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The Significance of Shortening Lead Time From a Business Perspective

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The Significance of Shortening Lead Time From a Business Perspective

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Abstract

The global economy has become stricter since the start of the 21st century. The international environment has continuously changed, making business more globalized and complicated. It has become common for companies and inter-firm networks to undergo transition periods, which demand agility and flexibility. As resources remain limited, greater speed is necessary.

In this article, the production lead time (LT) and the capability to shorten it are reconsidered. This LT is the key indicator of deep competitiveness and assists with the realization of surface competitiveness. Furthermore, the purpose is to extend it to management's understanding, and inspect its significance by judging it from the business management and corporate performance perspectives, which are concerned with the organizational capability of genba to shorten production LT.

In particular, two viewpoints will be proposed—one is the shortening of "Investment LT" into "Total LT for Investment Recovery Improvement," which is necessary for realizing business sustainability, and the other is the shortening of "Management LT," to build flexibility and agility in business activities. My research questions are simply, "What are the internal and external benefits of shortening LTs for organizations, and who enjoys them?" "Which LT has the most value?" and, finally, "In which business area are LTs noticed?" This analysis considers the internal and external environments of the manufacturing industry.

Keywords

Shortening Lead Time, Manpower Reduction, Inventory Reduction, Kaizen,
Toyota Production System (TPS), The Investment Recovery Efficiency, Agile Company

Introduction[1]

The global economy has become stricter since the start of the 21st century. The international environment has continuously changed, making business more globalized and complicated. It has become common for companies and inter-firm networks to undergo transition periods, which demand agility and flexibility (Oku *et al.*, 2010; Oku, *et al*., 2011). As resources remain limited, greater speed is necessary (Kazusa, 2000a/b/c).

Given these conditions, what is the most important competitive factor for a sustainable business? According to the notion of *monozukuri* ("open manufacturing"), innovation and product development power based on a corporate philosophy and a corporate strategy―or "good design"―are essential. The organizational capability to create a smooth product flow—or "good flow"—in manufacturing workplace (*monozukuri genba*) is also required. This capability is referred to as "deep competitiveness," as opposed to "surface competitiveness," such as market price competitiveness.[2] This deep competitiveness leads to valuable financing results and product share realization through surface competitiveness (Fujimoto, 1999, 2007).

These concepts were pieced together by considering manufacturing at *monozukuri-genba*, considered on the basis of product architecture. This architecture has also been applied to services (Sato and Fujimoto, 2007). However, when agile responses to environmental changes inside and outside the company are required, we can create a more workable frame by applying this concept to organizational structure and corporate management.

In this article, the production lead time (LT) and the capability to shorten it are reconsidered. This LT is the key indicator of deep competitiveness and assists with the realization of surface competitiveness. Furthermore, the purpose is to extend it to management's understanding, and inspect its significance by judging it from the business management and corporate performance perspectives, which are concerned with the organizational capability of *genba* to shorten production LT. However, in this instance, the long-term corporate performance including cash-in-flow increases is added to the short-term financing achievements.

In particular, two viewpoints will be proposed—one is the shortening of "Investment LT" into "Total LT for Investment Recovery Improvement," which is necessary for realizing business sustainability, and the other is the shortening of "Management LT," to build flexibility and agility in business activities. My research questions are simply, "What are the internal and external benefits of shortening LTs for organizations, and who enjoys them?" "Which LT has the most value?" and, finally, "In which business area are LTs noticed?" This analysis considers the internal and external environments of the manufacturing industry.

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[1] This article is the presented paper for the"The 5th International Supply Chain Management Symposium and Workshop –Building Dynamic Capabilities Across the Supply Chain: Challenges in the Age of Complexity and Globalization", held in MMRC (The University of Tokyo, Manufacturing Management Research Center) on March 08-10.

[2] Fujimoto,2007 says, "Surface competition takes place in plain view of customers. Companies strive to outdo each other in appealing to customers through pricing, performance, reliability, availability, and service .... Significantly, price competition does not necessarily include measures for strengthening companies' deep competitiveness" (Fujimoto, 2007, pp.7-8).

1. Strategies to achieve the customer LT

This chapter considers a variety of strategies for choosing appropriate customer LTs from the customer satisfaction perspective. Furthermore, the organizational capability to shorten production LT is considered to support strategic choice.

1.1 The existing definition of LT

Definitions of LT vary. There are two kinds under JIS Z 8141-1206:

(a) The time between the placement of an order and delivery. This is also called the "procurement LT."
(b) The time between the preparation of the material and the completion of the finished product.

