Tentative Classification of the Goals of the Lean Production System: Lessons for practitioners

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Abstract

Many studies have been and are being published about the lean production system. The focus of those studies is placed on the elimination of wastes that result in the overall cost reduction. This paper sheds a new light on the analysis of the lean production system from the perspective of its goals classification. The categorization has the merit to reveal not only the nature of the different of goals but also to show their hierarchy and how the different hierarchical levels are related to each other. Furthermore, the clarification of the nature of lean production system goals suggests and implies that goals that seem out of reach, i.e. asymptotic goals, are the internal engine that can keep a company looking continuously for better ways to reduce production costs. In the traditional manufacturing, setting apparently unreachable goals goes against the conventional wisdom that considers them to contribute to the image of a poor performance especially by the external evaluations. This study demonstrates the importance and the necessity of asymptotic goals for the lean production system.

Introduction

Many studies have been and are being published about the lean production system. The focus of those studies are on the elimination of wastes that result in the overall cost reduction as specified by the founder of the Toyota production System (Ohno, 1978). This paper sheds a new light on the way to approach the lean production system that consists in classifying its goals. The classification has the merit to reveal not only the nature of the different of goals but also to show their hierarchy and how the different levels are related to each other.

Monden (Monden, 1997, p. 1) has rightly pointed to the fact that "the primary goal of the Toyota production system is cost reduction". In fact, the cost reduction to the lowest level, to the bare minimum i.e., to zero might be considered the ultimate and legitimate target. But when one

examines the TPS or Lean Production System in general, the obvious goal and most pursued goal is in fact the reduction of the famous 7 kinds of wastes. Cost reduction appears nowhere at the production floor or production level. What is the relationship, if any and there must any, between the cost reduction objective and that of wastes elimination?

In fact, the goals of cost reduction and waste elimination are not at the same level, they are at different levels of the company organization. The goal of cost reduction is situated at a higher level and it can be reached only as results of attaining various other concrete goals [1] the best representative of the lean system, i.e. the Toyota production system (TPS) has assigned itself. Specifically operational level goals contribute to divisional or department goals and the latter ones to the overall corporate goals.

The common feature of these different goals of the lean system is the fact that they are by their very nature, asymptotic. Goals that cannot be reached, that are neither reasonable nor realistic fall outside the framework of SMART [2] goals and a plan without such goals is considered a bad plan. Toyota goals seems to question that logic.

As matter of fact, Toyota production goals seem unreachable or what we have termed "asymptotic" (Kupanhy, 2012, p. 78). Those unrealistic goals constrain thus the TPS/JIT system to continuously look for ways to improve the tools and means it uses in order to get closer and closer to those unreachable goals (Kupanhy, 2012, pp. 78–82).

z-goals and s-goals

This paper tentatively tries to identify two categories of the asymptotic goals of the Toyota's lean production system (LPS). The first category is made up of those goals that aim at reducing to zero any element that contributes to the cost increase, i.e. a 100% thorough elimination of each kind of targeted wastes[3]. Such objectives are termed here as z-goals, i.e. zero-unit or zero-object goals as identified below.

- zero inventories (of finished goods),
- zero defective items,

1 For the sake of simplicity, In this paper, TPS, JIT system and Lean Production System or Lean System are used as synonyms and are therefore interchangeable.

2 Doran, G. T. (1981). "There's a S.M.A.R.T. way to write management's goals and objectives", *Management Review*, 70 (11), pp. 35–36.

3 Hirano, Hiroyuki (1997) mentioned well 5 of the z-objectives as a background setting of the JIT system. He does not however look at them as the engine that makes up the dynamics of the JIT system. Chiba et al. (1998) also are interested in the production processes to which they assign z-goals but once again they don't find or establish any relationship with the production system's continuous improvement process.

- zero defective work/operations or zero wasteful processing,
- zero transportations (within the production system),
- zero delivery lead times (within the production system),
- zero setup times,
- zero time on hands,
- zero wasteful motions,
- zero overproduced items,
- zero delivery time (reaction time),
- zero accidents,
- zero physical and/or administrative barriers,
- zero design-in defects, and so on.

