The legacy of Dr. Shingo and his influence on TPS

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I recently gave a presentation at the annual Shingo Prize Conference on April 5th of 2006. As part of the conference I was honored and humbled to receive an induction as a life member into the Shingo Prize Manufacturing Academy for achievements and contributions in the field of manufacturing. Part of my presentation dealt with why Lean programs often tend to struggle and what words of advice I suspect that Dr. Shigeo Shingo and Mr. Taiichi Ohno might have for us today. The following text is a partial adaptation of my speaker's notes from the presentation and it also addresses some subsequent questions that I have been asked in the days following the conference.

There is little doubt that the Toyota Production System and its American derivative Lean Manufacturing is the most dominant improvement program of our time. Unlike other management fads that have come and gone TPS has been honed and steadily improved since the early 1950's in Japan for over fifty years. Sometime in the next year or so Toyota will achieve what was once unthinkable. The company will surpass GM as the largest seller of automobiles on the planet and achieve the "triple crown" of highest quality, highest profits, and highest volume. Not bad for a company that once almost went bankrupt and had to lay off one third of its work force many years ago.

However, as I look at the broad landscape I am often dismayed by why I see so few other Lean success stories. Of course there is always a bell curve in the population of companies attempting Lean. A few get it right, a few get it wrong, and there is a large mass in the center that seems to just stay average in terms of performance.

Over the years TPS has been studied and characterized by various parties. It has been discovered and mistakenly identified by many over the past 20 years as QC circles, a kanban system, kaizen events, and sometimes more broadly as a value stream. The cynic in me wonders at times "what on earth will someone call it next?" But the real issue to pursue is the following. Despite all the hoopla concerning Lean very few companies have been able to duplicate the success of TPS and deliver the same impact in terms of profits, quality, cost, and delivery lead-time improvement. Why is this? Certainly at some point the "5 Why" technique or something similar has to be applied to the situation and some rigorous analysis conducted regarding the root cause.

I frequently ask people their opinion on the matter. I tend to get the following types of comments and I suppose that they are all no doubt partly true. For example:

- Toyota took many years to build up its famous system and implement it across several sites. Most of us are in year five or less.
- The United States in particular tends to display a short term quarterly earnings emphasis in its business model and this makes the longer term sometimes harder to think about.

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- Most companies don't have a talented leader on the scale of a Taiichi Ohno in production nor do they have an expert aid like Dr. Shigeo Shingo either.
- And finally perhaps creating this type of new system in an existing company with an established culture is inherently difficult. There may be undiscovered invisible laws of change that we are up against?
- There are other likely reasons as well.

One aspect that I do not hear mentioned if ever is if the actual *way* we are going about implementing Lean itself. Everyone seems content with an overall plan of studying the current state at a high level, deriving a future state, applying tools, and making improvements. In theory I agree this should of course work. But as the old saying goes the "devil is in the details" and the details are where I suspect many companies are getting tripped up.

As my former manager Tom Harada from Toyota Corporation in Japan likes to point out the U.S. is very blessed with a wealth of tools and information that pertain to Lean Manufacturing. In fact there are more good books in English on the topic than in Japanese. On Amazon's site in both countries the current top selling book that relates to TPS is The Toyota Way, by an American author Jeff Liker. Also the Lean Enterprise Institute publishes a number of workbooks (of which I have authored one), and Productivity Press sells quite a few items as well. It seems we have a voracious appetite for this type of knowledge in the U.S.

However, Toyota did not have any of this material when they got started making improvements. Sometime I wonder if this wealth of knowledge and love of study on our part can get in our way of making improvements. We tend to be better in regards to *talking* about Lean than we are at actually *doing* Lean on the shop floor. In this respect I know for certain that both Mr. Taiichi Ohno and Mr. Shingo would have some very harsh words for us. Most problems are not fixed from a distance or just by discussing them. Problems are fixed at very short distances with observation, critical analysis, and hard work. Usually it is necessary to stick your head inside a machine, get your hands dirty and fix the problems from one foot away and not from an office or a training room.