Definition (a) issues from the viewpoint of the order side while (b) comes from the viewpoint of the supply side. One is the "customer LT," the flow of customer information when the customer's information is the input. The other is the "LT along the flows of supply chains," the flow of design information (Fujimoto, *ibid.*).[3] It is often meant as (a) customer LT according to the global standard, but, when the organizational capability of the *monozukuri* (manufacturing) of a Japanese company is discussed, (b) production LT is seen as the important direct measure of its ability (Womack, *et al.*, 1990; Fujimoto, *ibid.*; Tanaka, 2004, 2008, 2009). The objective of *kaizen* ("continuous improvement") as represented by the Toyota Production System (TPS) is clearly evident in the latter definition.

The "good flow" aspect of the notion of *monozukuri* (open manufacturing) is the added value flow (design information flow) aimed at attracting customers. To create a "good flow", we need to consider the definitions of "demand LT" and "delivery LT" (Suguro, 2005); both issue from the supply side. If the LT demanded by the customer is longer, it makes it possible to meet deadlines; if the LT to deliver to the customer is longer, it may mean missing goods. The former is controlled by the market, and manufacturers, like suppliers, compete to shorten the latter.

1.2 The strategy of production, sales, and inventory to achieve the customer LT

Achieving the customer demand LT results in customer satisfaction, thus we must understand how the customer demand LT is achieved. We define each LT as follows: α is customer demand LT; β is delivery LT; X is production LT, and Y is forecast LT, prepared before an order entry. In the event a delivery time is the same as the demand time, the following relational expression is formulated:

$$\alpha = \beta = X - Y$$

[3] Fujimoto,2007 says, "Once we comprehended products as media infused with information, we can understand product development as the creation of design information and production as the transfer of that information to products" (Fujimoto, 2007, p. 3).

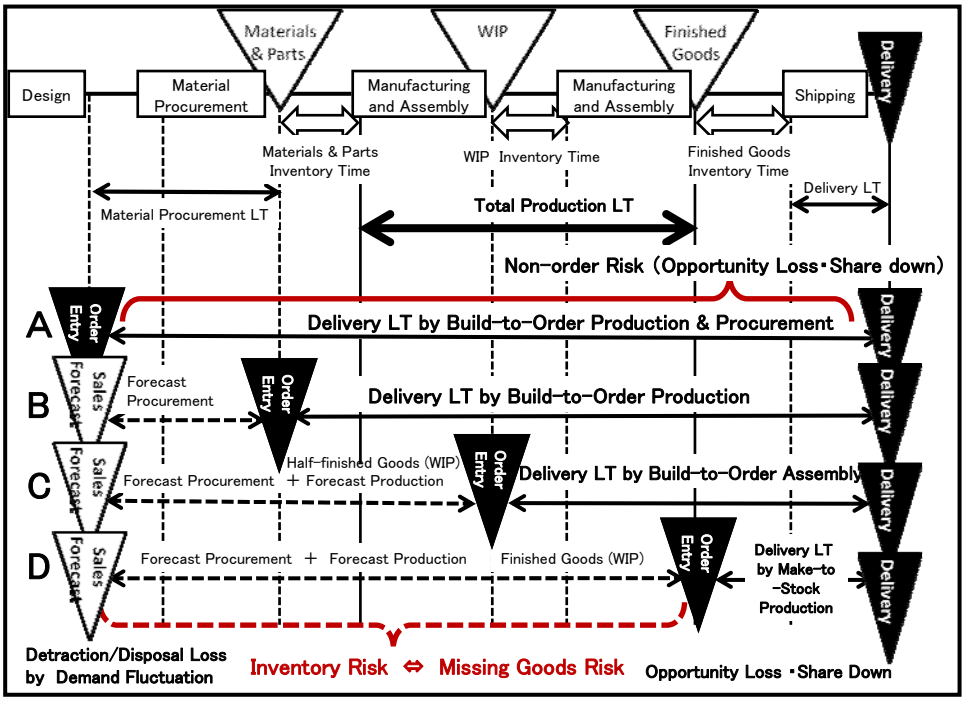

Figure 1 Relationship among delivery LT, inventory risk, and missing goods risk given various order entries and manufacturing configurations

Source: Author drawing based on Suguro, 2005, pp. 21–23

Figure 1 shows the relationship among delivery LT, inventory Risk, and missing Goods Risk given various order entries and manufacturing configurations. Manufacturing configuration is differentiated according to the timing of the order entry (presentation of the customer demand LT). The dashed line on the left side of Figure 1 shows the forecasting procurement and production based on the forecasting of market needs and sales. The solid line on the right side shows the procurement and production after each order entry. Patterns are used to show the process from A to D, where A is a complete built-to-order production, and D is a complete make-to-stock production. There are numerous patterns in *genba*. The boundary line between make-to-stock and built-to-order entry is the contact point between demand and supply, called the "decoupling point." According to the notion of *monozukuri* (open manufacturing) (Fujimoto, *ibid.*), this is the contact point between customer information and design information.

