BASIC STABILITY SUMMARY DOCUMENT

I. Introduction

This document summarizes the main contents from the Achieving Basic Stability workshop that I often use in training in conjunction with the Lean Enterprise Institute (LEI) and other parties into a simpler text document for distribution. The following points and questions are adapted from my workshop and work experiences with Toyota Motor Corporation in Japan. This summary document is not intended to be a complete and exhaustive guide covering all aspects of the workshop. Instead this document is intended as a high level summary tool emphasizing many shop floor basics that are often broken or under-analyzed for improvement potential. For simplicity this document will be broken down into the four areas of emphasis man, machine, material, and method.

The premise behind this topic is the simple notion that you need some level of "Stability" in order to be successful at many aspects of lean manufacturing. Imagine if there are poorly trained workers, frequent equipment stoppages, significant amounts of rework, missing materials, and non standardized methods in production – what would happen? It would be hard to produce good parts on a daily basis and if these problems are bad enough it will become impossible to flow production to the customer, implement pull, or produce to a steady takt time. In these cases I recommend that it is often better to put aside the "sexy" items in lean such as kanban, standardized work, or value stream maps, and instead work on the more fundament items that I will describe in this document. All of these concepts I will describe were used by Toyota on its improvement journey and they can help you as well.

II. Man Related

A. The Influence of TWI on Toyota

There is no one exact start date for the origins of the Toyota Production System. The Jidoka concept reaches as far back as 1902 on Sakichi Toyoda's Looms. Kiichiro Toyoda coined the phrase Just-in-Time in 1937. The famous Taiichi Ohno started experimenting with his notion of flow and man machine combinations in the late 1940's. Another important series of events occurred in the early 1950's that provided some key ingredients. In the spring of 1951 Toyota began implementing a series of management training programs known as the Training Within Industry Programs or TWI for short. These programs were introduced to Japan during the occupation period after World War II. Several companies in the Aichi prefecture region of Japan adopted the programs and one of those companies introduced the material to Toyota.

The TWI material was compiled by leading companies, trainers, and union representatives in the United States during the period leading up to WWII. The goal of the program was to help companies improve the capabilities of supervisors and leaders in production. With much of the labor force sent off to the war a sudden influx of new workers had to cope with the surging war production requirements. The TWI material is

based upon the notion of helping leaders in production make improvements by providing them with fundamental skills for instructing, leading, and making improvements in their work areas. The emphasis was on producing things safely, correctly, quickly conscientiously, and more easily. Several authors in recent years have called the TWI material the "missing secret ingredient in lean" or the "roots of lean manufacturing". I personally believe these claims to be somewhat overstated but I do agree that the TWI material which continues to be used in Toyota today had a significant impact on the production supervisor development program as well as the kaizen training courses developed in Toyota. Today the TWI material is not very widely used in Toyota. However if a company wants to improve its success in implementation of TPS/Lean I often advise them that improving supervisor skill set is one area that is always highly beneficial.

B. The 5 roles of a supervisor versus lean specialist

The TWI material specifically notes five requirements for a leader in manufacturing. Those five requirements are 1) Knowledge of work, 2) Knowledge of responsibility, 3) Skill in instruction, 4) Skill in leading teams, and 5) Skill in making improvements. Special distinction is place on the notion that the latter three items require skill to obtain proficiency and it is the duty of management to foster these capabilities in production leaders.

Normally companies implementing lean programs today employ a group of specialists called change agents or some other term to help drive improvements. While there is certainly a role for specialist in any endeavor I believe that companies would be better off if they would first developing the skill sets of natural work team leaders in production. Toyota Motor Corporation does employ around 50 or specialists to advise companies regarding TPS implementation however this group is relatively small when you consider there are over 200,000 employees in the company. Also this group of specialists was created around 1969 or about the time that TPS was already formulated and working well within the company. If companies was to make improvements in production and have the changes stick I strongly recommend that they spend more time developing the above mentioned skill set of supervisors in addition to that of the lean specialist.

