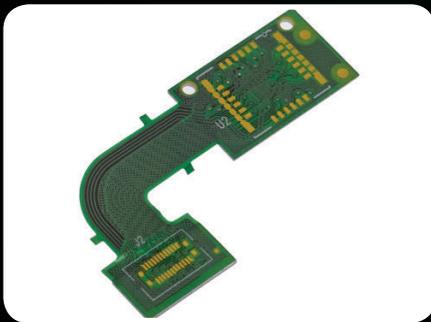
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AN UPDATE ON THE ROGERS MATERIAL SUPPLY LINE *continues*

pected so we had to do a course correction.

We are in very good shape now. Our goal is to get all of our lead times down to industry parity or better before the end of the year, and we are working our way down that glide path right now.

When looking at lead time, we want to be as good as anybody else in industry. So if the best in class is five days in a certain product line, we want to be at five days. If the best in class is 15 days, we want to be at least as good as them at 15 days. We want to be on parity when our customers want to place an order for Rogers' material versus a competitor; they know they can get it in at least the same time frame.

That's probably been the biggest source of irritation for our customers, when we had to balloon out the lead times, but at the time there was no other apparent solution that was quick. We had to create a little bit of breathing room so that we could try to get as much internal capacity turned around as we could. Overall, our team did a great job with that and with managing the customers through some difficult situations. The positive side you can make from the customer's view, we didn't really impact any customer that significantly. We didn't shut anybody down; we didn't create havoc at an OEM or anything like that. We were able to stay ahead of that, but it was not without pain.

Matties: *I don't know that you can say that with certainty, though, because maybe the major OEMs were allocated for, but perhaps not all customers.*

Pavlak: Right, for some of the customers there were bumps along the road. We put a new expedite process in and that expedite process didn't handle the smaller orders, so we created an escalation process; if they had a really critical order, we got it in the escalation process and gave them an answer within two to three days for how quickly we could pull it in. We did some displacements to try to help them through that period. With many customers, we didn't affect any big programs out there...

Matties: *Where the rocket ship didn't launch.*



Pavlak: Exactly. It's been an interesting journey for everybody. It's unfortunate that the capacity that we had planned didn't come on line sooner, but some of those projects you can't make go any faster without sacrificing something else. We did pay expedite cost for those capital expansion projects to try to bring them on faster, but I think the global operations team did a really good job of driving more internal improvements to make up much of the difference between demand and capacity.

Matties: *That's what is really interesting: your internal process improvement strategy and the increased performance that you found. However, this is just good business practice in any case, whether you are on time or trying to catch up, to find best practices to try reduce waste and improve yields.*

Pavlak: What it did was heighten the need to accelerate things that were already in progress. We really put a big effort on that to make sure that was number one in the operations playbook for

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AN UPDATE ON THE ROGERS MATERIAL SUPPLY LINE *continues*

everybody who was an engineer or technician. It is good business practice but it was like DEFCON 4, the highest sense of urgency. This was on top of everyone's list—no matter what you did when you come in today, here are the top two or three things you need to work on. We really stressed that mindset every week making sure we were focused on all the right things.

There are a lot of common challenges that happen in our industry that you have to overcome. You have to make sure all your suppliers are ready to go. There were some issues with copper availability for a short period of time, and we had a lot of pressure on our copper suppliers to deliver copper. We weren't the only ones suffering from copper shortages; it was across the industry—you mentioned some names earlier of other laminate suppliers having the same problems. We had to press that supply base really hard, too. In Q3 of last year, copper was probably at the tightest with supply it has been in recent times. Now we have some additional sources of copper for our materials, so we have flexibility that we didn't have before. From a raw materials standpoint, we are in really good shape going forward. It did press us into making some pretty tough decisions with some suppliers, as far as getting them moving with us in support of our customers.

Matties: *You have your own supply lines issues.*

Pavlak: The focus was from the suppliers all the way through the factories. We started at the factory level and said, "Let's look at what we can control and what we can push," and then we worked our way up to the supply base and made sure that we were good there.

We also introduced a slightly different concept into the operation called SMART planning. It's a rigorous S&OP process and we were able to utilize that process to drive more output through the plant without sacrificing qual-

ity. We took a much finer and granular look at our demand and who it's for and when it was needed, so we peeled back the onion on a lot of things and started looking at the demand data more closely to make sure we are taking care of our customers in a balanced manner.

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The focus was from the suppliers all the way through the factories. We started at the factory level and said, “Let's look at what we can control and what we can push,” and then we worked our way up to the supply base and made sure that we were good there.

This improved S&OP process has created more rigor in our global operation—in how we plan, how we execute the production schedule—and that rigor is still there and improving every monthly planning cycle. It took us internally to another level of performance on how we work with our plants in the different regions, how we look at customer demand, prioritizing orders, and things of that nature. We have a lot better system now than we did before.

”
Matties: *Your strategy has really been reaching into the OEM and getting spec'd at that level, not necessarily focused on selling to circuit fabricators, per se. It sounds like once these OEMs have spec'd you in, they don't want to go through another process of bringing in somebody else to replace it. They've been pretty patient with the delays and the delivery times.*

Pavlak: Actually, we have been working very closely with both OEMs and fabricators in selecting the best materials for particular applications and then supplying to them timely through our global manufacturing and supply chain network. Yes, our customers including OEMs and fabricators are very patient with us, but primarily because we have been working very closely with them on material selection, technical support, new products promotion, and various measures we have taken to improve the supply situation. I think the fact that we are spec'd in helped us through that period of time, and we spent a lot of time with those customers and the fabricators to make sure they understood that there was an end to this and we have an aggressive plan coming to fruition;

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AN UPDATE ON THE ROGERS MATERIAL SUPPLY LINE *continues*

just stick with us for a few more months. They didn't walk away and a lot of that is based on trust that we were telling them the truth and they understood what we were doing.

We did a lot of communication with the fabricators and a lot of communication with the OEMs to make sure that they understood there was a plan to get out of this; we laid out a rough timeline so they knew when the additional capacity would be available. Every time we made a milestone in that plan, we did our best to communicate to key fabricators and the OEMs that we made this milestone and here is where we are now on output. We made sure that they were connected with us. We did not want to leave them hanging out there, so we put a lot of work into the communication with the customers.

Another key point with the demand being so high was making sure that the demand we were receiving was real, and to make sure there was no over-buying going on by somebody. So we had checks and balances built in between what the fabricators were ordering and what the OEMs' volumes were, which we call the "zero schedule," and we made sure that we had the right allocations set based on the OEMs feedback.

Communication was the key through all of it. We had to stay tight with both the fabricator and OEM to make sure that everybody was singing out of the same book, and that allowed us to get through the period. We feel we came through it okay, only the customers can tell you how they feel about it, but from our perspective we thought we did a good job of managing through this tough period with them.

Matties: *Right, so now you started with the lead times over 55 days, and what are you currently at?*

Pavlak: All RO4000 laminates had peaked at 55 days. We were in that for over six months and

then we reduced it to 45 days a month ago. Recently we reduced it to 35 and we have plans to get it down under 15 days by the beginning of Q4. Actually, we are ahead of that schedule right now, based on what we are seeing. We think we can get there quicker, so we are making a big drive to bring down the lead times.

Matties: *The message then to the industry is, "We're almost there."*

Pavlak: Yes, we're almost there. There is another planned RO4000 lead time reduction for early Q3.

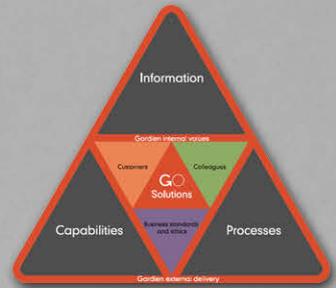
Matties: *You'll be on par with pretty much everyone else by Q4?*

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a milestone in that plan,
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where we are now on
output. We made sure
that they were
connected with us.
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Pavlak: Yes, and the new capacity we are putting in, all the new equipment, is designed to take us out to the next three years of demand as we see it. We stepped up lamination, we stepped up the pre-preg production for RO4000 lamination and we are also bringing on a brand new coating line in Arizona for the RO3000 product line that is being released for an OEM application at the end of June. That new line is going to give us 100% more capacity on dielectric paper for RO3000 materials. Now we'll be discussing the next wave of capacity we want to put in place, when and where.

Matties: *You don't want to find yourselves in the same position six months down the road.*

Pavlak: Exactly. We are going through another market evaluation cycle in the next couple of months, saying, "Where is the next capacity we need to be at, at what location on the globe, and what product lines do we need to provide additional capacity?" We are also taking a look at the former Arlon products, understanding



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AN UPDATE ON THE ROGERS MATERIAL SUPPLY LINE *continues*

that we are past the due diligence phase with the purchase and now we are into the integration phase. We are trying to understand what capacity we can squeeze out of the former Arlon plants to help with the overall future demands.

Matties: *Was the acquisition of Arlon capacity-driven or was it market-driven?*

Pavlak: It was really primarily market-driven. It got Rogers into markets that we weren't into before. One of the strengths of Arlon is that they are a very strong player in the antenna market. The acquisition brought some new customers to us. It also provided some new product breadth and feel that this is a growth area, therefore it was more of a market-driven acquisition. Some additional operational capacity also came along with the acquisition. I call it "the pants come with the suit." The factory in Suzhou has some open floor space for additional presses and a coating line providing some additional benefits for our operations with the acquisition.

