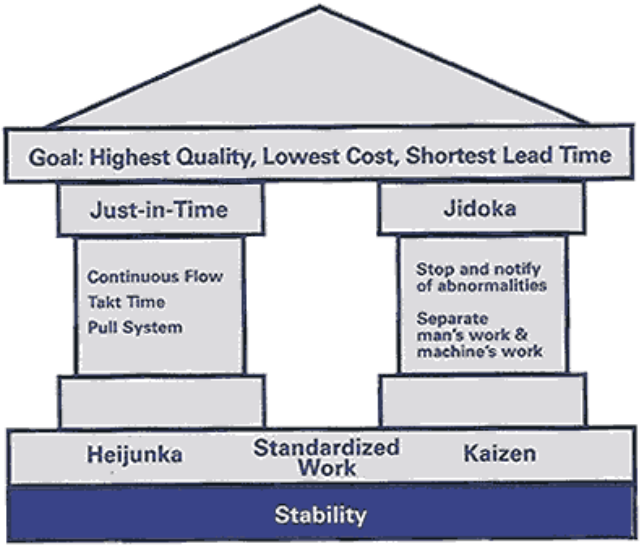
Eight Basic Questions of TPS

In previous articles and newsletters I have commented on my observation that many companies struggle to achieve significant results by applying standard Lean methods. No doubt this conversion to Lean is a long term effort and not an overnight change program. Different reasons exist as to why so many programs struggle despite what are often large and well intended efforts on the part of the company. Inadequate leadership, resources, experience, and competing priorities are all factors cited by practitioners I speak with regarding their primary obstacles. Interestingly one topic which does not get mentioned however is the topic of implementation methodology. Indeed it appears that everyone is satisfied with and committed to their current value stream mapping approach or some close derivative. But could practitioners be missing something due to the way most are attempting to implement lean? After all Toyota did not start with this approach on its journey as the tool was only developed many years later. For the sake of discussion I decided to query several current and former Toyota production experts on this topic. Below I will summarize the gist of the conversations. Some of their responses may surprise you.

TPS Framework

First for the sake of clarity let's review the main elements of the Toyota Production System from Toyota's point of view. For just over 30 years a version of the following graphic has been used to depict the Toyota system in internal training manuals in various forms. The first version is generally attributed to Mr. Fujio Cho in early 1970's who later rose to become President and CEO of the company. Several different alternative versions have been made over the years but generally speaking the graphic looks something like the following item on the next page.



Toyota Production System "House"

There are multiple parts to the TPS house as it is commonly referred to in many circles. Starting at the top there is the all important reference to the operational goals of the system; achieving the highest possible quality, with the lowest possible cost, with the shortest lead-time. Pursuit of profit via cost reduction is stressed as well. If you can accomplish all of these goals your company should be well on the way to satisfying its customers as well as stakeholder needs. Second there are the "two pillars" of the system Just-in-Time, and Jidoka. The former refers to the more famous elements of flow, takt time, and pull production for which the system is primarily known. In fact throughout the 1980's and much of the 1990's the system was often called the JIT system or kanban system in many publications.

The latter pillar is the more neglected and mysterious of the two pillars. Even the name "Jidoka" is hard to fathom or to translate properly. The reason why is that the name is made up even in Japanese. The word is a play on the Japanese term for automation (spelled Jidoka in English as well). Except in the Toyota training manuals one of the Chinese characters is altered to have a special stroke called a radical that stands for human placed next to it. The explanation given is that TPS specifically does not want machines that run continuously. Instead it strives for machines that will have a degree of human like intelligence and ones that will stop automatically at the first sign of any abnormality. The term also stressed the importance of separating man from machine in order to enable multi-process handling. Unfortunately due to the obscurity of the term and its counterintuitive wisdom most people breeze over this concept rather than explore it in detail. For example search "JIT" then look up "Jidoka" on Google or any search engine. I came up with over 3 million hits for the former but only 26,000 instances for the latter depending upon how exact you enter the term. This statistic is highly unfortunate and telling in an of itself as not only is the concept of Jidoka older than JIT by several decades but most Toyota production executives consider it to be more the important and more difficult of the two pillars.