I am increasingly concerned that the dominant Lean improvement method in companies I visit however is to study problems from the 10,000 foot view and not get into all the messy details of the process box. By this I refer to the general practice of drawing value stream maps and answering a specific set of questions about how you will drive improvements by adhering to takt time, implementing, flow, establishing supermarkets, leveling production, and achieving a state of pull instead of push scheduling.

There is nothing wrong with this method. It is all well intended and good practical advice. And I myself wrote a follow up workbook to this topic that provides even more detailed advice on how to attempt the level and pull part of the puzzle. So I am not idly casting stones here. But let's stop for a moment and consider the majority of what passes for Lean implementation today. From my vantage point it is mainly drawing high level value stream maps and answering the types of questions and implementing a few tools

corresponding to the related actions that I have mentioned above (i.e. flow, takt time, supermarkets, level, and pull). Of course there are other concepts as well such as 5S, Visual Control, Standardized Work, Kaizen, etc. But if you stop and look at the Lean questions asked in most workbooks and consider the tools and then compare it to Toyota's description of its own system I think you'll see some glaring holes. Specifically you should notice that the majority of what passes for Lean in most companies are the sub elements of the JIT pillar in Toyota (flow, takt time, pull, and level production). There is nothing wrong with any of the material but I am going to argue that we have a tremendous *imbalance* in where emphasis is placed in Lean and this is leading to a host of associated problems and difficulties.

Stop for a moment and ask yourself a question about the nature of your latest improvement efforts. I suspect that the majority of the effort has been related to the topics I mentioned above in JIT or perhaps standardized work or 5S. How many of you truly can state that most of your recent emphasis has been on the other mystery pillar of TPS Jidoka and its related concepts of 1) building in quality 100% of the time, 2) separating man from machine, and 3) stopping the process at any sign of an abnormality. My guess is that a relatively small percentage of your efforts go in this direction.

If you still don't believe me hop on-line for a moment and pull up a search engine such as Google. Type in "JIT" and see how many hits you get. Then type in "Jidoka" and see how many hits you get. My search obtained over 14 million related entries for the former and only 40,000 for the latter. This is a different of about 350 to 1. Not only was the quantity of information out of balance but the quality of the information available was quite different as well. Not nearly as much good material is available on the latter "Jidoka" pillar and Toyota considers this equal if not even more important that JIT.

I'm worried that there are implications if we continue down this unbalanced path. A great JIT system driven by value stream mapping, flow, level, and pull techniques will help your business. However it will mainly result in a shorter lead-time for delivery, less inventory, and higher on-time delivery. These are all sound gains. However, TPS aims for improvements in profits, quality, cost, productivity, and delivery lead-time and not just a subset of the latter items. JIT may surface problems in these other areas but it does not automatically solve them for you.

Cost and quality at least in manufacturing I can easily argue are heavily influenced by the pillar of Jidoka and the bedrock support in TPS of equipment reliability especially in non-assembly shops. This is not a simple digital "0" or "1" argument. Of course you need JIT and all the related components of TPS or you will not achieve all the gains possible. I continually observe however that most companies do not yet have a balanced "house" of improvements efforts underway in their lean programs. We tend to fall overly in love with mapping things at the high level and then working on "flow" and "pull" related issues. Quality, cost, and equipment availability is sometimes neglected.

So what would Mr. Ohno and Dr. Shingo this of all this if they were to observe us today? Frankly I suspect they would have some very harsh words for us. We would be chastised

that TPS is not just about drawing maps and implementing JIT. Nor is it just about standardized work or *any tool* for that matter. TPS aims to deliver quantitative improvements in a rigorous systematic manner and the emphasis should not be on the mere tools or techniques. The emphasis should be more on the rigor and discipline of applying the scientific method for thinking and then achieving the related goals of quality, cost, delivery and profit improvements in our respective operations.

Some people are shocked when I inform them that Toyota did not use value stream maps when TPS was getting started out in the 1950's and 1960's. This tool was developed much later in the course of TPS in relation to more specific problems about line configurations and material and information flow. It is more often associated with supplier work today than it is inside the four walls of Toyota. My manager at Toyota never drew one in his entire career which was spent in one of Mr. Ohno's machine shops. Value stream mapping is a good technique developed for some specific purposes and but it is not quite what people attempt to use it for today in most companies.