C. The 3J courses

In the TWI material a specific set of training classes exists in order to foster supervisor development in the three critical areas outlined above. The three courses were collectively known as the "3J" courses; Job Instruction, Job Methods, and Job Relations. Each course was a 10 hour training course that was broken down into five sessions each lasting two hours each in duration. Practical skills were demonstrated and practiced during the training sessions under the guidance of a master instructor. After completion of the courses the trainees were given instruction to implement the methods in there areas. Records from the Department of Defense War Manpower Commission in charge of the program show that significant gains in quality, scrap, productivity, safety, morale and other key areas were made in the companies that rolled out the program. In total over 2.7

million people were trained in these methods in the U.S. alone. Unfortunately despite their success the programs were virtually abandoned by the U.S. after the end of the war.

To this date however, the 3J courses essentially are still practiced in Toyota Motor Corporation in Japan with some modification nearly fifty years later as part of the supervisor development program in the company. The course content has changed slightly in some cases but not much when compared to the originals. Each of the courses has had a shaping influence on supervisor training and development.

Job Instruction (JI)

JI is a course that provides supervisors and work team leaders with a specific methodology and skill set in instructing jobs to new employees. Space does not allow for the method to be described here but the fundamental practice of creating a skill matrix, cross training employees, and break jobs down into major steps, key points, and the reasons why we do it this way are integral parts of the method. Attendees of the course practice instructing using a time proven method called the basic teaching pattern and are critiqued by a master instructor. Significantly Toyota used JI in production long before Standardized Work was invented and still used it as their training methodology today.

Job Methods (JM)

JM is a simple six step method for breaking down jobs into small steps and analyzing the contents for improvement. Specifically the contents are considered using the 5W 1H method (Who, What, When, Where, Why, and How) and checked to see if the step is really needed or not. The improvement principle of ECRS (Eliminate, Combine, Rearrange, or Simplify) is also used as well to teach a line of inquiry. As I mentioned earlier this course in particular has been called the "roots of lean" in many respects as it resembles a type of kaizen activity when put into action on the shop floor. I checked with the retired manager of Training and Development at Toyota in Japan and he agrees that the JM course had an influence on the kaizen methodology at Toyota. However the JM course was deemed too superficial by executives such as Taiichi Oho after several years of use. Specifically it contains no TPS elements such flow, takt time, kanban, etc. The JM course was modified several times by Toyota over the years and eventually replace with two courses known today as Standardized Work and Kaizen.

Job Relations (JR)

JR is a practical method based upon the concept that results are obtained through people or the work team. In order to achieve best results all people must be treated with respect and as an individual. The basic foundation of good JR means 1) letting people know how they are doing, 2) giving credit where credit is due, 3) letting people know in advance about changes that will affect them, and 4) making the best use of each persons ability.

Additionally in JR the participants are taught four very basic steps in handling difficult situations. 1) Get the facts about what is happening and not just opinions, 2) Weigh and decide what to do in light of the circumstances, 3) Take action and explain why this action is being taken, and 4) Check the results of your decision. When JR is practiced in this manner a supervisor become a more effective leader and is viewed as honest and trustworthy by their team members.

Summary

Taken collectively the 3J courses can provide a very important base for work team in a lean program that will sustain. At the heart of every system are people and their collective beliefs and behaviors. The TWI material played a powerful shaping force early on in Toyota's improvement journey. Instead of using value stream maps, kaizen events, or pull systems which all came later in Toyota's journey these basic courses were foundational elements in making the Toyota shop floor a more stable and predictable environment. I urge all parties interested in these materials to make them an integral part of your improvement journey.

III. Machine Related

After the human element the most often cited frustration regarding the topic of stability in most companies is that of equipment reliability. If the process is breaking down either frequently or intensively then you are likely to struggle in all aspects of lean. Standardized work, pull systems, etc. all assume that equipment is fairly reliable in order to work. If this is not the case then any implementation efforts will merely struggle and point out this inconvenient fact. In order to deal with these types of problems Toyota established a series of initial practices for stabilizing equipment and making improvements. The following items are merely an overview and not an exhaustive list. However if you practice them you can improve the machine related aspect of stability substantially in most environments.