The strategies for production, sales, and inventory are selected according to where the contact points between customer information and design information are set. When the contact point is set on the upstream, waste of inventory is decreased. Instead delivery LT gets longer after the order entry, along with the risk of missing orders, because the delivery date is missed. To avoid this, the manufacturer needs a product with an extremely strong appeal or the capability to meet deadlines by vastly shortening the LT.

On the other hand, in complete make-to-stock production, the missing order risk is decreased by adopting a sales strategy to handle inventory. Instead, the WIP and finished goods inventories increase. They are not guaranteed to sell, though; thus, the inventory risk through make-to-stock production

increases so that the point of contact becomes downstream. Under this circumstance, if we daringly try to reduce inventory, we will face a lack of an assortment of goods or product shortages. This leads to goods that cannot be sold, as there are no goods the customers want when they wants to buy, called the "missing goods risk." Methods were developed to solve this condition by minimizing risk: a later process takes what is needed from an earlier process, or the "*Kanban* Method" in TPS (Ohno, 1988). In the Theory of Constraints (TOC), the main method is the way the neck process is managed (Goldratt, 1984).

1.3 Capability building that can shorten production LT gives us many options for strategies

Customer needs diversify, and the competition among companies intensifies, so it is necessary to meet customer demand LT. However, there is more than one way to do this, as noted before. Even if the primary customer values are the same, the means of meeting them can be diametrically opposed to each other depending on the company's business condition and strategy. If we discuss local production LT in each process without taking into account these business strategies and policies, the discussion may not be suitable to the business objectives.

Which choice to make? Should we choose build-to-order production or make-to-stock production? Do we wish to make the inventory or to shorten production LT to meet the demand for short delivery times? Which side of the supply chain is to be selected as being more advantageous to the firm? Furthermore, how are the focused on, R&D in the upper stream of the value chain and marketing function connecting the upstream to the downstream? How do you distribute a resource for capability building in the production site? A business must consider various problems, including the difference in information granularity through the organization's hierarchy.

The problem concerning LT is the key to this paper's objective. Previously, cutting losses of sales opportunities or initiating stock reductions of finished goods have been defined as the conventional binary opposition. However, the best means of changing this relationship is shortening production LT. If this could be significantly shortened, it would reduce many risks, not only the inventory risk and the missing goods risks but also the product obsolescence risk and the abolishment risk when the products change, which are happening more often in this era of change. There are two possible directions of information flow—customer information and design information. The production LT strategy of the company is dependent upon where these two flows come up against each other; this decides the product and sales strategy. In this case, capability building that can shorten production LT gives us many options for strategies.

2. The present conditions and problems concerning shortening production LT

In this chapter, the present conditions and problems concerning the shortening of production LT in *Genba*-Kiazen are discussed. The difference between two kinds of time axes is noted: one is the axis for transferring design information, and the other is the axis for the transferred side.

2.1 The bridge between shortening production LT and corporate performance

There are studies from the viewpoint of production LT that can lead us to corporate performance and make use of proper business management (O'Brien and Sivaramakrishnan, 1994; Kazusa, 2000b; Kren and Tyson, 2002; Mizushima, 2002; Horngren *et al.*, 2008; Hiiragi, 2009, 2010, 2011; Kawada, 2009; Maguire, 2009; kawada and Imai, 2011). Some studies have even conceived of the time axis as the rate or cumulative data (Preiss, 2000a / b; Tanaka, *ibid.*). However, it has been less advanced that how every *kaizen* method is lead to its result as a business performance.

Figure 2 shows what kinds of effects *kaizen* has in actual *genba* when production LT is shortened. It also shows how to lead financing numerical value. Production LT is divided into three parts: working time, listed as manufacturing time (transferring design information time); transportation time; and retention time. Of these, it is only working time, which is involved in transferring value-added information to a media through the flow to the customer.[4] Even transportation time is now needed; this is the time during which the product moves, which adds no value. Furthermore, retention time is the wasted time during which the product cannot get any closer to its destination. That is the true identity of an in-process inventory.