The nice part about the Arlon acquisition is we now have two plants in Suzhou; from one plant to the other is about a 45-minute drive. We call the locations Suzhou East and Suzhou West. We have the opportunity to really leverage the fact that it's in the same city and not that far apart. We can leverage the expertise across the locations and we can look at the capacity across locations. I think that because of the short distance between locations there is a synergy there that's going to help us in our China market.

Matties: *And China is a booming market.*

Pavlak: Yes, a majority of our global laminate sales goes to the Asia region.

Matties: *Arlon did a phenomenal job in China when the markets were dropping and China brought on 3G; it was just a great time for them.*

Pavlak: They had a very strong year in 2014 as well. Of course, you always get into a lot of discussions when you are purchasing a company

and it's all about "what can you do for us right now?" The Arlon acquisition has been very good for Rogers and for Arlon. The former Arlon employees are very positive about the fact that Rogers bought them. They were part of a private equity group for a period of time and one of the comments I've heard from several people is, "I'm glad that somebody in the industry bought us who understands our wants and needs and what we need to do in the plant to improve." I think everything I've seen so far has been extremely positive from that standpoint. To my knowledge there is nobody in Arlon upset about the acquisition; I think they're actually relieved that it's over and it was acquired within the industry.

Matties: *John, thanks for sitting down with me today.* PCB

About John Pavlak

John Pavlak started in 1979 with General Motors in the Packard Electric Division and worked for General Motors in Delphi for more than a quarter-century. Starting out as a product design engineer, Pavlak then became a senior reliability engineer, quality manager, and eventually worked his way through many operational assignments. He ran two plants for General Motors/Delphi in Ohio before moving to Alabama, where he worked for eight years and again managed two plants, capping off more than 26 years with GM/Delphi. After leaving General Motors/Delphi, Pavlak went to Lennox HVAC, which provided a change of pace away from the automotive industry, and into the manufacturing of commercial rooftop air conditioning units. For two years he ran their HVAC commercial product factory in Stuttgart, Arkansas, and then accepted an opportunity with Stoneridge Electronics, based in Juarez, Mexico. After running their global factories for wiring harnesses and electronics manufacturing for more than six years, in mid-2013, John joined Rogers Corporation, where he now serves as the director of global operations.

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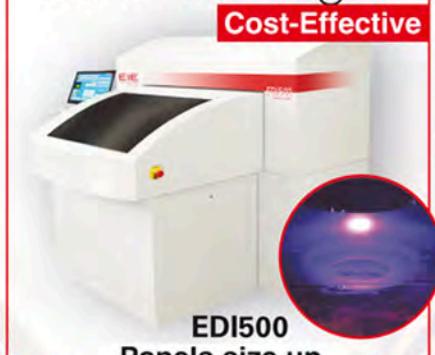
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The True Figures

A WELL-DESIGNED LAMINATE SUPPLY CHAIN HAS TO OWN IT! *continues*

you open to non-compliance, and worse. Not all laminates are created equal, and if you don't know where they are coming from you may open yourself and your customers up to reliability issues in the future, which can be at best expensive and at worst fatal. This can be further exacerbated when vendors provide laminate from multiple sources.

What starts as a simple request to one part of the supply chain, can end up quite confused at the far end of the supply chain when relayed through a number of parties. Like the example given by a general in the trenches, who said, "Send reinforcements, we're going to advance," and the message that reached his command back at base was "Send three and four pence, we're going to a dance."

There Must be a Better Way!

Of course there is, but it's not as simple as auditing lots of vendors and seeing what they have to offer and what solutions they can provide to unpredictable demand, risk mitigation, customization and traceability. The only real solution is to work with a vendor that owns the supply chain, providing you with the ability to customize that supply chain to meet all of your commercial, technology and service needs. Many regional agents understand their market well enough to develop a one-size-fits-all solution to cover most of the aspects of local demand, but very few can answer all of these questions. What's more, very few distributors, possibly none, have their own laboratory in region, something that we think is critical.

I don't buy off-the-peg suits, so why would I use an off-the-peg supply chain and put up with the compromises that go with that? Not having the right laminate at the right time is much worse than a jacket that won't button up properly after a big lunch!

What it Means to "Own" the Supply Chain

An exceptional supplier will "own" the supply chain—every part of it from the laminate and pre-preg production to the final interface with the PCB fabricator. Because of that, they can design and customize that supply chain to suit any demand mix. This could mean supply-

ing direct containers from China for constant price sensitive demand, all fully logistically supported. It might mean quick-turn from regional inventories to manage peak and variable loads, or even consigned stock to provide immediate availability. It might even mean regional panel format pressing, all cut and marked for complete traceability.

This approach, together with an extensive product range creates the optimum mix of quality, service, technology and cost, in a demanding market, whilst maximizing availability of the materials required, fulfils fabricators and the end customers' demands.

Forecasting is often just an educated guess. But with some science to that art and by considering past consumption, it is possible to predict some key elements of future demand. It will not provide a complete picture, but with this, and a combination of regional stock, quick-turn manufacturing capability and market intelligence, an exceptional supplier should be able to achieve the required delivery more than 99% of the time (OTIF, on time in full).

Now, if that same company owns the material, wherever it is in the world, in a laminate press in Suzhou, on a boat in the Pacific Ocean, or in other local facility throughout the world it means that no matter where the vendor is in the world, the person that you are talking to has access to the full global inventory.

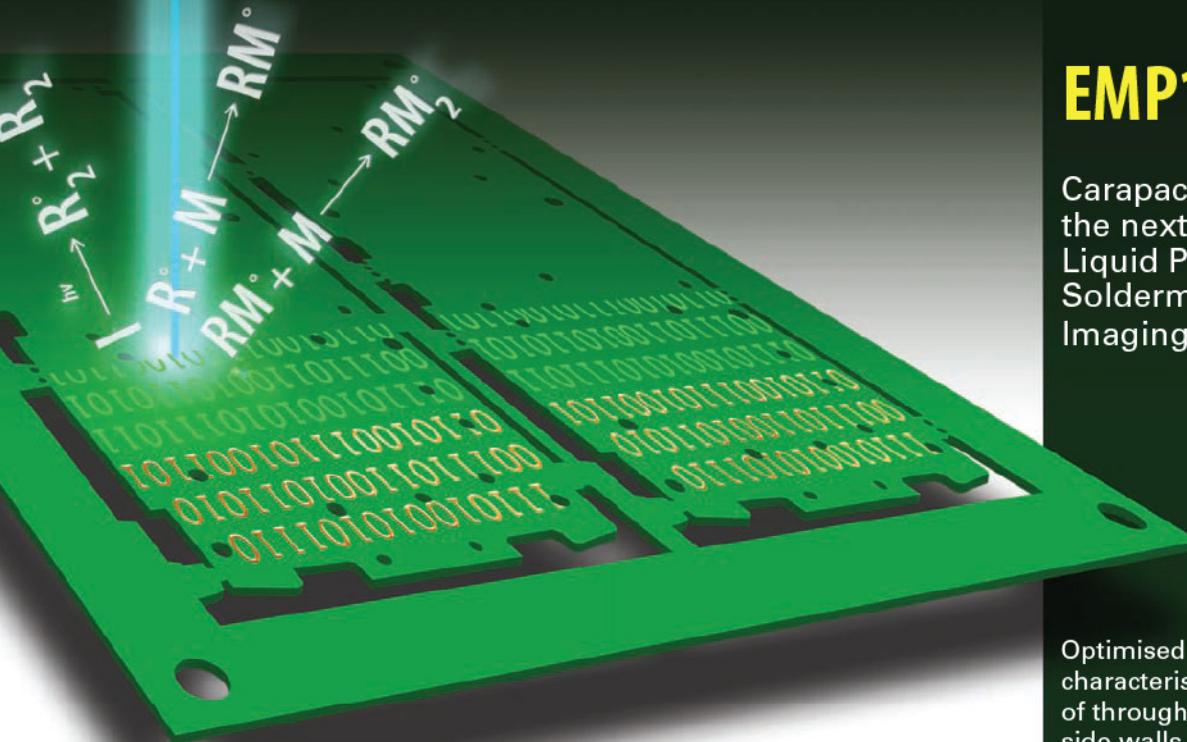
Suppliers must use industry knowledge, robust systems, clever software and total visibility to build a supply chain agile enough for any PCB fabricator. Consigned stock, local customization, regional hubs, short manufacturing cycles, controlled processes and highly evolved systems are just a few of the tools needed to develop custom fit solutions that flex and move with the needs of the fabricator and their customers.

You can only design the supply chain when you own the supply chain. **PCB**



Mark Goodwin is chief operating officer USA & Europe at Ventec International Group.

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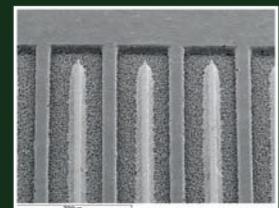
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Accomplish Change Together (ACT)

by **Barry Matties**
I-CONNECT007

Shifting strategies for selling PCBs and the materials to build them is the impetus for ACT. Insulectro's Ken Parent and Jason Marsh spoke to I-Connect007 Publisher Barry Matties about the ACT approach—and how it is helping their PCB fabricator customers increase sales and OEMs to get better products.