So what did Toyota do early on in its improvement journey to drive improvements? Well they did a lot and implementation was done more by trial and error than it was by a master plan or audit sheet. One of the more famous breakthroughs of course came when Mr. Ohno reorganized his machine shop factory layout from a process focus (lathes, mills, grinders, etc.) to one that emphasized product flow (connecting rod, cam shaft, crankshaft, etc.). This was significant breakthrough in terms of eliminating some forms of waste specifically inventory and shortening the lead-time for production inside his machine shop that produced engines and transmissions. However, he also made a painful related realization. Just moving machines around and improving the flow of material does not improve quality, reduce downtime, or reduce all the types of waste that affect cost. It other words improving flow is a *necessary* step but not a *sufficient* one in terms of making TPS work overall. More pointedly changing the flow simply does not improve the quality out of a machine tool, the uptime of the process, or the overall efficiency of the area.

In order to make improvements in these areas he realized that he needed to fix the individual **process boxes** in conjunction with the new flow layout. Quality and downtime problems however exist inside the machines and their related causes can not be discerned at the 10,000 foot level or by drawing high level maps. Mr. Ohno also realized early on that his new more efficient system was dependant upon processes with high availability and high capability, with highly skilled supervisors and operators. In other words it was a realization that he needed Jidoka, equipment reliability, and people with the capability to make improvements (i.e. Kaizen) happen on a daily basis. Simple flow improvements alone would not be sufficient in his machine shop.

Fortunately for Mr. Ohno along came Mr. Shigeo Shingo who was later accorded an honorary title in the U.S. from Utah State University and hence is known to most of us as Dr. Shingo. Unfortunately much of what has been written about Dr. Shingo over the years is either somewhat incorrect or exaggerated. He neither invented TPS, nor did he teach Mr. Ohno the concepts of TPS, nor surprisingly did he even achieve a ten minute

change over of dies inside Toyota as is often communicated. I have several of his older books in Japanese which have not been translated into English and he neither makes those claims either. (For those interested in what Dr. Shingo actually did do at Toyota I encourage you to read an interview I conducted with the person who was his handler in Toyota most of those years Mr. Isao Kato. Mr. Kato maintained a variety of notes from the visits and quite vivid recollections as well. A summarized version of the interview is available on the www.artoflean.com website.)

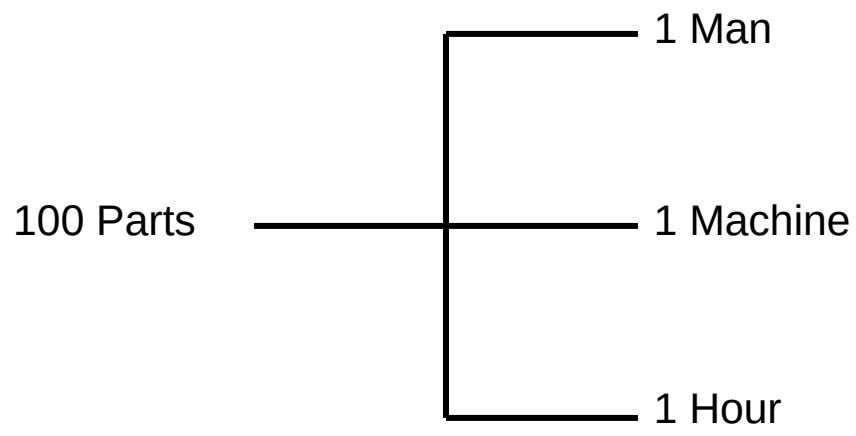
The truth however is that Dr. Shingo still did play a *profoundly important and much underemphasized* role in the history of TPS development. For approximately 20 years he taught a highly influential course in Toyota to manufacturing engineers and managers called the P-Course (the P stands for production). As much as anyone Dr. Shingo helped various Toyota personnel "Learn to See" at the most detailed process level. Over twenty years he taught his famous seminar a total of 79 times at Toyota and trained over 3,000 people in a combined class room and shop floor workshop format.