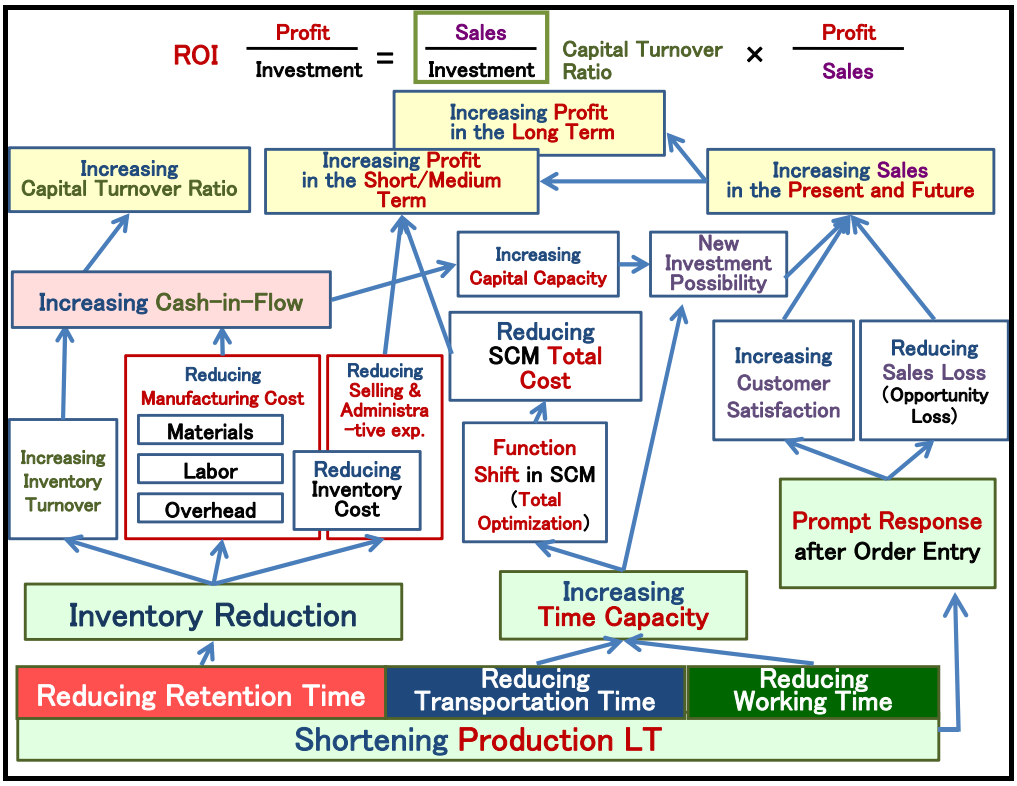

Figure 2 The relationship between shortening production LT and ROI through better corporate performance
Source: Author drawing

Theoretically, production LT can be shortened by reducing any part of the above. Among them, it is the retention time that is most shared and is easily reduced if someone feels like doing it. The in-process

[4] To be exact, only the net working time of the working time is transferring design information.

inventory, which has been retained, is decreased by making the lot size small or by elaborating the smooth production flow. This effect is considerably large. Next, the transportation time is preferably shortened, thus contributing to the shortening of production LT. In this case, not only is the physical shortening of distance by changing the layout demanded, but it is also important to always ask, "Is this transportation really needed?" Lastly, we should think about shortening the working time. The ratio of working time in production LT seems insignificant. However, changing the machine is a huge contribution in the apparatus industry. Furthermore, when the man-hours are virtually taken over and if the work is not yet standardized, only work standardization and *kaizen* in operation are sufficient to produce a shortened production LT.

Next, how do we connect the shortening of production LT through these *kaizen* methods to corporate performance? There are three main pathways, as shown in Figure 2:

(1) Increasing the capital turnover ratio by reducing the flow retention in order to increase cash-in-flow (see left side of Figure 2);
(2) Reducing total cost and increasing total profit by reducing inventory-related expenses (see center of Figure 2);
(3) Increasing customer satisfaction by meeting deadlines and achieving short delivery times, thereby increasing present and future sales to increase total profit (see right side of Figure 2).

Every pathway reaches a part of the ROI, broken down into a formula in the upper area of the figure. In particular, the effect on capital turnover is excellent, creating a "smooth capital flow". In addition, capital turnover is shown as the inventory turnover in *genba* level, and as the ROA or ROI in total business.

2.2 The trend of the themes in real-world *genba-kaizen* and related considerations

To assess the nature of *genba-kaizen* ("spotting continuous improvement") problems across industries in Japan as well as in shortened production LTs, I interviewed OJT Solutions Inc (OJTS), the consolidated subsidiary of Toyota Motor Corporation, in December of 2011. This company provided instructions on *kaizen* and human development based on TPS to all companies except the Toyota group since its foundation in 2003, leading to a total of almost 500 projects across more than a hundred and several tens of companies (mainly in Japan and elsewhere in Asia). **Figure 3** shows the trend of the main *kaizen* theme that OJTS has been instructing over the last five years.

Most instructions concern productivity improvement and occupy a quarter or more of the main theme. According to the OJTS, the contents are mainly efficiency improvements in time management, such as manpower reduction. Manpower includes direct working time, setup time, and preparation time. Some of these reductions lead to better corporate performance, while others are steps towards it. It includes other *kaizen* teachings, such as reduction in down time and increasing work efficiency by implementing operational improvements. All of them are organization capability building in *genba*, to make the base of

present and future corporate competitiveness.