Barry Matties: Ken, tell me a little bit about what ACT is.

Ken Parent: One of the biggest excuses I hear, which is a reality, is that fabricators can't put a new material in because a print comes in, they get a purchase order with the print, and it says that they have to use XYZ material. Their reasoning is that they cannot change materials because the OEM specified something else on the print. Accomplish Change Together (ACT) means there is probably something in the offering that we have that could make them more competitive as a fabricator; it could make the end-use product more competitive from a technology or cost perspective.

Matties: How do you do that? How do you get the OEM to change?

Parent: Well, we go after it together. When we met at APEX this year, you saw that we had Freedom CAD there in our booth. That is another important equation. We're bridging Isola and DuPont into the design community. We have to get it designed onto the print, so we bring those resources together. I met new designers at the IMS show that were interested in ACTing with us, and between those OEM requirements, the design community, the material supplier, the PCB or PE fabricators and Insulectro, we believe that together, we can accomplish that change on a print. ACT is all of the above: designer, fabricator, material supplier, and distributor.

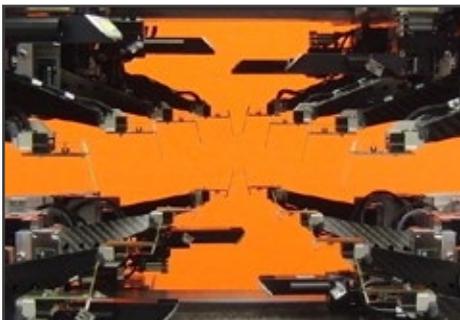
Matties: So by the time it reaches the fabricator, though, it's a print shop basically. All the decisions have been made. So now it's just matching the requirement with the best manufacturer.

Jason Marsh: In many cases that is true, but it is not always the case. In the really cutting-edge stuff, and you see a lot of it the RF space, people are pushing the physics envelope. We're trying to push material solutions that have been around for 25 or 30 years, and we are running

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ACCOMPLISH CHANGE TOGETHER (ACT) *continues*

out of runway, so to speak. They might come to the fabricator and say, “Okay, I’ve designed this. I’ve modeled this. Can this be done?” It might not even test the way it’s been modeled. It might not be possible to do, or certainly won’t be with reasonable yields. You mentioned the unique nature of us being a distributor, which is one of the things that allows us to sit in the middle—not just of traditional PCBs, but we also have this whole space in the additive conductor area of printed electronics. We have a lot of conversations with the assembly shop. We understand the whole ecosystem and how it fits together, and we’re continuously educating ourselves in that space.

We want bring the best solution, regardless of how it’s produced. We have cases where we’ve gone together with customers and said, “Traditionally, you’ve etched that out of a copper-clad laminate, but have you considered doing a cap layer with an additive conductor combined with an FR-4 stack up here?” And wow, all of a sudden cycle time is cut in half, yields go up, cost goes down, and they can enter a whole new arena they haven’t been in before.

But you’re not going to get that kind of sea-change in a design or technology progression as a one man band. You’ve got to have everyone sitting around that table. We talked a few minutes ago about the opening chapter of the CID certification course, which says just that. It says you need to have a conversation with the designer, the fabricator, the assembler, and the whole food chain to make sure your design for manufacturability is appropriate, your signal integrity is going to match what you modeled, etc. That’s what we want to do. We want to shepherd all of the components of that food chain together and have productive discussion, because at the end of the day what keeps work in America is moving that technology needle. You’ve got to be forward-looking to do that, and that’s really what the heart of ACT, for us, is about: helping our customers book more work in forward-looking technology tiers.

Matties: *It’s the right idea, and that’s how to stay competitive and move forward. And it puts you in a great position to sell a lot of product, too.*



Ken Parent (left) and Jason Marsh (right).

.....

Parent: That’s true. The big thing we’ve learned over the last couple of years is that as much as I love to call on the OEMs, I am much more effective calling on the OEMs with a fabricator-customer in tow. One of the things we’ve realized, when ACT came to be the acronym that we used to describe what we’re doing, is that we had a few of our customers who were ACT-ing in accomplishing these changes on the prints with us. But it was a handful of those customers, and it was happening on a weekly basis. So we started putting a lot more attention into collaborating with our customers, and as I broke it down and I tried to get my next customer on board I would say, “Look. We have some customers on a scale of 1–10 that are in a range of maybe 7 or 8. That’s as high up the scale as we get today. I am going to get a few customers that are in the 10 range. Right now, Mr. Customer, you’re at a level 2 with us. Your competitor is in a 5 or a 6 range with us. How do we get you up that scale?” I expect that we’re going to have more than 5% of our customers who are engaged in this program with us. We’re eventually going to have every single one of our customers engaged in this, where they trust us with their customers and with their salespeople, where we are working with them on a daily basis. And that’s how we’re going to sell more of the Isola and DuPont product.



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ACCOMPLISH CHANGE TOGETHER (ACT) *continues*

Matties: *What you're describing is actually becoming their sales people. You're smart for doing it because you're connecting the two. It lowers their cost of sales. You're giving them access to some OEMs that they may not otherwise have access to.*

Marsh: I'd say the converse is also very valuable. A fabricator says to an OEM, "I'd like to recommend this material alternative for these reasons." And then somebody that's never heard of that material might say, "Well, is he telling me that because it's cheaper? Does he have some sitting on the shelf?"

When we are there, it immediately dissolves the apprehension when they introduce us as "the guys who make the material." We can talk to both strengths and weaknesses because we're in the entire food chain. We solve problems.

Matties: *And you are technical.*

Marsh: We're technical, and by the way we're selling the entire process, so we have that implicit credibility that we, more or less, don't have a dog in the fight. Of course we like to sell the laminate, but we're happy that the board is getting built in North America. We're North America focused. If you're working with a big international manufacturer, it still shows up in their sales numbers whether the work goes to China or Korea or North America. But for us, we really want to keep giving the North American fabricator base a competitive edge to keep work in America, drive that technology needle, and leave the other guys catching up. The only way to do that is this ACT type of approach, and I think it's equally important for us when we have a new material and an OEM is very interested in bringing the right fabrication partners in with them. That's where that synergy happens.

Matties: *I don't see it as a negative strategy; I think this is really good, because a lot of these fabricators need help in their sales effort, and this strategy makes a lot of sense for everybody involved.*

Parent: We want to make our customers' salespeople stronger when it comes to the material side of what they have to represent. Nowadays they can't avoid it. They have to be talking about materials.

“
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 ”

Matties: *Eventually, they're not even going to make a sales call without you present.*

Parent: That's our goal.

Matties: *I see that. Changing gears a little, we did a survey on supply chain, and one of the big issues that was reported time and time again was delivery of product. In particular, laminate material, and for the RF market, it was short supply/big demand.*

Marsh: Obviously, there were some global drivers around that, with the 4G build out in China, which was kind of coupled with some preferential delivery activity. This sort of un-

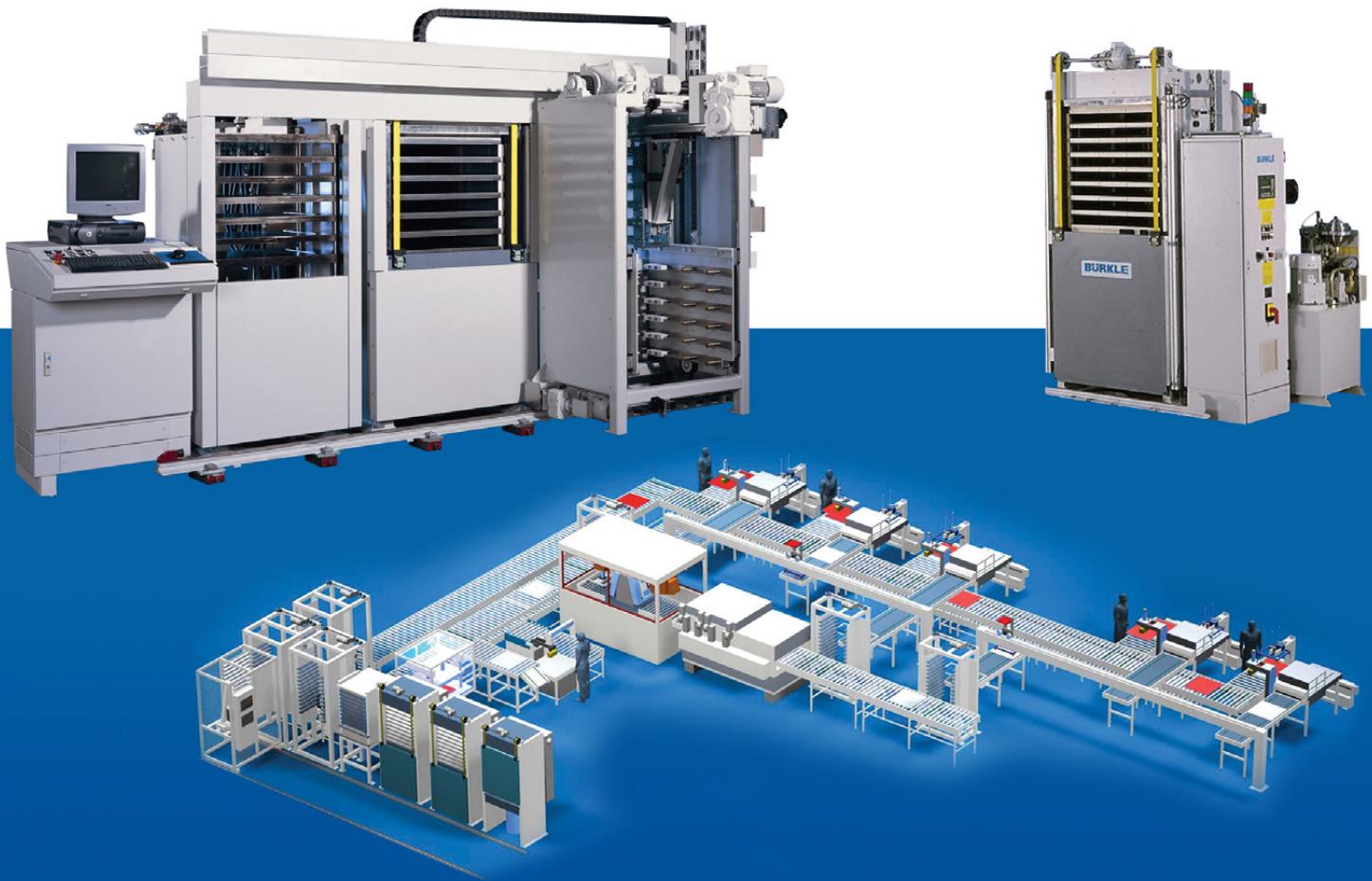
levelled the playing field, as it were.

