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Viewpoints for Effective Manufacturing Revolution*

— Changing Manufacturing Sites, Unchanged Principles —

Abstract

Many Japanese manufacturers are implementing various production revolution programs for their survival in the ever-severer business environment. Among those diverse programs are two which are attracting considerable attention: 'outsourcing' of production function; and 'cell production system' introduced in many assembly lines. Both of these activities are expected to generate sizeable performance improvement results, the former by concentrating management resources on core business areas while cutting off non-core operations of the business, and the latter by making a leap in productivity at assembly lines.

This paper discusses concepts of 'outsourcing' and 'cell production system' in order to clarify often-forgotten keypoints to be noted in adopting them, while paying attention to the mechanism of how each of these concepts achieves business performance results. More specifically, it presents viewpoints needed in evaluating these concepts from managerial viewpoints and considers each viewpoint using a couple of actual cases. It then goes on to present three basic principles to be remembered in implementing

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productive innovation in truly fruitful manner. This paper explains each of these principles and gives views on managerial guidelines for implementing them.

1. Introduction

In recent electronics industry, a business form of outsourcing manufacturing called EMS, or Electronics Manufacturing Service, is getting popular. This business style, born in the US in late 1990s, aims at achieving cost reduction through scale merits by accepting manufacturing orders of highly competitive electronic parts from multiple companies, and has come to be the center of attention in Japan. Solectron Corporation is a case in point. Its existence came to be known widely when Sony sold its Nakaniida Plant in Japan and Sony Industries Taiwan to Solectron Corporation in October 2000 as it made its manufacturing function to be an independent, manufacturing consolidated subsidiary called Sony EMCS (EMCS stands for engineering, manufacturing, and customer service). Choosing such a course expecting increased order receipt and cost reduction is getting more popular among Japanese electronics businesses. Other examples include: Matsushita Electric Industrial reorganizing its manufacturing sector as a factory center; and NEC making NEC Systems, a manufacturing subsidiary coordinating its manufacturing sector. Increased collaborative production on the global scale and rapid development of information technology, coupled with protracted recession of Japanese economy, have led businesses to rethink how products should be manufactured, compelling them to join cut-throat cost-reduction competition for their survival. Such cost reduction activities are generally referred to as 'production revolution' or 'production reformation'.

The general term 'production revolution' varies widely in its substance from case to case, sometimes even including activities not worthy of its name. In this article, the author will shed light on 'outsourcing of production functions' and 'cell production system' adopted in assembly lines, both of which are dealt with frequently in recent production revolution literatures, and sort out points the author considers important in effectively renovating production activities.

2. Implications of Outsourcing

'Outsourcing' takes various forms. Besides cases in which production operations are

entrusted to other companies (companies within their own group of companies, or sometimes entirely unrelated companies), there are those in which production and material handling activities of their factories are delegated to external human resource companies. It is no longer a rare view to find, in one factory, workers in various other companies' uniforms working on the premises under in-house labor subcontracting arrangements. Some companies even outsource indirect functions, such as personnel management and accounting. For instance, Hitachi Ltd. established a company to which they outsource accounting and financial functions, while Fujitsu and NEC outsource wage accounting function. With outsourcing, companies expect, at the management level, reduction of fixed personnel cost and converting such cost into a variable cost, besides increasing the level and speed of operations by depending upon specialized companies. Many companies choose to spin off part of their operations to be independent companies, holding up an objective similar to that of EMS, i.e. receipt of orders widely from other companies in such functional areas.

In the studies of business administration, argument that, against the backdrop of changing social structures where walls between different companies and different departments are getting lower, companies should network widely with many others and concentrate their management resources on their core business areas while outsourcing non-core operations to other companies. It is true that labor cost can be saved by replacing regular employees with those of subcontractors, and that increased fluidity of labor market is conducive to obtaining external labor resources. It is necessary, however, to stop and think carefully about merits and demerits of outsourcing. Questions are: why does cost decrease if production activities are entrusted to outside companies; what are merits other than cost reduction; is there no demerit in outsourcing? Asking such questions leads us to some points to be noted hidden behind outsourcing. The following section deals with important viewpoints and considerations about outsourcing.