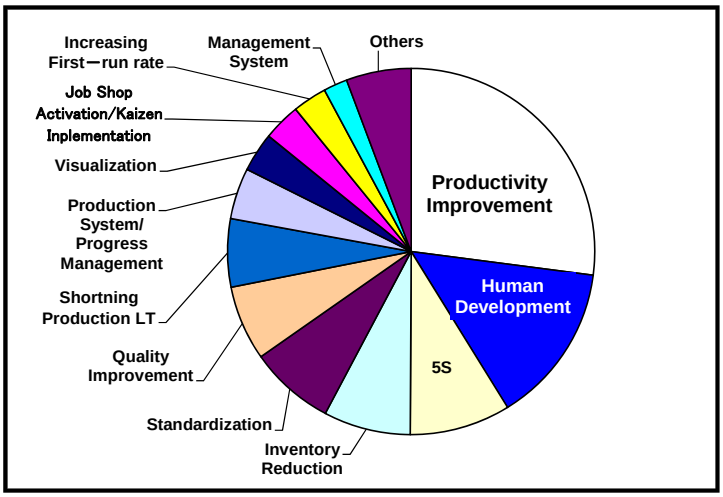

Figure 3 The trend of the main *kaizen* theme that OJTS has instructed (2006-2010)

Source: Author drawing based on data from OJTS

Human development is next, because the guiding principle of OJTS is that developing the talent that puts *kaizen* into execution is the way to make the company more competitive, not only in the short term but also in the long term.[5] Meanwhile, shortening production LT is not as large a share in Figure 3. However, it should be noted that the object of *kaizen* is not to find a solution for just one problem, but for several problems that are integrated in a complex relationship. In what follows, I try to explain these phenomena on the basis of the notion of the "design information transformation"[6] (Fujimoto, *ibid.*).

2.2.1 Shortening production LT, manpower reduction, and cost reduction

In the notion of *monozukuri* (open manufacturing), production is the transfer of design information to products. In the real manufacturing workplace (*genba*), design information is transcribed into media (raw materials), through media (machine and man), and then becomes the finished goods (Fujimoto, *ibid.*). Production LT is the flowing time of the "media (material) as the design information transferred side." Meanwhile, the time of "media (machine and man) as the design information transferring side" is machine working time or direct working time.

Productivity improvement is increased by reducing the input to the production output. To do that, it is necessary to reduce the design information transfer time, which is a manpower reduction. This is different from shortening production LT, which is the "transferred side" time. However, the method of improvement is the cross point between manpower reduction and shortening production LT.

Eliminating wastes, the basic theory in *kaizen*, means reducing non-value-added time in the time axis. It is key to increasing the value-added time rate for improving productivity. The value-added time is equal to the

[5] By valuing the investment in human resources, TPS is said to construct an autonomous system.
[6] Please see footnote 2 for transformation of design information.

net design transfer time, which conforms the transferor side time and transferee side time.

In the *kaizen* used for manpower reduction, many measures are taken to create good combinations of machine and man or to create an efficient media flow (products). As a result, the retention of media (in-process inventory) is eliminated. At that time, it may be used to shorten production LT also, not only reduce manpower. It is important not to confuse manpower with production LT. However, it should also be recognized, however, that, in the *genba*, these two time axes often cross.

2.2.2 Shortening production LT and increasing production output

The relationship between shortening production LT and production output will now be examined. The question, "When production LT is shortened, could we produce greater output?" is often asked. However, this occurs only under a particular set of conditions. The time axis that leads to the production output is the "*takt time*." This is expressed as follows:

Takt time = Today's operating hours／Necessary production output per day (Market needs per day)

In this case, if it is calculated by the second, it is clear how many seconds each cycle of the manufacturing process should take. In other words, *takt time* is the interval of time required to finish one product at the line end. It is assumed that every process of work is cyclic and that there is no variation among processes. Although it is generally called "cycle time" as well, TPS distinguishes them notionally. The "manufacturing process capability rate" is the cycle time, and the "market demand rate" is the *takt time*.

If every process has the same rate of process capability as the market rate, cycle time equals *takt time*. If the cycle time is longer than the *takt time* for one process, *kaizen* leads to cycle time being below *takt time*. The manufacturing strategy of adjusting *takt time* as demanded by the market is called "*takt time* production," which is the basis of TPS time management.

＜The case of shortening production LT and increasing production output＞

The precondition of *takt time* production is less variable among each manufacturing process capability. If it becomes a reality, there is no retention (in-process inventory). In this case, the following theoretically occurs:

Cycle time × number of processes ＝ total production LT through all processes

Thus, it is realized that when production LT is shortened, cycle time is also shortened, which shortens *takt time* too. This means we add more production output.

＜An instance of shortening production LT, although it does not guarantee an increase in production output＞

Aside from this, if there is retention (in-process inventory), because of the variability among

manufacturing process capabilities, total production LT through all processes will be long. Under this condition, if the variability is eliminated, retention is decreased, and production LT is shortened. However, in this case, each cycle time is not always shorten, so does not always shorten *takt time* and may sometimes not increase production output.