But in the backdrop of that, you also have this explosion of development and prototype work that feeds the North American PCB market, whether it's IOT activity, or other wireless protocols. You're seeing this huge growth here, and it's fantastically frustrating to have people trying to develop next-generation products who don't have access to materials because some deal has been brokered to feed a large build out. One of the advantages that we do communicate on the Isola front is this: Not only do we believe in being able to participate in the RF space with a glass-reinforced product that has some yield and processing benefits, but we can also treat and press in a matter of days, and we can

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ACCOMPLISH CHANGE TOGETHER (ACT) *continues*

get people quite a bit of capacity in a very short lead time. In the RF world, this has historically been a pretty drawn-out process.

In other parts of the circuit board industry people are used to building things in two to three days; 3–4 weeks is not uncommon for RF work. We'd like to change that paradigm as well, because again, that quick-turn negates the overseas competition. Because if I have an option, I have my 10 designers who have worked on a project, sitting around burning cash on my P&L waiting for the prototypes to come back to be tested. If I can turn that from 14 days to 4 days, that's a game changer for my cost structure and my ability to get my product out to commercialization. So we'd like to bring the kind of responsiveness to the RF world that we have done in the rest of the North American prototyping phase.

Matties: *It's a big issue out there. The other thing that survey respondents mentioned was strategy. Lowering cost and asking to reduce profit are separate issues, because there are strategies to lower cost while you still maintain the right profits, I would think.*

Parent: There are great opportunities to take cost out of building circuit boards; it's tough and it takes a lot of work. It really does mean you have to change some things. Jason talked about the printed electronics space. There is an opportunity for additive technology; we're going to see more of that. But for the day-to-day stuff, less expensive materials are available. And this brings opportunity for us; it challenges us on some fronts; it brings opportunities on other fronts, but people have to be willing to change. We spend a lot of our time trying to get people to change and trying to protect the markets that we do have from changing away from us. But whether it is quick turn, being able to deliver something in four hours instead of four days is what

brings the opportunity for our customers to be more competitive and adds to their bottom line and profitability. It isn't just about the price that we sell it at, it's the services behind it, and I know our customers are doing the same thing. They're trying to get top dollar for 24-hour quick-turns. We do a lot to support our customers; that's why we're in business, and we continue to be able to invest in Insulectro. Our customers depend on us for the inventory that we have on our shelf, or the ability to get it quickly from Isola or DuPont.

“

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Matties: *I don't know that price is the focal point; it's total cost. And there's a mindset that has to shift.*

Marsh: The incremental approach is to squeeze a few more pennies out of the traditional construction method, and obviously there's merit there; the market will progress. Where you get the sea-change opportunities, as Ken mentioned, are in totally different ways of looking at it. One example is the Ormet-type material where you can build a high layer-count board in sub-assemblies and test the sub-assemblies. So instead of having a 40-, 50- or 60-layer sequential lamination that fails at

the end, you have four 15-layer sub-lams, all of which you could confirm tested well before assembly. Now all of a sudden you have a significant yield improvement, and the part you're throwing away might cost you \$2,000 to produce instead of \$10,000. Those are the kinds of things that give the customers a competitive edge that is not easily supplantable. If it's just a material price negotiation, it's the same process everyone else uses; you're never going to be effective at going head-to-head against a shop that's on 700 acres in China. The scale is unmanageable. On the other hand, you're going to provide better reliability, quicker turns, and a different approach. Then all of a sudden it's not a level playing field anymore;

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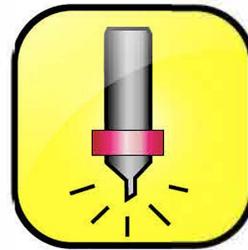
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– Yash Sutariya, Alpha Circuit Corp.

ACCOMPLISH CHANGE TOGETHER (ACT) *continues*

you have a performance value play, not a commodity play.

Matties: *But it's all about change, and we know how tough change can be.*

Parent: And creativity as well.

Matties: *There's a lot of creativity out in the world, you just have to be able to embrace it, see it, and believe it. Because some of the strategies you're talking about are from TQM. The principals of TQM still apply. We have to remove waste from our processes.*

Parent: And many have done a great job. I am very impressed at what some of our customers have accomplished and how their yields are today and the efficiencies they drive in their businesses—but they can't stop. We can't stop.

Matties: *We can't stop. It's more difficult because we've consumed the low-hanging fruit. But this is another issue that's out there: technical support. As*

we watched the race to China, a lot of technical support shifted. That really put the weight on distributors in America to be the core technical support.

Marsh: I think Insulectro does a fantastic job of leading the industry in our investment in technical support, and not just on the shop floor level, but we're sending our FAEs out to get board design certified, and these types of things. This allows them to have that conversation, cradle to grave. I was just talking to the folks at Besser Associates about putting together a training program for our teams and Isola's team to really understand the pains and challenges and what a day in the life of a designer looks like. You mentioned earlier about having things thrown over the wall at them. We want to hear what they are dealing with, and we want to address it, whether it's in supply chain or the materials offering, to give them those opportunities to move the needle.

Matties: *Well, thanks for chatting today, guys.*

Marsh: Thank you. PCB

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I-Connect007 is expanding its editorial department. The No. 1 source of information for the PCB design, fabrication and assembly/EMS markets is seeking an experienced editor to help us take our publications to the next level.

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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.

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.

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."



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The Keys to Success for Supply Chain Management

by **Fred Long**

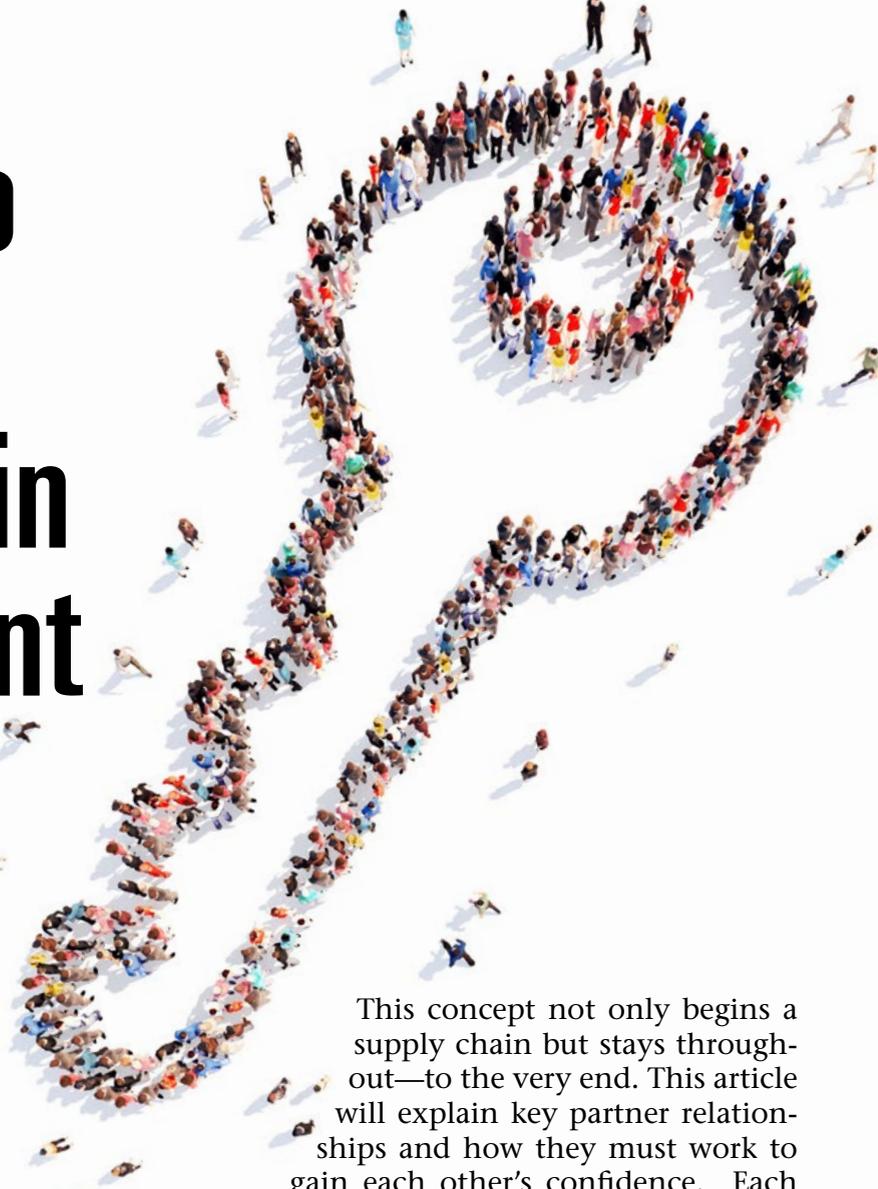
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Introduction