3. Viewpoints of outsourcing

Viewpoint 1: Total volume of work does not change.

When production activities are outsourced, the size of production lot increases at the outsourced company, bringing about (or more strictly, increasing the likelihood of bringing about) advantages of reduced setup cost as well as curtailed purchasing cost

through combined procurement of raw materials. If the outsourced company has extra production capacity, utilization ratio of their equipment will rise, to decrease equipment cost per piece of product and total production cost. Consolidating production volume thus produces effects generally referred to as 'economy of scale.' Skill development of operators would also be promoted through volume production. Whether production is outsourced or not, the total amount of work remains the same, excluding some factors such as setup change times. Naturally, production volume does not increase whether manufacturing is outsourced or done in-house, unless new orders are received.

Then a question rises: Why is it if the 'amount of work' changes, which is a substantial cost-driver in cost accounting? If the outsourced company should succeed in reducing the amount of work, then differences in factors, such as processing time per piece; time it takes to change setup every time; and efficiency of work related to planning and managing production activity, should be involved. Such differences are 'achieved' as a result of accumulated day-to-day, diligent improvement activities. An argument in which such differences are attributed to the economy of scale or advantages of specialized manufacturers without looking deeply into the reality lacks in the fundamental operational perspective, and looks only at superficial phenomena.

Now, let us leave manufacturing industry for a while and consider the case of entrusting a whole food section of a department store to s specialized company. Specialized food producers have accumulated know-how as to how the store space should be laid out, how the efficiency of order placement can be improved, and how best personnel can be assigned to the store space and payment counters. You are jumping to a conclusion if you decide to leave the whole store space to an outside company expecting increased sales and reduced cost. There should be various differences in the ways how work is executed between specialized producers and employees of department stores. Detailed analysis of such differences and their causes may clarify room for changing how department store staff may work. For example, in a department store, a great deal of man-hour may be spent in processing order placement forms because the form is not only complicated but to be handwritten and be carbon-copied. This not only reduces time for waiting on customers but becomes a cause for the staff having to work overtime. There is a lot of room for improvement in this case; changing the format of order placement form,

simplifying product item coding system; and systematizing work itself, among others. If all such areas are improved thoroughly, leaving little room for further improvement, then, very few companies would want to make a decision to leave the whole work with a specialized company. Comparing your work with that of a specialized company when there are a number of wastes and losses in your company is one thing; and doing so after your company's wastes and losses are sufficiently eliminated is another. There will be tremendous differences in terms of accumulated improvement skills and human resource development. All the knowledge and experience gained in the improvement process are important assets which are never born out of the attitude of simply choosing to outsource operations without improving their own processes.

Viewpoint 2: Negative Impact on the Improvement Activities on the Production Shop Floor

In the previous section, this paper stressed the importance of improving the company's own operations before outsourcing. In fact, outsourcing production operations may even obstruct daily improvement activities.

Typically a company subcontracts part of their production operations, such as certain assembly line or lines, processing or machining, or parts feeding to in-house labor subcontractors. In such a case, the leader of the subcontractor functions as a foreman or supervisor. When an operator of the subcontractor hits on a good idea for improvement, the idea would be conveyed through the leader to a person in personnel department of the parent company, then, it would be handed over to the manager of the pertinent production department/section. In some cases, there would be too many people and organizational levels in-between, where the improvement idea is 'filtered.'

It will take time for valuable suggestions to reach and in the process biases are likely to get in. In observing and analyzing work of subcontracted operators on the shop floor one often comes across cases where the operators' good ideas are not communicated, or information they have about brief but frequent stoppages is not informed to the manager of the manufacturer. Besides, concern that the amount of their work may be reduced as a result of their improvement suggestions may discourage operators and leaders to make such suggestions. Generally, they are simply expected to provide labor rather than

coming up with improvement suggestions, and in most of the cases, it is up to their own will to participate in the manufacturer's suggestion scheme or QC circle activities. This situation is not conducive to motivating subcontractor's workers to improve operations, and division of those who think and those who operate would advance. Besides such a division becoming a major obstacle to the progress of improvement activities, a split once created is hard to mend. Here lies an important point the management should keep in mind.