＜An instance of shortening production LT, but not increasing production output＞

In *genba*, there may be a large inventory between processes when the productive capacity is even. In such a case, if the inventory is eliminated, production LT is shortened. However, it is not enough to shorten *takt time*, because the cycle time of every process does not change. This means there might be no addition of production output.

＜In the case of remaining production LT and increasing production output＞

The reverse case is increasing production output without changing production LT. When there is no variability among manufacturing processes and retention, if the processes are broken down, every cycle time is shortened. It can even shorten the material input interval and shorten the last process output interval, making it possible to shorten *takt time* and increase production output.

However, there is a high possibility of breaking processes down to increase the input of human resources or machine on the line. This is the method of continuing under the demand expansion period when there is a great need to increase output as input is also being increased.

In this way, the relationship among LT, *takt time*, and production output cannot be uniformly defined. This should be realized not only in the processes (*genba*) but also on the management side.

2.2.3 Shortening production LT and inventory reduction

A man involved in *genba-kaizen* occasionally says, “Inventory reduction will shorten production LT.” This fits well with the process of eliminating retention and shortening production LT by changing the lot size from big to small. If the result is the same as shortening production LT—that is, if it is caused by reducing machine work time due to new machine injections or reducing transferring time due to a high-speed transfer machine injection—it cannot reduce in-process inventory. Once the objective of *kaizen* or the effect needed to improve business management is clarified, the recipe must be formulated; this is the most important part.

Since the fall of the Lehman Brothers, the process of reducing retention inventory in *genba* has attracted attention. In this case, shortening production LT is equal to inventory reduction. Furthermore, it leads to good cash management through cash-in-flow improvements. For this reason, it has been reassessed as a product management theory applicable to finance[7].

[7] Since the earthquake in Eastern Japan on2011.3.11, the demand of inventory has been advocated again. However, it is something that has to be weighed. Fujimoto, 2011 argues, “ the basic principle of designing industrial supply chains should achieve its competitiveness and robustness simultaneously” (Fujimoto, 2011).

3. The viewpoint of the investment LT－The Efficiency of Investment Recovery

In this section, the efficiency of investment recovery is analyzed, and the notion of the "investment LT" as the important indicator of investment recovery is examined.

3.1 The expression of investment recovery efficiency

It is an established theory in financial analysis that management efficiency is analyzed according to two terms: profit rate and capital efficiency. However, this analysis has never been applied enough to a shop floor problem or an improvement project. There is the study to contextualize it in total Management (Kazusa, 2003). And proposals exist for effective individual indexes (Tanaka, 2004, 2008, 2009; Kawada, 2009; Kawada and Imai, 2011), but a unified management theory is required that includes the viewpoint of the whole company and inter-firm network.

Investment recovery efficiency is broken down into two factors, "the rate of the recovery quantity" and "the rate of the speed of recovery." It is formulated as follows:

Investment recovery efficiency

＝ profit margin on sales × capital turnover ratio

＝ (margin／sales) × (sales／capital)

When capital and sales are considered uniform, the RS of the definitional identity—the profit margin on sales—is changed by the "amount of the surplus recovery." In comparison, the capital turnover ratio works directly with the "turnover period" and is influenced by "the speed of the recovery" (Hiiragi, 2011). Shortening production LT contributes to this turnover. However, it is important that the LT should be captured as the total investment LT, not only production LT. Investment LT is defined as the distance between the input of investment and the output of recovery investment. This is the new notion of LT on which this paper insists.

3.2 The homogeneity of company challenges and production spot QCD challenges from the viewpoint of the investment recovery efficiency

How does production LT connect to investment LT? Of course, it is considered most desirable that it is connected by accounting theory, but a considerable number of conditions affect it. As a result, it extracts a simultaneous equation with a great many variables, and it is difficult to formulate simply. However, it might be possible to compare this as a general idea, as shown in **Figure 4**.

The guarantee of quality, a constant basic premise, ranks among the leading QCD productive concerns of the manufacturing company. Its next priorities are cost and lead time reductions. These are the production site challenges of the products, which concern outputs, and they must be treated homogeneously as part of the overall challenges faced by the company in the process of seeking investment recovery efficiency (see Figure 4).