By the end of this article, I will have provided a guideline to help you achieve supply chain management success. But first, let's walk through the key components and issues regarding this challenge. Along the way, we will offer some suggestions and action items mostly for customers to store in their memory banks. After all, the customer is the one we need to satisfy.

I recently spent some sales road time with a Midwest distributor of PCB supplies. During the two-hour drive to a customer's plant, we discussed our beginnings in the industry. My distributor companion told me that he started as a teenager and his father immediately put him on the road to deliver product directly to any customer that needed it—rush! He would set out and arrive at the customer's loading dock or receiving area to be met by a plant employee who was usually waiting for him. Today, many years later, he still visits the same area accounts in one capacity or another and everyone knows him by name and trusts him. This, quite simply, is customer service.

The phrase can be stated two ways: customer service or service the customer. Either way it is one of the life forces of a successful business.



This concept not only begins a supply chain but stays throughout—to the very end. This article will explain key partner relationships and how they must work to gain each other's confidence. Each of us are so concerned and focused on our own needs that many times we forget to be aware of the goal and maybe even the other side's, shall we say, anxieties. The more we know about each other, the better.

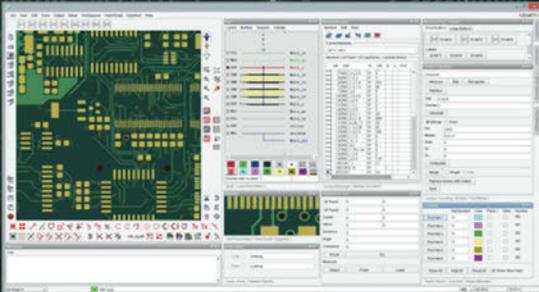
Key Issue: The Product and the Supplier

When it comes to results, the most important requirement is the product. When a distributor is awarded a tier one product from a tier one supplier, 50% of the goal has been accomplished. The remaining 50% is now up to the distributor to minimize all the remaining obstacles along the supply chain path and get that product to the customer on time.

The first endeavor is to start with certainty. In my former manufacturing world, if we started to make a printed circuit board with a defective phototool or database it was the beginning of wasted costs and hard times ahead. In our

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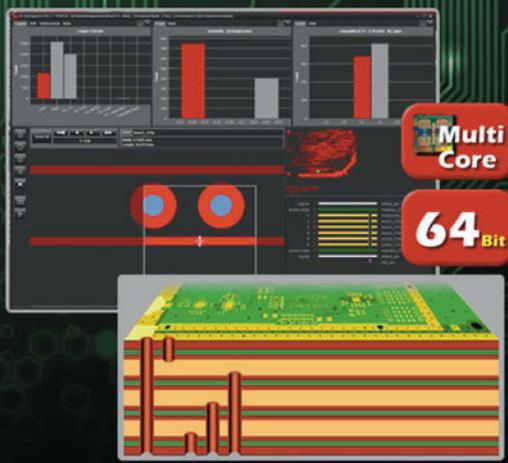


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THE KEYS TO SUCCESS FOR SUPPLY CHAIN MANAGEMENT *continues*

supply case let's start with a good product. Now the road is already paved.

A tier one supplier probably doesn't reach that status without a quality product. The product is everything and its quality dominates the vitality of the supply chain. Top quality ensures minimal manufacturing process intervention and everyone along the supply chain is motivated knowing that they have played a part in supplying a product that is universally respected and will most likely be a success for the customer.

"Quality is more important than quantity. One home run is much better than two doubles." – Steve Jobs

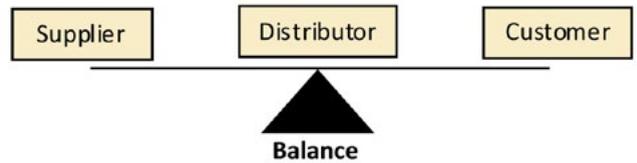
Key Issue: The Distributor and his Capability

Assuming there is a distributor in the supply chain (and who can survive these days in this global economy without one?); he will have two key partner relationships: the supplier and the customer.

Let's focus on the distributor, who, in today's ever-increasingly complex global supply chain, is the glue that results in success—or lack thereof. With utmost skill, the distributor must equally balance the needs of both partners and at the same time, show them dedication, respect, and integrity.

This can be an emotional experience for all

parties and the distributor, with guarded humility, is in the middle. He must be up to the task.



The increasing sophistication of printed circuits now requires several distributor skills and proficiencies that were not required in the past and with more and more products born in Asia, the list continues to grow.

Not the least of these capabilities is JIT delivery—a much exhausted term—but one that defines and separates the winners from the losers. In order to deal with a worst-case delivery scenario (a rush JIT) a tier one distributor must possess the following capabilities:

1. Financial stability
2. Local and regional warehousing (controlled environment)
3. Automated value-added services: cutting, paneling, tooling, and packaging
4. Strong local, national and international freight partnerships
5. Consignment offerings when required
6. EDI and B2B web services
7. ISO accreditation (proof and monitoring of responsibility)



Figure 1: The Symbol of quality planning and achievement.

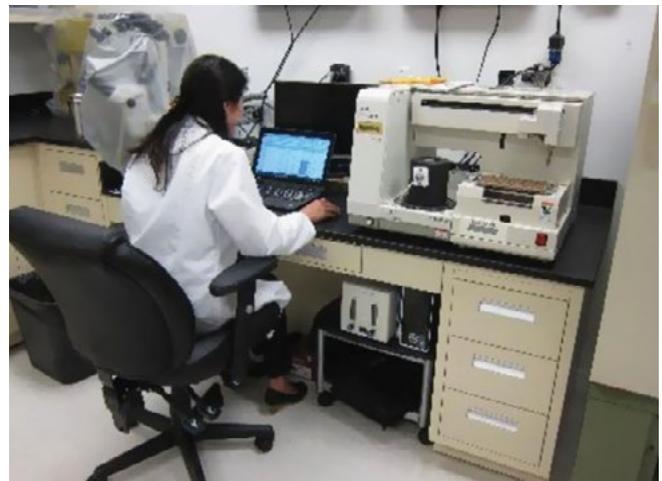


Figure 2: Quality check confirming laminate T_g.

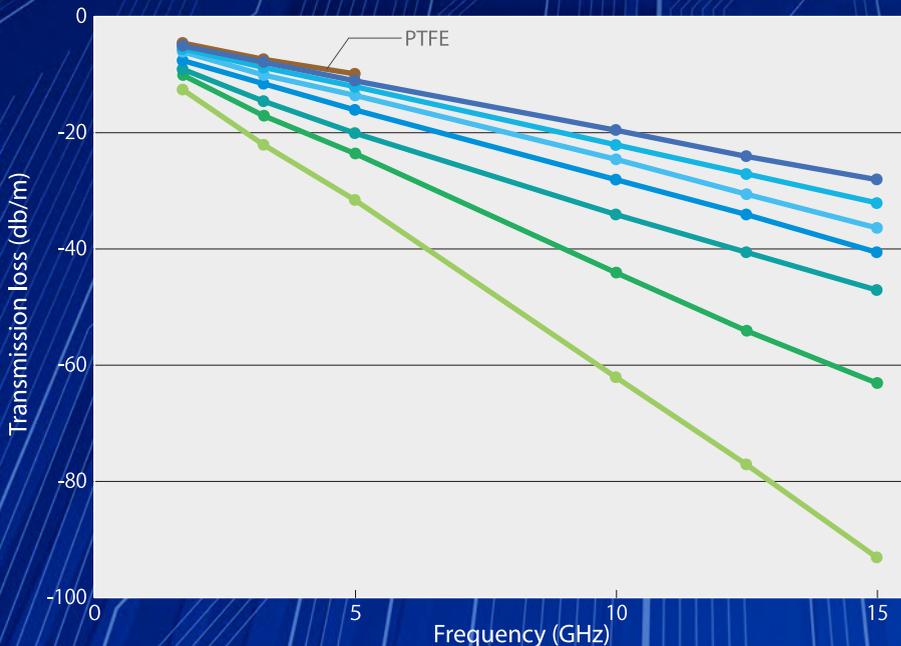


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R-1577(RT)
- HiPERV**
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● Evaluation sample

Core	0.13mm
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Length	1m
Cu thickness	t=35 μm
Impedance	50Ω

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THE KEYS TO SUCCESS FOR SUPPLY CHAIN MANAGEMENT *continues*

8. Ability to transport and store hazardous waste materials
9. Coordinated technical and training services from both the supplier and the distributor

To meet these most difficult delivery requirements, the distributor needs to be proactive and have as much product on the shelf as possible. When it comes to value-added, we call it staging. Materials and equipment need to be in place for quick and efficient completion. For example, in the case of laminate, panels need to be pre-cut to size and be ready for last-minute drilling of tooling holes if required.