On the other hand, are tentatively considered to pertain to the second group the lean system's goals that aim at a single unit or single object. Following are the elements of this category.

- single-unit production and conveyance, i.e., one-at-a-time production flow of materials,
- single unit of wip at each process (i.e. the item mounted on the machine and being processed),
- single integrated processing line,
- single reduced shop floor,
- single virtual company that includes suppliers and manufacturer and customers, and so on.

We term the elements of this second group as s-goals, i.e. single-object or single-unit goals.

In the framework of kaizen-supported JIT system with its unreachable goals, we will and can never say, when evaluating the results, that we have reached our objectives, but we can just say how far we have moved toward the goals or not.

These z-goals and s-goals are what makes up the foundation of the dynamics of the JIT/lean production system. The JIT/lean system is a set of many techniques and methods (Kupanhy, 1995). QCC and SS are for sure part of the JIT system. Furthermore, they provide support to each of the remaining JIT techniques. Without QCC and SS structures, it would be impossible to implement JIT, i.e., to attain its goals[4].

Goals Hierarchy: Strategic and operational goals

A close look reveals that the objective of zero inventories is not of the sphere of production operations. This objective is fixed at a higher level of the organization structure, and should be understood as situated at that level. It is in fact a strategic goal. The other goals can be categorized

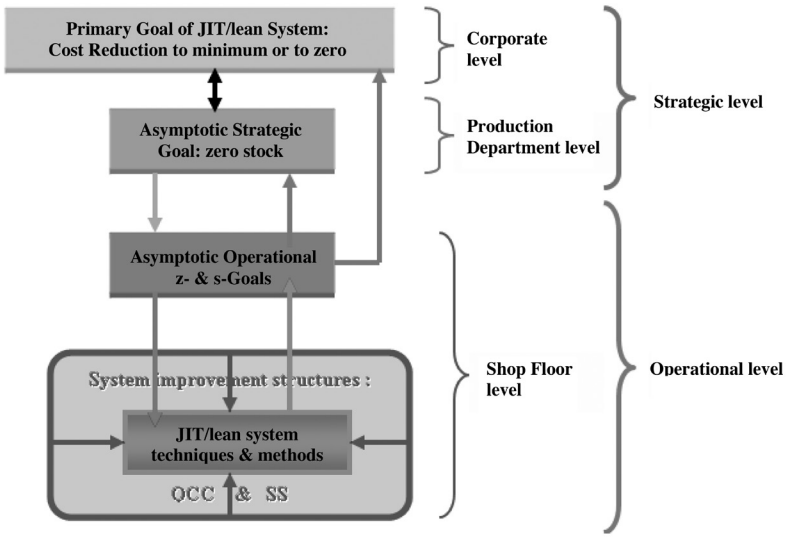
4 See Exhibit 3.

as operational targets. Their accomplishment at the production operations level makes it possible to attain the production department's strategic objective of zero inventories.

We do remember that the primary goal of the TPS is thorough cost reduction. This is a corporate strategic goal that shapes and impacts strategies of each functional department. In fact, it is translated differently in the different functional departments which will set their respective goals that will contribute to the accomplishment of that global goal of the corporation, i.e., the cost reduction to zero. In the manufacturing or production organization, that step may consist in the reduction of inventories to zero, which, as stated earlier, is a strategic objective of the production department.

Pursuing the objective of zero inventories can be attained through the accomplishment of operational targets (see Exhibit 1), such as zero setup (times), zero defective items, zero wasteful motions, single unit production and conveyance, etc. In other words, all z-goals and s-goals are operational except the zero inventories and cost reduction to zero. If the corporate objective were not asymptotic (cost reduction to zero), the production department's goal would not be fixed at a reasonably un-reachable level (zero inventories), and there would be no necessity of setting asymptotic operational goals. By the same token, there would be no reason for improvement structures to be permanent and dynamic. And without permanent improvement structures, it would not be possible to have continuous improvements (Kupanhy, 2005).