I use the term "Learning to See" by design. Today when we use the expression it refers to the title of the best selling LEI workbook authored by my friends John Shook and Mike Rother. It helps people see waste especially in the area of material and information flow at a high level by asking a series of insightful questions. The first seven questions relate to what is basically the JIT pillar of TPS while the eighth and much neglected final question asks what process improvements are needed to support flow. Most companies using the workbook put emphasis on the first seven questions and not as much on the eighth for some strange reason.

Oddly what Dr. Shingo essentially taught at Toyota for over twenty years was the very critical skill set of how to see problems and wastes within the details of the actual production process. Rather than emphasizing the JIT flow across processes in his teachings at Toyota he normally zeroed in on the basic production process itself. The point may sound trivial to some people since obviously you have to improve both material "flow" and process "stability" in order to move forward. However I think the distinction is very important. Mr. Ohno knew that flow concepts let along pull and level, etc. did not work well without equipment uptime, quality, and work efficiency. Flow production merely highlighted these problems but did not solve them. He needed help in directing his workforce to see the problems at the most minute detail level and to make required improvements. And for this task he turned to Dr. Shingo for help in training people to see and fix problems.

Starting in 1956 what Dr. Shingo taught at Toyota for period of twenty years was a series of specific industrial engineering concepts that he blended together. Dr. Shingo clearly states in his books that he was influenced by many before him such as Taylor, Gilbreth, Osborne, and many others. Dr. Shingo was a powerful force in Japan at the time helping transfer these works into Japanese and combining them into his own unique disciplined methodology of process improvement. Together with several other key people in Toyota this practice of study is what eventually leads to the beginnings of the modern day kaizen workshop.

A famous chart used in Dr. Shingo's P-course stipulates the following:



If one man and one machine in one hour can make 100 parts he would ask the class how can we make more parts? The normal answers were of course to 1) add people, 2) add machines, or 3) add more time. These were all unsatisfactory answers of course because they add cost to the system. A fourth answer was often given such as "work harder" which was also unsatisfactory since it could not be sustained. When the class was stumped he would inform them that the right way was the fifth way which is to improve the overall method by which the elements work together and produce more efficiently. Either the same combination would be used to make 120 parts per hour or if demand was not needed then instead it should strive to produce 100 parts in .8 hours. This dovetailed nicely with Mr. Ohno's experiments on his machining lines where he had already implemented separation of man from machine and achieved many instances of multi-process handling. In other words the participants of the P-Course learned they would have to take out what Mr. Ohno was calling the waste in the process. Later on of course he coined the seven specific types.

"In theory this of course sounds great" everyone normally replied. "But it is just not possible in our busy areas of production". Dr. Shingo would then visit the shop floor with the class and have the group look at a given area say a small assortment of production lathes for a short period of time. He would then ask them to state what they could see. Normally the answers were quite poor and high level. Dr. Shingo would then take them back to the class room and explain that they were now going to learn to see problems in a different way and then later repeat the exercise on another day.

In the mean time he then taught them the basic discipline of systematic process analysis for which he became so famous. In other words he showed them that manufacturing logically consisted of four primary elements 1) actual processing work, 2) conveyance work, 3) inspection work, and 4) delays. Only the process work of course added value. He would subdivide each of these items further. One part of the class would then look in detail at the four categories from above and draw out symbols that corresponded to the work flow. In addition he taught the engineers the basics of time study and how to identify and measure the length of time for the individual elements of a task.

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Additionally they had to learn the details of motion analysis and to map out the 17 symbols invented by Frank and Lillian Gilbreth that correspond to motion analysis. He taught other methods of looking at how the work was transformed step by step as well as basis operational availability analysis.

Once the methods were clear in their head everyone returned to the shop floor and began to re-study the process in great detail. What once seemed highly efficient now seemed utterly wasteful in comparison with their new sets of eye and quantitative analytic techniques. Where eight machines and four operators previously seemed efficient now there was suddenly a truer recognition of waste. With proper machine availability only six machines might be needed instead of eight. Where four operators were needed before now only two were required. Every aspect of the layout, tooling, motion, walk pattern, operation, and process were fit for more detailed study. During the workshop some of the items were fixed and improved on the fly and others were left as homework items to be resolved by the time Dr. Shingo returned in a couple of months.

