Fundamental mindset that drives improvements towards lean production

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Abstract
Purpose – The purpose of the paper is to present a fundamental mindset that an experienced Japanese Toyota Production System (TPS) consultant has when he drives a series of improvement activities during a lean transformation.
Design/methodology/approach – The main author of this paper conducted participant observations on two lean transformation cases at two medium-sized Swedish manufacturing companies. The studied lean transformations are driven by the mentioned Japanese consultant. Before he became a consultant, he had practiced TPS more than 20 years at a supplier company of Toyota.
Findings – Instead of making a detailed plan to implement lean production, the consultant focuses on creating the need for improvement. The identified fundamental mindset that drives a lean transformation can be described as "occasionally by force, create a situation where people have no choice (or little choice) but to feel the need of improvement. The situation is such that it brings different problems up to surface. Through letting people solve the problems one-by-one, the performance of the operation as well as the capability of individual and organizational learning are improved." Various lean techniques are simply used based on the surfaced problems.
Originality/value – The recent research shows that a contingent nature is required in lean transformation, especially when it requires an organizational cultural change. However, a limited number of researches have shown practical ways of conducting a lean transformation with a contingent approach. The paper identifies a simple but practical way of doing it.

Keywords Lean production, Continuous improvement, Learning organizations

Paper type Research paper

1. Introduction

Lean production is one of the most influential paradigms in the recent manufacturing industry. Its shop floor techniques and its production philosophies are widely recognized in the industry. Lean production is originated at Toyota Motor Corporation and other Japanese manufactures. However, the world's attention to lean production was limited until the publication of the book *The Machine that Changed the World* (Womack *et al.*, 1990), in which also the term "lean production" was introduced. In the early period of lean awareness, many of the manufacturers' efforts were focused on the emulation of shop floor techniques of lean, such as 5S, flow production, small batch production, single minute exchange of dies, standardized work, Kanban, etc. and they found it difficult to sustain them. Later, the necessity of organizational cultural change in lean application is denoted by several authors (Iwaki, 2005; Wakamatsu and Kondou, 2003; Womack and Jones, 1996; Liker, 2004). Womack and Jones (1996) identify the importance of "thinking" in lean production and summarize the five principles of lean thinking as a dependable guide for a lean transformation. These principles involve the identification of customer value, the management of the value stream, developing the capability of flow production, the use of "pull" mechanisms to support flow of materials, and the pursuit of perfection through reducing to zero all forms of waste in the production system. Liker (2004) further maintains that lean thinking based on the Toyota Way involves a far deeper and more pervasive cultural transformation than the application of set of lean tools, and he presents 14 management principles as the foundation of Toyota Production System (TPS). The mentioned authors and many other advocates of lean production commonly agree that a key advantage of lean transformation is to establish the culture of continuous improvement and organizational learning.

Although there are many literatures that discuss how to implement lean production, many manufacturers still fail to succeed in lean transformation especially in the area of cultural change. Previous experience in industry shows that it is difficult to achieve a cultural change only by introducing shop floor lean techniques. Making a detailed project plan to implement lean production does not always guarantee to bring about a cultural change, as Hines *et al.* (2004) claim that the contingent nature is required to apply lean thinking which is a general misunderstanding of lean application. Drew *et al.* (2004) also maintain that lean transformation is not a project but a journey, stating:

> [...] it may be tempting to turn these phases into a project plan or a process to be followed, the reality of the journey is not like that. There is no "right" way to approach a lean transformation.

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Assembly Automation
30/2 (2010) 124–130

[DOI 10.1108/01445151011029754]

This paper is an updated and revised version of an award-winning paper previously presented at Flexible Automation and Intelligent Manufacturing Conference (FAIM), University of Teesside, Middlesbrough, UK, July 6-8, 2009.

Assembly Automation
Volume 30 · Number 2 · 2010 · 124–130

These mentioned authors give a view of a lean transformation consisting of various improvement activities where different lean techniques are applied in an arbitrary manner largely depending on the context of company and individuals. Even so, is there any underlying principle that gives a certain consistency in conducting a series of improvement activities towards lean production?