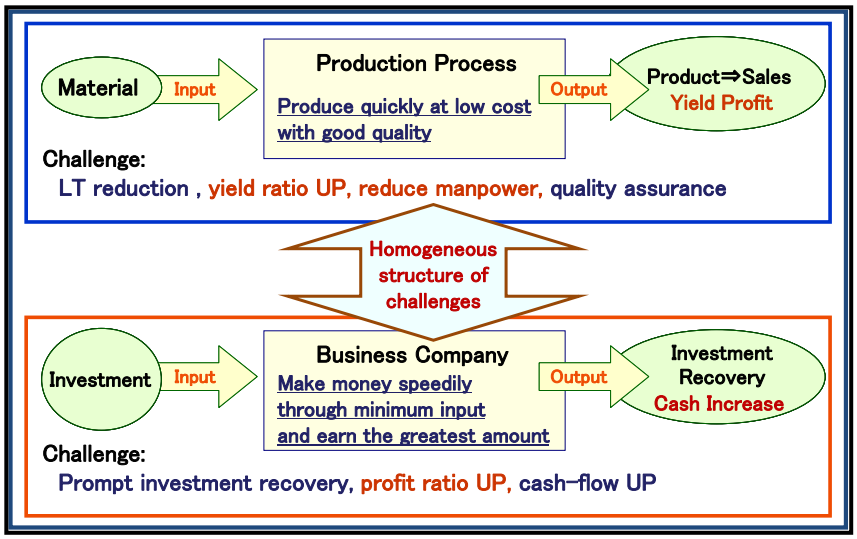

Figure 4 The homogeneity of company challenges and real-world (production spot / *genba*) QDC production challenges

Source: Author drawing (Hiiragi, 2011)

The business challenges faced by the company in seeking sustainability are summarized as "how speedily, through the minimum input and the greatest output, the investment placed should be recovered." This perspective very much resembles the QCD real-world challenge of "how products of good quality and low cost are quickly produced." In both cases, the maximum removal of waste and the greatest increase of output for input and of productivity are essential (Hiiragi, *ibid.*).

I explain this as the notion of the "design information transformation"[8] (Fujimoto, *ibid.*). Investment is the information (how much money the company invests), and investment recovery is the information concerning the company's returns. This is always shown in currency form, so it is easy to understand and for outside stakeholders to compare with the information of other companies. Inside the company, these correspond to the design information of business management. "How much money do we invest, and what return do we get?" are the prime questions (design information) in business.

Production LT is the LT of the "media (material) as the design information transferred side (transferee) " and the LT of the "design information itself transferred to the media." The information in business management includes corporate identity, management philosophy, and business policy. It is to the inventory that this information is transferred in every media as the resources in currency accrue. It is transferred to machine, man, and material. Otherwise, it is transferred to all media concerned with setting up the new project or constructing the new factory. Lastly, when it is transferred to the media as a product, to reach the customer's satisfaction through "good flow," information on the investment is transferred to the customer through all business activities.

In this sense, investment LT is defined as business design information flow in all business. Thus, as the production LT is the KPI of organizational capability in *genba*, investment LT is the same as the KPI of

[8] See footnote 2.

organizational capability in total business.

4. The viewpoint of the management LT

－Management becoming integral in the face of complexity and globalization, and its axis

In this chapter, various LTs in many phases of business are confirmed, the expansion of the product architecture theory into the management level is proposed, and the total indicator of business agility is advanced and concluded in management LT.

4.1 LT as the horizontal axis to get over the supply chain

The business activity of a manufacturing company is distributed as illustrated in **Figure 5**. In the first stage, the firm develops its business and product strategies, which determine what it will produce for its existing and potential customers. Next, facility and production strategies are put in place, since these processes concentrate on where and how the proposed goods will be produced. They include choices at the business level, such as product-out or market-in and make-to-stock or build-to-order. Such strategic decisions are the duty and responsibility of each management layer of the company.

In all these situations, competitiveness arises from each lead-time reduction, since the modern company requires quick responses to changes in its product strategy; it also contributes to the early recovery of investment. In all these LTs, the total flow indicated in Figure 5's lower section is equivalent to the main tasks of the manufacturing company. These embrace everything from the purchase of raw materials and parts to production, distribution, and sale. In the search for optimization, a company seeks to enhance its internal organization and its external collaboration with associated firms in the inter-firm network (Hiiragi, *ibid*.).

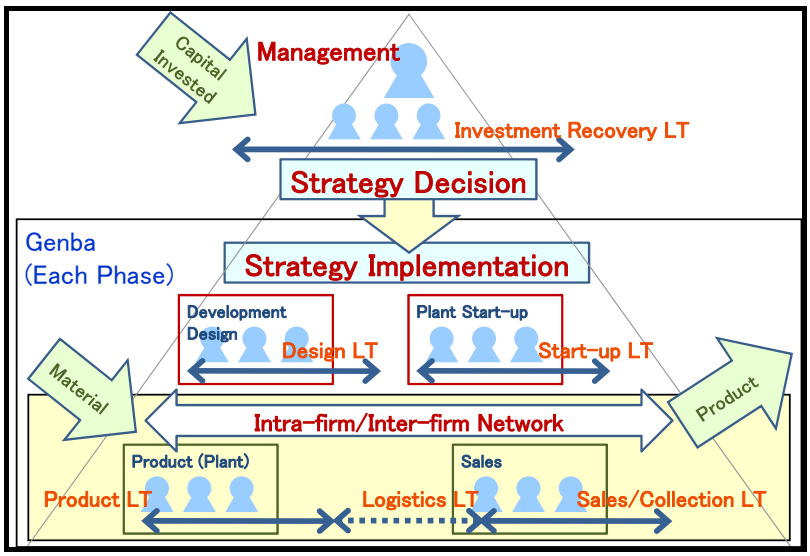

Figure 5 LT on each phase of the manufacturing company

Source: Author drawing (Hiiragi, 2011)