There are other parts to the house as well. On the bottom of the chart different elements are depicted depending upon which person or group in Toyota you speak with as the items are not all mutually exclusive. Generally however you will find a mix of things like level production (Heijunka) along with the all important concepts of standardized work, and kaizen. If you are speaking to a person from an equipment intensive shop like casting, forging, or machining for example they'll often include an additional stability plank as well for the underlying foundation. This reflects the additional emphasis these shops have to place upon maintaining equipment uptime and process stability to support the rest of the system. Additionally the TPS reference manuals always include a special section on the importance of respecting people and the large role the employee plays in making the system work. Indeed, without people at the center of the system the whole improvement effort not only fails but it is also fairly pointless as well.

Most people are probably quite familiar with this simple depiction of the Toyota production system I briefly described as it has been around for a couple of decades now. Usually we glance right at the pillar chart and then go right on past it without a second thought. But let's stop and actually check just how well the typical Lean implementation effort stacks up against this overall description of the Toyota system.

Lean Implementation Pattern

The primary lean implementation pattern in most companies today centers around the concept of waste elimination in a value stream. The goal is to pursue a notion of perfect flow that stretches from suppliers to customers without interruption. When queried about their methodologies most practitioners reply that they rely upon the techniques of value stream mapping and kaizen events. The former process is used to frame the kaizen events needed to improve value by emphasize the eight questions listed in the workbook *Learning to See*. For example:

1. What is the customer takt time?
2. Where can you use continuous flow processing?
3. What is the pacemaker production process that you will schedule?
4. Where will you need to introduce supermarket pull systems?
5. Will you build to a finished goods supermarket or to customer order?
6. How will you level the production mix at the pacemaker?
7. What increment of work will you release and take away?
8. What process improvements are needed for the value stream to flow as your future state design specifies?

These are good insightful questions and there is nothing wrong with any of them per se. (So that you don't mistakenly assume I am idly throwing stones here please note that I wrote a follow up workbook entitled *Creating Level Pull* that delves even further into several of the above questions.) However if value stream mapping and these types of questions are the way in which you approach Lean implementation I also urge some caution. Take a good hard look at the above questions (or the ones in my workbook) for a moment and reflect on the contents. Then go back if needed and compare it to the description of the TPS house for a moment or two. See anything different? At first

glance there might not be anything obvious. However the more you look into the contents of the questions the more I hope it becomes clear that the list predominantly centers upon the JIT pillar of the TPS system. In other words takt time, flow, pull, markets, leveling, etc. are the primary thrust of the questions. Only the eighth and final question from above begins to edge away from the JIT emphasis by asking an open ended question about necessary process improvements to support flow.

Unfortunately however, there is nothing about Jidoka (build in quality or separation of man and machine), metrics, people, standardized work, kaizen, or stability to guide the improvement journey. Of course you can make the case that all these items are all lumped in the eighth and final question but that is really my point. Will anyone be successful in implementing all of TPS if most of their efforts are guided by seven questions that relate to one pillar of TPS while the entire rest of the system is put under just one open ended question that provides no specific guidance? Personally I suspect not and this at least partially why so many lean efforts seem to center so much on "flow" and not the rest of the elements in TPS. Follow up workbooks including my own have only exacerbated the situation by further delving deeper into JIT pillar on related topics while ignoring the rest of the production system.