One-and-a-half years of participant observations on two lean transformations at two Swedish manufacturing companies facilitated by a Japanese consultant who has 20 years of experience within TPS, identify a fundamental mindset that acts as a central driver of the whole lean journey. The purpose of this paper is to present this fundamental mindset. Later, how to practice the mindset as well as how to institutionalize it into an organization are also suggested.

2. Research method

The fundamental mindset presented later in this paper is identified from case studies of two ongoing lean transformations at two manufacturing companies in Sweden. One of the two companies, hereby called company A, is a medium-sized company having approximately 150 employees. They produce precision casting goods for automotive, industrial equipment, and infrastructural industries. Product variation is about 600. At the time when they started the lean journey in September 2007, they had done little improvements in the operation for nearly 20 years due to the company's niche market position with less-competing pressure from other competitors. Owing to the poor operational performance, which was the main reason of the company's poor profitability, the president was eager to initiate a drastic change. The other company, here called company B, is also a medium-sized manufacturing company with about 130 employees. They produce electrical products mainly for infrastructural industry. This company is originally an R&D centered company and little attention had been paid to the production. Owing to the increasing production volume as well as the great concern of the production quality, the managements wanted to apply lean production to the shop floor operation.

The lean transformations at the two studied companies have been facilitated by a Japanese consultant. He had worked for one of the Toyota's supplier companies in Japan where he developed TPS-inspired production for more than 20 years. He retired from the company in 2005 and continues to consult TPS at a number of companies. In total, he has instructed TPS at more than 150 companies and 2,800 persons globally. His consultation style is the one commonly practiced within Toyota and its related companies; going to shop floor, seeing and analyzing operation carefully, and suggesting improvement. The main focus of his consultation is on shop floor operation but the range of change is often extended to the whole company, for example the management structure and the managements' mindset.

The lean transformations were directly observed by the main author of this paper. The author participated in the transformations as a translator and also as an assistant of the Japanese consultant. The participation began when the transformations started in September 2007 and September 2008, respectively, at companies A and B. The period of the participation was one and half years at company A and a half year at company B. Observation data were collected in various ways; through the author's participations of actual improvement activities, through the discussions with presidents, production managers, group leaders, engineers, and operators, and through the frequent conversations with the consultant that especially helped to understand the thinking behind of his behaviors, decisions, and actions during his consultation. Collected data were carefully documented. Participant observation has a distinct benefit of the ability to perceive reality from the viewpoint of someone "inside" rather external to it, but it has also the risk of potential bias produced (Yin, 1994). The author's position as a translator and an assistant consultant made it easier to observe the improvement events from third person's perspective.

3. Improvement events during the studied lean transformations

During the participant observation at companies A and B, the author observed a number of improvement events that are relevant to the fundamental mindset described in later section. In this section, some of the events are described in a narrative manner. The events were observed at the different points of time during the transformations. Most of the events are related to the consultant's advices and instructions, some of which were implemented immediately by the companies, while others took several months to be understood and implemented.

3.1 Improvement events at company A

The general direction of the improvement at company A was to reduce work-in-process (WIP), since the company was in the negative spiral of the poor operation caused by increasing WIP. At the beginning of the journey, the production had a chronic problem of delivery delay. To offset the risk of delay, the production control group started to produce goods as much and early as possible. This increased WIP, production lead time, and the complexity of the production process even more.

Event a. At one production process, the Japanese consultant thought that there were too many buffer stocks. It was because they produced with one-week batches. After a quick investigation showed that it was possible to produce with daily batches, he suggested to remove the buffer stock completely except the amount needed for the daily batches. The shop floor supervisor and the operators showed confusion and unwillingness to the reduction. The consultant however insisted them to do it anyway, saying that they would somehow find a way to manage the reduced amount of buffer stock.

Event b. At another process, the consultant found some pallet shelves that had too much space for the buffer stock. He requested to take away the half of the shelves immediately. He said:

> [. . .] half of the space is enough for the future buffer level. It is better to do it already now because then people have to think of a way not to produce too much. In general, people like placing things as soon as they find space.