Viewpoint 3: Loss of Inter-departmental Synergy

Another important viewpoint concerning the improvement of production workshops is that it involves coordination of work with other departments, such as product design, production engineering and production management. This means that, if there is a problem in such departments in terms of their quality of work or how work is carried out, such shortcomings may surface at the production workshop. For instance, if a product design is not appropriate or commonality of design between different models is minimal, shortcomings may emerge at the workshop, such as poor workability, unnatural workers' posture required, or increased man-hours for setup changes. If production engineering department develops hard-to-use equipment or jigs and tools, the production workshop will be faced with increased maintenance man-hours or unreasonable or wasteful motions. If the production control is poor, waste in communication associated with change in the production plan and confusion resulting from urgent orders will emerge. Conversely, various departments of a manufacturer may discover and understand their own areas of improvement by visiting production workshops.

Outsourcing production activities as an easy way out, therefore, has a demerit of making these problems obscure. If a manufacturer transfers its production base to an outside company, it would become difficult for them to observe its workshops directly. Even if it asks a subcontractor to operate on their own premises (in-house labor subcontracting), it would be hard for the indirect departments to obtain concrete suggestions from subcontractor's operators. Inter-departmental coordination made centering around production activities has been one of the strong points of the Japanese manufacturers. It should be noted that, no matter how advanced the information technology may be to make inter-departmental communication easier, coordination

stated above cannot be achieved without involving actual production workshops.

4. Significance of Cell Production System

In the recent discussions about manufacturing revolution, cell production system is particularly highlighted at assembly lines. Many journals feature the system as a hot topic with eye-catching titles, such as; 'This is the One-man Production Line in Vogue' (1995 July ed. Kojo Kanri (lit. Factory Management); 'Labor Saved to One-third by Introducing One-man U-line' (1997 June ed. Kojo Kanri; 'Shockwave from Removal of Conveyor Line—Cell Production Completed with One Man' (1995 July 24 ed. Nikkei Mechanical). Reading through all these articles reveals, though, that the cell production system is understood in a broad (or, in a way, ambiguous) sense, which means 'a method of production carried out by a limited number of operators by removing conveyor lines'. It is understood that such a system was started by Compaq in the early 1990s which replaced its existing belt conveyor-based flow production system with four-men units, each of which was engaged on a work table in the whole process, i.e. from assembly, installation of software, through final inspection, as a way to cope with increased number of PC models. Since then, this method has been adopted by various types of industry for producing such products as monitor TV sets, audio-visual equipment, personal computers, and cellular phones. It is generally defined as a system with which one to several operators manually work on a product, instead of belt conveyor-based flow production. There are, however, several variations including; division system, in which several operators divide assembly work in a workshop laid out in U shape; circulating system (rabbit-chasing system) in which each of several operators assembles from start to finish without dividing processes, while walking from a process to process; and one-man completing type system where there is only a single operator who assembles from start to finish (See Fig. 1). Unique names given by different companies, such as 'Clover Line', 'Hanagasa Line', 'Chaku-chaku Line', and 'Hitori Kanketsu Yatai (lit. One-man Completion Booth) further complicate the definition.

Cell production system is commended as being advantageous, because against the backdrop of accelerated multi-kind small-lot production requirement and intensified competition for cost reduction, it may eliminate setup time losses required in changing models typically experienced by conveyor lines, and may respond quickly to and inexpensively to volume fluctuations. It should be noted, however, that enjoying such

advantages requires several important premises. The following section deals with some viewpoints to be remembered in understanding cell production system.

5. Viewpoints of Understanding Cell Production System

Viewpoint 1: Validity of Comparison with Conveyor Line in Terms of Productivity

We come across many articles which advocate that introducing cell production system drastically improves productivity. Moreover, it is understood to enhance workers' morale comparing with those who take charge of only part of a process along conveyor lines, because a few (or even only one in extreme cases) finish up a product. It should be remembered, however, that with a one-man completion type system, there are some constraints, such as, naturally, the maximum number of part items one can handle, and skills required for assembling all the parts. Should a company choose to keep many skilled operators on the payroll, the total labor cost will rise, contrary to the aforementioned management needs, i.e. cost reduction.