Delivery to the customer is the final step, aside from further technical support. Many times the truck driver can be your best salesman and ambassador. His work ethic and reliable delivery routine can be his most important asset.

Key Issue: The Customer's Needs

As long as I can remember, the customer has never been wrong. He wants what he wants and the only way to change his mind is to service the hell out of him. Only then, and if the time is right, will you possibly be able to offer something new and different, but you must know for sure it is the right thing to do. At some point, everyone is a customer and again, relationship and trust are fundamental to the experience.



Figure 3: Laminate slitting, panelling, and tooling.



Figure 4: Copper foil preparation.

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Figure 5: Drill and router bits ready for immediate delivery.



Figure 7: Chemicals ready for immediate delivery.



Figure 6: Precut laminate panels.

***“Give the lady what she wants”
- Marshall Field
(department store founder)***

In the PCB manufacturing business there are over 70 different processes from start to finish, requiring many different supplies and most are essential to the final product. In addition, the expertise to manage each process requires many and varying levels of skill.

This complexity requires regular product training and updating, another opportunity for the distributor and the supplier to offer much needed advice.

Walking through a PCB manufacturing company is always interesting. From the engineering CAD room to Class 1000 clean rooms

to hot and stifling chemical areas, you will see a host of varying activities. There are few businesses in the world that can claim this many different processes and process complexity. It is truly a challenge and everyone needs to chip in to support the supply system.

And so it goes, the supply chain ends when the customer opens the package at his receiving door. Will it be a success and will there be peace?

The Answer to Supply Chain Management Success

And now the moment you’ve been waiting for: Nothing can replace the personal visit! This means that you must meet with your supply partners eyeball to eyeball.

Here is where balance comes back into play, and you may have heard hints of this along the way. How can you really become successful if you don’t get to know your business partners, who in time, and if all goes well, may become your business friends? This goes for everyone: the supplier, the distributor, and the customer.

I remember a visit to a supplier in China. We drove for three hours to a remote plant—another mind-bending cultural story for another day. We met with the manufacturing people, saw the product through its processes, and watched the packaging procedures.

Prior to leaving, we left a host of ideas, requests, and some demands to make sure we received the right product in faraway America. Both sides worked diligently to make it happen. When you meet people in another land and you can’t even say hello, but you see the body language and the desire to help, you can’t

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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
Corrosion	Nanotechnology	Test, Inspection & AOI
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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

THE KEYS TO SUCCESS FOR SUPPLY CHAIN MANAGEMENT *continues*

resist reciprocating. The unique experience of meeting an Asian supplier in a land that was completely foreign to me worked, because we developed mutual respect and trust. Today, the business is still thriving due to those original positive communications. Overcoming those unbelievable challenges will forever be remembered as a positive, true life experience.

In my view, if we had tried to do business without visiting the Asian supply source, it would have resulted in a failure.

As a distributor, when asked, I am always eager to visit a supplier's plant to see how the product is made; visiting the customer puts everything into its proper perspective. Knowing

the product and understanding the customer's need is very important to make the supply chain successful. You will then be able to make educated decisions when issues arise.

Get to know your partners. No two people are alike and one of our life challenges is to understand each other so we can all meet our expectations. **PCB**



Fred Long is in business development at Matrix Electronics.

Graphene Flexes its Electronic Muscles

Flexing graphene may be the most basic way to control its electrical properties, according to calculations by theoretical physicists at Rice University and in Russia. The Rice lab of Boris Yakobson, in collaboration with researchers in Moscow, found the effect is pronounced and predictable in nanocones and should apply equally to other forms of graphene.

Researchers discovered it may be possible to access what they call an electronic flexoelectric effect in which the electronic properties of a sheet of graphene can be manipulated simply by twisting.

The work will be of interest to those considering graphene elements in flexible touchscreens or memories that store bits by controlling electric dipole moments of carbon atoms, the researchers said.

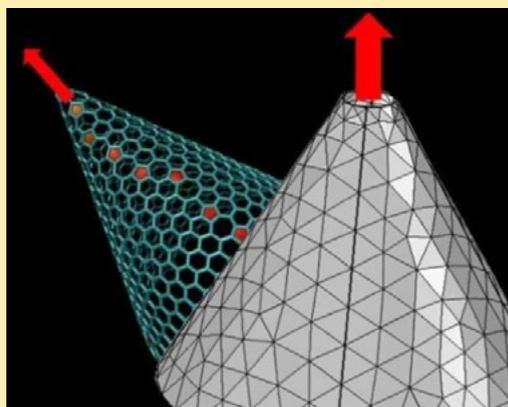
Perfect grapheme—an atom-thick sheet of carbon—is a conductor, as its atoms' electrical charges balance each other out across the plane. But curvature in gra-

phene compresses the electron clouds of the bonds on the concave side and stretches them on the convex side, thus altering their electric dipole moments, the characteristic that controls how polarized atoms interact with external electric fields.

The researchers discovered they could calculate the flexoelectric effect of graphene rolled into a cone of any size and length.

The researchers used density functional theory to compute dipole moments for individual atoms in a graphene lattice and then figure out their cumulative effect.

"While the dipole moment is zero for flat graphene or cylindrical nanotubes, in between there is a family of cones, actually produced in laboratories, whose dipole moments are significant and scale linearly with cone length," Yakobson said.



The Russian Federation, Moscow State University, the Russian Academy of Sciences and the Air Force Office of Scientific Research's Multidisciplinary University Research Initiative supported the research. Work at Rice was supported by the Air Force Office of Scientific Research and the National Science Foundation.

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PCB007 Supplier/New Product Highlights



A New Source for Laser Drills

Publisher Barry Matties recently visited the West Coast offices of Nano System Inc. to catch up with Sam Sekine, formerly of Hitachi. Nano System is a new company focused on producing and selling laser drill systems to the PCB industry. In this interview, Mr. Sekine discusses his staff, the company's technology, and Nano System's strategy for the future.

Insulectro Expands Sales Leadership to Meet Demands of Changing Marketplace

"2015 has been a strong year for us in both the PCB side of our business as well as our new printed electronics initiatives," Insulectro Vice President of Sales Ken Parent commented. "It's time to increase our focus on sales and service with two well deserved promotions."

Samtec Strengthens Cleaning Capabilities with Murray Percival Tech

When it became clear some months ago that their PCB cleaning capabilities needed to be expanded, Samtec's project team analyzed several alternatives, including two from Speedline Technologies presented by The Murray Percival Company.

ESI Supplies Model 5335 Laser Processing System to PFC

Electro Scientific Industries, Inc., an innovator in laser-based manufacturing solutions for the micro-machining industry, today announced that PFC Flexible Circuits Limited has selected the Model 5335 Laser Processing System to expand its high density interconnect (HDI) flexible circuit manufacturing capabilities.

Isola President and CEO Ray Sharpe to Retire

Isola Group President and CEO Ray Sharpe has announced plans to retire. He will stay with Isola until his successor has joined to ensure a smooth transition. The Board has already retained a search firm to guide the process of finding Isola's next CEO.

Camtek Receives Multiple Orders for its New Eagle-i System

Camtek Ltd. today announced the receipt of multiple orders totaling over three million dollars for the Eagle-i, its new generation of 2D surface inspection and metrology system, from a world leading Outsourced Semiconductor Assembly and Test (OSAT).

Lab Circuits Boosts Capacity with New 6-head Drilling Unit

The addition of the new ULTRA SPEED 6000-6 g-line allows us to adapt to the latest technological requirements. Equipped with a new camera system, it allows register settings using fiducial markers, offset and/or rotations. Its motors reach a rotation speed of 200,000 rpm, allowing the use of very small diameter drills.

Enigma Boosts Capabilities; Installs New Via Filling System

Enigma Interconnect has now installed the MASS VHF 200, the MASS ES 10 External Scavenger, and the MASS SV 100 Planarizer, all aimed at fulfilling the growing customer demand for filled and capped vias (via-in-pad), as well as controlled via plugging.

So Many Ways to Shoot Ourselves in the Feet, so Little Time

Yep, that's what I'm talking about. When we ignore common sense, we can always come up with lame-brained ideas and wind up shooting ourselves in the foot. It's not always common sense, unless you learn from what you are doing wrong.

Enthone Advanced Technology Center to Open in 2016

Enthone Inc. today announced that construction is underway to expand and transform the company's West Haven, CT Global Headquarters to become a premier technology and manufacturing center. The renewed location will be completed by 2016 and will be named the Enthone Advanced Technology Center.

