Supply Chain Shock and the Factory of the Future

Feature Interview by the I-Connect007 Editorial Team

IPC's Chief Economist Shawn DuBravac, Ph.D., CFA, and IPC's Chief Technologist Matt Kelly, P.Eng, MBA, discuss technology and market trends they're currently following, as well as the recent digitalization of the supply chain and what that means for domestic manufacturing.

Nolan Johnson: Regarding changes in the dynamics for electronics manufacturing, a number of factors point to an emerging trend toward regionalization and the potential development of captive facilities in North America. We want to talk about those possibilities. Can you start with your overall perspective on these trends?

Shawn DuBravac: It's clear that the supply chain is in flux and that there are a lot of dynamics in play. This dates to before the current pandemic engulfing the globe. I would argue that supply chains are always looking to optimize a number of factors. As supply chains are confronted with new challenges, the weight that manufacturers apply to those factors changes and evolves. Before the pandemic, the narrative that dominated supply chain decisions was trade tensions flaring up around the globe, most notably—but not exclusively—between the U.S. and China. There were trade tensions that were growing globally for a number of factors.

Companies were beginning to internalize those risks and were making adjustments accordingly. At the same time, one of the things that companies are always seeking to optimize is being able to deliver products in a timely manner. They're optimizing around cost and time. You naturally want to be in the market that you're serving, so some of the decisions that were being looked at involved areas of the world that were growing and evolving and what they wanted. Those are the dynamics that were influencing things over the last year.

Then, as the pandemic started to spread in China, it created some supply risks, constraints, and issues. It was a supply shock, not unlike the one that manufacturers have confronted in the past. Early on, it looked like a

Shawn DuBravac

supply shock, but it evolved into much more than a supply shock and became a demand shock as well. Companies and manufacturers are looking at all of those dynamics and how to optimize the factors. Some of the factors that manufacturers are optimizing have started to evolve and change as a result. For example, safety is much higher on everyone's list today than it was six months ago. Companies are adding that as one of their risk factors.

To your point about regionalization, some of these things were already in flux, and manufacturers were already looking at how to reoptimize their supply chain. They're continuing to have that conversation, and they're looking at what their regional strategies are. Companies will take all of this new experience and information into account and, in some instances, make changes. Notably, we see that manufacturers are starting to dedicate certain product lines to specific regions so that if the region is disrupted for any reason, then that entire product line will go down, but not every product line will go down. Whereas the way supply chains are globally distributed now, a disruption in any part of the world can have the potential to disrupt all of your supply chains throughout the world. To create some protection against those disruptions, you'll see manufacturers containing the entire manufacturing supply chain for given products within a region where possible.

Manufacturers were already looking at how to guard against some of these risks. The idea of dual sourcing is a way of guarding against some of these risks, but it is more difficult to do in practice than in theory. Another way of guarding against some of these shocks and risks is that you then dedicate and identify a specific region to be the sole manufacturer of a whole product line.

Matt Kelly: To build on that, I'd like to start with pre-COVID and get back to the tariff challenges. One thing to know is that the transformation of the supply chain, as we know it today, started from these tariffs. There are large OEM companies that were, when you work out the 25+% tariff on their products, spending single-digit millions—or more—inside of six months. This is a very large tax and erodes profit margin for the product line.

I have lived through the tariff transfer, which started around 2017–2019. Many products were being moved out of Asia into Mexico, for example. By the time last year rolled around, many large OEMs were already there. The migration that Shawn described happened quite a bit in commercial-grade computing and high-reliability electronics. They had already moved. That's from the EMS perspective, where the system is put together. There is an opportunity, and some of that's already occurred, where the geography and location have already moved. For regionalization, it makes sense that you want to be close to a hub.

However, the counter to this is you have to frame it with what we're making. Supply chains are not all alike. For example, you can't pick up the switching costs on your incoming material supply. That may not be an option. The example I like to give is a silicon fab. TSMC recently announced it was building a

new factory in Arizona for $12 billion. You don't pick up and move a fab because you want it closer; it depends on what element of the supply chain we're talking about. The way I describe this is that it's a combination of moving into strategic geographies for those benefits, such as supply continuity, probably not cost. We're going to have to get used to spending more on things if we want that security close to home.