Nevertheless, the system may be appealing if the system boosts up productivity well beyond the level of a conveyor line. It is necessary, though, to think about the reason why productivity increases. Content of work essential in assembling a product does not decrease even if the production method is changed. Therefore, a secret of improving productivity should be in reducing wastes and losses of operations. Removing 'balance losses' and 'setup losses' is generally claimed to be an advantage of shifting to the cell production system.

A careful examination, however, discloses some doubts. The situation resembles the case of outsourcing operations without improving how the work is carried out and then evaluating that their cost has been reduced. If a conveyor line is inefficient with a lot of balance losses, such situation should be improved before it is compared with a better (or so considered) production method. The same thing applies to setup losses; the situation should be improved to the extent technically and financially possible before considering advantages of shifting to the cell production system. Of course, should the decision be made to shift to the cell production system after thoroughly improving on the existing conveyor line, it would be essential to explain the reason of the shift and its aim to the management for approval. An important point here is that people involved in the

improvement may learn from the process and acquire and share know-how which otherwise is not possible. Such an experience and knowledge can never be acquired through copying or hearing from other people's experiences. Comparing the cell production system against a conveyor line with a lot of inherent wastes and losses is meaningless both in terms of equity of appraisal and negligence of improvement. An attitude of making light of or avoiding such improvement behind the recent boom of cell production, if any, should be strongly criticized.

Viewpoint 2: Capability to Cope with Volume Fluctuation as a Total System

Being able to respond flexibly to fluctuation of volume is often raised as an advantage of the cell production system. It should be pointed out, however, that it is necessary to consider the fluctuation by separating that of total volume for all the models and that in the model mix. While the latter can be coped with by changing the allocation of operators between model-wise cell lines, the former cannot be coped unless the production capacity is changed by increasing or decreasing the total number of operators, and so strictly speaking, it is not a unique advantage of cell production system.

It is necessary to satisfy several prerequisites in order for the cell production system to provide the capability of responding to variations in volume. First of all, because worker allocation has to be changed corresponding to fluctuation, developing multi-skilled workers who are able to produce many different models is essential. At the same time, since it would be necessary for changing worker allocation from one process (or one product) to the other between, let's say, the morning and the afternoon of a day, getting understanding and cooperation of the workers for such changes would be another important requirement. Consideration should be given to an issue of stress of workers resulting from frequent allocation changes.

Furthermore, for fine adjustment of production volume to be managerially meaningful, levels of finished product inventories (inventories at a factory, in distribution process, and at sales offices) should be sufficiently low, and at the same time, a system should be established where sales trend information is communicated real-time to the production floor so that the production plan may be changed according to the actual demand. Adjusting production volume aiming at inventory reduction only in the closed world of a

factory without effectively working on inventory in the distribution process would not produce a substantial result in the total production system. The same thing applies to the procurement of raw materials. In order for fine-tuning production volume with cell lines, it is essential that the system is there for the raw materials to be procured accordingly. Where raw materials inventory is overflowing, fine adjustment of production volume would only achieve partial optimum.

To summarize, in discussing capability of responding to volume fluctuations, it is vital to look at the total supply process, from materials procurement, distribution and sales of products, including procurement management and production planning systems. Although the importance of linking improvement activities of production department and other upstream and downstream departments has been stressed repeatedly in the discussions of SCM (Supply Chain Management), there are quite limited cases where improvement is carried out in the synchronized way. Even though adopting cell production may improve capability to cope with fluctuating volumes, capability as a total system would remain low if processes before or after the production process have limited capability or if inventory is overflowing before or after the production process. It is vital to keep in mind that it is only when improvement of the entire supply process is carried out along with the introduction of the cell production system that the system may produce appreciable results.

Viewpoint 3: Importance of Means and Hidden Technical Issues

Many cell production processes are arranged in the letter U shape to minimize movement of operating workers, who produce products one by one within a given cycle time. There, an emphasis is placed on keeping the cycle time and raising the operators' utilization ratio. As a result, processing time on a machine is naturally much shorter than the cycle time, causing work-in-process to wait on machines frequently.