Out of curiosity I asked several Japanese Toyota colleagues familiar with the situation about this topic and they were not very surprised about the whole relative imbalance in Lean implementation for a couple of reasons. For starters most of what is visible and simple about TPS is what is contained in the JIT pillar. It was no accident that various people called TPS the kanban system for over a decade. The other elements are just too hard to see or understand (i.e. Jidoka). Second much of the information pertaining to TPS has been disseminated by a department in Toyota called the Operations Management Consulting Division or the Toyota Supplier Support Center in the case of the U.S. As the title of the latter implies this group often works with Toyota suppliers and this involves a lot of materials and logistical elements by nature. Third the value stream mapping method outlined in *Learning to See* is actually a derivative of what is formally called Material and Information Flow Analysis in Toyota. In other words the tool is doing exactly what it is suppose to do – help you focus in on mainly the JIT pillar of the production system and material flow issues. The problem is not with the tool but with the way Lean programs typically use it to frame everything in production. It was simply never really intended to do all this extra work in the first place.

Finally Toyota itself is pretty cagey about the whole matter. The company is more than willing to show people the superficial parts of the system such as kanban, standardized work, and 5S for example. But there are also some real techniques and engineering expertise behind that mysterious pillar of Jidoka and the incredibly high levels of uptime they achieve in machine intensive shops to support the system that just don't get divulged. And I don't expect Toyota to unveil any of that content to us any time soon. Why give away the real secrets of the temple so to speak?

Implications

At this stage you might be thinking what's the big deal? After all I can put anything on a value stream map and target it as part of my future state so no problem! Well perhaps in

some instances but in most cases you are in for some difficulty. For starters if you still rely upon the main questions of *Learning to See* to design the entire future state of your operations you'll accidentally bypass many of the vital elements of the overall production system. This probably explains why I get lots of phone calls and e-mails about how to install a Heijunka box but upon visiting a plant the first thing I normally worrying about from a Toyota point of view is the low quality level and poor equipment availability. It is pretty hard to achieve JIT let alone basic production leveling with lots of scrap and downtime. Secondly even if you identify the problems pertaining to Jidoka and Stability for example on the value stream map I'm not sure the tools exist to solve these problems in most companies. If a Google search is a rough indicator then you are about 120 times more likely to find tools or information on JIT than Jidoka. And as I indicated earlier I don't think Toyota is going to divulge much of this material either. Almost all the deep knowledge pertaining to tooling, equipment specifications, process planning, and equipment vendors is still maintained primarily by Toyota experts in Japan so this information will remain invisible for quite a while.

Does it actually matter however if Lean is mainly a JIT emphasis in the U.S. while it is relatively speaking less of an overall emphasis in TPS for Toyota? The answer I think is yes for several reasons. Building a house with all the emphasis on just on one support pillar is inherently a risky design idea. Just like an actual house it doesn't take much to bring a system crashing down when it is supported primarily by only one pillar. Even if the house design analogy doesn't alarm you let's think about business metrics for one second. What does a typical JIT system do for the business? It primarily reduces inventory and shortens the lead-time from order to delivery. To a lesser extent however it affects the other two primary aims of TPS cost and quality by surfacing problems that then still have to then be resolved somehow. Quality is much more affected by Jidoka than JIT by definition. Indeed the internal Toyota reference manuals are quite emphatic about this point – good incoming quality is a prerequisite for JIT not an automatic outcome. And I'd argue that in most companies manufacturing cost is affected more by quality, or more precisely poor quality, and low equipment availability than inventory. Remember with JIT we are chiefly talking about inventory on the asset side of the balance sheet and not the cost of goods on the income statement side. In order to reduce material cost you generally have to negotiate a lower purchase price or somehow reduce the total cost of ownership and not just reduce inventory levels.

So in short I think the whole point is not all that pedantic or trivial when you stop and think about it. The frame through which we look at production directly affects what actions we take. The actions we take in turn affect the type of results we will obtain. So our framework for thinking about Lean has to be altered if it is to approach the level of actual TPS performance. The point is debatable of course but I believe that it is at least one of main the reasons companies struggle with Lean implementation and fail to obtain TPS size results. The focus is either too narrow, is just on tools and not outcomes, or it is even on the wrong topics in some cases. Realistically speaking the large JIT emphasis in the U.S. will not disappear for numerous reasons. I would however be a little more relieved if we could put more emphasis on the other parts of the TPS house to balance the load.

