Transcript for the WLEI Podcast:

Tapping Technology to Boost the Power of Lean: A Conversation with Jeff Liker and Jim Morgan

August 24, 2020

How does the emerging Industry 4.0 intersect with lean thinking? And how should smart companies adapt to this emerging new Internet of Things? This is the question we've asked lean thinkers Jeff Liker and Jim Morgan, whose recent book Designing the Future explores related issues in depth. Moreover, Jeff will be reissuing his classic title The Toyota Way later this year, with revised and additional information. Welcome to WLEI, the podcast of the non-profit Lean Enterprise Institute. I am your host Tom Ehrenfeld, and I'd like to welcome you to this episode.

Tom Ehrenfeld:
I'm delighted to have Jim Morgan and Jeff Liker for our podcast today. We're going to talk about the issue of Industry 4.0, and the ways that Lean thinking intersect, interfere, support and so forth. And a great starting-off point is just the simple quotation, Jeff, from your new revised version of The Toyota Way, a book that's coming out in October, in which you say the simple sentence, that, "Industry 4.0 is not a disruptive force that makes TPS irrelevant, but rather can be an enabler that builds on TPS culture and thinking." Can you just expand on that?

Jeff Liker:
Yeah. As background, I do a three-day masterclass on Toyota Way Leadership and get directors, executives, most people that are responsible for Lean continuous improvement. And the question often comes up, regularly comes up, how does Industry 4.0 affect Lean? Sometimes the question is asked as, does Industry 4.0 replace Lean? So the implication is there's this thing called Industry 4.0, and it's the next big wave, and if Lean doesn't somehow get on the bandwagon, Lean will become obsolete. And I was, as you might imagine, pretty skeptical about that. We also go into a Toyota factory as part of the course, and they will ask that question to Toyota people like, "Are you ready for Industry 4.0?" As if it's like a big tsunami wave coming, and if you're not prepared for it, it'll wash over you and destroy everything.

And the Toyota people are very polite and they say, "We have been looking into it. We don't consider ourselves very advanced, but we're considering it, and we're going to do some pilots." They're very cautious. And the reason for that, I think, is because they see it as possibly adding value to and integrating with their system of people, processes and technology, not as something replacing thinking and their system. And the cautious steps includes the Toyota idea that people should be thinking, challenging, observing, questioning, and improving the system. So they don't want to do anything that will kill Kaizen. If people start to depend on the system to think for them, then that would be the tsunami that would ruin it right away.

My response was glib, saying that companies that are on a bandwagon of Industry 4.0 actually don't have experience with it. They don't know what they're going to do with it, but somehow they believe that if they don't get on the bandwagon, if they're not one of the first, they're going to get behind. I was pretty skeptical until last fall, when I visited a DENSO factory in Battle Creek, Michigan, and there was a

guy named Raja, who is an engineer, and he's been with DENSO for a long time. And he knows DENSO's version of Lean and The Toyota Way. And he's very excited about Industry 4.0, particularly the Internet of things. And he's been doing projects that are transformative, that are building on Lean, instead of replacing it. When I saw the applications that he had, it was very different from what I'd read. And he truly was integrating Lean and IoT in a way that was very exciting.

Tom Ehrenfeld:
Can you just drill down a level? Were there specific tools or methods used?

Jeff Liker:
Well, for one thing, he put together a small team of people, say, roughly around eight or nine, and, say, four of them were people coming from the factory, particularly some from quality control. They knew the processes, they knew how the factory operated, the operating system, they knew the people. And they could then put themselves in the place of the users when they created this technology. What they were looking for were real problems where the technology can add value. One of the most obvious, and one of the most, I think, prevalent today being used, is in maintenance. There are fans for this big induction oven that had to have the same temperature throughout. And these are huge size of eight feet by 20 feet. And I guess they're convection ovens.

Anyway, the fans are blowing the stuff around and it has to be perfectly uniform or the parts will get ruined. If the fans break down, then the parts are ruined, and then they have to stop the machine and restart it, and it takes hours to set it up again. And they'll lose something like $50,000 worth of production. So, it's a huge deal. And it happens a number of times. Not every day, but maybe a half dozen times in a year. What they found was that by hooking up sensors to these motors and checking vibration, checking temperature automatically, then having that run through artificial intelligence, the computer could predict failure far earlier than the maintenance people realized there was failure.