A. Process capacity

As a starting point it is important to know exactly just how much capacity you are losing in regards to equipment stability issues. A tool developed in Toyota for this purpose is the simple form known as the process capacity sheet. The purpose of this sheet is to calculate what the expected output is from a machine during a standard period of time. The output number reflects the maximum amount of output that can be produced under current conditions with no losses to downtime, scrap, or other issues. The output number in other words is the maximum bar possible and the level against which you can measure your performance. If the maximum possible output in one shift for example is 500 units and only 350 are produced on an average shift then the process is working effectively 70% of the time and has healthy room for improvement. If demand is increasing to 650 units per shift however, then there is a potential problem since this figure is over the stated 500 unit output of the machine. In this case overtime, weekend work, or extra capacity will be needed to address the situation. The key point is to measure the process

capacity though and understand your current state in factual detail regarding output and not just rely upon assumptions or opinions.

B. Six types of losses

Once process capacity has been measured and compared against actual output there is often a significant loss that is experienced in many companies. In order to capture this lost production it is often necessary to measure and break it down further into more detail for analysis. There are many different categories that can be created to categorize the losses but for simplicity they can be broken down into three categories with two subdivisions each. There are availability losses such as breakdown and change over time. There are performance losses such as minor stops and cycle time losses. And finally there are quality losses such as scrap and rework, or yield related losses. Breaking down the losses into these categories and measuring them should give you enough insight into how to begin to attack them.

Each process should have its own unique shape of loss fingerprint and will require actions accordingly. In general however the following is normally true. If you experience breakdown losses further data collection over time and analysis will be required and I will outlines some key points of this process below. Changeover losses can easily be further analyzed and addressed by implementation of Single Minute Exchange of Die practices (SMED). Performance losses such as minor stops and cycle time losses often need direct observation and on site measurement to gauge for improvement. Changes to cycle time of course need to be careful considered for any impact upon quality and safety. Quality losses need to be further studied and broken down into types and made the topic of problem solving efforts.

Measuring the six losses or calculating and overall equipment efficiency metric in no way solves your stability problem. However breaking down the losses into categories can give you insight into how to resolve these problems and where to focus your efforts first in order to avoid wasting time. If breakdowns represent 90% of your losses for example then it is not going to be very useful to implement SMED techniques or standardized work for example.

C. Types of maintenance in Toyota

Normally all companies experience a fairly high level of equipment downtime as one of six losses mentioned above. How you maintain equipment and execute maintenance work can have a significant effect on this loss category. In Toyota's machine intensive shops maintenance work is typically broken down into the following five categories – Breakdown Maintenance, Preventive Maintenance, Daily Maintenance, Corrective Maintenance, and Maintenance Prevention.

Breakdown Maintenance (BM)

BM is the most typical category of maintenance work in most manufacturing companies. Toyota was no exception 30 years ago. Obviously every company would like to reduce the amount of down time they face in production. The question is where to begin. In Toyota's case the starting point was improved data collection for each piece of equipment and every maintenance call recorded. Much like quality improvements it is important to build a Pareto chart and identify your worst machines in order to improve. Generally in Toyota the work several machines in terms of frequency (number of times down) and intensity (amount of downtime) are tracked and constantly given priority attention. Special effort and attention is placed on getting to the root case of problems and preventing recurrence is the goal.

Preventive Maintenance (PM)

Further investigation of data in Toyota normally showed that breakdowns also fall into two types of failure modes – functional decline and functional failure. Functional failure problems are difficult to prevent since it is virtually impossible to detect the problem before it happens. Normally however they represent only about 20% of the breakdown cases. The other 80% falls into the category of functional decline and can often be eliminated by improved preventive maintenance.

Daily Maintenance (DM)

Daily maintenance in Toyota is the form of preventive maintenance that is conducted by production operators and not the maintenance department. DM tasks are simple in nature and yet often highly effective in terms of highlighting problems before they occur. Basic tasks in this category can include items such as daily cleaning and inspection, observation of fluid, temperature, and pressure levels, and monitoring of abnormal conditions such as tooling condition, noises, or other abnormal circumstances. Normally detection of a problem during the DM check requires the production department to communicate the exact issue to maintenance for rapid correction.