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Four Characteristics of a Great Flex Supplier

by **Dave Becker**

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Selecting the right supplier for your flexible circuit needs is one of the most critical decisions you can make for ensuring the success of your product introduction. There are a host of criteria and surveys used for vendor evaluations; many businesses perform supplier audits, which include reviewing the company's procedures, certifications, equipment and facilities.

While these audits are often useful, I would offer up four characteristics of a great company that are often overlooked or undervalued:

Initial Responsiveness: How fast was the response to your initial inquiry? Did your phone call get answered, or did you get stuck in someone's voicemail? Was your e-mail replied to promptly, or did you have to follow up? Granted, a rapid initial response does not guarantee the company will be responsive in all areas, but a poor initial response is a red flag, and there may be some systemic issues that could impact that company's ability to service its customers.

Employee Engagement: Having the best procedures and mission statements in the world is meaningless without a workforce that is committed to making the business successful by serving its customers. Empowered employees provide faster response and are more likely to go above and beyond the call of duty to address an issue.

Determining employee engagement probably requires visiting the production floor and talking with key operators and technicians. Charts on the wall may be useful, but can the line operators explain what they mean and how it impacts their job? Does the employee know the company's business objectives?

Talking to management can sometimes be misleading, but it is pretty easy to tell if a manager or owner really believes that the employees are highly engaged. A manager with strong engagement programs will be able to discuss them in great detail.

Growth/Investment/Financial Strength: It is important to understand the financial situation of your prospective supplier. An ideal supplier is growing because they are successful in the marketplace; they also have the financial resources to support that growth. Privately owned companies may not provide all their financial data, but they should at least be willing to honestly answer some frank questions about their short-term and long-term financial situation.

Employee/ Management Talent: Start at the top. Who is running the company? A broad experience level across the management team is a good indicator. If the entire salaried support staff is essentially homegrown, then there should be some questions about the company's ability to manage and adapt to change. Retention of employees, both in management and production, tells a lot about how well the company has been managed.

In conclusion, "superior delivery" and "quality performance" mean more than just performing a series of fabrication steps per written procedures. Dedicated high-energy teams empowered to make decisions, result in the highest level of customer satisfaction. This needs to be accompanied by a management team committed to creating an environment where employee engagement thrives. It also requires having the resources to adequately invest in equipment, facilities and personnel. Sometimes vendor surveys and evaluations don't always address these important characteristics. **PCB**



Dave Becker is vice president of sales and marketing at All Flex Flexible Circuits and Heaters.

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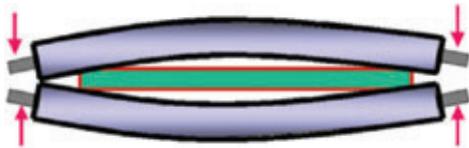
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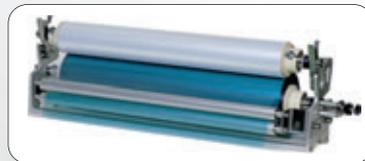
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American Standard Circuits Attending the 2015 International Paris Air Show

American Standard Circuits CEO Anaya Vardya will be part of a group of companies from Illinois attending this year's International Paris Air show to be held from Monday, June 15 to Sunday, June 21 at Le Bourget Exhibition Center outside of Paris.

Flexible Circuits and UAV Applications

The utility offered by flexible circuits in UAVs mimics the advantages that make it popular in other portable electronic applications: lightweight, thin, highly reliable, flexible during use, and possessing an ability to electrically connect across multiple layers as part of a complete packaging interconnect solution.

Wearable Technology and Flexible Circuits

Flexible circuits are an ideal fit for wearable technology. Wearable electronics need to be light, dense and bendable. While what is currently considered standard flexible circuit technology is more than adequate for many the wearable products, there are requirements that may be pushing the boundaries a bit.

Flexible Circuit Materials for High-Temperature Applications

To meet the increasing needs for flexible circuit materials for high-temperature applications, new test methods will need to be developed. These new methods will assign new ratings that are consistent with actual performance.

TTM and Viasystems Receive FTC Clearance for Acquisition

The United States Federal Trade Commission has closed its investigation into TTM's proposed acquisition of Viasystems and the parties are free to complete the transaction.

AT&S Receives Wiener Börse Award

AT&S AG is the winner of the "Small & Mid Cap" category of the Wiener Börse Award 2015. The specialist jury awarded AT&S the first place in this category because of its outstanding performance in 2014, its excellent investor support and its high liquidity.

Dynamic & Proto Circuits Names Matrix Electronics Supplier of the Year

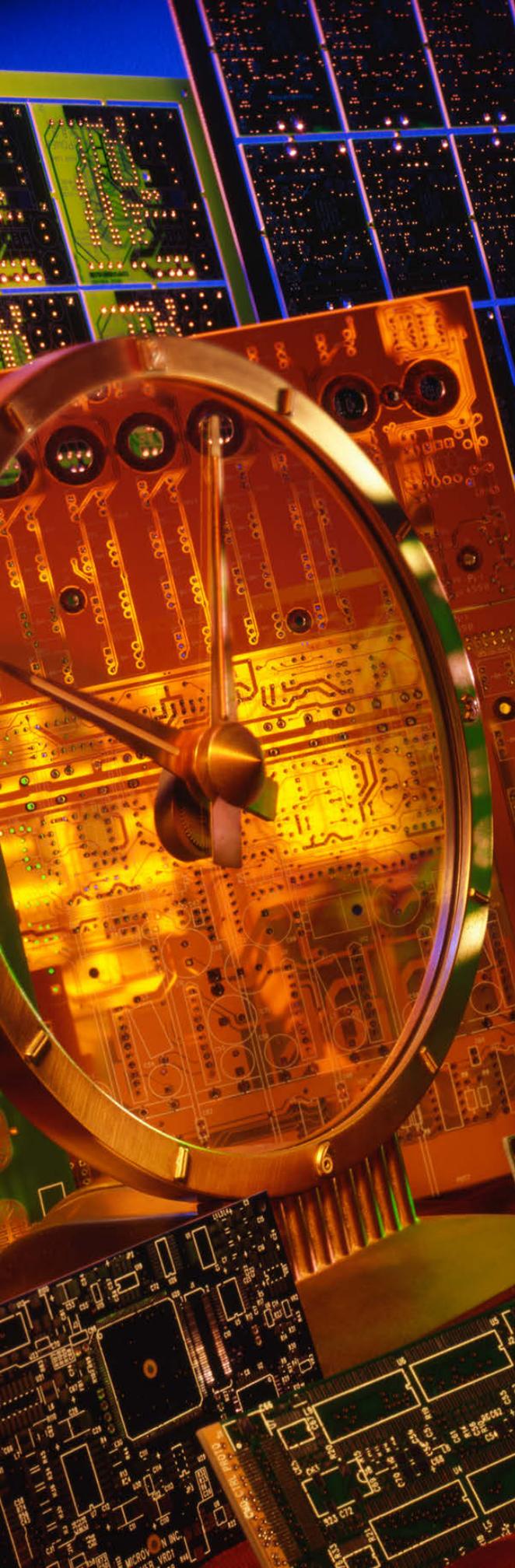
Dynamic & Proto Circuits Inc. (DAPC) named Matrix Electronics Limited as their Supplier of the Year. Each year, this award is granted to the supplier who demonstrates the most excellent track record for product quality, delivery and supply chain resourcefulness.

Prototron Circuits' Tucson Facility Purchases New Chemcut Etcher

Prototron Circuits recently purchased a Chemcut XLI-30 Alkaline Etch with Resist & Tin Strip modules for its Tucson facility. According to Kim O'Neil, general manager, this etcher will allow Prototron to produce fine line etching process materials as thin as 2 mil core inner-layers and will allow the company to continue its path towards very fine lines and spaces as well as complex RF geometries.

Sunstone Circuits Boosts Capability: Installs New Machinery

Sunstone Circuits, the leading PCB prototype solutions provider, has just added two new pieces of PCB manufacturing machinery, aimed at improving the PCB manufacturing process for design engineers. The newest piece of equipment is the AccuSystems™ AS-150-MAX CNC V-Score System.



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Dry Film Photoresist Thickness Selection Criteria

by **Karl Dietz**

KARL DIETZ CONSULTING LLC

Dry film photoresist suppliers typically indicate for which process (e.g., print and etch, pattern plate, tent and etch, gold plating) a certain resist type is suitable; however the fabricator still has to select the resist thickness that matches his needs best. The most important thickness selection criteria that come to mind are price, resolution, and yield.

Dry film photoresist with a thinner photosensitive layer tend to have a lower price because of the lower material cost of the resist layer. So it makes sense to use the thinnest resist that still satisfies yield and resolution expectations.

For print and etch, one would choose the thinnest film that still gives acceptable yields. The thinnest resist will also give the best resolution in print and etch because of the more favorable etch channel aspect ratio that will give the best etch factor. The etch channel aspect ratio is defined as the ratio of the total thickness of the resist and the copper to be etched, over the width of the space to be etched. The etch factor is the ratio of vertical etching over lateral etching whereby a high number is more favorable for resolution. High etch channel aspect ra-

tios will result in poorer etch factors. Therefore thinner resist (and thinner copper) give better resolution.