For the sake of discussion on this topic I traded thoughts with several current and former colleagues of Toyota Motor Corporation. I asked in their minds what are the fundamental questions of TPS. As a starting point I asked them what was the goal of the system and what where the main questions behind its key elements. My intent was simply to come up with a more complete check list of questions to ask regarding TPS implementation. Interestingly no such list formally exists in Toyota and everyone seemed to have their own opinion depending upon their background. None the less I did manage to come up with a list that was in the end a sort of compromise position on all their responses. The list essentially reflects the basic TPS framework since it no doubt was embedded in the back of everyone's mind.

Eight Basic Questions of TPS

1. How will you obtain a profit and satisfy the customer?
2. What exactly is the main problem (or set of problems) in production?
3. How will you achieve Jidoka (build in quality) at each process?
4. How will you enable Just-in-Time production and delivery?
5. How will you standardize work practices?
6. How will you stabilize and improve equipment availability?
7. How will you develop people and work team leaders?
8. How will you sustain and improve efforts over time?

Please note these are very general questions by nature and not specific "how to" points that you can put in a simple hand book. You would have to write a book on each question as the answers would take that many pages to draft and the specific details would still depend upon the exact nature of the production environment. Personally I think that is why it is so difficult to replicate TPS as it is not a simple matter of just training and transferring basic knowledge related to mere tools. Unfortunately, there is real skill and practical experience involved in implementing TPS in the correct manner. The transformation task requires changes in patterns of thinking, but also in behaviors, and the resulting actions. Even more importantly it requires deep capability in execution in each of these following questions. As you will see it is almost impossible to assign a prescriptive sequence or priority in terms of the questions I generated. Each question is a large topic onto itself and relates back to the others. The goal was not to try and answer the questions in this article – I'll leave that tall task for another day. Instead I'll briefly run through the list and comment on the topics that were discussed.

1. **How will you obtain a profit and satisfy the customer?**

This fundamental question is actually the fountainhead of TPS. Mistakenly many people tend to state that the goal of lean is "flow" or "pull" or some other concept. This is greatly mistaken however. The goal of lean is to deliver the highest possible quality, at the lowest possible cost, with the shortest lead-time possible. The end result of this should be enhanced customer satisfaction and improved profitability. Concepts such as

flow production, standardization, pull production, etc. are critical underpinnings of the system. However, they are merely the means to achieving an end state and not the goal of the system itself. This distinction is subtle but critical. Properly focusing on the aims of the system and not just the means is of critical importance if you wish to achieve maximum benefit and not just reduction of inventory.

2. **What is the main problem (or set of problems) in production?**

Rather than starting with a prescriptive approach in TPS (e.g. establish takt time, implement kanban, standardize work, improve flow) it is important to establish *what exactly is the problem*. Unfortunately most lean literature pushes us in the other direction and attempts to dictate what actions should be undertaken. The proper step is to first practice sound problem solving and frame your exact situation with the relevant facts and details. For example, in manufacturing is the problem delivery? Is it quality? Is it productivity? How much? Exactly which problem you should tackle first and how is of critical importance and each problem needs it own set of action items to address the root causes. In each case the proper path first depends upon what Toyota calls "grasping the current state" with facts and details in order to frame the situation and then to learn the required action steps. Fundamentally this process is what the eight questions in *Learning to See* aspired to accomplish but in hindsight the questions focused in on just a subset of issues mainly that of lead-time and material flow. Despite the well written advice in the workbook readers tend to jump to the solutions or tools proposed rather than frame and solve their own unique problems. Always remember the correct step in TPS is to define first what exactly is the real problem and then move on from there with good problem solving technique.