Corrective Maintenance (CM)

Certain problems in maintenance over time become consistent or chronic problems and must be addressed through special channels. In Toyota when there are repeat issues, or especially troublesome problems they are flagged as such and become the focus of corrective maintenance work. In the case of corrective maintenance special groups are formed to study the condition in more detail and to probe the root cause of the problem. Often superficial measures have no effect and the basic conditions of the machine such as jigs, clamps, fixtures, and other important sections of the machine must be modified. Since these items changes the basic conditions of the machine the vendor of the equipment or specialists in the company are often involved as needed. Conducting this level of maintenance work is higher level and more difficult than either BM, PM, or DM and normally reserved for experience employees.

Maintenance Prevention (MP)

The final main category of maintenance work is that of maintenance prevention. The type of work arises when ever new equipment is specified and ordered. Often repeat types of machines or elements of machines are ordered and before the machine is built represents the best chance for improving their performance. In advance of the machine order the known problems on all similar machines should be collected and analyzed for improvement opportunities. These improvement areas should be discussed with the designer of the equipment and requests for changes negotiated as part of the new equipment order.

Taken collectively these five categories of maintenance often represent areas for improvement in equipment down time. Normally the most gain is obtained initially through superior application of the first three items BM, PM, and DM. Please study the data collected by your equipment downtime tracking system and see how you might improve in each of these areas.

IV. Material Related

There are two aspects of material that typically are associated with stability in production. The first relates to general availability of material and making sure you have the right part in the right place at the right time. The second aspect pertains to quality of material and ensuring that it can be used for production. Both of these aspects can become advanced topics very quickly and go far beyond the scope of this summary document. Below I will outline the general points that I suggest as starting points for improvement.

A. Availability

Availability of material is a requirement for success in any system. Inventory is normally considered a form of waste by most companies practicing lean. This simple notion however misses a fundamental point. The exact quote by Taiichi Ono of TPS fame was actually “inventory beyond what the process needs to run is waste”. In other words not all inventories are actual waste some amount is required to run the process. Not having enough material in either raw, work in process, or finished goods is potentially a bigger waste than not having enough inventory.

As a basic rule of thumb you should take care to have enough material in the system to cover what Toyota calls cycle, safety and buffer stock. Each of these can be calculated for finished goods, work in process or raw material markets. Cycle stock is the portion of inventory that comprises average demand and the time it takes to replenish that material into a market location (i.e. every part every interval - EPEI). Buffer stock is the amount of material required to cover the average statistical variation in customer demand. This amount will depend upon the number of standard deviations you plan on covering in this amount. Lastly there is some final material known as safety stock and used for covering emergencies beyond what is described above. This might include situations like unplanned downtime or weather related disruptions in the winter. This amount is

normally a “decision” and the benefits of holding the inventory must be weighed against the associated cost.

B. Quality & Documents

The topic of material quality is far beyond the scope of this simple document as there are too many dimensions to cover. One aspect that I do believe requires mentioning with respect to basic stability is that of material documentation and quality. The assumption in many companies attempting lean is that if I have a standardized work chart then I can ensure quality is built into the process. Unfortunately the case is not that simple. Standardized work charts are used in areas like assembly and man machine combination areas where one person can cover multiple machines. However in equipment intensive areas standardized work charts are not used by Toyota. The reason is because that the equipment is driven by fixed cycle times and is often highly automated. The value-add portion of the work is performed by the machine and not the person. In these cases we still want to “standardize work” but the true standardized work chart is not the critical document. Instead a variety of other documents are used as a basis for the process and used to manage the quality and stability of the process. Sample documents include but are not limited to the follow types.

Work instruction chart

Work instructions are documents that specify the main steps, key points, and reasons why certain tasks are performed. These documents have their roots in JI as discussed above in an earlier section. The contents of work instructions may include but are not limited to how to start up or shut down machines, how to gauge parts or conduct quality checks, how to conduct troubleshooting, or how to maintain certain aspects of the equipment.