Potential problems that one can get into with films that are too thin for the application are poor resist conformation to a relatively rough copper surface, because there is not enough resist mass to flow and fill the recessed areas of the copper topography, which lead to circuit open defects or so called dish-downs. Another potential problem could be the formation of wrinkles during hot roll lamination. Print and etch resists are typically 25–35 microns thick. The thinnest available dry films are about 20 microns.

For tent and etch, one will have to pick a film that is thick enough to form 'tents' over the metalized through-hole openings to hold up against mechanical and/or chemical attack. Historically, these films had to be 50 microns to hold up. In recent years, resists have been improved to give good performance at only 40 micron thickness; in some cases it may be only 35 micron thickness. The tenting strength can be measured with an instrument like the one shown in Figures 1 and 2.



Figure 1: Instron® stress/strain tester.

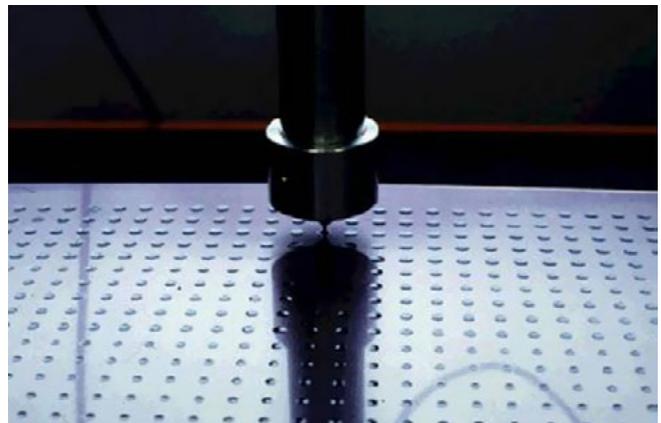


Figure 2: Instron® probe testing tent strength.

Hutchinson Technology Inc. (HTI)

Hutchinson, Minnesota, U.S.A.



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Hutchinson Technology manufactures high volume, very fine feature precision components for the medical, defense/aerospace, computer, and microelectronic industries. We currently ship over 10 million circuits per week with 1 mil lines and 1 mil spaces.

Markets: Automotive, Communication, Computers, Consumer, Medical

Board Types: Flex

Mfg Volumes: Medium, Large

Other Services: Photochemical machining, precision forming

Certifications: ISO 9001, ISO 13485



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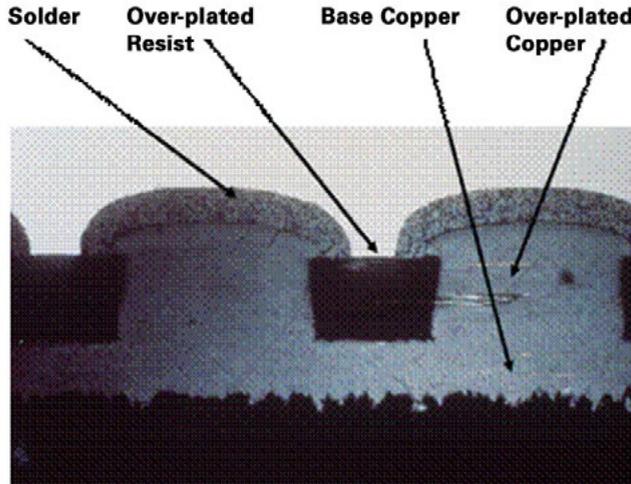


Figure 3: Over plating.

For pattern plating, one would have to choose a resist that is at least as thick as the intended plating thickness, which is a design parameter and cannot be changed. A typical plating film thickness is 50 micron. In fact, the plating resist should be a little thicker than the intended plating height so that there is no over-plating in areas of high current density. Figure 3 shows a severe case of over plating.

Over-plating (i.e., plating over the resist [mushroom plating]) and trapping the resist under the over-plated copper (and tin) will cause stripping problems. If the trapped resist cannot be stripped, it will act as an etch resist and

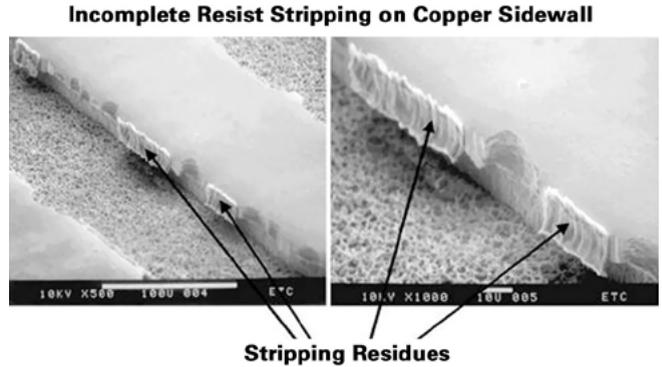


Figure 4: Incomplete resist stripping causing ragged plated lines.

will cause a short due to remaining base copper between plated lines. If the resist is partially stripped, leaving random resist residues on the plated side wall, inhibiting the natural etch-back so that the plated copper will look ragged (Figure 4). **PCB**



Karl Dietz is president of Karl Dietz Consulting LLC. He offers consulting services and tutorials in the field of circuit board and substrate fabrication technology. To view past columns or to reach Dietz, [click here](#). Dietz may also be reached by phone at (001) 919-870-6230.

UK PCB Industry Leader Brian Haken Passes Away

Brian Haken, one of the PCB industry's great leaders and visionaries, has passed away. An inspiration to many in the PCB field, Haken helped form the close ties and friendships that have bonded the UK's PCB industry together for many years.

Haken worked for E.K. Cole TV, before moving to Multitone Electronics, and to South East Printed Circuits as sales director. In 1987, he was instrumental in forming the Printed Circuit Industry Federation (PCIF), which he led as director from its inception until the merger with the FEI, and



later Intellect, in 2000.

The PCIF was the lead federation representing UK printed circuit manufacturers, suppliers and assembly companies. Its success was a testament to Haken's energy and drive. The regular quarterly meetings were eagerly attended and the annual conferences at Runnymede were always exceptional.

Haken helped steer the UK PCB industry to wider markets, forging close ties with the IPC in the United States and JPCA in Japan.

It is particularly sad to note that his wife Eileen also passed away a week before.

Haken's funeral was held June 23 at Southend Crematorium in West Chapel.

To make a donation to cancer research in his memory, [click here](#).

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 PCB007

1 **IMPACT 2015: An In-Depth Look**

IPC understands that presenting a unified voice for the electronics industry is essential for advancing policies that affect the industry's long-term future and strengthens the U.S. and global economy. That is why 22 IPC member-company executives descended on the nation's capital for IMPACT 2015: IPC on Capitol Hill, IPC's annual advocacy event.

2 **An Interview with Gardien Group's Jason Fraser**

Gardien Group CEO Jason Fraser talks to Dan Beaulieu about some of the latest developments at the company, some of the technology trends driving the company's strategies, as well as provides his outlook as to where the PCB industry is headed.

3 **NEPCON China 2015 a Resounding Success in Shanghai**

The three-day event was a complete success, bringing together nearly 22,000 trade visitors and high-quality buyers, as well as 450 leading brand names from 22 countries and regions worldwide. NEPCON China keeps up with market trends and gathers resources from all stakeholders to present a comprehensive event that covers SMT, new electronics materials, soldering, dispensing, electronics automation, measurement and other innovative technologies and products across the world.

4 **HDPUG Demonstrates Benefits of Cooperative R&D**

The High Density Packaging User Group (HDPUG) is a member-driven, non-profit, project-oriented industry consortium that addresses the integration of new electronics component packaging and interconnection technologies into the supply chains of its member companies.

5 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.

6 Being Flexible in a Rigid World

With double-digit growth in the foreseeable future, flexible printed circuits (FPC), have found a tremendous niche as an enabler for various electronic applications. This trend is expected to drive the need to increase productivity while improving performance and reducing costs. Of course, in order to sell flex, one must tackle the unenviable task of metalizing these often difficult-to-plate materials.

7 Papers Sought for IPC APEX EXPO 2016

IPC is inviting all industry professionals to submit an abstract for one of the industry's premier technical conferences, or provide a course proposal for one of its largest educational events.

8 Amphenol Invotec Accepted into the SiG Programme

Europe's leading manufacturer of PCBs for critical applications, is delighted to announce that it has been fully approved to be a beneficiary on the Government-backed Sharing in Growth (SiG) programme following a rigorous three-month diagnostic process.

9 IPC Releases N.A. PCB Industry Results for April

"North American PCB sales continued slightly below last year's level, and orders, which rallied in the fourth quarter of 2014 and remained strong in recent months, also fell below last year's level in April," said Sharon Starr, IPC's director of market research.

10 New IPC Report Details How PCB Makers Address Tech Trends

The survey-based study shows how PCB manufacturers are meeting today's technology demands and looks at the changes expected by 2019 that will affect PCB fabricators and their suppliers of materials and equipment.

For the latest PCB news and information, visit: PCB007.com



EVENTS



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

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

For the complete PCB007 Calendar of Events, [click here](#).

[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

[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



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PCB007 Presents



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**Coming Soon to
The PCB Magazine:**

**August:
The War on
Process Failure**

**September:
Cars: A Driving
Force in the
Electronics
Industry**