Event c. The production had delivery delay constantly for many years but the managers and the employees did not see it as a serious problem. The production was controlled by aiming to meet weekly targeted production volumes which were simply calculated from an annual volume forecast. Meeting the targeted volumes was more focused than meeting

the delivery due dates to the customers. The Japanese consultant instructed them to change the way of controlling the production from volume to delivery accuracy controls. He required the production manager to initiate delivery delay follow-ups and to do it every day. Similar follow-up system was implemented at each production process. During the follow-ups, the consultant repeatedly stressed that the aim is not to follow up the delays but to identify the causes that hindered to achieve 100 percent delivery accuracy.

Event d. During various improvement activities, the consultant repeatedly said that everyone must think from the customers' perspective. When the company causes a problem to the customers due to the company's internal problems, one shall not accept any excuses for it. For example, a delivery delay may occur due to lack of personal, machine breakdown, and internal quality problems, and so on, but they are nothing to do with the customers. He emphasized that one must focus on how to solve the problems instead of excusing oneself.

Event e. There was a tension between two groups within the company; production planning and production. The production planning felt that the production did not respect following the plan, and the production felt that many production orders based on prognosis and the frequent priority changes of the orders caused chaos at the shop floor. The consultant told the production planners that as far as they tried to reduce the risk of delivery delay by starting more than necessary and earlier than necessary, the problem-solving skill of the production would never be improved. They were advised to try to start only confirmed orders and to start as late as possible. With consideration of the actual value-added time of their products, the consultant estimated that the production lead time could be much shorter. He instructed them to reduce the lead time by 30-50 percent in their planning system immediately and to start production orders later in accordance with the shortened lead time.

Event f. One process of the production is dedicated to receive casted goods from the foundry and repair them and/or finish the surface of them. The process is called "finishing process." The company employed many operators to this process because of the high rate of casting defect. The foundry, however, had little awareness of this quality problem. The consultant told the finishing process that if a batch from the foundry contained many defects, the finishing process should return it to the foundry and require them to reproduce or repair it, just like the customers usually do to the company. If the foundry did not face the consequences of producing defects, they would never try to improve their process.

3.2 Improvement events at company B

When the lean transformation started at company B, the company had the higher delivery accuracy and the less-chaotic production shop floor than company A. The initial focus was made on creating a flow production and implementing standardized work.

Event g. Already on the second day of the transformation, an assembly section made a layout change to create a flow production. Then, the consultant instructed the production manager to carefully observe how operators assembled the products. He said:

> [. . .] layout change is just a first step. Now, observe the assembly process carefully and find any factors that disturb the repeatability of the operation. All the disturbances you may find are potential risks of quality problems. The disturbances can be because of lack of assembly instructions, poor product designs for assembly, insufficient operator training systems, inappropriate fixtures or jigs, inadequate positions of parts feeding, malfunctions of testers, lack of parts, defect parts, competence of supervisors, and so forth. Lead time can be shortened by the layout change but identifying and correcting all those disturbances is the main reason of this layout change.

Event h. After changing to the flow production, the consultant requested to the assembly section to match the rate of customer demand with the rate of production, based on the principle of just-in-time; producing just what is needed, just when it is needed, and just the amount needed. Matching the rate of customer demand and rate of production is called producing with "takt time." The production manager, however, wanted to assemble the products as earlier as possible in order to save some safety days before the actual delivery date. The consultant explained to the production manager that it is difficult to see the minimum resource needed for the assembly without producing with takt time. He said that as far as there is extra time and resource available, the assembly section would not feel the need for improving all the disturbances mentioned above.

Event i. After changing to the flow production at the assembly section, introduction of Andon was discussed. Andon is an alarm signaled by operators when they find an abnormality. When signaled, the leader of the area has to go to the place of the occurrence immediately and solve the abnormality right away. The production manager was willing to introduce it because he thought many quality concerns might be brought up to the surface by introducing it. The consultant agreed to the possible benefit of using Andon but doubted sustainability of its application. He said that the assembly section still did not produce with takt time and therefore the operators would not feel the need of using an urgent call even when they faced the disturbances.

The improvement events described above may appear to have little in common, however, there is a consistent thinking behind the consultant's various comments and behaviors.

4. A fundamental mindset that drives improvements towards lean production

A fundamental mindset is identified from the observations of improvement events during the studied lean transformations. In this section, the identified fundamental mindset is presented. Later, a way of practicing the mindset and how to institutionalize the mindset into an organization are suggested.