Generally, output of production processes is products. Operators, equipment, jigs and tools play the role of a means to apply power or hold the posture in the process of converting raw materials into products. Even if utilization ratio of the means is high, if there is a long waiting time in the transformation process from raw materials into products, production lead time will become long. Veteran operators' hands move skillfully

in the production process. Let's assume we can erase their hands (make them transparent), then we will see in the production process parts moving up and down, rotating, or stopping in the air. A process which depends only on the operators' skillful motions without improving on such part movements and stopping cannot be called a well designed process. Thinking along this line, one may realize that part ejecting units often employed in cell production processes are a mechanism which disorganize directions of parts already arranged in a single arrayed direction. 'Chaku-chaku Line', in which operators set parts on equipment and jigs/tools, can hardly be called a sophisticated process design because parts directions are changed and moved up and down frequently.

When production style is changed from process division type to cell production, parts and tools must be put in a limited space, and as a result, areas to be improved technically, such as commonization and unitization of parts, and tool standardization, would be surfaced. Also because machines are to be installed in-line, modifying them into more compact and cheaper ones would become necessary. As such, cell production system can be a means to make areas for improvement apparent, and so it provides an opportunity to design an efficient production process, which consists of only necessary operations for transformation to produce products, while tackling such challenges. Taking up such challenges requires time and energy. Therefore, introduction of cell production aiming at short-term efficiency improvement would let the good opportunity for process improvement be missed, and make technical issues which can be surfaced become hidden. Production engineers should consider introduction of cell production system as a means to make further improvements, and such an attitude of considering the introduction of the system to be a goal should be cautioned.

Viewpoint 4: Danger of Hasty Introduction of Cell Production System

Many companies are found to have introduced cell production system by the words from their consultants who suggested to 'remove conveyor lines'. It is somewhat understandable that consultants make such decisions hastily, considering their position of having to produce some results during a given contracted period. Ideally, however, companies should regard consultants as those who give tips, and accumulate human resources and skills for improvement internally. Different companies and factories have different problems and challenges to overcome. Although starting activities from

removing conveyor lines may (appear to) bring change to the workshop and produce results within a short period of time, it can hardly be considered as a contributor to the long-term development of improvement capabilities within the company.

Hastily introducing cell production system would deprive members of the organization of a valuable opportunity of devising good ideas and enjoying the sense of achievement. Hurrying to achieve good results naturally nurtures result-oriented thinking, affecting people's interest in change process. Under such circumstances, those members would lack the leeway of sharing problem consciousness or understanding the necessity of improvement or changes. On the surface, producing short-term results seems important and significant, but in reality, such an action may become an obstacle to continual improvement activities. An organization's problem- solving capability can be born out of long-term, continuous activities and takes root in the corporate culture. Although this view may sound going against the times of increased speed, it is something never to be forgotten from the viewpoint of true corporate competitiveness.

6. Toward Effective Manufacturing Revolution

On the basis of discussions in the previous sections, what are important points to be noted in order to make manufacturing revolution truly effective? What follows is the list of three principles the author considers most important.

Principle 1: Separation of Goals and Means, and Goal Orientation

Both outsourcing and cell production system are means but not goals themselves. As an activity gets started, people tend to turn the activity itself into a goal. It is essential therefore, to keep in mind what the goal of manufacturing revolution is and constantly seeking measures suitable to the goal. What is an important problem for the company? Why is the problem happening? Why can't it be solved? When you keep asking these questions, you may realize that, at some point, a technique which was considered suitable initially has become unnecessary or inappropriate. This is a common experience found these days as information systems are introduced. Although load on systems and data bases may be relieved greatly by improving the information flow in a company, it may choose to invest heavily on the most sophisticated and up-to-date information system. Such examples are too numerous to mention. Conversely, this is why the problem

solving process is interesting and dynamic, and gaining rich experience in problem solving is truly conducive to developing human resources.