3. **How will you achieve Jidoka (build in quality)?**

One of the must important yet least understood elements of TPS is the concept of Jidoka. If ever there was a "secret" or element to system it is certainly this elusive pillar. Essentially the concept has two meanings. First the concept relates to the notion of building in quality rather than inspecting it in at a later stage of the production process. Second it implies that the machine should automatically stop at the sign of any abnormality. This latter meaning is important for establishing separation of man and machine and enabling multi process handling.

The term is difficult to fathom since it is essentially a made up word in Japanese to describe a fundamental concept unique to Toyota. The simplest case of Jidoka is merely an operator stopping the line at the first sign of a defect. This ideal however is actually not all that simple when you realize that a highly trained and proficient supervisor must respond and resolve the issue quickly for the system to work. In other medium difficulty cases a low tech error proofing device might be utilized to catch problems. In the more complex cases however Jidoka involves equipment design, advanced sensors, and materials processing technology. Each of the equipment intensive production shops in Toyota (casting, forging, machining, stamping, body weld, paint, plastics, etc.) have their own different techniques for accomplishing some form of Jidoka. One size does not fit all it turns out and hence the difficulty in codifying this knowledge.

The “answers” for Toyota at least are mainly locked up inside their equipment specifications and detailed methods for production process design. When I worked for Toyota in Japan the specification for my division were encoded in a twenty volume set of documents know internally as TMS and MTS for example. TMS stand for Toyota Manufacturing Standards, and MTS stood for the more specific Machine Tool Standards relevant for our production processes. Other volumes existed in other production departments as well. These volumes represent a forty year learning history of Toyota’s production engineering and technology advantage. Trust me when I say these are not items you can simply learned or implemented in a kaizen events. In Toyota’s case they represent decades of process technology research and improvement.

4. **How will you achieve JIT production and delivery?**

This pillar is without a doubt the most famous part of TPS. JIT and its associated elements such as flow, takt time, pull, and level production are what most people often mistakenly assume area the entire system. However as important as the elements of TPS are it is vital to remember that they only comprise part of the system and not the whole. Focusing on this pillar will of course help shorten lead-times, reduce inventory, improve on-time delivery, and highlight many other problems. The basic questions outlined in many improvement workbooks such as *Learning to See* and *Creating Level Pull* and others are intended to help drive improvements in JIT style production in particular. From my vantage point lean practitioners have more than enough information in this area but suffer from a lack of tools and knowledge in the other areas in this list.

5. **How will you standardize work practices?**

The most famous tool in TPS may indeed be the standardized work chart. It is also among the most misunderstood. Many people mistakenly assume it is the only document Toyota uses on production to document jobs, train people, reduce variation, and drive productivity improvements. The truth however is far more complex. Actual training in TPS is first done using an older method called job instruction technique and relies upon a document called the job breakdown sheet. Toyota relied upon this methodology long before true standardized work was formalized and instituted in production. Additionally the most common documents in equipment intensive shops are the more mundane but equally important variety called work standards. These document jobs outline vital tasks such as how to change tools, gauge parts, conduct quality checks, troubleshoot, clean equipment, and many other vital tasks. Groups such as maintenance have extensive forms of work standards as well that help organize and document their job processes. All of these however are not pure standardized work charts since the do not contain the three elements of standardized work explained later. There are however equally critical.

True standardized work charts are used in TPS when the actual work being performed meets several important preconditions. First the work must be human centric and not machine centric. Second it must be repetitive in nature and consist of similar work content. Third the process has to be relatively free of quality or downtime problems for pure standardized work to function. If not these problems must be address first for success to be achieved. Once in place however the three primary elements composing standardized work (i.e. takt time, work sequence, and standard work in process) can be

established and implemented. Once accomplished however the end result should be a more effective and productive process that can vary with demand levels.