4.1 The fundamental mindset

Through the analysis of the various comments and behaviors made by the Japanese consultant during the studied lean transformations, it is possible to identify a fundamental mindset that underlies all of his comments and behaviors. This mindset is the underlying principle in driving improvements towards lean production. The mindset can be summarized as follows:

> [. . .] occasionally by force, create a situation where people have no choice (or little choice) but to feel the need of improvement. The situation is such that it brings different wastes and problems up to surface. Through letting people solving the wastes and problems one by one, the performance of the operation as well as the capability of individual and organizational learning are improved.

This mindset is closely related to one of the beliefs of Taichi Ohno, who is one of the Founders of TPS. From his plentiful

experience in developing and operating TPS, Ohno (1978) concluded that every improvement starts from the needs. He maintains that improvements without feeling the need of them tend to have low sustainability or to fail to yield benefits proportional to the investments made for the improvements. He therefore claims that how to provoke people to feel the need for improvements is the key for the improvements. The fundamental mindset is a practical way to put the mentioned Ohno's belief into practice.

The mindset can be illustrated by using the "Japanese sea model" as shown in Figure 1. This model is usually used to explain why stock level is reduced in lean production. In this model, when the water level is high, the objects are hidden under the water. By reducing the water level, the objects are brought up to the surface. Likewise, high-stock level hides different problems underneath. Problems such as lack of parts, producing defect parts, and machine breakdowns are absorbed by the stock and do not affect the operation directly. Consequently, these problems are not likely to be recognized with the sense of urgency. When the stock level is reduced, however, the problems start to directly affect the operation. Therefore, they have to be solved immediately. In the fundamental mindset, the water level does not represent only the stock level but also other parameters. The parameters are such that by changing them problems are brought up to surface and then people feel the need of solving them with the sense of urgency. Section 4.2 shows an operative way of practicing this fundamental mindset.

4.2 An operative way of practicing the mindset

An operative way of practicing the fundamental mindset consists of four steps that form one improvement cycle. The four steps are reduce, see, think, and act. The first step is to trigger the need for improvement, and the rest of the steps are similar to the general problem-solving process in continuous improvement. Each step is described below.

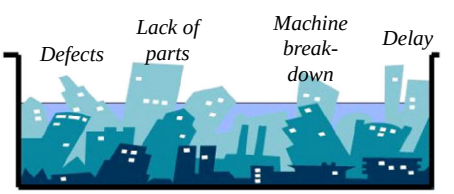
Reduce. This step is to change or to set a parameter by which people have little choice but to feel the need for improvement. Possible parameters are: level of stock (e.g. Event a), space for stock (e.g. Event b), connectedness of production flow (e.g. Event g), takt time production with minimum resource (e.g. Event h), standard in-process stock, lead time in production planning system (e.g. Event e), delivery accuracy (e.g. Event c), acceptance level of defect parts from the previous process (e.g. Event f), or number of operators and staffs. Choice of parameters depends on the context of a specific company, but there is a general rule. The consultant recommends first to change parameters related to delivery accuracy then to proceed to change those related to quality and cost, because in general at the companies with low-delivery accuracy the motivation for improving the operation is often low. The extent of parameter change should be the one that provokes people to feel the need for change. Too little extent does not make people feel the need with the sense of urgency, while too much extent may make people discouraged. "Edge of chaos" – the edge between order and chaos where the creativity, growth, and use of self-organization are at the optimal (Burnes, 2005) can be a good indication for parameter setting. The initiator of such parameter changes has to have an authority to change, is able to take risk in the operation, and is able to see the operation from a holistic perspective. Therefore, the initiator is best suited to production manager. Neither lean coordinator nor production engineer is suitable to do this task. Much resistance can be expected from staffs, leaders, and operators, when initiating the change. The production manager needs to be persistent about the change, otherwise the whole point of this kind of improvement approach can be lost.