An important thing to be remembered in thinking about goals is that they are hierarchical. There are different levels of goal: a goal is a means to achieve a higher goal, above which, in turn, there is even a higher goal. Generally, a higher goal takes longer time to achieve, but once achieved, the result obtained is significant. When taking goal-oriented approach, setting only an easy goal to achieve in short period of time is questionable. An important point of production revolution is to have a positive attitude to tackle a challenging and long-term goal fundamentally related to the culture of the company or department in question.

Principle 2: Improvement Activity before Introducing a New Method

A mistaken idea about manufacturing revolution which is often observed is that introducing some method would immediately solve problems, such as, outsourcing would reduce cost, and introducing cell production system would increase productivity. As in the above-mentioned goal orientation, to what extent the operations can be improved before opting for outsourcing or cell production is a key point in implementing manufacturing revolution.

What you should at first, for instance, is to reduce balance loss of a conveyor line and improve setup operation thoroughly. When the conveyor line is improved to a limit, or when conveyor line's problems become clear, then you may go ahead and introduce cell production. Taking this approach may make the effects of productivity improvement through manufacturing revolution look smaller. Although it may obscure the distinction between the daily improvement and manufacturing revolution activities, this in fact is a key. Trying to reduce cost by outsourcing operations full of wastes, or comparing a conveyor line with large balance losses with cell production system is a false idea overemphasizing methodology. How well can the management leading their manufacturing revolution activity understand the importance of, and implement steadily, daily efforts to improve operations will make a difference in the long run. The result of each improvement project may be small. However, when such efforts are accumulated, they will make an outstanding difference between companies where such activity is

routinely carried out and those where it is not.

Principle 3: Down-to-earth Thinking not Easily Tempted by Fashion

In the current world, where economic recession is protracted, information system prices are getting cheaper and IT is rapidly advancing, packages to support management innovation are overflowing, and books with titles of new management innovation methods are piled up in book stores. Many of them, however, come into fashion with an amazing speed and give way to other packages and methods one after another. While, unavoidably, cycles of fashion are becoming shorter in the current age of information and speed, it is important that truly valuable ideas should be accepted widely and for a long time. Unfortunately, study of existing literature on management innovation shows that most of them simply sort out and classify existing methodologies and theories.

If people leading manufacturing revolution try to follow the fashion, they will not only drift away from goal-oriented thinking, but will have to keep changing the focus of activities. As a natural course of event, their interest in daily improvement activity will keep fading away. As it has been described in this paper, making manufacturing revolution truly effective requires supporting and conducting improvement activities on a long-term basis, without seeking short-term results. Once leaders show that they are after methodology in fashion, the whole company will develop culture to be influenced by fashion. And once settled in a hierarchical organization, such culture is hard to change. In conclusion, the most important point about manufacturing revolution, which is easier said than done, is to clearly define your own company's problems and directions, and to keep firm and leave some leeway for coolly evaluating concepts in fashion, without easily influenced by information flooding in the society.

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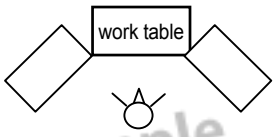
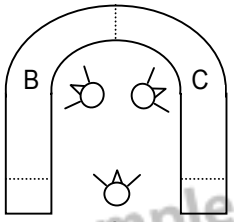
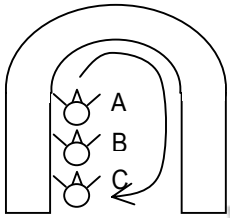
Postscript

This paper has been written by the author by modifying and adding to his earlier article titled 'Formula for Success in Production Workshop Innovation is Steady Improvement' carried in the 'Blind Spot of Manufacturing Revolution Boom' of Weekly Economist dated May 15, 2001.

Fig. 1　Three Cell Production Types

	One-man completion Type	Division type	Circulating type
Formation			 Each operator works on every process
No. of operators	One	A few	A few
Division of work	No division (One man completes every process)	Processes are divided	No division
Layout	No restriction except work table is at the center	U-shaped in principle	U-shaped in principle to return to the first process
Production lot size	One-piece production in principle, but other variations possible	One-piece production in principle, but buffer can be made between operators	Repetition of one-piece production
Coping with volume fluctuation	Cope by number of booths (Change process division)	Adjust number of operators	Adjust number of operators (If many operators, problem of over-taking happens)