The other element is that we spent the last 20 years creating a horizontal global supply chain. We can't undo that as easily, so we have to find clever ways to work with the supply chain as it exists today because, for example, you can be looking at a very sophisticated system with 5,000 part numbers in it. It only takes one part number in that system to not be in hand for that start-to-build to be delayed. It could be a half-cent resistor from Asia. I use that example because although there is this trend to circle the wagons, if you will, and go regional, there are certain supply elements that will not migrate easily for economic and capability reasons.

I highly recommend the article "Restoring American Competitiveness" from the July-August 2009 issue of the *Harvard Business Review*. If you read it today, the technology and devices examples they use have changed, but the idea of "industrial commons" still applies. Industrial commons is when business leaders dream up the product line, engineers, and operational staff, right down to the people that maintain the facility. All that lives and breathes when you have that ecosystem nearby. It's a very interesting article.

Dan Feinberg: There's no doubt that we see supply chain changes, and all of us know of additional supply chain changes that are coming—some that we talk about, some that we don't want to talk about, some that we're not sure about, and others that we probably shouldn't talk about. Do you expect these ongoing supply chain changes to become relatively permanent? Do you expect to see some movement back to the horizontal supply chain you were discussing?

Matt Kelly

Kelly: That's a great question, but the issue is difficult to predict. My opinion is that it's going to be a hybrid. Jumping from one to the next, it usually doesn't happen in business in our economy. It's often an evolution. While there are driving forces to be regional, there's going to still be blended, horizontal supply chain aspects of it because you can't pick up, build, and move staff and equipment with the notion of a commodity. The idea of a commodity, by definition, means that anybody can do it.

The analogy I like to use here is a loaf of bread. For example, you make a loaf of bread in Asia, but now I want to make it somewhere else. Ship the bread pans, order the flour, move some ovens, and make bread somewhere else—if it was that easy. In that case, you can do it because it is a commodity. However, we all know that electronics are not built like that.

While the idea of commoditizing elements of the supply chain looks great on paper and in concept, it's not quite that easy. For example, on the EMS side, my estimate is it takes somewhere between four and six years for an EMS facility to produce exactly the way you want

with your feet up on the desk, feeling comfortable. Moving around and chasing supply chain elements is very taxing. You're always chasing quality and delivery and that sort of thing.

Barry Matties: The case could be made, though, that now is an optimal time for several reasons. One reason is that there's plenty of money out there. From the financial side, money's cheap. With so much money available so cheaply, is this a move we're going to see because of that?

DuBravac: Going back to your question about these changes being permanent, I would say yes, they're permanent, but they're not universal. You're 100% going to see people move toward more regionally defined and designed supply chains, but it doesn't mean that solution is going to be a one-size-fits-all.

Would it be an ideal world if everybody dual sourced every component? Yes, but that's not realistic. Does it make sense to automate certain pieces of your production line to maintain costs so that you can enter into a developed market? Yes, but again, it's not realistic because you're turning over these product lines every 12 months. It doesn't make sense in all cases. The economics will make sense for some, and they'll do it, but it won't make sense for others. It will make sense for large companies that have a lot of volume, but maybe not for others.

Matties: But the timing now is pretty good considering that there's a real mindset to have supply chains shift. There's a lot of money available. What are your thoughts on that?

DuBravac: You're right. The timing probably makes more sense now than it has in the past, and partly because the factors that executives weigh are changing. To Matt's point, cost isn't as valuable as it once was. People are willing to change things and weigh other things besides cost. The timing makes sense now, but not for everyone.

Matties: Matt, you're an expert in future factories. If we see a supply chain shift, doesn't it make sense that people start building the factory of the future today?

Kelly: Absolutely. Money is money, but what are you going to use it for? It's great timing to see factory-of-the-future advancements take hold. A couple of interesting stats: You can't turn on your computer today without seeing droves of information regarding the factory of the future. It could be a webinar, an advertisement, etc., but it's the factory of the future.