See. This step is to carefully observe the shop floor to identify the problems brought up to surface. Then, causes of the problems are analyzed. Eight guidelines for problem solving in Kaizen suggested by Yamamoto (2008), which is the main author's previous work, can be also used. The overview of the eight guidelines is shown in Figure 2. In this step, the first four guidelines can be referred. For example, the third guideline – "Repeat why when one sees the abnormalities" (G3 in Figure 2) and the fourth guideline – "Do not blame operators but blame system or standard" (G4 in Figure 2) can be considered when analyzing the cause of the surfaced problems. An image of how the surfaced problems are linked to different causes is shown in Figure 3. The person who shall operate this step and the rest of the steps depends on the maturity of Kaizen in an organization. The more mature an organization is in Kaizen, people at the lower level in the organization can operate the mentioned steps. In the case of companies A and B, their maturities of Kaizen are low, thus the production managers have to drive all the steps until the shop floor leaders, staffs, and operators learn to increase their skills of problem solving.

Think and act. The think step is about coming up with solutions to the problems and the act step is to implement the solutions. In the think step, the fifth guidelines of "Use wisdom thoroughly before use money" (G5 in Figure 2) and the sixth guideline – "Create temporary solution even if the optimal solution is unknown or takes time to be implemented" (G6 in Figure 2) can be referred. In the act step, the seventh and eighth guidelines can be considered. They are "Initiate change immediately when a solution is available" (G7 in Figure 2) and "Initiate change even if there