Machine cycle chart

A machine cycle chart is a document created by the designer of the equipment and it includes the exact cycle of how the machine operates step by step. The cycle lists all the actuators and the time for each of their actuations during the normal machine cycle. This document is useful when the machine is no longer cycling at the desired speed and you want to locate where time is being lost. Comparing actual actuation of the machine to the cycle chart should give you clues as to where the source of the slow down is located. In most companies this document is kept by the designer of the machines but in Toyota it is requires for submittal along with other items in order to maintain the machines.

Operation drawings

Operation drawings are key documents that indicate what transformation of material removal is occurring step by step at each of the processes in the manufacturing line. Critical information is contained in these documents such as the exact amount of material to be removed, the locations where the part is to be held and clamped, exactly where the

datum surface is located, and any other useful information required to correctly make the part at this step of the process.

Precision Measuring / Quality Check Standards

This document summarizes all the precision measuring items and quality check standards for the process at each step. The number of checks, frequency of the check interval, type of gauge to be used, and party responsible for the check are outlined. For more specific detail a work instruction is written on how to perform each of the specific quality checks as required.

Tooling layout drawing

Tooling layout drawings are specialized documents that describe the tooling for the process and the exact conditions under which it is designed to operate. For example the tool number, tool name, exact speed, feed, and rotation, etc. of the tool are described. Furthermore the dimensions of the tool as well as the tool change frequency, and the coolant conditions etc. are specified as well. Normally these documents are highly technical in nature and only used during trouble shooting of certain types of tooling problems.

Machine static accuracy chart

The machine static accuracy chart is another document that Toyota requires to be created during the construction of equipment and submitted along with other documentation when machines are purchases. The static accuracy chart lists the conditions that must be maintained on the machine in order to make a good part. For example the exact amount of run out on spindle heads, parallelism of tables, or relationship of certain angles and geometry is precisely measured in microns (.001 millimeters). The actual value at the time the machine is built as well as the allowable tolerance band is stated as well. As long as the geometries described are maintained and the basic operating conditions are observed as well then the machine is virtually guaranteed to make a good quality part.

These documents are only but a handful of the types of documentation that I had to manage back when I was working for Toyota. There are more documents in production however and of course they vary tremendously by the nature of the process. These are a few of the key items that are used and controlled carefully by Toyota in its facilities. I hope this list helps to dispel the notion that simply posting standardized work charts are all that is necessary to stabilize or improve a manufacturing process.

V. Method

Almost every tool in TPS is essentially a method that can be used for improvement. In this section I will not attempt to list every tool of lean instead I will merely focus on three in particular that can be very useful in terms of stabilizing any process.

A. Five S

Five S and visual control are the most fundamental concepts in TPS or any lean program. Regardless of the situation you can take something from the concepts of these two items and apply them in some very basic fashion.

Normally when people hear the term Five S they either state that it is merely good housekeeping. Five S is not this simple. Five S is a process to apply in a systematic fashion to any area for improvement. Unfortunately the terms of Five S do not translate well into English. In their original Japanese context they each not only begin with S but have very precise meanings.

Seiri

The first word Seiri means to organize what you need and what you do not need in any area or operation. The critical part of this first step of the process means to discard or remove any unnecessary items for the area in question. Eliminate trash, dirt, extra items, and general clutter from the area that does not have a specific purpose in the area in question. This first step must be performed in order for any of the other steps to have impact. A normal practice is to organize a team to search an area and to place a red tag on items that are not needed.

Seiton

The second word Seiton means to organize and arrange all the items that will remain in the area. Specifically it means to find a place for everything and put everything in its proper place. If you leave positions arbitrary then later on you will have problems. Try to establish an exact place and only enough room for that item to be located there. If it is easier to follow the standard way than it is to deviate from the standard then people will likely adhere to the process you set up. Take special time and precaution to lay things out well and the impact from this method is much more likely to stick in place.

Seiso

The third word Seiso means to conduct a thorough cleaning of the items in the area and the locations established in the first two steps. If equipment is involved then you want to restore its condition to as close as original condition as possible. During the cleaning of any equipment you should pay special attention and look for minor problems or abnormal conditions.