In one case, where they had first demonstrated to the maintenance guys to win them over, the maintenance guys were convinced that the fans were fine. And they were asked, "Please open up the box and look at the fans," and the blades of the fans were almost disintegrated. And the sensors detected that way before the maintenance people. Now, when the maintenance people do their work, they actually have quite a bit more data than they normally would have, on how the fans failed and how the motors failed, or whatever it was. Still, they have to do problem- solving. One interesting thing was that they discovered that the maintenance people are not really good at problem-solving. They had taken problem solving courses years earlier, but hadn't been refreshed. So, they went back to teaching them root cause analysis, problem- solving.

And it was really the combination of high-quality problem solving, plus the information. And if you think about it, all that IoT is really doing is giving you information, and what matters is what you do with the information.

And there is a vision that Artificial Intelligence will process the data, and actually automatically adjust the equipment. But Raja, who runs this at DENSO, says that's going to be rare for a long time. So, basically, what you're doing is giving better, richer information to people, in this case, maintenance people. And then Raja was saying they're getting curves and distributions that they don't understand, so they have to train them on these distributions and how to interpret them. And they said the maintenance people were becoming like junior engineers.

The point was that, that was just a real life case where having the technology alone wouldn't do much good, but having the technology enabling smart engineers trained in problem-solving, working with maintenance people trained in problem-solving, troubleshooting machines, redesigning machines, everything we talk about in Lean thinking, that's what makes the IoT valuable.

The other interesting thing is, Raja had done a lot of benchmarking and he found in the cases where he was directed, "Go here," because they're a leader in Industry 4.0 and the Internet of things, he would find almost no examples of the technology being used in practice.

He'd find lots of people in a computer room that had really cool simulated examples. And in one case, they had 50 people doing this, and he had this small group, and he was intimidated. And this was an automotive customer, he visited the automotive customer. And he couldn't find a single application that was working. And then that auto company ended up benchmarking him, and the head of that group came and talked to him. And when he visited, he said, "I can't believe you have real working examples." So the difference between having the ... And he started to call what they had on the screen, IoT wallpaper. The difference between having the wallpaper that looks cool, that you presented to senior management, and real working examples that were getting real results, is often a big gap.

Tom Ehrenfeld:
Jim, what does this bring to mind for you?

Jim Morgan:
Interestingly enough, one of the things that comes to mind when Jeff was describing the IoT wallpaper, is some company's application of Lean. What I worry about, whether it's with technology or whether it's Lean, is getting caught up in implementation for its own sake, but where the technology becomes the goal. We want to be current, we want to be "high tech", and you chase that for its own sake. I think the same thing can be said about some companies' lean efforts. Some executive says, "What we need around here is a little bit more lean," and so they start up a group and they start to do lean, and so they chase the wrong rabbit, in my view. But, clearly, just like Lean, this technology has a tremendous potential.

The areas that I'm most familiar with, of course, are in the design and development side, where things like simulation, and Smart CAD, 3D printing, have made huge impacts to engineers' ability to develop robust products. But it doesn't replace the responsibility of the engineer. And that's another worry point that I have, is when we try to offload responsibility to the technology. In other words, "Well, the simulation said this," or, "My CAD error was that," as opposed to really understanding first principles of design and taking responsibility yourself.
So I think another worry point, in addition to the technology becoming the goal in and of itself, is letting the technology get in between you and the gemba. Whether it's in manufacturing, or whether it's in design, it's clear what the roles are, and what the strategy is for implementing either Lean or technology or whatever, that it's tied to a larger strategy.

Tom Ehrenfeld:
One thing that strikes me about Jeff's story with Raja, is the way technology seems to be functioning as a form of baka-yoke, or error proofing. That they're using this diagnostic capability to better understand the kind of trigger points that indicate the fans might be breaking down. And it sounds like incorporating digital technology into fundamental proven TPS practices is not only the safest route, but the, I guess, most expansive, and the place with the most potential.

What would you say are the key principles? Jeff, it's going back to people process purpose. Or Jim, what are the key principles of, say, LPPD that need to be front of mind when bringing in all this nifty, new IoT stuff?

Jim Morgan:
Yeah. I think, generally, and Jeff and I have talked about this before, I see technology's role as enabling people and process as opposed to vice versa. I think it's usually disruptive and doesn't bode well for companies when it's all about the technology, and people need to change to meet that. But on the other hand, I think that there's a clear interdependence, and this is often missed as well. When you do implement new technologies, whether it's in development or manufacturing, I think it's important to think about the larger system implications.