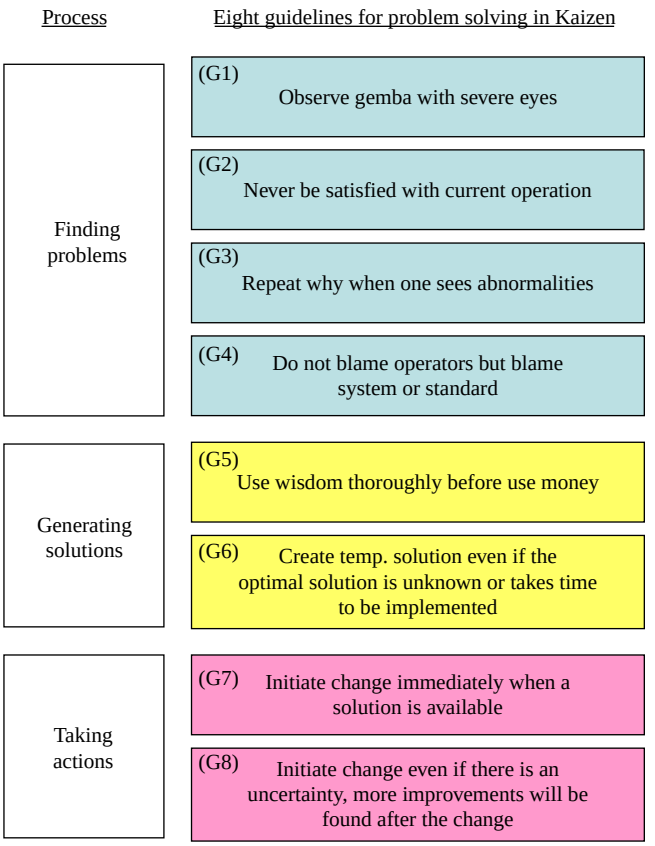
Figure 1 The "Japanese sea" model

When the water level is high, problems are hidden



When the water level is reduced, problems are brought up to the surface

Figure 2 The eight guidelines for problem solving in Kaizen



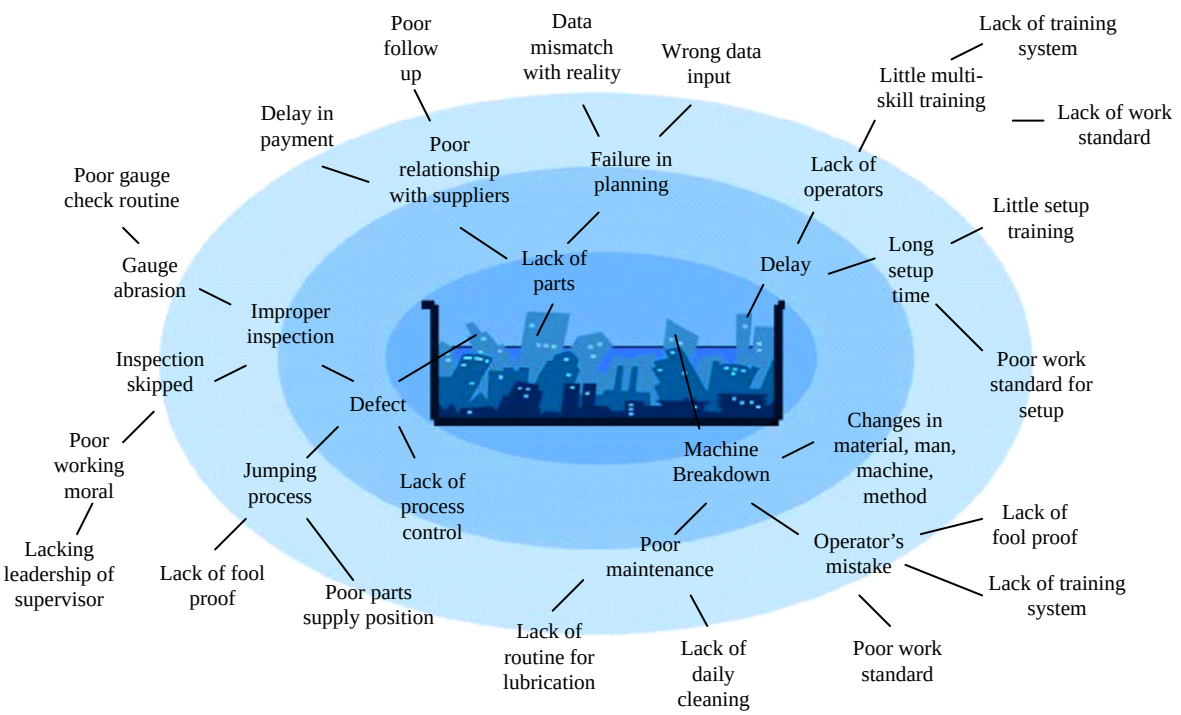
Source: Yamamoto (2008)

is an uncertainty, more improvements will be found after the change" (G8 in Figure 2). By doing the reduce step, people at shop floor aspire for a solution. Then, lean techniques other improvement methods become useful help for solving the problems. In this way, people can learn the meaning of the lean techniques and other methods better than when they are merely provided without people feeling the need of them.

4.3 Institutionalizing the mindset into an organization

Many companies are use to secure their operations by increasing safety margins such as buffer stocks. They are also use to do improvements without risking the operations. For such companies, conducting improvements based on the presented fundamental mindset may appear to be a completely opposite way of improving the production. Before initiating the suggested improvement approach toward lean production, both potential and risk of this way of working needs to be understood, especially by the production manager and other management members. The potential and the risk of practicing the mindset will be further discussed in the next section. Accepting a new way of working can be difficult. The Japanese consultant's experience and the author's experience from the observations of the companies A and B are consistent with the notion of Drew *et al.* (2004); "written documents and conversational presentations are not that helpful" and "it could take months or even years for the leaders of one company to decide to embark on the journey, whereas other might do so in weeks." The production manager at one of the studied companies took nearly one year to understand the fundamental mindset, while the production manager at the other company took a month to do so. The Japanese consultant and many other lean practitioners seem to agree that people tend to accept a new way of working only by experimenting it by themselves.

Figure 3 An image of how the surfaced problems are linked to different causes



5. Discussion and conclusion

The fundamental mindset presented in this paper provides a consistent way of driving improvements towards lean production, even if the contingent nature can exist to a large extent in a lean transformation process. Moreover, when one practices the presented mindset, how and when to use lean techniques becomes quite clear. They are simply used in order to provoke the need for improvement, or to solve the surfaced problems. It is interesting to consider that many of the lean techniques and lean thinking, for example, flow, pull, Kanban, standardized work (takt time, working sequence, and standard in-process stock), Andon, Jidoka, visualization, customer focus, and pursuit for perfection, have the aspect of bringing the problems up to surface and making people perceive them as urgent.