This is the "LT as a horizontal axis over supply chain companies." This used to be studied as the total management of supply chain (Fujimoto, 1997; Cooper and Slagmulder, 1999; Frazelle, E. H., 2002; Ferdows, *et al.*, 2004; Holweg and Pil, 2004; Slone, 2004; Iyer, *et al.*, 2009). It was repeatedly emphasized that the total optimization of the supply chain of total LT is important. It was researched using specific cases, such as the linkage between sales and production, and the formulation of the supply chain in global bases (Asanuma, 1994; Tomino, 2003, 2004, 2010; Liker and Chei, 2004; Kurokawa, 2008; Tomino, *et al.*, 2008). It has been also recommended to apply the accounting method to supply chain management (Mizushima, 2002; Monden, 2009, 2011). This is as important as the LT or the horizontal axis t in the cross-section.

4.2 LT as the vertical axis to connect management to *genba* in the organization

Proposal that the product architecture theory be expanded to the management level

I suggest that management under globalization and complexity does not come into effect by modular correspondence but needs integral capability. The strategic decision method that put a domain in the corporate strategy or the plural choices (such as product portfolios) are already well known. However, corporate management becomes a condition needing solution by a simultaneous equation under the multifactor. Under these circumstances, the integral notion is not product architecture but is, instead, extended to strategic or management architecture. In this way, the advantage of the Japanese company is exploited.

To not fall behind the speed of change but, rather, to create a competitive advantage, it is fundamental that we set milestones for each business objective, perform agile decision making, and take action quickly. Thus, the integration of management adds importance to management decisions and to the viewpoint of the time axis.

Investment LT is an example of currency amount. However, LTs should be established in physical amount, too. These correspond to the LTs in the phases in Figure 5. Among them, those stages have become more common that deal with changing, such as product development, factory launch, and elimination/consolidation of production bases in each strategy execution phase. This proceeds to increase sending and receiving information in a lengthwise direction to joint management in *genba*. It is important that the necessary information be delivered when it is needed. That is why applying the notion of LT is effective. This paper presents that the notion of management LT includes all those perspectives, and each one is also quite important.

Conclusion－Importance of shortening LT to realize a lean, agile, and flexible company

It has been insisted upon that speedy and agile management is important. Studies have pointed out the importance of LT speed in the supply chain (Facilitators, 1991a / b; Goldman, *et al.*, 1995; Christopher,

1999; Industry Team and Lee, 2004; Sabri and Shaikh, 2010). Being fast is not enough, though. Premature judgments are never good for business, either. A management strategy should be developed purposefully according to the appropriate schedule, starting from the customer satisfaction in the current and future markets. The "just in time management" is needed in the age of change (Kawada and Imai, 2011). A unique IT system has been also proposed to bring to fruition this kind of management (Oku, *et al.*, 2010; Oku, *et al*., 2011).

Therefore, the time schedule should be the back calculation from the last goal (customer). That is why this paper places so much focus on the notion of LT instead of speed. The pull production method (a latter process that takes what is needed from an earlier process) of TPS is in the back stream of the customer's needs. This was the "reversal" idea, taking the axis as the material flow (design information flow) in the supply chain.

Appling this to the total management system, the business management should be the "pull system of the customer-value." The axis of business management should be encompassed by the LT that is pulling-time inversing from the time over target instead of the speed of the pushing-time. This is the proposal I will conclude with.

The benefit of a "lean company," given the competitiveness of Japanese manufacturing, is not denied. The speed of the whole company is strengthened through the integrally grinding ability at the source of the power of a lean company. In this case, the LT perspective is needed, starting from the customer and extending backwards. The concept of the ""new" agile company" that is required is different from the "agile company" presented by the virtual corporation combination, advocated in the U.S formerly. Furthermore, to handle rapidly changing needs, a company needs not only agility but also flexibility. To realize a "lean, agile, and flexible company" for superior competition in the next generation, the expanded vision of the total management viewpoint, and the reevaluation and reconstruction of the capability to shorten LTs are required.

In this paper, I explained the contemporary condition of *kaizen*, and of shortening production LT in actual *genba*. How these actions relate to business performance issues was also examined. On that basis, two points were elaborated: the expansion of the LT viewpoint and the importance of the organizational capability to build in order to shorten all LTs in *genba* and at the management level. It is necessary that these issues be applied to real business cases. I present this as a future challenge.

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