Seiketsu

The fourth word Seiketsu pertains to neatness and keeping items in a clean state. Since the previous work seiso related to cleaning the emphasis on this word is to maintain neatness in the area or operation. It is critical to establish where and why dirt, contamination, and clutter are coming from when they enter the area and attempt to

prevent this problem from occurring. There is an element of root cause analysis and prevention within this term. Originally in TPS and other companies there were only Four S' in this methodology. The reason is because that practicing the first four S's well virtually guarantees that you will be successful.

Shitsukei

The fifth word Shitsukei essentially mean discipline. If you do the first Four S's correctly then the last one should be easy to implement as well. In particular with regard to the Fifth S you can establish audit check sheets and audit intervals to maintain the area as established in the above five steps.

B. Visual Control

There are several important aspects of Five S including increase safety, productivity, and morale. One aspect that is usually not mentioned however is that it helps establish a basis for visual control. When things are organized and in their place it is easier to see problems or abnormal conditions. The fundamental concept behind visual control is to make abnormal situations visually obvious. If a problem is made visual and apparent then it is more like that you will recognize it and take action before the problem becomes catastrophic.

Many companies take the concept of visual control to an extreme and attempt to make everything visual. I suppose that like taking too much vitamin C it can not hurt you however, I don't think it will help all that much either. The primary concept behind visual control is similar to the statement made many times by W. Edwards Demming. On more than one occasion Demming stated that more than anything he wished that he could get management to understand the difference between normal variation and abnormal variation in a process. When people attempt to react to inherent normal variation in a process they are generally wasting their time and efforts. They should instead be attempting to reduce the level of variation in the process by improving process capability. When however there is abnormal variation in a process then Demming of course wanted managers to recognize this aberration and take immediate action. This simple truth is the essence of visual control – clearly identify when an abnormal condition occurs and resolve it as quickly as possible.

C. PDCA

Several years ago an overview on TPS was written up in the Harvard Business Review by professors Spears and Bowen entitled the DNA of Toyota. The article implied that there were fundamental rules and logic at work behind the system. The rules the authors outlined tended to focus overtly on the importance of standardizing work, having standard flow paths, establishing clear signals for confirmation between areas, and constantly seeking improvement. The notion of having guiding logic behind lean is very appealing. However if you ask Toyota executives what is the simple management rule

they follow they will simply state Plan-Do-Check-Act or PDCA management. This simple management discipline was taught to the company in the 1960's as part of TQC implementation.

The key point in PDCA is to repeat the cycle over and over as needed until a problem is resolved or improved. The plan elements include clearly defining a problem or a goal in specific quantitative terms. The 5W's and 1H should be considered (Who, What, When, Where, Why, and How) as needed to clarify the situation. The most important aspect of the plan is to determine a hypothesis to test for improving the situation or a root cause of a problem.

The second phase of PDCA means to implement the hypothesis discussed above in the earlier phase. In the strictest sense you should only attempt as many items as you can positively confirm. Specific plans and communication to all related parties need to be implemented in order to ensure a smooth trial. Normally only one thing at a time should be implemented for effect.

The third phase of PDCA relates to confirming the effect of your train implementation. If you implement three things at once and the situation improves then you need to be able to determine which of the three things was responsible for the effect. Otherwise you are forced to guess or run further tests in order to determine cause and effect. Have a plan in place to check and confirm whether or not your test is successful.

The final phase of PDCA will follow one of two courses. If the test is successful and enough to resolve the problem to the extent required then the new method that was trialed needs become the new standard method for operation the process involved. Additionally if there are similar processes then the new method should be rolled out to these areas as well. If the test is not successful or enough to obtain the desired result then the process must be repeated until the desired result is obtained.

VI. Summary

This document is entitled "Basic Stability" for a simple reason. Instead of the sexier items in lean such as standardized work, kanban, or heijunka, for example you often first need to work on some things more fundamental in order to stabilize your operations. If you have a stable base from which to operate you will find it easier to make improvements. Also the gains will be much more likely to sustain as well.