It's about digitization, analytics, artificial intelligence, and blockchain. We all know those buzzwords, but the reality is that in the electronics manufacturing sector, less than 20% have assessed themselves and said that they are ready. You can see a very low adoption rate. We have all this technology that is ripe and money to spend, but we haven't adopted it. Those are all good ingredients to see some forward movement.

Matties: What does that factory look like to you?

Kelly: First of all, there are a lot of people in it, which is contrary to some conversations. The idea of being lights out and fully autonomous and replacing workers with equipment or machines? I'm not a subscriber to that. I'm not a subscriber to that as an engineer nor as someone who wants a gainfully employed industry as well. My view on a factory of the future is using all these technologies as tools in a toolbox, not replacements. Those tools enable a worker to become a superhero.

Today, you have a worker who does a specific task, which might be a lead on the front end of an SMT line. They are looking after maybe a couple of pieces of equipment at a maximum, and are very focused. When you bring in factory-of-the-future elements—digital frameworks surrounded by proper security, data analytics, real-time machine/equipment control, etc.—you've enabled that worker to do many more things in a day. That's the power of what all this can be.

Do you want that worker to go away? There will be some reductions, I'm assuming, but

you're giving more power to the operators and engineers as well. You're improving productivity, essentially. You are also able to upskill those employees. You're not paying that person to move a part from point A to B, or solder a particular device over and over again. Some of that can be automated, and now that person is a higher value in your operations. That's my response in terms of integrating technology with the workforce. By saying that, I'm not expecting to make up 70–80% reduction in labor; it might be 10–15%.

Matties: It seems to me that the role of people will shift to more of the front end, making sure that the digital information is accurate and correct to run it through a digital line because digital manufacturing is in play and will continue to be in play. This is an opportunity for people to rethink that; the day of the operator moving a panel from point A to B, B to C, etc., will come to an end. Especially from a financial point of view, if you want to be competitive on the labor front, you have to reduce that cost of labor.

Kelly: Agreed. That's how I always frame it, too. I was hired at IPC to drive the factory of the future implementation and work very closely with Shawn, John Mitchell, and the entire executive staff. This is a focus of IPC. We have today's standards and technology sets, but we are already working on these new elements.

Matties: Most likely, you're familiar with GreenSource Fabrication out of New Hampshire; it's a bare board facility. They're not doing assembly yet in a digital factory, but they built a digital factory with zero waste. They didn't even need a wastewater permit. Happy Holden can talk quite a bit about it because he has studied this model, which will be a gamechanger and drive the ability for OEMs to consider having captive facilities again.

Happy Holden: The fact they have no production workers means that they have no training program or recruiting. They have engineers—maybe more than others would have—because they're state of the art. They do semiconductor-sized geometries on PCBs. What's most interesting is they can do a lot quantity of one, which means that they can change the recipe in milliseconds. A human can't possibly memorize nor look up the details fast enough. I don't totally agree with you in this particular case for quality and productivity. Having no humans involved is their competitive advantage. That capability is not necessarily needed everywhere, but it's a different paradigm.

Kelly: You bring up a good point that the factory of the future is not just about a lack of lights or cool technology; there's a lot wrapped around it. I ask myself, "What do I want my factory of the future to look like 10 years from now?" It's about defining the kind of factory. Is it in silicon? Is it an EMS provider, where you're bolting metal to electronics? Is it a bare board shop? We can't apply this model to everything because it doesn't work; there are variations.

Matties: From a financial point of view, there's a lot of acquisition opportunities. What do you see in that climate?

DuBravac: A time like this opens up a lot of opportunities to acquire resources and capital. This was true even before the pandemic when you had supply chains that were reconfiguring themselves. You have people who are disposing of assets and acquiring assets that make sense for their portfolio. We were already in a period where acquisitions made sense from the economics of what was happening in the environment and in the industry. Whether the current environment supports the financial needs to make acquisitions is another story.