Exhibit 1: QCC/SS activities pervade the whole JIT/lean system to support its methods aimed at operational targets



JIT/lean system's goals and continuous improvement structures

For the sake of illustration, let's just examine a few operational goals in order to show a) how lean methods aimed at the system's operational goals are supported and sustained by QCC and SS; b) how the asymptotic features of those goals imply the setting of permanent but dynamic QCC and SS structures.

In fact, the kanban system implementation requires that the set-up time be reduced first. Without ideas for improvement, it would be impossible to reduce the changeover time. And, in the absence of QCC and/or SS structures, it would be very difficult, if not almost impossible, to gather ideas for improvement, and then turn them into actual improvement, i.e., actual set-up time reduction. The likelihood of reaching such a goal of zero set-up time makes it necessary to keep QCC/SS continuously running.

Zero defects & wasteful processing operations

The JIT aims at zero defects and defective processing (operations). Poka Yoke can help reach those objectives. It is known that Poka Yoke devices are based on the suggestions for improvement and are at the same time results of QCC and SS suggestions for improvement. Because of the practical unlikelihood of reaching that goal on the one hand, and the possibility of getting closer and closer to it through sustained effort on the other hand, it seems necessary to set permanent but dynamic QCC and SS programs.

Zero defects mean 100% good products, aiming at zero tolerance instead of at a zone (range) of tolerance[5]. And this is a goal that requires continuous improvements and its supporting structures.

Zero transportations, zero wasteful motions, and one single integrated processing line

The JIT/lean system requires that operations be standardized, the processes be laid close and/even linked to each others. Ideas for standardization, freeing unnecessary space that is the cause of transportation and laying processes in an efficient way have their sources in QCC and SS activities, etc. Is it possible to have zero transportation? Is it possible to reduce an operator's motions to only value-creating ones? Unfortunately, one could hardly find a single production

5 Taguchi's Loss function constrains process control to aim at zero tolerance while the traditional view of process control regards all performance within the control limits as being acceptable (See J. Heizer, and Barry Render, pp. 178–179). Thus, in the traditional view, there is no necessity of continuous improvement since goals can easily achieved within the specified zone. Morita has experienced it with Sony's American workers: "But if we said make it between plus or minus five, we would get it somewhere near plus or minus five all right, but rarely as close to zero as the Japanese workers did" (A. Morita, 1990, p. 233) .

site that could proudly pretend to have realized such a feat. Therefore, keeping QCC and SS permanently would contribute to continuously reducing those wastes.

Table 1: Some characteristics specific to JIT/lean and conventional production systems

Input (Main transforming resources)	Aimed, desired or observed quantities	
	JIT/lean system	Conventional production system
Processing line	one	Many focused lines? (see FWF)
Production processes	As many as possible	?
Production lot size	As small as possible	Large lots or batches
Production type	Mixed-type	Single type
Number of model	As many as possible	As few as possible
Number of setups	As many as possible	As few as possible
Setup time	Aim: zero times	No clear objective
Operator	As few as possible (one being the ideal)	At least as many as the number of machines
Operator's skills	As many as possible	One specialized skill
# of tasks within the worker's cycle time	As many as possible	One task per operator per cycle
Improvement ideas	As many as possible	? (sporadic)

Besides, one of the underlying principles of the QCC/SS-supported JIT/lean system is that the imagination and creativity of the human being as well as his capabilities to learn has virtually no limits. That may be the reason why the system 1) expects the ideas from employees their career long; 2) trains its operators in developing as many skills as possible; 3) sticks to continuous job rotation and training; 4) requires that an operator be able to man as many machines and/or processes as possible; 5) aims at using the least number of people on the production line. Such an operator can attend to a whole production line would the latter consist of a limited number of machines[6]. This means that one (operator) would be then the ideal number of operation workers. As though things were not yet too complicated, the ideal production line, under the JIT/lean