What are the skillsets that will be needed going forward? Jeff's example was fantastic, in terms of what the maintenance guys need to enhance in terms of their skill sets. Same thing in the engineering community. If you're doing more simulation, if you're doing more 3D printing, in order to move experimentation up in the process, which is a fundamental part of LPPD, as experiment to learn, this can really help enable that, and to do it more quickly and obviously more cheaply. But you have to make sure that you have the right skill sets, and you have to make sure that your process allows that.

Jeff Liker:
Yeah. This idea of enabling, another example from the DENSO plant was, actually, to enable the operators. And one of the systems was essentially doing X-bar R process control charts. And normally, you would do a process control chart, you have an upper limit and a lower limit, and you're plotting data points one by one. And then you're looking to see if there's a trend toward moving out of control, and then if there is, then you take action before it goes out of control. Because you get the closed loop feedback system with the operator, taking some action. And, in this case, they had the process control chart being created automatically through sensors, and then the computer system through the internet. And in real time, you're watching these points be plotted. And it was actually a continuous graph being created.

And we walked up to one operator, and Raja said, "Oh, look here. Just a few minutes ago, it was starting to move out of control, then the operator took action there, and now it's in control again." Simply the speed, in almost real time, it was within microseconds, of having the data being plotted for you. You don't have to collect it, make a note on a piece of paper. Not normally plants will do that occasionally, because it's time consuming. So, this was very efficiently giving you a picture that you could adjust in real time. Again, if the operator didn't have the skills or was not empowered to take action, then the technology would just be looking cool on the screen. Again, it was a combination of the way DENSO have used operators.

And it reminds me of when I was writing *The Toyota Way to Lean leadership.* I interviewed Mark Hogan, who was a GM executive when NUMMI was launching. And he became the Executive in Residence at NUMMI, and he learned the Toyota Production System there. I asked him a question, "What is the single most important part of The Toyota Way that was different from General Motors?" And he said, "For General Motors, if you were to have a machine and a person, and you were to draw a circle around the process, at General Motors, you would draw a circle around the machine. And then the person was outside the circle, tending the machine. At Toyota, you would draw a circle around the person and the machine was outside the circle, serving the person."

And that image is what I saw at DENSO, that the tool was enabling, thinking, and problem solving, rather than trying to replace it. And if the company doesn't already have that, which few companies do, they don't have ... And it's not just a matter of telling workers they're empowered or putting them into some sort of work group, but actually developing the skills and the sense of ownership. And if they don't have that, giving them more information faster is not going to be very valuable.

Tom Ehrenfeld:
One interesting analogy that Jim Womack made in a piece long ago was that, the characteristics of a system where it's like a finger touching the stove, you don't necessarily need everything to go back to the brain and think about that it's touching a hot stove, that there's built-in responses that immediately pull it away. That there's nerves that trigger the response at the point of touch. And it sounds like this is an element of a vibrant production system, is that you have built in the qualities of informed responsiveness at the point of action.

Jeff Liker:
And even getting in at DENSO to see how they do it. Using a lot of iPads, or phones, where you could get that hot-stove response on your phone. It buzzes. And then they were starting to get into wearables like watches. So, you're feeling and hearing that something's wrong, you look on the screen, you see immediately what the problem is, and then you can take immediate action. And you can't ignore it.

Tom Ehrenfeld:
It just feels like the ever-present challenge with this is, the greater the sophistication and power of these information systems, the greater the risk of ceding control to them as their role in the process increases. How do companies maintain this sense of individual ownership and so forth, as they are incorporating these new powerful production systems into the work they're doing?
Jeff Liker:

Yeah. I think the first thing is not, how do they maintain the power and control of the individual, but, did they ever create it to begin with? And in the initial system, then the answer is no. You haven't really done that part of Lean yet. That's in the culture piece of the assessment. You haven't gotten there yet.

Tom Ehrenfeld:
And you see that happening?

Jeff Liker:
Oh, all over the place. That's more common than actually adopting the real Toyota Way, the way it's intended.

Jim Morgan:
I was thinking about companies that get excited about organizational learning as part of their continuous improvement. And learning is so critical. Learning and knowledge reuse is so critical in product development. And right away, they want to talk about the tool, that is the technology, that will capture their lessons and will make it easy to just play it or build it into whatever.

And, typically, that's not what the roadblock is. The roadblocks are, much more often, cultural or leadership based, and whether they truly value learning or not. And I think the same thing can be true for people. Whether they're really a people-centric organization that's investing in their people and developing their people, all has to come before they can make the most of these technologies.