As mentioned in the previous section, the potential and the risk of practicing the fundamental mindset should be discussed. Table I shows the comparison of two improvement approaches towards lean production; one is the improvement approach based on the fundamental mindset, and the other is the "plan-based" improvement approach where solutions and implementation plans are carefully designed by a limited number of specialists before its implementation to the production. For the plan-based approach, the transformation process can be more systematic than the other, but the process is more rigid and difficult to deal with unexpected internal or external changes on the production during the transformation. This approach provides less-learning opportunity to shop floor employees, since solutions are often already designed during the planning phase and given to the shop floor to be implemented. On the other hand, the approach based on the fundamental mindset has less-systematic transformation process, and is more difficult to know exactly what outcome will be obtained after the improvements and exactly when the desired outcome will be obtained. Uncertainty is especially high at the beginning of the transformation. Perhaps, this is the largest disadvantage of this approach, and this is one of the reasons why managers sometimes have a difficulty in accepting it. However, a significant advantage of this approach is that it involves a process of collective learning and therefore it has a higher chance to achieve a cultural change to a learning organization. In this approach, improvements are often triggered by the managers but actual problem solving is expected to be done by the shop floor leaders, staffs, and operators. They face the problems with the sense of urgency, and try to solve the problems in different ways. Managers or consultants provide support when needed with lean techniques or other methods. In this way, leaders, staffs, and operators learn problem solving, and lean thinking can gradually filter into their mindset.

Table I Comparison of improvement approaches towards lean production

Approach based on the fundamental mindset	Plan-based approach
Process is contingent and less-systematic	Process is systematic
Flexible to the unexpected changes during the transformation process	Process is rigid, thus less-flexible to unexpected changes
What outcome is obtained when is not exactly predicted	Outcome is designed prior to the execution
Much time is spent in actions	Much time is spent in planning
Managers set direction, and employees find answers	Managers provide answers, employees follow orders
"Execution as learning" (Edmondson, 2008)	"Execution as efficiency" (Edmondson, 2008)
Focus in the process is learning	Focus in the process is implementation
Chance to become a learning organization is higher	Chance to become a learning organization is not high

The analysis of the observation and theory formulation in this paper are made in the context of lean transformations at medium-sized companies. At a larger sized company, a systematic aspect probably needs to be more considered in a lean transformation. As Hines and Taylor (2000) suggest, the application of policy deployment with consideration of various contingent factors can be a useful way to keep the balance of contingent and systematic aspect in the transformation. Finally, the paper implies that the fundamental mindset can be used not only for lean transformation but also stimulating creativity in an organization to realize an innovation in production. If the mentioned water level is reduced drastically and any existing best practices or latest equipment cannot meet the changed requirement, an innovation needs to be realized. The linkage of the fundamental thinking and innovation is an interesting area for the further research.

References

Burnes, B. (2005), "Complexity theories and organizational change", *International Journal of Management Reviews*, Vol. 7 No. 2, pp. 73-90.

Drew, J., McCallum, B. and Roggenhofer, S. (2004), *Journey to Lean: Making Operational Change Stick*, Palgrave Macmillan, New York, NY.

Edmondson, A.C. (2008), "The competitive imperative of learning", *Harvard Business Review*, Vol. 86 Nos 7-8, pp. 60-7.

Hines, P. and Taylor, D. (2000), *Going Lean – A Guide for Implementation*, Cardiff Business School, Lean Enterprise Research Center, Cardiff.

Hines, P., Holwe, M. and Rich, N. (2004), "Learning to evolve: a review of contemporary lean thinking", *International Journal of Operations & Production Management*, Vol. 24 No. 10, pp. 994-1011.

Iwaki, K. (2005), *Jissen Toyota seisan hoshiki*, Nikkei, Tokyo (in Japanese).

Liker, J.K. (2004), *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, McGraw-Hill, New York, NY.

Ohno, T. (1978), *Toyota Seisan Hoshiki*, Diamond, Toyko (in Japanese).

Wakamatsu, Y. and Kondou, T. (2003), *Toyota shiki Kaizen ryoku*, Diamond, Tokyo (in Japanese).

Womack, J.P. and Jones, D.T. (1996), *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Simon & Schuster, New York, NY.

Womack, J.P., Jones, D.T. and Roos, D. (1990), *The Machine that Changed the World*, Rawson Associates, New York, NY.

Yamamoto, Y. (2008), "Guidelines for increasing skills in Kaizen shown by a Japanese TPS Expert at 6 Swedish Manufacturing Companies", paper presented at the 18th International Conference on Flexible Automation and Intelligent Manufacturing, Skövde.

Yin, R.K. (1994), *Case Study Research: Design and Methods*, Sage, Beverly Hills, CA.

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