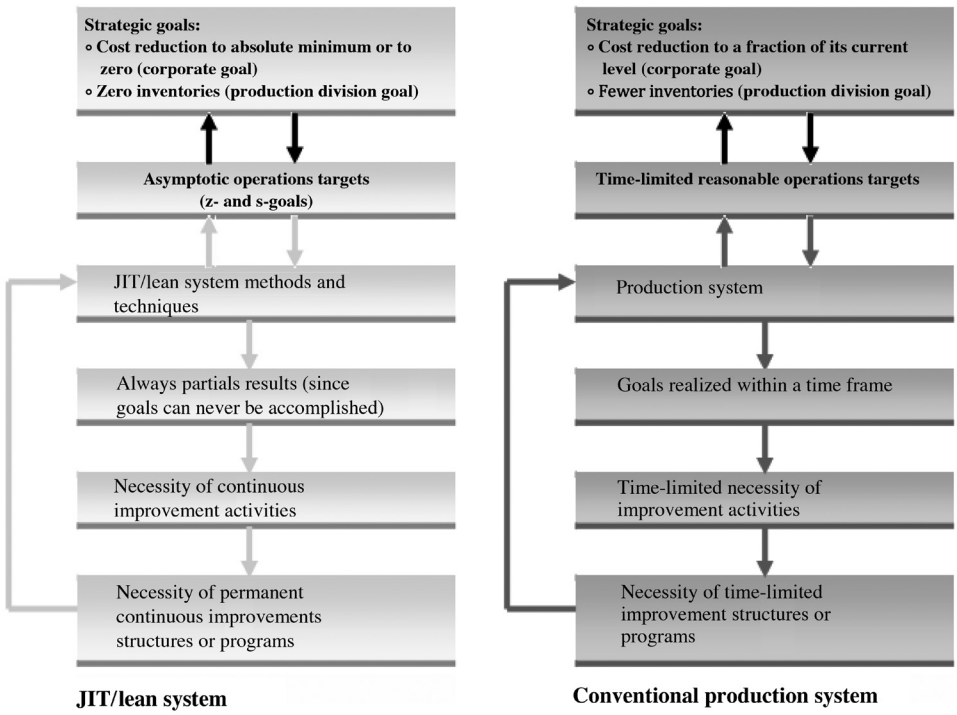
6 Shingo (1981, p. 103) reported that at Toyota "Around 1955, 3500 sets of machines were equipped in the machine plant and only 700 workers were employed. Therefore, an average of 5 sets of machines was managed by one worker". In a survey conducted in Osaka, two companies stated that the maximum number of machine a worker can supervise was 10 (Kupanhy, 1994, p. 168). And Monden (1983, pp. 69–70) reported that at Toyota, "In the gear manufacturing process, (. . .) each worker attends to 16 machines (. . .) which perform different types of operations: grinding, cutting, etc." This aspect of having the minimum number of workers handling the maximum number of different processes should not be confused with the notion of un-manned processes or computerized processes. Here the worker successively switches on machines, mounted items on them, detached processed items, etc.

production system, with its numerous machines/processes handled by a single multi-skilled and multi-function operator should be designed — and usually is so — to perform the mass production of mixed items in batches as small as possible (see Table 1). Its aim is thus to ideally produce as many various types of similar products as possible so as to meet the various demands of the market. *Single operator, single production line, multitude of various processes and mixed production system constitute another set of asymptotic goals that just keeps the system dynamics alive and reminds us that there is no end to improvement activities.*

Asymptotic goals and JIT/lean system's dynamics

The asymptotic goals of the JIT/lean are the engine that keeps the system running continuously, autonomously and confers to it its auto-dynamic aspects.