Essentially according to Isao Kato who organized the classes and later taught the same style of course after Dr. Shingo retired, people learned how to see problems at a detailed level within the production process. The more you learned to look the more waste you would find. Even the value added part of the machine cycle would be challenged. Just because a machine tool has 40 seconds of cycle time once loaded did not mean it would escape analysis. For example they might ask why did it take so long to clamp the part? Why did it sit for 2 seconds idle? Why couldn't the cutting cycle speed be increased? Why did the operator have to wait a couple of seconds at the end of the cycle? Why was this particular type of tool used or cutting chip formed? Why did it take three seconds to unclamp? Everything was studied to see if it could be eliminated, combined, rearranged, or even just simplified for the sake of the operator and efficiency.

Furthermore the observations and experiments were not done in a haphazard fashion by feel or by mere opinion in the P-course. The most challenging part of the seminar was to learn the discipline and rigor of the scientific method for making improvements. There were no value stream maps, standardized work charts, or standard kaizen tools yet invented in those early days. Instead Dr. Shingo emphasized the basic scientific method for experiments. For example first observations were conducted. Then specific questions or hypothesis were formed. Then data was collected or further detailed study of the process conducted. Eventually a plan to try something was put into place in a structured manner. Then the results were checked to see their effect on the process. Finally the learning points were summarized. In essence it was the basic PDCA cycle for improvement but implemented six years before PDCA was widely introduced to Toyota in 1962 as part of a corporate wide TQC program.

The effect and application of all this highly structured learning within Toyota over time was significant to say the least. Problematic areas or inefficient processes were fixed over time and new ones were engineered to come in better the next time around instead. Quality issues, downtime, wait time, etc. were targeted for improvement and solved at lower levels of the company. Of course Mr. Ohno had already been driving these

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improvements for over ten years in areas where he was in charge but as he progressed upwards in the company he did not have time to train everyone personally. Also he had to work on larger problems in the company than just fixing individual production processes. Dr. Shingo was a timely ally.

79 times Dr. Shingo conducted his P-Course training sessions inside Toyota and over 3,000 employees were trained by the time he stopped in 1975. Would Toyota have made these improvements without Dr. Shingo? Perhaps. Industrial engineering techniques and as in the U.S. operations research courses were added to the curriculum of Japanese Universities after World War II and eventually they would have entered Toyota somehow. But without Dr. Shingo's training course it probably would have taken a lot longer and been more difficult along the way for Toyota.

So how does this old story from over thirty years ago affect today? Are there any lessons to be learned that can help us now? Yes. I think there are many. I will summarize them below in the short remaining time.

First it is vital to remember that Toyota once had quality problems, uptime problems, and wasteful work methods in production just like many companies still have today. Toyota did not just jump into flow and pull methods and have those items magically fix everything. Along the way Toyota learned to fix serious process stability problems as well. Normally quality and downtime problems are at the individual process level each with unique and distinct root causes. They often can not be surfaced just by drawing high level value stream maps or be analyzed from afar. Can you see the effect of metal cutting chips left on datum faces, the effect of poor coolant flow, or find wasted seconds in a machining cycle from far away? I don't think so. Learning to see and solving these problems requires the dedication to "get the facts" and study the production process at the one foot level and not the 10,000 foot level that is often true today.

Secondly, it is important to note that mapping the detailed problems at the process level and solving them was done long before the current overall style of mapping material and information flow was invented in TPS development. Can it be done in the reverse order? I suppose so. In theory at least you can use the high level to frame the detailed level and proceed to work where needed. In reality however I think it is a bit more complicated. Mapping at the high level by design almost always fails to expose the actual details at the process level that are inside the machine in many cases. Mapping the detailed level also takes more expertise in some areas (e.g. tooling). I had a recent client experience with seasoned Lean practitioners along these lines. The overall value stream looked all right at the high level but upon detailed observation of the processes hundreds of thousands of dollars of savings (i.e. waste) were identified that had been completely missed before. The point is debatable but often a microscope is a better tool than a macroscopic device depending upon the specific analysis task at hand.