Jeff Liker:
If you view the technology's main goal is to eliminate the people, as fast as possible, that obviously don't want to invest in them. A lot of the companies are really fascinated by the idea of a lights-out factory, where there are no people. And that assumes the technology will somehow maintain itself.
And then there's the other level, and Toyota's gotten into this pretty heavily in the last five years or so, which is, people continuously improving, Kaizen-ing automated equipment. They want to make the automated equipment better. And then we have the IoT systems, including a user interface, Toyota would like to make that better.

And that's being made better by the people on the floor who are using it. They don't want to replace the people, they wanted to not only support the people, but they want the people to be continuously improving the technology. And that's why they sometimes will keep more people, say, in welding, in processes that other auto companies will automate, because they want a certain number of people there on the floor, scattered throughout the shop, who are sensing, reacting, problem-solving, and continuously improving.

Tom Ehrenfeld:
I'm struck by this technique, method called Karakuri. And will ask one of you guys to explain what that means, and how Toyota uses it, and how it relates to this topic we're discussing.

Jeff Liker:
Originally, it's best known to Japan as dolls. They're these dolls kids buy that have mechanical devices built, then you build the doll, and the doll, for example, can walk by itself. And what Toyota's been using it for is to mostly move materials without electricity, using gravity and weighing the mechanical devices.

There was one application where on one side of the aisle, there's a machine producing something and it goes to the bins, and then they have to get those bins across the aisle to another machine. And they built a Karakuri device, which would take the bin and move it up overhead, high enough so that you can walk under it, and then and it would come down to the next process, and it would be oriented in exactly the right way. They did need a small motor to go up, but other than that small monitor, everything was done through gravity and mechanics.

They have developed kits where they have all the components of Karakuri, like the little motors, and the mechanical devices, the springs and the little conveyors. And they have all these parts like Legos, and then the operator can put them together and create a system for a particular purpose. And the operators love it. It was two purposes from Toyota's point of view. One, the obvious one, is that it's green. We're not using electricity. But the less obvious one is it's really

a tool for people development, because it ends up encouraging very creative problem-solving. And when you have a constraint like that, you can't use electricity, you're forced to think more creatively and outside the box.

One other example of that was in a engine plant in Japan, where they were experimenting with ... Well, the goal was to bring senior workers back into the process. And the senior workers, usually, are not

assigned to the assembly line, because it takes a lot of lifting and moving. You're tough on your body. They wanted to see if they could create an engine assembly line that was so easy to use, that even a retired person who was 70 years old could do the jobs. The way they approached us, which was typical Toyota Way and almost nobody else would do this, is they hired back retirees, and they worked with engineers to design the line. And one of the constraints was, almost no electricity. So they had to create various kind of mechanisms to move stuff, and lift stuff, and push things out.

And automatically, they did all the testing with mechanical devices, and then some probes and electrical diagnostics equipment set up. But it was mostly using all your senses, and then things would move to you and from you. And it took almost no force and effort by the people. And then when they got that operating, they would bring senior people in, and their task was to do Kaizen. Then they started using it as a training ground for engineers. They brought engineers from all over the world who would spend a month and a half there, just working online and doing Kaizen, to learn how to do Kaizen.

Then when they got the process really simplified, it was very easy to automate parts of it using intelligent automation, that a lot of these things that are being done. But, mechanically, it could be done with electronics. And then they would introduce that to the high-speed engine lines. And they ended up with a simpler form, cheaper form of automation and use of technology. And they were then using that Karakuri line as a think tank, brainstorming opportunity for creativity, to then come up with ideas that could then be incorporated into the assembly line, with the ultimate goal of having intelligent, simple automation to assist the operator, and being able to use senior people who are retired, because they have a labor shortage in Japan.

Jim Morgan:

Yeah. I thought that engine plant was amazing when we visited there. Including the use of cobots. That's the first time I've seen such creative use of the small cobot technology to help enable people as opposed to robots to replace them.

Tom Ehrenfeld:
Jim, what are your takeaways about the meaning of Karakuri? It sounds like it's very important to frame any improvement work as an experiment and a learning opportunity, and, while respecting the power of any technology, to constantly keep it in perspective, and keep the focus on identifying the problem and understanding it better first, as a way of developing the appropriate response to it.

Jim Morgan:
I think, just as Jeff said, the genius is in putting those constraints on to challenge the understanding of the folks involved. If you recall, seems like a hundred years ago now, they talked about the initial visual management. A lot of companies wanted to, right away, go to sophisticated systems and spend a lot of money. And oftentimes their Japanese or Lean mentors would say, "No, we're going to start with some flags. We're going to have a red and green flag." One of the things I love about learning from Toyota and the Lean community is this genius that runs through challenging and developing people, even if it is around technologies.