Exhibit 2: Characteristics of production systems' dynamics: JIT/lean system vs. conventional production system

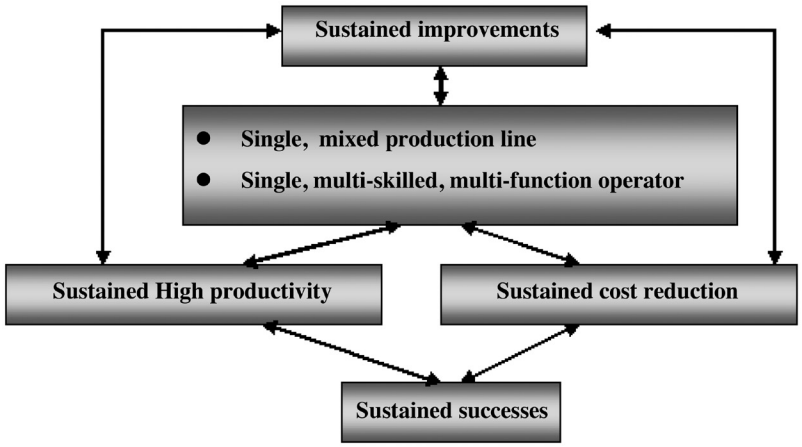


In fact, those goals keep the system questioning not only itself, but also the means and methods it uses since it can never be 100% satisfied of its performance even though it breaks many of its own past records. If the too high level at which those goals are set is lowered, one may get

the satisfaction of reaching them; but at the same time that sets limits to human creativity and, by the same token, leads to *time-framed* improvement activities. Therefore, there is no kaizen without unreachable goals. And kaizen is the sign that the system as well as its supporting structures (QCC and SS) remain permanently dynamic (Exhibit 2). This is a main feature that distinguishes JIT/lean or TPS from other production systems.

The TPS/JIT production system is the best example and the classic model of the lean production system (Womack et al, 1991). The system goals were inscribed into its genes at its inception more than 50 years ago. This internal source of seemingly unstoppable dynamism ingrained into the production system genes has allowed TPS to sustain its successes (See Exhibits 2 & 3) over half a century and nothing seems to stop it from doing so for another 50 years or more. The system's real focus on the minimal use of its resources and on the maximal output is another source of its internal dynamics (Exhibit 3).

Exhibit 3: Lean system's resource goals and sustained successes



The JIT/lean system's dynamics are shaped in the management vision, i.e. "reduce the cost to its bare minimum"[7]. That vision of total cost reduction prevents the system from being idle. The dynamics of the system seems thus to be innate.

The initiator of the TPS must have foreseen the fact that in the Japanese context where managers are promoted from within, if there are no extremely, over-ambitious goals to aim at, it would be impossible for a company to keep improving and improving, i.e. to overcome the routinely negative effects of the corporate cultural inertia that threatens the life and the future of

7 The reduction concerns: the costs of quality, fast delivery, holding and/or producing inventories, logistics, maintenance, after-sale service, customer's turnover, lost sales, mixed production, production equipment, etc.

any business enterprise. On the other hand, it was understood that if those ambitious goals were not perennial, the risk of not being able either to make or to sustain improvements (i.e., the risk of becoming less performing and less competitive) would increase highly with the time.

Decades ago, the TPS/JIT system looked then like an automatic self-winding watch, as opposed to an ordinary mechanical watch that needs manual winding every 24 hours or so. Nowadays, it can be likened not to an ordinary battery-operated electronic watch, but to a solar watch for which there is no periodical or frequent need of battery replacement. It can also be understood in the same framework as the mechanism of a radio wave-controlled watch that does not require manual adjustment. The system adjusts itself to the evolution of time and technologies while its basic ideas, philosophy and goals do not change all. The kanban system, for example, that is a necessary step toward the single-object lot production has adapted itself from paper-based to electronic-based format. The basic concept has not been affected at all. Only the tool has been adapted to take advantage of the new technologies in the changing working environment[8].

Toyota has accumulated over 50 years of 1) relying on the same system that keeps running perfectly and performing well; 2) teaching the system to generations and generations of workers; 3) stunning results, steady growth, and sustained successes, and unstopped improvements based on the lean system's application: The TPS/JIT/lean system is thus not only part of Toyota's blood and flesh, but also integral part of its culture, vision and philosophy. And the system's positive inertia was set in motion half a century ago. That initial inertia has been maintained by and thanks to asymptotic goals that make up the system's dynamics, which in their turn keep the latter, we insist, running in an autonomous and continuous way.