Other critical documents exist in TPS however beyond the ones I have mentioned. A variety of forms and techniques exist in parallel to standardized work in to help analyze and improve jobs over time. Key examples include time studies, motion analysis, work element analysis sheets, and a variety of check lists. Standardizing work and achieving true standardized work requires more effort and difficulty than most people realize.

6. **How will you stabilize and improve equipment availability?**

As mentioned in several instances above not much works in TPS unless the process is fairly stable and predictable. Without a reliable process for example it is extremely difficult to achieve either JIT or pure standardized work for example. Many companies would be better served by spending some time on the un-stable processes and fixing basic problems in production. These basic process problems usually relate to quality, downtime, and other vital areas.

Often the basic sources of equipment instability are in the four areas of man, machine, material, and methods. Arguably what Toyota did for much of the 1950's and 60's was to improve process stability and capability in many primary manufacturing shops. Elements of both TQC and TPM were adapted and employed as needed to help bring equipment uptime and quality to levels required to satisfy the customer both downstream and outside of the factory. Many companies attempt to skip this step or fail to execute it in conjunction with JIT style improvements. The result is a pull system that does not work as well as it could and of course the inherent quality and downtime problems.

7. **How will you develop people and work team leaders?**

Despite all the attention lavished upon the tools of TPS the key ingredients behind the system work are the people and the work team leaders. Much of TPS boils down to daily execution and the ability to conduct small daily improvements over time. Toyota has proven that its unique production system can be exported overseas with success in many countries. The essence of TPS and the Toyota Way lie in the fundamentals of employee and leadership development. There is a saying in Toyota that translates "making things is about making people". At every level of the company the chief tasks are standardized and taught to new employees in a structured on the job (OJT) fashion. Once capable of operating a process (office based or production) the employee is challenged to analyze the process in an eternal search for improvement. Each section of the company has its own set of analytical tools developed over the years to help drive performance improvement. The stereotypical methods listed above are merely some of the more common items used in production and the tip of the iceberg in many respects. The common elements in Toyota's development cycle is that of coaching standardization, executing basic problem solving with rigorous analysis, and requiring improvement actions over time.

8. **How will you sustain and improve over time?**

The DNA of Toyota has been described and depicted in different ways by different authors. If you ask the average Toyota manager however about their management culture and the essence of the Toyota Way they will likely emphasize the rigor of basic Plan-Do-Check-Act (PDCA) management. Indeed much of TPS itself arose from simple the application of constantly repeating the PDCA cycle time and time again in order to drive improvements. QC circles, problems solving, A3 thinking, and kaizen are all linked to this simple method of PDCA.

Taiichi Ohno was fond of commenting that TPS was very much like the scientific method of investigation. Continuously he and his followers would observe the plant floor for hours upon end and learn to see various problems in production. The root cause of the problem was discussed and various countermeasures were attempted. If the countermeasure was confirmed as effective it was kept and maintained as the new standard. Then the cycle would start all over again with a new round of observations on the shop floor. The discipline and rigor of executing this cycle is what makes Toyota unique and not just the tools commonly associated with the system.

Conclusion

In conclusion I have tried to summarize a more balance view of the basic questions that drive Toyota's production system on a daily basis. There is no one secret topic or recipe that can enable the system to work. All the elements describe above plus many others are required for the system to function as intended. These should however help as a more balanced starting point.

Keep in mind this list is not a holy grail for improvement by any means. The questions are essentially a derivative of the pillar chart that Toyota depicted over 30 years ago to visually represent its production system. I do believe however that this list of questions is more balanced and closer to the totality of TPS in production today than the eight questions expressed in *Learning to See* or my own workbook *Creating Level Pull* for that matter.

Try using this list of questions in conjunction with your next process improvement activity. The task you face may not be any easier however I promise your investigation and analysis points will both be more thorough and complete. You'll also be less likely to overlook opportunities and more likely to hone in on solutions that will generate impact and sustain in the long run. Good luck!