You see it in some sectors where companies sitting on a lot of cash continue to acquire the pieces that they want for the products that they'll deliver in the future. Outside of core manufacturing, if you look at Microsoft, Google, and Apple, they have all announced recent acquisitions, and arguably do so on a weekly basis. They're sitting on billions in cash, so to make a $100 million investment doesn't change their financial position. One

of the challenges moving forward in this environment is access to the financial resources needed to make some of these changes. These are not inexpensive changes.

Johnson: Matt, following up on that, earlier on in our conversation, you mentioned that it takes about five years to get an EMS facility fully optimized, where you can put your feet up on your desk and let it run. Do you have any sense for how long a PCB fab shop would take to get to that point?

Kelly: It would be about the same—three or four years.

Johnson: Three or four years to get the wet chemistries and everything in place?

Kelly: People are going to look at that and say, "No way. That's too long." But people who have done it say, "Thank you for saying that," because it goes quiet after a while. New products and technologies are usually measured in that product launch cycle, so once the product goes out the door, everybody assumes it's great, and everything is figured out, but that's not usually the case. There's constant learning, and I'm not saying the quality or the reliability isn't good enough. It has all been qualified, but there are business and operational procedures and things that are constantly changing, so it takes a good couple spins and the follow-on generation of a product.

And it's not just the technology. We always look at the product at the end of the day, but Happy, you were talking about the workforce. Is the workforce doing what it's supposed to do from an operator's standpoint, from an engineering standpoint? Do they know how to get to business quotes in the business office? There's a variety of things from the beginning to the final delivery of that product that is maturing. That's why I say it's somewhere between three and four years for a board shop, and four or six years for an EMS.

Johnson: During the opening remarks in this conversation, you suggested we're on the verge of a hybridized supply chain. I had written down the word "matrixed." Until the '60s, the supply chains were very vertical. I grew up a kid for whom most of my relatives worked at the Tektronix headquarters. Tektronix did everything in the '60s on-site; they even machined their own screws for their oscilloscope products. It was a very vertical supply chain. That has all changed into a very horizontal global supply chain, as you were saying. It seems like there are portions going vertical again, creating a matrix organization. Does that ring true to you?

Is the workforce doing what it's supposed to do from an operator's standpoint, from an engineering standpoint?

Kelly: Yes, but again, my lens is it will still be dominated by the horizontal supply chain. This doesn't change overnight; it took two decades to get to this point. There will be individual points where, for security and bottleneck reasons, they're going to say, "We're going to invest in this. We want to pull it closer to the final hub," etc. We'll call it a handful of strategic moves dominated by a horizontal supply chain.

Johnson: As I look forward, there's going to be a mix. We'll have the traditional job shop fab or EMS provider doing work for third-party clients. But there seems to be a lot of room for some return to captive or a consortium of companies that timeshare a facility that they've built and maintained. Are you hearing anything like that in the market at this time?

Kelly: I've seen nothing that I would say is a dominating trend at this point. I'm sure things are swirling. Picking up on expansion, one thing I do see, using EMS as our anchor, is if we look at the late 1990s and 2000s, we

were in more of that conventional CM model. The OEM owned the design, they partnered with someone to build it, and you know the rest of that chain. Over the last five to eight years, there has been more and more expansion happening by the EMS providers. That's how ODM was born, where they basically say, "We'll finish off the design for you. The OEM needs to own the design, but we'll finish up physical design, or we'll do the roll-up-your-sleeves-type work on the back end of design." The ODM is trying to capture more of that work upfront before they build anything. They're trying to open up the aperture to the left, closer to design.

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They're also offering more final system build services at the back end, so instead of producing a PCBA, I'll make it up—10 PCBs come to a hub and they get put into a subsystem, bolted together and made into the final assembly. The EMS is also doing that now. I'm not sure if you've heard the terminology of a level build, like L6 versus L9, where that EMS provider is producing the final subsystem, including software and firmware loaded. They're trying to expand to the right as well. When an EMS now says, "I'll be your partner," they're expanding their service offering to the left on the design side and to the right on the final fulfillment side. By that, they're trying to expand their margins.

Matties: That makes sense. They have to keep adding value.