Concluding lessons and perspectives

Of the many lessons that can be learned from the inquiry into the JIT/lean system dynamics' analysis and the classification of its objectives, the following (just a few) may be mentioned.

1. Reachable goals result in time-framed projects on the application of the JIT/lean system. Such a system, even though it is lean, can not sustain its improvement activities and its successes beyond the defined time range. The production system usually loses its dynamics or impetus once the goals have been attained.
2. Reachable goals may be a symptom that management have a short-sighted or short-termed

8 In the same way, the concept of self winding-mechanism is realized through the one of permanent solar recharging batteries. The main concept remains the same, i.e., not to wind manually, or not to recharge the watch (by changing batteries).

vision. It may also be a sign of a partial understanding of the true nature of the JIT/lean system.

3. The true JIT/lean system pursues goals that are both asymptotic and perennial in their ambitions (z-goals and s-goals). These two attributes of the JIT/lean system goals imply the setting of not only permanent but dynamic QCC/SS structures.
4. Such goals are the sources of the driving forces that keep the JIT/lean system dynamics active and permanently activated and that constrain to endless efforts at making improvements continuously
5. Because of the perennial aspect of the pursued goals, JIT/lean's system by its nature is not time-framed. Consequently, the JIT/lean system's successes are sustained over an extremely long period of time that may go beyond any expectation.
6. Corporate ultimate, primary and/or fundamental goals must be the driving and main forces that energize in a perennial way all the techniques of the production system and their respective operational goals.
7. Management must have a long-term vision that can not be badly affected by the changing industrial and technological environments over a short period of time. The corporate vision shapes strategic goals, which in their turn affect production & operations system's goals.
8. The system dynamics should be inscribed in the corporate vision and genes. And we need great visions. "Give men castles to build", stated J. Malraux, a French statesman and man of culture. How long will your castles stand the demanding test of Time? The answer may reside in the fact that your goals are time-framed or not.
9. The system must become part of the corporate active life and of its past, present and future culture.

In a word, the analysis of the JIT/lean system shows that company goals and vision are the source of its dynamics and its sustained successes.

As a manager on the hands of whom lies the future of your company, have you ever benchmarked your enterprise's goals and production system against one of the best production system, i.e., JIT/lean production system? Is your firm lean? Do your production system and its goals contain the internal sources of its dynamics? If you have ever made or make improvements, can they qualify as non-time-framed improvements? Can their supporting structures stand the demanding test of the times ahead? Can your production system keep its dynamics for ever? And so on. If the answer is no, the JIT/lean production system with its asymptotic and perennial goals offers itself as a very good ready-made alternative, an effective and efficient potential solution for your company. Don't waste time and company resources trying to re-invent the wheel since it is already there, i.e., this excellent lean production system of our time is already there waiting to be

adopted and used. You can and need to use it instead of trying to develop in-house production system[9]. Schonberger[10] clearly reassures every potential user that the JIT/lean system is simple to learn and to use. You may have to improve and modify it so that it can fit the specific needs of your company. Switching to JIT/lean system may mean identifying and setting goals that would require company's life long efforts and would thus keep the system running continuously.

This paper may suffer from focusing on a very few companies and drawing a lot on our own long Japanese experience and on some company visits in Japan, France and Germany. But the totally new approach to the JIT/lean dynamics has the main advantage of opening new investigation paths. I hope this study will attract the attention of company executives and managers, management professionals, consultants, students and researchers. I hope it will become a valuable source of reference and discussions. I hope at last that it will be supplemented by some other qualitative investigations and completed by more quantitative approaches.

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9 Nowadays, nobody tries to waste company's scarce resources developing in-house or customer-made spreadsheet or word processing software. One just picks and uses the best packaged products that are in stores!!!

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