Third it is insightful that the participants of the P-course seminars were process owners and not some sort of staff level change agent. Each person in attendance had specific production line responsibilities and thus was not merely a passive participant. They had

to actively participate and then apply the learning points of the workshop and not just sit through monotonous Lean training slides on PowerPoint. In Toyota the saying was developed, "If you can't take the shop floor to the workshop, then take the workshop to the shop floor".

Fourth the most lasting aspect of Dr. Shingo's involvement with Toyota was the disciplined application of the scientific method towards making improvements in manufacturing that he taught. Everything he taught in the P-course had a distinct bent towards applying the principles in a scientific manner. For example observations of the process were made. Problems, hypothesis, or questions were clearly generated. Specific data was measured and collected. Root cause insights of cause and effect were formed. Tests were quickly done one by one and the results verified. What did not work was discarded and what did work was implemented elsewhere as soon as possible.

Interestingly culture is used as a convenient way to explain away Toyota's success in manufacturing. "Improvement (Kaizen) is just part of their culture and not ours", the excuse goes. Strangely if you ask a Japanese Toyota veteran what the most important skill or discipline is however they will often comment that it is the western practice of scientific management and learning by doing in a structured fashion. Somehow the very thing in our culture that should work in our favor is what often holds us back in practice.

Unfortunately I have no quick or easy answers for people regarding the topic of how to make improvements. There are no shortcuts or magic tools to use. If there were we would have fixed all the problems in manufacturing by now and I would not be making this speech. I will however leave you with two suggestions.

For starters I would urge most practitioners attempting Lean to not just settle for relying upon the JIT pillar of the Toyota production system. Not because the pillar is not important – it clearly is. But because we typically already have enough inherent focus on it already in our existing efforts. It is merely one of many areas that we must learn to improve. And it is the other areas that I sadly find lacking.

In order to help correct this perceived imbalance I put together a list of fundamental improvement questions. The list is nothing more than an attempt to ask the logical questions embedded in a graphic that Toyota uses to describe its own production system. The list attempts to strike a balance across all the different part of TPS and stay out of the realm of just tools. The strength of Toyota is the ability to ask such hard questions and then to implement corrective actions which accomplish actual results. The hard work of course is answering these questions, determining the countermeasures, and getting on with the business of making improvements.

<u>Basic TPS questions:</u>

1. How do you make a profit and compete in your industry?
2. What exactly are your main problems in production to fix?
3. How will you achieve 100% on time delivery to the customer via JIT?

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4. How will you achieve 100% built in quality through Jidoka?
5. How will you thoroughly standardize work 100%?
6. How will you stabilize operational availability to 100% when needed?
7. How will you develop natural work team leaders?
8. How will you sustain and improve over time?

If we address each of these topics earnestly (and yes there are dozens of other questions beneath each one of these and others as well for the whole enterprise) I believe we can better begin to edge our way towards what many in Toyota call "True North". True North means perfectly satisfying the customers 100% of the time, with zero defects, on demand, and one by one in production. It represents a notion of the ideal state to always strive for step by step and not just fall into the trap of using tools for show purposes.

Secondly, I want you put into practice what Dr. Shingo helped teach Toyota over fifty years ago. At its core TPS is really about making improvements in a structured scientific manner. It is not about just applying tools that have interesting sounding names like kanban and heijunka for example. Whether you are working at the JIT level across processes or within a given process box to improve quality, uptime, or efficiency you must follow a disciplined method of improvement. Just emphasizing tools is like just buying new golf clubs or woodworking tools and hoping for better results. The new tools may make you feel better for a while but they are not likely to improve your fundamental skill level or average performance over the long run.

In one of his books in Japanese Dr. Shingo states the following. "If you want to understand TPS then you must first understand the scientific method and thinking behind the system". This is still good advice for most companies today and something I often find totally lacking in most improvement efforts.

I hope that you keep both of these closing points in mind as you go forward with Lean implementation. If you do this then you should be well on your way to getting past just the current situation in most companies and begin to approach the more critical and fundamental aspects of the actual Toyota Production System. Thank you for your time and attention.

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