Kelly: Remember that with EMS, margins are razor-thin—around 2–3%. If you hit 10%, it's a good financial result.

Matties: As long as profit margins are so thin, if you have the right partner, there is no reason to seek out a captive facility.

Kelly: It's also the reason you don't want to move too much because the transfer and movement costs can kill 3% pretty quickly. That's why you want to get a good partner and keep them.

Matties: Maybe it's quicker for a captive facility to be optimal. What trends in technology do you see in the market that the industries should be mindful of right now?

Kelly: The number one trend is digital transformation. I know that sounds like a buzzword, but if you look at the level of sophistication, it's quite low. There's still a lot more to be done. Again, we have to partition this. Silicon semiconductor wafer technology is probably somewhere between 10 and 15 years ahead, so I'm not talking about that; I'm talking about EMS in electronics manufacturing, which includes PCBA, PCB, mechanical assembly, system fab, and final test.

The digitization of operations and changing the way people work alongside that digital transformation is huge. I know that sounds vague; everything is about digital, but there's a lot to it. It's how designs are made at the very beginning. Someone talked about design for manufacturing. That's still not done very well. Some people have figured it out, but at large, it's not designed for sustainability or some of those back-end processes. The digital aspect of it enables business-to-business, so transferring data securely is number two.

As soon as we talk digitization, it's probably in parallel. Security is right there. In the electronics manufacturing industry, if we're going to make real strides in implementation—not just describing these great technologies but making them work—we need common digital platforms. An example is IPC's Connected Factory Exchange (CFX) protocol, where we have a common language that allows data to be moved around. If we can't agree on the common digital thread, then we can't connect the way that we want to.

Matties: It's the Beta/VHS situation.

Kelly: Yes. And there are different groups out there vying to do this. We totally understand that. Hopefully, the best technical solution will prove itself by its own performance.

Matties: With those trends, there has to be a big demand for retraining the workforce. How is IPC playing into that?

Kelly: Training and education is a very big portion of IPC's strategic focus. There are new platforms like IPC EDGE, which allows for digital training and certification.

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Matties: IPC is an industry resource. We have to make sure that our readers understand the tools and opportunities available to them, especially as they move into the future.

Kelly: We often put technology first because it's neat. AI, neural networks, and machine learning are pretty cool, but if left alone, they will fail. One reason is that it's technology only and doesn't serve a business need. Two, where are the people? Some of the best insights I've gained lately are from Bob Murphy, SVP, Connected Enterprise Consulting, Rockwell Automation. He is adamant about putting the change management of people right beside all this technology change. It has to be done in parallel. If you don't do it, then you have all this stuff you've purchased and nobody knows how to use it, or they think it's the enemy. There's bias.

DuBravac: If you think about the investments a manufacturer needs to make, it's not only in capital and technology but also in people. Those investments need to happen in tandem. We're in an environment where these shifts take place, and companies will need to make those investments so that they can be viable moving forward. That will require investments in both people and capital. Often, that investment in human capital is an investment in training and other things like that, too.

Matties: What final advice would you give to manufacturers today?

Kelly: My answer will be relatively narrow, but I'm keeping it narrow so we can progress the electronics manufacturing sector and start to work independently as businesses need to. We need healthy competition and differentiation so that people can make money, along with more emphasis on working together as a supply chain in the context of digitization. People are still doing their own things. "This is the best way to do it. This is my partner. This is a better mousetrap than the other." There's still a lot of "turf battling" occurring. We will not progress if this continues.

My call to action would be to agree to keep certain things off the table: business secrets and trade-offs. That's business as usual. But for linking the supply chain together, that's where IPC comes in. We need standardized processes and digital formats that everyone can read. Once we agree on these protocols, companies can work together. A good starting point would be to take a good look at your own company in terms of where you are in this transformation, and then don't just work independently. Instead, branch out to your supply chain to see how everyone can work together. Underneath that, standards bodies like IPC and others can be the framework for that to happen.

Matties: We appreciate your expertise. Thank you very much.

DuBravac: Any time we can help, let us know. Thanks, everyone.

Kelly: Take care. SMT007