And I think one of the people that we met while we were in Japan ... Jeff, I can't recall his name right now. Even as they brought technology into the plant, he insisted that the engineers and the operators understood the machinery. One of the things that really bothered him was this idea of, "Yeah, I know how to make a casting. I push this button and the casting comes out over there." And he was not

satisfied with that answer, and wanted to make sure that they really understand what it takes to create that. And again, that goes back to my point about the technology getting between you and the gemba.

Jeff Liker:
Yeah. It was Mr. Kawai who started off graduating from Toyota Technical High School. And then, for some reason, Taiichi Ohno saw potential in him and spent a lot of time teaching him. And he spent like 50 years with Toyota. He's still there. He's the first non-college-educated employee to be put on the Board of Directors of Toyota. And his main responsibility is education and training. How do you spread this deep knowledge across the world? And what Jim mentioned was that he saw a problem, which was that engineers and supervisors and operators, they didn't really know what was going on inside the equipment, that was all very automated.

One of the things he did, what he called "My Machine", where he said to the operator, "This is your machine. I want you to open it up, take off a lot of these barriers, so you can see inside and study everything that happens in hundreds of seconds, as the part gets turned into something that the customer wants, and identify waste in the equipment, and in the way the process was set up by the vendor." And then they would come up with Kaizen ideas to eliminate waste, and wasted motion, and wasted movement. It allowed them to shrink the machines down. Then the operators were then talking to the vendors and saying, "Why don't you redesign it this way?" And they would do a redesign.

The other collaborative [clever?] thing he did is he went to the supervisors of the operators, and he said that, "The operators are going to be studying the machine and coming up with ideas for improvement, and they're going to have a lot of questions for you. So I need you to be able to answer their questions." And he actually pretended that the supervisors, of course, already knew how the machines operated, recognizing they didn't, and they would have to really study hard to keep ahead of the operators.

Jim Morgan:
Awesome. That's a great story.

Jeff Liker:
There's one other thing I wanted to add, is that part of what's going on is really a different paradigm among the producers of the technology, mostly IT software people, and on the users of the technology, where people and companies trying to do jobs. And DENSO helped reduce this gap, for example, by having some people from the floor who then were really good at programming, and they learned how to program, so they could create that liaison role. But the other side of the story is that Raja had spent several years in Japan for DENSO, and when he looked at where Japan was in software development and compared it to Silicon Valley, there was no comparison. He said, "The U.S. is the center of the development of this technology. And the Japanese are way behind, including in DENSO."

He saw it as his mission to bring this technology from Silicon Valley and MIT and the United States, to DENSO, globally. And he did that in a way where he was integrating the existing strengths of DENSO with the technology. But, on the other hand, it was not the case that DENSO was automatically taking advantage of the technology sitting there in Japan. They were pretty primitive, and he saw a need to educate them and to become a salesman for the technology. And then he would work with vendors in the United States, even small vendors, like sometimes a university professor. There was one who had a neat idea for motion technology that would use cameras to observe people doing work, and then

through AI, what actually developed standard work in real time. And he saw tremendous potential for that, even though the professor knew nothing about TPS or standard work, But working with that professor, with people in DENSO who understood TPS and standard work, they created a really great system that does a lot of the manual stuff you would do to develop standard work automatically in real time. And that's become real important technology.

I don't want to talk negatively about the importance of the software technology side, because that's being developed at lightning speed, and the potential is tremendous when married with real applications and with a good thinking process.

Jim Morgan:
Yeah, I agree. I think that collaboration is absolutely key. And I also really want to emphasize what Jeff already said, and that's that all software is not created equal. And these are huge expenditures that the business is taking on, and due diligence, and having a piloting-focused implementation plan is crucial, because the wrong technology can bring down your whole operation.

Tom Ehrenfeld:
The final question is just, as companies assess the potential incorporation of these powerful tools, what are the principles to keep front of mind? What do they need to focus on proactively above all else? What are the key ideas?

Jeff Liker:
I would say, the purpose, what is the problem you're trying to solve, and then good problem- solving.

Jim Morgan:
Yeah. I agree. I think keeping the idea of what the problem is you're trying to solve is so important, whether it's a technology application, or a process application. I think collaboration, that we already pointed out, is crucial, so that you get the right people engaged. And then having an overall strategy that goes beyond just implementing the technology for its own sake.